ISO/IEC JTC 1/SC 24/N 3983

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Web3D Consortium Report to ISO-IEC/JTC 1/ Standards Committee SC 24

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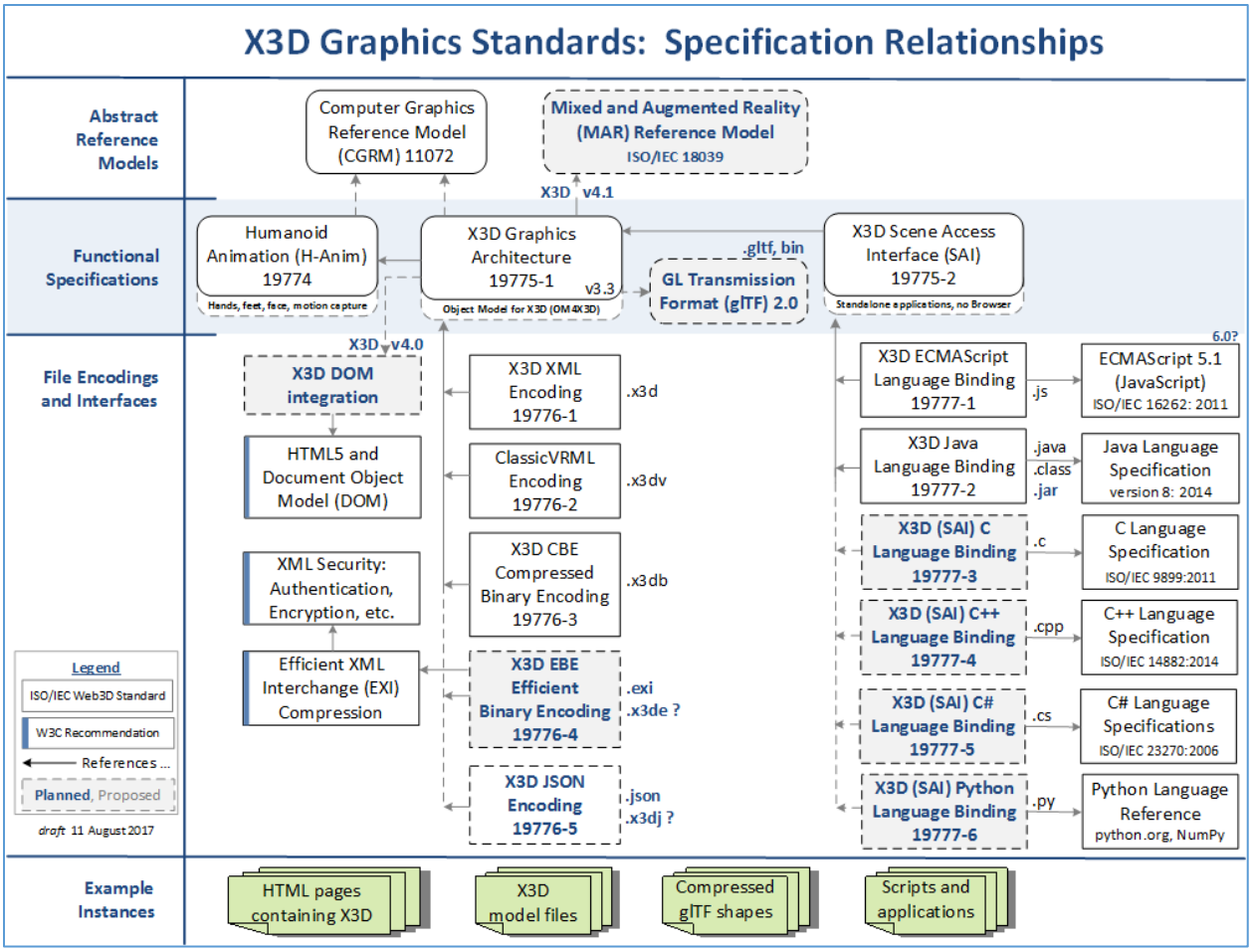
Web3D Consortium members are again pleased to contribute to the important standardization activities of SC 24 in computer graphics and mixed augmented reality (MAR). This report summarizes the many efforts of participants in the X3D Working Group. More information is available at http://www.web3D.org

