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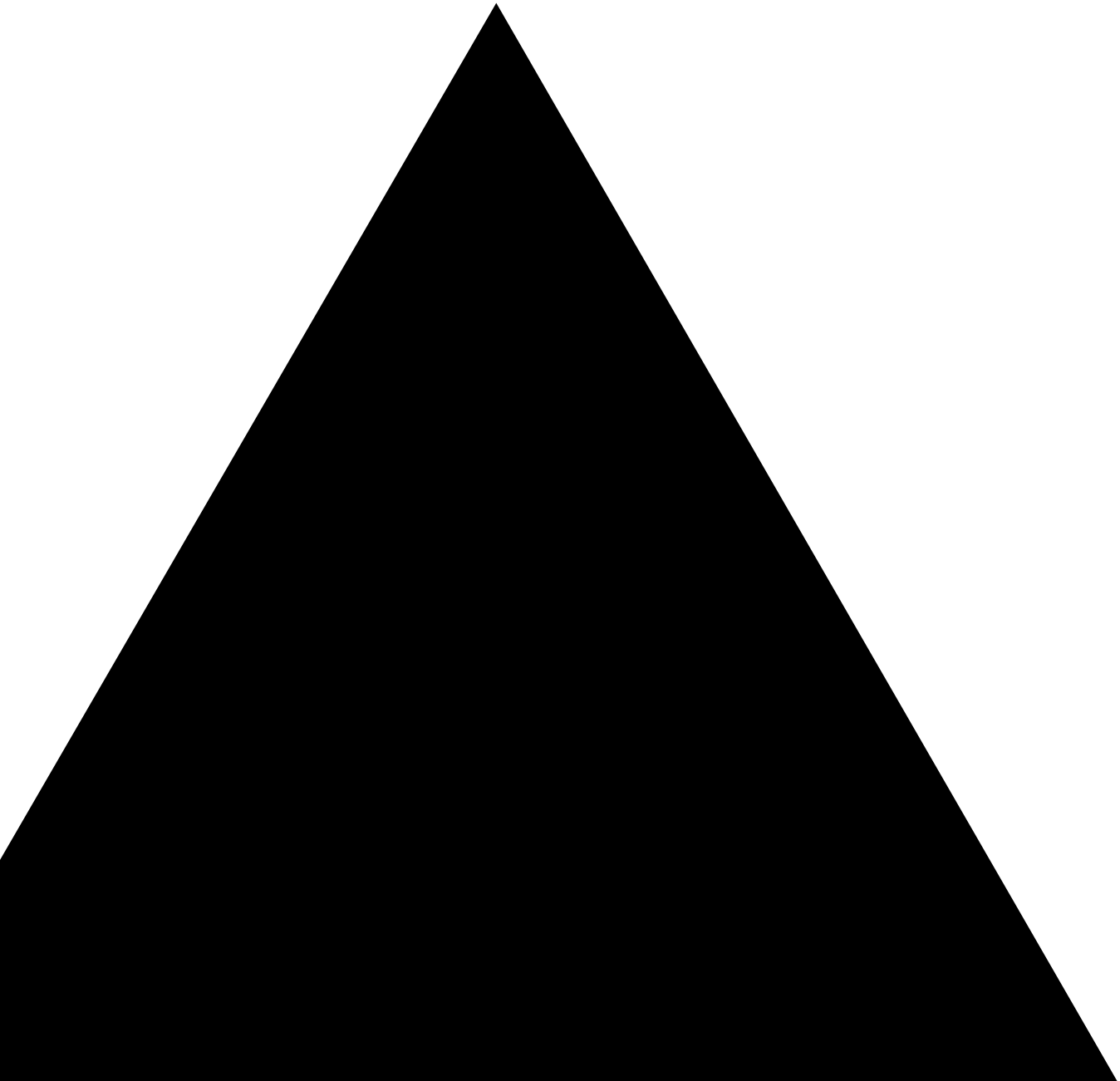
Industry Perspective

Inside DXC's Digital Health Platform

How DXC is leveraging its health platform to create a digital health ecosystem prototype

November 2017



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It is no longer good enough to have electronic medical records (EMRs) supporting episodic care. Today's healthcare organizations need to account for mobile patients leaving a trail of records across multiple providers, healthcare organizations and EMRs. Additionally, tech-savvy patients can track and participate in their healthcare through tools developed by the rapidly evolving mobile health, consumer health device and wearable health IT market — key components in the healthcare internet-of-things (IoT) industry.

