General ISP Data Usage Meter Specification and Best Practices

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Many ISPs track subscriber data usage for the purposes of informing subscribers about their data consumption, imposing a cap, or charging for usage. The meter systems that track data usage operate within a set of measurement and operational parameters. NetForecast refers to these parameters as the usage meter specification. Most ISPs do not write a usage meter specification—but they should—because it enables them to define proper operation and assess whether their meter is operating as expected.

This document describes aspects of meter operation that should be included in a formal usage meter specification and it identifies best practices for each specification factor. The usage meter specification is a de facto agreement between an ISP and its subscribers that voluntarily subjects the ISP to ethical standards that protect the subscriber.

This best practices specification has been adopted by nine ISPs in North America. It is designed for Telecommunications Company (Telco) and Multiple System Operator (MSO) (also known as cable company) ISPs. This report is a guide for ISPs to plan and validate the accuracy of their usage meters. Each ISP's specification may be customized, and ISPs are welcome to add to or improve on what is presented in this report.

The goals of this report are to:

- Encourage transparency by showing how meter systems work
- Define an industry common description for data usage meters
- Provide ISPs with best practices guidance to assure a successful meter system
- Help ISPs document their meter systems
- Provide information about meter systems to consumers

Usage Meter System Functions

There are six processing functions in a typical meter system as shown in Figure 1.

CPE	ISP Network Edge Device	Counter Collection	Counter Aggregation	Account Mediation	Web Portal
Sends/receives subscriber traffic using various last-mile technologies	Counts subscriber traffic and periodically exports counter data	Ingests and decodes counter data from many edge systems	Aggregates counter data and converts data into uniform values	Correlates data to subscriber information and calculates usage values	Accesses meter records and displays usage graphics

Figure 1 – Subscriber Usage Meter Processing Functions

The Customer Premises Equipment (CPE) device (e.g., cable modem, residential gateway, etc.) sends subscriber traffic to and receives subscriber traffic from the ISP's network edge device (e.g., router, CMTS, switch), which counts the traffic, and puts that count into a count record. Count records are then aggregated from multiple collectors and the data is converted into uniform values (typically per hour) that are forwarded to the account mediation function. There the usage values are associated with subscriber accounts and any business rules associated with each account are applied. Account mediation then stores the usage information as formal meter records in a general database. In a final step, the data is made available to users in graphical form via a customer portal.

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Meter Specification Factors

In this section, NetForecast defines the critical factors and describes best practices ISPs should follow based on our experience gained from validating the accuracy of meter systems at nine ISPs over the past six years. Factors 1 through 4 cover meter accuracy, and Factors 5 through 10 pertain to the subscriber's experience using the meter.

Meter Accuracy Factors

Factor 1 - What Is Counted

ISPs count subscriber usage within their networks, not at the customer premises. This assures uniform counting, scales efficiently, and protects against count tampering. Because Telcos and MSOs use different last-mile technologies, the edge systems that count traffic are subject to the impact of different access protocols. Thus, this meter specification factor differs for Telco and MSO ISPs.

For Telcos: The Telco meter system counts all subscriber-generated Internet Protocol (IP) traffic traversing the subscriber's Internet access line (down and up), along with the Ethernet protocol header (14 bytes) and checksum (4 bytes). The system also counts broadcast traffic (e.g., ARP) and IP protocol management traffic (e.g., DHCP).

In addition, subscriber packets are transferred within IEEE 802.1Q virtual LANs (VLANs) that are identified by VLAN tags. The meter system adds a 4-Byte VLAN tag to each downstream and upstream packet, which is counted as data usage. The number of VLAN tags used depends on the circuit configurations:

- Single VLAN: Each frame has an 802.1Q VLAN tag (4 bytes added per packet down and up)
- Two VLANs: Each frame has two 802.1Q VLAN tags also known as QinQ or VLAN stacking (8 bytes added per packet down and up)
- Asymmetrical VLANs: Some implementations treat traffic in one direction (up or down) differently, so the VLAN tags described above may not exist in one direction (typically down).

