OpenVault Usage Meter IPDR Processing Accuracy

by Peter Sevcik
September 2012

NetForecast Report NFR5111

OpenVault supplies an IPDR processing system as a service in support of ISP usage meters. The service shows how much Internet traffic a cable subscriber consumes and generates.

OpenVault engaged NetForecast to audit the accuracy of its IPDR processor as deployed in the production environment within a US cable Internet Service Provider (ISP). This report documents the results of an extensive battery of accuracy tests NetForecast performed in July and August, 2012 at a location in Iowa and Illinois. NetForecast had no role in designing or implementing the OpenVault service or the ISP's usage meter.

NetForecast generated test traffic, performed independent traffic measurements and calculations, obtained usage meter records from the OpenVault system for the test periods, and compared the NetForecast data with OpenVault's meter records. Neither OpenVault, nor the participating ISP had prior knowledge of the timing or volume of NetForecast's test traffic.

At the project outset, OpenVault established an accuracy goal for the usage meter records to correctly report on traffic passing through a subscriber's cable modem within plus or minus (+/-) 1.0%. Our analysis validates that, if the ISPs' cable modem termination system (CMTS) functions properly to generate accurate IPDRs, the OpenVault meter is accurate within plus or minus (+/-) 0.3% for each day and month—an outcome that falls well within OpenVault's 1% stated accuracy goal.

The OpenVault Role an ISP's Usage Meter

An MSO ISP's usage meter is a multi-tier implementation as shown in Figure 1 below. OpenVault supplied the middle tier identified as IPDR Processing which includes IPDR collection and aggregation. OpenVault also provides some of the Account Mediation functions shown in Figure 1 but they were not evaluated in this study.

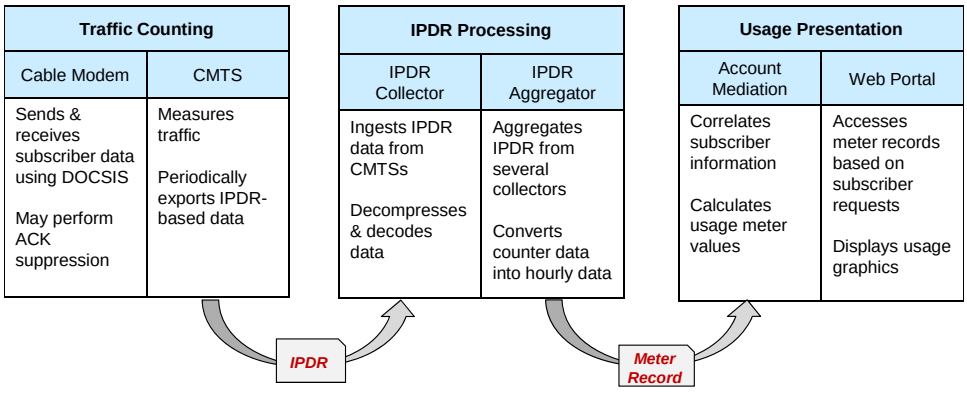

Figure 1 – Subscriber Usage Meter Processing Tiers

Usage Meter: Specification Factors and System Elements

All ISP usage meters operate within a set of measurement and operational rules which define a de facto meter specification. NetForecast has identified the following critical factors that should be properly described for a successful meter. See reference [1].

- What Is Counted
- Error Bounds
- Timeliness
- Exception Handling
- Granularity
- Mathematical Consistency
- Accessibility
- Availability
- Clarity

Figure 2 shows how the meter specification factors map to the various elements of the meter system. The shaded cells in the table identify which element of the meter system have an influence each meter specification factor. The green cells identify the parts of the meter system that NetForecast validated.

