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# USING STANDARDIZED APPROACH FOR OPERATIONS MANAGEMENT OF CARRIER ETHERNET

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## Abstract:

*Carrier Ethernet has become a technology of choice for service providers to provide WAN services. Carrier Ethernet provides must have factors to efficiently provide WAN connectivity to enterprises such as scalability, reliability, hard QoS, service internetworking. An ability to manage service sessions and service delivery is the most important aspect of making Carrier Ethernet more successful.*

For the fact that Carrier Ethernets may be deployed over multiple technologies such as Copper / Fibre, RPR (Resilient Packet Rings), MPLS, SONET / SDH and DWDM / CWDM; it becomes critical to have right solution in place to quickly enable launch of carrier Ethernet and effectively manage the same. Considering the complexity of Carrier Ethernet that uses multi-technology and multi-vendor network environment; effective usage of standards based integration layer becomes a key success factor when it comes to standing the tests of quick service roll outs and an ability to effectively manage these services.

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## Background

Carrier Ethernet has become a technology of choice for service providers to provide WAN services. Carrier Ethernet provides must have factors to efficiently provide WAN connectivity to enterprises such as scalability, reliability, hard QoS, service internetworking. An ability to manage service sessions and service delivery is the most important aspect of making Carrier Ethernet more successful.

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## Impending need for robust service deliveries

Service Providers need a robust, reliable infrastructure for service deliveries and thereby widen their customer base. The next generation service characteristics demand high bandwidth and require a lot of service intelligence at the edge of the network. Edge devices include CPE devices such as PCs, set-top boxes, mobile handsets and smart phones. Besides the need for high bandwidth, most of the new generation services require session management. The service sessions are one-to-many and many-to-many in most cases.

CE infrastructures & deployments may vary based on several criteria:

- Vendor offerings for 'Edge devices' of a Carrier Ethernet network may differ in terms of the number of customer edge connections they can support, the port density and the processing speed
- Core Service Topologies may support logical Full-Mesh, Hub-n-Spoke
- Carrier Ethernet circuits can be end-to-end, in which case they are tunneled through the service provider network
- Although Carrier Ethernets are traditionally deployed over pure Ethernet transports, sometimes, there is a need to accommodate legacy WAN technologies such as ATM and Frame-Relay. This leads to a variety in Carrier Ethernet network architectures
- Choice of Access Speed Range [1.5 Mbps as in T1 to 45 Mbps in DS3]

The diagram below shows all the Carrier Ethernet Business and Residential services:

## Network Nodes as Service Function Points

While the transport technology can vary both in the core and access, the functional units in a Carrier Ethernet network are mainly the edge devices in various constituent domains, such as the Access, Aggregation, Distribution and Core.

Functionally, these network nodes are a part of:

- End-to-end Layer 2 virtual circuits [e.g., ATM VCs]
- Pseudo wires and Attachment Circuits
- Port mappings
- Access Terminations
- Service multiplexing
- Traffic engineering policies
- Hybrid Network Gateways
- Traffic engineered Ethernet Virtual Circuits (EVC)

The diagram below is an illustrative view of key service function points in Carrier Ethernet network:

| Technology | Management Activities | Functional Points [ Network Devices ] | | | | | |
|---|---|---|---|---|---|---|---|
| | | U-PE | N-PE | PE-Agg | P-Core | Service Gateway | Access End-points |
| MPLS / T-MPLS / PBT Transport Technologies | 1. Pseudowire configuration<br>2. Layer 2 tunnel configuration<br>3. Service Mapping (e.g. PBT to MPLS Pseudowire) | • | • | • | • | • | |
| Ethernet Transport | 1. VLAN Configurations<br>2. Attachment circuits | | • | • | • | | |
| RPR SubLayers | | | | | | | • |
| Fibre, Copper and Microwave Access Technologies | 1. Access Multiplexing<br>2. Access Security | | • | • | | | • |
| Ethernet over PDH / SDH | | • | • | • | • | | |
| Layer 3 Technologies & above [IP, BGP...] | 1. Routing & Signaling [eg., BGP signaling]<br>2. Layer 3 tunnel configuration | • | • | | | | |

## Carrier Ethernet Service Deployment: Key Challenges

- Multi-Domain Environment

Ethernet is no longer just a LAN technology. It has pervaded the MAN and the WAN segments. It is used at Access, Distribution and Core. It can be implemented over T1/E1/Fibres. It can support bandwidth range beyond that can be supported by ATM and Optical counterparts. A typical Metro Ethernet network spans across multiple geographic and vendor domains. Effectively managing such networks and ensuring guaranteed service delivery is a big challenge.

