eQube® - a modern Data as a Service (DaaS) platform

Accelerating Digital Transformation

eQube® as well as the graphic representation of the logo of eQube with a drawing of a cube are Registered Trademarks of eQ Technologic, Inc., registered in the United States Patent and Trademark Office. All other logos, trademarks or service marks used herein are the property of their respective owners. Nothing contained herein is intended to claim ownership of, title to, interest in or sponsorship of the owners of product(s) identified by logos, trademarks or service marks, whether or not registered, which are not specifically stated to be owned by eQ Technologic, Inc.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

Executive Summary

Many organizations across the world are embarking on Digitalization or Digital Transformation of their businesses with multiple objectives: to gain long-term sustainable competitive advantages, to substantially increase their top-line and bottom-line performance, and to realize their organization's full potential. They have established organizational goals to dramatically increase their productivity and have embraced Digital Transformation / Digitalization as their core strategies to realize those goals. Productivity is measured in terms of financial performance, increased speed and throughput in all parts of their businesses, and reduction in NVA (non-value-added) time and efforts. In the Industrial domain, productivity improvement goals are being established for R&D, engineering, manufacturing, supply-chain, logistics and delivery-chain, MRO (maintenance, repair, and overall), after-sales support and service, CRM (customer relationship management), finance, HR, IT, quality, sales and marketing.

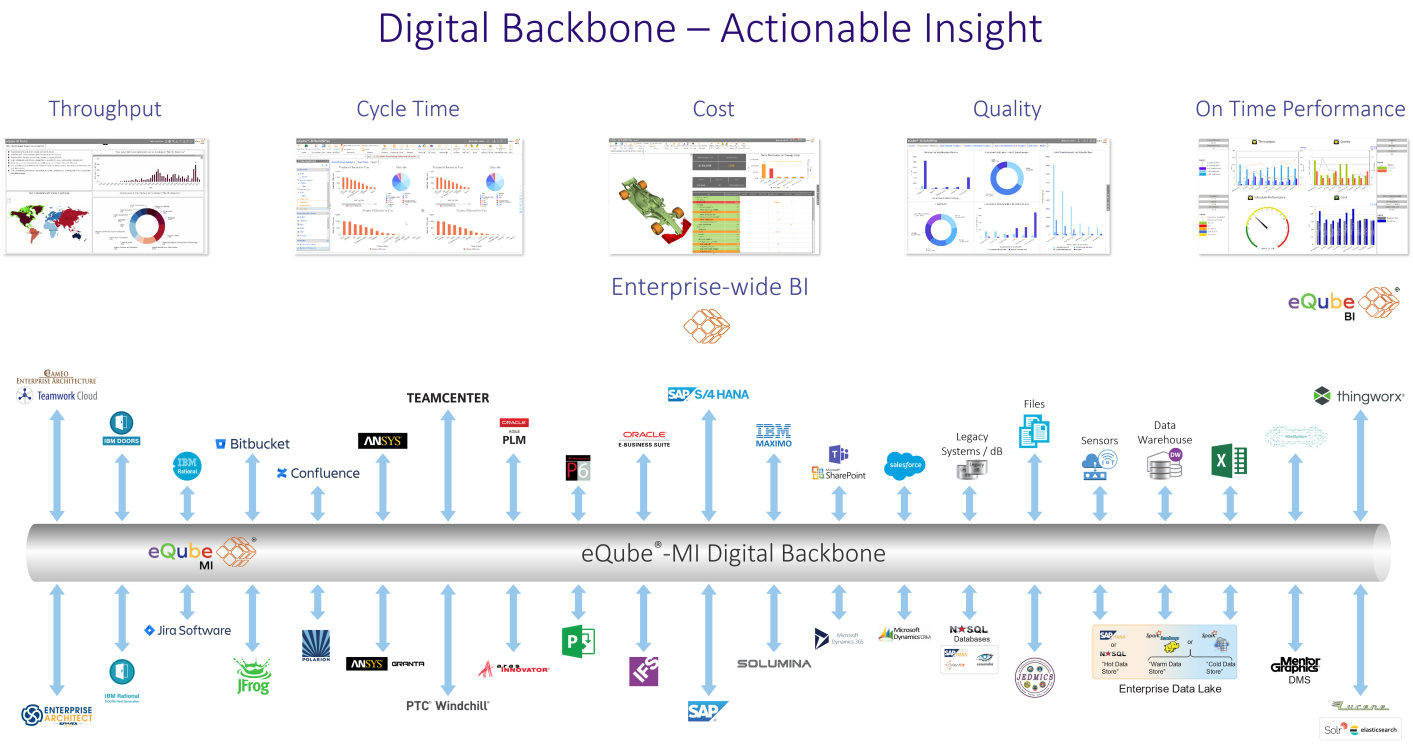
To achieve these productivity goals, there is a clear need to: efficiently and rapidly integrate many legacy systems and new COTS (commercial off the shelf) systems, federate data across systems for much quicker implementations to realize value and mitigate risks associated with long duration IT projects, responsibly retire legacy systems in an orderly manner without disrupting the business, rapidly implement intuitive end-user centric 'for-purpose' applications and provide on-demand 'visibility' across business processes with analytics and business intelligence (A/BI). Essentially, a core and strategic business requirement for an enterprise class scalable framework that can offer Data as a Service (DaaS) in an Integrated Data Environment (IDE).

This white paper discusses the eQube®-DaaS platform capabilities for establishing an enterprise class scalable framework for an IDE that accelerates Digital Transformation. eQ defines this enterprise class scalable framework as 'Data Fabric'. It also highlights how eQube®-DaaS platform provides a powerful low-code/no-code integration environment to rapidly and responsibly deliver multiple solutions for the IDE while mitigating risks of long-duration and expensive IT programs.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube®-DaaS platform establishes a Digital Backbone of integrated data, applications and devices (a.k.a. 'Data Fabric') that puts the power of analytics in the hands of end users leading to Actionable Insight. eQube-MI (Digital backbone) provides a comprehensive and efficient infrastructure for APIs, enterprise application integration, federation, orchestration, secure collaboration, synchronization, and migration. eQube-BI, the modern analytics and business intelligence (A/BI) solution for Actionable Insight puts the power of analytics in the hands of end users. eQube platform is flexible, robust, resilient, scalable, and secure with overall lower total cost of ownership. It can be deployed in a cloud only or on-premise only or in a hybrid (cloud or multi-cloud with on-premise) manner. eQube-DaaS deployment can be containerized using Docker and Kubernetes for auto-healing and elastic scaling in support varying business demand.

Therefore, the eQube platform can comprehensively address IDE requirements in delivering substantial productivity improvements and accelerate the realization of Digitalization or Digital Transformation. Figure 1 shows the eQube platform – Digital Backbone with Actionable Insight.



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 1: eQube Digital Backbone - Actionable Insight

Over the past 15 years, eQube platform-based solutions have been widely deployed across many of our world-wide customers. Our customers are from multiple major industries: Aerospace & Defense, DoD, Auto & Machinery, High-Tech, Ship Building, Energy, Food, and Consumer Packaged Goods (CPG). For our customers, eQube based solutions have and continue to responsibly retire legacy systems, integrate legacy applications and COTS solutions across networks, deliver low code end-user centric 'for-purpose' apps with data federation, and deliver analytics / business intelligence capabilities that provide reports, KPIs and dashboards leading to actionable insights. Some of our key customers include: Lockheed Martin Aero (including the prestigious F-35 program), Northrop Grumman (all sectors and programs including the B-2 and B-21 programs), US Navy (NAVSEA and NAVAIR), Adient, , Micron Technologies, Conagra foods, MOOG, L-3 (multiple divisions), Rolls-Royce, Siemens AG, General Electric (multiple divisions), EDF (Nuclear power plants), General Dynamics (multiple divisions), Dyson, Visteon, Yanfeng, BAE Systems – MAI (Typhoon), BAE Systems – Marine (Successor submarine program), Boeing, SPIRIT AeroSystems, SS/L, ULA, MTU, and Honeywell-Aero among many others.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

Table of Contents

Executive Summary 1
Table of Contents 3
List of figures 4
eQube®-DaaS based proposed reference architecture for an IDE 5
eQube®-DaaS Platform 5
eQube®-DaaS Platform's Deployment flexibility: 8
eQube® Platform's ability to leverage existing investments: 8
eQube® Platform Architecture 10
Key components of eQube's innovative architecture 11
eQube Connectors 11
eQube's Data Virtualization layer with Semantic capabilities 11
Integrated Process Designer capability in eQube-MI 12
eQube-MI: a Low-code/No-code integration platform 13
eQube-TM: Transformation Modeler for 'solution models' & 'data transformation maps' 14
eQube-AG: API Gateway for API lifecycle management 15
eQube-BI: a modern Analytics / Business Intelligence (A/BI) platform 17
eQube-ADA: Augmented Data Analytics (ADA) for data discovery 19
eQube-DP: Data Profiler for data quality assessment 20
eQube®-DaaS Platform based Solutions 21
1) Developing end-user centric low code 'for-purpose' apps 21
2) Rapidly building OData services for any application (COTS or legacy and any old/new version) 22
3) Enterprise-wide application integration infrastructure 23
4) Data federation with ability to take 'action' 23
5) Orchestration of enterprise-wide business processes 25
6) Application consolidation/legacy system migration 25
7) Secure collaboration across networks, partners, and customers 27
8) Executing 'action' based on analytics 28
9) Data Lake and Data Warehouse development 29
10) Master data management (MDM) 31
eQube-DaaS Platform Benefits 32
eQ's experience 33
eQube®-DaaS for an Integrated Data Environment (IDE) summary 34

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

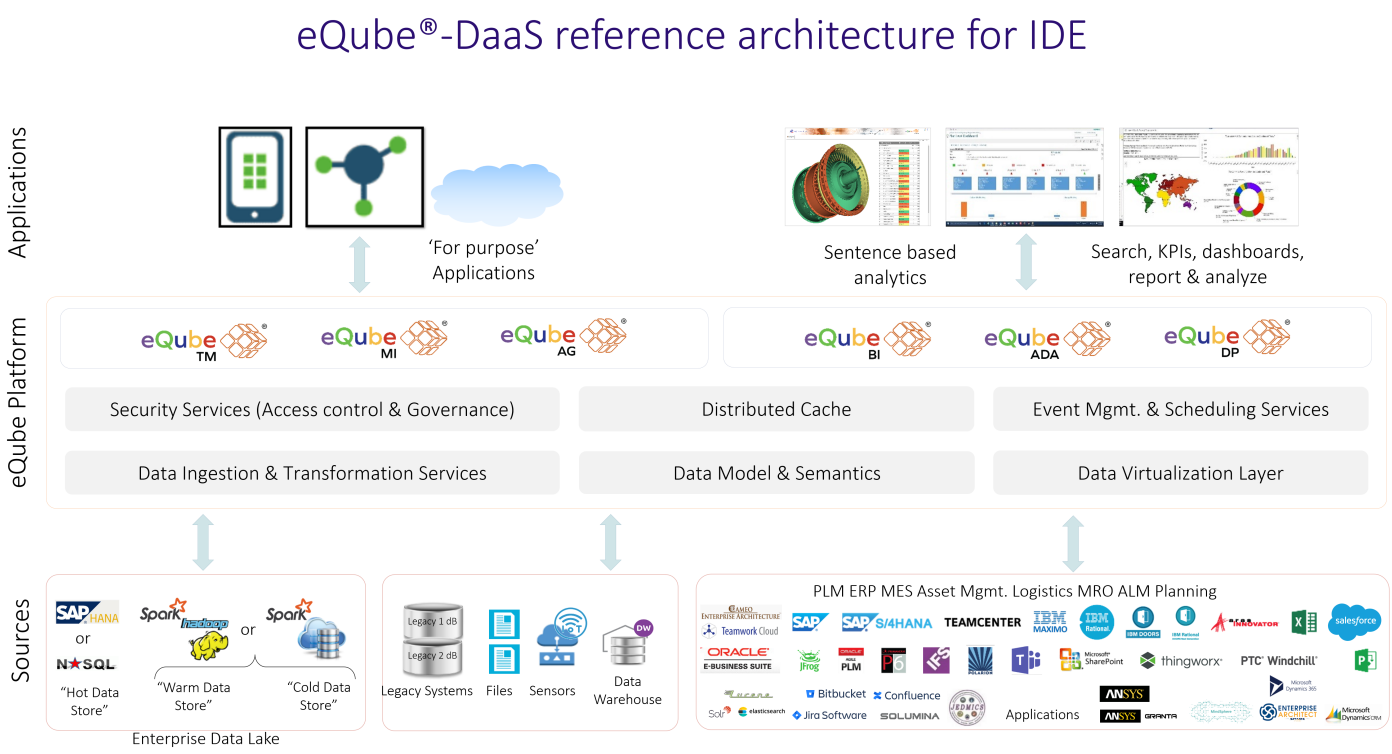
List of figures

Figure 1: eQube Digital Backbone - Actionable Insight 2
Figure 2: eQube-DaaS reference architecture for IDE 5
Figure 3: eQube-DaaS platform hybrid deployment (multi cloud + on-premises) 8
Figure 4: eQube-MI leveraging investments in other ESBs 9
Figure 5: eQube-BI leveraging investment in a Data Warehouse 9
Figure 6: eQube Platform Architecture 10
Figure 7: MI Process Designer with Processing Pipeline - example 1 12
Figure 8: MI Process Designer with Processing Pipeline - example 2 12
Figure 9: eQube-TM: Maps identifying gaps in the Destination system model 14
Figure 10: eQube-TM maps and transformation rules used with eQube-MI 15
Figure 11: eQube-AG at-a-glance map of API consumers and source systems 16
Figure 12: Example eQube-API Gateway dashboard 16
Figure 13: Key tenets for Modern A/BI platform 17
Figure 14: Traditional / Competitive BI approach 18
Figure 15: eQube-BI approach for A/BI 19
Figure 16: eQube-DP - Opioid crisis data discovery, correlation, & insight narration 20
Figure 17: eQube-DP - Data discovery example 20
Figure 18: Data federation app through Teamcenter Active Workspace 21
Figure 19: Data federation app through Mendix 21
Figure 20: Navy Demonstrator app using Mendix 21
Figure 21: BOM management with Cost - app in a Web UI 21
Figure 22: eQube-TM – mapping Teamcenter & Salesforce objects to OData – JSON object 22
Figure 23: eQube-API Gateway – OData service for 'part-cost model' mapped in eQube-TM 23
Figure 24: eQube-DaaS based Data Federation: Teamcenter + SAP + Oracle EBS – data flow 24
Figure 25: eQube-DaaS based Data Federation: Amazon Cloud (MI + AG+ Teamcenter) + On-Premise (SAP & Oracle EBS) 24
Figure 26: eQube-MI process orchestration: SAP & Teamcenter 25
Figure 27: eQube-MI process orchestration: Teamcenter & SharePoint 25
Figure 28: Migration strategy 'Bulk load + delta (s)' 25
Figure 29: Bulk load with One-way sync - by programs / projects 26
Figure 30: Bulk load with One-way sync - by domains 26
Figure 31: Migration strategy - Bi-directional sync 26
Figure 32: Secure collaboration across high & low security networks - D-DIL operations 27
Figure 33: Secure collaboration - Disconnected mode 28
Figure 34: eQube solution integrated in SharePoint portal (watch this use case) 29
Figure 35: 'Worklist items by age' dashboard by eQube-BI. 29
Figure 36: User taking 'action' - eQube-MI then carries out 'action' on user's behalf 29
Figure 37: Data Lake architecture using eQube platform 30
Figure 38: eQube based Data Warehouse solution 30
Figure 39: eQube Select Customer case studies 33

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube®-DaaS based proposed reference architecture for an IDE

The following figure 2 depicts a proposed reference architecture for eQube-DaaS based IDE. It shows the eQube platform connecting with multiple data sources (legacy, relational and NoSQL databases, sensors, files, COTS applications) to consume and update data in any format (text files: fixed length and delimited, relational tables, columnar data, NoSQL formats, binary, objects from applications) and publishing it as APIs (REST or OData services) in end-user centric 'for-purpose' apps. It also shows eQube platform aggregating data from multiple sources for analytics/BI (A/BI) presented in a cognitive layer for Actionable Insight.