	Traffic Counting		IPDR Processing		Usage Presentation	
	Cable Modem	CMTS	IPDR Collector	IPDR Aggregator	Account Mediation	Web Portal
What Is Counted						
Error Bounds						
Timeliness						
Exception Handling						
Granularity						
Mathematical Consistency						
Accessibility						
Availability						
Clarity						

Figure 2 – Mapping Which Subsystem Delivers Each Factor

Cable subscribers connect to the Internet through a cable modem at the subscriber's location, and from there traffic travels over a local coaxial and hybrid fiber-coaxial (HFC) cable system to a CMTS, typically located within a headend facility on the ISP's network. The traffic then continues through the ISP's network and into the Internet.

The CMTS measures downstream and upstream traffic for each subscriber cable modem it serves. Downstream traffic flows from the Internet to the subscriber, and upstream traffic flows from the subscriber to the Internet. The CMTS periodically embeds the down and upstream counts in an Internet Protocol Detail Record (IPDR).

From the CMTS IPDRs are sent to OpenVault's collectors that operate as a service on the Internet. OpenVault then aggregates IPDRs and converts incremental traffic counts into hourly traffic data in the form of Meter Records.

The specification for how a cable modem communicates with the CMTS is defined in the Data over Cable Service Interface Specification (DOCSIS) developed by CableLabs. The IPDR specification is managed by the TeleManagement Forum (TM Forum). A DOCSIS Management Information Base (MIB) defines how traffic is counted in the IPDR.

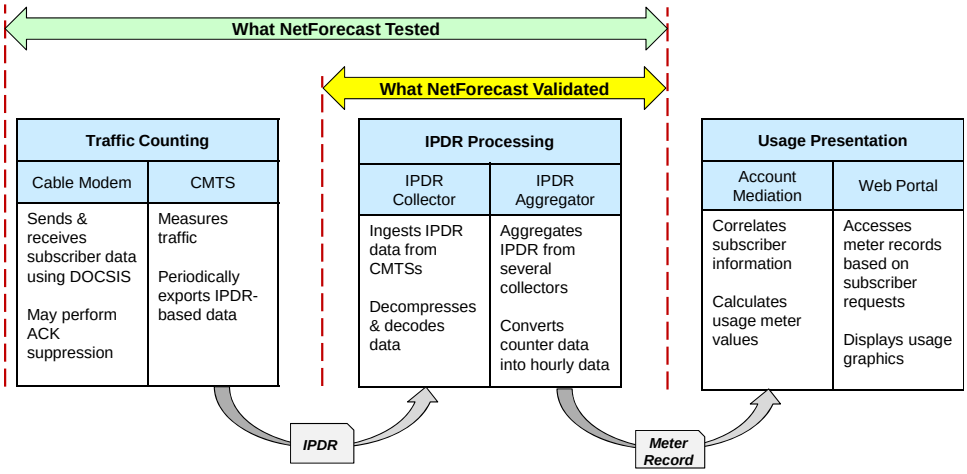

Figure 3 – What NetForecast Tests and Validates

The OpenVault System Specification

The following meter specification factors apply to the OpenVault system as it applies to the accuracy and correct operation of any ISP's meter.

What is Counted as Subscriber Traffic

OpenVault is not responsible for the traffic counters. Traffic counting is performed by the CMTS. A general specification for counting is presented here for completeness since it is a critical input to the OpenVault service.

All of the subscriber traffic to and from the Internet (known as payload) is counted, along with a small amount of protocol overhead required to transfer subscriber traffic over the cable modem access line. This overhead is contributed by a number of network protocols including: DHCP, DNS, Ethernet, IP, and TCP. The overhead varies by application, depending on the protocols the application employs to transmit user data over the Internet. A rule of thumb is that Internet protocols add between 6% and 7% more bytes to the user data traffic.

Usage data is sent periodically by the CMTS to an IPDR collection system. The ISP is responsible for operating the CMTS with sufficient capacity and software capabilities to transmit IPDR records on a defined time basis. Most CMTS models transmit the IPDR every 15or 20 minutes. The reporting time period must be adhered to. Erratic reporting leads to erratic meter accuracy.

If the ISP includes information about management, telephone, video, television services in the IPDR, then OpenVault will include it in the meter report.