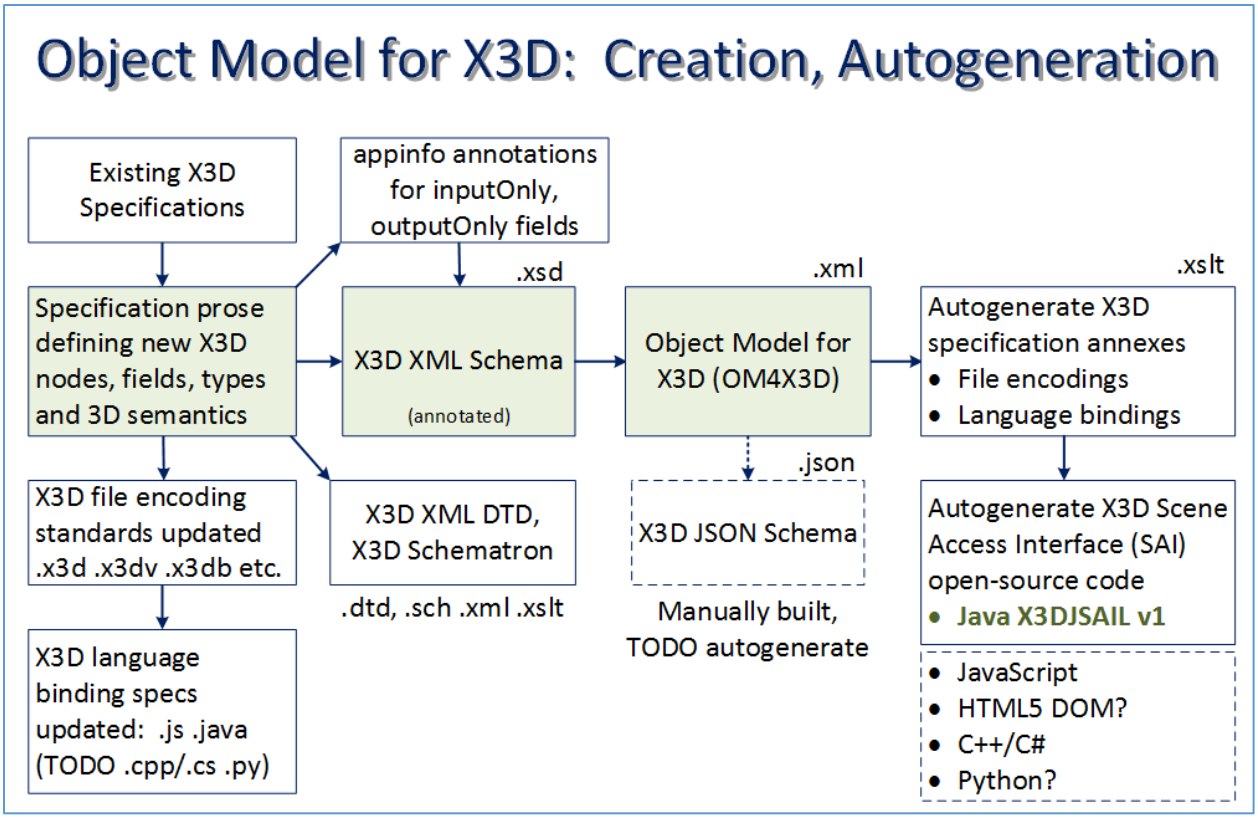
1. **X3D 4.0 is primarily focused on HTML5/DOM integration**.
    a. X3D models can be embedded or successively inlined within an HTML page.
    b. Event-model correspondences between internal ROUTEs and external DOM events to permit internal animation by interpolators/sensors/etc. and external HTML callbacks.
    c. New nodes and components expected, many candidates are listed for consideration.
    d. Key references for X3D version 4 strategy and development:
        i. http://www.web3d.org/x3d4
        ii. http://www.web3d.org/wiki/index.php/X3D_version_4.0_Development
    e. TODO: ensure image-based rendering plan is included.
    f. Slow steady progress, two open-source example implementations (Cobweb, X3DOM).
    g. A forecast of upcoming activity was provided in the *Future of X3D* presentation at Web3D 2017 Conference: http://www.web3d.org/sites/default/files/page/X3D%20Version%204/FutureOfX3D.pdf
    h. http://www.web3d.org/sites/default/files/page/X3D%20Version%204/FutureOfX3dWeb3d2017June7.pdfX 3D Specification Relationships diagram illustrates how X3D 4.0 is expected to fit with other X3D specifications. While current thinking is that a single document might be best, and numerous W3C Recommendations pertain, it is important to note that X3D v4 will include both file-encoding and language-binding guidance. This diagram is maintained at http://www.web3d.org/specifications - approved versions are found at http://www.web3d.org/specifications/X3dSpecificationRelationships.png



