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GROUP SPECIFICATION

Permissioned Distributed Ledgers (PDL); PDL in Settlement of Usage-Based Services

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Contents

Intellectual Property Rights	5
Foreword.....	5
Modal verbs terminology.....	5
Executive summary	5
Introduction	6
1 Scope	7
1.1 Introduction	7
1.2 In scope	7
1.3 Out of scope	7
2 References	7
2.1 Normative references	7
2.2 Informative references.....	7
3 Definition of terms, symbols and abbreviations.....	8
3.1 Terms.....	8
3.2 Symbols.....	9
3.3 Abbreviations	9
4 Management of Data in a multi-domain environment	9
4.1 Introduction	9
4.2 Sources of data	10
4.2.1 Single-Sourced data	10
4.2.2 Multi-Sourced data	10
4.3 Characteristics of Data	11
4.3.1 Introduction.....	11
4.3.2 Commercial value	11
4.3.3 Cost of transacting	11
4.3.4 Volume of data	12
4.3.5 Processing of Per-Item data and Aggregated data	12
4.3.6 Frequency of Reconciliation and Settlement	12
4.3.6.1 Term-based.....	12
4.3.6.2 Event-based.....	13
5 PDL Nodes in a multi-domain environment	13
5.1 Introduction	13
5.2 Number of nodes	13
5.3 Ownership of nodes.....	13
5.4 Location of nodes	13
5.5 Chain type	14
5.6 Data Sovereignty	14
5.7 Local legislation	14
6 Rating	14
7 Reconciliation.....	15
7.1 Definition of Reconciliation	15
7.2 Reconciliation prior to invoicing.....	15
7.3 Reconciliation after invoicing	16
8 Invoicing.....	17
8.1 Introduction to Invoicing.....	17
8.2 Invoicing occurrence	17
8.3 Invoice contents.....	17
8.4 Buyer-Seller entity multiplicity.....	18
8.5 Additional requirements related to Invoicing in a PDL enabled environment	18
9 Discrepancy and Dispute Management.....	18

9.1	Introduction to Discrepancies and Disputes	18
9.2	Dispute Threshold	19
9.3	Dispute Resolution	19
9.4	Finality	20
10	Settlement.....	20
10.1	Definition of Settlement	20
10.2	Payment.....	20
10.3	Netting.....	20
10.4	Netting and Payment process diagram	21
History	22

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Permitted Distributed Ledger (PDL).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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Executive summary

The application and use of PDL in settlement of usage-based services is discussed and analysed resulting in specifications, requirements and recommendations related to management of data sources, processes and actions related to commercial and commercial affecting attributes. The present document is broken down to three main parts: Data management, PDL node management and Settlement process, including Rating of usage records, discrepancy and dispute management and reconciliation, invoicing, and commercial settlement.

Introduction

Usage-based services are consumed in a manner that can be measured by units of measurement such as time, distance, speed, volume, temperature, pressure, and many other measurable attributes. An example of a measurable service would be a telephone call where the duration, destination and quality of the call can all be measured (each with a certain degree of accuracy). An in-depth discussion of measurable attributes related to the ICT sector can be found in MEF-74 "*Commercial Affecting Attributes*" [i.1].

A commercial rate can be applied to a measurement of a service giving the measurement a commercial value. Taking the example of a telephone call: Suppose the agreed rate between a buyer and a seller of telephony service is USD 0,50 per minute of call destined to the USA, and the buyer places a call whose duration is measured to be three minutes, the usage-based fee for such call would be USD 1,50.

A similar logic can be applied to other services in most areas of life:

- Household water consumption and the municipal water supply service.
- Agricultural produce and the wholesale/retail supply chain from the field to the consumer.
- Data Centre computation and storage capacity and the users of such services.
- Toll road usage, the toll road operators and the drivers of vehicles on such roads.
- And many more.

Once a record of usage has been established it may go through commercial processes of:

- **Rating** (see clause 6 herewith)
- **Dispute management and Reconciliation** (see clauses 7 and 9 herewith)
- **Invoicing** (see clause 8 herewith)
- **Settlement** (see clause 10 herewith)

Usage-based services differ from other consumables in that the amount of use of such service is not known until it had been actually used. This affects the way such services are billed for.

Payment for services may be performed in advance (when the service will only become available to the buyer after payment had been made) or in arrears (where payment is made after the service has been consumed). Regular services, that are not usage based, would be billed the same amount whether they are billed in advance or in arrears (e.g. some bridge or tunnel tolls are charge upon entry ad some upon exist). Usage-based services, however, will be treated differently if they are charged in advance, where the buyer will buy some balance in advance and will be able to use such service until their balance depletes (e.g. a pre-paid calling card) or in arrears, where the buyer pays for whatever service was consumed (e.g. a monthly telephone bill).

