



Interoperability in Healthcare

Partner Success Team



- **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

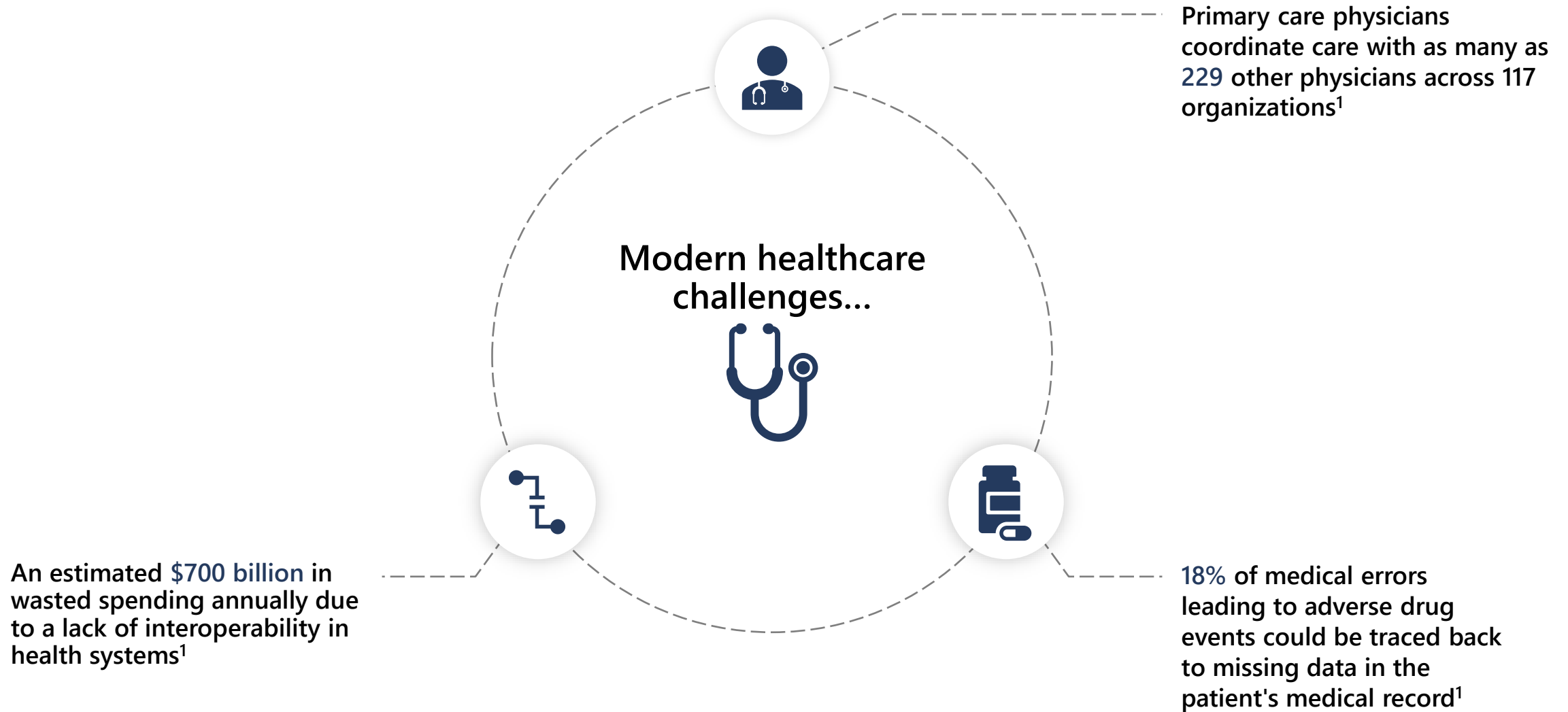
U.S. hospital EHR adoption

98%

meaningful use of health IT



Office of the National Coordinator for Health Information Technology 2016



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/>

Current situation only
accelerating /Increasing a need

The Internet of Medical
Things (IoMT) market is
expected to reach **\$136.8
billion** by 2021¹

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

...expanded
by new health data systems



Advancements in genomics
and immunomics provide
new insight into a single
patient or a population.

Targeted Domains



Health Data Interoperability

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



Healthcare Research

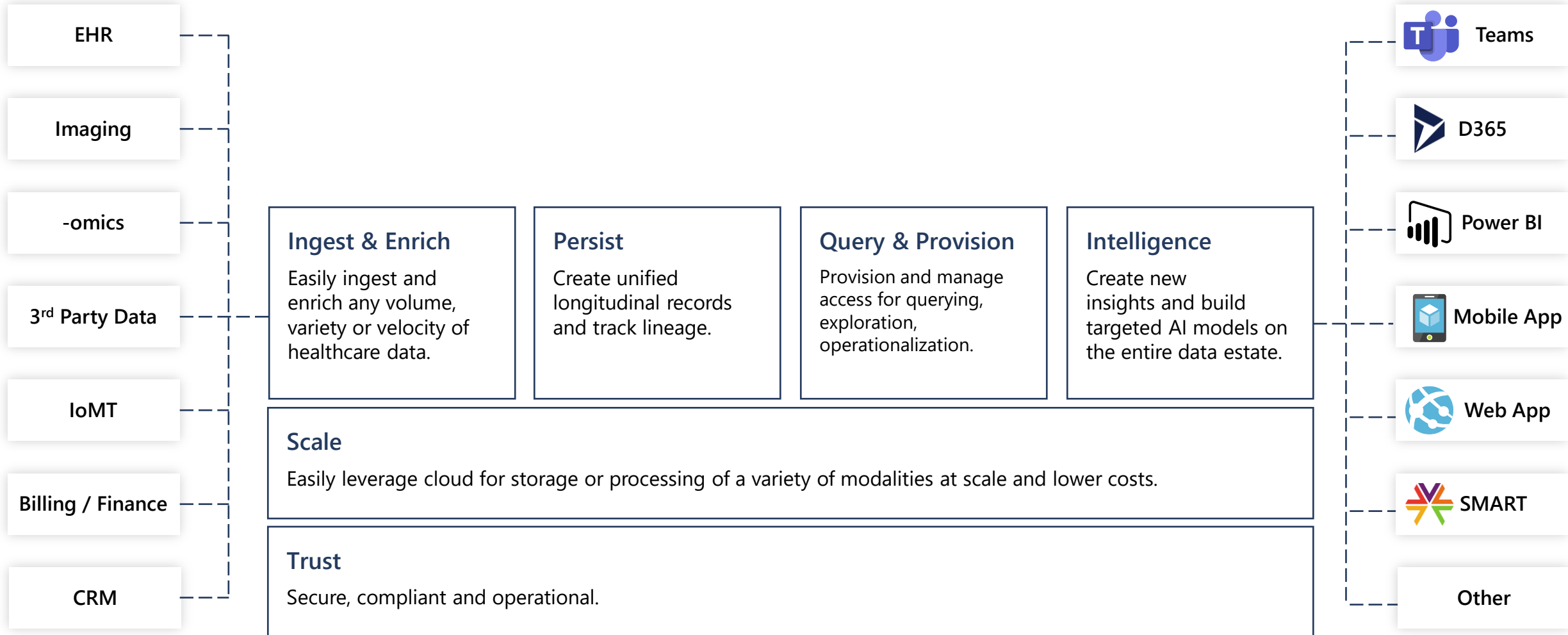
*How can we support
organizations using
health data with
social determinants of
health for research?*



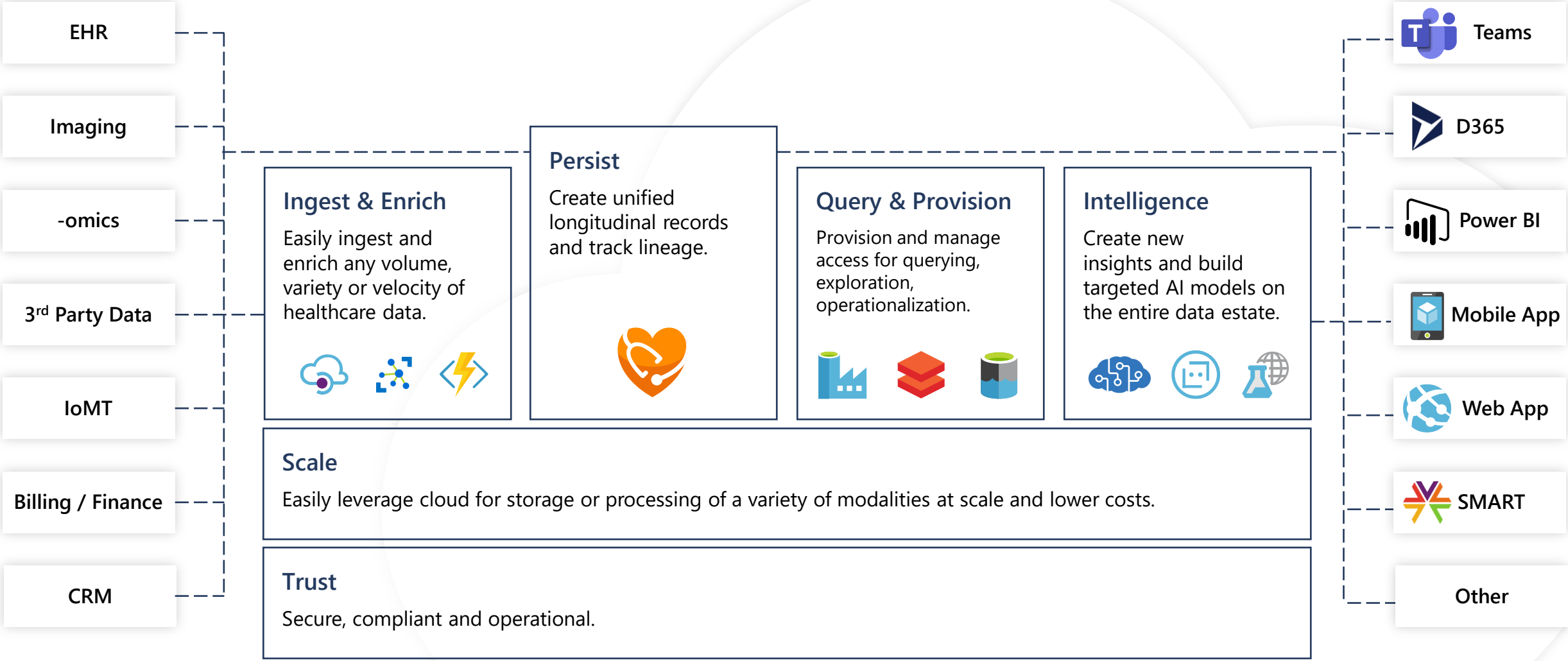
Startup & Innovation

*How can we support
startup projects that
need to collect and
managed clinical data?*

