



Distributed Decision Support Services & Knowledge Management Repository (KMR-II)

A Knowledge Management Architecture For Healthcare

**Naval Health Research Center
San Diego, CA**

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Disclaimer

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Cognitive Environment

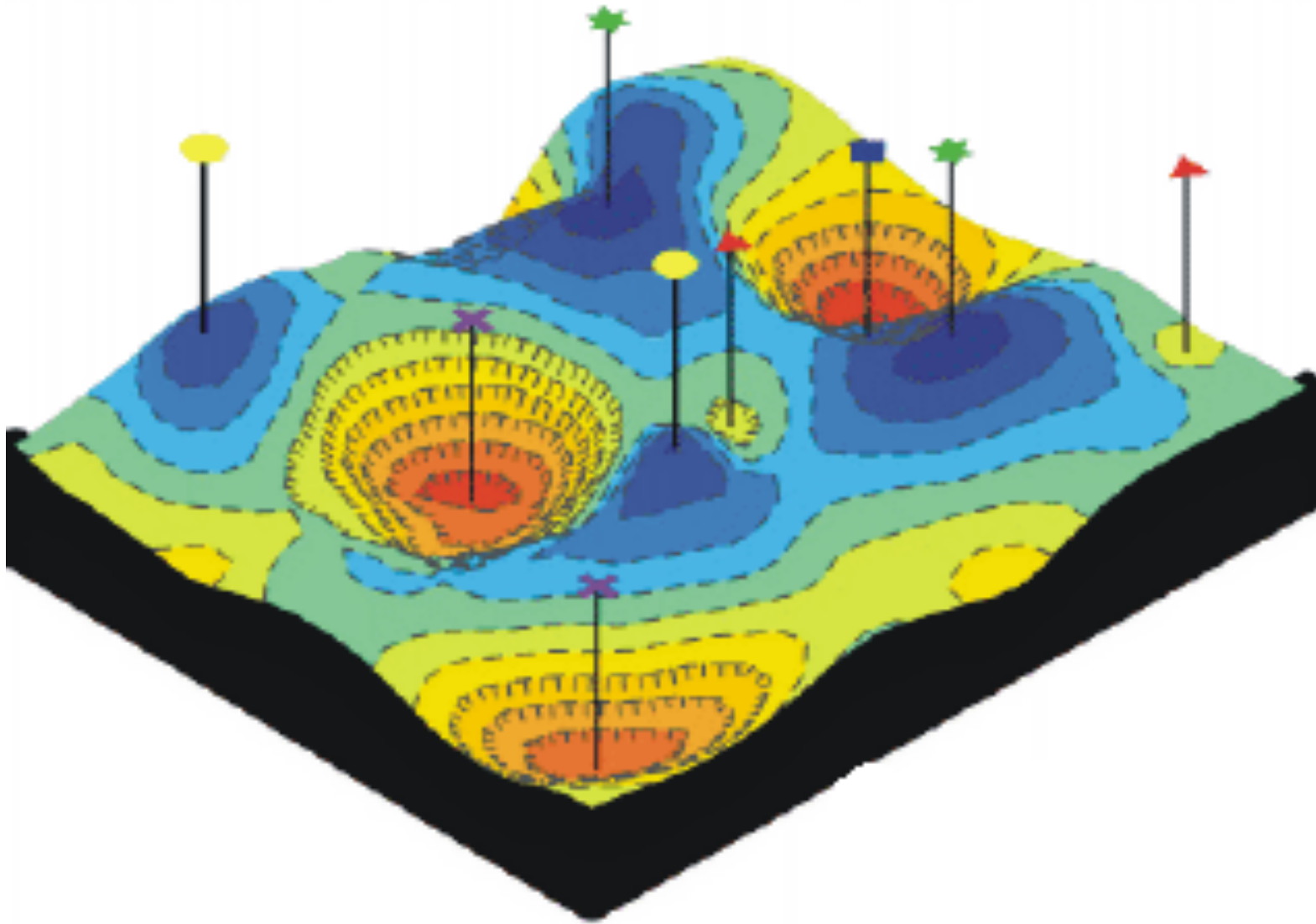
Healthcare is a knowledge management challenge

- Data / information
- Regulations
- Process orchestration
- Individualized care
- Education
- Access to care
- Patient-empowerment

- “Cognitive” technologies must integrate and support all these dimensions if quality care and desired behavior is to be achieved



Behavioral Entropy





Will It Improve Outcomes?





