CBAN 2.0

DLT-Based Commercial and Operational Framework for Automated Data-on-Demand Services

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1 List of Contributing Members

The following members of CBAN participated in the development of this document and have requested to be included in this list.

Editor Note 1: This list will be finalized before Letter Ballot. Any member that comments in at least one CfC is eligible to be included by opting in before the Letter Ballot is initiated. Note it is the MEF member that is listed here (typically a company or organization), not their individual representatives.

2 Abstract

This standard defines the functional requirements for a DLT-based (Distributed Ledger Technology) commercial and operational framework for automated data-on-demand services that includes an abstract reference architecture and the processes for the following service lifecycle steps: inquiry and quote, order, service delivery, SOAM (Service Operations and Maintenance), billing and change management. This standard builds on the MEF LSO Reference Architecture defined in MEF 55 by adding commercial and operational layers and processes. The framework is predicated on the use of at least one DLT implementation.

The standard will be used primarily by ICT-SPs (Information and Communications Technology Service Providers) that want to offer data-on-demand services that include combinations of data connectivity, compute and storage both for retail customers and for wholesale customers, as well as a range of technology solution providers supporting them.

3 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions to terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other MEF or external documents.

Term	Definition	Reference
AML	Anti-Money Laundering	IMF [1]
Anti-Money Laundering	Anti-money laundering (AML) refers to a set of laws, regulations, and procedures intended to prevent criminals from disguising illegally obtained funds as legitimate income.	IMF [1]
B-BUS	Functional block in Reference Architecture that handles a range of Buyer-related ICT-SP activities as defined in Section 10 and elsewhere in the standard.	Section 9.3 of this document
Bilateral Agreement	The business relationship between two Participant ICT-SPs. The business relationship between these Participant ICT-SPs is always direct, private and bilateral.	Section 7.10 of this document
Bilateral business process	The various business processes that are part of the Bilateral Agreement. The bilateral business process includes Pre-Order, Order, Service Delivery, SOAM, Billing and Change Management.	Section 10 of this document
Bilateral Ledger	A ledger shared between exactly two parties.	Section 9.5.2 of this document
Billing	Billing is the commercial process of invoicing, reconciliation and settlement of amounts due by Buyer, Seller or bidirectional trading partners.	MEF 74 [3]

Term	Definition	Reference
BSS Layer	A system or a collection of systems that include the components that an ICT-SP uses to run its business operations towards its customers and partners. Traditionally BSS was referred to customer-facing activities only but in the context of the supply chains discussed in this document the definition of BSS is expanded to include partner/supplier-facing activities as well. The two systems together are often abbreviated OSS/BSS, BSS/OSS or simply B/OSS or B-OSS.	This document
Buyer	An entity that buys a service from a Seller of which it is an immediate upstream neighbor in the Supply Chain.	Section 7.4.1 of this document
Change Management	Changes made to in-operation service instances.	This document
Cloud	Non-geographically specific environment offering data services such as compute, storage and connectivity.	Journal of Object Technology [3]
Commercial Agreement	Agreement between two parties allowing for buying services, selling services between them or both.	Section 7.10 of this document
Commercial Framework	A framework that facilitates the generation of commercial value through wholesale trading of data services.	This document
Compute	Act of manipulating data or taking action based on data using a computing resource.	Section 7.1.2 of this document
Connectivity	Act of transporting data through space.	Section 7.1.1 of this document
Credit Allocation	The amount of monetary funds that a Buyer can consume prior to making payment to Seller. This is typically derived from Credit Score and Payment History. Example: The Buyer has been allocated credit of USD 5,000.	MEF 74 [2]
Credit Score	The amount of confidence the Seller has in the Buyer's ability to pay its bills. Example: The Buyer has missed the due date an average of 1 out of 4 of its last payments thus it has been given a credit score of 75%.	MEF 74 [2]
Data Measurement Unit	An abstract definition of data as a string of bits or bytes. Measuring different types of data allows for data to be quantified and billed in financial terms.	MEF 74 [2][2]
Data Service	Service that combines one or more of the following: Connectivity service; Compute service; Storage service	Section 7.1 of this document
Data-on-Demand Service	Data-on-demand services are expected to be activated, operated, billed and settled with immediate effect. This expectation is based on pre-existing and pre-on-boarded facilities and interconnects	Section 7.2 of this document
DB	Downstream Bilateral Ledger	Section 9.5.2 of this document
Downstream Bilateral Ledger	Repository containing information that is shared with the Downstream Participant ICT-SP (Seller)	Section 9.5.2 of this document

Term	Definition	Reference
Deposit	An amount pre-paid by the Buyer to the Seller prior to consuming services.	MEF 74 [2][2]
Distributed Ledger Technology	A digital system for recording information so it is recorded in multiple places at the same time.	*Defining DLT*, University of Cambridge [4]
Downstream Participant ICT-SP	The Participant ICT-SP immediately downstream of the subject Participant ICT-SP in the direction away from the originating customer.	Section 7.4 of this document
DLT	Distributed Ledger Technology	University of Cambridge [4]**Error! Reference source not found.**
DLT Abstraction Layer	Architectural abstraction between applications using the DLT and the DLT itself.	Section 8.3 of this document
Distributed Ledger Technology	Distributed Ledger Technology is a digital system for recording the transaction of assets in which the transactions and their details are recorded in multiple places at the same time. Unlike traditional databases, distributed ledgers have no central data store or administration functionality.	University of Cambridge [4]**Error! Reference source not found.**
Ecosystem	In the context of this document an Ecosystem is a federated and collaborative platform that enables establishment of data services through a Supply Chain of ICT-SPs.	This document
Electronic Record	Information captured through electronic means, and which may or may not have a paper record to back it up.	Bulletin of the American Society for Information Science and Technology [5]
ENNI	Reference point representing the boundary between two networks that are operated as separate administrative domains.	MEF 26.2 **Error! Reference source not found.**[6]
Entity ID	An ID assigned to an entity by official ledgers that exist in certain countries/continents.	MEF 74 [2][2]
Fault Management	Process of identifying and rectifying faults in services.	MEF 30.1 **Error! Reference source not found.**[7]
SOF	A functional block in Reference Architecture that handles a range of ICT-SP **internally**-oriented service lifecycle orchestration activities as defined in Section 10 and elsewhere in the standard.	Section 9.4 of this document
ICT-SP	Information and Communications Technology Service Provider	This document
Identity	Combination of one or more unique identifiers with data associated with this/these identifier(s). Identity associated data consists of signed certificates or credentials such as verifiable credentials and other unsigned, non-verifiable data objects generated by or on behalf of the unique identifier(s).	Merriam-Webster Dictionary [8]
Information Model	Representation of concepts and the relationships, constraints, rules, and operations.	RFC3444 [9]

Term	Definition	Reference
Inquiry	The first part of the process 'Inquiry and Quote'. It includes request by Buyer from Seller confirmation of ability to Quote followed by a Quote for service as described in the Inquiry. Service details may include: Locations, Bandwidth, QoS, VNF details (CPU, OS, RAM, Storage…)	Section 10.1 of this document
INT	Internal Ledger	Section 9.5.1 of this document
Inter ICT-SP	Refers to activities between two or more ICT-SPs	This document
Internal Ledger	Repository that contains information that is used internally by an ICT-SP and that does not need to be shared with any external entity.	Section 9.5.1 of this document
Intra ICT-SP	Refers to activities within a single ICT-SP	This document
Invoicing	The process in which the Seller generates and sends an invoice to the Buyer for the amount stipulated by the Bilateral Agreement and based on utilization information and SLA or other credits as applicable based on agreement. Billing is expressed in currency, FIAT, cryptocurrency or stablecoin as agreed by both parties.	Section 10.5 of this document
IRP	Interface Reference Point	MEF 55 [10]
Know Your Customer	A process of identifying and verifying the identity of a person or an entity.	International Journal of Scientific and Research Publications [11]
KYC	Know Your Customer	
Lifecycle Service Orchestration	Open and interoperable automation of management operations over the entire lifecycle of Layer 1, Layer 2 and Layer 3 Data Services. This includes fulfilment, control, performance, assurance, usage, security, analytics and policy capabilities, over all the network domains that require coordinated management and control in order to deliver the service.	MEF 55 [10]
LSO	Lifecycle Service Orchestration	MEF 55 [10]
LSO Reference Architecture	A layered abstraction architecture that characterizes the management and control domains and entities, and the interfaces among them, to enable cooperative orchestration of Data Services.	MEF 55 [10]**Error! Reference source not found.**
LSO Sonata IRP	An IRP through which a Buyer and Seller exchange commercial and operational information pertaining to services.	MEF 55 [10]**Error! Reference source not found.**
Master Service Agreement	A legal contract that defines the General Terms and Conditions governing the entire scope of services between the parties to the agreement.	Section 7.10.1 of this document
MSA	Master Service Agreement	Section 7.10.1 of this document
Omni	A short name for an Omni-Lateral Ledger. Derived from Latin word *omnis* meaning "All".	Section 11.1 of this document

Term	Definition	Reference
Omni-Lateral Ledger	Repository whose information is shared with all Participant ICT-SPs.	Section 9.5.3 of this document
Order	Request from Buyer to Seller for service based on Quote provided by Seller	Section 10.2 of this document
Order Form	Integral part of the legal and commercial commitment between the Seller and the Buyer whereby the Seller commits to deliver the service instance stipulated in the Order Form and the Buyer commits to pay the Seller the amounts stipulated in the Order Form.	Section 7.10.3 of this document
Ordering	Service lifecycle phase in which a Buyer places an order for a service with a Seller based on a quote received from the Seller either through an inquiry/quote phase or based on a valid rate sheet.	Section 10.2 of this document
Operational Support Systems	A term used to describe the information processing systems used by operators to orchestrate and manage their communications networks.	Global Market Insights, Inc. [12]
OSS	Operational Support Systems	Global Market Insights, Inc. [12]
Participant ICT-SP	An ICT-SP that is participating in a Supply Chain	Section 7.4 of this document
Payee/Receiver	An entity that requests and/or receives a payment from another entity.	MEF 74 [2]
Payer	An entity that pays or is requested to make a payment to another entity. This will typically be the same entity as the Buyer, though “Buy/Sell” typically refers to Services and Products while “Pay/Receive” typically refers to monetary exchange.	MEF 74 [2]
Payment	Transfer of monetary funds from Payer to Payee. A Payment may cover multiple Services or Products.	MEF 74 [2] [2]
Payment History/Payment Record/Payment Cycle Time	The duration from forwarding an invoice from Seller to Buyer until payment of same is received by the Seller. Example: Payment was received an average of 45 days after invoice date.	MEF 74 [2]
Payment Reputation	A metric representing the payment history of an ICT-SP including punctuality and accuracy of payments.	Section 10.6 of this document
Product Catalog	A ledger listing the products an ICT-SP can deliver. Product availability may vary depending on location and magnitude.	Section 8.1 of this document
Provisioning	A phase in the lifecycle of a data-on-demand service during which an order is fulfilled and implemented on the respective network components.	Section 10.3 of this document
Quote	Price for a service offered by a Seller to a Buyer.	Section 10.1 of this document
Rate	Monetary value applied to a unit of measurement of a service.	MEF 74 [2][2]
Rate Sheet	Table of rates for services.	MEF 74 [2]
Rating	Application of rate to usage records.	Section 10.5 of this document

Term	Definition	Reference
Reconciliation	The process of reaching agreement in case of a dispute.	MEF 74 [2][2]
Repository	Collection of data stored over time.	Section 7.9 of this document
SDN	Software Defined Network	ONF [13]**Error! Reference source not found.**
S-BUS	A functional block in Reference Architecture that handles a range of Seller-related ICT-SP activities as defined in Section 10 and elsewhere in the standard.	Section 9.1 of this document
SCO	Supply Chain Orchestrator	Section 9.2 of this document
Seller	An entity that sells a service to a Buyer of which it is an immediate downstream neighbor in the Supply Chain.	Section 7.4.2 of this document
Service Capability	A specific feature offered by a service. Examples include: Ability to preform a certain number of calculations per unit of time; Ability to transport a certain number of bits over a period of time; Ability to store a certain volume of data.	This document
Service Chain	A single composite service comprising one or more Service Elements.	Section 7.7 of this document
Service Chaining	The process of configuring and integrating multiple Service Elements to become a single composite service referred to as a Service Chain.	IETF RFC-7665 [14]**Error! Reference source not found.**
Service Delivery	The process of integrating different Service Elements and delivering them as complete service to the Buyer.	Section 10.3 of this document
Service Element	Component of a service. Examples include VM, Access E-Line, combination of the two etc.	Section 7.6 of this document
Service End-Point	A physical or virtual service element where a human or a machine interfaces with the service. Examples include: A compute resource where computations related to the service are performed; A physical device with a GUI where a user consumes or generates content related to the service;	This document
Settlement	The transfer of monetary funds between parties based on billing and reconciliation. The process of analysing the amount a Buyer is invoiced by the Seller, comparing the resource usage and the monetary amounts associated with use of the resource as per commercial agreement, identifying the differences between the Seller's records and calculations to those of the Buyer. The differences may be settled either automatically or manually through algorithms.	MEF 74 [2]
Service Level Agreement	The contract between the Subscriber and Service Provider specifying the service level commitments and related business agreements for a service.	MEF 10.4 [15]

Term	Definition	Reference
Service Lifecycle	Sequence of phases in the life of a service including Inquiry, Quote, Order, Billing and Change Management.	Section 10 of this document
SLA	Service Level Agreement	MEF 10.4 [15]**Error! Reference source not found.**
SLA Reputation	A metric representing the on-going performance of an ICT-SP network compared to its Service-Level commitments. The reputation is a score based on a moving average.	Section 10.6 of this document
SOAM	Service Operations, Administration, and Maintenance	MEF 17 [16]
Specific Terms and Conditions	Legal contract defining the terms and conditions governing a specific service between the parties.	Section 7.10.2 of this document
Stablecoin	A class of cryptocurrencies that attempts to offer value stability through pegging to a reserve asset such as a fiat currency or a commodity (e.g. gold).	This document
Storage	Act of transporting data through time.	Section 7.1.3 of this document
Supply Chain	Collection of ICT-SPs that in combination deliver one or more end-to-end data-on-demand services through ENNIs and bilateral agreements.	Section 7.3 of this document
Supply Chain Orchestrator	A functional block in Reference Architecture that handles a range of ICT-SP **externally**-oriented service lifecycle orchestration activities as defined in Section 10 and elsewhere in the standard.	Section 9.2 of this document
Trust Model	Collection of entities and processes that ICT-SPs rely on to help preserve security, safety and privacy of data and which is predicated on the use of a DLT implementation.	Section 6 of this document
UB	Upstream Bilateral Ledger	Section 9.5.2 of this document
Upstream Bilateral Ledger	Repository containing information that is shared with the Upstream Participant ICT-SP (Buyer)	Section 9.5.2 of this document
Upstream Participant ICT-SP	The Participant ICT-SP immediately upstream of the downstream Participant ICT-SP in the direction towards the originating customer.	Section 7.4 of this document
VM	Virtual Machine	

Table 1 Terminology and Abbreviations

4 Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (RFC 2119[17], RFC 8174 [18]) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

Items that are **REQUIRED** (contain the words **MUST** or **MUST NOT**) are labeled as **[Rx]** for required. Items that are **RECOMMENDED** (contain the words **SHOULD** or **SHOULD NOT**) are labeled as **[Dx]** for desirable. Items that are **OPTIONAL** (contain the words **MAY** or **OPTIONAL**) are labelled as **[Ox]** for optional**.**

A paragraph preceded by **[Cra]<** specifies a conditional mandatory requirement that **MUST** be followed if the condition(s) following the "<" have been met. For example, "**[CR1]<**[D38]" indicates that Conditional Mandatory Requirement 1 must be followed if Desirable Requirement 38 has been met. A paragraph preceded by **[CDb]<** specifies a Conditional Desirable Requirement that **SHOULD** be followed if the condition(s) following the "<" have been met. A paragraph preceded by **[Coc]<** specifies a Conditional Optional Requirement that **MAY** be followed if the condition(s) following the "<" have been met.

5 Numerical Prefix Conventions

This document uses the prefix notation to indicate multiplier values as shown in Table 2.

Decimal		**Binary**	
Symbol	**Value**	**Symbol**	**Value**
k	10^3	Ki	2^{10}
M	10^6	Mi	2^{20}
G	10^9	Gi	2^{30}
T	10^{12}	Ti	2^{40}
P	10^{15}	Pi	2^{50}
E	10^{18}	Ei	2^{60}
Z	10^{21}	Zi	2^{70}
Y	10^{24}	Yi	2^{80}

Table 2 Numerical Prefix Conventions

6 Introduction

A DLT-based Commercial and Operational Framework for data-on-demand services facilitates the near real-time creation of data services delivered through self-organizing, secure Supply Chains of interconnected Information and Communications Technology – Service Providers ("**ICT-SPs**").

The resulting Supply Chains deliver data-on-demand services to end customers directly served by one of the participating ICT-SPs in the Supply Chain. Applications supported by data-on-demand services use varying combinations of the connectivity, storage and compute capabilities of those services.

For readability, the term ICT-SP will be presented as "Service Provider" ("SP") throughout the remainder of this document, however the scope of this document covers all aspects of the ICT sector, including mobile operators, IoT operators, Cloud operators, Fixed line operators and Data operators, domestic and international, retail and wholesale.

Distributed ledger technology (DLT) is a digital system for recording the transaction of assets in which the transactions and their details are recorded in multiple places at the same time. Unlike traditional databases, distributed ledgers have no central data store or administration functionality.

In a distributed ledger, each node processes and verifies every item, thereby generating a record of each item and creating a consensus on each item's veracity. A distributed ledger can be used to record static data, such as a registry, and dynamic data, i.e., transactions.

This computer architecture represents a significant revolution in record-keeping by changing how information is gathered and communicated. [19]

This standard defines a commercial and operational framework which is independent of the service type/technology used. The purpose of this framework is enabling wholesale trading of data-on-demand services. The document includes a reference architecture that treats a single SP as a link in the automated Supply Chain. The automated Supply Chain is based on an automated recursive process where the originating customer requests a data service from its SP, which in turn, where required, requests wholesale data service from one or more of its downstream SP partners. The process continues until the Supply Chain successfully reaches all the required service end-points and service capabilities. A complete Supply Chain integrates all the required service end-points and capabilities to the originating customer. It should be noted that the Supply Chain in its entirety may not visible by any single entity in real-time. The participating SPs (including the SP that originates the Supply Chain as the result of a service request from an enterprise customer) in a Supply Chain only know the identities of their immediate upstream or downstream neighbors. For this reason, a Supply Chain in this document can be a segment of a larger Supply Chain but is not referred to as a sub-segment.

The abstract architecture builds on MEF LSO Reference Architecture (MEF 55) using several of its concepts and constructs.

This standard also defines processes that operate in the defined reference architecture for the following service lifecycle steps: quote; order; service delivery; fault management; billing; change management.

The framework defined in this standard is predicated on a distributed authority trust model which in turn requires the use of Distributed Ledger Technology (DLT). Therefore, this standard defines the use of DLT, unified Information Models and unified processes in said commercial and operational framework.

The document is divided into four main sections:

- Key concepts and definitions.
- High-level functional requirements from a commercial and operational framework that manages automated supply-chains.
- The reference architecture for the framework.

- Processes that describe the intra-SP and inter-SP processes for each service lifecycle stage.

The document has identified three abstract types of ledgers required for the framework:

- Internal (used by a single SP)
- Bilateral (used by a pair of SPs that share an ENNI and LSO Sonata IRP)
- Omni-Lateral (Shared by all SPs participating in the DLT-based ecosystem).

7 Key Concepts and Definitions

This section provides definitions, key concepts, and overviews of the components of a DLT-based commercial and operational framework for automated data-on-demand services.

7.1 Data Service

A data service is a combination of Data Connectivity, Compute, and Storage functions. Data services vary by multiple factors related to each of said functions.

Data services are operated by one or more SPs and are offered to consumers. Multiple SPs may be involved in a Supply Chain where each of the SPs contributes certain elements of the complete data service.

7.1.1 Data Connectivity

Data Connectivity is the transportation of data through space regardless of the type of data, the protocol or the physical means of transport. It is commonly also referred to as Connectivity. Factors affecting connectivity include:

- Location and number of end-points.
- Bandwidth between pairs of end-points.
- Service-Level-Guarantees between each pair of end-points.
- Type of transport (CE, IP, L1 etc.)
- Underlying transmission technology (Copper, Fiber, Coax, RAN etc.).
- Security and encryption.

7.1.2 Data Compute

Data compute is the manipulation of data or taking action based on data using a computing resource. It is commonly also referred to as Compute. Factors affecting compute include:

- Type of CPU
- Number of Cores
- Amount of RAM
- Virtualization platform (e.g. Kubernetes)
- Operating system
- Application software.
- Volume and type of integrated storage
- Network connectivity (number of network ports, type of ports, bandwidth per port)

7.1.3 Data Storage

Data storage is the transportation of data through time. It is commonly also referred to as Storage. Factors affecting storage include:

- Storage space (allocated, used)
- Storage type (RAID type, Spinning discs, SSD)
- Network connectivity (type, speed)
- Access method and speed (direct connect, NAS)
- Duration of storage
- Distribution or replication of data across multiple devices and locations.
- Security and encryption.

7.2 Data-On-Demand Service

A data-on-demand service is a specific case of a data service combining one or more data service components – namely compute, storage and connectivity. Data-on-demand (DoD) services are data services that are ordered, activated, operated, billed and settled rapidly.

A data-on-demand service is implemented over a Supply Chain and may span multiple SPs.

7.3 Supply Chain

A Supply Chain is the sum of the Customer and the set of one or more SPs that in combination deliver one or more end-to-end data-on-demand services to the Customer through ENNIs and bilateral agreements. Each entity in the Supply Chain only knows the identities of its immediate neighbor(s), and only transacts with the same. A supply chain is always viewed in the context of a given service. A different end service may have a different supply chain even if some or all participating SPs participate in both supply chains. Likewise, an SP that is a Buyer in one supply chain may be a Seller in a different supply chain, even with the same partner.

[R1] A Supply Chain **MUST** contain at least one Buyer and one Seller.

[O1] A Supply Chain **MAY** access multiple geographical and non-geographic service end-points and service capabilities.

7.4 Participant SP

The Participant SP is an entity that participates in a Supply Chain by actively contributing one or more elements of a data-on-demand service.

7.4.1 Buyer

An immediate upstream neighbor in the Supply Chain which buys services from another (downstream) SP is the Buyer. Note that a Buyer in one Supply Chain context may be a Seller in another Supply Chain context.

7.4.2 Seller

An immediate downstream neighbor in the Supply Chain which sells services to the Buyer is a Seller. The Seller is accountable to the Buyer for all the service elements it sells to the Buyer, including service elements sourced externally by the Seller. Note that a Seller in one Supply Chain context may be a Buyer in another Supply Chain context.

[R2] A Participant SP **MUST** have at least one ENNI with at least one other Participant SP and/or a UNI with q Customer.

[R3] An SP in the Supply Chain **MUST** be a Buyer and/or a Seller.

[R4] A Buyer **MUST** be an SP or an enterprise customer of an SP

[R5] A Buyer **MUST** source any externally-sourced Service Elements only from a Seller.

[O2] A Buyer **MAY** buy from multiple Sellers.

[R6] A Seller **MUST** be an SP.

[R7] A Seller **MUST** provide one or more Service Elements of the overall service to the Buyer.

[O3] A Seller **MAY** also be a Buyer.

Examples of participation in a Supply Chain:

1. SP-B has ENNIs with both SP-A and SP-C (who do not have an ENNI with each other) and provides a Transit-E-Line service between them.

2. SP-D provides an E-Access service to SP-E.

3. SP-F has an ENNI with SP-G and offers a compute and storage service that is connected through an E-LAN service to SP-G.

7.5 Commercial Agreements and ENNIs

Each pair of neighboring SPs in a Supply Chain will have an ENNI and a Commercial Agreement between them. Such a Commercial Agreement may allow for buying services, selling services or both. More information on the resulting documents are described in Section 7.10.

[R8] Each bilateral pair of Participant-SPs MUST have an ENNI and a corresponding commercial agreement.

[R9] A Participant SP **MUST NOT** trade data services with SPs with which they do not have an ENNI and a corresponding commercial agreement.

[R10] Each service end-point and/or service capability **MUST** be connected to a Participant SP through a UNI or an ENNI.

7.6 Service Element

A Service Element is a component of the service that is offered by a Seller to its Buyer. Examples of Service Elements include a VM in a cloud, an Access E-Line service, an E-Transit service, a combination of the above and more.

[O4] A Service Element **MAY** include other Service Elements that are chained into a Service Chain.

7.7 Service Chain

The Service Chain is the sum of all the Service Elements provided by a Participant SP and its Sellers (if any) connected in a manner and a topology that enable the required functionality of the data service. The Service Chain may be linear or branched.

Example of Service Chain and Service Elements

An enterprise customer buys from SP-A an E-Tree service that includes 3 geographical locations (L1, L2, L3) and non-geographic cloud storage (C1). Geographic locations L1 and L2 are accessible through SP-A and SP-B respectively. Geographic location L3 is accessible through SP-C with which neither SP-A or SP-B have an ENNI. SP-D has an ENNI with SP-B (“ENNI-BD”) and SP-C (“ENNI-DC”). SP-B has an ENNI with SP-E (“ENNI-BE”) that offers non-geographic cloud storage which none of the other SPs can offer. SP-A and SP-B have an ENNI (“ENNI-AB”).

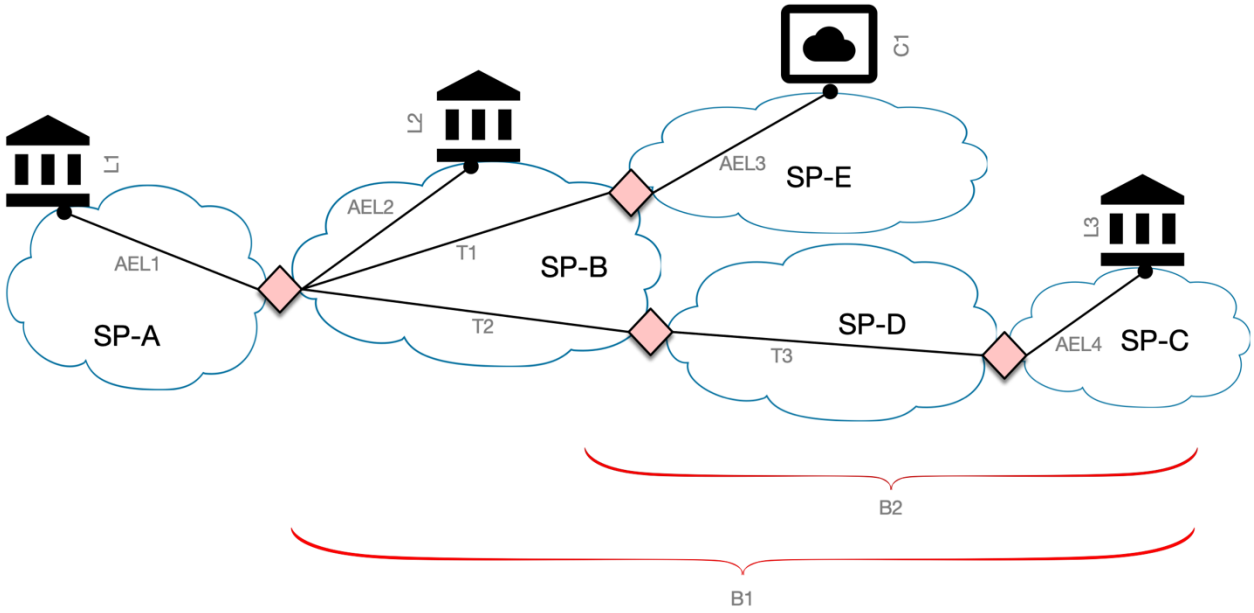


Figure 1 Wholesale Supply Chain and Service Elements

In this example SP-A provides access to L1, which is a Service Element, and will buy the remaining Service Elements (L2, L3, C1) from SP-B as a bundle (B1). SP-B will break that B1 Service Element into smaller Service Elements, namely – L2, L3 and C1. SP-B will provide access to L2, will buy the C2 Service Element from SP-E, and will buy the L3 Service Element from SP-D, who will add an E-Transit Service Element (T1) and buy the L3 Service Element from SP-C. SP-D bundles L3 and T1 into a bundle (B2) and sells B2 to SP-B, who bundles B2, C1 and L2 into B1 and sells it to SP-A, who bundles B1 and L1 into the E-TREE service sold to the enterprise customer.

