Indian Health Service

Four Directions Warehouse (4DW)

CHARLES CROSS, ENGINEERING BRANCH CHIEF

AUGUST 2024

Electronic Health Record (EHR) Branding Announcement

EHR Branding

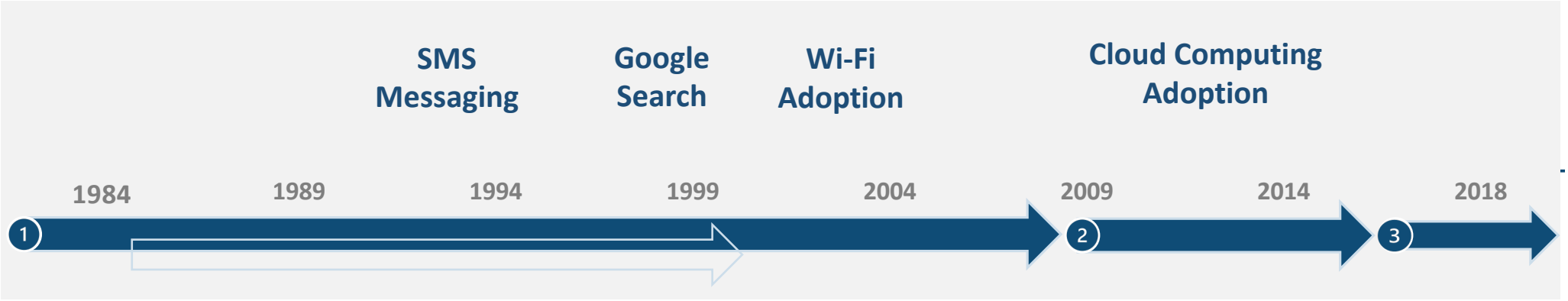
Using PATH as the name of our EHR solution will evoke themes of guidance, connection, and holistic well-being. It signifies our commitment to supporting individuals on their healing journeys, fostering a sense of empowerment, and promoting health and wellness in harmony with nature and community values. PATH represents "Patients at the Heart" which further ties the branding to our Program vision statement.

WHERE WE ARE

AND HOW WE GOT HERE

Technology Years

Resource and Patient Management System (RPMS) and Centuries of Advancement



1 RPMS

RPMS development started officially in 1984

- Implementation of RPMS across IHS spanned approximately 15 years

2 EHR Mandates

The Health Information Technology for Economic and Clinical Health (HITECH) Act promotes adoption and meaningful use of health information technology.

- Interoperability with Department of Veterans Affairs
- Participation in Health Information Exchange

3 Modern EHR

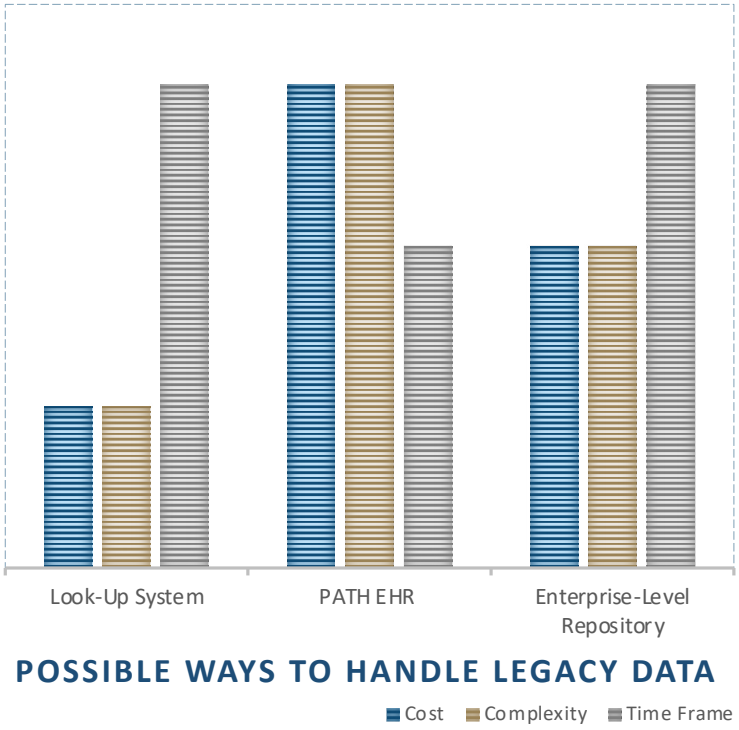
The IHS began research on the feasibility and need for transitioning from RPMS to more modern EHR due to system challenges with resources, integration, and outdated technology

- IHS recognized that RPMS was outdated and saw the need for a new, modern EHR

WHAT TO DO ABOUT RPMS DATA?

Decades of Clinical Data in RPMS:

Managing the Transition to a PATH EHR



Maintain RPMS as a Look-Up Reference System

Keep RPMS operational for references purposes for over 75 years

Incorporate Data into New EHR

Migrate all RPMS data into PATH EHR, ensuring seamless access to historical data

Create an Enterprise-Level Repository

Consolidate legacy data into centralized, enterprise-level repository for comprehensive access

Discussion on Data Options

Evaluating Options for Managing Legacy Data

Maintain RPMS

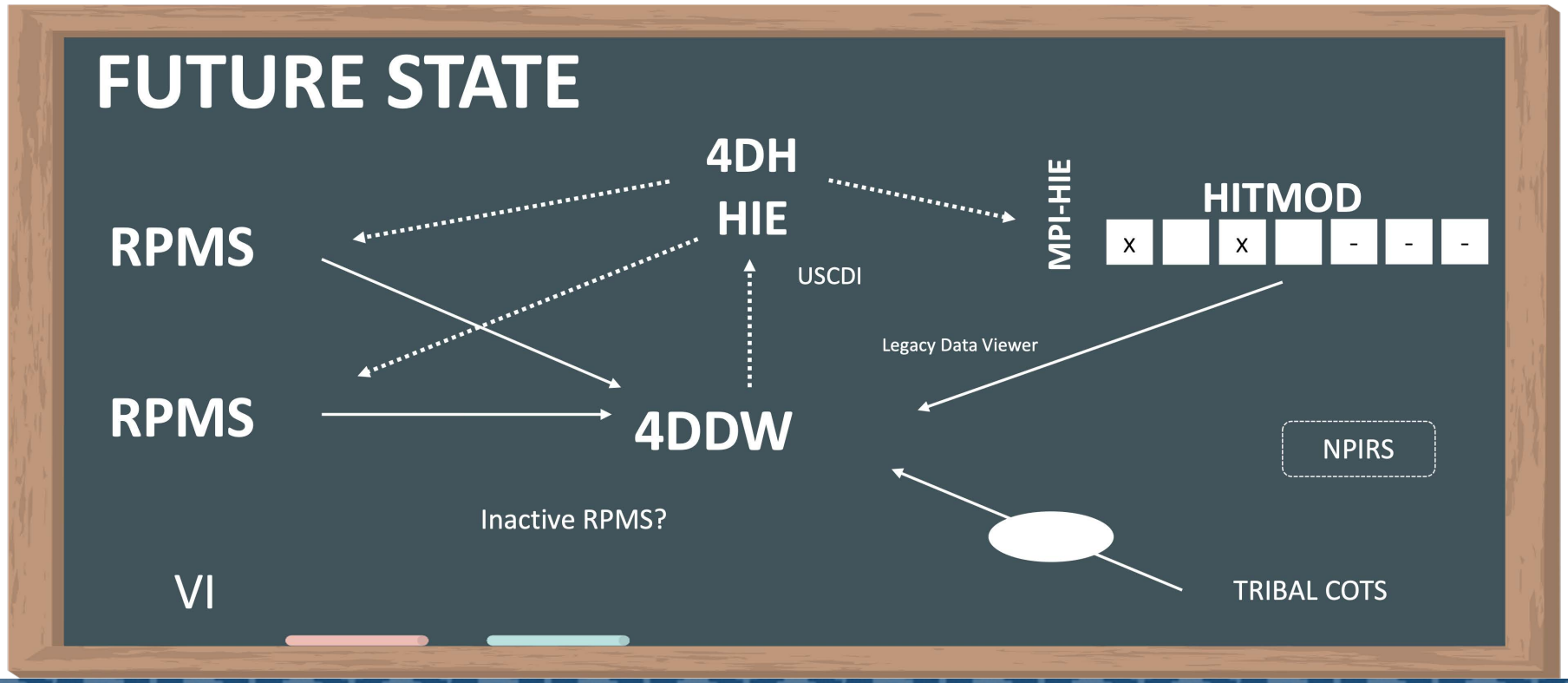
- Does not facilitate universal use of data
- Increasingly cumbersome to operate and maintain
- Risk of data damage or deletion
- Requires maintenance of software licenses

Incorporate Legacy Data into PATH EHR

- Very difficult from a technology standpoint
- Increase implementation time
- Large possibility of introducing instability into PATH EHR
- Requires extensive data cleaning and transformation

A REPOSITORY

The 4DW Brainstorm Session



The Concept

Central Repository for Clinical Data

CORE BENEFITS

- Use legacy information without loading into PATH EHR
- No maintenance of RPMS
- 'Seeding' PATH EHR with small subset of data

