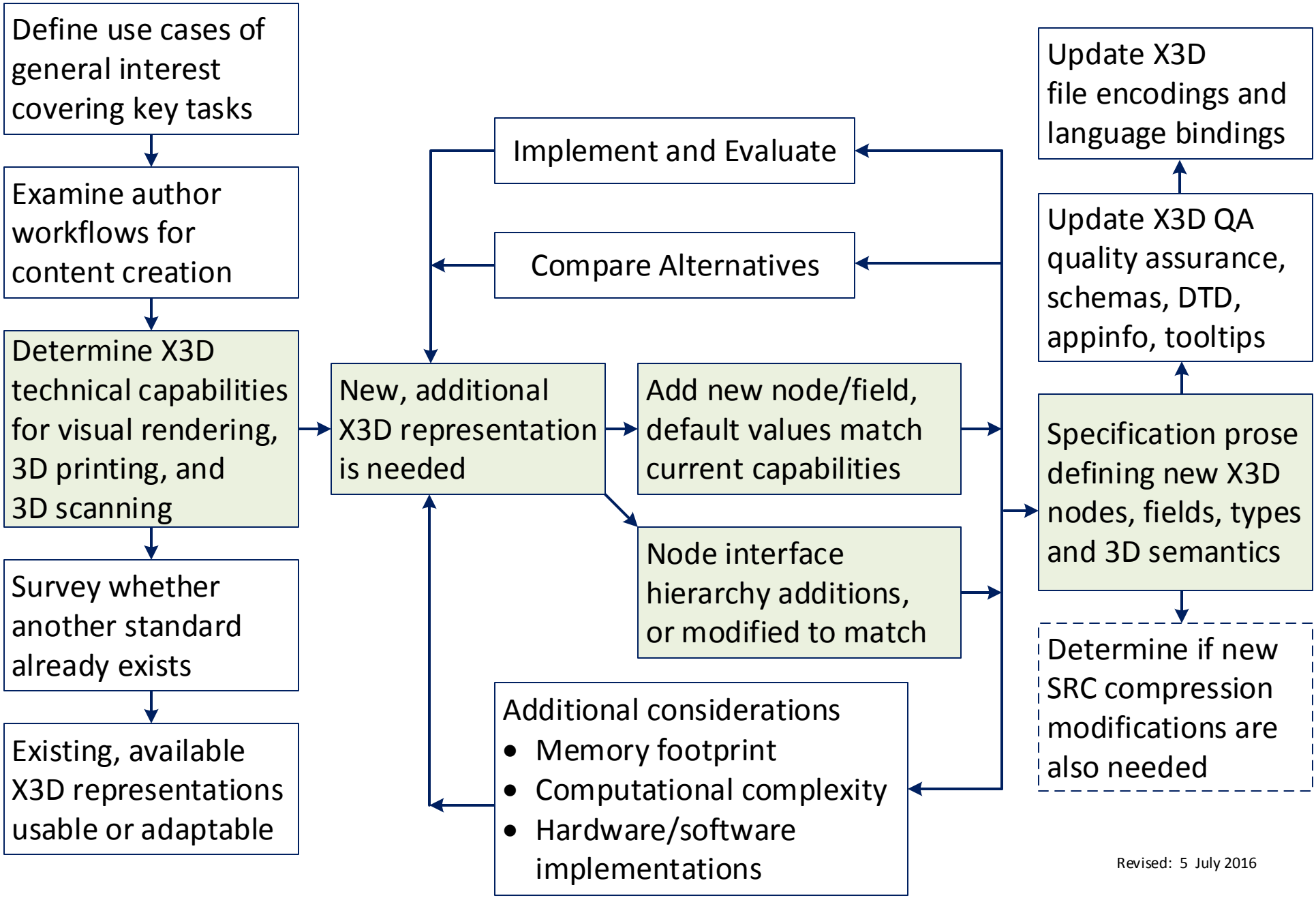
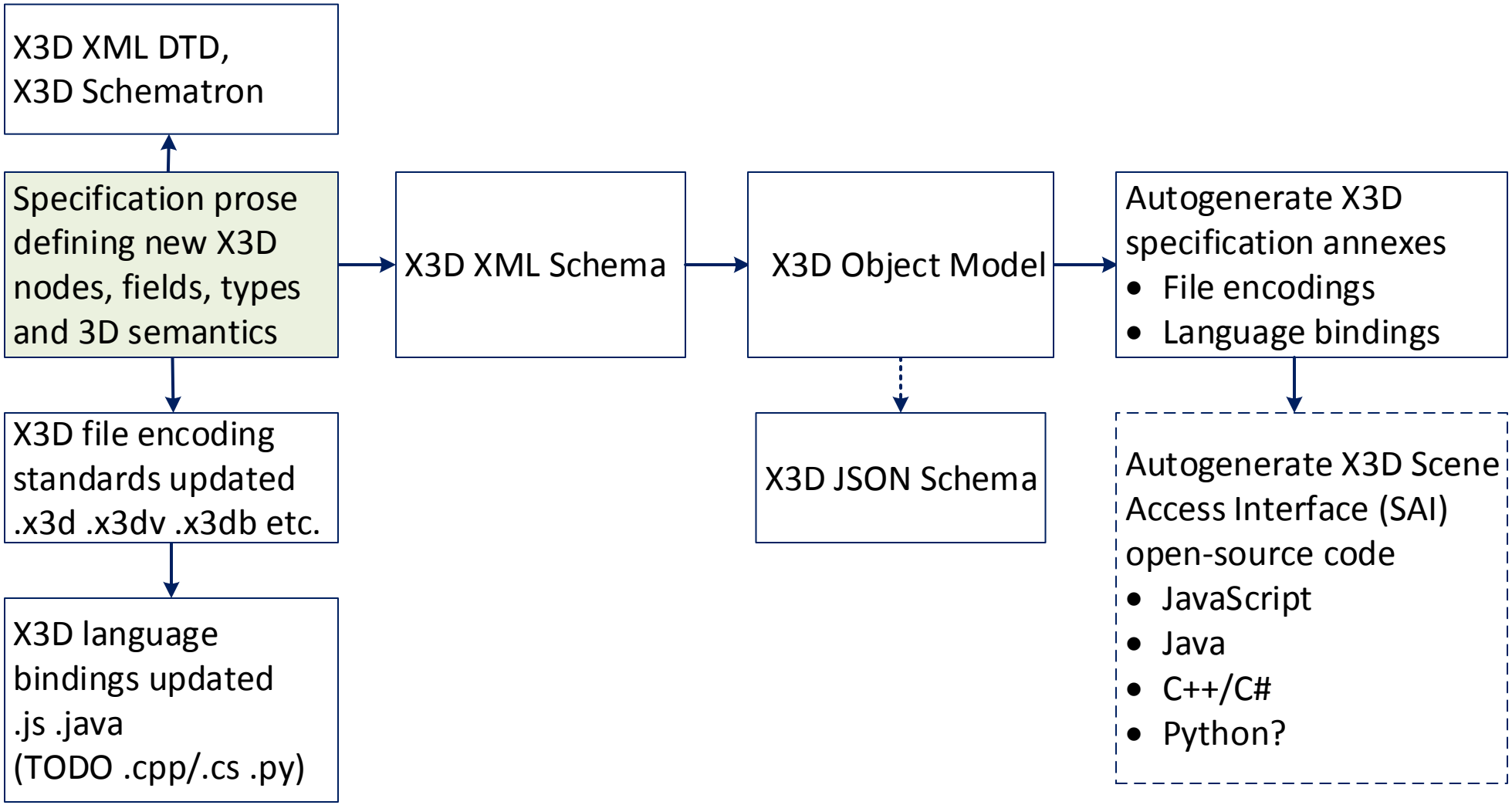
Specification design process for new capabilities



