

# X3D Efficient Binary Encoding Progress Summary

X3D Working Group, Web3D Consortium

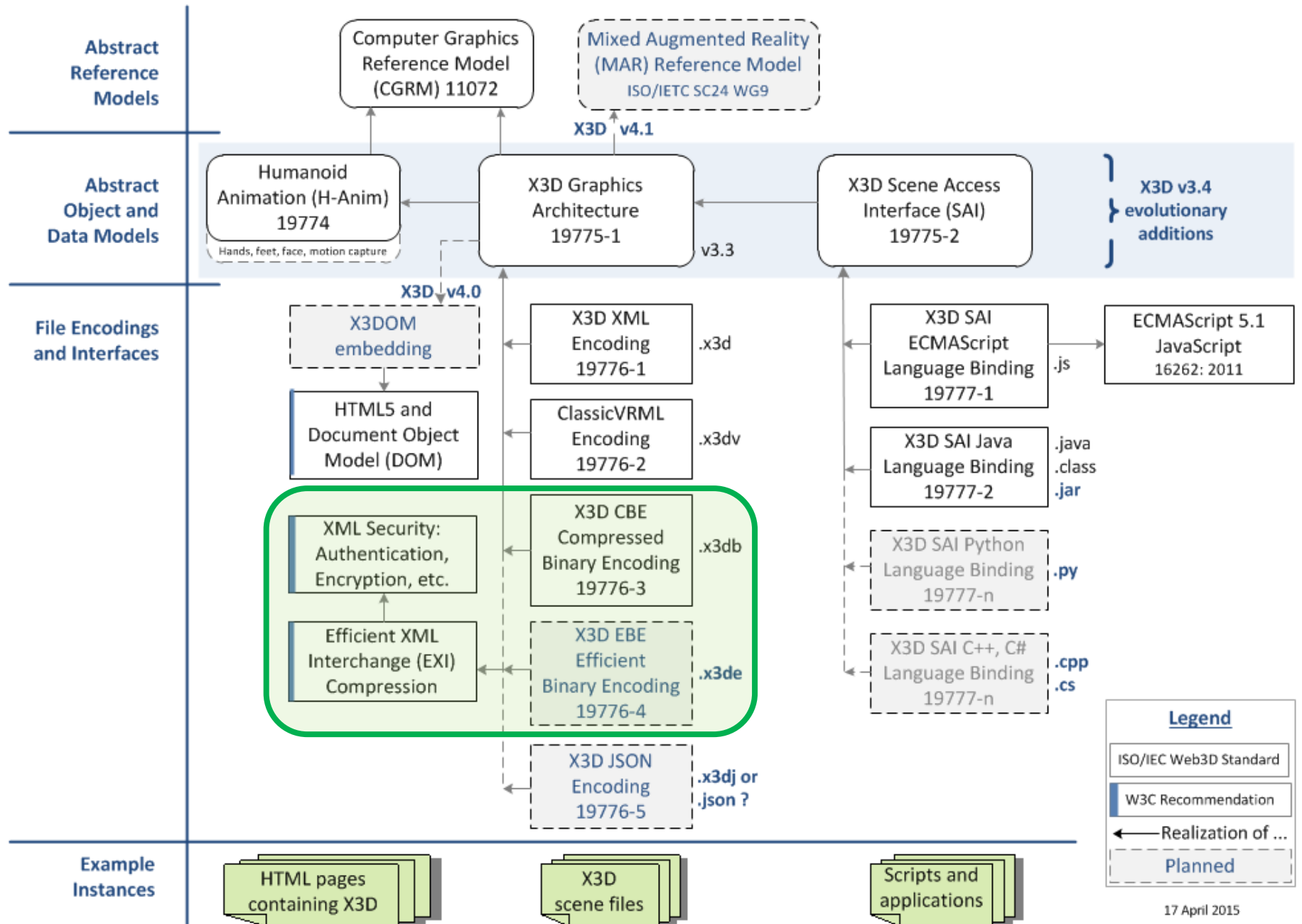
Don Brutzman  
[brutzman@nps.edu](mailto:brutzman@nps.edu)