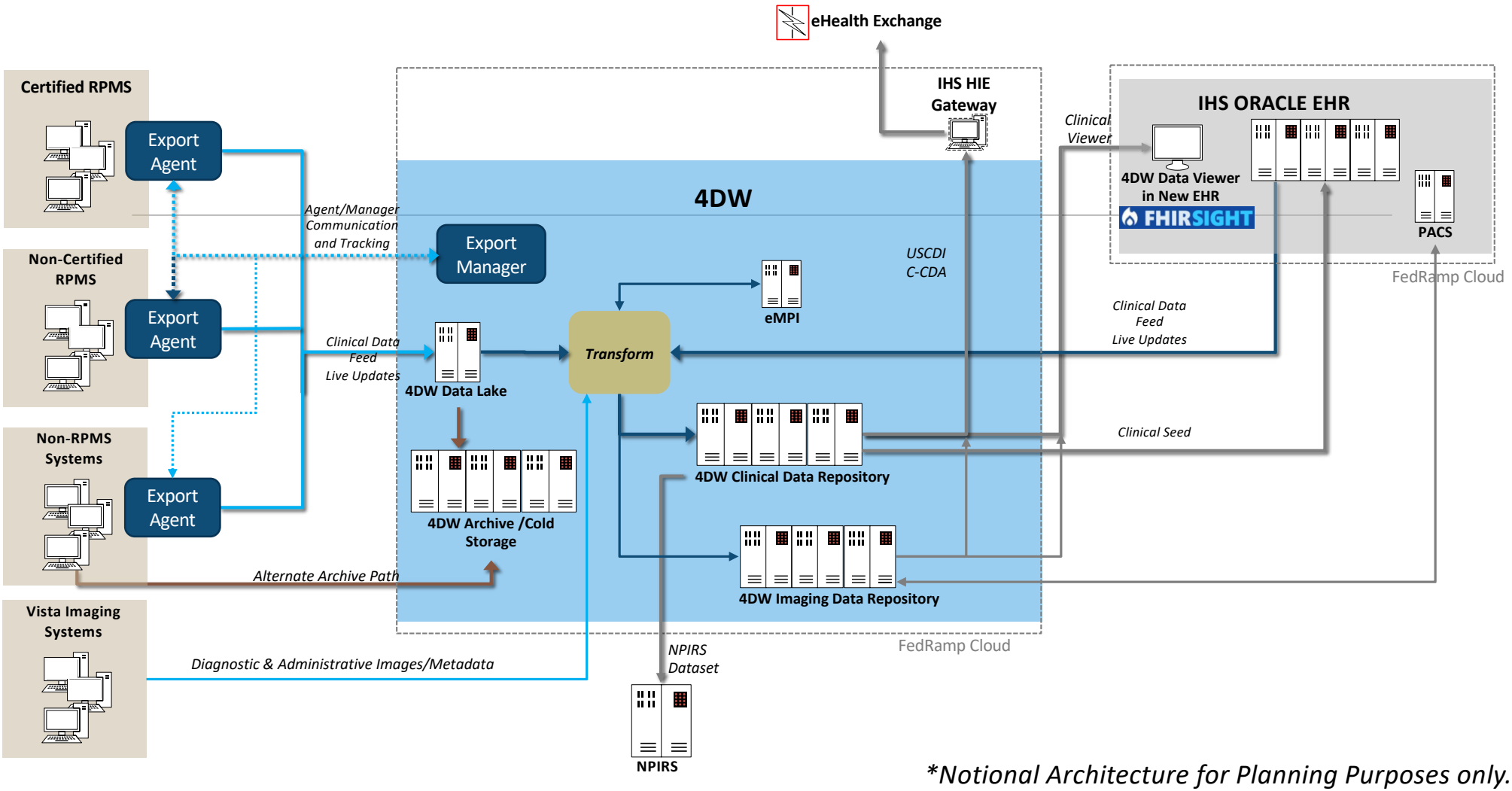
- Satisfy record retention requirements
- Maintain central longitudinal record
- Robust security controls
- Comprehensive enterprise data analytics

Continuous Data Submission to Repository

IHS 4DW Project Vision:

Enhancing Data Management and Accessibility

 **Standardize Cloud-Based Data Repository**	Independent of EHR vendor constraints, fully controlled by IHS, accessible via standard data access methods and Application Programming Interfaces (API)
 **Data Migration Pipeline**	Facilitates migration of RPMS and non-RPMS IHS EHR data to populate the Health Information Technology Modernization (HITMOD) system with cleansed PAMPI (patient demographics, problems, allergies, medications, procedures, and immunization) and other selected data domains
 **Archive for RPMS Data**	Allows continued access/viewing after RPMS servers are decommissioned, supports adherence to patient data retention guidelines
 **Readiness for Future Use Case**	Support advanced analytics, population health analysis, and centralized data feeds
 **Robust Access Controls**	Provides secure access to authorized users with full auditing



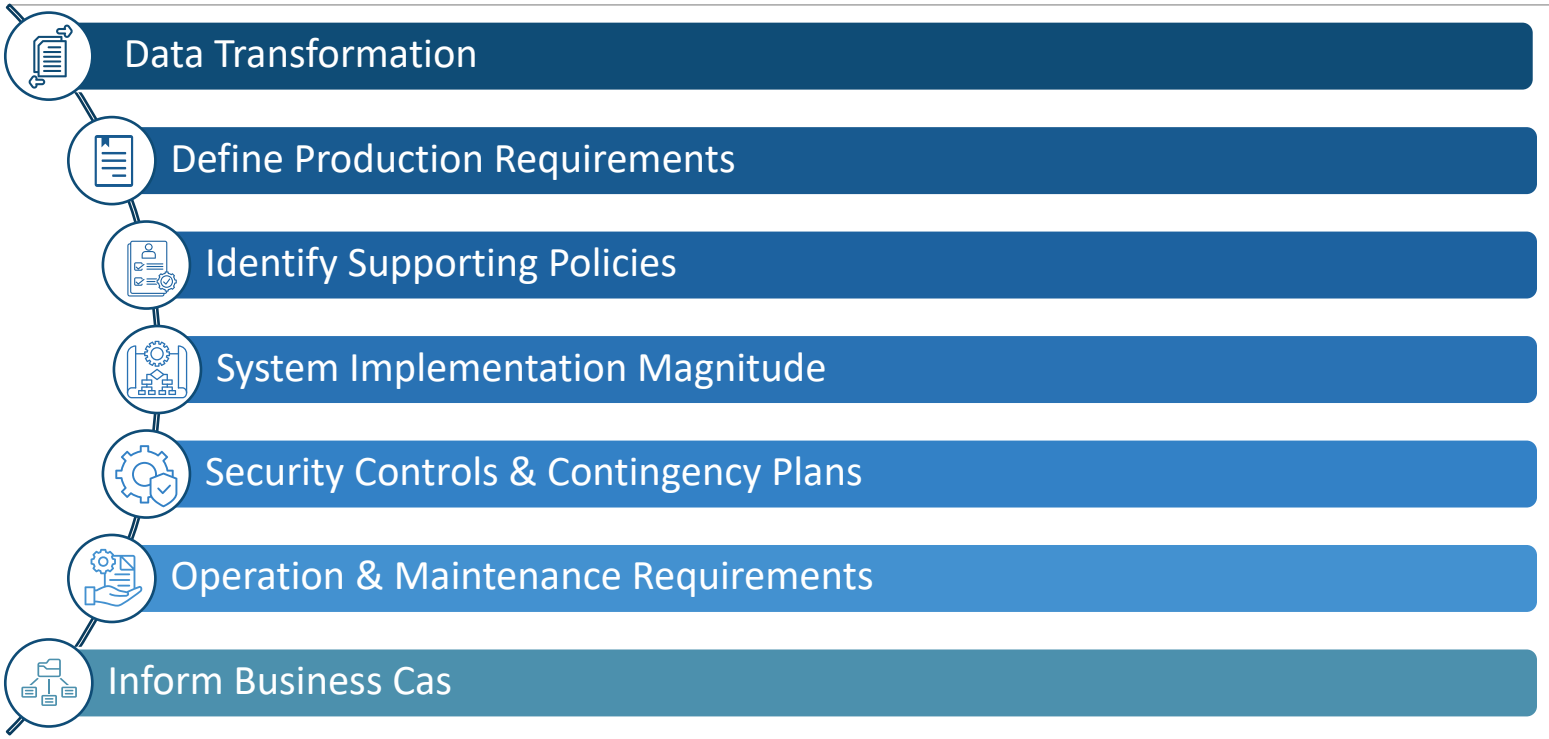
Notional Architecture for Planning Purposes only.