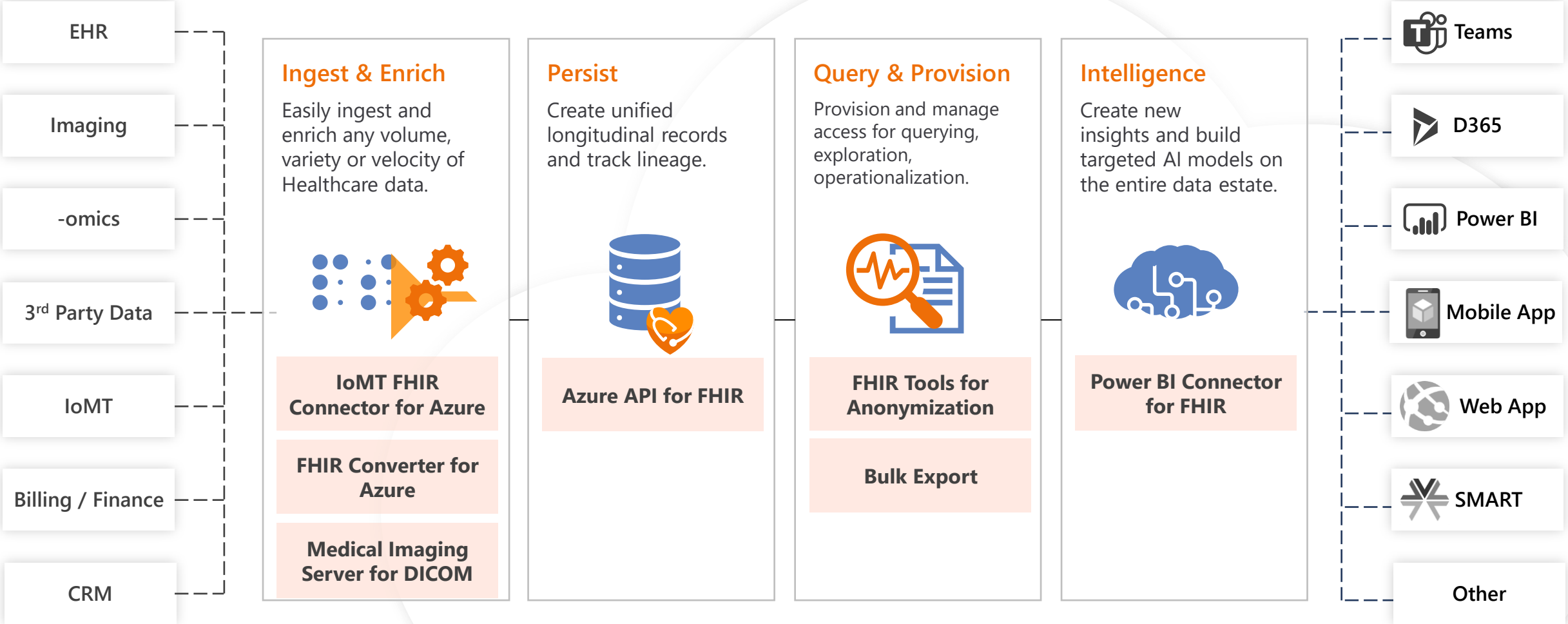
What Organizations Are Asking For



Enabling Healthcare Solutions in Azure



Generate insights about patients and the operation



Two offerings to meet your needs

Open source, full control

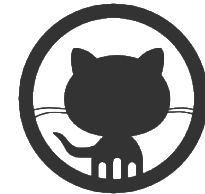
Built, managed and maintained by the Microsoft Healthcare engineering team.

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

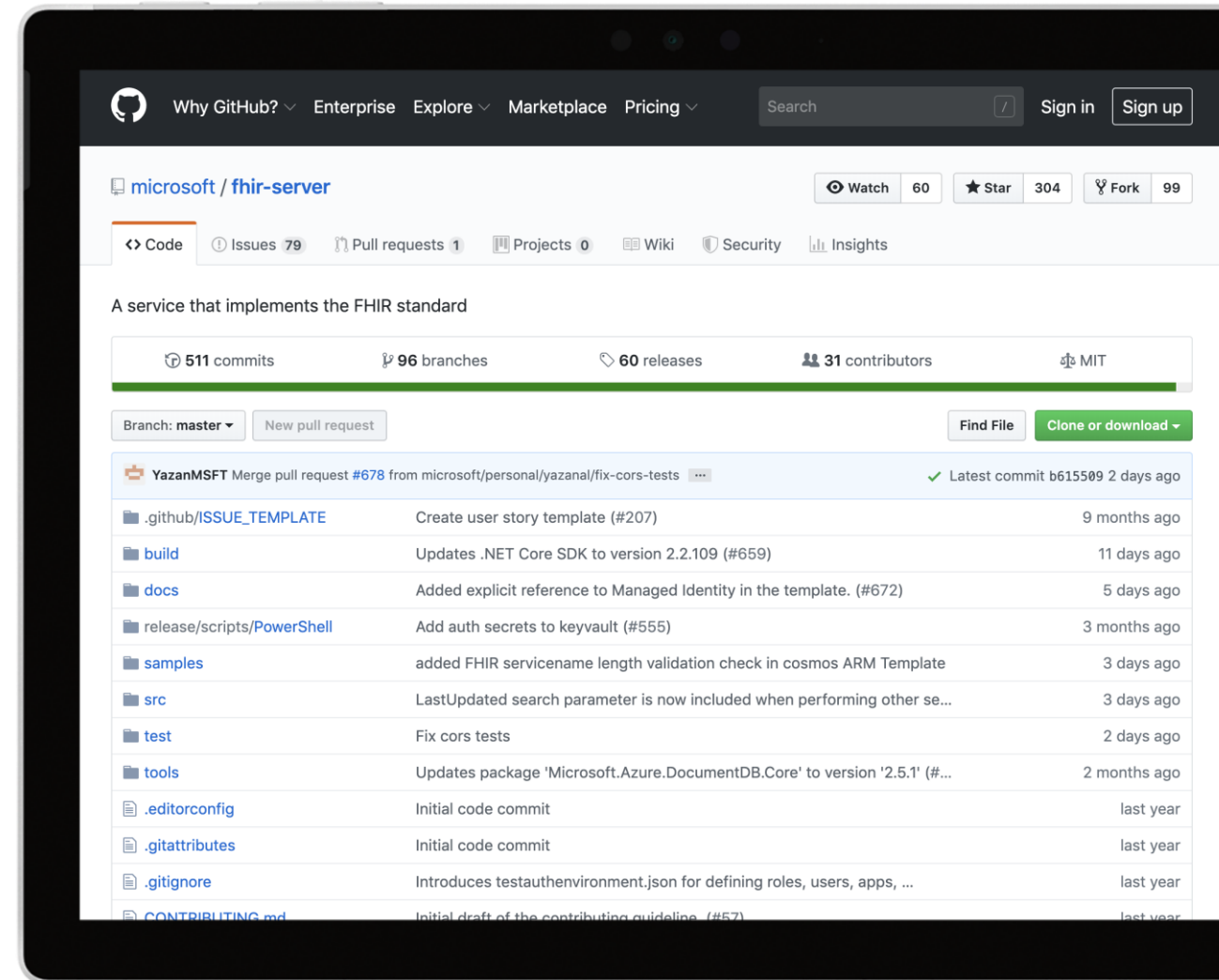
Open source implementation of the industry HL7 Fast Healthcare Interoperability Resources (FHIR) specification.

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.