23 August 2015

# 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

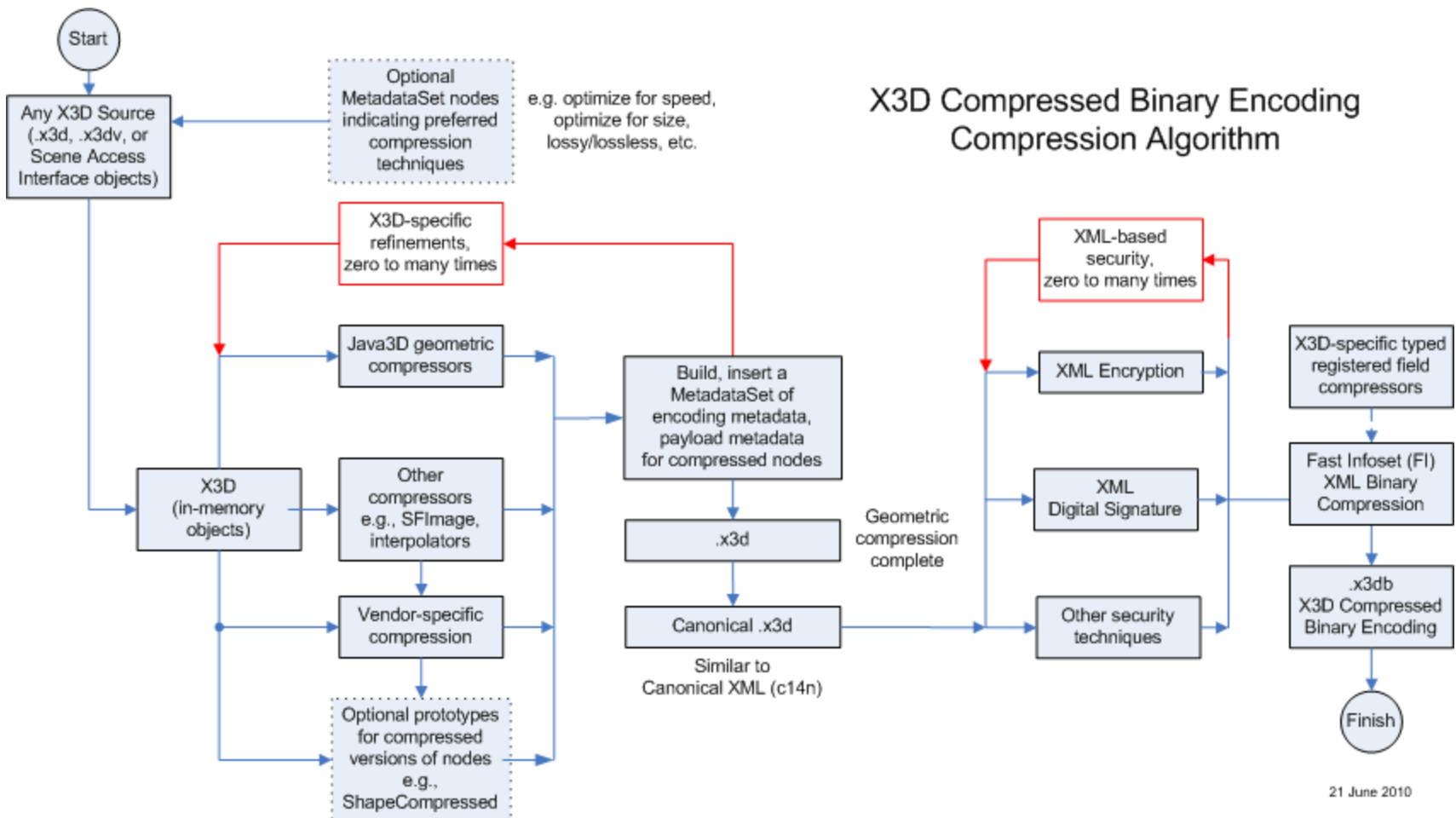
- EXI has demonstrated compaction that always meets or beats all of the most commonly used compression techniques (zip and gzip, Fl, many others).
- Additionally, because EXI decompression goes straight into memory rather than string characters, which then require significant additional parsing, decoding 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.



