MEF Standard

MEF 74

Commercial Affecting Attributes

Technical Standard

December 2018

Disclaimer

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1 List of Contributing Members

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

- PCCW Global
- AT&T
- Century Link
- Cisco

2 Abstract

This document specifies the Commercial Affecting Attributes that need to be agreed between a Service Provider and a Subscriber and between a Service Provider and a Partner for Commercial activity related to MEF Defined Services. The document is divided into three major chapters: Chapter 7 discusses the Key Concepts of commercial relations between entities, going from definitions of what a Customer is, the differences between Price and Cost, and the concept of Margin. Chapter 8 lists attributes that may have commercial implications. Those attributes may or may not be measurable. Chapter 9 describes the methods by which a commercial value can be applied to an attribute, measured or not. It is not the scope nor the intent of this document to specify what the billed amount will be and how Cost, Margin or Selling price are defined by each participant in a commercial transaction. However – this document does specify the method by which attributes and their commercial value are to be measured, calculated and presented in commercial transactions between entities.

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
95th Percentile Bandwidth Usage	A method commonly used to represent maximum utilization over a period of time while eliminating the effects of short bursts. Collecting Bandwidth Usage results in intervals that must be Same or Shorter than 1/20 of the billing interval. Remove the Measurements with the top 5% of completed usage measurements. The highest remaining usage measurement represents the 95th percentile usage during billing interval.	This Document
Aggregate Congestion Induced Frame Delay	The sum of Congestion Induced Frame Delay induced by all the devices along the path an electronic transmission traverses.	This Document
Aggregate Equipment Induced Frame Delay	The sum of Equipment Induced Frame Delay induced by all the devices along the path an electronic transmission traverses.	This Document
Allocated Cost	An amount of money allocated out of the cost of a shared resource used for rendering a service, representing the prorated or respective part of the service in the cost of the entire resource.	This Document
Amount of RAM allocated to a VM	Measures the amount of RAM, in MB, allocated to a VM.	This Document

Term	Definition	Reference
Availability	The percentage of time a service is available during a given period.	MEF 10.4 [1]
Average Band-width Usage	A method of calculating a Bandwidth Usage Metric by Collecting Bandwidth Usage results in intervals that must be Same or Shorter than the billing in-terval. Summing up all the results of completed Usage measurements and dividing by the number of com-pleted Usage measure-ments.	This Document
Bandwidth Us-age	A method of calculating the number of bits flowing through a reference point during a certain sampling period.	This Document
Bandwidth, Ca-pacity	Rate of Flow of infor-mation (occurrences per unit of time) or frequency at which electronic signals travel through a medium.	This Document

Term	Definition	Reference
Bit-Wise data unit	Data Measurement unit typically used to measure flow of information such as transmission speeds.	This Document
Buyer	An entity obtaining goods or services from a Seller as part of a commercial transaction.	This Document
Byte-Wise data unit	Data Measurement Unit typically used to measure Storage/volume	This Document
Class of Service Name	An administrative name assigned to a particular set of Performance Objectives and related Bandwidth Profiles.	MEF 10.4
COS Name	Abbreviation for Class of Service	MEF 10.4
Congestion Induced Frame Delay	Frame Delay caused by queuing at the egress port of a device.	This Document
Cost	An amount of money levied on a Seller as a result of delivering Goods, Products or Services to a Buyer.	This Document
Credit Allocation	The amount of monetary funds that a buyer can consume prior to making payment to seller.	This Document
Credit Score	The amount of confidence a seller has with the buyer to pay their bills.	This Document
Data Measurement Unit	An abstract definition of data as a string of bits or Bytes.	This Document
Day	The time elapsing from one midnight to another.	This Document
Deposit	An amount pre-paid by the buyer to the seller prior to consuming services.	This Document

Term	Definition	Reference
Direct Cost	An amount of money paid by an entity acting as a Buyer from a Seller for goods or services provided by the Seller specifically for the rendering of a specific service or product provided by that entity acting as a Seller.	This Document
Distance	An amount of space between two things.	This Document
Distance Induced Frame Delay	Frame Delay induced by the distance between the source point and the target point.	This Document
Downtime	The aggregate time a service is unavailable during a given period.	This Document
Duration of Compute Service	The time elapsing between the start and end of a compute service.	This Document
Duration of Outage	The time elapsing between the start and end of an Outage.	This Document
Duration of Service	The time elapsing between Start and Termination of a Service excluding Outages.	This Document
Entity ID	An ID assigned to an entity by official repositories that exist in certain countries/continents.	This Document
Equipment Induced Frame Delay	Frame Delay induced by the time it takes an electronic transmission to traverse between the ingress port and the egress port of a device exclusive of Congestion Induced Frame Delay.	This Document
Event-Driven Charge	An amount of money charged per recurrence of an event.	This Document

Term	Definition	Reference
Flow (of Data)	The amount of data that flows through a reference point or is being processed by a certain device during a specified unit of time.	This Document
Rate (of Data)	Synonym to Flow (of Data).	This Document
Frame Delay	The time it takes an electronic transmission to traverse between two reference points.	MEF 10.4
FD	Abbreviation of Frame Delay	MEF 10.4
Geographical Distance	The shortest distance between two points over the surface of earth.	This Document
Gross Margin	The difference between the Selling Price and the Overall Cost exclusive of the Indirect costs.	This Document
GM	Abbreviation of Gross Margin.	This Document
Hour	60 (Sixty) Minutes	This Document
IFDV	Variations in FD	MEF 26.2 [2]
Indirect Cost	An amount of money allocated for the on-going operations of a company.	This Document
Margin	The difference between the Price and the Cost.	This Document
Maximum Bandwidth Usage	The highest recorded usage of Bandwidth during a period of time.	This Document
Maximum Storage Used during a Period	The highest number of Bytes that were stored in a storage space during a certain period.	This Document
Minute	60 (Sixty) Seconds, with the exception of Leap Minutes which may have 59 or 61 Seconds.	This Document
Month	One of the twelve periods of time that a year is divided into.	This Document

Term	Definition	Reference
Mean Time to Repair	The mean time it takes to restore service to perform according to the SLS over a given period.	This Document
MTTR	Abbreviation to Mean Time to Repair.	This Document
Net Margin	The difference between the Selling Price and the Overall Cost.	This Document
Non-Recurring Charge	An amount of money charged by the Seller from the Buyer once per order.	This Document
Once-off Charge	Synonym to Non-Recurring Charge	This Document
Installation Charge	Synonym to Non-Recurring Charge	This Document
Set-up Charge	Synonym to Non-Recurring Charge	This Document
NRC	Abbreviation to Non-Recurring Charge.	This Document
Number of Computations	Aggregate number of Computation cycles during measurement period	This Document
Number of CPU Cores used	Indicates the number of CPU cores allocated for a Service	This Document
Operating System	Specifies the Type and Version of Operating System loaded on a virtual or physical computer system.	This Document
Operator	An Administrative Entity that Operates a Network or a Data-Centre and offers Telecommunications Services.	This Document (Extends the definition of Operator appearing in MEF 26.2)
Overall Cost	The sum of all Costs associated with a specific service.	This Document
Packet/Frame Loss	The percentage of packets or frames or transmission units that were expected but failed to arrive at the target reference point.	This Document

Term	Definition	Reference
Path Distance	Actual distance measured as a curved line connecting two points, including physical obstacles and construction.	This Document
Route Distance	Synonym to Path Distance.	This Document
Payee/Receiver	An entity that request and/or receives a payment from another entity.	This Document
Payer	An entity that pays or is requested to make a payment to another entity.	This Document
Payment	Transfer of monetary funds from Payer to Payee. A Payment may cover multiple Services or Products.	This Document
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.	This Document
Price, Selling Price	An amount of money the Seller charges the Buyer for a Service or a product.	This Document
Recovery cost	A once-off fee associated with the service, charged to the Buyer, bypassing the revenue system and paid directly to a third party or a cost-center.	This Document
Recurring Charge	An amount of money charged by the Seller from the buyer on a recurring basis with the frequency of recurrence mutually agreed by both parties.	This Document

Term	Definition	Reference
Round Trip Delay	In scenarios where a confirmation is being sent by the destination device to the transmitting device upon receipt of a transmission, Round Trip Delay represents the aggregate Frame Delay of the transmission and the confirmation legs as measured at the transmitting device, inclusive of Distance, Equipment and Congestion delays.	This Document
RTD	Abbreviation of Round Trip Delay	This Document
Second	The duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom.	NIST (https://physics.nist.gov/cuu/Units/second.html)
Seller	An entity offering goods or services to a Buyer and charging a sum of money in return for the provisioning of such goods or services.	This Document
Service Provider	An entity offering services to other entities. Such offer can be associated with charging a sum of money, in which case the Service Provider also becomes a Seller.	This Document (extends the definition of Service Provider appearing in MEF 26.2)