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 2: eQube-DaaS reference architecture for IDE

eQube®-DaaS Platform

eQube® Data as a Service (DaaS) platform establishes a Data Fabric with connected network of integrated data, applications and devices that puts the power of analytics in the hands of end users leading to Actionable Insight. Data from any source can be aggregated using eQube's Data Virtualization layer and exposed as a Web-service, REST service, OData service or API. This rapid and flexible capability to expose data as a service/API is at the heart of efficiently delivering eQube-DaaS based solutions in an Integrated Data Environment (IDE).

eQube-DaaS has the following offerings in the market:

The six eQube offerings broadly fall under two families of offerings: eQube-MI and eQube-BI family of products. eQube-MI family of products is made up of eQube-MI (Migration and Integration), eQube-TM (Transformation Modeler), and eQube-AG (API Gateway). eQube-BI family of products is made up of eQube-BI (Business Intelligence and Analytics), eQube-ADA (Augmented Data Analytics), and eQube-DP (Data Profiler).

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube-MI is a powerful Low-code/No-code integration platform that establishes a Digital Backbone of integrated applications. It provides a comprehensive and efficient infrastructure for APIs, enterprise application integration, federation, orchestration, synchronization, and migration. In addition, eQube-MI based application integration infrastructure can be readily extended for secure, scalable, and robust information collaboration across networks, partners, suppliers, and customers that are geographically dispersed. eQube-MI represents 'Not only ESB' integration architecture. Based on the use case, eQube-MI can be used to build integration solutions conforming to either ESB type integration or loosely coupled application-to-application type integration or API gateway type integration; hence 'Not only ESB'. It has significant advantages over ESBs or message brokers as the entire integration solution can be rapidly created, extended or updated without having to write code.

A BPMN-compliant Process Designer integrated in eQube-MI enables visual development of interfaces that include process workflows and processing pipelines containing the integration steps necessary for a given data integration pattern. With the Process Designer, all enterprise integration patterns are supported. Processes can be nested, support transaction boundaries, and include manual steps such as approvals and other forms of human intervention. With the Process Designer, interfaces can be readily developed by visually designing processing pipelines made up of activities, gateways, effects, and paths that capture the business logic of an interface and its process orchestration. The highly configurable eQube-TM maps are directly consumed in the MI processing pipelines as 'activities', providing flexibility to the developers to rapidly implement APIs (REST, OData or Webservices). This capability can be used to build OData or REST service layer on top of one or more Enterprise applications (Legacy systems, COTS with old and new versions).

eQube-TM provides unprecedented capabilities to establish a catalogue / knowledgebase of 'models' and 'transformation maps' for data federation, 'for-purpose' apps, application integration and migration solutions. TM enables developers to visually define, maintain, and update data transformation 'maps' and solution 'models' between source and destination data elements (objects, relational dB tables, files, XML, JSON, etc.). TM catalogue stores connected applications' data models, simple/complex maps and rule-based transformations between systems. The TM catalogue is discoverable for reusing and re-purposing 'maps' and 'models' that speed up the development and maintenance of new interfaces and / or new APIs.

TM's sophisticated and intuitive data mapping and rules-based transformation features are capable of supporting large, complex data models usually found in engineering and PLM, as well as other industries with complex data models, such as insurance and telco. Mapping leverages eQube's integrated and powerful data virtualization layer with semantics. Out of the box ('OOTB'), eQube's sophisticated semantic layer supports Manufacturing, Finance, and PLM concepts like MBOM, BOP, Structure, Plant, Supplier, Revenue, Margins, Parts, Changes, eBOM etc. Maps are neutral to input and output data formats as well as lower level constructs and can support multiple outputs (such as COTS specific object / relationships, relational database tables, files, SOAP, JSON, etc.) with different data models. Customers have the flexibility to extend the OOTB semantic model / concepts or create new ones for their businesses.

eQube-API Gateway efficiently creates, publishes, monitors, maintains and secures APIs. Its visual and intuitive user interface provides complete governance framework for API lifecycle management in any organization. It has flexibility to define security policies at organization level and apply security rules for each API. Monitoring the consumption of APIs is intuitive with in-built BI dashboards that allow administrators to pin-point areas of concern and take rapid action. The API definition capability (REST or OData or Webservices) is integrated with TM maps and MI processing pipelines enabling developers to rapidly develop, publish, discover, reuse, and augment (i.e., 'repurpose') APIs. API Gateway accepts and executes API calls and is central for efficient delivery of eQube-DaaS based solutions.

The powerful combination of eQube-TM, eQube-API Gateway, and eQube-MI provides an integrated Low/No-code development environment for defining, publishing, discovering, reusing and executing OData, REST, Webservices, APIs, and interfaces.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube-BI is a modern A/BI platform that Democratizes BI. It puts the power of analytics in the hands of end users. It unshackles end users to analyze live enterprise-wide data on-demand while honoring the security rules of the underlying applications. In addition, it efficiently deals with streaming/sensory data as well as Big data stores and Data Lakes to provide aggregated view across these data sources and core business systems (PLM, ERP, MRO, Supply Chain, Asset management, Logistics, ALM, etc.) for critical insight. It interactively mashes-up data with stunning visualizations to reveal the 'story' behind the data for Actionable Insight. The underlying architecture is enterprise-class scalable architecture with highly optimized in-memory cubes that scales out to support thousands of end users.

eQube-ADA provides advanced analytics capabilities. It incorporates Machine Learning (ML) and Advanced Statistics techniques for automated data discovery: to identify patterns, clusters, anomalies, textual insights, forecasting, time series decomposition, and text similarity in data. It leverages state-of-the-art ML libraries like scikit-learn, dask, statsmodels and spark-ml. In addition, it has innovative Augmented semantic modelling capabilities to auto discover schema and create semantic model based on data. With ADA, analysis pipelines are defined for specific use cases (tasks) that incorporate multiple ML techniques as steps in the pipeline. The task results, made up of trained models and datasets, are consumed using REST APIs across eQube offerings (MI, BI, and DP).

eQube-DP assesses data quality, quantity, composition, anomalies, similarities, and patterns. It is instrumental in the data discovery phase in understanding the facets of data and for data curation (i.e., data-prep) for ingestion. Such qualification of data then can be used not only to correct and repair the data, but also as an essential step in establishing transformation rules for application migration and integration. DP leverages ADA and BI capabilities to deliver an integrated solution for data profiling and data curation.

These six eQube offerings individually and collectively form a flexible, robust, resilient, scalable, and secure framework in delivering eQube-DaaS based solutions for an Integrated Data Environment at unprecedented speed with overall lower total cost of ownership. eQube-DaaS platform's low/no-code integrated environment results in faster 'time to value' for various integration and migration solutions mitigating the risks of long-duration and expensive IT programs.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube®-DaaS Platform's Deployment flexibility:

eQube-DaaS platform can be deployed as a cloud only or on-premise only or in a hybrid manner. Hybrid deployment can be a combination of cloud and on-premise deployment or a combination of cloud to cloud and on-premise deployment. When deployed in any combination involving cloud deployment, eQube-DaaS platform acts as an integration platform as a service (iPaaS). Figure 3 depicts the concept.

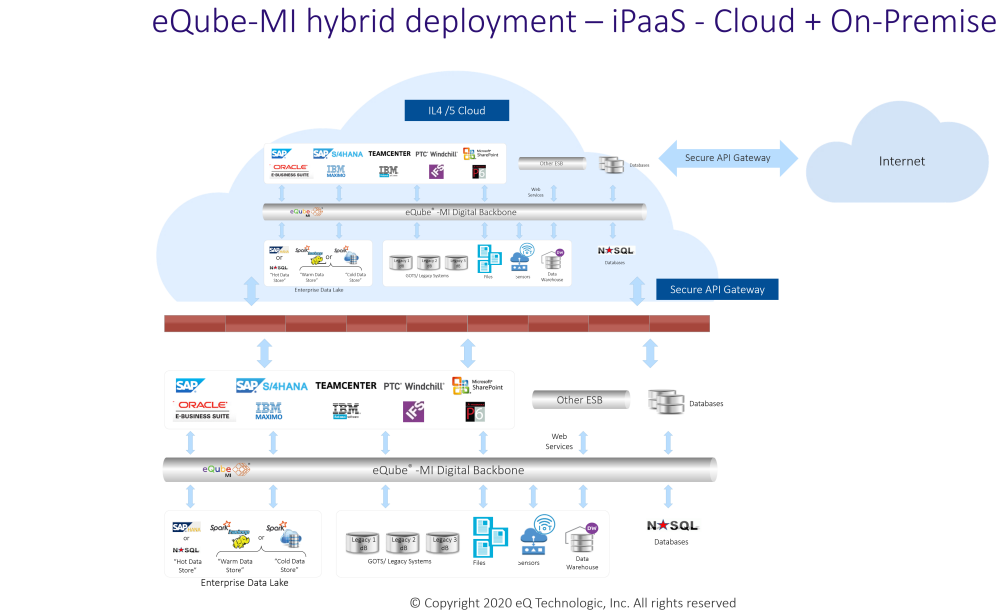


Figure 3: eQube-DaaS platform hybrid deployment (multi cloud + on-premises)

eQube-DaaS offerings and eQube based solutions can be containerized for ease and flexibility of deployment, supporting 'Digital Twin' for solution replication and deployment strategy. Due to the containerized deployment option, eQube platform provides auto-healing and elastic-scaling capabilities supporting robust and resilient scale-out architecture. eQube platform works with various container services such as Docker, Amazon ECS, Azure ACS, Kubernetes, Red Hat OpenShift, etc. eQube platform is certified on Amazon cloud and Azure cloud.

eQube® Platform's ability to leverage existing investments:

eQube platform offers a different approach to effectively address challenges of data and application integration, legacy system migration/retirement, data federation, 'for-purpose' app development, and providing A/BI capabilities resulting in Actionable Insight. In addition, due to its open and flexible architecture, it can readily leverage prior investments a customer may have made in other integration platforms (ESBs, message brokers, …). Several eQube-MI implementations have leveraged existing ESBs or integration platforms where data is exchanged between eQube-MI and other ESBs as SOAP or JSON or as a Web-service or REST service or API. Such co-existence architecture has provided customers with practical flexibility required to leverage prior investments with new capability offered by the eQube platform. Figure 4 shows the concept.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

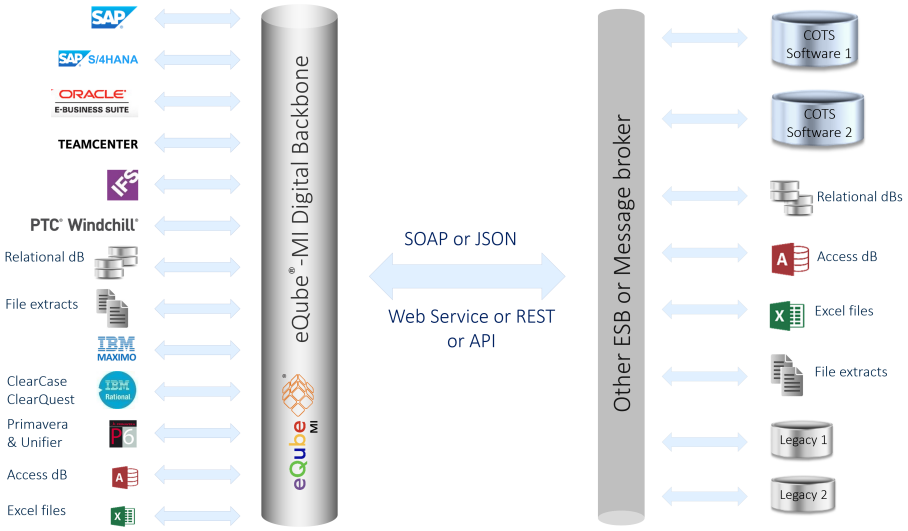


Figure 4: eQube-MI leveraging investments in other ESBs

eQ believes in keeping data where it belongs – in the source systems. However, if a customer has already invested in a Data Warehouse or Data Mart (s) or Data Lake, eQube-BI can easily leverage it as a source for A/BI capabilities. In addition, it can mash-up data from the Data Warehouse or Data Mart (s) or Data Lake along-with the data from other enterprise systems (legacy, COTS, files, etc.). Figure 5 shows the concept.

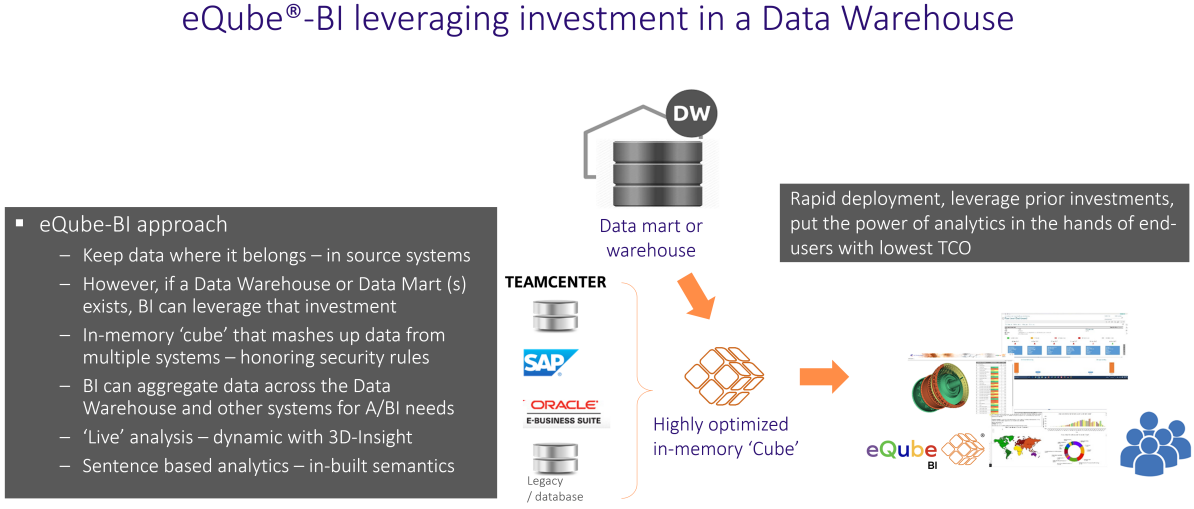


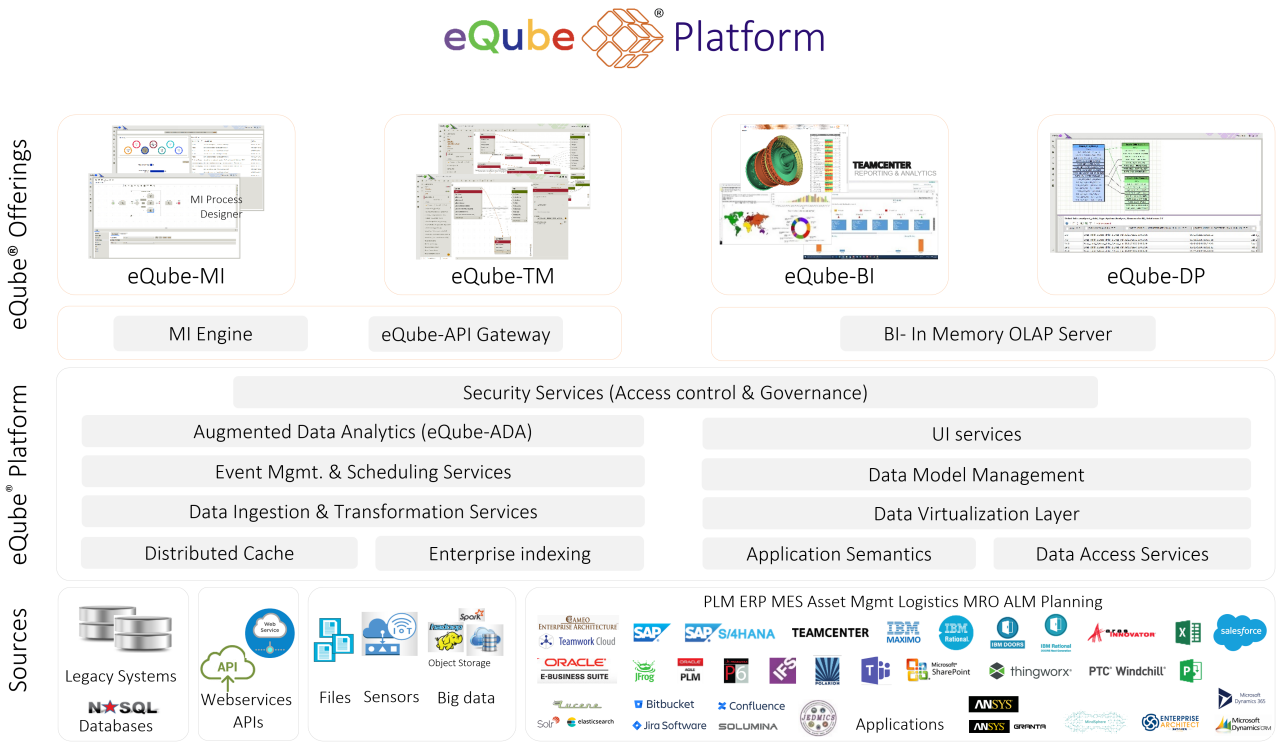
Figure 5: eQube-BI leveraging investment in a Data Warehouse

Additionally, due to eQube's modern architecture, it can be used for developing and maintaining a Data Warehouse or a Data Lake with speed, agility, and lower total cost of ownership. Refer to eQube solution titled "Data Lake and Data Warehouse development" in this white paper.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube® Platform Architecture

eQube platform is a SOA-compliant Java J2EE open platform. It is a common platform leveraged by each of the eQube offerings. As shown in the figure 6, it is modular in nature with multiple core components that are loosely coupled offering flexibility, scalability, and robustness to the solutions. All eQube offerings are web- based pure thin client applications (browser as the client and no other client-side modules need to be installed).



