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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

QoE factors in web-browsing

Recommendation ITU-T G.1031

International Telecommunication Union

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Recommendation ITU-T G.1031

QoE factors in web-browsing

Summary

Recommendation ITU-T G.1031 describes the framework for an opinion model for web-browsing quality of experience (QoE). User perceived quality for web-browsing is dependent on various influence factors (IF) that are related to user, context and system. This Recommendation addresses the latter two influence factors (context and system) and provides an overview of them. At the perceptual level, it defines the relevant events that the user perceives while accessing a web page and contrasts them with the events taking place at the application level and at the network level.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.1031	2014-02-13	12	11.1002/1000/12123

Keywords

Modeling, page-view cycle, perceptual events, web-browsing session, web-QoE.

* 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.

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QoE factors in web-browsing

1 Scope

This Recommendation describes the framework for an opinion model for web-browsing QoE. This Recommendation aims to provide:

– guidance in the development of an opinion model

– an overview of key influence factors (IF)

– a starting point for performance assessment and KPI definitions.

This Recommendation introduces a taxonomy of influence factors and related model parameters, as well as a definition of QoE relevant perceptual events.

2 References

This Recommendation does not use any normative references.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 element: Visual content of a webpage, which is displayed to the user on the rendered webpage, e.g., text, pictures, widgets, videos, etc.

3.2.2 first element: A character or a picture for example.

3.2.3 object: A HTTP object that is used for processing and rendering the webpage and is referenced by the page mark-up or script. An object however is not necessarily visible on the fully rendered page (see the definition for element).

3.2.4 visible portion: The part of the requested web page that is visible to the user.

3.2.5 web-browsing session: A web-browsing session is an interactive information exchange between a user and one or more websites over a limited period of time, mediated via a web-browsing application. The starting point of such a session is the first page request initiated by the user, which is followed by a number of request–response interactions between the user and the webhost(s), resulting in a series of page views [b-Egger1]. A web session is typically terminated when the user exits the browsing application or stops the browsing activity for a certain period of time.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CPU Central Processing Unit

HTML Hyper Text Mark-up Language

IF Influence Factor

OS Operating System

PLT Page Load Time

QoE Quality of Experience

RTT Round Trip Time

5 Conventions

This Recommendation uses the following notation:

t_0: The moment in time when the user requests a new web page (typically by clicking or pressing enter "Enter" after having typed the URL of the web page in the browser's address bar).

t_{SBr}: The moment in time when a change in the status bar happens (usually a progress bar becomes visible at this moment).

t_{SgB}: The moment in time when the previously viewed web page vanishes and the content of the requested page has not yet started to render.

t_{Prs}: The moment in time when the first element of the requested page appears on the screen, independent of the type of element.

t_{PPLT}: The moment in time when from the point of view of the user the page is sufficiently rendered such that he can access the information he is looking for.

t_{VSrc}: The moment of time when the visible portion of the web page (as determined by screen or browser windows size) is fully rendered[1].

t_{IHRs}: The moment in time when the initial HTTP request is sent by the browser.

t_{BHPr}: The moment in time when the first HTML <head> element is received (see [b-W3schools]).

t_{Hp}: The moment in time when the HTML page is processed by the browser (can only be observed at application level).

t_{TPLT_1}: The moment of time when all objects of the page are downloaded from the server at the browser's device.

t_{TPLT_2}: The moment of time when the page is completely rendered and displayed by the browser.

6 Factors influencing web-QoE

Typically, QoE influence factors (IFs) are grouped according to the following three main categories:

– User influence factors

– Context influence factors

– System influence factors

User influence factors are outside of the scope of this Recommendation. Context influence factors are discussed in clause 6.1. System influence factors are discussed in clause 6.2.

6.1 Context influence factors

The context in which a web page is accessed can have a critical influence on the user behaviour and his QoE. The range of context influence factors spans:

– Location: Cafeteria, office, home

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1 It should be noted that there can be further rendering activity outside of the visible screen area.

– Interactivity: High level interactivity vs. low level interactivity
– Task type: business, entertainment, etc.
– Task urgency: urgent vs. casual (without time constraints).

6.2 System influence factors

The range of system influence factors spans the following content, network and client related IFs:

– Server-related influence factors (see clause 6.2.1)
– Content-related influence factors (see clause 6.2.2)
– Delivery network influence factors (see clause 6.2.3)
– Client influence factors (see clause 6.2.4)

In order to better understand the position of these IFs in the delivery chain, a typical Web-QoE delivery chain is depicted in Figure 1.

