ELEXON

MHHS AWG

Recommendation

Public

Document Owner	Document Number	Date
AWG Tech Lead	**1.0**	**22 April 2021**

Contents

Ofgem Forward

Ofgem welcomes this consultation from the Architecture Working Group (AWG) on the reference architecture to enable the Target Operating Model (TOM) for Market-wide Half Hourly Settlement (MHHS). We recently published our Decision and Full Business Case on when and how to move to MHHS, and amongst other decisions we confirmed that we will introduce MHHS on the basis of the Design Working Group (DWG) TOM.[1]

MHHS is a significant step in enabling and encouraging demand side flexibility in the electricity market, and its successful implementation is key to the UK's ability to meet its net-zero goal. The energy sector is undergoing a major transformation as we decarbonise our economy and embrace the opportunities of a digitalised energy system and better use of energy data. One of the key priorities for the design of the TOM is the need for it to be forward-looking.[2][3] It must be able to accommodate future changes, enabling and not acting as an impediment to new technologies, products and services as the energy industry rapidly evolves.

The first stage of the TOM design work was developed for Ofgem by the Elexon-chaired DWG. The DWG delivered their final report to Ofgem in August 2019. In October 2019 we provided a 'least regrets steer' that the further work on the TOM should continue on the basis of the DWG's preferred TOM, and proposed the creation of two new industry groups to carry on this work: the AWG and the Code Change and Development Group (CCDG). The AWG has met 16 times since December 2019. In that time they have developed proposals for the target state architecture to enable the TOM.

Following on from this, and subject to Ofgem's decision on the AWG recommendation, the next phase of architectural development will begin. Details of this are set out in the AWG recommendation next steps section and in the associated product description for the next industry working group. We would like to thank Elexon and all the members of the AWG and its supporting working groups for providing their time, experience and expertise to the development work on the TOM.

This consultation document has been prepared by the AWG to inform stakeholders about their proposal for the target state architecture for MHHS. Market-wide Settlement Reform is a fundamental market reform, which will impact both existing and future participants in the energy market. It is important that stakeholders who have not been directly involved in the TOM design work are provided with the opportunity to review and give input at key stages. For this reason, I would encourage all stakeholders to take the opportunity to look at and respond to the consultation document, and attend the associated webinar being organised by Elexon.

Further information on the Settlement Reform project and recent Decision and Full Business Case, including information relating to the implementation of MHHS can be found at the Ofgem website.

Thank you for your interest in this important reform and we look forward to your responses to this consultation on the AWG recommendation on the reference architecture.

Anna Stacey

Head of Settlement Reform

[1] MHHS Decision Document, April 2021.

[2] As set out in the Innovation Design Principle in the Ofgem TOM Design Principles: https://www.ofgem.gov.uk/system/files/docs/2018/01/updated_target_operating_model_design_principles.pdf

[3] For the avoidance of doubt, we will also be taking into consideration the other TOM Design and the TOM Development Principles when we come to make a decision on the AWG recommendation. The TOM Development Principles can be found here: https://www.ofgem.gov.uk/system/files/docs/2019/12/mhhs_tom_development_principles.pdf

Introduction

This document begins with a brief background to the MHHS AWG recommendation (from herein, referred to as the *recommendation*) as requested by Ofgem, the approach taken, and introduces the concept of a technology Reference Architecture as the result of this recommendation.

The main body of the document is focused on describing how the reference architecture meets the business and non-functional requirements investigated and understood by the AWG. This explains how the architecture is an essential technology component that will assist all market participants with the implementation and delivery of the MHHS market model.

The final section provides a brief description of the possible alternative architectures and gives reasons why they were not selected.

Please send your responses to awgsecretary@elexon.co.uk by 08:00 on 24th May 2021, using the separate proforma. Please use the subject line 'MHHS AWG Consultation Response'.

Acronym		Meaning
MHHS	Market-wide Half Hourly Settlement	Facilitates effective HHS for domestic and smaller non-domestic consumers (elective).
AWG	Architecture Working Group	An industry working group to design the IT architecture needed to support the MHHS implementation.
DWG	Design Working Group	A prior industry working group to design the Target Operating Model for MHHS (concluded in 2019).
DWG TOM	DWG Target Operating Model	A DWG deliverable, which outlines how MHHS will operate within the existing market.
CCDG	Code Change & Development Group	An industry working group focused on developing the detail of the DWG's TOM design and the required changes to impacted industry codes.

Table 1 - Acronyms

Background

The Ofgem Significant Code Review on Electricity Settlement Reform web site[4] contains a wealth of information detailing the purpose and scope of MHHS within the overall context of the retail focused smarter markets programme.

The executive summary of the Ofgem outline business case[5] identifies consumer benefits. In doing so, it indicates the desired strategy for *communicating* and *utilising* a higher volume of more frequent meter readings that will support their development.

In addition, Ofgem provided programme development principles[6] that extend the MHHS requirements. From this, the key architectural points can be summarised as; enabling future uses of data, ensuring data is always secure, ensuring data standards for communication, and whole system considerations for the avoidance of unnecessary complexity.

While Ofgem are not a member of the AWG it attends all meetings and provides a Technical Consultant to the group. The AWG is tasked with providing a recommendation to Ofgem who will make the final decision on the reference architecture.

[4] https://www.ofgem.gov.uk/electricity/retail-market/market-review-and-reform/smarter-markets-programme/electricity-settlement-reform
[5] https://www.ofgem.gov.uk/system/files/docs/2018/08/marketwide_settlement_reform_outline_business_case.pdf
[6] https://www.ofgem.gov.uk/system/files/docs/2019/12/mhhs_tom_development_principles.pdf

Recommendation Scope

The scope of the AWG work is as one of the groups responsible for the overall MHHS service design that is a precursor to industry parties starting work on their internal system designs to meet their new or changed obligations. The AWG scope is set out in the AWG Terms of Reference,[7] and includes the consideration of the style of communication required to realise the MHHS TOM, and what any modified or new shared services might look like.

The AWG's scope is to recommend the target-state architecture for the TOM, how the business processes should be designed and what technology services will be required to realise them. Whilst the AWG is mindful of existing data integration arrangements, a key ask from Ofgem is to ensure the design is fit for the future and the new requirements.[8] The initial scope does not extend to processes outside the MHHS TOM.

Note that the AWG scope does not extend to prescribing how individual companies architect their internal systems. The AWG recognise further work is required to determine the full detail, costs and impacts associated with this architecture, and expect this to be carried out in the next phase of design. This is set out in the Next Steps section.

DWG	CCDG	AWG
Scope		
▪ Develop options for the MHHS Target Operating Model (TOM), covering the meter-to-bank Settlement process. ▪ Recommend a preferred TOM to Ofgem. ▪ Develop the Service Requirements for each TOM Service. ▪ Develop, and recommend to Ofgem, a high-level Transition Approach for moving from current Settlement arrangements to the TOM.	▪ Develop the outstanding areas of detailed design for the DWG's preferred TOM. ▪ Develop further detail on the DWG's Transition Approach. ▪ Develop the required legal drafting to Industry Codes to deliver the DWG's preferred TOM.	▪ Develop, and recommend to Ofgem, the industry-wide integration architecture that best serves the DWG's preferred TOM. ▪ Includes consideration of how to send/receive the materially increased volumes and frequency of data required to realise the TOM.
Inputs		
▪ Ofgem's TOM Design Principles. ▪ Related Ofgem policy decisions under the wider SCR. ▪ Input from the Design Advisory Board (DAB). ▪ Industry consultation responses on the TOM options and Transition Approach.	▪ Ofgem's TOM Design & Development Principles. ▪ Related Ofgem policy decisions under the wider SCR. ▪ Input from the DAB. ▪ Industry consultation responses on the detailed design areas, Transition Approach and legal drafting.	▪ DWG's preferred TOM & CCDG's Business Requirements. ▪ Ofgem's Design & Development Principles. ▪ Related Ofgem policy decisions under the wider SCR. ▪ Input from the DAB. ▪ Business Processes. ▪ Indicative data volumes & frequency. ▪ Industry consultation responses on the proposed reference architecture.
Outputs		
▪ DWG preferred TOM and Transition Approach. ▪ Identification of outstanding areas of detailed design requiring subsequent development by the CCDG.	▪ Detailed TOM Business Requirements and transition approach. ▪ Legal drafting to Industry Codes.	▪ Drivers to architecture decision (e.g., centralised / decentralised business rules / data). ▪ Reference Architecture Style – what overall pattern best fits MHHS.
Recommendations to Ofgem		
▪ Recommend a preferred TOM with rationale. ▪ Recommend a Transition Approach with rationale. ▪ Recommend areas to be developed further by CCDG.	▪ Recommend detailed Business Requirements for the DWG's preferred TOM, with rationale. ▪ Recommend further detail on the DWG's Transition Approach, with rationale. ▪ Recommend Industry Codes legal drafting to deliver the DWG's preferred TOM.	▪ Recommend the most appropriate reference architecture to deliver the DWG's preferred TOM.

[7] The AWG Terms of Reference can be found on the Ofgem Webiste, here: https://www.ofgem.gov.uk/system/files/docs/2019/12/mhhs_awg_terms_of_reference.pdf

[8] As set out in the TOM Development Principles. Here: https://www.ofgem.gov.uk/system/files/docs/2019/12/mhhs_tom_development_principles.pdf

Approach

Within larger technology projects or programmes, there is often an initial EA (Enterprise Architecture) activity whose purpose is to understand the technology change in the context of the overall business problem, the overall landscape, and the scope of those changes which must inevitably occur to meet the stated objectives. As shown in *Figure 1*, EA is distinct from the implementation architectures that are needed to design and build (or modify) individual physical IT systems.