L1, L2, L3, C1, T1, T2, T3, AEL1, AEL2, AEL3, AEL4, B1, B2 are all Service Elements.

B1 is a Service Element that includes additional Service Elements (L2, L3, C1), and in order to deliver L3, additional Service Elements (B2, T1) are created.

The following table shows the supply-chain flow:

Buyer	Seller	Buyer inquires	Seller Internal Delivery	Seller External Delivery (Buys from downstream Sellers)
Enterprise	SP-A	Connectivity between 4 enterprise sites (L1-4) + cloud service (C1)	Access E-Line (AEL1) from ENNI-AB to L1	From SP-B Bundle (B1) = O-Tree from E-NNI-AB to L2, L3, C1.
SP-A	SP-B	Bundle (B1) = O-Tree from E-NNI to L2, L3, C1.	Transit E-Line (T1) from ENNI-AB to ENNI-BE + Transit E-Line (T2) from ENNI-AB to ENNI-BD + Access E-Line (AEL2) from ENNI-AB to L2	From SP-E: Access E-Line from ENNI-BE to C1. From SP-D: Access E-Line from ENNI-BD to L3 (implemented by SP-D as Bundle B2 = E-Transit (T3) from ENNI-BD to ENNI-DC + Access E-Line from ENNI-DC to L3 bought from SP-C)

SP-B	SP-E	Connectivity from ENNI-BE to Cloud service C1 + Cloud Servcie C1	Access E-Line (AEL3) from ENNI-BE to C1 + Cloud service (C1)	
SP-B	SP-D	Connectivity from ENNI-BD to 1 site L3	Transit E-Line (T3) ENNI-BD to ENNI-DC	Access E-Line (AEL4) from ENNI-DC to L3
SP-D	SP-C	Connectivity from ENNI-DC to L3	Access E-Line (AEL4) from ENNI-DC to L3	

Table 3 - Example of a Wholesale Supply Chain flow

7.8 Service Lifecycle

The Service Lifecycle is the sequential set of actions through which a service transitions from the initial expression of interest by the Buyer potentially through its being ordered, delivered, maintained, billed and eventually terminated.

The detailed processes behind each stage of the Service Lifecycle are defined in Section 10 of this standard.

7.9 Repository

The Repository is the collection of information relating to the Service and its Service Lifecycle. Such information can be stored in different Repositories which differentiated by their access permissions, visibility and replication. The types of Repositories for use in the DLT-based commercial and operational framework are defined in Section 9 of this standard.

7.10 Commercially and Legally Binding Documents

Prior to establishing a business and operational environment for the trade of data-on-demand data services Participant SPs sign documents that commercially and legally bind the pair of Buyer and Seller ("the parties"). Such documents may be presented as a combination of one or more of the following: Master Service Agreement, Specific Terms and Conditions and Order Form.

[R11] Participant SP **MUST** sign commercially and legally binding documents with at least one other Participant SP.

7.10.1 Master Service Agreement

A Master Service Agreement ("MSA") is a legal contract that defines the General Terms and Conditions governing services between the parties to the agreement. The MSA will typically govern all services and will include sections defining the Governing Law, the Legal Jurisdiction, Indemnity, Liability, Force Majeure, Charges and Taxes, Term, Obligations, definitions of Locations and Equipment, definitions of Services and Termination thereof as well as any other terms and conditions that apply to the entire scope of commercial and legal relations between the parties.

[O5] There **MAY** be an MSA between the Buyer and the Seller.

[O6] The MSA **MAY** be replaced by Specific Terms & Conditions documents for specific services.

[CR1]<[O5] There **MUST** be only one MSA between a Buyer and a Seller.

7.10.2 Specific Terms and Conditions

The Specific Terms and Conditions ("Specific T&C") is a legal contract that defines the terms and conditions governing a specific service between the parties. In the absence of an MSA or additional agreements, the Specific T&C constitutes the entire understanding of the parties related to the service.

[D1] Each service type **SHOULD** have its own Specific T&C document.

[O7] Specific T&C **MAY** include its own Service Level Agreement (SLA).

[O8] Specific T&C **MAY** define, in addition to an MSA, any terms, conditions and definitions that are specific to the service type.

[CR2]<[O8] Specific T&C **MUST** override the MSA in case of conflict between the two documents.

7.10.3 Order Form

An Order Form refers to a specific service instance and includes operational and commercial details pertaining to that specific service instance. The Order Form is an integral part of the commercial and legal commitment between the Seller and the Buyer whereby the Seller commits to deliver the service instance stipulated in the Order Form and the Buyer commits to pay the Seller the amounts stipulated in the Order Form. An Order Form is an abstract construct representing the mutual commitments of the Buyer and the Seller. In an automated ecosystem it will likely take the form of an electronic record resulting from, for example, pressing the "place order" or "start service" button in a portal.

[R12] An Order **MUST** be accompanied by an Order Form.

[O9] An Order Form **MAY** be represented as an electronic record.

[R13] An Order Form **MUST** be signed where the definition of a signature is stated in the MSA and/or Specific T&C.

Example
The Buyer and Seller may agree that a signed Order Form requires a signed original paper or they may agree that an Order Form can be digitally signed or, as would be expected in an automated DLT-based data-on-demand service environment, they agree that the Order Form will be an undisputed record that contains the required information and is stored in the Bilateral Ledger.

8 High Level Functional Requirements

This section states the commercial and operational functionalities required from a Participant SP.

8.1 Functional Requirements from Participant SPs

[R14] A Participant SP **MUST** support all the bilateral Supply Chain business processes as specified in Section 10 of this standard.

[R15] A Participant SP **MUST** support bilateral Supply Chain business processes in a manner that is independent of the implemented service type, internal architecture and internal processes (e.g. catalogs of inventory, product catalogs, service chaining etc.)

[R16] A Participant SP **MUST** enable sharing via Repositories of specific information with all participants in the Ecosystem (e.g. SLA reputation score, payment reputation score).

[R17] A Participant SP **MUST** support the Reference Architecture defined in Section 9 of this standard.

[R18] A Participant SP **MUST** support MEF LSO Sonata in order to buy a service from a Seller.

[R19] A Participant SP **MUST** support MEF LSO Sonata in order to sell a service to a Buyer.

An ability of a Participant SP to buy services through a MEF Sonata IRP does not necessarily imply ability to sell services through a MEF LSO Sonata IRP and vice versa.

[D2] A Participant SP **SHOULD** comply with all the Service Lifecycle processes defined in Section 10 of this standard.

[R20] A Participant SP **MUST** publish their conformance with the standards in Section 10 of this standard on the Omni-Lateral Ledger.

[D3] A Participant SP **SHOULD** support decomposition of Orders into smaller Service Elements.

[CR3]<[D3] A Participant SP **MUST** decompose Orders into smaller Service Elements while preserving the service requirements in order to sell a service to the Buyer.

[R21] A Participant SP **MUST** support Billing granularity (i.e. grouping on a per service instance basis or detailed on an element or sub-elemental level) mutually agreed with the Buyer.

[R22] A Participant SP **MUST** support SLA credits granularity (i.e. grouping on a per service instance basis or detailed on an element or sub-elemental level) mutually agreed with the Buyer.

8.2 Service Lifecycle Processes

[R23] During the Quote process the Buyer **MUST** state the maximum number of SP hops allowed to be offered by the Seller.

[R24] During the Quote process the Seller **MUST** state the number of SP hops involved in the Quote.

[R25] A Participant SP **MUST** record on the Bilateral Ledger a pseudo-anonymous map of the Supply Chain in compliance with AML and KYC.

A pseudo-anonymous map is the list of Participants in a Supply Chain downstream of a Seller implemented without disclosure of identifying details. This allows enforcement of conformance with regulations, hop count and additional legal and technical requirements as defined in the Inquiry without disclosure of confidential information. The map is recorded on the Upstream Bilateral Ledger and draws some of the information from the Omni Ledger. Example: (X) (Y) (Z) implies that hop count is 3 and the Buyer can verify from the Omni ledger that none of these downstream participants traverse a rogue state in a blacklist.

8.3 DLTs and DLT Abstraction Layers

[R26] DLTs and DLT Abstraction Layers **MUST** support bilateral and omni-lateral contracts.

[R27] DLTs and DLT Abstraction Layers **MUST** be able to transact bilateral transactions at the rate agreed by the parties to the Bilateral Ledger.

[R28] DLT Abstraction Layers **MUST** Support omni-lateral ledgers made up of multiple DLTs synchronized at an interval set by an external governance entity.

The agreement on the governance entity and its method of achieving interval synchronization consensus is beyond the scope of this document. An example of such a governance structure is the GLF CBAN initiative [20].

[R29] DLTs and DLT Abstraction Layers **MUST** support SLA reputation per product type as defined in Section 10.6 (Reputation Management).

[R30] Participant SP **MUST** maintain its own Reputations in the Omni-Lateral Ledger through the DLT consensus mechanism.

[R31] DLTs and DLT Abstraction Layers **MUST** support Commercial Reputation as defined in section 10.6 (Reputation Management).

[R32] The Buyer and Seller **MUST** agree on the implementation of the DLT for their Bilateral Ledger.

8.4 Applications

[R33] The Participant SP’s application/s providing the Service Lifecycle functionality MUST operate independently of the implementation of the underlying DLT.

8.5 Abstraction and Functional Elements

Figure 2 describes the abstractions between applications and DLTs.

The DLT abstraction is obtained through [R33]. The Participant SP’s application abstraction is derived from the MEF LSO Sonata definitions.

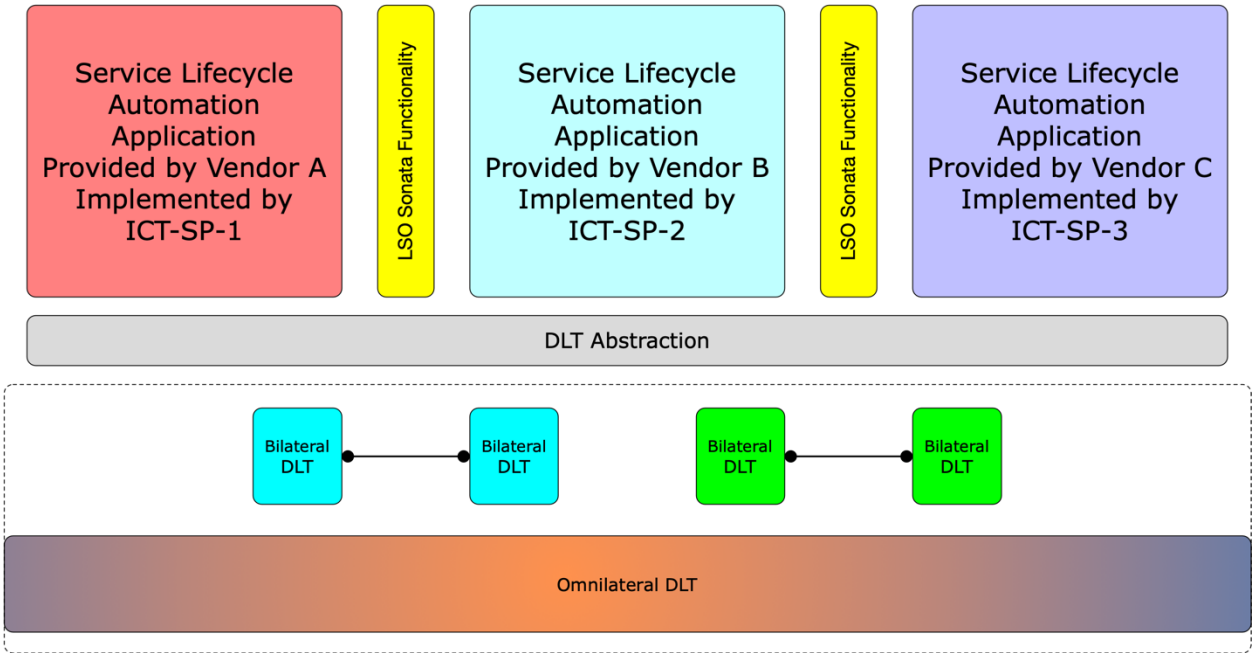


Figure 2 DLT and SP Abstraction

9 Data-on-Demand Commercial and Operational Reference Architecture

Figure 3 presents the Reference Architecture for the Supply Chain of SPs.

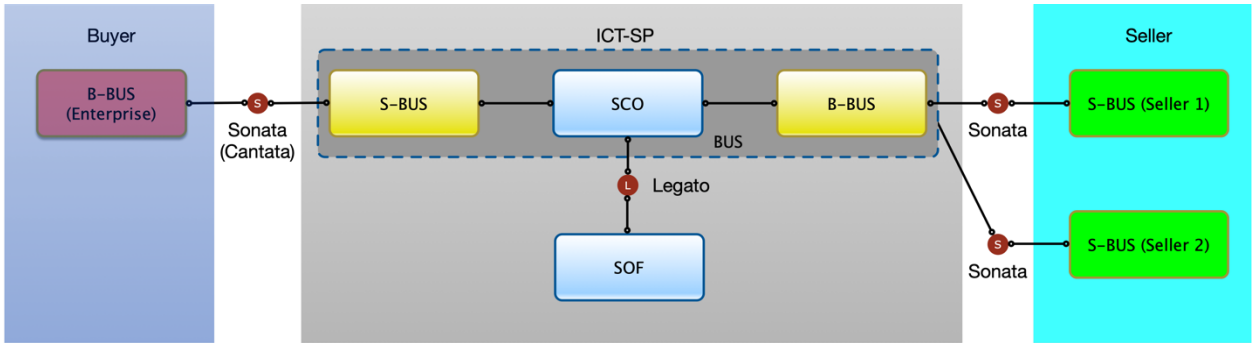


Figure 3 Automated Data-on-Demand Commercial and Operational Reference Architecture

The fundamental elements of the Supply Chain are the Participant SP (Section 7.4), its upstream neighbour SP (Buyer, Section 7.4.1) and its downstream SP(s) (Sellers, Section 7.4.2) together with the four functional blocks – S-BUS, SCO, SOF and B-BUS within each SP and the four Repositories (INT, UBL, DBL and Omni). The upstream and downstream neighbors (the two Buyer/Seller pairs) are specific to a Supply Chain. The same actors may play different Buyer/Seller roles in other Supply Chains.

9.1 S-BUS

S-BUS is the Selling functionality of an SP. Each Participant SP participates in a Supply Chain in order to sell data services to a customer. That customer may be an enterprise at the beginning of the Supply Chain or another SP. S-BUS handles all the commercial and business interactions with the upstream neighbour via the LSO Sonata/Cantata IRPs. It also records and reads information from one or more of the Repositories described in Section 9.5.

S-BUS communicates internally with SCO and externally with the B-BUS (Buying functionality) of the SP's upstream neighbour.

9.2 SCO

SCO is the Supply Chain Orchestration Functionality. Its responsibilities include decomposition of Inquiries from a Buyer (upstream SP) for a service into Service Elements, determining which of those Service Elements can be sourced internally, design of a solution, service activation through chaining of internally and externally-sourced Service Elements, measuring performance and maintaining SLA and financial score, and coordinating fault recovery. In the event that SCO determines that it cannot source all the required Service Elements internally, it will determine what to try to source externally. It also records and reads information from one or more of the Repositories described in Section 9.5.

SCO communicates with all functional blocks of the SP (S-BUS, B-BUS and SOF).

9.3 B-BUS

B-BUS is the Buying functionality of an SP. It handles procurement from Sellers (downstream SPs) to source Service Elements that are required for a service, but cannot be sourced internally within the SP. It also records and reads information from one or more of the Repositories described in Section 9.5.

B-BUS only communicates internally with SCO and externally with one or more S-BUSs of the SP's downstream neighbour(s).

9.4 SOF

SOF is the Internal Orchestration Functionality. It orchestrates the lifecycle of internally-sourced Service Elements. It also records and reads information from one or more of the Repositories described in Section 9.5.

SOF only communicates with SCO among the four functional blocks of the Reference Architecture.

The processes involving each of these functional blocks are set out in detail in Section 10.

[R34] A Supply Chain **MUST** be an implementation of the DLT-Based Commercial and Operational Reference Architecture.

[R35] A Supply Chain **MUST** be implementable without the need for any third party not shown in the Reference Architecture depicted in Figure 3 .

[R36] A Supply Chain **MUST** provide bilateral transparency of information between neighboring SPs while protecting their private information.

[R37] A Supply Chain implementation MUST provide SLA and commercial reputation management while disclosing identity of Supply Chain participants only between immediate neighbors in the Supply Chain.

[R38] A Supply Chain implementation MUST provide real-time inventory and prevent "double spend/commit" on resources.

[R39] A Supply Chain implementation **MUST** provide performance monitoring and reporting per the terms of the Service Level Agreement.

[R40] A Supply Chain implementation **MUST** provide auditability of service lifecycle transactions.

[R41] A Supply Chain implementation **MUST** support calculations of mark-up, credit and any additional commercial factors that may affect the amounts due by Buyer to Seller.

[R42] A Supply Chain implementation **SHOULD** be capable of transparently handling a sufficient number of commercial contingencies so that it provides near real-time automation.

[R43] A Supply Chain implementation **SHOULD** offer managed visibility of information across multiple SPs.

[CR4]<[R43] The participants in a Supply Chain **MUST** agree on the information visibility on a per Service Chain basis.

9.5 Data Ledgers

Data ledgers must support the following levels of visibility:

9.5.1 Internal

Internal ledgers contain information that will be used internally by the SP and is not shared externally with other parties. These ledgers are marked as "**INT**" in the workflow diagrams and tables.

9.5.2 Bilateral

Bilateral ledgers are shared between Buyer-Seller pairs and are used to exchange commercial and operational information related to all bilateral services bought/sold between each pair. The nature of bilateral trade is that two parties may buy and sell to/from each other interchangeably. Each Bilateral Ledger therefore has two aspects: When the bilateral partner is a Buyer the bilateral ledger is used to sell services to it upstream and is viewed as an Upstream Bilateral Ledger, and when the bilateral partner is a Seller the bilateral ledger is used to buy services from it downstream and is thus viewed as a Downstream Bilateral Ledger. Those are two aspects of the same Bilateral Ledger.

9.5.2.1 Upstream Bilateral Ledger (UBL)

An aspect of a Bilateral Ledger that contains information which is shared between the ICT-SP and the Buyer (upstream) ICT-SP or enterprise customer. These ledgers are marked as "**UBL**" in the workflow diagrams and tables.

9.5.2.2 Downstream Bilateral Ledger (DBL)

An aspect of a Bilateral Ledger that contains information which is shared between the ICT-SP and a Seller (downstream) ICT-SP. These ledgers are marked as "**DBL**" in the workflow diagrams and tables.

9.5.3 Omni-Lateral

An Omni ledger contains information that is shared with all SPs in the ecoystem and is labeled "Omni" in the workflow diagrams and tables.

[O10] The same information can serve different purposes and **MAY** be stored in more than one of the above ledgers.

The following diagram illustrates the three types of ledgers (Internal, Bilateral, Omni-Lateral) and the relation between UBL and DBL. The information stored in such ledgers is described in section 10.

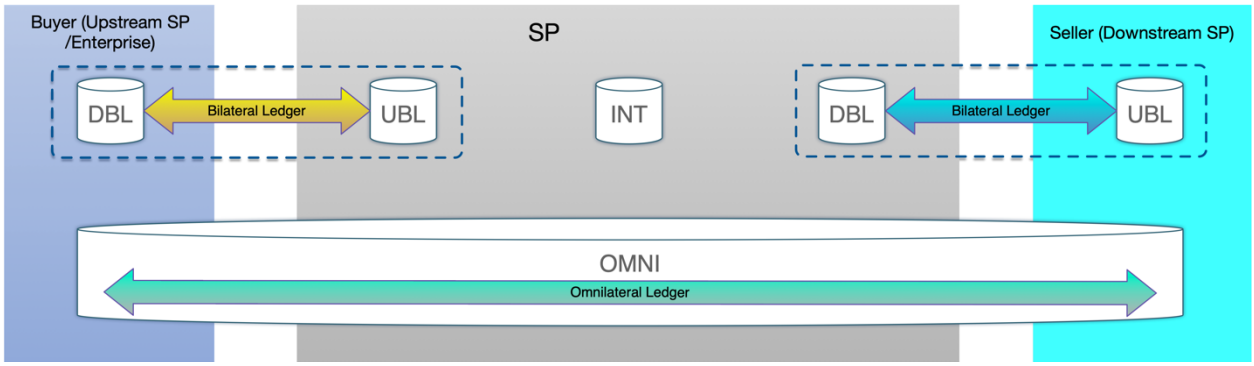


Figure 4 Data Ledgers Reference Architecture

10 Service Lifecycle Processes

This section provides detailed processes and actions, in and between the functional blocks defined in the Reference Architecture, for each stage of the service lifecycle.

10.1 Pre-Order

The Pre-Ordering phase is a collection of processes that occur prior to an Order being placed. Those include Inquiry of availability, feasibility and request for a Quote.

[R44] An Inquiry **MUST** include technical, operational and commercial requirements as specified in the relevant MEF product specifications including the relations and dependencies between different elements of the requirement.

Examples of details included: Locations, Bandwidth, QoS, VNF details (CPU, RAM, Storage), Target delivery lead time, Target price, Target SLA performance.

10.1.1 Inquiry and Quote Process diagram

The diagram below shows the Pre-Ordering processes. This is followed by a textual description of the process steps.

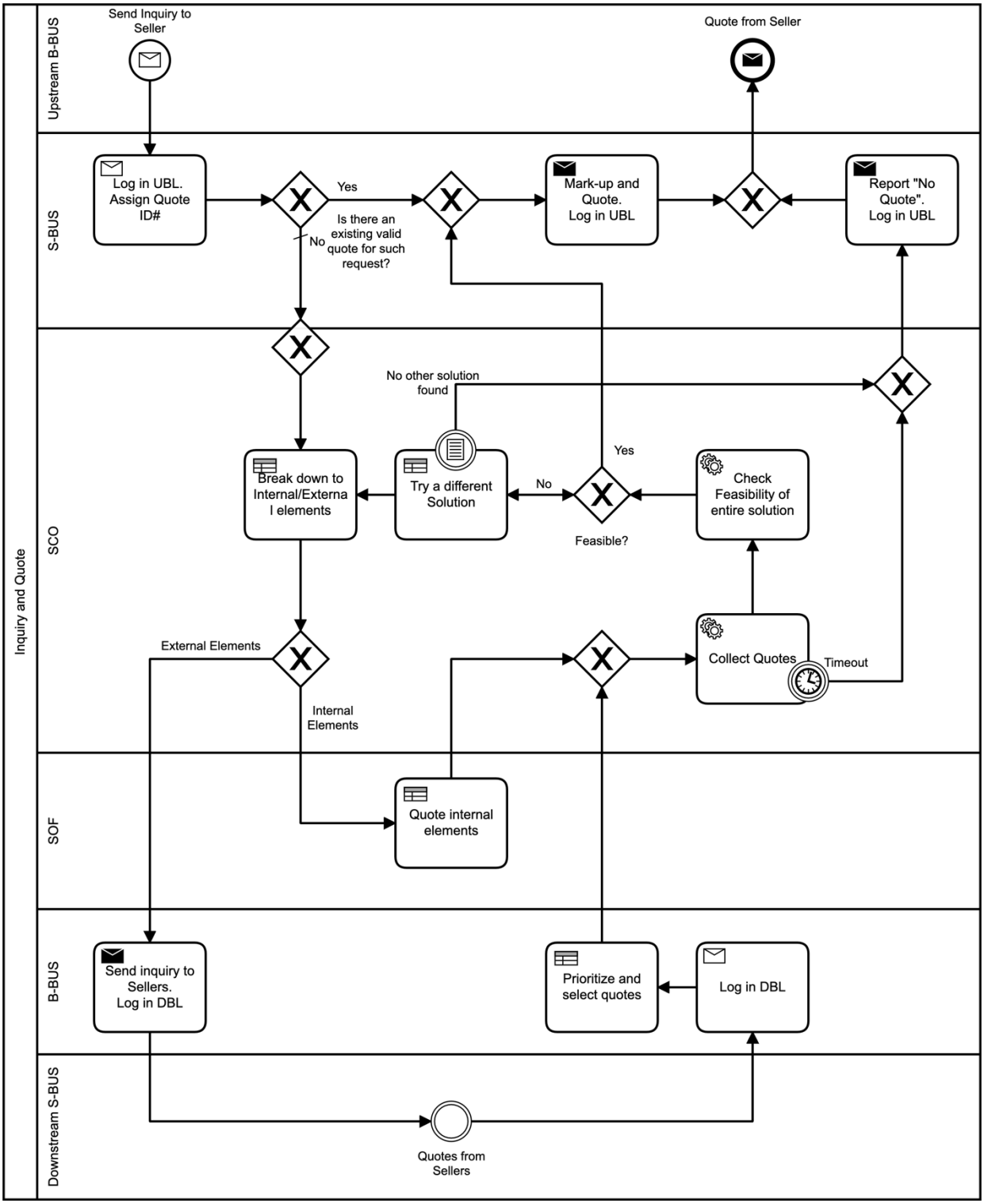


Figure 5 Inquiry and Quote Process

10.1.2 Inquiry and Quote Process

The following describes the steps from the point of view of the SP in its interactions with the Buyer upstream in the chain and the Seller(s) immediately downstream in the chain.

1. When SP receives an Inquiry from the Buyer, it either responds with a Quote or an 'Unable to Quote' response.

    [R45] S-BUS **MUST** respond to all Inquiries.

    [R46] S-BUS response to Buyer **MUST** be with one of the following: Quote or 'Unable to Quote' response.