As digital health evolves, it won't be a problem to create digital assets or data; instead, the challenge will be to solve the data fragmentation that is accelerated by the combination of mobile patients, multiple EMRs and increasing use of mobile health and health IoT technologies.

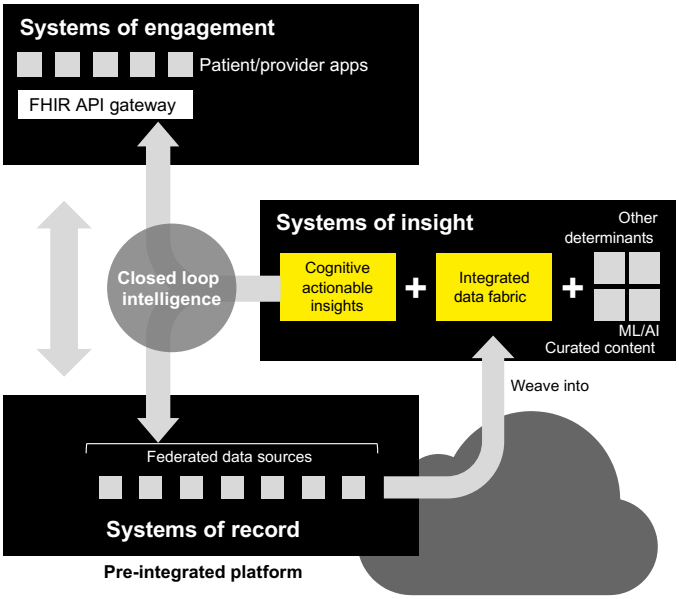
DXC Technology is helping the health industry and our clients with this digital health transformation. Using core products such as Open Health Connect — our enterprise-scale healthcare interoperability and analytics platform — we are engaging with partners and clients in the digital evolution of healthcare.

Open Health Connect

The DXC Open Health Connect (OHC) platform is situated between sources of health data ("systems of record") and consumers of health information ("systems of engagement"). OHC cross-links information to derive new insights, deploys cognitive tools for knowledge workers, and provides a technology platform that enables standardized information to be rapidly shared via APIs and microservices. Using standards-based APIs and microservices has the effect of significantly reducing interdependencies among solution elements, permitting maximum speed and freedom to maneuver.

In the architecture sketched out in **Figure 1**, OHC is a "system of insight" capable of accessing, aggregating, integrating, standardizing and processing health data from multiple sources to extract meaningful information and business insights.

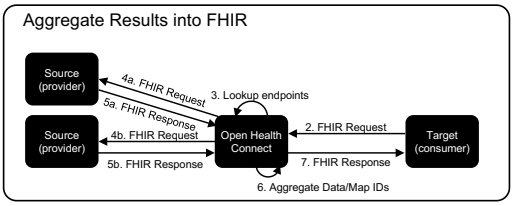
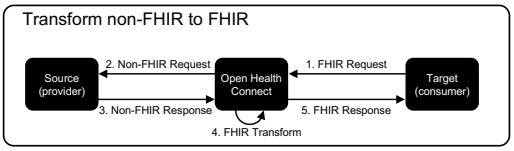
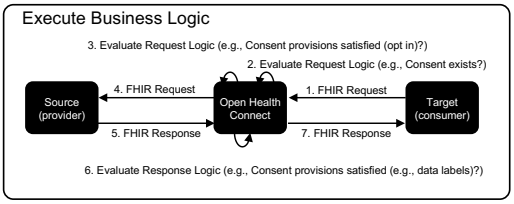
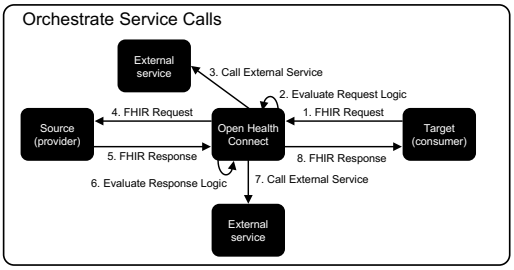
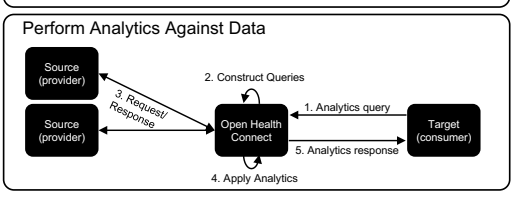
Figure 1. Conceptual systems architecture