They Earned It





They Deserve It

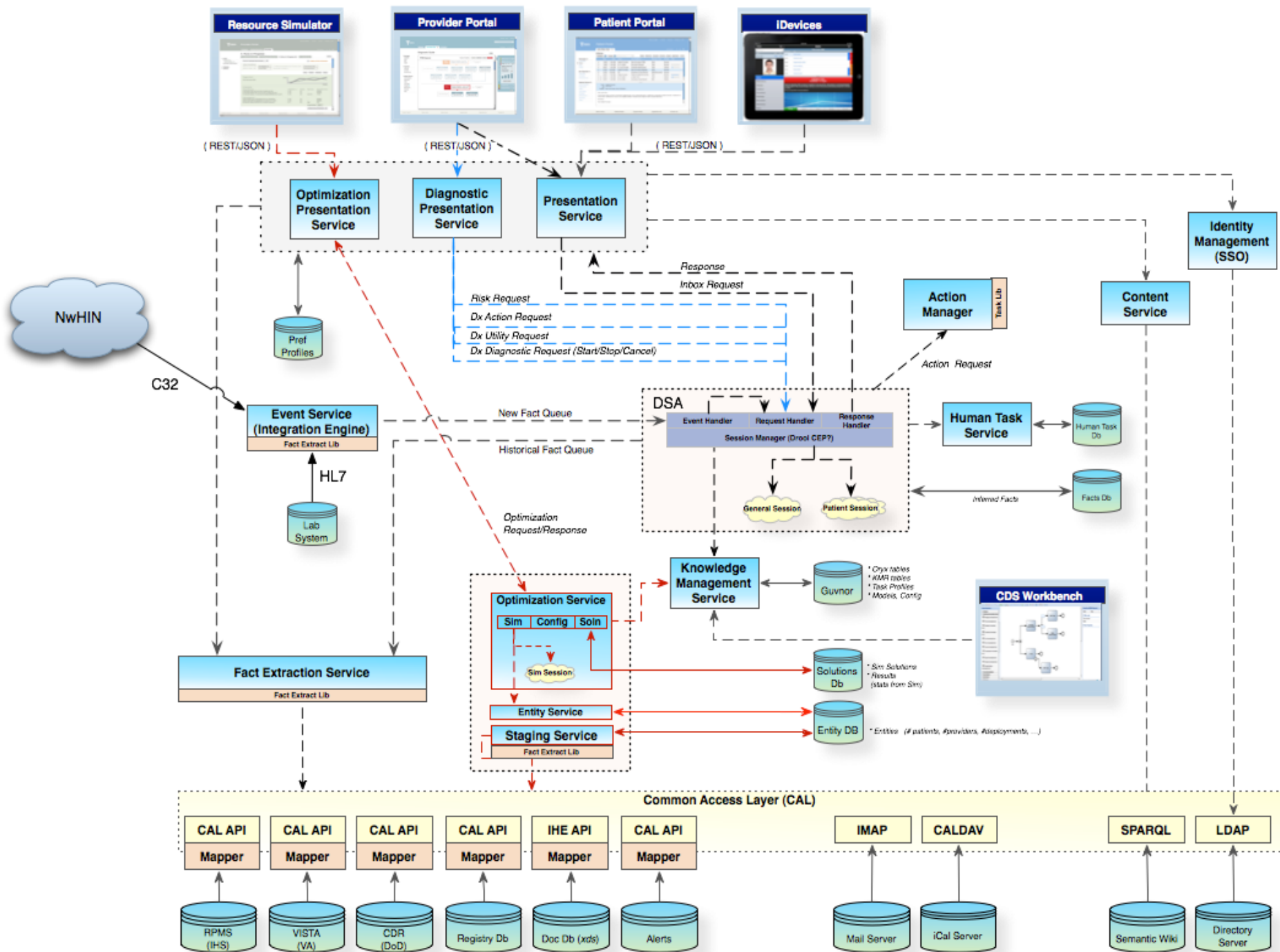


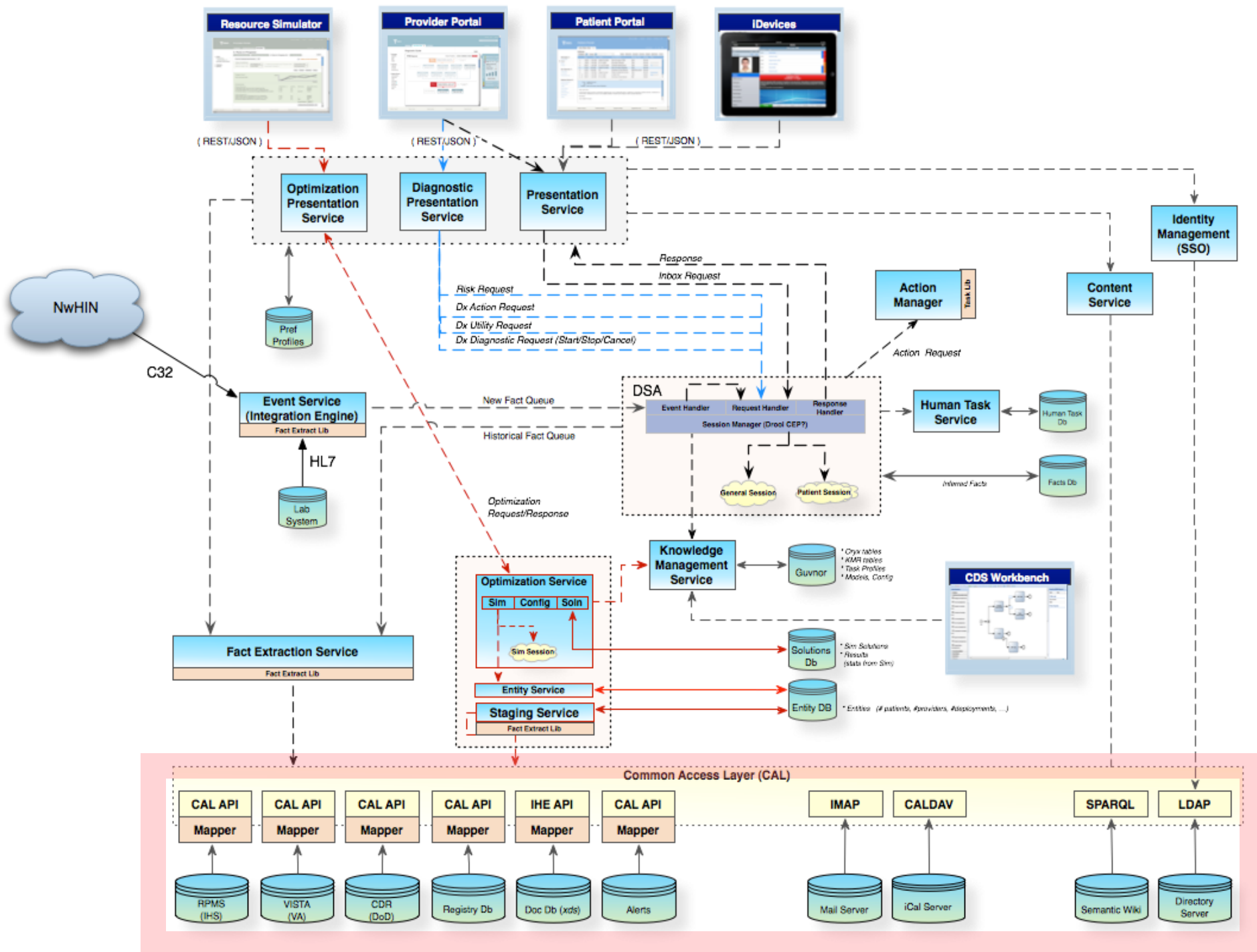


DDSS-KMR Objectives

US Navy research effort to create a reference
KNOWLEDGE MANAGEMENT architecture

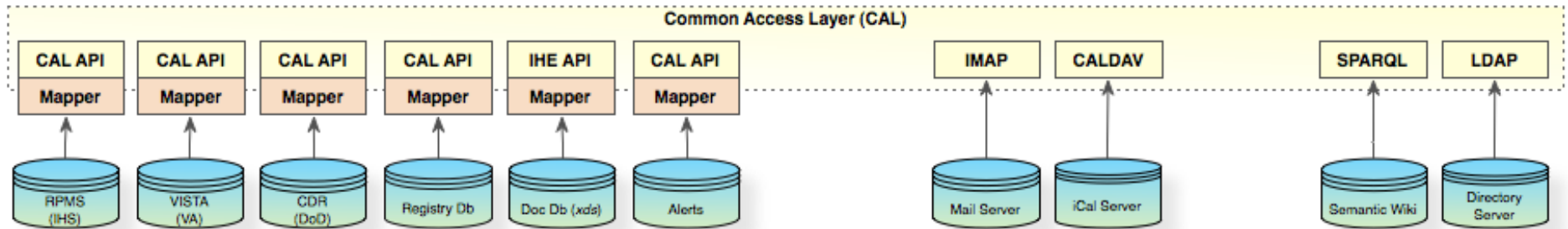
- System should be able to provide “real-time” analysis
- System knowledge modules should be sharable between systems and organizations
- System should be able to request, receive, and process distributed data
- System should be able to leverage different inference capabilities as appropriate
- System should support generalized decision support for populations AND rules individualized for a specific patient

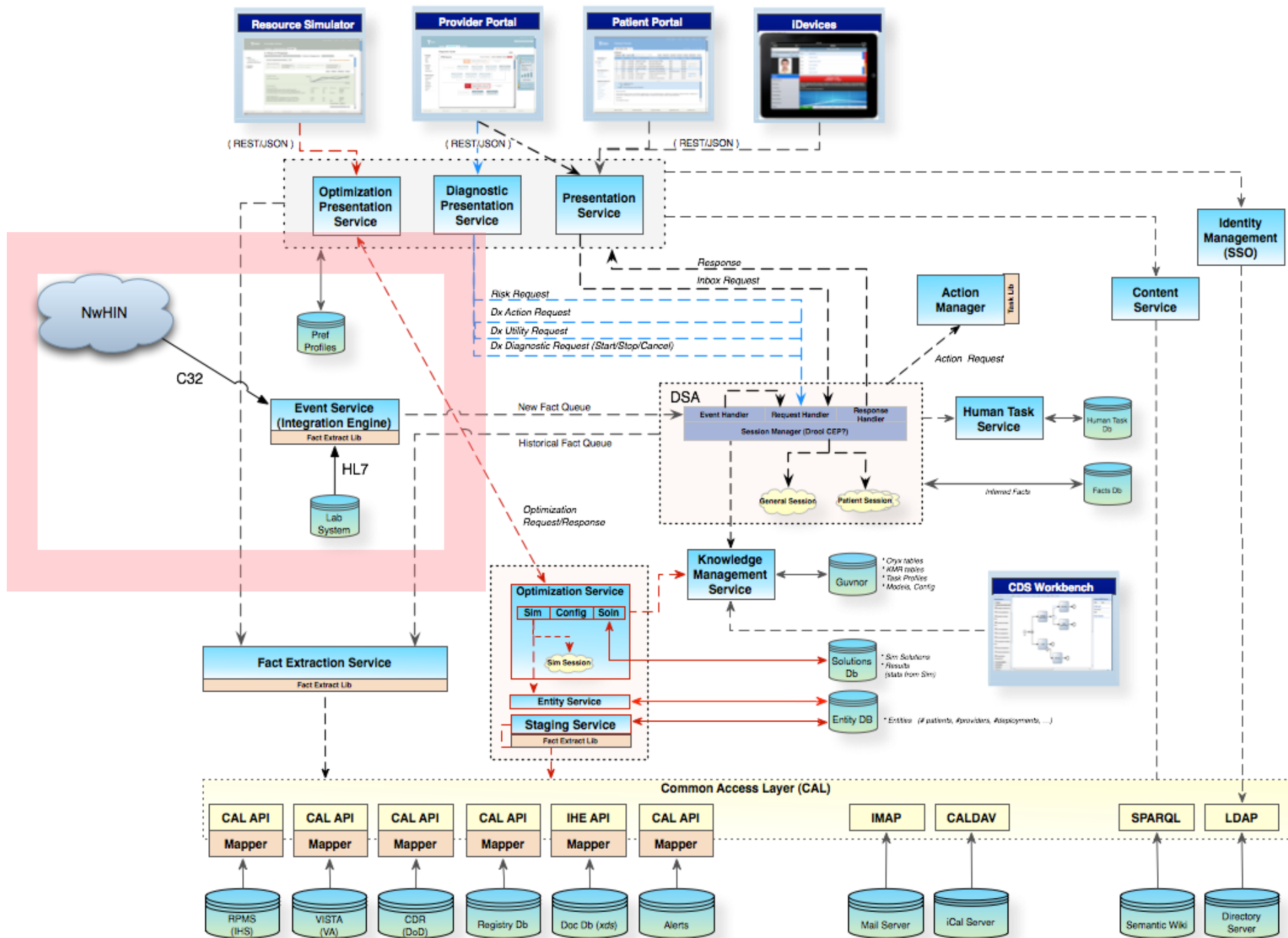






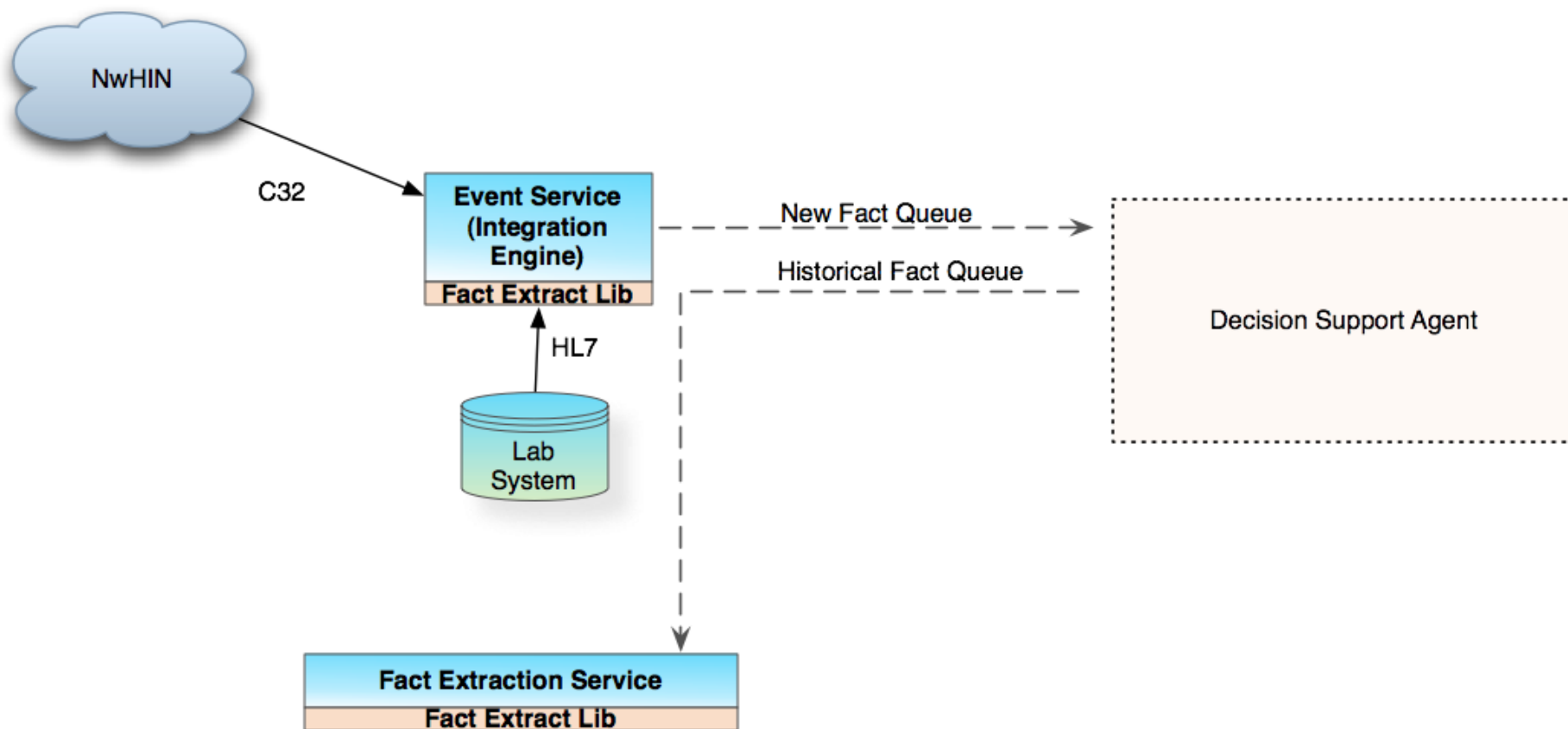
Common Access Layer (CAL)