    [D4] If Buyer specifies a Response Window, S-BUS **SHOULD** respond within the Response Window.

    [R47] The Service Lifecycle Quote process **MUST** prevent request loops where a request for Quote for a Service Element is being sent to a Seller that has received that same request elsewhere in the Supply Chain.

    [R48] The identities of all upstream Buyers in the Supply Chain **MUST** be included in a Request for Quote in the form of a pseudo-anonymous list.

An example to [R48] would be a list of identities that includes X, Y and Z received in Request for Quote by J. So J knows that it must avoid sending an Inquiry to X, Y or Z.

    [D5] Participant SP **SHOULD** use the pseudo-anonymous list resulting from [R25] and [R48] to identify potential Sellers that are to be avoided.

2. Buyer sends contents of Inquiry to S-BUS across LSO Sonata/Cantata.

    [R49] Inquiry **MUST** include mandatory information for Quote as specified in related MEF standards for that service for the following categories: Service attributes; location attributes; performance objectives.

    [O11] The Inquiry **MAY** be structured to enable decomposition into multiple Service Elements (e.g. multiple sites; connectivity and cloud) and describe relations and dependencies between those Service Elements (e.g. Service Chain sequence).

    [O12] The Inquiry **MAY** include dates and timelines for service activation.

    [R50] The Inquiry **MAY** include the Buyer's reference Inquiry ID.

3. S-BUS records the request, identifies similar requests from other Buyers, and sends the request to SCO.

    [R51] SP **MUST** record receipt of the Inquiry in the Upstream Bilateral Ledger and assign at least one unique ID.

    [O13] SP **MAY** assign multiple IDs for complex Inquiries which include multiple Service Elements.

    [O14] SP **MAY** check for existing Quotes for Inquiries with identical characteristics in which case SP MAY repurpose such Quotes to the Buyer with the appropriate commercial and operational considerations (e.g. resources are still available; apply different markup).

4. SCO decomposes the Inquiry into actionable Service Elements and queries SOF on its ability to deliver each Service Element.

[O15] SCO **MAY** decompose the Inquiry into actionable Service Elements.

[R52] SCO **MUST** query SOF its ability to deliver each Service Element in the Inquiry.

[R53] SOF **MUST** respond to each inquiry from SCO in the form of YES or NO. If YES, then it must include operational and commercial attributes (e.g. cost; time to deliver; bandwidth limitations etc.)

[R54] SCO **MUST** record all responses from SOF.

5. SCO sends all information on all undeliverable items (as well as, at their discretion, other elements that may have been sourced internally) to B-BUS for external procurement from Sellers.

[O16] SCO **MAY** generate an Inquiry to Sellers via B-BUS for some or all of the Service Elements in the Buyer Inquiry.

6. B-BUS then generates Inquiries to its potential Sellers downstream in the Supply Chain for the Service Elements that are not available internally to the SP according to the requirements in Step 1 in this process. The Sellers will respond according to the requirements in Step 2 of this process.

[R55] B-BUS **MUST** generate an Inquiry with at least one Seller for each Service Element requested by SCO.

[D6] B-BUS **SHOULD** consider lack of response within the Response Window from Sellers as 'Unable to Quote' response.

[O17] B-BUS **MAY** accept a Quote outside the Response Window.

7. B-BUS receives and collects responses from Sellers. B-BUS sorts the responses (per Inquiry) based on criteria such as Price, SLA, Lead-Time, Proximity of response to requested service.

[R56] B-BUS **MUST** record all responses from Sellers to its Inquiry on the respective Downstream Bilateral Ledgers.

8. B-BUS can choose which Quotes to prefer based on commercial considerations.

[D7] B-BUS **SHOULD** forward all Quotes to SCO.

[O18] In the event of multiple Quotes in response to an Inquiry from B-BUS, B-BUS **MAY** indicate to SCO that a Quote from a specific Seller is preferred based on commercial considerations.

9. SCO checks ability within a Response Window to integrate all Service Elements quoted in responses from SOF and B-BUS in a manner that meets requirements specified in Inquiry from the Buyer.

[R57] SCO **MUST** record all Quotes (both internal and external) and assess its ability to chain them into a Service Chain that meets the requirements specified in the Inquiry from the Buyer.

[R58] S-BUS **MUST** provide a Quote for a data service that is either (a) decomposed to its functional elements, each quoted individually, or (b) presented as a bundled quote that includes all functional elements.

[D8] If unable to Quote, and still within response window, SCO **SHOULD** attempt a different decomposition and return to step 4.

[D9] SCO **SHOULD** make a decision to Quote or respond 'Unable to Quote' within the Response Window.

10. S-BUS then responds to the Buyer according to Step 1 of this process.

[R59] S-BUS **MUST** respond to Inquiry from the Buyer with a response in accordance to decision of SCO.

[D10] If SCO specifies Quote response, S-BUS **SHOUD** calculate mark-up and send Quote to Buyer.

[R60] S-BUS **MUST** record response on the Upstream Bilateral Ledger with unique ID.

[O19] Quotes for complex orders **MAY** be grouped under a master Quote/Inquiry ID.

[R61] Quote **MUST** have a validity expressed in time with a timestamp.

10.1.3 Inquiry and Quote Data Management

The following diagram illustrates the flow of information between functionalities of the reference architecture (S-BUS, B-BUS, SCO, SOF) and the ledgers (UB, DB, INT, Omni) through the Inquiry and Quote process steps.

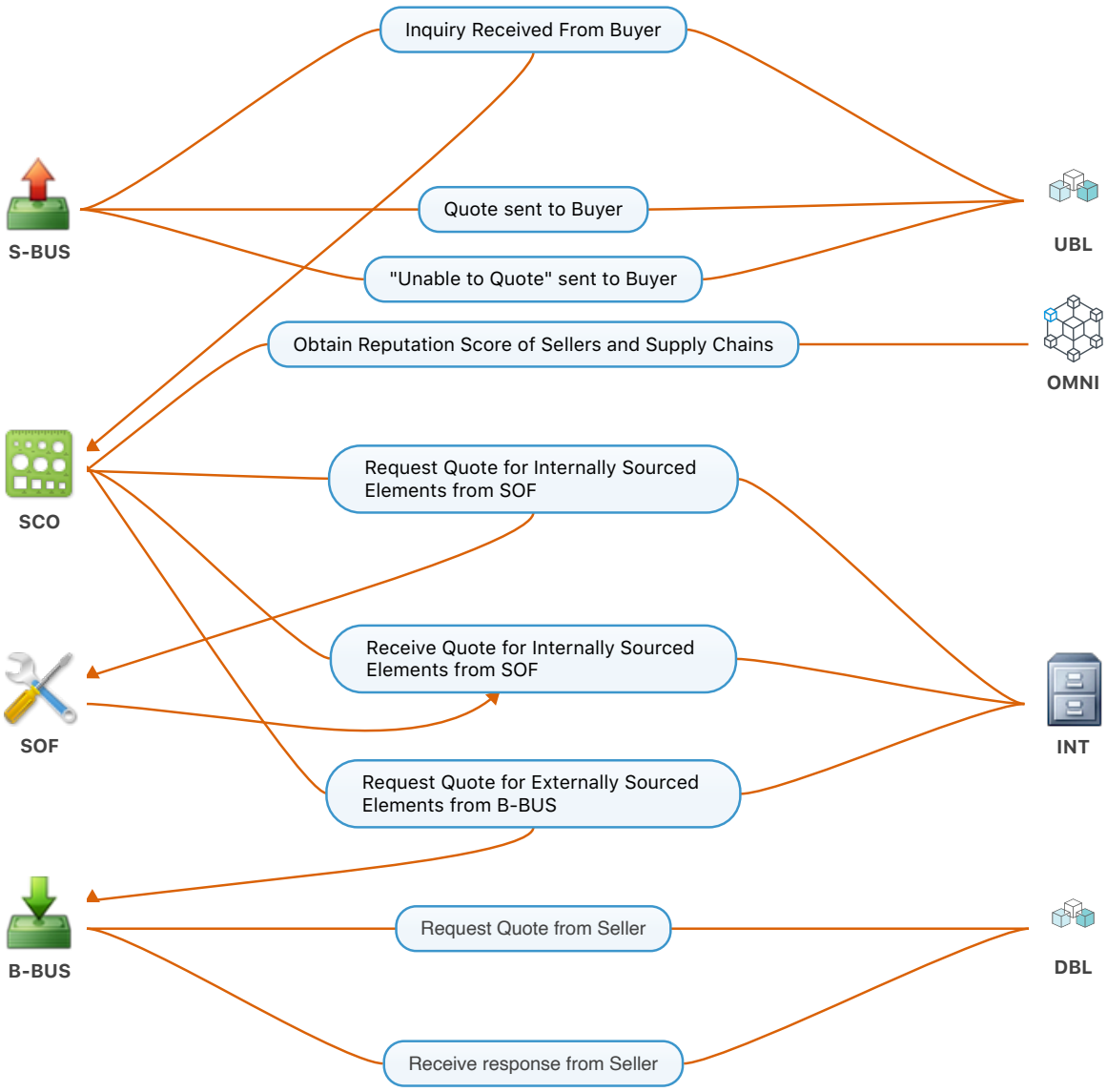


Figure 6 Inquiry and Quote Data Management

10.1.4 Inquiry and Quote Sequence Diagram

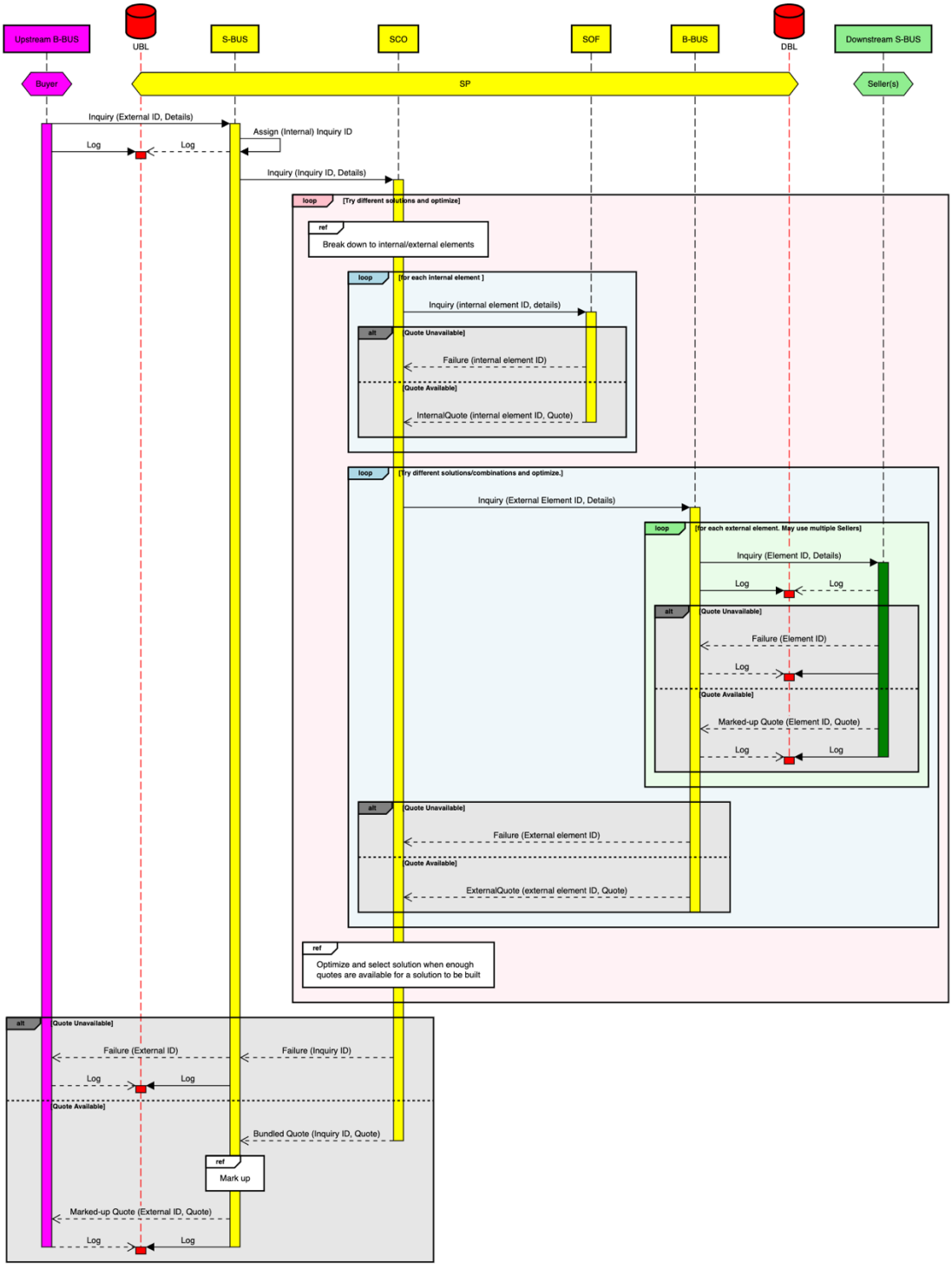


Figure 7 Inquiry and Quote Sequence Diagram

10.2 Order

10.2.1 Introduction

The Ordering phase begins when the Buyer places an Order for a service with a downstream SP (Seller). The Order MUST reference a quote ID that is received from the Seller during the Quote phase (as described in Section 10.1 above). The order MAY include the technical, operational and commercial requirements that were described in the Quote but MUST NOT change any of said details, otherwise a fresh Quote MUST be requested to accommodate any change. The Order, including per-instance and item details, is logged as a contract into the Bilateral Ledger between the respective SPs.

[R62] The Order **MUST** reference a quote ID that is received from the Seller during the Quote phase (as described in Section 10.1 above).

[O20] The Order **MAY** include the technical, operational and commercial requirements that were described in the Quote.

[R63] The Order **MUST NOT** change any of said details

[R64] A new Quote **MUST** be requested to accommodate any change in the event that a Quote changes details

The Order, including per-instance and item details, is logged as a contract into the Bilateral Ledger between the Buyer and Seller.

Orders are based on Quotes provided as a result of Section 10.1.

[D11] Orders **SHOULD** include any additional information that is required to deliver the service that was not provided during the Inquiry and Quote phase. Examples of such information would be: IP addresses, VLAN-ID and any other information that does not affect commercial or operational aspects.

The process results in the confirmation of receipt of the Order and the initiation of Service Delivery.

10.2.2 Order Process Diagram

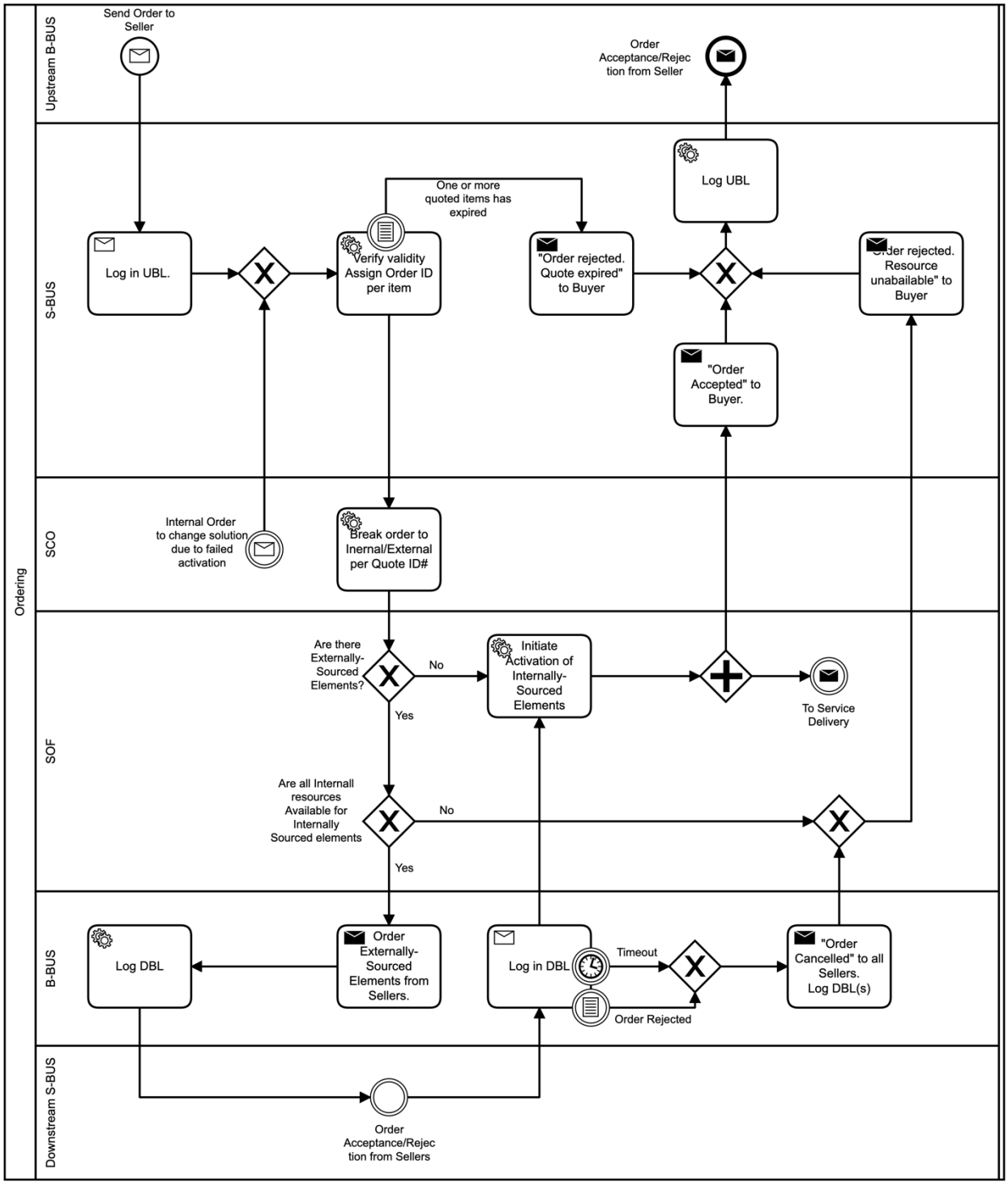


Figure 8 Order Process

10.2.3 Order Process

1. Buyer sends Order to S-BUS referring to Inquiry ID#.

[R65] An Order **MUST** reference a valid Quote ID.

[R66] The Order **MUST** be recorded on the Upstream Bilateral Ledger.

2. S-BUS verifies Quote validity and sends the request to SCO.

[R67] If Quote is valid, S-BUS **MUST** forward request to SCO.

3. SCO decomposes Order to Service Elements based on information recorded in Inquiry ID#, verifies availability of Service Elements for each and all internally sourced elements with SOF.

[R68] SCO **MUST** decompose the Order into Service Elements as per Quote ID#.

[R69] SCO **MUST** verify availability with SOF of internally sourced Service Elements.

[R70] SOF **MUST** report availability of Service Elements for each and every internally sourced Service Element in one of two ways: “Available” or “Rejected”.

4. If SOF reports “order rejected” on any of the internally sourced elements – SCO reports to S-BUS “order rejected”.

[R71] SCO **MUST** respond to S-BUS “Order Rejected” in the event that one or more Service Elements are reported by SOF as “Rejected”.

5. If all internally sourced Service Elements are available, then, for each externally sourced Service Element, SCO forwards the details with Service Element ID# to B-BUS.

[R72] B-BUS **MUST** place Orders with downstream Sellers for all externally sourced Service Elements as per Quote ID#.

6. B-BUS receives responses from the respective Sellers for each Order. The response can be “Order accepted” or “Order rejected” and reports acceptance/rejection to SCO. Depending on API version, the reason for rejection can be detailed.

[R73] The response from Seller **MUST** be either “Accepted” or “Rejected”.

7. If all responses from B-BUS for each and all externally sourced Service Elements are “Accepted” then SCO reports “Order Accepted” to S-BUS and requests activation of internally sourced Service Elements from SOF.

[R74] SCO **MUST** report to S-BUS “Order Accepted” if all responses from B-BUS are “Order Accepted”.

[R75] SCO **MUST** request activation of all internally sourced Service Elements from SOF for Quote ID# if all B-BUS reports all externally sourced Service Elements are “Order Accepted”.

8. S-BUS reports “Order Accepted” to Buyer if SCO reports all Service Elements as “Order Accepted”.

[R76] S-BUS **MUST** respond to Buyer “Order Rejected” if one or more Service Elements is reported by SCO as “Rejected” or was not accepted within ‘Order Acceptance Window’.

[R77] S-BUS **MUST** respond to Buyer “Order Accepted” if all Service Elements are reported by SCO as “Accepted” within ‘Order Acceptance Window’.

9. An Order must include an ‘Order Acceptance Window’. If an SP is unable to confirm acceptance of the Order within the ‘Order Acceptance Window’ Order ID# is automatically rejected. Each downstream Seller along the Supply Chain should derive its own internal timeout periods based on its customer’s timeout.

   [R78] An Order **MUST** specify duration of ‘Order Acceptance Window’.

   [D12] SP **SHOULD** specify to its downstream Sellers an Order Acceptance Window which is calculated as the Order Acceptance Window specified by its Buyer minus its internal order process time.

10.2.4 Order Data Management

The following diagram illustrates the flow of information between functionalities of the reference architecture (S-BUS, B-BUS, SCO, SOF) and the ledgers (UBL, DBL, INT, Omni) through the Ordering process steps.

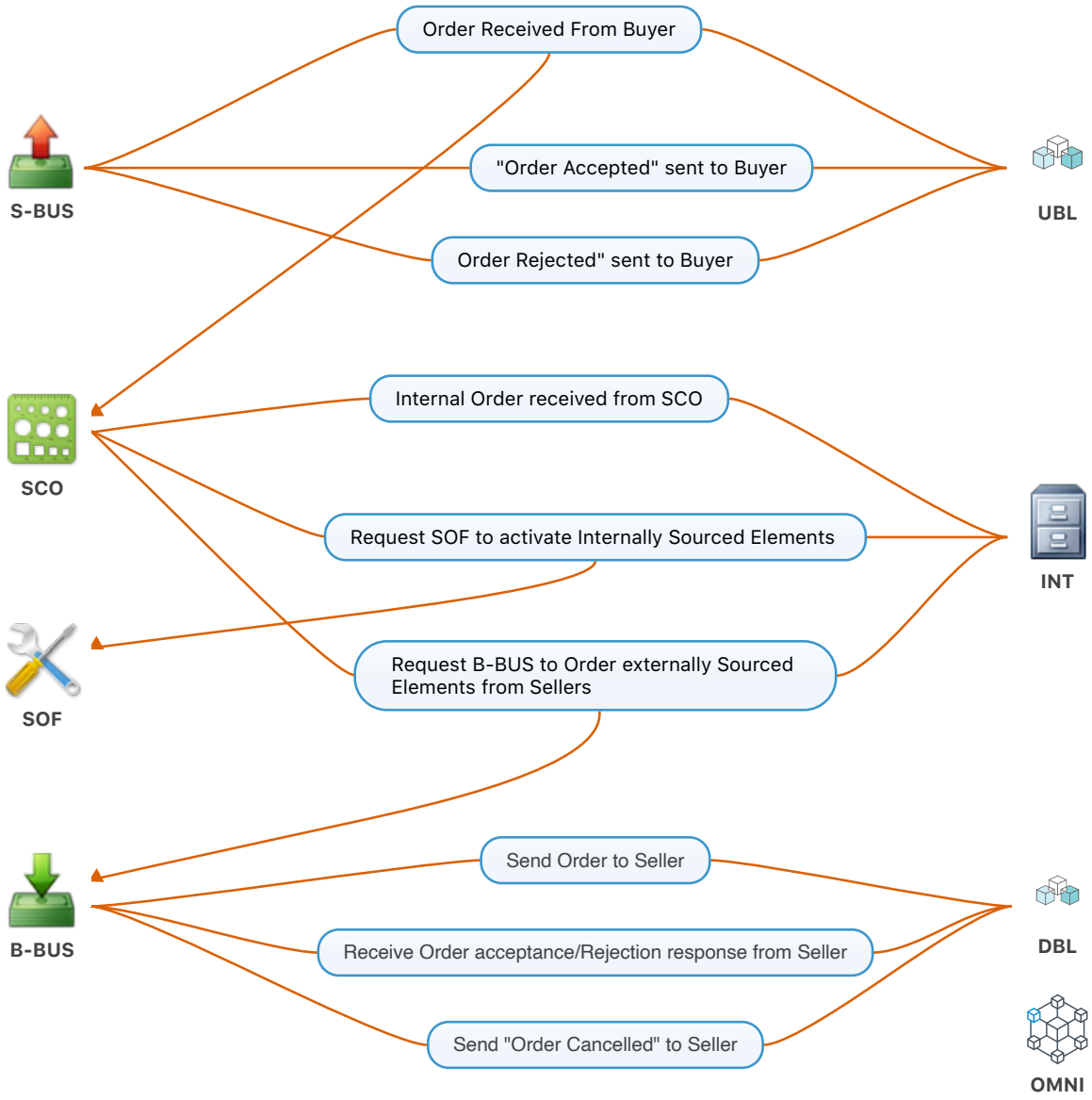


Figure 9 Order Data Management

10.2.5 Order Process Sequence Diagram

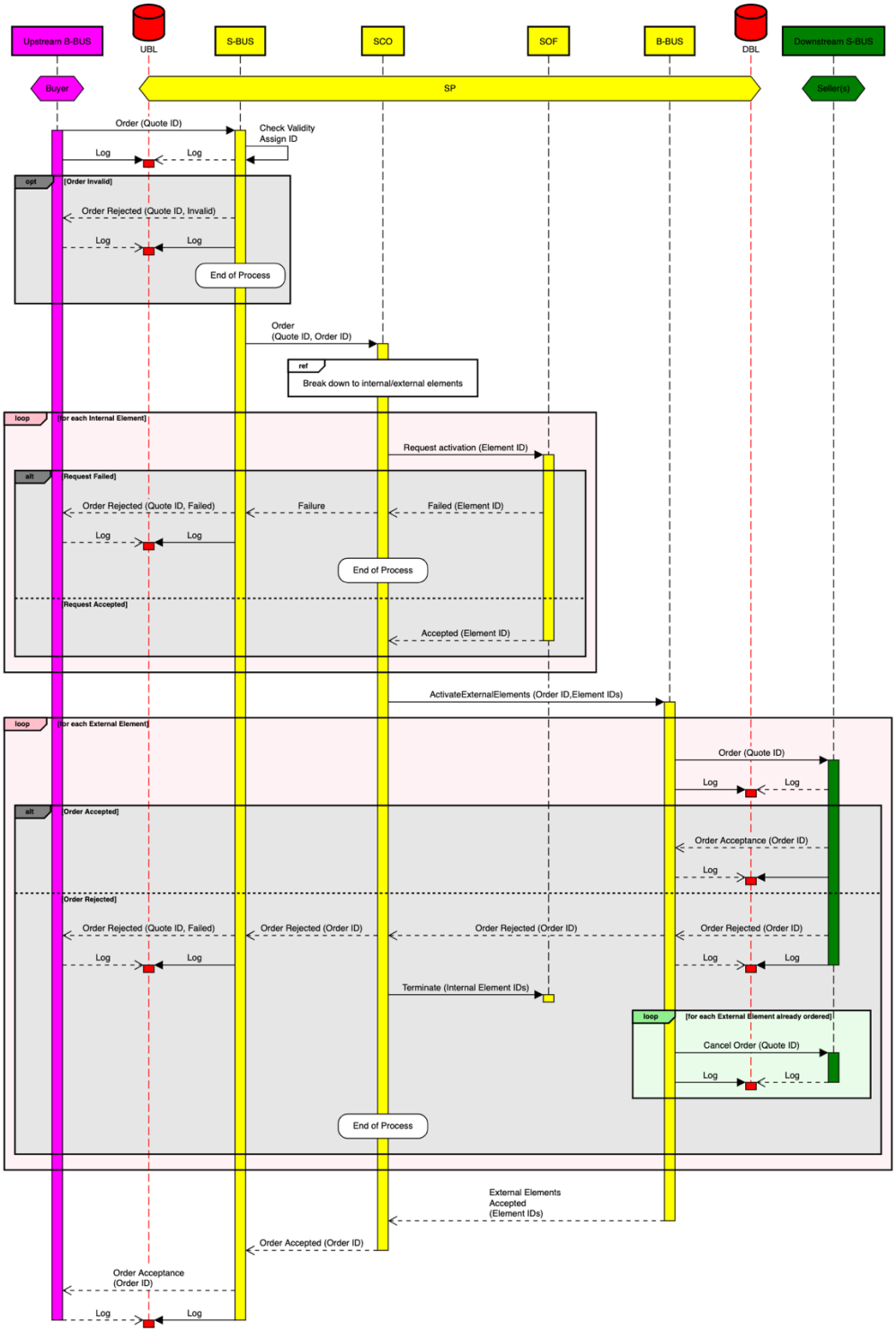


Figure 10 Order Process Sequence Diagram

10.3 Service Delivery

10.3.1 Introduction

Service delivery is handled by each SP based on accepted Orders. This specification defines the way in which a service that was delivered through a downstream supply chain is handed off to the Buyer. Note that the standard does not define how each SP delivers each element of service.

