



**Human Factors (HF);
ETSI Accessibility Strategy;
Accessibility of ETSI Deliverables and Improvement
of the Development Process of Deliverables**

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
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Foreword

This ETSI Guide (EG) has been produced by ETSI Technical Committee Human Factors (HF).

It is a contribution to the implementation of ETSI's Accessibility Strategy as endorsed by ETSI's General Assembly #81. The Accessibility Strategy calls for four projects to be carried out with the aim of making ETSI's products, environment, and meetings accessible to users and participants with a wide range of characteristics.

The objectives of these projects are to:

- 1) Review the accessibility of ETSI infrastructure (buildings, facilities); Define baseline requirements and guidelines.
- 2) Make ETSI published deliverables accessible, including improvement of their development process.
- 3) Make ETSI meetings accessible on demand, including online and hybrid meetings.
- 4) Make IT processes and tools accessible, possibly starting with an audit and recommendations for the future.

The present document reports the results of the second of the four projects, providing solutions that enable ETSI to publish accessible documents.

The work carried out for the creation of the present document has been conducted in an open collaboration with ETSI members (including authors of ETSI deliverables), user and accessibility representatives, and other relevant stakeholders. The present document is based upon desk research (documents and online sources), best practices, expert knowledge, and stakeholder consultation.

Intended readers of the present document include, but are not limited to:

- ETSI Technical Committee members including committee chairs;
- authors of documents published by ETSI;
- ETSI personnel involved in document processing and publishing.

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Executive summary

The present document addresses the accessibility of ETSI deliverables for users with physical and/or cognitive disabilities. It contains recommendations that are based on the consultation of different sources:

- Expert judgement for the identification of improvements that are easily implemented and that can immediately improve the accessibility of ETSI deliverables (clause 5).
- Consultation of authors of ETSI deliverables with a focus on their requirements related to the creation of content for accessible deliverables (clause 6).
- Consultation of users of ETSI deliverables who have physical and/or cognitive disabilities (clause 7).

The results of the analysis are summed up in clause 8 in the form of a comprehensive set of guidelines recommendations to ensure accessible and usable ETSI deliverables, including recommendations for the needed modifications of the ETSI publication processes and specifications of most suitable tools for publication.

Introduction

The currently implemented processes for drafting, creating, and publishing ETSI deliverables are stable and state-of-the-art, and have allowed ETSI over the last decades to publish high-quality deliverables satisfying all quality criteria applicable to international standardization publications.

The one aspect in which ETSI deliverables (and those of all other standards bodies) may fall short is the accessibility of the deliverables, i.e. aspects of ETSI deliverables that make it difficult or impossible for people with physical or cognitive disabilities to use them.

The present document explores options to make ETSI deliverables fully accessible for users with disabilities. Based on expert judgement as well as on the consultation of both content creators of ETSI deliverables and of users with disabilities, the guidelines and recommendations offer many options to ensuring the accessibility of ETSI deliverables.

1 Scope

The present document addresses the accessibility of ETSI deliverables for users with physical and/or cognitive disabilities. It contains recommendations that are based on the consultation of different sources: expert judgement for the identification of improvements that are easily implemented and that can immediately improve the accessibility of ETSI deliverables, the consultation of authors of ETSI deliverables with a focus on their requirements related to the creation of content for accessible deliverables, and the consultation of users of ETSI deliverables who have physical and/or cognitive disabilities.

The results of the analysis take the form of a comprehensive set of recommendations and guidelines to ensure accessible and usable ETSI deliverables, including recommendations for the needed modifications of the ETSI publication processes and specifications of most suitable tools for publication. For this task, short-term, mid-term and, long-term perspectives have been adopted, ranging from immediate changes to a strategic outlook of a future publication environment of ETSI deliverables.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] ETSI EG 201 013: "Human Factors (HF); Definitions, abbreviations and symbols".
- [i.2] ISO 26800:2011: "Ergonomics — General approach, principles and concepts".
- [i.3] W3C® Recommendation (December 2024): ["Web Content Accessibility Guidelines \(WCAG\) 2.2"](#).
- [i.4] W3C®: ["Guidance on Applying WCAG 2 to Non-Web Information and Communications Technologies \(WCAG2ICT\)"](#).
- [i.5] Yale University: ["Usability & Web Accessibility: Types of Disabilities"](#).
- [i.6] ISO 32000-1:2008: "Document management — Portable document format".
- [i.7] ETSI EN 301 549 (V3.2.1): "Accessibility requirements for ICT products and services" (jointly produced by ETSI/CEN/CENELEC).
- [i.8] [CAN/ASC - EN 301 549:2024](#): "Accessibility requirements for ICT products and services (ETSI EN 301 549:2021, IDT)".
- [i.9] [ISO/IEC SMART](#): "Unleashing the digital power of international standards".
- [i.10] [Directive \(EU\) 2019/882](#) of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services (Text with EEA relevance).

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI EG 201 013 [i.1] and the following apply:

accessibility: extent to which products, systems, services, environments and facilities can be used by people from a population with the widest range of characteristics and capabilities, to achieve a specified goal in a specified context of use

NOTE 1: Context of use includes direct use or use supported by assistive technologies.

NOTE 2: The context in which the ICT is used may affect its overall accessibility. This context could include other products and services with which the ICT may interact.

NOTE 3: As defined in ISO 26800 [i.2].

assistive technology: hardware or software added to or connected to a system that increases accessibility for an individual

NOTE 1: Examples are Braille displays, screen readers, screen magnification software and eye tracking devices that are added to the ICT.

NOTE 2: Where ICT does not support directly connected assistive technology, but which can be operated by a system connected over a network or other remote connection, such a separate system (with any included assistive technology) can also be considered assistive technology.

caption: synchronized visual and/or text alternative for both speech and non-speech audio information needed to understand the media content

NOTE 1: This is also variously described using terms such as "subtitles" or variants such as "subtitles for the deaf and hard-of-hearing".

NOTE 2: As defined in WCAG 2.2 [i.3]

content: information and sensory experience to be communicated to the user by means of software, including code or markup that defines the content's structure, presentation, and interactions

NOTE 1: Content occurs in three places: web pages, documents and software. When content occurs in a web page or a document, a user agent is needed in order to communicate the content's information and sensory experience to the user. When content occurs in software, a separate user agent is not needed in order to communicate the content's information and sensory experience to the user - the software itself performs that function.

NOTE 2: As defined in WCAG2ICT [i.4].

document: logically distinct assembly of content (such as a file, set of files, or streamed media) that functions as a single entity rather than a collection, that is not part of software and that does not include its own user agent

NOTE 1: Letters, email messages, spreadsheets, books, pictures, presentations, and movies are examples of documents.

NOTE 2: A single document may be composed of multiple files such as the video content, closed caption text etc. This fact is not usually apparent to the end-user consuming the document/content.

NOTE 3: As defined in WCAG2ICT [i.4].

markdown: lightweight markup language for creating formatted text using a plain-text editor

web content: content that belongs to a web page, and that is used in the rendering or that is intended to be used in the rendering of the web page

web page: non-embedded resource obtained from a single URI using HTTP plus any other resources that are used in the rendering or intended to be rendered together with it by a user agent

NOTE: As defined in WCAG 2.2 [i.3].

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACM	Association of Computing Machinery
ADHD	Attention Deficit Hyperactivity Disorder
ASC	Accessibility Standards Canada
CCMC	CEN/CENELEC Management Centre
CEN/CENELEC	European Committee for Standardization/European Committee for Electrotechnical Standardization
DIN	Deutsches Institut für Normung
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JSON	JavaScript Object Notation
NSB	National Standards Body
NSO	National Standards Organization
OCR	Optical Character Recognition
PDF	Portable Document Format
PDF/A	PDF Archivable
PDF/UA	PDF Universal Accessibility
RDF	Resource Description Framework
SDO	Standards Development Organization
TIES	Telecommunication Information Exchange Service

NOTE: An ITU service, offering access to ITU standards for ITU members.

UML	Unified Modeling Language
WCAG	Web Content Accessibility Guidelines
XML	Extensible Markup Language

4 Basic assumptions

4.1 Characteristics and abilities of users and content creators of ETSI deliverables

Unless ETSI deliverables are developed and made available in an accessible format, they may present challenges to users and content creators with physical, sensory, or cognitive impairments.

Users and/or creators of ETSI deliverables may be experiencing varying degrees or combinations of visual, auditory, physical, speech or cognitive impairments (for more details see e.g. Usability and Web Accessibility: Types of Disabilities [i.5]):

- visual impairments: including any form of colour blindness, low vision, and blindness (substantial loss of vision in both eyes);
- auditory impairments: including mild to moderate hearing impairments in at least one ear up to deafness (hearing impairment that is substantial and non-correctable in both ears);
- physical impairments: including amputation (e.g. missing digits or limbs), arthritis (inflammation and damage to joints), paralysis (loss of control over a limb or other part of the body), and Repetitive Stress Injury;
- speech impairments: including muteness (the inability to speak due to a multitude of reasons), dysarthria (weakness or paralysis of the muscles required to speak), and stuttering; and
- cognitive, learning, and neurological impairments: including Attention Deficit Hyperactivity Disorder (ADHD), autism spectrum disorder, perceptual disabilities (also called "learning disabilities" such as dyslexia and dyscalculia), and seizure disorders.

The impairments may be due to a persistent health condition, being in-born or a result of illness or accident. But they may also be due to a temporary condition incurred by a short-term health condition (like a broken arm), or by current situational circumstances including specific environmental conditions, such as a very bright light or a very noisy environment, or other circumstances, like lack of access to specific technologies resulting in the need to access a document on a device with a smaller screen.

In all cases, it is assumed that users/creators who have any individual impairment or a combination thereof, deploy suitable assistive technologies to access digital documents.

NOTE 1: Users/creators of ETSI deliverables are expected to be able to understand written language.

NOTE 2: ETSI deliverables are written and published in English language. Users/creators of ETSI deliverables are expected to either have a sufficient command of the English language and/or have access to tools that represents the content of ETSI deliverables in a language they understand.

NOTE 3: Users/creators of ETSI deliverables are expected to have a relevant educational background, e.g. in the specific engineering domain of a given deliverable.

5 Important recommendations to enhance the accessibility of ETSI deliverables

5.1 Overview

The recommendations and guidelines presented in this clause are based on the evaluation of several ETSI deliverables representing a range of document types. Those documents were evaluated (a) against a set of criteria extracted from EN 301 549 [i.7] and (b) against a set of testing tools for the accessibility of Microsoft Word and PDF files (the tools included Microsoft Word, Adobe Acrobat Pro and PDF accessibility checkers available as freeware).

This clause lists the accessibility issues found in the ETSI deliverables tested (in the document formats currently used by ETSI, i.e. Word and PDF). For each of the issues identified recommendations (guidelines) are presented on how to either resolve these issues in existing documents or to avoid these accessibility issues in future documents.

This clause contains guidelines which will help to make ETSI deliverables more accessible. These guidelines may be applied both to existing documents and to deliverables which are developed in the future.

The list of accessibility issues in this clause is by no means exhaustive as more issues may be identified in the future.

Many of the guidelines explain "low-hanging fruits". Both the ETSI Secretariat and the authors of documents can use them to ensure accessibility of their deliverables with reasonable additional effort. Many of these guidelines may be treated in future updates of the ETSI Drafting Rules or in a separate publication on accessibility.

These guidelines presented in this clause fall into three categories:

- 1) Recommendations for measures to apply in order to guarantee the maximum degree of accessibility of documents when issuing (e.g. upon request) accessible documents previously published. These recommendations are mainly directed at the ETSI Secretariat which may have to contact document authors in some cases.
- 2) Recommendations for changes to be made to the document templates in order to minimize accessibility issues.
- 3) Recommendations for authors: these are instructions to authors of measures to apply in order to minimize accessibility problems for users (e.g. use of colours, alternative text for images, etc.). These may be added by ETSI in a future revision of the ETSI Drafting Rules or in a separate publication on accessibility. In the following text, "ETSI" is used to denominate the "ETSI Secretariat".

NOTE 1: The responsibility for creating accessible content lies with the authors of that content, i.e. while it is ETSI's task to identify content that is not accessible, it is not their task to fix this. Instead, they should return the document to the authors with a pointer to the problem(s) identified and proposed solutions.