Revised: 5 July 2016

X3D Object Model Creation and Autogeneration



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X3D Specification Implementation & Evaluation

Mailing list discussions

Working group focus, projects, papers

X3D specifications

Specification comments

Version control of examples: SourceForge

Web3D Strategy

Mantis issue tracker

Version control of specifications: GitHub

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 tests

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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

Customization

Publishable final print

- 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, C++, JavaScript

- 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 options

- **Metadata** annotated information

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

- **Authentication** (digital signature)

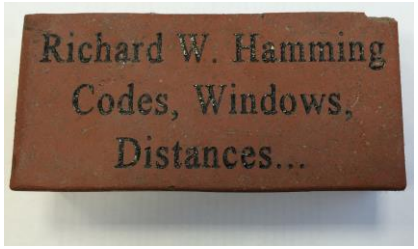
- **Encryption** (in whole or parts)

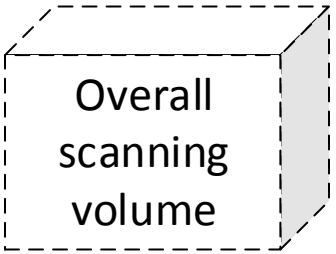
- Model size
- Model orientation
- Material(s)
- Thickness
- Support struts

plus
- Specialized printer settings

Revised: 5 July 2016

Workflow: Scanning Shapes for 3D Mesh Data





Scanner

- Hybrid types: video-based, photo merge, infrared (IR), laser, acoustic
- Prepare gear
- Data capacity OK
- Data backup

Scanned Object

- Clean and uncovered
- Handling precautions
- Supporting equipment (if any)

Scanning Workspace

Extrinsic registration markers (April tags)

- aids reconstruction of subsections
- which type used?
- document in records

- Consistent lighting
- Free from occlusions
- Standoff distance, possible rotation OK
- Power recharge
- Network connection

Checking Scan

Atoms into bits

- Scan log metadata
- All facets captured?
- Any holes or misregistration?

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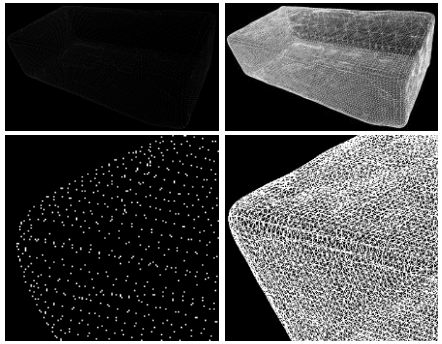
Workflow: Scan Post-Production to Build Mesh

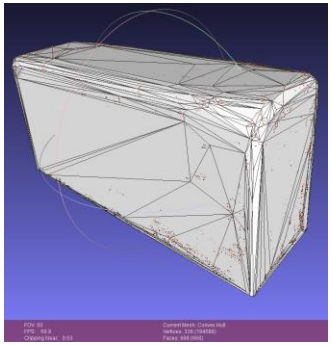


Point cloud vertices

Wire-frame lines

Point correlation and convergence

Point index correspondence with color values



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 X3D model

Alternate construction path:

Volume dataset (voxels) → Isosurface selection, filtering

Significant data reduction occurs during these processes.

Commonly offline task for authors or cloud computation, increasingly portions are onboard the scanning device.

Revised: 5 July 2016

X3D Model Repository: Capabilities and Structure

User Access, Authentication 

- Public or private webserver
- Community portal
- Model database
- Converter engine (e.g. Blender)
- Network security
- Information assurance (IA)
- Usage statistics
- Model export to collaboration and simulation systems

View, Discuss 

- Browse, discover
- Search using metadata terms
- 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 printer services for special capabilities

Publication options

- **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
- Usage and repair information
- Case studies, new training resources