- Service Differentiation

Carrier Ethernet infrastructures are designed to transport a whole variety of services from VPN connectivity to Video broadcasts. There would be a large customer base for these service offerings and each with a different service package / Class of service. The service provider's primary challenge is to differentiate between different service offerings and their corresponding quality tolerance levels.

This has direct impact on the network design and planning on one side and on the other hand; configurations for service filtering and traffic engineering, so as to meet QoS requirements. Most of the service differentiation logic is ideally focused at entry points of Carrier Ethernet network and this increases capacity demands for access network devices.

- Widening Service Offerings – Not Considered as it's not very pertinent to CE
- Sizing – Network, Services and Subscribers

Traditionally, service providers design their network (from sizing and scaling aspect) just on the basis of subscriber base. Owing to rapidly increasing service variations, efforts to reduce management hassles and sky scrapping costs would add other dimensions namely, network and services while designing networks (from sizing and scaling aspect). Although, all these dimensions can not be standardised in proportion, this can be the key differentiator between different CE service provider implementations that in turn can significantly impact profits.

Carrier Ethernets need to be more intelligent at the Access Network which has to be designed keeping three dimensions intact, i.e. subscriber base, network (Edge points in an Access Network multiplex into different transport technologies in the core such as Fibre, T1, E1, each supporting different transmission bandwidths) and service forecasts.

- Legal and Security Issues

Carrier Ethernet are typically large scale deployments spanning multiple administrative and geographic domains. Besides, it can transit pockets of hybrid technology clouds such as a satellite / wireless communication, where different legal issues and security concerns come into picture. Network designs are significantly influenced by these non-technical factors.

As an observation, universally standardised legal policies and CE security principles will help as much as it helps in using standardised management interfaces.

## Increasing Operations and Maintenance Efficiencies

From this point onwards, this paper brings out some of the aspects of Ethernet Operations, Administration and Management and throws light on ways to increase the OAM efficiency.

Standardised interfaces between a heterogeneous matrix of systems, common views of the managed entities, seamless storage and backup facilities and adequate failover strategies will help ease out complexities that can arise due to an unanticipated breakdown of integrated systems.