For MSOs: The MSO meter system counts all subscriber-generated IP traffic traversing the cable modem/CMTS HFC connection (down and up), along with the Ethernet protocol header (14 bytes) and checksum (4 bytes). The system also counts broadcast traffic (e.g., ARP) and IP protocol management traffic (e.g., DHCP). All subscriber traffic is carried via the Data Over Cable Service Interface Specification (DOCSIS) protocol, which is terminated at the CMTS that does the counting; however, the DOCSIS protocol is not counted. CMTSs report the counts using the standard Internet Protocol Detail Record (IPDR) definition.

For Both Telcos and MSOs: Usage data is sent periodically by the edge devices to a collection system. The ISP is responsible for operating the edge systems with sufficient capacity and software capabilities to transmit counter records on a defined-time basis.

Best Practice: ISPs should specify services or management functions that they do not count as data usage, such as:

- Voice traffic for telephone service supplied by the ISP
- Video traffic for services supplied by the ISP such as movies or television
- Internal ISP management traffic
- CPE (modem or gateway) control traffic

Factor 2 - Meter Record Update Rate

The meter system process starts by counting usage at an ISP network edge device. Network edge counts are periodically transmitted to the next processing stage. Count transmission may be triggered by a timer or a poll for the count. Each count transmission from the edge device is the most detailed sample of subscriber usage. During subsequent processing, these samples are aggregated to report usage on a predetermined hourly or daily basis.

Best Practice: The ISP should state how frequently the official meter record will update, so subscribers will know how frequently they can check the meter portal (e.g., every minute, hour, or day) to see the effect of a high-usage event.

Factor 3 - Accuracy Time Period

The accuracy time period is the timespan over which accuracy is stated, such as +/- x% accurate over each hour/day/month.

Best Practice: ISPs should use the following two time periods for calculating accuracy:

- The cumulative daily time period adds the counts for each day of a month, with a day defined as midnight to midnight, at a specific time zone. Cumulative daily views are prevalent in online usage meter web views, and help the subscriber manage usage, particularly as thresholds are approached.
- Month end is the final reading of the month, which is useful for determining whether a usage threshold has been exceeded, and may be used in an overage calculation.

Factor 4 - Error Bounds

No large-scale, real-time measurement system is perfect. However, the ISP must strive to design, build, validate, and maintain the meter system with an acceptable specific error range. Errors can be introduced by all parts of the end-to-end system from the CPE to the web subscriber view and/or bill. Error bounds are the explicit accuracy goals for the meter.

Best Practice: The meter should operate within +/- 1% at the cumulative daily and month end views. Positive error means that the meter over-reports subscriber traffic. Negative error means that the meter under-reports subscriber traffic.

User Experience Factors

Factor 5 - Timeliness

Timeliness is defined as the time delay between a traffic event occurrence on the CPE to/from the edge device link and the appearance of the measured value on the subscriber's online usage meter view. With proper timeliness, an ISP will not display usage later than the maximum specified time. This allows the subscriber to see usage numbers within a reasonable time after the usage accrues.

Best Practice: The online meter should update with a typical delay of four hours and a maximum delay of 24 hours after the traffic event.

Factor 6 - Granularity

Granularity defines the mathematical basis of the value reported within the reporting period. The mathematical basis of the value must be noted when the usage value is displayed. For example:

Binary: MB = 1024^2 = 1,048,576 bytes, or
Decimal: MB = 1000^2 = 1,000,000 bytes

Best Practice: The values are calculated using binary math and displayed as whole Megabytes (MB) or Gigabytes (GB). The fractional value can be handled one of two ways:

1. Typically the values are displayed as whole number which truncates the decimal digits (5.9 becomes 5). If truncation is used, it must be stated.
2. Some ISPs support displaying a single decimal digit value (5.9 remains 5.9). Under these conditions, the ISP must use standard mathematical rounding (no truncation).

Factor 7 - Mathematical Consistency

For mathematical consistency, various views of a subscriber's meter provide consistent traffic consumption values. For values to be consistent, the sum of individual (detailed) values shown for each display period within a month matches the total value shown for the month. Month end values shown on the portal must match any value shown in a subsequent bill.

