RECOMMENDATION ITU-R BT.1790

Requirements for monitoring of broadcasting chains during operation

(Questions ITU-R 44/6, ITU-R 48/6 and ITU-R 109/6)

(2007)

Scope

This Recommendation describes broadcasters' requirements for operational monitoring in digital broadcasting chains. Monitoring issues are first categorized into status monitoring and quality monitoring, and the requirements are itemized in each category.

The ITU Radiocommunication Assembly,

considering

a) that broadcasting chains are composed of contribution and distribution networks, production and post-production, and satellite and terrestrial emissions to the end-user;

b) that the whole delivery chain is composed of a multiplicity of cascaded processing devices such as converters, encoders, switches, multiplexers, modulators, receivers, etc.;

c) that digital audiovisual and audio services have rapidly developed based on advances in digital signal compression and communication technologies;

d) that digital compression coding technologies have enabled the widespread growth of high-quality multichannel audiovisual services;

e) that audiovisual signals after digital coding processing have different characteristics from those of conventional analogue signals;

f) that the digitizing of broadcasting systems have made them more advanced and complex;

g) that it has become difficult to manage the quality by conventional methods for monitoring or subjective evaluation, and has become necessary to develop new monitoring methods;

h) that monitoring today is conducted mainly by human operators, but the increased functionality and complexity of digital broadcasting systems increase the need for automatic monitoring;

j) that a unified approach for monitoring for every step in a broadcasting chain would facilitate the development of reliable, efficient and cost-effective monitoring systems for broadcasting chains;

k) that broadcasters are seeking to provide guidance to equipment manufacturers on the operational monitoring requirements in broadcasting chains,

recommends

1 that the broadcaster's requirements for operational monitoring described in Annex 1 should be taken into account for the development of monitoring systems in broadcasting chains.

Annex 1

1 Introduction

Digital compression coding technologies have enabled the widespread growth of high-quality multichannel audiovisual services. Audiovisual signals after digital coding processing have characteristics different from those of conventional analogue signals, e.g. the perceptual quality depends on the content and the characteristics of the original signal, and degradation due to digital compression coding and transmission errors often occurs locally. In addition, digitalization has made systems more advanced and complex, and new services, such as data broadcasting, have emerged.

Therefore, it has become difficult to manage the quality of digital broadcasting systems by conventional methods for monitoring analogue systems or subjective evaluation, and a new monitoring method is needed. This Recommendation describes user requirements for operational monitoring for digital broadcasting chains based on the quality monitoring/assessment technologies to be introduced in broadcasting stations and communication carriers.

2 References

2.1 Informative references

Recommendation ITU-R BS.1387 – Method for objective measurements of perceived audio quality.

Recommendation ITU-R BT.1204 – Measuring methods for digital video equipment with analogue input/output.

Recommendation ITU-R BT.1683 – Objective perceptual video quality measurement techniques for standard definition digital broadcast television in the presence of a full reference.

Recommendation ITU-R BT.1720 – Quality of service ranking and measurement methods for digital video broadcasting services delivered over broadband Internet protocol networks.

ITU-T Recommendation J.143 (2000) – User requirements for objective perceptual video quality measurements in digital cable television.

ITU-T Recommendation J.148 (2003) – Requirements for an objective perceptual multimedia quality model.

3 Types of monitoring

Operational monitoring means to monitor whether the object is in the desired operational status or conforms to the standard or specification. In this Recommendation, operational monitoring especially means in-service objective monitoring operation by equipment, not by human operators. It is categorized into status monitoring of physical signal levels and perceptual quality monitoring of audiovisual contents.

Signals to be monitored are categorized into the following three:

– Baseband signal (SDI, analogue video and audio signals, etc.).

– Coded bit-stream (MPEG-2-TS signals, etc.).

– Modulated signal (RF signals, etc.).