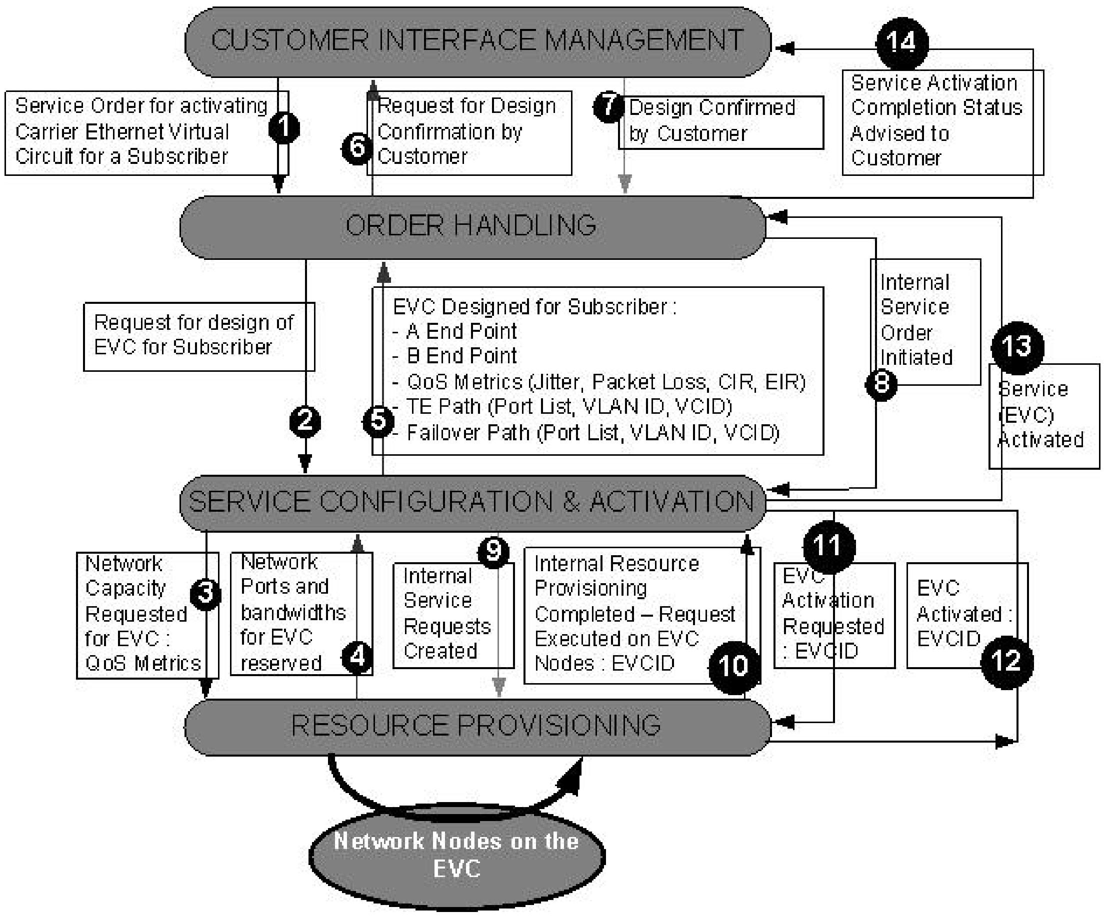
## Provisioning Approach

The typical provisioning tasks for setting up Carrier Ethernet Services include:

- Configuration of the UNI for:
    - Connecting to the CE Service provider Access Edge Device [U-PE]
    - Setting up bandwidth profiles [configuration of CIR, CBS, EIR, EBS] per UNI or per EVC per UNI
    - Setting up CoS values at the UNI for traffic profiling
    - VLAN tags

- Configuration of the NNI on the network nodes [N-PE, PE-Agg, Service Gateways] for:
  - Mapping incoming and outgoing ports on the EVCs (Ethernet Virtual Circuits)
  - Setting up subscriber specific CoS parameters for traffic profiling
  - Traffic parameters
  - VLAN tags

The diagram below depicts a sample Ethernet Service Provisioning and Activation Workflow based on TMF ETOM process interactions:




## Performance and reporting

QoS and SLA were not of much concern for legacy Ethernet services. Nevertheless, they are quite important for carrier grade Ethernet deployments.

Key Performance Indicators for connectivity service offerings [VPLS (Virtual Private LAN service), VPWS (Virtual Private Wire Service) and L3-VPNs] on Carrier Ethernet infrastructure include:

- Bandwidth Profile [Committed Information Rate, Committed Burst Size, Excess Information Rate, Excess Burst Rate]
- Service Availability
- Delay
- Delay Variation (Jitter)
- Packet Loss

Key services offered over CE infrastructure include Video, VoIP, Triple Play and different type of Internet services. Bandwidth requirements are unique for each service. Delay tolerance levels also differ from one service to the other. While applications such as video conferencing are very sensitive to delay, others like data applications are highly sensitive to packet loss.

Legacy Ethernet services were more of LAN based services and in order to scale them up to carrier grade; it became imperative to address issues related to network size, geographically distributed network topologies, etc. All these issues influence range / values of performance parameters. For instance, typical recovery time in case of a link breakdown fault in a Metro Ethernet is of the order of 10 milli seconds. On the contrary, allowed value is of the order of 10 micro second in case of a Carrier Ethernet.

Performance indicators for transport services such as MPLS include:

- MPLS forwarding performance metrics such as latency, throughput, loss and delay
- MPLS LSP error rate, downtime, flapping rate

Performance indicators for signaling / control services such as BGP and other routing protocols include:

- Membership Synchronization time
- Routing Table Capacity
- Signaling system reliability

The kind of performance reports vary for residential and business customers. Typically, residential customers like to be reported on their service usage (for an accounting period) rather than performance reports on the network. But it is imperative for a NOC operator to gain access to reports on the performance of the network path utilized by the customer and that of their service instances, for analyzing deterioration of service quality.

