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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Internet protocol aspects – Quality of service and network performance

Home network performance parameters

Recommendation ITU-T Y.1565

International Telecommunication Union

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Recommendation ITU-T Y.1565

Home network performance parameters

Summary

Recommendation ITU-T Y.1565 describes the performance model, reference events and performance parameters for generic home networks and their interfaces to the operators' broadband access networks. It augments existing information on packet performance parameters in ITU-T Recommendations. IPv4 and IPv6 are both within its scope, as well as the possibility to perform network address and port translation, allowing the use of private address space in the home network. These parameters are also applicable to non-IP networks, such as Ethernet VLANS and IEEE 802.11 wireless networks.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y.1565	2011-12-14	12

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Introduction

This Recommendation specifies performance parameters for the home network environment.

Ideally, the parameters specified in existing Recommendations would suffice completely, and all that remains would be to apply the generic performance model(s) to the specifics of the home network environment.

However, there are several challenges unique to the home network, such as the low complexity required in mass-market devices. Also, it may be sufficient to monitor layer-specific performance parameters (e.g., errored packets), since the home network will typically have a simple topology with few links and nodes in tandem.

Recommendation ITU-T Y.1565

Home network performance parameters

1 Scope

The purpose of this Recommendation is to define performance parameters applicable to home networks, within the conventions of the ITU-T performance models.

The following areas are within the scope of this Recommendation:

1) Networks based on wired physical media.
2) Networks with either parameterized QoS or mechanisms that prioritize traffic, or no QoS mechanisms whatsoever.
3) IP networks based on IPv4 or IPv6, using network address and port translation or not.
4) Non-IP networks, for L2 and L3 (e.g., Ethernet).
5) Metrics lending themselves to traditional active or passive measurement techniques.
6) Home network configurations (LANs) outside the UNI-UNI cloud. Other Recommendations are relevant within the UNI-UNI scope.

Figure 1 is a diagram to explain the network scope. It is taken from [ITU-T G.9970].

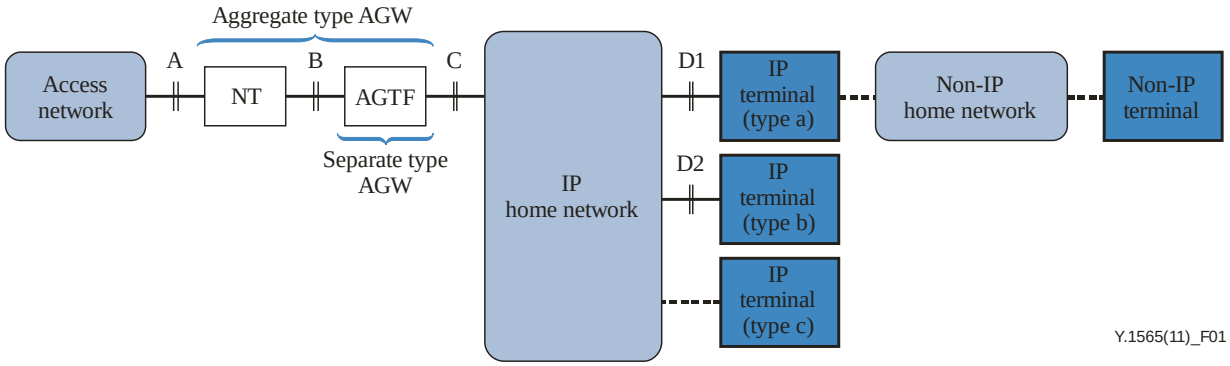

Figure 1 – Alternative demarcation points for IP UNI and the scope of Y.1565

Points A, B, and C are the most likely positions of the user-network interface (UNI), but point B (separating the access gateway transport layer function, AGTF, from the network terminal, NT) is inaccessible in many access gateway implementations. Only the access network is out-of-scope.

IP-based television (IPTV) is the driving application at present for home network performance ([ITU-T G.1081]), others are for further study.

Establishing a mapping between a wide area network (WAN) and home network QoS classes is deemed to be out-of-scope for this metric-defining effort.

