Interoperability in Healthcare

Partner Success Team

Terminology

- **MC4H**: Microsoft Cloud for Healthcare
- **FHIR**: Fast Healthcare Interoperability Resources
- **Azure API for FHIR**: Managed PAAS offering from Microsoft
- **EMR**: Electronic Medical Record
- **EHR**: Electronic Health Record
- **CDS**: Common Data Service
- **CDM**: Common Data Model
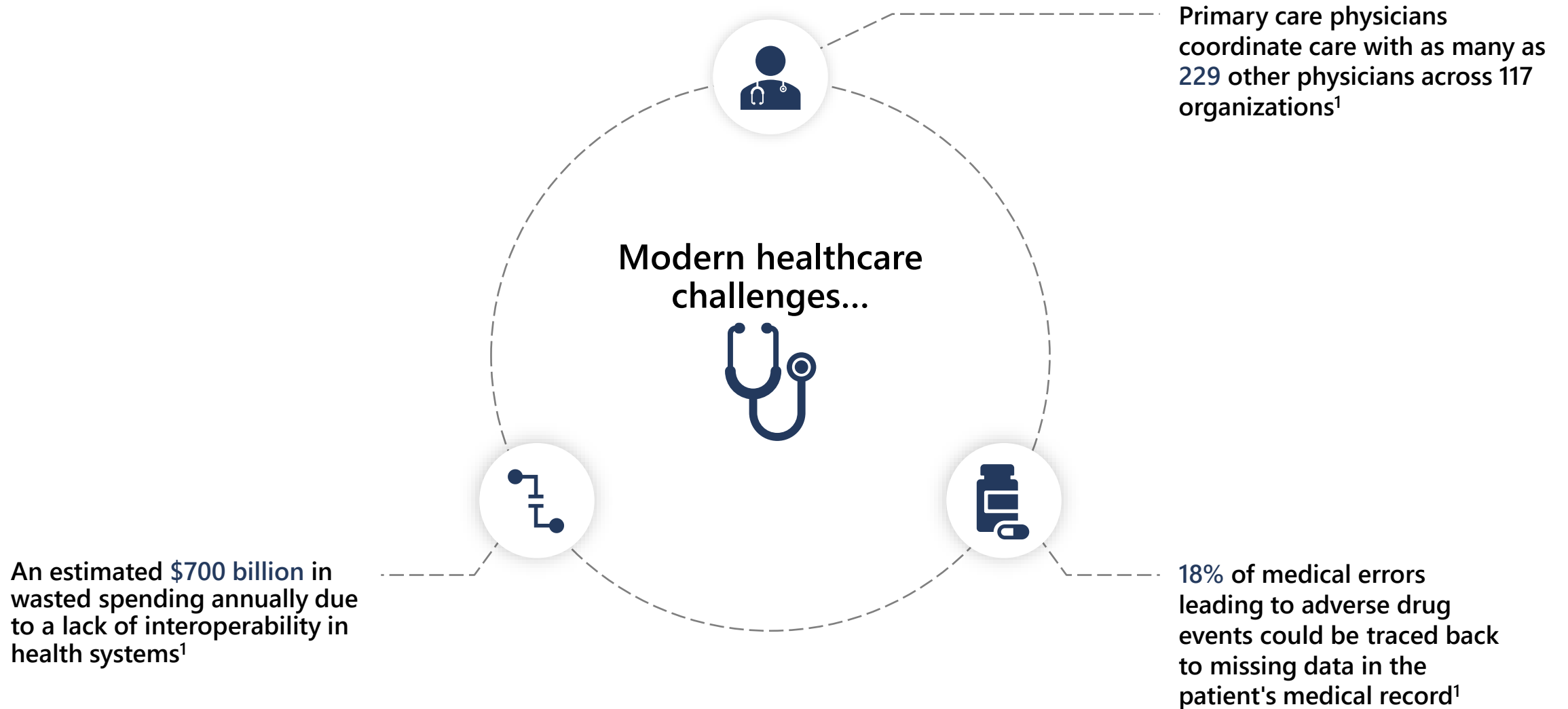
U.S. hospital EHR adoption

98%
meaningful use of health IT

Office of the National Coordinator for Health Information Technology 2016

Modern healthcare challenges...

Primary care physicians coordinate care with as many as 229 other physicians across 117 organizations[1]

18% of medical errors leading to adverse drug events could be traced back to missing data in the patient's medical record[1]

An estimated $700 billion in wasted spending annually due to a lack of interoperability in health systems[1]

[1] Validation and Testing of Fast Healthcare Interoperability Resources Standards Compliance: Data Analysis by Jason Walonoski1, MS ; Robert Scanlon1, MS ; Conor Dowling1 ; Mario Hyland2 ; Richard Ettema2, BS ; Steven Posnack3, MS, MHS - https://medinform.jmir.org/2018/4/e10870/

The Internet of Medical Things (IoMT) market is expected to reach $136.8 billion by 2021[1]

Current situation only accerlating /Increasing a need

...expanded by new health data systems

Big data sets from government agencies and research institutions create new opportunities for clinical research, precision medicine and population health

Advancements in genomics and immunomics provide new insight into a single patient or a population.
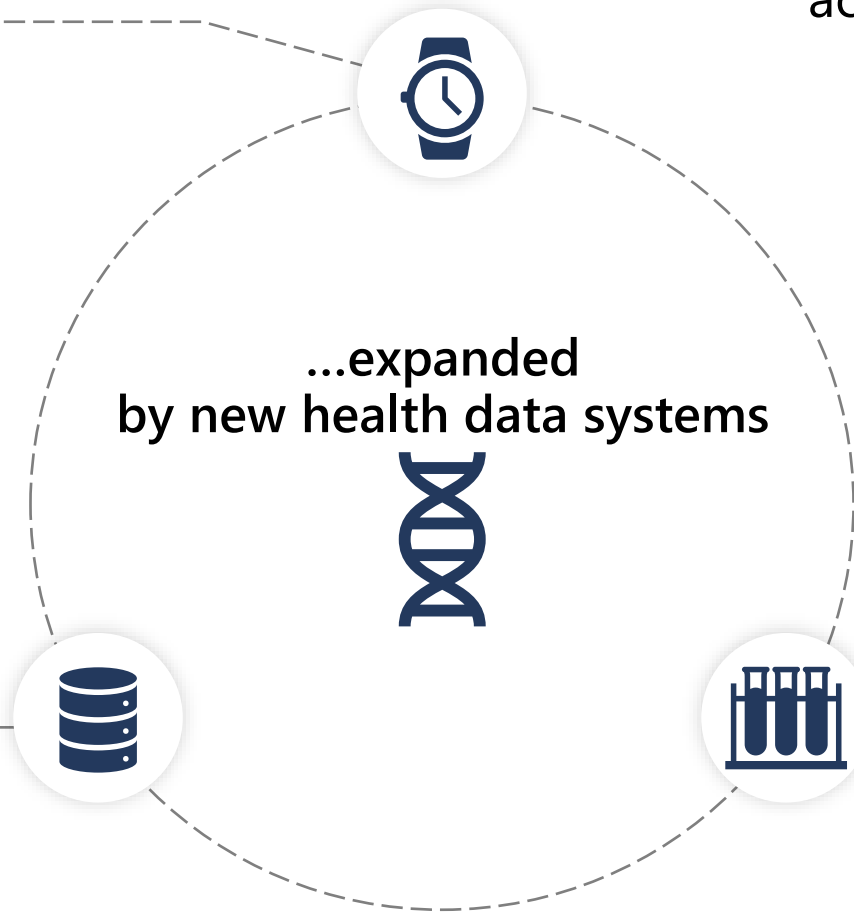
[1] World Internet of Things (IoT) Healthcare Market - Opportunities and Forecasts, 2014-2021 – Allied Market Research

Targeted Domains

Health Data Interoperability

How can we support organizations bringing together data from disparate systems?
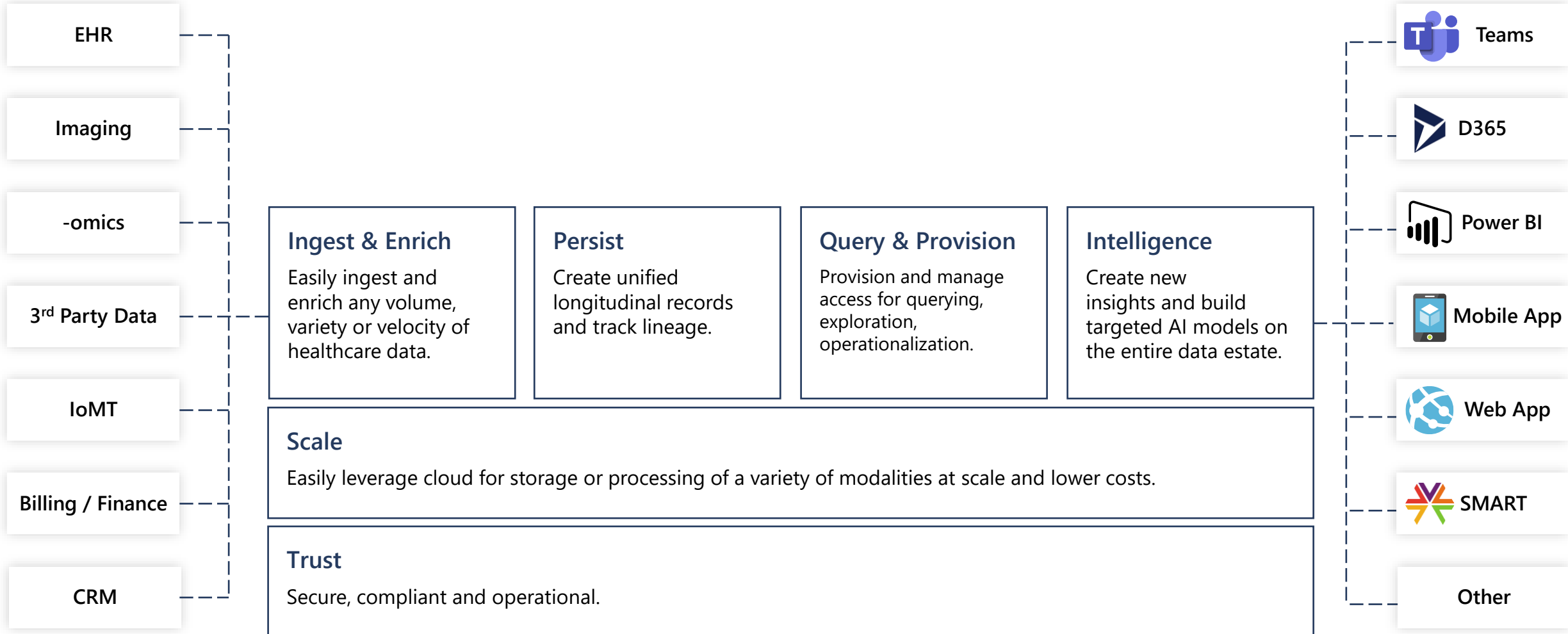
Healthcare Research

