X3D Efficient Binary Encoding Progress Summary

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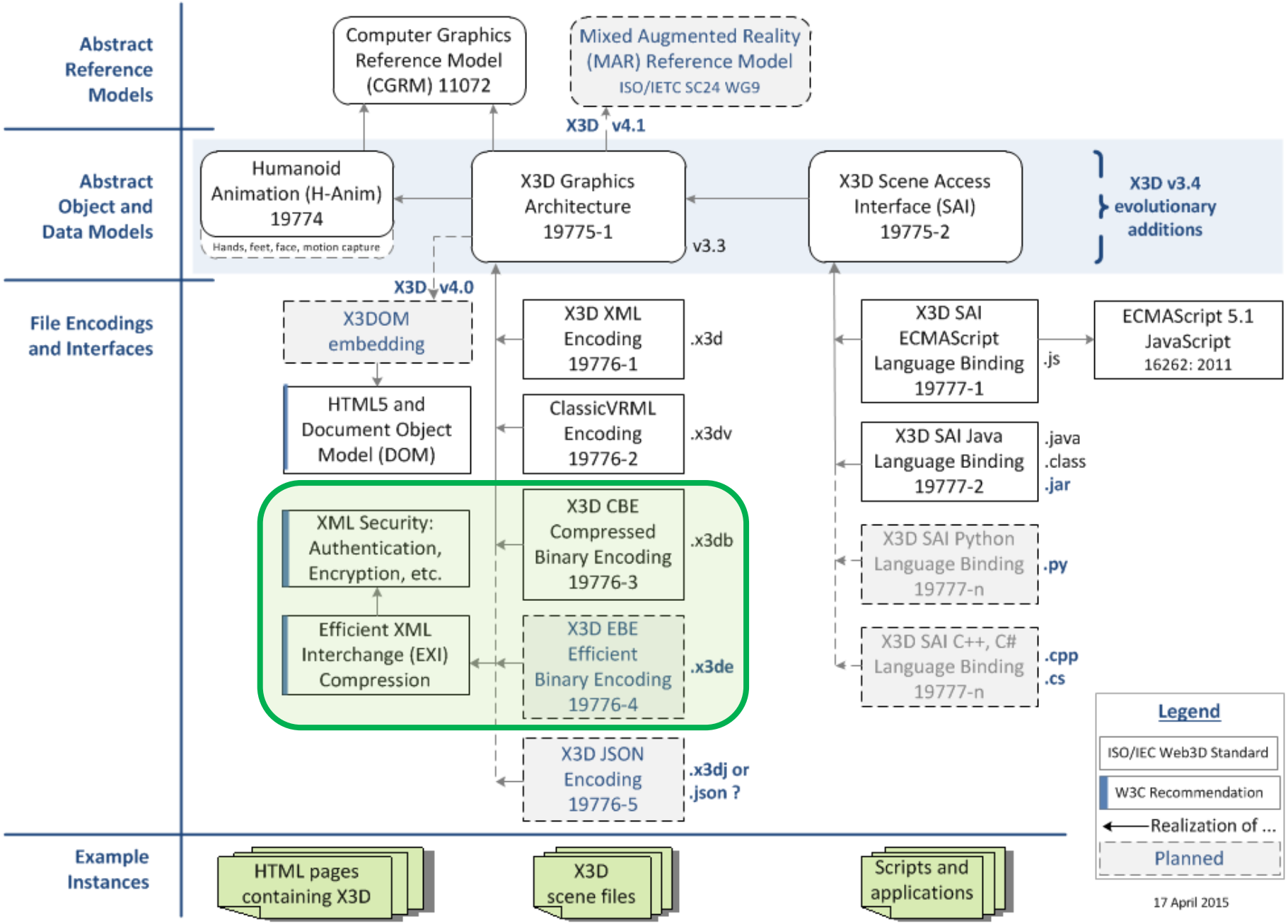
Goals and Approach

- Upgrade X3D Compressed Binary Encoding design to improve capabilities, as listed in Call For Contributions
- Design requirements:
  - Full representational capability for X3D graphics
  - Royalty free (RF), two or more implementations
- Components
  - Shape and geometry compression using
    - SRC, Shape Resource Container by Fraunhofer IGD
    - Streamable progressive mesh at run time
  - Efficient XML Interchange (EXI) compressed XML, compatible with digital signature and encryption
    - W3C Recommendation, multiple implementations available
  - Still needed: typed compressors for interpolators, volumes