Term	Definition	Reference
Settlement	The process of analyzing 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.	This Document
Service Level Agreement	The contract between the user and the provider of a Service specifying the service level commitments and related business agreements for the Service.	MEF 10.4
SLA	Abbreviation of Service Level Agreement.	MEF 10.4
Service Level Specifications	The technical section in a Service Level Agreement.	MEF 10.4
SLS	Abbreviation of Service Level Specifications.	MEF 10.4
Speed of CPU	The Clock-Speed of a CPU	This Document
Storage Space Plan	The number of Bytes allocated for use by a specific consumer during a defined period.	This Document
Time Unit	Time expressed in units of time measurement.	This Document
Transaction Loss	The percentage of Computational or Storage transactions that were assigned for a compute or storage node (physical or virtual) to process/store and failed to be processed/stored.	This Document
Time to Restore	The amount of time it takes to restore service to perform according to the SLS.	This Document
TTR	Abbreviation of Time to Restore.	This Document

Term	Definition	Reference
Uptime	The aggregate time a service is Available during a given period.	This Document
Vendor	An entity offering goods to other entities.	This Document
Volume	A cumulative amount of data that is processed at, stored in or traverses a certain point over time.	This Document
Space	Synonym to Volume but only applies to Storage.	This Document
Week	7 (Seven) Days	This Document
Year	A period approximately representing one full rotation of earth around the sun.	This Document

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 [3], RFC 8174 [4]) 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 labeled as **[Ox]** for optional**.**

Editor Note 1:   The following paragraph will be deleted if no conditional requirements are used in the document.

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

Editor Note 2:   This section will be deleted if no numerical prefixes are used in the document.

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

MEF Defined Services have been widely deployed by Service Providers and Operators for many years. However, there is no standard framework that specifies how Commercial Activities related to such services are described from the perspective of the buyer and seller of the service. In a very abstract level Operators perform three basic functions to data:

- Transport: They transport data through distances.

- Storage: They store data over time.

- Compute: They manipulate data.

Enterprise and Consumer applications will typically require one or more of the above. Operators may offer the above services either bundled or separately and will need to bill their customers accordingly. Factors such as time, distance, volume, Flow rates and number of occurrences may all need to be considered when billing customers for services they have subscribed to. The purpose of this document is to define the attributes, the measurement methods and the association of measured values with a commercial value that can be billed.

One important thing to keep in mind is that while Sellers sell Products and Services, and Buyers buy Products and Services, the invoices, bills and commercial transactions use commercial currencies such as USD, EUR etc. Thus, when calculating the commercial value of a service and using a mathematical formula to arrive at a commercial value – dimensional analysis must take place to ensure the result of the calculation yields Commercial Currencies alone without attributes such as time or bandwidth being left in the equation

7   Key Concepts

This section explains some key concepts necessary for understanding MEF Commercial Affecting Attributes.

7.1   Participating Entities

Entity Term	Definition
Seller	An entity offering goods or services to a Buyer and charging a sum of money in return for the provisioning of such goods or services. *Example: Telecommunications Service-Provider offering an E-Line with managed CLE (Customer Located Equipment) or SE (Subscriber Edge) at both UNIs service to a Buyer.*
Buyer	An entity obtaining goods or services from a seller as part of a commercial transaction. *Example: An Enterprise buying Internet-Access from an ISP.*
Vendor	An entity offering goods to other entities. Such offer can be associated with charging a sum of money, in which case the Vendor also becomes a Seller. *Example: A Telecommunications hardware manufacturer selling CLE or SE to a Buyer.*
Service Provider	An entity offering services to other entities. Such offer can be associated with charging a sum of money, in which case the Service Provider also becomes a Seller. In a multi-operator environment an Operator may view itself as a Service Provider as the Operator from which the request is coming through may be either a Service provider to a Subscriber or the Subscriber itself. *Example: A Mobile Operator offering unlimited calls to its subscribers.*
Entity ID	An ID assigned to an entity by official repositories that exist in certain countries/continents. Such ID could be assigned to any of the above types of Entities. *Example: NECA, an official repository available in North America.*

Table 3 – Participating Entities

7.2   Cost, Price and Margin

Pricing Term	Definition
Price, Selling Price	An amount of money the Seller charges the Buyer for a Service or a product. The Price must include one or more of the following: Once-off Charge, Recurring Charge, Event-Driven Charge *Example: The amount of money a gas station charges a person for filling up their tank. This will be represented in Dollars per Gallon multiplied by the number of gallons used.*
NRC (AKA: Once-off Charge, Non-Recurring Charge, Installation Charge, Set-up Charge)	An amount of money charged by the Seller from the Buyer once per order. Such amount is typically charged upon signature of contract or immediately upon ordering of goods or services based on an existing signed contract. This charge typically covers costs associated with establishing the resources required to deliver the goods or services. *Example: A PTT charges a subscriber $20 for installation of a new telephone line at their office. This amount grants the subscriber access to the POTS but does not cover the calls made using this line.*
Recurring Charge	An amount of money charged by the Seller from the buyer on a recurring basis with the frequency of recurrence mutually agreed by both parties. The amount can be fixed per recurring period, in which case it will typically be charged in advance at the beginning of the recurrence, and/or it can be a variable amount determined through a formula that takes into account one or more variable attributes related to use of said goods or service during the recurrence. In such case the amount will be charged in arrears at the end of the recurrence. *Example: A Telecommunications Network Operator Charges an Enterprise subscriber a fixed amount of USD 500 per month for a 100 Mbps CE E-Line service between two of the Enterprise's office locations.* *A Telecommunications Network Operator provides an Enterprise subscriber a 100 Mbps CE E-Line service between two of the Enterprise's office locations and charges the subscriber a variable amount of USD 5 per Mbps per month based on the actual usage of the E-line service. There are multiple methods of measuring and calculating the usage of the service over the recurrent period, which are discussed in Chapter 9 of this document.*

Pricing Term	Definition
Event-Driven Charge	An amount of money charged per recurrence of an event. This amount can be fixed per recurrence and/or a variable amount determined through a formula that takes into account one or more variable attributes related to use of said goods or service during the event. Said charges can either be charged immediately upon the occurrence of the event, or can be accumulated over a recurrent period and charged in arrears by the end of the recurrent period. *Examples: A bank charges its customers a fee of USD 0.10 per transaction.* *A cable company charges its subscribers a fee of $5 per movie rental for a 24 hour rental period.* *A bank charges its customers a fee of 2.5% of the value of a wire-transfer per transfer.* *An ice-cream parlor charges a rate of USD .75 per ounce of ice-cream plus USD .50 for the cone.*
Cost	An amount of money levied on a Seller as a result of delivering Goods, Products or Services to a Buyer. A Cost can be of any of the below types: Direct, Allocated or Indirect. Additional types of cost may exist. Costs are handled internally by the Seller and are not exposed to its Buyers. *Example: A Telecommunication Operator buys last-mile access from a CLEC and a CLE from a Vendor in order to provide an E-Line service to an enterprise customer.* *For the provisioning of said service the Telecommunications Operator also allocates 100Mbps of capacity on its network between two UNIs.* *The employees of the Telecommunications Operator spend a total of 50 hours of work during the selling, ordering, activation and testing of said service.* *There is an amount of money associated with each of the above items.*
Direct Cost	An amount of money paid by an entity acting as a Buyer from a Seller for goods or services provided by the Seller specifically for the rendering of a specific service or product provided by that entity acting as a Seller. Such Cost is typically provided by a third party Seller either through a rate-sheet or on an individual case basis. *Example: A Telecommunication Operator buys last-mile access from a CLEC and a CLE from a Vendor in order to provide an E-Line service to an enterprise customer.*

Pricing Term	Definition
Allocated Cost	An amount of money allocated out of the cost of a shared resource used for rendering a service, representing the prorated or respective part of the service in the cost of the entire resource. The methods by which respective parts of a resource are assigned specific costs is beyond the scope of this document. Such cost is typically represented in a cost-book, table or obtained through a formula. Allocated cost may also include specific taxation for specific types of services. *Example: For the provisioning of said service the Telecommunications Operator also allocates 100Mbps of capacity on its network between two UNIs. A cost of 10$ per month per port is allocated for use of a physical electrical (RJ45) port in a 10-port blade in a router. A state may charge a 5% tax of the selling price for IP services.* *A city may charge a 2.5% tourism levy/resort fee for every night of stay.*
Recovery cost	A once-off fee associated with the service, charged to the Buyer, bypassing the revenue system and paid directly to a third party or a cost-center. *Example: Special entrance facility/construction fee to historical buildings.*
Indirect Cost	An amount of money allocated for the on-going operations of a company. This amount covers for elements such as HR, office rental, legal advice, Tax (State, Income etc.) etc. The amount is typically calculated as an internal tax, or percentage, of the Overall cost or the Selling price of the service. It may also appear as a fixed overhead per service type. The methods by which indirect costs are determined and calculated is beyond the scope of this document. *Examples: The employees of the Telecommunications Operator spend a total of 50 hours of work during the selling, ordering, activation and testing of said service. This is covered by adding 19% on top of the Direct and Indirect Costs.* *An "integration overhead" of $500 per month per 1 Gbps of traffic is levied on all 1 Gbps services in order to cover expenses associated with the acquisition of a competitor.*
Overall Cost	The sum of all Costs associated with a specific service.
Margin	The difference between the Price and the Cost. It can be represented as a number in a specific currency or as a percentage calculated as: (Price - Cost) divided by Cost.
Gross Margin, GM	The difference between the Selling Price and the Overall Cost exclusive of the Indirect costs. It can be represented as a number in a specific currency or as a percentage calculated as: (Selling Price - Direct Cost - Allocated Cost) divided by (Direct Cost + Allocated Cost).