How can we support organizations using health data with social determinants of health for research?
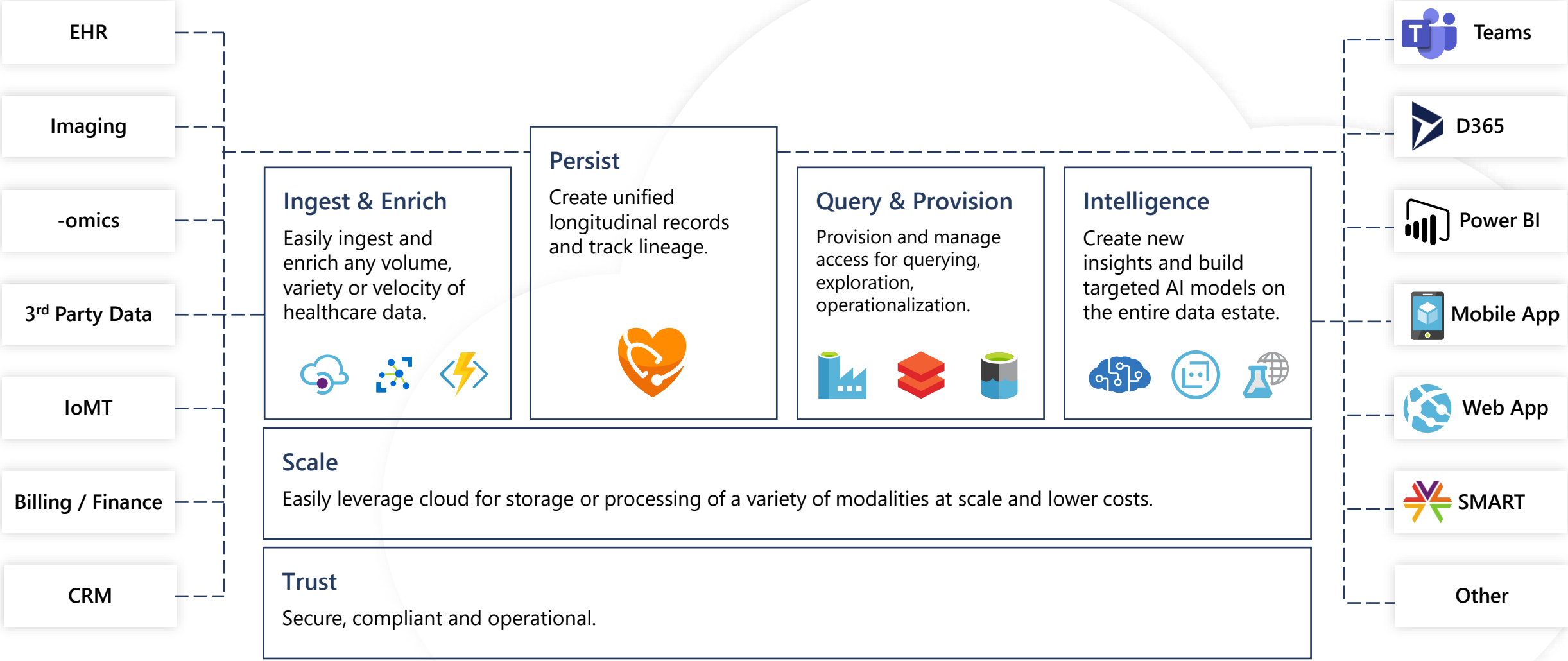
Startup & Innovation

How can we support startup projects that need to collect and managed clinical data?
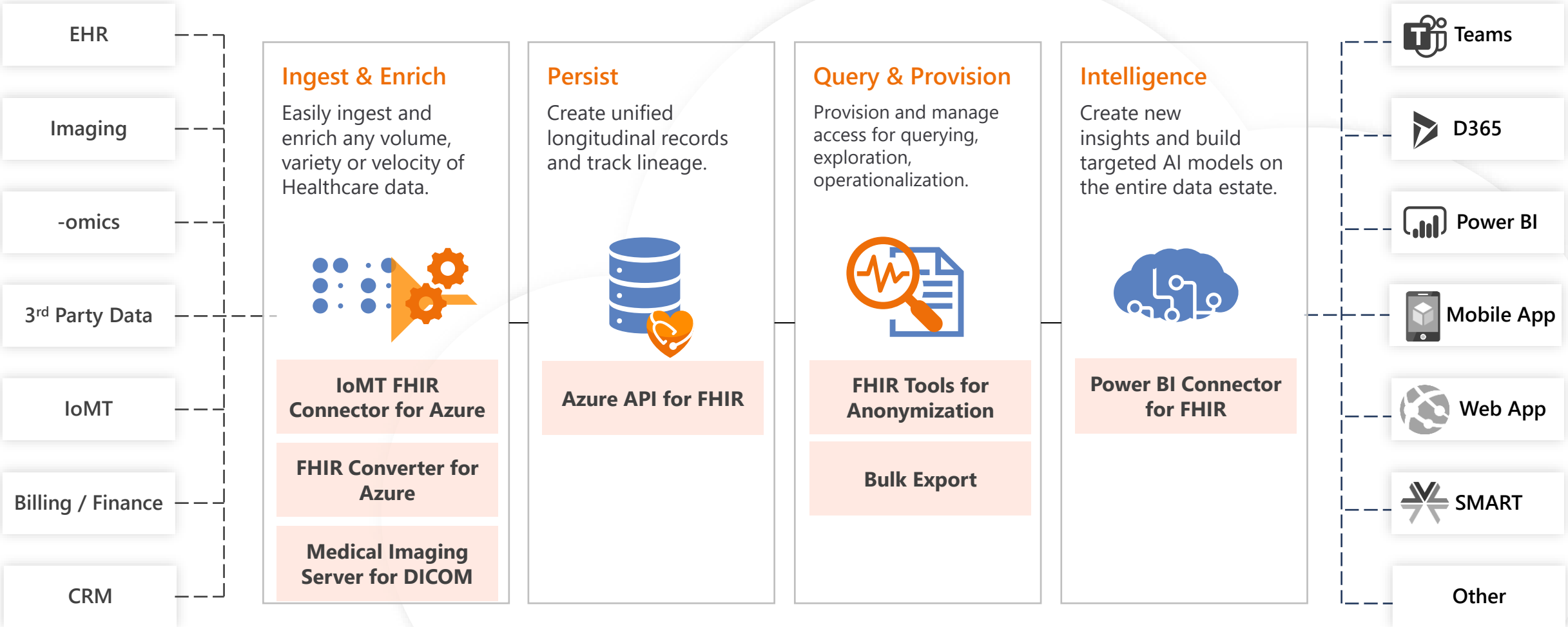
What Organizations Are Asking For

EHR

Imaging

-omics

3rd Party Data

IoMT

Billing / Finance

CRM

Ingest & Enrich
Easily ingest and enrich any volume, variety or velocity of healthcare data.

Persist
Create unified longitudinal records and track lineage.

Query & Provision
Provision and manage access for querying, exploration, operationalization.

Intelligence
Create new insights and build targeted AI models on the entire data estate.

Scale
Easily leverage cloud for storage or processing of a variety of modalities at scale and lower costs.

Trust
Secure, compliant and operational.

Teams

D365

Power BI

Mobile App

Web App

SMART

Other

Enabling Healthcare Solutions in Azure

EHR

Imaging

-omics

3rd Party Data

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Other

Generate insights about patients and the operation

EHR

Imaging

-omics

3rd Party Data

IoMT

Billing / Finance

CRM

Ingest & Enrich
Easily ingest and enrich any volume, variety or velocity of Healthcare data.

IoMT FHIR Connector for Azure

FHIR Converter for Azure

Medical Imaging Server for DICOM

Persist
Create unified longitudinal records and track lineage.

Azure API for FHIR

Query & Provision
Provision and manage access for querying, exploration, operationalization.

FHIR Tools for Anonymization

Bulk Export

Intelligence
Create new insights and build targeted AI models on the entire data estate.

Power BI Connector for FHIR

Teams

D365

Power BI

Mobile App

Web App

SMART

Other

Two offerings to meet your needs

Open source, full control

Built managed and maintained by the Microsoft Healthcare engineering team.

Designed to enable you to operate and manage compliance.

Fully managed Azure offering

Distribution of the open source project, offered as a Platform-as-a-Service in Azure.

Meets regulatory compliance requirements for Protected Healthcare Information (PHI).
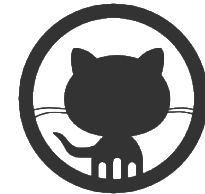
FHIR Server for Azure

Azure API for FHIR

FHIR Server for Azure

Open source implementation of the industry HL7 Fast Healthcare Interoperability Resources (FHIR) specification.

Supports FHIR STU3 and FHIR R4 versions.

Easily deployable into your Azure subscription

An extensible persistence provider model enables multiple options for how data is stored, including Azure Cosmos DB and Azure SQL.

http://github.com/Microsoft/fhir-server
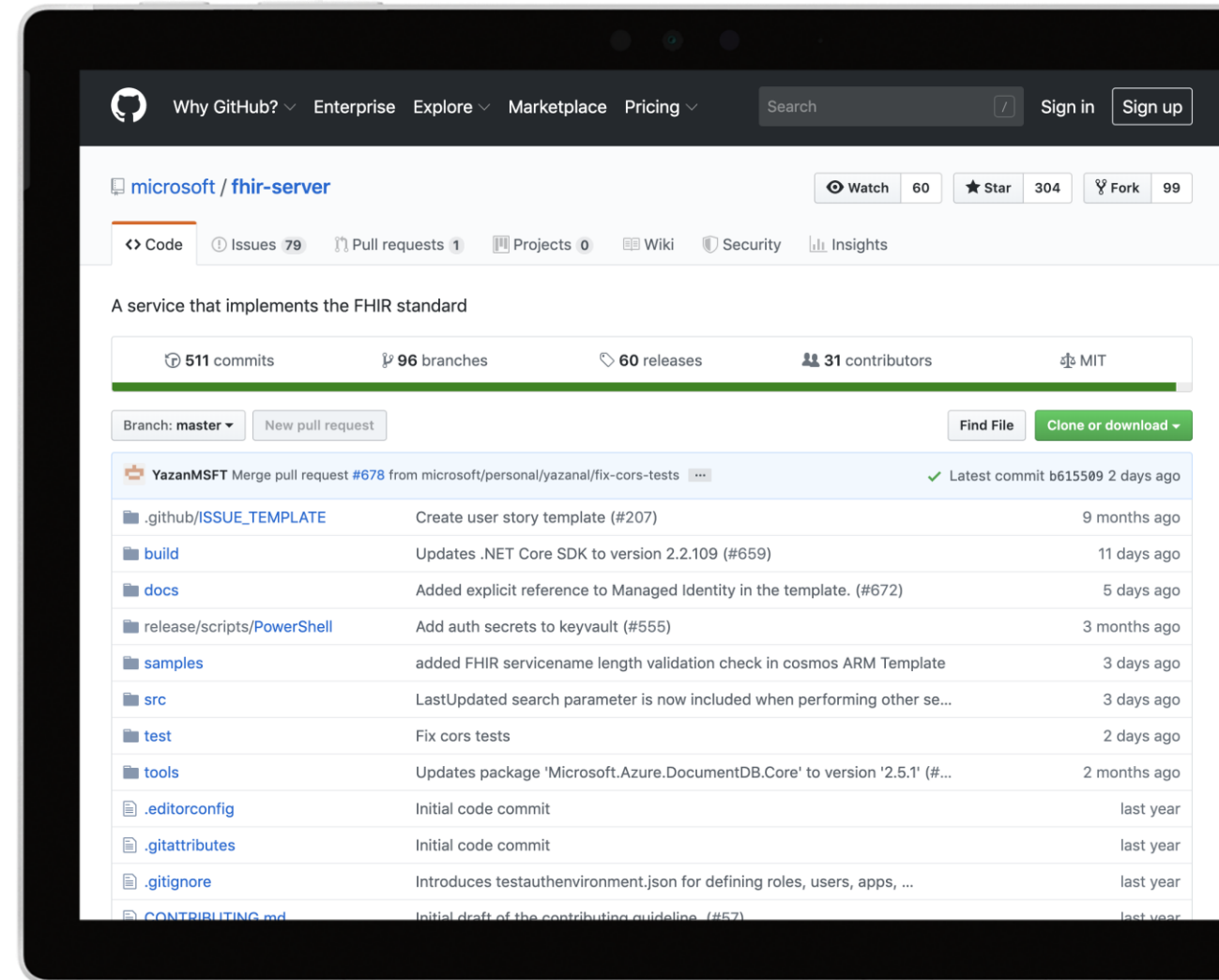
Azure API for FHIR

Fully managed, enterprise-grade FHIR service. Provisioned in the cloud in less than 5 minutes

Enables bringing together health data from disparate systems using industry standard HL7 FHIR (Fast Healthcare Interoperability Resources).

