OA&M: How a Frame Relay SLA is Measured and Diagnosed

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Abstract

In this White Paper, we discuss the purpose and use of the Frame Relay Forum's Interoperability Agreement for Operations, Administration, and Management (OA&M) Protocol and Procedures, FRF.19. Frame Relay OA&M is used by communication managers to diagnose potential issues with Frame Relay Circuits, as well as monitor Service Level Agreement (SLA) verification.

Introduction

The success of Frame Relay in the marketplace can, in part, be attributed to its simplicity. That is especially true in the case of simplicity for the end-user. Thanks to rigorous emphasis on interoperability, Frame Relay just plain works. A Frame Relay end-user can simply contract for the service, buy any off-the-shelf terminating device (such as a router or FRAD), plug it in, enable Frame Relay and be up and running in minutes. The basic provisioning information required to bring the circuit up and enable data transmission is sent by the service provider equipment and automatically detected by the terminating device. (With the implementation of FRF 1.2, even more provisioning information can be automatically detected.)

In all networks, things occasionally do go wrong. Problems such as network congestion, access link over-subscription, and backhoe accidents induce delays or outages. When problems occur, communication managers need proper tools and procedures in order to detect, diagnose and isolate the problem. A troubleshooting method is needed to identify if the problem is inside the Frame Relay network or somewhere in the customer's equipment or application.

Of course downtime is the exception in most networks, but even when things are running well, there is a need to measure service quality. Users typically make use of Frame Relay's ability to handle traffic beyond the limits of the contract – the Committed Information Rate (CIR) – because most of the time, that traffic will traverse the network. In recent years the practice of guaranteeing network performance, for both committed and uncommitted traffic, in the form of a Service Level Agreement (SLA) has become very popular. Tools and methods are required for the verification of these agreements. The

Frame Relay Forum has addressed these two challenges with two Interoperability Agreements.

The first, FRF.13, is an Interoperability Agreement that provides a common language for the development of a Service Level Agreement (SLA), which is the contract between a Service Provider and its customer. The following description of FRF.13 is taken from the Frame Relay Forum's Technical Brief *Service Level Agreements*.

> "A host of application and networking needs are driving user interest in frame relay service quality. The FRF.13 Service Level Definitions Implementation Agreement (IA) defines the metrics used to describe frame relay service performance in the areas of delay, delivery success and availability. These metrics can be used in Service Level Agreements (SLAs) established between the network service provider and the customer. They can also be used in SLA documents established between network service providers."

In addition to the metrics, it also provides explicit reference points for measurements to be made. The Brief, as well as FRF.13, is publicly available on the Forum's website (www.frforum.com).

The second Interoperability Agreement, which is the focus of this paper, is FRF.19 *Frame Relay Operations, Administration, and Maintenance (OA&M) Protocol and Procedures*. OA&M provides two fundamental capabilities: a vendor-independent method of monitoring an FRF.13-compliant SLA and new diagnostic tools for frame networks. This IA describes both a protocol used to provide the measurements as well as procedures that ensure interoperability.

Why a separate protocol?

The Frame Relay OA&M protocol is designed specifically for Frame Relay. It is directed towards providing much needed information at layer 2 and below. It is agnostic to the protocols being used on the Frame Relay circuit (improving interoperability). It will not interfere with Layer 3 (and above) measurements, nor do they encumber it.

Starting in the mid 1990's, proprietary protocols that were precursors to OA&M were deployed in some networks. Vendor interoperability without a new, common, protocol could not be achieved. FRF.19 represents an interoperable solution.

Who Measures and Where?

In designing a system to monitor frame relay circuits, the Technical Committee considered all the possible audiences. Frame relay circuits often consist of multiple providers, and each provider may want to monitor the section they administer. In addition, the customer may want to independently monitor the circuit. OA&M supports the overlapping segmentation of the network, allowing independent measurements to be made.

An example of a Virtual Circuit (VC) with overlapping domains is shown in Figure 1. In this example, measurements made in Frame Relay Provider Domain A are independent of those in Domain B. The End-User Domain is not allowed to address OA&M components in Domain A or B, but may pass OA&M messages through the frame relay provider equipment to reach the far end.