Pricing Term	Definition
Net Margin	The difference between the Selling Price and the Overall Cost. It can be represented as a number in a specific currency or as a percentage calculated as: (Selling Price - Overall Cost) divided by Overall Cost.

Table 4 – Cost, Price and Margin
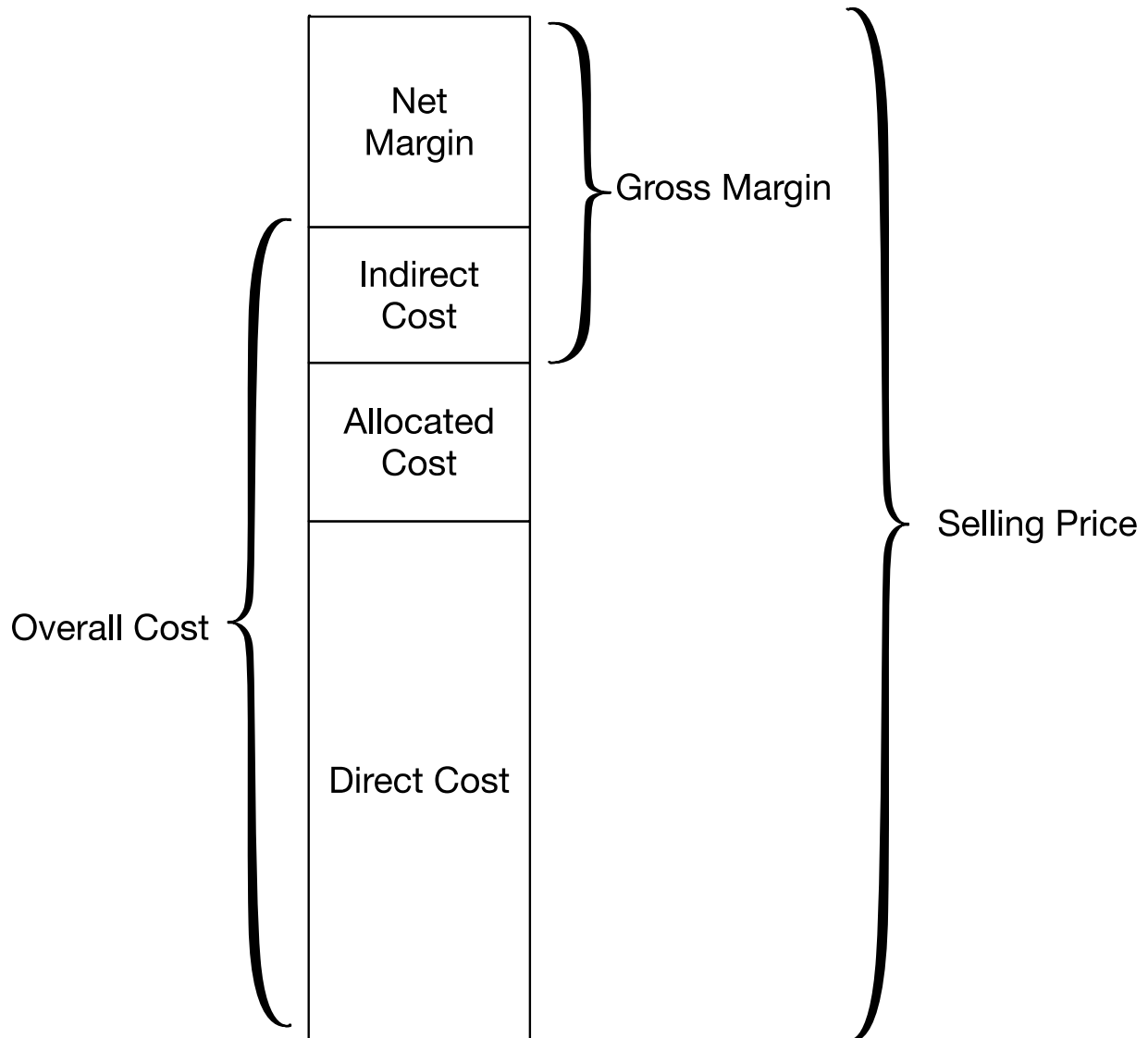
Figure 1 – Cost, Price and Margin

7.3 Payments and Settlements

Payment Attribute Term	Definition	Unit of Measurement	Value Range
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%.*	Per-Cent	0-100%
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.*	Time	0-∞
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.*	Currency	0-∞
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 recurring amount) or the estimated recurring amount to be billed (in the case of usage-based recurring amount)] by the Payment History. *Example: A customer with a Payment History of 45 days and a recurring fee of USD 3000 per month is required to pay a deposit of USD 4500 prior to activation of service.*	Currency	0-∞
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.	entity	
Payee/Receiver	An entity that request and/or receives a payment from another entity.	entity	

Payment Attribute Term	Definition	Unit of Measure-ment	Value Range
Settlement	The process of analyzing 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 that are beyond the scope of this document.	process	
Payment	Transfer of monetary funds from Payer to Payee. A Payment may cover multiple Services or Products.	currency	0-∞

Table 5 – Payments and Settlements

8 Properties used to define Commercial Attributes

When it comes to units of measurements, certain attributes can be grouped together into a known generic industry term. Examples would be: Meter, Yard, Mile and feet can all be grouped under a generic term named Distance. Another example would be Second, Month and Year which can be grouped under the generic term of Time. There are, however, certain attributes that can not be grouped under a generic name. An example would be Bits and Bytes that represent data but lack a generic term for such units. The following sections discuss families of units that are used to define Commercial Affecting attributes.

8.1 Data Measurement Units

When it comes to Data there is no generic term and we use either Bits or Bytes, either stand alone or tied to time. Typically Flow of Data (e.g. Bandwidth of a circuit or Utilization of a circuit) is represented in Bits per time (typically bits per Second) while Volume (also referred to as Space in some use cases) of Data (e.g. Storage Space) is measured in Bytes.

There are 8 bits in a byte, so when we calculate e.g. Volume (measured in Bytes) from Flow (measured in Bits) we will need to add the factor of 8 to the calculation. E.g. A flow of 100 bits per second for a duration of 80 seconds will accumulate to a volume of 100x80 = 8000 bits, which are 1000 Bytes. The use of Bits per Second for Flow and Bytes for Volume is an industry convention, a de-facto standard. However – one can also measure flow using Bytes per Hour or any other form that puts either Bits or Bytes in the denominator and any form of Time in the numerator.

Multiples of bits or Bytes can be grouped into units represented by a prefix of Kilo, Mega, Giga, Tera, Peta etc. Though in scientific measurements of distance or weight the prefixes are multiples by a factor of 10^3 (10^3, 10^6, 10^9 etc.) when it comes to data there is a difference between the way multiples are presented for Flow of data versus the way multiples are presented for Storage of data. Flow of data is measured in bits per time, where the multiples of bits use the same scientific notation of a factor of 10^3, (meaning a kilobit per second is 1000 bits per second) while Storage/Volume is measure in Bytes, and the multiples of Bytes are grouped by a factor of 1024 (or rather 2^{10} meaning a KiloByte is 1024 Bytes). The scientific notation of the factors of 10^{3n} or 2^{10n} is presented in table 2 hereof. For the purpose of this document we will be using a convention widely adopted by the industry representing the decimal (10^{3n}) factor using a single character k,M,G,T etc. and representing the binary (2^{10n}) factor using two characters Ki, Mi, Gi, Ti etc. as per table 2 hereof.

For clarity the table below shows a decimal representation of some of the binary factors.

Factor	Binary	Number of Bytes
KiByte	2^{10}	1,024
MiByte	2^{20}	1,048,576
GiByte	2^{30}	1,073,741,800
TiByte	2^{40}	1,099,511,600,000
PiByte	2^{50}	1,125,899,900,000,000

Table 6 – Decimal representation of some of the binary factors

To arrive at the number of bits in each of the above factors you will need to multiply it by 8 (eight).

To arrive at the next factorial level, you will need to multiply the previous level by 1024 (2^{10}).