Error Bounds

OpenVault has an accuracy goal for the usage meter records to correctly report on traffic passing through a subscriber's cable modem within plus or minus (+/-) 1.0%. Positive

error means that the meter over-reports subscriber traffic. Negative error means that the meter under-reports subscriber traffic.

Another way of stating this goal is that OpenVault will properly convert IPDR information into hourly meter records within plus or minus (+/-) 1.0%.

Timeliness

Timeliness is defined as the time delay between a traffic event occurrence on the cable modem to/from the CMTS link and the appearance of the measured value on the subscriber's online usage meter view. In this case, timeliness is defined when OpenVault makes the meter record available to the next stage of the ISP's meter system.

OpenVault's system updates the meter records every hour with a maximum of 3 hour delay from real-time. Therefore subscriber traffic events are shown within a maximum of 3 hours. OpenVault aggregates meter records by hour, day, and month.

NetForecast Meter Accuracy Validation Methodology

OpenVault defined the specifications for the accuracy of its subscriber traffic usage meter. NetForecast independently validated the meter relative to the specification for meter accuracy.

As the meter system auditor, NetForecast has no stake in the design or implementation of the meter, nor do we endorse the meter specification. The objective of our testing is to assess whether or not the system complies with meter specification.

NetForecast obtained subscriber accounts and performed subscriber usage meter accuracy validation testing in Des Moines, Iowa and Marion, Illinois. The testing was performed under a variety of conditions.

NetForecast instrumented the account with a test laptop PC running Windows 7 and a Linux-enabled NetGear router on which we installed Tomato router firmware. In addition, we used FTP accounts on various NetForecast servers on the Internet. Figure 4 describes the NetForecast instrumentation.

The tests generated 873 meter accuracy measurements. We performed both down and up traffic tests.

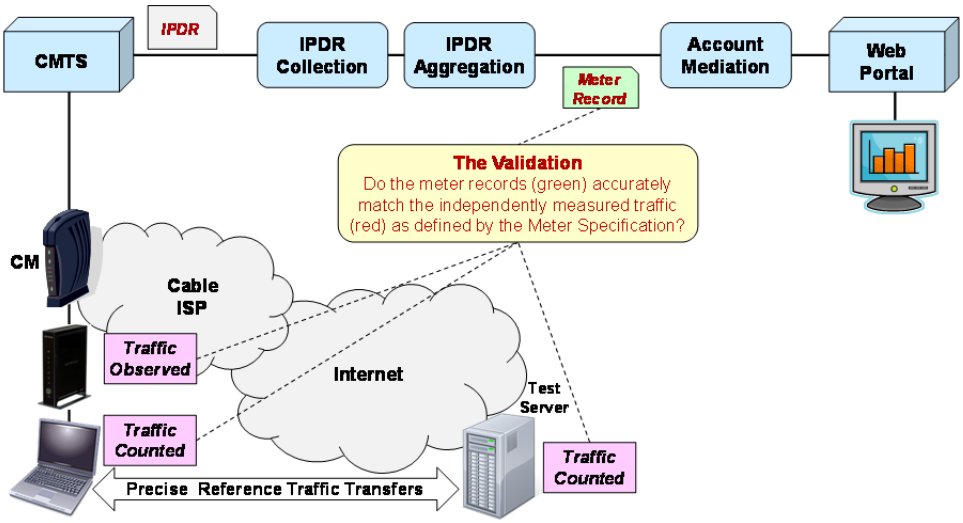

Figure 4 – The NetForecast Methodology

The basic NetForecast test involved a script performing an FTP file transfer from one of our test servers to the laptop. The tests consisted of repeatedly transferring files of several file sizes in complex patterns. These tests were also performed as uploads from the laptop to the server. The test system recorded detailed data from three instrumentation points: client, router, and server. All three instrumentation records were adjusted to account for upstream and downstream protocol overhead that was seen and counted at the CMTS.