The present document discusses the application and use of PDL in settlement of usage-based services. It defines specifications, requirements and recommendations related to management of data sources, processes and actions related to commercial and commercial affecting attributes of such services.

The present document is broken down to three main parts: Data management, PDL node management, and Settlement process, including Rating of usage records, discrepancy and dispute management and reconciliation, invoicing and commercial settlement.

1 Scope

1.1 Introduction

The present document discusses and specifies the processes and methods of utilizing PDL in settlement of usage based services.

1.2 In scope

- a) Definitions of processes.
- b) Definitions and requirements related to PDL node management.
- c) Definitions of commercial and data management terms and operational methods.
- d) Definitions and specifications of dispute resolution stages and processes.

1.3 Out of scope

- a) Specific reconciliation and dispute resolution algorithms.
- b) Commercial agreements.
- c) Commercial data.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] MEF Forum, MEF-74, December 2018: "Commercial Affecting attributes".

- [i.2] ETSI GS PDL 012 (V1.2.1): "Permissioned Distributed Ledger (PDL); Reference Architecture".
- [i.3] ETSI GS PDL 022 (V1.1.1): "Permissioned Distributed Ledgers (PDL); PDL in Wholesale Supply Chain Management".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

billing: commercial process of invoicing, reconciliation, and settlement of amounts due by Buyer, Seller or bidirectional trading partners

NOTE: See MEF 74 [i.1].

buyer: entity that buys a service from a Seller of which it is an immediate neighbour in the Supply Chain

Call Details Record ("CDR"): digital record containing information related to a telephone call traversing a telephone network

commercial agreement: agreement between two parties allowing for buying services, selling services between them or both

compute: act of manipulating data or acting based on data using a computing resource

connectivity: act of transporting data through space

data: information related to the characteristics and usage of services

NOTE: This term is generic and may have other interpretations in other documents. This definition is specific to the context of the present document.

data service: service that combines one or more of the following:

- Connectivity service
- Compute service
- Storage service

domain: group of ICT elements administered and operated by an entity and subject to specific rules, regulations and procedures

gas cost: cost of performing a blockchain transaction

Internet of Things ("IoT"): network of physical objects that are embedded with sensors, software and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet

invoicing: process in which the Seller generates and sends an invoice to the Buyer for the amount stipulated by an agreement and based on utilization information and SLA or other credits as applicable based on agreement

multi-domain environment: ICT environment where multiple domains exist and are managed by different entities

netting: subtracting amounts due by two parties to each other resulting in a net amount owed by one party to the other and a zero amount owed by the other party

rating: application of a commercial rate to a usage record

reconciliation: process of reaching agreement in case of a dispute

NOTE: See MEF 74 [i.1].

seller: entity that sells goods or a service to a Buyer of which it is an immediate neighbour in the Supply Chain

Service Level Agreement (SLA): contract between the Buyer and Seller specifying the service level commitments and related business agreements and penalties related to failure to meet such service level for a service

settlement: transfer of monetary funds between parties based on billing and reconciliation

supply chain: collection of entities that in combination deliver one or more goods or end-to-end services through bilateral agreements

transaction point: physical or virtual meeting place between a buyer and seller where transactions are being performed

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CDR	Call Details Record
CPU	Central Processing Unit
DLT	Distributed Ledger Technology
ETSI	European Telecommunications Standards Institute
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
ICT	Information and Communications Technology
ID	Identification/Identity Document
IoT	Internet of Things
ISG	Industry Specification Group
MBPS	MegaBits Per Second
MEF	MEF Forum

NOTE: Formerly known as "Metro Ethernet Forum".

PDL	Permissioned Distributed Ledger
PoC	Proof of Concept
SLA	Service Level Agreement
USD	United States Dollar
VAT	Value Added Tax

4 Management of Data in a multi-domain environment

4.1 Introduction

When handling data in a multi-domain environment the following aspects should be considered:

The source of data:

- a) How is it measured?
- b) By whom?
- c) Can the data be measured by more than one entity or in more than one point?

The different characteristics of data:

- a) The direct or derived commercial value of the data or that the data defines/describes.
- b) The volume of data.
- c) The cost of transacting the data.

The following clauses discuss the above in detail.

4.2 Sources of data

4.2.1 Single-Sourced data

In many instances there is only a single source of data. In such events even when multiple parties use such data, they are all dependent on that single source and in the event of dispute the different parties cannot provide alternative data to contradict that single source of data. There may be disputes on interpretation of data or on assignment of a commercial value to such data, but the data itself cannot be disputed.