Based on the Ordering process defined in Section 10.2 internally sourced elements of the service may only be activated if and when all externally sourced elements of the service have initiated the service delivery process. However, service delivery may not be instantaneous and there is a possibility that in a chain of nested service delivery processes, certain elements may be activated prior to others, not necessarily in the sequence of the service topology.

- SCO instructs SOF to activate each and all internally sourced elements of service. For each internally sourced element: SOF activates internally sourced elements.
- SOF reports “service element activated”
- SCO chains internally sourced elements in topology/sequence.

- Once all internally sourced elements have been activated and chained – for each externally sourced element (grouped by SP):

    - Seller reports to B-BUS “service element activated”
    - B-BUS reports to SCO of same
    - SCO chains the externally sourced element into topology/sequence.
    - SCO performs “SP to end” test.

- Once all SP to end” tests have been successfully completed – SCO reports to S-BUS “service delivered”:

    - S-BUS reports to Buyer “service delivered”.

The specification includes provisions for events that may cause failure to activate certain elements and the resulting actions:

- Delay in delivery (may be subject to penalty).

- Inability to deliver (permanently or within a specified time) that will lead to cancellation of order and failover to alternative (internally or externally sourced)

There may be failover to an alternative Supply Chains in the event that the primary Supply Chain cannot be delivered. Note that there may be SLA (performance) and commercial implications to such a failover. In which case the Seller may cancel the Order or renegotiate the commercial terms with the Buyer so far as the contract between them allows that.

10.3.2 Service Delivery Process Diagram

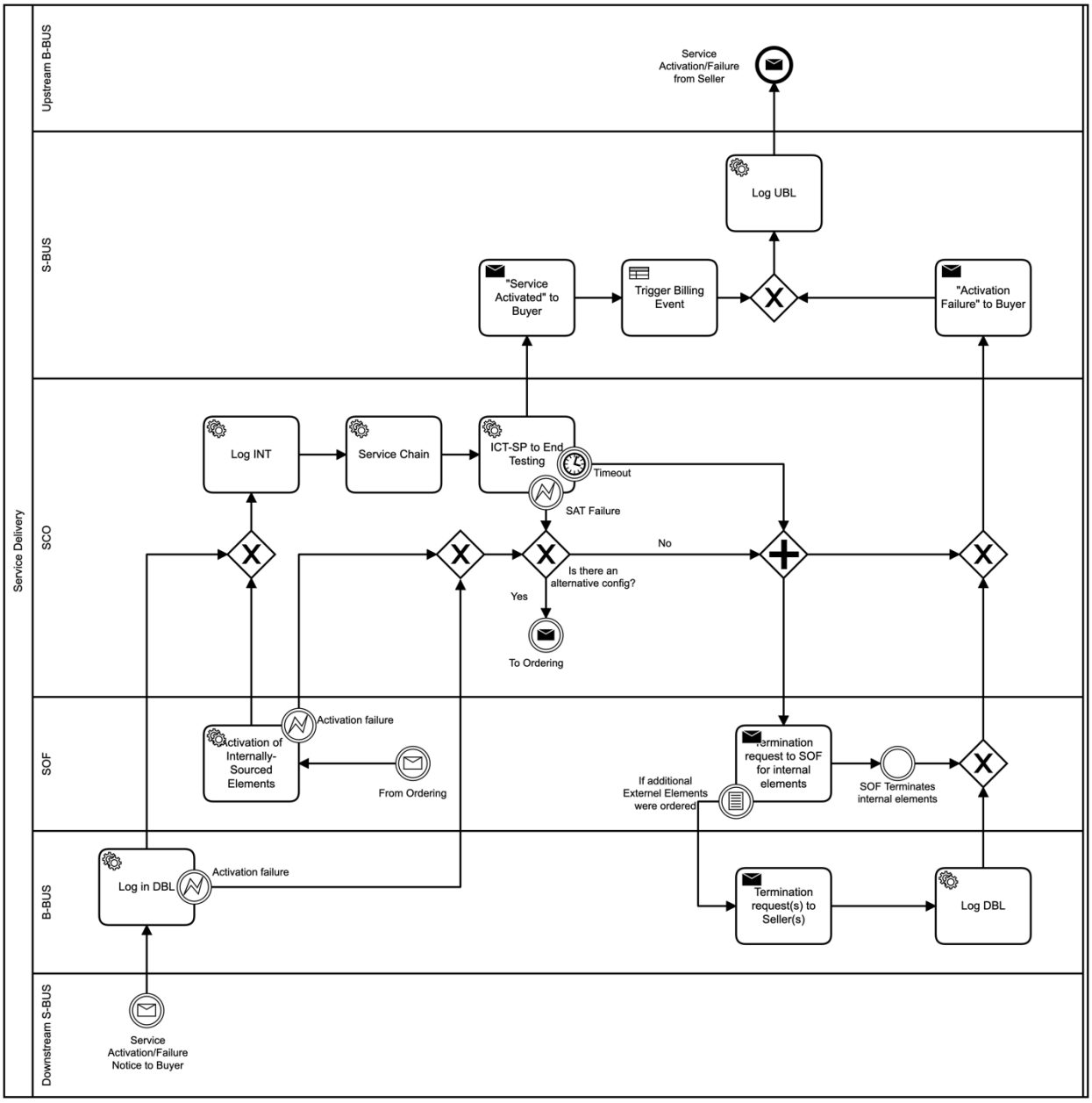


Figure 11 Service Delivery Process

10.3.3 Service Delivery Process

1. Upon receipt of request of activation of internally sourced Service Elements, SOF activates all such Service Elements.

   [R79] SOF **MUST** attempt activation of all internally sourced Service Elements on receipt of such a request for activation.

2. SOF reports “Service Element Activated” to SCO for each Service Element successfully activated within the respective ‘Service Element Activation Window’.

[R80] All external messages referring to Service Element **MUST** include Service Element ID#.

[R81] All external messages referring to Service **MUST** include Service ID#.

[R82] All external messages referring to Order **MUST** include Order ID#.

[R83] SOF **MUST** report "Service Element Activated" for each successfully activated Service Element within the 'Service Element Activation Window'.

[R84] SOF **MUST** report "Service Element Activation Failure" for each failure to activate a Service Element within the 'Service Element Activation Window'.

3. B-BUS receives notification from downstream Sellers respectively "Order Activated" for all externally sourced Service Elements.

[R85] B-BUS **MUST** report "Service Element Activated" for each successfully activated Order within the 'Order Activation Window'.

[R86] B-BUS **MUST** report "Service Element Activation Failure" for each failure to activate an Order within the 'Order Activation Window'.

4. If all the notifications received by SCO from B-BUS and SOF indicate successful activation, then SCO chains all Service Elements into Service Chain and performs testing from SCO to downstream end of Service Chain. If test succeeds within 'Service Activation Window', SCO reports to S-BUS "Order Activated".

[R87] SCO **MUST** chain all Service Elements into Service-Chain upon receipt of fully positive notifications of activations from B-BUS and SOF.

[R88] SCO **MUST** perform testing on Service Chain from SCO to downstream end of Service Chain.

[R89] SCO **MUST** report to S-BUS "Order Activated" if the service test is successful within the 'Service Activation Window'.

[R90] SCO **MUST** report to S-BUS "Order Failed" if the service test does not succeed within the 'Service Activation Window'.

5. S-BUS notifies Buyer of successful activation and records in Upstream Bilateral Ledger.

[R91] S-BUS **MUST** record successful activation in the Upstream Bilateral Ledger.

6. If any internally sourced Service Elements cannot be activated within its Service Element Activation Window, then SOF reports to SCO "Service Element Activation Failed".

[R92] SCO **MUST** specify 'Service Element Activation Window' to SOF for each internally sourced Service Element when placing activation request.

[R93] SOF **MUST** report to SCO for any internally sourced Service Element that was not activated successfully within the Service Element Activation Window "Service Element Activation Failed".

7. If any externally sourced Service Elements cannot be activated within its Service Element Activation Window, then B-BUS reports to SCO "Service Element Activation Failed".

[R94] B-BUS **MUST** report to SCO for any externally sourced Service Element that was not activated successfully within the Service Element Activation Window "Service Element Activation Failed"

8. If SCO receives one or more "Service Element Activation Failed" notifications, it can (a) seek an alternative internally sourced Service Element from SOF according to Step 4 in Inquiry and Quote Section 10.1 or (b) it can initiate an Inquiry for an externally sourced Service Element according to Step 6 in Inquiry and Quote Section 10.1 or (c) decide to abandon the Order.

[R95] SCO **SHOULD** choose one of the following actions:

i. Seek alternative internally sourced Service Element according to Section 10.1

ii. Seek externally sourced Service Element to according to Section 10.1

iii. Decide to abandon the Order

9. S-BUS will either (a) abandon an Order or (b) decide to request an extension of the 'Order Activation Window' if it does not receive a positive notification from SCO within the 'Order Activation Window'.

[R96] S-BUS **MUST** notify the Buyer "Order Failed" if S-BUS decides to abandon the Order.

[O21] S-BUS **MAY** request from the Buyer "Request Order Activation Window Extension" if it does not receive an "Order Activated" from SCO within the 'Order Activation Window'.

10. If S-BUS decides to abandon the Order, S-BUS will notify SCO and SCO in turn will notify B-BUS and SOF.

[R97] S-BUS **MUST** notify SCO of decision by S-BUS to abandon an Order.

[R98] SCO **MUST** notify both B-BUS and SOF of decision by S-BUS to abandon an Order.

11. SOF will release all internally sourced Service Elements when notified by SCO of abandonment of Order.

[R99] SOF **MUST** release all internally source Service Elements when notified of abandonment of an Order.

12. In the event of notification by SCO of abandonment of Order, B-BUS will then notify all downstream Sellers that are parties to the Order that their respective Orders are cancelled.

[R100] B-BUS **MUST** notify all Sellers of order cancellation using "Order Cancelled" and record it on the respective Bilateral Ledgers.

13. If an extension is granted by Buyer to S-BUS, then S-BUS will notify SCO accordingly. SCO will then transmit a recalculated 'Order Activation Window' onwards to SOF and B-BUS.

[R101] S-BUS **MUST** notify both SOF and B-BUS of any 'Order Activation Window' changes.

[R102] Any changes in the 'Order Activation Window' or downstream 'Order Activation Windows' **MUST** be recorded on the respective Bilateral Ledgers.

10.3.4 Service Delivery Data Management

The following diagram illustrates the flow of information between functionalities of the reference architecture (S-BUS, B-BUS, SCO, SOF) and the ledgers (UB, DB, INT, Omni) through the Service Delivery process steps.

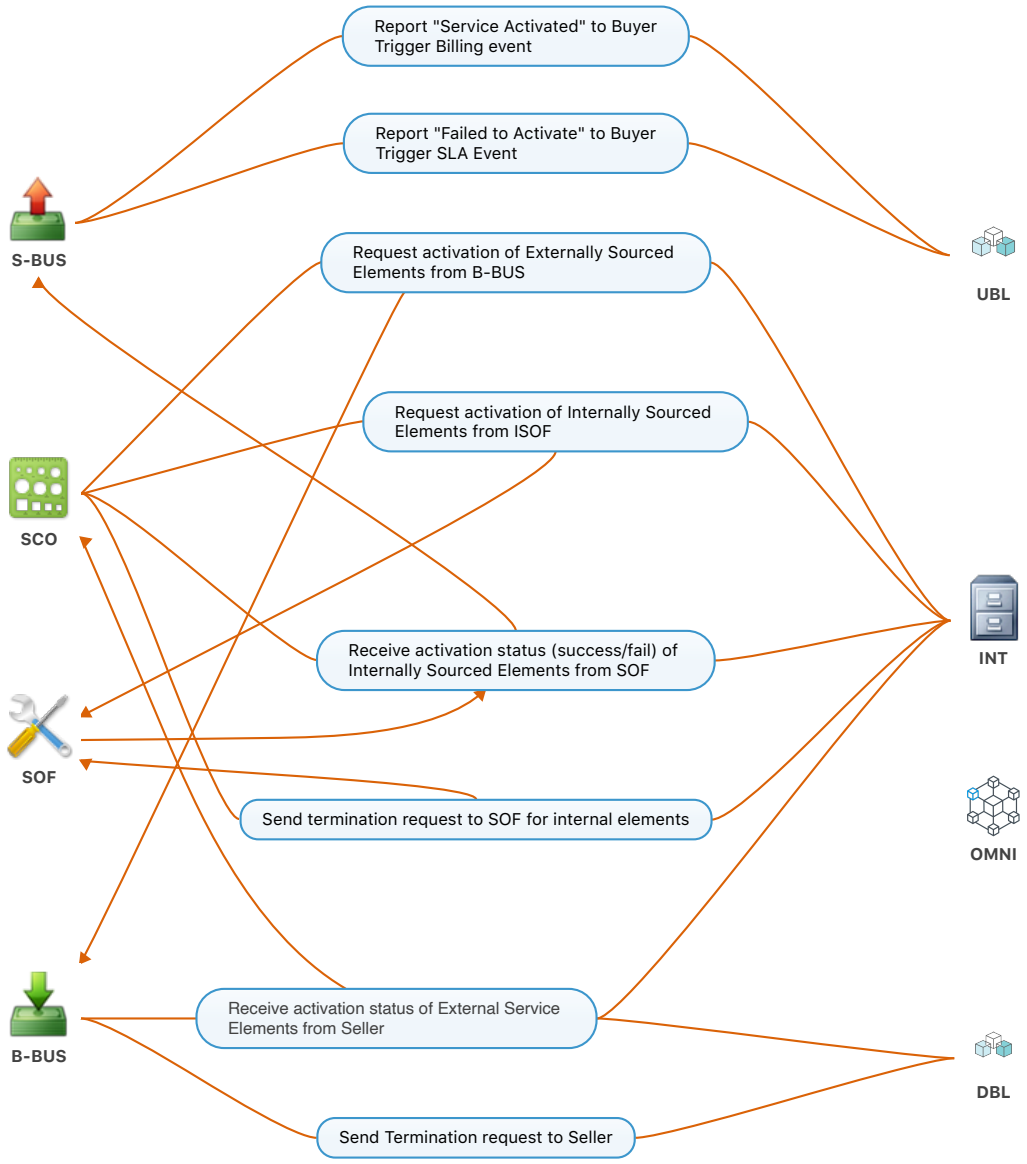


Figure 12 Service Delivery Data Management

10.3.5 Service Delivery Sequence Diagram

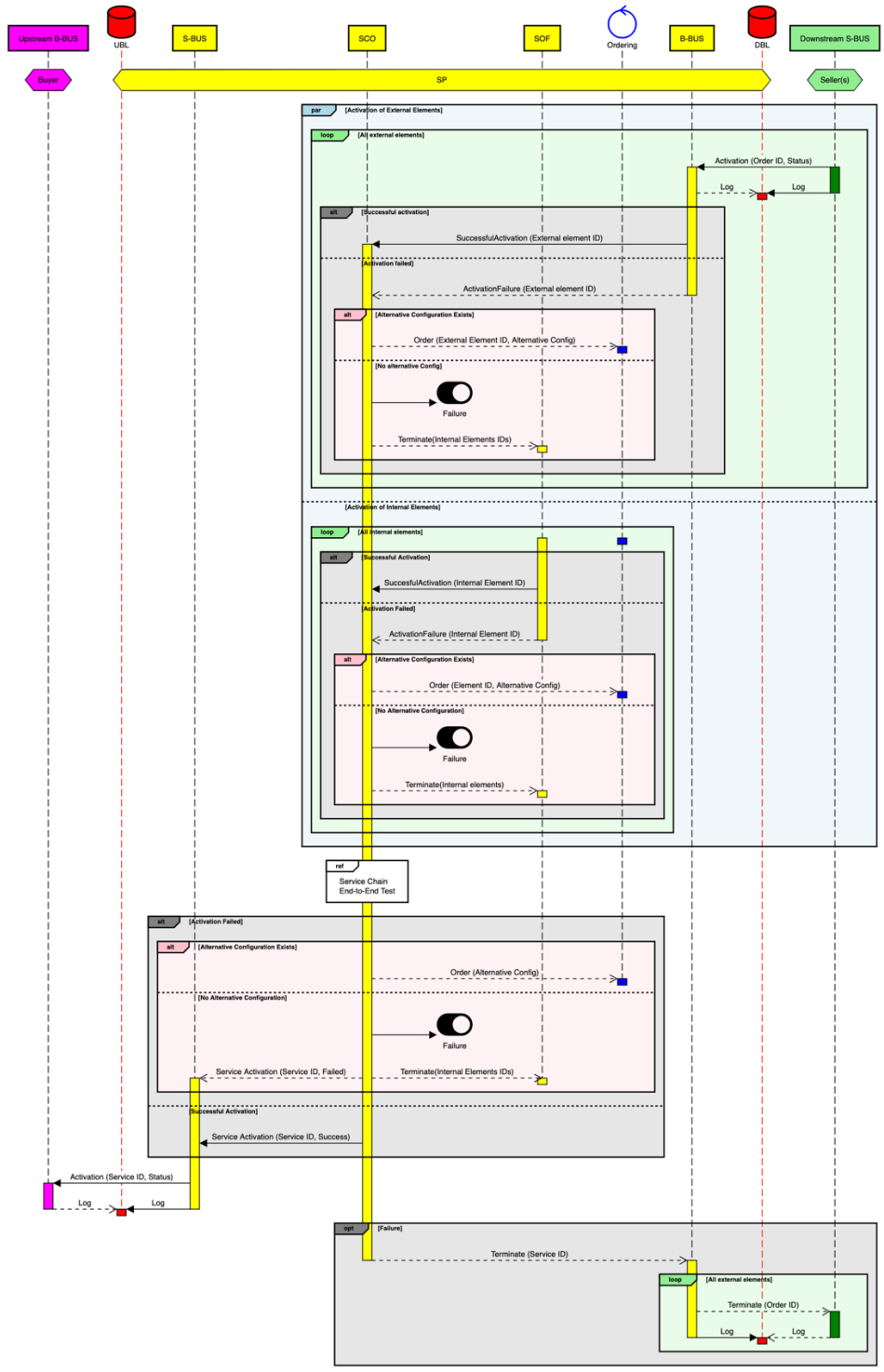


Figure 13 - Service Delivery Sequence Diagram

10.4 SOAM (Service Operations and Maintenance)

On-demand services may last anything from seconds to years. This has implications for SOAM as described in this section.

10.4.1 Fault Management

10.4.1.1 Introduction

This document differentiates between SP handling of resources and services. The management of faults in resources is out of scope for this document.

[O22] Fault in an on-demand service **MAY** be handled through (a) repair OR (b) abandoning the service.

The handling of a fault in a service may have implications for both Upstream and Downstream Participants in the Supply Chain.

The user may not even report the failure unless it is repetitive and the attempts to re-establish the service (i.e. hang up and redial) don't lead to a stable service.

10.4.1.2 Fault Management Process Diagram

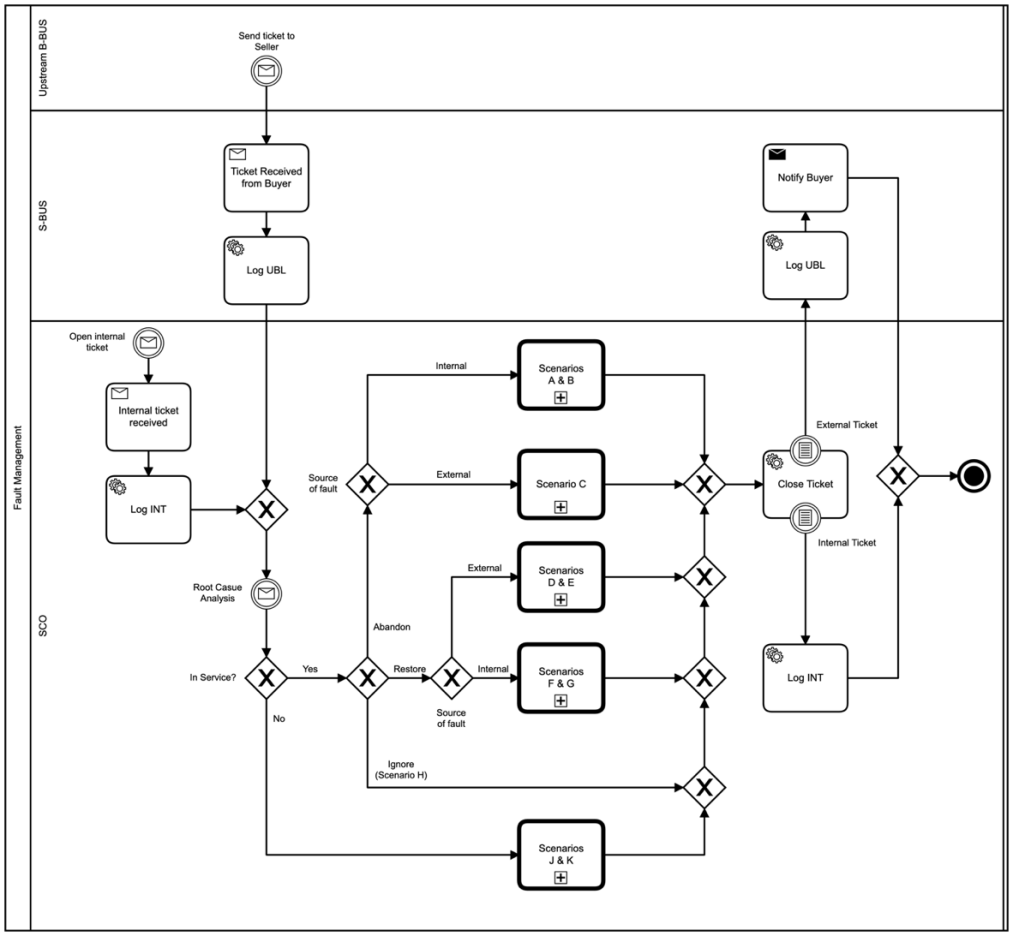


Figure 14 Fault Management

10.4.1.3 Proactive Fault Management

Each Participant SP may proactively handle faults that it has identified.

[D13] SP **SHOULD** be able to proactively identify, and trigger handling of, service faults.

[O23] If the Buyer has not opened a ticket for said fault, the SP **MAY** open an internal ticket.

10.4.1.4 Reactive Fault Management

Tickets may be opened by the Buyer through a message sent from Buyer to S-BUS.

[O24] Seller **MAY** open a trouble ticket with one or more of its Sellers in the event of identifying a fault or being notified of a fault by its Buyer.

10.4.1.5 Fault Management Sequence Diagram

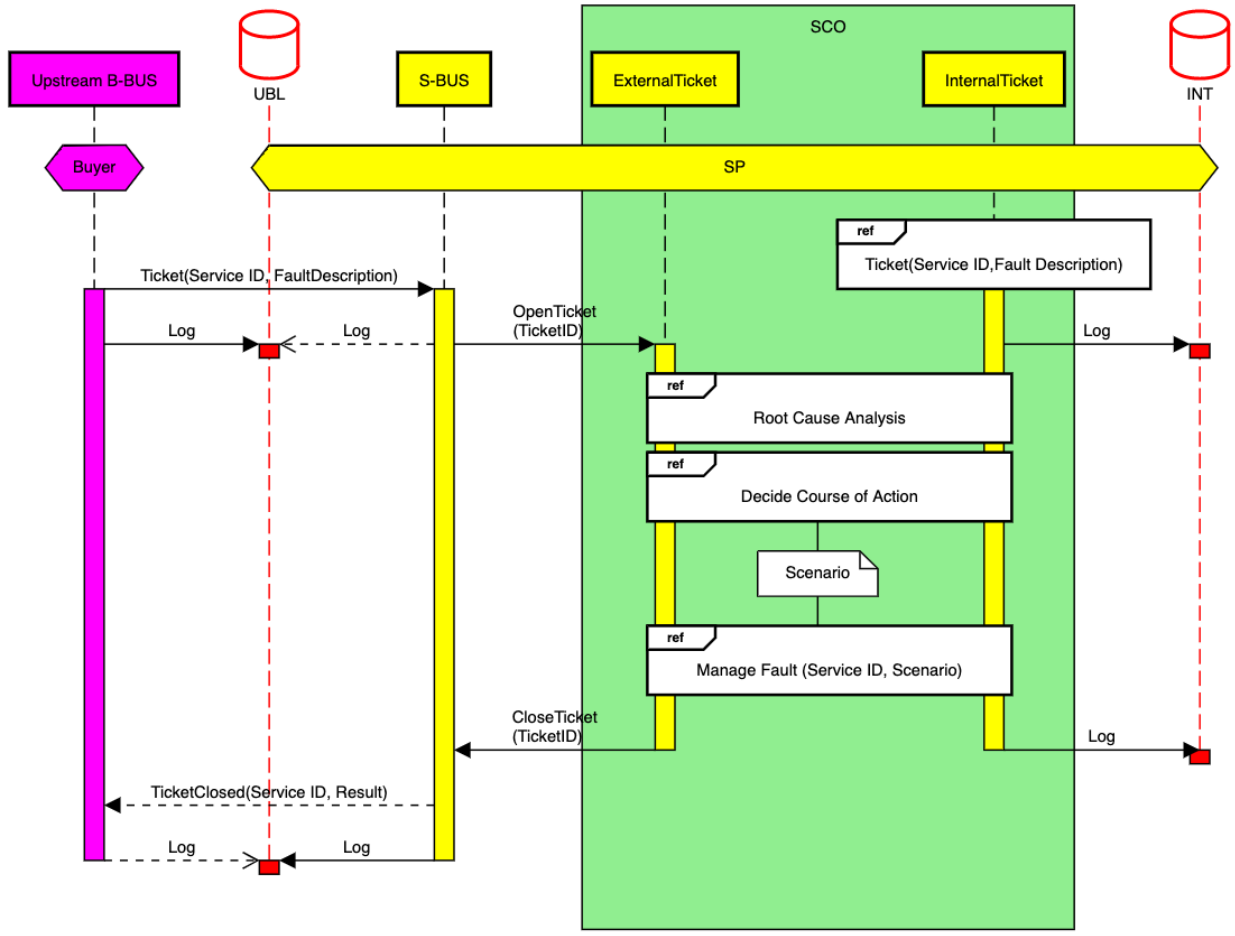


Figure 15 Fault Management Sequence Diagram

10.4.1.6 Fault Management Scenarios

There is a range of scenarios (A-K) which result from a combination of conditions:

1. Service in operation or out of operation.
2. Fault is internal or external to the SP.
3. Outage (downtime) is required or is not required to carry out the repair.
4. Whether an SP is the last in the Supply Chain or not.
5. SP's decision to restore service, abandon service or ignore the fault.