PROTOTYPE

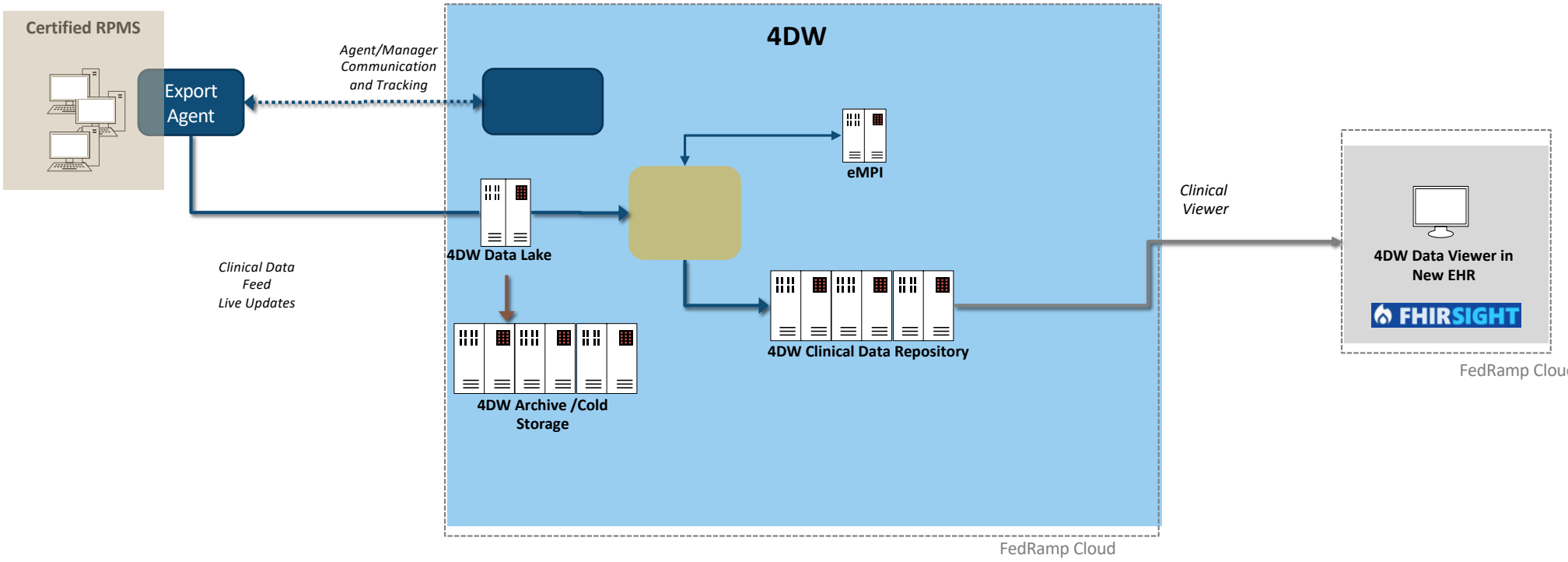
LET'S CONFIRM THIS WILL WORK

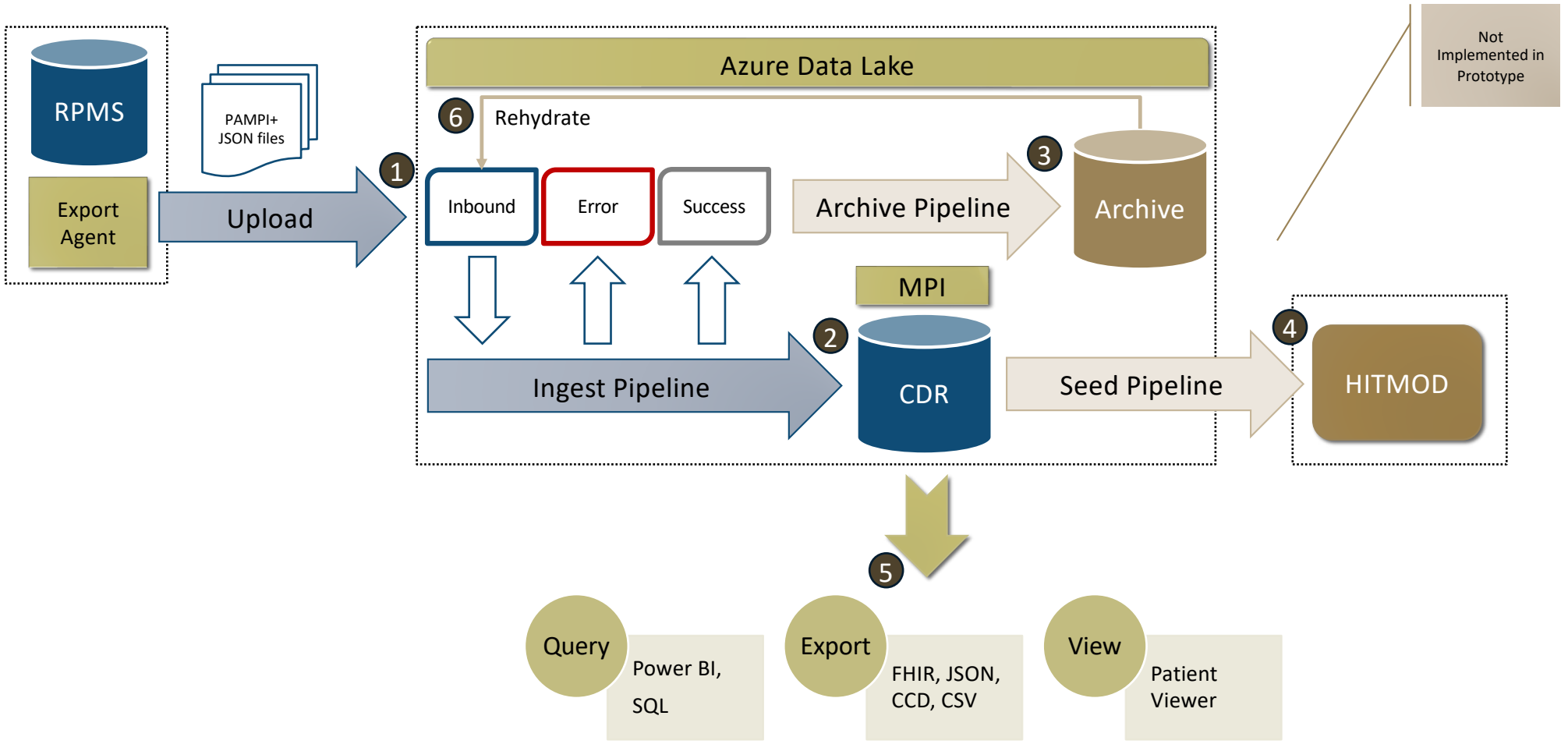
Prototype Initiation Objectives

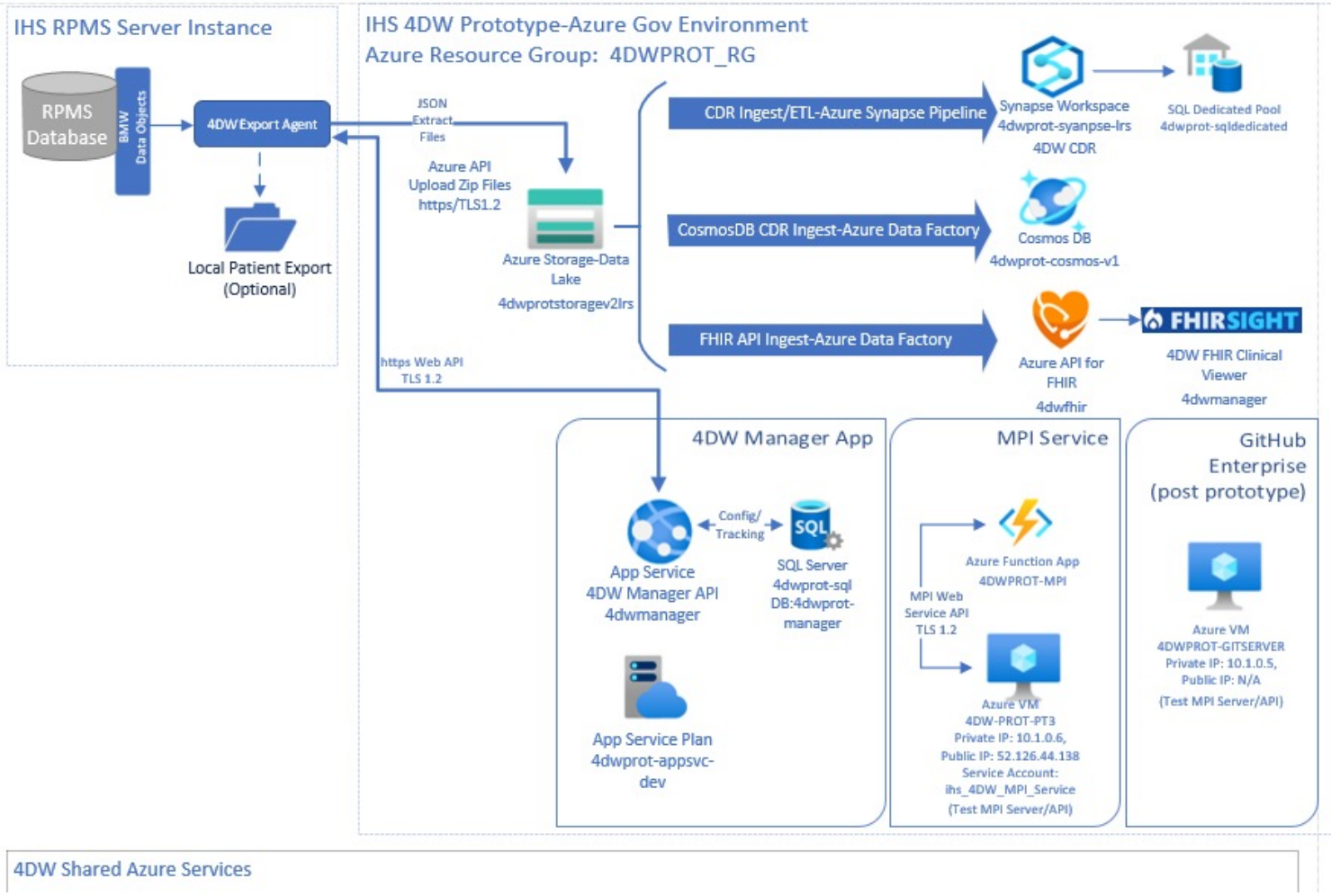
Key Goals for the Design & Implementation Phase



Prototype Architecture




RPMS
Export Agent
PAMPI+ JSON files
Upload
1
Azure Data Lake
6
Rehydrate
Inbound
Error
Success
Archive Pipeline
3
Archive
Not Implemented in Prototype
MPI
2
CDR
Ingest Pipeline
Seed Pipeline
4
HITMOD
5
Query
Power BI, SQL
Export
FHIR, JSON, CCD, CSV
View
Patient Viewer


IHS RPMS Server Instance
RPMS Database
BMW Data Objects
4DW Export Agent
Local Patient Export (Optional)
IHS 4DW Prototype-Azure Gov Environment
Azure Resource Group: 4DWPROT_RG
JSON Extract Files
Azure API Upload Zip Files https/TLS1.2
Azure Storage-Data Lake
4dwprotstoragev2lrs
CDR Ingest/ETL-Azure Synapse Pipeline
Synapse Workspace
4dwprot-syanpse-lrs
4DW CDR
SQL Dedicated Pool
4dwprot-sqldedicated
CosmosDB CDR Ingest-Azure Data Factory
Cosmos DB
4dwprot-cosmos-v1
FHIR API Ingest-Azure Data Factory
Azure API for FHIR
4dwfhir
FHIRSIGHT
4DW FHIR Clinical Viewer
4dwmanager
https Web API TLS 1.2
4DW Manager App
App Service
4DW Manager API
4dwmanager
Config/ Tracking
SQL Server
4dwprot-sql
DB:4dwprot-manager
App Service Plan
4dwprot-appsvc-dev
MPI Service
Azure Function App
4DWPROT-MPI
MPI Web Service API TLS 1.2
Azure VM
4DW-PROT-PT3
Private IP: 10.1.0.6,
Public IP: 52.126.44.138
Service Account:
ihs_4DW_MPI_Service
(Test MPI Server/API)
GitHub Enterprise (post prototype)
Azure VM
4DWPROT-GITSERVER
Private IP: 10.1.0.5,
Public IP: N/A
(Test MPI Server/API)
4DW Shared Azure Services