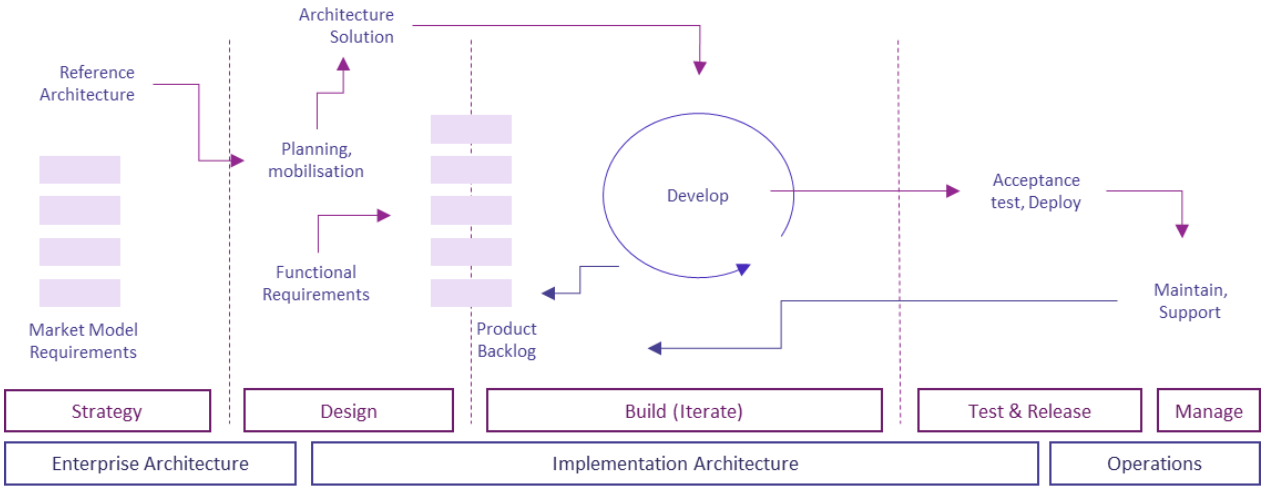

Figure 1 - Project Lifecycle

The AWG, with a membership including enterprise architects and business domain experts from a range of market participants, and with access to DWG and CCDG resources, was formed to undertake an EA function for the MHHS programme. Therefore, to produce this recommendation, the AWG activity has been an essential step in ensuring that any resulting solution(s) contribute towards meeting both the DWG TOM and Ofgem requirements and promotes the overall business goals.

To accomplish this, the AWG spent significant time understanding the outline impact of the DWG TOM on business processes and to identify where most changes would occur. This resulting collaboration with the CCDG, whereby clarification of business scope was provided, has enabled the AWG to recommend a strategic technology pattern that is both suitable and capable of contributing towards MHHS. AWG evaluated reference architectures against the requirements of MHHS and future market drivers. This document outlines both the AWG recommended architecture and summarises the alternatives discussed. The recommended architecture will provide a facility that enables MHHS services to deliver the required functionality needed to progress towards industry implementation.

The strategic technology approach, and the subject of this recommendation, is given as a reference architecture. This provides specific guidelines and options for making decisions in the development of more specific architectures and the implementation of solutions. For MHHS, this is presented diagrammatically as a reference model[9] with the capabilities and features that must be included in the implementation phases of its lifecycle.

For more information about the benefits of a reference architecture, see the AWG architecture product descriptions[10].

Note: The documents produced as part of the analysis and provided for reference (as described in the architecture product descriptions) are not final design artefacts as will be required in the design phase illustrated above. They were created only to the minimum level of detail required for the AWG to recommend a suitable reference architecture and should not be read as final or as a complete set at this stage.

[9] MHHS 202 EDA Reference Model.pptx
[10] MHHS 200 Architecture Product Descriptions.docx

Glossary of Terms

This following a list of Defined Terms and Acronyms that have been used in this consultation.

A

Advanced Data Service

The Advanced Data Service is the 'Qualified' service that provides the Advanced Retrieval and Processing Service (ARP).

Advanced Meter

The electricity supply licence defines an Advanced Meter as electricity Meter that, either on its own or with an ancillary device, and in compliance with the requirements of any relevant Industry Code:

a) provides measured electricity consumption data for multiple time periods, and is able to provide such data for at least half-hourly time periods; and

b) is able to provide the licensee with remote access to such data.

Advanced Market Segment

The Advanced Market Segment is the Market Segment where Settlement Level Period data is collected for Settlement purposes from Advanced Meters. For the avoidance of doubt where the Advanced Meter communications are faulty, the Advanced Meter would remain in this Market Segment, processed by the Advanced Retrieval and Processing Service (ARP). The communications fault would be fixed by the Advanced Metering Service (MSA).

Advanced Retrieval and Processing Service (ARP)

The Advanced Retrieval and Processing Service (ARP) is the service that retrieves and processes Settlement Period Level data from Advanced Meters that are in the Advanced Market Segment.

B

Balancing and Settlement Code (BSC)

The BSC is the document that sets out the terms for electricity balancing and Settlement in Great Britain, including the governance process for modifications to the BSC.

D

Data and Communications Company (DCC)

The DCC is the company that manages the data and communications to and from smart Meters.

Data Service

This is the generic reference to Data Services under the TOM and includes the ADS, SDS and UMSDS.

Distribution Network Operator (DNO)

See definition for Licenced Distribution Network Operator

E

Electricity Supplier

A company licensed by Ofgem to sell energy to and bill customers in Great Britain.

Elexon

Elexon (as BSCCo) is the organisation responsible for administering the BSC and provide and procure the services needed to implement it. The role, powers, functions and responsibilities of Elexon are set out in Section C of the BSC.

Electricity System Operator (ESO)

ESO is the System Operator for the electricity transmission system in Great Britain, with responsibility for making sure that electricity supply and demand stay in balance and the system remains within safe technical and operating limits.

Event Driven Architecture (EDA)

A software design pattern used to loosely couple components of a system. When something of business significance occurs (an event), such as registration information being updated or new meter data becoming available, the producing system simply publishes the event to an event handler (broker). Subscribers (authorised, interested parties to such events) are notified by the event handler that the business event has occurred, and they retrieve the event content (the changed registration state, new meter read etc.).

This is different from a commanding architecture in which one system instructs another to do something with some data (e.g., calling an API) and removes the handshaking (response) nature of transfer systems that require the sender to wait until they receive an acknowledgement before assuming data has been sent. Publishers and subscribers have no knowledge of each each-other and a single event can be consumed by many subscribers.

F

Faster Switching Programme

The Faster Switching Programme is the Ofgem initiative to deliver next-day switching (of gas or electricity supplier) as a new industry standard. It also aims to improve reliability of the switching process through better management and oversight of industry data.

H

Half Hourly Settlement (HHS)

Half Hourly Settlement (HHS) is the process that covers the services and governance procedures from the electricity meter to the imbalance settlement function (meter-to-bank process). This describes the processes of using half-hourly usage (and longer time periods of energy usage) data collected from an electricity meter for use in Imbalance Settlement.

I

Industry Standing Data (ISD)

Industry Standing Data (ISD) is the data used by the Services to interpret the information relating to each Metering System. This data will include some of the data in the current Market Domain Data (MDD) and will have new standing data included.

L

Load Shape

A Load Shape is a set of daily average consumption or export data for each Settlement Period in Coordinated Universal Time (UTC) for a Categorisation of Metering System in the population. It is derived and provided by the Load Shaping Service.

Load Shaping Service (LSS)

The Load Shaping Service (LSS) is the service that calculates load shapes from valid Settlement Period level data accessed from the Processing Services. The Load shape data will then be used by the Processing Services (PSS) to convert Register Readings (RRs) or Daily Consumption values into Settlement Period level data.

Licenced Distribution System Operators (LDSOs)

LDSOs are the companies that are licensed by Ofgem to maintain and manage the electricity distribution networks in Great Britain.

M

Market Participants

Market Participants are any party that interact with Settlement or other industry process.

Market Segments

The three Market Segments are:

- The Smart and Non-smart (S)
  - Smart Meters with Settlement Period level data available
  - Smart Meters with only Register Readings available
  - Non-smart Meters with Register Readings
- Advanced
  - Advanced Metering Systems with Settlement Period level data available
- Unmetered
  - Unmetered Supplies.

Market-wide

Market-wide in the context of the Significant Code Review (SCR) means the Settlement of Settlement Period data where such data can be accessed subject to data privacy and data access policy. Market-wide in the context of Services means a service which would provide cross-segment aggregation.

Market-wide Data Service (MDS)

The Market-wide Data Service (MDS) is the service that provides integrity checks and calculations on Settlement Period level data ingested by BSC Central Settlement Services from the Smart Data Service(s) , the Advanced Retrieval and Processing Service(s) and the Unmetered Supplies Data Service (s).

N

Non Half Hourly Settlement (NHH)

As part of the Settlement process, NHH Settlement is the arrangement for estimating how much energy a supplier's customer's use (or export) in each Settlement period (where their meter is not capable of recording energy usage for a Settlement Period). The arrangement uses Meter readings spanning longer intervals, e.g. days, weeks and months.