Useful reports for NOC operators include those about the performance of transport and signaling protocols. Some examples include:

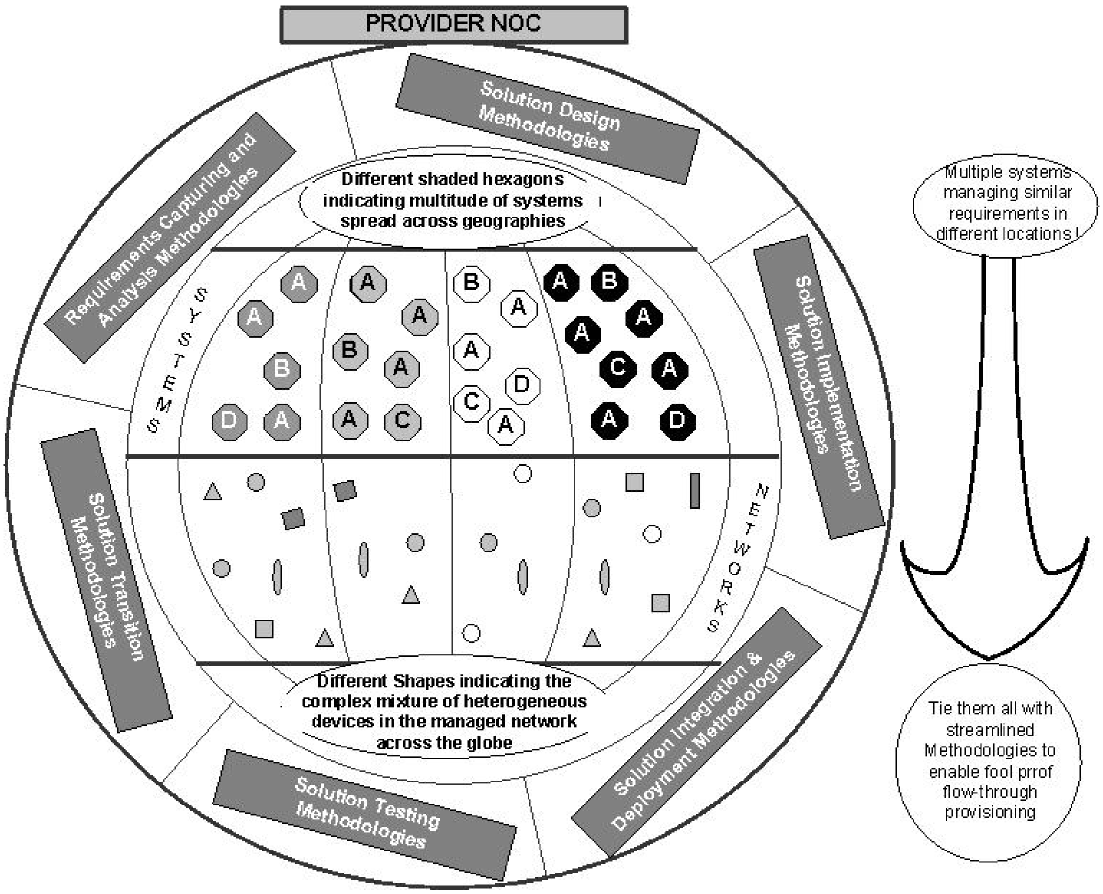
- Subscriber CoS (Class of Service) specific performance reports
- Signaling Efficiency Reports
- Service Availability Reports

## Streamlining OAM process for CE Deployment

As we understand, a typical Carrier Ethernet network size is proportionate to the size of customer base and networks are expected to transport traffic for millions of customers. The network is simpler and flexible given easy availability of Ethernet interfaces on an existing widespread network. On the other hand, sheer size of CE deployments presents us with a challenge to manage its OAM efficiently. The complexity of the operations, administration and management of these vast networks can be attributed to the following known factors:

- Geographic distribution of the networks
- Need for supporting almost all next generation services
- Heterogeneity in network compositions (multi-vendor devices)
- Varied service support (Communicating UNI's may not be both supporting VLAN tag stacking etc)
- Limitations of existing OSS
- Diverse interface types complicating service management manifold
- Multi-vendor management stack (current systems without uniform functional boundaries)
- Ethernet implementation styles: In cases where the CE deployments include multiple implementation styles (e.g., RPR pockets in the CE network), managing the bandwidths becomes a challenge.
- Legal and regulatory impediments

The above constraints must be appropriately balanced, so as to not outweigh the benefits of CE deployments. The only way to accomplish this is by adopting effective OAM processes. The diagram below depicts the same.