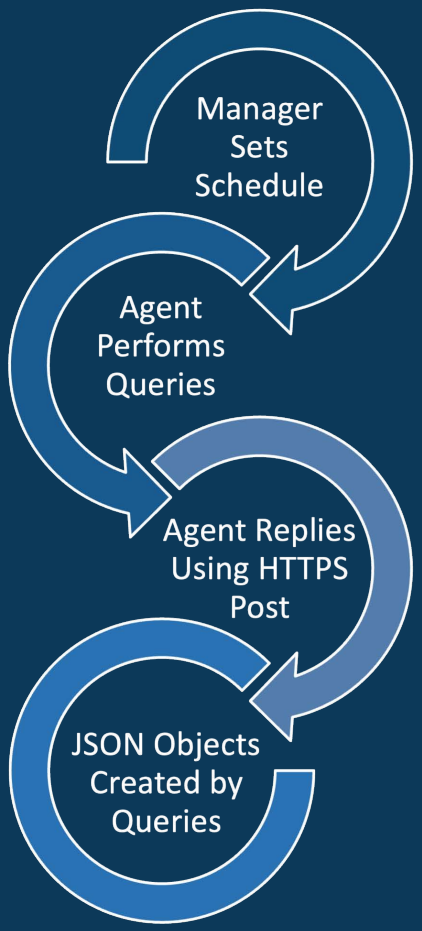
Overview:
Export Manager and Export Agent(s)

Export Manager

- Create and manage site/agent onboarding
- Create and manage domain query specs (DQS)
- Provide web API for agent
- Export monitoring and reporting
- Export data viewer
- Hosted in Azure App service
- Configuration data in Azure structured query language (SQL)

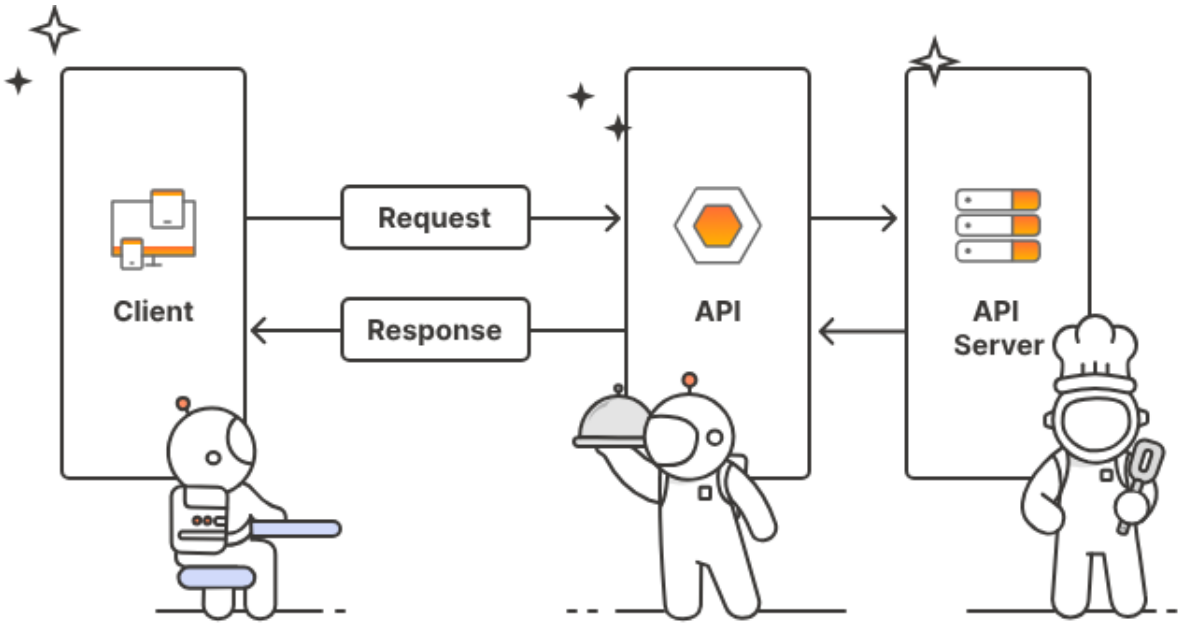
Export Agent(s)

- Pull configuration and DQS from Manager
- Maintain patient list and schedule jobs
- Execute export per DQS
- Push status and events to manager
- Upload compressed data to Azure Data Lake for storage
- Hosted on application server (site)
- Configuration data in memory (or SQLite)



Moving Source Data:

Manager and Agent Communication Process



Data Processing Flow:
From RPMS to HITMOD

- The export agent uploads patient data files from RPMS to the inbound folder in Azure Data Lake

- Ingest Pipeline
  - Process files and loads to Clinical Data Repositories (CDR)
- Success/Error Handling
  - Files are moved to success or error folder based on processing results
- Data Access
  - Data can be exported, queried, and viewed from CDR

- Archive Pipeline
  - Move files to the archive folder (cold tier)
- Data Rehydration
  - Data can be rehydrated back to inbound folder for re-processing as needed

- The seed pipeline moves data to HITMOD – format to be determined later

Not Implemented in Prototype

JavaScript Object Notation – *Provenance*

All images containing examples of data are used for demonstration purposes only and do not contain any real data

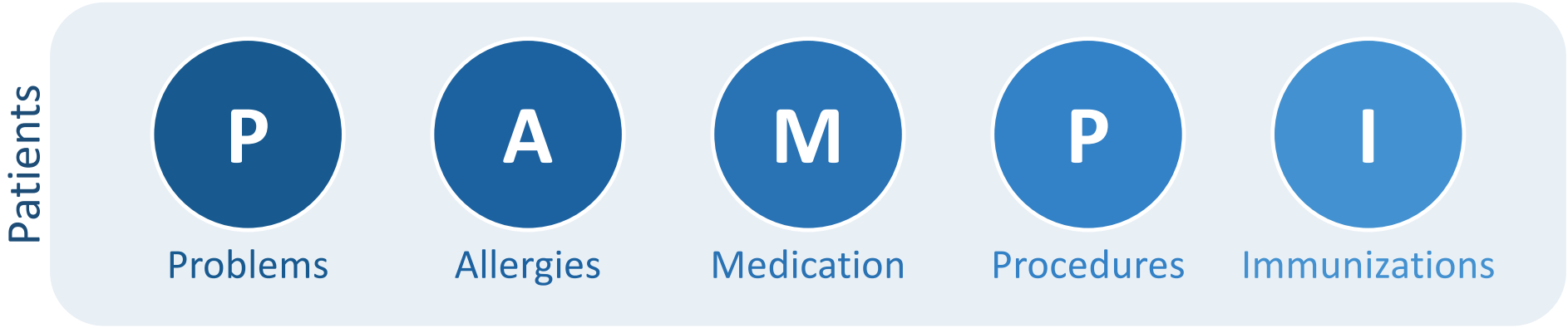
JavaScript Object Notation – *Demographics*


```
"demographics": {
  "id": "27447",
  "name": "GONZALEZ,WOZNIACKI,GIMBLE",
  "preferred_name": null,
  "other_names": [{"id":"27447||1","alias":"GONZALEZ,ASTERRR,LIZA"}],
  "date_of_birth": "1958-04-02",
  "place_of_birth_city": "DUMAGUETTE",
  "place_of_birth_state": {"id":"CT","name":"CONNECTICUT"},
  "religious_preference": {"id":"9","name":"MORMON"},
  "social_security_number": "123452022",
  "datetime_of_last_update": "2023-06-16T12:20:23",
  "health_record_no": [{"id":"27447||978","number":"1004","inactivation_date":null,"facility":{"id":"978","name":"2013 DEMO TRIBE
  "sex": {"id":"U","name":"UNKNOWN"},
  "marital_status": {"id":"1","name":"DIVORCED"},
  "employer": {"id":"7735","name":"1ST IMPRESSN SCRTY DOORS"},
  "spouse_employer": {"id":"5483","name":"1ST CAUSE MAINTANCE DS"},
  "employment_status": {"id":"2","name":"PART-TIME"},
  "race": [{"id":"19","name":"CAMBODIAN","code":"2028-9"},{"id":"42","name":"BOTSWANAN","code":"2054-5"},{"id":"49","name":"BARBA
  "ethnicity": [{"id":"8","name":"CASTILLIAN","code":"2135-2"},{"id":"10","name":"BELEARIC ISLANDER","code":"2135-2"},{"id":"13",
  "eligibility_status": {"id":"C","name":"CHS & DIRECT"},
  "eligibility_reasons": [{"id":"27447||1","eligibility_modifier":{"id":"11","name":"NON-INDIAN CHILD LIVING IN AN ELIGIBLE INDIA
  "beneficiary": {"id":"19","name":"NOAA PERSONNEL"},
  "indian_blood_quantum": "FULL",
  "tribe_of_membership": {"id":"660","name":"AHKIOK-KAGUYAK NATIVE CORP.","code":"711"},
  "tribe_quantum": "FULL",
  "other_tribes": [{"id":"27447||1","tribe_quantum":"1/4","tribe":{"id":"507","name":"AGDAAGUX TRIBE OF KING COVE","code":"597"}]
```


All images containing examples of data are used for demonstration purposes only and do not contain any real data

Data Domains:

That will "seed" PATH EHR



These data domains are considered the basic data domains that will "seed" PATH EHR.