Non-smart Meter

A non-smart Meter is a Meter that is not compliant with the Smart Metering Equipment Technical Specifications (SMETS). These Meters include legacy non-smart Meters for customers refusing smart Meters, premises where smart Meters cannot be fitted,

O

Ofgem

The Office of Gas and Electricity Markets (Ofgem) is responsible for protecting gas and electricity consumers in Great Britain. It is governed by the Gas and Electricity Markets Authority (GEMA).

P

Processing Service (Smart) [PSS]

The Processing Service (Smart) is responsible for obtaining and validating and estimating (where needed) raw meter readings (both Settlement Period and Register Reads) from smart and non-smart Meters.

Programme Implementation Plan

The Programme Implementation Plan is the detailed plan with timings that will need to be developed during the implementation phase for the TOM.

R

Reference Architecture

A reference architecture in software terms provides a template or pattern to solve a defined problem. It is very unusual for a business change to require a new type of solution. For example, registering details of an asset occurs in many business domains from energy (a meter), aviation (an aeroplane), consumer (a mobile phone). Reference architectures describe patterns for solving such problems and indicate the types of technologies and considerations that are typically employed. Specific technologies, how individual components/services of the system are architected, interface/protocol details and the like are the scope of subsequent architecture and design phases.

Registration Service (SMRS)

The Registration Service (known as the Supplier Registration Service (SMRS) under the BSC. Note this is not the Central Switching Service) is the LDSO service that holds Meter point standing data information about each MPAN

within its distribution Region. Data includes the Supplier the data and metering services appointed to the MPAN. It also includes information on the type of customer, Energisation Status and Line Loss Factor Class.

S

Settlement

In the context of this report Settlement process refers to the Imbalance Settlement arrangements. Settlement places incentives on generators and Suppliers to contract efficiently to cover what they produce or their customers consume (or produce) respectively. For Suppliers, it operates by charging for any difference between the volumes of electricity that they buy and the volume that their customers consume.

Significant Code Review (SCR)

The SCR process is an Ofgem led process that is designed to facilitate complex and significant changes to a range of Industry Codes. It provides a role for Ofgem to undertake a review of a code-based issue and play a leading role in facilitating code changes through the review process.

Smart Data Services (SDS)

The Smart Data Services comprise the Meter Data Retrieval Service, Processing Service (Smart) and Meter Reading Service, which together enable settlement of the Smart and Non-smart Market Segments.

Smart and Non-smart Market Segment

The Smart and non-Smart Market Segment is the Market Segment that covers smart Meters serviced by the DCC. This covers smart Meters with Settlement Period level data available and smart Meters where only Register Readings are available. It also covers non-smart Meters.

T

Target End State

The Target End State is deemed to be when the majority of customers will have a Meter capable of delivering Settlement Period level meter data for Settlement purposes.

Target Operating Model (TOM)

The Target Operating Model is the set of services and settlement arrangements designed to deliver Market-wide Half Hourly Settlement.

Transition Approach

The Transition Approach sets out the key milestones and dependencies for moving to the TOM from the existing market services and Settlement arrangements.

U

Unmetered Supplies

Unmetered Supplies (UMS) means a supply of electricity to a particular inventory of equipment in respect of which a Licensed Distribution System Operator (LDSO) has issued an Unmetered Supply Certificate. For example, this equipment could be any electrical equipment that draws a current and is connected to the Distribution Network without a Meter, i.e. there is no Meter recording its energy consumption, e.g. street lights, traffic signs, zebra crossings, etc.

Unmetered Supplies Data Service (UMSDS)

The Unmetered Supplies Data Service (UMSDS) is the service that calculates Settlement Period Level consumption data for Unmetered Supplies.

Unmetered Supplies Market Segment

The Unmetered Supplies Market Segment is the Market Segment for Unmetered Supplies, e.g. street lights, traffic signs, zebra crossings, etc.

Unmetered Supplies Operator (UMSO)

The Unmetered Supplies Operator (UMSO) is the service that interfaces with the Unmetered Supplies (UMS) customer and other industry stakeholders. The UMSO Service is provided by the Distribution Business.

V

Volume Allocation Service (VAS)

The Volume Allocation Service (VAS) is the service that processes Settlement Period level data provided by the Market-wide Data Service (MDS). The processed data is allocated to Balancing Mechanism Units (BMUs).

Business Context

The DWG TOM describes an environment where faster and more accurate settlement processing is possible due to the ability to capture and use a larger number of smart meter (half-hourly) readings for consumption.

In order to achieve this within the market model and across market participants, there are many processes executed by a combination of services that need to exchange data in volumes an order of magnitude greater than at present. The exchange of data is not limited to point to point communications, rather multiple services may consume data produced by a single service.

The AWG also noted that some existing market data flows would be retained and require updating as part of MHHS.

Business Scope

As shown in *Figure 2*, the MHHS market model defines new and adapted services. This identifies where potential changes to IT systems and related processes will occur, as each service may need varying degrees of modifications or enhancements by those participants implementing them.

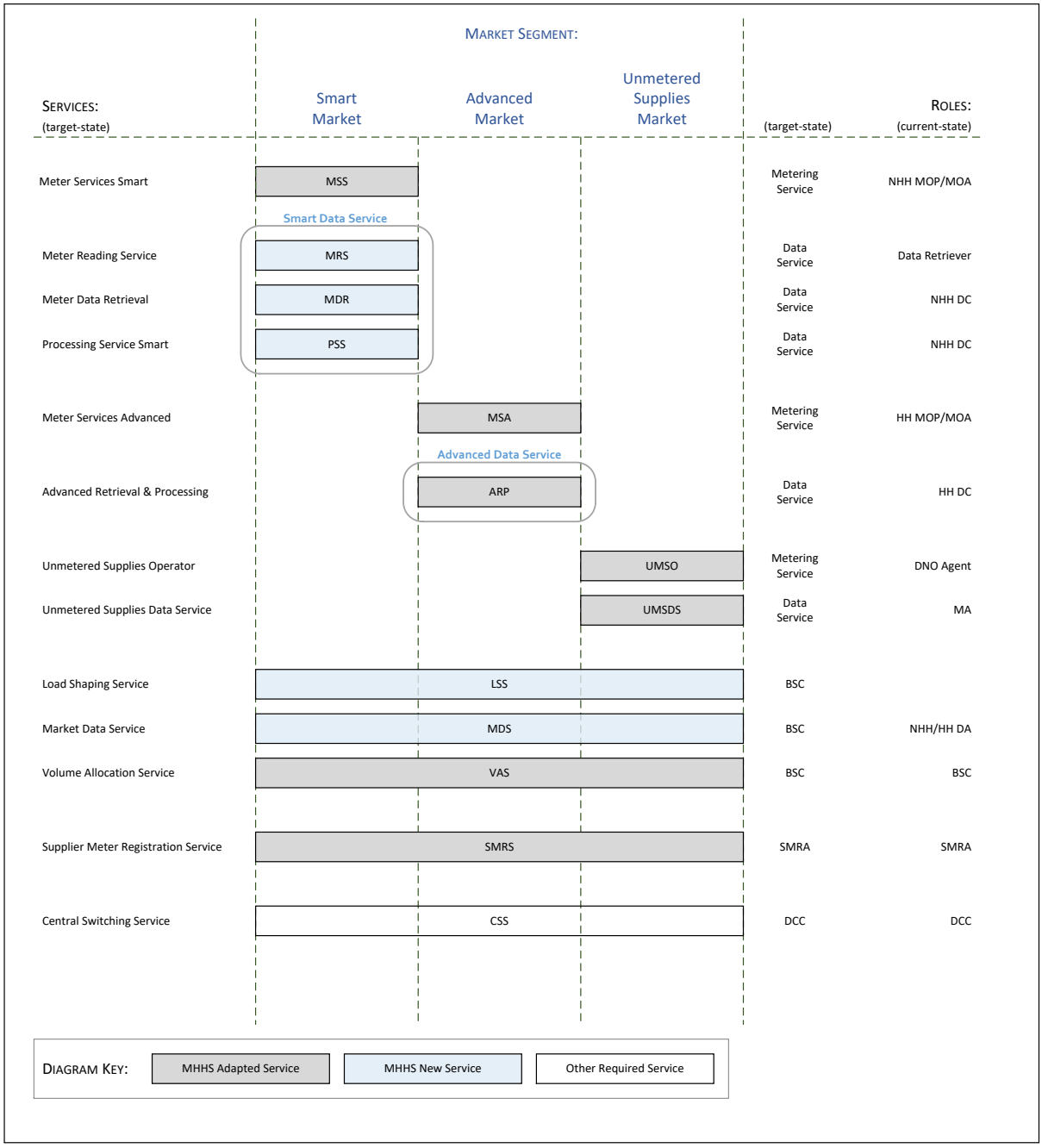

Figure 2 - Market Model Services & Roles

Therefore, in order to implement MHHS, it is likely that each market participant performing one of the target-state roles will be required to make modifications so they can deliver the required functionality of the new or adapted services.

During the first phase of the AWG, this market model was investigated within the context of the requirements stated in the *Background* section above. In other words, for the communication of data and how that data may be utilised by the business processes of the market participants. In architecture terms, this asks how the data can be integrated (or synchronised between multiple locations) so that existing business processes continue to function as expected. Given this requirement, identification of where data is produced and who needs to consume it, forms the main business scope.