EXAMPLE: When a mobile device is roaming from its home operator to a hosting operator the measurement of call duration and data consumption is done by the hosting operator. The roaming user and the home operator both do not have the ability to measure call duration or data consumption thus are unable to provide alternative measurements to contradict the measurements of the hosting operator. There may be a dispute over the rates applied to the measured data (e.g. the home operator may argue that the hosting operator has applied a higher per-minute or per-kilobit rate than agreed) but there is no way for the home operator to prove a possible claim that the duration of calls or volume of data consumed by the roaming user was different than the measurements made by the hosting operator.

4.2.2 Multi-Sourced data

When data can be measured by more than one entity and/or in more than one location, it is considered Multi-Sourced. There may be discrepancies between data generated for a certain event by different sources. The reasons for such discrepancies can be:

- a) Different measurement methods.
- b) Different Measurement equipment/calibration.
- c) Measurements at different points along the path of flow of information/matter which may be subject to data loss/corruption.
- d) Others.

When different entities can present different measurements for the same event - each entity may dispute the measurements presented by the other entity. In such event the parties may choose to go through a dispute resolution process and reconcile.

EXAMPLE: When a telecom carrier routes an international telephone call to another telecom carrier each carrier generates a Call Details Record ("CDR") for that call. The CDR includes certain data such as call duration, originating number of the call, destination number of the call. Such attributes determine the commercial value of that call: the monetary amount that the sending carrier is obligated to pay to the receiving carrier for extending the call to its destination. There may be instances where the CDRs generated by the sending carrier and the receiving carrier differ (e.g. the call duration does not match). In such instances the carriers may debate until they reconcile and agree on a value (or a monetary amount) to be used for settlement of the CDR.

Figure 1 herewith depicts the differences between Single-Sourced and Multi-Sourced data.



Figure 1: Single and Multi-sourced data

4.3 Characteristics of Data

4.3.1 Introduction

Measured data may have multiple characteristics that may affect the way data is measured, collected, stored, calculated, reconciled and settled.

4.3.2 Commercial value

The commercial value of measured data may have effect on the way the data is measured (frequency of measurements, level of accuracy/tolerance, number of measurement points) and the way it is reconciled and settled. The commercial value of a transaction can range from a fraction of a cent per transaction (e.g. IoT transactions) to hundreds or thousands of Euro/Dollar per transaction (e.g. trading precious metals, wholesale energy consumption, car rentals). As a general rule, though not mandatory, the higher the commercial value of the data - the more accurate the measurement should be and the more measurement points there should be.

MEF-74 [i.1] defines attributes that affect the commercial value of measured data with focus on MEF services (Carrier Ethernet and Layer-3). Most of the commercial affecting attributes defined in that document may apply to other ICT services.

EXAMPLE: When shipping crude oil from the wells to the refinery it is likely that the amount being shipped is measured both at the well and at the refinery by two separate entities (and possibly at additional points along the route such as shipping loading docks, etc.), whereas in the event of IoT data is often only measured at one point. By applying multiple measurement points the entities involved in crude oil supply chains (well operators, pipeline operators, ship operators, refineries etc.) can apply a commercial value to the crude oil traversing the supply chain and settle the payments between themselves. Note that different commercial values may be applied to the crude oil as it traverses the supply chain. E.g. the commercial value of crude oil off-loaded from a ship may be higher than the commercial value of the crude oil when it was loaded to the ship, as it now includes the cost of shipping, insurance, tax etc. Such commercial value is agreed between the buyer and seller at each transaction point along the way, and may also be subject to regulations, tax, and other levies.

[R1] The commercial value of goods **SHALL** be agreed between each pair of buyer and seller along a supply chain.

[D1] In a PDL enabled supply chain the commercial agreements between buyers and sellers **SHOULD** be implemented using a smart contract.

4.3.3 Cost of transacting

Transacting data incurs costs such as cost of measurement, cost of storage, cost of processing and cost of energy required to store and process such data. When PDL is involved the cost of transaction may grow compared to traditional transaction costs because of the distribution of nodes, networking costs and cost of consensus algorithm in use (also known as "gas cost").

[D2] For proper commercial value assessment the cost of transaction **SHOULD** be measurable and known.

4.3.4 Volume of data

The volume of data generated by measurements varies by use-case. Certain transactions occur frequently and generate huge amounts of data (e.g. IoT, wholesale telephone calls, inter-bank monetary transactions) while other transactions occur less frequently thus generating less transactional data (e.g. car-rental).

[R2] PDL platforms **SHALL** be capable of handling the volume of data generated by the participating nodes.

4.3.5 Processing of Per-Item data and Aggregated data

Depending on factors of commercial value of a transaction, cost of transacting and volume of data, processing of data may be performed in a discrete manner (processing each transaction by itself) or in an aggregated manner (aggregating multiple transactions and processing the aggregate).

Table 1 describes the considerations related to the method of processing such data.

