X3D Version 4 Working Draft
Moving in Fast: 3D Everywhere!

Web3D 2019 Conference
Los Angeles California USA
26-28 July 2019

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X3D Working Group

Web3D 2017, Brisbane Australia: Future of X3D

"**Future of X3D**" presentation and detailed notes from Web3D 2017 Conference, Brisbane Australia, 7 June 2017 (photograph).

Web3D 2018, Poznan Poland: Future of X3Dv4

"**Future of X3D**" progress [presentation](#) from [Web3D 2018 Conference](#), Poznan Poland, 20-22 June 2018. Continued scrutiny and development.

Web3D 2019, Los Angeles: X3Dv4 Working Draft

First [X3Dv4 Working Draft Specification](#) release, numerous execution
discussions in group meetings and technical sessions. Onward we go!

Strategy: X3D Version 4 www.web3d.org/x3d4

X3D® Version 4 is a major upgrade to the Extensible 3D (X3D) Graphics International Standard that aligns with the HTML5 Recommendation. This is major work in progress, expected to include several future versions. This effort is driven by the X3D Graphics Working Group with regular community outreach.

X3D is always evolving, and the Web3D Consortium Standards Strategy carefully guides all these improvements. X3D Version 4 enables authors to publish any interactive 3D content anywhere on the Web, without restrictions or plugins.

Next-generation evolution + revolution is combined with archival compatibility of existing legacy content.

- X3D Implementations Status and X3D Version 4.0 Development show specific details and planned evolutionary changes to the baseline X3D architecture.
- X3D Version 4.1 will add Mixed Augmented Reality (MAR) capabilities and consider improved geometric compression.

W3C Workshop on Web and Virtual Reality
Samsung San Jose, October 19-20, 2016; San Jose, CA, USA

White paper: **X3D Capabilities for Declarative Virtual Reality**

Keeping track of what is happening

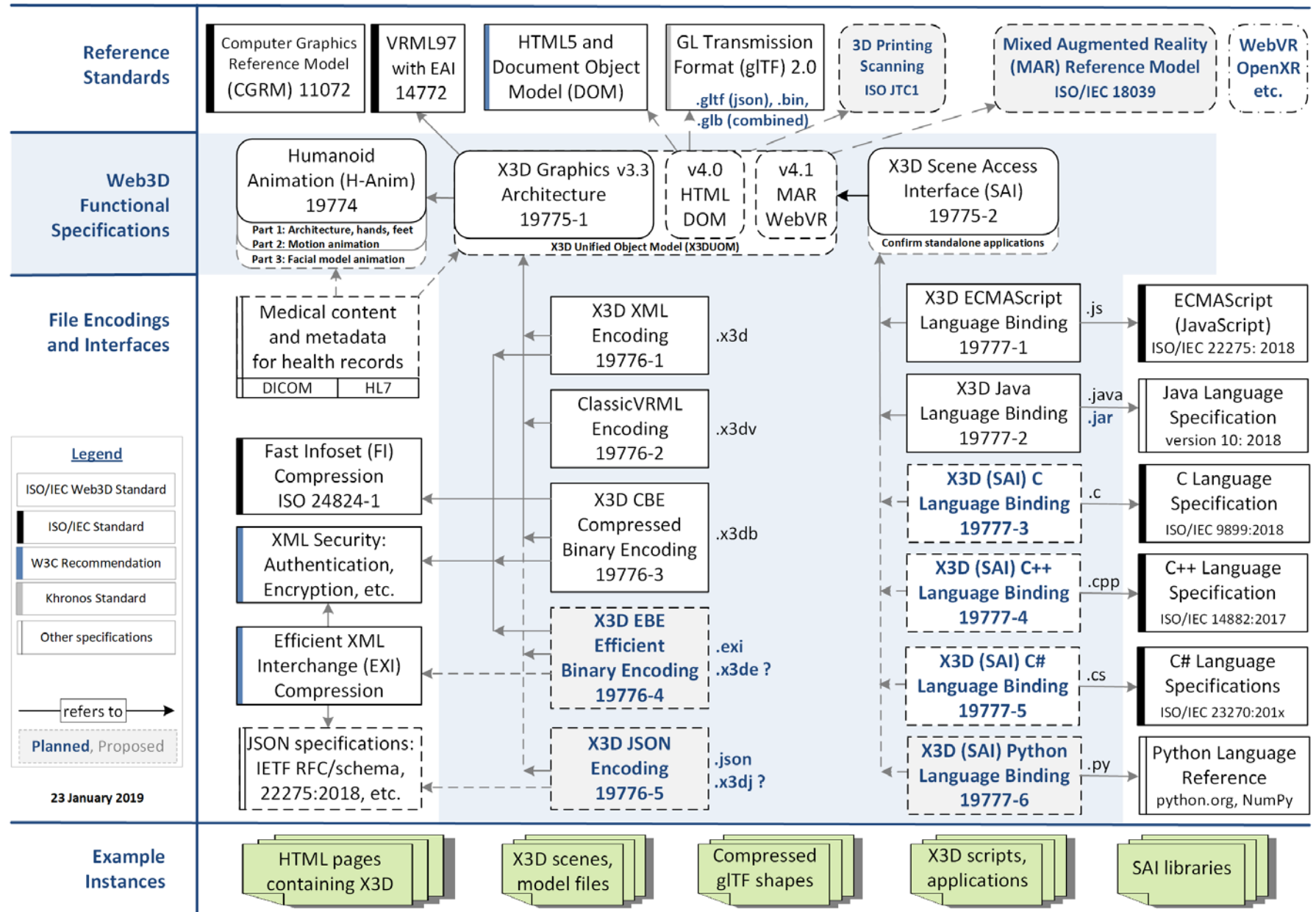Strategy: X3D Version 4
- http://www.web3d.org/x3d4