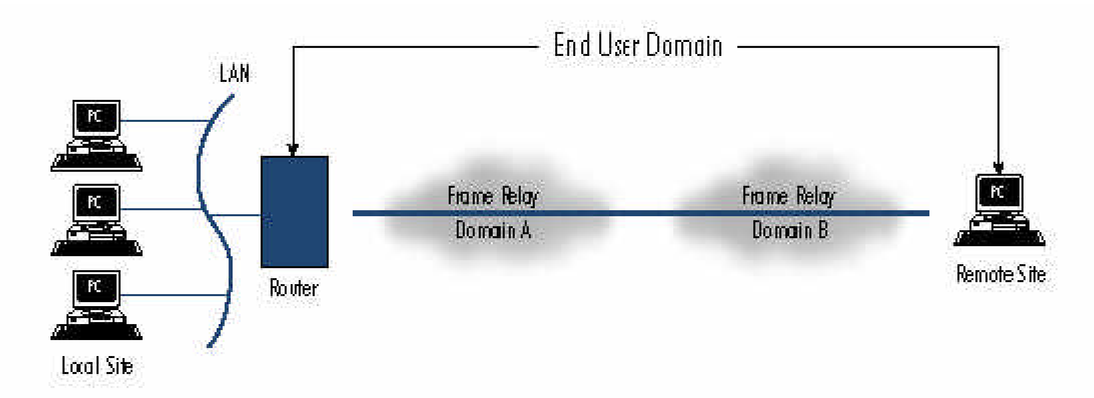

Figure 1

This concept of Administrative Domains is essential to deployment in the multi-provider environment. It allows for independent measurements using a common protocol. Security of OA&M domains is provided by the introduction of a selective Administrative Boundary located at the edge of a Domain. This boundary will protect the OA&M of one administration from being interfered with by another, yet allow outer Domains, such as the End-User Domain shown in Figure 1, to pass through.

Keeping it simple

OA&M keeps true with the simplicity concepts so ingrained in Frame Relay. OA&M devices will automatically detect peers within their Domain on a given VC. End users do not need to know or care about the multiple domains as the protocol will ensure that they do not see OA&M capable devices inside the provider domains (unless, of course, the provider decided to allow them to). As the outermost domain, they simply need to enable OA&M to run.

OA&M Measurements

FRF.13 defined four measurement parameters:

- Frame Transfer Delay
- Frame Delivery Ratio
- Data Delivery Ratio
- Service Availability

Of the four measurement parameters defined in FRF.13, the OA&M protocol is needed to measure all except Availability. This is because Virtual Circuit (VC) Status is already propagated end-to-end via link management procedures. OA&M devices will typically incorporate the VC Status information already present to complete the SLA verification.

Frame Transfer Delay (FTD) represents the amount of time it takes a frame to traverse the network. To measure FTD, occasional test frames will travel round trip between two measurement points. The "turn around time" at the far end is removed in the measurement, allowing the OA&M frames to use low priority queuing at the measurement endpoints. By using a round-trip measurement, and dividing it by two, the need to synchronize the clocks used by the two OA&M devices is eliminated. Figure 2 shows the flow of the test frames.

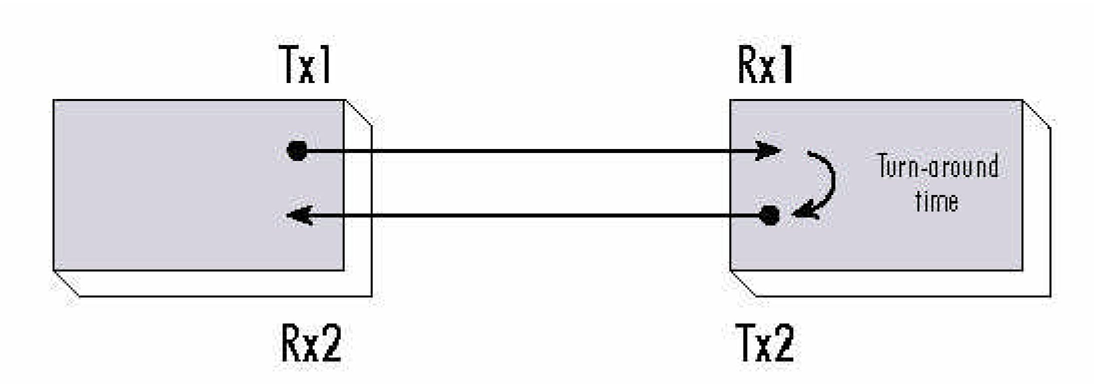

Figure 2

Most data applications perform some form of flow control, and thus are susceptible to FTD induced performance impacts. Synchronous stream applications (such as voice or video) are more susceptible to the variations in delay over time than to the actual delay itself. This is called *delay jitter*. Although not defined in FRF.13 or FRF.19, the protocol of OA&M could be used to also measure the delay jitter.