NOTE 2: ETSI intends to provide guidance to authors on the recommendations listed in clause 5.2. This should cover what is being expected from authors and how they can apply these recommendations. Options for providing this guidance are to express them in a revision of the ETSI Drafting Rules, or to release them as a separate publication made available to authors.

5.2 Recommendations and Guidelines

5.2.1 Colour

5.2.1.1 Contrast

Accessibility Issue

Low contrast between text and surrounding background in pictures or diagrams.

Explanation

If text in pictures or diagrams is necessary for the interpretation of the picture, text and background should have a contrast ratio of at least 4.5:1, or 3:1 for large text.

Guidelines for authors

- For each picture in a deliverable, authors should perform the following checks and actions:
 - If a picture or diagram contains text or text images, check the contrast ratio between text and background using publicly available contrast checker tools (e.g. Colour Contrast Analyser). If the contrast ratio minimum is not met, modify the picture/surrounding in a way that the contrast ratio gets enhanced.
 - If the contrast ratio minimum cannot be met by colour modifications, change the picture or part of the picture to black and white presentation.

Background Information / References

Covered in EN 301 549 [i.7], clause 10.1.4.3, and WCAG Success Criterion 4.1.3 ((WCAG) 2.2 [i.3]).

5.2.1.2 Colour combinations

Accessibility Issue

Certain colour combinations (e.g. yellow/purple and black/red, etc.) may cause problems with blurs for people with reduced eyesight. Also, colour blindness may cause certain colour combinations to not be interpreted correctly.

Explanation

Combinations of certain colours either cause lines to be blurred or may be difficult to be interpreted by people with colour blindness.

Guidelines for authors

- Authors should avoid too stark colour contrasts (e.g. yellow/purple or black/red,) as this may cause blurred lines on displays.
- Authors should avoid colour combinations like blue/yellow or red/green as these may be seen as grey shades only by readers who are colour blind.

5.2.1.3 Colour coding / use of colour

Accessibility Issue

Colour should not be used as the only visual means to convey meaning in a document.

For example, diagrams may encapsulate a colour code to represent specific elements based on their context. This aspect increases the difficulty of reading the document by accessibility tools used by people affected by visual or cognitive impairments.

Explanation

If colour is used (in formatting text or in pictures) to convey a special interpretation of the displayed content, this interpretation may be lost to colour-blind people or users of screen readers or of documents printed on a monochrome printer. Therefore, the interpretation of the colour should be conveyed by other means (e.g. alt text, colour plus hatching, other font properties, or textual explanations).

It is a recognized usability requirement that colour should never be used as the only means for encoding a certain type of information. For example, data expressed in a bar diagram can be displayed in bars of different colours, provided that (a) those colours are appearing discernibly different when displayed/printed in grey tones and (b) the information is also presented when the user requires information about a specific element (e.g. using mouse over or a screen reader). Patterns (dots, hatching lines) can be used in addition to colours.

Guidelines for authors

- Authors should either decide not to express information in colour or ensure that colour is never the only means for expressing information.
- If colours are used in pictures or graphs, the colour coding should be explained in alt text.
- If colours are used to convey meaning in running text, other coding means (bold face, italics, other font sizes) should be used in addition to the colour code.
- If colours are used to convey meaning in a running text, the colour code should be explained at the beginning of the text section (or as alt text, if possible).
- Authors should provide a description of the colouring conventions used in each diagram included in a document.
- Authors should provide an equivalent textual representation of the diagram's content to enhance the comprehensiveness of the document and to enable accessibility tools to provide all information to the reader.

Guidelines for ETSI

- ETSI should provide guidelines about the use of colours in ETSI deliverables (this applies to text, graphics, tables, and any other means for expressing information).
- ETSI should check that each diagram contained in ETSI deliverables has an equivalent description of its content.
- ETSI should check that possible implicit conventions used by the authors are explained in the document.

Background Information / References

Covered in EN 301 549 [i.7], clause 10.1.3.1.

Covered in EN 301 549 [i.7], clauses 9.1.4.1 and 10.1.4.1, and WCAG Success Criterion 1.4.1 Use of Colour (WCAG 2.2 [i.3]).

Covered in EN 301 549 [i.7], clauses 9.1.1.1 and 10.1.1.1, and WCAG Success Criterion 1.1.1 Non-text Content (WCAG) 2.2 [i.3]).

5.2.2 Missing alt text

Accessibility Issue

For tables, pictures, formulae, and other specially formatted content ("Non-text Content"), which may be difficult or impossible to assess by people with limited eyesight or by the users of screen readers, an alternative textual description (alt text) should be attached to the Non-text Content.

Explanation

If a document contains pictures, formulae, tables or other content not formatted as running text (Non-text Content), the users of screen readers or readers with very limited eyesight may not be able to correctly interpret the content of these sections. For these users, an alternative text-based explanation of the Non-text Content should be made available (alt text).

Guidelines for authors

- Authors should provide for each picture, table, formulae or other non-text content an alt text description.

Guidelines for ETSI

- ETSI should check that for each picture, table, formulae or other non-text content an alt text description is available.

Background Information / References

Covered in EN 301 549 [i.7], clauses 9.1.1.1 and 10.1.1.1, and WCAG Success Criterion 1.1.1 Non-text Content (WCAG 2.2 [i.3]).

5.2.3 Diagrams / Pictures

5.2.3.1 Machine-readable text

Accessibility Issue

A picture or graph should not contain text in binary form, if that text is relevant for the interpretation of the content.

Explanation

Text in binary format is usually not accessible to screen readers. For screen reader users the text should either be changed to machine-interpretable text (OCR), or the contents should be explained in the alt text.

Guidelines for authors

- Authors should mention in alt text if a picture or graph contains text that is only decorative.
- If a picture or graph contains binary representations of text that is needed for the interpretation of the graph or the document contents, authors should extract the binary text and apply OCR.
- Authors should replace the binary representation of text with the text extracted by the OCR.
- Authors should explain the contents of text presented in binary format in alt text, if integrating OCR-ed content is not possible.

Background Information / References

Covered in EN 301 549 [i.7], clauses 9.1.4.5 and 10.1.4.5, and WCAG Success Criterion 1.4.5 Images of Text (WCAG 2.2 [i.3]).

5.2.3.2 Large amount of text in figures

Accessibility Issue

Pictures containing large amounts of text may cause problems for assistive technologies and should be avoided.

Explanation

If large amounts of text are contained in pictures which may not be subject to reformatting, accessibility tools like screen readers may run into problems when trying to display the contents of a picture. Also, trying to enlarge the picture may lead to unusable pictures requiring scrolling.

Large amounts of text in pictures should therefore be avoided.

Guidelines for authors

- If a picture or graph contains a lot of text, authors should try to move the text to the figure header or add it as a note right below the figure.
- If that is not possible, authors should explain the contents of the relevant text sections in the alt text of the figure or in a paragraph of text following the picture.

Background Information / References

This is primarily a usability issue but also relevant for assistive technology.

5.2.3.3 Diagrams developed with tools which do not capture semantic information

Accessibility Issue

Some diagrams and pictures contained in ETSI deliverables have not been composed using tools which also save semantic information about the diagram components. They do not follow any established representation model, and the semantics of each element are not clear and not described. Moreover, it may occur that, within the same document, diagrams with the same scope are not represented homogeneously.

Explanation

Authors of ETSI deliverables may use diagrams to explain complex information using visual representations. However, if the information expressed in the diagrams does not correspond to established standards (e.g. it is not a description of a use case for which UML diagram representations are available) the comprehension of the diagram content may be difficult by people affected by visual and/or cognitive impairments. Indeed, the use of diagrams developed with tools that do not cover the semantic content of the figure requires the inclusion of a complete description of its content to enable accessibility tools to provide the appropriate information to users. A second aspect linked to this scenario is the consistency of diagrams used across multiple documents. If the same type of diagrams is used in different ETSI deliverables, the authors should preserve the semantics to avoid misinterpretation by readers, especially by users affected by cognitive impairments.

Guidelines for authors

- Authors should provide a textual description of each diagram to enable its comprehension by people affected by visual and/or cognitive impairments.
- Authors should check if the information expressed in diagrams they provided has already been described by following an established format in other existing ETSI deliverables.

Guidelines for ETSI

- ETSI should check that figures are accompanied by appropriate description of their content.

- ETSI should ask authors to check if diagrams used for the same purpose are consistent across the same document and existing documents and request related changes if needed.

Background Information / References

Covered in EN 301 549 [i.7], clauses 9.1.1.1 and 10.1.1.1, and WCAG Success Criterion 1.1.1 Non-text Content (WCAG 2.2 [i.3]).

5.2.4 Tables

5.2.4.1 Structure: Table headings

Accessibility Issue

The error "Logical structure - Regular tables - Irregular table lines" was found by PDF accessibility checkers for tables in ETSI deliverables.

Explanation

Tables with a first line that spans across more than one column can cause problems for blind users reading the table with a screen reader.

Guidelines for authors

- Authors should be aware of the problem and should avoid the problem wherever possible. In some cases, the information contained in one table with spanning headers needs to be expressed in more than one table.
- Authors should avoid tables with more than one header line.
- Authors should avoid merging table cells.

Guidelines for ETSI

- Authors should be made aware (e.g. in the "Principles for drafting ETSI Deliverables with the use of skeletons" guide) of the problem and should be encouraged to avoid the problem wherever possible. In some cases, the information contained in one table with spanning headers needs to be expressed in more than one table.

Figure 1 shows the "History" table found in an ETSI Guide and Figure 2 shows an improved version that avoids the spanning header.

Table A.1: Web Content - relationship between the present document and the essential requirements of Directive 2016/2102/EU

Requirement					Requirement conditionality		Assessment	
No.	Clause of the present document	Essential requirements of Directive 2016/2102				Conditional or Unconditional	Condition	Clause of the present document
		Perceivable	Operable	Understandable	Robust			
1	5.2 Activation of accessibility features	✓	✓	✓	✓	C	Where web content has documented accessibility features	C.5.2

NOTE: Table copied from EN 301 549, version 3.2.1.

Figure 1: Example Table with merged cells and multiple header lines

Table ZA.2: Mobile Applications - relationship between the present document and the essential requirements of Directive 2016/2102/EU

Clause	Requirement	P	O	U	R	Condition	Assessment
5.1.3.6	Auditory output for non-text content	✓		✓		Where ICT includes closed functionality, and presents non-text content other than video	C.5.1.3.6
5.1.3.7	Auditory output for video information	✓		✓		Where ICT includes closed functionality, and pre-recorded	C.5.1.3.7

NOTE: Table copied from EN 301 549, version 4.1.1 (publication forthcoming).

Figure 2: Table header with improved accessibility

Background Information / References

<https://www.w3.org/WAI/WCAG22/Techniques/pdf/PDF6>

<https://www.w3.org/WAI/tutorials/tables/irregular/>

5.2.4.2 Structure: Tables with different types of technical content

Accessibility Issue

Some ETSI deliverables contain tables with specific technical content, containing different types of information in different columns (e.g. examples of server requests, JSON packages, code snippets). This heterogeneous structure of these tables may present a challenge to some accessibility tools.

Explanation

Authors working on technical ETSI deliverables may create tables to structure the presentation of specific content. Sometimes, such content is very technical, and it can include examples of HTTP requests, description of data beans using JSON, or snippets of source code that are relevant for the document. This heterogeneous representation of information may impede the understanding of the content of people with visual and/or cognitive impairments since the accessibility tools are not able to distinguish the different content types and to provide the appropriate content. Authors should consider this aspect when they create these tables to enable a complete comprehensiveness of tables content.

Guidelines for authors

- Authors should avoid, whenever possible, the creation of complex tables and structure the content in a different way within document clauses.
- Authors should provide a complete and precise description of table structure enabling accessibility tools to provide the users with all the information required to understand table content. Such a description should be provided in the table caption or in columns header (e.g. by mentioning within the header if the content of that column is different from a usual text) or within the document, possibly close to the table that should be described.
- Authors should develop their tables using tools for table creation (e.g. Microsoft Excel) and consider providing these tables as (individual) data files.

Guidelines for ETSI

- ETSI should check that each table is accompanied by a description of its structure. This can be provided either in the running document text or as a note to the table title.
- ETSI should suggest the authors a different way to provide specific content when complex technical tables are used.

NOTE: If the structure of a table is obvious (e.g. through clearly identified column and line headers without any merged cells), the textual description of the table structure may not be required.