X3D Graphics Standards: Specification Relationships



X3D Binary Capabilities Timeline

- **Annual**. Web3D has published and reviewed goals and developmental capabilities annually at the Web3D Conferences and SIGGRAPH in 2013, 2014, and 2015.
- **2012**. Efficient XML Interchange (EXI) is a fully approved W3C Recommendation with multiple implementations (both commercial and open source).
- **2013**. We accomplished our strategic goal to define revised X3D Compressed Binary Encoding (CBE) requirements and planned all steps needed to proceed.
- **2014**. We received multiple contributions for geometric compression and progressive streaming for X3D.
- **2015**. Decision: retain existing Compressed Binary Encoding (.x3db) for model stability, add Efficient Binary Encoding (.x3de) for improved capabilities.
- **2015**. Major necessary components are in hand. Now possible to begin in-depth implementation and specification-writing efforts. Still needed:
  - Non-geometric data types like interpolators deserve additional compression options.
  - Volume Compression is less common and may deserve a follow-on Call for Contributions.
- **Target completion?** Given sufficient member contributions, likely 2016.
  - Not “if,” simply “when” all due-diligence efforts are complete.

CAD Distillation Format (CDF)

- Developed by first X3D CAD Working Group
- Allows creation of small specialty encoders suitable for individual X3D data types
- Iterative process
  - Identify and replace sections of scene graph with compressed or distilled alternatives
  - Metadata nodes document revisions, reversability
  - Intermediate, final results remain valid X3D scenes

SRC: Shape Resource Container

- Flexible, highly efficient format for progressive transmission and compositing of 3D asset data
  - Meshes, textures, arbitrary vertex attributes
  - Related improvements shown by image retrieval
- ExternalGeometry node retrieves data via url
  - Alternative to Shape (not to entire scene graph)
  - Data is also sharable by other such Shape nodes
- SRC appears to be useful for all X3D encodings
  - Separate specification, will apply for MIME type
  - Alignment with Khronos binary glTF under review

EXI: Efficient XML Interchange

W3C XML Binary Characterization

- Established common needs among hard use cases

W3C EXI Recommendation: approved

- http://www.w3.org/XML/EXI

Technical approach: aligns well with X3D XML

- Better compaction + decompression speedup
- Type aware, schema-informed

Further tuning possible with EXI Options

- Adaptive tokenization, compression tables
- Can stabilize on a document type or further refine based on statistical analysis of corpus