3.1 Status monitoring (test of physical signal conformance to standards and specifications)

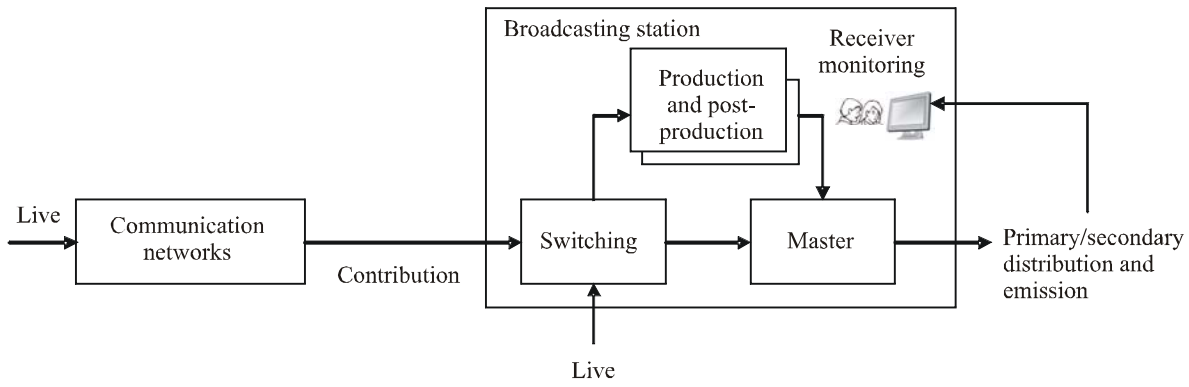
Status monitoring means to monitor whether signals conform to certain standards or specifications, which means judgment by some physical quantity of in-service signals including the status of equipment and transmission links. Equipment and networks necessary for digital broadcasting chains are also monitored as to whether they are functioning appropriately. Applications of status monitoring include contribution such as transmission by communication networks, live relay and news gathering, production and post-production and master in a broadcasting station, and primary/secondary distribution and emission (see Fig. 1).

3.2 Quality monitoring (assessment of perceptual quality for service contents)

Quality monitoring means to monitor whether the perceptual quality of contents such as video, audio, data and characters conforms to a certain quality level, which depends on the applications intended by the providers. This Recommendation concerns monitoring of in-service contents by objective assessment instead of subjective assessment. The monitored points are those where subjective or objective quality assessment by operators is possible. Applications of quality monitoring include broadcasting reception in addition to those for status monitoring (see Fig. 1). It is important to include monitoring of the received signal because clock jitter and cyclic redundancy check (CRC) errors are accumulated at each stage and sometimes lead to degradation of final quality, even if each process in a broadcasting chain conforms to the standard.

FIGURE 1

Basic processes in a broadcasting chain



1790-01

4 Issues in operational monitoring

4.1 Issues in status monitoring

– There are different causes of signal degradation, such as transmission errors, unlocked clock, improper original signals and malfunctioning of transmission links and equipment. It is difficult to identify the cause only by monitoring video and audio signals.

– Errors may occur in video and audio signals even if the signals conform to standards and equipment is functioning normally. The causes of digital errors are in general more difficult to identify than those of analogue errors. For example, even if each piece of equipment conforms to its specification, clock jitter and CRC errors may accumulate at each process.

– Black signals or silent signals may lead to false alarms by automatic monitoring equipment even though they are intentional.

4.2 Issues in quality monitoring

– In digital audiovisual systems, very complex processing such as content-adaptive processing, switching between different operational modes and change of bit rates is performed. In addition, the operational status of an encoder frequently changes. Therefore, the cause of degradation is very complicated.

– The quality of digitally encoded video and audio signals depends on the characteristics and contents of the original signal and tends to degrade locally. In addition, the degradation peculiar to digital coding, such as blockiness is very different from analogue degradation. Therefore, the conventional quality criteria for analogue signals are not necessarily appropriate for judging the quality of digitally coded audiovisual signals.

– In digital broadcasting, various levels of quality of services can be provided in the same channel, according to bit rates and content. Quality criteria may differ depending on services.

– Quality management is not easy for format converters (e.g. up-converters, down-converters, frame rate converters and aspect ratio converters) since the input and output formats are different.

– There may be problems in synchronizing video processing and audio processing.

– Reception quality may be dependent on receivers due to different performance behaviours especially in the case of transmission errors.