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 6: eQube Platform Architecture

eQube offerings are certified on several open source and major commercial application servers (JBoss, WebLogic, WebSphere, and Tomcat). It supports HTTP, HTTPS, FTP, SFTP, and JMS protocols. Active-MQ is embedded as a part of the eQube platform and is used for communication between eQube-MI API Gateway and the eQube-MI server. Out of the box, eQube-MI supports various 3rd party message queues such as: IBM MQ, WebLogic JMS, and Active MQ. This enables eQube-MI to leverage existing integrations that are built using various message queues. Being a SOA-compliant platform eQube can create and expose APIs as well as consume services exposed by any other integration solution.

eQ platform supports various authentication mechanisms such as: SAML, Kerberos, Active Directory / LDAP, certificate based, dual-factor authentication, PKI/CAC card, etc. eQ's security services layer is flexible and can leverage any other 3rd party authentication or SSO services.

eQube platform supports various DevOps tools and methods. In eQ's own development certification environment, we leverage Jenkins based pipeline for nightly builds, deployment on various certification platforms, and executing automated test suites. All eQ installers support a silent mode of deployment and configuration, making them suitable for integrating in any DevOps environment and a robust continuous integration/continuous deployment (CI/CD) pipeline.

eQube based solutions can be containerized for ease and flexibility of deployment, supporting 'Digital Twin' for solution replication and deployment strategy. eQube platform can work with various container services such as Docker, Amazon ECS, Azure ACS, Kubernetes, Red Hat OpenShift, etc. eQube platform is certified on Amazon cloud and Azure cloud.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube platform provides OOTB JMX extensions for monitoring various operational parameters (such as: resources CPU and JVM memory, number of total and active threads, number of requests and status of requests, etc.). This monitoring allows the eQube platform to elastically scale based on the load. This capability in conjunction with support for containerization and auto-scaling services provided by various cloud providers, allows eQube platform to scale-out and support extensive installations with thousands of users. In addition to JMX extensions, eQube platform can be deployed with Kubernetes (Amazon EKS and Azure AKS) for elastic scaling.

eQube's data virtualization layer provides integrated view of data mashed-up from multiple data sources (like building a view on top of connected data sources). eQube-MI with its Process Designer with integrated eQube-TM transformation maps and API gateway can be used to build application logic layer on top of this data virtualization layer and to expose the required services (OData, REST, Webservices or APIs) to build applications. eQ believes this is a far efficient approach for development and maintenance of applications. However, if direct access to the eQube data virtualization layer is required, it also can be provided and HIBERNATE, JPA, and method calls can be used to access the integrated data directly from the data virtualization layer.

Key components of eQube's innovative architecture

eQube Connectors

eQube pre-built Connectors use application specific APIs covering the entire application capability. With these Connectors, eQube leverages the entire OOTB object model as well as customized object model including data security rules. eQube Connectors are stateless and do not perform any business logic or transformations. Interface business logic and transformations are managed in eQube-MI's processing pipelines with eQube-TM maps. eQ maintains and certifies these Connectors, buck stops with eQ! eQube based solutions are application version and upgrade tolerant. If APIs change from one version to the next, eQ updates and certifies that specific application Connector. The list of eQube Connectors released in the market can be found at: http://www.1eQ.com/eQube-connectors

eQube's Data Virtualization layer with Semantic capabilities

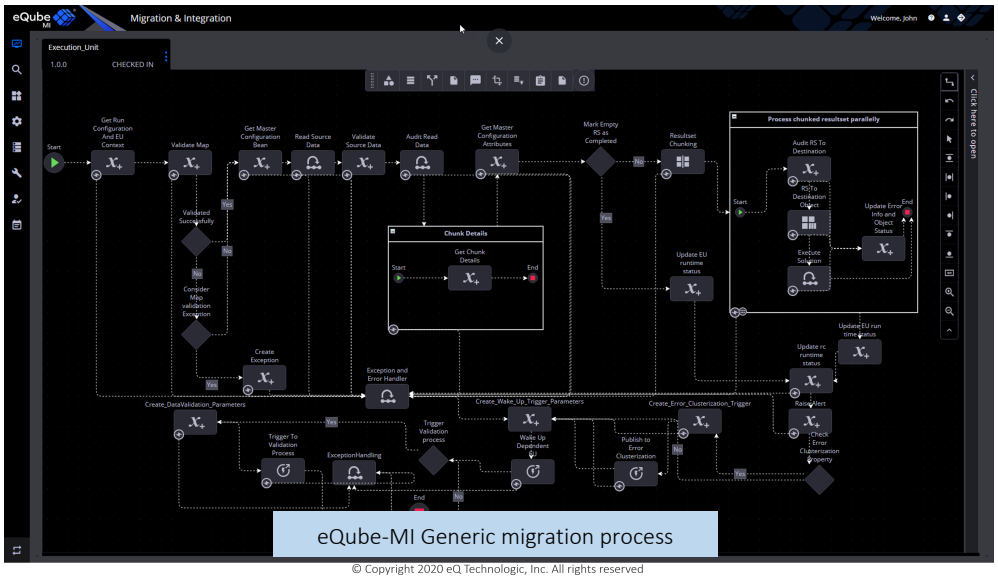
eQube's powerful data virtualization layer is a common neutral layer to access data from one or more applications that hides the complexity of each application from the developers. It creates a logical data abstraction layer enabling multiple sources to be treated as one logical data source. It results in eQube's core capability of easily mashing up data from multiple sources and in multiple formats. This core eQube capability supports broad set of use cases from data federation, replication, integration, API creation, migration, A/BI, IoT data mashups with core systems, etc. while ensuring that data and business objects are wholly owned and managed by their respective authoring systems. With data virtualization, mashed up data resides in-memory without a need to copy or persist it.

eQube Connectors translate the requests from the data virtualization layer to application specific API calls. Thus, eQube-BI and eQube-DP can read data; while eQube-TM with eQube-MI can read and write data into the application (s) by utilizing application specific APIs without the developer having to know the details of those applications. eQube platform builds a comprehensive model of connected applications including an integrated semantic layer. OOTB, eQ ships ontology for Manufacturing, Finance, and PLM concepts. Application specific objects/relationships/attributes implementation can be mapped to each domain ontology concept. Semantic layer further enriches the object model of the underlying application by introducing higher-level concepts. These higher-level concepts and their implementations in each application's object model further simplify the process of developing and maintaining interfaces.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

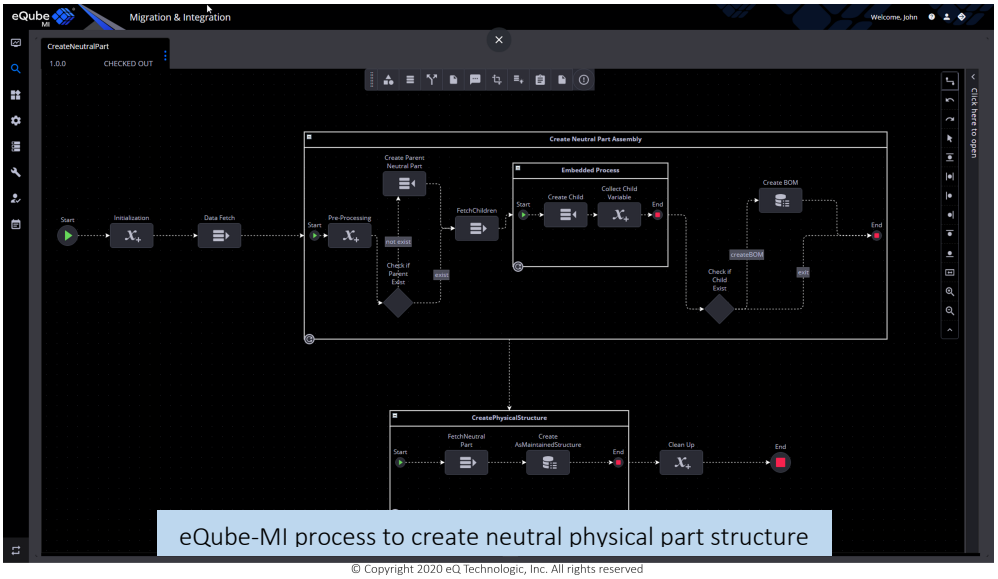
Integrated Process Designer capability in eQube-MI

A BPMN-compliant Process Designer integrated in eQube-MI enables visual development of interfaces that include process workflows and processing pipelines containing the integration steps necessary for a given data integration pattern. With the Process Designer, all enterprise integration patterns are supported. Processes can be nested, support transaction boundaries, and include manual steps such as approvals and other forms of human intervention. With the Process Designer, interfaces can be readily developed by visually designing processing pipelines made up of activities, gateways, effects, and paths that capture the business logic of an interface and its process orchestration. The highly configurable eQube-TM maps are directly consumed in the MI processing pipelines as 'activities' providing flexibility to the developers to rapidly implement REST services, OData services or Web-services without writing code. This capability can be used to build OData or REST service layer on top of any Enterprise application (Legacy systems, COTS with old and new versions). Figures 7 and 8 show examples of eQube-MI processing pipelines representing an interface developed in the visual eQube-MI Process Designer.



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 7: MI Process Designer with Processing Pipeline - example 1



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 8: MI Process Designer with Processing Pipeline - example 2

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube-MI: a Low-code/No-code integration platform

eQube-MI (Digital Backbone) comprehensively addresses application integration challenges. It establishes a robust, resilient, scalable, and secure application integration infrastructure to integrate any data, from any application, in any format, any API, at any velocity and from any device. For rapid integration solutions, MI's powerful low/no-code development environment enables rapid creation of various integration solutions such as: Data federation for efficient development of low code end-user centric 'for-purpose' apps. Data replication for certain use cases where it is the correct answer for data/application integration. Application consolidation and retirement of legacy systems present significant opportunities and threats to any organization. With eQube-MI, 'bulk load + delta' approach or 'bi-directional sync' approach can be used for orderly retirement of legacy systems without business disruptions or blackouts. These approaches dramatically reduce the risks in consolidation of applications while providing a responsible path forward.

While integrating or migrating applications, interfaces need to be built. Data from different applications and in different formats need to be transformed for proper ingestion in destination system (s). Multiple data and business conditions must be addressed in those interfaces while fetching, transforming, and updating data. Many times, business processes span across application boundaries and need to be orchestrated. Business logic that enables business process orchestration needs to be managed in the interface (s). With traditional integration approach of using message brokers or ESBs, this 'last-mile' connectivity to the participating applications must be programmed in the endpoints or end application connectors. When business logic changes due to evolving business requirements or when the software versions of the participating applications or message brokers/ESBs change, the logic in the endpoints or 'last-mile' connectivity must be re-programmed. Traditional integration platforms (ESBs or message brokers) guarantee delivery of messages to participating applications. However, they do not guarantee consumption of those messages in the participating applications, that is the responsibility of the interface and application connectors. Again, that logic must be programmed in the endpoints and at times it requires extensive programming. All these factors make those solutions inefficient, laborious, slow, and expensive!

With the eQube platform, 'last-mile' connectivity is addressed without any developer having to write code in the endpoints or connectors! eQube's low/no-code integration environment has powerful and intuitive UI that enables modeling interfaces in the MI Process Designer as process workflows or processing pipelines with TM defined transformation maps directly consumed in steps of the processing pipelines. The application specific eQube Connectors working with the integrated Data Virtualization layer with semantics underpin the TM maps enabling MI to efficiently execute interfaces. Therefore, the speed and agility with which interfaces can be developed, maintained and modified is unprecedented. It supports microservices development architecture enabling development of interfaces conforming to service orchestration design. A business process modeled in eQube-MI (either a microservice or a complex business process) can be exposed as a REST or OData or Webservice API.

The entire business logic of an interface resides in the realm of eQube-MI managed by its integrated Process Designer. The pre-built eQube Connectors are stateless and are developed using the underlying application's published services or APIs. The integrated revolutionary eQube Data Virtualization Layer interacts with the eQube Connectors allowing for efficient data fetch and insert/modify operations as well as creating complex linkages between various objects in the target system. The combination of eQube-MI Process Designer, eQube-TM maps and models, eQube Data Virtualization layer, and eQube Connectors results in no 'last-mile' coding or end-point coding. Therefore, changes to the business logic of interfaces or the impact of version changes of the source/destination applications are managed within the boundary of eQube-MI and not in the 'last-mile' connectivity, thereby reducing rework, implementation time and lowering total cost of ownership.

Although the eQube-MI based integration approach is different than traditional integration platform's (ESBs, message brokers, …) approach, due to eQube's open architecture, eQube-MI can readily leverage prior investments made by a customer in other integration platform (s). It can exchange data with any other integration platform as SOAP or JSON or as

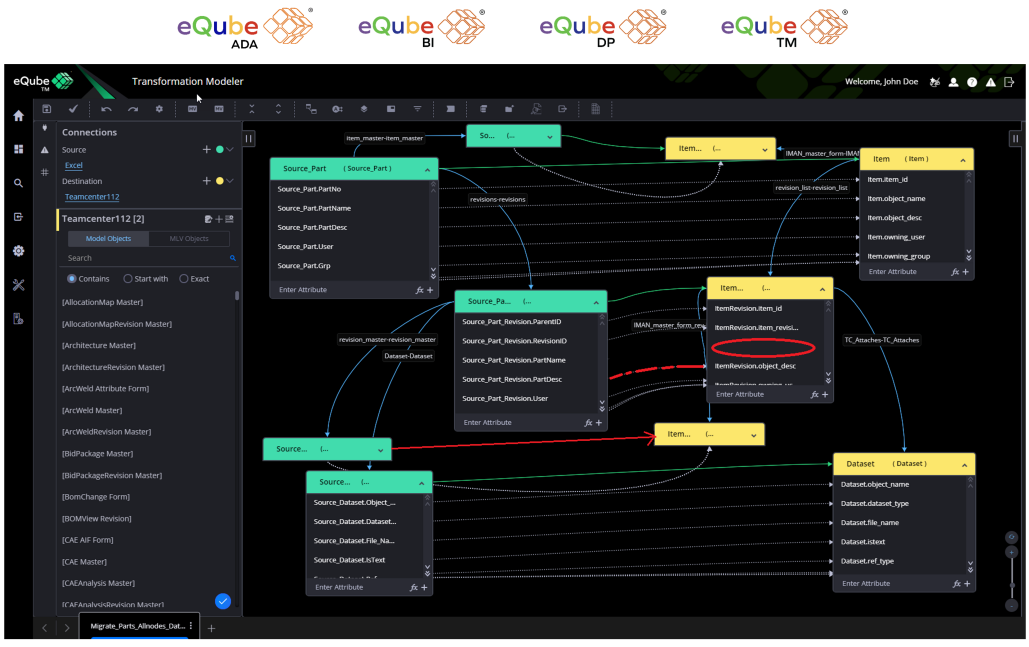
© Copyright 2020 eQ Technologic, Inc. All rights reserved.

a Webservice or REST service or API. Thus eQube-MI can easily co-exist with other integration platform (s) providing the greatest flexibility.

eQube-TM: Transformation Modeler for ‘solution models’ & ‘data transformation maps’

eQube-TM provides unprecedented capabilities to establish a catalogue / knowledgebase of ‘models’ and ‘transformation maps’ for data federation, ‘for-purpose’ apps, application integration and migration solutions. TM enables developers to visually define, maintain, and update data transformation ‘maps’ and solution ‘models’ between source and destination data elements (objects, relational dB tables, files, XML, JSON, etc.). TM catalogue stores connected applications’ data models, simple/complex maps and rule-based transformations between systems. The TM catalogue is discoverable for reusing and re-purposing ‘maps’ and ‘models’ that speed up the development and maintenance of new interfaces and / or new APIs.

eQube-TM assists in defining ‘for-purpose’ applications’ data models derived from the catalogue / knowledgebase. It also enables data model definition for REST services or OData services or Webservices. Maps are defined with a powerful visual and intuitive user interface enabling speed and flexibility to augment maps and models. The catalogue of maps is searchable and enables reuse as well as augmentation (i.e., ‘repurpose’) of maps to rapidly build and extend models as well as REST or OData or Webservices. Figure 9 shows an example of TM maps that identify ‘gaps’ in mapping.