Technology: X3D Version 4 list of potential specification improvements
- http://www.web3d.org/wiki/index.php/X3D_version_4.0_Development

Web3D Standards
- http://www.web3d.org/standards
- http://www.web3d.org/specifications/X3dSpecificationRelationships.png

X3D Graphics Standards: Specification Relationships

Common basis for every kind of X3D model, confirmed by round-trip tests

Reference Standards
- Computer Graphics Reference Model (CGRM) 11072
- VRML97 with EAI 14772
- HTML5 and Document Object Model (DOM)
- GL Transmission Format (glTF) 2.0 — .gltf (json), .bin, .glb (combined)
- 3D Printing Scanning ISO JTC1
- Mixed Augmented Reality (MAR) Reference Model ISO/IEC 18039
- WebVR OpenXR etc.

Web3D Functional Specifications
- Humanoid Animation (H-Anim) 19774 — Part 1: Architecture, hands, feet; Part 2: Motion animation; Part 3: Facial model animation
- X3D Graphics v3.3 Architecture 19775-1 — X3D Unified Object Model (X3DUOM)
- v4.0 HTML DOM
- v4.1 MAR WebVR
- X3D Scene Access Interface (SAI) 19775-2 — Confirm standalone applications

File Encodings and Interfaces
- Medical content and metadata for health records — DICOM | HL7
- Fast Infoset (FI) Compression ISO 24824-1
- XML Security: Authentication, Encryption, etc.
- Efficient XML Interchange (EXI) Compression
- JSON specifications: IETF RFC/schema, 22275:2018, etc.
- X3D XML Encoding 19776-1 — .x3d
- ClassicVRML Encoding 19776-2 — .x3dv
- X3D CBE Compressed Binary Encoding 19776-3 — .x3db
- X3D EBE Efficient Binary Encoding 19776-4 — .exi .x3de ?
- X3D JSON Encoding 19776-5 — .json .x3dj ?
- X3D ECMAScript Language Binding 19777-1 — .js — ECMAScript (JavaScript) ISO/IEC 22275: 2018
- X3D Java Language Binding 19777-2 — .java .jar — Java Language Specification version 10: 2018
- X3D (SAI) C Language Binding 19777-3 — .c — C Language Specification ISO/IEC 9899:2018
- X3D (SAI) C++ Language Binding 19777-4 — .cpp — C++ Language Specification ISO/IEC 14882:2017
- X3D (SAI) C# Language Binding 19777-5 — .cs — C# Language Specifications ISO/IEC 23270:201x
- X3D (SAI) Python Language Binding 19777-6 — .py — Python Language Reference python.org, NumPy