There are three main points of data creation within the MHHS market model; The Supplier Meter Registration Services (from herein referred to as Registration Services) are responsible for recording the relevant MHHS roles for each MPAN. The new Data Services are responsible for gathering meter consumption data for settlement. And BSC Central Settlement Services (from herein referred to as Central Settlement) is responsible for providing ISD (Industry Standing Data) for everyone.

The analysis shows three main types of data entity:

- Change of State: e.g. Registration (appointments, de-appointments, etc.) or Meter Technical Data changes
- Data Pipeline: e.g. Consumption (meter readings)
- Reference Data: e.g. ISD (market domain data)

Additionally the analysis identified several changes to existing data flows which will continue to be transferred over the DTN. These D-flows are illustrated on the accompanying business process model diagrams.

As well as data being communicated within the new market model, it should be considered that MHHS functions within the wider industry and there is likely to be a broader set of impacted participants other than just those described by its core services and roles. The MHHS changes are both internal to the new market model and external where that model must interact with the existing market.

To understand the broader impacts, *Figure 3* shows where the main data entities for MHHS are communicated, with the new market model forming the primary scope, and the wider market as shown in the additional scope.

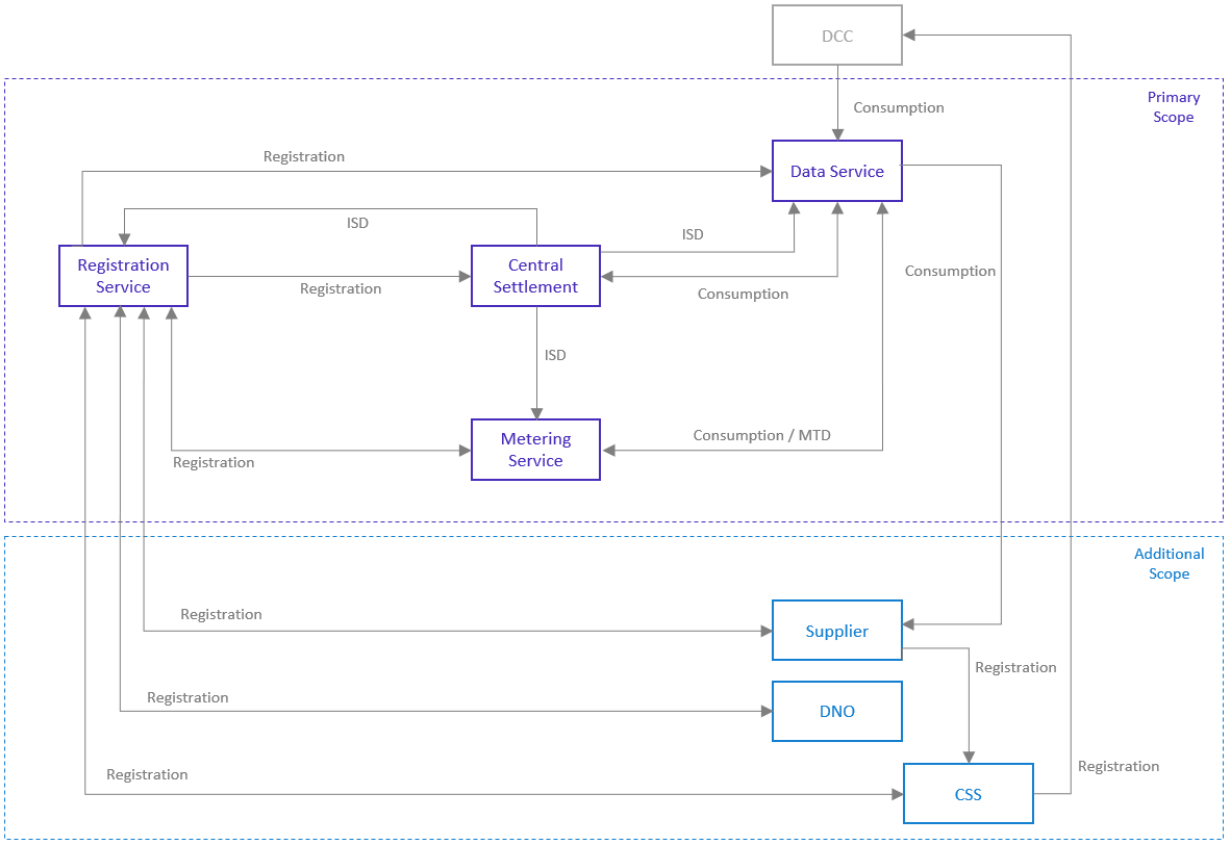

Figure 3 – Data Entity / Communication Diagram

Figure 3 indicates breadth, but not depth, and so to better assess the scale of change required for data integration, *Table 2* shows indicative numbers of market participants for each role.

Role	Market Segment	Estimated #
Data Services	Smart	21
	Advanced	7
	Unmetered	7
Metering Services	Smart	50
	Advanced	35
	Unmetered	27
Registration Services		27
LDSO		27
Supplier		60

Table 2 - Indicative Numbers of Participants

The second phase of the AWG focused on understanding the characteristics of the required data integrations, and how those could influence the recommendation.

The AWG created a set of interface specifications which details their data catalogue contents and provides some estimated volumetrics. A sample of these estimates are shown in *Table 3*.

Data Entity	Interface	Target	Annual Volume		Annual Data Size	
			Typical	Maximum	Typical	Maximum
Registration	Appointment	Metering Service	6,202,000	31,020,000	1.9 GiB	9.7 GiB
		Data Service	6,202,000	31,020,000	1.9 GiB	9.7 GiB
	De-Appointment	Metering Service	6,202,000	31,020,000	402 MiB	2 GiB
		Data Service	6,202,000	31,020,000	402 MiB	2 GiB
	Accept/Reject Appointment	Registration Service	12,404,000	62,040,000	800 MiB	3.8 GiB
	Updates	Metering Service	1,551,000	31,020,000	365 MiB	7.2 GiB
		Data Service	5,271,000	31,020,000	1.6 GiB	9.7 GiB
		Central Settlement	6,000,000	30,000,000	840 MiB	4.2 GiB
Consumption	Daily SP level data	Central Settlement	15,309,000,000	n/a	1,052 GiB	n/a
	Load shapes	Data Service	297,410	n/a	74 MiB	n/a
ISD	All Entities	n/a	2,520	n/a	33.8 GiB	n/a

Table 3 - Sample Interface Volumes

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The volumetrics for appointments were based on current estimates of the number of switches following the implementation of faster switching. The consumption estimates were based on market wide 30 minute data with a percentage (10% for smart) of estimates being replaced by actual data.

The AWG has also delivered a set of high-level business process models which show how the interfaces apply to existing industry activities, and where the new MHHS interfaces are used.

Business Scope Summary

The information presented by the business scope uses a sub-set of the AWG architecture products and outputs. More detail and clarification can be found within those artefacts (as listed in the Appendices). However, for this recommendation, the details provided above are sufficiently representative to describe the main features and characteristics which must be considered for a technology strategy and a proposed architecture that can contribute to MHHS implementation.

- MHHS will create five new services and modify six existing services. It will coalesce some existing roles into two new roles (metering and data services). It will require registration service changes. All of these services have points of impact to IT systems and the processing needed to deliver their outputs.
- There are an estimated 170 market participants performing the MHHS services, and if DNO's and Suppliers are added the estimate increases to 260. This indicates that IT system changes will need to be assessed and undertaken by a large number of organisations.
- Annually, there will need to be a total of circa. 48 million interfaces sent or received between the registration, data, and metering services. Also, there will need to be circa. 14 billion consumption interfaces sent or received between the data services and central settlement. This indicates that IT systems must work in a coordinated manner for timely and efficient operation.
- The registration, meter, and data services are impacted across the majority of business processes, sometimes at multiple points in the sequence. This also indicates that some market participants could have many points of IT systems impact, requiring either sending or receiving of data in order to successfully conclude a process.
- Neither the current market model nor the MHHS TOM define a service where the orchestration of business processes or business rules processing are centralised. Nevertheless, a common data integration service is required to simplify data exchange for all.

Non-Functional Scope

The business scope defined in the previous section is a collection of concrete conditions and known (sometimes estimated) or observable facts that are documented using architecture artefacts. But these are not the only requirements that must be considered by EA when defining a strategic approach.

There also exists other desirable conditions that can be stated. For the purpose of this recommendation, these characteristics and conditions will be combined under the non-functional scope.

There are two sets of non-functional requirements, those defined by Ofgem that are specifically related to architecture, and those developed[11] by the AWG throughout a continual risk assessment.

Ofgem Development Principles

The development principles are expressed as characteristics or questions and are listed in *Table 5*.

#	Development Principle	Addressed by
1	How will non-aggregated HH data be transferred to central settlement	AWG Recommendation

[11] MHHS 201 Architecture Risk Assessment.docx

MHHS AWG: Recommendation

2	How will non-aggregated HH data be stored	AWG Recommendation
3	IT system design should not be a barrier to future uses of non-aggregated HH data	AWG Recommendation
4	Data must be secure in transit and at rest	AWG Recommendation
5	Technical data specifications should be standardised	AWG Outputs
6	The recommendation should not create barriers to innovation	AWG Recommendation
7	Standards should be adaptable to future requirements	AWG Outputs
8	Recommendations will consider potential transition plans	AWG Recommendation

Table 4 – Ofgem Architecture-related Development Principles

AWG Risk Assessment

Table 6 lists the AWG risk assessment.