The following subsections list the requirements for each scenario.

The Root Cause Analysis (RCA) and the decision by the SP whether to restore, abandon or ignore is internal to the SP and is out of scope for this document.

The Buyer eligibility for SLA credits is based on performance records and ticket status as per agreement between each pair of Buyer and Seller.

[D14] Each pair of Buyer and Seller **SHOULD** load their SLA as a Smart Contract in the respective Bilateral Ledger.

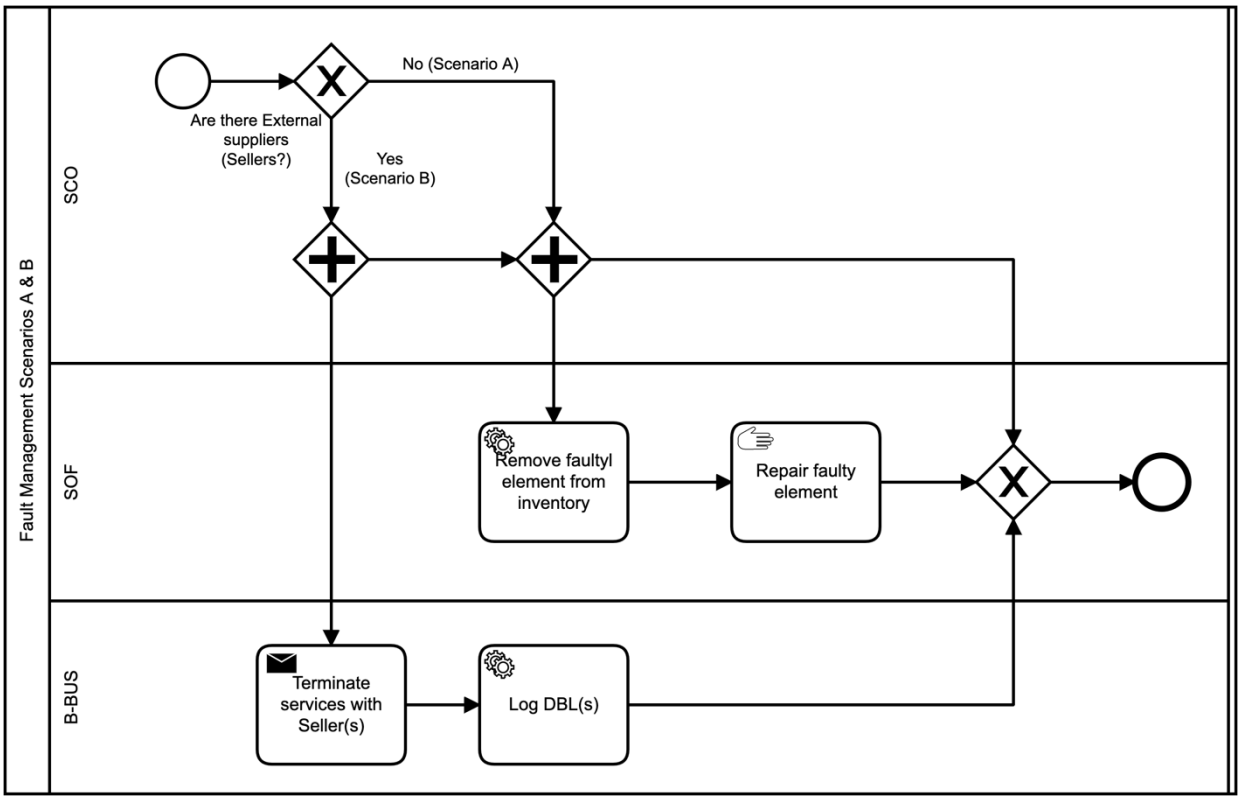


Figure 16 - Fault Management Scenarios A and B

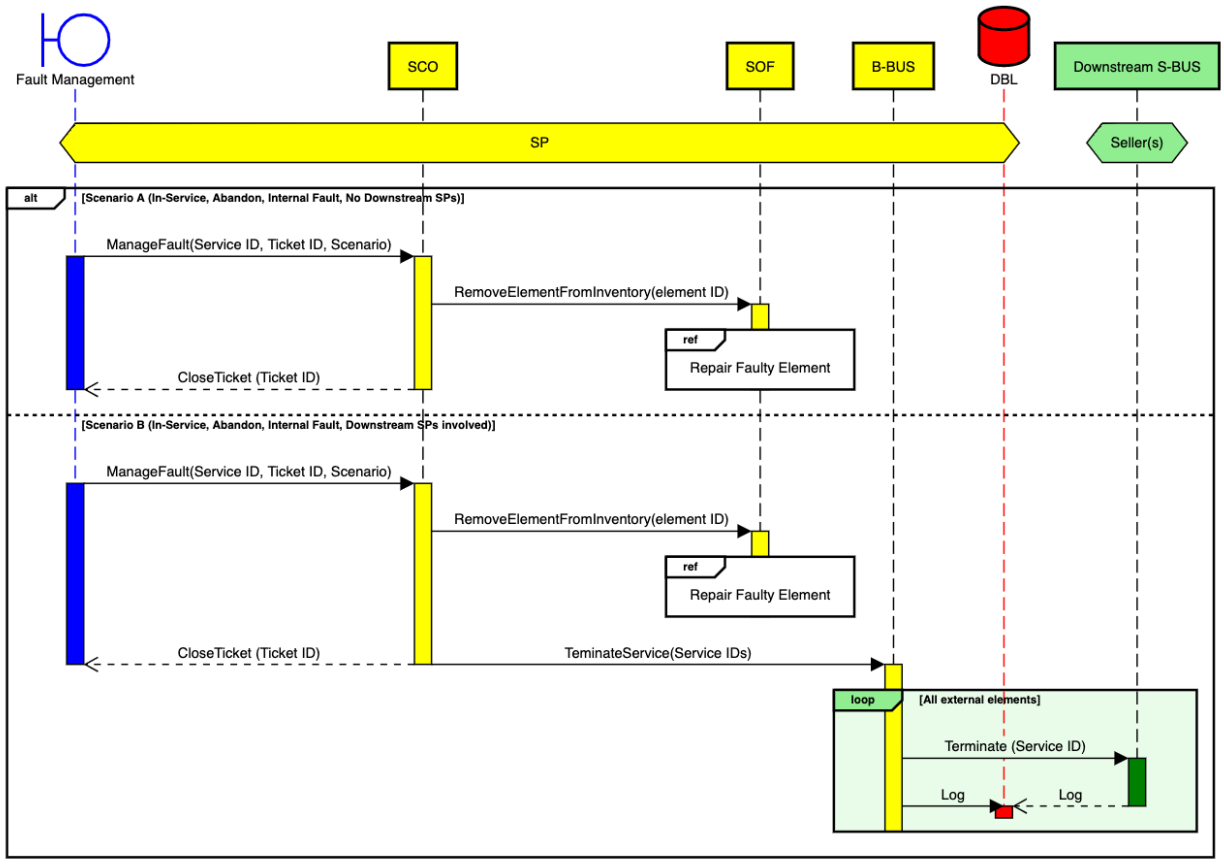


Figure 17 Fault management Scenarios A+B Sequence Diagram

10.4.1.6.1 Scenario A: Service still in operation, decided to abandon, fault is internal and there are no Sellers

[R103] S-BUS **MUST** notify Buyer (“Service Terminated”) and log event to Upstream Bilateral Ledger.

[R104] SCO **MUST** remove Service from Inventory.

[R105] SCO **MUST** notify SOF of termination of service due to internal fault (“Service Terminated – Internal Fault”).

[D15] SCO **SHOULD** close Ticket.

10.4.1.6.2 Scenario B: Service still in operation, decided to abandon, fault is internal and there are Sellers

[R106] S-BUS **MUST** notify Buyer (“Service Terminated”) and log event to the Bilateral Ledger.

[R107] SCO **MUST** remove Service from Inventory.

[R108] SCO **MUST** notify SOF of termination of service due to internal fault (“Service Terminated – Internal Fault”).

[R109] B-BUS **MUST** terminate service with Sellers.

[D16] SCO **SHOULD** close Ticket.

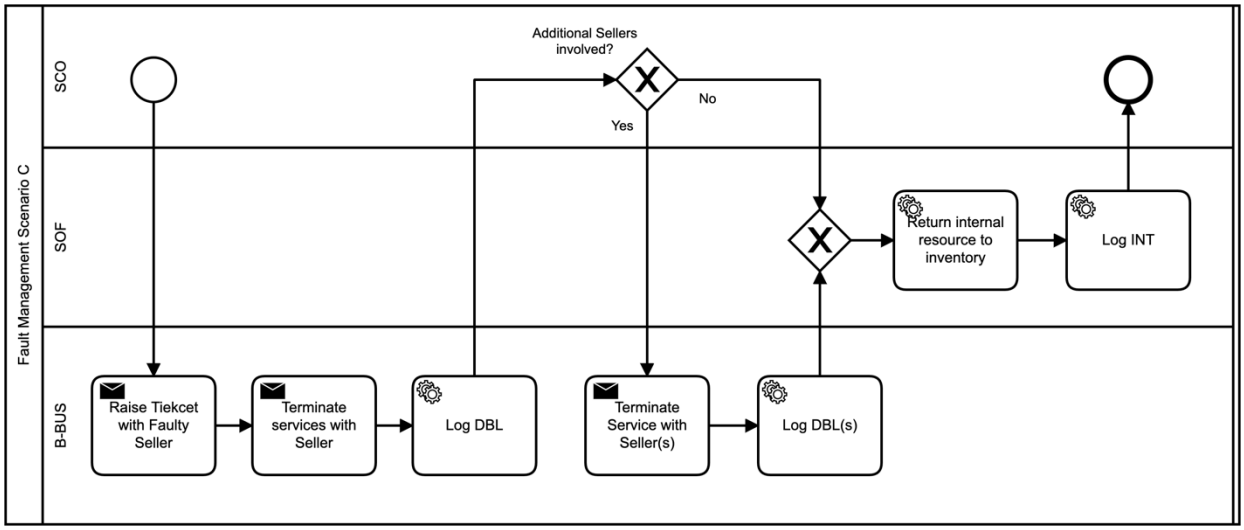


Figure 18 - Fault Management Scenario C

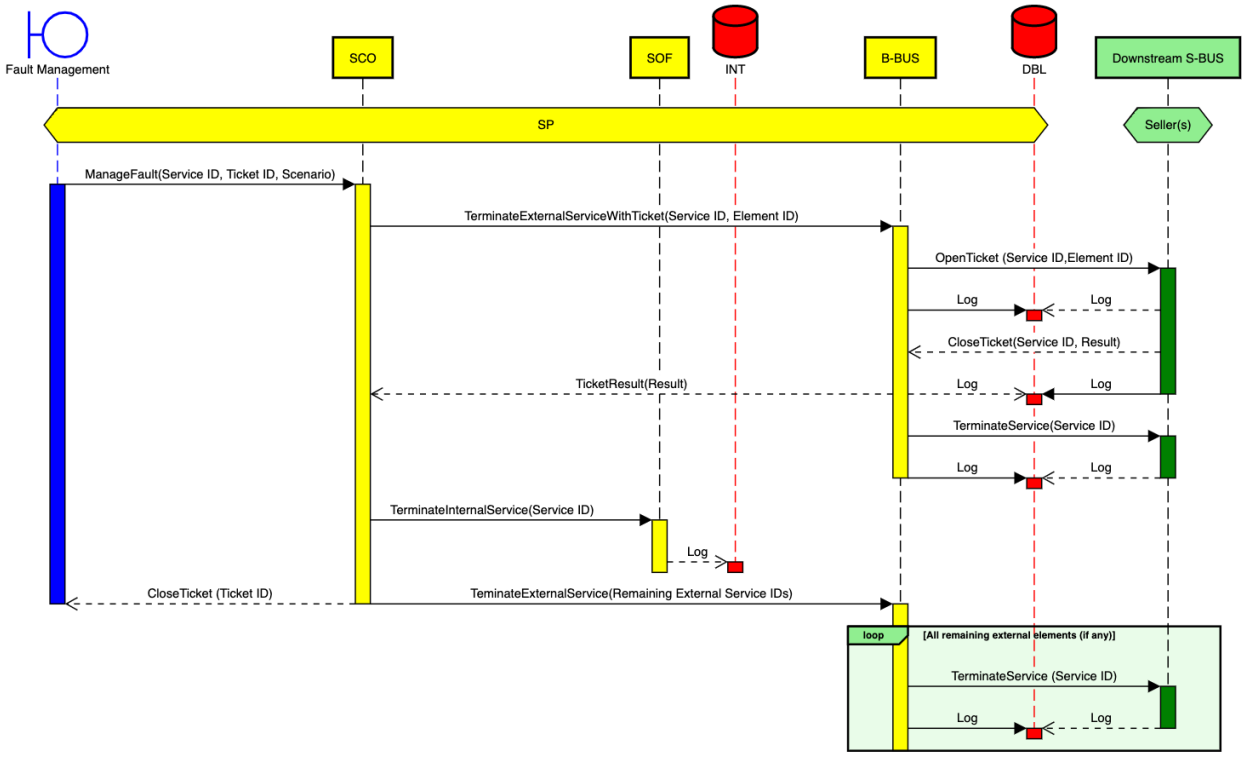


Figure 19 Fault management Scenario C Sequence Diagram

10.4.1.6.3 Scenario C: Service still in operation, decided to abandon, and fault is external

[D17] B-BUS **SHOULD** open Ticket with faulty Seller

[R110] B-BUS **MUST** request termination of Service

[R111] S-BUS **MUST** notify Buyer ("Service Terminated") and log event to the Upstream Bilateral Ledger

[R112] SCO **MUST** remove Service from Inventory

[R113] SCO **MUST** notify SOF of termination of service due to internal fault ("Service Terminated – Internal Fault")

[R114] B-BUS **MUST** terminate service with Sellers

[D18] SCO **SHOULD** close Ticket

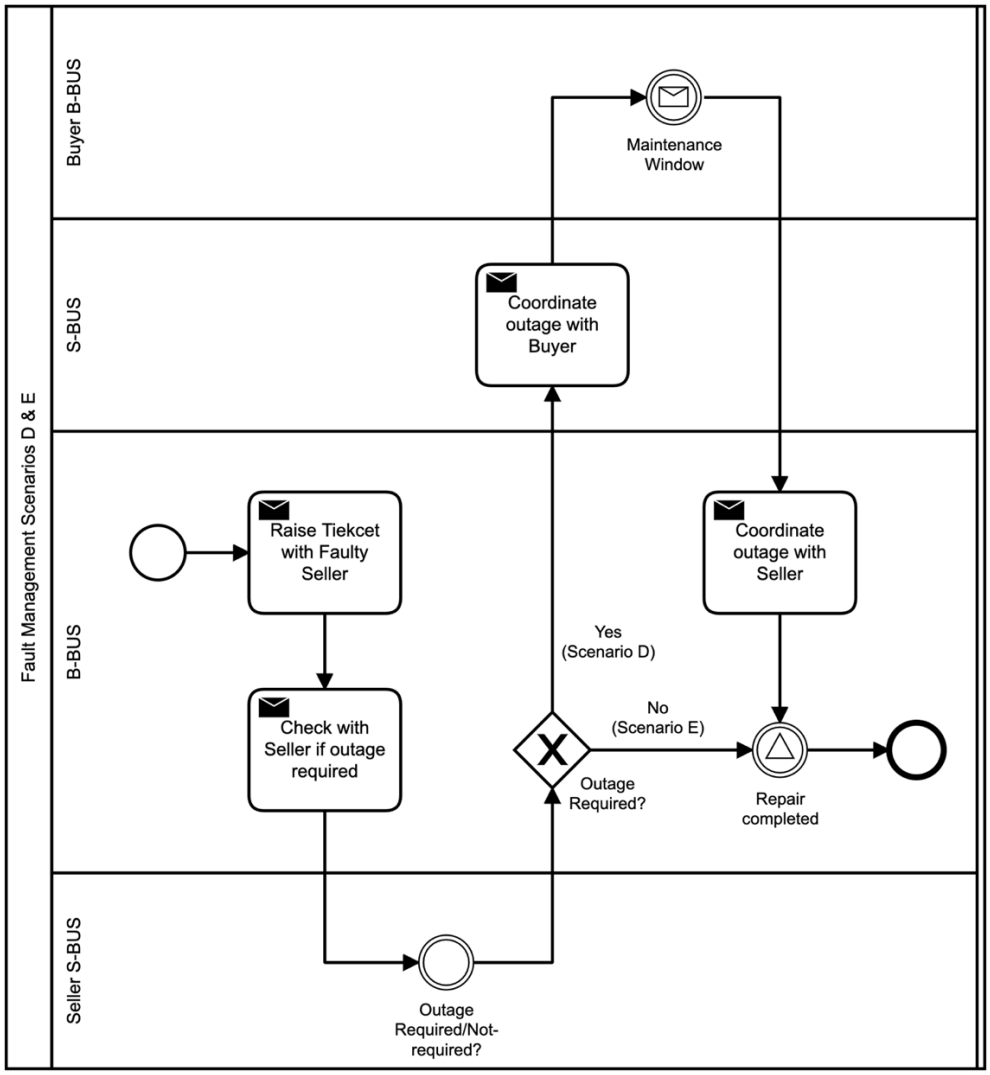


Figure 20 - Fault Management Scenarios D and E

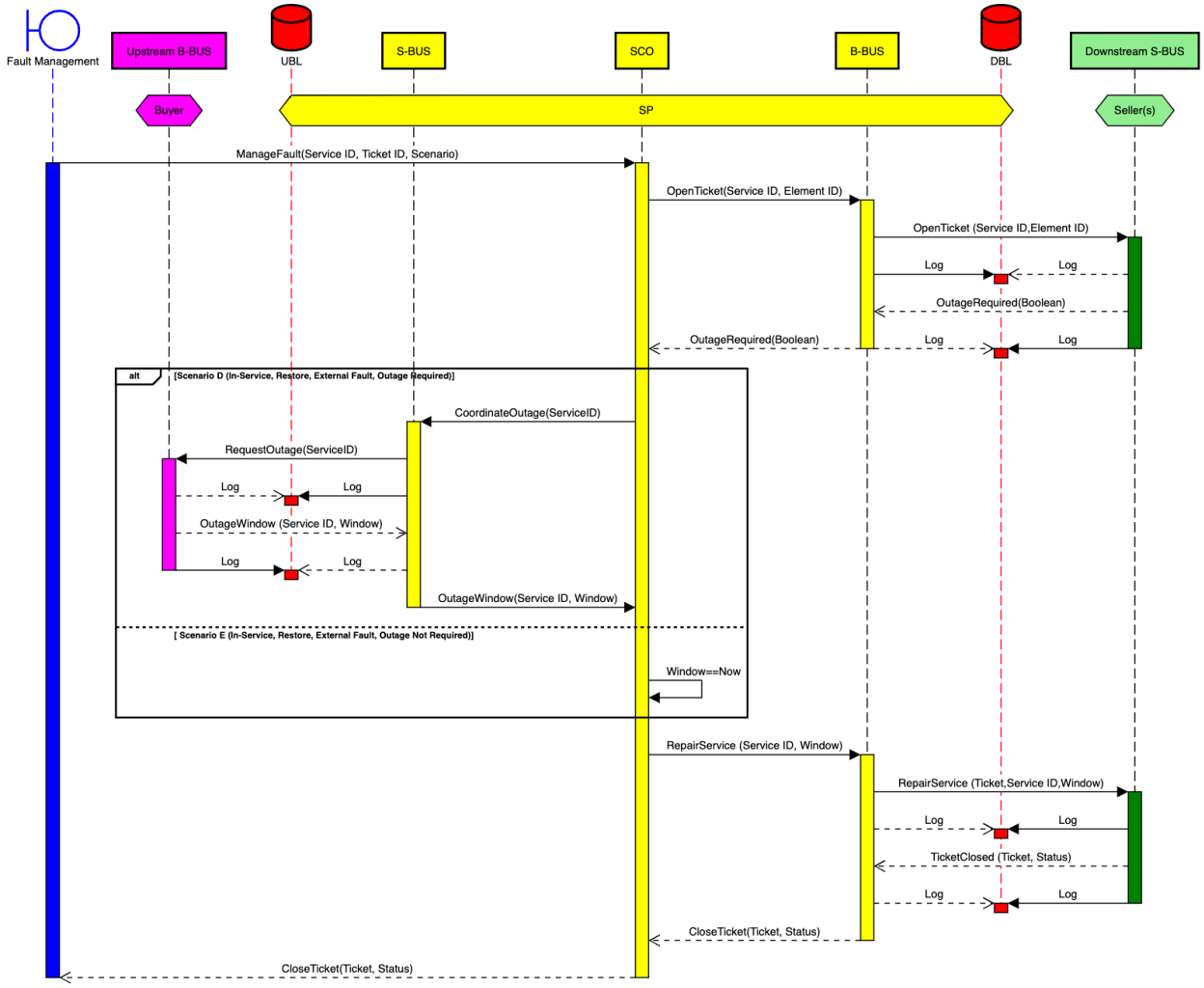


Figure 21 Fault management Scenarios D+E Sequence Diagram

10.4.1.6.4 Scenario D: Service still in operation, decided to restore service and fault is external and outage is required

[D19] B-BUS **SHOULD** open Ticket with faulty Seller.

[R115] S-BUS **MUST** coordinate with Buyer downtime for repair.

[R116] B-BUS **MUST** coordinate with faulty Seller downtime for repair.

[R117] Once repair is completed by Seller, S-BUS MUST close Ticket, notify Buyer and record event on the Upstream Bilateral Ledger.

10.4.1.6.5 Scenario E: Service still in operation, decided to restore service and fault is external and outage is not required

[D20] B-BUS **SHOULD** open Ticket with faulty Seller.

[R118] Once S-BUS receives notification from SCO that fault is repaired, S-BUS **MUST** close Ticket, notify Buyer and record event on the Upstream Bilateral Ledger.

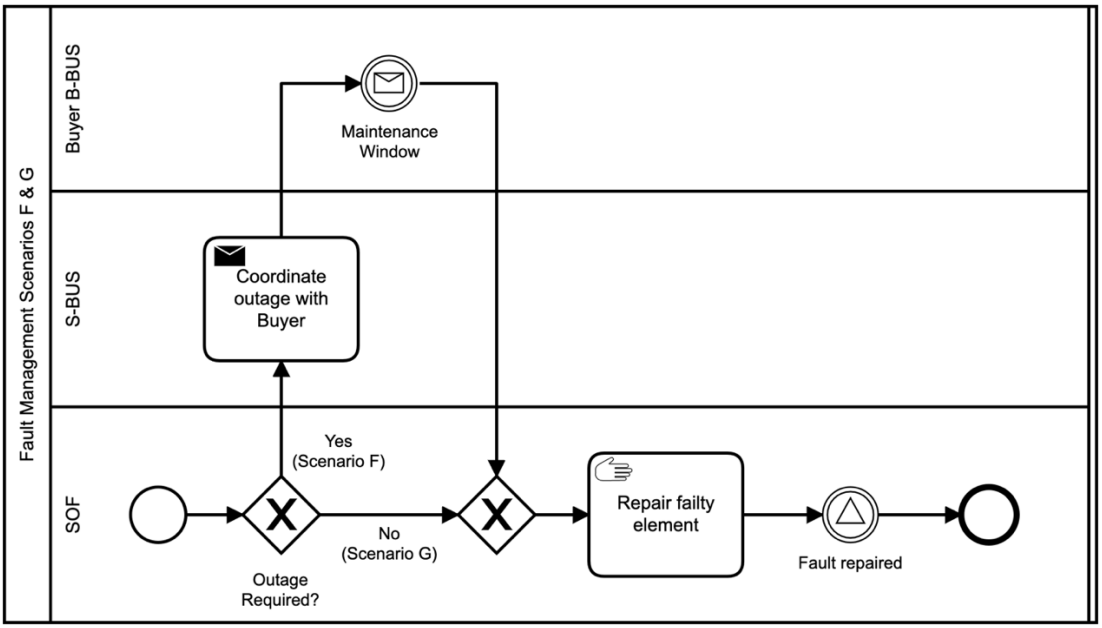


Figure 22 - Fault Management Scenarios F and G

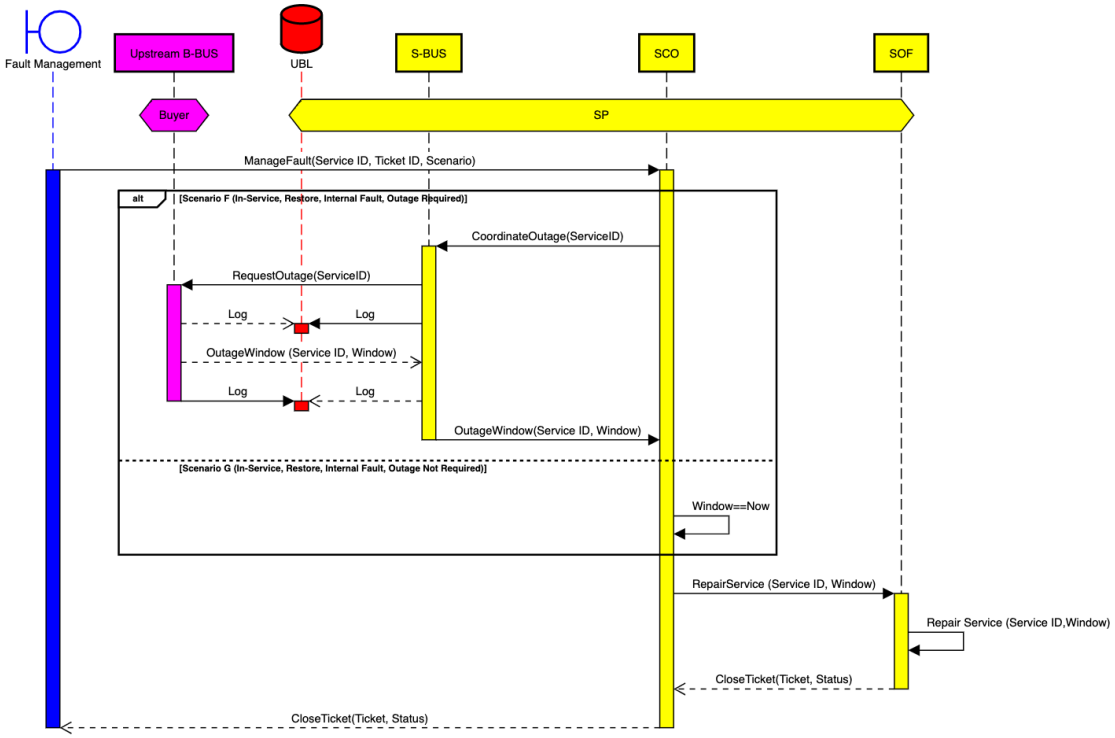


Figure 23 Fault management Scenarios F+G Sequence Diagram

10.4.1.6.6 Scenario F: Service still in operation, decided to restore service and fault is internal and outage is required

[R119] S-BUS **MUST** coordinate with Buyer downtime for repair.