Supports FHIR STU3 and FHIR R4 versions.

Data is isolated and protected with layered, in-depth defense and advanced threat protection according to the most stringent industry compliance standards.

http://aka.ms/fhir
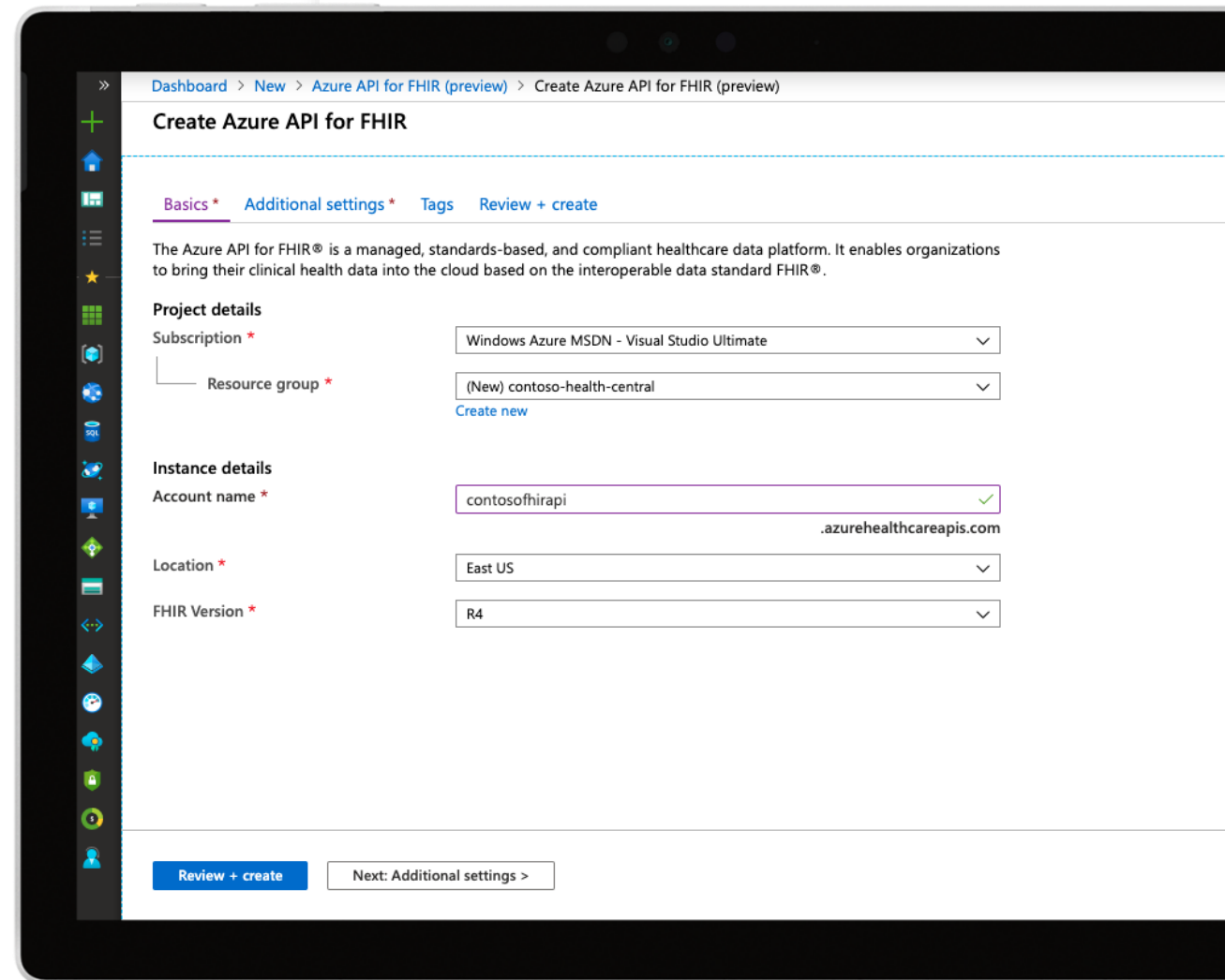
Health Data Interop Enabled by FHIR

Fast Healthcare Interoperability Resources (FHIR) is the health industry data standard describing:

Data formats and elements (known as "resources").

Application Programming Interface (API) for exchanging the resources.

Uses a modern web-based suite of technology, including an HTTP-based RESTful protocol, and JSON.
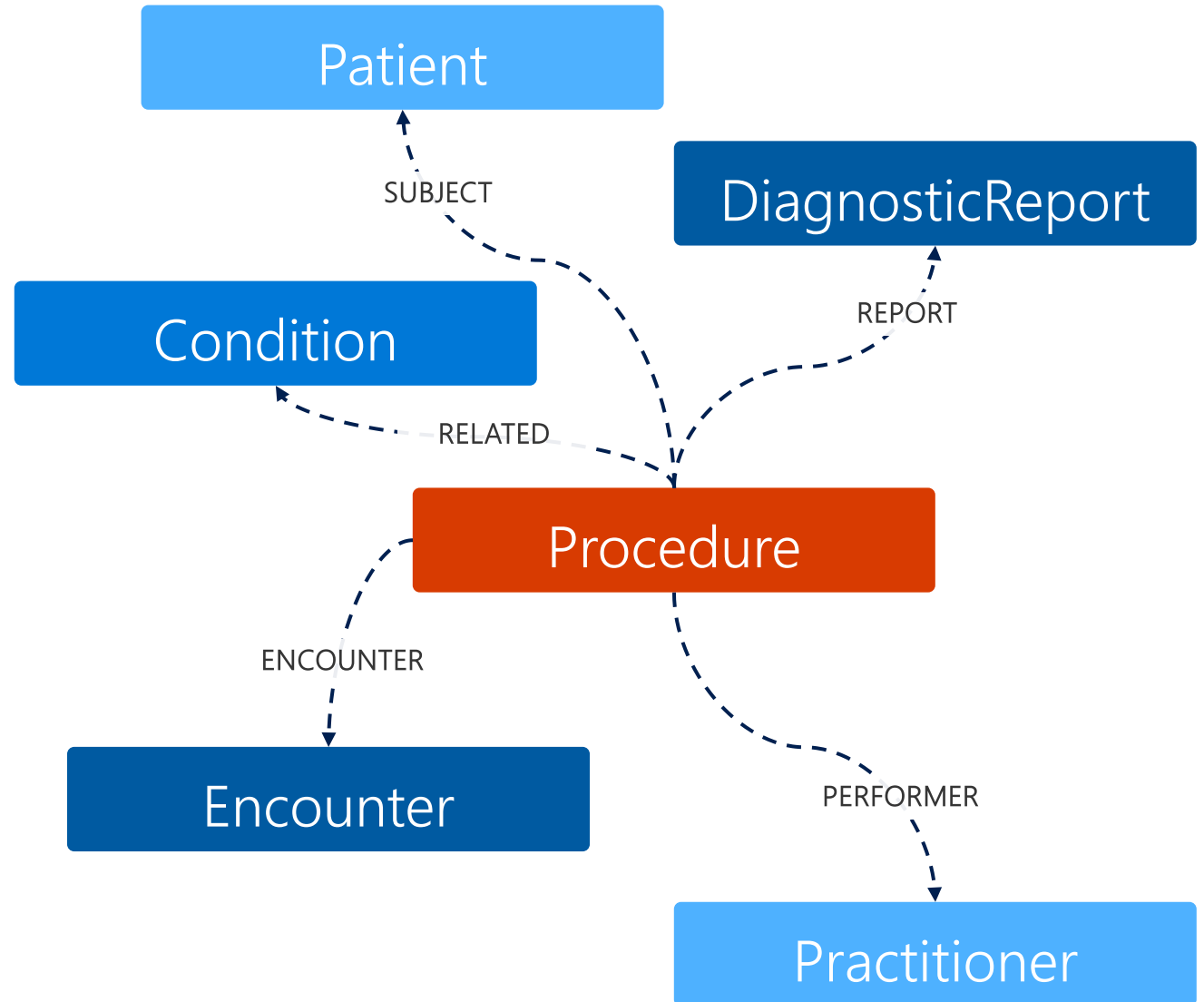
Example FHIR Patient Resource

```
{
    "resourceType": "Patient",
    "id": "ffe591e6-9ee9-460a-8d9b-cbe45cc18732",
    "meta": { "versionId": "1", "lastUpdated": "2019-10-09T13:31:52.544+00:00" },
    "text": {
        "status": "generated", "div":"Generated by Synthea.Version identifier: v2.4.0-418-<snip>" },
        "extension": [ {
            "extension": [ {
                "url": "ombCategory",
                "valueCoding": {
                    "system": "urn:oid:2.16.840.1.113883.6.238",
                    "code": "2106-3", "display": "White"
                }
            },{
                "url": "text",
                "valueString": "White"
            } ],
            "url": http://hl7.org/fhir/us/core/StructureDefinition/us-core-race
        } ],
        "identifier": [ {
            "type": {
                "coding": [ {
                    "system": "http://terminology.hl7.org/CodeSystem/v2-0203",
                    "code": "MR",
                    "display": "Medical Record Number"
                } ],
                "text": "Medical Record Number"
            },
            "system": "http://hospital.smarthealthit.org",
```
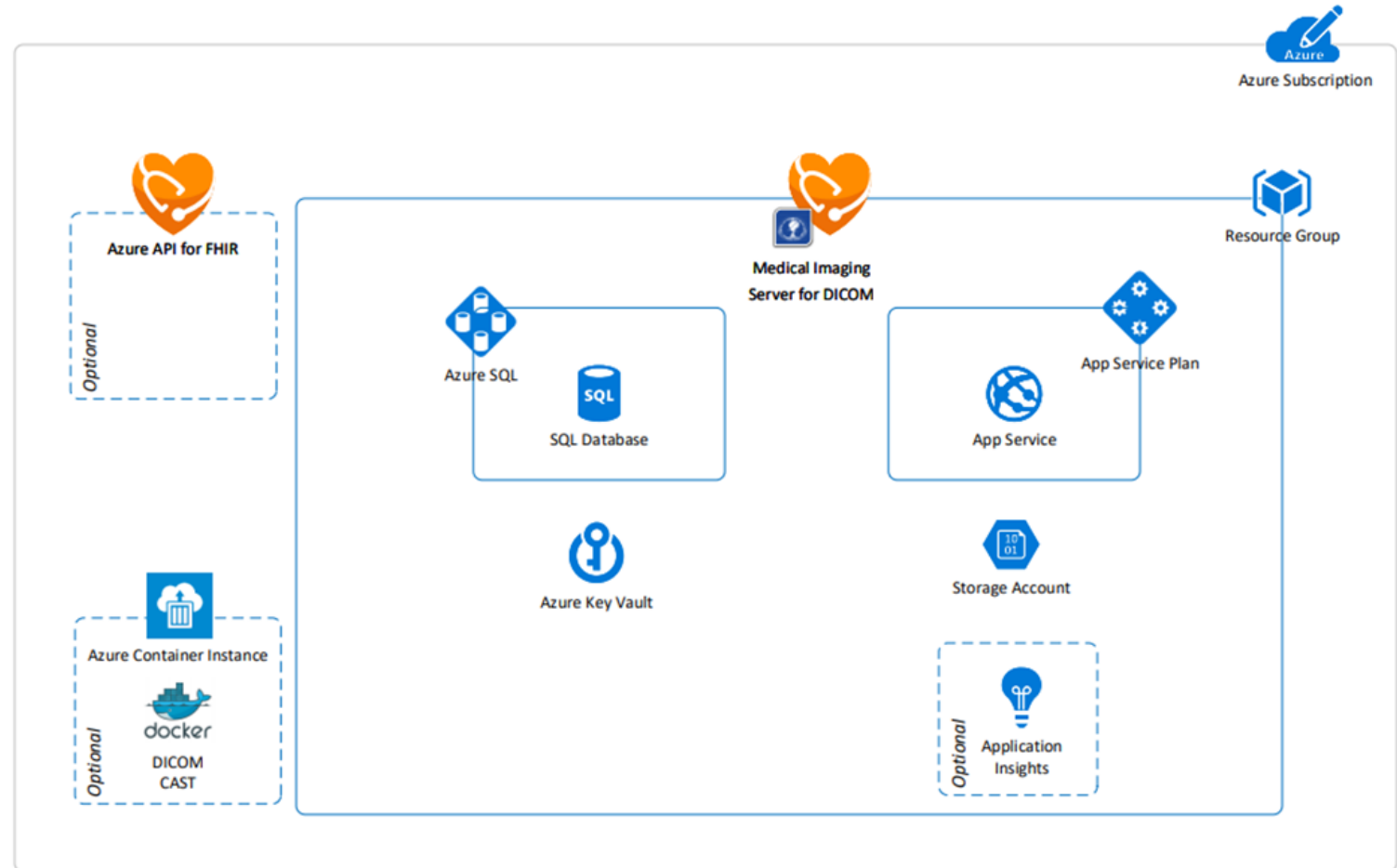
Resource Identity & Metadata
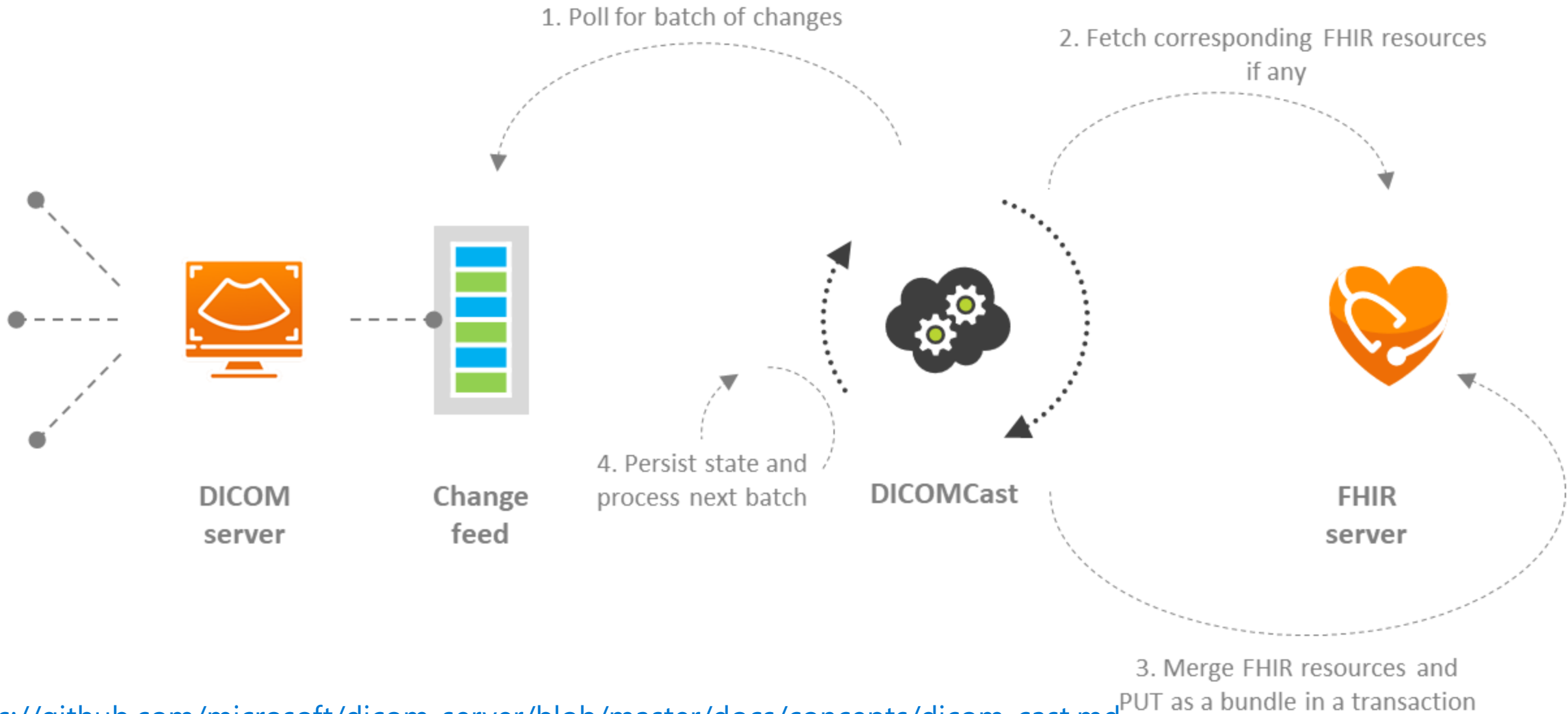
Extension with URL to Definition