#	Data Availability	Addressed by
1	Data should be distributed between market participants as soon as possible	AWG Recommendation
2	Follow the principle whereby data is made available without delays	AWG Recommendation
3	Each interface should have a business SLA to indicate the maximum allowed time delay	High Level Design
4	Meet aspirational targets for speed of data exchange but allow for exceptions (e.g., may use batch interfaces where needed)	AWG Recommendation
5	Provide the opportunity to use improved technology which will encourage faster execution of data transfers	AWG Recommendation
6	Data created by data producers may need to be retained by those data producers in case of problems in the network, resulting in additional storage and logic requirements for each organisation	AWG Recommendation
7	Data created by data producers can be immediately passed to a data integration component (an adapter), resulting in minimal technology changes within each organisation	AWG Recommendation
8	If data consumers cannot receive their relevant data, they should still be able to receive everything they missed, once they have resolved their issues	AWG Recommendation
9	Data consumers may request previous/historical data, up to a certain historical point in time	AWG Recommendation
10	All data sent by data producers should be stored (or retained) for an agreed time period, to aid recoverability and re-processing	AWG Recommendation
11	Data distribution/transfers must have an availability SLA	High Level Design
12	All data transfers should be automatic. But restricted data should only be automatically provided to authorised industry roles	AWG Recommendation
13	The method of distribution should guarantee delivery of content, obviating the need to create acknowledgment logic	AWG Recommendation
14	Allow transition between older and newer technologies so that existing system logic can be maintained across generations of hardware/software	AWG Recommendation
#	**Industry Change**	**Addressed by**
15	The AWG recommended architecture should not be too simple/narrow it cannot cater for future changes	AWG Recommendation

MHHS AWG: Recommendation

16	A major change to IT infrastructure or methods may be too costly for some market participants	AWG Recommendation
17	Cost effective architectures may not be suitable for future growth or future requirements	AWG Recommendation
18	The MHHS (current) requirements and control of costs are of primary importance	AWG Recommendation
19	MHHS may impact as-yet unknown processes and so the AWG recommendation must be applicable to a wide range of data synchronisation requirements	AWG Recommendation
20	Existing technology may be due for an upgrade and MHHS should take advantage. Even though costs will be a factor, this should be balanced against market progress	AWG Recommendation
21	The architecture should be scalable to cater for possible increasing numbers of data transfers and /or data producers/consumers	AWG Recommendation
22	Future requirements must still be considered and balanced to enable long-term value, although this should not negatively impact or deter the immediate needs of MHHS	AWG Recommendation
#	**Technology Change**	**Addressed by**
23	The variety of technologies used by market participants internal IT systems should not prevent their ability to implement the AWG recommended architecture	AWG Recommendation
24	The AWG recommended architecture should allow creation of adapters and connectors to enable data producers and consumers to transition technology over time	AWG Recommendation
25	To avoid being impractical or inflexible, the recommended architecture should follow modern industry standards and patterns for data integration	AWG Recommendation
26	Technology complexity should be balanced by MHHS business requirements	AWG Recommendation
27	Promote industry inclusion in the high level design phase so that market participants have an opportunity to assess and influence the technology complexity	High Level Design
28	The AWG recommended architecture should allow technical data validations but should exclude business validations (business rules)	AWG Recommendation
29	Technology transition should be made as flexible as possible to accommodate the variety of market participants resources	AWG Recommendation
30	The AWG recommended architecture should allow increases to both compute processing and data storage resources	AWG Recommendation
31	It should be possible to component test or boundary test roles/services in isolation or in limited configuration	AWG Recommendation
#	**Data Security**	**Addressed by**
32	Data being transferred by must not be accessed by unauthorised parties and so appropriate security controls such as role-based access and least-privilege data provision should be enforced	AWG Recommendation
33	Data distribution requires data publishers and data consumers to be registered as valid organisations. Therefore, the AWG recommended architecture must allow for this technical facility and an industry party must manage the governance	AWG Recommendation
34	The AWG recommended architecture must allow for data governance and security to be an integrated component or process	AWG Recommendation

Table 5 - AWG Risk Assessment

Non-Functional Scope Summary

MHHS AWG: Recommendation

These requirements provide a significant list of behaviours and characteristics to be considered when assessing architectures. However, these can be grouped into a set of overall high-level statements or goals.

- The recommendation should seek to minimise costs to market participants, and therefore an architecture should not enforce a heavy burden of IT change at each participant. Cost is influenced by complexity and scale and for participants, these should be minimised as much as possible.
- Necessary (technology) complexity should be centralised, removing it from the participants. The recommendation should primarily meet current needs, but the architecture must be extensible to meet future scale without incurring the expense of re-design.
- The recommendation should not be a barrier to future market changes, and it should allow for a transitional MHHS implementation across the industry.
- Technology modernisation should be used to increase overall efficiency and enable industry standard technology patterns and components for interoperability.
- The recommendation should allow for security and governance processes to be configured and applied to data, automatically.

Recommended Architecture

The AWG considered both the business rules and data exchange requirements when proposing the most suitable architecture to enable MHHS. To recap:

- About 260 organisations may have to exchange data between themselves.
- Many organisations may be performing the same role in a competitive market.
- The existing market model and the MHHS TOM do not describe centralising of the processing logic, business rules or orchestration of the market wide business processes.
- Volume and frequency of data exchanges is materially greater than the existing non-MHHS state.

From a purely architectural perspective, the simplest and most efficient method would be to place processes executing business rules into a central or single location.

The counterbalance to the efficiency view is that centralised systems running business rules can, over time, create an environment which attracts ever more centralisation. In demanding situations this can encourage short-term tactical solutions at the expense of the strategic long-term.

In addition, it can be seen that centralisation does not complement the new MHHS market model, nor the existing business environment where market participants such as supplier agents provide competitive conditions.

- **Architectures requiring centralisation of business rules have been excluded.**

Another consideration concerns potential impacts or changes to market participants own IT systems and processes. Attempting to make any architectural recommendations for how participants should interpret and structure MHHS changes would be inappropriate. This means that any architectural recommendation should not mandate unnecessary changes to existing participant IT systems, but should instead, seek to provide some efficiency benefits to all participants responsible for implementing the MHHS services.

- **Architectures providing a centralisation of shared technology features are included. i.e. where everyone would have to implement the same function in the same way architectures that provide a shared service at a reduced complexity/cost to industry to all were considered.**

Given this reasoning, and the changes being proposed by the DWG TOM, there is one clear architecture strategy that benefits the immediate goals of MHHS, and which also provides ongoing benefits for the industry as a whole.

- **This recommendation suggests using a modern data integration architecture, which has the responsibility for technically coordinating and routing all data interfaces between the MHHS services.**

This should, where practically possible, simplify data communication between market participants own IT systems, and make use of technology advances to enable modernisation within the whole system.

After considering the different styles of architecture, the AWG is recommending that data integration be accomplished by the application of *EDA (Event Driven Architecture)* to be used as the method for communicating data between all services and roles impacted by MHHS.

To minimise cost to industry, AWG recommends the DTN be maintained for data flows that are not (or only minimally) impacted by the MHHS TOM. Additionally, centrally provided services should be assessed that translate between existing DTN flat file formats and new Event formats (similar to how DTN offers translation to/from XML)

The EDA should not be specific to MHHS processes, allowing industry to update other processes over time as further benefits can be realised.

EDA Reference Model

> For the reader less familiar with architecture styles; an event driven architecture describes communications between systems as an intermediary service that lets anyone interested know that something of business significance has occurred. In perhaps more familiar terms, it is more like a social media platform than email. With email the sender must address a message, perhaps add a read receipt, and then monitor their inbox for acknowledgment. With social media the sender posts something interesting and is not concerned with how many of their followers read the message. The overheads are lower, and information can be shared faster and to a wider and potentially new audience more easily.
>
> A reference model, such as presented in this document, gives a birds-eye view of the entire landscape but does not detail the specific components, technologies, languages, protocols and processes used to implement a solution.

For MHHS, Event driven architecture is a design pattern to be used for data integration between the services and roles of the market model.

Although EDA in general places event processing as its central architectural concept for applications and processes, this recommendation does not seek to influence market participant's internal systems architecture in any way (they may or may not be using EDA internally). However, participants implementing MHHS services will need to interact with data integration architecture at their boundary points, even if they are fulfilling multiple roles, as other services may require visibility of the event data.

The purpose of presenting this architecture as a reference model is to specify the required capabilities that should be included within the design for an implementation. As is shown in *Figure 1 - Project Lifecycle*, the reference model is an artefact used as an architecture input into the design phases that precedes a physical implementation activity. The capabilities of the reference model must meet both the business scope and the non-functional scope.

For the MHHS requirements, an EDA reference model contains three components:

- A data/event broker – responsible for coordination and routing of communication
- An event stream processor – allows event processing
- An event store – retains a history of data

Figure 4 below, shows a simplified version of the reference model and it illustrates how the components of EDA are arranged and combined. Additional components will handle security, monitoring and other operational concerns.