<https://github.com/Microsoft/fhir-server/blob/master/docs/DefaultDeployment.md>



<http://github.com/Microsoft/fhir-server>

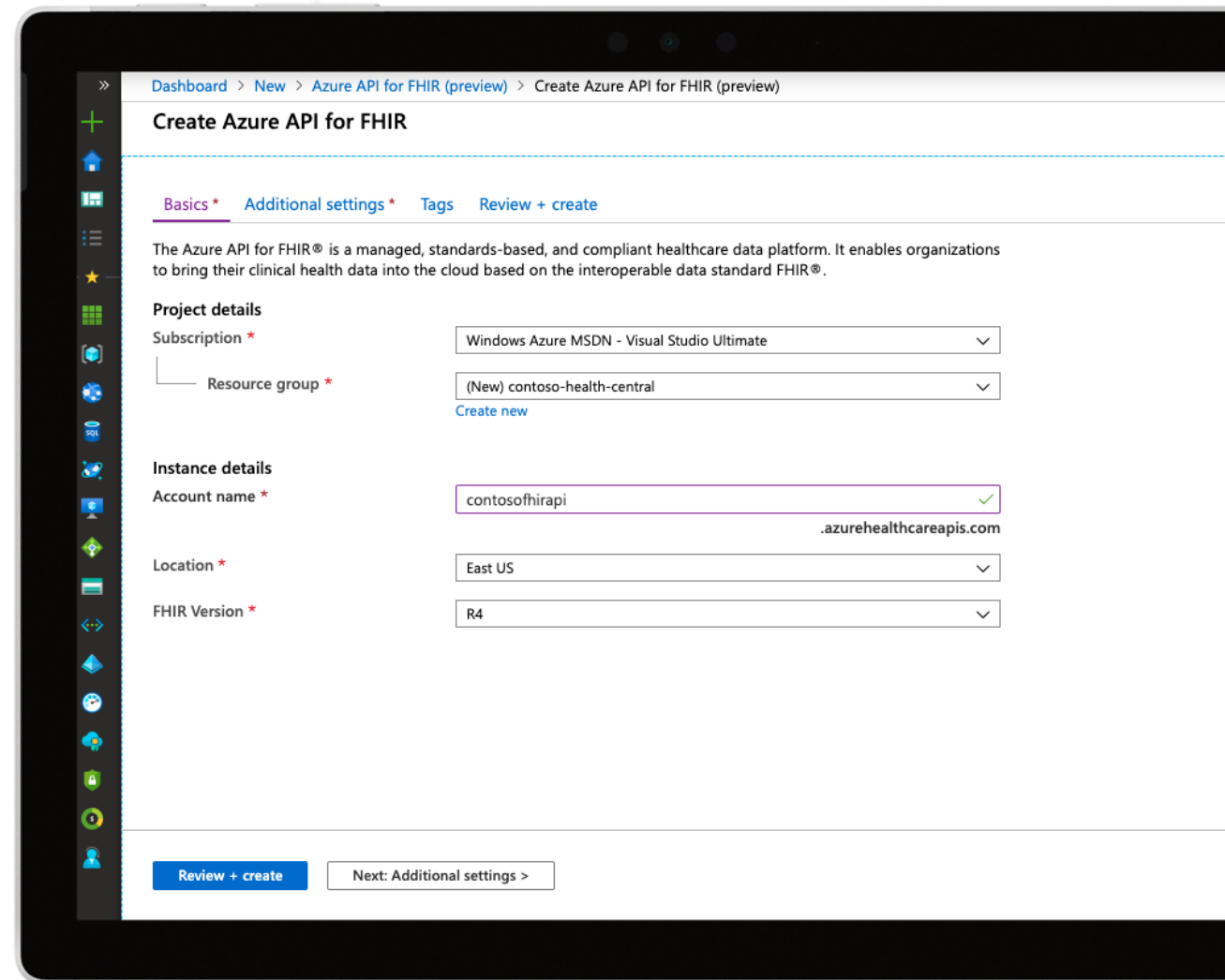
Azure API for FHIR

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.



The screenshot shows the 'Create Azure API for FHIR' page in the Azure portal. The breadcrumb navigation at the top reads: Dashboard > New > Azure API for FHIR (preview) > Create Azure API for FHIR (preview). The page title is 'Create Azure API for FHIR'. Below the title are tabs for 'Basics *', 'Additional settings *', 'Tags', and 'Review + create'. A descriptive paragraph states: 'The Azure API for FHIR® is a managed, standards-based, and compliant healthcare data platform. It enables organizations to bring their clinical health data into the cloud based on the interoperable data standard FHIR®.' The 'Project details' section includes a 'Subscription *' dropdown set to 'Windows Azure MSDN - Visual Studio Ultimate' and a 'Resource group *' dropdown set to '(New) contoso-health-central', with a 'Create new' link below. The 'Instance details' section includes an 'Account name *' field with 'contoso.fhirapi' and a green checkmark, and a '.azurehealthcareapis.com' domain suggestion; a 'Location *' dropdown set to 'East US'; and an 'FHIR Version *' dropdown set to 'R4'. At the bottom, there is a blue 'Review + create' button and a 'Next: Additional settings >' button.