Frame Delivery Ratio (FDR) and *Data Delivery Ratio* (DDR) are measurements of the ability of the network to deliver the frames to the end destination. This is typically stated as a percentage (such as 99.997% of frames offered that are within CIR). To measure this between two points, marker OA&M frames are occasionally sent containing the current transmitted Frame and Octet counters for the circuit. The receiving OA&M device will compare differences between these counters with the state of its own receive counters to determine the ratio of transmitted to received frames in the interval. This measurement is made for both frames within the Committed Information Rate and for Excess Burst frames. The measurement is made independently for each direction.

OA&M Diagnostics

In addition to SLA verification, FRF.19 is dedicated to providing real-time diagnostic capabilities – focused at layer 1 and layer 2. The protocol supports segmentation of Frame Relay circuits, allowing isolation of issues. A variety of diagnostics are supported.

In addition to using them for SLA verification, the measurements for FTD, FDR, and DDR, may be used as a diagnostic when needed. Let's say that users are complaining about slowness. Perhaps they have even done a PING from their desktop to a server, showing a 400ms delay. Using FTD end-to-end on the Frame Relay portion of the network, you can isolate out the Frame Relay portion. On a national circuit, one might expect to see a FTD of 60ms. In our hypothetical situation, that only accounts for 120ms (since PING is round trip and FTD is one way). By comparing a real-time FTD measurement you can easily determine if the problem is in the WAN portion of the network or the LAN. If the problem was within the WAN, further measurements could isolate the problem between OA&M devices.

To improve the ability to test networks, two additional diagnostic tools are included in FRF.19. The first is a Virtual Channel Loopback, shown in Figure 3. This allows an individual VC to be temporarily taken out of service for testing, without affecting other VCs sharing the same link.

The second tool is a "virtual bit error rate test" (Virtual BERT). Together, these tools provide the means to test both the layer 1 and 2 subsystems between two points. They can also be used to quantify how the network will respond to a specific traffic load pattern.

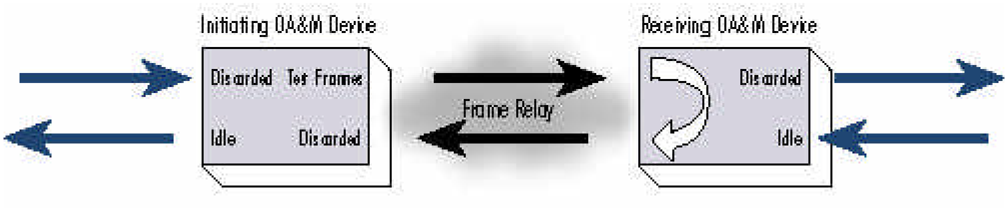

Figure 3

To better enable the control of these diagnostics, the IA recognizes the need to propagate more status information about a VC than is currently provided through Link Management Procedures. The OA&M protocol supports the concept of a Test Status (in addition to Active and Inactive Status) that can be sent to other OA&M devices, and will also propagate fault location and cause information (when it is known) when circuits change status. Many frame networks currently have ATM backbone sections capable of providing this information to the frame relay gateway – the OA&M protocol provides a method to carry this information out through the Frame Relay Interfaces.

Extensibility.

Finally, the protocol is designed to allow for extensibility. Updated versions may be produced in the future that will be compatible with existing deployments. A standard method for vendor extensions is also provided that will allow proprietary features or experimentation without compromising interoperability.

Summary

In an era of mergers and acquisitions, interoperability is all the more important in our networks. FRF.19 enhances the value of Frame Relay equipment and services, not only improving the service directly, but in avoiding the need to swap equipment out when the inevitable occurs.

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