4DW Patient "PAMPI" Data

Patient

CRITERIA
ALIVE, ACTIVE STATUS, VISIT WITHIN 3 YR

- Patient Name
- Address
- Contact Info
- Emergency Contacts
- Next of Kin
- Date of Birth
- Language
- Race/Ethnicity
- Gender
- Tribal Affiliation

P — Problems

CRITERIA
ALL CHRONIC PROBLEMS FOR SELECTED PATIENTS

- Problem Code/Dx
- Description
- Body Location Code
- Related Visit
- Start/Stop Dates
- Status
- Resolved Date
- Rendering Provider
- Comments

A — Allergies

CRITERIA
ALL ACTIVE ALLERGIES FOR SELECTED PATIENTS

- Allergy Code
- Criticality
- Status
- Related Visit
- Date of Onset
- Record Date
- Resolution Date
- Reaction Type
- Asserting Provider

M — Medications

CRITERIA
ACT. MEDS, OUT PT RX LAST TBD YRS, ACT. OUTSIDE RX

- Drug Codes (RxNorm/NDC)
- Drug Name
- Start/Stop Dates
- Category
- Dose Info
- Frequency/Route
- Prescribing Provider
- Status
- Comments
- Instructions

P — Procedures

CRITERIA
ALL EXCEPT 99XXX, FOR LAST TBD YEARS

- Procedure Code
- Procedure Date/Time
- Recorded Date/Time
- Status
- Performing Provider
- Location
- Body Site
- Notes
- Reason
- Outcome

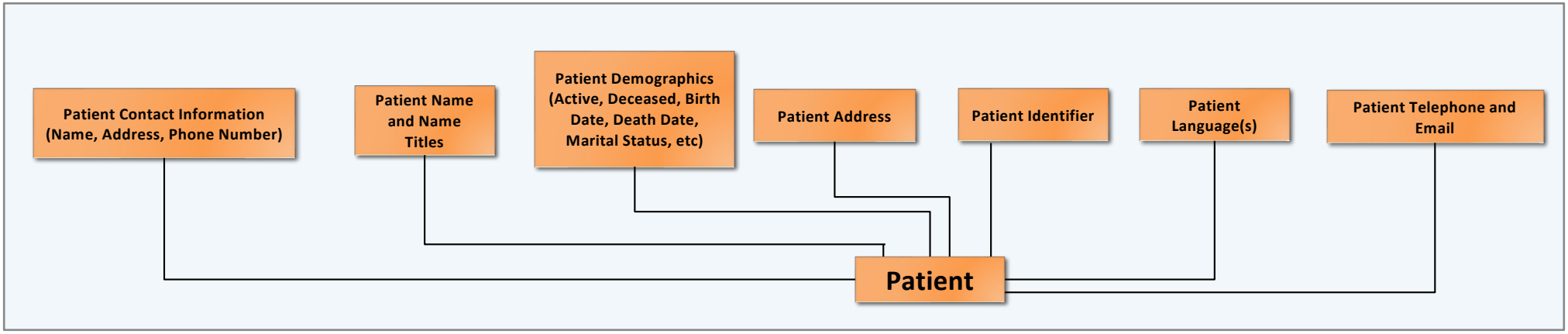
I — Immunizations

CRITERIA
ALL IMMUNIZATIONS FOR SELECTED PATIENTS

- Vaccine Code
- Vaccine Lot
- Dosage Info
- Manufacturer
- Administered Date
- Administer Location
- Ordering Provider
- Administering Provider
- Related Visit
- Dispensing Type
- Body Loc. Code

**Data fields listed are summarized for space Full catalog of planned fields is still being finalized*

Developing Conceptual Models:
Mapping Patient Data Domains

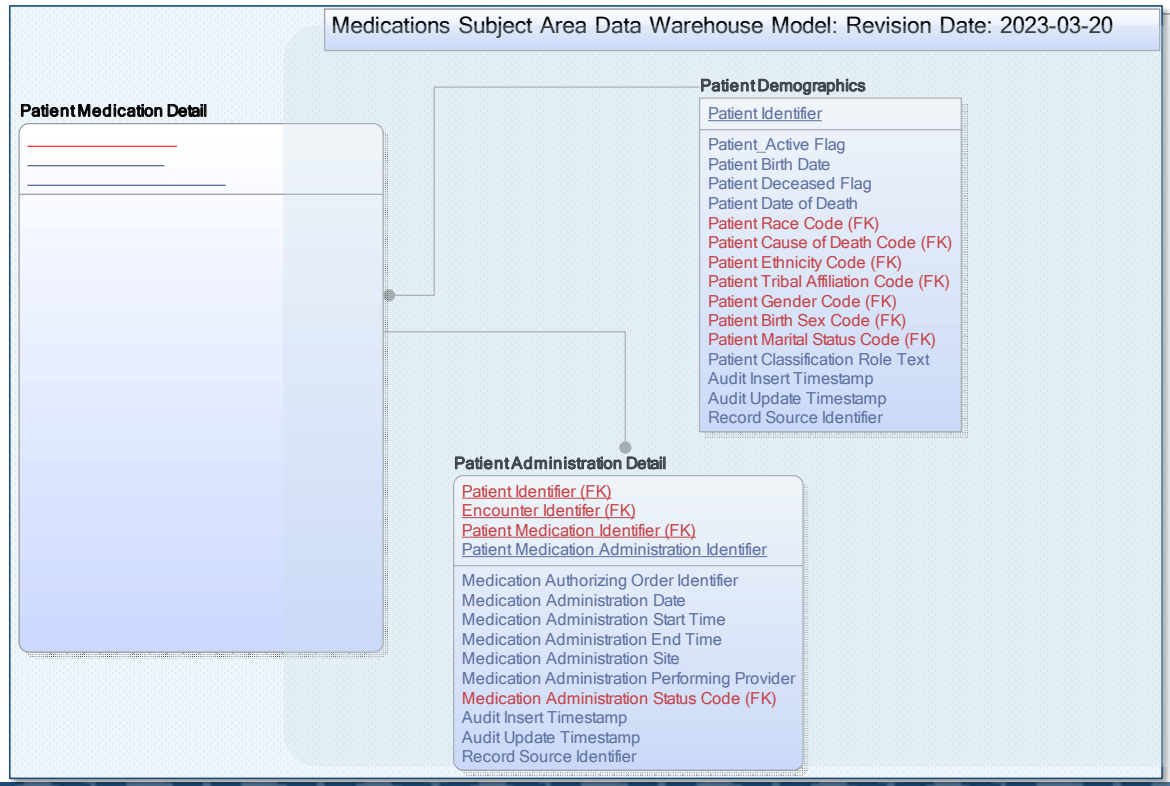


Key Characteristics of Conceptual Data Models

Each of the data domains are conceptualized and modeled.

Conceptual data models focus on identifying the data used in the business.

Logical Model:
Establishing Data Structures and Relationships



Key Concepts

- A logical data model establishes the structure of data elements and the relationships among them
- There are several types of logical models; this is an example of a relational data model

Data Dictionary:
Defining and Organizing Data Elements

Created for Each Domain

Contains information about the data repository (Meaning, Relationships, Origin, Usage, and Format).

Adopts a convention for naming elements

Standardizes element names for consistency.

Identifies appropriate data for different use

Ensures data is suitable for various applications.