2. **X3D 4.1 Mixed and Augmented Reality (MAR)**.
    a. Priority: first finish X3D v4.0 ! This deconflicts and also effectively supports MAR work.
    b. Goal is to adopt, implement MAR Reference Model from SC 24 WG 9 insofar as possible. X3D Working Group intends to review this architectural guide at regular intervals.
    c. Ongoing consideration of health, safety and security aspects is necessary since such critical prerequisites often seem overlooked.
    d. WebVR https://webvr.info and Kwan Hee Yoo's work are expected to provide design mature comparisons of detailed requirements – hopefully starting next spring.
    e. Rough box score: 60-80% coverage of needed support may already be available in X3D.
    f. Samsung's GearVR device has immense adoption, open-source GearVRF Java library is steadily implementing the X3D scene graph. https://github.com/Samsung/GearVRf https://resources.samsungdevelopers.com/Gear_VR_and_Gear_360/GearVR_Framework_Project
    g. TODO. Consider how proposed Web-izing reference-model work by Byounghyun Yoo might be implemented in concert with X3D specification capabilities..
    h. *Missing:* identification of user characteristics that are beyond authors' scope, distinguishing personal identifying information (PII) and HIPAA/medical data, recognizing need for data-privacy policies (likely following Web best practices).
    i. *Missing:* spatialized audio model for VR, which is surprising but reflects a general gap.

j. Donning a headset is an act of great trust. Interocular and interaural distances, skin temperature, galvanic response etc. are PII or even HIPAA/medical data. No longer is a programmer or scene author able to define everything needed for experiencing a scene.
k. TODO: consider Haptic component relationship: simply new features in v4.0 or related to .v4.1 MAR