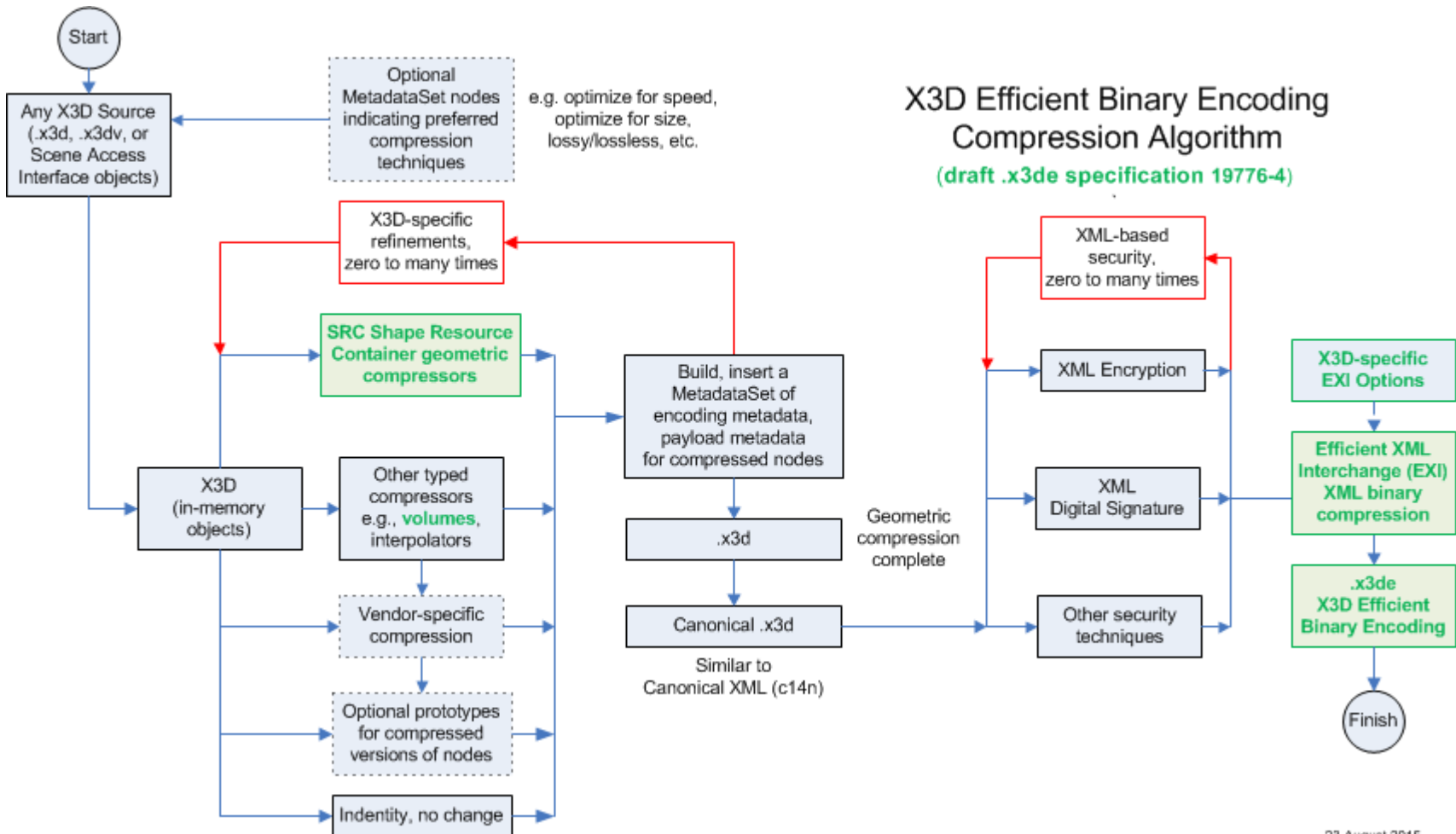
# Comparison .x3db, .x3de

Compressed Binary Encoding (CBE)	Efficient Binary Encoding (EBE)
File extension <b>.x3db</b>	File extension <b>.x3de</b>
X3D encoding ISO/IEC <b>19776-3</b>	X3D encoding ISO/IEC <b>19776-4</b>
<b>Geometric compression:</b> Java3D <ul style="list-style-type: none"><li>• Deering patented algorithms</li><li>• Royalty free (RF) status never secured before Sun Microsystems purchased</li><li>• No progressive mesh or streaming</li></ul>	<b>SRC Shape Resource Container</b> <ul style="list-style-type: none"><li>• Fraunhofer IGD algorithms</li><li>• Submitted on Royalty Free (RF) basis</li><li>• Progressive mesh and streaming</li><li>• Suitable for use with all X3D encodings</li><li>• Exploring synergy: Khronos Binary glTF</li></ul>