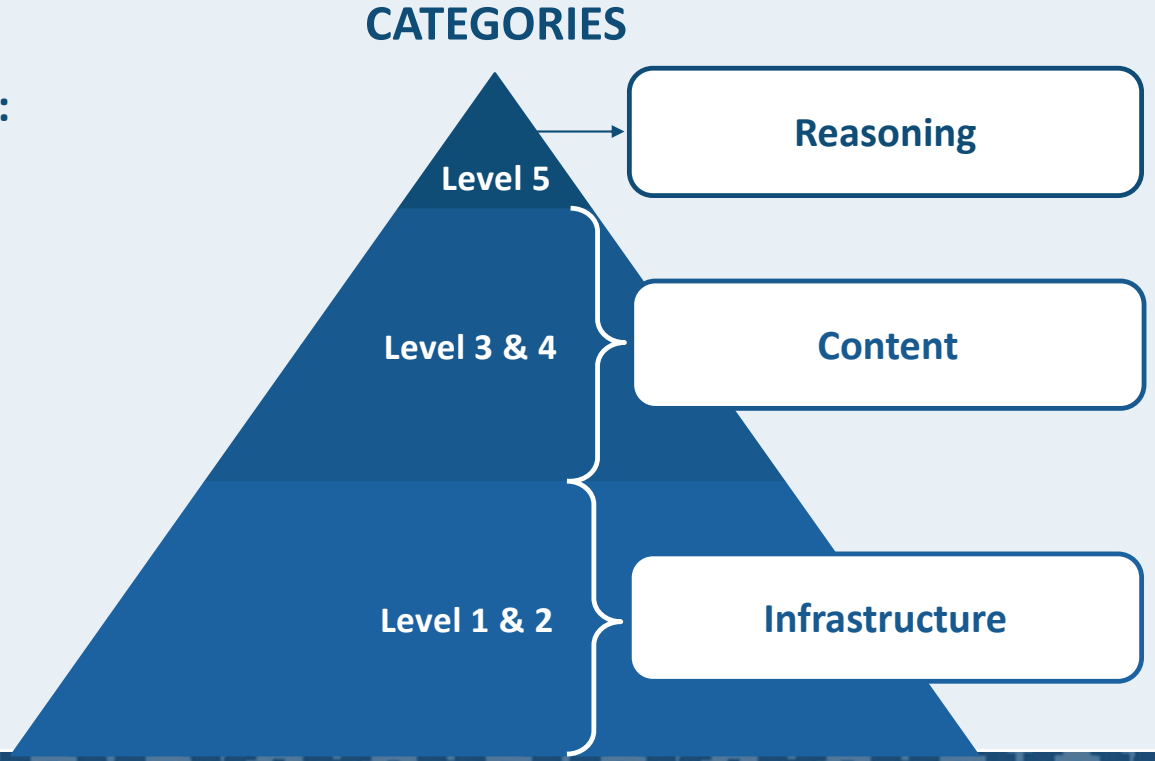
Sample Data Dictionary

Subject Area Name	Entity_Logical Name	Table Physical_Name	Attribute Name	Column Name	Attribute.Physical.USCDI/FHIR Field Name	Column Definition
Patient	Patient Demographics	Patient_Demographics	Patient Identifier	Patient_Identifier	Patient.Id	Unique Identifier for this Patient
Patient	Patient Demographics	Patient_Demographics	Patient_Active Flag	Patient_Active_Flag	Patient.Active	Flag to indicate whether the patient is considered active
Patient	Patient Demographics	Patient_Demographics	Patient Birth Date	Patient_Birth_Date	Patient.BirthDate	Known or estimated year, month, and day of the patient's birth.
Patient	Patient Demographics	Patient_Demographics	Patient Deceased Flag	Patient_Deceased_Flag	Patient.Deceased.DeceasedBoolean	Flag to indicate whether patient is deceased
Patient	Patient Demographics	Patient_Demographics	Patient Date of Death	Patient_Date_of_Death	Patient.Deceased.DeceasedDateTime	Known or estimated year, month, and day of the patient's death.
Patient	Patient Demographics	Patient_Demographics	Patient Classification Role Text	Patient_Classification_Role_Text	Encounter.Hospitalization.SpecialCourtesy	A Flag indication of confidentiality that allows different functionality around privacy or special treatment of a Patient. Possible values are EMPLOYEE, DONOR, SENSITIVE PATIENT.
Patient	Patient Demographics	Patient_Demographics	Patient Cause of Death Code	Patient_Cause_of_Death_Code		The cause of death code for a given patient
Patient	Patient Demographics	Patient_Demographics	Patient Ethnicity Code	Patient_Ethnicity_Code	USCoreEthnicityExtension	The ethnicity of the patient code
Patient	Patient Demographics	Patient_Demographics	Patient Tribal Affiliation Code	Patient_Tribal_Affiliation_Code		Tribe or a band the individual associates with
Patient	Patient Demographics	Patient_Demographics	Patient Birth Sex Code	Patient_Birth_Sex_Code	Patient.Gender	Supporting US Core - Sex code of the patient at birth
Patient	Patient Demographics	Patient_Demographics	Patient Gender Code	Patient_Gender_Code	Patient.Gender	Documentation of a specific instance of sex and/or gender information.
Patient	Patient Demographics	Patient_Demographics	Patient Marital Status Code	Patient_Marital_Status_Code		The marital status code of a patient
Patient	Patient Demographics	Patient_Demographics	Audit Insert Timestamp	Audit_Insert_Timestamp	Derived	The insert timestamp of when the record was inserted in the table
Patient	Patient Demographics	Patient_Demographics	Audit Update Timestamp	Audit_Update_Timestamp	Derived	The update timestamp of whne the record was updated in the table
Patient	Patient Demographics	Patient_Demographics	Record Source Identifier	Record_Source_Identifier	Derived	The source code of the record (e.g. 1 -RPMS, 2-EHR system, etc)
Patient	Patient Demographics	Patient_Demographics	Patient Race Code	Patient_Race_Code	USCoreRaceExtension	The race of the patient code
Patient	Patient Name	Patient_Name	Patient Identifier	Patient_Identifier	Patient.Id	Unique Identifier for this Patient
Patient	Patient Name	Patient_Name	Patient Name	Patient_Name	HumanName.Text, HumanName.Given, HumanName.Family	The name of the patient tied to the type and class of the patient name
Patient	Patient Name	Patient_Name	Patient Prefix	Patient_Prefix	HumanName.Prefix	The prefix portion of the Patient / Member / Consumer 's name.
Patient	Patient Name	Patient_Name	Patient Suffix	Patient_Suffix	HumanName.Suufix	The suffix portion of the Patient / Member / Consumer 's name.
Patient	Patient Name	Patient_Name	Patient Name Effective Date	Patient_Name_Effective_Date	HumanName.Period.Start	The start of the time period when the name was or is in use. The dates between the effective and obsolete dates should be non overlapping

Fast Healthcare Interoperability Resource:
A Standard for Health Care Information Exchange

Key features and Structure of FHIR:

- Created in 2012 and maintained by Health Level 7 (HL7)
- Supported by major vendors and open-source communities
- Uses the concepts of 'resources' with extensibility



FHIR V5.0.0 R5 –
Infrastructure

Level 1 Basic framework on which the specification is built

Foundation	Base Documentation, XML, JSON, RDF, Datatypes, Extensions

Level 2 Supporting implementation and binding to external specifications

Implementer Support	**Security & Privacy**	**Conformance**	**Terminology**	**Exchange**
Downloads, Version Mgmt, Use Cases, Testing	Security, Consent, Provenance, AuditEvent	StructureDefinition, CapabilityStatement, ImplementationGuide, Profiling	CodeSystem, ValueSet, ConceptMap, Terminology Svc	REST API + Search Documents Messaging Services Databases Subscriptions

https://build.fhir.org/modules.html

FHIR V5.0.0 R5 –
Content

Level 3 Linking to real-world concepts in the healthcare system

Administration	Patient, Practitioner, CareTeam, Device, Organization, Location, Healthcare Service

Level 4 Record-keeping and Data Exchange for the healthcare process

Clinical	Diagnostics	Medications	Workflow	Financial
Allergy, Problem, Procedure, CarePlan/Goal, Family History, RiskAssessment, etc.	Observation, Report, Specimen, ImagingStudy, Genomics, etc.	Medication, Request, Dispense, Administration, Statement, Immunization, etc.	Introduction + Task, Appointment, Schedule, Referral, PlanDefinition, etc.	Claim, Account, Invoice, ChargeItem, Coverage + Eligibility Request & Response, ExplanationOfBenefit, etc.

https://build.fhir.org/modules.html

FHIR V5.0.0 R5 –
Reasoning

Level 5 Providing the ability to reason about the healthcare process

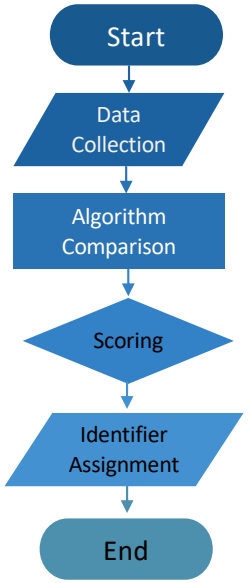
Clinical Reasoning	Medication Definition
Library, PlanDefinition & GuidanceResponse, Measure/MeasureReport, etc.	Medicinal, Packaged & Administrable product definitions, Regulated Authorization, etc.

https://build.fhir.org/modules.html

Master Person Index:

Uniquely Identifying Patients Across the Enterprise

Master Person Index (MPI) Process Flow

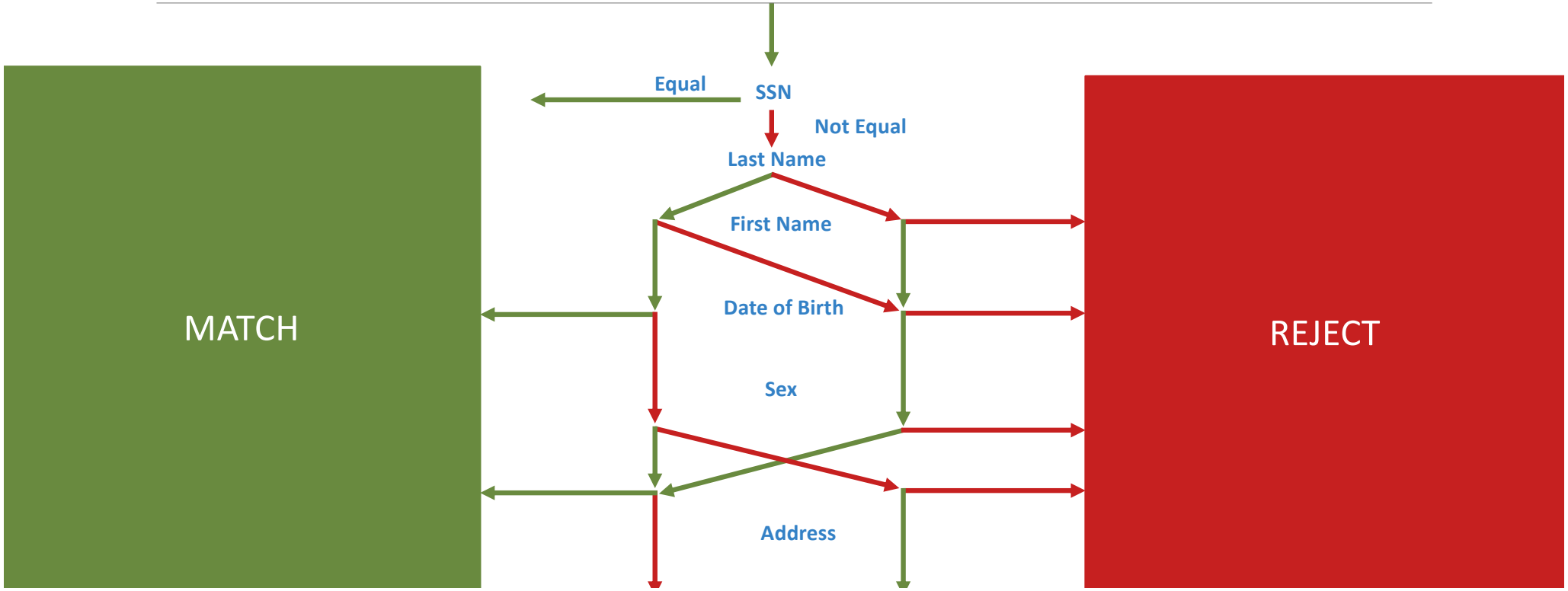


Unique Patient Identification
Provides a method to uniquely identify a patient across the enterprise

Prototype Implementation
Four Directions Hub (4DH) services were used for the prototype