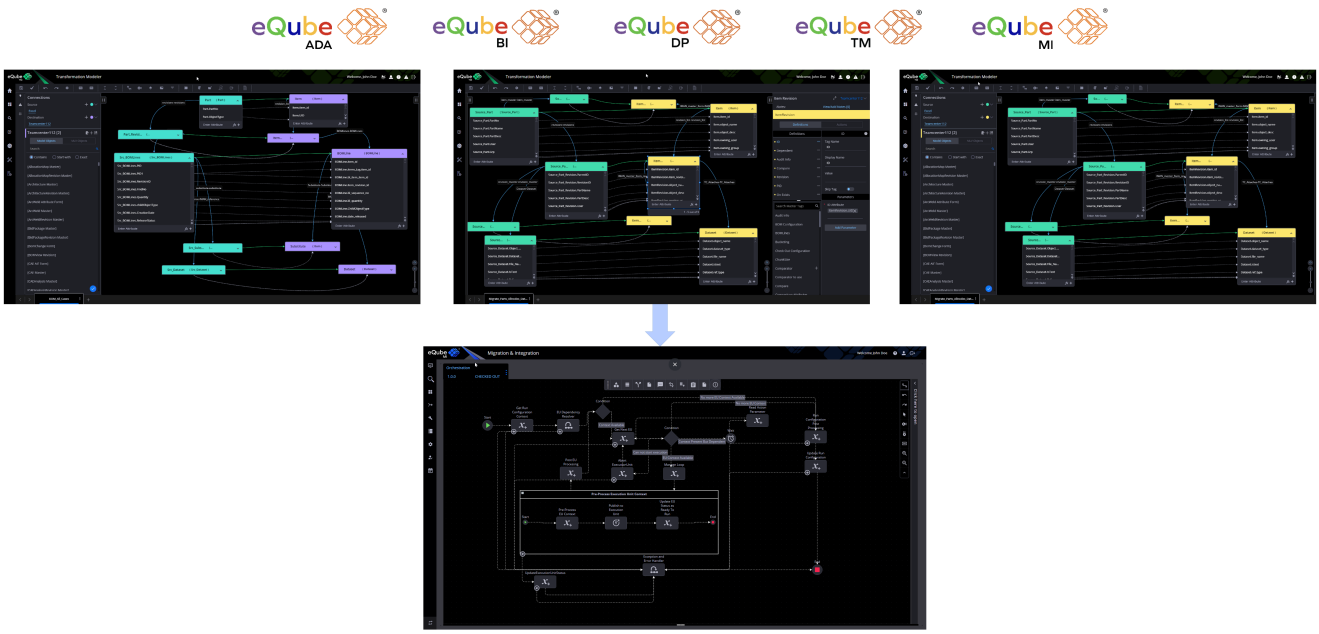
© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 9: eQube-TM: Maps identifying gaps in the Destination system model

TM defined maps are readily consumed in the MI processing pipelines as ‘activities’ and are also integrated with eQube-API Gateway that enables REST or OData or Webservice definition. These TM capabilities accelerate model driven application development with any low code development platforms (i.e., eQube low/no-code for API implementation as well as for App development). The catalogue of maps and model definitions are leveraged by all eQube offerings for data

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

curation, 'for-purpose' apps development, data federation, secure collaboration, application orchestration, integration, synchronization, and migration solutions. Figure 10 shows an example of TM maps being directly consumed in the MI processing pipelines.



© Copyright 2020 eQ Technologic, Inc. All rights reserved

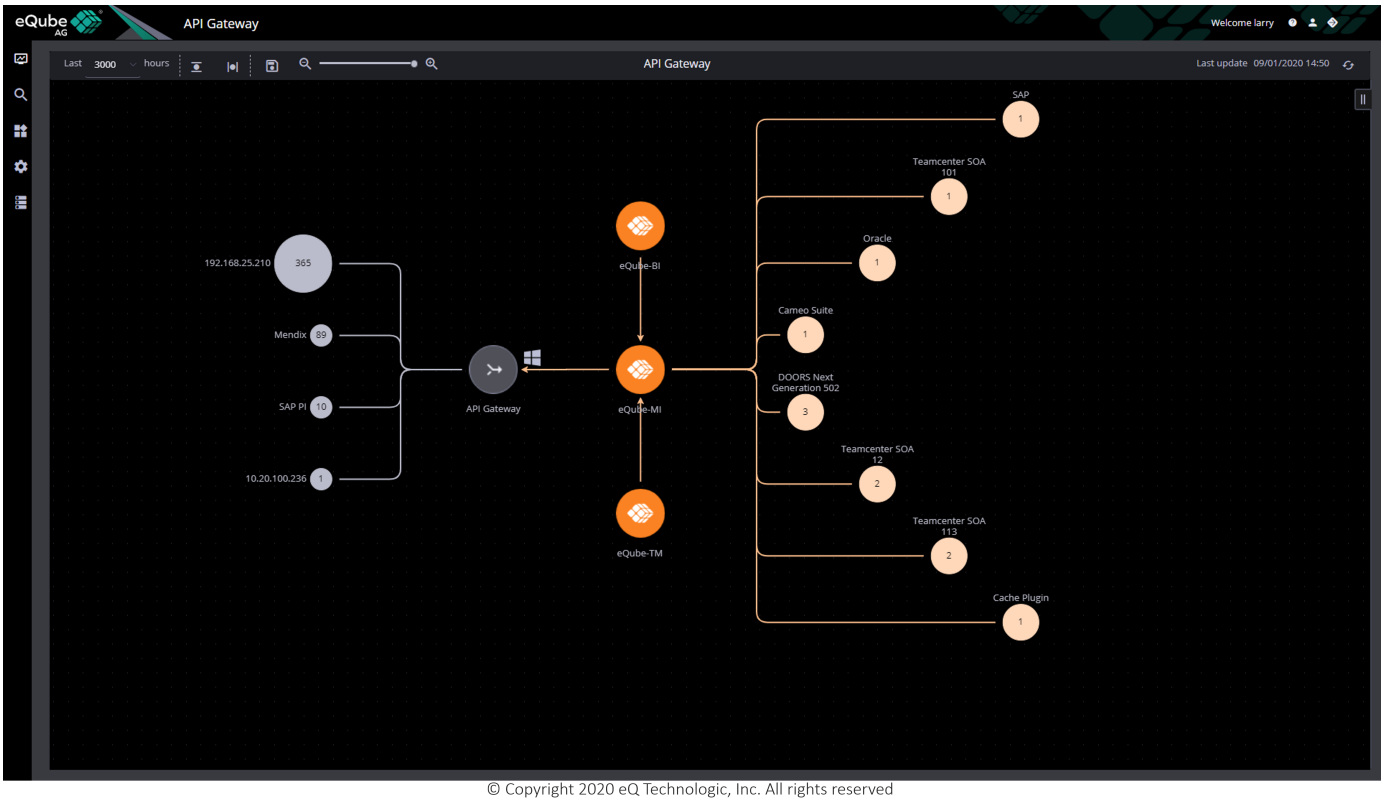
Figure 10: eQube-TM maps and transformation rules used with eQube-MI

TM's sophisticated and intuitive data mapping and rules-based transformation features are capable of supporting large, complex data models usually found in engineering and PLM, as well as other industries with complex data models, such as insurance and telco. Mapping leverages the integrated and powerful data virtualization layer with semantics. eQube's sophisticated semantic layer out of the box includes Manufacturing, Finance, and PLM concepts like MBOM, BOP, Revenue, Margins, Parts, Changes, eBOM etc. Maps are neutral to input and output data formats as well as lower level constructs and can support multiple outputs (such as COTS specific object / relationships, relational database tables, files, SOAP, JSON, etc.) with different data models.

eQube-AG: API Gateway for API lifecycle management

eQube-API Gateway efficiently creates, publishes, monitors, maintains and secures APIs. Its visual and intuitive user interface provides complete governance framework for API lifecycle management in any organization. It has flexibility to define security policies at organization level and apply security rules for each API. Figure 11 shows an at-a-glance map of API Gateway with API consumers and source systems.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 11: eQube-AG at-a-glance map of API consumers and source systems

Monitoring the consumption of APIs is intuitive with in-built BI dashboards that allow administrators to pin-point areas of concern and take rapid action. Figure 12 shows an example API Gateway dashboard.

© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 12: Example eQube-API Gateway dashboard

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

The API definition capability (REST or OData or Webservices) is integrated with TM maps and MI processes enabling developers to rapidly develop, publish, discover, reuse, and augment (i.e., 'repurpose') APIs. API Gateway accepts and executes API calls and is central for efficient delivery of eQube-DaaS based solutions.

The powerful combination of eQube-TM, eQube-API Gateway, and eQube-MI provides an integrated Low/No-code development environment for defining, publishing, discovering, reusing and executing OData, REST, Webservices, APIs, and interfaces.

eQube-BI: a modern Analytics / Business Intelligence (A/BI) platform

eQube-BI democratizes BI. It puts the power of analytics in the hands of end users. It unshackles end users to analyze live enterprise-wide data on-demand while honoring the security rules of the underlying applications.

For too long, end users have been relying on power-users or internal IT developers to develop business critical reports, KPIs, or dashboards. In a governed environment, these analytics artifacts are well defined and approved by the business before they are put in production. They are typically developed by power-users or IT developers and are published at predefined frequencies or schedules (such as daily, weekly, monthly, etc.). This governed analytics approach is most appropriate to ensure consistency of analysis across any organization. However, it can take weeks or more to productionize these artifacts. With the proliferation of streaming/sensory data, needs for data scientists are also exploding. Data scientists need to harness and analyze Big data to gain insights that are business critical. Many times, they need to aggregate Big data with core business applications' data. With the pace of change in any business, end users need to have on-demand access to data spread across the enterprise. In addition, some of the end users have become 'Citizen Data Scientists' and have a need to rapidly build the analytics views to aid business leaders for timely decision-making. To effectively address the needs of power-users, end users, data scientists, and citizen data scientists, there is a clear need for a bi-modal modern A/BI platform. Key tenets for Modern A/BI platform are summarized in Figure 13. Mode 1 is for the governed BI deployment for all users where the BI artifacts are developed and managed by power-user or IT developers. While Mode 2 is for rapid and agile A/BI approach for citizen data scientists, end users, and data scientists. In both modes of deployment, security and access control are paramount for any business. Underlying applications' security rules are expected to be enforced in A/BI artifacts.

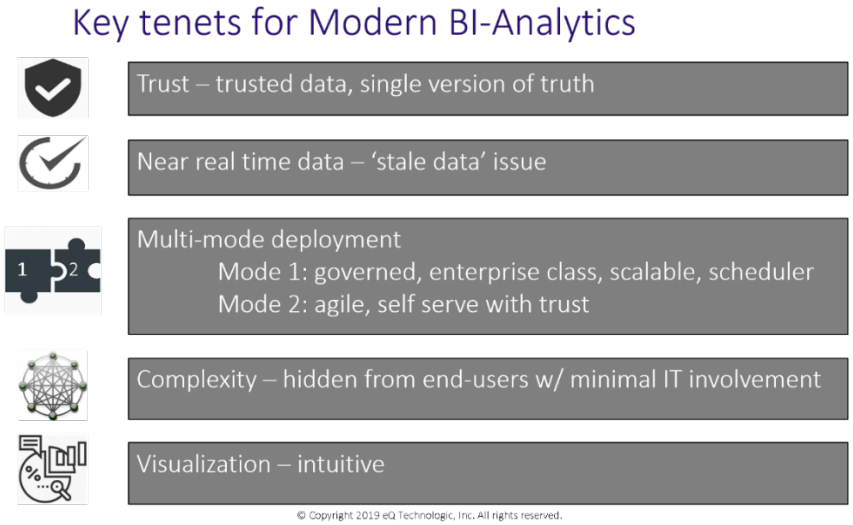


Figure 13: Key tenets for Modern A/BI platform

Many A/BI products approach the problem of aggregating data from across the enterprise by first developing an intermediate data store (a Data Mart or a Data Warehouse) that stores a copy of the data from source systems. With this

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

approach, the security and access control rules of the underlying source systems are by-passed. Additionally, data ETL routines must be developed, maintained, and deployed to make this approach work. When the business conditions or requirements for analytics artifacts change or when the source systems' versions change, the entire infrastructure of ETL and intermediate data store must be upgraded. At times, this approach can result in data discrepancies between source system data and intermediate store data. Resolution of these data discrepancies can take a lot of effort and may impact the perception of end users that they are not dealing with trust-worthy data. ETL routines are typically run overnight and therefore, the analytics is not real-time or near real-time. For certain business decisions, this 'stale-data' can be a major problem. Figure 14 depicts the traditional approach and summarizes its challenges. This entire approach is laborious, expensive, and slow!