Background Information / References

Covered in EN 301 549 [i.7], clauses 9.1.1.1 and 10.1.1.1, and WCAG Success Criterion 1.1.1 Non-text Content (WCAG 2.2 [i.3]).

5.2.5 Text properties and coding

5.2.5.1 Machine-readable text properties: programmatically determinable information and relationships

Accessibility Issue

Structure and relationships between different elements of ETSI deliverables are typically communicated to the readers through various visual cues (e.g. typeface, font size, table structures). The same information should be made available in a programmatically usable manner to accessibility tools (user agents) such as screen readers.

Explanation

Structure and relationships between different elements of ETSI deliverables is typically communicated through various visual cues - such as different font styles used for headings, body text or notes, or information conveyed in tables allowing to effectively communicate the specific properties of text.

Sighted users perceive this information visually. For users relaying on screen readers, it is indispensable that these structures and relationships are programmatically determined.

ETSI deliverable templates implement a set of styles helping to maintain the programmatically determinable structure information. However, there are some elements in the templates like references that are not properly programmatically determined.

NOTE: "Programmatically determinable" refers to information or functionality that can be understood or accessed by software without needing human interpretation. For example, in the context of web accessibility, something is programmatically determinable if assistive technologies (like screen readers) can extract and interpret it using the code or markup.

Guidelines for ETSI

- ETSI should ensure in its document templates that all formatting options are programmatically determinable and should alert the authors to use exclusively ETSI deliverable templates.

Background Information / References

Covered in EN 301 549 [i.7], clause 10.1.3.1.

5.2.5.2 Use of paragraph formats

Accessibility Issue

Text passages expressing specific semantics (e.g. explanatory text vs. data, or program code) need to be marked accordingly to facilitate users with and without visual impairments as well as accessibility tools to capture the specifics of the text.

Explanation

Within the same document (or even text paragraphs), text can have different semantic meanings. For example, explanations or background information may be presented in natural language, while text elements may refer to technical contents expressed in source code, data samples, ontologies, or queries. If the switch between the different semantics is not marked, visually impaired users may fail to notice the semantic difference between text passages and accessibility tools may fail to recognize them. This is a shortcoming that should be addressed in order to increase accessibility to more technical aspects of ETSI deliverables.

Guidelines for authors

- Authors of ETSI deliverables should mark any paragraph formats they require that are not supported yet by the ETSI templates.

Guidelines for ETSI

- The ETSI "skeletons" (Microsoft Word templates) should be updated to make sure that appropriate paragraph formats are available for the whole range of contents currently expected in ETSI deliverables. Examples of such content types are source code, data, and AI prompts or artifacts using other languages such as the Resource Description Framework (RDF).
- ETSI should ensure that those paragraph formats are supported by conversion tools, i.e. that the text appears in the resulting PDF-files as intended.
- ETSI should provide guidelines about how and when to use specific paragraph formats.
- ETSI should review the supported paragraph formats on a regular basis and offer support to authors on when to apply them.

Background Information / References

Covered in EN 301 549 [i.7], clause 10.1.3.1.

5.2.5.3 Text property "language"

Accessibility Issue

The language in which the document or document parts are written should be properly specified to ensure that the content is well accessible also for screen reader users.

Explanation

When the users access documents using screen readers it is important that the language of the textual content is set properly.

ETSI deliverables are produced in English. However, for some documents it may be necessary to include parts written in a different human language. For these parts, the text property should be specified properly so that the screen reader reads the text using a proper language.

Guidelines for authors

- Authors should ensure that the language property (in Microsoft Word) of their text is set correctly (e.g. Bulgarian text formatted as "Bulgarian").

Guidelines for ETSI

- ETSI deliverable templates should have the language set to English. The authors should be alerted not to change it unless there are parts of the document written in a different language. In such case, they should set a different language for the specific text passage.
- The production process of PDF documents should keep the language setting of a particular paragraph or table cell so that it is rendered correctly by e.g. screen readers.

Background Information / References

Covered in EN 301 549 [i.7], clause 10.3.1.

5.2.5.4 Font formats used to carry information

Accessibility Issue

Means of typographical emphasis such as italics and bold are sometimes used to carry information (e.g. something is special or important).

Explanation

Using typographical emphasis such as italics and bold may not be rendered correctly by screen readers or Braille readers, or, if they are rendered, may hinder the comprehension of the text.

Guidelines for authors

- Authors should avoid the use of typographical emphasis, or, alternatively, make sure that typographical emphasis is not the only means for coding text properties (such as importance). This is similar to the use of colour.

Guidelines for ETSI

- ETSI should discourage the use of typographical emphasis, or, alternatively, stress that typographical emphasis should not be used as the only means for coding text properties (such as importance). This is similar to the use of colour.

Background Information / References

More information can be found at <https://uit.stanford.edu/accessibility/concepts/typography>.

5.2.5.5 Not embedded fonts

Accessibility Issue

The error "Not embedded fonts" was found by PDF/UA repeatedly, mainly in the first two pages of ETSI deliverables.

Explanation

If a font used in a document is not embedded in the PDF production process, it may not be rendered properly in the PDF, possibly leading to problems when the product is displayed with accessibility tools such as screen readers or Braille readers.

Guidelines for ETSI

- ETSI should make sure that all fonts used in a document are embedded in the PDF document to be produced. For example, in the case of producing PDF files with Acrobat Pro, the following solution is recommended: Tools > Print Production > Preflight > expand "PDF Fixups" > select "Embed Fonts" > click "Analyse and fix". This suggestion will not work if the font is licensed such that embedding is forbidden. In such a situation, a change of font will be required.

Background Information / References

More information can be found at <https://taggedpdf.com/508-pdf-help-center/font-not-embedded/>.

5.2.6 References

5.2.6.1 List of references

Accessibility Issue

Properly formatted references to content inside or outside of a given document increase the accessibility and the usability of an ETSI deliverable.

Explanation

If PDF files are created without proper formatting ("tags"), a blind user has no indication of how many entries of a kind (e.g. references) follow the header, i.e. they have no way of telling whether three or 300 references follow the heading "References".

NOTE: .

Guidelines for authors

- At the beginning of a "List of References" clause with more than 20 entries which is not properly formatted ("tagged"), consider inserting a note that explains how many references have been collected in an ETSI deliverable.

- For each document in the list of reference, authors should provide an explanation of the reference contents in alt text if this information cannot be unambiguously derived from the reference title or from externally available data.
- For every document listed in the list of references or the bibliography of an ETSI deliverable, authors should check if a link to the reference on the Web can be provided.
- For every reference in a document, authors should try to provide a link to the reference on the web.

Guidelines for ETSI

- ETSI should ensure that in the production process of a PDF file, all paragraphs are tagged properly.

Background Information / References

"Improve the accessibility of PDFs by adding tags in Acrobat. If a PDF does not contain tags, Acrobat attempts to tag it automatically when users read or reflow it, and the results may be disappointing. With a tagged PDF, the logical structure tree sends the contents to a screen reader or other assistive software or hardware in an appropriate order" (<https://helpx.adobe.com/acrobat/using/creating-accessible-pdfs.html>).

5.2.6.2 Accessible navigation

Accessibility Issue

ETSI deliverables frequently have referenced content. The link to these references should be provided for the ease of the users including those using assistive technologies.

Explanation

Navigation should be intuitive and accessible to all users, including those using screen readers or keyboard navigation. A clear and consistent navigation structure helps users find and access content easily within the document and from other related documents (such as data models, clauses, and other specification documents). Some ETSI deliverables lack direct links to references, causing users to be redirected to a list of references when a reference is cited. It would be more user-friendly if assistive technology users could access these links directly within the document. The same applies to data models and clauses; users should be able to click on them directly rather than having to search for them, which can be challenging for people with disabilities.

Guidelines for authors

- Authors should ensure that the document should provide clear and consistent clickable links for navigation wherever available.

Background Information / References

Covered in WCAG Success Criterion 2.4.5 Multiple Ways (WCAG 2.2 [i.3]).

5.2.7 Acronyms and capitalized text

Accessibility Issue

ETSI deliverables frequently contain words written in capitals. These words are often interpreted as acronyms by screen readers and spelled out as a list of letters. Text (including headers) should be written in normal lower case/upper case and be presented as "All Caps".

Explanation

Current screen readers read out words like "NOTE" as a sequence of individual characters "N", "O", "T", "E", which makes it very difficult for users of screen readers to correctly interpret the text (see Figure 3).

NOTE 1: The present document reflects the content of the W3C WCAG 2.1 Recommendation [5].

NOTE 2: Annex E provides an overview and simple explanation of the structure of the present document, including an explanation of how it can be used. Readers who are unfamiliar with the present document are recommended to read Annex E first to give them a better understanding of the present document and how to use it.

Figure 3: Example of NOTES from an ETSI deliverable

To avoid such an interpretation by screen readers text should always be written as normal text and presented as "All caps" (see Figure 4).

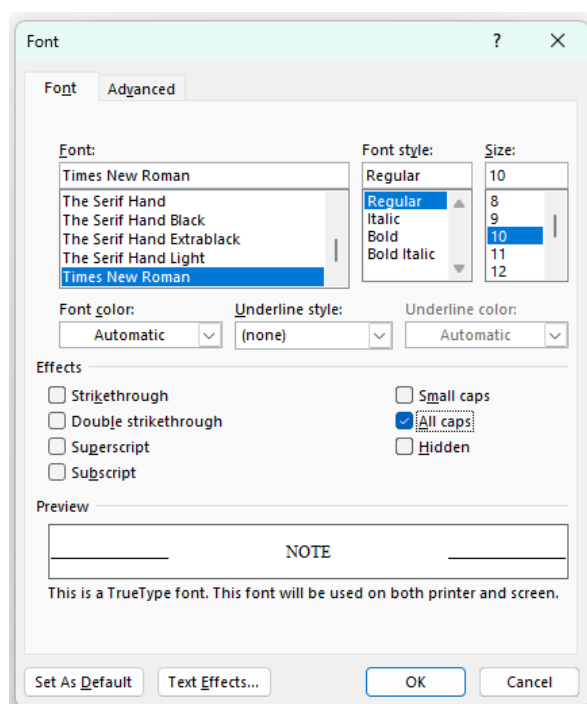


Figure 4: Microsoft Word procedure for marking text as "All caps"

Guidelines for authors

- Authors of ETSI deliverables using Microsoft Word should avoid the use of capitalized text and use "All Caps" instead. This applies to capitalized text that would be pronounced as a word (e.g. "UNESCO" or "ISO"). In cases where the capitalized text is usually read as letters (e.g. "UN"), the formatting as "All Caps" is not recommended.
- Section headers or other prominent text should never be written in capitals unless the capitalized text is an acronym spoken as individual characters.

Guidelines for ETSI

- ETSI deliverable templates should discourage the use of capitalized text for acronyms that are not spoken as single characters.
- ETSI deliverable tables should not have section headers presented as capitalized text.

5.2.8 Document properties

5.2.8.1 Document size

Accessibility Issue

ETSI deliverables are frequently very long and complex. Both their size and their structure make it extremely difficult for assistive technology tools to make the documents accessible.

Explanation

Even when large documents contain useful internal links to refer to other, related sections of text (see clause 5.2.6), if they exceed a certain length, they become unmanageable. This is both a usability and an accessibility issue. Computers are challenged (e.g. when asked to go from the front page to page 794) and users have to wait for an operation to be carried out. Users reading a document with assistive technology such as screen readers are hindered even more.

Guidelines for ETSI

- Prior to publication ETSI deliverables should be checked for accessibility problems that affect inter alia their use by assistive technology tools.
- If the documents can be expected to cause usability and/or accessibility problems because of their sheer size, a publication of the document as multi-part documents should be considered.

5.2.8.2 Document information

Accessibility Issue

ETSI deliverables frequently have titles in their meta data that are identical with the ETSI deliverable numbers as opposed to the title on the front page. Such meta data titles do not provide any meaningful information about the document content or purpose.

Explanation

Every Microsoft Word document contains metadata (available in the Files - Properties menu of Microsoft Word). Some tools access this information e.g. for indexing purposes.

Good document titles in a document's meta data are beneficial for all users, and especially for people who rely on audio mode of operation (persons with visual or severe mobility disabilities) using screen readers, who get the document title as the first information introducing the document.

Document titles (on the front page and in the meta data) should provide a precise and clear information about the document's content and/or purpose, allowing the user to determine easily whether the document is indeed the item of interest.

