eQube® - a modern platform for Data as a Service (DaaS) / Integrated Data Environment (IDE)

Accelerating Digital Transformation
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 long-term 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, 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 the 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® platform capabilities for establishing an enterprise class scalable framework for DaaS and IDE that accelerate Digital Transformation.
eQube®, our platform for Enterprise Information Infrastructure establishes a Digital Backbone of integrated data, applications and devices 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, synchronization, and migration. eQube-BI, the modern analytics and business intelligence 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. Therefore, the eQube platform can comprehensively address DaaS/IDE requirements in delivering substantial improvements in productivity and accelerate the realization of Digitalization or Digital Transformation. Figure 1 shows the eQube platform – Digital Backbone with Actionable Insight.

Figure 1: eQube Digital Backbone – Actionable Insight

Over the past 15 years, eQube platform-based solutions have been widely deployed across many of our worldwide 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 (including the B-2 and B-21 programs), US Navy (NAVSEA and NAVAIR), Adient, Fiat-Chrysler, 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, UL, MTU, and Honeywell-Aero among many others.
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eQube based proposed reference architecture for DaaS/IDE

The following figure 2 depicts a proposed reference architecture for eQube® based DaaS/IDE solution. 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 in end-user centric ‘for-purpose’ apps. It also shows eQube platform aggregating data from multiple sources for analytics/BI (A/BI) capability presented in a cognitive layer for Actionable Insight.

Figure 2: eQube reference architecture for DaaS / IDE

eQube® Platform

eQube based Digital Backbone – Actionable Insight framework forms a Connected Network of integrated data, applications and devices (a.k.a. ‘Data Fabric’) that puts the power of analytics in the hands of end users. Data from any source can be aggregated using eQube’s Data Virtualization layer and exposed as a Web-service or RESTful service or API. This rapid and flexible capability to expose data as a service/API is at the heart of efficiently delivering eQube based solutions for DaaS in an IDE.

eQube has the following four offerings in the market:

**eQube-MI is a next generation Hybrid integration platform** that establishes a Digital Backbone of integrated applications. It is a single platform that efficiently addresses application integration, synchronization, and migration challenges. 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’. eQube-MI can be deployed in multiple ways: cloud only or on-premise only or in a hybrid manner, such as 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-MI acts as an integration platform as a service (iPaaS).

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-TM provides unprecedented capabilities to establish a knowledgebase of connected applications’ data models, simple/complex maps and rule-based transformations between systems. eQube-TM assists in defining for-purpose application’s data model derived from the knowledgebase. This enables low code model driven application development. This model and knowledgebase are leveraged by all eQube offerings for application integration, synchronization, and migration.

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 preparation of data 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.

These offerings individually and collectively form a flexible, robust, resilient, scalable, and secure framework in delivering eQube-based integrated solutions for DaaS/IDE at unprecedented speed with overall lower total cost of ownership.

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 RESTful 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 3 shows the concept.
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 4 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 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 5, 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).

Figure 5: 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 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: 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.

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 and API gateway can be used to build application logic layer on top of this data virtualization layer and to expose the required services (Web-services, RESTful services 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 Process Designer. 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 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. eQube Connectors translate the requests from virtualization layer to application specific API calls. Thus, eQube-BI and eQube-DP can read data; and 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 business, manufacturing, and PLM concepts. Application specific implementation can be mapped to each domain ontology concepts.
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.

Integrated business process modeling (BPM) capability in the eQube-MI server

eQube-MI includes OOTB integrated Process Designer with BPM capability. With the Process Designer, interfaces can be readily developed by visually designing corresponding eQube-MI Processes made up of activities, gateways, effects, and paths that capture the business logic of an interface and its process orchestration. Any eQube-MI Process can be published as a Web-service or as a RESTful service or API. Figures 6 and 7 show examples of eQube-MI Processes representing an interface developed in the visual eQube-MI Process Designer.

Figure 6: MI Process Designer - example 1

eQube-MI bulk migration process

Figure 7: MI Process Designer - example 2

eQube-MI process to insert a new item in a BOM
eQube-MI - the next generation Hybrid 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, at any velocity, in any format, with any application and any device. For rapid integration solutions, it enables data federation and efficient development of low code end-user centric ‘for-purpose’ apps. For certain use cases where data replication is the correct answer for data/application integration, eQube-MI efficiently replicates data. 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 end-points 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 end-points 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 end-points 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 end-points or connectors! 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 Web-service or as a RESTful service or 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 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 a Web-service or RESTful service or API. Thus eQube-MI can easily co-exist with other integration platform(s) providing the greatest flexibility.

**eQube-BI - the 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 8. 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.

![Key tenets for Modern BI-Analytics](image)
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 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 9 depicts the traditional approach and summarizes its challenges. This entire approach is laborious, expensive, and slow!

**Competitive BI Implementation**

![Competitive BI Implementation Diagram](image)

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 10 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.