Legend
- ISO/IEC Web3D Standard
- ISO/IEC Standard
- W3C Recommendation
- Khronos Standard
- Other specifications
- refers to →
- Planned, Proposed

23 January 2019

Example Instances
- HTML pages containing X3D
- X3D scenes, model files
- Compressed glTF shapes
- X3D scripts, applications
- SAI libraries

X3D 4 Summary   #1

- First X3Dv4 Public Working Draft specification released for Web3D 2019! Scrutiny, feedback and engagement are welcome.

- Big detailed Big Picture: see X3Dv4 Strategy and X3Dv4 Implementations Status.

- Following the path projected by Web3D 2017's Future of X3D session, building on steady progress at Web3D 2018, daily email posts and weekly meetings, multiple Web3D Consortium working groups and community participants continue to build on the architectural stability of the Extensible 3D (X3D) Graphics International Standard.

- Two open-source implementations (X3DOM and X_ITE) adapt X3D content for HTML5 integration, with excellent results showing compatible event models for user interaction and model animation.

- Considering a 3D Printing and 3D Scanning profile for hardware interoperability.

- Virtual, Augmented and Mixed Reality (VR/AR/MR) can all use X3D and continue being explored to good effect – X3Dv4.1 to follow. Strategic timing is valuable.

X3Dv4 Strategy

X3D® Version 4 (X3Dv4) is a major upgrade to the Extensible 3D (X3D) Graphics International Standard that provides close support for the HTML5 Recommendation. This is major work in progress, expected to include several future versions. This effort is driven by the X3D Graphics Working Group with contributions from other working groups and regular community outreach.

- *Imminent.* X3Dv4 Public Working Draft specification release for Web3D 2019 and SIGGRAPH conferences
- *Current.* X3Dv4 Implementations Status provides summary links tracking active efforts,
- *Recent.* "**X3D Futures: what is happening, how to get involved!**" presentation from Web3D 2018 Conference, Poznan Poland, 22 June 2018.
- *Previous.* "**Future of X3D**" presentation and detailed notes from Web3D 2017 Conference, Brisbane Australia, 7 June 2017 (photograph).

X3D is always evolving, and the Web3D Consortium Standards Strategy carefully guides all these improvements. X3D Version 4 enables authors to publish interactive 3D content anywhere on the Web, without restrictions or plugins. Next-generation evolution + revolution is combined with archival compatibility of existing legacy content. Please see:

- **X3D Version 4.0 Technical Development** shows planned evolutionary changes to the baseline X3D architecture.
- X3D Version 4.1 will add Mixed Augmented Reality (MAR) capabilities for diverse virtual and augmented reality (VR, AR) devices.

Normalizing interaction (event model) semantics with HTML5 can further open up X3D for the vast majority of Web authors. The Web3D Consortium has identified X3DOM and X_ITE as prototypes for the next generation X3D Version 4.0 that support direct integration into HTML5 webpages without requiring the use of any browser plug-in. The Consortium and the X3D community are working closely with open-source exemplars to maintain and expand the X3D standard as it progresses and moves into full browser support. The Consortium also continues to support all existing X3D and VRML content.

Steady progress towards X3D Version 4 continues. We cordially invite you to Join Web3D as we continue to reliably build a stable foundation that establishes 3D graphics as a "first-class citizen" in the World Wide Web.

X3Dv4 Implementations Status

X3Dv4 implementations are under way. X3D™ Version 4 (X3Dv4) is a major upgrade to the Extensible 3D (X3D) Graphics International Standard that provides close support for the HTML5 Recommendation.

The X3D Working Group is executing the Web3D Web3D Standards Adoption Process and meeting guidance by Web3D Board of Directors, all to good effect. Web3D Consortium membership has value!