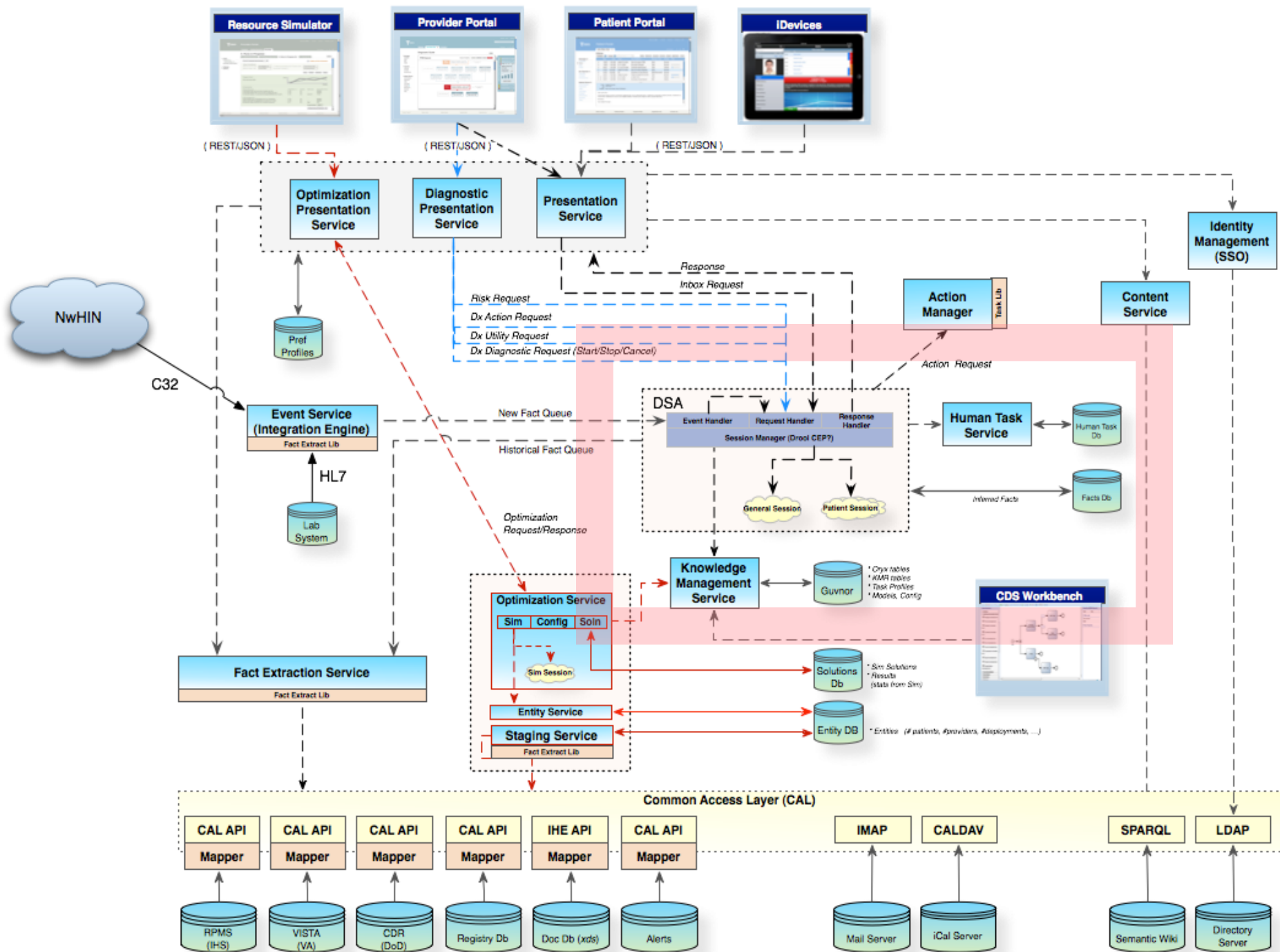






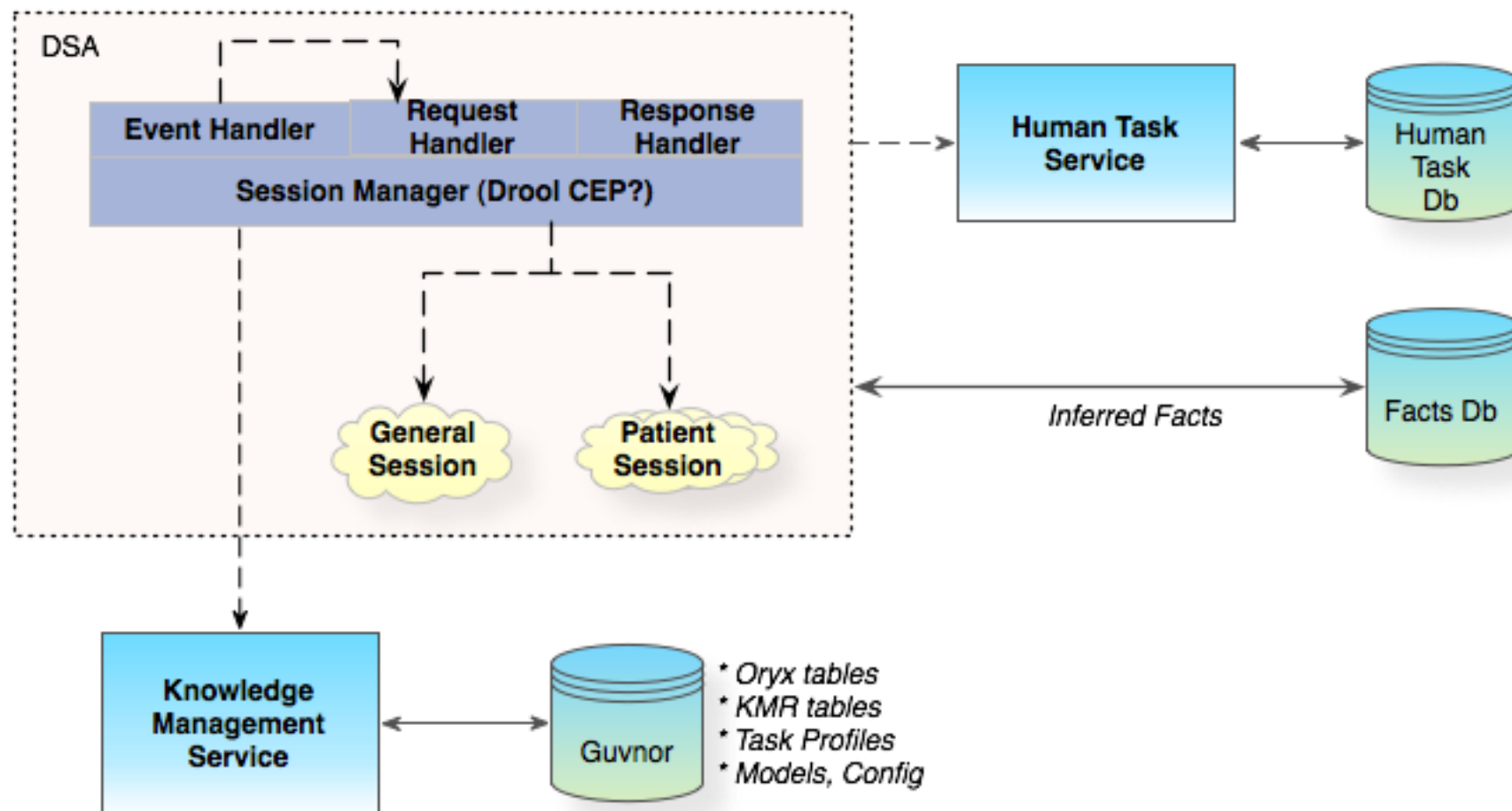
Event Service





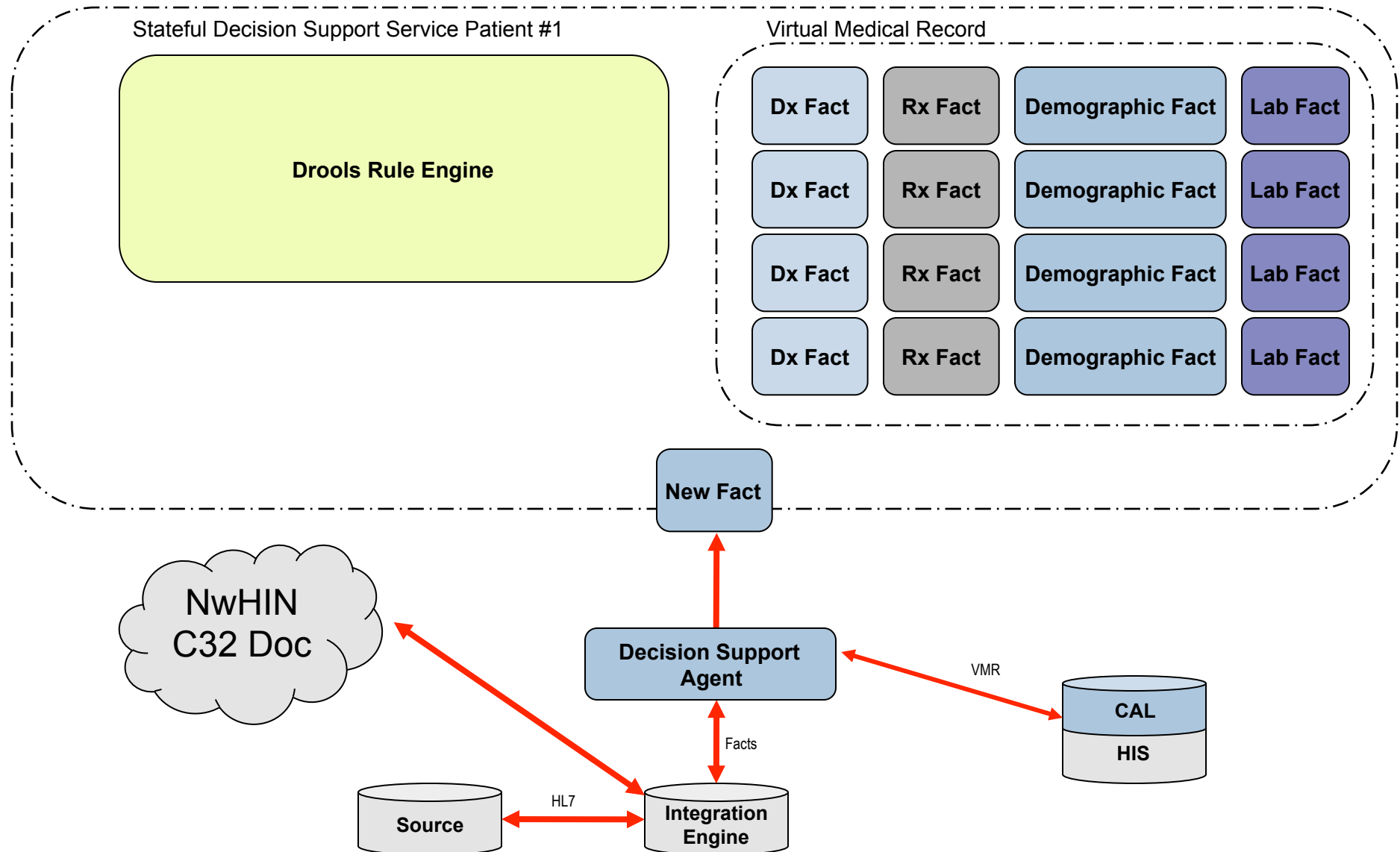


Decision Support Agent (DSA)