5 User requirements for operational monitoring

5.1 Common requirements for status and quality monitoring

In digital broadcasting, bandwidth is very effectively used by compression coding of audiovisual contents, which is different from analogue systems. Digital broadcasting has increased the number of channels and made various services possible. On the other hand, the broadcasting system has become so complex that the limited number of operators can no longer adequately monitor digital broadcasting equipment.

The common requirements for status and quality monitoring, which are essential for reducing the operational burden and realizing advanced and flexible digital broadcasting services, are as follows:

– Capability of in-service monitoring

– Applicability to the video formats in use such as SDTV and HDTV

– Applicability to the numbers of audio channels in use

– Applicability to the coding bit rates in use, irrespective of variable bit rate (VBR) or constant bit rate (CBR)

– Applicability to the transmission bit rates in use

– Applicability to the coding parameters and tools (e.g. profile/level, picture structure, range of motion vectors) in use

– Applicability to different signal processing such as compression coding, standards conversion and aspect ratio conversion

– Applicability to different sources of degradation (e.g. compression ratio and transmission error rate)

– Applicability to different programme contents
– Applicability to the system configurations in use
– Traceability of the causes of malfunction, failure and degradation
– Availability of precise information for switching to a reserve system from the monitoring result

5.2 Requirements for status monitoring

In digital broadcasting chains, even if the monitored signal conforms to its specification and each piece of equipment is functioning normally, errors sometimes occur in a later stage of the chain. It is highly desired to adapt to complex digital broadcasting systems and to support operators by the precise detection of errors and malfunctions of equipment.

The user requirements for status monitoring are as follows:

– Ability to judge whether the signal including RF characteristics and syntax conforms to its specification
– Ability to detect any errors in the signal
– Ability to monitor the functioning status of equipment including malfunctions
– Ability to detect errors and malfunctions precisely in a short time (preferably in real-time)
– Ability to monitor each component and equipment in the broadcasting chain
– Ability to check auxiliary data (e.g. data broadcasting contents, closed captions and EPG)
– Applicability to bit-streams (e.g. MPEG-TS) and RF signals, in addition to baseband video and audio signals
– Ability to detect errors which cannot be detected by humans (e.g. occasional bit error)
– Ability to automatically scan auxiliary data (e.g. data broadcasting contents and closed captions) to see whether they are as intended

5.3 Requirements for quality monitoring

For quality management of digital broadcasting, conventional subjective quality assessment methods and waveform-based measurement methods are not sufficient. A novel assessment method based on systematic monitoring of quality is needed.

As digital broadcasting mainly uses a signal form of bit-streams such as MPEG-TS instead of conventional baseband signals, there are fewer monitoring points which human operators can subjectively assess. In addition, there is an issue of relative delay between video and audio due to the processes such as codecs, A/D and D/A.

The user requirements for quality monitoring are as follows:

– Ability to evaluate quantitatively the perceptual quality
– Ability to perform systematically an objective quality assessment with a precision close to subjective quality assessment by humans
– Ability to perform perceptual quality assessment using only bit-streams (e.g. TS)
– Ability to perform perceptual quality assessment using only the signals concerned (i.e. non-reference methods)
– Ability to evaluate an overall audiovisual quality (e.g. A/V relative timing)
– Ability to detect the occurrence point of quality degradation
– Ability to perform perceptual quality assessment using only baseband signals

– Repeatability (i.e. evaluation result should not be affected by the successive signals)
– Ability to evaluate quality in a short time or instantaneously

5.4 Requirements for monitoring equipment

Equipment for monitoring status and quality must be highly functional and compact, as digital broadcasting systems are becoming increasingly advanced and complicated.

The scope of applications for status and quality monitoring is very wide as shown in § 4, and the requirements for monitoring equipment depend on the cases. The common requirements are as follows:

– The monitoring method should not disturb the monitored signals
– Simultaneous measurement of multiple signals or channels in use
– Easy maintenance
– Quietness
– Ability to log the assessment results for later use
– Compatibility among different manufacturers, including the log format (i.e. a standard format needs to be provided)
– Extendibility to more monitored signals and items when required
– Easy selection of displayed items among multiple items to be monitored
– User-friendly display of the status and errors
– Real-time and continuous usability