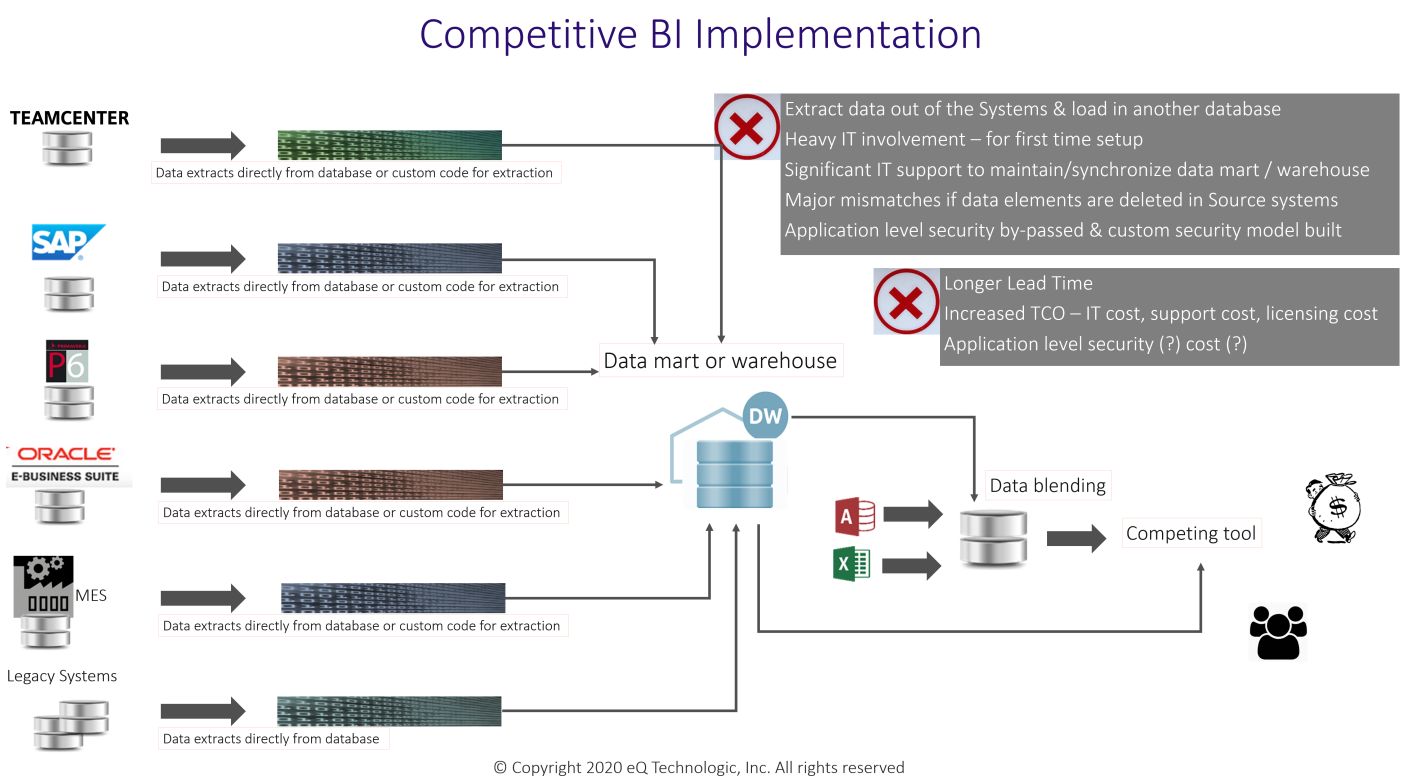


Figure 14: Traditional / Competitive BI approach

eQ's approach is to keep data where it belongs – in the source systems. eQube-BI can be deployed in a bi- modal manner. It interactively mashes-up data from multiple systems with stunning visualizations to reveal the 'story' behind the data for Actionable Insight. It honors and leverages the underlying applications' security and access control rules. Therefore, end users see only the information they are authorized to see. Analytics artifacts can be consumed by end users in an eQube-BI defined portal or as part of a SharePoint portal or as part of a web-based 'for-purpose' app or on any mobile device. It has in-built powerful scheduler that can publish the analytics artifacts for end users in both Mode 1 and Mode 2 deployment approaches. Figure 15 depicts the eQube-BI approach for A/BI.

eQube-BI has in-built event management system (EMS) that generates A/BI artifacts upon certain events in underlying system (s), such as upon executing certain step (s) in a workflow or upon state change of an object or a database record. In addition, end users can generate A/BI artifacts in real-time on-demand. Sentence-based analytics is fully incorporated in eQube-BI. End users can type in their questions in plain English in a search bar and generate A/BI artifacts due to the interaction between eQube-BI's powerful natural language processing (NLP) engine and its data virtualization layer with semantic capabilities.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

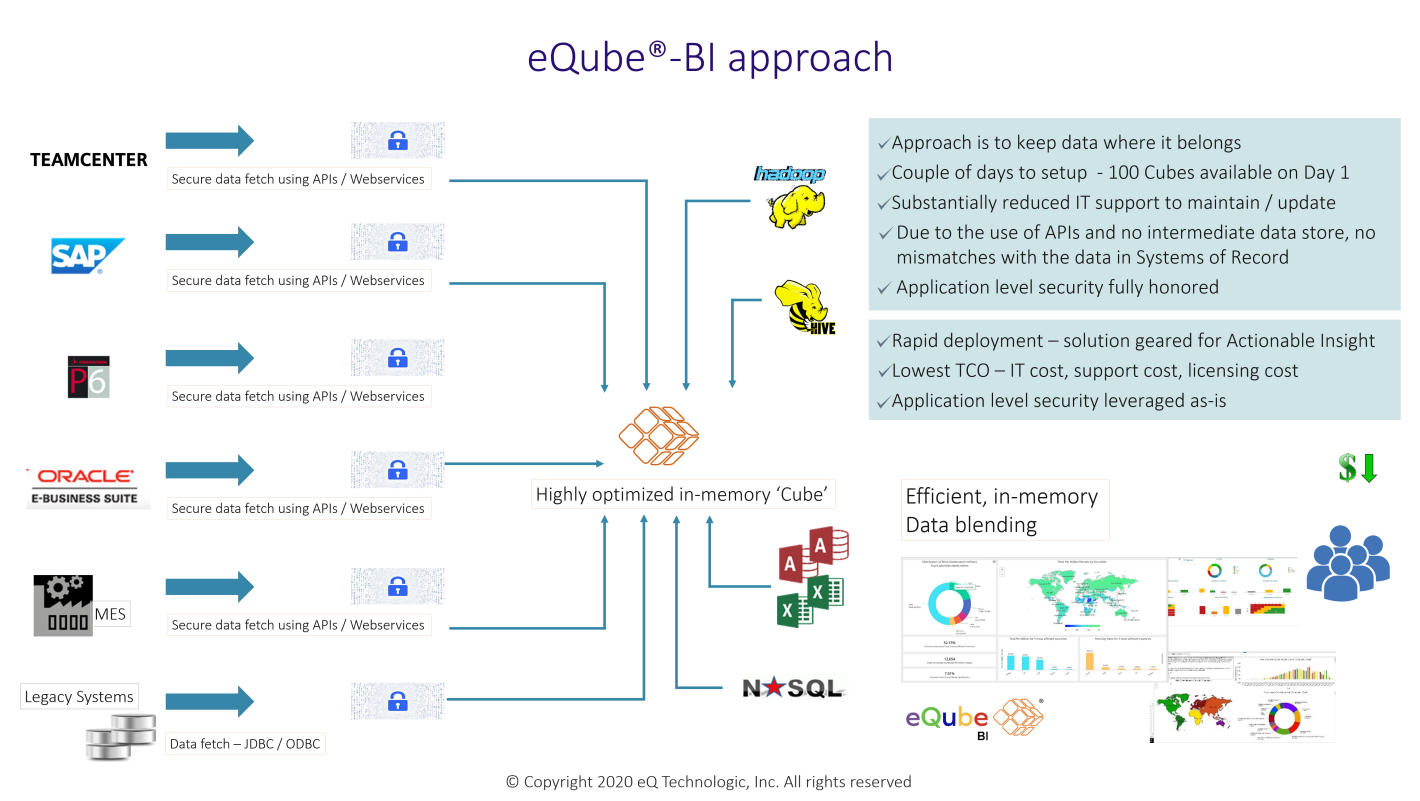


Figure 15: eQube-BI approach for A/BI

In addition, eQube-BI efficiently deals with streaming /sensory data as well as Big data stores and Data Lakes to provide aggregated view across these data sources and core business systems (such as: PLM, ERP, MRO, Supply Chain, Asset management, Logistics, ALM, etc.) for critical insight. The underlying architecture is enterprise-class scalable architecture with highly optimized in-memory cubes that scales out to support thousands of end users.

eQube believes in keeping data where it belongs – in the source systems. However, if a customer has already invested in a Data Warehouse or Data Mart (s) or Data Lake, eQube-BI can easily leverage it as a source for A/BI capabilities. In addition, it can mash-up data from the Data Warehouse or Data Mart (s) or Data Lake along-with the data from other enterprise systems (legacy, COTS, files, etc.). Figure 5 shows the concept.

Additionally, due to eQube's modern architecture, it can be used for developing and maintaining a Data Warehouse or a Data Lake with speed, agility, and lower total cost of ownership. Refer to eQube solution titled "Data Lake and Data Warehouse development" in this white paper.

eQube-ADA: Augmented Data Analytics (ADA) for data discovery

eQube-ADA provides advanced analytics capabilities. It incorporates Machine Learning (ML) and Advanced Statistics techniques for automated data discovery: to identify patterns, clusters, anomalies, textual insights, forecasting, time series decomposition, and text similarity in data. It leverages state-of-the-art ML libraries like scikit-learn, dask, statsmodels and spark-ml. In addition, it has innovative Augmented semantic modelling capabilities to auto discover and create semantic model based on data. With ADA, analysis pipelines are defined for specific use cases (tasks) that incorporate multiple ML techniques as steps in the pipeline. The task results, made up of trained models and datasets, are consumed using REST APIs across eQube offerings (MI, BI, and DP).

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube-ADA works with the rest of eQube offerings to augment data profiling and data quality, harmonization, modeling, manipulation, enrichment/inference, metadata development, and data cataloging.

eQube-DP: Data Profiler for data quality assessment

eQube-DP assesses data quality, quantity, composition, anomalies, similarities, and patterns. It is instrumental in the data discovery phase in understanding the facets of data and for data curation (i.e., data-prep) for ingestion. For example; "part' is defined as a semantic concept which is represented by multiple objects/relationships in different systems. eQube-DP can identify commonalties, correlations, and differences ('quality') for 'part' irrespective of its data structure in those systems. Such qualification of data then can be used not only to correct and repair the data, but also as an essential step in establishing transformation rules for application migration and integration. Figures 16 and 17 show examples of eQube-DP based analysis. DP leverages ADA and BI capabilities to deliver an integrated solution for data profiling and data curation.

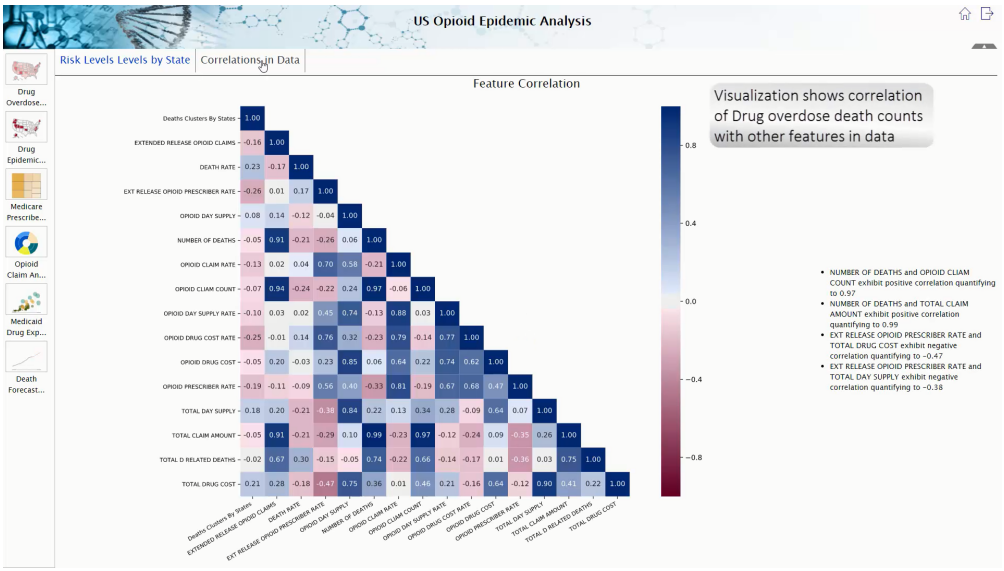


Figure 16: eQube-DP - Opioid crisis data discovery, correlation, & insight narration

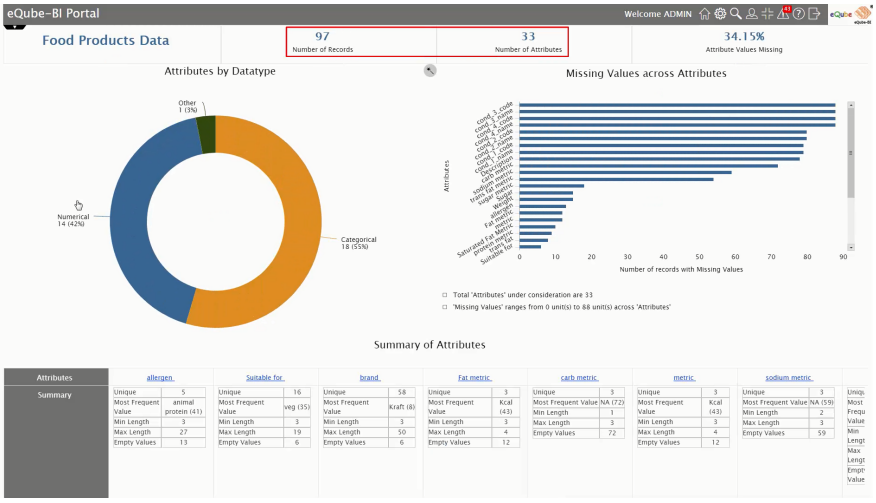


Figure 17: eQube-DP - Data discovery example

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube®-DaaS Platform based Solutions

eQube-DaaS platform's powerful low/no-code integration environement enables rapid delviery of multiple solutions, some of them are as follows:

1) Developing end-user centric low code 'for-purpose' apps

To achieve productivity goals across any organization, there is a clear need to rapidly implement intuitive end-user centric 'for-purpose' applications and provide on-demand 'visibility' across business processes with A/BI capabilities. These apps need to access contextual relevant data from multiple systems to enable end users in carrying out their end-to-end business transactions. Security and access control of underlying source systems must be honored.

eQube platform enables rapid development of low code end-user centric apps. eQube-MI enables development of REST or OData APIs by exposing data as a service from multiple systems. eQube-BI aggregates data from multiple systems and exposes it with detailed analysis or stunning intuitive visualizations. These capabilities are provided with minimum need to write code. Given, its web-based service oriented open architecture, it is easy to expose these capabilities in any Web UI or portal or any platform that enables development of apps, such as Mendix or ThingWorx or OutSystems. This is a critical capability for DaaS in an IDE.

Figure 2 depicts a proposed reference architecture for eQube based DaaS/IDE solution. Examples of eQube based apps are shown in figures 18- 21.

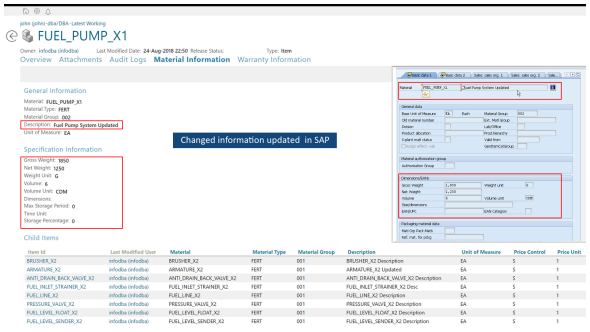


Figure 18: Data federation app through Teamcenter Active Workspace

(watch this use case)

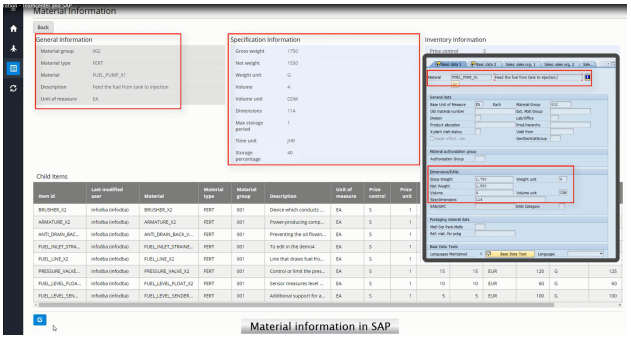


Figure 19: Data federation app through Mendix

(watch this use case)

Figure 20: Navy Demonstrator app using Mendix

(watch this use case)

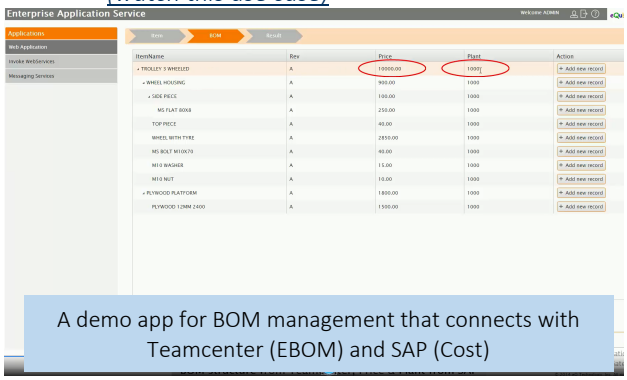


Figure 21: BOM management with Cost - app in a Web UI

(watch this use case)

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

2) Rapidly building OData services for any application (COTS or legacy and any old/new version)

OData (Open Data Protocol) is an ISO/IEC approved, OASIS standard that defines a set of best practices for building and consuming RESTful APIs. Its tag line is "OData – best way to REST"! OData services can be used, discovered, reused or extended to rapidly develop 'for-purpose' apps or integrations.