An example of the relations between Flow and Storage is presented in Figure 2 below, where the flow (in bits per seconds) is presented over time. The accumulated volume of data over time is represented in the area under the graph captured between two time stamps. By multiplying the flow (e.g. a constant flow of 10kbps) by the time the flow took place (e.g. 80 seconds) we arrive at the total number of bits that were transported (800,000 bits) which through division by 8 translates to 100,000 Bytes which through division by 1024 translates to ~98KiByte. The actual payload traversing the distance in this flow may be smaller than 98KiByte due to control bits, headers, footers etc. that flow through the reference/measurement point but do not count towards the accumulated payload.
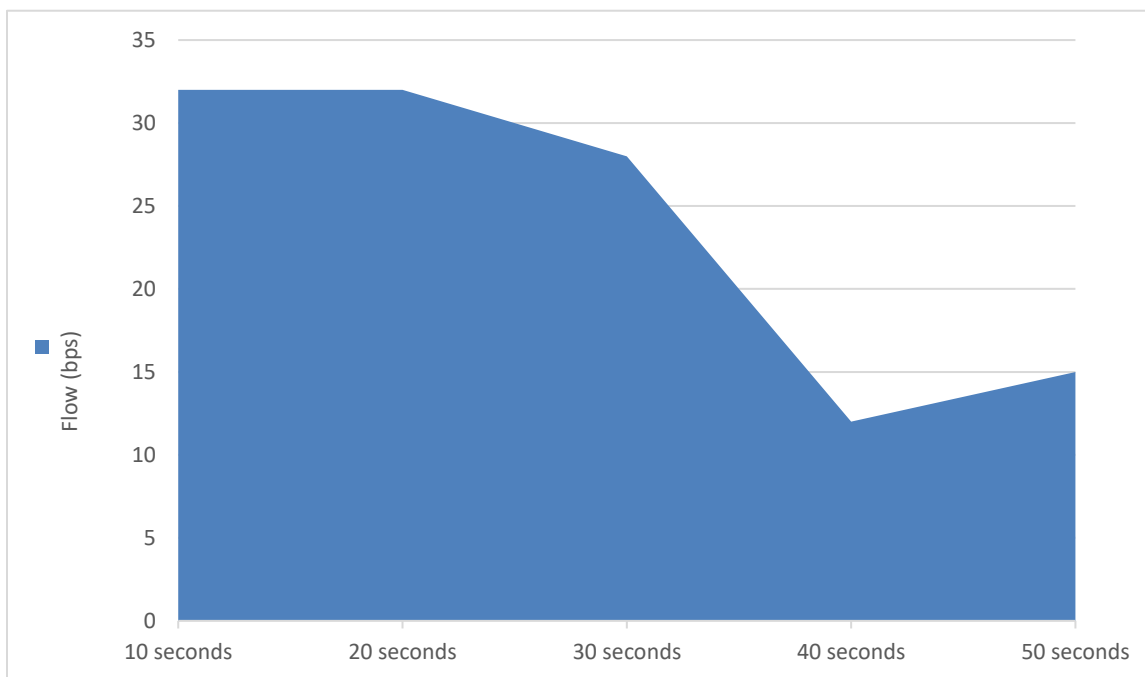
Figure 2 – Flow and Accumulation of Data

Technical/Product Attribute Term	Definition	Type	Unit of Measurement	Value Range
Data Measurement Unit	An abstract definition of data as a string of bits or Bytes. Exists in more specific instances related to storage and transmission (see below)			

Technical/Product Attribute Term	Definition	Type	Unit of Measurement	Value Range
Byte-Wise data unit	Data Measurement Unit typically used to measure Storage/volume	text	Byte, KiB, MiB, GiB, TiB etc.	
Bit-Wise data unit	Data Measurement unit typically used to measure flow of information such as transmission speeds.	text	Bit Kb Mb Gb	
Flow (of Data) Rate (of data)	The amount of data that flows through a reference point (e.g. UNI, ENNI) or is being processed by a certain device during a specified unit of time. *Example: The Subscriber has consumed a peak of 2Mbps during the measurement period.*	Numerical, Discrete	DMU divided by Time	0-∞
Bandwidth, Capacity (in the context of frequency spectrum)	Rate of Flow of information (occurrences per unit of time) or frequency at which electronic signals travel through a medium. *Example: The customer has been allocated a bandwidth of 2.4 GHz.*	Numerical, Discrete	Oscilations per Time Unit, Hertz	0-∞
Volume, Space	A cumulative amount of data that is processed at, stored in or traverses a certain point over time. *Example: The customer has subscribed to a storage plan of 3TiB.*	Numerical, discrete	DMU	0-∞

Table 7 – Data Measurement Units

8.2 Time Measurement Units

Time can be measured in multiples or fractions of the following units: Second, Month, Year.

Week and Day, Hour and Minute are multiples of a Second. The number of Seconds in each is fixed, with the exceptions of leap seconds and daylight savings that add or remove fixed amounts of seconds on specific calendric occasions. The effect of such exceptions on measurements of Commercial Affecting Attributes is to be agreed by the respective parties.

Months can contain either 28, 29, 30 or 31 days therefore there is no direct correlation between a Second and a Month.

Years contain 12 Months but can contain 365 or 366 Days, therefore there is no direct correlation between a Second and a Year.

Time Measurement Units based on Calendar systems other than the Gregorian Calendar are out of scope of this document.

[R-CAA-1]: Commercial contracts that refer to time **MUST** be based on one or more of the time units defined in table 8 herewith.

Technical/Product Attribute Term	Definition	Unit of Measurement
Time Unit	Time expressed in units of time measurement (e.g. Second, Day, Month). Considering a direct arithmetic link between second/minute/hour/day/week and an indirect link between Day/month and day/year. Examples: 1 Week (60 seconds x 60 minutes x 24 hours x 7 days) 3 Seconds	Days Hours Minutes Seconds Months Years
Day	The time elapsing from one midnight to another. Typically, that will be 24 (Twenty-Four) Hours, but may be 23 or 25 hours when moving to/from Daylight Savings.	
Hour	60 (Sixty) Minutes.	
Minute	60 (Sixty) Seconds, with the exception of Leap Minutes which may have 59 or 61 Seconds.	
Second	The duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom.	
Week	7 (Seven) Days.	
Month	One of the twelve periods of time that a year is divided into. Months can consist of 28, 29, 30 or 31 days.	
Year	A period approximately representing one full rotation of earth around the sun. Can consist of 365 or 366 days.	

Table 8 – Time Measurement Units

8.3 Distance and Distance Induced Measurement Units

Distance can be measured using different systems. Most scientific and business-related distances are measured using the Metric system that is based on multiples of a Meter, which is the length of the path travelled by light in vacuum during a time interval of 1/299,792,458 of a second. However, there are certain applications and geographies where other speed and distance units are used such as the imperial system.

The below table represents Distance related attributes that may have commercial context.

Tech-nical/Product Attribute Term	Definition	Type	Units of Measure-ment	Value Range
Distance	An amount of space between two things. *Examples: 100km* *3′ (feet)*	Numerical, Floating	Imperial or Metric Units (e.g. Meters, Feet, Miles {Nautical and Statute})	0-∞
Geograph-ical Dis-tance	The shortest distance between two points over the surface of earth.	Numerical, Floating	Same as above	0-∞
Path / Route Dis-tance	Actual distance measured as a curved line connecting two points, including physical obstacles and construction.	Numerical, Floating	Same as above	0-∞

Table 9 - Distance Measurement Methods

8.4 SLA Related Attributes

An SLA (Service Level Agreement) is the commercial framework that defines the remedies a Service-Provider grants the customer for failure to meet the SLS (Service Level Specifications).

As such, the SLA has commercial implications and may affect the billed and paid amounts between a Service Provider and its Customers.

The application of commercial remedies based on failure to meet the SLS is discussed in Section 10 hereafter.

Tech-nical/Product Attribute Name	Description	Type
SLS	The technical section in a service provider's Service Level Agreement (SLA). The SLS often includes, not exclusively, the following topics: Service performance Service objectives Metrics definitions Measurement of metrics Method of classification (e.g. Bandwidth Profiles, CoS levels) Bandwidth profile details	Contract

Tech-nical/Prod-uct Attrib-ute Name	Description	Type
SLA	A Service Level Agreement (SLA) is the contract between the user and the provider of a Service specifying the service level commit-ments and related business agreements for the Service. It typically in-cludes a Service Level Specification.	Contract

Table 10 - SLA and SLS definitions

8.4.1   SLA Attributes related to Distance

The table below represents Distance related attributes that may have an effect on SLA, and through that, a commercial impact.