Service providers can use well-defined, streamlined processes for:

- Seamless integration of systems, allowing for new additions and modifications to solution components:

Although it is ideal to have standards compliant interfaces, in reality this is not the case. Until then, quick integration is possible only through handy adapters and concrete integration processes.

- Quick roll-out of new services through well defined methodologies for service fulfillment:

Service Fulfillment is an elaborate process and can involve several different systems in real time deployments. Methodologies tuned to specific services need to be made available for rapid service commissioning. Key methodologies include:

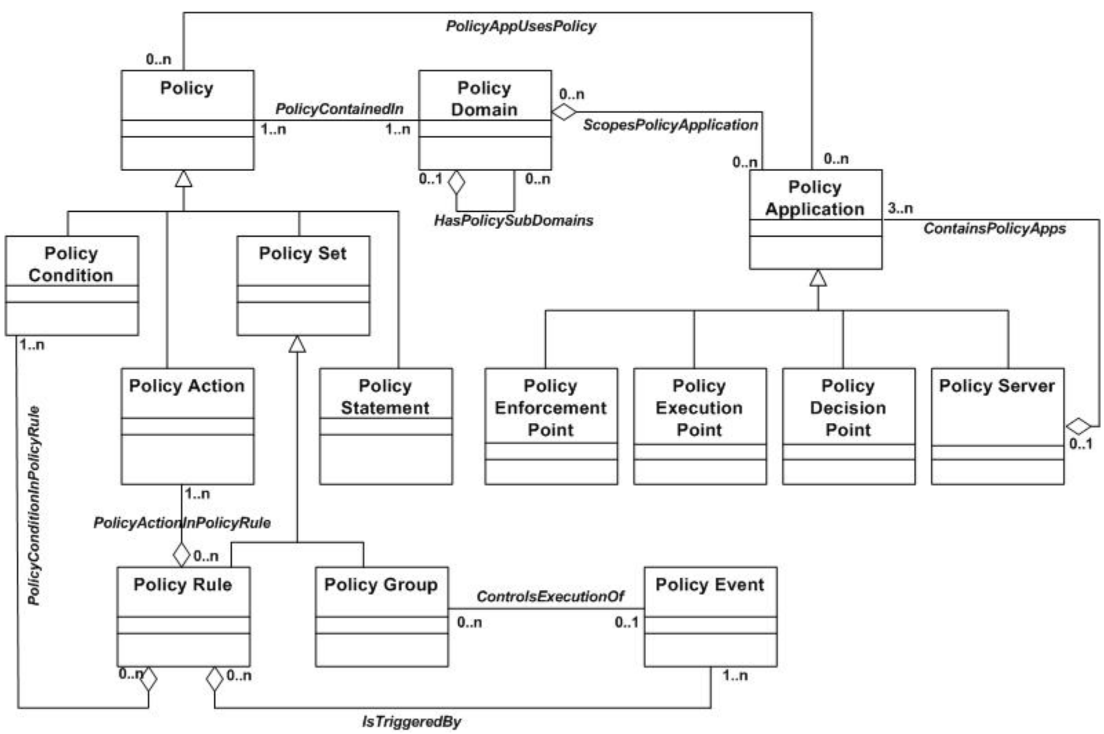
- Enhancing support for new model network elements
- Integrating activation systems with others say – the inventory modules
- Planning and designing of policies for service fulfillment

- Maintaining high SLGs (Service Level Guarantees) through effective service assurance practices:

Maintaining quality of service in Carrier Ethernet networks can be achieved through a well-designed service assurance framework. Multiple classes of service may be supported using IP/Diffserv, 802.1p frame header and still further, using information at the application layer. Typically, SLAs are agreed upon on the basis of the network level KPIs and KQIs discussed above and apart from that, service specific QoS metrics such as 'MoS' in case of VoIP.

- Policy Management

The kind of policy enforcement techniques and the variety of policy definitions made available can be a TSP differentiator. Security policies, QoS policies and Network Administrative policies can be defined as per the TSP requirement. The TMF SID has an abstract policy definition framework that can be made use of here. The diagram below represents the same.