Approach Summary

X3D activity includes over 20 years of progressive evolution that maintains durable stability and backwards compatibility. The best way to introduce new capabilities is to propose them on the x3d-public mailing list so that they can be considered in detail. Then we add an agenda item to the next X3D Working Group teleconference so that the proposed capability can be discussed. Then, away we go:

- *Specification Prose:* produce draft X3Dv4 Architecture Specification (github) aligning with W3C HTML5/DOM Recommendations.
- *Implement Code:*   open-source JavaScript X_ITE and X3DOM players (for HTML5) plus other X3D browsers.
- *Evaluate Examples:* using all available X3D implementations and ~3500 models in X3D Example Archives.
- *Finalize and Review:* iteratively improve specification, implementations and examples until success thresholds are met.

X3D Node and Statement Inventory Comparison tracks progress of all known X3D players, authoring and validation tools.
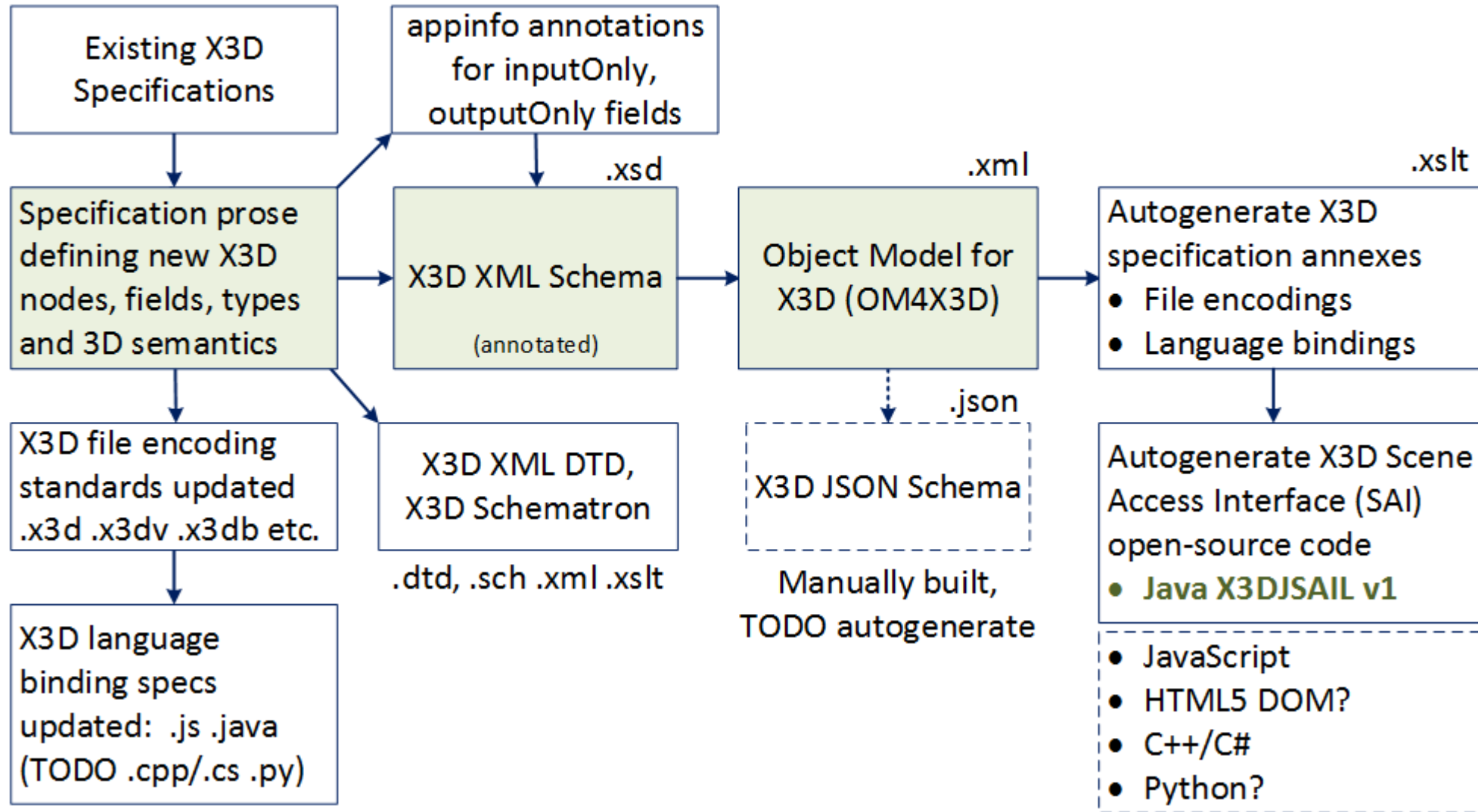
Milestones