New sub-networks and devices in the home network are for further study. The femtocell network device is one example.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.1081] Recommendation ITU-T G.1081 (2008), *Performance monitoring points for IPTV*.

[ITU-T G.8013] Recommendation ITU-T G.8013/Y.1731 (2011), *OAM functions and mechanisms for Ethernet based networks*.

[ITU-T G.9970] Recommendation ITU-T G.9970 (2009), *Generic home network transport architecture*.

[ITU-T Y.1540] Recommendation ITU-T Y.1540 (2011), *Internet protocol data communication service – IP packet transfer and availability performance parameters*.

[ITU-T Y.1541] Recommendation ITU-T Y.1541 (2011), *Network performance objectives for IP-based services*.

[ITU-T Y.1544] Recommendation ITU-T Y.1544 (2008), *Multicast IP performance parameters*.

[ITU-T Y.1563] Recommendation ITU-T Y.1563 (2009), *Ethernet frame transfer and availability performance*.

[IETF RFC 5357] IETF RFC 5357 (2008), *A Two-Way Active Measurement Protocol (TWAMP).*

3 Definitions

This Recommendation specifies performance metric definitions, thus definitions appear in the body of the Recommendation.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AGAF Access Gateway Application layer Function

AGTF Access Gateway Transport layer Function

AGW Access Gateway

MEP Maintenance End Point

MP Measurement Point

NT Network Terminal

UNI User Network Interface

WAN Wide Area Network

5 Performance model

5.1 Generic model, based on Recommendation ITU-T G.9970

[ITU-T G.9970] divides the home network into transport and application layers, then further into entities such as the access gateway (AGW), primary and secondary application-layer terminals, and IP or non-IP terminals in the transport layer. To explain the network model, we refer to Figure 2 (taken from [ITU-T G.9970]).

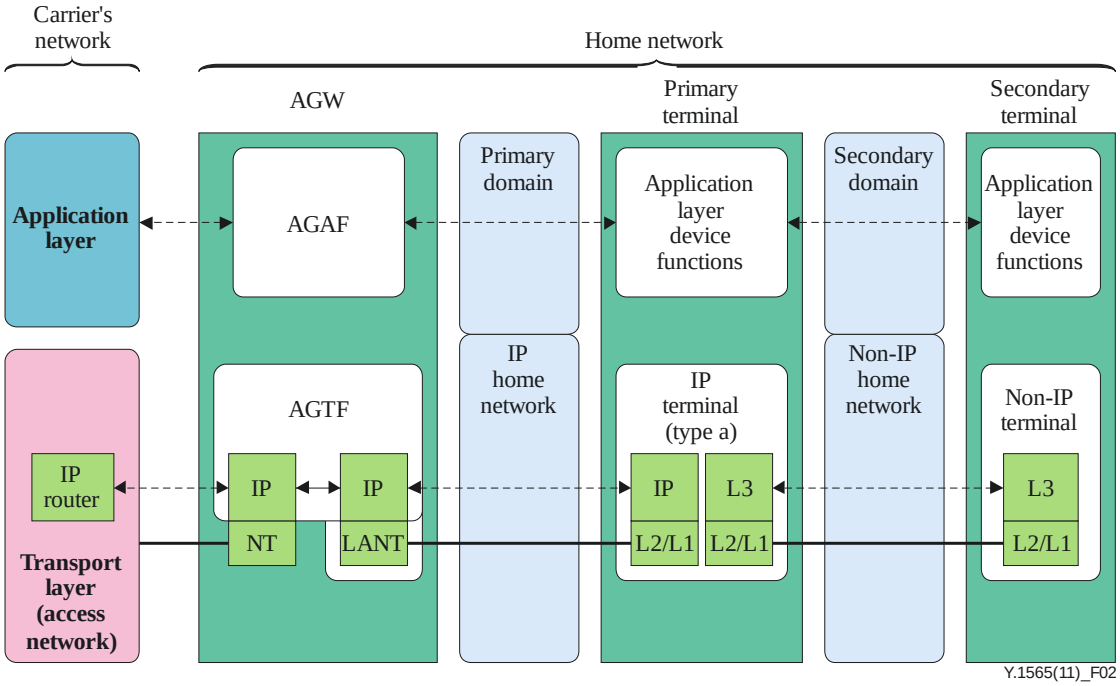

Figure 2 – One physical configuration based on two generic home architectures

Demarcation points can be defined at the boundaries of the entities and networks or domains shown above. AGAF stands for access gateway application layer function and AGTF for access gateway transport layer function. Please refer to [ITU-T G.9970] for a complete description of their functionalities.