Data Utilization
MPIs use various pieces of data associated with a person

MPI Decision Tree



MPI Matching Values

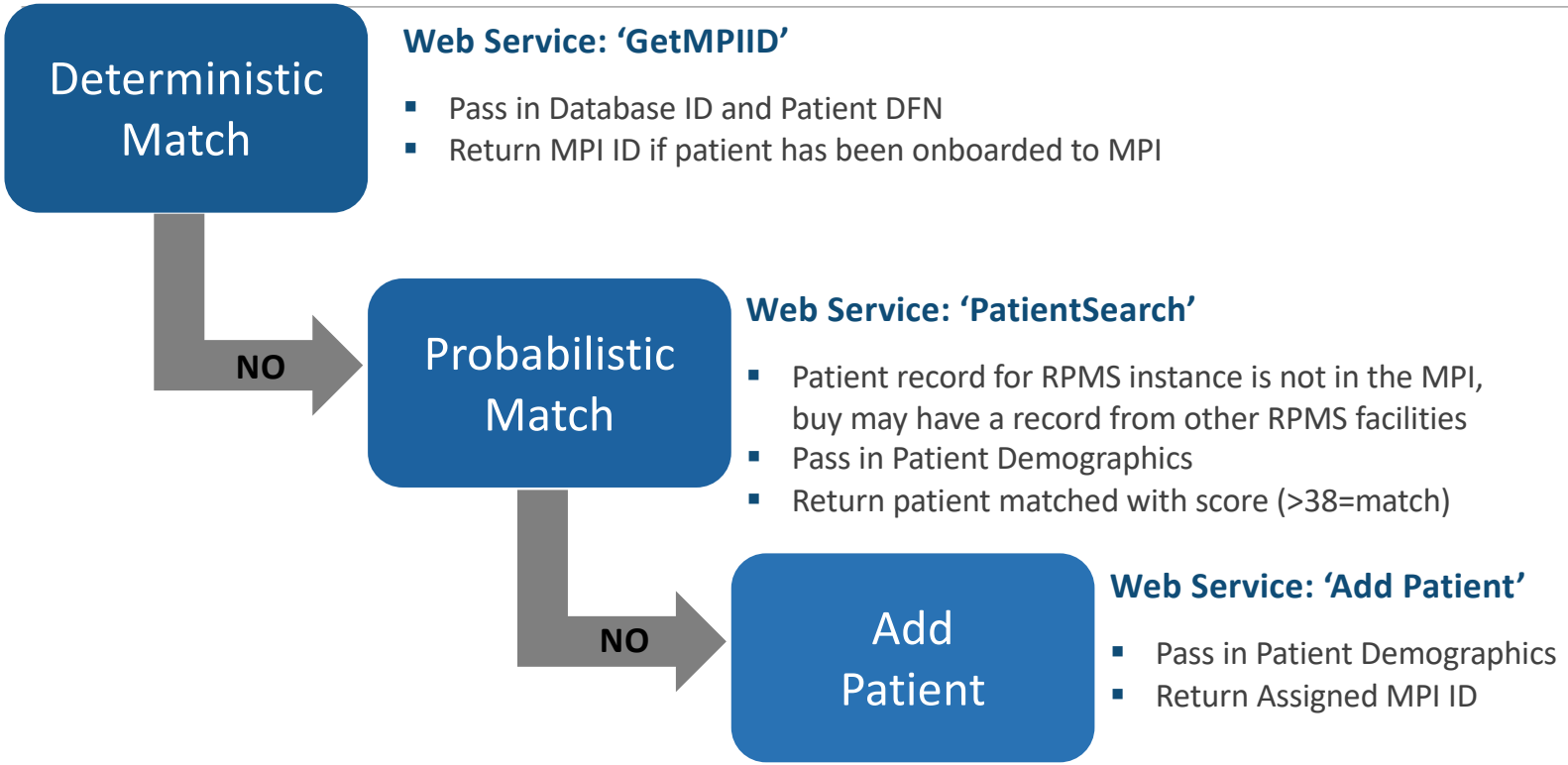
Parameter	Agreement	Disagreement
Facility		
MRN		
names	14	-11
ssn	13.152	-9.7
gender	2.1	-1
birthdatetime	12.127	-9
identifiers	0	0
addresses	5.237	0
telecoms	5.286	0
(total)	51.902	-30.700

Key Concepts

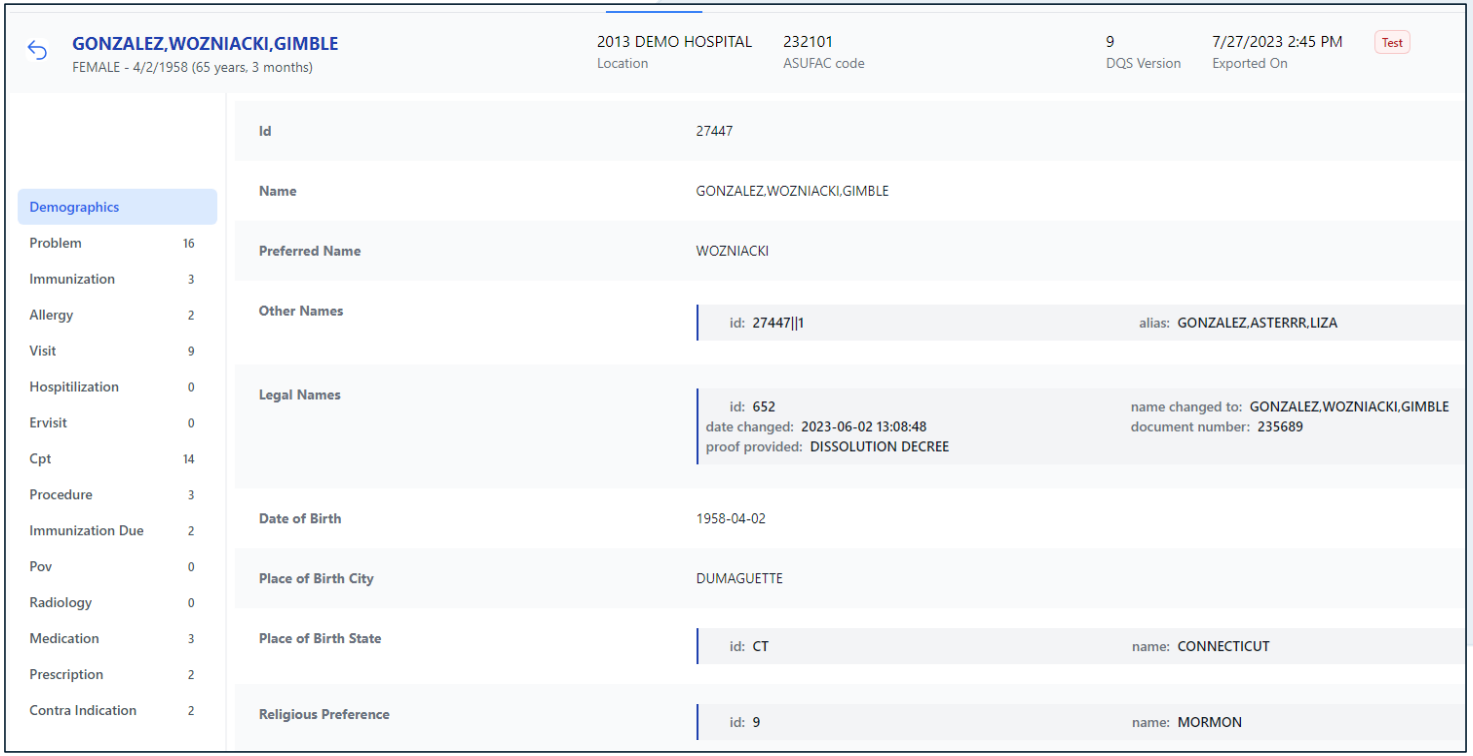
- Medical record number (MRN) in this context is the internal entry number (IEN or DFN) of the patient record, not the Health Record Number

MPI Design Flow:

Determining Patient Match and Onboarding



Sample Viewer

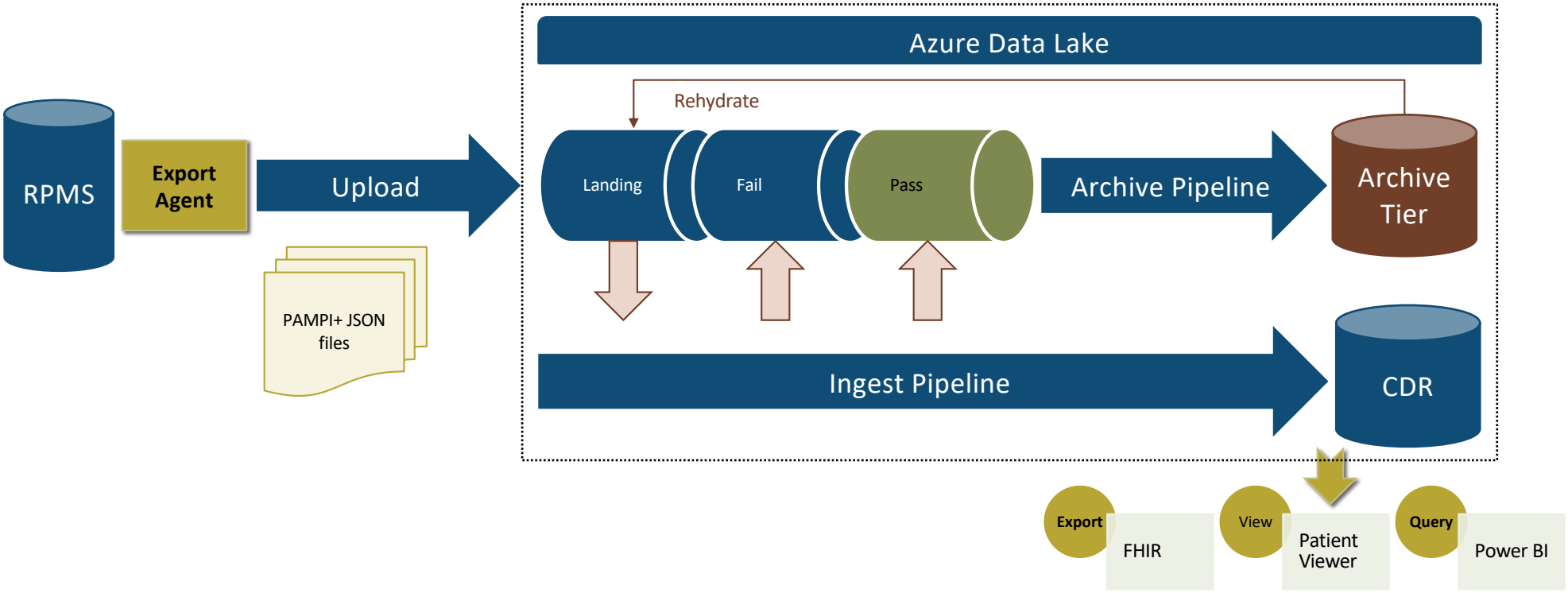


All images containing examples of data are used for demonstration purposes only and do not contain any real data