Good document titles benefit also people with cognitive disabilities such as limited short-term memory or reading disabilities, as they help to identify easily content of the document.

Finally, good document titles help to navigate between multiple PDF files - document titles are displayed as file tab headers, providing clearer navigation means across various documents.

Guidelines for ETSI

- Instructions should be added to the Principles for drafting ETSI deliverables guide (see Bibliography) reminding the authors to enter the document title in the meta data that allows to understand what the topic or purpose of the document is. It is important to emphasize that the document title is not equivalent to the file name and should be entered as part of the document properties.

Background Information / References

Covered in EN 301 549 [i.7], clause 10.2.4.2.

6 Authors'/content creators' requirements with respect to the accessibility of ETSI deliverables and the development process of accessible documents

6.1 Overview

Requirements of authors/content creators with respect to the accessibility and usability of ETSI deliverables and with respect to the tools and processes used to create them were identified through a series of in-depth interviews conducted with a selection of the ETSI authors/content creators. The results are presented in clause 6.2 below.

Additionally, an analysis of the guidelines and policies of other SDOs regarding the accessibility of standardization documents was conducted. The results are presented in clause 6.3 below.

6.2 Requirements of authors/content creators of ETSI deliverables

6.2.1 Introduction

To identify the requirements of authors/content creators of ETSI deliverables, a series of in-depth interviews was conducted with eight ETSI authors/content creators. All interviewees had an extensive editorial and authoring experience and record, developing various types of ETSI deliverables, some having experience in drafting other standards, too. All but one were also experienced and knowledgeable about ETSI structures, having held positions in ETSI Technical Committees, including Chair or Vice-chair positions of ETSI Technical Committees and project leaders of ETSI STFs.

During the interviews, the authors reflected on the instructions/training that would be needed to facilitate the implementation of the accessibility guidelines, on their requirements regarding tools that are needed to support the development of accessible deliverables, and on possible implications of the guidelines on the publishing/editing process.

6.2.2 Requirements on instructions and training

6.2.2.1 General

According to all interviewees, the guidelines and recommendations listed in clause 5 are reasonable and achievable. Moreover, most of the interviewees highlighted the importance of the guidelines and recommendations contained in the present document considering the EU Accessibility Act [i.10].

No need for any extensive training has been voiced. Nevertheless, it has been noted that awareness raising sessions could be useful. ETSI authors that are not fully knowledgeable about the accessibility of documents could benefit from presentations during which barriers are identified and explained that might be encountered when using ETSI standards. Such background information could help to sensitize the authors to the needs of readers with various abilities.

The value of good instructions, embedded directly in the ETSI deliverable skeletons, was emphasized, together with the need of producing a separate publication and/or updating the ETSI Drafting Rules with further accessibility information.

6.2.2.2 Requirements

- Materials that describe the specific problems that persons with disabilities are likely to encounter when working with ETSI deliverables could help ETSI authors to understand the need for following the given guidelines.

- All ETSI deliverable skeletons should include easy-to-follow instructions about all relevant accessibility aspects. The instructions should:
 - include a description of what to do or not do to ensure an accessible content; and
 - include a description of how to make content accessible (pointers to any relevant functions available in the tools used to edit the present document or other relevant documents).
- Jargon should be avoided (terms like "alt text", "binary representation of text", "typographical emphasis" or "spanning table headers" cannot be assumed as understood by all). For these terms, definitions are required which should be available to all authors.
- It would be valuable to remind authors that UK English is the English language version that is to be used in ETSI deliverables.

6.2.3 Requirements related to tools for creating accessible deliverables

6.2.3.1 General

The authors in general applaud the current editorial tooling provided by ETSI in terms of ETSI templates and the ETSI style toolbar. The consistent and robust implementation of the accessibility recommendations into these existing tools, along with the appropriate instructions on what and how to do to ensure accessibility of the content, could probably be sufficient for the basic implementation of the guidelines.

However, to improve the efficiency of the authoring process, as well as to improve the accessibility and usability of the final ETSI deliverables, additional tools were indicated as desirable.

6.2.3.2 Requirements

- All authors agreed that the ETSI deliverables templates should contain as many elements safeguarding the documents' accessibility as possible. Examples include the structure of numbered clause headings and the structure of numbered/bookmarked references.
- Some authors indicated that it would be beneficial to develop the deliverables in an editorial environment that is not so tightly related to the way the final content is formatted/presented but rather focuses on defining an appropriate semantic structure of the document. ETSI deliverables with such semantically identifiable content would bring potentially several benefits:
 - 1) Using dedicated tools that allow the on-demand generation of tables or graphs, depending on the specific needs or the purpose of the generation. Such automatic generation of complex tables or graphs would not only make the authoring process more effective, but it would ensure that the output is consistent with the complex source data. Provision of more powerful tools for the generation of graphs from tables was an explicit need expressed by one group of authors. There are already tools such as UML editors that could support such a process by providing a markdown-inspired text definition and a renderer to create and modify complex diagrams. It is worth noting that some authors already developed and use such tools in the preparation of ETSI deliverables.
 - 2) Developing ETSI deliverables in a format that can be easily transformed into different final publications, ensures not only greater accessibility of the ETSI deliverables, but also their greater usability. In addition to supporting various formats, such semantic-based formats would facilitate the retrieval of selected elements of the standard instead of having to manually identify the relevant parts. The adoption of the micropublications paradigm, i.e. the integration through a semantic format of statements and their attributions supporting an automatic and structured extraction of essential information, would support this requirement. This is particularly important in case of large documents that are rarely used in their entirety, but rather their selections apply depending on the use context.
 - 3) Maintenance over time would be easier. Today, revisions and updates are often challenging, especially with respect to updating the content of images stored in a binary format. With the adoption of a document development that is based on meta-data and semantical structure, also the maintenance of the document content would be much simpler and more efficient.

- Some authors developing highly-structured and technology-centred documents have needs for creating the standards in a machine-readable and interpretable format. For these authors, it is essential that the documents are organized in tools like Forge (and the graphical elements in UML tools), and only later converted to Microsoft Word documents or PDF.
- Tools to support the generation of quality alt text descriptions should be considered. Tools for the creation of adequate verbal descriptions of graphs, figures (and potentially tables) using ML techniques under the control of the author/rapporteur could be considered.

6.2.4 Requirements on the editing/publishing processes

6.2.4.1 General

Some of the authors have identified several aspects that would, in their opinion, be handled better by the ETSI Secretariat during the processing of deliverable drafts for publication.

6.2.4.2 Requirements

- Aspects related to indexing of terms were indicated as an area that could be best handled during the final publication processing.
- Authors acknowledge the value of incorporating elements that enhance the navigational support within the document. While navigational elements for the main document structure have been recognized as ordinary elements of the basic document templates, elements such as internal links between terms and their definitions, abbreviations and their explanations/definitions, or even the development of terms indexes were seen as more complex and possibly suited better for implementation by the ETSI publishing team.
- Regarding bibliographical references:
 - Adding short alt text summaries for the bibliographical references was identified by some authors as bringing an excessive burden on the authors. It was noted that such summaries of the external documents should be retrieved from the sources and would be best done with the support of automated tools.
 - A guideline alerting the authors to provide reference addresses where the given bibliographical item is available in multiple formats (such as HTML, PDF, or a Word document), rather than providing a link to a given document format, should be included to increase the reference accessibility.
- Tools would be helpful that automatically check for potential accessibility issues within the document content. Examples are the colour composition of images to verify the presence of possible contrast shortcomings, or the font adopted.
- Moreover, the verification of the presence of images containing textual descriptions that can be transferred into the textual content of the document without affecting the document understanding should be implemented.
- Guidelines for the development of accessible diagrams/pictures should be provided that include a requirement to ensure that, whenever needed, the images are embedded in a way that ensures that the images are resizable without any damage to their content.
- The use of tools for measuring and ensuring the quality and completeness of alt text in the publication processing of the documents should be considered.
- Several comments dealt with the different formats in which ETSI deliverables are available (PDF for non-members) and Microsoft Word and PDF for ETSI members. Additional formats for users preferring browser-based access should be provided, accompanied by background information that might be used to create more usable, accessible, and personalized versions of deliverables.

6.2.5 Concluding remarks

By and large, the proposed accessibility guidelines were recognized as reasonable and achievable. No aspects were identified as major blocking factors in their implementation. The interviewees also suggested some additional extensions of some of the identified accessibility requirements and considerations.

Most interview participants acknowledged that addressing the accessibility problems identified by STF 675 is essential for ensuring accessibility of ETSI deliverables, and that doing so will also increase the general usability of the ETSI publications. Hence, solving these problems will benefit all readers and users of ETSI deliverables.

6.3 SDOs and their approach to creating accessible standards documents

6.3.1 General

The present clause summarizes the results of a review of policies and practices of other Standards Development Organizations (SDOs) regarding the accessibility of their standardization documents. In total, the approach in the area of accessibility of seven SDOs was examined. The results are based on the analysis of standards document available from other SDOs and in some cases discussions with SDO representatives.

6.3.2 CEN/CENELEC

In the early 2020s the CEN/CENELEC Management Centre (CCMC) published a short guidance document on making Microsoft Word documents accessible. The document mainly covered issues like the proper usage of section headers, correct table formatting and the provision of alt text for figures or formulae and did not cover solutions for more challenging problems.

Other activities related to the accessibility of CEN/CENELEC documents could not be identified. CEN/CENELEC are not publishing their documents themselves but use the sales channels of their members, the National Standards Organizations (NSOs). The task to ensure that the documents are accessible seems to be transferred to the NSOs.

6.3.3 DIN

DIN has a team working on targets which are quite similar to the work done by STF 675. The current results are, however, mainly directed towards making PDF-documents accessible and deal with the question of how to ensure that DIN standard documents are PDF/A compatible.

As with most other NSOs, the business model of DIN relies on selling their standards documents, usually in PDF format only. For selected standards, DIN offers additional information to enhance the accessibility of their documents. There is, however, no regular process to make sure that standards are accessible beyond PDF/A compliance.

As most other NSOs, DIN is selling their products through its publication service (in the case of DIN "DIN Media"). This implies that the writing of standards in source format (e.g. Microsoft Word) is separated from the publishing process, and since DIN standards are sold for a fee, access to source formats is not possible for external users.

Only in very rare cases does DIN Media offer access to separate files to enhance the accessibility of DIN standard documents. One example is an Excel version of Annex A of EN 301 549 (V3.2.1) [i.7], but that file can only be accessed by users who pay for access to the main EN 301 549 [i.7] document.

6.3.4 ITU

ITU documents are available without cost in PDF format (and in Microsoft Word format only for Telecommunication Information Exchange Service (TIES) account holders). This is quite similar to the way ETSI make their documents available to the public and to ETSI members. Some of the ITU documents are also available in ePub format.

An analysis of currently available ITU standards (recommendations) shows that the Microsoft Word versions do not pass an accessibility check by Microsoft Word. Identified problems include missing alt text and some related to table formatting. Also, the document structure cannot be inferred from the available document. The respective PDF documents show the same accessibility problems; no additional issues can be identified.

6.3.5 IEEE

IEEE are selling their standards documents in PDF format. Because of the paywall restriction, only a limited number of documents could be checked for their accessibility. While most of those documents are aligned with the PDF/A standard, they are not actually accessible. The most striking shortcoming is that figures and tables are not recognized by PDF readers as figures or tables but only as collections of text fields. This leads to a situation in which no alt text information is available for these and other document components as e.g. formulae.

There is no insight into the way these documents are developed.

6.3.6 IEC

IEC have presented an approach to making standards documents more usable, customizable, and machine-interpretable [i.9]. In that approach, accessibility is not mentioned as a target property for IEC standards. The SMART approach presented in that document seems, however, well suited to include accessibility features (at least) to new documents.

For those required document properties that are identified as usability related, the SMART approach offers a promising solution. The publishing process and the change to different formats (XML, HTML) seems to be aligned with the requirements mentioned by ETSI authors (see clause 6.2 above).

6.3.7 Canadian Standards Organization (Accessibility Standards Canada)

Accessibility Standards Canada (ASC) have applied a publication style that is different from that of most other SDOs. They normally publish their standards as PDF documents and behind a paywall, with the exception of a few standards as e.g. EN 301 549 [i.7] and [i.8]. For that publicly available standard they offer PDF, Microsoft Word and HTML versions. In particular, the HTML version shows a higher degree of usability, the accessibility deficiencies identified for the ETSI publication of the same standard have, however, not been entirely removed.

