Delivering a 360° View in Healthcare and Life Sciences
With Agile Data

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Healthcare & Life Sciences
Changes & Uncertainty
Healthcare Costs Continue to Rise

Rising costs, coupled with stagnant wages, create barriers to care

Cumulative Increases in Health Insurance Premiums, Workers’ Contributions to Premiums, Inflation, and Workers’ Earnings, 1999-2016

Source: Kaiser Family Foundation

Percentage of Americans Putting Off Medical Treatment Because of Cost
Within the last 12 months, have you or a member of your family put off any sort of medical treatment because of the cost you would have to pay?

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QUALITY & PAYMENT REFORM

The Shift Toward Risk-Based Reimbursement

- Most clinicians don’t know what is coming
- A September 2016 survey found that 28.6% of the responding clinicians said they have not heard of MACRA. 39.2% said they have but do not know a lot about it.
- CMS will allow clinicians to “pick their pace” for 2017 reporting / 2019 payment under the final rule.

Sources: MedAxiom, HealthcareDive
HIMSS MACRA Survey

“Success with MACRA requires a joint effort of IT and departmental resources to successfully combine clinical, financial and operational data.”
There is Growing Uncertainty

…

“The Health Care Bill Has Failed. Let the Finger Pointing Begin.”
“Some Lawmakers Now Look to Bipartisanship on Health Care”
“Health Bill’s Failure Leaves Supporters in a Political Jam Back Home”
“Health Proposal Would Undermine Coverage for Pre-existing Conditions”
…
Healthcare & Life Sciences is changing…

- EXPANSION
- MERGERS & ACQUISITIONS
- NEW MONETIZATION STRATEGIES
- NEW RESEARCH REQUIREMENTS
- NEW REGULATION
- EMPLOYEE TURNOVER

The data & infrastructure are changing…

- OPEN DATA
- VIRTUALIZATION & CLOUD
- MACHINE LEARNING
- WEB SERVICES
- INTERNET OF THINGS
- MORE ANALYTICS
- NEW APPLICATIONS
- NEW RESEARCH REQUIREMENTS
A NEW APPROACH

Expect That Over Time, *Everything* Can Change, at Any Time

- **DATA**
- **WHERE DATA COMES FROM**
- **HOW DATA IS ACCESSED**
- **WHO ACCESSES THE DATA**
The Challenge

- Legacy systems used mainframes
  - Memberships, Claims, Provider, Individuals & Prescriptions
  - Overloaded ESB
- Needed to:
  - Create a consumer product
  - Move to best-of-breed solutions
  - Create a virtual database layer
  - Decouple HA & Perf SLAs
- 9 MONTHS vs YEARS
9 Years?
9 Months! In Production!
Change Our Approach
The Need for an Agile Development Strategy

WATERFALL

- Analyze
- Plan
- Design
- Build
- Test
- Deploy

AGILE

- Analyze
- Plan
- Design
- Build
- Test
- Deploy
- Analyze
- Plan
- Design
- Build
- Test
- Deploy
- Analyze
- Plan
- Design
- Build
- Test
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TimeLine

New Requirements

- Ability to react to regulations, user requirements, ops requirements & changing laws
The Need for an Agile Development Strategy

WATERFALL

- Ability to react to regulations, user requirements, ops requirements & changing laws
- But what about the data?
Relational DB – Design, Build, Test Problem

1. Design the application
2. Determine needed data
3. Determine needed queries
4. Design the schema and indexing strategy
5. Build a database
6. Design & code ETL approach
7. Load the data
8. Code the application
9. Test the application

Design
Build
Test
WHAT’S FASTER?

Agile Development on Relational Data

VS
Agile Development Needs Agile Data

What is agile data?

- Data that is “able to move quickly and easily”

To support agile data we need to:

1. Bring the data in quickly and flexibly
2. Search and query in real-time
3. Harmonize and enrich the data “in situ”
4. Operationalize and expose the data as needed

Of course we still need to persist the data in a reliable and secure fashion
MARKLOGIC APPROACH TO DATA INTEGRATION: AGILE DATA

1. Ingest Data As-Is
2. Search / Access & Deliver the Data
3. Harmonize & Enrich the Data
4. Operationalize

Design Build Test
Ingest data “As-Is”

- Bring structured, unstructured, semantics, geo data & binary together
- Keep the data and its metadata together
- Allow for data changes to flow through
SLIDE: 21

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Universal index allows data to be found in real-time

- Search for:
  - Words & phrases
  - Semantic graphs & links
  - Numbers & dates
  - Geospatial data
  - Virtual tables (rows & cols)

Search / Access & Deliver the Data

MULTI-MODEL

MULTI-MODEL = AGILE DATA
Harmonize and Enrich the Data

- Create meaningful business objects
- Harmonize data from different sources
  - Data focused MDM
- Link business objects together semantically
  - Instead of the ORM tool, the code, the developer’s head
- Persist the semantics in the database
  - Critical to data reusability
Business Objects + Semantics Example

Now we can search for:
“Radiology procedure for a cancer near a kidney”
Even though none of these terms are in the document!
Multi-Model as Far as Needed!