OHC accesses and aggregates data from multiple EMR systems, health repositories, mobile applications, consumer and home telehealth devices, patient portals and other patient-generated data sources; it also standardizes the data internally as Fast Healthcare Information Resources (FHIR). The systems of engagement access this integrated and standardized information from OHC, benefiting from the insulation that OHC provides from the underlying complex, fragmented and heterogeneous data landscape. In addition, OHC can enable "closed loop intelligence" by accessing healthcare knowledge repositories and analytical models to provide cognitive actionable insights that are fed back to the systems of record and the systems of engagement.

OHC can be used in several ways to solve interoperability and analytics problems in a complex, heterogeneous environment with multiple systems of record and systems of engagement. **Table 1** outlines five basic patterns implemented by OHC. Most of these patterns are used in combinations to solve real business problems through the use of FHIR. FHIR is the data exchange standard that allows for interoperability across systems. OHC is FHIR-native, using FHIR resources as the internal data model and exposing a FHIR-conformant API.

Table 1. OHC implementation patterns

	• Accessing more than one system of record • Aggregating results into an in integrated, FHIR-based data set • Providing a simple, FHIR-based API to the systems of engagement
	• Addressing heterogeneity of data structure through FHIR standardization • Transforming non-FHIR compatible data (e.g., SQL results, HL7 v2 messages, CDA documents, etc.) into FHIR resources
	• Providing configurable data processing workflows • Leveraging the Drools business process model execution engine to evaluate and execute business logic • Evaluating logic pre- and post-query
	• Supporting a platform with the ability to call external services and trigger external workflow • Useful for third-party, clinical decision support services using CDS Hooks, terminology services, identity management services, consent management services, etc.
	• Leveraging ElasticSearch to index data and enable FHIR-based and cross-FHIR (e.g., population) queries • Leveraging the Kibana data visualization plug-in to unlock data insights and analytics

Digital Health Platform prototype

To demonstrate the value that a platform such as OHC can provide to heterogeneous, fragmented and nonstandardized data environments, DXC is developing a prototype of a complex ecosystem with several systems of record and several systems of engagement. In this prototype implementation of OHC, we leverage all of the patterns listed previously. In this ecosystem, all the systems of engagement require an integrated and standardized dataset but are encumbered by data fragmentation and lack of standardization across the systems of record.

At the heart of this ecosystem is the DXC Digital Health Platform (DHP), composed of OHC as the core integration and analytics engine coupled with common services that provide additional functionality, such as managing healthcare terminologies and mapping patient identities.

The DHP architecture is highly extensible and modular, allowing for plug-and-play inclusion of several different common services accessed through standards-based APIs. **Figure 2** shows the components that make up this prototype ecosystem as of November 2017.