The process of making that particular standard more accessible and usable has been mostly manual, no tools to achieve higher accessibility have been used. This is an indication that accessibility should be taken into consideration at the very beginning of the authoring process. Achieving a higher degree of accessibility based on an existing non-accessible document will usually not lead to completely accessible documents.

6.3.8 ACM

While ACM is not an official "SDO" they are publishing technical documents which they claim to be accessible. A simple accessibility check of their resulting PDF documents shows, however, that the documents fail those checks in many aspects, e.g. tagging, alt text, identification of figures and tables. Since the documents can only be downloaded as PDFs it is not possible to assess whether meta information related to the documents is not available at all or if it gets lost in the publishing process (transposition from Microsoft Word to PDF).

According to external sources, ACM documents are developed as Microsoft Word documents and accessibility features are added through Microsoft Word macros which ensure e.g. the existence of alt text and the correct formatting of tables.

The ACM approach has not been discussed with their editing team. One assumption is that only part of the process of creating accessible (Microsoft Word?) documents is automatic, but it seems clear that the publication process does not retain the accessibility of the original documents.

6.3.9 Concluding Remarks

Most of the SDOs have no identifiable approaches to enhance accessibility features of their standards documents beyond compliance with PDF/A. The business model of most of the SDOs analysed is based on selling their standards documents. From the analysis of standards documents published by other SDOs a consistent approach to ensuring accessibility cannot be inferred.

Regarding usability, several documents which show somewhat better quality could be identified, but it was not possible to identify any set of documents from any one SDO that could serve as an indication that the SDO applies any rules consistently. As far as possible, this needs to be cross-checked with the SDOs' publication departments in the future.

As mentioned in interviews with authors and rapporteurs (see clause 6.2) the provision of standards documents in different publishing formats, which ideally should also be machine-interpretable, is considered a key factor in making documents more accessible. This provision is extremely difficult for SDOs who publish documents which they receive in final form from other international SSOs. Providing of multiple formats runs contrary to the financial interest of the publishing SDOs or their publication subsidiaries.

There is one distinct advantage that ETSI (and potentially also ITU) have over most other SDOs: the entire process from authoring to final publication is in one hand, with the ETSI Secretariat being the responsible single process owner. This allows that authors can be advised and supported to create source documents which support the later creation of publications in formats that allow the improvement of both usability and accessibility of the finally published standard deliverables.

7 User-centred analysis of the accessibility and usability of ETSI deliverables

7.1 Overview

The requirements presented in this clause are based on a number of interviews that were conducted to identify specific accessibility requirements users of ETSI deliverables may have. Interviewees were (a) experts representing nationally and internationally the community of people with impairments and/or (b) people with specific impairments who regularly use and create documents in a professional context.

7.2 Requirements of blind users and those with low vision

7.2.1 General

For the purpose of the interviews, the widest-possible understanding of the term "visual impairment" was adopted, i.e. the whole range of impairments up to legally blind and totally blind persons as well as conditions such as colour blindness or tunnel vision. As an illustration, the interviewee from the Hilfsgemeinschaft der Blinden und Sehschwachen Österreichs, based in Vienna (Austria) explained that in Austria there are around 400 000 - 500 000 visually impaired citizens (not counting short sighted users wearing glasses) and about 9 000 - 12 000 legally blind citizens. Of the latter, only around 800 use Braille.

7.2.2 Requirements

It is safe to assume that readers of ETSI deliverables use their familiar PDF reader or other dedicated software product, which may support functionalities such as screen reading or Braille display.

Users of PDF documents with low vision can be expected to use functionalities of their preferred PDF software that allows them to change the visual appearance of the page, changing background and foreground colour, changing the displayed fonts or zooming the contents of the page.

- ETSI deliverables released as PDF documents should not prevent users from changing visual aspects of the documents such as background and foreground colour, fonts, or zoom factor when read with the user's preferred PDF reader.
- Blind users and those with low vision (and particularly those who use screen readers) need PDF files that are properly tagged (see ISO 32000-1 [i.6], section 14.8). That means that each element is marked with the intended attribute. For example, a paragraph of text is usually marked by the attribute <p>, a top-level heading with <H1>. These attributes are not visible to the user but are interpreted by PDF reading software and screen readers. In order to generate a PDF file with tags, it is not sufficient to "print" a PDF file from the Microsoft Word application (menu "File", submenu "Print", option "Print as PDF"), instead the file needs to be either "saved as PDF" or "exported as PDF".
- The PDF files produced by ETSI should be accessibility checked, e.g.:
 - with the Microsoft Word accessibility check ("File", "Information", "Accessibility Check");

- with a PDF/UA accessibility checker that ensures the file conforms (at least) to WCAG 2.1. For this, here are many accessibility checkers available, both FreeWare and licensed at cost.
- with Adobe Acrobat Professional which allows to check the presence of tags in a PDF file and even to add tags automatically to a file previously produced without tags.
- Accessibility tests should be conducted at writing time (in Microsoft Word) and should always be conducted at production time (i.e. the resulting PDF file is tested).
- Elements of an ETSI deliverable:
 - Tables:
 - Spanning headers (i.e. headers spanning more than one column below or covering more than one line) can be a problem for screen readers, but less so if the headers are formatted as headings. In any case, it is recommended to express the table's content verbally or at least summarize it in the space immediately before or following the table.
 - Merged cells (both horizontally and vertically merged) in tables cannot be interpreted correctly by screen reader users because screen readers cannot detect the extent of these merged cells. They should be avoided, or the tables should be represented and made available in different formats (e.g. as separate Microsoft Excel files and not as part of PDF or Microsoft Word files).
 - Lists: Those should not present a problem provided they are properly tagged, e.g. as ordered list with ordered list items.
 - Figures: All figures should include a text description (alt text) to be included by the authors at writing time. If a figure such as a logo has purely decorative function, this, too, should be expressed in the alternative text description.
 - Graphs: Graphs such as bar graphs should be supported by text descriptions (alt text) and/or include a verbal description or summary of the information expressed in the graph in the space immediately following the graph.
 - Colour:
 - To ensure a sufficient colour contrast of text or any visual element, a colour checker should be employed. There are many contrast checkers available, both as web tools and as downloadable apps which can be used for this purpose.
 - Information should always be coded redundantly, meaning that colour should never be the only way of expressing a piece of information.
 - Navigation within the document:
 - For navigation to be supported by assistive technology such as screen readers, all structural elements of the document such as headers (e.g. "2 References") should be numbered (and tagged) automatically.
 - Properly tagged elements support users in navigating through the document by indicating the number of elements to follow in a section of the document (e.g. the indication that under the heading "2 References" follow 372 elements formatted as references - this allows blind users to decide whether they want to navigate through those elements or jump straight to the next heading/section).
 - Language:
 - Blind users and those with low vision do not have any particular needs regarding language. However, it was noted that it is essential to ensure that the language of ETSI standards is as clear and simple as possible in order to minimize the possibility of different interpretations of, for example, applicability of a requirement. The concept of closed and open functionality in EN 301 549 (V3.2.1) [i.7] was given as an example of language that is not clear and leaves too much room for individual interpretations. No advice can be given to the language style employed in ETSI deliverables. An easy-to-understand language (short sentences, words the readers can be expected to be familiar with) benefits all readers. However, no international standard is available

that recommends a particular style of writing to facilitate comprehension by blind readers and those with low vision.

- Non-English content should be formatted correctly (e.g. Bulgarian text formatted as "Bulgarian").
- Fonts and typeface:
 - Words written in upper case (e.g. "UNESCO") may be interpreted by common screen readers as acronyms and spelled out as individual characters. They should be formatted properly (as "all Caps" if they are acronyms, which should not be spelled out), both in Microsoft Word and PDF documents.
 - The choice of specific fonts, i.e. the ones that are not commonly used for text but that may be used for specific technical sections like source code or data packages, may have a detrimental effect on the understandability of the whole document. Indeed, some screen readers may not be able to properly detect them with the result that portions of text may be skipped by the screen reader and not communicated to the user.
- Publication/document type:
 - Several of the interview partners expressed their clear preference for reading ETSI deliverables in Microsoft Word, XML or HTML formats, in particular when using screen readers.
 - PDF should not be the only format in which the ETSI standards are published. PDF is a format for producing stable printed versions of the document. It is less suitable to support efficient digital access to the document content:
 - PDF documents are slow to load when using screen readers for ensuring accessibility.
 - Even when proper tags are implemented, an efficient navigation within the document is not easily possible in the PDF format because it is constrained by the predefined document sequence and available tagging structure. Effective use of an ETSI deliverable often requires the simultaneous access to various elements that may be placed in different parts of the document (e.g. a requirement, the associated test for checking if the requirement is achieved, and the relevant provision in an external legal document (e.g. an EU Directive) that that is addressed by the requirement).
 - It is recommended to publish ETSI deliverables in formats that facilitate interactive and dynamic navigation within the document, allowing quick access to the different parts of the document. Formats such as HTML, XML or Microsoft Word have been mentioned as plausible solutions. Producing text in XML and/or HTML will also facilitate the creation of tables and forms with elements that are easily and correctly interpreted by assistive technologies such as screen readers.

It was emphasized that an available document representation in XML/HTML formats would clearly not only alleviate the barriers existing now for the screen reader users but would also be beneficial for all users of the ETSI deliverables. All users have essentially the same need for effective access to different parts of the document containing an ETSI standard.

7.3 Requirements of deaf users and those with hearing impairments

7.3.1 General

In the context of the requirements presented in this clause, the widest possible understanding of the term "hearing impairment" was adopted, i.e. covering the whole range of impairments from mild forms of hearing loss (hard of hearing persons) to legally and completely deaf persons.

Most deaf people do not have any particular problems reading PDF documents including those released by ETSI. This is because an ETSI deliverable that does not include multimedia contents such as sound exclusively provides visual information that is accessible to deaf users and those with hearing impairments.

However, those persons with severe hearing loss who use their national sign language as their first language may be challenged. This is because their own national language is already a first language they have to learn in addition to national sign language. English is then added as a third language (for those who did not grow up in an English-speaking country). Those people may benefit from an easy/simple language, but they may not necessarily be readers of ETSI deliverables.

7.3.2 Requirements

It was assumed that deaf readers of ETSI deliverables and readers with hearing impairments use their familiar assistive technology devices that they also use for the purpose of reading PDF documents from other sources:

- Many readers including deaf persons and persons with hearing impairments may benefit from summaries and illustrative examples presented after a complex or abstract text. This can be done using NOTE and EXAMPLE formats of the ETSI templates and support readers in comprehending the text.
- So-called "rich media" or "multimedia" with audio and video content may present additional challenges to deaf persons and persons with hearing impairments. They require provision of text-based communication channels (e.g. real-time text), captions for audio and multimedia content, and sign language interpretation where feasible. This is detailed in EN 301 549 [i.7], which details accessibility requirements for ICT products and services.
- Users with multiple impairments (e.g. hearing and visual impairments) may have additional and particular requirements (see clause 7.6).

NOTE 1: Some NSOs and other users of ETSI deliverables translate ETSI deliverables into their national language(s). Deaf persons and persons with hearing impairments (and in particular those that use sign language) may benefit from that practice.

NOTE 2: In the future, video applications such as SORA (<https://openai.com/sora/>) may be capable of illustrating content information of selected ETSI deliverables. Those should then also be provided with high-quality subtitles.

7.4 Requirements of mobility-impaired users

7.4.1 General

In the context of the requirements presented in this clause, the widest possible understanding of the term "mobility impairment" was adopted, i.e. including all kinds of physical impairments including e.g. paralysis of limbs, missing limbs, and restricted reach/dexterity. The requirements of this group of users are, therefore, diverse. For example, one person interviewed for the elicitation of requirements is both a user of and contributor to ETSI deliverables and is not able to properly use her hands; she is equipped with an accessibility device supporting the navigation of documents.