Standard Data
- MRN
- Name
- Gender
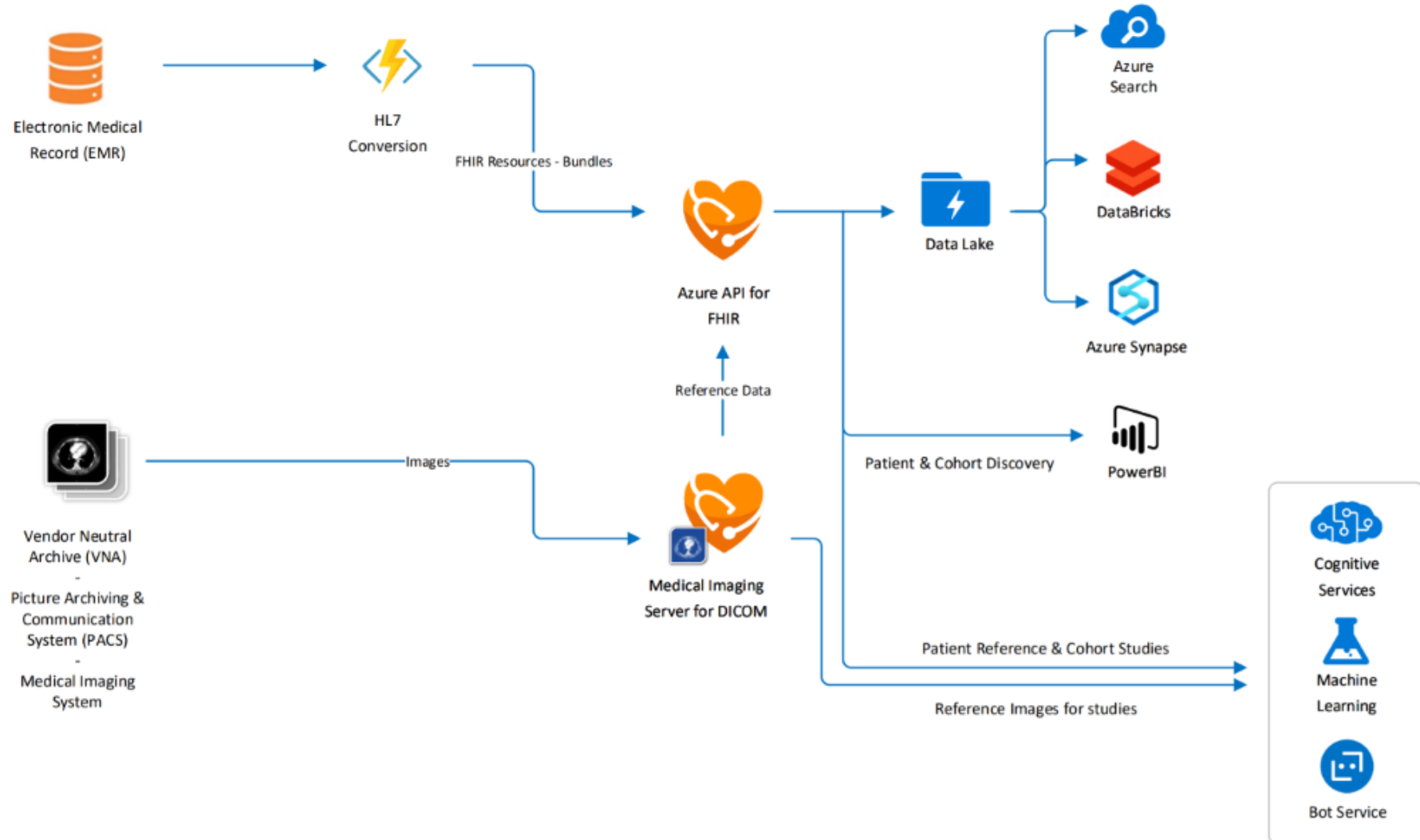- Birthdate
- Provider

Medical Imaging Server For Dicom

DICOM Cast overview

1. Poll for batch of changes

2. Fetch corresponding FHIR resources if any

4. Persist state and process next batch

3. Merge FHIR resources and PUT as a bundle in a transaction

DICOM server

Change feed

DICOMCast

FHIR server

https://github.com/microsoft/dicom-server/blob/master/docs/concepts/dicom-cast.md

Sample Architecture

Assistive AI for radiotherapy planning

Problem: Delineating tumors and anatomy in images by hand is costly and inaccurate