Meter accuracy validation entailed comparing data from the two OpenVault reporting sources to the three sets of NetForecast measurement data. The NetForecast data were seen by NetForecast only and were not shared with OpenVault. OpenVault did not know which tests NetForecast performed or when they were performed. More information about the measurement process is available at [2].

Results of the NetForecast Independent Meter Validation Study

Based on the results of our extensive testing and analysis, NetForecast validates OpenVault to be accurate within plus or minus (+/-) 0.3% as shown in Figure 5.

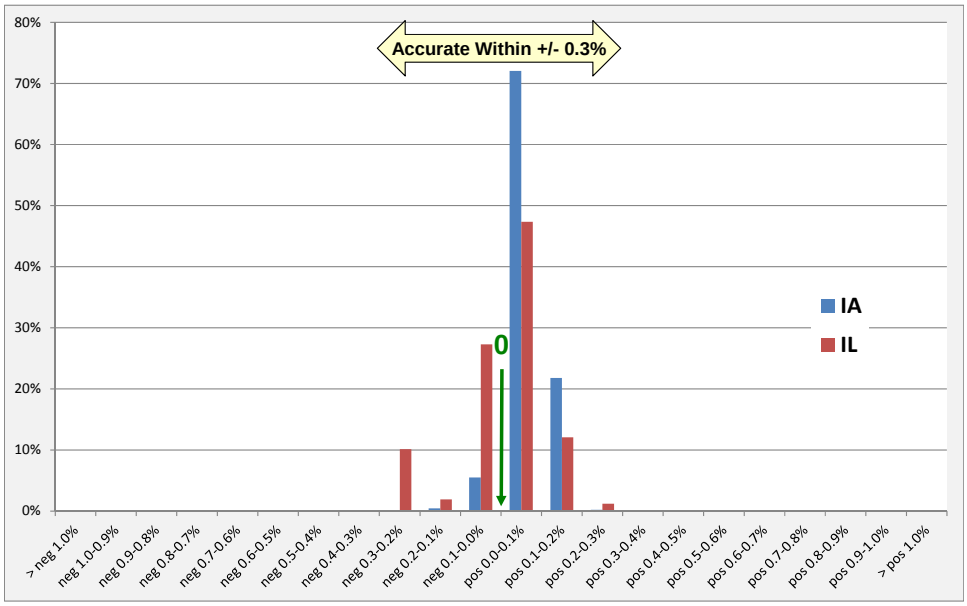

Figure 5 – IPDR Processor Error Distribution

We found, however, that improper CMTS functioning can introduce inaccuracies into the OpenVault meter reports. This statement applies when comparing the meter with the actual traffic sent to and from the cable modem, which includes some protocol overhead as explained above.

Figure 5 shows the error distribution across the two test sites. A negative error indicates that the meter value is low relative to the NetForecast reference value (under reporting). A positive error indicates over reporting. All tests fell within the plus or minus (+/-) 0.3% range. The overall mean for all tests was essentailly zero, indicating no bias.

Conclusions

The OpenVault subscriber usage meter is highly accurate to within plus or minus (+/-) 0.3% over the month and day, assuming proper CMTS operation. Based on our test results, ISPs should be able to rely on the accuracy of the OpenVault service as a critical element of a production meter system.

References

1. “ISP Data Usage Meter Specification Best Practices for MSOs,” by Peter Sevcik NetForecast Report NFR5110, Sep 2012

2. “Validating the Accuracy of ISP Subscriber Traffic Usage Meters,” By Peter Sevcik, SCTE Cable-Tec Expo 2011, Nov 2011

About the Author

Peter Sevcik is President of NetForecast and is a leading authority on Internet traffic and performance. Peter has contributed to the design of more than 100 networks, including the Internet, and is the co-inventor of two patents on application response-time prediction and congestion management. He works extensively with the SamKnows system in support of the FCC Measuring Broadband America project, analyzing operational integrity and performing deep data analysis. He can be reached at peter@netforecast.com.