7.4.2 Requirements

- The production of PDF version of ETSI deliverables should ensure that the interaction elements mentioned in EN 301 549 [i.7] are supported. Those include media control (play, pause, etc.), forms and links.
- The PDF documents should not hamper the use of keyboard shortcuts as offered by PDF readers.
- Voice input should be supported for handling the document (e.g. page turning), supporting the user's preferred language.
- As mentioned in EN 301 549 [i.7] (e.g. clauses 10.2.1, 11.2.1, 11.2.1.25), there should be no mismatch between the label of a button (e.g. "send") and its identifier (e.g. "button 15"), as the latter may be displayed by a PDF reader with accessibility functionalities.
- Headings should be created with the correct mark-up characteristics ("tags").
- The navigation support of internal hyperlinks should be supported to facilitate coming back to a previous point in the document when a jump is performed. For example, when users click on a reference, they should be able to go back to the point of origin.

- Users with multiple impairments (e.g. visual and mobility impairments) may have additional and particular requirements (see clause 7.6).

7.5 Requirements of users with cognitive or intellectual disabilities

7.5.1 General

People with cognitive or intellectual disabilities encompass a wide range of challenges and needs. These may include conditions such as dyslexia and autism but may also present specific needs such as an impaired short or long-term memory as a result of a head injury or other trauma. This does not mean they cannot process or create technical documents; many cognitive needs do not indicate low intelligence but rather represent a problem in dealing with text.

Many of their requirements are shared by many or most people at least in some times during their lives, and most readers may benefit from the implementation of some of the recommendations listed below (in particular those readers of ETSI deliverables whose mother tongue is not English - those may well be the majority).

7.5.2 Requirements

The following requirements are shared by many people with cognitive requirements:

- Text: Reverse text (white on black), light print on a dark background, underlining and italics should be avoided, wherever possible. High contrast should be used to make documents more legible.
- Writing style: A simple and clear language should be used, avoiding long, dense paragraphs. In many cases, the use of active voice results in easier-to-understand sentences. Double negatives should be avoided as well.
- Organization: A proper heading structure and a meaningful description of important images should be aimed at. In many cases, bullet points and/or numbered lists are easier to process than continuous prose.
- White space: White space can be employed to structure the text better and make relevant information easier to detect and read.
- Flow charts: Flow charts can be used to explain procedures and processes (however, they can create hurdles for people with visual impairments).

7.6 Requirements of users with multiple impairments

Many people suffer from a combination of mild impairments (e.g. reduced mobility and impaired hearing). In most cases, this does not restrict them in their use of PDF or other documents. Only very severely impaired people (in particular those who are deaf blind) will be severely challenged and require solutions that most likely go beyond what ETSI can offer.

NOTE: There may be very little that can be done to support deaf-blind people for their comprehension of written materials. However, many (legally) deaf-blind people have residual hearing or visual abilities that help them understanding spoken or written text.

8 Recommendations for accessible and usable ETSI deliverables and solution proposals to implement these recommendations

8.1 Overview

The purpose of this clause is twofold. First, the solutions proposed to implement the accessibility recommendations identified in the earlier clauses of the present document are distinguished between solutions for 1st phase implementation and solutions which might only be implemented in the 2nd phase.

In the final clause 8.4, a number of options to make ETSI deliverables more usable and accessible in the 3rd phase are presented.

NOTE 1: The responsibility for creating accessible content lies with the authors of that content, i.e. while it is the ETSI Secretariat's task to identify content that is not accessible, it is not their task to fix this; instead, they should return the document to the authors with a pointer to the problem(s) identified and proposed solutions.

NOTE 2: ETSI intends to provide guidance to authors on the recommendations raised in Table 1. This should cover what is being expected from authors and how they can follow the recommendations. Options for providing this guidance are to express them in the Principles for drafting ETSI Deliverables guide (see Bibliography), or to release them as a separate publication made available to authors.

8.2 Proposals and solutions - 1st phase

8.2.1 Content creation by authors

This clause summarizes guidelines authors should follow when creating content for ETSI deliverables in order to make those publications accessible.

Table 1 lists changes that can and should be introduced in the very near future. The columns of Table 1 contain the following information:

- Recommendation number: unique identifier for referencing a particular recommendation from Table 1.
- Reference clause: reference to clause in the present document.
- Recommendation and proposed solution(s): one-sentence summary of the recommendation and proposed solution.
- Tool support: tool to be provided to authors / to be used by authors in order to comply with a given recommendation.

Table 1: Recommendations for authors

Req. Nr.	Reference clause	Recommendation and proposed solution(s)	Tool support
1.1	5.2.1.1, 7.2.2	Low contrast between text and surrounding background in pictures or diagrams should be avoided.	Colour Contrast Analyser, Contrastchecker
1.2	7.5.2	Reverse text (white on black), light print on a dark background, underlining and italics should be avoided, wherever possible. High contrast should be used to make documents more legible.	n/a
1.3	7.5.2	White space can be employed to structure the text better and make relevant information easier to detect and read.	n/a
1.4	5.2.1.2	Certain colour combinations (yellow / purple, black / red, etc.) may cause problems with blurs for people with reduced eyesight and/or with colour blindness and should be avoided.	n/a

Req. Nr.	Reference clause	Recommendation and proposed solution(s)	Tool support
1.5	5.2.1.3, 7.2.2	Colours should never be the only means for expressing information.	n/a
1.6	5.2.1.3	If colours are used in pictures or graphs, the colour coding should be explained in alt text.	n/a
1.7	5.2.1.3	If colours are used to convey meaning in running text, other coding means (bold face, italics, other font sizes) are used in addition to the colour code.	n/a
1.8	5.2.1.3	If colours are used to convey meaning in a running text, the colour code should be explained at the beginning of the text section (or as alt text, if possible).	n/a
1.9	5.2.1.3	Authors should provide a description of the colouring conventions used in each diagram included in a document.	n/a
1.10	5.2.1.3	Authors should provide an equivalent textual representation of the diagram's content to enhance the comprehensiveness of the document and to enable accessibility tools to provide all information to the reader.	n/a
1.11	5.2.2, 7.2.2	Authors should provide for each picture, table, formulae or other non-text content an alt text description.	n/a
1.12	5.2.3.1	Authors should mention in alt text if a picture or graph contains text that is only decorative.	n/a
1.13	5.2.3.1	If a picture or graph contains binary representations of text that is needed for the interpretation of the graph or the document contents, authors should extract the binary text and apply OCR.	n/a
1.14	5.2.3.1, 6.2.4.2	Authors should explain the contents of text presented in binary format in alt text, if integrating OCR-ed content is not possible. Use of tools for measuring and ensuring the quality and completeness of alt text in the publication processing of the documents should be considered.	n/a
1.15	5.2.3.2, 7.2.2	If a picture or graph contains a lot of text, authors should try to move the text to the figure header or add it as a note between the figure and its title.	n/a
1.16	5.2.3.2	If Recommendation 1.15 is not possible, authors should explain the contents of the relevant text sections in the alt text of the figure or in a paragraph of text following the picture.	n/a
1.17	7.5.2	Flow charts can be used to explain procedures and processes (however, they can create hurdles for people with visual impairments).	n/a
1.18	5.2.4.1, 7.2.2	Authors should avoid table header lines that span across more than one column or line ("merged cells").	n/a
1.19	5.2.4.1	Authors should avoid tables with more than one header line.	n/a
1.20	5.2.4.1	Authors should avoid merging table cells.	n/a
1.21	7.2.2	Lists should be properly tagged, e.g. as ordered lists with ordered list items.	accessibility checks
1.22	5.2.5.3	Authors should ensure that the language property (in Microsoft Word) of their text is set correctly (e.g. Bulgarian text formatted as "Bulgarian").	n/a
1.23	7.5.2	A simple and clear language should be used, avoiding long, dense paragraphs. In many cases, the use of active voice results in easier-to-understand sentences. Double negatives should be avoided as well.	n/a
1.24	7.5.2	A proper heading structure and a meaningful description of important images should be aimed at. In many cases, bullet points and/or numbered lists are easier to process than continuous prose.	n/a
1.25	5.2.6.2	Authors should ensure that the document should provide clear and consistent clickable links for navigation wherever available.	n/a
1.26	5.2.7	Authors of ETSI deliverables using Microsoft Word should avoid the use of capitalized text and use "All Caps" instead. This applies to capitalized text that would be pronounced as a word (e.g. "ETSI" or "ISO"). In cases where the capitalized text is usually read as letters (e.g. "UN"), the formatting as "All Caps" is not recommended.	n/a
1.28	7.2.2	The language of ETSI standards should be as clear and simple as possible in order to minimize the possibility of different interpretations of e.g. the applicability of a requirement.	n/a
1.29	7.2.2	Words written in upper case are interpreted by common screen readers as acronyms and spelled out as individual characters. They should be avoided, both in Microsoft Word and PDF documents.	n/a
1.30	7.3.2	Many readers including deaf persons and persons with hearing impairments may benefit from summaries and illustrative examples presented after a complex or abstract text. This can be done using NOTE and EXAMPLE formats of the ETSI templates and support readers in comprehending the text.	n/a

Req. Nr.	Reference clause	Recommendation and proposed solution(s)	Tool support
1.31	7.4.2	The navigation support of internal hyperlinks should be supported to ease the coming back to a previous point in the document when a jump is performed. As example, when users click on a reference, they should be able to go back to the point of origin.	n/a

8.2.2 Document preparation by ETSI

This clause summarizes changes ETSI intends to make when reviewing and editing content for ETSI deliverables in order to make those publications accessible.

Table 2 lists changes that can and should be introduced in the very near future. The columns of Table 2 contain the following information:

- Recommendation number: unique identifier for referencing a particular recommendation from Table 2.
- Reference clause: reference to clause in the present document.
- Recommendation and proposed solution(s): one-sentence summary of the recommendation and proposed solution.

Table 2: Recommendations for ETSI related to document preparation

Req. Nr.	Reference clause	Recommendation and proposed solution(s)
2.1	5, 6.2.2.2	ETSI should publish instructions for authors (e.g. in a revision of the ETSI Drafting Rules or as a separate publication) on practices they should apply in order to make ETSI deliverables accessible.
2.2	5	ETSI should return draft documents back to the authors if there are instances of authors not following the recommendations in clause 8.2.1, possibly with a link to information on how to create accessible content (see requirement 2.1).
2.3	6.2.4.2	Guidelines for development of accessible diagrams/pictures should be extended to include also a recommendation to ensure that whenever needed, the images are embedded in a way that ensures that the images are resizable without any damage to their content.
2.4	5.2.5.1, 6.2.2.2	The Principles for drafting ETSI deliverables with the use of skeletons guide" should include instructions about accessibility aspects (do's and don'ts), pointing to relevant functions in the editing tools while avoiding jargon (e.g. alt text, "binary representation of text", "typographical emphasis").
2.5	5.2.5.2	The ETSI "skeletons" (Microsoft Word templates) should be checked to make sure that appropriate paragraph formats are available for the whole range of contents that can be expected in current and future ETSI deliverables. Examples of such content types are source code, data, and AI instructions/queries, or artifacts using other languages such as the Resource Description Framework (RDF).
2.6	6.2.3.2	ETSI deliverables templates should contain as many elements safeguarding the documents' accessibility as possible. Examples include structure of numbered clause headings, structure of numbered/bookmarked references, etc.
2.7	6.2.2.2	Authors should be reminded of the English-language version (i.e. UK English) that is to be used in ETSI deliverables.
2.8	5.2.5.2	ETSI should ensure that paragraph formats (that are expected to be used in ETSI deliverables) are supported by conversion tools, i.e. that the text appears in the resulting PDF-files as intended.
2.9	5.2.5.2	ETSI should provide guidelines about how and when to use specific paragraph formats.
2.10	5.2.5.2	ETSI should review the supported paragraph formats on a regular basis and offer support to authors on when to apply them.
2.11	5.2.5.3	ETSI deliverable templates should have the language set to English. The authors should be alerted not to change it unless there are parts of the document written in a different language. In such case, they should set a different language for the specific passage.
2.12	5.2.7	ETSI deliverable templates should discourage the use of capitalized text or headings.
2.13	7.2.2	For navigation to be supported by assistive technology such as screen readers, all structural elements of the document such as headers (e.g. "2 References") should be numbered (and tagged) automatically.
2.14	7.2.2	Non-English content should be formatted correctly (e.g. Bulgarian text formatted as "Bulgarian").

8.2.3 Document production by ETSI

This clause summarizes changes ETSI intends to make when producing ETSI deliverables in order to make those publications accessible.

Table 3 lists changes that can and should be introduced in the very near future. The columns of Table 3 contain the following information:

- Recommendation number: unique identifier for referencing a particular recommendation from Table 3.
- Reference clause: reference to clause in the present document.
- Recommendation and proposed solution(s): one-sentence summary of the recommendation and proposed solution.