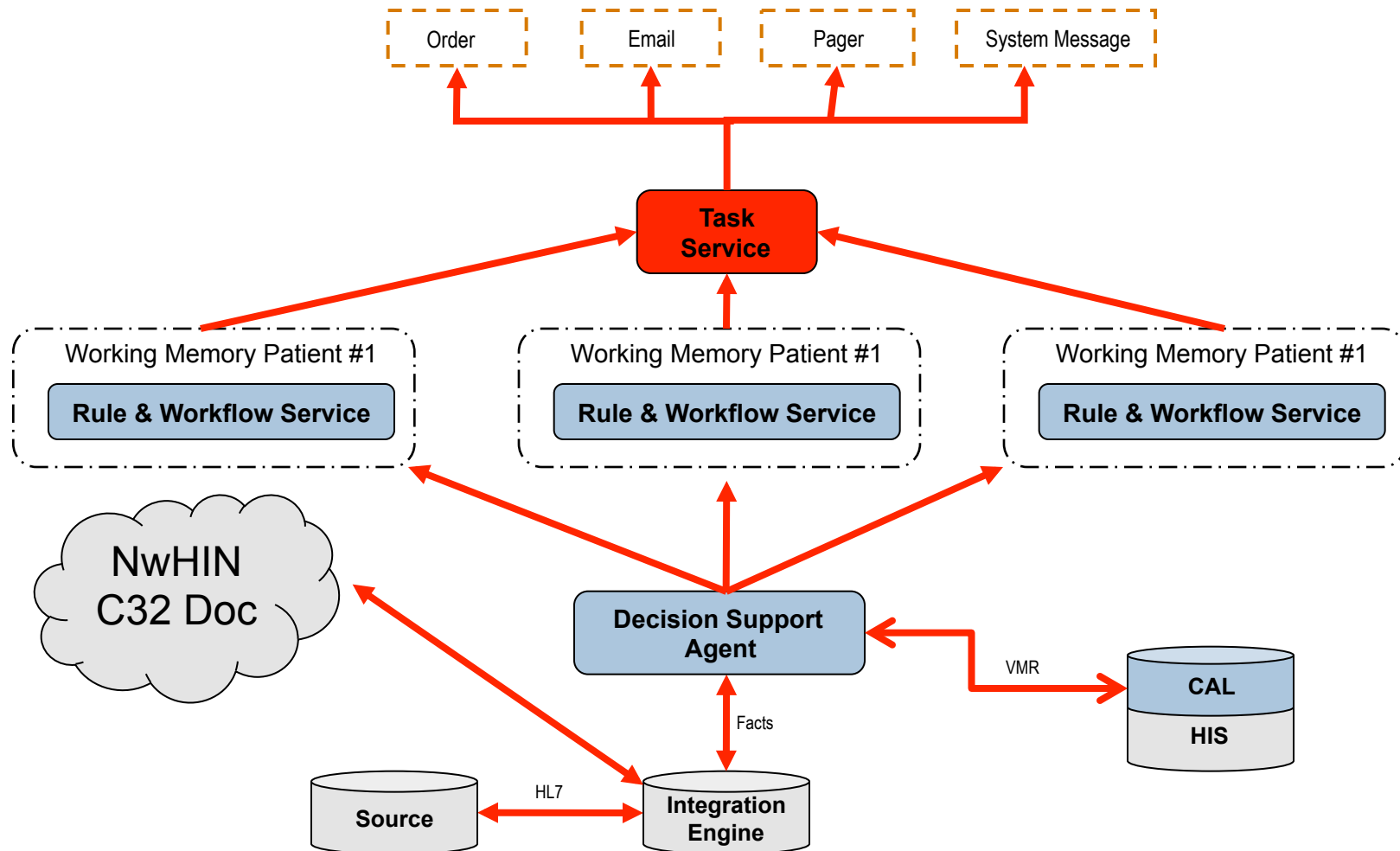


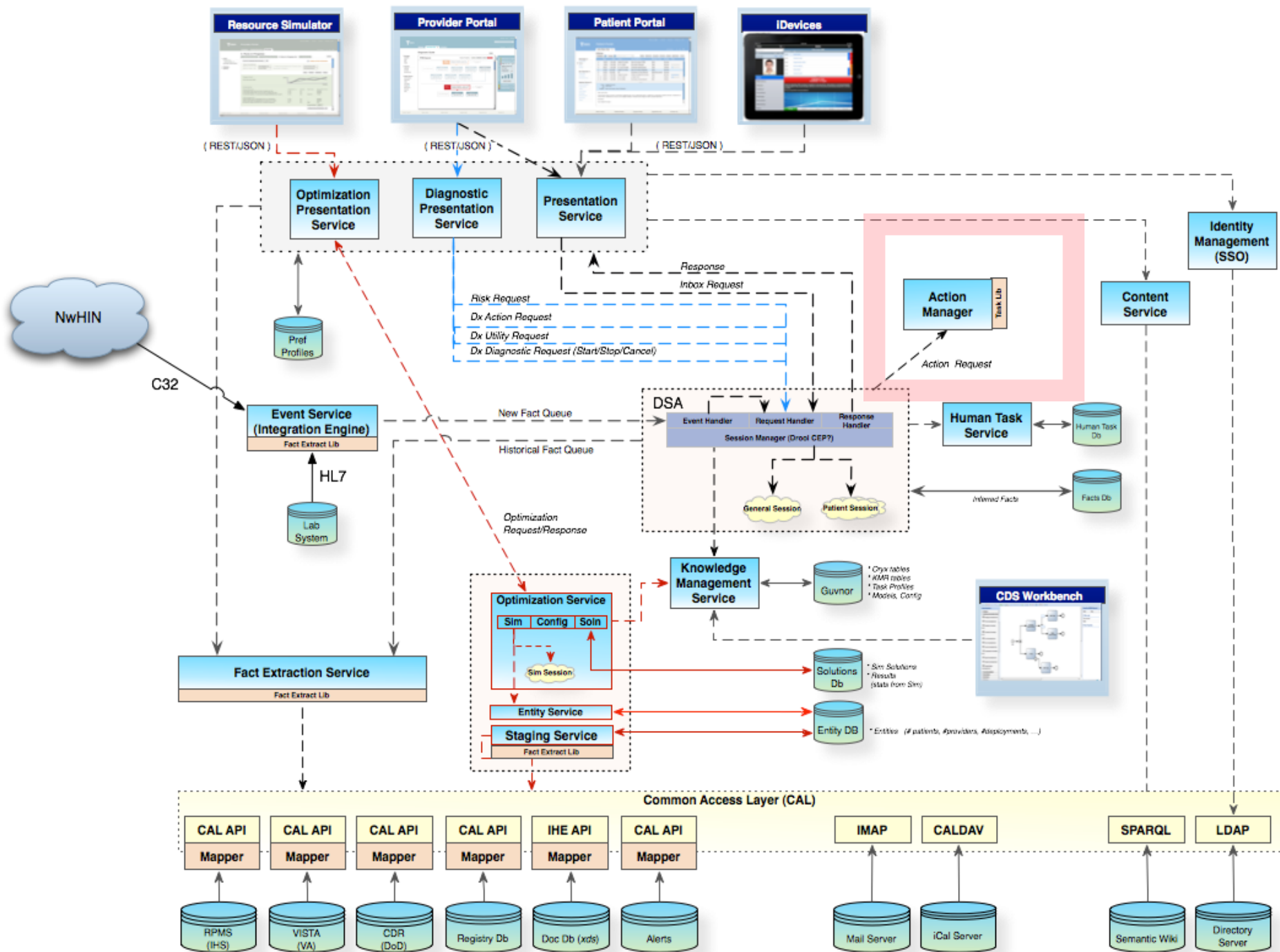
Session Virtual Medical Record





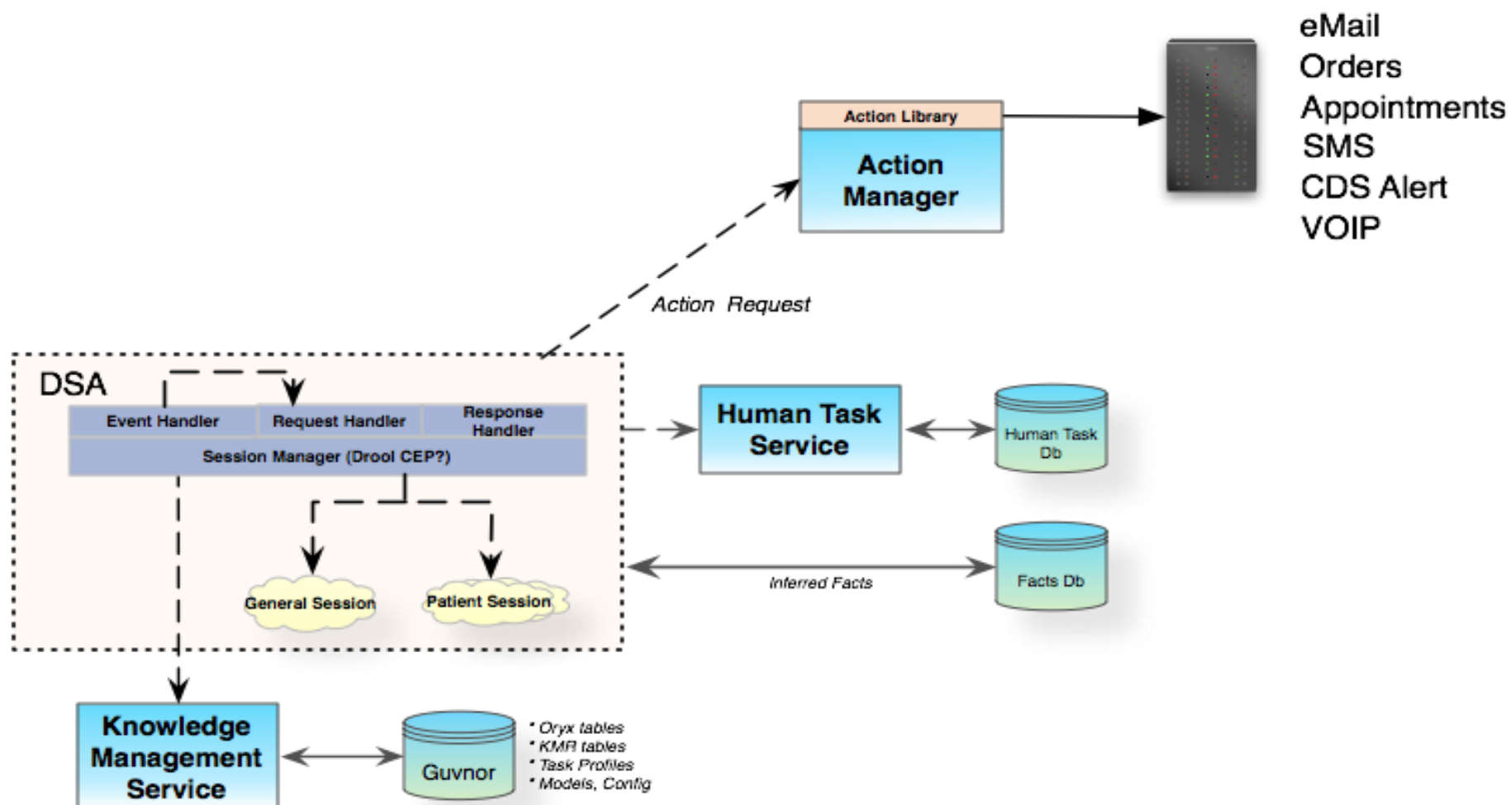
Individualized Stateful Rule Sessions

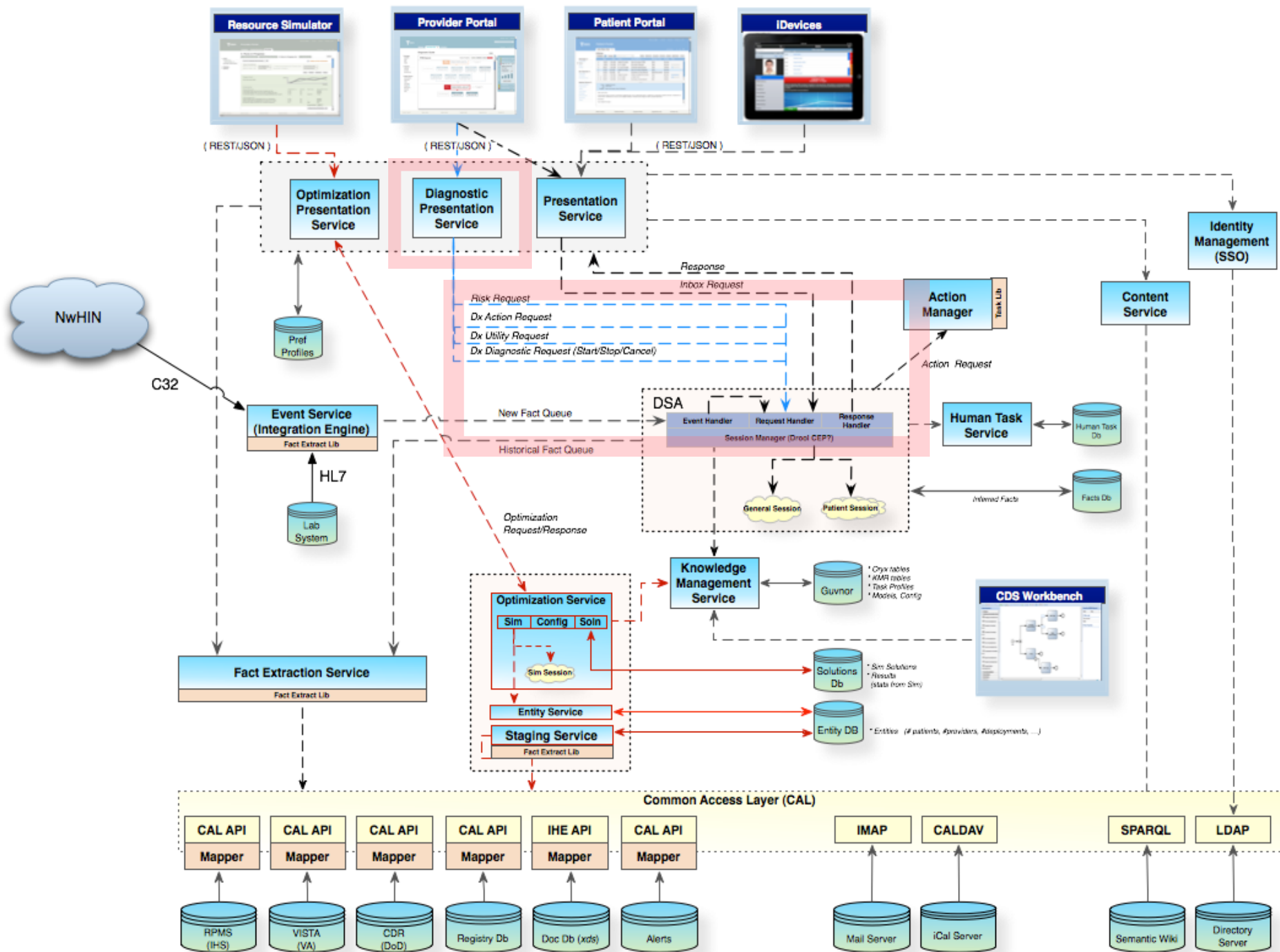






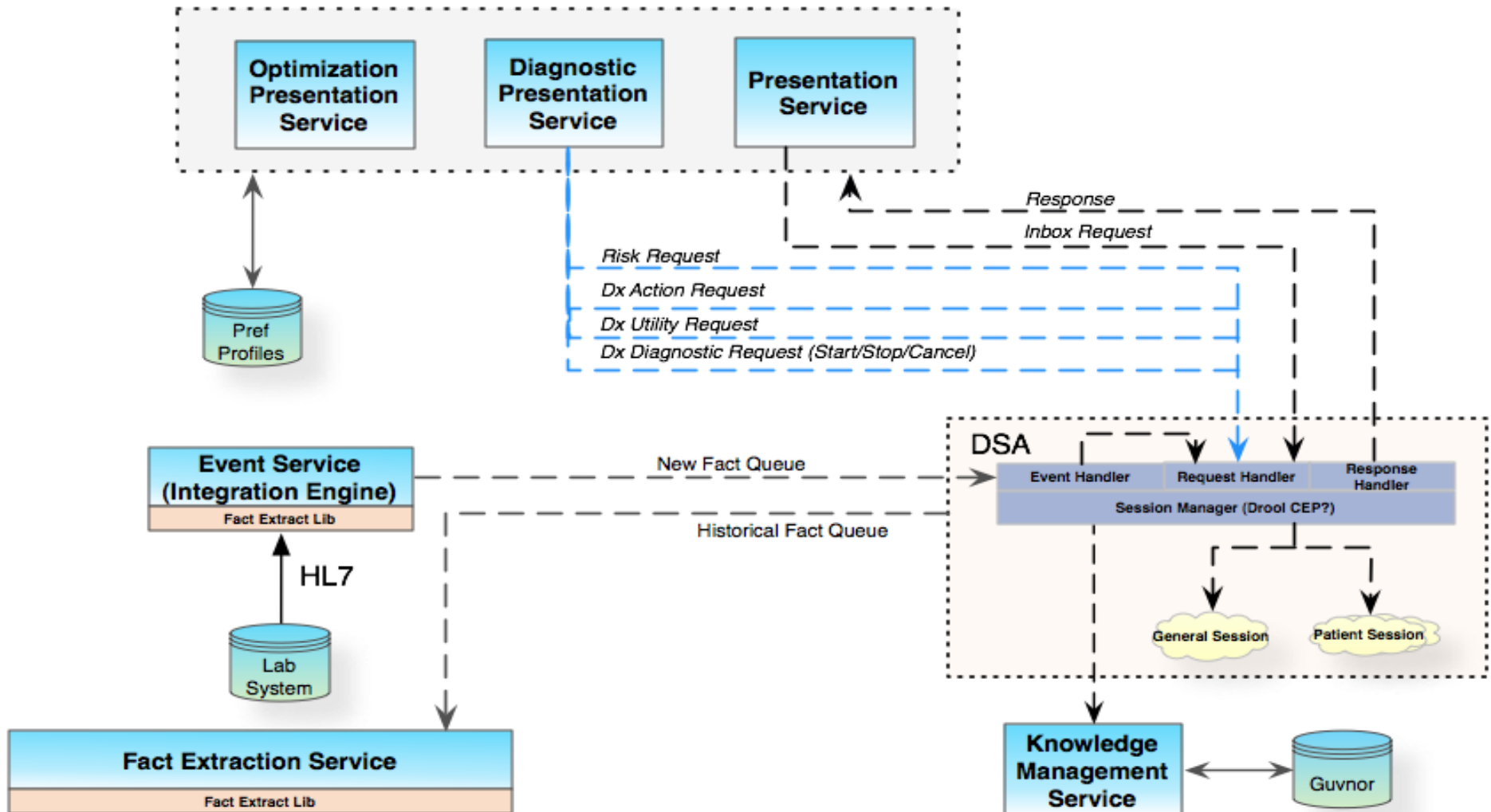
Action Manager

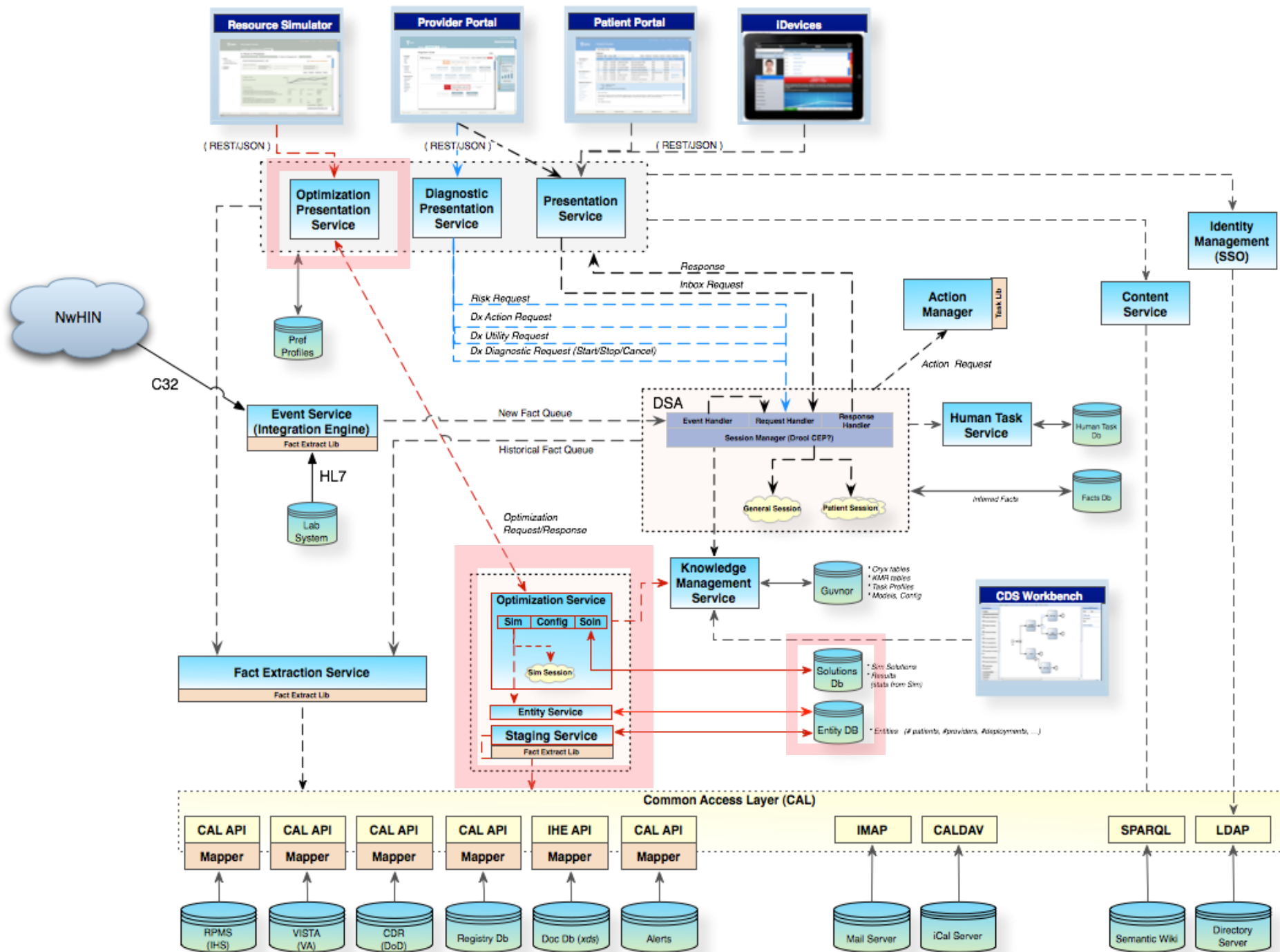






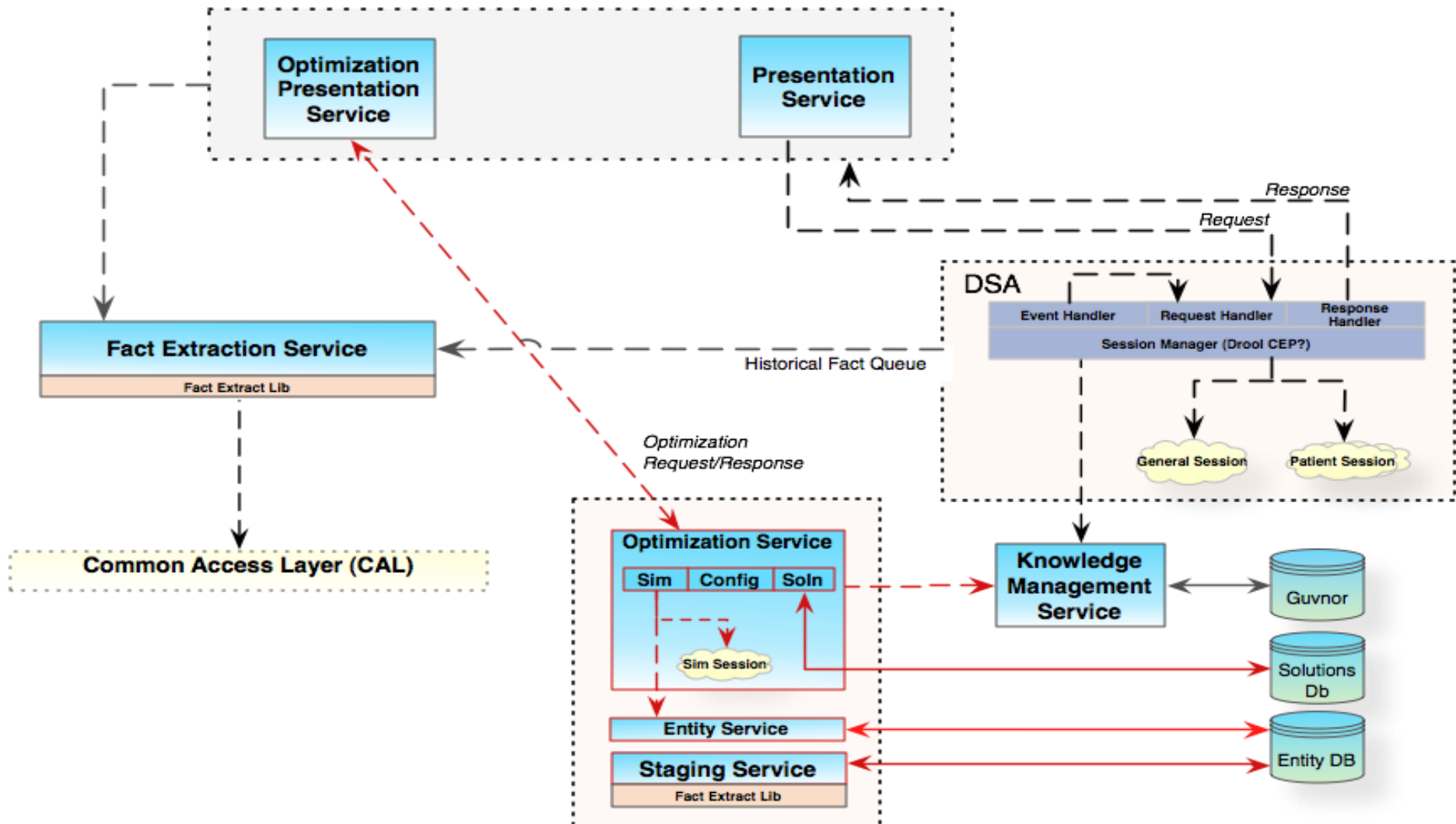
Predictive / Diagnostic Services

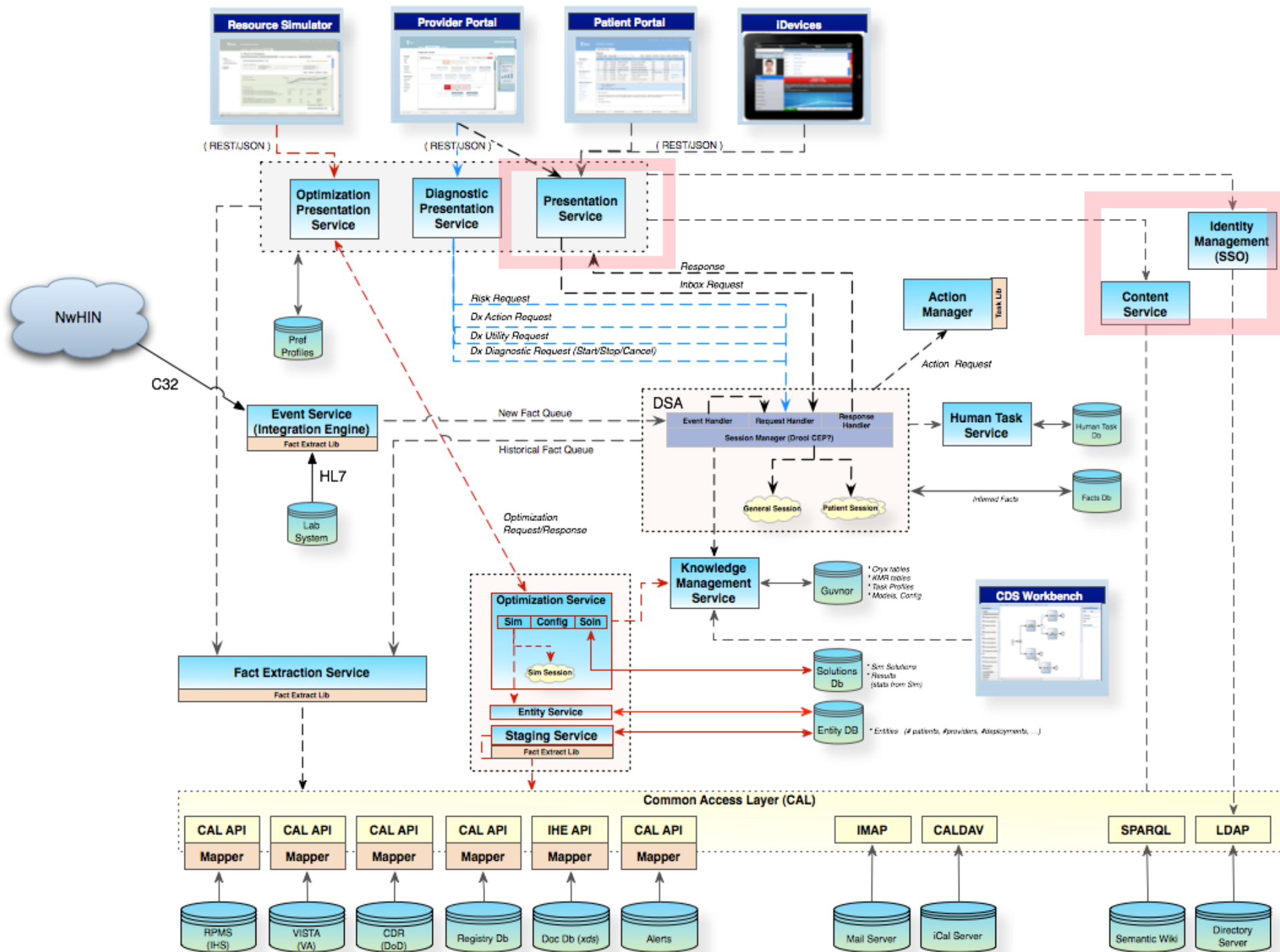






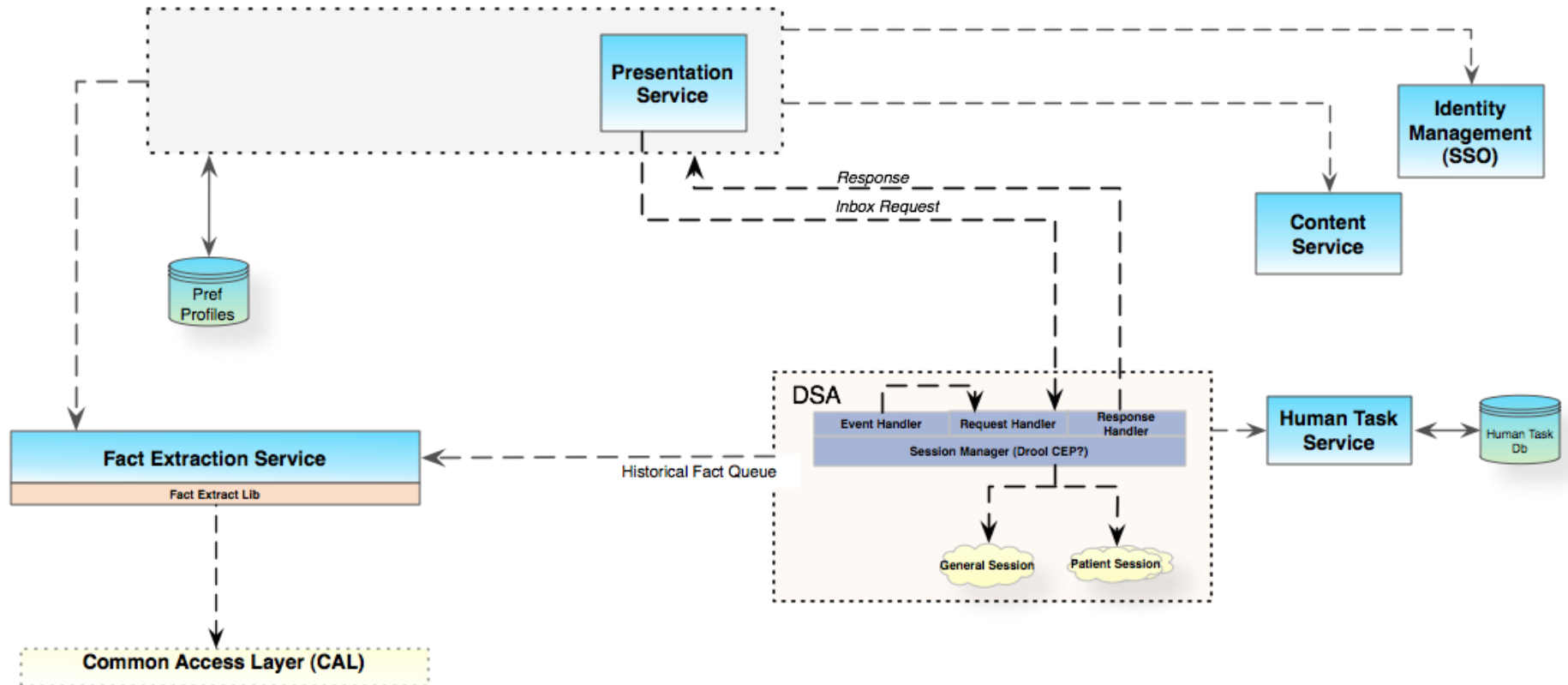
Optimization Service





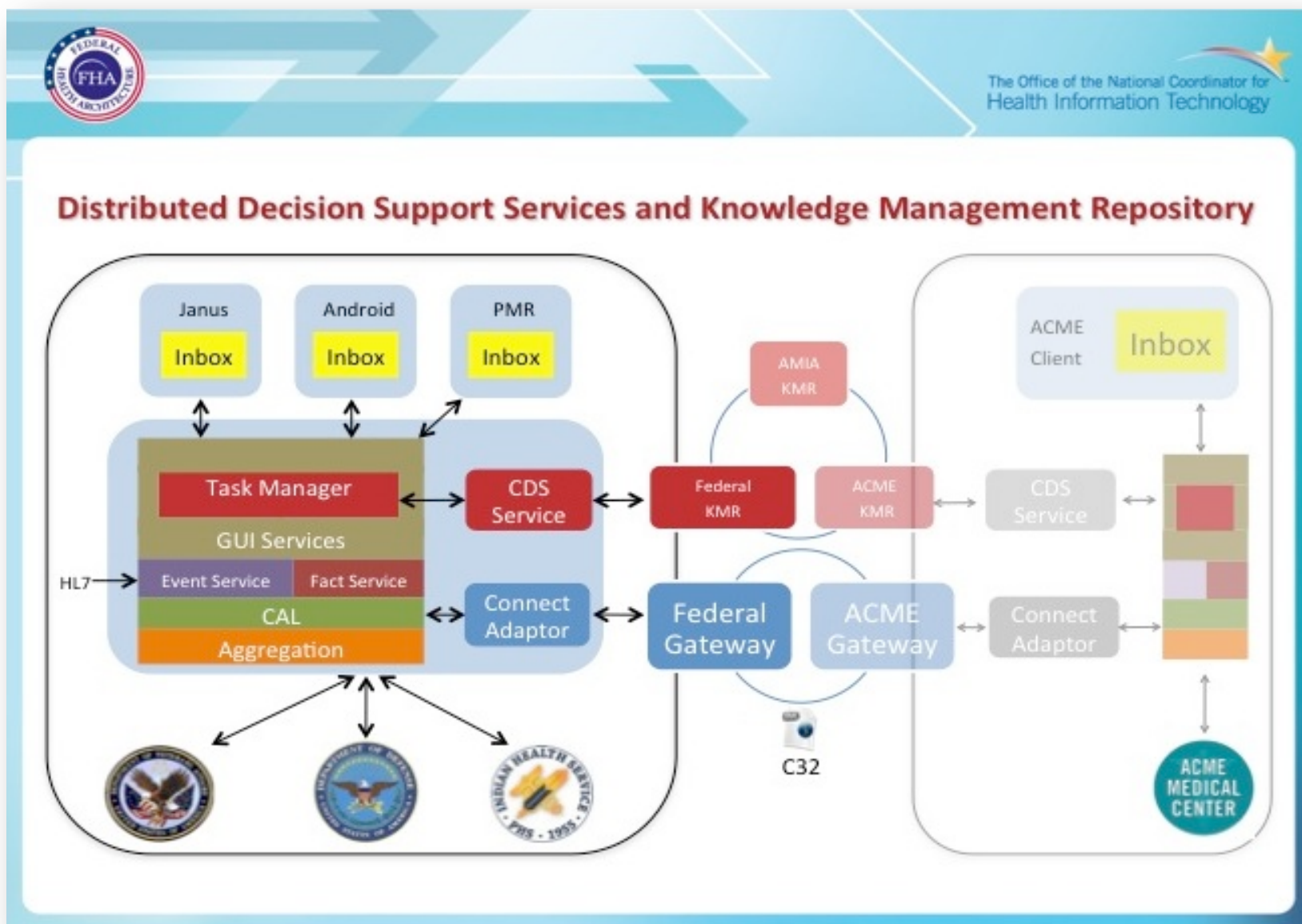


Presentation Service





HIMSS Demonstration





Unified Clinical Portal



Medical Records Online

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vivamus vel ipsum quam, vitae
posuere tellus etiam bibendum.

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Patient Perspective

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Jane Mary Doe

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Date	Time	From	Title (Subject?)	Message Type	Priority	Task
☐	1/02/11	11:05 AM	Health Provider	New info about PTSD	Alert	Normal
☐	1/02/11	11:05 AM	Dr. K. Smith	Document Request	Task	Normal