Revised: 5 July 2016

Model Repository: 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 options

- **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

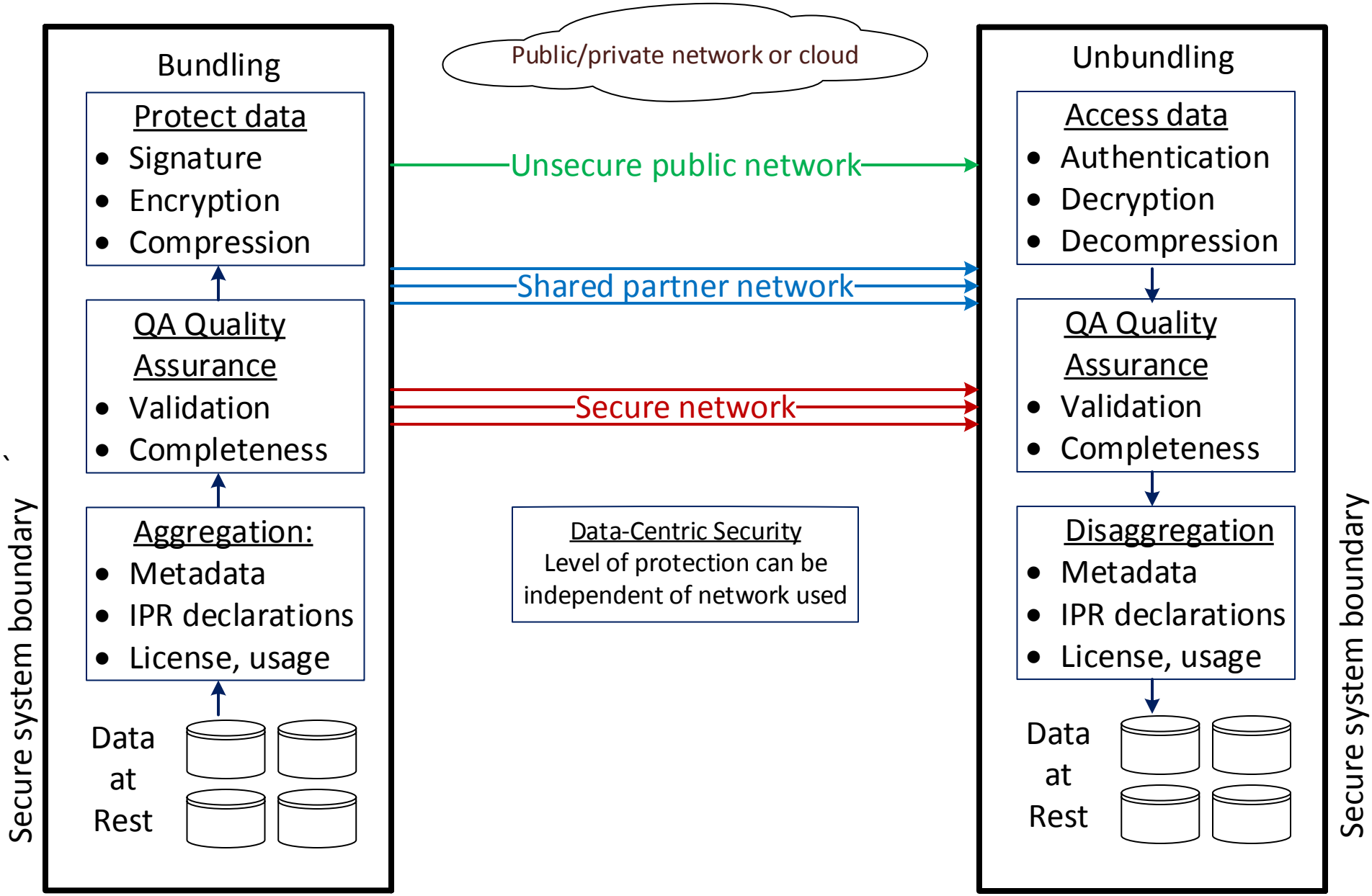
- Certified software
- Certified systems
- Certified network

Access

- Trusted employee
- Trusted contractor
- Trusted partner
- Public

Revised: 5 July 2016

Model Repository: Data in Motion



Revised: 13 July 2016