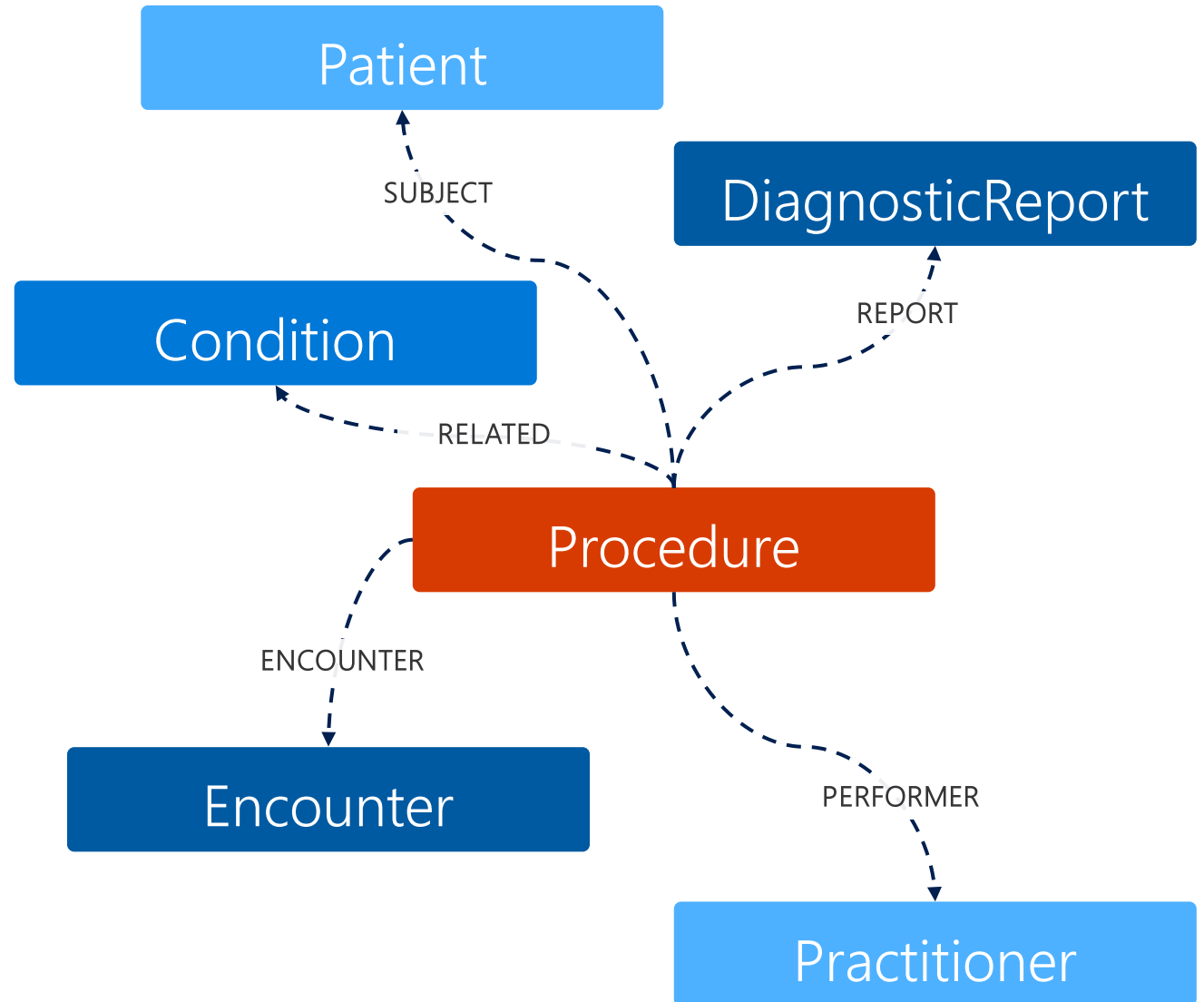
Health Data Interop Enabled by FHIR

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",
```

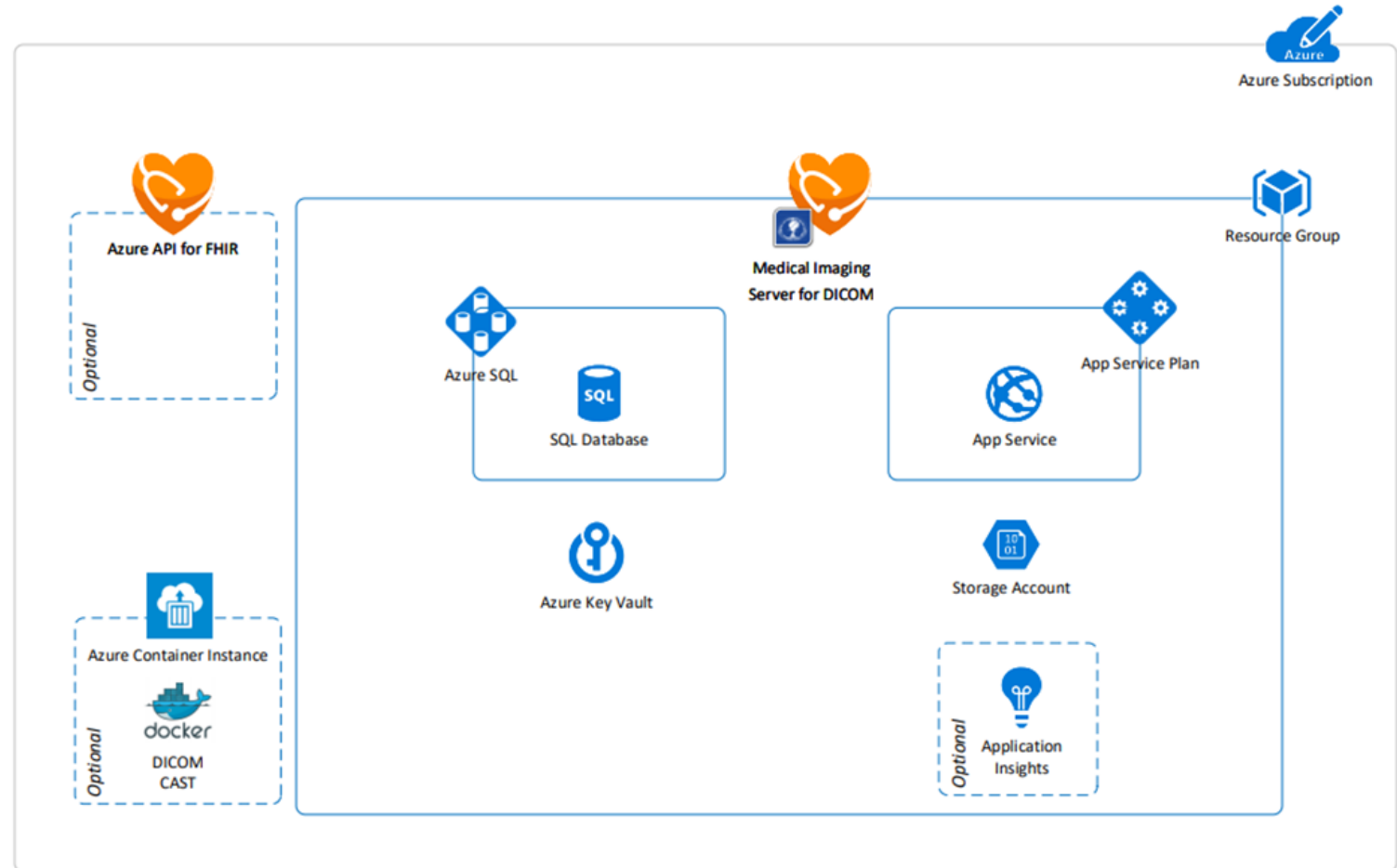
Resource Identity &
Metadata

Extension with
URL to
Definition

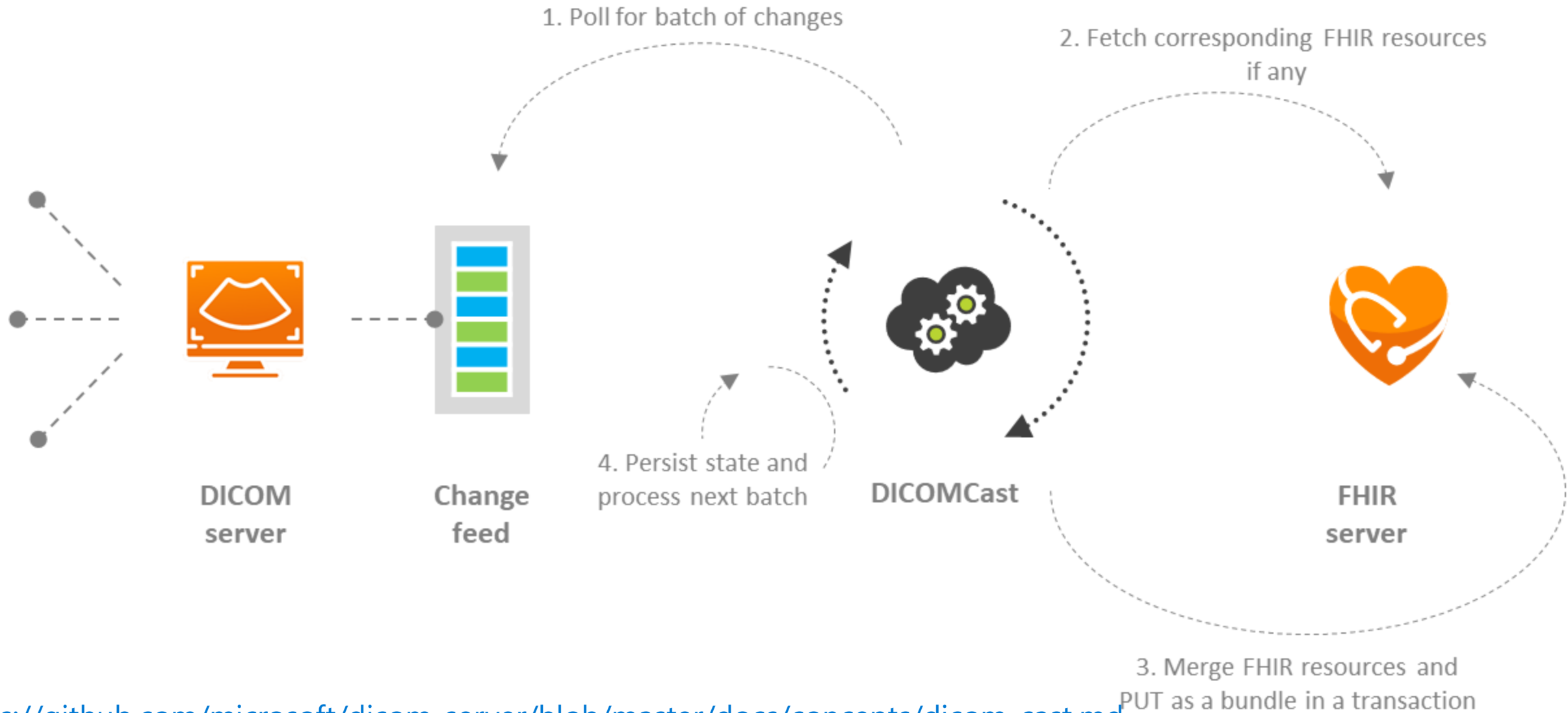
Standard Data

- MRN
- Name
- Gender
- Birthdate
- Provider

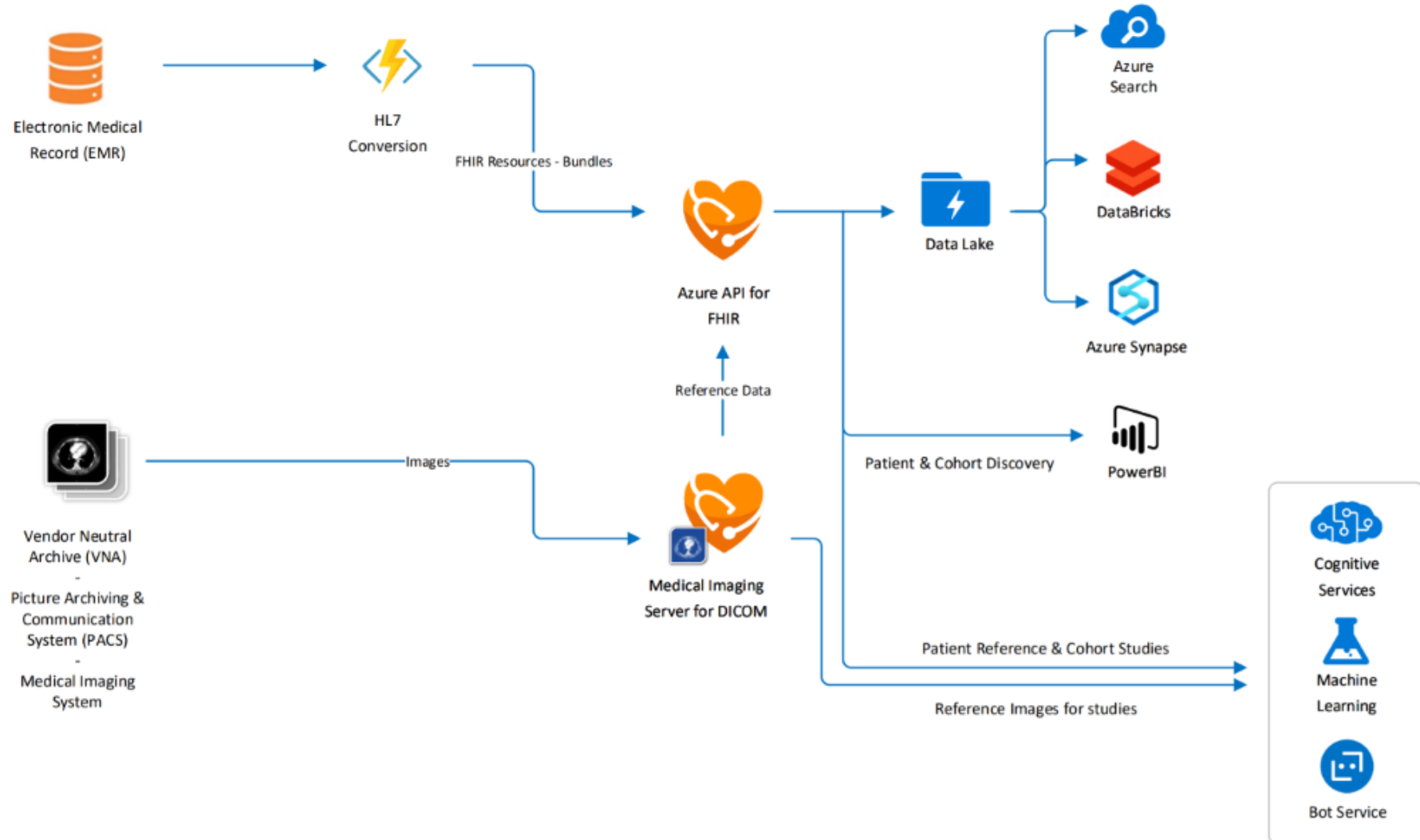
Medical Imaging Server For Dicom



DICOM Cast overview



Sample Architecture

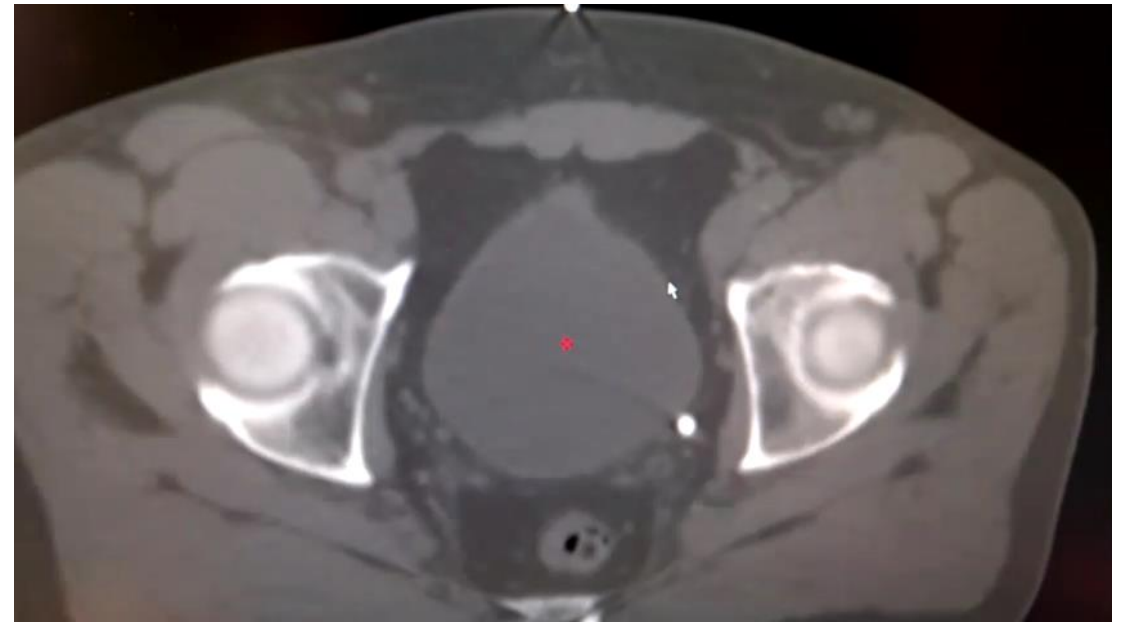


Assistive AI for radiotherapy planning

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

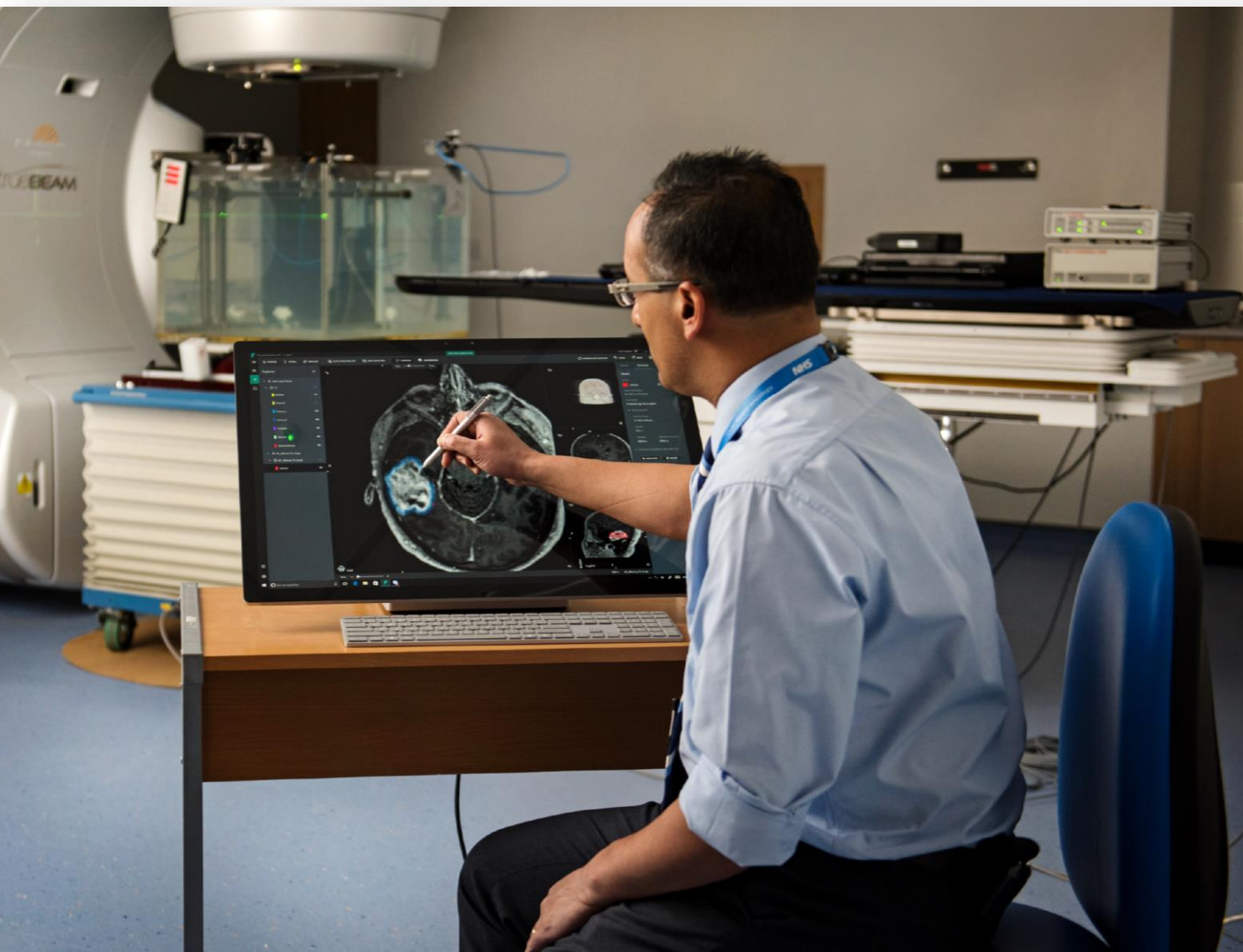


A linear accelerator (linac) for radiotherapy delivery

