Web3D Consortium Liaison Report,
ISO/IEC Standards Committee SC24 Annual Meeting

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1. **Summary**. The mission of the Web3D Consortium . The Web3D Consortium liaison relationship with ISO/IEC JTC 1/SC 24 Standards Committee on Computer Graphics, Image Processing and Environmental Data Representation holds essential efforts to our standards-development activities. Much work has occurred (for nearly three decades) and more is planned. Two sets of standards are central to our current shared work: the **Extensible 3D (X3D) Graphics** and **Humanoid Animation (HAnim) standards**. This liaison report summarizes current progress and plans.

2. **SC24 Scope**. As background information, SC24 scope and working groups follow.

ISO/IEC JTC 1/SC 24, Computer graphics, image processing and environmental data representation
https://www.iso.org/committee/45252.html

The current area of work for JTC 1/SC 24 consists of standardization of interfaces for information technology-based applications relating to:
- computer graphics, *(Working Group 6)*
- image processing, *(Working Group 7)*
- environmental data representation, *(Working Group 8)*
- virtual reality, augmented reality, and mixed reality, *(Working Group 9)*
- visualization of, and interaction with, information, *(Working Group 10)*
- Included are the following related areas: Modeling and simulation, related reference models; virtual reality with accompanying augmented reality/augmented virtuality aspects, related reference models; application program interfaces; functional specifications; representation models; interchange formats, encodings and their specifications, including metafiles; device interfaces; testing methods; registration procedures; presentation and support for creation of multimedia, hypermedia, and mixed reality documents.
- Excluded: efficient coding of multimedia

Of special note are broadly valuable efforts in Working Group 10 on Smart Cities integration and Working Group 11 on VR/AR health and safety.

Figure 1. ISO/IEC JTC 1/SC 24 Standards Committee activities and working groups.

3. **X3D4 Architecture**. Following the earlier international CD ballot, SC24 document editors Dick Puk and Don Brutzman have addressed and resolved approximately 250 editorial issues. Close tracking and review was performed for each issue. Web3D Consortium versions of the proposed 19775-1 standard are online at

   a. Extensible 3D (X3D) Part 1: Architecture and base components, ISO/IEC 19775-1:2022
   b. https://www.web3d.org/specifications/X3Dv4Draft/ISO-IEC19775-1v4-CD1/Part01/Architecture.html (with change markup)
   c. https://www.web3d.org/specifications/X3Dv4Draft/ISO-IEC19775-1v4-DIS/Part01/Architecture.html (pristine for ballot)

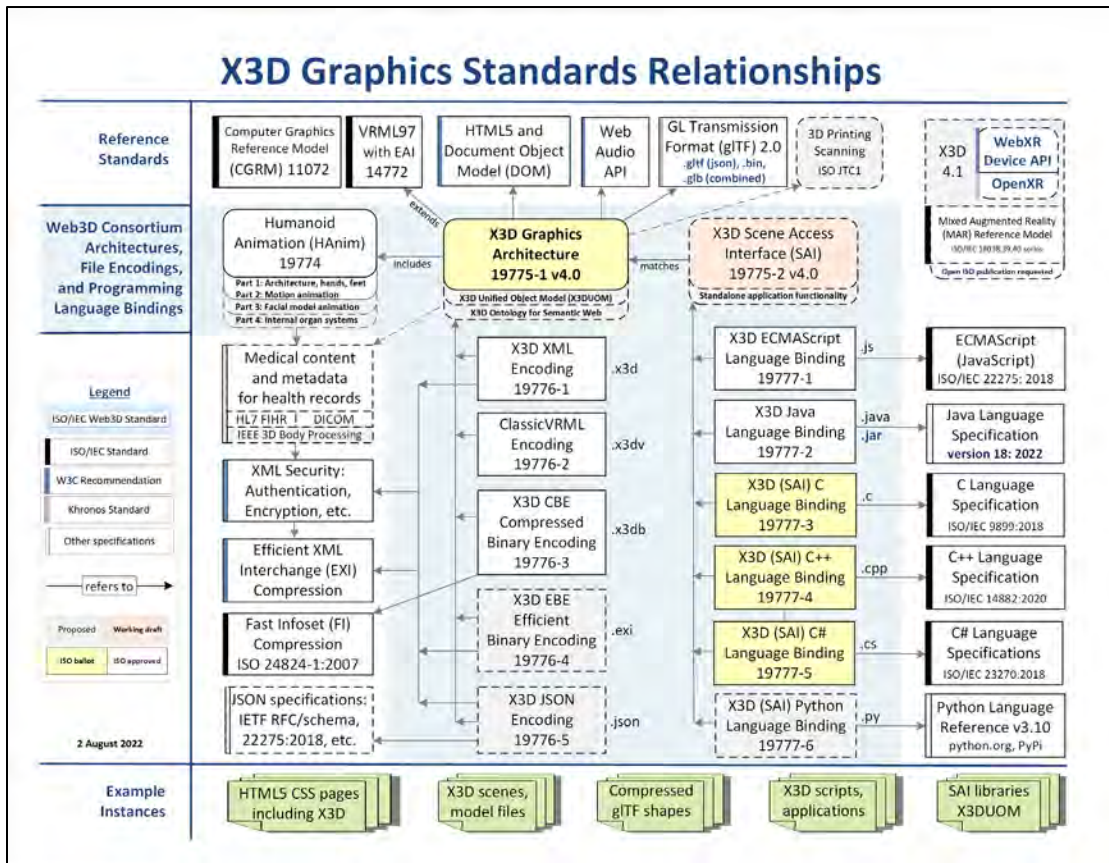4. **Standardization Planning**. The Figure 1 diagram shows X3D Graphics Standards Relationships.