From:
- Radiology procedure for a cancer near a kidney

To:
- Radiology procedure for a cancer near a kidney, that occurred in the past 12 months, was administered by a doctor who is a member of an HMO, in California, within 20 miles of an ER (geo), where we knew 6 months ago that it wasn't covered by insurance (bi-temp) ....
Operationalize

Real-time access

Multiple APIs to access the data:
- Node, Java, REST, XQuery, SPARQL, SQL

Cloud neutrality

Scalable performance

High availability

Security
- Role based, doc-level, element-level, encryption

Operational Flexibility

Expose and operationalize the data

Agile Data
Agile Development Needs Agile Data

SQL Data
Analyze → Plan → Design → Build → Test → Deploy

Agile Data
Analyze → Plan → Design → Build → Test → Deploy

3 - 4x faster development
THE MARKLOGIC ALTERNATIVE

Immediate Value, Faster Time to Results

MARKLOGIC AGILE DATA APPROACH

RELATIONAL APPROACH

Design Build Test

LOAD AS IS
HARMONIZE & ENRICH
DEPLOY

SEARCH
UI & APP DEVELOPMENT

REDUCE FOR CHANGES & NEW DATA SOURCES

Current State Snapshot

DATA MODELING
ETL
CREATE INDEXES

SEARCH
INTEGRATE SEARCH
UI & APP DEVELOPMENT
DEPLOY

BUILD IN ADVANCED FEATURES

MARKLOGIC
AGILE DATA
APPROACH

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Recap: The Challenge

- Legacy systems used mainframes
  - Memberships, Claims, Provider, Individuals & Prescriptions
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- Needed to:
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  - Create a virtual database layer
    - Decouple HA & Perf SLAs
    - 9 MONTHS vs YEARS
Agile Parallel Development & Modeling

- Aggressive 9 month federally mandated schedule
- Spun up about two dozen scrum teams running in parallel
Agile Models During Development

Models used across teams over time (weeks)
AGILITY WITH MARKLOGIC

Data Modeling in Parallel

TEAM 1
SCHEMA v1.1

TEAM 2
SCHEMA v1.2

TEAM 3
SCHEMA v2.0
Q1

TEAM 10
SCHEMA v1.1

SCHEMA v1.1

SCHEMA v2.0
Q1

SCHEMA v2.1-1
v2.1-2
v2.2-1
v2.2-2
v2.2-3

SCHEMA v2.3-1

SCHEMA v3.0
Q2

v2.x

v3.1-1
v3.1-2
v3.2-1
v3.2-2
v3.3-1
v3.3-2
v3.x

SCHEMA v4.0
Q3

SCHEMA v2.x

SCHEMA v3.x
AGILITY WITH MARKLOGIC

Data Modeling in Parallel

TEAM 1
SCHEMA v1.1

TEAM 2
SCHEMA v2.0

TEAM 3
SCHEMA v1.3

TEAM 10
SCHEMA v1.x

No need to wait, Use your data immediately
The Results

### Development Duration

<table>
<thead>
<tr>
<th>Legacy Time</th>
<th>Agile Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

### Operations Cost %

<table>
<thead>
<tr>
<th>Legacy Ops Cost</th>
<th>New Ops Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>100</td>
<td>120</td>
</tr>
</tbody>
</table>
HEALTHCARE 360

Resulting 360 Views

- PERSONS
- MEMBERSHIPS
- PROVIDERS
- CLAIMS
- RX
- PLANS
Life Sciences
RAPID GROWTH OF CLINICAL TRIALS

Background

- Clinical trial management systems (CTMS) provide critical insight into the progress of clinical trials and historical data for research.
- The number of clinical trials is increasing at a rapid pace.
- Duration and scope of trials is increasing.

Source: https://ClinicalTrials.gov
The Challenge

- Downstream systems already in place (e.g. BI tools, operational data warehouse) require a consistent view of study data for auditing and analytics.

- Today’s clinical trials frequently have mid-study changes – “adaptive clinical trials” – which results in a changing data model that forces data remodeling on downstream systems.

- It can take a month or more for downstream systems to be re-coded. This process requires programming changes that need to be validated before promotion to production environments.
The Solution: MarkLogic Data Hub Framework

- Ingest as-is allows loading of data regardless of changes
- Harmonization of ingested data creates a canonical representation – a clinical study 360
- Reports and views for downstream systems are based on canonical representation
- Changes to harmonization transformation are created via Template-Driven Extraction (TDE) templates
- Template changes can be implemented by non-programmers
- SQL / ODBC views are used to provide a consistent representation for downstream relational systems
Target Architecture

Source Systems

- CTMS
- Investigator Information
- Non-CRF Data

INGEST
- Audit Documents
- Site 2 Documents
- Study Data Documents

Staging
Raw, As-Is Data

MarkLogic

HARMONIZE
- Discovery, Harmonization
- Enveloped Documents (Entity 2)
- Study 360 Documents
- Enveloped Documents (Entity N)

Final
Harmonized, Indexed data

SERVE
- Operational Apps
- Analysis/BI
- Data Feeds

Consuming Applications

Data Flow
Results

- Initial implementation completed in **six calendar weeks**
- Single, harmonized model serves as the basis for multiple downstream systems
- Changes in clinical studies are **available within one day** versus one month or more
- Full implementation is underway
Months not Years!
Thank You

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