<b>XML compression:</b> Fast Infoset (FI), 2005 <ul style="list-style-type: none"><li>• ISO Standard</li><li>• Many other approaches evolved</li><li>• <a href="http://en.wikipedia.org/wiki/Fast_Infoset">en.wikipedia.org/wiki/Fast_Infoset</a></li></ul>	<b>Efficient XML Interchange (EXI), 2011</b> <ul style="list-style-type: none"><li>• W3C Recommendation, best of breed</li><li>• XML schema-aware datatype compression<ul style="list-style-type: none"><li>• Always beats .zip, .gzip, FI, others</li></ul></li><li>• Significant performance speedups</li><li>• Shown suitable for small devices</li><li>• <a href="http://en.wikipedia.org/wiki/Efficient_XML_Interchange">en.wikipedia.org/wiki/Efficient_XML_Interchange</a></li></ul>

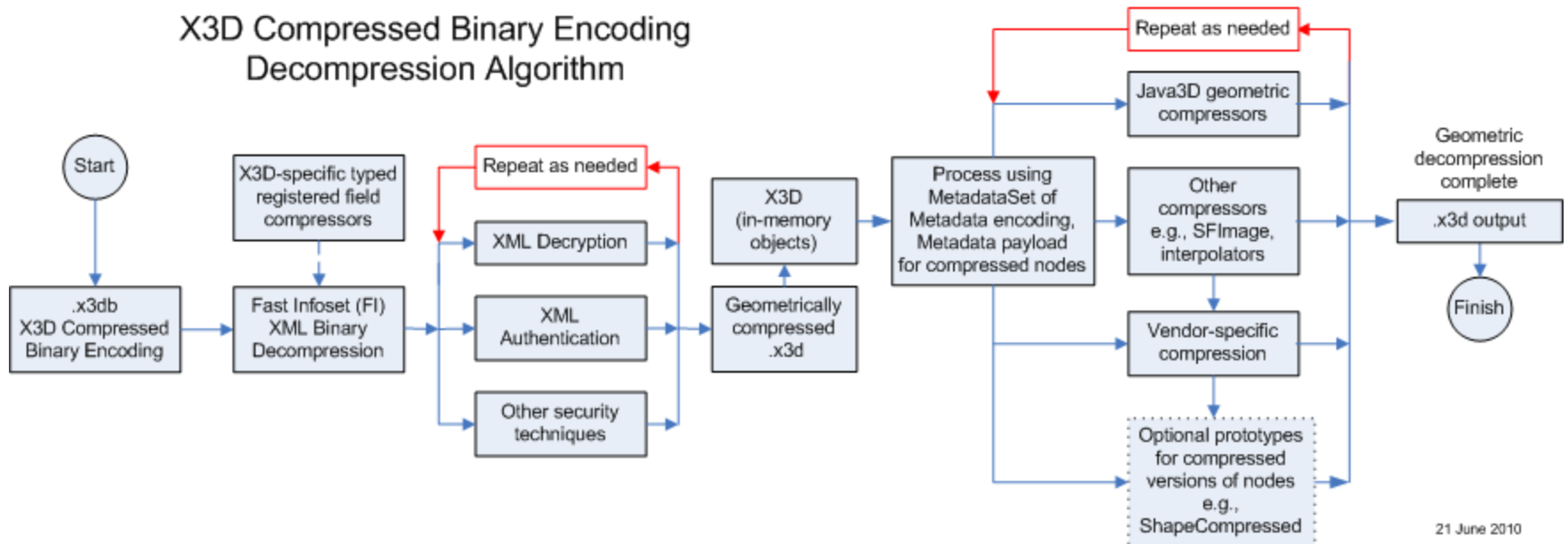
# Compression algorithm CBE (.x3db)