1. *26-31 July 2019.* Publish draft specification plus examples and implementation updates at Web3D2019/SIGGRAPH 2019 conferences.
2. *16 December 2019.* Working group closes new-technology submissions, finalize all efforts. Prepare ISO NWIP document.
3. *First quarter 2020.* Working Draft submitted to X3D Community, Web3D Consortium members, Web3D Board and ISO.

X3Dv4 Summary   #2

- Central to these efforts is an [X3D Unified Object Model (X3DUOM)](#) that enables consistent implementation and presentation of content across multiple file encodings (XML, ClassicVRML, JSON, binary) as well as multiple programming language bindings (JavaScript, Java and planned adaptations to C/C++/C# and Python).
  - [X3D JSON Loader (X3DJSONLD)](#) and [X3D JSON Encoding](#)
  - [X3D Java Scene Access Interface Library (X3DJSAIL)](#)
  - Turning the corner: **X3D Python Package** alpha release!

- Second-generation Humanoid Animation (HAnim) has stabilized motion-capture (mocap) outputs for both general-purpose and human-specific (i.e. medical) usage. Medical mappings and deployment efforts continue.
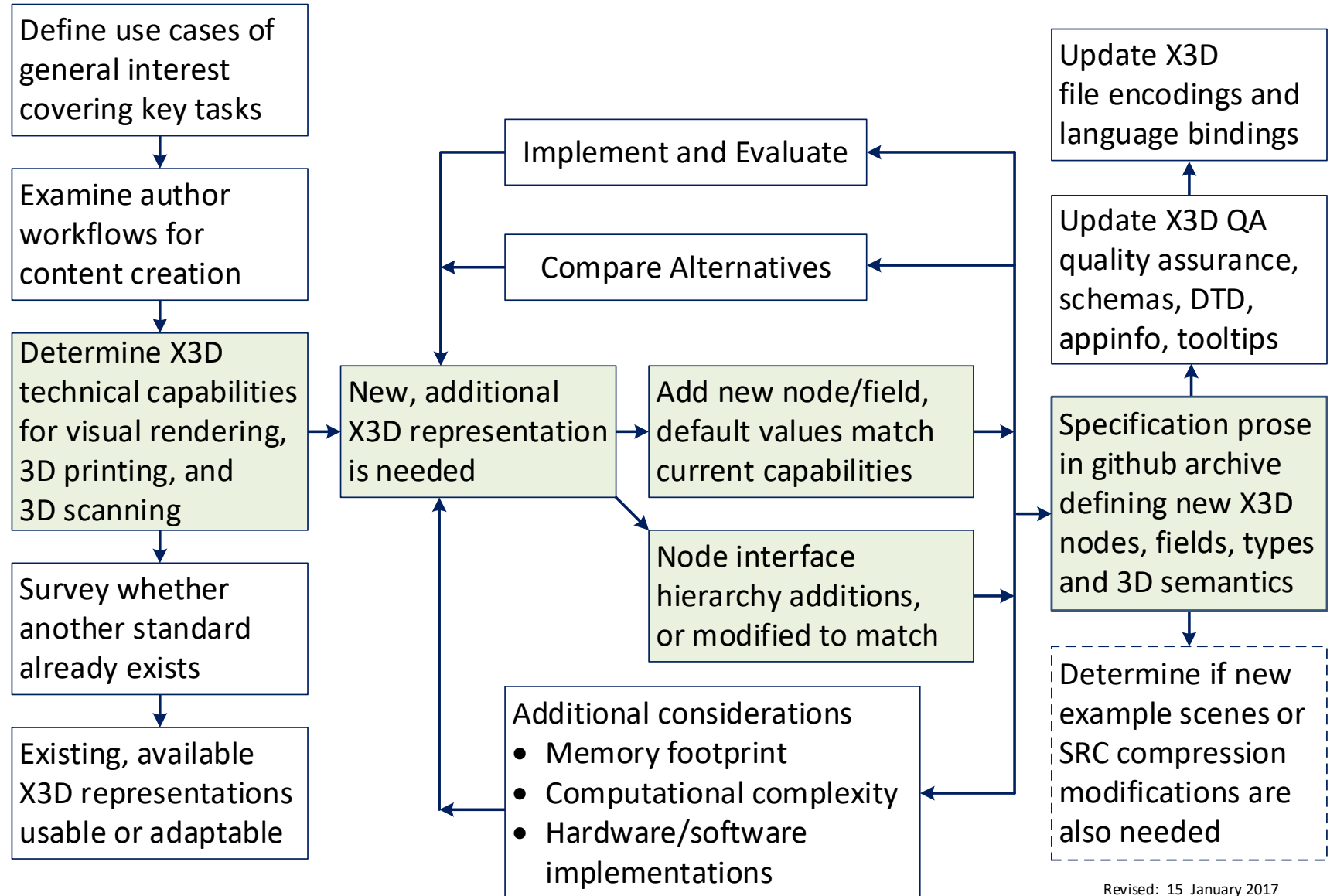
Object Model for X3D: Creation, Autogeneration