3. **Object Model for X3D (OM4X3D)**
   a. The Object Model for X3D (OM4X3D) is a full set of object-oriented interfaces for all nodes, fields and statements in the X3D Abstract Specification.
   b. OM4X3D is produced by decorating the X3D XML Schema with carefully structured annotations that describe the entire object-oriented nature of the X3D scene graph. http://www.web3d.org/specifications/OM4X3D/ObjectModelForX3dCreation.png
   c. Instantiation: Object Model for X3D definitions are explicitly listed in X3DObjectModel-3.3.xml with corresponding XML schema x3dObjectModel.xsd
   d. Ongoing public/private dialog using the x3d-public@web3D.org mailing list and presentation at Web3D 2017 Conference has been productive. http://www.web3d.org/specifications/OM4X3D/ObjectModelForX3dMasterClassWeb3dConference2017June7.pdf
   e. Demonstration of strict object model in X3D JSON Encoding, which is 98% complete and undergoing extensive review and testing, initial-draft specification has been prepared.
   f. Initial implementations are available in JavaScript, Java, and C++. Also planning to prepare programming-language implementations for C, C#.
   g. Two new versions for Python are started, with dialog occurring to discern best practices.
   h. SAI no longer just Script node in Browser object, includes full application-oriented API. This will lead to some changes and generalizations in 19775-2 Abstract SAI specification.
   i. Multiple emerging SAI specifications and implementations are shown on updated draft X3D Specifications Relationships diagram (attached)
   j. Implementation: X3D JSON Loader (X3DJSONLD) https://github.com/coderextreme/X3DJSONLD
   k. Implementation: X3D Java Scene Access Interface Library (X3DJSAIL) http://www.web3d.org/specifications/java/X3dJavaSceneAuthoringInterface.html
   l. Under consideration: integration into X3D Abstract Specification 19775-1 to more thoroughly expand on current abstract interface hierarchy.
   m. Emerging capability: coherent X3D center, multiple different programming languages that offer common design patterns to programmers to create identical scene graphs.


Object Model for X3D: Creation, Autogeneration
Existing X3D Specifications
appinfo annotations for inputOnly, outputOnly fields
.xsd
.xml
.xslt
Specification prose defining new X3D nodes, fields, types and 3D semantics
X3D XML Schema
(annotated)
Object Model for X3D (OM4X3D)
Autogenerate X3D specification annexes
• File encodings
• Language bindings
.json
X3D file encoding standards updated .x3d .x3dv .x3db etc.
X3D XML DTD, X3D Schematron
X3D JSON Schema
Autogenerate X3D Scene Access Interface (SAI) open-source code
• Java X3DJSAIL v1
.dtd, .sch .xml .xslt
Manually built, TODO autogenerate
X3D language binding specs updated: .js .java (TODO .cpp/.cs .py)
• JavaScript
• HTML5 DOM?
• C++/C#
• Python?

4. **glTF 2.0 specification by Khronos for gl transmission format**
    a. Recently announced at Web3D Conference in Brisbane Australia July 2017.
    b. Many feature and much support demonstrated at SIGGRAPH 2017. https://www.khronos.org/assets/uploads/developers/library/2017-siggraph/glTF-BOF-SIGGRAPH-Aug17.pdf
    c. Consists of geometric shape and appearance. No input or output events.
    d. Physically Based Rendering adds advanced material properties, and greatly improves rendering palette without requiring custom shader support.
    e. Point-cloud compression expected as proposed glTF extension from Microsoft: Draco https://github.com/google/draco
    f. Gap: no progressive mesh LOD streaming. Fraunhofer indicates that this has again become an area of much activity, so goal of formalization will likely be deferred. Nevertheless design patterns that utilize existing X3D capabilities with Inline, LOD, ProximitySensor, VisibilitySensor and Script nodes can offer similar capabilities, especially if accompanied by corresponding server-side optimization techniques triggered by url retrievals.
    g. Opportunity: X3D needs to update lighting model in concert with advanced physically based materials released with glTF 2.0.
    h. Opportunity: X3D needs to examine whether more advanced image texturing and other formats might become similarly feasible to take advantage of these improved rendering capabilities, for example Bidirectional Reflectance Distribution (BRDF) etc. This can help all X3D models but might especially support Cultural and Natural Heritage Working Group goals for high-fidelity capture.
    i. Needed: restore Khronos liaison with SC 24 to ensure these strategies are supported.