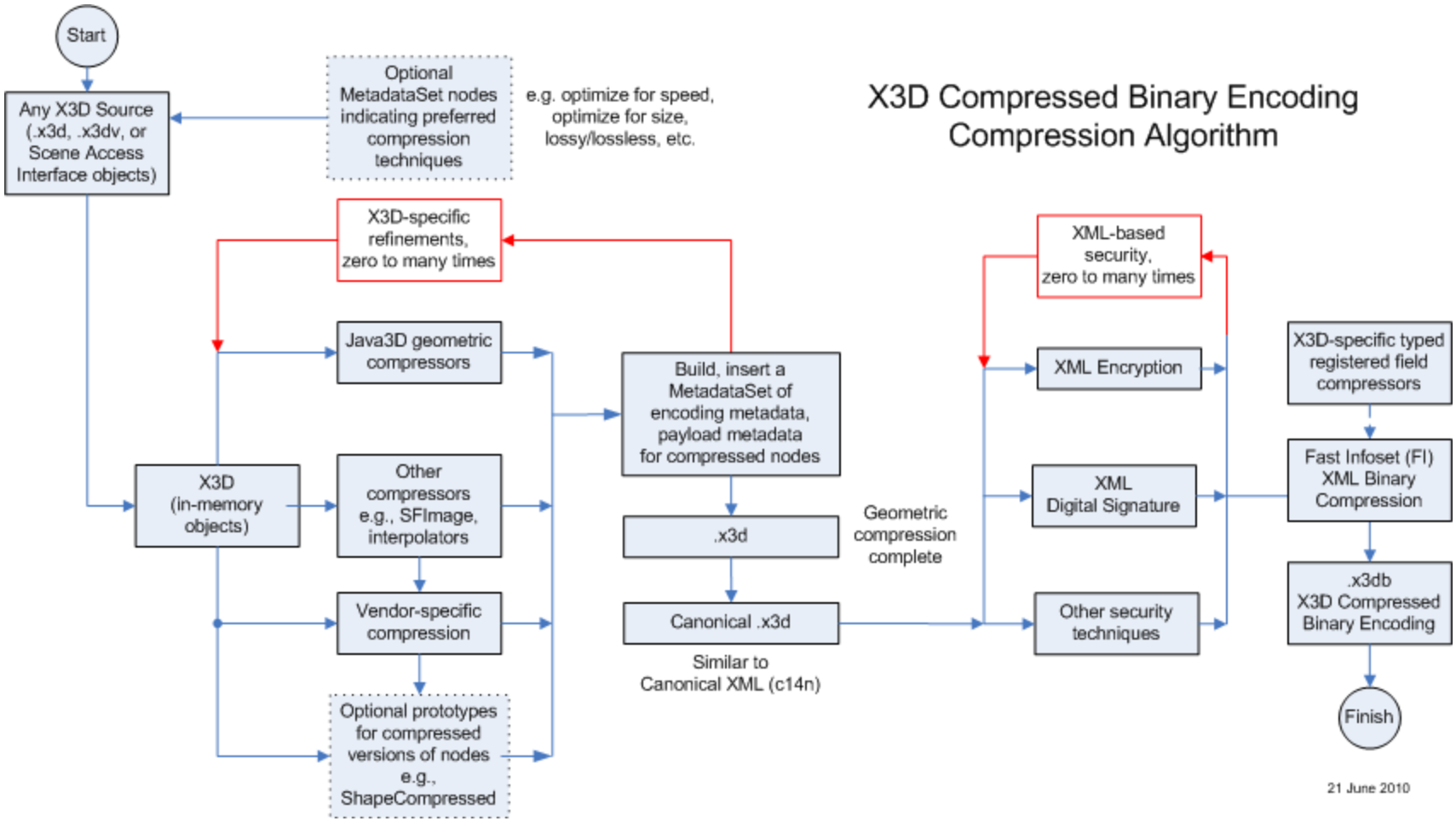
“Efficiency” means both size and speed

- EXI has demonstrated compaction that always meets or beats all of the most commonly used compression techniques (zip and gzip, FI, many others).
- Additionally, because EXI decompression goes straight into memory rather than string characters, which then require significant additional parsing, decoding EXI is many times faster than other techniques.
- This approach also reduces memory requirements and power consumption on small devices.
- Because X3D is highly structured and highly numeric, EXI provides major advantages. Alternative bit-centric compression schemes cannot take full advantage of those characteristics.