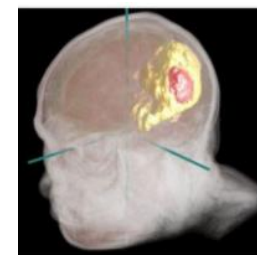


Tracing anatomy in a popular commercial tool

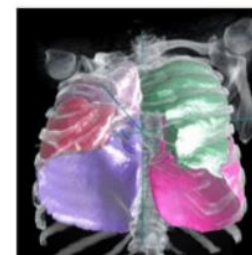
Project InnerEye open-source deep learning toolkit



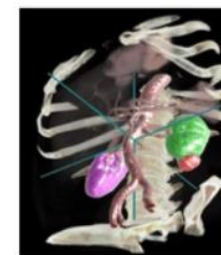
Democratizing medical imaging AI



Quantitative radiology



Radiation oncology

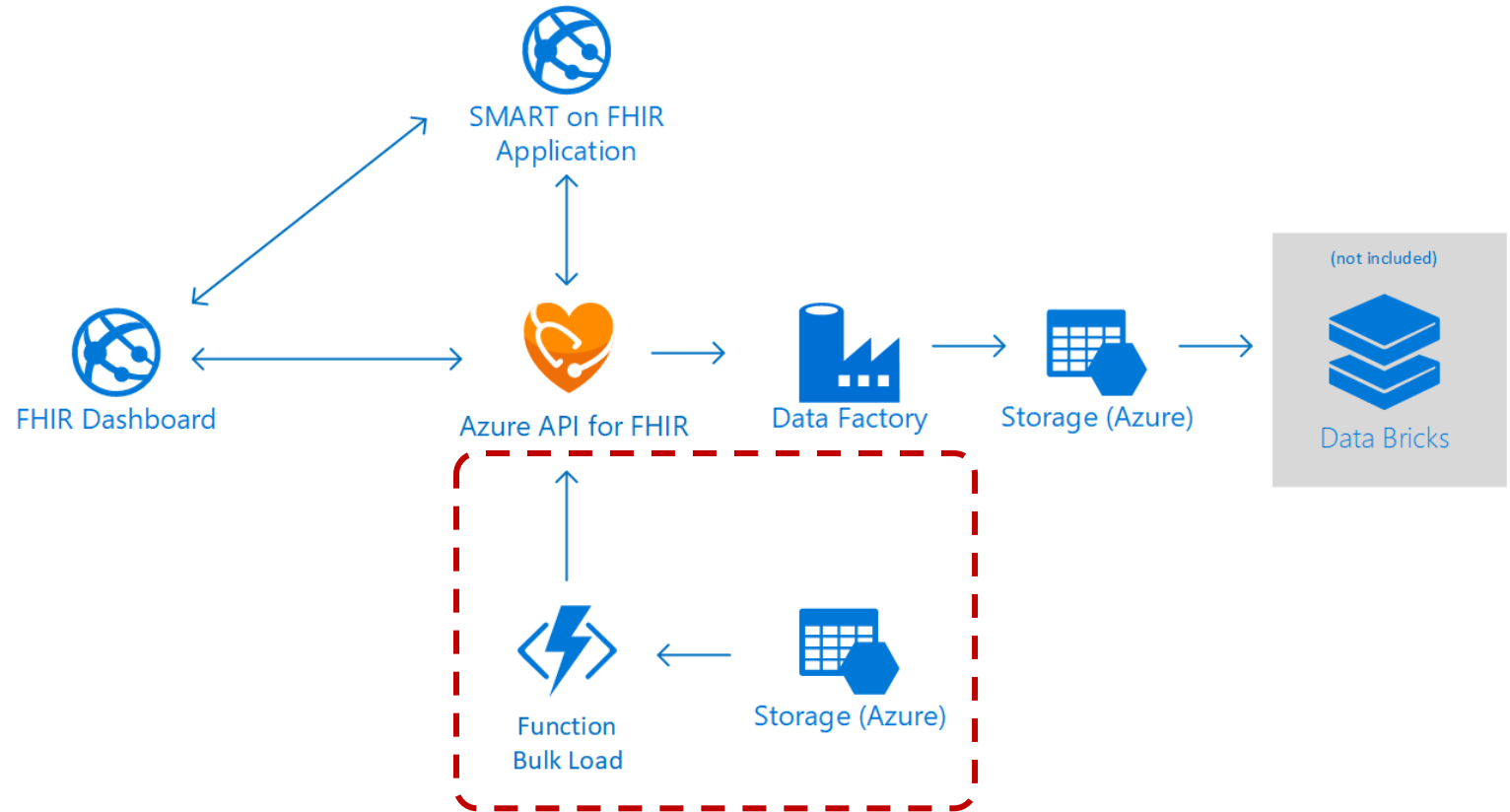


Surgical planning

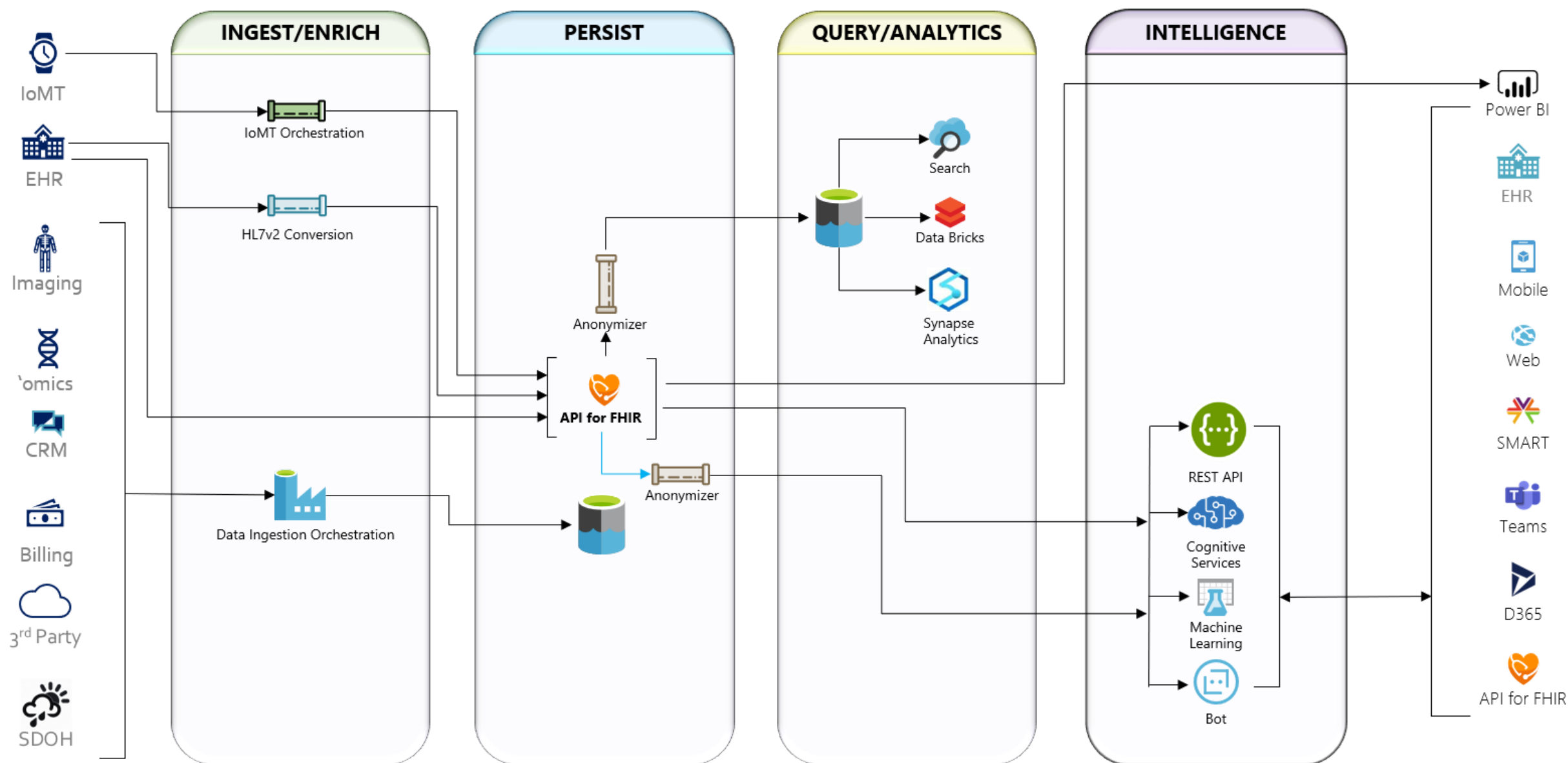


FHIR Server Samples

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



Microsoft Health – Conceptual Architecture (core)



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.



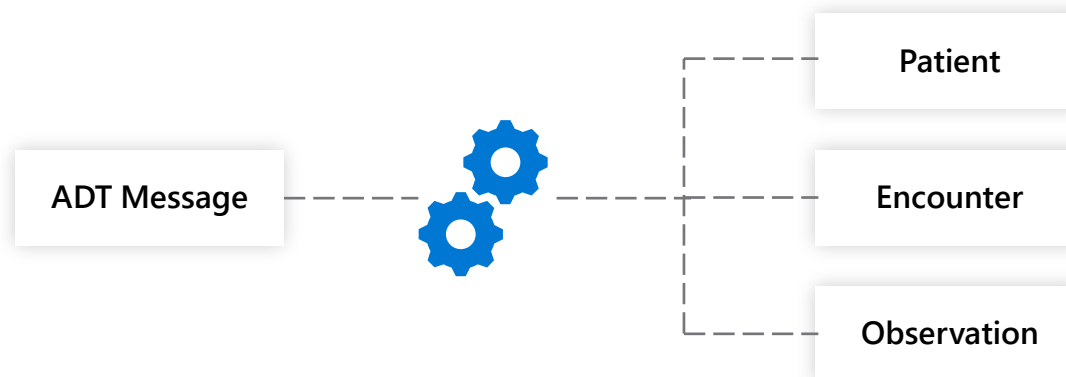
Support for HL7v2

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": [ {
```