The following demarcation points are identified for measurement points (MP) and performance parameters:

- Access gateway (AGW) – ingress and egress interfaces
- Primary terminal – ingress and egress interfaces
- Secondary terminal – ingress and egress interfaces
- ([ITU-T G.1081] points 4 and 5 are within this scope)

6 Measurement challenges

To be useful, the performance parameters defined for home networks must be measurable in pre-service testing (active) or during service (passive monitoring), or both.

The home environment represents a special set of challenges for in-service measurement that bear mentioning at the outset of this effort:

1) The home network is a network of low-complexity devices, and embedded resources for testing purposes may be scarce.
2) Some, or all, of the home network may be the responsibility of the customer to maintain. Therefore, it is useful to have measurements that may identify and localize packet transfer issues to specific network domains, or to specific traffic conditions in the different domains.

6.1 Applicability of existing Recommendations and RFCs

[ITU-T Y.1540], [ITU-T Y.1544] and [ITU-T Y.1563] are completely applicable to the IP and Ethernet layer performance measurement and specification of home networks.

The two-way active measurement protocol, TWAMP [IETF RFC 5357], is particularly well-suited for application to home networks, because measurements can use a low complexity TWAMP server and test-reflector, possibly embedded in the general purposes hosts on the network.

[ITU-T G.8013] may be useful in an all Ethernet access environment, where the IP layer is not available. In this case, the access gateway should act as a maintenance end point (MEP).

7 New transfer outcomes and performance parameters

This clause defines performance parameters that are feasibly measurable in the low-complexity environment of the home network. Several assumptions elaborate the definition of "low-complexity":

1) Stable and/or accurate network time may not be present in network devices and user hosts.
2) Very short one-way delays and round-trip delays require sub-millisecond resolution and accuracy, if possible.
3) Well-understood paths may allow approximation of one-way delay from halving round-trip measurements, when needed.
4) Uncontrolled user traffic may need to be the basis for measurements.
5) Round-trip measurements may help to address timing problems and isolate performance issues to segments of a sub-network.
6) Passive single-point measurements are also useful for diagnostic purposes.

In the round-trip category, we have the following outcomes, parameters and definitions. In these definitions, the terms "packet" and "frame" are interchangeable, since the Ethernet-based and IP-based definitions take the same form.

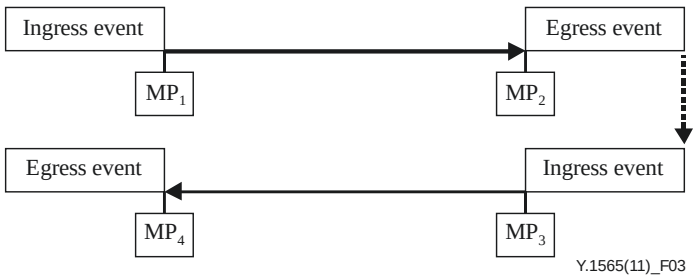

Figure 3 – Round-trip reference events and measurement points

7.1 Round-trip packet outcomes

Successful round-trip packet transfer outcome

A successful round-trip packet transfer outcome occurs when a single IP packet reference event at a permissible ingress MP_1 results in one (or more) corresponding reference event(s) at one (or more) MP_i (i=2,3,4), all within a specified time T_{max} of the original ingress event, and:

1) all MP_i where the corresponding reference events occur are permissible; and
2) the complete contents of the original packet observed at MP_1 are included in the delivered packet(s); and
3) the binary contents of the delivered IP packet information field(s) conform exactly with that of the original packet; and
4) the header field(s) of the delivered packet(s) is (are) valid.