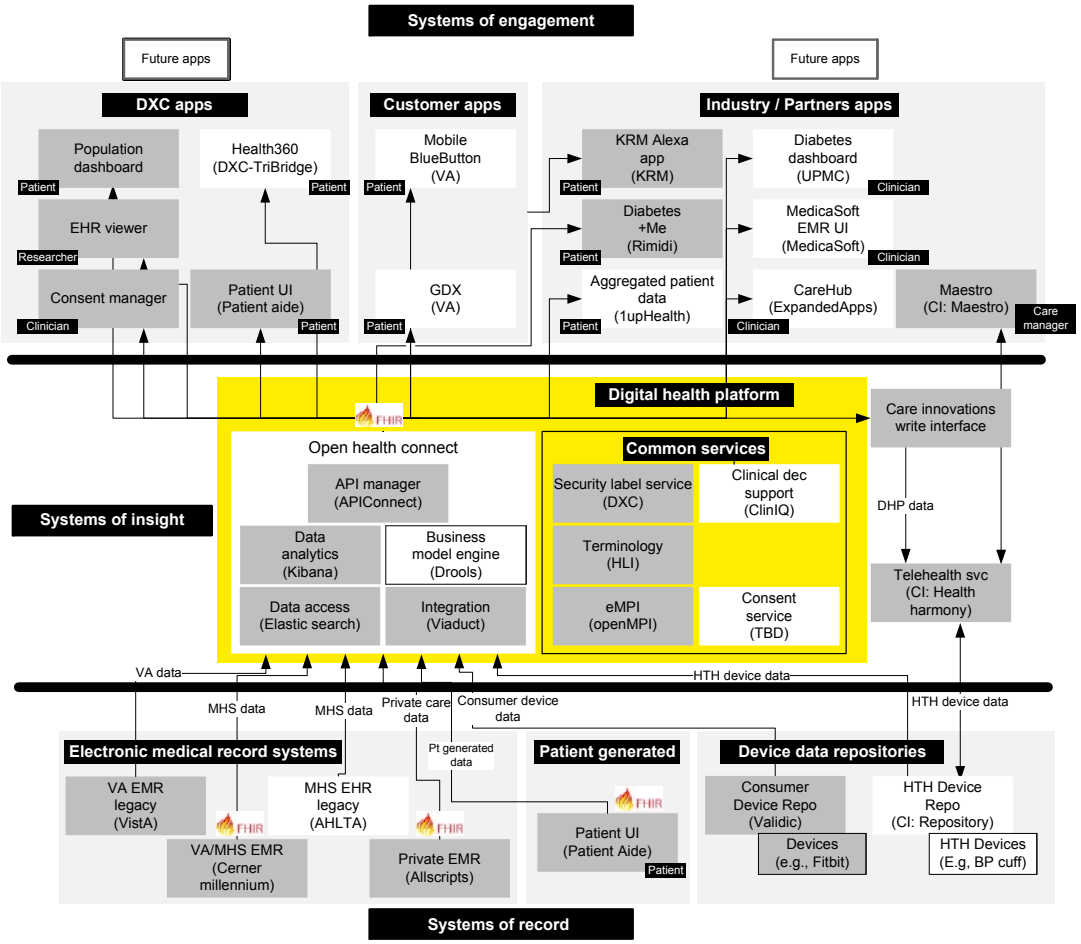


Figure 2. DXC Digital Health Platform and ecosystem component architecture. Components with a white background and gray text are planned but are not yet in scope. All other components are implemented or actively being developed.

For the prototype, the DHP collects data from four different electronic medical record (EMR) systems. These systems were chosen specifically because they are representative of those used by the Veterans Health Administration (VHA) and the Defense Health Agency (DHA). The Veterans Health Information Systems and Technology Architecture (VistA) system is the VHA's legacy EMR, and the Armed Forces Health Longitudinal Technology Application (AHLTA) is a core part of the DHA legacy EMR. Cerner Millennium has been selected as the future EMR for both agencies. Allscripts represents the kind of EMR system that active military patients or veteran patients may encounter when they receive care from private care providers.

In addition to the EMRs, the DHP includes patient-generated data, captured through a patient-facing portal developed by DXC, and from medical devices. Our partner, Validic, aggregates data from patient devices such as Fitbit and provides an API that exposes consumer device data to our DHP. Likewise, Care Innovations, through its Care Management and Home Telehealth solution stack, provides access to data coming from telehealth devices. Care Innovations provides telehealth services to the VHA today. For demonstration purposes, we use synthetic patients with synthetic health data from the SyntheticMass repository created by MITRE. This gives us a rich and robust data set to populate our source systems without breaching patient privacy or incurring security concerns.

After data is pulled into the DHP, OHC converts it into FHIR DSTU (Draft Standard for Trial Use) v3 resources. Leveraging FHIR is critical to our standards-based architecture strategy. Internal to OHC, FHIR resources are used as the data model to avoid relying on a proprietary health data model. The contents of each FHIR resource are inspected and translated against standard health terminologies (e.g., SNOMED CT and LOINC).