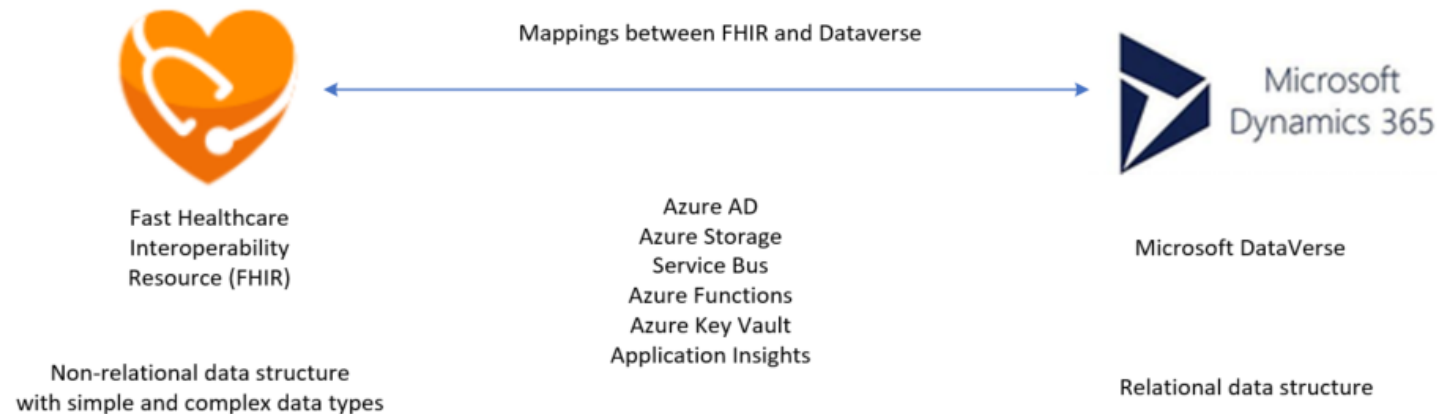


What is FHIR Sync Agent?

- ✓ 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.





FHIR Sync Agent – Rules & Guidelines

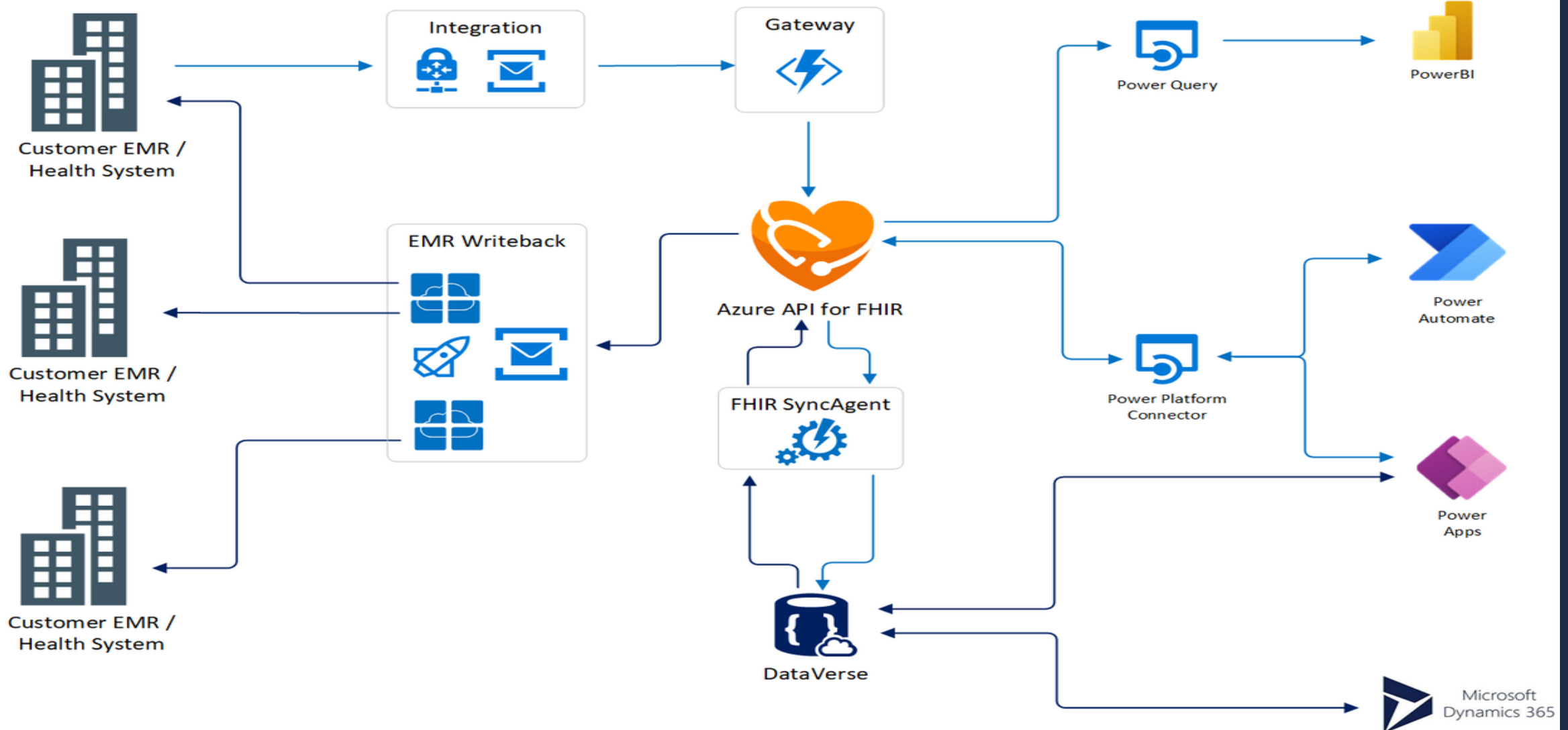
- ✓ Data synchronization is triggered by an event or a message.
- ✓ Only metadata is stored in the service bus queue. No FHIR or patient health information (PHI) is stored in any service bus queue.
- ✓ You can turn off or turn on which elements to sync. By default, patient (contact) records in Dataverse 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.