With the latest 4.x version, OData standard has evolved considerably. OData is an open protocol that allows the creation and consumption of 'queryable' and interoperable REST APIs in a simple and standard way. OData works to simplify the querying and sharing of data across disparate applications and multiple stakeholders for re-use in the enterprise, Cloud, and mobile devices. It provides full CRUD capabilities of managing data. OData provides many benefits that come with standardization being followed across the industry. Many Software vendors / manufactures are in the process of releasing OData services for their applications.

The challenge for practical and wide adoption lies in the coverage of any application (COTS system) with OData services. In addition, in any customer organization, many of the critical applications are customized or configured to fit their business needs. OData services shipped out of the box (OOTB) may not work due to object model extensions and may need to be extended. Customers tend not to have the latest version of every key application deployed in their organization and therefore, may not even have access to OOTB OData services shipped by the manufacturer. Also, large organizations tend to have many home-grown legacy systems that do not have any APIs, let alone OData services associated with them.

With eQube®-DaaS, OData services and associated models can be rapidly developed on top of one or more systems, COTS and/or Legacy, for any old or new version of the connected systems. This flexibility and speed for publishing OData services is unprecedented. Composite models can be defined with data from multiple systems and then using the powerful combination of TM, API Gateway, and MI, OData services can be created, published, discovered, reused or extended, and executed. This powerful capability helps in developing end-user centric for-purpose apps with any Web-UI, SharePoint, rapid application development platform (e.g., Mendix, ThingWorx, OutSystems, Microsoft Power apps, etc.), or embedded in any application (PLM, ERP, ALM, MES etc.). An example of OData creation for data from Teamcenter and Salesforce is shown in Figure 22 and 23.

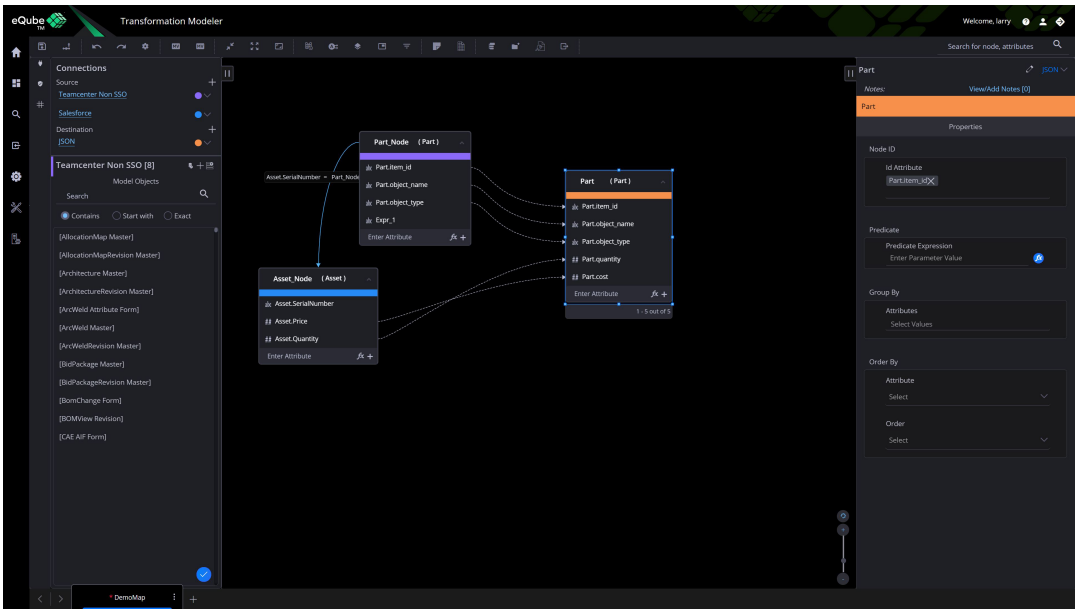


Figure 22: eQube-TM – mapping Teamcenter & Salesforce objects to OData – JSON object

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

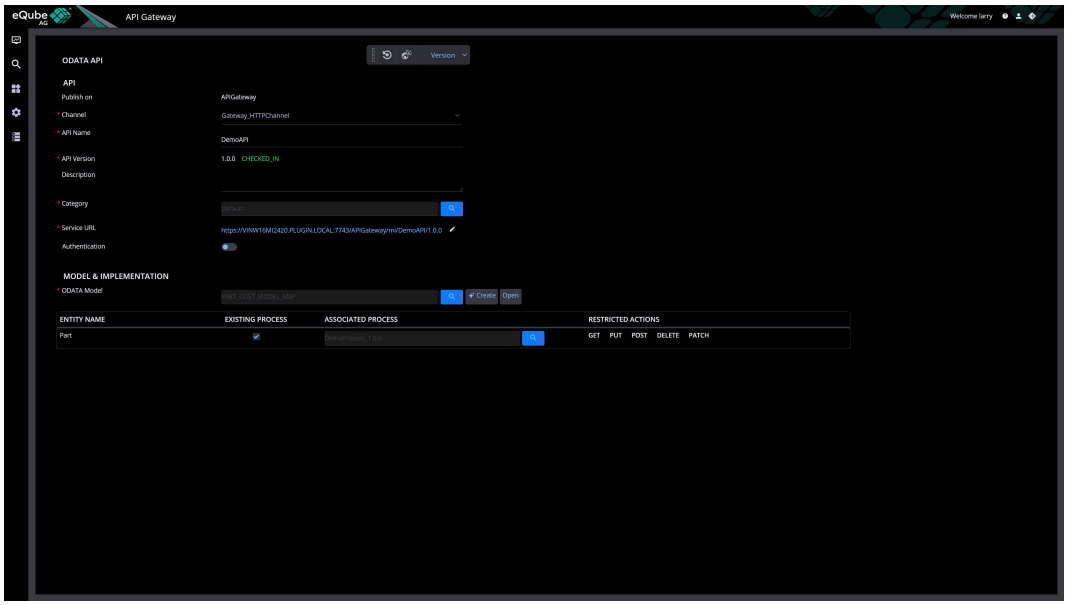


Figure 23: eQube-API Gateway – OData service for 'part-cost model' mapped in eQube-TM

3) Enterprise-wide application integration infrastructure

In the industrial domain, eQube-MI connects to ERP, PLM, MRO, ALM, MES, Ent. Asset management, planning systems, Logistics systems, CRM, quality systems, warranty systems, Big data stores, etc. Once COTS and legacy systems are connected on the eQube-MI Digital Backbone, these systems and data can be seamlessly integrated in a holistic environment. Figure 1 shows eQube-MI (the Digital Backbone) with various Connectors.

With applications connected on eQ's Digital Backbone, multiple business critical solutions can be rapidly built. With eQube, Digital Thread (s) can be automatically established allowing users to continue to work in their chosen system of record ('SOR') while contextual data is integrated with other applications based on triggers or events, such as, workflow completion or saving the work or establishing a baseline. The eQube based Digital Thread solution is captured in this 'eQube® MBSE App video'. Using the powerful combination of eQube-TM, MI, and API Gateway, a digital thread can be automatically established on behalf of the user. With eQube-BI, any user can have the visibility into the health of the digital thread to understand where the thread may be broken. Automatic alerts in BI can identify the issues in the digital thread and provide the necessary insight to the right user (s) for corrective actions. This visibility can be provided in an eQube-BI portal or in a 'for-purpose' app. Multiple 'for-purpose' apps can be delivered such as MBSE (model-based systems engineering) or SLM (service life cycle management) while a digital thread is automatically established behind the scene by the eQube-DaaS platform.

Digital Twin solution (s) can be built by connecting multiple COTS systems and legacy systems. Challenges associated with consolidation of multi-PLM or PDM systems or multi-MES systems can be comprehensively addressed. PLM systems can be integrated with ERP systems and MES systems for Closed Loop Manufacturing (CLM). Sensory data from the shop-floor or from the products can be aggregated with MES, ERP, SCM, EAM, PLM, or other critical legacy systems for end-to-end closed-loop business. These eQube based solutions can be realized within a much shorter timeframe and at lower total-cost than other approaches or methods of integration.

4) Data federation with ability to take 'action'

Using eQube-MI as an orchestration engine, a solution can be built with a unified intuitive UI (rendered in any Web UI or Mendix or ThingWorx or eQ Portal or SharePoint or integrated in application UI) for dramatic productivity improvement. eQube-MI federates the relevant data from multiple applications, in-context and in real-time, for a

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

unified view while honoring the underlying applications' security and access control rules. Then the user can take 'action' of updating or modifying the information in the unified UI that is carried out by eQube-MI on-behalf of that user in the underlying application (s) honoring each application's access control and security rules. The Figures 24 - 25 show data federation across Teamcenter, SAP, and Oracle EBS carried out by eQube-MI. Figure 25 shows Amazon Cloud and On-Premise deployment for this federated data solution.

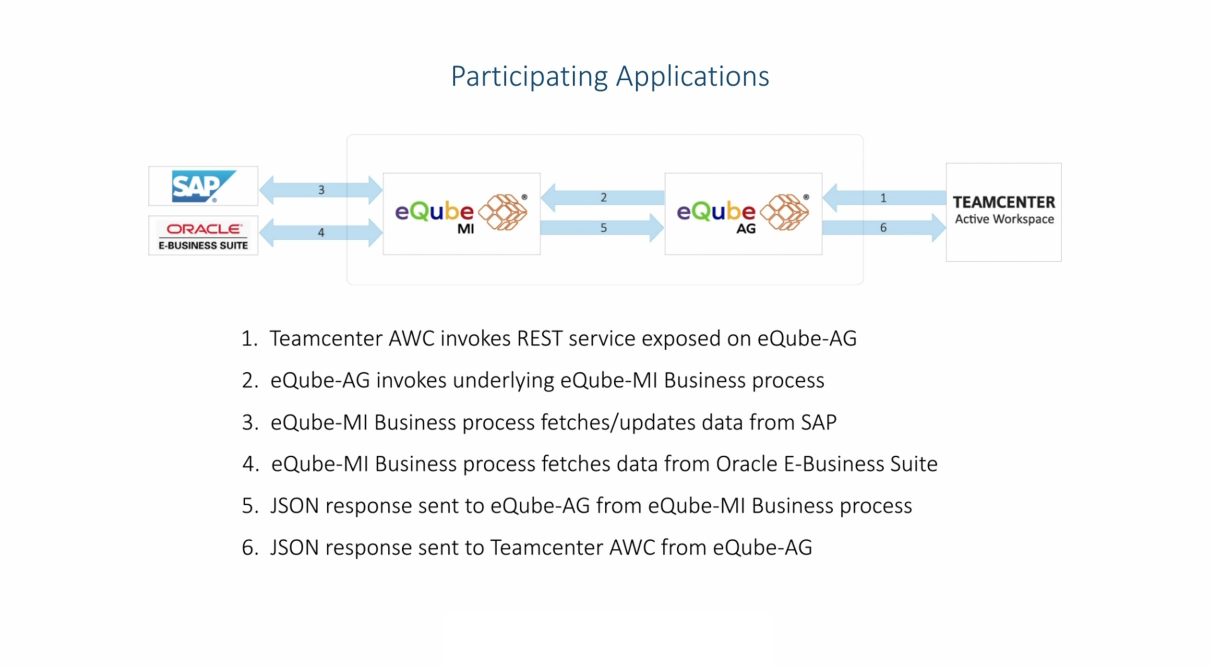


Figure 24: eQube-DaaS based Data Federation: Teamcenter + SAP + Oracle EBS – data flow

(watch this use case)

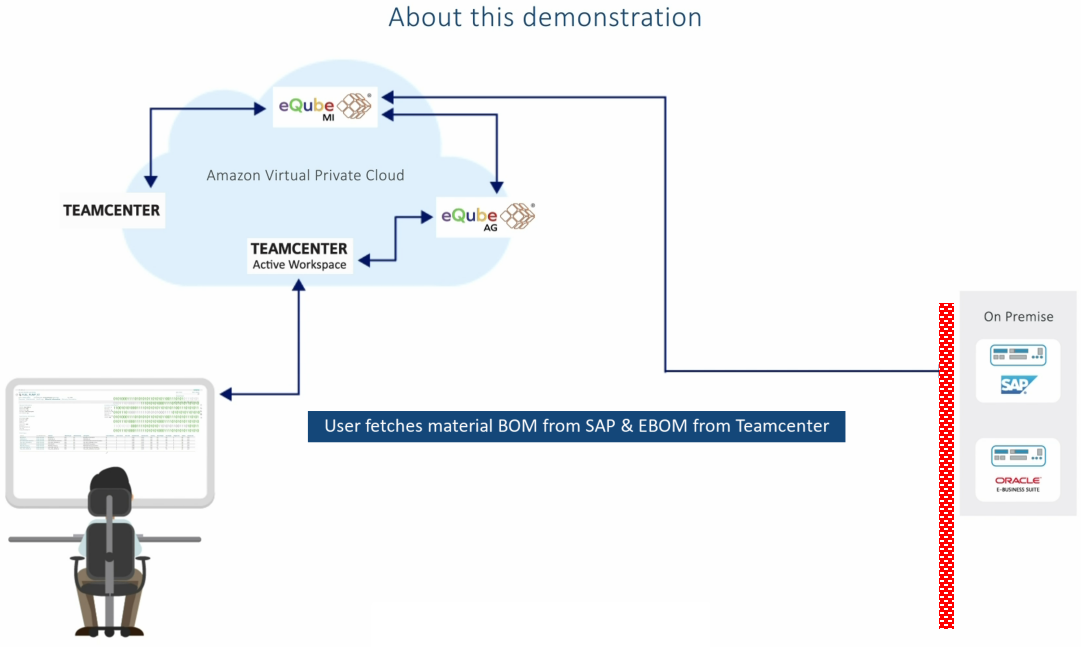


Figure 25: eQube-DaaS based Data Federation: Amazon Cloud (MI + AG+ Teamcenter) + On-Premise (SAP & Oracle EBS)

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

5) Orchestration of enterprise-wide business processes

eQube-MI can orchestrate enterprise-wide business processes. With eQube-MI, transaction boundary for an interface can be established across applications, ensuring guaranteed consumption of each message in each participating application. It offers in-built capabilities of blocking transactions and auto retry to ensure the transactions are successful. Figure 26 shows an example of an interface that creates Material masters in SAP from Manufacturing parts authored in Teamcenter. Figure 27 shows an example of an interface that creates light weight 3D JT files and visual issues list with session package and images in SharePoint (located in a lower security network) from the data in Teamcenter (located in a higher security network).

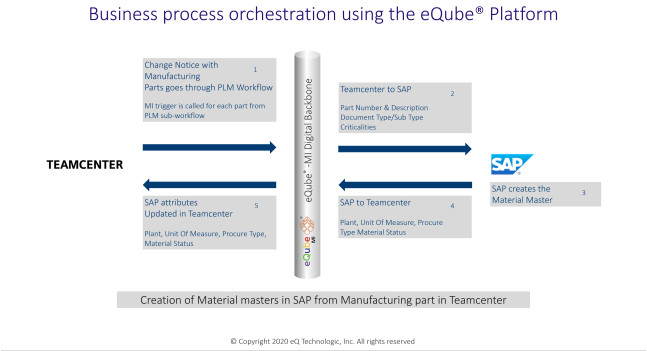


Figure 26: eQube-MI process orchestration: SAP & Teamcenter

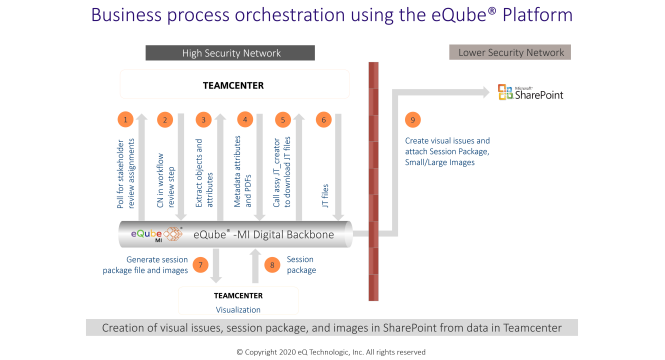


Figure 27: eQube-MI process orchestration: Teamcenter & SharePoint

6) Application consolidation/legacy system migration

Using eQube-MI, multiple proven options are possible for orderly migration of legacy systems without business disruptions or end user blackout periods: 'Bulk load + deltas' with various strategies and 'Bi-directional synchronization'. Figures 28 - 30 show the concepts.

a. 'Bulk load + deltas': In this approach, initially, legacy data is bulk loaded in the target system. Data changed during the initial bulk load period is migrated subsequently under a 'delta' migration or multiple 'delta' migrations, until legacy and target system data is the same. Figure 28 shows this concept.