A linear accelerator (linac) for radiotherapy delivery
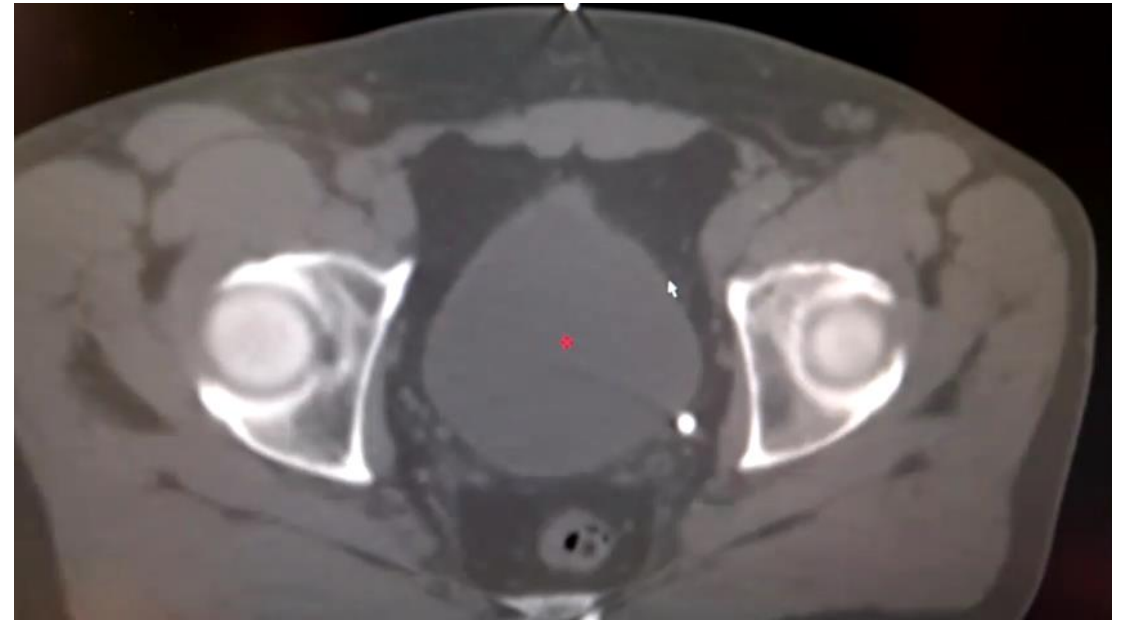
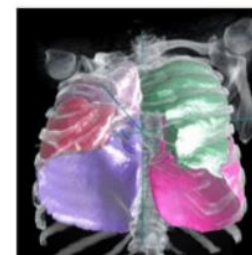Tracing anatomy in a popular commercial tool
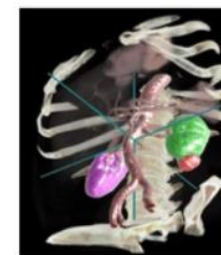
Project InnerEye open-source deep learning toolkit
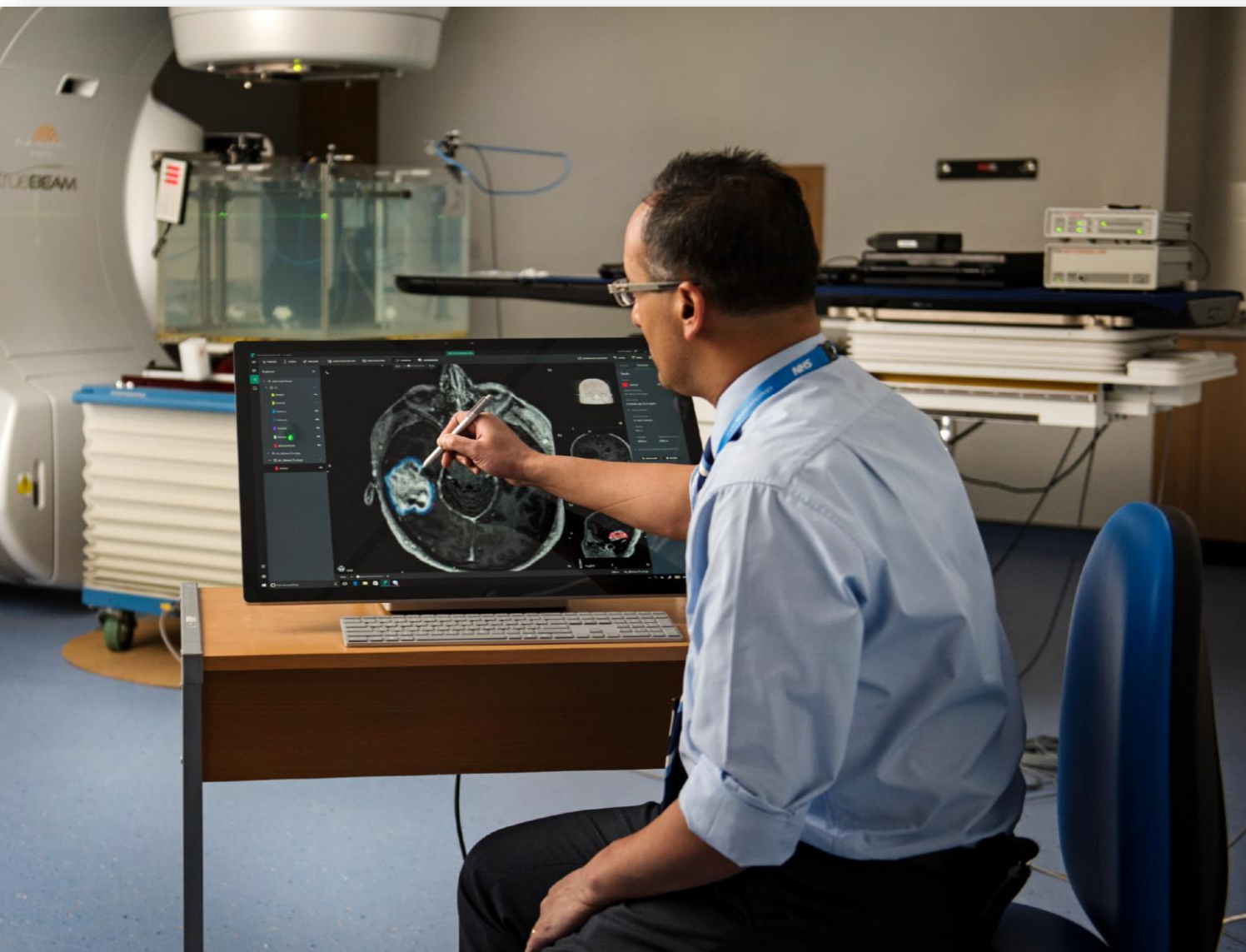
Democratizing medical imaging AI
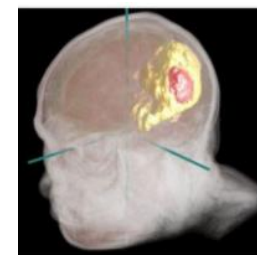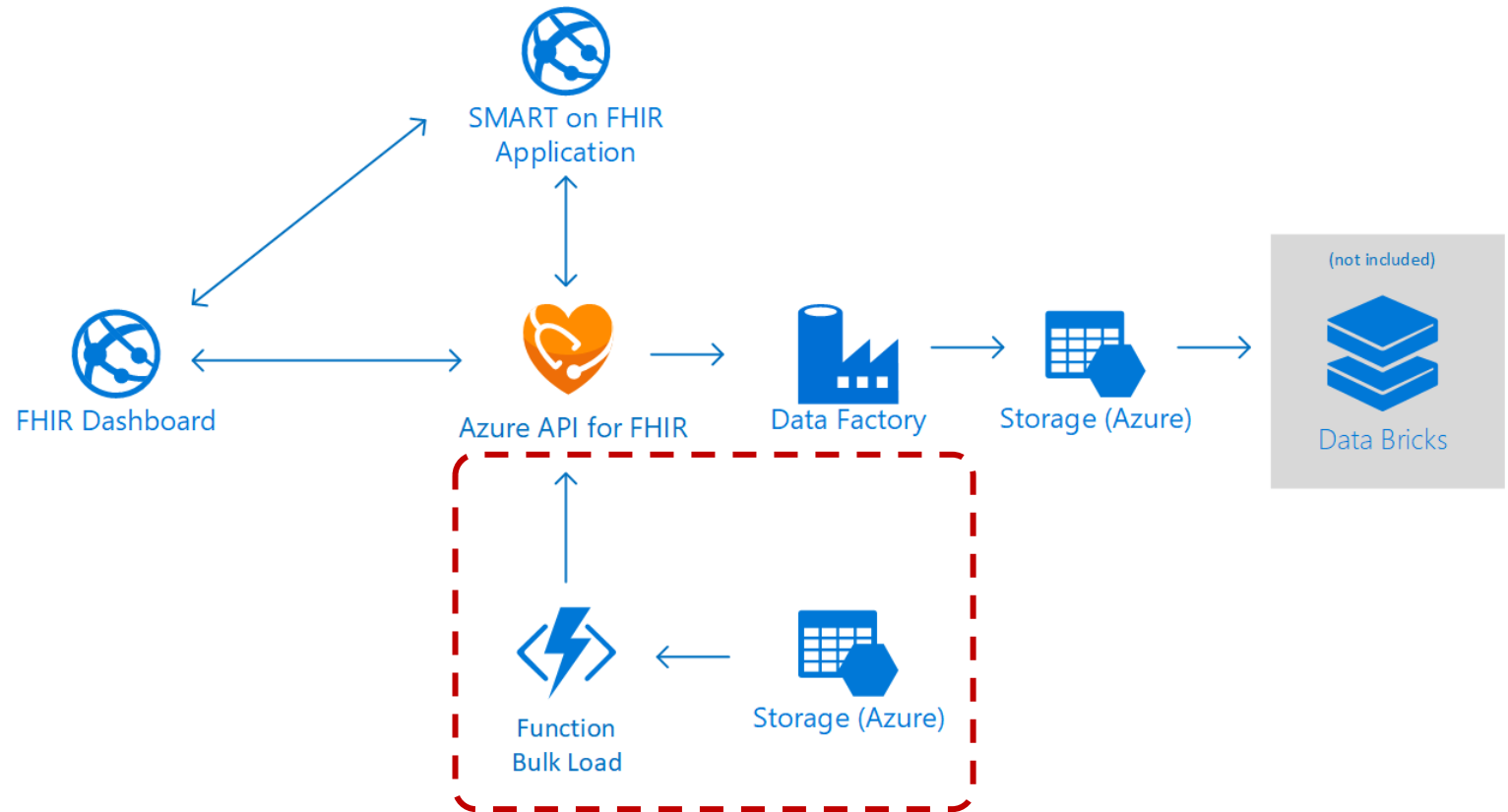

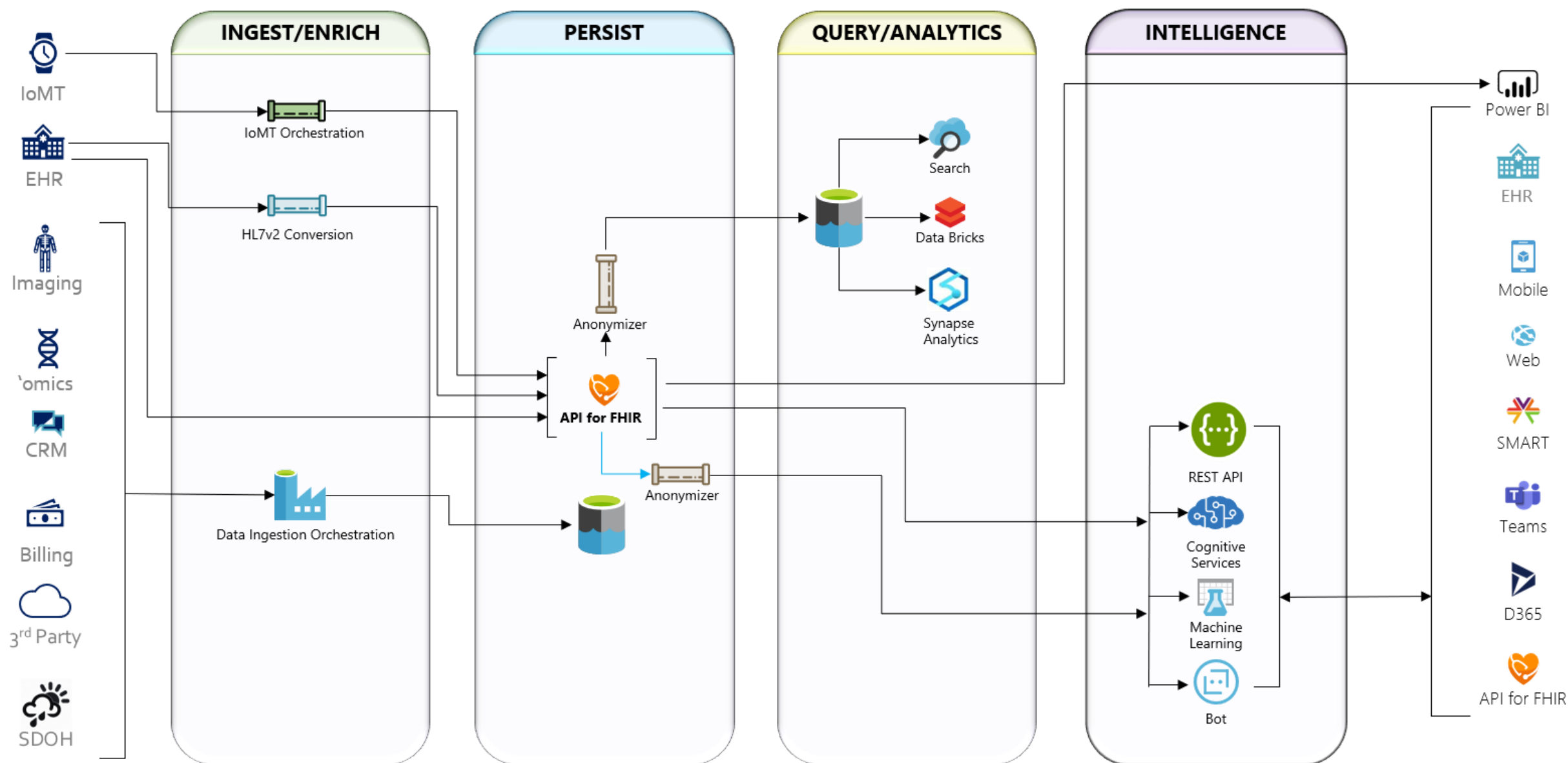Quantitative radiology   Radiation oncology   Surgical planning

FHIR Server Samples

http://github.com/Microsoft/fhir-server-samples

Microsoft Health – Conceptual Architecture (core)

https://github.com/microsoft/health-architectures

Coming soon.