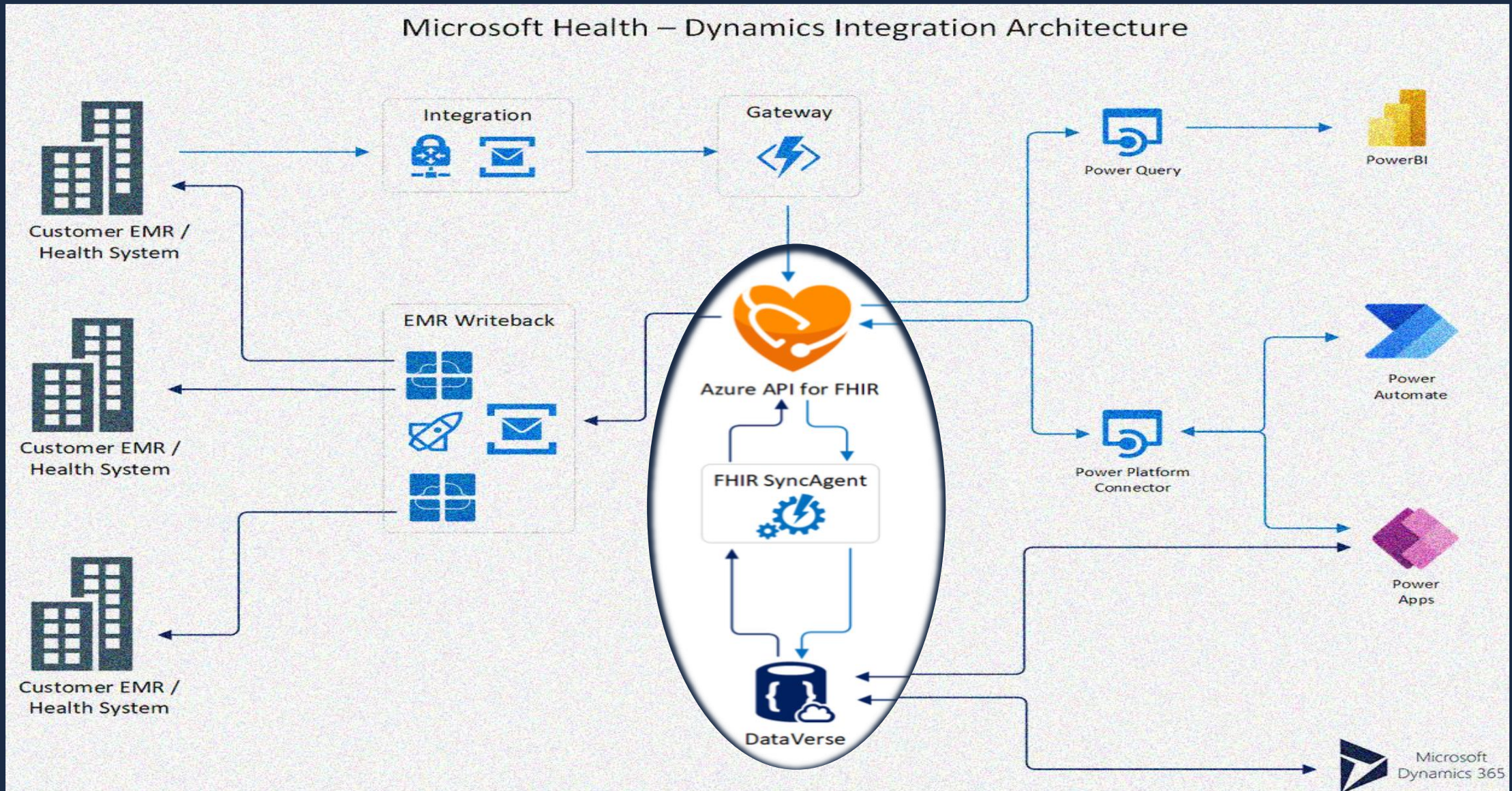
FHIR Synch Agent - Overview



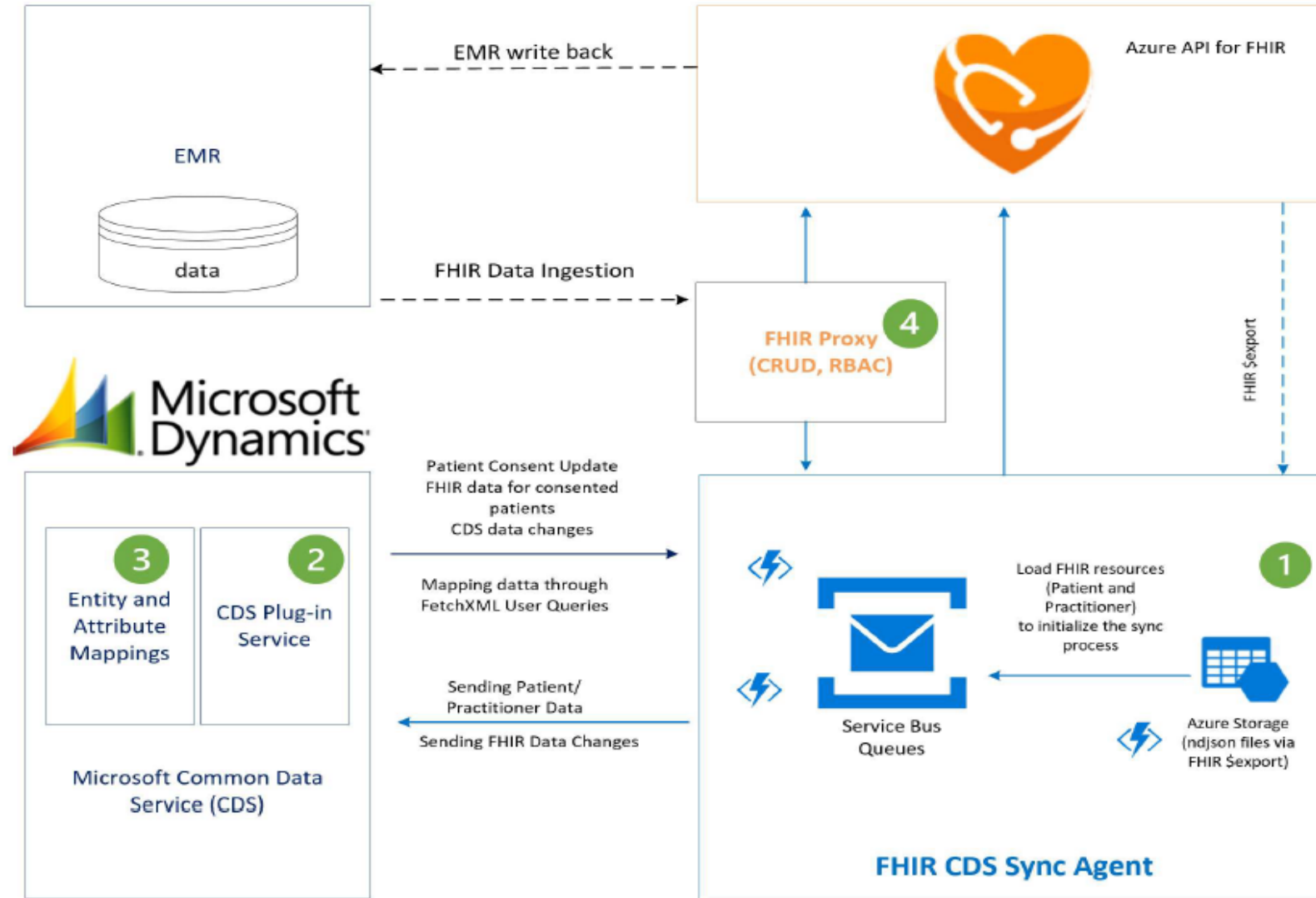
Microsoft Health – Dynamics Integration Architecture



FHIR Synch Agent - Overview



FHIR Sync Agent – High Level Architecture



FHIR Sync Agent - Components



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 in flight. 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 in flight. 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



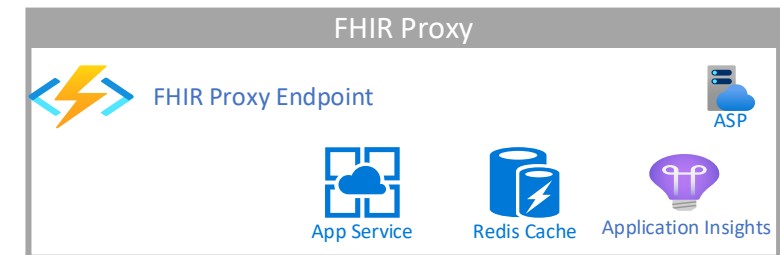
Dataverse Components (2 & 3)