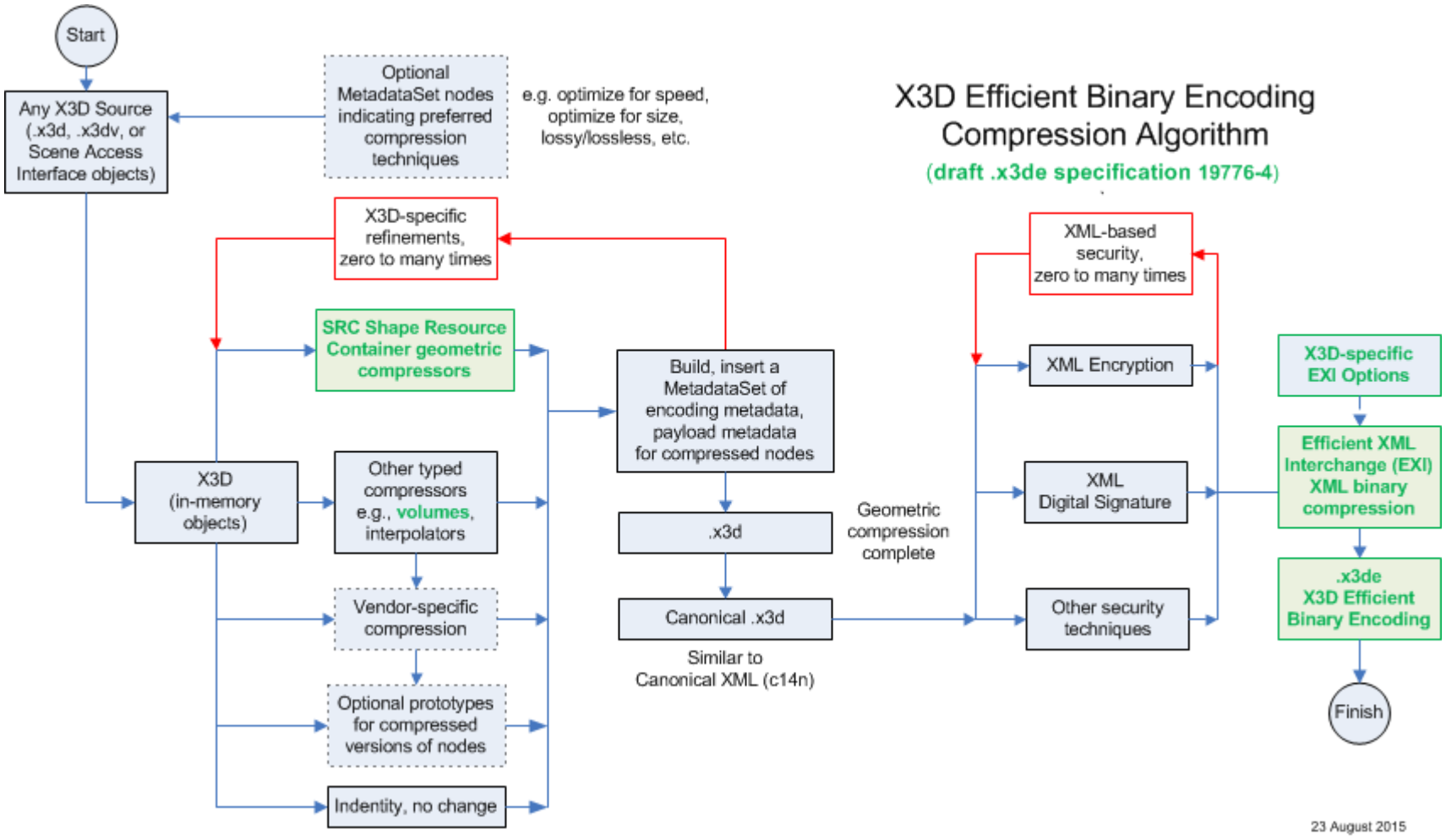
Comparison .x3db, .x3de

Compressed Binary Encoding (CBE)	Efficient Binary Encoding (EBE)
File extension **.x3db**	File extension **.x3de**
X3D encoding ISO/IEC **19776-3**	X3D encoding ISO/IEC **19776-4**
Geometric compression: Java3D • Deering patented algorithms • Royalty free (RF) status never secured before Sun Microsystems purchased • No progressive mesh or streaming	**SRC Shape Resource Container** • Fraunhofer IGD algorithms • Submitted on Royalty Free (RF) basis • Progressive mesh and streaming • Suitable for use with all X3D encodings • Exploring synergy: Khronos Binary glTF
XML compression: Fast Infoset (FI), 2005 • ISO Standard • Many other approaches evolved • en.wikipedia.org/wiki/Fast_Infoset	**Efficient XML Interchange (EXI)**, 2011 • W3C Recommendation, best of breed • XML schema-aware datatype compression • Always beats .zip, .gzip, FI, others • Significant performance speedups • Shown suitable for small devices • en.wikipedia.org/wiki/Efficient_XML_Interchange

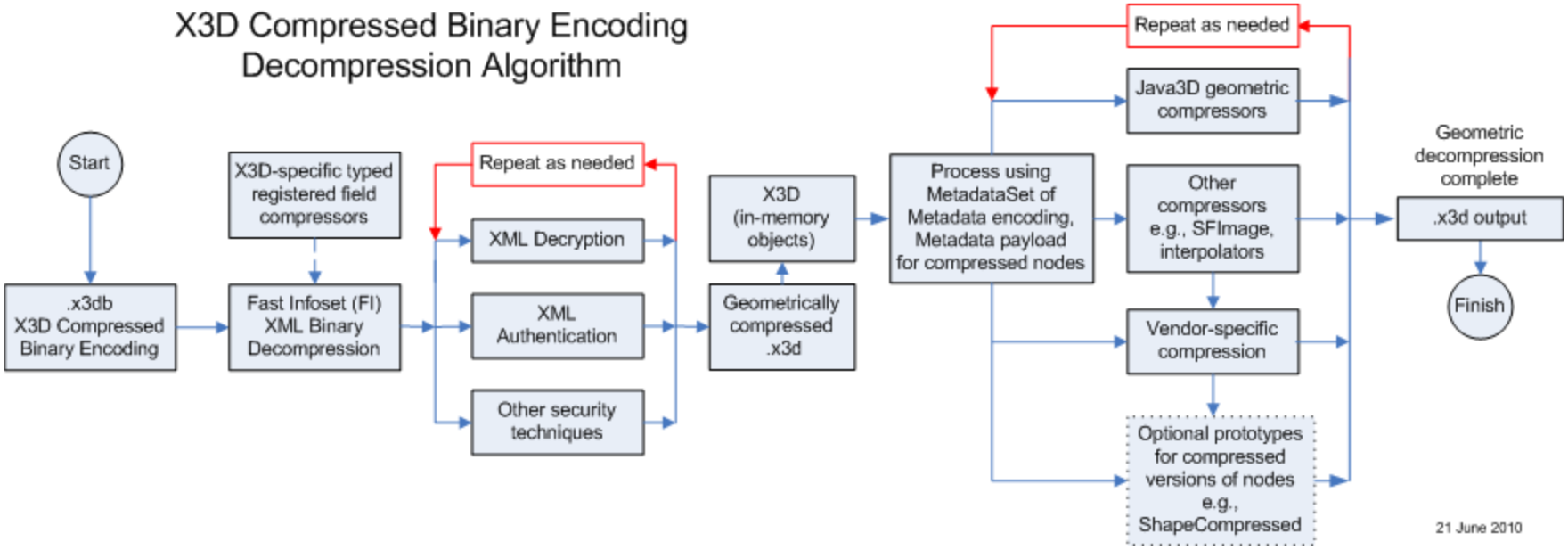
Compression algorithm CBE (.x3db)