Bulk Export

Coming soon

Run FHIR search queries where the results are asynchronously dropped into a storage container.

Initiates the asynchronous process of a client's request for the generation of a set of data to which the client is authorized – whether that be all patients, a subset (defined group) of patients, or all available data contained in a FHIR server.

Currently available in the open source FHIR Server for Azure.
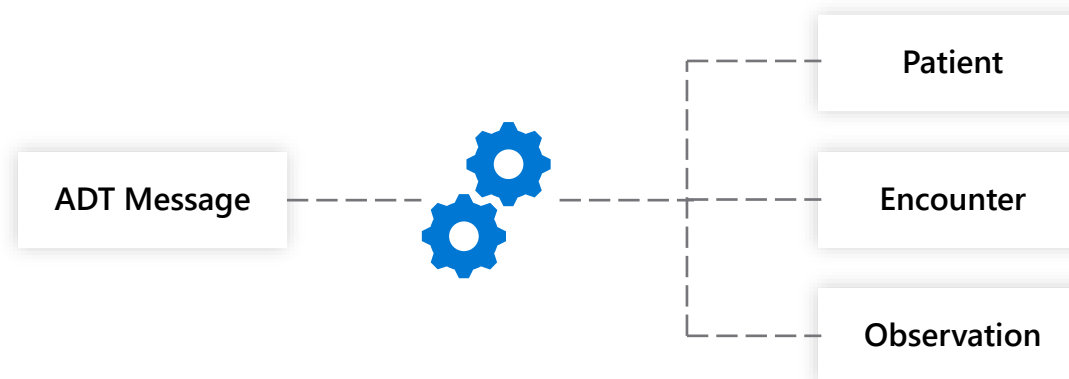
FHIR Query

Patient

Support for HL7v2
Coming soon

Ingest HL7v2 messages that are converted to FHIR resources and persisted.

A library of templates for common HL7v2 messages types, such as ADT messages to Patient, Encounter and Observation resources.

Extensible and customizable templates allowing you to define your own HL7v2 to FHIR transformations.

FHIR for Data Science
Coming soon

Query for de-identified cohorts to enable data scientists to build new models.

Phase 1: Redaction of 18 HIPAA defined identifiable attributes (e.g. names, addresses, dates).

Phase 2: Expert determination enabled through tooling that allows you to define the rules for de-identification.

Phase 3: Risk analytics help identify the likelihood of a de-identified data set being re-identified.

```
{
    "resourceType": "Patient",
    "id": "ffe591e6-9ee9-460a-8d9b-cbe45cc18732",
    "meta": { "versionId": "1", "lastUpdated": "2019-**-**T**:**:**.***
    "text": {
        "identifier": [ {
            "type": {
                "coding": [ {
                    "system": "http://terminology.hl7.org/CodeSystem/v2-020
                    "code": "SS", "display": "Social Security Number"
                    } ],
                "text": "Social Security Number"
                },
            "system": "http://hl7.org/fhir/sid/us-ssn",
            "value": "***-**-****"
            } ],
        "name": [ {
            "use": "official",
            "family": "********", "given": [ "********" ],
            "prefix": [ "*" ]
            } ],
        "telecom": [ {
            "system": "phone",
            "value": "***-***-****",
            "use": "home"
            } ],
        "birthDate": "1994-**-**",
        "address": [ {
```
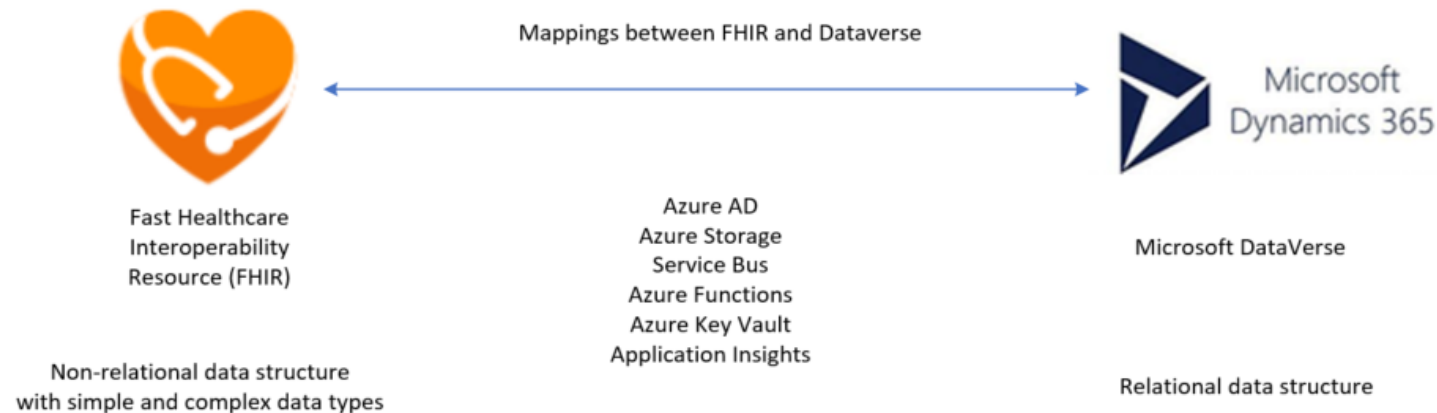
What is FHIR Sync Agent?

✓ FHIR Sync Agent is a data synchronization Solution between the two data service platforms, Azure API for FHIR and Microsoft Cloud for Health.

Why do we need FHIR Sync Agent?

✓ Azure API for FHIR and Dataverse(Microsoft Cloud for Health) are two different services from Microsoft. Azure API for FHIR uses flexible data structure and Dataverse uses relational data tables and columns. FHIR sync agent is created to synchronize data between two services securely and seamlessly.

Mappings between FHIR and Dataverse

Fast Healthcare
Interoperability
Resource (FHIR)

Azure AD
Azure Storage
Service Bus
Azure Functions
Azure Key Vault
Application Insights

Microsoft Dynamics 365

Microsoft DataVerse

Non-relational data structure
with simple and complex data types

Relational data structure

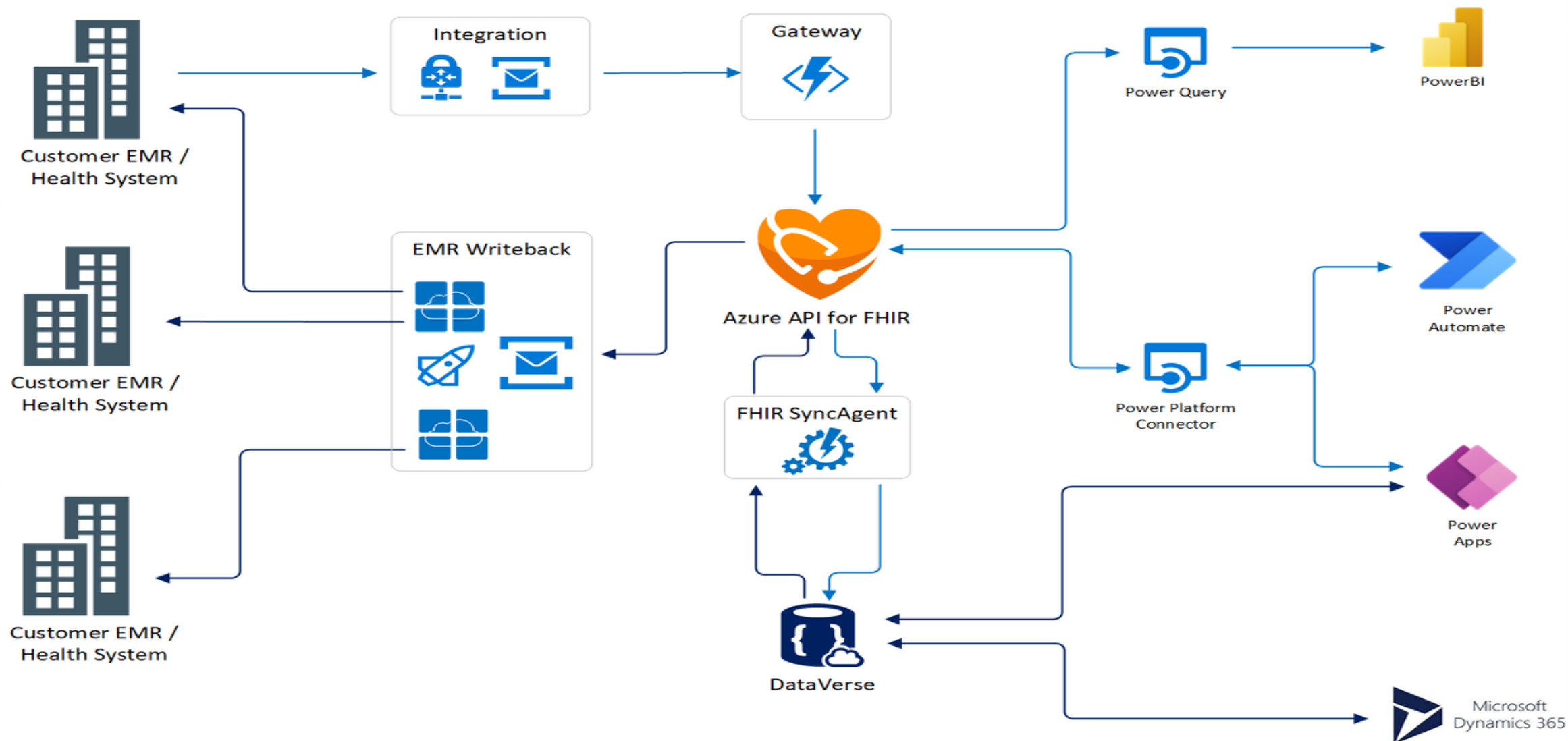# FHIR Sync Agent - Overview

FHIR Sync Agent – Rules & Guidelines

✓ Data synchronization is triggered by an event or a message.

✓ Only metadata is stored in the service bus queue. No FHIR or patient health information (PHI) is stored in any service bus queue.

✓ You can turn off or turn on which elements to sync. By default, patient (contact) records in Dataverse are enabled for synchronization. For all other data, do not sync the data if you do not need it in FHIR.

✓ Only a patient resource is sent to and populated in Dataverse. All patient clinical and financial data, such as encounters, observations, and appointments, are sent to Dataverse after patient consent. All subsequent data changes for consented patients are synchronized automatically. This reduces the amount of FHIR data that is synchronized with Dataverse.

✓ Only a subset of FHIR data is synchronized between Azure API for FHIR and Dataverse.

Important: The FHIR Sync Agent does not interact with any electronic medical record (EMR) system directly. The FHIR Sync Agent does not read data from an EMR system and does not write data to an EMR system. Instead, Azure API for FHIR is responsible for data ingestion from an EMR system and data write-back to an EMR system.