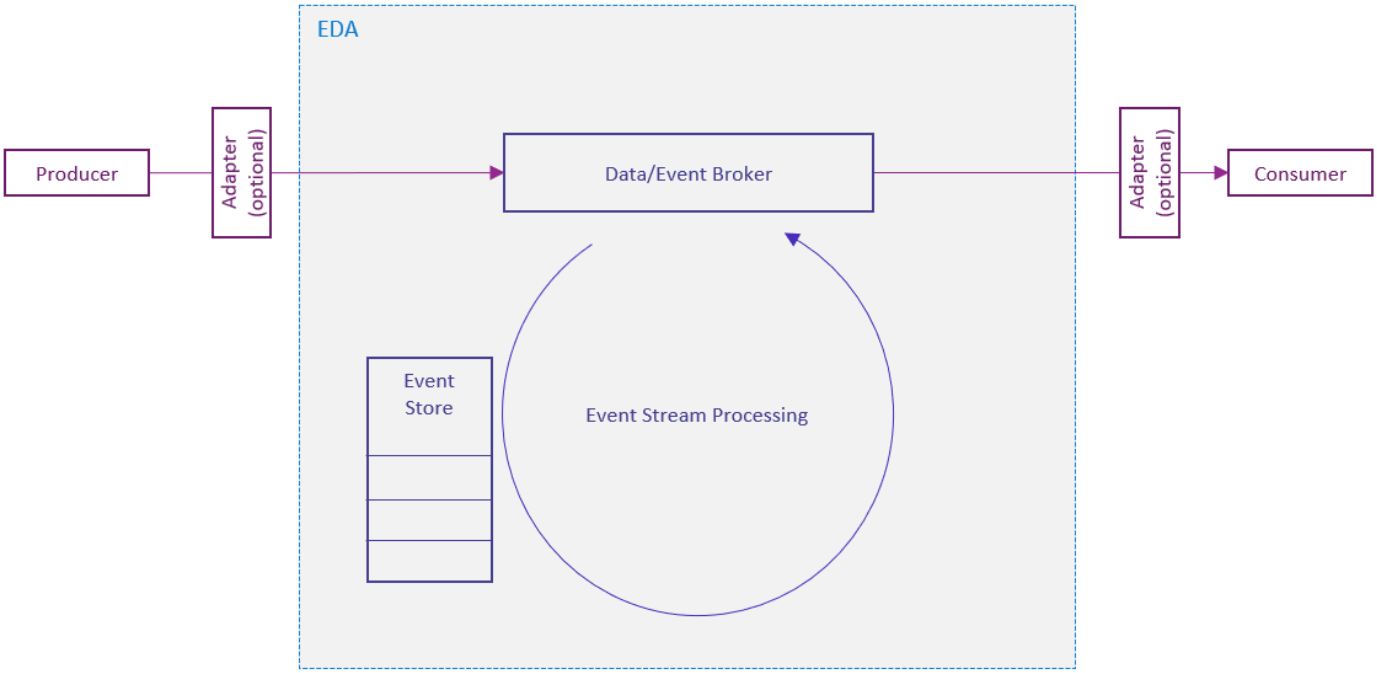

Figure 4 - Simplified EDA

MHHS AWG: Recommendation

An event represents something of business significance that has happened within a business process, such as a registration de-appointment. The subsequent data changes must be captured and used by other processes. For MHHS these other processes are often in different service in the market model. EDA is the facilitating mechanism by which data pipeline processes can be completed across multiple MHHS services.

Within the EDA pattern, data is modelled as streams of events rather than messages which are considered to be static records. However, both an event and a message convey information about a business change. The granularity of events for MHHS are defined by the AWG interface specifications.

For this recommendation, and architecturally significant, EDA provides:

- Data integrity for consumers by ensuring guaranteed delivery.
- Event store as a permanent immutable record of events.
- Security at various levels of authentication, authorization, and access controls.
- Resilience by supporting high availability and scaling that supports varying workloads.

Event

An event is conceptually defined as the occurrence of something of significance to the business. Events typically contain a “header” describing the type of event that occurred, which service raised the event and a timestamp. They also contain a “body” which contains the thing that changed e.g., a new meter register value or a change of asset registration.

The event is agnostic to what processing may take place. Different subscribers may take different actions on the event data they receive but they all do so independently of the publisher, whose sole responsibility stops with the publication of the event. Orchestration of business processes is achieved by each publisher and subscriber fulfilling their obligations.

Event Broker

Event brokers are advanced message brokers and so they represent an evolution of the publish/subscribe and queue-based middleware that is an extensively used (technology) industry standard.

To role of an event broker is to provide a technical service that routes events to their destination:

- MHHS services that publish data are registered with the event broker for security and validity. They generate their data (as defined by the AWG interface specifications) and securely publish them as events. The publishers do not need to be concerned with addressing their events or communicating directly with data consumers. The broker is responsible for notifying the relevant consumers of events they are authorised to ingest.
- There are a variety of technical options that publishers may use, such as internally built services using allowed light-weight protocols, using a software vendor client package or an already created adapter service.
- The broker is responsible for validating and routing the data so that any MHHS service authorised to consume the data can either retrieve this by asking for it, or the broker can directly notify them at an address given during the subscription operation. Both methods allow loosely coupled but cohesive asynchronous communication.
- Events are published to topics, which are subject specific groupings of events, such as daily consumption reads or registration appointments. A topic that contains a sequence of events is called an event log and this is retained for a configurable duration. Each subscriber knows the position in the event log that they previously consumed by using a pointer.
- Because events are ordered as they are received, there is no complex logic needed for each data consumer to know what they have or have not already consumed. Additionally, consumers have flexibility to move backwards or forwards in the event sequence, as fits their needs.
- MHHS services that consume data must first register to a broker topic through its subscription service. In a similar approach taken with publishers, the data consumers must be validated and added to the security protocols. Subscribers may of course unsubscribe at any time.

MHHS AWG: Recommendation

Subscribers can choose to consume events in real-time by being notified (event carried state transfer) through a push operation by the broker. Or they can choose their own time to read all or selected events using a pull operation which they are responsible for initiating (request/response) in a pseudo-batch orchestration.

The broker provides security by implementing identification, authorisation (IAM) and all user-based (publisher/subscriber) security features including role based access (RBAC) controls and integration with directory services. The broker also provides data governance by allowing schema management (the structure of events) and performing schema validation on events.

Schema management allows subscribers to optionally query a schema of an event type, before retrieving events. This allows producers to modify event schemas and it allows the data consumer to separate data retrieval from data processing.

The broker provides scalability through topic partitioning. To ensure high availability the broker may be replicated on clustered infrastructure. Both of these options provide business continuity.

Event Stream Processing

An ESP (Event Stream Processor) is software that can perform real-time or near real-time processing on event data.

It takes incoming events as they arrive (via the broker) and performs any required computation, validation, or analytics before storing it back into the correct broker topic for data consumers.

For MHHS, this recommendation provides the ability for an ESP to provide streaming data integration operations for policy enforcement, bespoke monitoring of events, storing of ingested data into the event store, and management of output queries over the event store.

Specifically, in relation to the event store an ESP will enable MHHS services to automatically insert events into the store (as they are accepted by the event broker) and to handle consumer output queries over the content of the event store.

Examples of these operations and capabilities include:

- Adding to the event store
- Executing queries for consumers of historical data
- Ensuring consistent output of events which may have been subject to schema changes
- Aggregations or other technical operations (which do not alter data)
- Masking or obfuscation of sensitive information for some consumer types

Event Store

Subscribers connected to the broker obtain events in near real time from the log. If the subscriber is unable to retrieve events for a period of time a larger batch can be retrieved from the long-term store.

The long-term store securely persists events in an immutable form for a business defined period of time. The store itself does not contain processing capabilities like for example a relational database. It only needs to store the events in a form that another service can retrieve.

The store must support the bulk extract of filtered sets of events for purposes such as system recovery, investigation of data quality or governance issues.

Given the requirements it is recommended to utilize a big-data / data lake type store over which the event stream processor can retrieve events.

The events should be stored with all associated metadata such that they could be used by new subscribers should new types of business services emerge.

EDA Suitability

Business Scope

It can be seen that the EDA pattern appears as an intermediary between MHHS services. This allows those services to be loosely coupled from each other, reducing the friction and the effort needed to direct data to multiple locations. Being able to provide a single technology service which can perform data integration across the number of market participants implementing the new market model is a large resource saving benefit.

As the number of data events increases, so too does the technical processing surrounding that event. The number of registration and consumption events that are predicted could have significant impact on the required MHHS services as they modify existing business processes. By using the EDA pattern, architectural concerns such as high availability, guaranteed delivery of events and data integration security can be designed and built just once rather than repeated within each MHHS service.

Similarly, as the event store becomes the authoritative source (single truth) of communicated data, it becomes unnecessary to duplicate that ability within the many MHHS services. As long as the event store is configured to retain events, it can always be made available to help with data quality issues or for root cause analysis of historic changes.

MHHS presents two main types of business change, an increase in volume of data and the multiple points of impact to industry processes. The EDA pattern will allow for high velocity and high volume throughput to be reliably integrated between the many MHHS services. The communication can be in real-time for high performance but can also operate in a pseudo-batch mode if needed and this both minimises and simplifies the MHHS changes.

The EDA pattern is also technically agnostic to the specific types of business events. It creates an integration service that in the first instance will be used to route MHHS events and data but can equally be configured to support and integrate new MHHS and non-MHHS business services in future.