Table 1: Per-Item and aggregated reconciliation

	Per-Item processing	Aggregate processing
Reconciliation	Each record is reconciled and processed discretely.	Consent on the total aggregated value. Can not reconcile each record of data.
Benefits	Full visibility and clarity on all aspects of reconciled data.	Fast reconciliation based (primarily) on commercial value.
Disadvantages	Slow. Resource intensive. Cost of transacting may reduce commercial profitability.	Actual data is not reconciled, and source of discrepancy remains in place (or left unknown).
Suitable for	Low volumes of data where the commercial value of the data is >> the cost of the transaction.	High volumes of data where the commercial value of each item of the data is << the cost of the transaction.

4.3.6 Frequency of Reconciliation and Settlement

4.3.6.1 Term-based

Reconciliation and settlement may occur on pre-defined intervals such as a monthly, weekly, hourly basis. The frequency is related to attributes such as:

- a) The commercial agreements in place between the stakeholders of the transactions. E.g. Utility bills are typically settled on a monthly or bi-monthly basis regardless of the frequency at which the utility suppliers measure the usage.
- b) The duration of the events being measured. It would not make sense to reconcile at intervals shorter than the duration of the events being measured. E.g. when reconciling CDRs (see clause 4.2.2 above) it would make sense to reconcile and settle at daily intervals or longer, considering that the average duration of a telephone call is 5-10 minutes and on occasion (e.g. a conference call) calls may stretch for one or two hours, but is highly unlikely to span more than a day.

[D3] Term-based PDL enabled reconciliation **SHOULD** be performed at intervals longer than the duration of the events being reconciled.

In a term-based reconciliation environment the data (e.g. volume of water or energy being consumed by a household during the billing period; number, duration and destination of calls made by a user during a billing period) is being measured and recorded during the billing period and summarized, reconciled, and transacted at said predefined intervals.

4.3.6.2 Event-based

Reconciliation and settlement may occur based on events such as:

- a) Specific commercial transactions. E.g. buying a theatre ticket generates an immediate reconciliation and settlement between the ticket seller and buyer and triggers generation of the actual ticket (be it a paper ticket or an electronic document).
- b) Certain conditions. E.g. A vehicle crossing a toll gate and paying the required toll.
- c) Threshold being reached. E.g. A consumer's credit limit had been reached and the consumer is required to top-up their credit to continue consuming the service.

5 PDL Nodes in a multi-domain environment

5.1 Introduction

The architecture and topology of PDL nodes and networks is discussed thoroughly in ETSI GS PDL 012 [i.2] and ETSI GS PDL 022 [i.3].

This clause further expands the concepts defined therein with specific focus on settlement of usage-based services in a multi-entity environment.

5.2 Number of nodes

In most PDL scenarios there will be at least one node per participant in any chain such participant is part of, however there may be unique cases where all participants are using a single node. This is typically an interim transitional phase when establishing a PDL platform when the focus is on developing applications and PoCs in pre-production environments.

However, in a production system there has to be at least one node for each participant in a chain.

- [R3]** There **SHALL** be at least one node per transacting participant in a chain that performs reconciliation and settlement.

Some chain types mandate the inclusion of non-transacting nodes for the proper operation of such chain.

- [O1]** There **MAY** be one or more neutral nodes operated by non-transacting entities in a chain.

5.3 Ownership of nodes

- [O2]** Nodes **MAY** be owned by any entity as long as all participating entities can gain unbiased access to all required functions.

- [R4]** An entity owning a node **SHALL** provide unbiased access to all required functions to all participants in the chain.

- [O3]** Access to certain administrative functions on a node **MAY** be limited to specific entities for operational purposes regardless of ownership of such node.

- [R5]** Since access to data on all PDL nodes is unbiased, confidential data or data subject to specific privileges (e.g. GDPR) **SHALL** be properly encrypted.

5.4 Location of nodes

- [O4]** Nodes **MAY** be located on premisses of a participating entity, in a private cloud and on public cloud.

- [R6] The location of a node **SHALL** comply with corporate policies and local legislation where applicable.

5.5 Chain type

- [R7] Chain type **SHALL** be agreed by all participating entities.
- [O5] Subject to [R7] The participating entities **MAY** agree to use any chain type, be that private, public or side chain, and any consensus mechanism.

5.6 Data Sovereignty

- [R8] The chain type, location and ownership of nodes **SHALL** meet all jurisdictional regulatory requirements and all data sovereignty requirements defined and agreed between the participating parties.

5.7 Local legislation

- [R9] The chain type, node ownership, node locations and implemented applications and smart-contracts **SHALL** comply with local legislations in all jurisdictions where such nodes and entities are operated.

An example of such local legislation is GDPR compliance.

6 Rating

For the purpose of the present document, the term 'rate' represents the monetary value of the unit of measurement of a service. For example, *5 cents* (monetary value) per *minute of use* (unit of measurement) of a service; *1 USD per mile* a service traverses; *0,05 cent per CPU cycle* consumed by a service, etc.