Tech-nical/Prod-uct At-tribute Name	Description	Type	Units of Meas-urement
Frame De-lay (FD) (in the context of Carrier Ethernet) or Latency or Packet Delay (in the context of other service types)	The time it takes an electronic transmission to traverse between two reference points. Calculated as the differ-ence between the time the first bit of an electronic trans-mission leaves a reference point and the time the last bit of the same electronic transmission arrives at the destina-tion reference point. The Frame Delay will typically be the sum of Distance Induced Frame Delay, Aggre-gate Equipment Induced Frame Delay and Aggre-gate Congestion Induced Frame Delay. *Example: 53ms*	Numerical, Floating	Unit of Time
Distance Induced Frame De-lay	Frame Delay induced by the distance between the source point and the target point. This is typically calculated as the Path-Distance divided by the speed of light. Note however that light travels at (slightly) different speeds in different media. *Example: 20ms*	Numerical, Floating	Unit of Time

Tech-nical/Product Attribute Name	Description	Type	Units of Measurement
Equipment Induced Frame Delay	Frame Delay induced by the time it takes an electronic transmission to traverse between the ingress port and the egress port of a device exclusive of Congestion Induced Frame Delay. Such FD can be affected by conversion of Optical to Electrical signals, Processing of information or other factors. *Example: 1.5ms*	Numerical, Floating	Unit of Time
Aggregate Equipment Induced Frame Delay	The sum of Equipment Induced Frame Delay induced by all the devices along the path an electronic transmission traverses. *Example: 12ms*	Numerical, Floating	Unit of Time
Congestion Induced Frame Delay	Frame Delay caused by queuing at the egress port of a device. Queuing is typically caused by information arriving at an egress port at a rate that exceeds the processing capability of such port. This is typically calculated as the difference between FD when a transmission path is Congested versus the FD when the transmission path is not congested. *Example: 3ms*	Numerical, Floating	Unit of Time
Aggregate Congestion Induced Frame Delay	The sum of Congestion Induced Frame Delay induced by all the devices along the path an electronic transmission traverses. *Example: 12ms*	Numerical, Floating	Unit of Time
Round Trip Delay (RTD)	In scenarios where a confirmation is being sent by the destination device to the transmitting device upon receipt of a transmission, Round Trip Delay represents the aggregate Frame Delay of the transmission and the confirmation legs as measured at the transmitting device, inclusive of Distance, Equipment and Congestion delays. Note that the transmission and confirmation do not necessarily take the same path so an assumption that RTD = 2 x FD is not necessarily correct. *Example: 125ms*	Numerical, Floating	Unit of Time

Tech-nical/Product Attribute Name	Description	Type	Units of Measurement
IFDV (AKA Jitter)	Inter-Frame Delay Variation. *Example: 12ms*	Numerical, Floating	Unit of Time

Table 11 - SLA attributes related to Distance

8.4.2   SLA Attributes related to availability of Service

Tech-nical/Product Attribute Name	Description	Type	Units of Measure-ment	Value range
Uptime	The aggregate time a service is Available during a given period. Depending on the contract signed between the parties there could be situations where a service is considered Available even when its performance does not conform with the SLS. *Example: 719 hours*	Time	Typically a Month	0-∞
Downtime	The aggregate time a service is unavailable during a given period. Planned Maintenance may or may not be included in Downtime depending on the Contract between the parties. *Example: 3 hours*	Time	This is "Period minus Uptime"	0-∞
Packet Loss	The percentage of packets or frames or transmission units that were expected but failed to arrive at the target reference point. Note that not all packets sent from an originating reference point necessarily have to arrive at a target reference point (e.g. control packets) and certain packets (e.g. those in excess of CIR) may or may not be counted towards the Packet Loss metric depending on Contract. *Example: 0.005%*	%	% of the total number of units	0-100%
Transaction Loss	The number of Compute or Storage transactions that were assigned for a compute or storage node (physical or virtual) to process/store and failed to be processed/stored. *Example: 0.0005%*	%	% of the total number of transactions	0-100%

Tech-nical/Product At-tribute Name	Description	Type	Units of Measure-ment	Value range
Availabil-ity	The percentage of time a service is available during a given Period. Calculated as Uptime divided by Pe-riod. *Example: 99.999%*	%	% of total time	0-100%
TTR (Time to Restore)	The amount of time it takes to restore service to per-form according to the SLS. The starting point of same is to be defined in the contract between the par-ties involved in delivery and consumption of the Ser-vice or Product. *Example: 4.5 hours*	Time	Typically hours	0-∞
MTTR (Mean TTR)	The mean time it takes to restore service to perform according to the SLS over a given period. Typically used as a target where penalties may be paid if it is not met. *Example: 4.5 hours*	Time	Typically hours	0-∞

Table 12 - SLA Attributes related to availability of Service

8.4.3   SLA Attributes related to CoS (Class of Service)

Tech-nical/Product At-tribute Name	Description	Type
Class of Service Name (COS Name)	An administrative name assigned to a particular set of Performance Objectives and related Bandwidth Profiles. *Examples of CoS Names are Bronze, Gold, Silver, and Platinum.*	Text

Table 13 - SLA Attributes related to Class of Service

9 Measurement Methods and application of a commercial value.

This section discusses the measurement methods for Measurable Attributes and application of a commercial value to same.
In abstract terms we divide the association of a commercial value to a Product between **Fixed Price Products** and **Variable-Price-Products**.

9.1 Fixed Prices

A fixed price can be derived from type of Product and the value of certain attributes related to the Product, but it is determined independent of the actual consumption of resources described by those attributes.

Example: different price tags may exist for Products of 10Mbps, 100Mbps and 1000Mbps, but in a fixed-price scenario a consumer subscribing to a 100Mbps Product will pay a fixed amount regardless of the actual utilization of the resources providing this Product. Even if the customer actually never exceeds utilization beyond 15 Mbps they will still be billed the fixed 100 Mbps fee they have subscribed to.

It is not the intent of this document to specify the rules or logic by which Operators assign fixed prices to Products. This could be based on a combination of multiple factors, including (but not limited to) estimated utilization, various costs, market price and others. However - this document does specify the rules by which Operators bill their customers for use of Fixed-Price Products as described herewith:

1. Fixed Price Products are Products which are billed a fixed amount per occurrence regardless of the measured values related to the product rendered.

2. Fixed Price Products may be associated with a billing interval *(e.g. a monthly bill)* or may be billed on a per-occurrence basis.

[R-CAA-2]: Fixed Price Products **MUST** either be associated with a billing interval or be billed on a per-occurrence basis.

3. Fixed Price Products that are associated with a billing interval can be billed at any point during the billing interval but are typically being billed either in advance (at the beginning of each interval) or in arrears (by the end of each interval).

   Example: a $50 monthly internet service fee paid to an ISP.

[R-CAA-3]: If a Fixed Price Product is associated with a billing interval, the Buyer and Seller **MUST** agree whether it will be billed before, during or after the billing interval.

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4. Fixed Price Products that are not associated with a billing interval can be billed on a per occurrence basis. but can also be aggregated and accumulated and billed on either intervals or when the accumulated billed amount reaches or exceeds a certain threshold.

    Example: a $7.99 per movie download paid to content distributor upon download.

[R-CAA-4]: Fixed Price Products that are <u>not</u> associated with a billing interval **MUST** either be billed on a per occurrence basis or aggregated and accumulated and billed on either intervals or when the accumulated billed amount reaches or exceeds a certain threshold.

5. In the event that multiple Fixed-Price Products are being consumed during the billing interval, the bill may include multiple items, as per the number of occurrences of Fixed-Price Service events during the billing interval period, or an aggregated amount.

    Example: An International Mobile Data roaming package that is billed on a $5 per day of international roaming, may include, say, six instances of data-roaming-days in a certain month and thus the monthly bill from the mobile operator may include an aggregated $30, representing 6 days x $5 per day international data-roaming charge, or six individual items of $5 each.

[R-CAA-5]: The bill **MUST** include at least one item and may include multiple items represented either as a single aggregated amount or as multiple occurrences of Fixed-Price Product events during the billing interval period.

6. Periodical bills may include both Products associated with or not associated with the billing interval and may include multiple billed items.

    Example A mobile data monthly bill may include both a fixed price monthly domestic data plan and several occurrences of per-day international data roaming items.

[R-CAA-6]: Periodical bills **MUST** include Products associated with the billing interval and **MAY** include items that are not associated with the billing interval.