5. **X3D Compression**
    a. Formerly Fraunhofer Shape Resource Container (SRC). All changes accepted into glTF2.0, except progressive-mesh streaming.
        i. Add links…
    b. Use of glTF 2.0 will likely become primary X3D strategy for geometric compression. Full review of original requirements needed.
    c. Gap: point compression needed for scanning of point clouds, possible overlap with 3D printing of meshes. Likely Draco or other techniques will be considered.
    d. Gap: compression of animation-oriented data structures, such as interpolators.
    e. Use W3C Efficient XML Interchange (EXI) https://www.w3.org/TR/exi for typed data compression is available for XML-encoded files with multiple implementations available.
    f. EXI work in progress: adding support for Nagasena OpenEXI and Exificient implementations to X3DJSAIL and X3D-Edit.
    g. Interestingly EXI is adapted for JSON-encoded files https://www.w3.org/TR/exi-for-json with interest by W3C Web of Things (WoT) Interest Group. https://www.w3.org/WoT/IG
    h. Design discussions: applying XML Security algorithms in concert with EXI compression.
    i. TODO: keep 19776-3, can now begin to address documenting inclusion of EXI, likely similar, to become 19776-4

6. **Security Considerations**
    a. Needed: top-to-bottom review of all X3D specification sections to include security considerations, similar to IETF RFC requirements. To be part of X3D v4.0.
    b. W3C Recommendation for XML Digital Signature available for authentication and nonrepudiability. https://en.wikipedia.org/wiki/Digital_signature https://www.w3.org/TR/xmldsig-core
    c. W3C Recommendation for XML Encryption available for privacy and confidentiality. https://en.wikipedia.org/wiki/XML_Encryption https://www.w3.org/TR/xmlenc-core
    d. Depends on existing X3D C14N
    e. Emerging: cybersecurity issues for 3D printed models are unique, often surprising.
    f. List of issues and assets maintained at X3D Resources: Security http://www.web3d.org/x3d/content/examples/X3dResources.html#Security

7. **Spatialized Sound Model Improvements**
    a. Major gap: current X3D model is overly simplistic, reflecting poor state of the art. A variety of capabilities are emerging that may allow further advancement.
    b. Multiple aspects improve in tandem: 3D spatialization algorithms for Sound node attenuation ellipsoids, computational propagation including reflection and reverberation, acoustic materials using simplistic geometry, sound sources and filters, plus relevant W3C relevant standards efforts.
    c. Draft outline of design considerations is attached, review and comment is welcome.

8. **Design Printing Scanning Working Group**
    a. Rename, recharter of CAD working group approved by Web3D Board of Directors. "*The Design Printing and Scanning Working Group develops and demonstrates best practices for X3D support of Computer-Aided Design, 3D Printing, and 3D Scanning applications.*" http://www.web3d.org/working-groups/cad/charter (revised) http://www.web3d.org/working-groups/design-printing-and-scanning
    b. General metadata model: given the strongly typed X3D metadata model already available, we are now looking at general techniques for mapping various metadata vocabularies. This will assist in the use of X3D as presentation layer for all manner of content that includes sufficient embedded metadata to permit informed user activities and mashups with other Web-based data sources.
    c. Actively participation JTC-1 3D Printing and 3D Scanning group, chair Byoung Nam Lee. Report by predecessor JTC-1 Study Group included extensive considerations for X3D that related to perhaps 20 other ISO standardization activities.
    d. Discussing work with TC184 to jointly produce CAD-X3D technical report for ISO.
    e. Continuing to consider model support for IAEC power plants, annual discussion series.
    f. Strategic interest in aligning with ISO initiatives for Big Data and Smart Cities.

9. **Humanoid Animation (H-Anim)**
    a. Standardizing the ad hoc industry practices for BVH motion capture (MOCAP) files.
    b. Striving towards usability for digital medical records.
    c. Shared interest with other working groups to finish Annotation Component.