Best Practice: All views of a subscriber's usage data provide a consistent traffic consumption value(s) (e.g., detailed views by day sum up to the total value presented for the month).

If an ISP chooses to display truncated values in detailed views (Factor 6), the truncated values must sum to the aggregate view (e.g., sum of daily values in a daily view must equal the month value).

Factor 8 - Accessibility

The subscriber portal shows an online view of the meter. This is an important tool with which subscribers can manage their usage to avoid charges. The ISP must make it clear and simple for a subscriber to access their data.

Best Practice: The meter is no more than two clicks away after logging into the subscriber portal.

Factor 9 - Availability
Usage information must be reliably available to each subscriber.

Best Practice: The meter view must be accessible from any browser (not just browsers directly connected to the ISP). Furthermore the ISP website must be available at least 99.4% of the time (permits no more than 1 hour of downtime each week). Announced maintenance windows do not apply towards downtime.

Factor 10 - Clarity
The ISP usage meter system must be explained to subscribers on the web page where they see the meter value or in subsequent directly-linked pages.

Best Practice: The portal should clearly answer (at minimum) the following questions:

- What is a usage meter?
- What is and is not counted in the meter?
- What are the usage limits (if any)?
- What are the consequences of exceeding those limits?
- How can I learn more about the usage meter?
- How do I know that the meter is accurately counting my traffic?

Each usage view and description must be easy to understand and augmented with simple, clear graphics.

Mapping Specification Factors to System Elements

Figure 2 shows how the meter specification factors map to various elements of the meter system. Each of the green cells shows the intersection of a meter system element and a meter specification factor it influences. It is important that the accuracy and efficacy of the meter system be assessed in a comprehensive, end-to-end fashion. Focusing on one element (e.g., is the count aggregator properly converting incremental counters to hourly values?), or focusing on one factor (e.g., are the graphics clear?) does not give the complete picture.

Generally, different groups within an ISP—often supported by different suppliers—operate and manage the various elements (columns in Figure 2). This can lead to classic IT silo management which lacks an end-to-end understanding of the system's behavior.

	CPE	Net Edge System	Counter Collection	Counter Aggregation	Account Mediation	Web Portal
What Is Counted						
Meter Record Update Rate						
Accuracy Time Period						
Error Bounds						
Timeliness						
Granularity						
Mathematical Consistency						
Accessibility						
Availability						
Clarity						

Figure 2 – Mapping Which Subsystem Delivers Each Factor

For a meter to be correct and useful, an important best practice is to approach the system holistically. As Figure 2 shows, a meter has many constituent subsystems (each column in the Figure). Focusing only on validating the performance of select subsystems risks inaccurate and/or misleading meter system results, because even though a subsystem may be operating to spec, the system as a whole may be inaccurate.

An accurate meter system is one in which all of the green boxes in Figure 2 are operating properly relative to the applicable specification factors. Furthermore, all of the green boxes must meet the specification on an end-to-end basis simultaneously. This comprehensive approach is the only way to assure that a meter system is delivering proper information to subscribers and the billing system.

How to Use This Document

This report provides the foundation for an ISP's data usage meter or usage-based billing (UBB) system accuracy specification. The factors may be tightened if the ISP so chooses; however, all 10 specification factors should be adopted in some form.

The ISP's specification should be published for transparency purposes so subscribers can clearly understand how the meter works and how a threshold or usage billing will affect them. An ISP should also validate to subscribers that it complies with its meter specification. Compliance can be determined on a partial basis to the billing system or on comprehensive end-to-end basis to the subscriber portal as Figure 3 shows.