☐	1/02/11	11:05 AM	Dr. Joe Provider	Schedule Appointment	Task	Critical
☐	1/18/11	9:35 AM	Health Provider	Annual Flu Vaccination	Alert	Normal
☐	1/18/11	9:35 AM	VA	Summary of Care Record	NHIN Document	Normal
☐	1/02/11	11:05 AM	Health Provider	Please complete this survey	Task	Normal
☐ ★	1/02/11	11:05 AM	Dr. K. Smith	re HgA1 Due	Task	Critical
☐ ★	1/02/11	11:05 AM	Dr. K. Smith	Summary of Care Record	Mail	Critical

From: Health Provider
To: Jane Doe
CC:
Subject: Annual Flu Vaccination

Dear Jane,
You are due for your annual Hgb A1c and your annual Flu vaccination. Dr. Smith's next available routine appointment is Nov 12, 2011 at 0800. If this appointment is acceptable, please select "ACCEPT" from your choices below you would like to review other alternatives, select "MODIFY" You may also "REJECT" the suggestion and call the clinic appointment line directly if you wish to discuss alternative arrangements. Thank you.

Internal Medicine
ACME Medical Center

Accept Modify Reject

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Provider Perspective



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☐	1/18/11	9:35 AM	Health Provider	Jane Doe / Renal Insufficiency	Alert	Critical	