Figure 2. X3D Graphics Standards Relationships, https://www.web3d.org/specifications/X3dGraphicsStandardsRelationships.png

The most beneficial work is finally complete: X3D4 Architecture design. Improvements include direct relationships with **HTML5 integration, glTF 2.0 rendering/import, and high-fidelity W3C Audio API**. Related X3D specifications for file formats and programming-language bindings are quite similar and follow identical design patterns. We expect more rapid progress on production of related specifications.

The primary 2022 activity of the X3D Working Group in is the continuing preparation, submission, and implementation of numerous X3D4 specifications to the International Standards Organization (ISO). We predict sustained steady progress on all X3D4 and Humanoid Animation (HAnim) capabilities. A consistently designed X3D4 architecture enables modeling and interactive visualization using **ClassicVRML, XML, HTML5, glTF, Web Audio, JavaScript, JSON, Java, Python, C, C++, C#, Efficient XML Interchange (EXI) compression, and X3D Ontology for Semantic Web**. Rigorous levels of validation and scene diagnostics enable creation of an excellent User Experience (UX) with exceptional quality assurance (QA) for all X3D models.

Additional areas of interest and inspection include VR/AR/XR/MAR, Smart Cities, and Metaverse concepts. Metaverse Standards Forum (metaverse-standards.org) is off to a compelling start and Web3D Consortium is a founding member.

All comments, feedback and improvements to the X3D Architecture document always remain welcome. We recommend close review and prompt approval by participating national bodies.

5. **Humanoid Animation (HAnim).** HAnim2 is an abstract specification that is fully adopted as part of X3D4. Here are preliminary points under discussion regarding posed work building on HAnim version 2 capabilities.
   a. Now that X3D4 is stabilized and fully implementing the ISO-approved HAnim 2.0 specification, improved implementations are possible and much excellent implementation work continues.
   b. Historically, any-character-animation aspects never got picked up much by communities/companies. As a result, without reduction in extensibility capabilities, we have emphasized human-body rigor and detail with full success on skeleton.
   c. Motion objects for BVH-level capabilities hold significant expressive power and are ready for further implementation, potentially exposing many behavior libraries as animation assets.
   d. Levels of articulation (LOA) 0..4 skeletons/skin resolve level-of-detail subsets for both rendering and animation.
   e. Korean researchers have similarly structured models for internal organs and facial animation that are structurally compatible and could be predictably pursued, implemented, and standardized.
   f. We are steadily approaching multiple levels of capability, fidelity, and interoperability such that **human medical records** are a candidate use case. HL7 liaison discussions are further interesting.
   g. Rigorous validation (in place for XML, plus autogenerated Java and Python) of existing skeletal structures is already in place. Further quality assurance (QA) efforts are ongoing.
   h. Continued focus on capability, validation, libraries is path to "easy" and greater growth.
   i. Web3D Consortium member 3DMD has immense domain experience that can keep our technical design pointed in good directions.
   j. Many opportunities await a working group and company/community participants to exploit.
   k. Applying Semantic Web capabilities and standardizing the X3D Ontology (which includes HAnim) can expose numerous new domains of value.

