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Recommendations

International Telecommunication Union
Radiocommunication Sector

Recommendation ITU-R BT.2167-0

(02/2025)

BT Series: Broadcasting service (television)

A framework for content-adaptive methods for reduction of energy consumption in television displays

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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Series of ITU-R Recommendations

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Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	**Broadcasting service (television)**
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R BT.2167-0

A framework for content-adaptive methods for reduction of energy consumption in television displays

(Question ITU-R 147/6)

(2025)

Scope

Television displays consume a relatively large part of the total energy consumed in the end-to-end of a broadcasting chain from production of programmes to final viewing by consumers. The energy consumption by television displays may be mitigated by content-adaptive methods without unduly impacting visual quality. This Recommendation defines a framework for such techniques.

Keywords

Energy reduction, television displays

The ITU Radiocommunication Assembly,

considering

a) that broadcasting incurs a cost in terms of energy that is distributed over the entire transmission chain, from production to distribution/transmission and final viewing by consumers;

b) that television displays consume a relatively large part of the energy consumed in the end-to-end chain of broadcasting;

c) that the energy consumption by television displays has a relationship with image characteristics such as video levels and frame frequencies;

d) that content-adaptive methods that modify the image characteristic while minimizing the impact on visual quality would help reduce energy consumption in television displays;

e) that content analysis forms part of such content-adaptive methods, and that the cost of this analysis can be amortised by performing it once prior to transmission;

f) that ISO/IEC 23001-11, Information Technology – MPEG systems technologies – Part 11: Energy-efficient media consumption (green metadata), specifies metadata for energy-efficient decoding, encoding, presentation and selection of media;

g) that the energy used by displays strongly relates to the amount of light emitted, and therefore to the images being displayed;

h) that the image pixels to be displayed may be adjusted so as to induce a lower energy consumption;

i) that the energy and computational cost of the image analysis can be amortised by performing it prior to its delivery;

j) that the result of this analysis can be attached to the images as metadata, so that displays receiving this metadata may adjust the images, and thereby require less energy;

k) that to coordinate the analysis, delivery, and application of content-adaptive energy reduction methods requires a unifying framework,

recognizing

a) that Resolution ITU-R 60-2 – Reduction of energy consumption for environmental protection and mitigating climate change by use of ICT/radiocommunication technologies and systems, encourages the consideration of environmental issues by Study Groups;

b) that Resolution ITU-R 70-1 – Principles for the future development of broadcasting, notes that the transition to future broadcasting systems, technologies and applications potentially presents energy saving opportunities;

c) that Report ITU-R BT.2385 – Reducing the environmental impact of terrestrial broadcasting systems, provides information related to improving environmental performance of terrestrial broadcast systems;

d) that Report ITU-R BT.2521 – Practical examples of actions to realize energy aware broadcasting, provides information on tools for measuring the environmental impact of programme production, data on the energy use of transmission systems, and information on mitigating energy consumption of broadcast operations;

e) that Opinion ITU-R OP.104 – Advice for sustainability strategies incorporating carbon offsetting policies, emphasizes the need to avoid carbon offsetting as a means to achieve net-zero emissions;

f) that Recommendation ITU-T L.1410 – Methodology for environmental life cycle assessments of information and communication technology goods, networks and services, provides information on the assessment of the environmental impact of information and communication technology;

g) that Report ITU-R BT.2540 contains background information on image processing methods to reduce the power consumption of display devices,

recommends

that the framework described in the Annex should be considered for the development and implementation of a content-adaptive method for reduction of energy consumption in television displays.

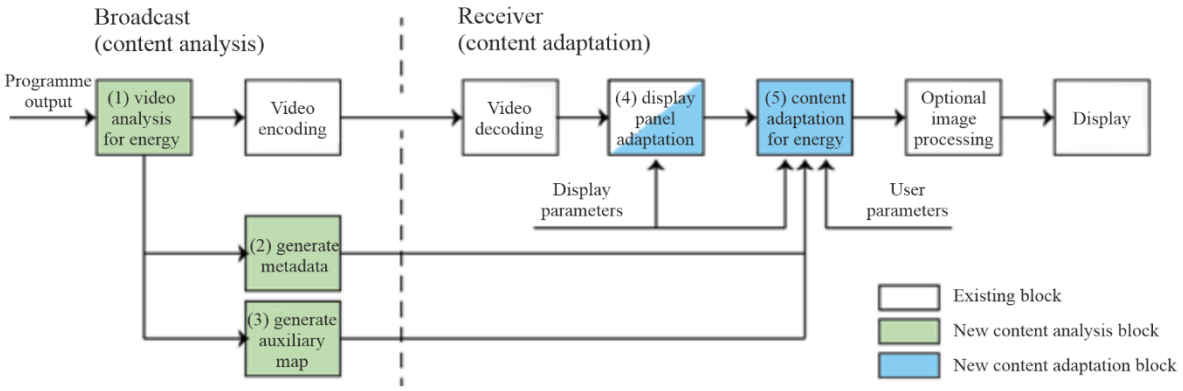
Annex

A framework for content-adaptive methods for reduction of energy consumption in television displays

The framework described here allows video content to be analysed and adapted to reduce the energy consumption of display devices, without unduly affecting the visual quality of the content. The block diagram in Fig. 1 shows the various elements of the framework.

FIGURE 1

A block diagram showing the elements of the framework for energy reduction of display devices



The framework applies to the situation where the programme output is to be broadcast or streamed to multiple receivers. It consists of two main components: an analysis part and a content adaptation part.

With reference to the different blocks in Fig. 1, the purpose of the analysis part '(1) Video Analysis for Energy' is to analyse the individual frames of the video content for the potential to reduce display energy. The resulting information is then used to derive metadata '(2) Generate Metadata' as well as an auxiliary map '(3) Generate Auxiliary Map'. Both metadata and auxiliary map will be sent in addition to the encoded video. The metadata and auxiliary map are preferentially generated for each frame. The auxiliary map may be down-sampled and compressed as part of the video encoding process.

A receiving device, such as a set-top box or a television, will perform the decoding of the video stream, and will receive the metadata and the auxiliary map. If the receiving device is a set-top box, the result of this decoding process, as well as the metadata and auxiliary map, will be passed on to the display device. The display device may then adapt the content to match its display panel characteristics '(4) Display Panel Adaptation', taking into account for example the peak luminance of the display. Such a mapping of content to the capabilities of a display panel may or may not already exist in display device.

Subsequently, the framework provides for a content adaptation module '(5) Content Adaptation for Energy' that interprets the metadata and the auxiliary map to reduce the luminance of the content. The auxiliary map provides a spatially varying input to a computation which processes the image to reduce its luminance while minimally affecting its visual quality. This module may use display parameters such as for example the peak luminance, display size and, if such information is available, its distance to any viewers. It may also take into account display settings, such as the brightness selected by the user. Further, the content adaptation module may benefit from user input, enabling the user to either modify the strength of the adaptation, or to switch the module on or off.

Note that display panel adaptation (4) should be carried out prior to content adaptation (5), as otherwise it may undo the effect of the content adaptation module (5). Proprietary and display-specific image processing may occur afterwards and prior to displaying the frame on the display panel. Examples of such additional processing may include the presence of additional energy-saving processing (notably automatic brightness control), or the implementation of different viewing modes (cinema, sport, etc.).