Non-Functional Scope

The ability to publish and subscribe by using a broker (a third party facility) is a familiar concept to the industry today, through the long-term use of the Data Transfer Service. The points of interaction within individual participant IT systems would be similar. It is the choice of each system how to best integrate with the broker, but the use of 3rd party adapter services to handle the interfacing with the new data integration service would simplify the required changes and reduce the integration complexity for individual companies who do not wish to build the interface themselves.

Event brokers and event stream processors allow for scale-out infrastructure to ensure high performance throughput. If the combination of data services attempts to send tens of millions of consumption events at similar times, the event broker pattern is capable of supporting these volumes. The benefit of scale-out infrastructure is that additional cost is incurred only for the duration of the increased workload, when the events subside, resources can be released.

The data in the event log in combination with the event store becomes the authoritative log of published events for MHHS information as all events are immutable. Events can be either consumed in sequence or replayed at a later date. This removes the potential cost, time, and effort of retrieving data from multiple services and having to perform additional validation logic.

The EDA pattern uses the concept of an append-only queue to form the event log. The event log contains all events for a specified time window (such as a rolling 7-day or 3-week sequence) and this means that consumers can be offline but may connect periodically to consume events they are interested in. This also means that an MHHS service in a recovery scenario may only need to connect and replay available data from the event log.

For recovery of a longer time frame, the service would be able to query the event store to rebuild any data content and therefore, restore its data integrity to an accurate operational state.

The event log for any particular topic can be used by many consumers (each consumer has their own pointer). This is an advance from previous message brokers that created queues for each consumer, resulting in duplication of data and utilising additional resources when storing and delivering data content.

The additional benefit of the event log is that it allows for an increased capacity of consumers with minimal increase in infrastructure and resources. This is most applicable to consumption events, where multiple consumers may exist, but they can all be satisfied by the same event stream in the same topic.

MHHS AWG: Recommendation

Event stream processing provides the ability to add custom processing whenever that may be required by industry, for any valid reason. Given that ever more uses of published event data will become apparent, the ESP is a key future proofing capability.

The ESP can be utilised to configure periodic data extracts from a longer history of saved events in the store. The output data can be arranged and, critically, any security or governance processes can be applied to the data before it is delivered to a destination. This meets the Ofgem goals for enabling access to non-aggregated data, whenever and where it may be required.

The decoupled nature of an EDA can ease transitioning to new processes. Participants can work on their own publish/subscribe obligations independently of one another, simulating receipt of relevant events as required to build their systems. The decoupled nature can likewise reduce complexity for cross-industry change.

Suitability Summary

Significant business change usually means accompanying technology change. The purpose of finding a suitable architecture is to minimise the impact of those changes, and where possible, to also reduce their complexity.

The adoption of event driven architecture is increasing as digital businesses create and utilise ever more data in their services and products. The ability to provide EDA benefits for data being communicated across MHHS services creates a core technology facility that can be extended and enhanced to complement additional industry changes as they arise.

Event brokers are a technology built on existing well proven messaging tools. The architecture supports the cost-effective ingestion, processing and distribution of large data volumes that flexes as business load changes. Event stores can utilise the best parts of big-data storage patterns. By combining these with cloud-native (e.g., microservice) architectures to provide scale-out/scale-in processing results in an overall strategy that immediately benefits MHHS and the technology programme being initiated to implement it. Crucially, it also provides a technology facility that will benefit the industry as it moves towards a more data-centric and challenging future.

Event driven architectures can help to minimise change costs. Organisations may have legacy systems that do not require updating at this point but need to communicate with new services. Lightweight intermediary adapters may be provided to translate between the legacy interfaces and the event protocol that allow legacy services to interact in the event driven architecture. New business processes can thus be orchestrated across new and legacy services with minimal impact to the legacy services. Of course, if the new business process requires real-time end to end processing more significant changes may be required, but that is a function of the business process change rather than the integration architecture.

Alternatives

During the opening remarks of the ***Error! Reference source not found.*** section above, it was stated that the AWG would avoid architectures that encourage the centralisation of business rules. This means that any type of application or database centric approach would be rejected in favour of a technology facility that can assist in delivering the data outputs of the MHHS services.

A resulting data integration architecture using EDA patterns was described. However, EDA is not the only integration pattern and some alternatives to this are presented below.

Other Data Integration Patterns

Data integration technology has a long and successful history. The AWG discussed the list given in *Table 7*, which are presented in a general ascending time order of their evolution.

Technology Pattern	Notes
MFT (Managed File Transfer)	File transfer protocols (e.g., FTP). Batch point to point transfers, de-centralised. Low volumes.
EDI (Electronic Data Interchange)	Proprietary formats and standards. Batch point to point transfers, de-centralised. Low volumes.
CDC (Change Data Capture)	Database replication in batch or real-time. Medium volumes.
MDM (Master Data Management)	Semantic accuracy, data replication, early publish/subscribe. Medium volumes.
MOM (Message Oriented Middleware)	Publish/subscribe message brokers and message queues (e.g., JMS, MQ, AMQP, DDS, etc.). Centralised, frequent batch (pseudo real-time). Medium volumes.
ESB (Enterprise Service Bus)	Publish/subscribe but internal (single organisation) messaging for Service Orientated Architecture (SOA) patterns and complex orchestration in real-time. Medium to high volumes.
API (Application Programming Interface)	Request/response for point-to-point transfers, de-centralised. Real-time or batch but for low to medium volumes.
EDA (Event Driven Architecture)	Event notification (incorporates publish/subscribe & request/response). Centralised, real-time or batch for medium to high volumes.

Table 6 - History of Data Integration Technologies

EDA, as a design pattern has existed for over 15 years. But what makes this a suitable recommendation today is a combination of cloud-native services providing high performance and flexible compute, low-latency networks, big-data storage, as well as popular open source software and a raft of vendor provided solutions (see the list given in the appendices).

Out of all the technology patterns in *Table 7*, either MOM or API can also use variations of these architectural features, but there are specific reasons why they were not selected.

MOM: Message Brokers

A message broker uses a message queue for each subscriber. As shown in *Figure 5* below, there are as many queue's as there are subscribers. For every new subscriber, the publisher must send an additional message to a new queue, thereby creating a tight coupling between a publisher and all of its subscribers.

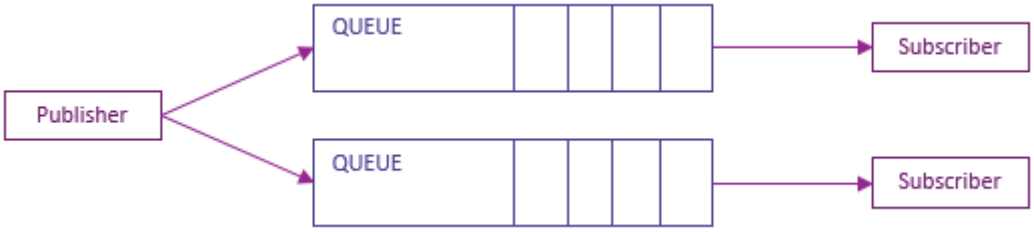

Figure 5 - Message Queue Model

This results in scalability problems when the number of subscribers becomes large as data and processing may be duplicated many times. The subscribing behaviour of a message results in that message being deleted from the queue once it is read. This creates problems in case of recovery, as the producer must know to re-create the message and re-send it.

Comparatively, *Figure 6* shows how an event broker uses a single topic which can be used by many consumers, avoiding data duplication. The EDA Reference Model section above describes the event log benefits. Event filters can be created that enable certain consumers to receive selective events.

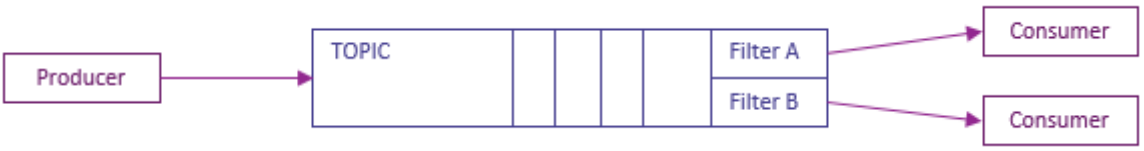

Figure 6 - Event Topic with Filters

A message broker does not provide the ability to

- Guarantee delivery
- Provide custom processing for messages
- Store messages
- Re-query past messages

In summary, message brokers are a good but previous technology, and although they function well as a delivery mechanism, they do not provide the many additional features or the improved architecture that is found in event brokers.

API

In the context of data integration, an API is a point-to-point interface. These are light-weight protocols mainly using either HTTP-based REST or socket-based RPC. The main features of an API for integration are in their suitability for resource oriented design.

A resource is usually something that needs to be retrieved and used. Therefore, an API is considered to be a request/response pattern.

But also, API's are flexible enough to be used to issue commands, sometimes with an accompanying data payload. A good example of this in industry would be where a supplier initiates a customer switch request by pushing some data content with a command to the appropriate resource within the CSS. This begins a process integration sequence

which eventually culminates in a call-back to the supplier (who has provided a return resource) to indicate the resulting status of the executed command.

The relevance for MHHS, is that the point-to-point nature of an API as a data integration pattern means that each service in the network must create the infrastructure and logic needed to manage communications. The API pattern is shown in *Figure 7*.