Table 3: Recommendations for ETSI related to document production

Req. Nr.	Reference clause	Recommendation and proposed solution(s)
3.1	5.2.5.3	The production process of PDF documents should keep the language setting of a particular paragraph or table cell so that it is rendered correctly by e.g. screen readers.
3.2	5.2.5.5	ETSI should make sure that all fonts used in a document are embedded in the PDF document to be produced. For example, in the case of producing PDF files with Acrobat Pro, the following solution is recommended: Tools > Print Production > Preflight > expand "PDF Fixups" > select "Embed Fonts" > click "Analyse and fix". This suggestion will not work if the font is licensed such that embedding is forbidden. If access to the source document is available, a different font should be selected.
3.3	5.2.6.1, 7.2.2, 7.4.2	ETSI should ensure that in the production process of a PDF file, all paragraphs are tagged properly (properly tagged elements support users in navigating through the document by indicating the number of elements to follow in a clause of the document).
3.4	7.4.2	The production of PDF version of ETSI deliverables should ensure that the interaction elements mentioned in EN 301 549 [i.7] are supported. Those include media control (play, pause, etc.), forms and links.
3.5	7.4.2	The PDF documents should not hamper the use of keyboard shortcuts as offered by PDF readers.
3.6	7.4.2	As mentioned in EN 301 549 [i.7] (e.g. clauses 10.2.1, 11.2.1, 11.2.1.25) there should be no mismatch between the label of a button (e.g. "send") and its identifier (e.g. "button 15"), as the latter may be displayed by a PDF reader with accessibility functionalities.
3.7	7.4.2	Voice input should be supported for handling the document (e.g. page turning), supporting the user's preferred language.
3.8	6.2.4.2	Aspects related to indexing of terms were indicated by authors as an area that could be best handled during the final publication processing. This includes internal links between terms and their definitions, abbreviations and their explanations/definitions, or even development of terms indexes.
3.9	5.2.8.1, 7.2.2	Prior to publication ETSI deliverables should be checked for accessibility problems that affect inter alia their use by assistive technology tools (with the Microsoft Word accessibility check ("File", "Information", "Accessibility Check"), with a PDF/UA accessibility checker that ensures the file conforms to WCAG 2.0 (e.g. PAC 2024), with Adobe Acrobat Professional which allows the presence of tags in a PDF file and even to add tags automatically to a file previously produced without tags).
3.10	5.2.8.1	If the documents can be expected to cause usability and/or accessibility problems because of their sheer size, a publication of the document as multi-part documents should be considered.
3.11	5.2.8.2	ETSI deliverable templates should contain instructions reminding the authors to enter the document title in the meta data that allows to understand what the topic or purpose of the document is. It is important to emphasize that the document title is not equivalent to the file name and should be entered as part of the document properties.
3.12	7.2.2	ETSI deliverables released as PDF documents should not prevent users from changing visual aspects of the documents such as background and foreground colour, fonts, or zoom factor when read with the user's preferred PDF reader.

8.3 Recommendations for implementation - 2nd phase

8.3.1 Content creation by authors

This clause summarizes changes authors should make when creating content for ETSI deliverables in order to make those publications accessible.

Table 4 lists changes that can and should be introduced in a mid-term perspective. The columns of Table 4 contain the following information:

- Recommendation number: unique identifier for referencing a particular recommendation from Table 4.
- Reference clause: reference to clause in the present document.
- Recommendation: one-sentence summary of the recommendation and proposed solution.
- Tool support: tool to be provided to authors / to be used by authors in order to comply with a given recommendation.

Table 4: Recommendations for authors

Req. Nr.	Reference clause	Recommendation and proposed solution(s)	Tool support
4.1	5.2.3.3, 7.2.2	Authors should provide a textually equivalent description of each diagram and table to enable to allow visually impaired readers to understand its content.	n/a
4.2	5.2.4.2	Authors should avoid, when possible, the creation of complex tables and structure the content in a different way within document clauses.	n/a
4.3	5.2.4.2, 7.2.2	Authors should provide a complete and precise description of table structure enabling accessibility tools to provide the users with all the information required to understand table content.	n/a
4.4	5.2.5.2	Authors of ETSI deliverables should communicate to ETSI any paragraph formats they require that are not supported yet by the ETSI templates.	n/a
4.5	5.2.5.4, 7.2.2	Authors should avoid the use of typographical emphasis, or, alternatively, make sure that typographical emphasis is not the only means for coding text properties (such as importance). This is similar to the use of colour.	n/a
4.6	5.2.6.1	Authors should provide a link for every document cited in the text to the list of references or the bibliography.	n/a
4.7	5.2.6.1	For every reference in a document, authors should try to provide a link to the reference on the web.	n/a
4.8	7.3.2	So-called "rich media" or "multimedia" with audio and video content may present additional challenges to deaf persons and persons with hearing impairments. They require provision of text-based communication channels (e.g. real-time text), captions for audio and multimedia content, and sign language interpretation where feasible. This is detailed in EN 301 549 [i.7], which details accessibility requirements for ICT products and services.	n/a

8.3.2 Document preparation by ETSI

This clause summarizes changes ETSI intends to make when reviewing and editing content for ETSI deliverables in order to make those publications accessible.

Table 5 lists changes that can and should be introduced in a mid-term perspective. The columns of Table 5 contain the following information:

- Recommendation number: unique identifier for referencing a particular recommendation from Table 5.
- Reference clause: reference to clause in the present document.
- Recommendation: one-sentence summary of the recommendation and proposed solution.

Table 5: Recommendations for ETSI related to document preparation

Req. Nr.	Reference clause	Recommendation
5.1	6.2.4.2	A guideline alerting the authors to provide reference addresses where the given bibliographical item is available in multiple formats (such as HTML, PDF, or a Microsoft Word document), rather than providing a link to a given document format, should be included to increase the reference accessibility.
5.2	6.2.3.2	It would be beneficial to develop the deliverables in an editorial environment that is not so tightly related to the way the final content is formatted/presented but rather focuses on defining an appropriate semantic structure of particular elements. For the various advantages of such an approach (e.g. on-demand generation of tables, facilitated export of a document into different publication formats, and easier maintenance over time), see clause 6.2.3.2.
5.3	6.2.4.2	Use of tools able to check automatically potential issues within the document content. Examples are the colour composition of images to verify the presence of possible contrast shortcomings, or the font adopted. Moreover, the verification of the presence of images containing textual descriptions that can be transferred within the textual content of the document without affecting the document understanding should be implemented.
5.4	6.2.4.2	Guidelines for development of accessible diagrams/pictures should be extended to include also a requirement to ensure that whenever needed, the images are embedded in a way that ensures that the images are resizable without any damage to their content.
5.5	6.2.3.2	Tools to support generation of quality alt text descriptions should be considered. Tools for creation of adequate verbal descriptions of graphs, figures (and potentially tables) using ML techniques under the control of the author / rapporteur could be considered.

8.3.3 Document production by ETSI

This clause summarizes changes ETSI intends to make when producing ETSI deliverables in order to make those publications accessible.

Table 6 lists changes that can and should be introduced in a mid-term perspective. The columns of Table 6 contain the following information:

- Recommendation number: unique identifier for referencing a particular recommendation from Table 6.
- Reference clause: reference to clause in the present document.
- Recommendation and proposed solution(s): one-sentence summary of the recommendation and proposed solution.

Table 6: Recommendations for ETSI related to document production

Req. Nr.	Reference clause	Recommendation and proposed solution(s)
6.1	6.2.3.2	Some authors developing highly structured and technology centred documents have needs for creating the standards in machine-readable and interpretable format. For these authors, it is essential that the documents are organized in tools like Forge (and the graphical elements in UML tools), and only later converted to Microsoft Word documents or PDF.

8.4 Proposals for implementation - 3rd phase

8.4.1 Introduction

This clause presents options for improving the accessibility (and usability) of ETSI deliverables in the long term. These options clearly require considerable effort for a potential implementation and are, therefore, only to be considered in the long term.

These proposals take into account, that while it is possible to create formally accessible documents, i.e. documents which pass an Adobe or Microsoft Word accessibility test, with limited effort, the resulting documents are by no means truly usable. Usability problems encountered in relation to ETSI deliverables are much more serious for people with accessibility needs.

As an example, fully sighted users have the possibility to read an ETSI deliverable on paper in case their reading device (computer or eBook reader) cannot present a document. For blind users that option does not exist. ETSI has published a considerable number of documents which are too large to be uploaded or presented on most personal reading devices - these documents remain entirely inaccessible to users without vision.

The proposals to overcome some of these usability issues are organized along the SMART model proposed by ISO/IEC SMART [i.9]). Figure 5 shows the main components of that model.

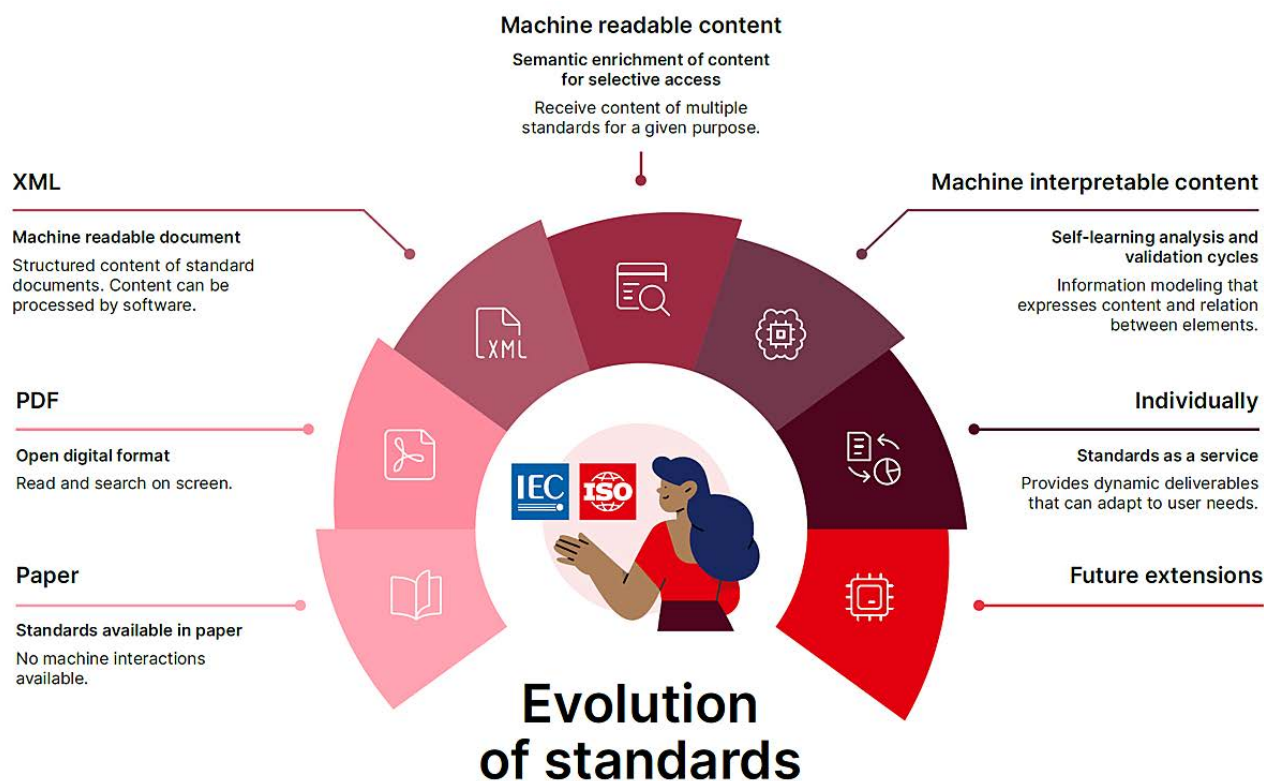


Figure 5: The ISO/IEC SMART model for document production and delivery

In this model ETSI is currently on the first two steps of the entire cycle with a few projects investigating the generation of machine-readable documents and content. While the SMART approach does not identify the presentation of accessible content or documents as an own goal, this target will probably only become achievable based on machine-interpretable content, alongside the production of standard documents rendered for individuals and their needs.

The proposals below cover the area of document creation and content generation, content presentation, improvement of access to content, and access to content by assistive technology tools.