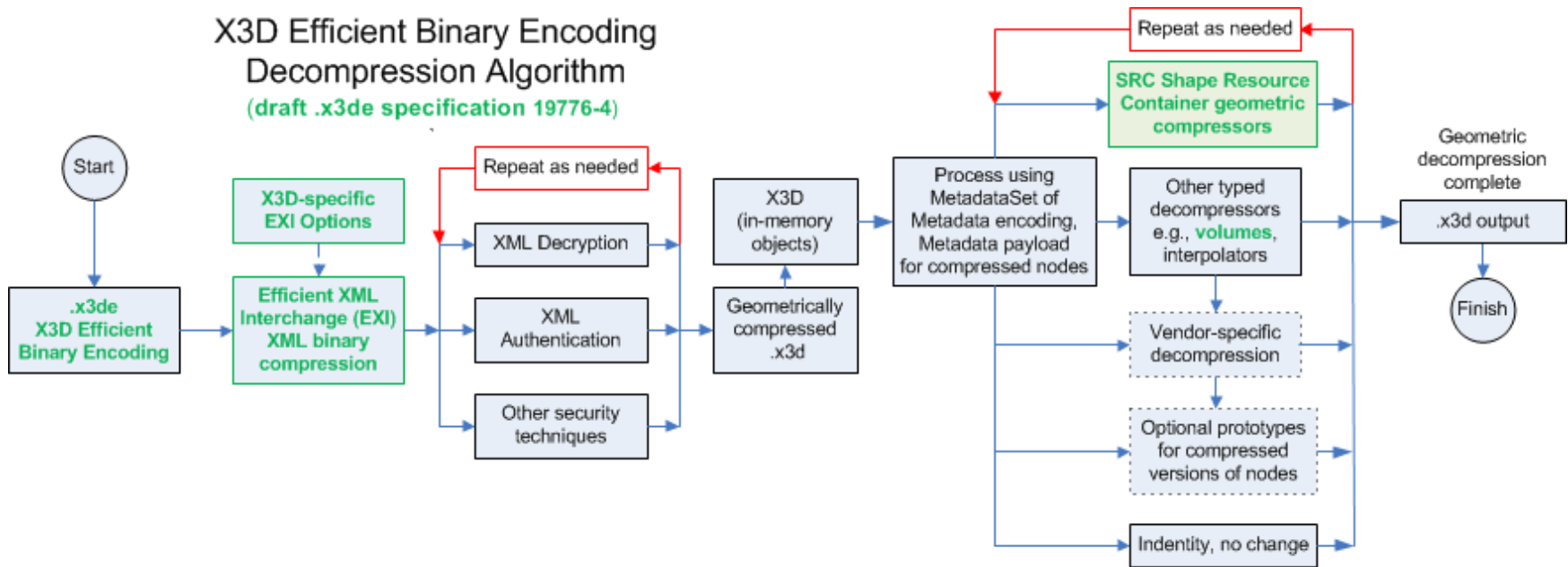
# Compression algorithm EBE (.x3de)



# 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>