10. Projective Texture Mapping (PTM) Component

a. Expected to be the first new component ready for X3D v4.0 abstract specification.
b. Updated slideset will be published on forthcoming web3D.org PTM page.
c. Implementations: FreeWrl, X3DOM, seek Cobweb and Castle Game Engine support
d. Example scenes and screenshots provided for development and testing.
e. KHY has initial draft of specification prose, TODO Don edit and put in github
f. TODO: invite implementation by Cobweb and other players
g. TODO: Don add X3D-Edit support
h. TODO: KHY continue to refine paper for Web3D 2018

11. X3D Working Group Process Improvements

a. HTML source for approved and draft specifications in version control on github.
b. Detailed issues maintained in Mantis issue tracker receiving regular exposure, review.
c. Custom CSS styles wrapped around specification changes to facilitate later review.
d. More tools, examples and assets are in open-source version control than ever before.
e. X3D Example Archives (~3900 scenes) serve as a large suite of conformance tests for each of the various file encodings and language bindings. http://www.web3d.org/x3d/content/examples/X3dResources.html#Examples
f. Three dozen converters and translators now available for X3D. http://www.web3d.org/x3d/content/examples/X3dResources.html#Conversions
g. Autogeneration tools are showing the capability to immediately upgrade OM4X3D and corresponding SAI implementations, improving evolutionary testing and progress.
h. X3D Validator integrates 9 test methods, with addition of more techniques expected.
i. Under development: X3D Regular Expressions for further checking of special data types.

12. Medical Organ Modeling

a. Several preliminary models were presented for possible inclusion in
b. Polygonal models have a number of fundamental representational problems
    i. Not comparable, either between subjects or for a single subject over time.
    ii. Compressible in isolation using glTF, but not in combination with animation.
    iii. Human organs have an important constraint: adjacent organs deform together.
c. Parametric surface models hold greater appeal
    i. Choice of control points allow repeatability and comparability of instances.
    ii. Well-defined targets support fitting and smoothing of scanned isosurface point collections into parametric surfaces.
    iii. Well-defined target control points provide targets for medical-model output presentations.
d. Authoritative medical standards and anatomical models are a necessary prerequisite
    i. Precise nomenclature from medical community (still not found for skeletons!)
    ii. Models of how an organ works, with parameters equations and example values
    iii. System-of-system of composed models
    iv. What are relevant organizations: ISO, DICOM, perhaps others. Likely helpful: Medicine Meets VR and related conferences.

13. **Web3D Conference**
    a. 22nd year of publication, success. Well regarded by parent ACM SIGGRAPH organization.
    b. Successful Web3D 2017 Conference in Brisbane Australia. Next conference June 2018 in Poznan Poland. New rotation: Asia-Europe-North America (collocated SIGGRAPH).
    c. *Recommendation:* consider Mixed Augmented Reality (MAR) workshop, tutorial and papers session at Web3D 2018 Conference. Past experience has repeatedly shown that such activities provide a great boost to international working group efforts.
    d. *Suggestion:* align annual rotation of SC 24 meetings to match new Web3D Conference rotation: Pacific/Oceania, Europe, North America (in that order).
    e. *Increasing maturity:* as part of a larger ACM effort, SIGGRAPH has requested permission to commence an online journal *Proceedings of the ACM on Computer Graphics and Interactive Techniques*. The Web3D Conference is one of three initial specialized SIGGRAPH conferences expected to participate in the inaugural issue. Elevation to journal status is expected to require an increased degree of review and a corresponding increase in stature, appeal and impact for graphics research.