Existing X3D Specifications

appinfo annotations for inputOnly, outputOnly fields

.xsd

Specification prose defining new X3D nodes, fields, types and 3D semantics

X3D XML Schema
(annotated)

.xml

Object Model for X3D (OM4X3D)

.xslt

Autogenerate X3D specification annexes
- File encodings
- Language bindings

X3D file encoding standards updated .x3d .x3dv .x3db etc.

X3D XML DTD, X3D Schematron

.dtd, .sch .xml .xslt

.json

X3D JSON Schema

Manually built, TODO autogenerate

Autogenerate X3D Scene Access Interface (SAI) open-source code
- **Java X3DJSAIL v1**

- JavaScript
- HTML5 DOM?
- C++/C#
- Python?

X3D language binding specs updated: .js .java (TODO .cpp/.cs .py)

X3D Unified Object Model (X3DUOM)

X3D 4 Summary #3

- Over two decades of progress are steadily evolving to finally unlock full promise of Interactive 3D Graphics within the Web architecture.

- X3D Resources, X3D Scene Authoring Hints, X3D Tooltips, import/export support, forwards/backwards version compatibility, X3D Quality Assurance (QA) validation tools, and a large corpus of open-source version-controlled X3D examples are together ensuring that consistent semantics are emerging for 3D on any platform.

- XML compression, encryption and authentication available already.

- This progress report outlines numerous parallel lines of effort, and also points out individual opportunities to utilize and extend X3D consistently across multiple domains.

Specification design process for new capabilities

Web3D process helps us *work together* to get a big job done!

Define use cases of general interest covering key tasks

Examine author workflows for content creation

Determine X3D technical capabilities for visual rendering, 3D printing, and 3D scanning

Survey whether another standard already exists

Existing, available X3D representations usable or adaptable

Implement and Evaluate

Compare Alternatives

New, additional X3D representation is needed

Add new node/field, default values match current capabilities

Node interface hierarchy additions, or modified to match

Additional considerations
- Memory footprint
- Computational complexity
- Hardware/software implementations

Update X3D file encodings and language bindings

Update X3D QA quality assurance, schemas, DTD, appinfo, tooltips

Specification prose in github archive defining new X3D nodes, fields, types and 3D semantics

Determine if new example scenes or SRC compression modifications are also needed

Revised: 15 January 2017

HTML5 and Open Web Architecture

- Harmonization of ID linkages and event models, HTML DOM and X3D
- Composition with Cascading Style Sheets (CSS)
- Compatibility + usage of Scalable Vector Graphics (SVG)
- Accessibility, annotations, internationalization (I18N), etc.
- X3D as presentation layer compatible with Semantic Web
- Linkage of hybrid model data (MOST)

Some aspects are standardization, others can simply align good design.
- *New.* Call for participation to start **User Experience Working Group** that shares, assesses, promotes best practices for X3D + HTML usage.

