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SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Multimedia Quality of Service and performance – Generic
and user-related aspects

Estimating end-to-end performance in IP networks for data applications

Recommendation ITU-T G.1030

ITU-T

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TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

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For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T G.1030

Estimating end-to-end performance in IP networks for data applications

Summary

Recommendation ITU-T G.1030 provides a framework of tools to obtain IP network performance, estimate the performance of user applications, and apply perceptual models to gauge user satisfaction with the end-to-end performance.

The user-perceived performance of data applications on packet networks is dependent on many factors, including the end-to-end performance of the packet network, the application's dependency on the communications network, the performance of the terminals and other devices beyond the purview of the network operator(s), and the user's task and the extent of user interaction with the application. Network designers take these factors into account to assure user satisfaction. Once the application performance has been estimated, perceptual models can be applied to interpret the level of end-to-end performance attained.

This Recommendation assumes that the reader will be able to provide at least some level of detail about each of the key factors above, and will then use the framework of tools to estimate end-to-end performance.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.1030	2005-11-29	12	11.1002/1000/8672
2.0	ITU-T G.1030	2014-02-13	12	11.1002/1000/12122

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

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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Recommendation ITU-T G.1030

Estimating end-to-end performance in IP networks for data applications

1 Scope

This Recommendation provides a framework of tools and the process for estimating end-to-end performance of applications operating on IP networks.

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.1010] Recommendation ITU-T G.1010 (2001), *End-user multimedia QoS categories*.
- [ITU-T G.1031] Recommendation ITU-T G.1031 (2014), *QoE factors in web-browsing*.
- [ITU-T G.1040] Recommendation ITU-T G.1040 (2006), *Network contribution to transaction time*.
- [ITU-T Y.1540] Recommendation ITU-T Y.1540 (2011), *Internet protocol data communication service – IP packet transfer and availability performance parameters*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

HPT	Host Processing Time
IPLR	IP Packet Loss Ratio
MOS	Mean Opinion Score
MSS	Maximum Segment Size
NAT	Network Address Translation
QoS	Quality of Service
RTT	Round-Trip Time
TCP	Transmission Control Protocol
UNI	User Network Interface

5 Conventions

None.

6 End-to-end performance estimation

This Recommendation covers the process of estimating end-to-end performance of applications operating on IP networks, using:

- performance of the IP network of interest, based on relevant measurements or network modelling results;
- specifications of the application of interest, in terms of its governing protocol(s) with specified options, or a model of the application using network performance and customer appliance performance as input and producing a key metric of application performance (e.g., file download time) as a result;
- a perceptual model intended for the applications of interest, to interpret the application performance as an estimate of the quality experienced by a typical population of users.

Figure 6-1 illustrates the general process used to develop an end-to-end performance estimate

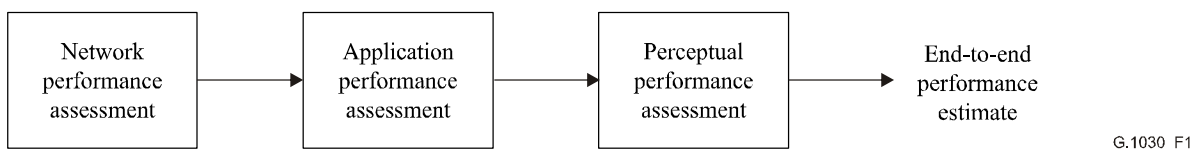


Figure 6-1 Process to obtain end-to-end performance estimate

The steps to obtain network and application performance may be combined in some cases, such as when a simulation provides a means to measure the performance of a particular session, or set of sessions.

6.1 Network performance assessment

Network performance may be assessed in terms of the packet transfer performance parameters defined in [ITU-T Y.1540] and other relevant standards (e.g., RFCs developed by the IETF IP Performance Metrics Working Group). Besides the usual one-way transfer performance metrics, the most straightforward assessment of application performance will sometimes be possible with round-trip metrics instead.

There are two principal sources of network performance information: measurement and modelling.

Network measurements allow the assessor to treat the network as a black-box, and produce information that may be useful in the remaining steps of the modelling chain. However, there are several important considerations for the measurement design, including:

- 1) The sending discipline needs to match the application of interest in some cases. For example, transmission control protocol (TCP) flow control responds to network conditions and tends to fill the queue at the bottleneck, increasing delay beyond that which would otherwise be measured.
- 2) The non-measurement load must be similar in size and character to the conditions where the performance estimates are to be applicable. Measurements on an unloaded network are not particularly useful.

Network modelling can provide the needed performance characterization when the network is not yet fully constructed (e.g., nodes and links are in place, but not running a critical protocol), or when the key considerations for measurement are not attainable. There are many choices of modelling tools, including commercial products and public domain research tools. Modelling tools require a substantial degree of expertise and information about the network of interest to be used effectively. As an alternative to this fairly precise network modelling, Appendix I provides simplified methods which may be used for estimating end-to-end performance in an IP network. However, the accuracy of this method will depend greatly on the accuracy of the information provided.

6.2 Application performance assessment

Application models take the estimates of network performance and information describing application device performance as inputs, and produce one or more key metrics of application performance as outputs.

One such application performance model has been specified in [ITU-T G.1040] for conversational packet exchanges typical of credit card and other point-of-sale transactions.

For long-lived file transfers using TCP's reliable byte transfer service, the models described in Appendix I provide accurate results, assuming the inputs are correct.

6.3 Perceptual models

This Recommendation includes a limited perceptual model for a simple web search task in Appendix II.

It should be noted that this model cannot be applied to general web browsing as experienced by the end-user as it does not consider the dynamics of real web browsing. For the more complex case of real web browsing, [ITU-T G.1031] defines perceptual events that have to be considered for creating a perceptual model and goes beyond the events considered in the model described in Appendix II.

6.4 Framework for models in the end-to-end performance assessment process

Figure 6-2 illustrates the various alternatives in the process to estimate the end-to-end performance of applications on IP networks. As indicated in this figure, there are many options available to complete the process, although in practice the assessor must combine options that are consistent with the goal of an end-to-end estimate (and with one another).