14. **Collaboration and Outreach**
    a. Multiple VR Hackathons have been held and are quite helpful to encourage experimentation, adoption and integration. http://www.vrhackathon.org
    b. *Needed:* corroboration by IS/IEC SC 29 whether an X3D MPEG4 Profile is appropriate for the forthcoming future X3D version 4 specification.
    c. *Needed:* further dissemination of Mixed Augmented Reality (MAR) Reference Model for comment. Web3D willing to do this as part of our public review process, in a manner that is consistent with ISO access requirements. Of note is that two years of distributing draft documents within the Consortium and selected invited experts has been productive. Nevertheless direct experience has showed many times that knowledge of MAR Reference Model is a rarity among the hundreds of individuals companies and organizations working in this arena. Continuing unavailability regarding review of draft versions is clearly having a negative effect on the evolution of this important document.
    d. *Dialog of interest*. Web3D Consortium is discussing common capabilities and shared goals with 3DPDF Consortium, which is now recognized by ANSI as US TAG administrator for PDF ISO Standards as part of ISO/TC 171/SC 2. We recommend that SC 24 pursue similar dialog with TC 171 counterparts with respect to 3DPDF. http://3dpdfconsortium.org/2017/07/26/3d-pdf-consortium-approved-ansi-us-tag-administrator-pdf-iso-standards

Very respectfully submitted, Don Brutzman

8 August 2017

Strategies to Improve X3D v4 Sound Component

1. **3D spatialization algorithms for Sound node attenuation ellipsoids**
    a. McDermott 2014: Bouncing Reflections, Reflected Path
    b. RESound: Interactive Sound Rendering for Dynamic Virtual Environments, http://gamma.cs.unc.edu/Sound/RESound
    c. Others, perhaps including parameterized/extensible algorithms
    d. Consider ordered list of supported algorithms, corresponding to computational complexity and X3D player support
    e. Define corresponding list of enumerations for each spatialization algorithm
    f. Scoping within scene graph: boolean *global* variable for localization, computational efficiency?
    g. Boolean attributes to enable/disable, also to facilitate disabling attenuation effects
    h. Consider composable regions of higher/lower fidelity or salience
    i. Various graphics techniques such as ray tracing or radiosity

2. **Audio material properties**
    a. Add to *Material* node, or add new *AcousticMaterial* within Shape node
    b. Properties: absorption, dispersion, medium attenuation, others
    c. Frequency distribution of attenuation
    d. Characteristics of transmission media, perhaps refraction

3. **Scene graph integration: simplified geometry for satisfactory sound reflection**
    a. Direct integration within *Shape* node
    b. Consider further restrictions via *Collision-proxy* or *Collision-acoustic*
    c. Consider bounding box restrictions in addition to (overriding) outer attenuation ellipsoid
    d. Fast Fourier Transform (FFT) precomputations: allow? How to include precompiled values?
    e. Similarities, differences, relationships with radiosity, haptics, and shadows

4. **World Wide Web Consortium (W3C) efforts**
    a. W3C Audio Group https://www.w3.org/2011/audio
    b. W3C Audio Publications, Milestones https://www.w3.org/2011/audio/wiki/PubStatus
    c. File formats: match accepted standards, royalty-bearing formats can only be optional
    d. Streamable input: simply file-format capability? perhaps other aspects with common metadata
    e. Filter chains on sound sources, Web audio models http://www.webaudiomodules.org
    f. W3C Audio and Video https://www.w3.org/standards/webdesign/audiovideo.html
    g. W3C Accessibility https://www.w3.org/standards/webdesign/accessibility.html
    h. Compatibility with hardware acceleration developments
    i. Follow WebVR developments https://w3c.github.io/webvr to ensure matching (or at least compatible) aspects related to wearable devices and user settings/preferences.
    j. Possible discussions, collaboration with Khronos

k. X3D v4.0 scene-related acoustics model
l. X3D v4.1 (MAR) user customization for AR/VR
    i. Head shadow, head motion, pinna and shoulder response, interaural distance
    ii. Head related transfer functions (HRTF) https://en.wikipedia.org/wiki/Head-related_transfer_function
m. Other ISO and industry standardization efforts?
n. X3D player implementations in C/C++, Java, Javascript
o. Example scenes demonstrating auralization effects with corresponding visualization assists
p. McDermott Three Dimensional Sound (TDS) Simulator improvements to support/evaluate X3D
q. Careful observance of Web3D Intellectual Property Rights (IPR) Policy to achieve royalty free (RF) solution