7. A monthly bill may include credits associated with SLAs. Those will typically be deducted from the billed amount.

[O-CAA-1]: A monthly bill **MAY** include credits associated with SLAs.
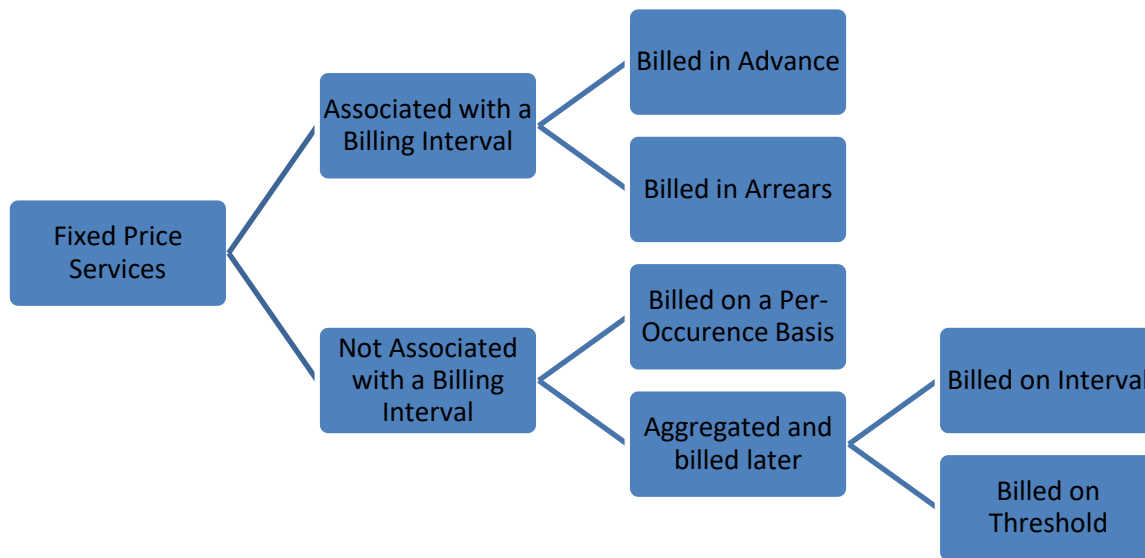
Figure 3 - Fixed Price Services

9.2   Variable Prices

The Price of Variable-Price Products may vary based on values of one or more attributes meas-
ured when the Product is being consumed. The values can be related to the **Time** a Product has
been used, the **Distance** associated with consumption of said Product, the **Volume of data** that
was transferred or processed or stored, the **Type or Amount of Cumulative Intrinsic Discrete
Events** that occurred, or a combination of two or more of the above. The amount billed may be
based on tiers or on a formula or on a combination of both.

For clarification purposes – Cumulative Intrinsic Discrete Events refers to events such as CPU or
GPU computations. Though the majority of such events are typically associated with computa-
tion resources, the definition in this document is generic, in order to allow applications that facil-
itate other types of intrinsic discrete events.

*Example: Image processing could be billed on a fixed price per image basis, regardless of the computational re-
sources that were required to process that image. On the other hand, depending on contract between the parties,
Image processing could also be billed on a variable price basis that is derived from the computational resources
(e.g. number of GPU computations) required to process that image.*

9.2.1   Formula Based Billing

Formula Based Billing occurs where the seller offers an agreed contracted formula based on one
or more units of consumed resources and calculates the billed amount by applying the actual uti-
lization of said resource(s) (as measured) on the agreed contracted formula. The formula may be
linear or non-linear and may include one or more measured attributes. It is not the intent of this
document to dictate or suggest the formula to be used.

An example of a Linear formula would be an agreed rate of $2/MiByte of mobile data roaming. In a hypothetic scenario of an actual consumption of 535MiByte over a period of one month the billed amount will be calculated using the formula of $2/MiByte x 535MiByte = $1,070. An example of a Non-Linear formula would be an agreed rate of $2/Mbps/(Distance in Meters)^2 which may be relevant in Radio Transmissions, where the electromagnetic field strength drops by 1 over the distance squared.

[R-CAA-7]: The formula used in Formula-Based-Billing **MUST** include at least one measured attribute.

9.2.2   Tiered Based Usage Billing

Tiered Based Usage Billing occurs where the seller has established a table representing a different Fixed price per tier. The actual price paid will be calculated by measuring the usage of the resource, identifying the tier in which this level of usage falls, and billing according to the agreed rate for that tier.

An example would be an agreement that offers a rate of $5/month for accumulated use of music streaming of less than one hour, a rate of $15/month for accumulated use of music streaming of more than one hour and less than 15 hours, and a rate of $50/month for unlimited music streaming. A user that has used a cumulative time of 14 hours will be billed $15 for that month.

9.2.3   A Tiered-Formula-Based Billing

A Tiered-Formula-Based Billing occurs where the seller offers an agreed contracted formula based on one or more units of consumed resources, and calculates the billed amount based applying the actual utilization of said resource(s) (as measured) on the agreed contracted formula, but the formula differs depending on the measured utilization of one or more attributes.

An example would be a pricing scheme that charges a rate of $5/Mbps of bandwidth used if usage is below 20Mbps, a rate of $4/Mbps if usage is larger than 20Mbps but lower that 30Mbps and a rate of $3/Mbps if usage is larger than 30Mbps.

Figure 4 content:

Measured Attribute
Time
Distance
Volume
Cumulative intrinsic discrete events
Flow

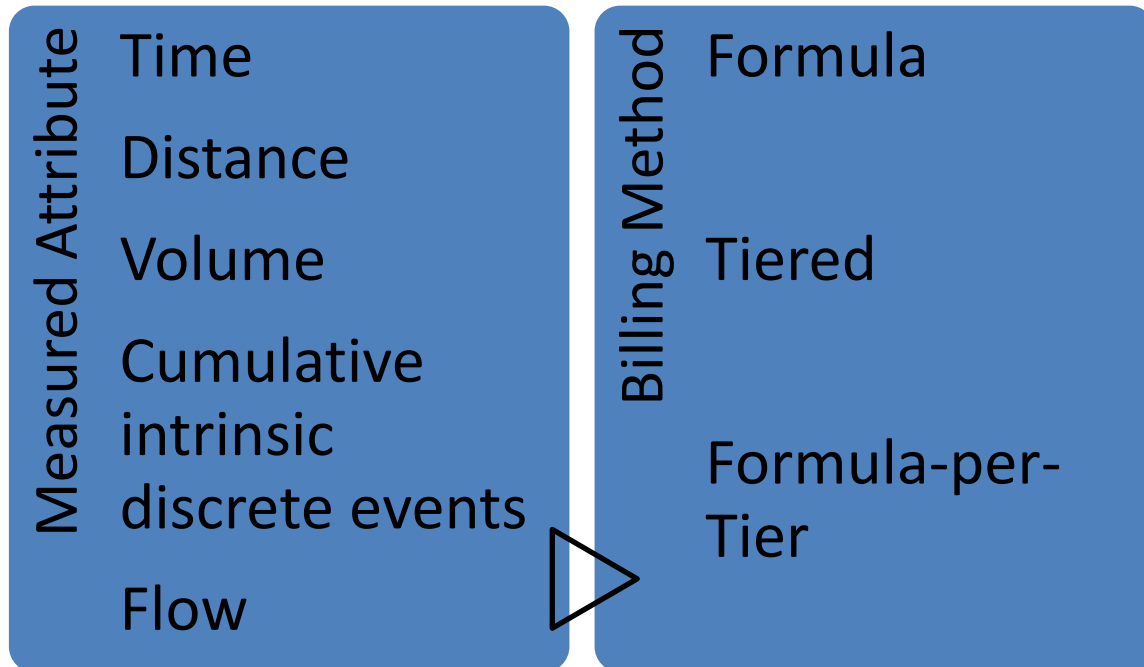**Billing Method**
Formula
Tiered
Formula-per-Tier

Figure 4 - Variable Price Services

9.3 Combined Prices

[O-CAA-2]: Products **MAY** be billed in a combined mix of Fixed and Variable pricing.

An example would be a service that is billed a fixed monthly amount (that would typically cover fixed cost elements such as a local tail and equipment rental) and by a usage-based amount (that would typically cover resource utilization).

9.4 Dimensional Analysis

When attaching a commercial value to a measured attribute one has to keep in mind that the result of a calculation that yields a billable item that goes into an invoice (or an electronic monetary transaction) must only include items defined by currency.

[R-CAA-8]: The result of a calculation that yields a billable item **MUST** only include items defined by currency.

Other attributes, such as duration of service, distance or number of bits or bytes may appear in an invoice for informational purposes but cannot be billed as one entity cannot charge another entity with minutes and cannot be charged with distance. The monetary exchange is done in currency that may represent the commercial value of time, distance or other technical or physical attributes.

[O-CAA-3]: Non-Currency attributes **MAY** appear in an invoice for informational purposes.

In order to ensure the result of the formula being used to calculate the billed amount only represents currency and no other attribute a simple rule must be followed: The monetary rating of a Product

must be represented by the same formula and dimensions that are being used to measure the attribute.

For example: If a product is billed based on a formula of USD5 per Kilometer of distance between two reference points then the measured attribute on which the Product is billed must be Kilometers.

A more complex eample: If a product is billed based on a formula of USD 5 per MiBytes per Kilometer of distance between two reference points then the measured attributes must be MiBytes multiplied by Kilometers.

[R-CAA-9]: The monetary rating of a service **MUST** be represented by the same formula and dimensions that are being used to measure the attribute.

For the purpose of clarity, the currency symbol $ used in the tables herewith, represents an abstract currency and does not refer specifically to USD or any other specific currency that may be associated with the $ sign. The actual transactions are to be made using a currency agreed between the Buyer and the Seller.