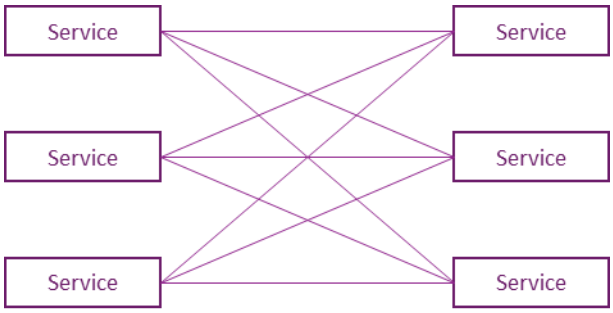

Figure 7 - API Integration

This results in a scalability problem that can only be solved by increasing both resources and complexity within each service.

In contrast, *Figure 8* shows an event broker pattern which removes effort from each service and places it centrally within the broker, so that many resources can be optimised.

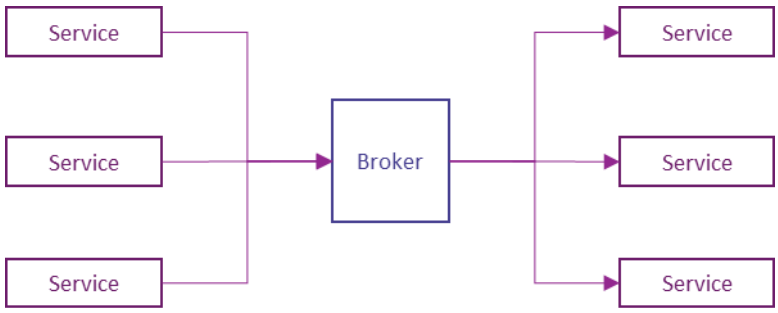

Figure 8 - Broker Integration

Within a reasonably sized network, it can be seen that an API based approach results in the maximum amount of data traffic and the most duplication of functionality, as each service would need to create the same resources to handle the same data integrations.

Each service would need to provide

- High availability infrastructure
- Resource (processing) for each interface type
- Security and access controls
- Retained history of data for recovery scenarios

In summary, an API is not a recommended pattern for data integration as there are many infrastructure requirements that are more efficient in a centralised model such as a broker. Creating and managing API resources results in a tightly coupled topology as each service must be aware of all the other services with which it communicates, leading to increased complexity over time.

No Change

There is always the potential option of doing nothing, but the consequences of this can be severe, as the effort required to apply new data integration characteristics to existing processes and tools could be very costly.

As has already been discussed, architectural characteristics of data integration for MHHS include high volume and velocity, guaranteed delivery, no duplication of interface data, re-query of historical data, use of modern cloud-native tools and the option of conversion to a real-time event driven approach at the data integration boundaries of industry processes.

Therefore, to recommend no change as a viable option, the AWG would have to be confident that the MHHS requirements and the future data integration needs of the market as a whole would be satisfied with existing methods, and this is not the case.

When considering the existing data transfer service the group (with membership of the service owner) found that the new business requirements describe an environment that the existing service was not required or architected to perform. Specific (new) characteristics that the existing arrangements lack include:

- Speed of data transmission.
- Speed of acceptance of messages sent.
- Moving away from batch processing to real-time processing of small data packets.
- Real time validation.
- End to end encryption & protection of sensitive data.
- Replay of event history.

It should be recognised that the existing data transfer service does share some common characteristics such as a broker, defined interface formats and routing of messages to intended recipients. *The AWG is recommending a modernisation of the data transfer architecture rather than replacing it with something altogether different such as a centralised data processor or process orchestrator.*

Next Steps

Referring back to Figure 1, this document sets out the reasoning behind the AWG's proposed reference architecture which in turn will allow solution architects to form the detailed designs necessary to build against. While this reference architecture outlines the recommended style of data integration, the group acknowledges the difference to existing arrangements. Planning for the next steps has already started and it is expected that as part of the transition between the AWG and the next phase, a series of activities will be undertaken to provide further detail on how MHHS can operate with an EDA.

In preparation for this next stage, a draft Product Description[8] has been produced, setting out the products required to deliver this recommended reference architecture, and provide industry with enough information from which they can start their own internal system design and build. The product description contains an initial plan for the immediate steps that will provide industry with examples of how the MHHS processes may be designed around an EDA. These include:

- Listing the main business events and describing their information model.
- Defining what the event schema will look like (in a similar way to how MRA describe a DTN flow)
- Explaining how to engage an EDA backbone service to publish and subscribe to events.
- A comparison between the existing DTN and new EDA styles of communication for a given data flow.
- Explaining how an adapter service might let parties continue with DTN style integration until they are ready to switch over.

Additionally, as the business processes are described in more detail, it will be necessary to highlight where they impact non-MHHS processes such that these touch points can be evaluated by those concerned. This would therefore provide enough further detail to enable an Ofgem decision on the final scope and allow industry to move onto the next phase of the detailed design and subsequent implementation.

[8] Architecture Design Working Group (ADWG) Product Description.docx

Appendices

Interface Specifications & Business Process Models List

Interface Specifications

From Registration Services to:
Metering Service (Appointment)
Metering Service (De-appointment)
Metering Service (Updates)
Data Service (Appointment)
Data Service (De-appointment)
Data Service (Updates)
Settlement Service (Updates)
Supplier (Appointment Related)
Supplier (De-appointment)
DNO (Updates)
From Metering Services to:
Registration Service (Accept/Reject Appointment)
Registration Service (Updates)
Data Service (UMS Inventory)
From Data Services to:
Registration Service (Accept/Reject Appointment)
Metering Service (UMS Response)
Settlement Service (Consumption)
From Settlement Service to:
Data Service (Load Shape Details)
Data Service (Load Shape Totals)
Everyone (ISD)
From Suppliers to:
Registration Service (Appointment Related)
Registration Service (Accept/Reject Appointment)
Registration Service (Updates)
From DNO's to:
Registration Service (Updates)

Change of Supplier (COS)
Change of Agent
Change of Market Segment
Connection
Disconnection
Data Collection
Data Retrieval
Change of Meter
Registration Service Updates
Data for Network Charges
Domestic Opt-Out

Business Process Models

Sample EDA Software Vendors/Products

The following tables are examples of software products and providers.

Event Brokers[12]

Providers:
Oracle Event Hub Cloud Service
Microsoft Azure Event Grid
IBM Event Hub
Confluent Cloud
Solace PubSub+
Vantiq Application Platform
SAP Project Kyma
AWS Simple Notification Service (SNS)
Apache ActiveMQ
IBM MQ
TIBCO FTL
Open Source:
RabbitMQ
Apache Kafka
Apache Pulsar

Event Stream Processing[13]

Vendor	Product
AWS	Amazon Kinesis & Kinesis Data Analytics
Cloudera	Cloudera Data Flow
Confluent	Confluent Platform
Databricks	Unified Analytics Platform
Datastreams.io	Data Stream manager
EsperTech	Esper Enterprise Edition
Google	Cloud Dataflow & Cloud Data Fusion
Hitachi	Hitachi Streaming Data Platform (HSDP)
IBM	IBM Stream, IBM Decision Server Insights
Informatica	Big Data Streaming
Microsoft	Azure Stream Analytics, Stream Insight
Oracle	Oracle Stream Analytics

[12] Gartner G00362911 – Innovation Insight for Event Brokers (June 2020)
[13] Gartner G00367575 – Market Guide for Event Stream Processing (August 2019)

MHHS AWG: Recommendation

SAP	SAP Event Stream Processor
Streamlio	Streamlio Intelligent Platform for Fast Data
Talend	Talend Data Streams
TIBCO Software	TIBCO Streaming
Open Source:	
Apache Beam (batch and streaming data processing)	
Apache Flink (computations on data streams)	
Apache Samza (distributed stream processing framework)	
Apache Storm (real-time computation)	
Spark Structured Streaming (framework for building streaming applications)	

EDA – Vendors with Event-Driven product offerings[14]

Providers:
Amazon — Amazon Kinesis, AWS Lambda
Confluent Platform
Google Cloud Pub/Sub
IBM Event Hub
Microsoft Azure Event Grid
Oracle Event Hub Cloud Service
Salesforce Platform Events
Serverless Event Gateway
TIBCO BusinessEvents
Vantiq Application Platform

[14] Gartner G00338551 – Innovation Insight for Event Thinking (June 2020)

Consultation Questions

Question 1. Do you agree that the business and non-functional scope as set out is consistent with Ofgem's business case, target operating model development principles, the agreed TOM and subject areas considered by the CCDG?
Yes / No
Rationale:

Question 2. Do you agree that data integration is the appropriate architecture style to realise the MHHS TOM requirements rather than a more process centric architecture such as process automation or centralised business rules processing? If not, why not and what would be the most appropriate architecture style?
Yes / No
Rationale:

Question 3. Do you agree that Event Driven Architecture is the most suitable data integration style to realise MHHS and should be taken forward to the next stage of design? If not, why not and what would be the most suitable data integration style to realise MHHS.
Yes / No
Rationale:

Question 4. Do you agree that a new data integration service is required to satisfy the data volume and frequency requirements mandated by the MHHS TOM? If not, why not?
Yes / No
Rationale:

Question 5. Do you see any other benefits to industry of having an EDA for data integration available?
Yes / No
Rationale:

Question 6. Do you have any other comments?
Yes / No
Rationale: