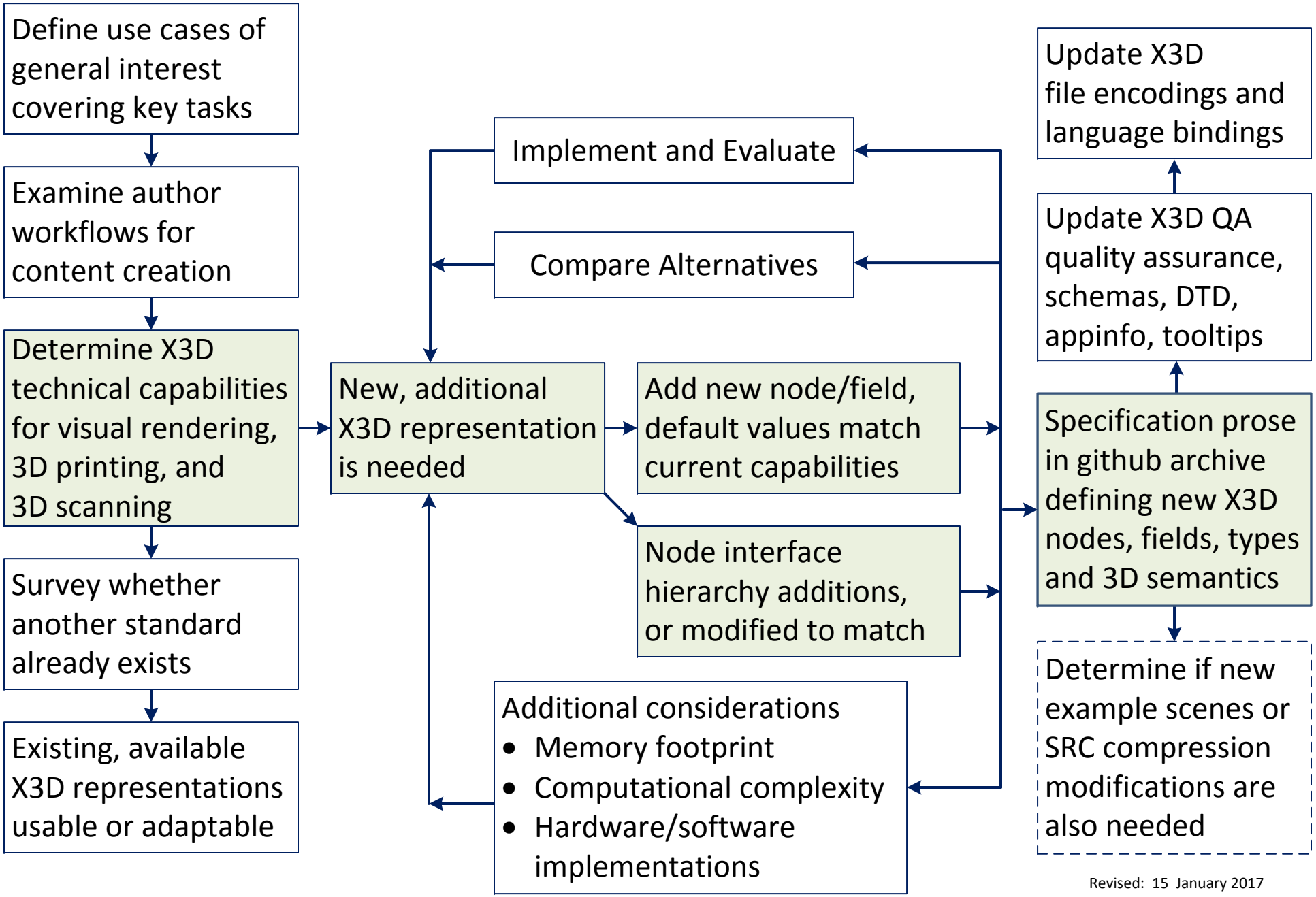
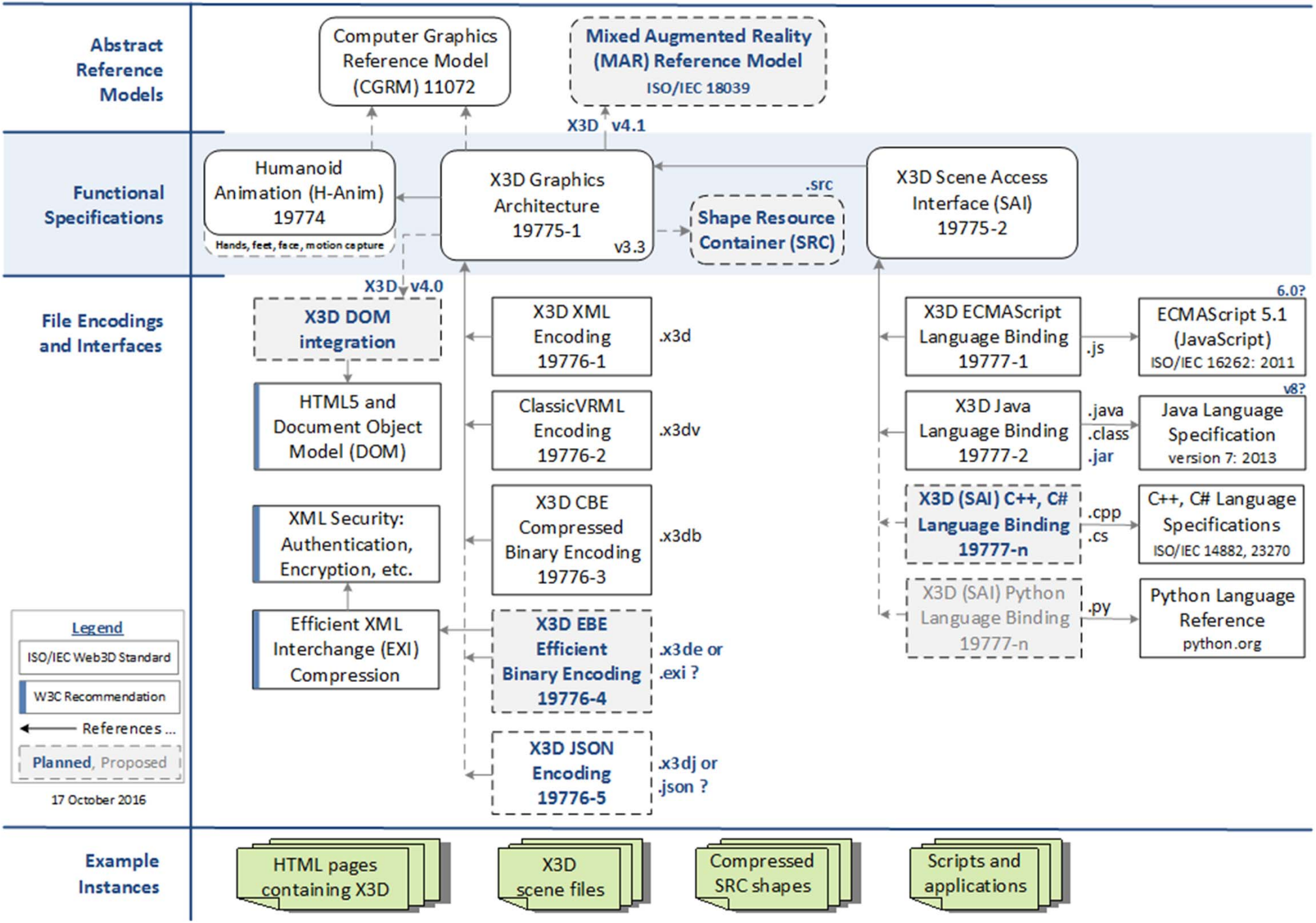
Specification design process for new capabilities

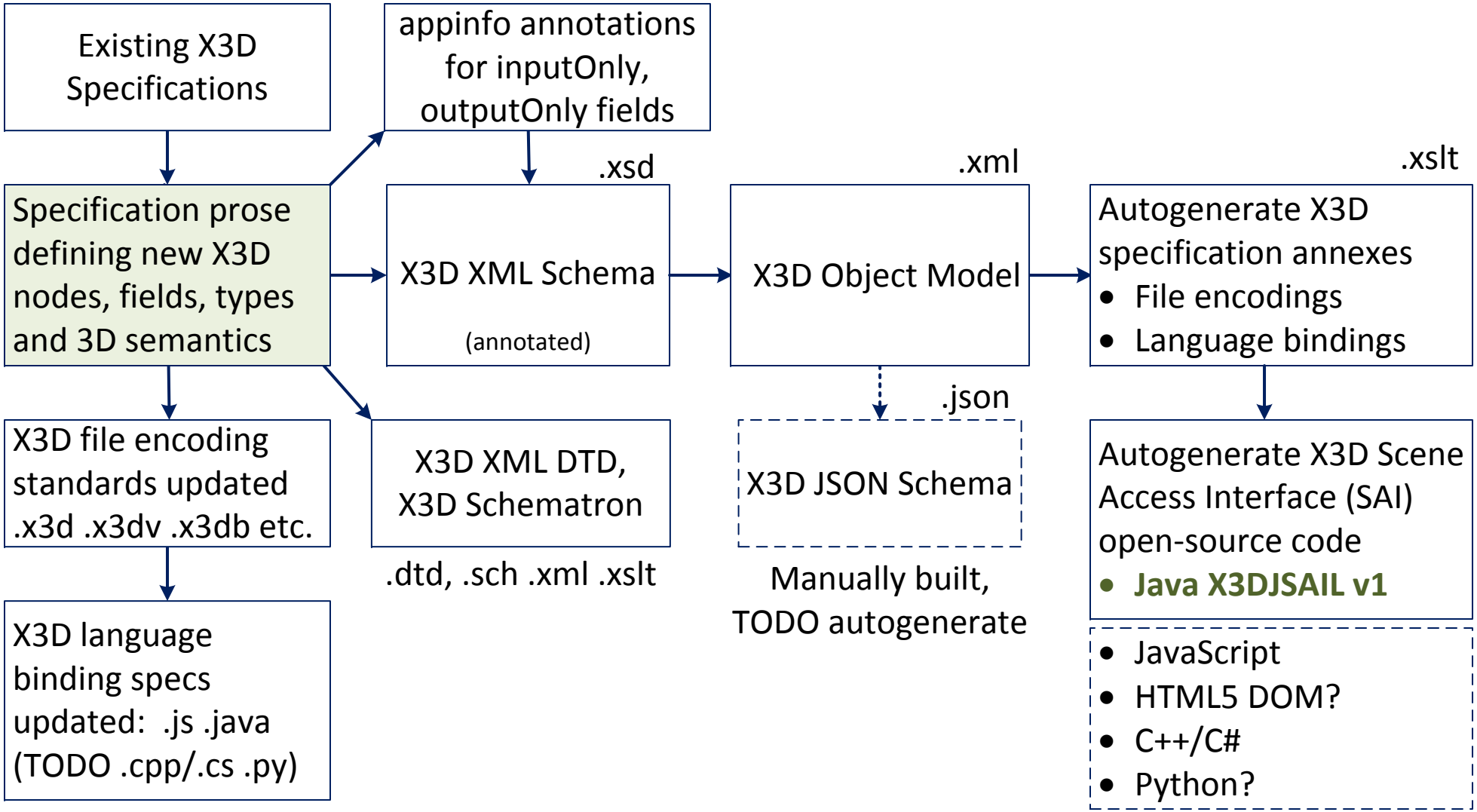


Revised: 15 January 2017

X3D Graphics Standards: Specification Relationships



Object Model for X3D: Creation, Autogeneration



Revised: 29 May 2017

X3D Specification Implementation & Evaluation

Mailing list discussions

Specification comments

Mantis issue tracker

Working group focus, projects, papers

Version control of examples: SourceForge

Version control of specifications: GitHub

X3D specifications

Web3D Strategy

ISO, W3C, OGC specs

- HTML5, CSS, SVG, Efficient XML Interchange (EXI), MathML, Security
- Open Web Platform
- JavaScript, Java
- KML, CityGML, etc.

Example X3D scenes

Example X3D implementations

Quality Assurance (QA)

- .x3d as master version
- X3D Validator (all tests)
- XML well-formed
- XML DTD validation
- XML Schema validation
- XML Schematron rules
- X3D Regular Expressions (regexes) for numeric values
- X3D Canonicalization (C14N) for comparability
- Autotranslation into multiple X3D encodings
- JSON Schema validation

Open Source, Commercial Codebases

- X3D players
- X3D authoring tools, workflow support
- X3D converters and translators
- X3D import, export support by independent tools
- X3D Scene Access Interface (SAI) in JavaScript, Java, C++/C#, Python?

Possible additions

- Conformance test suite certification
- SRC compression, streaming tests
- 3D print “unit tests”

Revised: 15 January 2017

Workflow: 3D Printing for X3D Models

X3D model archive repositories

Alternative printer formats
- STL or PLY
- AMF or 3MF

Valid X3D model from arbitrary source

Ignore non-printable scene graph elements

Ready-to-print 3D geometry

Production settings and characteristics for 3D printer

3D printer software tool creates G-code file

Model format conversion or tool export

Preparation for printing

Publishable final model

Bits into Atoms

Customization

Publishable final print archived

- X3D Resources: Conversion Tools
- Native support for X3D, VRML in tools
- Open-source SAI APIs for X3D Scene Authoring Interface (autogenerated, work in progress) in Java, JavaScript, C++

- Retain all metadata
- Retain full spatial transformation hierarchy of all 3D component shapes

- Retain all 3D shapes OR
- Retain only chosen, printable 3D shapes

Publication facets

- **Metadata** annotated information for data

- **Compression** of data and 3D geometry

- **Authentication** (digital signature)

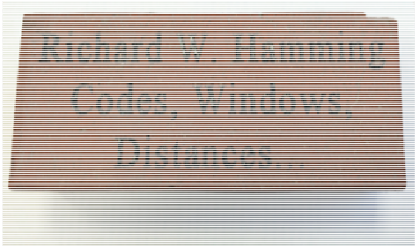
- **Encryption** (in whole or parts)

- Model size
- Model orientation
- Material(s)
- Thickness
- Support struts

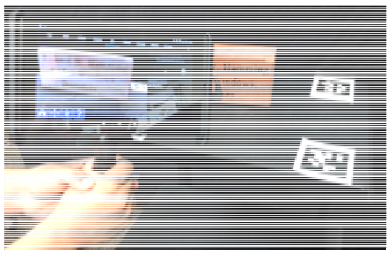
plus
- Specialized use-case printer settings
- Software tool and API exemplars (e.g. Cura)

Revised: 12 March 2017

Workflow: Scanning Shapes for X3D Mesh Data



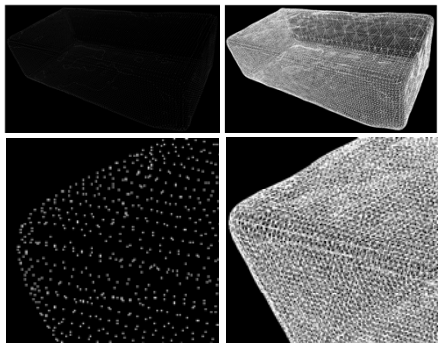
Overall scanning volume



Scanner	Scanned Object	Scanning Workspace		Checking Scan
• Hybrid types: video-based, photo merge, infrared (IR), laser, acoustic • Prepare gear • Data capacity OK • Data backup is ready, accessible	• Clean and uncovered • Handling precautions • Supporting equipment (if any) • Support "as-is" reality comparison to "as-built" plans	Extrinsic registration markers (April tags) • aids reconstruction and reassembly for subsections • QR code data/GUID alternatives • Which type used? • Data, metadata documentation and correlation for diverse records	• Consistent lighting • Free from occlusions • Standoff distance, possible rotation OK • Power recharge • Network connection • Shipboard location and logistics inventories	**Atoms into Bits** • Scan logs, narratives, annotation metadata • All facets captured? • Watertight: any holes or misregistration?