6. **X3D Unified Object Model (X3DUOM).** The X3D Unified Object Model (X3DUOM) is a full set of object-oriented interfaces for all nodes, fields and statements in the X3D Architecture Specification. It provides comprehensive coverage and is expressed in XML, both machine readable and human readable. This work has greatly facilitated autogeneration of programming-language bindings and file encodings, model validation, and various specification annexes. We are considering where we might place an informative specification within the set of X3D standards. Relevant references:

   • X3D Unified Object Model (X3DUOM)
   • https://www.web3d.org/specifications/X3DUOM.html

7. **Smart Cities.** Working Group WG10 efforts on Smart Cities continue to provide excellent design challenges and use-case rationales for X3D and HAnim models getting integrated at scale. The visualization overviews and across-standard interoperability goals all appear feasible using the capabilities and extensibility of X3D4. We salute the excellent strategic vision and sustained progress of this group and will continue to contribute.

   a. **X3D4 Metadata** can be included at two separate levels: per-model meta tags aligned with HTML5 practices (using vocabularies such as Dublin Core) and typed metadata sets (highly structured collections of *name="value"* pairs) embedded within a model provide perhaps-complete expressive power for information inclusion. X3D Scene Authoring Hints: meta Statements and Metadata Nodes provides links to key references for technical details, best practices, and examples.
   b. X3D Ontology maps all of these structures to W3C Semantic Web triples, allowing construction of sophisticated structures for query and reasoning, across diverse sources and disparate datasets.

c. **Humanoid Animation (HAnim)**. Full support for HAnim2 in X3D4 means that each of the compelling used cases in the presentation *Human Information Data Modeling for VR Smart Cities* appears to be compelling and feasible using X3D4 and HAnim2. Continuing development work is warranted. Producing sharable exemplars can accelerate support by authoring tools and validation suites. Most functionality exists already, with human-body internal organs, circulatory system, etc. being possible with future extensions (namely X3D prototypes leading to eventual standardization). Recommend renewed efforts at cooperative planning and coordinated effort.

d. *Big Data Visualization* looks similarly feasible and can likely benefit from separate construction of visualization libraries demonstrating repeatable examples. The provided list of existing libraries is excellent, but please note that additional X3D-native libraries exist already (such as x3d.py and d3-x3d). Similarly I recommend publicizing these possibilities and encouraging applied implementation efforts of compelling use cases, building awareness and sharing exemplars.

e. *Scientific Visualization* exemplars look great. If some of these models might be placed into open source as part of Web3D Consortium's X3D Examples Archive that will doubtless encourage further adoption. Conceivably the establishment of best practices might further lead to multimedia electronic-publication (EPUB) standards for 3D models as part of regular archival journal-paper 33publication.

f. **Informative exemplars for standards.** Each of the proposed new ISO standards for Human Information, Big Data Visualization and Scientific Visualization might benefit from including an informative annex that includes example models, in X3D and perhaps in other forms as well. Since the X3D and HTML standards provide most functionality needed, creation of duplicate X3D standards matching WG10 initiatives appears to be unnecessary. The archived mailing list x3d-public@web3d.org is an appropriate forum for all questions and for encouraging creation of effective exemplars.

g. **Naming suggestion**: we might better communicate the scope and cross-connecting mashup impact of these imperatives with a title such as "*Big Data Analytics, Composition and Visualizations*."

h. **Web interoperability**. X3D4 Architecture includes Annex L HTML Authoring Guidelines to show X3D scene integration within an HTML page, emphasizing user interaction and animation in addition to 2D/3D hypermedia integration. Such capabilities offer the prospect of immense exposure and sharability of information assets for Smart Cities by taking full advantage of World Wide Web capabilities. Such capabilities appear to be a natural byproduct even for systems using other technologies when implementing WG10 standards.

i. **Metaverse Standards Forum**. Web3D Consortium has published a point paper Keys to an Open, Interoperable Metaverse and is one of the founding members of the recent Metadata Standards Forum initiative. Viewed objectively, the goals of WG10 already appear to be as compelling (and perhaps more achievable) as any goals yet expressed there. Further consideration of potential SC24 participation is warranted.

