TECHNICAL REPORT

**ISO/IEC
TR
21000-11**

Information technology — Multimedia framework (MPEG-21) —

Part 11:
Evaluation Tools for Persistent Association Technologies

Technologies de l'information — Cadre multimédia (MPEG-21) —

Partie 11: Outils d'évaluation relatifs aux technologies d'association persistante

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

In exceptional circumstances, the joint technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC TR 21000-11, which is a Technical Report of type 3, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

ISO/IEC TR 21000 consists of the following parts, under the general title *Information technology — Multimedia framework (MPEG-21)*:

— *Part 1: Vision, Technologies and Strategy*

— *Part 2: Digital Item Declaration*

— *Part 3: Digital Item Identification*

— *Part 5: Rights Expression Language*

— *Part 6: Rights Data Dictionary*

— *Part 7: Digital Item Adaptation*

— *Part 8: Reference Software*

— *Part 9: File Format*

— *Part 11: Evaluation Tools for Persistent Association Technologies*

The following parts are under preparation:

— *Part 10: Digital Item Processing*

Introduction

Today, many elements exist to build an infrastructure for the delivery and consumption of multimedia content. There is, however, no "big picture" to describe how these elements, either in existence or under development, relate to each other. The aim for MPEG-21 is to describe how these various elements fit together. Where gaps exist, MPEG-21 will recommend which new standards are required. ISO/IEC JTC 1/SC 29/WG 11 (MPEG) will then develop new standards as appropriate while other relevant standards may be developed by other bodies. These specifications will be integrated into the multimedia framework through collaboration between MPEG and these bodies.

The result is an open framework for multimedia delivery and consumption, with both the content creator and content consumer as focal points. This open framework provides content creators and service providers with equal opportunities in the MPEG-21 enabled open market. This will also be to the benefit of the content consumer providing them access to a large variety of content in an interoperable manner.

The vision for MPEG-21 is to define a multimedia framework to enable transparent and augmented use of multimedia resources across a wide range of networks and devices used by different communities.

This eleventh part of MPEG-21 (ISO/IEC TR 21000-11) documents best practice in the evaluation of Persistent Association Technologies – that is, technologies that persistently link information to identify and describe content with the content itself. Its purpose is to allow such evaluations to be conducted using a common evaluation framework with more specific test methodologies for each of the discussed persistent association technology types or paradigms. This Technical Report is intended to give confidence to those relying on the results that they are:

— Appropriate tests of the technology that will predict its performance under real-world conditions and

— Comparable with results obtained from other tests conducted using the same methodology.

Information technology — Multimedia framework (MPEG-21) —

Part 11:
Evaluation Tools for Persistent Association Technologies

1   Scope

1.1   Introduction

MPEG-21 will provide an over-arching framework within which many elements of multimedia are brought together. In particular, coded representations of content will be juxtaposed with metadata descriptors and the Intellectual Property Management and Protection (IPMP) protection that apply to the content. This leads to a requirement for tools that can create and maintain (e.g. detect or extract) an *association* between content, metadata and IPMP elements within MPEG-21. Tools based on the techniques known as "watermarking" and "fingerprinting" offer a means to form associations between multimedia elements and the related information, where that association can be directly embedded within or inferred from the content itself. Furthermore, tools based on watermarking and fingerprinting allow such inferences to *persist* in the face of adaptation of the content. Such tools are termed Persistent Association Technologies (PAT) and within MPEG-21 there is a need to assess and evaluate these tools. This report sets out a process and plan for evaluating PAT. It does not provide information on how to normatively interpret results of tests conducted in accordance with this Technical Report as the selection of a set of specific evaluation procedures depends on the application scenario.

This Technical Report focuses on the evaluation of two classes of technology: watermarks and fingerprints (see Definitions in Subclause 2.1) when applied to Audio content.

It is expected that the scope of this Technical Report will be enhanced in future to cover other media types including video, still pictures and text.