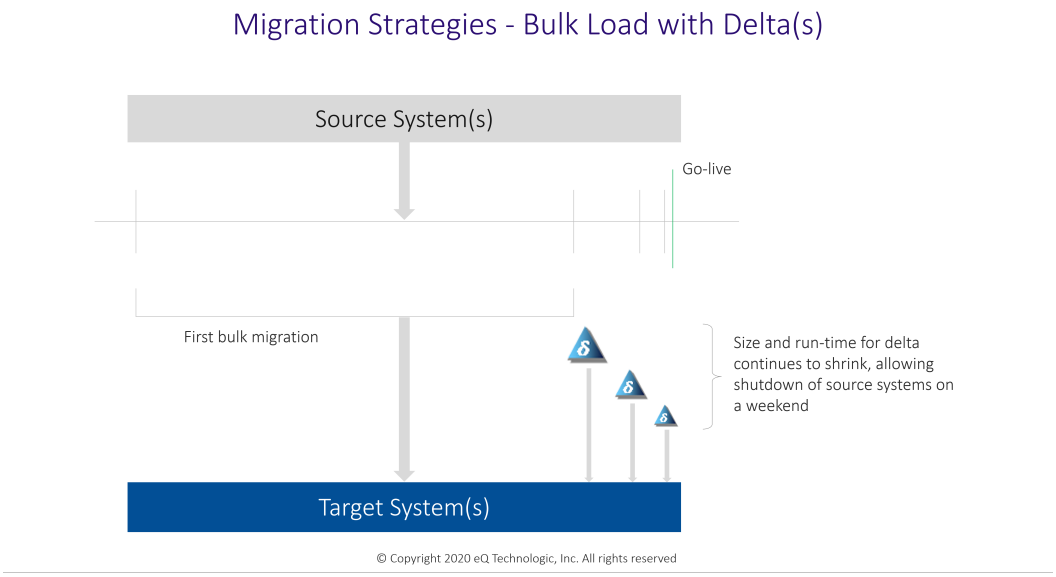


Figure 28: Migration strategy 'Bulk load + delta (s)'

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

After that point, multiple options are available:

1. Switch-off the legacy system and move the end users to the target system. Legacy system is kept for archival purposes, target system is the new system of record (SOR).
2. Keep the legacy and target systems in-sync – by each transaction or hourly or daily. Then make the target system the SOR by each program or project or domains (such as parts, BOMs, Changes, etc.). Figures 29 and 30 depict the concepts.

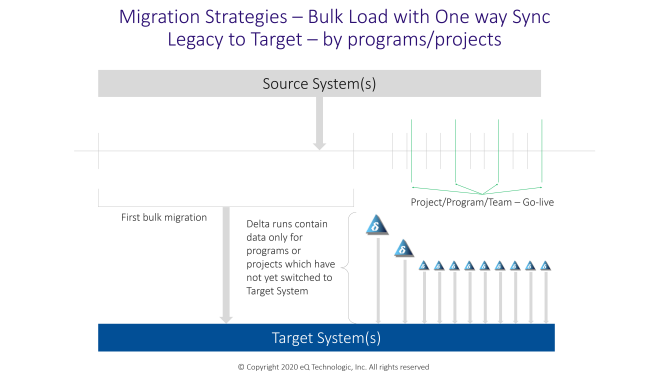


Figure 29: Bulk load with One-way sync - by programs / projects

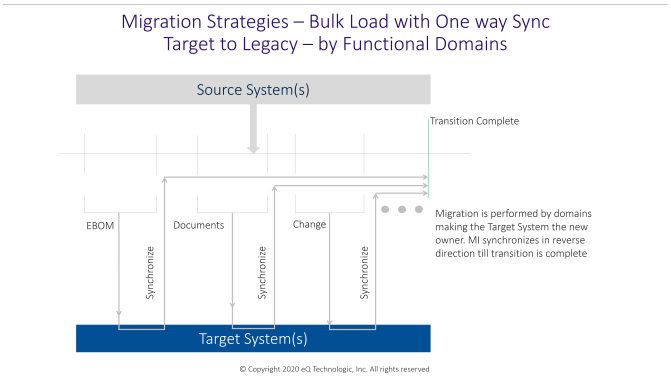


Figure 30: Bulk load with One-way sync - by domains

b. 'Bi-directional synchronization': In this approach, migration is performed on-demand and by each transaction by end users. Upon migrating data to the target system, it is made the 'owner' or SOR for those objects and changes carried out on those objects are synchronized back to the legacy system. Once all the functionality of the legacy system is enabled in the target system, the need to synchronize the data from target to legacy is eliminated. Figure 31 depicts the concept.

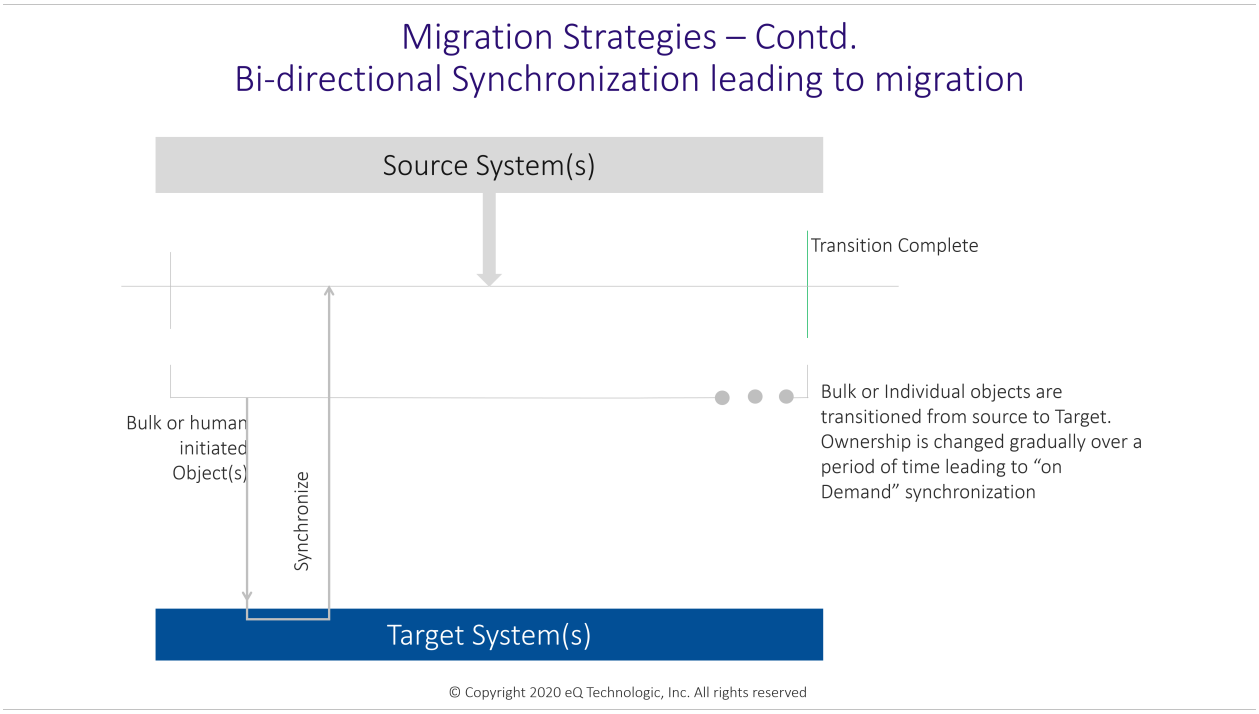


Figure 31: Migration strategy - Bi-directional sync

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

7) Secure collaboration across networks, partners, and customers

Across all secure collaboration modes, eQube-MI can compress message payload from the source system (s) and encrypt with various encryption algorithms including FIPS compliant algorithms ensuring secure transfer of the payload. Payload can be decrypted before updating the target system.

a. Secure collaboration between higher and lower security level networks - 'connected mode':

In this scenario, eQube-MI is deployed on both the high and low security networks with MI's Reverse Invoke (RI) module. RI module deployed in the lower security network (s) accumulates and queues the transactions meant for collaboration with the higher security network. eQube-MI residing in the higher security network connects to the eQube-MI in lower security network (s) during scheduled or pre-defined time window (s). Once the connection is established, all queued transactions from lower security network are transferred to eQube-MI in the higher security network. Figure 32 shows the concept. Again, the messages on the wire can be encrypted using various encryption algorithms and compressed for efficient transfer.

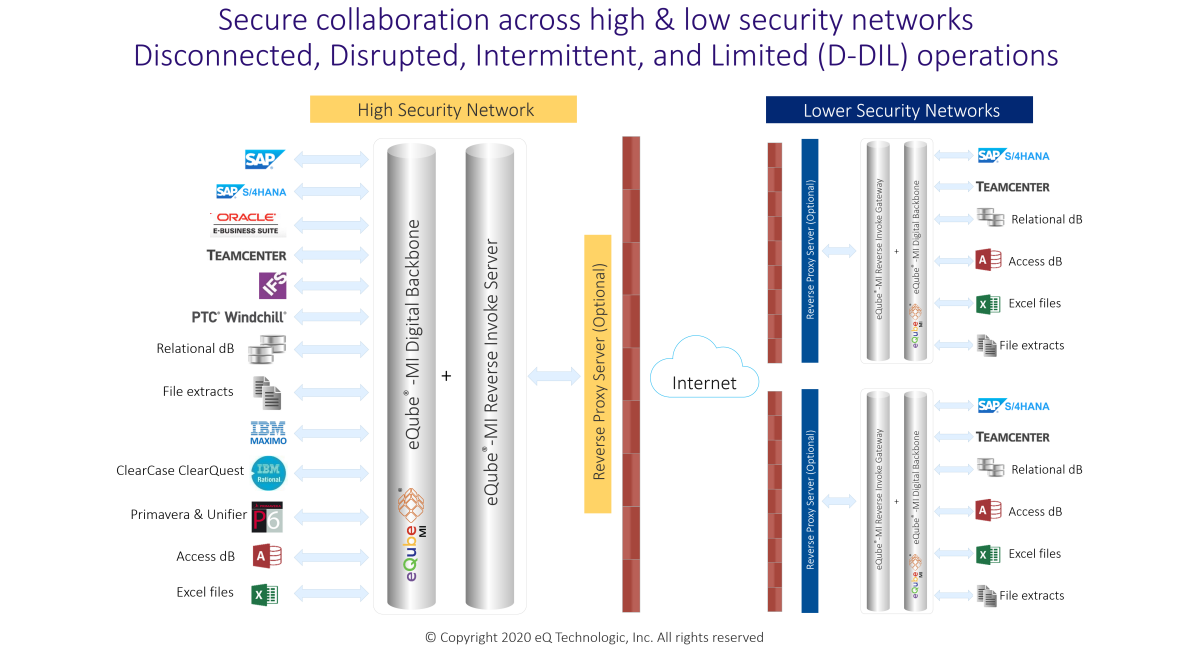


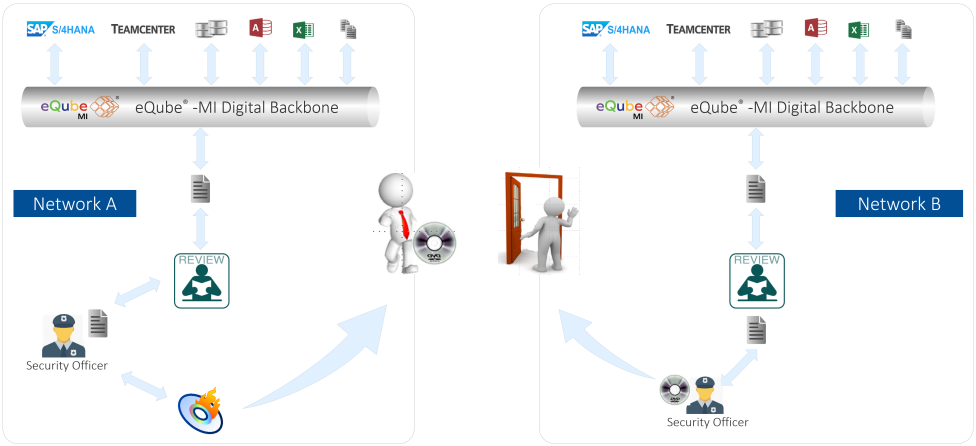
Figure 32: Secure collaboration across high & low security networks - D-DIL operations

b. Secure collaboration 'disconnected mode':

Under this mode of collaboration, participating applications are not on the same network with no ability to connect across networks, essentially 'air-gapped' networks. eQube-MI can be deployed on both networks. Using eQube-MI, data from a source system (s) is extracted, transformed, and can be submitted to a workflow for security approval for transferring the data out of the network. Upon the security approval, the data can be written to a file and if required, the file can be encrypted with any algorithm of choice. This source system transaction file then can be physically carried over to the other network where target system is located. At the target network, using eQube-MI it can go through a reverse process of decryption, security workflow approval for ingestion of data, and then inserting the data in the relevant target application (s). The below figure 33 depicts this approach.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

Secure collaboration – Disconnected/Air Gap mode



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 33: Secure collaboration - Disconnected mode

c. Secure collaboration 'disconnected, disrupted, intermittent and limited connected mode' (D-DIL):

Under this mode of collaboration, source and target systems are on different networks and may not be connected at times. In this scenario, eQube-MI can be deployed on both networks with RI deployment as discussed in section '7) a.' above. eQube-MI deployed in a network can establish a perpetual or always-on connection with eQube-MI deployed in the other security network (s). If there is no network connectivity for some time, then eQube-MI with RI Server will put the transactions in eQube-MI queue and will continue to ping to establish a connection. RI Gateway on the other server (s) will accumulate transactions in its queue (s). As soon as the network connectivity is available, all accumulated transactions will be transferred to the other eQube-MI sever on the other network. The transactions can be encrypted and compressed for secure and efficient transfer. Figure 32 above shows the concept.