Rating is the act of application of a rate to a service. Based upon agreed billing interval, utilization records for said interval are matched with and multiplied by the agreed upon contracted rates yielding rated utilization records. These records are then fed into the invoicing process. E.g. two telephone operators agree that the rate for terminating a telephone call in the USA is 5 USD cents per minute. They also agree on a monthly billing interval occurring on the last second of the last day of each month. The cumulative duration of calls destined to the USA that one carrier had sent to the other carrier is measured throughout the entire month and counted on the last second of that month and turned out (for the purpose of this simplified example) to be exactly one million minutes. By multiplying the measured cumulative duration (1 million minutes) by the agreed upon and contracted rate of 5 USD cents per minute the total due amount sums up to $1\,000\,000 \text{ minutes} \times 0,05 \text{ USD/minute} = 50\,000 \text{ USD}$.

- [R10] A Seller **SHALL** rate utilization records according to agreed-upon and contracted rates between the Seller and the Buyer.

The Buyer and Seller may add clauses to their agreement that apply certain discounts or penalties when certain conditions are met. E.g. in the example above the Buyer and Seller may agree on a volume discount scheme such that any minute in excess of 800 000 minutes is billed at a rate of 4 USD cents per minute rather than the full price of 5 USD cents per minute. In such case the calculation shall look as follows:

$800\,000 \text{ minutes} \times 0,05 \text{ USD/minute} + 200\,000 \text{ minutes} \times 0,04 \text{ USD/minute} = 48\,000 \text{ USD}$. Another example may involve data connectivity service provided by a Seller to a Buyer, that is subject to SLA penalties if the service quality drops below a certain level. In such event the Buyer may be eligible to receive SLA credits from the Seller. Suppose such service is rated at USD 1 per MBPS of maximum usage during a calendar month and the measurement of the usage during such month was 1 000 MBPS yielding a monthly fee of 1 000 MBPS at 1 USD per MBPS/Month = USD 1 000. However, if during said month the service had suffered certain intermittent outages that were measured and recorded and, according to the SLA signed between the Buyer and Seller, the Buyer is eligible to a credit worth USD 100 for that month.

NOTE: The methods of measurement and calculation of such credits are out of scope of the present document.

In such case the total due amount will be USD 1 000 (based on rating) minus 100 (credit amount) = USD 900.

- [O6] The rating process **MAY** include application of discounts and/or penalties based on volume or type of data transactions or events as mutually agreed by both parties.
- [D4] When the data is processed through a PDL platform the rating **SHOULD** be performed using a smart-contract.

7 Reconciliation

7.1 Definition of Reconciliation

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

- [O7] Reconciliation **MAY** occur prior to or after issuance of an invoice.

In the event there is only a single source of data as described in clause 4.2.1, reconciliation is based on that source alone. In absence of other data that may contradict that single source of information, the ability of parties other than the one performing the measurements to dispute the amount requested by the Seller is limited. Such parties may dispute the rating (i.e. the rate applied to the measurements) but not the measurement itself. Example: Consider a scenario where the Seller is the only party performing measurements (i.e. in a mobile roaming scenario measurement of the data consumption of the roaming user is performed only by the hosting mobile operator). In such scenario the buyer (be that the home mobile operator or even the mobile user itself) is unable to dispute the volume of data stated by the hosting operator but is still able to check if the rate that was applied by the hosting operator per unit of data was indeed according to the agreed upon roaming rate between the home operator and the hosting operator. In the event that the Buyer suspects that a wrong rate was applied - it may dispute the rating and negotiate with the seller towards reconciliation.

Reconciliation may involve resolution of disputes and discrepancies between the Buyer and the Seller. Several methods and approaches to dispute resolution are discussed in clause 9).

In the event there are multiple sources of data as described in clause 4.2.2, several scenarios may be considered and are summarized in Table 2 below:

Table 2: Reconciliation with Multi-Sourced data

	All measurements are identical	Different measurements by different sources
No dispute on rating	Automatic reconciliation and rating	Reconcile measurements
Rating disputed	Reconcile rating	Reconcile measurements Reconcile rating

7.2 Reconciliation prior to invoicing

Supply chain partners may prefer to reconcile their records prior to issuance of an invoice. The benefit of such approach is it reduces the overheads of issuing credit notes if discrepancies are found between the rated records of those parties. However, this option requires the Buyer and Seller to coordinate their respective business processes, align their data models, and spend the efforts to compare the records/data rather than the invoices. Such coordination is often performed using a neutral platform that offers the ability to:

- a) Each party to upload its respective data/records.
- b) An algorithm that identifies matching records coming from different sources.
- c) A GUI presenting the data in a manner that allows comparison of records, identification of discrepancies and reconciliation.
- d) Generation of billing statements that include reconciled records that are ready for invoicing.