Example: If a service is being billed by its duration then the rate of the service is determined by a monetary value per unit of time, and the measured attribute will be of type "time".

Rate: USD 5 per minute of service. $\quad Rate = \frac{USD\ 5}{Minute}$

Measurement: 15 minutes of service.

Calculation: Billed Amount $= \frac{USD\ 5}{Minute}\ x\ 15\ Minutes = USD\ 75$

Dimensional analysis: Minutes appear both in numerator and denominator thus cancel each other and we end up with a currency attribute only.

Similarly, dimensional analysis can be used to convert from one measurement/unit system to another.

Example: A service is rated on a per second basis but is measured in hours.

A conversion from hours to seconds is performed based on the formula that 1 hour $= \frac{3600\ Seconds}{Hour}$

Example: A conversion from Meters to Miles is performed based on the formula that 1Mile $= \frac{1609\ Meters}{Mile}$

Rate: USD 5 per Km of service $\quad Rate = \frac{USD\ 5}{Km}$

Measurement: A distance of 10.5 Miles

Calculation: Billed amount $=\ 10.5\ Miles\ x\ \frac{1609\ Meters}{Mile}\ x\ \frac{1\ Km}{1000m}\ x\ \frac{USD\ 5}{Km} = 10.5\ x\ \frac{1609}{1000}\ x\ USD\ 5 = USD\ 84.47$

[R-CAA-10]: The Units defining the Rate **MUST** be the reciprocal of the units by which Measured Attributes are measured excluding the currency.

[O-CAA-4]: Different units of the same type **MAY** be used for rating and measurement.

[R-CAA-11]: When different units of the same type are used for rating and measurement, the formula used to calculate the monetary value of the transaction **MUST** include a conversion to a single unit.

9.5 Measurement of Transport related attributes

Transport related measurement can represent Distance, Time, Flow and Volume related attributes.

9.5.1 Distance related attribute measurement

Measurable Attribute	Description of Measurement Method	Rate defined by	Result of Measurement	Applicable Commercial Value
Geographical Distance	Geographical Distance between two points (may be different than actual route traversed due to terrain/environmental/building constrains).	$ per unit of distance ("D")	"d" = Measured Distance represented in Units of distance (e.g. meter, mile)	$/D*d=$
Route Distance	The actual length of a route connecting two points (may be curved thus longer than Geographical Distance)	$ per unit of distance ("D")	"d" = Measured Distance represented in Units of distance (e.g. meter, mile)	$/D*d=$

Table 14 - Distance Related Attribute Measurement

9.5.2 Time related attribute measurement

Measurable Attribute	Description of Measurement Method	Rate Defined By	Result of Measurement	Applicable Commercial Value
Duration of Service	The time elapsing between Start and Termination of a Service excluding Outages. (Service Termination Time) - (Service Start Time) - (Accumulated Service Outage Time)	$ per unit of time ("T")	"t" = Measured Duration represented in Units of Time (e.g. One Second)	$/T*t=$
Duration of Outage	The time elapsing between the start and end of an Outage. (Service Restoration Time) – (Outage Start Time)	SLA	"t" = Measured Duration of Outage represented in Units of Time (e.g. One Second)	Per SLA

Table 15 - Time related attribute measurement

9.5.3 Flow related attribute measurement

Measurable Attribute	Description of Measurement Method	Rate defined by	Result of Measurement	Applicable Commercial Value
Bandwidth Usage	A method of calculating the number of bits flowing through a reference point during a certain sampling period. [(BitCount at end of Sampling Duration) – (Bitcount at Beginning of Sampling Duration)] divided by (Sampling Duration) = Number of bits flowing through a point during Sampling Duration	$ per Usage ("U" represented in Bits per Second)	"u" = Measured Usage in Bits per second	$/U*u=$
Average Bandwidth Usage	A method of calculating a Bandwidth Usage Metric by Collecting Bandwidth Usage results in intervals that must be Same or Shorter than the billing interval. Summing up all the results of completed Usage measurements and dividing by the number of completed Usage measurements.	$ per Usage ("U" represented in Bits per Second)	"u" = Average Usage in Bits per second	$/U*u=$
Maximum Bandwidth Usage	The highest recorded usage of Bandwidth during a period of time. Calculated by Collecting Bandwidth Usage results in intervals that must be Same or Shorter than the billing interval. Then Selecting the Usage Record with the highest rate.	$ per Usage ("U" represented in Bits per Second)	"u" = Measured Usage in Bits per second	$/U*u=$
95th Percentile Bandwidth Usage	A method commonly used to represent maximum utilization over a period of time while eliminating the effects of	$ per Usage ("U" represented in Bits per Second)	"u" = 95th percentile Measured Usage in Bits per second	$/U*u=$

short bursts. Collecting Bandwidth Usage results in intervals that must be Same or Shorter than 1/20 of the billing interval. Remove the Measurements with the top 5% of completed usage measurements. The highest remaining usage measurement represents the 95th percentile usage during billing interval.				

Table 16 - Flow Related Attribute Measurement

9.5.4 Volume related attribute measurement

Measurable Attribute	Description of Measurement Method	Rate defined by	Result of Measurement	Applicable Commercial Value
Volume of Data	Number of Bytes traversing a measurement point, or stored in a storage space, or processed by CPU.	$ per Byte	Number of Bytes	$/Byte*Bytes=$

Table 17 - Volume Related Attribute Measurement

9.6 Measurement of Storage related attributes

Measurable Attribute	Description of Measurement Method	Rate defined by	Result of Measurement	Applicable Commercial Value
Maximum Storage Used during a Period	The highest number of Bytes that were stored in a storage space during a certain period	$ per S (Represented as Bytes*Time)	s = Maximum Number of Bytes used for Storage by Customer during billing period Multiplied by billing period.	$/S*s=$

Storage Space Plan	The number of Bytes allocated for use by a specific consumer during a defined period.	$ per S (Represented as Bytes*Time)	s = Number of Bytes allocated Multiplied by billing period.	$/S*s=$

Table 18 - Measurement of Storage Related Attributes

9.7 Measurement of Data Transformation/Compute related attributes

Measurable Attribute	Description of Measurement Method	Rate Defined By	Result of Measurement	Applicable Commercial Value
Duration of Compute Service	The time elapsing between the start and end of a compute service. (Compute End Time) - (Compute Start Time)	$ per T (defined in units of Time)	"t" = Unit of Time (e.g. One Second)	$/T*t=$
Number of Computations	Aggregate number of Computation cycles during measurement period	$ per C (defined as a Computation Cycle)	"c" = Number of Computations measured	$/C*c=$
Number of CPU Cores used	Indicates the number of CPU cores allocated for a Service	$ per Core	"c" = Number of Cores	$/Cores*c=$
Speed of CPU	Select from a list of available CPU speeds	$ per item in the list	"s" = allocated CPU speed	$
Amount of RAM allocated to a VM	Measure the amount of RAM, in MiB, allocated to a VM.	$ per M (defines amount of RAM in MiB)	"m" = Amount of RAM allocated	$/M*m=$
Operating System	Specifies the Type and Version of Operating System loaded on a virtual or physical computer system.	Discrete list of OS options	Price per option	$

Table 19 - Measurement of Data Transformation/Compute Related Attributes

10 Commercial Aspects of SLA and SLS

This section explains some key concepts necessary for understanding the Commercial aspects of SLA, SLS and related attributes.

A Service Level Specification defines performance objectives for service level tiers. A Service Level Agreement defines the commercial implications of deviation from, or failure to meet, such objectives. The commercial implications will typically be in the form of financial remedies such as discounts, refunds, penalty payments or grant for free use of resources in the future.

There are multiple methods through which such deviation or failure could be measured, and the respective remedies calculated. This MEF Technical Specification will discuss the following methods:

- Percentage based remedies.

- Tier based remedies.

10.1 Percentage based remedies

The simplest form of remedy calculation is one that results from an arithmetic formula based on the percentage of actual performance vs. a certain target. This is a two-step calculation though. The first step would be to represent the performance vs. target as a fraction represented in percentage. The second step would be to apply a remedy based on the percentage.

10.1.1 Calculation of Deviation from Target

The Deviation from Target is calculated as the difference between the actual performance vs. the Target Performance, divided by the Target Performance.

$$Deviation\ from\ Target = \frac{Measured\ value - Target\ value}{Target\ value}$$

Example of use of the first step would be to calculate actual frame loss vs. a target frame loss. If the SLS states a target of, say, at or below 0.1% frame loss during a certain period, and the actual packet loss was indeed at or below 0.1% then the performance target was met, and no remedies are required. If, however, the actual frame loss was 0.15% then there is a 50% deviation from the target.

$$Deviation\ from\ Target = \frac{Measured\ value - Target\ value}{Target\ value} = \frac{0.15 - 0.1}{0.1} = 0.5 = 50\%$$

10.1.2 Application of Remedies based on Deviation from Target

There are three methods of application of Remedies based on the Deviation from Target.