[D21] SOF **SHOULD** repair fault.

[R120] Once repair is completed, S-BUS **MUST** close Ticket, notify Buyer and record event on the Upstream Bilateral Ledger.

10.4.1.6.7 Scenario G: Service still in operation, decided to restore service and fault is internal and outage is not required

[D22] SOF **SHOULD** repair fault.

[R121] Once repair is completed, S-BUS **MUST** close Ticket, notify Buyer and record event on the Upstream Bilateral Ledger.

10.4.1.6.8 Scenario H: Service still in operation, decided to ignore

[R122] S-BUS **MUST** close Ticket, notify Buyer and record event on the Upstream Bilateral Ledger.

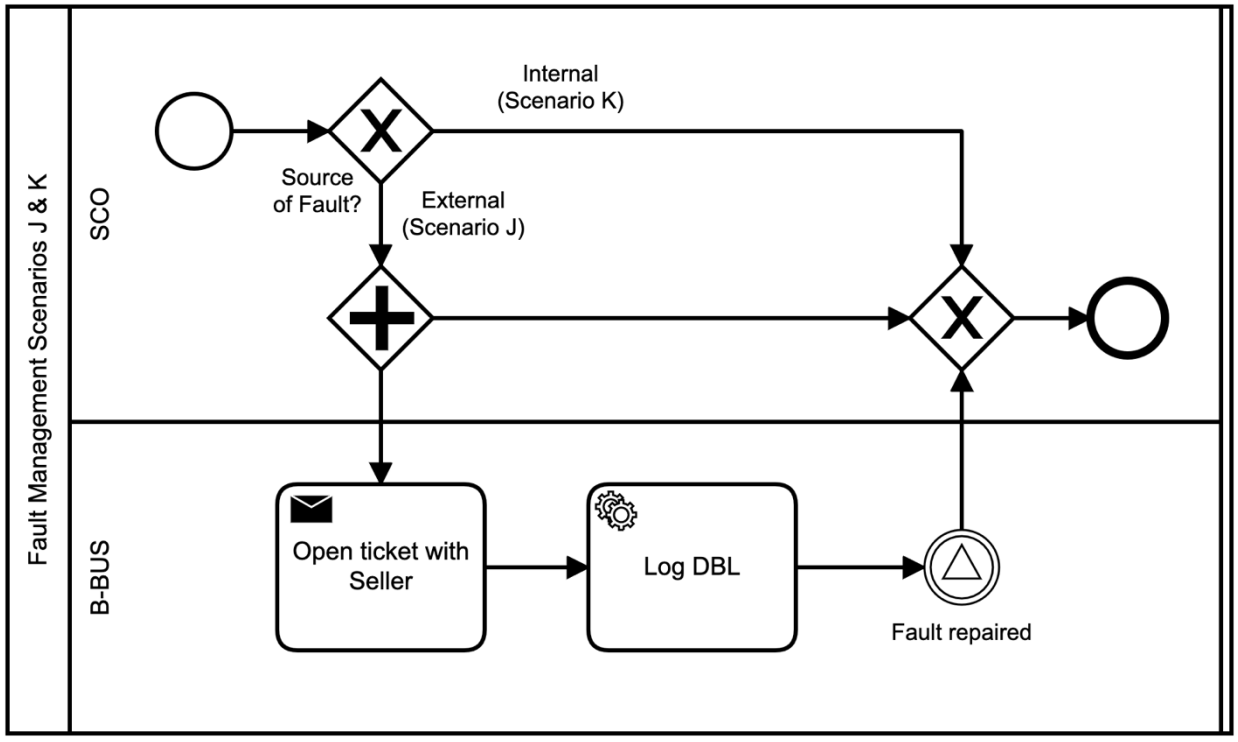


Figure 24 - Fault Management Scenarios J and K

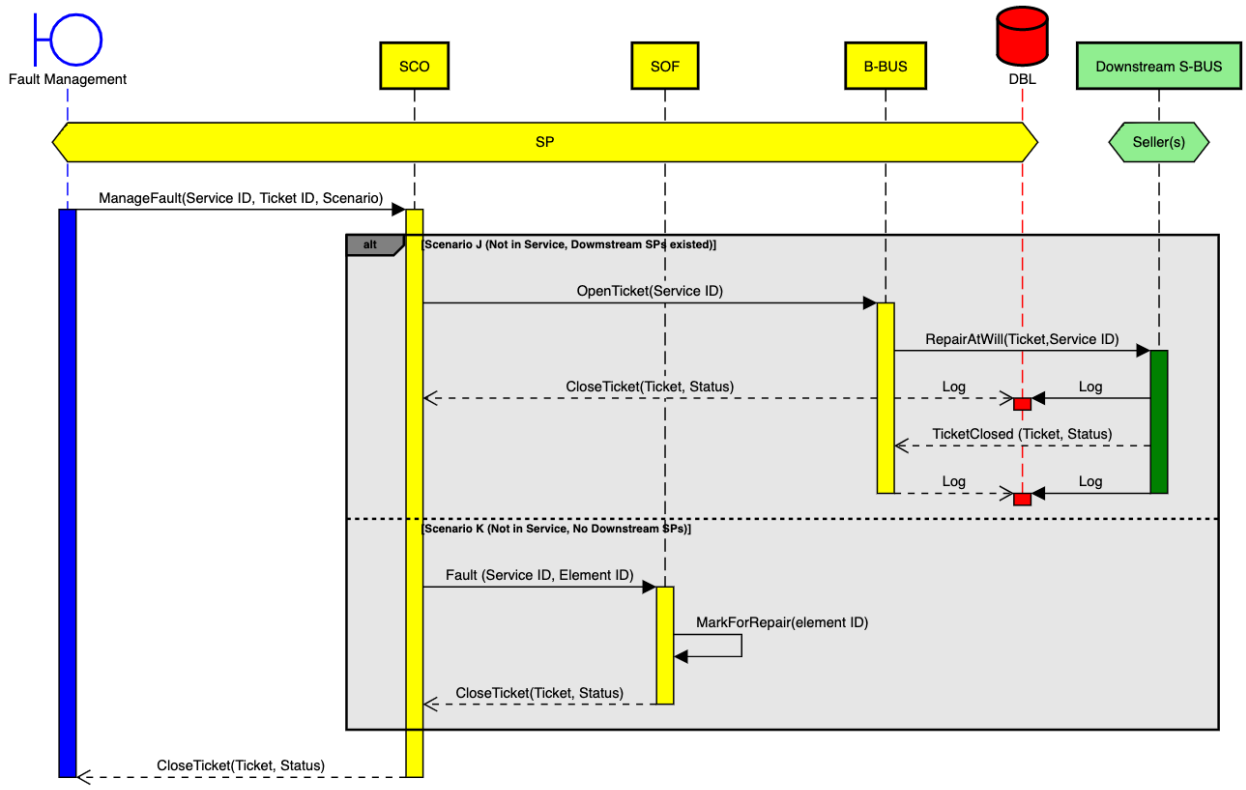


Figure 25 Fault management Scenarios J+K Sequence Diagram

10.4.1.6.9 Scenario J: Service not in operation, fault is external

[R123] B-BUS **MUST** open Ticket with faulty Seller

[R124] Once Ticket is closed by faulty Seller, S-BUS **MUST** close Ticket, notify Buyer and record event on the Upstream Bilateral Ledger.

10.4.1.6.10 Scenario K: Service not in operation, fault is internal

[R125] SCO **MUST** notify SOF of fault.

[R126] S-BUS **MUST** close Ticket, notify Buyer (“Acknowledged”) and record event on the Upstream Bilateral Ledger.

10.4.2 Fault Management Data Management

The following diagram illustrates the flow of information between functionalities of the reference architecture (S-BUS, B-BUS, SCO, SOF) and the ledgers (UBL, DB,L INT, Omni) through the Fault Handling process steps.

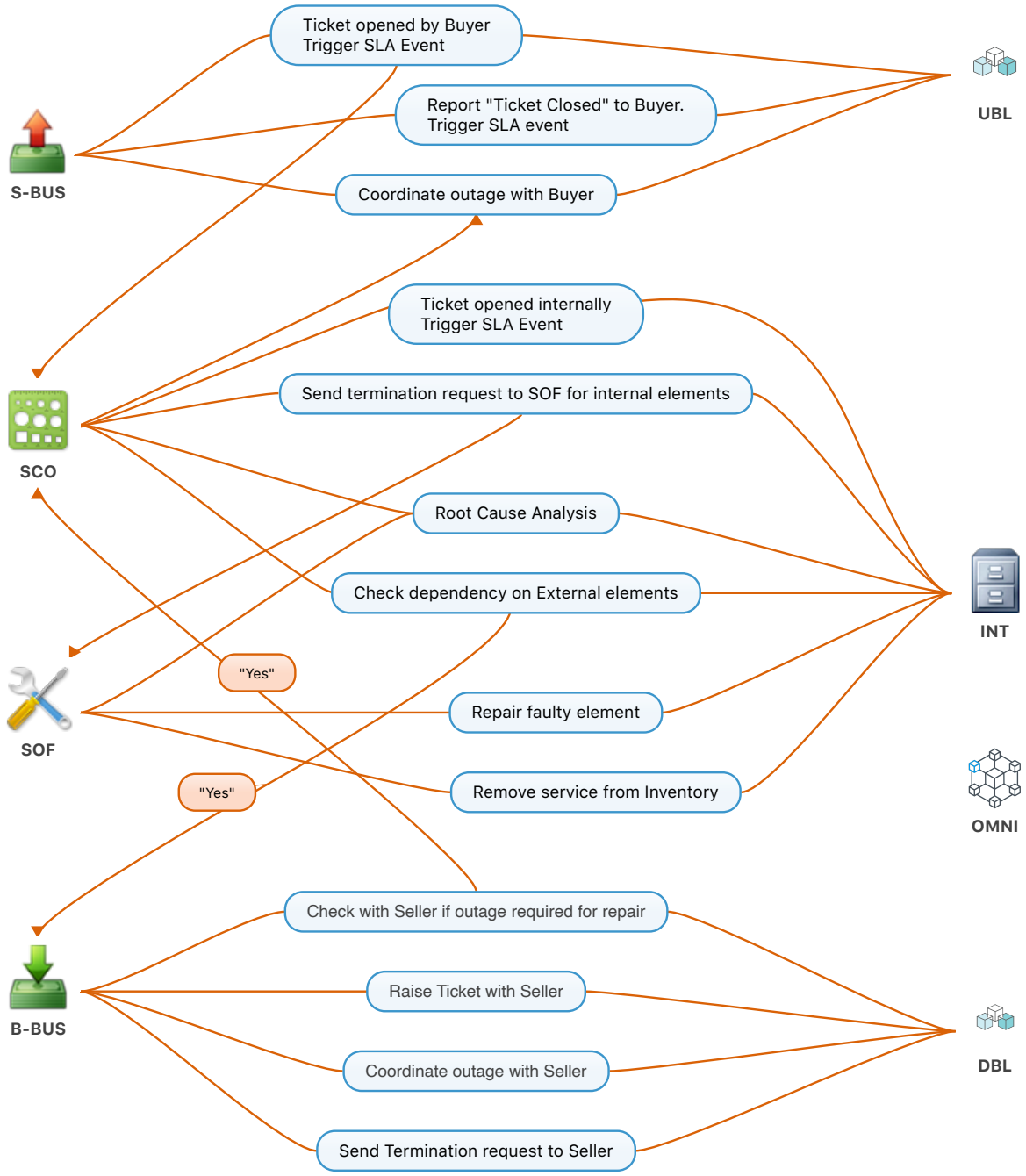


Figure 26 Fault Management Data Management

10.4.3 Performance Reporting

SP is responsible for monitoring performance and utilization of each internally and externally sourced element of service. The parameters to be monitored vary by service type and are subject to agreements between SP and its Buyer. MEF-52 [21] defines the framework by which performance monitoring and reporting is performed for services delivered on a multi-domain environment.

[R127] Trouble tickets and performance reports **MUST** include the respective Service ID.

10.4.3.1 Report Triggers/Generation

Reports may be triggered/generated in one of two ways:

1. Scheduled reports that are generated automatically at agreed upon intervals.
2. On-request reports that are triggered by any SP in the Supply Chain and apply to that SP and its Sellers.

[R128] SP **MUST** generate and propagate performance reports according to MEF 52 on a pre-defined and agreed-upon schedule/frequency.

[O25] SP **MAY** trigger the generation of non-scheduled performance reports from Sellers according to MEF 52.

[CR5]<[O25] SP **MUST** generate and propagate performance reports triggered by its Buyer.

10.4.3.2 Non-Scheduled Report Request Propagation

Propagation of a request for a non-scheduled performance report:

[R129] Upon receipt of a request for a non-scheduled performance report from the Buyer, S-BUS **MUST** record the request on the Upstream Bilateral Ledger and forward to SCO.

[R130] Upon receipt of request from S-BUS, SCO **MUST** request from SOF a report for each and every internally-sourced Service Element.

[R131] Upon receipt of request from S-BUS, SCO **MUST** request from B-BUS a report for each and every externally-sourced Service Element.

[R132] Upon receipt of request from SCO, B-BUS **MUST** request from all Sellers a report for each and every externally-sourced Service Element and record on the respective Downstream Bilateral Ledger(s).

10.4.3.3 Performance Reporting Process

Collection and aggregation of report data in performance reports is identical for both scheduled and unscheduled performance reports.

[R133] Upon receipt of performance report from a Seller, B-BUS **MUST** log the data in the respective Downstream Bilateral Ledger and forward it to SCO.

[R134] Upon receipt of request for non-scheduled report from SCO as well as based on interval, SOF **MUST** record performance of internally-sourced Service Elements and report them to SCO.

[R135] SCO **MUST** aggregate the performance data for all internally and externally-sourced Service Elements based on chaining sequence and topology and generate SP-End performance report.

[R136] SCO **MUST** send its aggregated performance reports to S-BUS.

[R137] S-BUS **MUST** record the performance report on the Upstream Bilateral Ledger and forward to Buyer.

10.4.3.4 Non-Scheduled Performance Reporting process diagram

The following diagram illustrates the process flow of non-scheduled performance reporting.

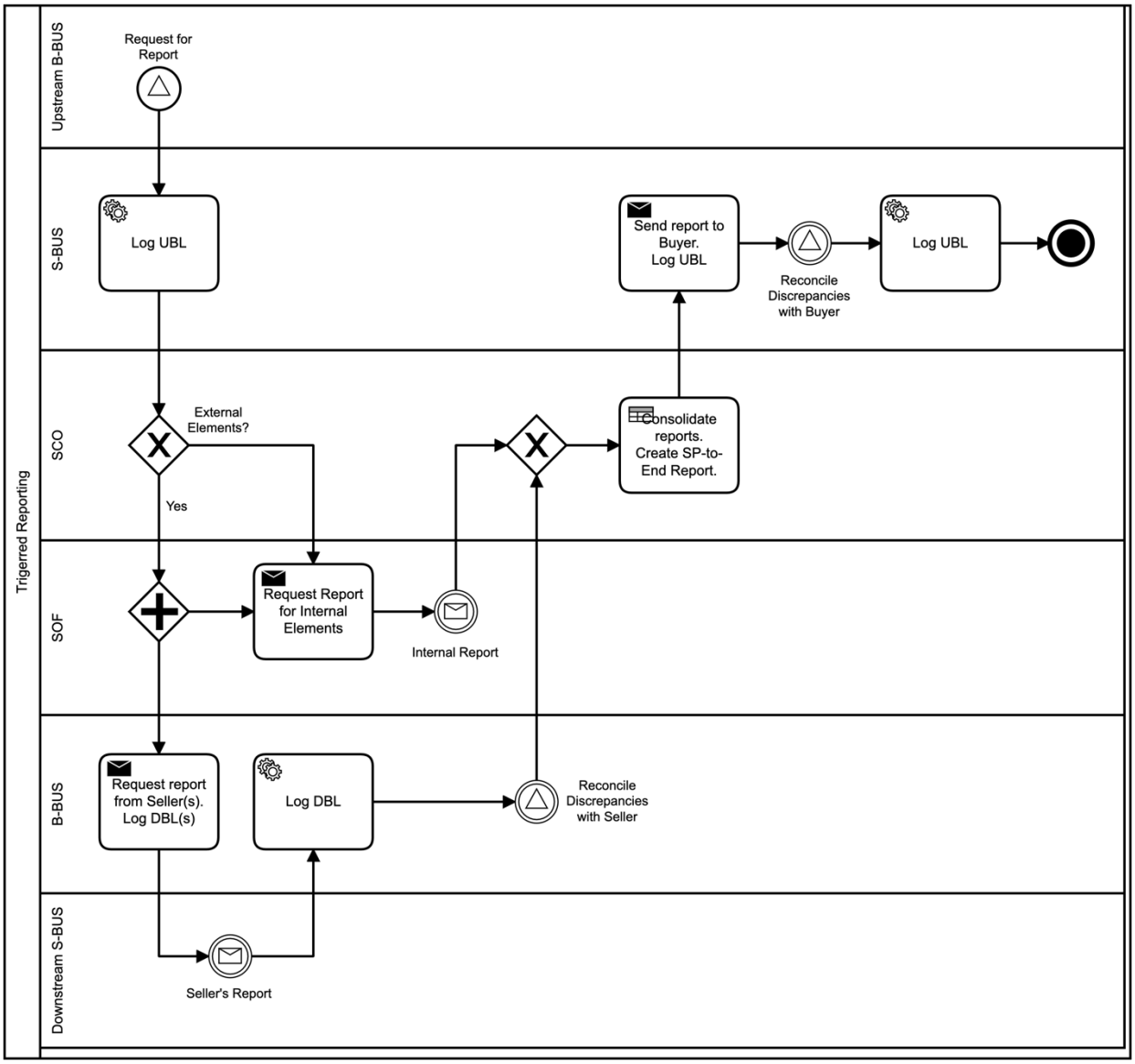
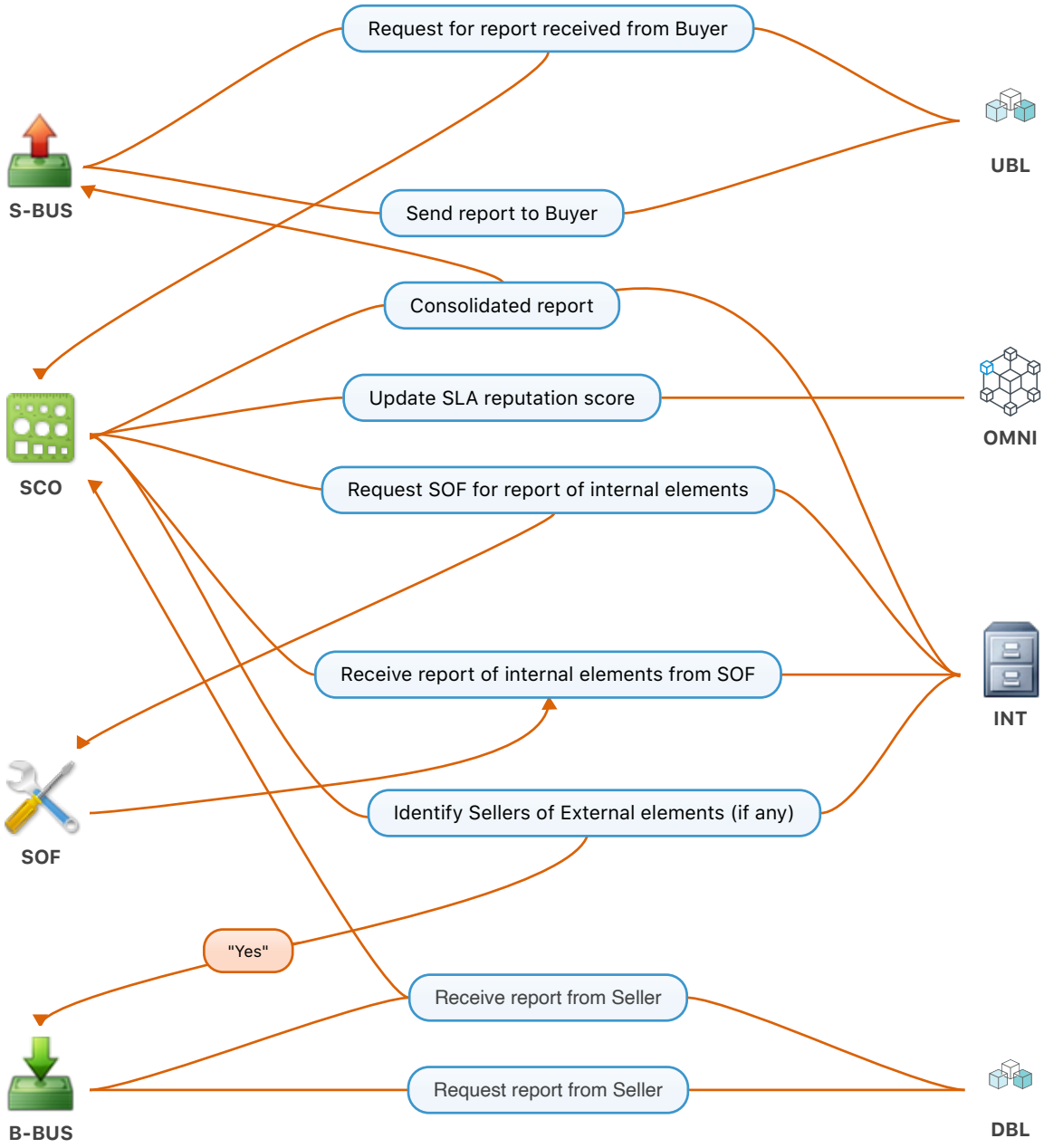


Figure 27 Non-Scheduled Performance Reporting Process

10.4.3.5 Non-Scheduled Performance Reporting data management

The following diagram illustrates the flow of information between functionalities of the reference architecture (S-BUS, B-BUS, SCO, SOF) and the ledgers (UBL, DBL, INT, Omni) through the non-scheduled performance reporting process steps.



*

Figure 28 Non-Scheduled Performance Reporting Data Management

10.4.3.6 Non-Scheduled Performance Reporting Sequence Diagram

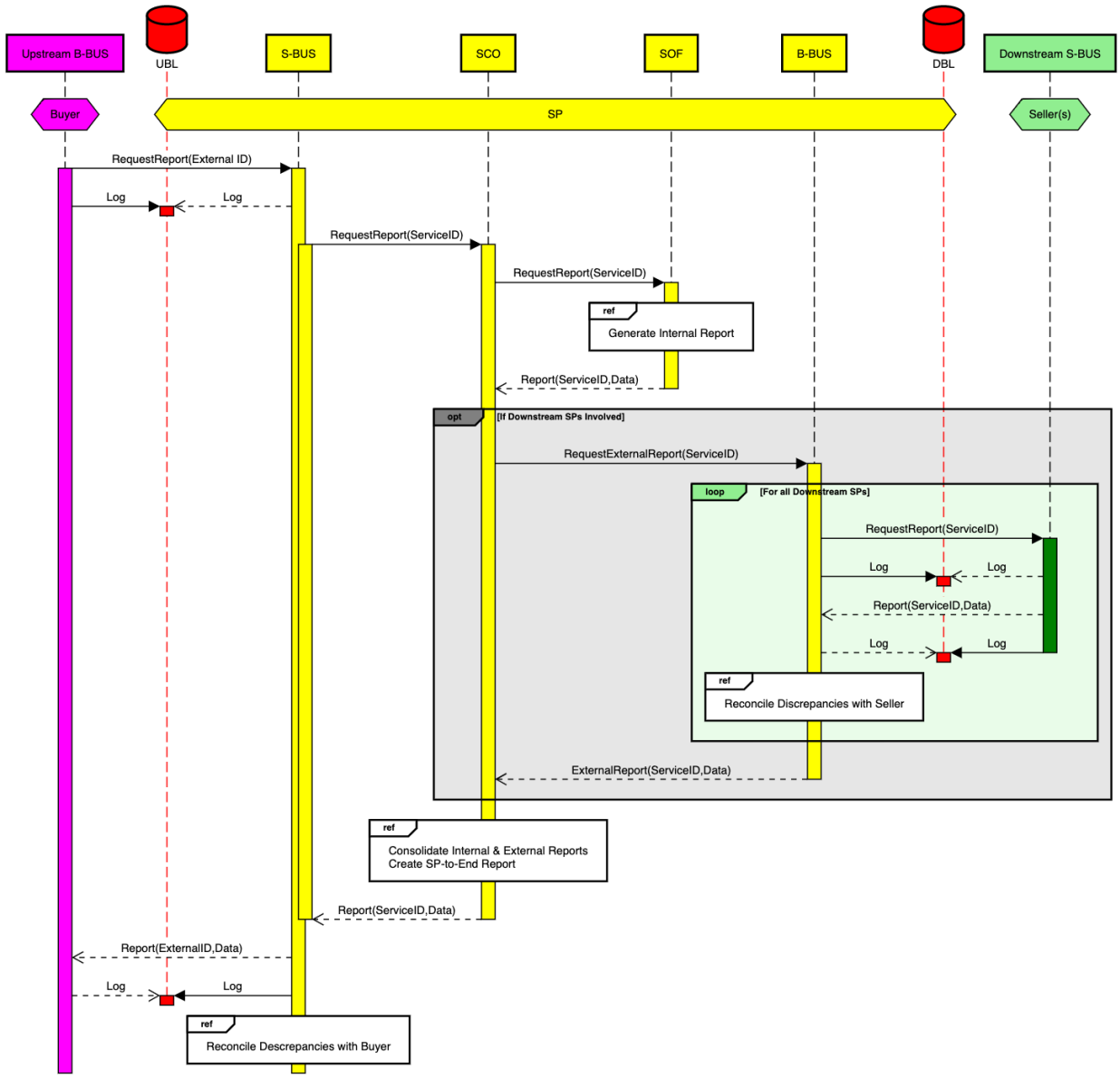


Figure 29 Non-Scheduled Performance Reporting Sequence Diagram

10.4.3.7 Scheduled Performance Reporting process diagram

The following diagram illustrates the process flow of scheduled performance reporting.