- e) Each party may download such billing statements and use them to generate undisputed invoices (Seller) and verify and approve such invoices (the Buyer).

[D5] PDL **SHOULD** be used by such platform as it offers the disintermediation and neutrality requirements of such platform.

7.3 Reconciliation after invoicing

Albeit the operational benefits of reconciliation prior to invoicing, many Buyers and Sellers, likely the majority of both, are still using the more traditional way of reconciliation:

- The Seller issues an invoice based on their measurements, ratings, SLA monitoring, and sends it to the Buyer.
- The Buyer calculates their expected due amount based on their own usage records, SLA monitoring and rating.
- The Buyer verifies the invoice and compares it with their expected due amount calculated in step "b" above.
- If a discrepancy is found the Buyer opens a dispute with the Seller and both parties engage in a manual reconciliation process until they reach an agreement on the final due amount. Such process may stretch over weeks and months during which payment is held.
- If required - the Seller sends a credit or debit note to the Buyer to balance the difference from the original invoice.
- The Buyer pays the invoice minus any amount in a credit note or plus any amount in a debit note.

Figure 2 describes how a Buyer can estimate the amount it will be charged by the Seller through applying the business logic stipulated in the agreement with the Seller on the utilization records and SLA records it has stored in its own data repositories. The amount may differ from the amount actually invoiced by the Seller, which may trigger a dispute resolution process.

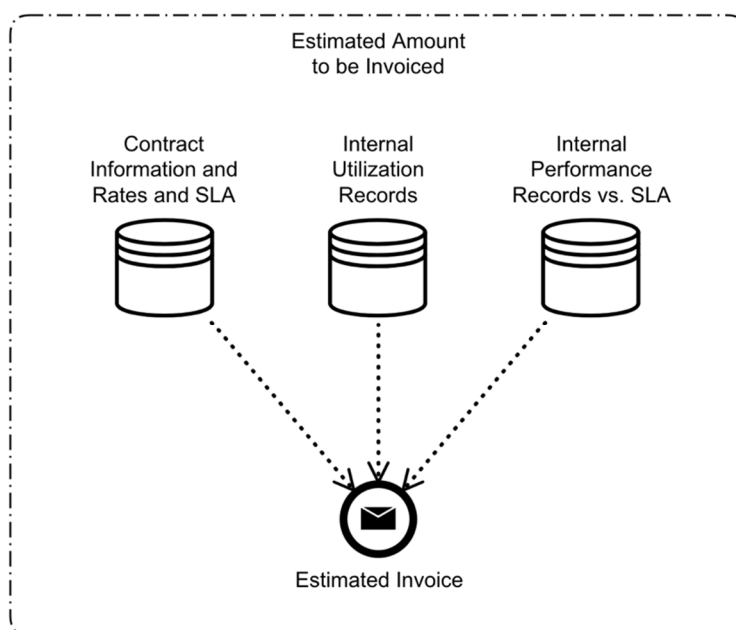


Figure 2: Estimating charges

8 Invoicing

8.1 Introduction to Invoicing

Invoicing is a process where the Seller is generating an Invoice and sending it to the Buyer.

A Seller in a Supply Chain invoices its Buyer for the services the Buyer has consumed. The invoice is based on an agreement between the Buyer and the Seller.

[D6] An agreement **SHOULD** be implemented using a smart-contract where applicable.

8.2 Invoicing occurrence

As discussed in clause 4.3.6 above invoices are issued on interval or event-based as defined in an agreement between the Seller and the Buyer.

- a) Interval based invoices are generated on agreed upon intervals (e.g. Monthly, Quarterly, Weekly). Such invoices may include:
 - Recurring charges for long-term services.
 - Non recurring charges that represent once-off transactions that occurred between the previous and current invoicing cycles.
 - Adjustments to previous invoices (e.g. debit or credit notes).
- b) Event-based invoices are generated when an event occurs (e.g. a Buyer places an order with a Seller for a once off service such as hardware or software upgrade).

[R11] A Seller **SHALL** invoice a Buyer on interval or event as per agreement between the Buyer and Seller.

[D7] Invoice generation **SHOULD** be triggered by a smart contract where applicable.

8.3 Invoice contents

[R12] An Invoice **SHALL** include the following information:

- Legal name of the Seller as stated in the agreement.
- Legal name of the Buyer as stated in the agreement.
- Date when invoice was issued.
- Description of goods and/or services covered in the invoice.
- The monetary amount of the invoice.
- Tax amount and respective tax type (e.g. VAT/GST) and amount (e.g. 21 %).
- The currency of the invoice.
- A unique ID/Number of the invoice.
- Any information or detail required by policy or regulation.

[O8] An invoice **MAY** include some or all of the following additional information:

- A detailed list of items included in the invoice.
- The monetary amount and currency of each item.