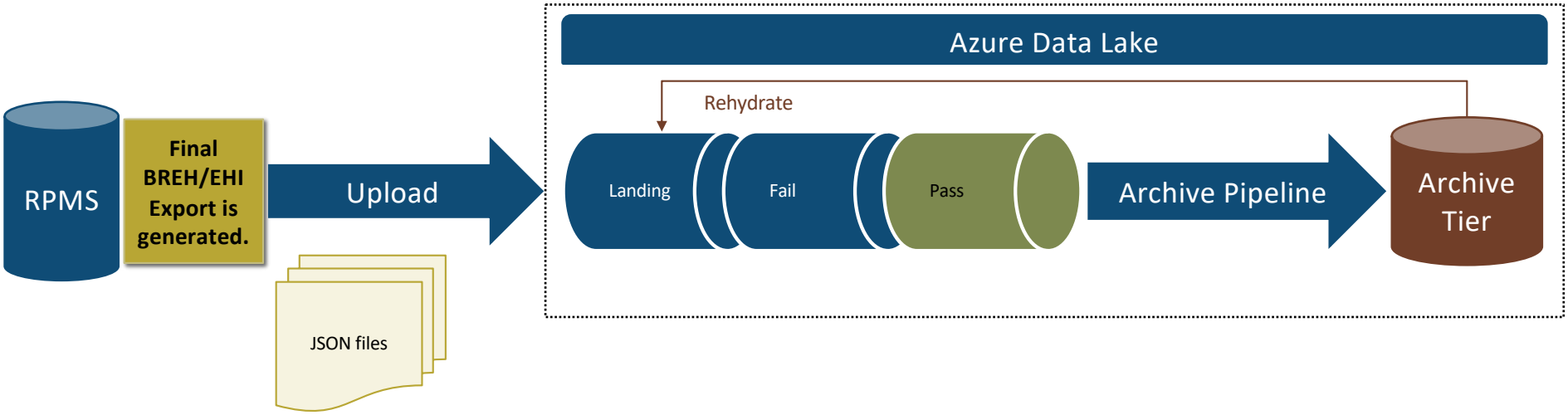
Archive the Data

Option	A	B	C
Mode	PAMPI+ Archive	Fileman Archive	Database File Archive
File Type	JSON	JSON	DAT/BCK (Binary)
Toolset	4DW Agent / BMW	EHI / Fileman	Native (Cache/SQL etc)
Data Definition	Specific Domains (DQS)	Generic File/Field range	Native Backup
Export	Available (prototype)	Available (baseline)	Available (native)
Transport	Available (prototype)	TBD	TBD
Browsing	Patient Viewer (prototype)	Basic JSON Viewer	Requires VM/Lab InterSystems setup
Querying	Yes - Cosmos DB or Synapse	Yes - Cosmos DB	Requires VM/Lab InterSystems setup

Archive Model –
Option A



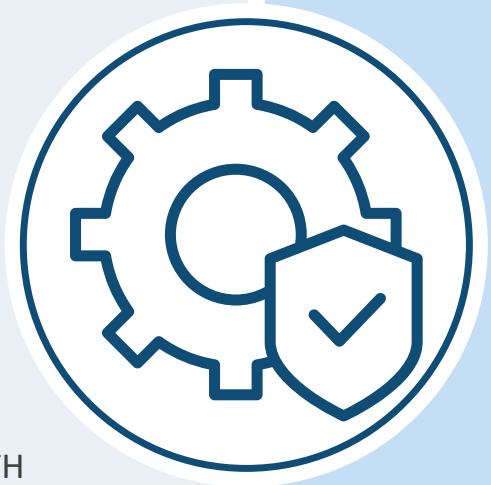
Archive Model –
Option B



Non-functional Requirements:
Ensuring Security and Resiliency

Security Requirements

- Encryption:
  - Encryption in transit
  - Encryption of data at rest
- Information flow enforcement
- Audit tracking
- No direct end user access:
  - Privilege separation
  - Management capabilities and application functionality separated
  - Defined access through system and service accounts
  - User interaction occurs through PATH EHR or viewer application



Infrastructure & Resiliency

- Use of Infrastructure as Code:
  - Support version control
  - Support resiliency and disaster recovery
  - Backup and restore capabilities
- Use of FedRAMP High Approved Service:
  - Undergo formal assessment for an authority to operate

Prototype Documentation:

Foundational Documents for Operational Success

Source Site Preparation

Systems Security Plan (SSP)

Business Case for Investment

Security Impact Assessment (SIA)

Privacy Impact Assessment (PIA)

Business Impact Assessment (BIA)

Incident Response Plan

Contingency/ Disaster Recover Plan

Disposition Plan

Plan of Action and Milestone (POA&M)

Imaging Considerations:
Migration Activities for Visa Imaging (VI) Data

Migration of Vista Imaging Data

Migration Workflow

- The Vista Imaging data will be migrated in conjunction with the clinical data using similar workflows

Vendor Neutral Archive (VNA)

- Technology that stores medical images is a standard format and interface
- TBD if VNA will hold administrative and diagnostic images in one archive or separate archives
- VNA will not replace local picture archiving and communication system (PACS), but will receive updates

Diagnostic Evaluation

- Diagnostic evaluation of image will follow the current process
- Central radiology services are possible if sufficient throughput is available via VNA

Data Loading Considerations:

Phased Approach for 4DW System Integration

Phase 1
Initial Data Seeding

- Subset of data to 'seed' PATH EHR
- Can be conducted anytime before PATH EHR onboarding process
- Updates on data elements will flow to the 4DW until Phase 2 begins

Phase 2
Full Clinical Data Load

- Full clinical data set load coinciding with 'go-live'
- Exact timing TBD
- Updates to clinical data made after the export will be handled through subsequent differential exports if needed

Phase 3
RPMS Operation & Decommissioning

- RPMS will continue to operate for a period after 'go-live' to support billing and purchase referred care closeout
- Final export will be placed in long-term archive to satisfy record management timelines
- Upon completion and validation of the export, RPMS can be decommissioned

Historical Data Viewer Considerations:
Capabilities and Integration

Viewer Creation

A viewer will be created on top of the data in the clinical data repository.

Full Specification Development

Full specification for the capabilities of the viewer will be created during the development of the operational system.

Standard View Integration

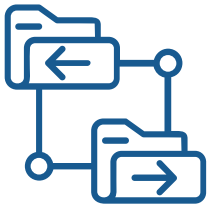
Since the data is being mapped into the FHIR framework, it is anticipated that standard views will be easily incorporated.

Policy Next Steps:
Key Areas of Focus

Operational Terms and Conditions

- Federal, tribal, and urban operational terms and conditions of use

Record Management and Archiving



- Record management policy – data archiving requirements

Special Policies

- Boarding school data policy
- Potential changes to patient privacy forms
- Tribal withdrawal policy/procedure

Data Policies

- 42 CFR Part 2 data policy
- 4DW and patient consent
- Data use agreements

Data Governance

- Data governance and management plans

Preparing for 4DW:
Steps to Ensure Readiness

Key Steps

Ensure Up-to-Date Systems

- Ensure RPMS is up to date with certified software

Fix Common Data Issues

- Begin fixing discovered data issues (LOINC codes, RxNorm nomenclature, NDCs, CPT codes, etc.)

Maintain Integrated Problem List

- Ensure the integrated problem list is maintained

Special Handling

Identify Data Requiring Special Handling

- Substance abuse treatment records
- Behavioral health provider notes
- Employee health records

Identify and Handle Special Data

- Identify these types of data
- Local personnel will need to assess and assist in identifying these elements

IHS Mission

To raise the physical, mental, social, and spiritual health of American Indians and Alaska Natives to the highest level

IHS Vision

Build healthy communities and quality health care systems through strong partnerships and culturally responsive practices

Questions?

Please email the Modernization Program at Modernization@ihs.gov

Stay Connected with IHS

Stay informed on the Health IT Modernization Program at www.IHS.gov/HIT

Resource Hub

Participate in

THE HEALTH IT MODERNIZATION PROGRAM AWARENESS SURVEY

WE WANT YOUR FEEDBACK

SCAN ME


INDIAN HEALTH SERVICE • PHS • 1955

Acronym Definitions (1 of 2)

Acronyms	Description
4DW	
API	Application Programing Interface
C-CDA	Consolidated Clinical Document Architecture
CDR	Clinical Data Repository
CPT®	Current Procedural Terminology
CSV	Comma-separated values
DFN	Data File Number, also IEN
DQS	Domain Query Specification
EHI	Electronic Health Information
EEHR	Enterprise Electronic Health Record
EHR	Electronic Health Record
HIE	Health Information Exchange
HRN	Health Record Number sometimes Chart Number

Acronym Definitions (2 of 2)

Acronym	Description
ICD	
IEN	Internal Entry Number, also DFN
IHS	Indian Health Service
JSON	JavaScript Object Notation
LOINC®	Logical Observation Identifers Names and Codes
MPI	Master Patient Index
MRN	Medical Record Number
NARA	National Archives and Records Administration
NPIRS	National Patient Information Reporting System (IHS)
PAMPI	Problems, Allergies, Medication, Procedures, Immunizations
RPMS	Resource Patient Management System
SNOMED CT®	Systematized Nomenclature of Medicine Clinical Terms
TBD	To be Determined
XML	Extensible Markup Language