In addition, eQube-BI efficiently deals with streaming sensorial 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 with the data from other enterprise systems (legacy, COTS, files, etc.). Figure 4 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 Augmented Data Analytics server (ADA)

eQube’s ADA server leverages machine learning (ML) capabilities. For data discovery and preparation, it enables analyzing data using ML techniques and statistics to automatically find correlation, clusters, and anomalies in data. It also has the capabilities to automatically generate insight from the analysis and present it as narrative using its in-built natural language generation (NLG) engine. End users interact with eQube-BI using
its sentence-based analysis capabilities built on its powerful NLP engine and review insights generated by ADA including narrative generated by the NLG engine.

eQube’s ADA server works with the eQube platform to augment data profiling and data quality, harmonization, modeling, manipulation, enrichment/inference, metadata development, and data cataloging.

**eQube-DP – a solution for data discovery and data quality analysis**

eQube-DP is used during the data discovery phase to understand various facets of data including data quality. eQube-DP assesses data quality and provides data correction and repair capabilities. It analyzes data from disparate systems and provides quality assessment based on semantics. 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 11 and 12 show examples of eQube-DP based analysis.

![Figure 11: eQube-DP - Opioid crisis data discovery, correlation, & insight narration](image-url)
eQube-TM – a data transformation modeling solution

eQube-TM provides unprecedented capabilities to establish a knowledgebase of connected applications’ data models, simple/complex maps and rule-based transformations between systems. eQube-TM assists in defining for-purpose application’s data model derived from the knowledgebase. This enables low code model driven application development. This model and knowledgebase are leveraged by all eQube offerings for application integration, synchronization, and migration. Figures 13 and 14 show examples of eQube-TM usage.

Source to Destination – Gap Analysis

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Figure 12: eQube-DP - Data discovery example

Figure 13: eQube-TM: Maps identifying gaps in the Destination system model
eQube Platform based Solutions
There are multiple solutions that can be built using the eQube platform, 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 RESTful 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. 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 15 - 18.
2) Enterprise-wide application integration infrastructure

In the industrial domain, eQube-MI connects to ERP, PLM, MRO, ALM, planning and execution 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 with various Connectors.

3) 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 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 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 19 - 24 show data federation across Teamcenter, SAP, and Oracle EBS carried
out by eQube-MI. Figure 20 shows Amazon Cloud and On-Premise deployment for this federated data solution.

1. PLM Web Client invokes REST service exposed on eQube-MI API Gateway
2. eQube-MI API Gateway invokes underlying eQube-MI Business process
3. eQube-MI Business process fetches/updates data from SAP
4. eQube-MI Business process fetches data from Oracle E-Business Suite
5. JSON response sent to eQube-MI API Gateway from eQube-MI Business process
6. JSON response sent to PLM Web Client from eQube-MI API Gateway

Figure 19: eQube-MI based Data Federation: Teamcenter + SAP + Oracle EBS – data flow

Figure 20: eQube-MI based Data Federation: Amazon Cloud (MI + Teamcenter) + On-Premise (SAP & Oracle EBS)
4) 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 25 shows an example of an interface that creates Material masters in SAP from Manufacturing parts authored in Teamcenter. Figure 26 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).

Business process orchestration using the eQube® Platform

Figure 25: eQube-MI process orchestration: SAP & Teamcenter

Figure 26: eQube-MI process orchestration: Teamcenter & SharePoint
5) 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 27 – 29 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 25 shows this concept.

Migration Strategies - Bulk Load with Delta(s)

Figure 27: Migration strategy 'Bulk load + delta(s)'

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 26 and 27 depict the concepts.

Migration Strategies – Bulk Load with One way Sync

Legacy to Target – by programs / projects

Figure 28: Bulk load with One-way sync - by programs / projects

Target to Legacy – by Functional Domains

Figure 29: 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 30 depicts the concept.

Migration Strategies – Bi-directional Synchronization leading to migration

6) 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 31 shows the concept. Again, the messages on the wire can be encrypted using various encryption algorithms and compressed for efficient transfer.
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 32 depicts this approach.
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 ‘6) 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 31 above shows the concept.

7) 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 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 33 - 35 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’.
8) 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 is a modern A/BI platform that addresses 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 36, 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 and eQube-DP solutions are used for 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.

Data Lake Architecture using the eQube® Platform

b. Data Warehouse: As shown in the Figure 37 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 and eQube-DP solutions are used for 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.
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.

9) **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.
eQube Platform Benefits

1) A single 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 Mendix.
   b. 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)
   c. Data federation with ability to take ‘action’: Federate data from multiple systems with ability to carry-out ‘action’ in underlying system (s).
   d. Orchestration of enterprise-wide business processes across applications and networks
   e. 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.
   f. Secure collaboration across networks, partners, and customers in a connected, intermittently connected, and disconnected modes.
   g. Data lake and Data Warehouse development
   h. Executing ‘action’ based on analytics insight
   i. 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) iPaaS architecture: 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.
eQ’s experience

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 – 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, Fiat-Chrysler, 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 DaaS/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 38.

Figure 38: eQube Select Customer case studies

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Figure 38: eQube Select Customer case studies
eQube® for DaaS and 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 offerings individually and collectively form a flexible, robust, resilient, scalable, and secure framework in delivering integrated solutions for DaaS/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 youtube channel: 1eQT: https://www.youtube.com/1eQTechnologic

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

Gartner Market Guide for Data Virtualization (ID: G00340606)