- A reference to an external record (e.g. exchange rate published by a specific bank, a specific DLT record).
- Due date of the invoice.
- Any other detail mutually agreed upon between the Buyer and the Seller.

8.4 Buyer-Seller entity multiplicity

For tax, legislative and trade purposes companies may have multiple commercial, operational and legal entities registered in different jurisdictions. Such entities may be grouped and operate as a single Buyer/Seller or may operate as independent entities. Each such entity has a unique legal name.

- [O9] A Buyer and a Seller **MAY** each operate multiple entities.
- [R13] An agreement between a Buyer and a Seller **SHALL** include one or more entities on each side.
- [R14] An agreement between a Buyer and a Seller **SHALL** list all the entities, on both sides, it applies to.
- [R15] When a Buyer places an order with a Seller it **SHALL** specify the Buyer's and Seller's legal entities involved with the specific order.

The above requirements, together with [R12], mandate that each pair of Buyer-Seller entities is invoiced separately.

8.5 Additional requirements related to Invoicing in a PDL enabled environment

- [R16] The Seller **SHALL** invoice in conformance with MEF 74 [i.1].
- [D8] The Seller **SHOULD** keep a copy of the invoice in a PDL that has been established with the Buyer.
- [R17] The Seller **SHALL** invoice based on contracted payment method (e.g. FIAT currency, crypto-currency or stablecoin) as agreed by both parties.
- [R18] The Seller **SHALL** be able to generate printed originals or human-readable electronic versions of invoices if required to do so by the Buyer or by local regulations and/or legislation.
- [D9] The notification of the Buyer about issuance of an invoice **SHOULD** be automated through a Smart Contract.
- [O10] The invoice **MAY** include recurring charges, one-off charges, service credits based on SLA, penalties, refunds, discounts and taxes.
- [R19] The inclusion of multiple charge items into a single invoice **SHALL** be agreed by the Buyer and Seller and abide by the respective regulations and or legislation.
- [O11] SLA credits included in an invoice **MAY** be calculated on a per-service-instance basis or be aggregated in agreed-upon forms in conformance with MEF 74 [i.1].

9 Discrepancy and Dispute Management

9.1 Introduction to Discrepancies and Disputes

Discrepancies are differences between data/information held by two entities with relation to a specific item such as an invoice, a rate or a measurement. Discrepancies may be measured by the following metrics:

- Differences in the monetary value of a rate (e.g. Seller claims the rate is USD 1,05/mile and Buyer claims it is USD 1,03/mile thus the difference is USD 0,02/mile).

- Differences in measurements represented in units of measurement (e.g. Flow of data is measured in GB. The Seller claims the Buyer has used 2,5 GB of data and the Buyer claims they have only used 2,4 GB thus the difference in measurements is 0,1 GB).
- Fractional difference between numerical values represented in percent or decimal notation (e.g. 1,05 divided by 1,03 yields a ~2 % discrepancy which can also be represented as a decimal fraction 0,02).
- Total Monetary value of the difference (e.g. Based on rate and measurements the Seller invoices an amount of USD 1 500 while the buyer claims that based on their own calculations, they only owe the Seller USD 1 300 thus the total monetary difference is USD 200).

- [D10]** Discrepancies and dispute management methods **SHOULD** be agreed between the Buyer and Seller and documented in a legal agreement.
- [D11]** In a PDL enabled environment such agreement **SHOULD** be implemented as a smart contract where applicable.
- [R20]** If the parties agree that there is no discrepancy, or if the discrepancy is below a defined threshold (see clause 9.2 herewith), the settlement amount **SHALL** be equal to the invoice amount.
- [O12]** If the Buyer determines that there is an actionable discrepancy, it **MAY** raise a dispute that triggers a dispute resolution process.
- [O13]** 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.

9.2 Dispute Threshold

The dispute threshold is a value in an agreement between the Buyer and the Seller.

When the discrepancy is above the dispute threshold, the Buyer may trigger a dispute resolution process (see requirement [O12]), and conversely, when below the threshold, it will accept the invoice as-is.

EXAMPLE 1: The parties may agree that a discrepancy below 1 % is ignored, in which case when the discrepancy is below 1 % the Buyer will accept the invoice and not raise a dispute.

[O14] Thresholds **MAY** be combined.

EXAMPLE 2: The parties may agree that a discrepancy below 1 % is ignored unless the total monetary value of the discrepancy is above USD 500, in which case the Buyer may open a dispute even if the discrepancy (say USD 550 for the purpose of this example) is less than 1 % of the invoice value.

9.3 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 the present document. The examples presented herewith are for demonstrative purposes only.