This Technical Report describes evaluation methodologies for only some of the characteristics of these technologies. In particular, it does not attempt to define methodologies for evaluating the resistance of these technologies to deliberate attack on the association. Further detail is contained in Clause 7.

1.2 Background to ISO/IEC TR 21000-11

Recognising that the standardisation of Persistent Association Technologies (PAT) is not currently thought to be viable in the context of MPEG-21 and the wider international standardisation community, ISO/IEC JTC 1/SC 29/WG 11 (MPEG) examined options which would allow it to assist the adoption of PAT by industry.

A call for Requirements on PAT was issued and generated numerous responses. The analysis of these responses has allowed WG11 to understand the characteristics of PAT that may be required. This analysis also showed both a need and a possibility to establish a consensus approach to the *Evaluation* of such technologies which would be useful in selecting appropriate technologies for particular applications.

1.3 Organisation of the Document

ISO/IEC 21000-11 contains nine clauses. Clauses 1 and 2 set out the scope of this Technical Report, provide definition for terms and a list of abbreviations used and not used.

Clause 3 then familiarises the reader four different persistent association technology paradigms by providing a reference architecture for each of the discussed PAT paradigms[1]. Clauses 4 and 5 contain short use case scenarios for how to use Persistent Association Technologies, and how to evaluate such technologies.

Clause 6 then lists the seven characteristic parameters of PAT that can be used to evaluate such technologies. Before the main discussion on the evaluation methodology is discussed in Clause 8, Clause 7 contains a discussion on issues such as security and malicious attacks.

2 Terms and Abbreviations

2.1 Terms and Definitions

For the purpose of this document, the following terms and definitions apply.

2.1.1 Computational Performance

Computer scientists generally refer to the computational complexity of an algorithm in terms of the number of processor cycles needed as well as memory requirements (including lookup tables and/or databases). On any given platform (e.g. RISC, CISC and DSP) this complexity manifests itself as the *Computational Performance* of an implementation.

Watermark embedding and detection entail digital signal-processing operations that are similar to compression. The signal processing during embedding is largely concerned with the analysis of the original audio signal to so that masking methods can be exploited to reduce the audibility of the embedded signal. Digital signal processing associated with watermark detection and recovery is principally determined by the need to establish synchronisation between the detector and the embedded signal. Its computational complexity is increased if transforms involving scaling and shifting of the signals is anticipated whilst watermark detection is still required.

Digital signal processing of fingerprinting involves both calculating the fingerprint and comparing extracted fingerprint fragments with a large database of candidate exemplars, while seeking a match. The computational task is eased if simplifying assumptions are made (such as assuming a particular offset within larger objects) but is compounded if transformations such as scaling/shifting are anticipated and if the offset of the fingerprint is unknown, e.g. within a streaming environment.

2.1.2 Fingerprinting

Fingerprinting is the term used for to a type of pattern-recognition techniques when applied to identifying content and associating information with content, albeit without modifying the content. It works by extracting characteristics of a piece of audio content and storing them in a database. When the technology is presented with an unidentified piece of audio content, characteristics of that piece are calculated and matched against those stored in the database.

One technique is standardised within MPEG-7 using the *AudioSpectalFlatness Low Level Descriptor*, but there are many other approaches.

2.1.3 Impairment

Any modification to audio signals can have an impact on the perceived quality of the material regardless whether the modification is associated with embedding a PAT or subsequent manipulation of the content. In the context of assessing PAT it is helpful to define the term *Impairment* strictly on the basis of deliberate signal manipulations introduced in a controlled way for the purpose of testing reliability or robustness of the PAT. This is distinct from perceptibility effects that may be associated with embedding of a PAT (see Subclause 2.1.4).

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1) While Clause 3 introduces four PATs (headers, digital signatures, watermarks and fingerprints), the remainder of this Technical Report concentrates on watermarks and fingerprints only.