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

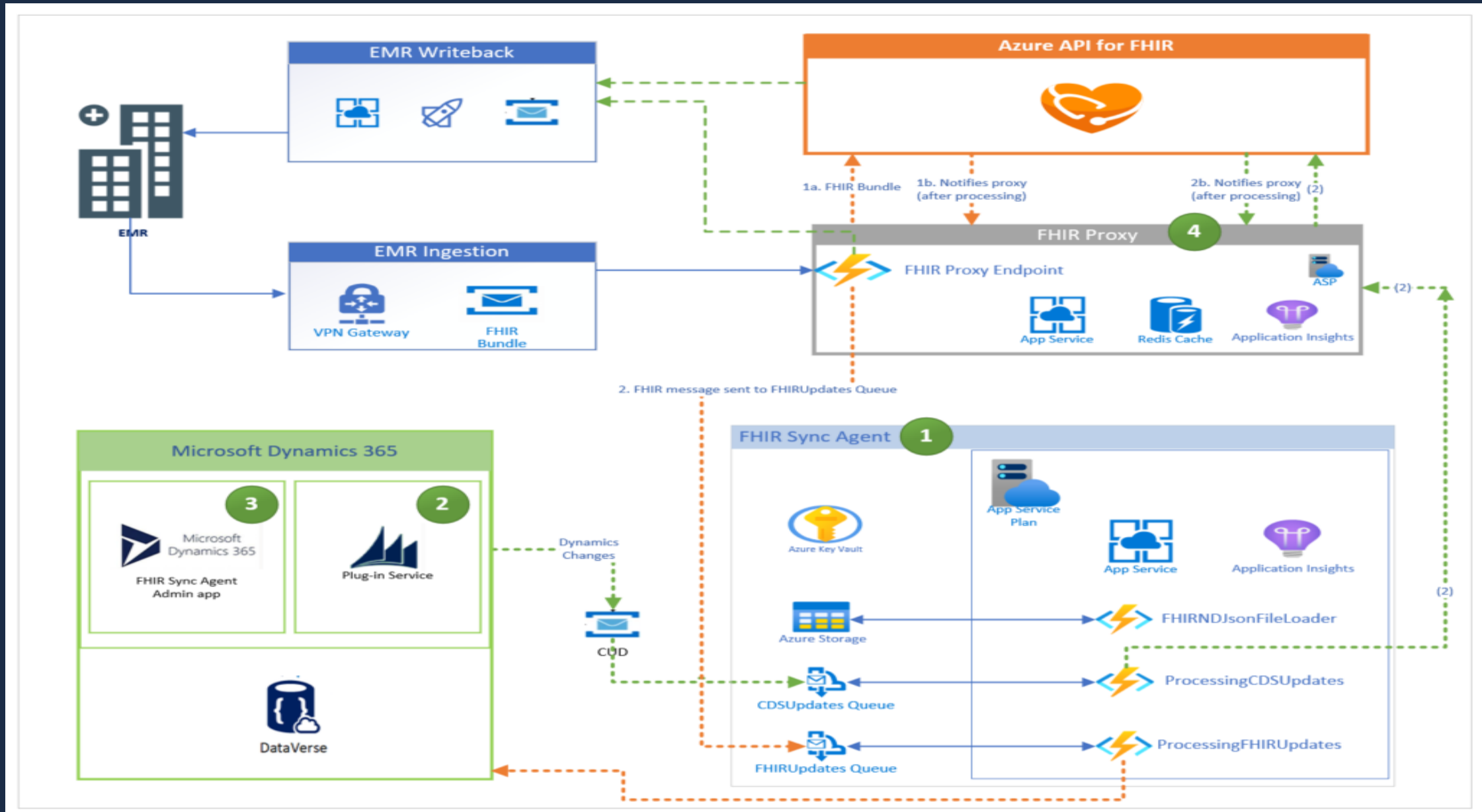


FHIR Proxy (4)

- 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 – Dataflow



FHIR Sync Agent – Pre-requisites



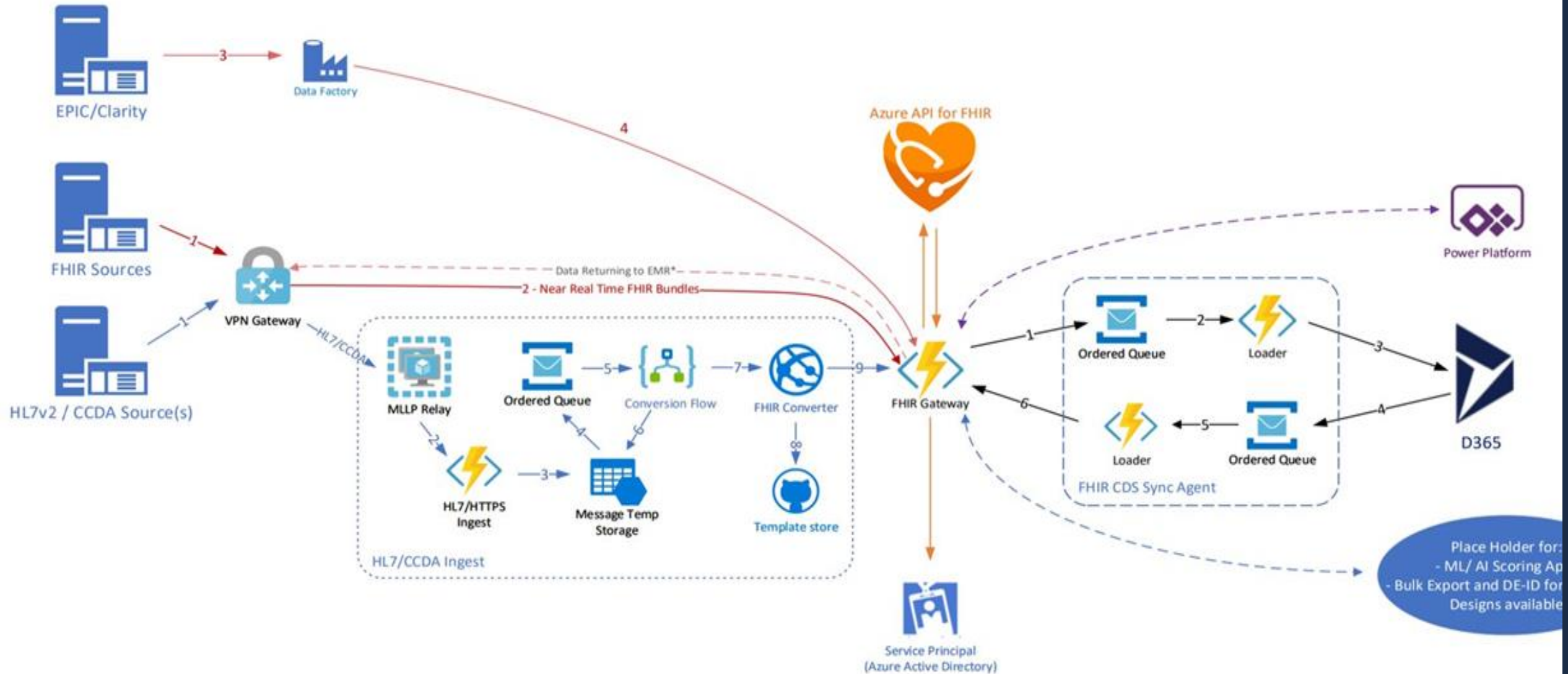
■ Pre-requisites

- Microsoft Cloud for Healthcare Environment
 - If you have not completed the environment setup, please reference the following two links:
 - [Setup configure Microsoft Cloud for Healthcare](#)
 - [Microsoft Cloud for Healthcare Licensing](#)
- Azure API for FHIR
 - Please refer to the following links:
 - [Deploy Azure API for FHIR using Azure portal | Microsoft Docs](#)
 - [Azure API for FHIR\(r\) | Microsoft Azure](#)
- 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
 - [Setup and Configure FHIR Proxy](#) (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

Integration Scenarios - Examples

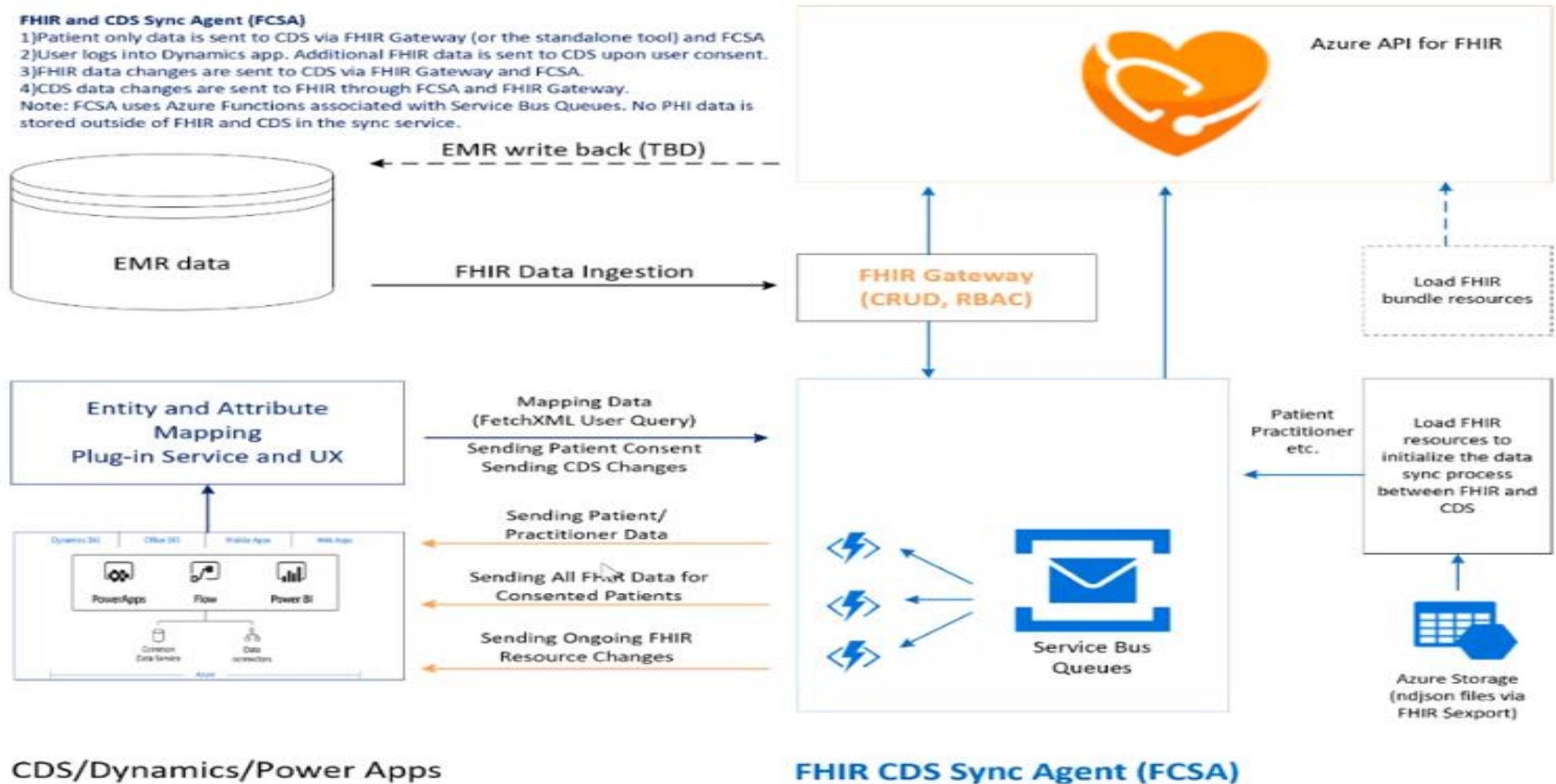


Integration Scenarios - Examples



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.



Thank you