An example of dispute resolution logic:

- *If discrepancy is lower than 1 % then no dispute.*
- *If discrepancy is between 1 % and 5 %, then take the arithmetic average between the values of Buyer and Seller.*
- *If discrepancy is higher than 5 % then defer to manual (case-by-case) dispute resolution.*

Another example may be similar to the above with the exception that for the case of a discrepancy between 1-5 % the settlement value is calculated using heuristics based on previous settlements in a manner that removes bias caused by one party consistently reporting values in its own favour.

[O15] Subject to contract the parties **MAY** agree to perform partial reconciliation and settle some of the pending invoice/invoices while continuing reconciliation of others.

- [D12] Dispute thresholds and resolution **SHOULD** be implemented by a smart contract where applicable.
- [R21] If a dispute is triggered by Buyer or a Seller, it **SHALL** be resolved either (a) manually, (b) automatically or (c) through a mix of both.

9.4 Finality

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

- [R22] Upon completion of the Reconciliation process, a final and binding mutually-agreed-upon amount **SHALL** be settled between the Buyer and the Seller.
- [R23] If an invoice has already been issued and it differs from the final amount agreed by the parties, a credit note or a debit note **SHALL** be issued by the Seller to cover any differences.
- [R24] In a PDL enabled environment the final invoice and any credit and debit notes **SHALL** be recorded on to the PDL.

10 Settlement

10.1 Definition of Settlement

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

10.2 Payment

Upon completion of reconciliation and issuing a final invoice and/or any credit/debit notes the parties settle through payment of the agreed upon amount between the parties.

- [R25] The payment **SHALL** take form of one of the following: (a) transfer of a fiat currency through legacy means (bank transfer, cheque), (b) an electronic transaction of a stablecoin (a crypto-currency whose value is pegged to a fiat currency) or (c) a crypto-currency transaction.
- [R26] The form of payment and the currency/currencies used for payment **SHALL** be agreed upon by both parties in the contract.
- [R27] Payment **SHALL** be made in accordance with the terms stipulated in the agreement.
- [R28] Payment **SHALL** comply with all regulatory requirements by the jurisdiction(s) where the Buyer and the Seller are established.

10.3 Netting

Netting is the act of subtracting the amounts due by two parties to each other. If 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 party is subtracted from the pending amount of the other party and only the net amount, after such subtraction, is being transferred from one party 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 Net Amount to B, otherwise B pays Net Amount to A.

- [O16] If two parties have a reciprocal trade, they **MAY** net their invoices as part of the settlement process.
- [CO1] < [O16] In a PDL enabled environment the Netting **SHOULD** be recorded in a PDL where applicable.

10.4 Netting and Payment process diagram

Figure 3 illustrates the Netting and Payment process flow.

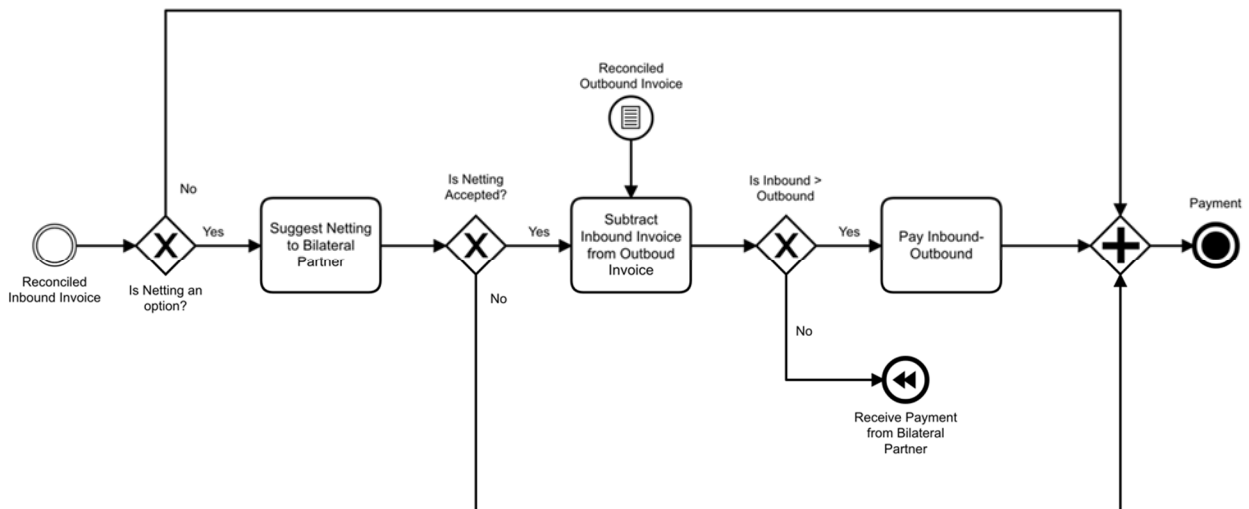


Figure 3: Payment and Netting process flow

History

Document history		
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