10.1.2.1 *Formula based application*

When a Formula is used to apply remedies based on the Deviation from Target then the level of remedy is calculated by using a formula that includes both the Remedy and the Deviation. The

simplest form would be a simple multiplication of a Reference Remedy by the Deviation from Target.

$$Remedy = Reference\ Remedy \times Deviation\ from\ Target$$

An example would be a Reference Remedy that equals one recurring periodical payment (which in this example would be USD 100) and if we apply the 50% Deviation from Target from the example in the previous section that will yield a remedy in the form of a penalty payment of USD 50 as calculated herewith:

$$Remedy = Reference\ Remedy \times Deviation\ from\ Target = USD\ 100 \times 50\% = USD\ 50$$

The formula can be more complex and non-linear depending on contract to be mutually agreed between buyer and seller. The formula can also include a fixed amount on top of the variable, percentage based, amount.

10.1.2.2 Flat Rate application

In a flat rate application – the remedy is pre-defined and is applied as a flat rate in any event that the Deviation from Target is greater than Zero.

An example would be that in an event of a failure to perform a certain network function – the user is given another attempt at no extra charge.

10.1.2.3 Tier based application

Remedies can be based on tiers of Deviation from Target. Each tier represents a certain range of Deviation from Target, and different remedies apply for each tier. The remedy in each tier can be based on either a Formula or a Flat rate.

An example Tier based application is presented in the table below.

Range of Deviation from Target	*Remedy Type*
$0\% > Deviation \geq 5\%$	$Reference\ Remedy \times Deviation\ from\ Target$
$5\% > Deviation \geq 15\%$	$2 \times Reference\ Remedy \times Deviation\ from\ Target$
$15\% > Deviation$	*100% Refund*

Table 20 – Tier based application - Example

10.2 Tier based remedies

While Percentage based Remedies can only be applied to SLS metrics that could be measured and represented as a percentage of certain target metric, there are certain SLS metrics that cannot be measured and represented in such manner. Furthermore –the Buyer and the Seller can mutually agree not to use Percentage based Remedies for commercial or operational reasons and may prefer to use other methods. Tier based remedies can be applied to all SLS metrics, both those for which a Deviation from Target can be calculated and those for which it cannot. Each tier represents a certain range of an SLS metric and can be based on a formula or on a flat rate. However – since certain SLS metrics cannot be represented as a Deviation from Target – not all Tier based remedy options are available for all SLS metrics.

10.2.1.1   Formula based Tiers

This option is only applicable for SLS metrics that can be represented either as a numerical value or as a percentage representation of Deviation from Target. The formula must include the numerical value or percentage and may include additional fixed amounts. The simplest form for a Deviation from Target percentage remedy calculation would use the same formula presented in section 10.1.2.1 above and can be more complex and non-linear depending on contract to be mutually agreed between buyer and seller. In the event of remedies based on a numerical value representing an SLS metric the formula would apply an arithmetic function (multiplication, division etc.) on that numerical value and multiply that by a factor and a currency.

An example would be TTR remedies that are calculated thru multiplication of TTR, represented in hours, by a currency rate per hour, coming up with a penalty to be paid.

$$Remedy = TTR \ (hours) \times \ Rate \ (\frac{Currency}{hour})$$

If we take an example of a TTR of 2.5 hours and a rate of USD 225 per hour we come up with a calculation of:

$$Remedy = 2.5 \ hours \ \times \ \frac{USD \ 225}{hour} = USD \ 562.50$$

10.2.1.2   Flat Rate Tiers

The remedy on flat rate tiers is pre-defined and is applied as a flat rate as defined for that tier.

An example of Tier based Remedy is presented in the table below.

SLS metric	Remedy Type
$FD \ \leq 175ms$	*No Remedy*
$175ms \ < FD \ \leq 200ms$	$\frac{USD \ 30}{ms} \times \ FD \ (ms)$
$200ms < FD$	*100% Refund*

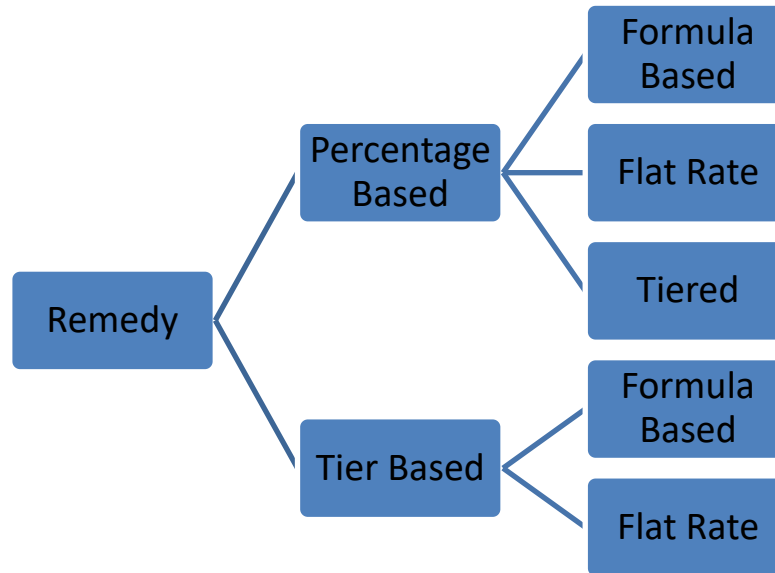**Table 21 – Tier based Remedies - Example**

Figure 5 – Remedy Calculation Options

10.3   Remedy options per SLS metric

The following table represents remedy calculation options per SLS metric.

Tech-nical/Product Attribute Name	Deviation from Target calculation	Direct Calculation
Frame Delay (FD), Latency or Packet Delay and their variants (such as RTD, Distance induced FD, Equipment induced FD etc.)	$$R = \frac{MFD\ (time) - TFD(time)}{TFD(time)} \times RR$$ R = Remedy r = rate of Remedy per unit of time MFD = Measured FD TFD = Target FD RR = Reference Remedy Time typically measured in millisecond (ms)	$$R = MFD\ (time) \times \frac{r}{time}$$

Tech-nical/Product Attribute Name	Deviation from Target calculation	Direct Calculation
IFDV (AKA Jitter)	$$R = \frac{MIFDV\ (time) - TIFDV(time)}{TIFDV(time)} \times RR$$ R = Remedy r = rate of Remedy per unit of time MIFDV = Measured IFDV TIFDV = Target IFDV RR = Reference Remedy Time typically measured in millisecond (ms)	$$R = MIFDV\ (time) \times \frac{r}{time}$$
Uptime	$$R = \frac{TU\ (time) - MU\ (time)}{TU\ (time)} \times RR$$ R = Remedy TU = Target Uptime MU = Measured Uptime RR = Reference Remedy Time typically measured in hours	*Not Applicable*
Downtime	$$R = \frac{MD\ (time) - TD\ (time)}{TD\ (time)} \times RR$$ R = Remedy r = rate of Remedy per unit of time TD = Target Downtime MD = Measured Downtime RR = Reference Remedy Time typically measured in hours	$$R = MD\ (time) \times \frac{r}{time}$$

Tech-nical/Product Attribute Name	Deviation from Target calculation	Direct Calculation
Packet Loss, Frame Loss, Transaction Loss	$$R = \frac{ML\ (\%) - TL\ (perent)}{TL\ (\%)} \times RR$$ R = Remedy r = rate of Remedy per percent TL = Target Packet/Frame/Transaction Loss ML = Measured Packet/Frame/Transaction Loss RR = Reference Remedy Packet/Frame/Transaction loss represented as percentage as defined in section 8.4.2 herewith.	$$R = ML\ (\%) \times \frac{r}{\%}$$
Availability	$$R = \frac{TA\ (\%) - A\ (\%)}{TA\ (\%)} \times RR$$ R = Remedy A = Availability (measured) TA = Target Availability (Typically 100% but not mandatory) RR = Reference Remedy Time typically measured in hours. In the event of TA<100% and A>TA the commercial contract between the parties may include provisions for a bonus.	*Not Applicable*

Tech-nical/Product Attribute Name	Deviation from Target calculation	Direct Calculation
TTR (Time to Restore)	$$R = \frac{MT\ (time) - TT\ (time)}{TT\ (time)} \times RR$$ R = Remedy r = rate of Remedy per unit of time MT = Measured TTR TT = Target TTR RR = Reference Remedy Time typically measured in hours	$$R = MT\ (time) \times \frac{r}{time}$$

Table 22 - Remedy calculation options for SLA affecting attributes

11 References

[1]   [MEF 10.4] MEF Forum, Ethernet Service Attributes Phase 4, MEF 10.4, November 2018.

[2]   [MEF 26.2] MEF Forum, External Network to Network Interfaces (ENNI) and Operator Service Attributes, August 2016.

[3]   Internet Engineering Task Force RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, March 1997

[4]   Internet Engineering Task Force RFC 8174, *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, May 2017