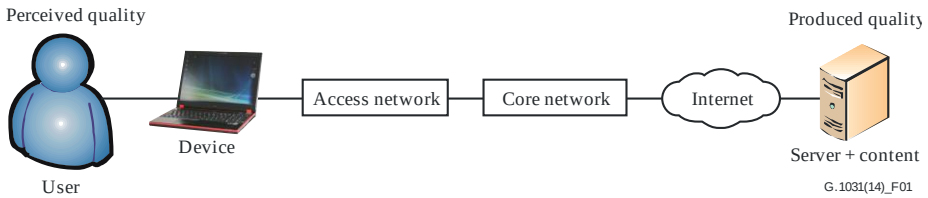

Figure 1 – Delivery chain for a typical webpage

6.2.1 Server-related influence factors

– Response time (determined by CPU, OS, memory, software, etc.)
– Capacity of the link(s) connecting the server(s) and the Internet.

6.2.2 Content-related influence factors

These factors go beyond the established notion of content as used in QoE. This is because in Web QoE, content is typically constituted by a mix of different element types such as text, pictures, audio files and videos. In addition, the HTML mark-up of the webpage (and related scripts) strongly determines the actual loading behaviour of the page according to its internal structure and the utilized objects such as:

– Number of objects
– Type of objects
– Size of objects
– Order of objects
– Number of elements
– Type of elements
– Size of elements
– Element appearance on the screen (determined by the order of the objects as well as by the rendering strategy of the browser, see [b-Strohmeier]).

6.2.3 Delivery network influence factors

– Network contribution to transaction time (see [b-ITU-T G.1040])
– Available capacity (see [b-ITU-T Y.1540])
– Caching along the delivery network: The caching elements lower perceived server response time as they shorten client-to-server requests and therefore lower the RTT.

6.2.4 Client influence factors

– Resource (webpage) loading procedure

– Processing power and other processes demanding processing power

– Browser implementation

– TCP/IP stack and configuration

– Operating system.

All of these IF's impact the user perceived performance of the web page display when requested by the user.

7 Perceptual dimension

When the end user requests a page by means of entering a dedicated web address or clicking on a link on an already loaded web page, the download of content from a web server is initiated. This requested content (typically a base HTML page that references additional elements like images and scripts) is progressively fetched and rendered by the browser. During this process the user encounters several observable events as depicted in Figure 2.

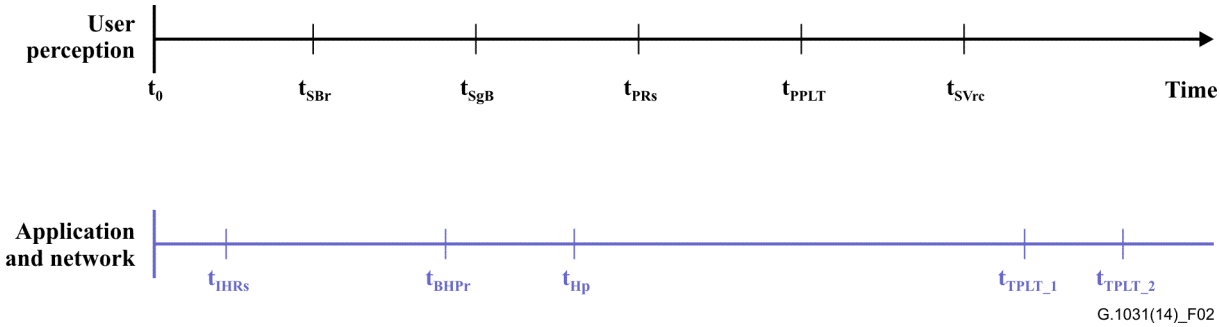

Figure 2 – Perceptual events in a web page view cycle from the end-user point of view

Note that in this figure the application and network timeline (in blue) displays related technical events at the application or network levels. Note also that in this figure the distance between the perceptual events is shown as being equal, but this is not necessarily the case in real-world browser implementations.

This description differentiates between perceived page load time (PLT) t_{PPLT} and technical page load time t_{TPLT_1} (or t_{TPLT_2} depending on the actual measurement procedure). This differentiation is important since ultimately, for the user QoE, only the perceived PLT t_{PPLT} matters. This distinguishes this description from related work described in Annex A of [b-ITU-T G.1030], where only the technical PLT t_{TPLT} is used as a basis for QoE estimation. This difference is essential, since t_{PPLT} can be considerably shorter than t_{TPLT} and depends on several technical and non-technical influence factors such as user task, web page design, number of elements, etc. This is shown in [b- Egger2] where the presented empirical data from subjective tests quantifies the differences between these two points in time.

NOTE – In a regular web-browsing session the end user encounters several sets of such page view event sequences.

8 Use cases of a web-QoE opinion model

A perceptual opinion model for Web-QoE can be used in the following use cases:

– Network dimensioning, including:

  • Network planning

- Traffic management solutions design and optimization

– Online/offline measurement of Web-QoE based on network and application logs or probes
– Performance testing (of elements in the delivery chain).

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