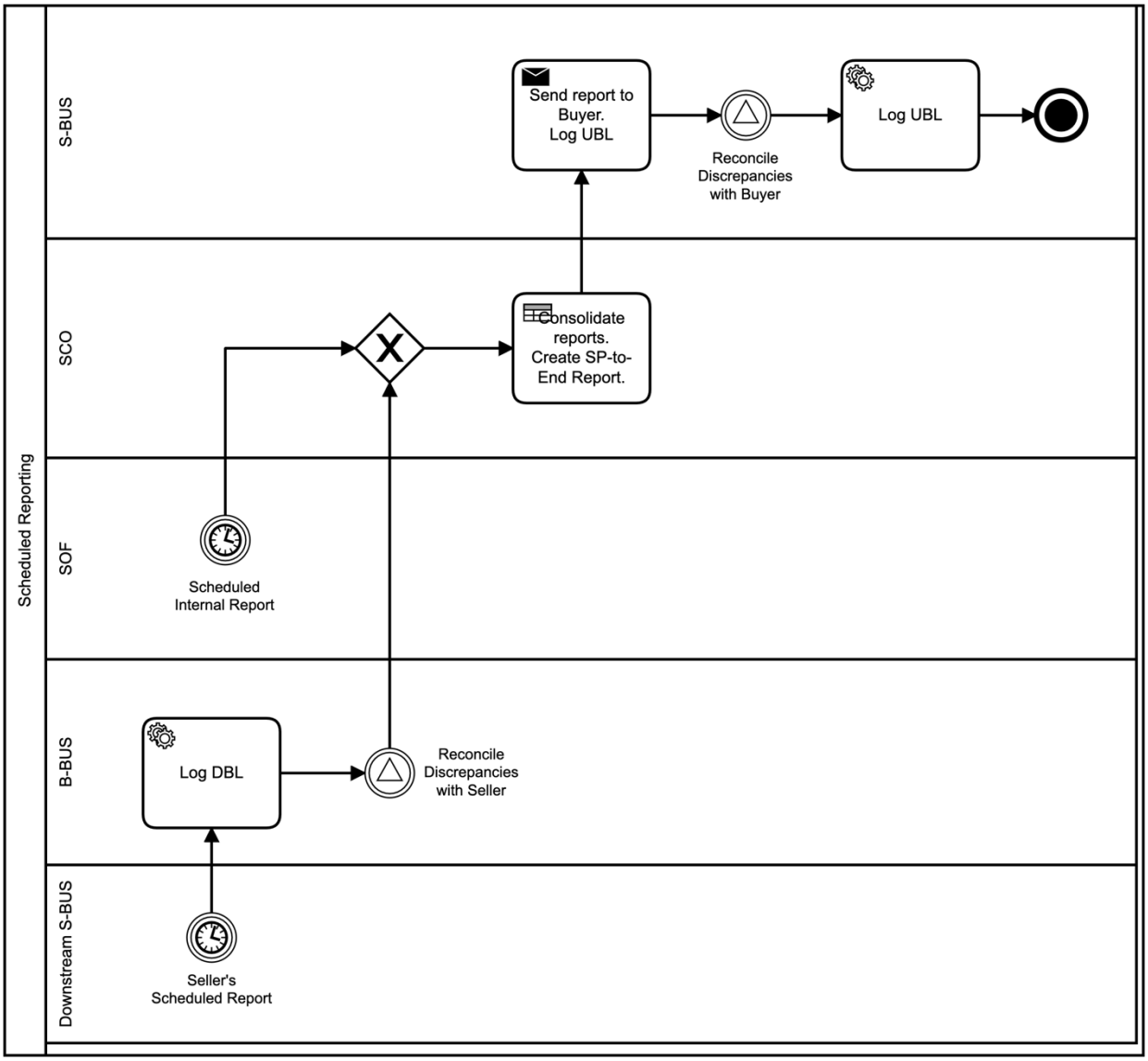


Figure 30 Scheduled Report Process

10.4.3.8 Scheduled Performance Reporting data management

The following diagram illustrates the flow of information between functionalities of the reference architecture (S-BUS, B-BUS, SCO, SOF) and the ledgers (UBL, DBL, INT, Omni) through the scheduled performance reporting process steps.

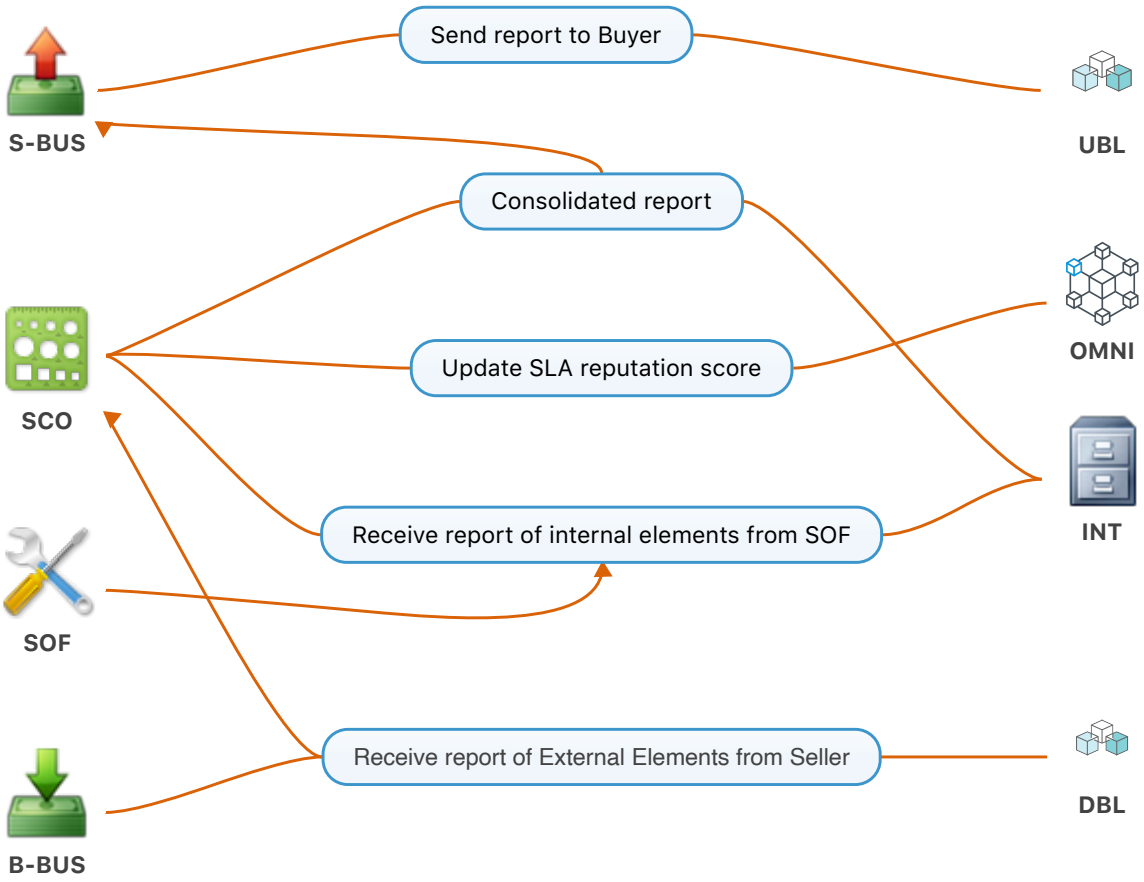


Figure 31 Reporting Data Management

10.4.3.9 Scheduled Performance Reporting Sequence Diagram

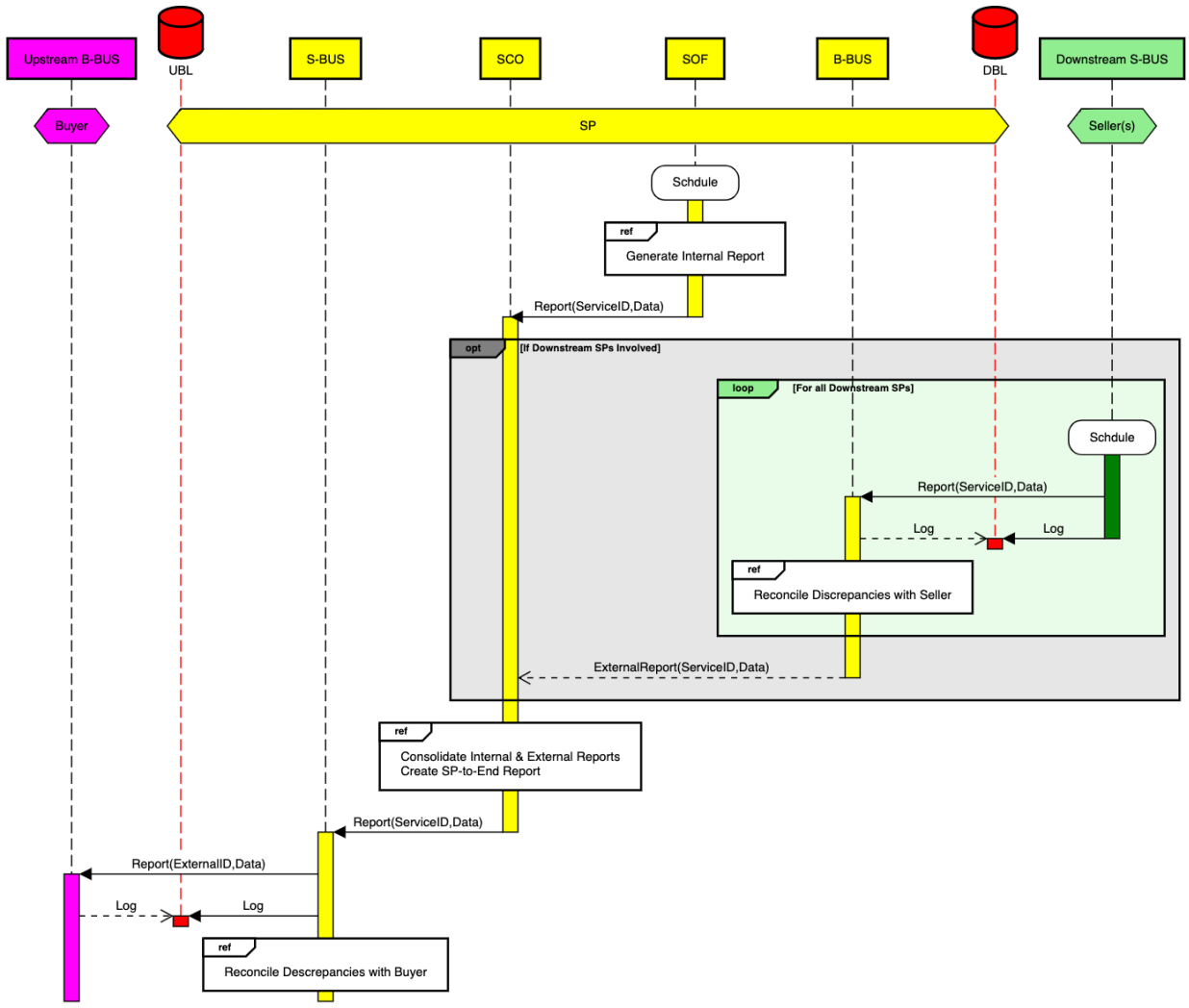


Figure 32 Scheduled Performance Reporting Sequence Diagram

10.5 Billing

10.5.1 Introduction

Billing is divided into four consecutive processes:

- Rating
- Invoicing
- Reconciliation
- Settlement

Specific considerations for on-demand services:

- Billing intervals may cover multiple service instances.
- Each billing interval must be identifiable for SLA credit negotiation and settlement purposes.

10.5.2 Rating

For the purpose of this document, the 'rate' is the monetary value of the unit of measurement of a service. For example: 5 cents per minute; US$1 per mile; 0.05 cent per CPU cycle etc.

Rating is the application of a rate to a service. Based upon agreed billing interval, utilization records for said interval are matched with and multiplied by agreed upon contracted rates yielding rated utilization records. These records are then fed into the invoicing process.

[R138] S-BUS **MUST** rate utilization records according to agreed-upon and contracted rates between SP and Buyer.

[O26] SP rating process **MAY** include application of discounts based on volume or type of data transactions as mutually agreed by both parties.

10.5.3 Invoicing

Invoicing is the process of generating an Invoice and sending it to the Buyer.

Each SP in the Supply Chain invoices its Buyer (Upstream SP or an enterprise/retail customer) for the services the Buyer has consumed. The invoice is based on marked-up cost of externally-sourced Service Elements, if relevant, as well as list price or marked-up cost of internally-sourced Service Elements.

If rated utilization records are available, the Seller may aggregate them per contract or generate an individual invoice per rated utilization record. Alternatively, invoice will be based on a fixed fee. The frequency and type of invoicing is subject to agreement between the parties and according to the specifications in MEF 74.

[R139] SP **MUST** invoice the Buyer as per the contract between them with regards aggregation of items, frequency of invoicing and type of invoice.

[R140] SP **MUST** invoice in conformance to MEF 74.

[R141] SP **MUST** load the invoice to the Upstream Bilateral Ledger and notify the Buyer.

[R142] SP **MUST** invoice based on contracted payment method (e.g. FIAT currency, crypto-currency or stablecoin) as agreed by both parties.

[R143] SP **MUST** be able to generate printed originals or human-readable electronic versions of invoices if required by the Buyer or by local regulations and/or legislation.

[D23] The notification of the Buyer **SHOULD** be automated through a Smart Contract.

[O27] The SP issued invoice **MAY** include one-off charges, service credits based on SLA, penalties, refunds, discounts and taxes.

[O28] SLA credits **MAY** be calculated on a per-service-instance basis or be aggregated in agreed-upon forms in conformance with MEF 74.

10.5.4 Rating and Invoicing process diagram

The following diagram illustrates the process of Rating and Invoicing and describes the sources of information that may be used during this process.

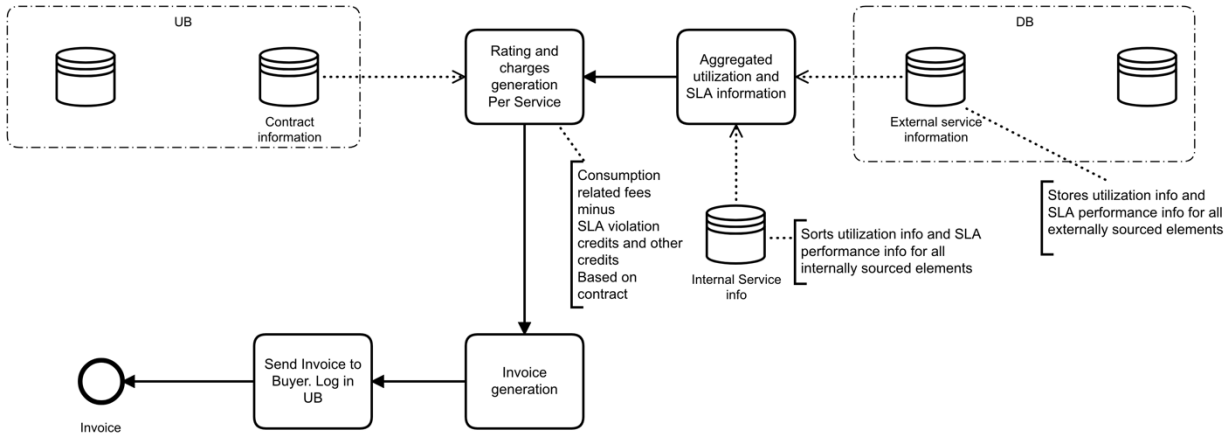


Figure 33 Rating and Invoicing Process

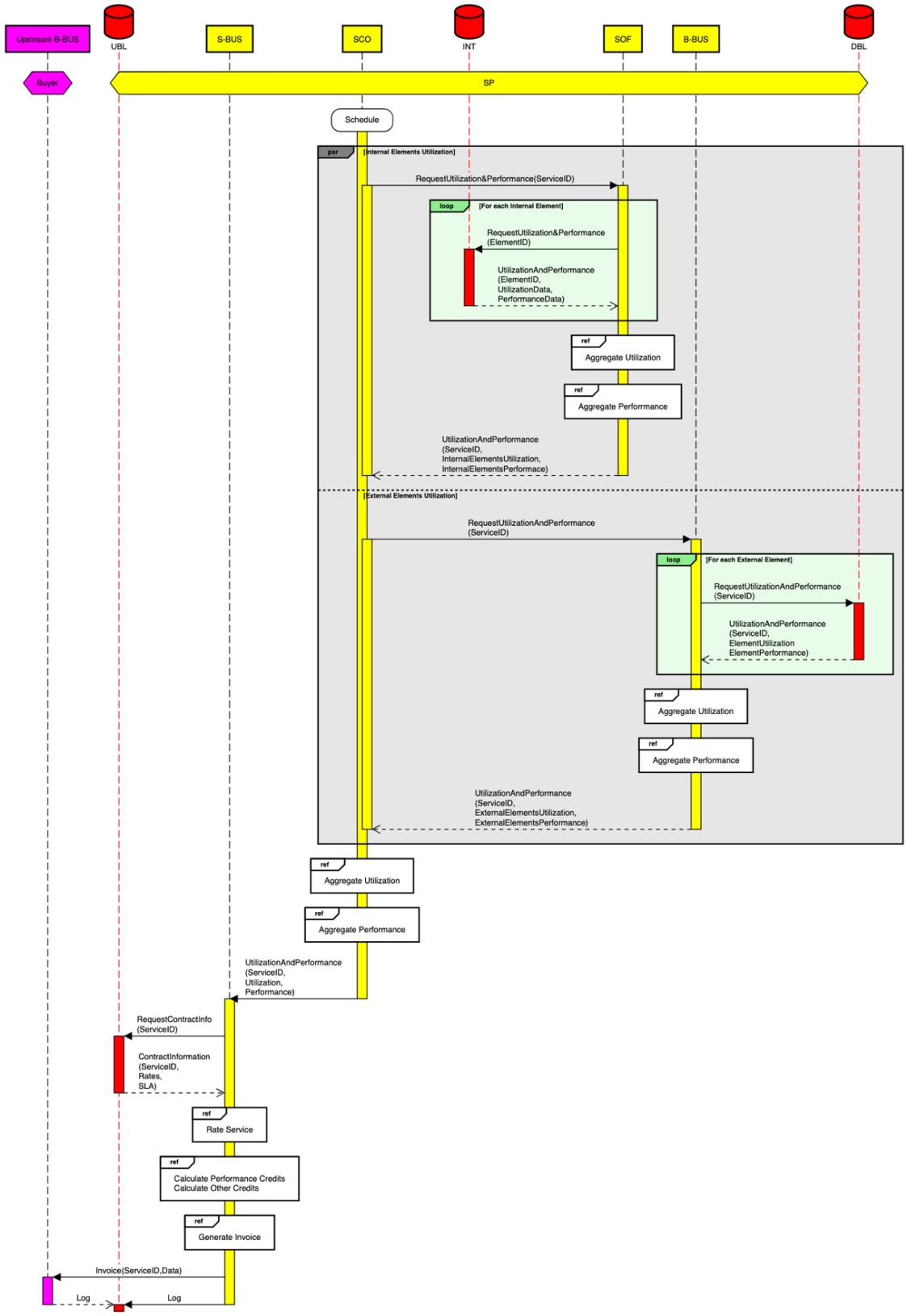


Figure 34 Rating and Invoicing Sequence Diagram

The Data Model for Invoice is out of scope of this document and requires further study in the context of MEF Object Models (MOM) standardization work.

Table 3 extends Section 7.3 in MEF 74 titled 'Payments and settlements' with an additional column describing the role DLT can play in this part of the settlements process.

Payment Attribute Term	Definition	DLT Role
Credit Score	The amount of confidence a seller has with the buyer to pay their bills. Example: the customer has missed the due date an average of one out of 4 of its last payments, thus it has been given a credit score of 75%.	See entry in next row.
Payment History/Payment Record/Payment cycle time	The duration from forwarding an invoice from seller to buyer until payment of same is received by the seller. Example: Payment was received an average of 45 days after invoice date.	Credit reputation can be associated with an SP pseudonymously through Omni-Lateral Ledger. DLT may be used to support the need for entities to state different payment terms (1x1, 3x1, 7x7, 15x15, 30x15, 30x30, 45x45 etc.), facilitated by way of a smart contract between two entities. Payment cycle time can be automatically calculated on a regular basis.
Credit Allocation	The amount of monetary funds that a buyer can consume prior to making payment to seller. This is typically derived from credit score and payment history. Example: the customer has been allocated a USD 5000 credit.	Credit reputation can be associated with an SP pseudonymously through Omni-Lateral Ledger.
Deposit	An amount pre-paid by the buyer to the seller prior to consuming services. This is typically derived by multiplying the [Recurring Selling Price (in the event of a fixed recur-ring amount) or the estimated recurring amount to be billed (in the case of usage-based recurring amount)] by the Payment History.	DLT may be used to allocate FIAT stable coin and stable coin or Crypto assets with the ability to perform atomic swaps to facilitate exchange between a diverse set of currencies. Token balances bay be used for deposit or as a replacement to deposits.
Payer	An entity that pays or is requested to make a payment to another entity. This will typically be the same entity as the buyer, though "Buy/Sell" typically refers to services and products while "Pay/Receive" typically refers to monetary exchange.	It is recommended that Know-Your-Customer and Anti-money laundering laws be part of the entry process when entities conduct business with each other in the CBAN. Adopting a financially regulated environment where compliance checks can be independently carried out should be a pre-requisite to payment finality for anyone operating within the CBAN. KYC documents should be stored in a decentralized Self-Sovereign Identity so they can be re-shared with other entities.
Payee/Receiver	An entity that request and/or receives a payment from an-other entity.	Same as for Payer.

Payment Attribute Term	Definition	DLT Role
Settlement	The process of analysing the amount a Payer is invoiced by the Payee, comparing the resource usage and the monetary amounts associated with use of the resource as per commercial agreement, identifying the differences between the Payee's records and calculations to those of the payer. The differences may be settled either automatically or manually through algorithms.	Settlement cycles can be triggered by the smart contract. Elimination of dispute about source data (does not eliminate dispute about commercial aspects). Elimination of commercial dispute through Smart Contracts. Automated reconciliation.
Payment	Transfer of monetary funds from payer to payee. A Payment may cover multiple services or products.	Use of FIAT-to-settlement token and settlement token-to-FIAT atomic swaps to facilitate money in/out to a diverse set of currencies. Automated payment finality using settlement tokens (requires all members of the CBAN can send/receive payments within the network environment). An immutable audit trail on any settlement logs and transactions. All negotiated, contracted expectancies, such as payment terms, SLA, agreed costs based on units of measure data, as well as any cost associated with any SLA deviation could be supported through automation via DLT.

Table 4 Financial and Commercial Terms

10.5.5 Reconciliation

Reconciliation is defined for the purposes of this document as the process of reaching agreement on the amount to be settled between neighboring entities in the Supply Chain (i.e. Buyer and Seller).

Upon receipt of an invoice from the Seller, SP compares the details and amounts in the invoice with its own records (agreement, utilization records, SLA performance).

Figure 18 describes how an SP can estimate the amount it will be charged by its Sellers through applying the business logic stipulated in the agreements with its Sellers on the utilization records and SLA records it has stored in the respective Repositories. The amount may differ from the amount actually invoiced by the Seller, which may trigger a dispute resolution process.

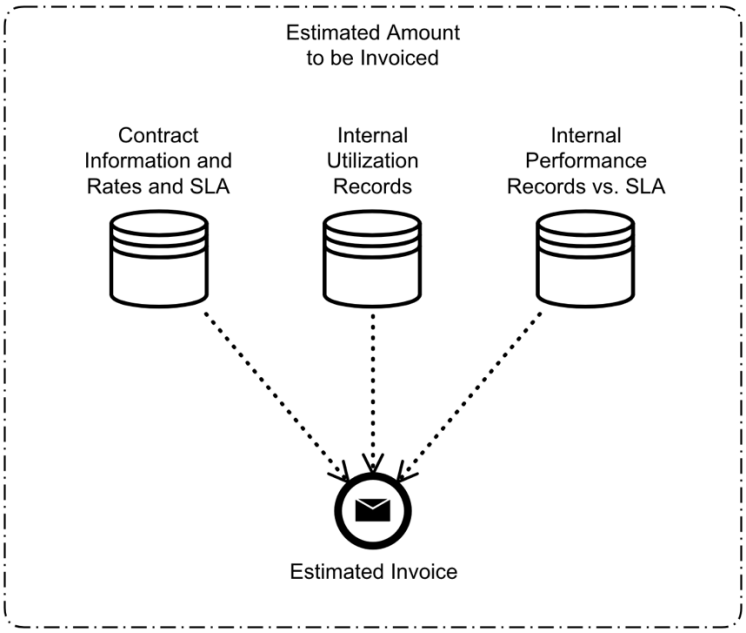


Figure 35 Estimating charges

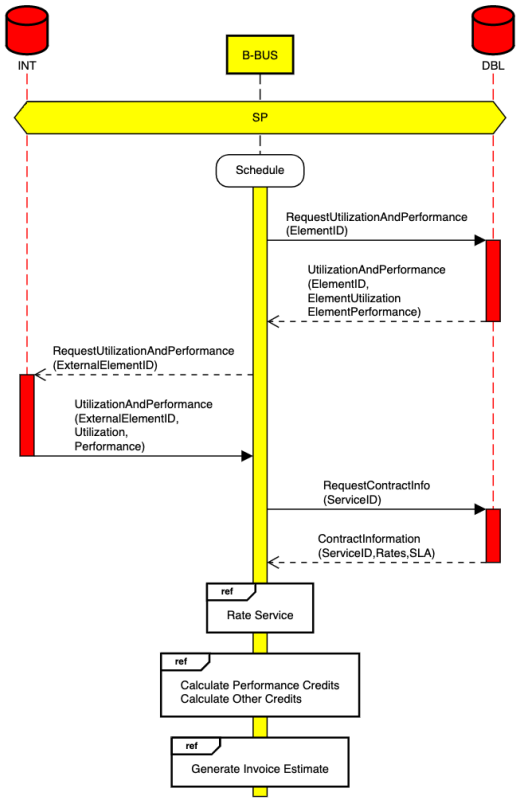


Figure 36 Invoice Estimation Sequence Diagram

10.5.5.1 Discrepancies

If the SP determines that there is no discrepancy, or if the discrepancy is below its self-defined threshold, the SP may set the settlement amount equal to the invoice amount.