☐	1/18/11	9:35 AM	VA	Summary of Care Record	NHIN Document	Normal	
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☐ ★	1/02/11	11:05 AM	Dr. K. Smith	Summary of Care Record	Mail	Critical	

...

From: Health Provider
To: Dr. Smith
CC:
Subject: Jane Doe / Renal Insufficiency

Dear Dr. Smith,

Your patient, Jane Doe, is developing renal insufficiency and demonstrates a 25% increase in her creatinine level over the past 24 hours. The patient's creatine clearance is now 30 ml/min and her serum creatine is 1.14 mg/dl. This patient is receiving Gentimcin 1.7 mg/kg/dose IV q8h. It is recommended that you adjust this dosing to 1.2 mg/kg/dose IV q24h. Do you accept this recommendation? If you accept, the order will automatically be placed and electronically signed.

AcceptHoldModifyRejectForward

Clinical Analytics

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Jane Karen Doe

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Order D/T	Medication	Sig	Formulation	Unit	Dose	Route	Frequency	Duration	Quantity	Refills	Prescriber	Order Expir.	Indication	Source
1989-01-15	Amoxicillin		Tablet	500mg	500mg	Oral	Once a Day	Indefinite	30	1/3	Jim Kelly	1989-02-15	Cholesterol	VA