Microsoft Health – Dynamics Integration Architecture
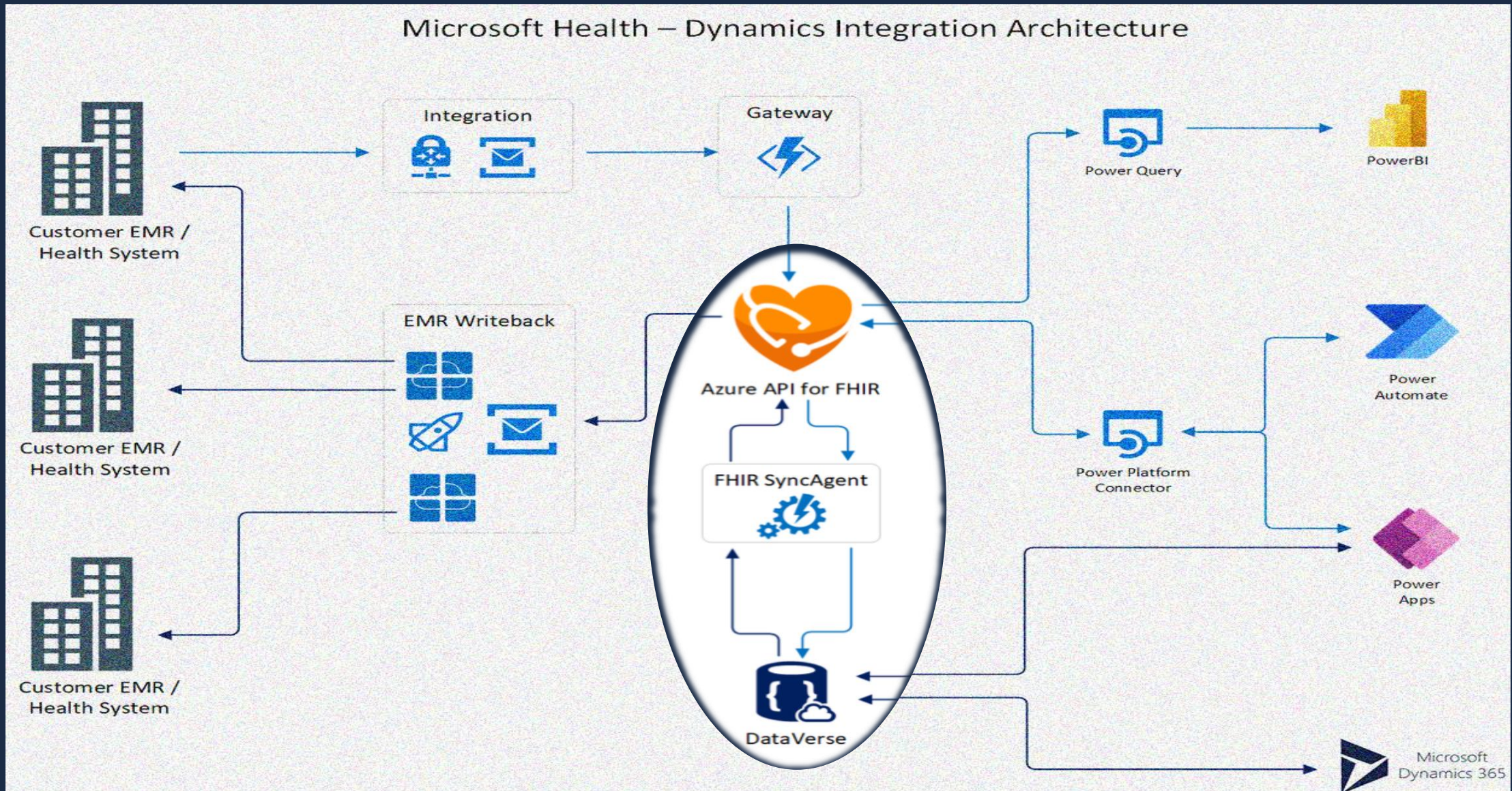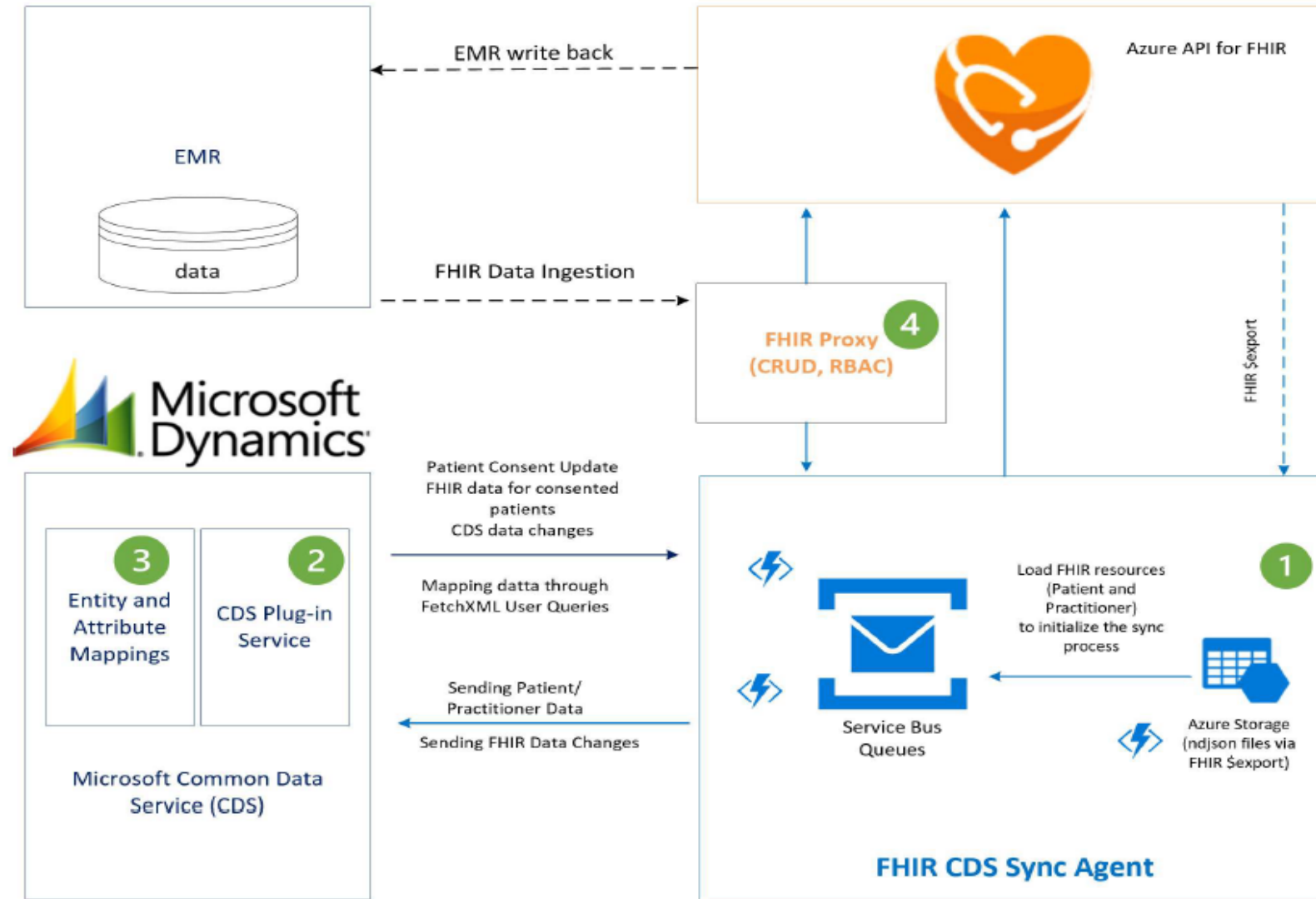
Microsoft Health – Dynamics Integration Architecture

Azure Components (1)

- **Azure Key Vault – Safeguard's connection secrets used by Azure Functions**
- **Azure Service Bus – Maintains the ordered queues for processing messages/event**
  - **cdsupdates -** This queue is for messages from Dynamics CDS to the FHIR Service. It is responsible for maintaining ordering and temp storage of messages while inflight. These messages do not store PHI or PII. The messages have an id for the function to use for pulling data from CDS and pushing to the FHIR service
  - **Fhirupdates -**This queue is for messages from the FHIR Service going to Dynamics CDS. It is responsible for maintaining ordering and temp storage of messages while inflight. These messages do not store PHI or PII. The messages have an id for the function to use for pulling data from FHIR and pushing to the CDS service
- **Azure Functions - Message/Event Processor.** There are three functions in the function app.
  - **FHIRNDJsonFileLoader** - Used to bulk load the data from the API for FHIR or FHIR Server for Azure to the Dynamics CDS. These loads are not continuous. They are planned. For example, this process would be used to seed patients in Dynamics CDS
  - **ProcessingCDSUpdates** - Used to load messages from Dynamics CDS via the cdsupdates queue to the API for FHIR or FHIR Server for Azure on an ongoing basis.
  - **ProcessingFHIRUpdates** - Used to load messages from the API for FHIR or FHIR Server for Azure via the fhirupdates queue to the Dynamics CDS on an ongoing basis.
- **Azure Storage -** Used for the staging the ndjson files for the bulk loading Dynamics CDS via the Azure Function FHIRNDJsonFileLoader. Also used as the storage location for the Azure Function typical processing needs.
- **Application Insights** - Central logging of the Azure Function message/event processing
- **App Service Plan** - the compute plan for the Azure Function.

FHIR Sync Agent – Dependencies

Dataverse Components (2 & 3)

- Dataverse Plug-in service
- FHIR Synch Agent Administration App
    - Settings to communicate with Azure Components
   - Healthcare Entities Mappings

FHIR Proxy (4)