Revised: 12 March 2017

Workflow: Post-Production Scan to X3D Mesh



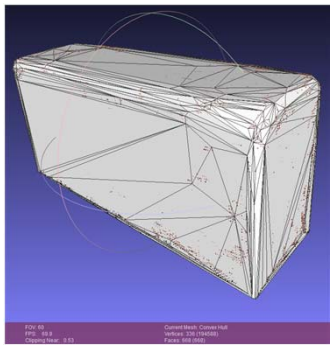
Point cloud vertices

Wire-frame lines

Point correlation and convergence

Point index correspondence to color values

- Registration confirmation
- Merged metadata and annotations



Ordered polygon mesh

- Pairwise indexing of vertices, colors
- Ordered mesh for TriangleSet or TriangleStripSet

Cleanup noisy data

- Close missing sides (if needed)
- Close surface holes, create convex hull
- Consistent ordering of vertices
- Register and align parts or subshapes

Publishable, archived, registered X3D model

Significant data reduction occurs during these processes.

Commonly offline task for authors or cloud computation. Increasingly performance is onboard the scanning device.

Alternative volumetric construction paths:

Volume dataset (voxels) → Isosurface selection, filtering → Tomography or other solid techniques

Revised: 12 March 2017

X3D Model Repository: Capabilities and Structure

User Access, Authentication

- CAC-access and public webservers
- Multimedia images, 3D model database
- Converter engine (e.g. Blender)
- Network security and information assurance (IA) protections
- Usage statistics and usefulness metrics
- X3D visualization, model sharing with SPIDERS3D and simulation systems

View, Discuss

- Browse, discover
- Search using metadata terms
- Collaborative community portal for group projects
- Metadata tagging and annotation
- Shape-based query
- Documentation
- Online training
- Maintenance, routine and repair
- Trouble reports
- Lessons learned
- Availability and alternatives

Download, Print

- Selected models
- Modified models
- Licensed models
- Converted models
- Tutorials and guides
- Technical support
- Online 3D printing services to order special capabilities

Publication facets

- **Metadata** annotated information

- **Compression** of data and 3D geometry

- **Authentication** (digital signature)

- **Encryption** (in whole or parts)

Upload

- New models with original CAD plans
- Model updates and modified versions
- 3D scans for model comparison
- Import, convert alternate formats
- Validation, cleanup, QA quality assurance
- Metadata, photos
- Confirmation of licensing terms
- Usage and repair information
- Case studies, new training resources

Revised: 12 March 2017

X3D Model Repository Security: Data at Rest

Secure system boundary

Secure system boundary

Secure system boundary

Product data family

- Functional capability model
- Engineering design model
- Material requirements and alternatives
- 3D printing guidelines
- Acceptance test criteria

Process data family

- Business processes
- Intellectual property rights (IPR) terms and usage
- Logistics requirements
- Contract requirements
- Additional restrictions

Information Infrastructure

- Heterogeneous databases for 3D models, scans and related assets
- Data validation capabilities via reference schemas
- Authoritative metadata
- Distribution restrictions
- Maintenance logs
- Quality Assurance (QA) records
- Usage accountability
- Trouble reports
- Safety considerations

Publication facets

- **Metadata** annotated information

- **Compression** of data and 3D geometry

- **Authentication** (digital signature)

- **Encryption** (in whole or parts)

Data-Centric Security

- In general, all data is maintained compressed, signed and encrypted for maximum security throughout the product lifecycle.
- Only data “in active use” by applications needs to be decrypted and protected by software. Note: many applications are themselves distributed, so application usage can be a form of “data in motion.”