NOTE – The value of T_{max} is recommended to be set at 2 seconds for home network use.

Errored round-trip packet outcome

An errored round-trip packet outcome occurs when a single IP packet reference event at a permissible ingress MP_1 results in one (or more) corresponding reference event(s) at one (or more) MP_i (i=2,3,4), all within T_{max} time of the original reference event, and:

1) all MP_i where the corresponding reference events occur are permissible; and
2) the complete contents of the original packet observed at MP_1 are included in the delivered packet(s); and
3) either:
   – the binary contents of the delivered packet information field(s) do not conform exactly with that of the original packet; or
   – one or more of the header field(s) of the delivered packet(s) is (are) corrupted.

NOTE – Most packets with errored headers that are not detected by the header checksum will be discarded or redirected (e.g., based on corruption in the address or Type of Service/Diffserv code point, or ToS/DSCP fields). The result is that no reference event is created for the higher layer protocols expecting to receive this packet. Because there is no reference event, these packet transfer attempts will be classified as lost packet outcomes. Errored headers that do not result in discarding or misdirecting will be classified as errored packet outcomes, and the direct connectivity of home networks makes detection of errored packet outcomes more likely.

7.2 Lost round-trip packet outcome

A lost round-trip packet outcome occurs when there is a single packet reference event at a permissible ingress MP_1, and when some or all of the contents corresponding to that ingress packet do not result in:

- a packet reference event at a permissible reflecting egress MP_2, immediately followed by a packet reference event at a permissible ingress MP_3, and
- a packet reference event at a permissible egress MP_4 within the time T_{max}.

A lost packet outcome may in fact be one or more misdirected packet outcomes (which were not observed), as defined below.

A misdirected packet occurs when a single packet reference event at a permissible ingress MP_1 results in one (or more) corresponding reference event(s) at one (or more) egress MP_i, all within a specified T_{max} time of the original reference event and:

1) the complete contents of the original packet observed at MP_1 are included in the delivered packet(s); but
2) one or more of the egress MP_i where the corresponding reference events occur are not permissible egress MP(s).

8 Round-trip performance parameters

8.1 Round-trip packet delay parameters

Mean round-trip packet transfer delay: Mean round-trip packet transfer delay is the arithmetic average of round-trip packet transfer delays for a population of interest.

8.2 Round-trip packet loss and error parameters

Round-trip packet error ratio: round-trip packet error ratio is the ratio of total errored round-trip packet outcomes to the total of successful round-trip packet transfer outcomes plus errored round-trip packet outcomes in a population of interest.

Round-trip packet loss ratio: round-trip packet loss ratio is the ratio of total lost round-trip packet outcomes to total transmitted packets in a population of interest.

9 Single measurement point parameters

For single measurement point configurations, performance parameters essentially count events as defined below.

The following are all single-point metrics.

9.1 Octets transmitted

At an egress interface/measurement point, the number of octets that are sent, including framing information within the population of interest.

9.2 Octets received

At an ingress interface/measurement point, the number of octets that are received, in well-formed frames, including framing information within the population of interest.

9.3 Frames or packets transmitted

At an egress interface/measurement point, the number of frames or packets that are sent, within the population of interest.

9.4 Frames or packets received

At an ingress interface/measurement point, the number of frames or packets that are received in well-formed status, within the population of interest.

The following parameters are intended to quantify physical and link layer error conditions.

9.5 Frame alignment/Checksum errors

At an ingress interface/measurement point, the number of frames that are received that are not well-formed, which have a non-integer number of octets or do not pass the frame checksum test within the population of interest.

9.6 Frame length errors

At an ingress interface/measurement point, the number of frames that are received that are longer than the maximum permitted frame size, within the population of interest.

9.7 MAC-layer sending errors

At an egress interface/measurement point, the number of attempts to send frames or packets that encounter collisions, deferred transmission, carrier-sense errors, or any other abnormal transmission status.

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