8.4.2 Document creation by authors

During the assessment of reader preferences one of the recurring requests was that ETSI should offer documents in formats other than PDF which is the only format available for non-ETSI members. Several of the interview partners expressed their clear preference for reading ETSI deliverables in XML or HTML formats, in particular when using screen readers. Documents created using Microsoft Word can be saved as XML files or conversion tools may be used to create the equivalent XML format from the "standard" .docx" format.

The assessment of author's preferences (see clause 6) resulted in a very clear requirement from many of ETSI's authors and rapporteurs to be able to develop their documents using XML-editors or editors for mark-down representations.

Several shortcomings of the PDF format have been mentioned in the preceding clauses:

- PDF documents are slow to load to be accessible with screen readers.

- Even when proper tags are implemented, an efficient navigation within the document is not easily possible in the PDF format because it is constrained by the predefined document sequence and available tagging structure. Effective use of an ETSI deliverable often requires the simultaneous access to various elements that may be placed in different parts of the document (e.g. a requirement, the associated test for checking if the requirement is achieved, and the relevant provision in an external legal document (e.g. an EU Directive) that that is addressed by the requirement).
- PDF is a format for producing stable printed versions of a document. It is less suitable to support efficient digital access to the document content.

Additional formats for users preferring browser-based access should be provided, accompanied by background information which might be used to create more usable, accessible, and personalized versions of deliverables.

It is recommended to publish ETSI deliverables in formats that facilitate interactive and dynamic navigation within the document, allowing quick access to the different parts of the document. Formats such as HTML, XML or Microsoft Word have been mentioned as plausible. Producing text in XML and/or HTML will also facilitate the creation of tables and forms with elements that are easily and correctly interpreted by assistive technologies such as screen readers.

Implementation in XML/HTML formats would clearly alleviate many barriers existing now for screen reader users and would be beneficial for all users of the ETSI deliverables. All users have essentially the same need for effective access to different parts of the document containing an ETSI standard.

- **For the creation of ETSI deliverables, the use of different editors (besides Microsoft Word) should be allowed (and promoted). Moving to XML-based editors and formats or markdown would facilitate the production of accessible versions of the deliverables.**

Independently from the selection of editing tools, it should be possible to store the resulting documents in different formats, in particular in XML, HTML, or markdown formats. ETSI should provide (and propose) tools which allow changing between these different document formats after the document has been produced in the authors preferred authoring tool.

A number of editing and document conversion tools are listed in Annex A of the present document, and it is proposed that ETSI evaluate these tools and propose a small number of authoring and conversion tools which authors are free to use.

Using markdown-based documents contributes significantly to improving document accessibility for a variety of reasons rooted in the simplicity, structure, and flexibility of the format. At its core, markdown-like languages are a lightweight solution that enables writers to format text in a way that is both human-readable and machine-parsable. This dual compatibility plays a key role in making content more accessible to a wider audience, including people with disabilities who rely on assistive technologies to read digital content.

One of the primary advantages of such languages is their semantic clarity. Unlike rich text formats or visual document editors that can be cluttered with hidden styles and formatting inconsistencies, markdown languages enforce a clean separation between content and presentation. Headings, lists, links, and emphasis are all represented with plain text symbols that clearly communicate the structure and intent of the content. This clarity ensures that screen readers and other assistive tools can interpret the document more reliably, without being hindered by visual flourishes or formatting noise that may obscure meaning.

Moreover, markdown languages are inherently compatible with web technologies, which are already governed by accessibility standards such as the Web Content Accessibility Guidelines (WCAG 2.2 [i.3]). When content developed in markdown languages is rendered to HTML, this typically results in semantic elements like `<h1>`, `<p>`, and `<ul>`, which are easily navigable by assistive technologies. This means that even simple markdown-based documents can be transformed into accessible web pages with minimal additional effort, making it easier to share accessible content across platforms. Authors will not have to deal with those formats, as all the formatting options available in the ETSI Microsoft Word templates (e.g. paragraph formats such as B1, NO, EX) can be defined for the editor and will be usable by authors with comparable ease.

The plain text nature of markdown languages also benefits users with cognitive disabilities or low vision who may prefer simplified, distraction-free content. Since markdown languages lack the embedded media and complex layouts often found in traditional word processors, it fosters a reading experience that is less visually overwhelming.

Additionally, markdown-based files are small and fast to load, which can be particularly helpful for users with slow internet connections or older hardware, i.e. another important aspect of accessibility often overlooked.

Then, the adoption of markdown-based strategies encourages good authoring practices by design. Authors should think in terms of structure rather than appearance, which often leads to more logically organized documents. This logical flow benefits all readers and enhances accessibility by supporting technologies that navigate content based on its structure, such as keyboard-only browsing or voice-controlled interfaces.

Finally, within an ETSI long-term perspective, producing documents in markdown languages would foster the design and development of novel tools transforming markdown-based documents into equivalent versions targeting specific accessibility needs.

8.4.3 Tools for the Development of Specific Content

Many of the accessibility problems identified are centred around specific document content, in particular tables and diagram / figures.

- **ETSI should consider an evaluation of different (already existing) tools for the creation of these document elements and the later conversion into the chosen document format and offer these tools to their authors.**

These tools (e.g. Microsoft Excel for tables, or UML editors for diagrams) offer the possibility to create the later visual representation of tables and diagrams in the final document and to save (some) semantic background information about the content produced with these tools. The semantic background information can be used to present these elements in accessible formats and should be made available to readers using their own document presentation software.

There already are initial usages of such an approach within ETSI, e.g. the storing of table content in Forge in Excel format, which is available in the Microsoft Word version of the ETSI deliverable as Microsoft Word tables.

8.4.4 (Semi-) Automatic creation of document-internal references

One of the most serious usability issues identified for ETSI deliverables is the lack of reliable document-internal references and, even if these links are available, the lack of appropriate tools to navigate this interlinked document space. These references include links between document sections, links from the document structure (table of content) to the document and vice versa, links to references and links from the list of references to the related point, where references are used. This very often leads to situations in which readers of documents are "lost in the document space".

Moreover, the lack of a useful index covering ETSI deliverables causes difficulties when trying to find specific content in ETSI deliverables. From reading and using academic and/or scientific paper documents (books) many readers are used to having an index linking to important document sections.

Creating such an index file for a large ETSI deliverable and the integration of document-internal references requires efforts that most authors would not be willing to spend. It should, however, be possible, using tools employing generative AI techniques to create these index files automatically and only for later correctness checking by the document authors. If these index files are created automatically, they may contain more link information, not only to defined and used terms, but also to reference citations, and other document internal or external reference points.

The information created using such an approach would not be integrated into a pdf-version of an ETSI deliverable but should be made available as additional (machine interpretable) information for the use in html-browsers or document presentation software.

- **ETSI should explore the semi-automatic creation of document-internal references and index information and should make the information created available to the public. During this process feedback from authors and rapporteurs on the result of the process may be necessary.**

8.4.5 Using alternative formats to make long ETSI Deliverable accessible

One problem encountered by readers using assistive technologies is that virtually all assistive technologies tools cannot deal with documents exceeding a certain size. As an example, loading the Microsoft Word version of EN 301 549 [i.7] into Microsoft Word on an average PC takes several minutes, while loading the same document into a screen reader make take almost an hour. That is obviously not an acceptable system behaviour for users with visual deficiencies.

While PDF is clearly fast to load and read documents, the PDF-format does not allow to use many functions available in editing tools.

One obvious solution to this problem is to create a well-structured HTML version of ETSI deliverables. An example how the result of such a conversion could look like can be found in the Canadian version of EN 301 549 [i.8]. In the converted version, all document components are small enough to be immediately presented and available to assistive technology tools.

In [i.8] the conversion has been done with a lot of manual interaction and for ETSI only a mostly automatic conversion tool would be useful, but there are many conversion tools already on the market which might be useful and can possibly be enhanced to achieve the desired document format semi-automatically with very little or no human intervention.

- **ETSI should explore means to convert ETSI deliverables from Microsoft Word, XML, or markdown formats into well structured HTML formats.**

8.4.6 Provision of alternative document formats and additional background information in the ETSI standards repository

From the interviews describe in the earlier sections of the present document, it can be seen that there is a clear need/desire from both authors and users to make machine-interpretable document content and additional information available to ETSI deliverables readers/users.

This would imply that in the ETSI standards repository not only PDF versions (for non-members) and Microsoft Word versions (for ETSI members) are made available, but also links to respective XML-versions and markdown versions of these documents.

In addition to these different formats, machine-interpretable content describing the content of ETSI deliverables (alternative table formats, UML description of diagrams, access to code-sequences in the documents) should be made available in the repository, along with the index and reference information proposed in clause 8.4.4 above. This information could be used to improve the usability of ETSI deliverables for all, and in particular for people with accessibility needs, as it can be used to "educate" the assistive technology tools used by that target group.

- **ETSI should consider making more formats of ETSI deliverables available in their database, in combination with additional machine-interpretable content describing these deliverables.**
- **As a final potential target ETSI should consider the development of an Internet-browser tool for usable and accessible access to ETSI deliverables.**

Annex A: List of available markdown tools

Table A.1 summarizes a list of the major markdown editors available at the date of the writing of the present document.

Table A.1: List of available markdown tools

Name	Type	URL	Note
WordPress	Online	https://wordpress.com/	Free
Mark	Online	https://mark.barelyhuman.dev/	Free
JekyllPad	Online	http://www.jekyllpad.com/tools/online-markdown-wysiwyg-editor	Free
Holocron	Online	https://holocron.so/markdown-editor	Free
Minimalist Online Markdown Editor	Online	http://markdown.pioul.fr/	Free
StackEdit	Online	https://stackedit.io/	Free
Dillinger.io	Online	http://dillinger.io/	Free
MarkTwo	Online	https://marktwo.app/	Free
HackMD	Online	http://hackmd.io/	Free, Paid premium options
Typo	Online	https://typo.robino.dev/	Free
Word2md.com	Online	https://word2md.com/	Free
Readme.so	Online	https://readme.so/	Free
Reprose	Online	https://reprose.pp.ua/	Free
type	Online	https://type.baby/	Free
Markwhen	Online	https://meridiem.markwhen.com/	Free
TypeMD	Online	https://typemd.kevinbarrionuevo.ch/	Free
Slate	Online	https://slate.ink/	Free
321Markdown	Online	https://321markdown.com/	Free
Wysimark	Markdown Editor for Integration in Web Apps	https://wysimark.com/	Free, Open Source
Doc to Markdown Pro	Markdown Editor for Integration in Web Apps	https://www.docstomarkdown.pro/	Paid
Umo Editor	Markdown Editor for Integration in Web Apps	https://www.umodoc.com/en/	Free, Open Source
Caret	Desktop	https://caret.io/	Paid
CodeLobster	Desktop	CodeLobster IDE	Free
Deepdown	Desktop	https://billiam.itch.io/deepdwn	Paid
GeekDown	Desktop	https://github.com/fearlessgeekmedia/geekdown	Free, Open Source
KeenWrite	Desktop	https://gitlab.com/DaveJarvis/keenwrite	Free, Open Source
Obsidian.md	Desktop	https://obsidian.md/	Free, Paid syncing option
Tangent	Desktop	https://www.tangentnotes.com/	Free, Open Source
Typora	Desktop	https://typora.io/	Paid
MarkFlowy	Desktop	https://github.com/drl990114/MarkFlowy	Free, Open Source
Yank Note	Desktop	https://github.com/purocean/yn	Free, Open Source
MarkText	Desktop	https://github.com/marktext/marktext	Free, Open Source
QOwnNotes	Desktop	https://github.com/pbek/QOwnNotes	Free, Open Source
Visual Studio Code	Desktop	https://code.visualstudio.com/	Free, Open Source
Zettlr	Desktop	https://www.zettlr.com/	Free, Open Source
GhostWriter	Desktop	https://github.com/wereturtle/ghostwriter	Free, Open Source
Znote	Desktop	https://znote.io/	Free
Joplin	Desktop	https://joplinapp.org/	Free, Open Source
Markdown Tools	Desktop	https://github.com/igormironchik/markdown-tools	Free, Open Source

Annex B: Bibliography

- ETSI: "[Principles for drafting ETSI deliverables with the use of skeletons](#)".

History

Version	Date	Status
V1.0.0	August 2025	Membership Approval Procedure MV 20251020: 2025-08-20 to 2025-10-20
V1.1.1	October 2025	Publication