1989-01-16	Zocor		Tablet	200mg	200mg	Oral	Once a Day	Indefinite	30	1/3	Mr. Smith	1989-02-16	Cholesterol	IHS
1989-01-17	Erythromycin		Tablet	300mg	600mg	Oral	Twice a Day	10 days	10	0/2	Mr. Smith	1989-02-17	Otitis Media	Kaiser
1989-01-18	Hydrocortisone		Cream	1%	1%	Topical	PRN	As Needed	20	2/3	Mr. Smith	1989-02-18	Exzema	VA

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Dispensations

Description

Instructions

Indications

Side-Effects

Potential Interactions

Erythromycin

PTSD is a disease that affects your lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean feugiat fermentum nulla, vel luctus lorem lacinia Lorem ipsum dolor sit amet, consectetur adipiscing elit. Donec aliquet molestie sollicitudin. Suspendisse a augue tortor, et ullamcorper magna. Mauris vel erat mauris, ut tempor neque. Aenean sed mi nec enim aliquam lobortis. Suspendisse vel nibh sit amet erat viverra rutrum. In eu hendrerit mauris. Maecenas ac turpis in risus pellentesque porta sed a felis. Nunc pretium erat sed tortor pretium vestibulum. Maecenas a vestibulum libero. In laoreet mi et ligula ornare at fringilla magna sollicitudin.