8) Executing 'action' based on analytics

Using eQube-BI as the front-end for analytics and eQube-MI as the orchestration engine, a solution can be built that has a unified intuitive UI (rendered in an eQ Portal or SharePoint or integrated in application UI or ThingWorx or Mendix or any Web UI) displaying KPIs or dashboards and the capability for end users to act. First, using eQube-BI, relevant data from multiple applications is aggregated and displayed as KPIs or dashboard. Then the user can take 'action' of updating or modifying the information in BI or in a form on the UI that is carried out by eQube-MI on-behalf of that user in the underlying application (s) honoring that application's access control and security rules. The Figures 34 - 36 show an example of Worklist items related dashboard served by eQube-BI with PLM data, rendered in a SharePoint portal, and an in-context form that can be used by the end user to take 'action'.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

The ‘Hub’ @ work

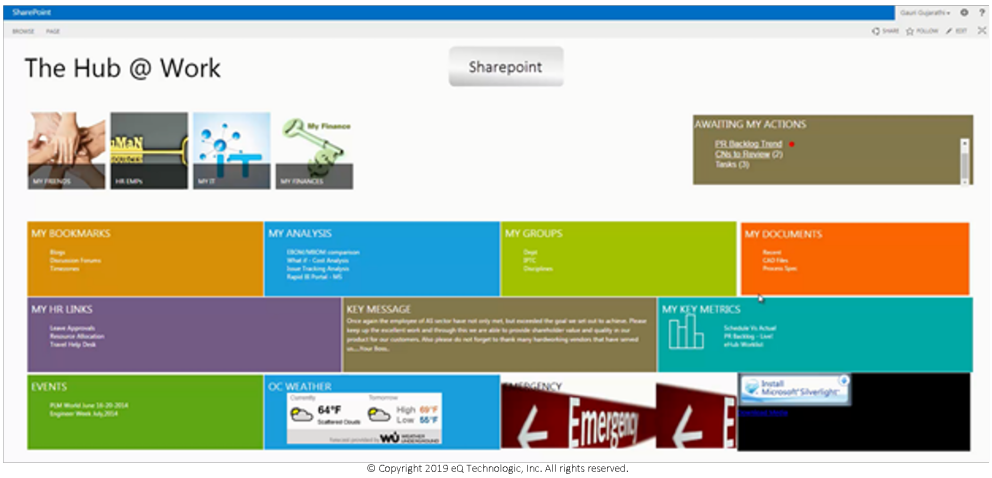


Figure 34: eQube solution integrated in SharePoint portal (watch this use case)

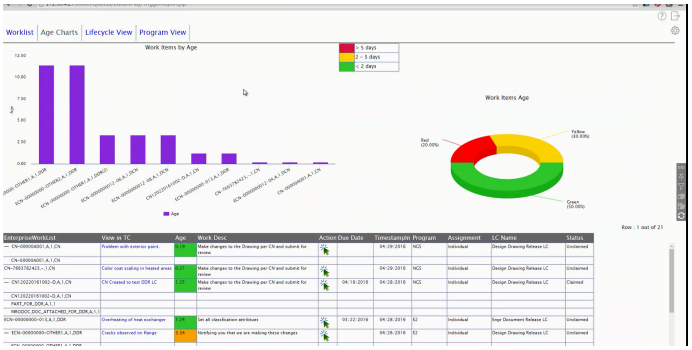


Figure 35: ‘Worklist items by age’ dashboard by eQube-BI.

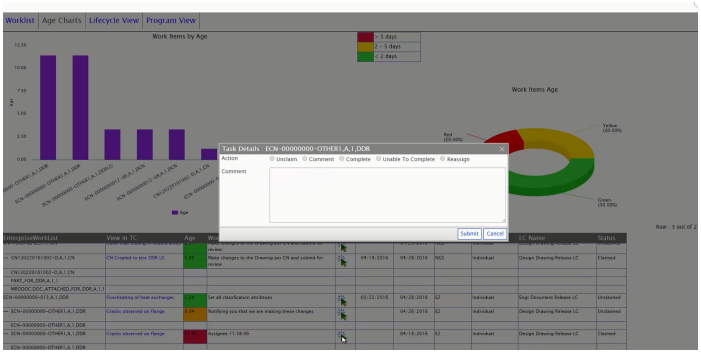


Figure 36: User taking ‘action’ - eQube-MI then carries out ‘action’ on user’s behalf

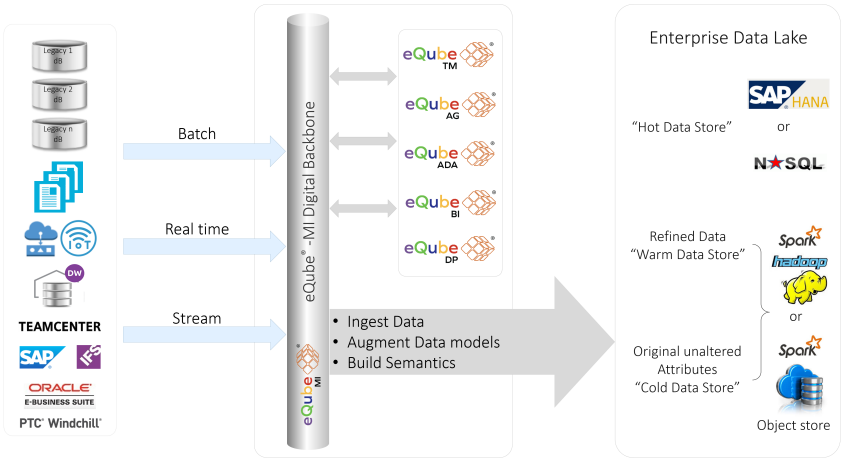
9) Data Lake and Data Warehouse development

With the advent of Big data due to explosion in data volume, variety, and velocity there is a need to have solutions in place to effectively manage, massage, analyze, and leverage the knowledge in the data with insights. Solutions ranging from modern BI analytics platforms, Data Warehouses, and Data Lakes are available to address various use cases. eQube-BI, a modern A/BI platform, and eQube-ADA address multiple analytics use cases for many personas (such as: a regular end user, a power-user with software background, a citizen data scientist, a data scientist, a manager or an executive, etc.). In addition, using eQube-MI as the core platform, efficient and comprehensive solutions can be built for Data Lake and Data Warehouse initiatives.

a. Data Lake: As shown in the Figure 37, data from multiple sources (files, sensors – products and machines, sentiment – social media, databases, and COTS applications) can be ingested in a Data Lake using the eQube platform. eQube-BI, ADA and DP are used for auto data discovery and preparation during the ingestion process orchestrated by eQube-MI while eQube-TM maintains the knowledgebase of the data augmenting the semantics information related to the data. eQube based approach provides a framework for efficient ingestion of raw data in a ‘Cold store’ and enables orchestration for populating ‘Warm store’ and ‘Hot store’ for rapid analysis. eQube Connectors for file systems, COTS applications, databases, NoSQL systems, and Big data stores can be leveraged to develop and maintain the Data Lake solution on-premise or in the Cloud. eQube based DaaS/IDE reference architecture is shown in the figure 2. As shown in this reference architecture, once a Data Lake is a part of it, multiple business use cases are addressed efficiently and comprehensively.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

Data Lake Architecture using the eQube® Platform



© Copyright 2020 eQ Technologic, Inc. All rights reserved

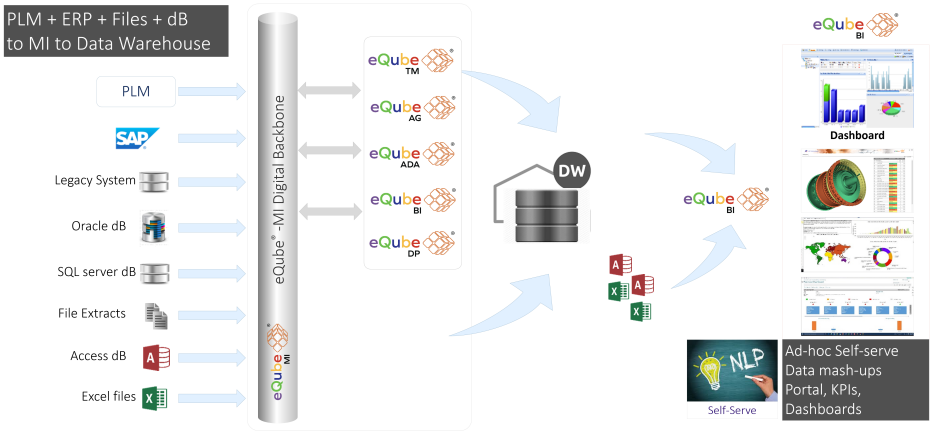
Figure 37: Data Lake architecture using eQube platform

b. Data Warehouse: As shown in the Figure 38 below, data from multiple sources (text files, databases, and COTS applications) can be transformed and populated into a dimensional model in a Data Warehouse using the eQube platform. eQube-BI, ADA, and DP are used for auto data discovery and preparation during the ETL process orchestrated by eQube-MI while eQube-TM maintains the knowledgebase of the data augmenting the semantics information related to the data. eQube connectors for file systems, COTS applications, and databases can be leveraged to develop and maintain a Data Warehouse solution on-premise or in the Cloud. Due to eQube's innovative architecture, using eQube for the development and maintenance of a Data Warehouse is far more efficient than traditional approaches and tools. Data Warehouse as a solution is most applicable for the following types of business use cases:

I. Decision-making and business performance reporting based on past performance:
    1. Financial reporting and analysis
    2. Sales and customer satisfaction analysis
    3. Business performance analysis

II. Descriptive analytics: predominantly focused on past performance data.

Data Warehouse and analytics using the eQube® Platform



© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 38: eQube based Data Warehouse solution

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

If 'stale-data' is unacceptable and security/access control are critical, eQ recommends using its modern A/BI platform, eQube-BI. eQube-BI aggregates data by directly connecting to SORs for providing real-time or near-real time analytics honoring the underlying applications' security/access control rules. In this approach, data is kept where it belongs and the need for a Data Warehouse is eliminated. However, if a Data Warehouse already exists and data from it also needs to be aggregated with data from certain SORs, then eQube-BI can mash-up data from both the SORs and the Data Warehouse on-demand. Thus eQube-BI can leverage the investments made in a Data Warehouse or Data Mart (s).

Speed, agility, and total life cycle cost of eQube-BI based solution are far superior to a traditional Data Warehouse based analytics solution. The number of business use cases addressed by eQube-BI based solutions tend to be extensive and therefore, it can be deployed as an enterprise-wide solution for A/BI.

10) Master data management (MDM)

a. Traditional approach to MDM involves extracting relevant data from multiple systems and storing it in a centralized MDM database. MDM database becomes the master for certain data types and changes to the master data are managed in the MDM system that are propagated to upstream and downstream systems. There are several challenges with this approach:
    I. Efforts, time, and costs involved in the initial setup and on-going maintenance of the data extraction, transformation, and load (ETL) infrastructure and the central MDM database.
    II. Efforts, time, and costs involved in adding change management functionality to the MDM system including infrastructure to propagate the changes to other systems.

b. Using eQube platform the MDM challenge can be addressed in multiple ways:
    I. If a customer insists on using a central MDM system or has a requirement to maintain or upgrade an existing MDM system, then eQube platform-based solution can be rapidly built to populate and maintain a central MDM system. With eQube-MI, the initial solution development time can be substantially reduced. Additionally, when the source applications are upgraded to their respective next versions, due to the eQube architecture, the impact of such upgrades on the solution is minimized.
    II. eQ's recommended approach for MDM revolves on the philosophy of 'keeping data where it belongs – in the source systems' – essentially, a decentralized MDM solution. Under this approach, the system of record (SOR) for each key data element is identified and is designated as the 'master' for that data element. All changes to each key data element are managed by change management process in each SOR for that data element. eQube-MI based business processes are developed to propagate those changes from each SOR to appropriate downstream and upstream systems. The advantages of this decentralized approach to MDM are as follows:
        1. Simplified MDM solution as there is no central MDM system.
        2. Keeps data where it belongs. No central copies of data are created.
        3. Leverages core capabilities of each SOR regarding data integrity checks and change management process for each relevant data element. No need to have change management process in a central MDM system.
        4. eQube-MI orchestrates the changes in upstream and downstream systems and due to use of eQube-MI, version upgrades of SORs have minimum impact on the solution.
        5. All these benefits add to speed, agility, and lower total life cycle cost of a scalable MDM solution.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube-DaaS Platform Benefits

1) A powerful low/no-code platform that delivers many solutions, including:
   a. Developing low code end-user centric 'for-purpose' apps: Ability to develop end-user centric apps with data from multiple systems with UI as a simple web app or integrated in a SharePoint Portal or integrated in an application UI or through ThingWorx or Mendix.
   b. Rapidly building OData services for any application (COTS or legacy and any old/new version)
   c. Enterprise-wide application integration infrastructure: Providing a robust, agile, resilient, scalable, and secure foundation for offering data as a service (DaaS) in an Integrated data environment (IDE)
   d. Data federation with ability to take 'action': Federate data from multiple systems with ability to carry- out 'action' in underlying system (s).
   e. Orchestration of enterprise-wide business processes across applications and networks
   f. Application consolidation/legacy system migration without business disruption: Synchronization leading to orderly migration: multiple proven migration strategies for mitigating the risks for orderly migration of legacy systems with no end user blackout periods.
   g. Secure collaboration across networks, partners, and customers in a connected, intermittently connected, and disconnected modes.
   h. Data lake and Data Warehouse development
   i. Executing 'action' based on analytics insight
   j. Master data management

2) No coding for 'last-mile' connectivity for the following:
   a. To develop and maintain interfaces: a developer does not need to know or understand the underlying application's APIs.
   b. Guaranteed message consumption: interfaces can be built spanning multiple applications with guarantee of message consumption (not just delivery of the message) in the target applications.
   c. Implementation of 'roll-back' capability: in the event of a transaction failure, integrity of participating applications can be maintained.
   d. Version upgrades: due to a combination of pre-built certified eQube Connectors for each specific application's version, eQube Data Virtualization layer, and eQube-MI Process Designer; no coding is required in the 'last-mile' connectivity due to eQube-MI and applications' version upgrades.
   e. Creation of microservices and APIs: processes modeled in eQube-MI can be exposed as microservices and APIs.
   f. Ability to choose the appropriate integration strategy (i.e., 'Not only ESB' - loosely coupled application-to-application type, or API gateway type, or ESB type: message-driven, common data model based, service orchestration based) without a need to write code.

3) Ability to leverage investments made in other integration platforms (ESBs, message brokers, …) and Data Warehouse (s) or Data Mart (s) or Data Lake (s).

4) Deployment flexibility: eQube-MI can be deployed as cloud only or on-premise only or in a hybrid manner, such as cloud and on-premise or cloud to cloud and on-premise. When deployed in any combination involving cloud deployment, eQube-MI acts as an integration platform as a service (iPaaS).

5) These benefits result in unprecedented speed and agility to develop and maintain the Digital Backbone of integrated applications that is robust, scalable, and secure at industry leading lower TCO.

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQ's experience

Over the past 16 years, eQube platform-based solutions have been widely deployed across many of our world-wide customers. Our customers are from multiple major industries: Aerospace & Defense, DoD, Auto & Machinery, High-Tech, Ship Building, Energy, Food, and Consumer Packaged Goods (CPG). For our customers, eQube based solutions have and continue to responsibly retire legacy systems, integrate legacy applications and COTS solutions across networks, deliver low code end-user centric 'for-purpose' apps with data federation – not data replication, and deliver analytics/business intelligence capabilities that provide reports, KPIs and dashboards leading to actionable insights. Some of our key customers include: Lockheed Martin Aero (including the prestigious F-35 program), Northrop Grumman (including the B-2 and B-21 programs), US Navy (NAVSEA and NAVAIR), Adient, MOOG, Micron Technologies, Dyson, Visteon, Yanfeng, BAE Systems – MAI (Typhoon), BAE Systems – Marine (Successor submarine program), Boeing, L-3 (multiple divisions), Rolls-Royce, Siemens AG, General Electric (multiple divisions), EDF (Nuclear power plants), General Dynamics (multiple divisions), SS/L, ULA, MTU, and Honeywell-Aero among many others.

For many of our world-wide customers, eQ has successfully delivered solutions for multiple use cases spanning the IDE: for-purpose apps, data federation, modern A/BI capabilities (including bi-modal deployment), application integration, synchronization, and migration (retirement of legacy systems without business disruptions or blackouts). Some of our customers are shown in the following figure 39.

© Copyright 2020 eQ Technologic, Inc. All rights reserved

Figure 39: eQube Select Customer case studies

© Copyright 2020 eQ Technologic, Inc. All rights reserved.

eQube®-DaaS for an Integrated Data Environment (IDE) summary

To successfully deliver on the Digitalization or Digital Transformation and to meet or exceed organizational goals of dramatic productivity improvements, there is a clear need to establish an enterprise class scalable framework that can offer Data as a Service (DaaS) in an Integrated Data Environment (IDE). eQube®-DaaS platform provides a powerful low-code/no-code integration environment to rapidly and responsibly deliver multiple solutions for the IDE while mitigating risks of long-duration and expensive IT programs.

eQube offerings individually and collectively form a flexible, robust, resilient, scalable, and secure framework (a.k.a. Data Fabric) in delivering integrated solutions for an IDE that accelerates Digital Transformation with overall lower total cost of ownership.

For further information about eQ and eQube, please visit:

Our website: www.1eQ.com

Our you tube channel: 1eQT: https://www.YouTube.com/1eQTech

Gartner innovation insight: Turbocharge your API Platform with a Digital Integration Hub (ID: G00722630)

Gartner research note: Other Vendors to Consider for Modern Analytics and BI (ID: G00369983)

Gartner Market Guide for Data Virtualization (ID: G00340606)

© Copyright 2020 eQ Technologic, Inc. All rights reserved.