8. **Web3D Conference.** Now preparing its 27th presentation, the annual Web3D Conference has hosted influential workshops in past years regarding Smart Cities collaboration possibilities. Given the diversity of goals and commonality of technical approaches described today, a coordination workshop again appears like a valuable opportunity. This year's conference provides further opportunities (such as papers and tutorials) and is scheduled 2-4 November at Telecom Sud-Paris, Evry France. https://web3d.siggraph.org
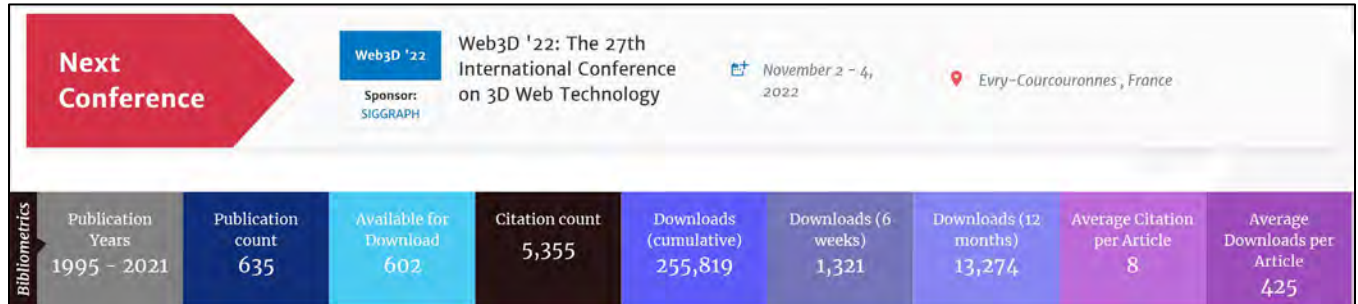

Figure 3. Association for Computing Machinery (ACM) Digital Library (DL) archives and distributes Web3D Conference products.
https://web3d.siggraph.org

9. **Updates to X3D SAI Language Bindings for C, C++, C#.** Concurrent document updates are planned in 2023. Such document evolution maintains consistency of the X3D Graphics Standards Relationships diagram.

   a. Note that 19775-2 X3D SAI (revised for X3D version 4) draft is being prepared and a corresponding New Work Item Proposal (NWIP) is planned for late 2022. Once that occurs, then further work will be possible to upgrade X3D Language Bindings C, C++, C# from X3D version 3.3 to X3D version 4.0.
   b. Such upgrades can take place after submission of matching NWIP documents for all interrelated documents. Projected commencement is in 2023.
   c. Note that two versions of the C, C++, C# 19777 documents will then be running concurrently in the ISO timeline.? This plan works from a technical perspective, but might be confusing from a ballot perspective. Based on group discussion, we agreed to pursue such work concurrently.

10. **Cooperative Implementation Work using X3D with Other SC24 Specifications.** Multiple SC24 working groups do not have explicit implementation plans. In contrast, SC24 Working Group 6 produces specifications that are examined, implemented, and tested by Web3D Consortium prior to ISO specification.

    Implementation and public review have important benefits. Web3D Consortium has offered to host work on example content that demonstrates example implementations for a variety of other SC24 standards. Multiple documents by Smart Cities, VR/AR/MAR/XR and Health/Safety have potential for such work. Historically this has been difficult because most Web3D Consortium efforts are executed with public participation and scrutiny, while restrictions may exist on sharing work-in-progress ISO documents. Since SC24 specifications (other than X3D) are typically not placed into open distribution, such document-sharing restrictions have inhibited cooperative work.

    Two approaches for enabling collaborative work appear to be possible.
    a. Formally seek ISO approval of publicly available standards of mutual interest, including drafts, so that openly discussed implementation work is possible. (Ballot versions remain restricted to ISO.)
    b. Base initial Web3D collaborative work on SC24 Working Draft documents, with open access, leaving any subsequent updates performed by respective Web3D Consortium members.

Implementation is important to ensure that specifications perform as expected. Web3D Consortium recommends that SC24 shares draft specification information in an open manner to achieve effective collaborative work on example implementations. Demonstrating the actual use of SC24 standards increases confidence in standards correctness and provides excellent value for all concerned. Web3D Consortium members and community remain keen to support and help, with public visibility for in-depth scrutiny and best results.

11. **Thanks**. The Web3D Consortium is happy to continue our productive partnership with ISO/IEC SC24. We thank our colleagues for many diligent efforts and look forward to continued collaborations. We further thank U.S. national standards body (NSB) INCITS committee H3 for corresponding collaborative efforts.

Very respectfully submitted,

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