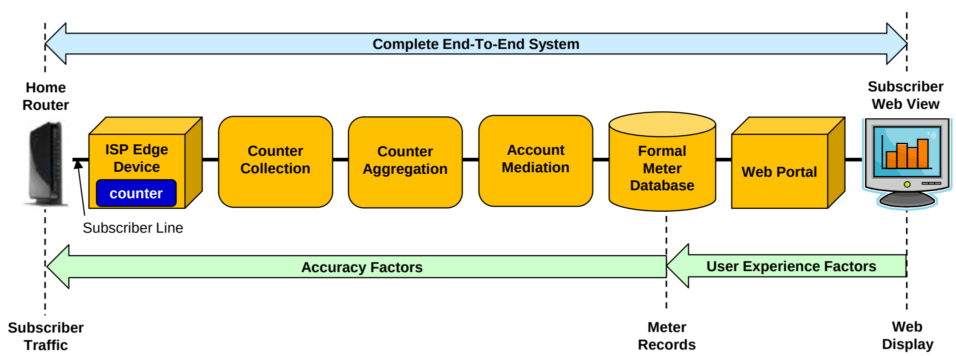

Figure 3 – Assessing Meter Specification Compliance

Usage meters are complex systems that require the underlying network and the many count processing functions to work seamlessly together. It is a best practice to determine if a meter system complies with the specification at initial deployment—and because no complex system is static and network and meter system changes that can degrade accuracy are inevitable, it is also a best practice to continuously monitor usage meter system compliance with the meter specification over time.

The results of meter specification compliance monitoring should be published periodically to assure subscribers that they can trust that an ISP's meter is accurate, and that they can rely on portal data to manage data consumption.

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How the Consumer Relies on the Meter Specification

Consumers value transparency and control of their expenditures. ISPs value customer goodwill as well as timely and accurate information about the performance and accuracy of their meter. Figure 4 illustrates how an accurate usage meter, performing to a public specification, provides a foundation for customer trust and accurate billing. If knowledge is power, the most empowered are those with both useful and trustworthy information.

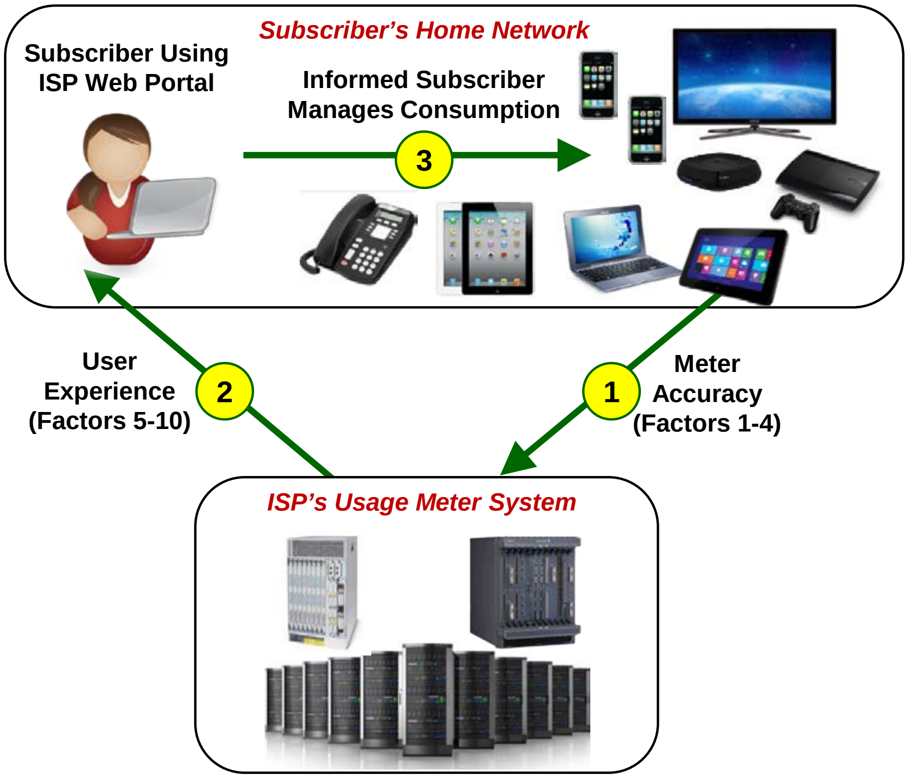

Figure 4 – Consumer Usage Management Cycle

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