Rendering

X3D version 4, HTML5/DOM

- Inline, ExternalShape:
  - glTF models, STL, PLY, others
- Physically Based Materials: glTF
- Advanced lighting model
- Shadows and reflections
- Cloud-based, offline rendering

X3D version 4.1, VR/AR/MAR

- Co-develop 4.1 to immediately follow completion of X3D v4.0
- WebVR as baseline capability set
- Composing see-through/360 video, high-definition, green screen, etc.
- Push "settled issues" to X3D v4.0, defer final WebVR support to v4.1

3D Printing and 3D scanning

- 3D Printing: bits into atoms
- 3D Scanning: atoms into bits

> **Uh, approximately everything?!**

CAD Design Printing Scanning Working Group is building profiles
- Geometry requirements essentially complete
- **Metadata and annotations** getting close scrutiny, building exemplars
- Contributing to multi-standard ISO tech committee, Byoung Nam Lee
- Also STEP Visualization group, Soonhung Han, Christophe Mouton

Simple use case: scan, print, view any object archivally published to X3D
Share via NIH 3D Print Exchange and Navy/Marine X3D Model Exchange

Audio

White paper: [Strategies for Improved Sound Support in X3D](#)

[W3C Audio Working Group](#)
- Web Audio, Web Midi, Web Audio Processing: Use Cases and Requirements
- MediaStream Processing API

Audio shaders/scripts in combination with configurable pipeline?

Use of audio in annotations to provide assistance in descriptions

Confirmed commitment by Athanasios Malamos, TEI Crete

But Wait There's More!

... deadline for member submissions

16 DEC 2019

X3Dv4 Draft Specification Implementation Status

Components and Nodes	X3D Specification Paragraphs	Examples	Implementations	Tooltips, links to Validation	Notes
Annotation	42 Annotation component	TODO	Xj3D (partial)		Work in progress by Design Printing Scanning and Medical Working Groups
Event model alignment	Modifications to Concepts, 4.4.8 Event model		X_ITE (complete), X3DOM (partial)		X3D Script/ROUTE events via DEF, HTML5/DOM events via id, browsers exchange event changes after render loops
Field name changes	Affects child SF/MFNode field naming for ~10 nodes		X3D-Tidy conversion updates once resolved		See Potential future changes for improved consistency of field names
glTF file loading	Multiple nodes for scene graph integration and advanced rendering		X3DOM, others		glTF closely related to Lighting model, also provides geometric compression.
HAnim v2	26 Humanoid Animation (HAnim) component, updating HAnimHumanoid and adding HAnimMotion node for BVH-style motion animation	TODO update Basic Archives: HAnim	X3DJSAIL Ready for update by other existing applications.	HAnimMotion, HAnimHumanoid	HAnim v2 is undergoing ISO Final Draft International Standard editors review, expected completion 7 August 2019.
Inline	9 Networking component Allow loading other model types, security precautions	TODO	X3DOM		Mantis 744, Mantis 1151, Mantis 1171, Mantis 1257 TODO support STL, PLY?
Lighting model	TODO add new capabilities while retaining optional backwards compatibility with X3Dv3 17 Lighting component	TODO	TODO confirm: Castle Game Engine X3DOM		Satisfactory review by X3D Working Group of Physically Based Rendering (PBR) proposals by Michalis Kamburelis

Humanoid Animation (HAnim) + Medical

New HAnim Draft International Standards (DIS) available online!
- HAnim Architecture (skeleton, skin, hands and feet, precise naming)
- HAnim Motion Animation (e.g. mocap, BVH conversion)
- HAnim tool, player and example updates are ongoing

Medical Working Group meets regularly with accelerating progress
- Liaisons with DICOM imaging, Health Level 7 (HL7), etc.
- Diverse applications and uses, demonstrated by test cases

- Shared strategy: suitable for archival Electronic Health Records (EHR)

- **Metadata and annotations**, security, compression, ontologies, standards

Bottom lines all around

An amazing amount of progress is clearly possible, working in parallel.

We have a feasible path forward, good process and good procedures.

Web3D membership has value!
- Can accelerate, focus attention on your project of interest
- Web3D needs you to [Join Our Team](#) as business, university, agency or individual

Community contributions add major value too!
- Ask questions, review, contribute code and models

Get involved, we want you!

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