For the prototype, OHC calls on the health language terminology services from Wolters Kluwer for terminology lookups and translations. OHC also interfaces with the Open MPI, an open source component to map patient identities from multiple sources. After the contents of the FHIR resources are mapped and translated, a DXC-developed Security Labeling Service inspects the data and applies security labels to differentiate "sensitive" data from "normal" data. Security labels are added as metadata to the FHIR resources, which are then used for fine-grained consent-management processing and filtering based on patient-consent provisions.

In the future, we will implement CDS Hooks interfaces to a clinical decision support service and also implement interfaces to external consent-management services that store and manage patient-consent provisions as a service.

The systems of engagement include user-interface applications and platforms developed by DXC and partner organizations. In the future, we also aim to include VHA-created mobile applications.

The DXC apps include a general-purpose EHR viewer, a consent manager app, a general-purpose population dashboard and our commercial PatientAide product. The EHR viewer enables users to see the integrated data from all systems of record for a select patient via the OHC FHIR API. The Consent Manager is used to manage patient-consent provisions and generate FHIR consent resources stored and processed by OHC. The population dashboard uses the OHC Kibana module to report on and visualize data in aggregate across the entire population. PatientAide provides a portal for patient self-management and a data-capture capability for patient self-reported data.

Community of Partners, Contributors and Collaborators

Validic	Validic simplifies device connectivity, clinical interoperability, and access to patient-generated data - by providing platform and mobile solutions that enable you to derive and analyze meaningful insights from your population.
Care Innovations	Care Innovations is your clinical, technical, and operational partner for delivering care beyond the traditional walls of medicine.
Wolters Kluwer	Health language® provides terminology management solutions that can unlock your healthcare data to help you maximize reimbursement, meet regulatory compliance, improve operational efficiencies, and enhance patient care.
KRM	Innovators in Healthcare Information Technology, KRM is a small, woman-owned technology consulting company providing Custom Computer Coding and IT Security Services for over 25 years.
Rimidi	Rimidi is your partner for turning population health into personalized management for chronic health conditions.

Additional recognition for Cerner and Allscripts for allowing us to build DHP interfaces to their public developer sandboxes, to the VHA for making VistA available as open source, to Mitre Corporation for creating the open source Synthea and Synthetic Mass products, and to Georgia Tech and the University of Pittsburgh Medical Center for consultation on the DHP concept.

From our partners, we have the KRM Alexa app that provides a voice interface to the patient's health record, a SMART on FHIR app from the SMART App Gallery (https://apps.smarthealthit.org/) for diabetes management called Diabetes+Me from Rimidi and the care-management application Maestro that is part of the Care Innovations solution stack. Maestro accesses DHP data via its own middleware platform called Health Harmony.

The objective of the systems of engagement in this prototype is to demonstrate that the DXC DHP can support multiple use cases implemented by an array of apps and platforms developed by different companies and developers. This is possible because all of these apps share a common set of data requirements and all benefit from having access to a standardized and integrated dataset provided through a standards-based API.

This system-of-systems architecture evolves continuously as new systems of engagement, systems of record or common services are identified and included in the ecosystem. The prototype effort is a collaboration across a community of like-minded companies with software assets that are most valuable when used in the context of a larger ecosystem.

DHP benefits

When architected thoughtfully, we believe a cloud-hosted, highly secure, platform-based approach such as the DHP we are implementing can realize the benefits of "best of breed," where the customer is uninhibited when choosing which solutions to procure and has a mechanism in place to effectively integrate diverse, modularized solutions as well as optimize their contributions to the ecosystem.

Learn more at www.dxc.technology/gov

Future systems of engagement will be able to focus on end user functionality and user experience without exerting significant resources on solving the data access challenges stemming from data fragmentation and lack of standardization. Systems of record can be decoupled from specific end user apps and can be leveraged to support a variety of apps developed over time by different teams. This helps to achieve a longer value proposition for the systems of record.

MD_7264a-18. November 2017