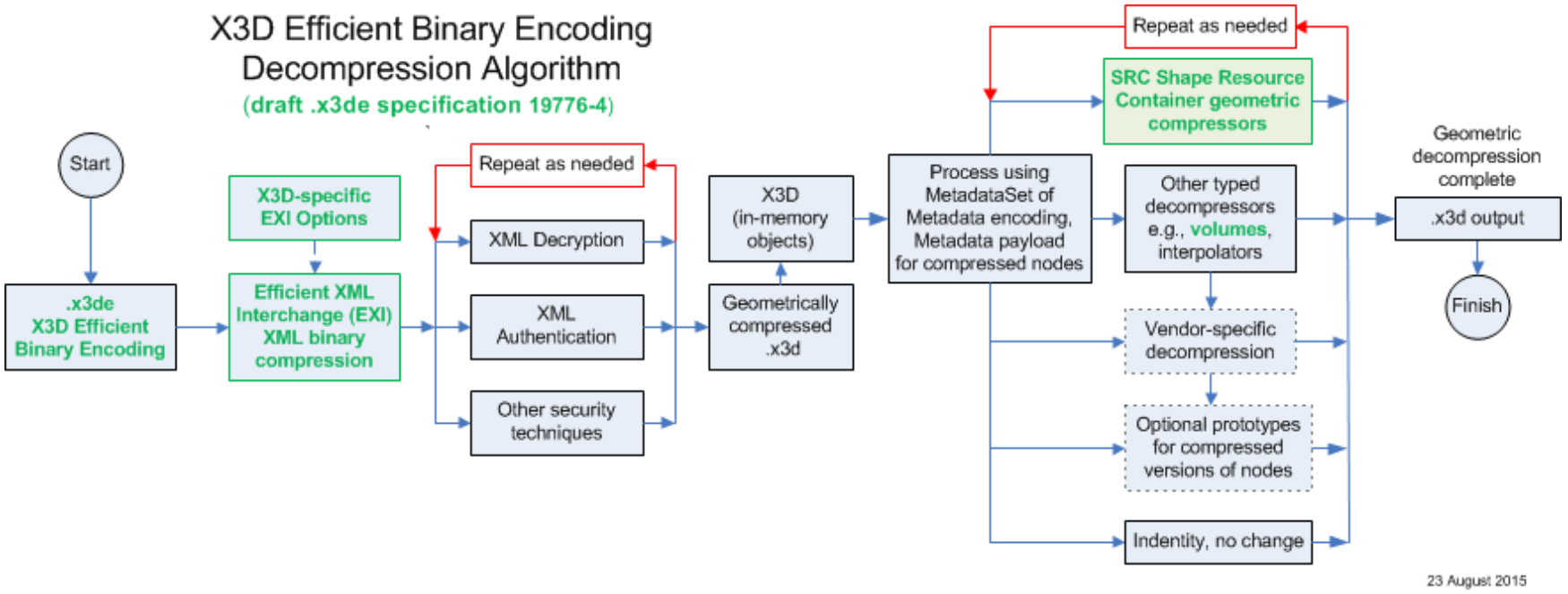
Compression algorithm EBE (.x3de)



Decompression algorithm CBE (.x3db)



Decompression algorithm EBE (.x3de)



References

- Web3D Consortium
  - http://www.web3d.org
- X3D Compressed Binary Encoding Activity
  - http://www.web3d.org/working-groups/x3d/compressed-binary-encoding-activity
- X3DOM Shape Resource Container (src)
  - http://x3dom.org/src
- Efficient XML Interchange (EXI) compression
  - http://www.w3.org/standards/xml/exi