If the SP determines that there is an actionable discrepancy, it may raise a dispute that triggers a dispute resolution process. The dispute resolution process may be automated as per prior agreement between Buyer and Seller or it may be manual or a combination of the two.

[O29] Buyer **MAY** dispute an invoice received from the Seller.

10.5.5.2 Dispute Threshold

The dispute threshold is a value set by each SP. When the discrepancy is above the dispute threshold, the SP will trigger a dispute resolution process, and conversely, when below the threshold, it will accept the invoice.

10.5.5.3 Dispute Resolution

The reconciliation and dispute resolution processes may vary depending on agreement between each pair of Buyer and Seller. The methods and algorithms of resolving a dispute are beyond the scope of this document.

[O30] Subject to contract the parties **MAY** agree to perform partial reconciliation and settle some of the pending invoice/invoices while continuing reconciliation of others.

[D24] Dispute thresholds **SHOULD** be implemented by a Smart Contract on the Bilateral Ledger.

[R144] If a dispute is triggered by an SP, it **MUST** be resolved either (a) manually, (b) automatically or (c) through a mix of both.

10.5.5.4 Finality

The end result of the reconciliation process is final and binding to both parties.

[R145] Upon completion of the Reconciliation process, a final and binding mutually-agreed-upon invoice **MUST** be loaded to the bilateral ledger.

[CO1]<[O30] The partially reconciled invoice **MUST** be uploaded to the bilateral ledger.

[CO2]<[O30] The unresolved elements **MUST** remain open for future reconciliation.

10.5.5.5 Dispute Resolution and Reconciliation process diagram

The following diagram illustrates the Dispute Resolution and Reconciliation process.

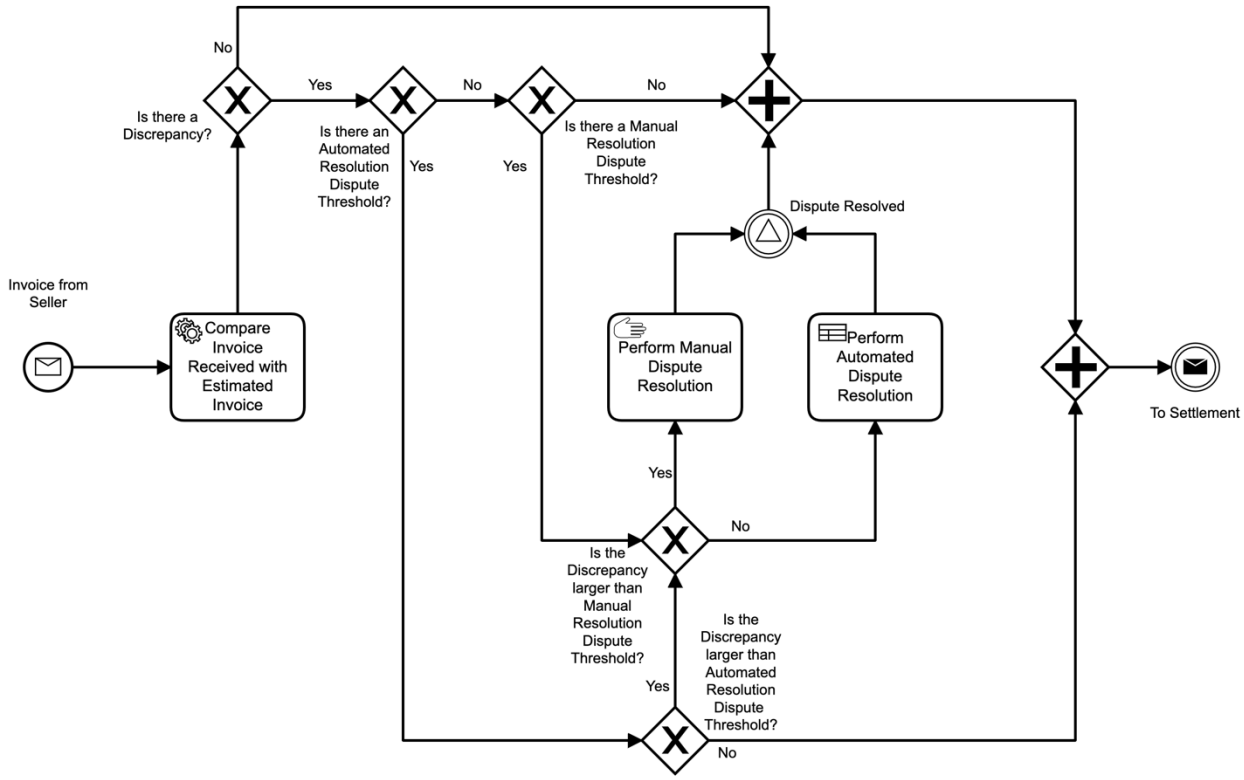


Figure 37 Dispute Resolution and Reconciliation process diagram

10.5.5.6 Dispute Resolution and Reconciliation data management

The following diagram illustrates the flow of information between functionalities of the Reference Architecture (S-BUS, B-BUS, SCO, SOF) and the Repositories (UB, DB, INT, Omni) through the Dispute Resolution process steps.

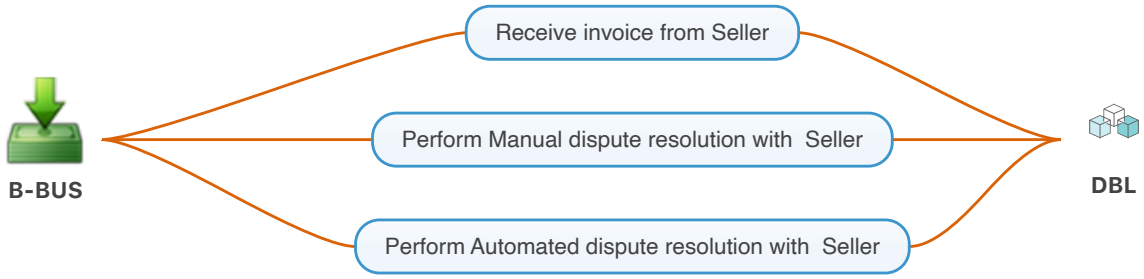


Figure 38 Dispute Resolution Data Management

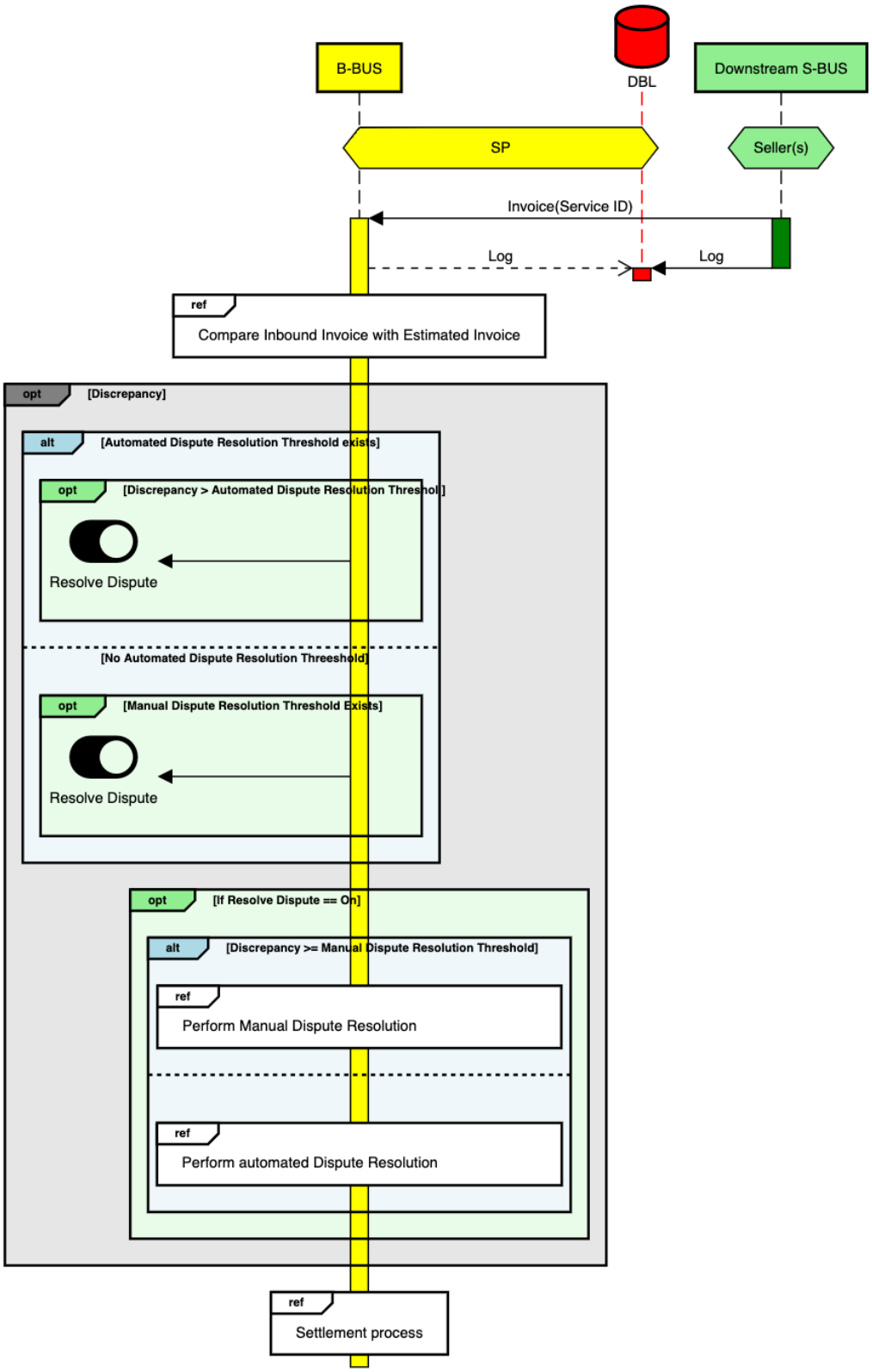


Figure 39 Dispute Resolution and Reconciliation Sequence Diagram

10.5.6 Settlement

Settlement is the transfer of monetary funds between parties based on invoicing and reconciliation.

10.5.6.1 Payment

Upon completion of reconciliation the parties settle through payment of the agreed upon amount between the parties.

[R146] The payment **MUST** take form of one of the following: (a) transfer of a fiat currency, (b) an electronic transaction of a stablecoin (a crypto-currency whose value is pegged to a fiat currency) or (c) a crypto-currency transaction.

[R147] The form of payment **MUST** be agreed upon by both parties in the contract.

[R148] Payment **MUST** be made in accordance to the terms stipulated in the agreement.

10.5.6.2 Netting

Netting is the act of subtracting the amounts due by two parties to each other. In the event that the parties have reciprocal services (both buy and sell with each other) the settlement may include netting of pending amounts where the actual amounts being transferred will be the net amount. In such event the pending amount of one SP is subtracted from the pending amount of the bilateral SP and the net amount, after such subtraction, is being transferred from one SP to the other.

Net Amount = (amount owed by A to B) – (amount owed by B to A)

If (amount owed by A to B) > (amount owed by B to A) A pays to B, otherwise B pays to A.

[O31] If two SPs have a bilateral agreement they **MAY** net their invoices as part of the settlement process.

[CO3]<[O31] The Netting **MUST** be recorded in the Bilateral Ledger.

10.5.6.3 Netting and Payment process diagram

The following diagram illustrates the Netting and Payment process flow.

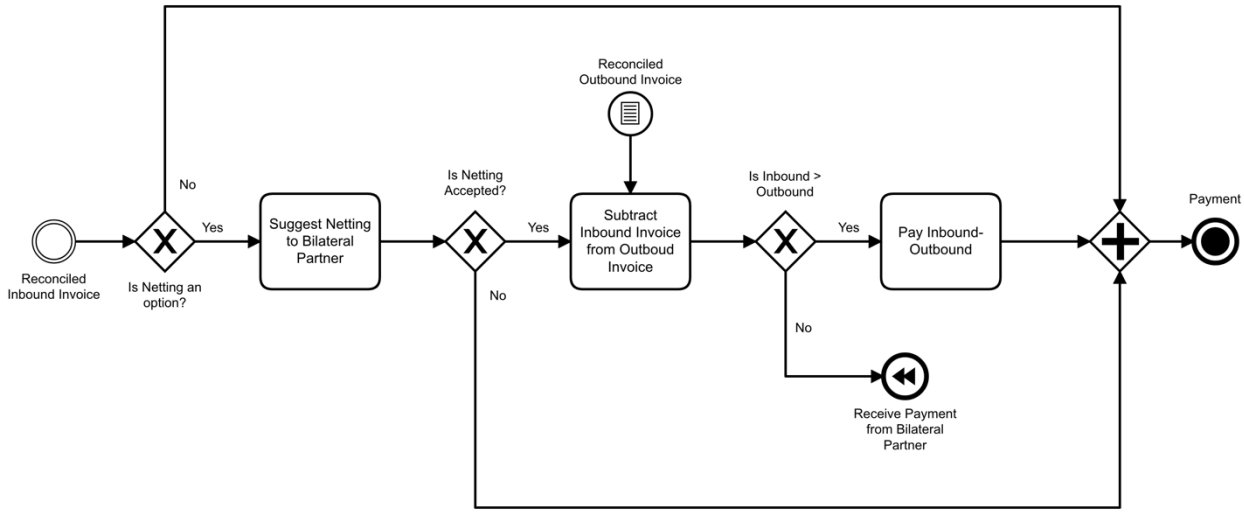


Figure 40 Payment and Netting process flow

10.5.6.4 Netting and Payment data management

The following diagram illustrates the flow of information between functionalities of the reference architecture (S-BUS, B-BUS, SCO, SOF) and the ledgers (UBL, DBL, INT, Omni) through the Payment process steps.

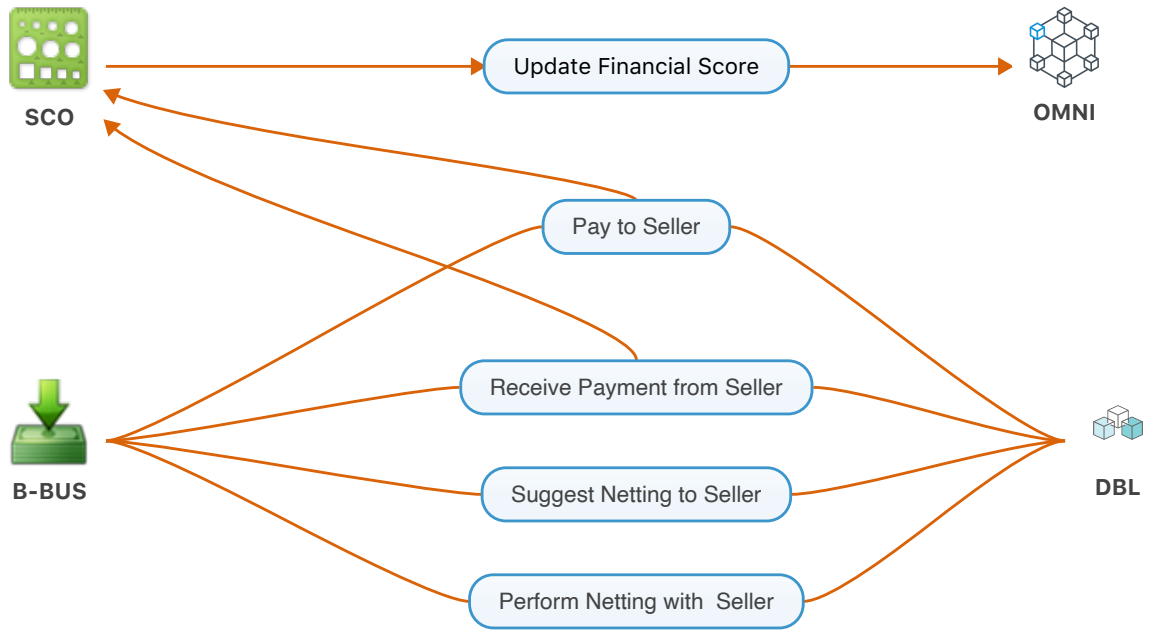


Figure 41 Payment Data Management

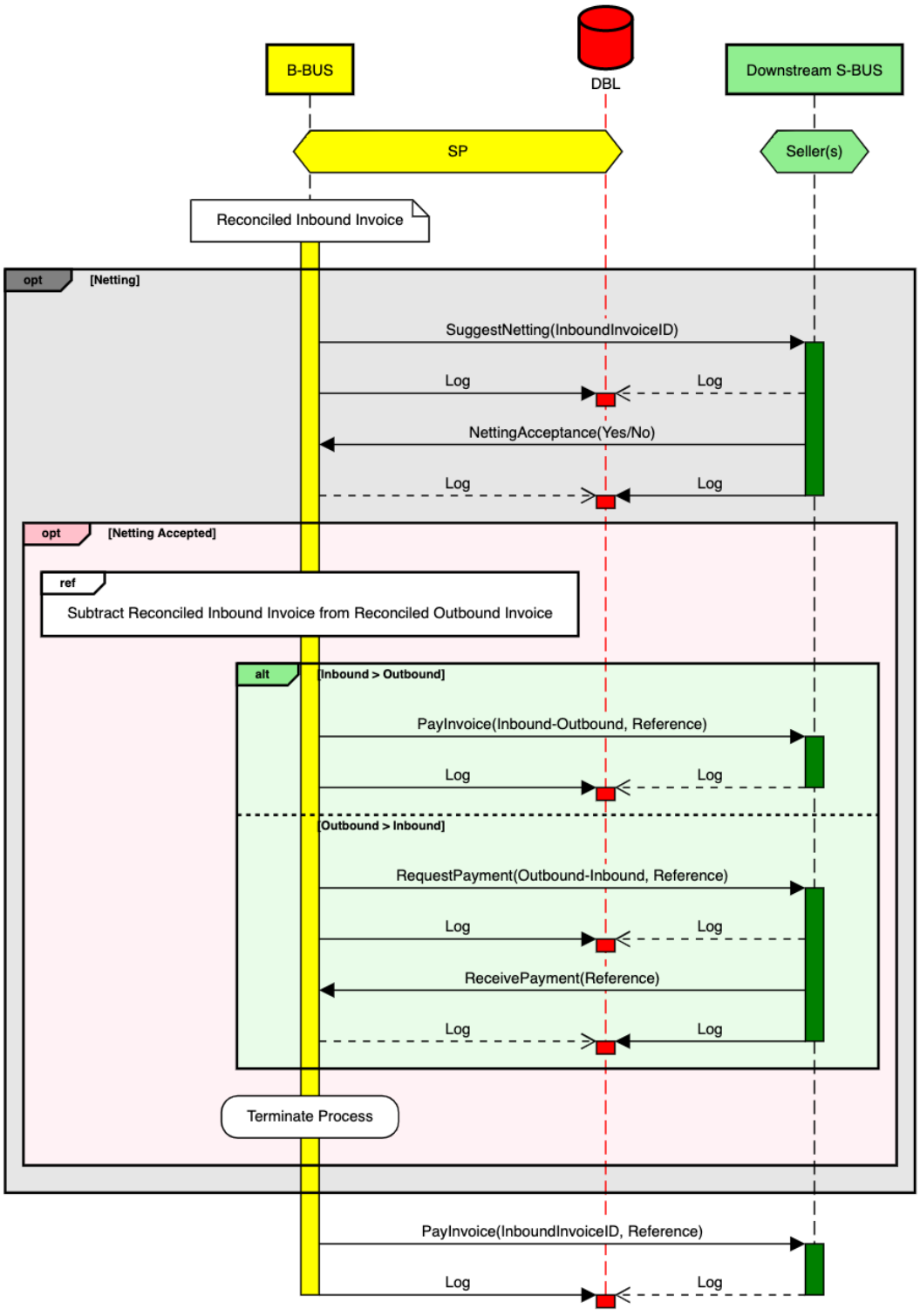


Figure 42 Payment and Netting Sequence Diagram

10.5.6.5 Credit Notes

Credit notes are forms of payment used when the amount due by one party to the other is negative. Such events result from SLA credits, overpayments, recalculations or netting arrangements. Credit notes are settled through the same process as invoices as described in Section 10.5.3 above.

[D25] Credit notes **SHOULD** be settled through the same processes and methods as invoice settlement.

10.6 Reputation Management

Reputation of the SP is an indicator of its capabilities and reliability, and may play a factor in being selected for participation in a Supply Chain. This document describes two forms of reputation and how the features of a DLT can be utilized to generate trustworthy reputations.

10.6.1 SLA Reputation

SLA reputation represents a weighted moving average of the deviation between actual performance and performance specified in the SLA. The actual performance is derived from measurement of service parameters defined in Section 10.4.3 (Performance) and from outage or fault repair information defined in section 10.4.1 and 10.4.2 (Fault).

[R149] SP **MUST** derive actual performance from measurement of service parameters defined in Section 10.4.3 (Performance) and comparison to SLA commitments.

The SLA reputation is defined as a normalized score that spans between 0.0 (lowest score, complete failure to meet the SLA) and 9.9 (highest score, no SLA violations).

[R150] SP **MUST** generate, using the WMA(t) formula described in this section, a normalized SLA Reputation score between 0.0 to 9.9 representing their ability to meet the metrics defined in the SLA.

[D26] SP **SHOULD** record SLA Reputation score in [R137] to Omni-Lateral Ledger through consensus with its neighboring SPs.

The SLA score is calculated based on a weighted moving average (“WMA”) algorithm that gives higher value to recent performance records compared to historical performance records. C(t) is the performance of record "t” where “t” represent the latest record that was recorded, “(t-1)” is the previous record and so on.

The WMA is calculated as follows:

$$WMA(t) = \frac{n \cdot C(t) + (n-1) \cdot C(t-1) + \cdots + 2 \cdot C(t-n+2) + 1 \cdot C(t-n+1)}{n + (n-1) + \cdots + 2 + 1}$$

Or in shorter form:

$$WMA(t) = \frac{\sum_{j=0}^{n-1} (n-j)\, C(t-j)}{\sum_{i=1}^{n} i} \quad ; \quad Where\ n \geq 1$$

Where *n* is the duration of the longest instance of service to date, expressed as a discrete number of the time-measurement units used to measure the service (e.g. a “by-the-second” service will be measured by the number of seconds duration of the longest instance, while a “by-the-hour” service will be measured by the number of hours duration of the longest instance, not by the number of seconds). Meaning that if the

longest duration of instance of service to date has been 60.1 seconds, *n* will equal 60 and the WMA will be based on the last 60 records (previous records are ignored).

In the event that the number of performance records is smaller than *n* then *n* will equal the number of performance records.

[D27] SP **SHOULD** use the number of performance records that equals the number of time measurement units in the longest instance to date.

[CR6]<[D27] SP **MUST** use all available records in the event that the number of available records is less than the number defined in [D27].

C(t) is the performance of record t. It is measured and normalized to a value between 0.0-9.9 at the end of the service instance or at the time of measurement (which is applicable for long-term services that span longer than an agreed-upon measurement interval). The method of normalization is product specific and the per-product definition is beyond the scope of this document.

[R151] SP **MUST** make performance calculations at an interval that is less than or equal to average duration of the service type being measured.

[O32] SP **MAY** synchronize the timing of the performance calculations and SLA measurements.

[O33] SP **MAY** make performance calculations based on past performance information that was recorded in the Bilateral Ledger.

The overall score is calculated as the average of all the per-product scores.

[D28] SP **SHOULD** calculate average of all its per-product SLA Reputation scores and upload to the Omni-Ledger through consensus with its immediate Supply Chain neighbors.

[O34] SP **MAY** calculate per-product SLA Reputation score and upload to the Omni-Ledger through consensus with its immediate Supply Chain neighbors.

The score must be accompanied by the number of performance measurements it is based on in the following format: x.y:n where x.y is the score and n is the number of performance measurements. E.g. 8.9:132.

[CR7]<{[D28] OR [O34]} SP **MUST** specify on the Omni-Lateral Ledger the SLA Reputation score together with the number of performance measurements on which the score is based using the format “x.y:n” where x.y is the score and n is the number of performance measurements.

Additional technical performance metrics and scores out of scope of this document and are for further study.

10.6.2 Commercial Reputation

The Commercial Reputation score represents the payment and financial stability of the SP.

The Commercial Reputation score is calculated based on payment history and credit score of an entity (either an SP, an enterprise customer or a consumer). The score is derived from timeliness of payments, accuracy of payments, duration and effectivity of reconciliation process compared to a target performance defined in agreements signed between the entity and its suppliers.

The score may also take into account information received from external sources such as analyst reports and publicly available financial records.

The calculation formula for the Commercial Reputation score is out of scope of this document and is for further study.

10.7 Service Change Management

Service change management refers to changes made to in-operation service instances.

Service changes may include, but are not limited to:

- Termination of service.
- Change of service characteristics.
    - Change of QoS.
    - Change of a service parameter (Bandwidth, CPU, number of seats etc.)
    - Relocation of an endpoint.

With the exception of termination, a change to in-operation service instances may fall into one of two categories:

- Service changes that can be made without interrupting service (outage) such as:
    - Change of bandwidth
    - Change of QoS
    - Addition or removal of a service end-point in a multi-end-point service.
- Service changes that interrupt the service (outage) such as:
    - Relocation of an end point.
    - Change of CPU/RAM/OS/Configuration

The ordering process of a change to an in-operation service follows the same process as a new quote and a new order with the exception that the inquiry and order must state that they refer to an in-operation service (and include the service ID#) and the responses must state if the change can be performed with or without interruption to service.

[R152] SP requesting Service Change from one or more Sellers **MUST** specify in the request that this refers to an existing service and provide a Service ID#.

The implementation of a change may require a parallel build and a “cold” (downtime for re-cabling) or “hot” (software re-route) swap. In other cases, the implementation may not require a swap but may require software reconfiguration. If such implementation is expected to cause service interruption, it must be coordinated between the parties and agreed by the ultimate customer (ICT entity originating the request) and all SPs that are required to take action as a result of such change request (Note that in complex services changes to certain part of the service may not affect other parts, e.g. upgrade of bandwidth between two end points in a multi-point VPN may not affect the other end points in that VPN and may not require any action from the SPs delivering the elements of service related to those other locations).

[R153] SP receiving a Service Change request from a Buyer **MUST** indicate in the response the price for the Service Change and if service interruption (outage) is required and its estimated duration in order to perform the requested Service Change.

[R154] SP **MUST** coordinate a maintenance outage with its Buyer and Seller(s) prior to commencing the Service Change in the event that the Service Change requires such an outage.

[O35] Buyer **MAY** place the Service Change order in advance and specify the time for implementation.

11 Summary

The DLT-Based Commercial and Operational Framework defined in this document enables the automated implementation of data-on-demand services across a Supply Chain of SPs.

This document defines the constructs and processes required from an SP to become a standardized link (participant) in such a Supply Chain.

The use of DLT is a pre-requisite for the implementation of such Supply Chains and enables the use of Smart Contracts for automation of a range of business processes. This document defines constructs and processes without regard to specific DLT implementation.

The document defines SLA Reputation which can be used to assess suitability of a potential SP as a participant in any new Supply Chain.

12 References

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