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Nullam lobortis varius arcu, id tempus nibh euismod a. Curabitur elit quam, vehicula eu tincidunt ut, adipiscing id felis. Nunc nisi nibh, blandit vitae interdum nec, tristique imperdiet mi. Morbi iaculis, neque et imperdiet congue, erat neque venenatis augue, a molestie sem dui eu est. Nullam tempor lobortis magna, quis dapibus diam ullamcorper non. Suspendisse et nunc id mi fermentum vehicula. Nunc luctus, eros vel suscipit volutpat, ipsum ligula vulputate diam, in imperdiet velit dolor ut enim. Ut vehicula ipsum id lorem congue eu dapibus libero aliquam. Praesent metus mi, consequat ut pharetra nec, dignissim at velit. Etiam augue risus, tincidunt at accumsan in, eleifend eget sem. Praesent vel auctor nisl.

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Diagnostic Guide



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Diagnoses

Visits

Vital Signs

Allergies +

Medications

Vaccines

Tests

PTSD Diagnosis

Disease Probability: LOWUNCERTAINHIGHCERTAIN

State 1
Current

Disease Probability: Uncertain (50%)
Confidence Interval: Weak (0.3)

Other Diagnostic Choices

Lower Utility Options

Option 1.1
Ask Alcohol / 0.03

Option 1.2
Test Alcohol / 0.1

Option 1.3 (Recomd)
Deployments / 0.5

Diagnostic Guide: Risk Prediction Drawer

Asthma: 70% +/-5

Diabetes: 77% +/-5

PTSD: 75% +/-20

Additional Input Data

Hx Trauma

Physical Abuse

Deployments 3

Stop Dx Guide

Schizophrenia

Testicular Cancer

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Utility Calculations

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Authorizations

Diagnoses

Visits

Vital Signs

Allergies +

Medications

Vaccines

Tests

PTSD Diagnosis

Disease Probability: LOWUNCERTAINHIGH**CERTAIN**

State 2
Current

Disease Probability: High 72%
Confidence Interval: Strong (0.8)

Other Diagnostic Choices

Lower Utility Options

Option 2.1
Ask Alcohol / 0.23

Option 2.2
Test Alcohol / 0.33

Option 2.3
Psych Visit / 0.75

Option 2.4
Psych Visit / 0.85

Completed 11/25/11 8:30am

Completed 11/25/11 9:30am

Completed 11/25/11 9:30am

Completed 11/25/11 10:30am

LU Option 2.1
Ask This / 0.2

LU Option 2.2
Ask That / 0.2

LU Option 2.3
Ask This / 0.2

Completed 11/25/11 9:30am

Completed 11/25/11 9:35am

Completed 11/25/11 11:30am

State 3
Current

Disease Probability: Certain 100%
Confidence Interval: Strong (0.8)

Other Diagnostic Choices

Lower Utility Options

Option 3.1
Psych Visit / 0.85

Option 3.2
Psych Visit / 0.95

Diagnostic Guide: Risk Prediction Drawer

Asthma: 70% +/-5

Diabetes: 77% +/-5

PTSD: 75% +/-20

Additional Input Data

Hx Trauma

Physical Abuse

Deployments 3

Stop Dx Guide

Schizophrenia

Testicular Cancer

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Resource Capacity Simulator

 **Provider Portal**

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3. Runs in Progress

1. Model Description | 2. Configure New Run | **3. Runs In Progress (3)** | 4. Results (0) | [Print](#)

▼ PTSD

Scheduling

Optimization →

Specialty Optimization

► Diabetes

► Asthma

Run #14 Expected Case Scenario

 **SIMULATION RUNNING**

Stop Conditions

Maximum Time (s): 600 | **Time Elapsed: 45** | % of Maximal Achievable Score Threshold: >95% | **Current Score: 85%**

Maximum Steps: 1500 | **Current Step:** | Improvement Threshold: < | **Last Improvement:**

[Run](#) | [Pause](#) | [Resume](#) | [Stop](#)

Toggle Chart

This is the score chart.



Constraints

General Resource	# Violations / #	Penalty	Relevance	Score /Max Score
An MD MUST NOT visit more than 5 patients per day	0 / 25	0.0	-	250/250
A Psychiatrist MUST NOT visit more than 2 patients per day	0 / 30	0.0	-	300/300
For security reasons, no more than 25 people SHOULD be in a room	4 / 10	2.6	Low (x1)	7.4/10
PTSD Package #B1 —				
Patients MUST have a psychiatrist visit if on medications	0 / 50	0.0	-	500/500
Patient visits MUST be separated by a minimum of 1 week	0 / 50	0.0	-	500/500
Educational classes SHOULD be in preferred sequence	5 / 5	5.0	High	0/25

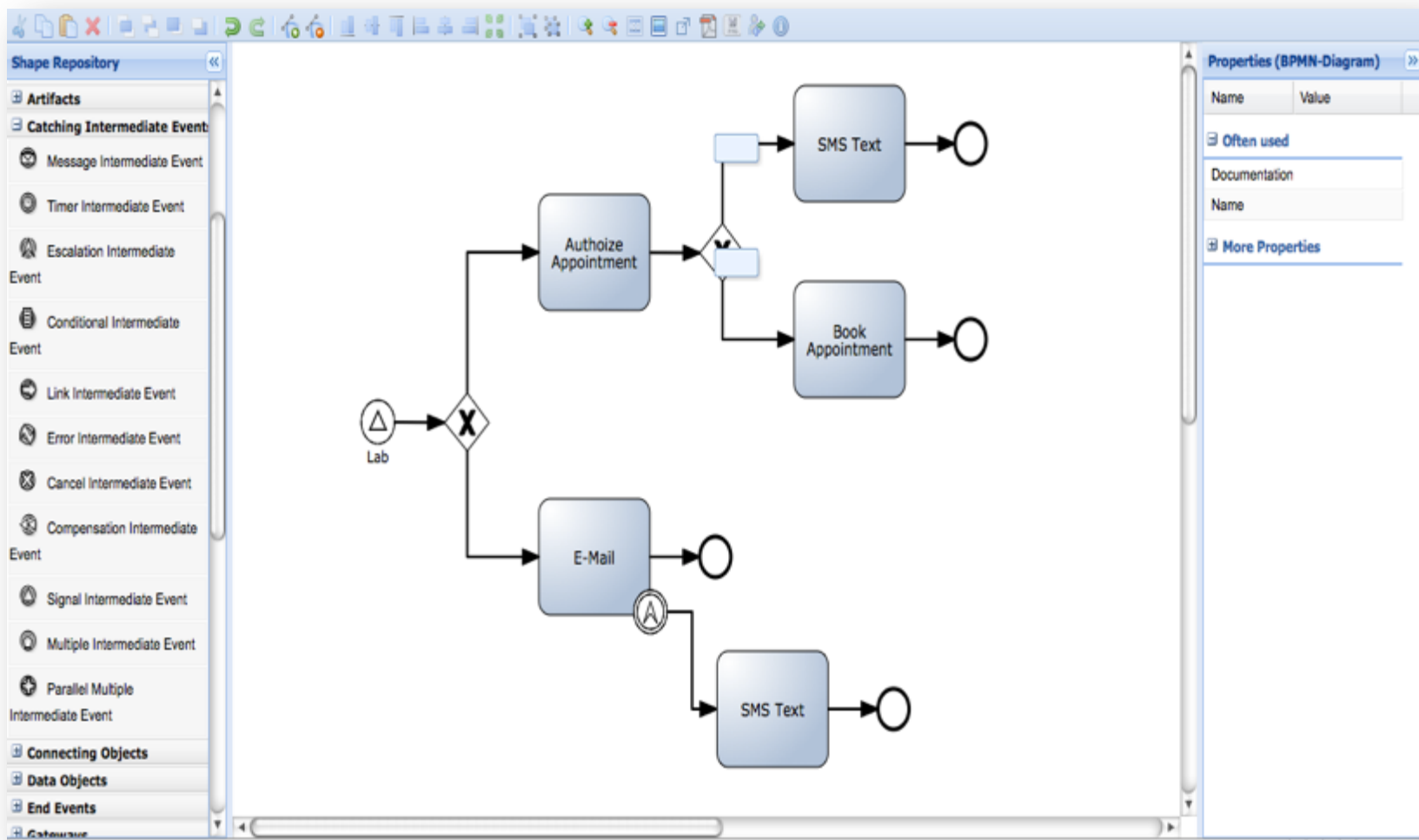
Current Score **1557.4**

[Refresh Every 30 Seconds](#)

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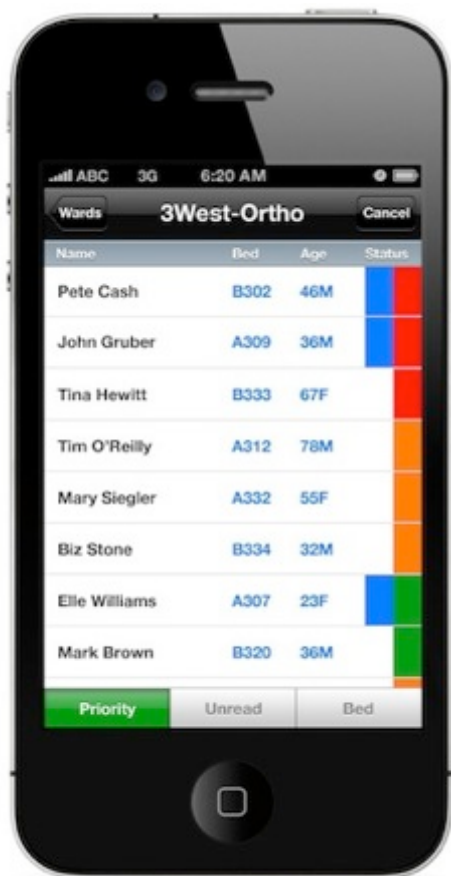


CDS Workbench





iDevices





Key Functionality

- Standards compliant canonical object model
 - Defines clinical fact structure and semantics
 - Constrains rule authoring and run-time bindings
- Knowledge Repository semantically cross-indexed
 - Artifacts searchable by specialty, fact types, tasks, disease, role, etc. across organizational boundaries
- Integrates multiple inference technologies
- Manages individualized, stateful inference sessions with asynchronous workflows and task execution
- Provides for user interaction / data visualization research
- Tooling to facilitate domain knowledge creation and translation



Conclusion

- DDSS-KMR is a reference implementation for CDS and human process reengineering research
- Open source and will be donated to FHA for inclusion in CONNECT and / or DIRECT as appropriate
- Goal is to create a “stack” available to government, academia, and vendors for exploring concepts, sharing results, and improving the reference implementation over time
- Infrastructure is decoupled, standards based, and semantically constrained - real-time hybrid architecture for healthcare