Cybersecurity

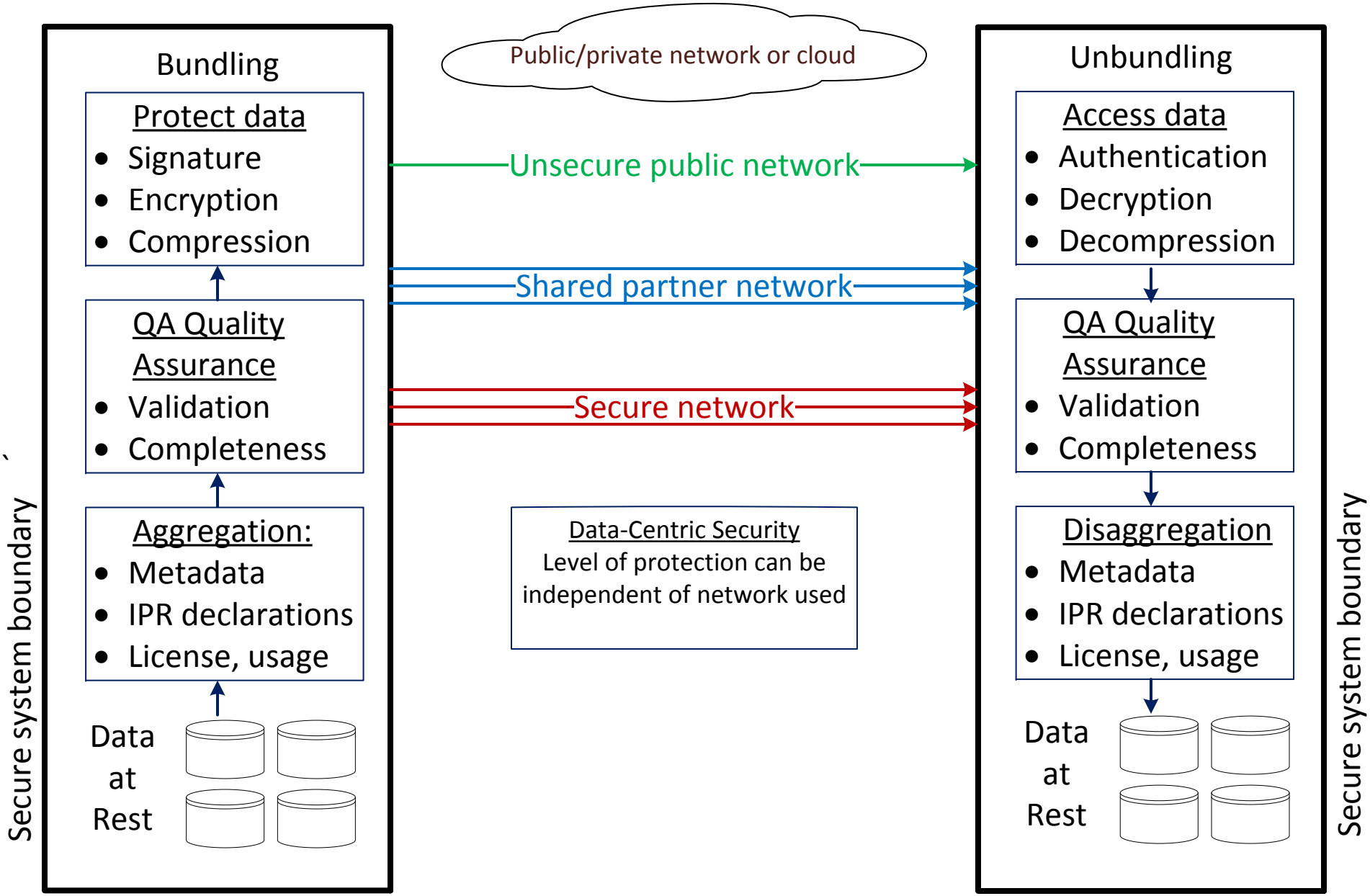
- Certified software
- Certified systems
- Certified network

Access

- Trusted employee
- Trusted contractor
- Trusted partner
- Public

Revised: 12 March 2017

X3D Model Repository Security: Data in Motion



Revised: 12 March 2017