- Secure FHIR Proxy is an Azure Function
    - Acts as an intelligent and secure gateway to Azure API for FHIR
    - Allows multi-tenant access and purpose driven security policies for specialized access to FHIR servers
    - Provides Pre & Post processing support
    - Integrated with Azure Active Directory for authentication to provide Role Based Access Control
    - Acts as a FHIR specific reverse proxy rewriting responses and brokering requests to FHIR servers
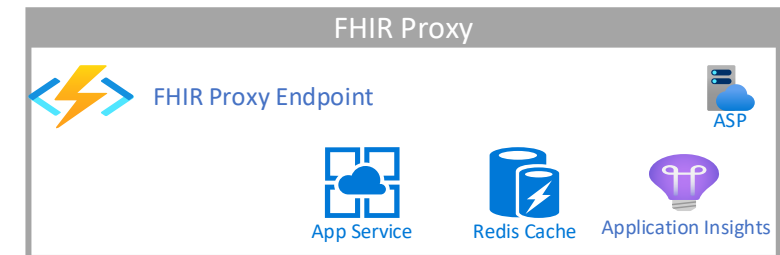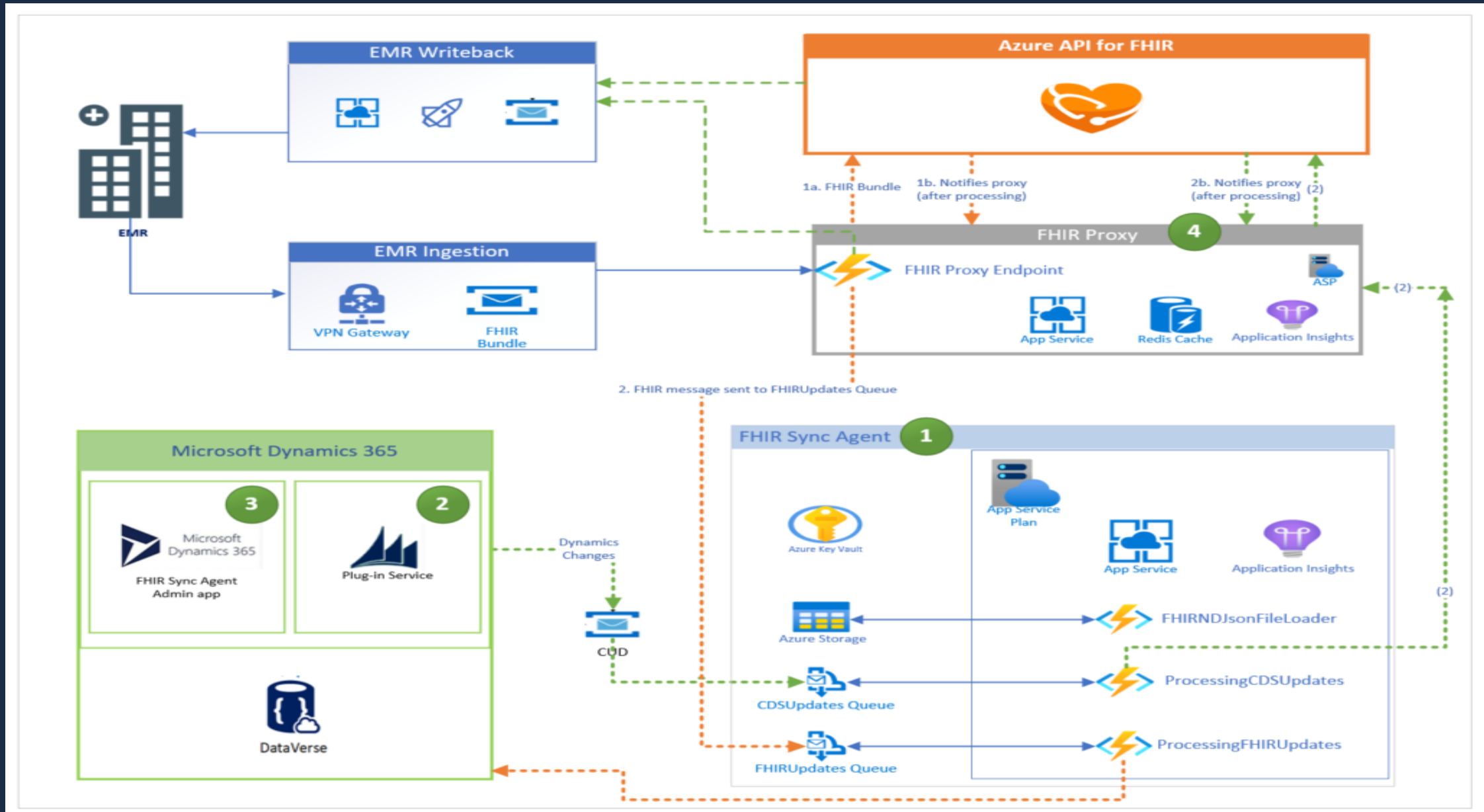
FHIR Sync Agent – Pre-requisites

- **Pre-requisites**

    - Microsoft Cloud for Healthcare Environment

        - If you have not completed the environment setup, please reference the following two links:

            - <u>Setup configure Microsoft Cloud for Healthcare</u>

            - <u>Microsoft Cloud for Healthcare Licensing</u>

    - Azure API for FHIR

        - Pleaser refer to the following links:

            - <u>Deploy Azure API for FHIR using Azure portal | Microsoft Docs</u>

            - <u>Azure API for FHIR(r) | Microsoft Azure</u>

    - FHIR Proxy * (Documentation does not include configuration of FHIR Sync Agent Post processor plugin – Internal for now)

        - FHIR Proxy consists of an Azure Function to process data (FHIR bundle) to Azure API for FHIR

        - <u>Setup and Configure FHIR Proxy</u> (Known Issue: Azure subscription resource types → List resource types)

- **Best Practices – Order of Installation**

    - Setup Microsoft Cloud for Healthcare Environment

    - Install Azure API for FHIR

    - Install the FHIR Proxy in the same resource group as the FHIR Service

    - Install the FHIR-Sync-Agent in the same resource group as the Azure API for FHIR and FHIR Proxy
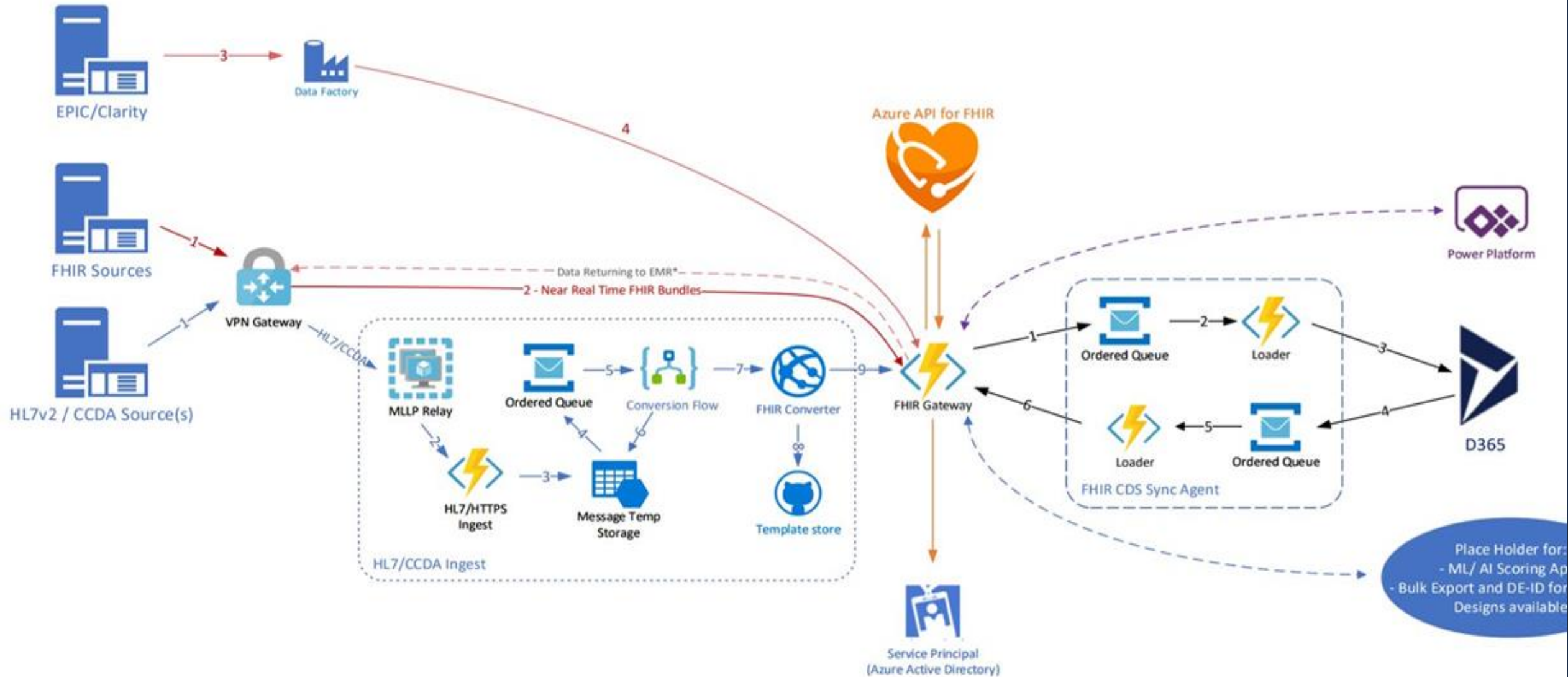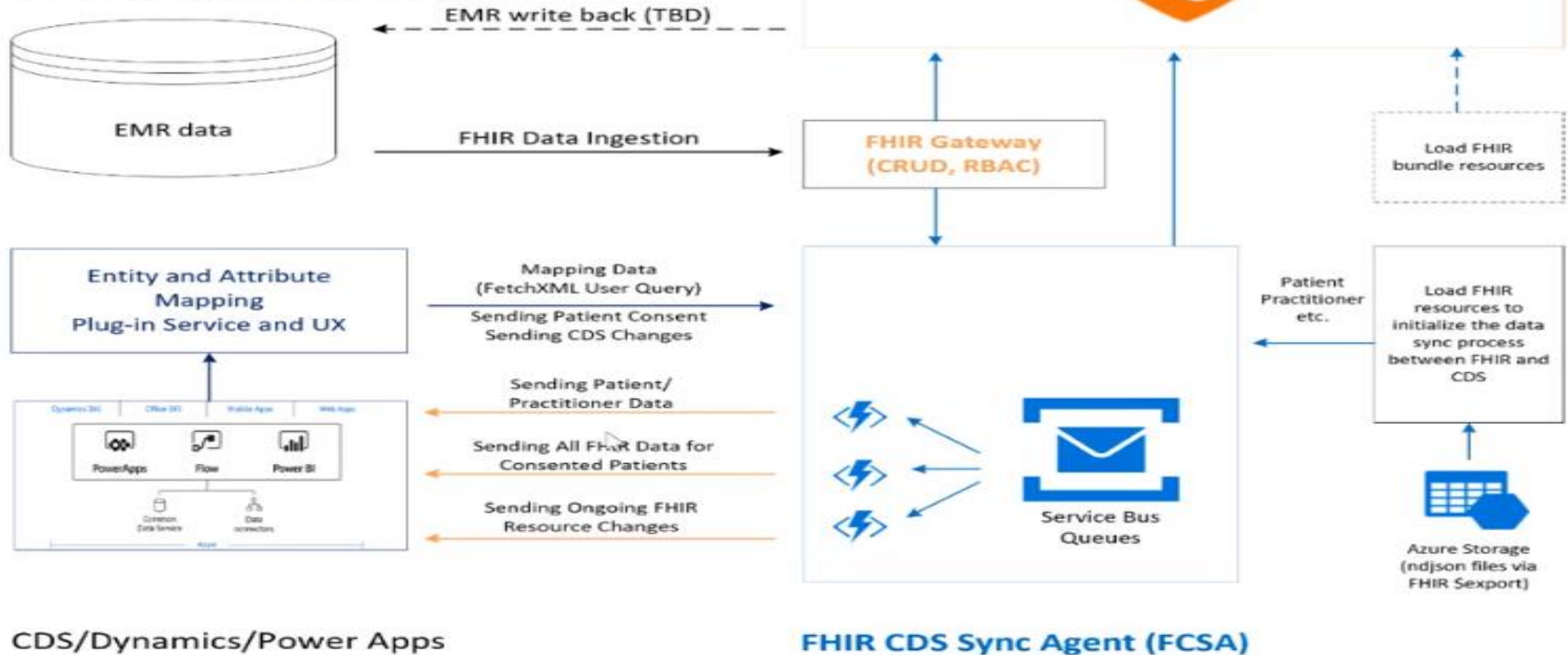
FHIR and CDS Sync Agent (FCSA)
1) Patient only data is sent to CDS via FHIR Gateway (or the standalone tool) and FCSA
2) User logs into Dynamics app. Additional FHIR data is sent to CDS upon user consent.
3) FHIR data changes are sent to CDS via FHIR Gateway and FCSA.
4) CDS data changes are sent to FHIR through FCSA and FHIR Gateway.
Note: FCSA uses Azure Functions associated with Service Bus Queues. No PHI data is stored outside of FHIR and CDS in the sync service.

EMR write back (TBD)

Azure API for FHIR

EMR data

FHIR Data Ingestion

FHIR Gateway (CRUD, RBAC)

Load FHIR bundle resources

Entity and Attribute Mapping Plug-in Service and UX

Mapping Data (FetchXML User Query)
Sending Patient Consent
Sending CDS Changes

Patient Practitioner etc.

Load FHIR resources to initialize the data sync process between FHIR and CDS

PowerApps   Flow   Power BI

Common Data Service   Data connectors

Sending Patient/ Practitioner Data

Sending All FHIR Data for Consented Patients

Sending Ongoing FHIR Resource Changes

Service Bus Queues

Azure Storage (ndjson files via FHIR $export)

CDS/Dynamics/Power Apps

FHIR CDS Sync Agent (FCSA)

Microsoft

Thank you