- Testing CE services

It is needless to emphasize on the importance of innovative test strategies here. Pre-defined Test Methodologies will help in interoperability testing for new service deliveries over different CE physical infrastructures, device compliance testing and in end-to-end performance testing of EVCs, especially because simulating a carrier Ethernet Network in a test lab is a challenge. The Metro Ethernet Forum (MEF) has done a great deal of work here and specifications [MEF 9, MEF 14 etc] are available as test references. Many vendors have come up with tools for simulating these networks and for testing Ethernet Connectivity, Link QAM and Traffic Engineering of services.

## Planning and Engineering CE Services

Planning CE service deployments is a critical phase in the whole cycle. Typically Carrier Ethernet transports packets using IP/MPLS. It is generally a one-time activity to plan and layout the Ethernet circuits and the corresponding MPLS LSPs. Nevertheless, a fully automated flow-through provisioning of active and backup circuits is really a challenge. This 'Operations Support & Readiness' activity needs to be fool-proof and is by-far the only main activity in the CE service deployment cycle. Here are some things that can go wrong in this planning stage and can jeopardize the overall service deployment:

- Incorrect modeling of target devices considering OS versions, port densities, port configurations. This could result in envisaging wrong devices in the plan leading to non-uniform end-to-end capacities of connection pipelines (A requirement for an end-to-end pipe of 100 MB may not be met due to an incorrect positioning of a device / port in the network)
- Incorrect estimates of Service Connection loads. This could result in the positioning of a wrong device at the network edges, the device could under-perform and thus could result in lots of service connection drops. Where service multiplexing is involved as in the case of E-LAN based services, the processing overhead could lead to lower throughput.
- Class of service / execution policy mismatch leading to wrong traffic engineering rules and sub-optimal traffic paths.

The key note here is that the operational systems need to be equipped with adequate mechanisms to curtail all the limitations to a minimum. It just does not help by simple automation of configurations through integration of multiple applications. Automated processes need to be more of expert systems with both service and process intelligence.

In case of Carrier Ethernets, the following items call for planning attention:

- Bandwidth Allocation
- Service Availability
- Choice of access device based on subscriber location and service requirements
- Allocation of port(s) for UNI on the Access device based on media and bandwidth
- Design of various traffic profiles based on service offerings and classes of service
- Creation of end-to-end service connections (EVCs at Layer 2 and MPLS LSPs) by right identification of ports along the path based on service requirements and traffic profiles

## Modeling CE networks and services

We have already seen how imperative it is to have CE Networks and Services managed using a standardised approach. Having said this, the (TMF513) MTNM standard for connectionless transports is a good point to start off. MTNM has modeled Ethernet transport and connectivity services. Services that can be delivered over this infrastructure can be seen as a collection of discrete functions that can be executed in different combinations by different network nodes. This is what we can refer to as 'Functional Modeling' which is something similar to the way the IMS (IP Multimedia Subsystem) has been modeled by ETSI/TISPAN].

Most services transported by Carrier Ethernet infrastructures would be IP services. MTNM approach can be adopted to develop standardized views of these services across various systems, so as to ease out their management. TechMahindra has generated a blue-print illustrating how MTNM building blocks can be enhanced to represent / model an IP Flow domain in a node in an Ethernet Network. This can be extended to universally model IP services executed by nodes in a CE Network.

## Reference: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*Metro Ethernet Forum: http://metroethernetforum.org*


## Glossary

| | | |
|---|---|---|
| 1 | U–PE | User - Provider Edge (Provider Edge Device facing the User Network) |
| 2 | N–PE | Network - Provider Edge (Provider Edge Device facing the Provider Network) |
| 3 | PE–Agg | Provider Edge – Aggregation (Node Aggregating the PE devices in the provider network ) |
| 4 | TMF | TeleManagement Forum (www.tmforum.org) |
| 5 | ETOM | Enhanced Telecom Operations Map (A Telecom Process Map Created by TMF) |
| 6 | MoS | Mean Opinion Score (VoIP Service Quality Indicator) |

| | | |
|---|---|---|
| 7 | TSP | Telecom Service Provider |
| 8 | SID | Shared Information and Data (A Common Information Model Framework Created by TMF) |