

Fast Infoset (FI)
encoding for X3D

Kristian Sons

Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

Fast Infoset (FI) encoding for X3D

Speed-up X3D processing

Kristian Sons

24th July 2010

SUPPORTING *you!*

Outline

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- 1 Fast Infoset
 - How does FI work?
 - Example
 - Result
- 2 Performance
 - Size
 - Memory
 - Processing
- 3 Implementations
 - Overview
 - ParaView
 - libfi

Fast Infoset

General

Fast Infoset (FI)
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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- Binary representation of XML Information Set
- ISO and ITU-T standard
- Optimize document size and processing performance
- No information lost compared to UTF-8 encoding of XML documents
- Tables for Elements, Attributes, CDATA ...
- Algorithms for Attribute Values
- X3D has predefined tables
- X3D defines specific encoding algorithms

Fast Infoset

Standard XML encoding

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Fast Infoset

How does FI
work?

Example
Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

```
<?xml version="1.0" encoding="utf-8"?>
<X3D profile="Immersive" version="3.1">
<head>
  <meta name="created_with" key="Actor3D"/>
</head>
<Scene>
  <Transform DEF="pCube1">
    <Shape DEF="pCubeShape1">
      <Appearance DEF="phong1SG">
        <Material DEF="phong1" ambientIntensity="0.0" diffuseColor="0.4 0.4 0.4"
          shininess="1.0" specularColor="0.5 0.5 0.5"/>
      </Appearance>
      <IndexedFaceSet DEF="pCubeShape1_ifs" solid="false" colorPerVertex="false"
        coordIndex="0 1 3 2 -1 2 3 5 4 -1 4 5 7 6 -1 6 7 1 0 -1 1 7 5 3 -1 6 0 2 4 -1"
        normalIndex="0 0 0 0 -1 1 1 1 1 -1 2 2 2 2 -1 3 3 3 3 -1 4 4 4 4 -1 5 5 5 5 -1"
        creaseAngle="1.57">
        <Coordinate DEF="pCubeShape1_coord" point="-0.5 -0.5 0.5 0.5 -0.5 0.5 -0.5 0.5 0.5
          0.5 0.5 -0.5 0.5 -0.5 0.5 0.5 -0.5 -0.5 -0.5 0.5 -0.5 -0.5"/>
        <Normal DEF="pCubeShape1_normal" vector="0 0 1 0 1 0 0 0 -1 0 -1 0 1 0 0 -1 0 0 0"/>
      </IndexedFaceSet>
    </Shape>
  </Transform>
  <DirectionalLight DEF="directionalLightShape1" intensity="0.1"
    direction="-0.597679 -0.634059 -0.49066"/>
</Scene>
</X3D>
```

Fast Infoset

Encoding of elements

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- Use element index as defined in X3D specification

```
<?xml version="1.0" encoding="finf"?>
<139 profile="Immersive" version="3.1">
<143>
  <145 name="created_with" key="Actor3D"/>
</143>
<119>
  <6 DEF="pCube1">
    <1 DEF="pCubeShape1">
      <2 DEF="phong1SG">
        <3 DEF="phong1" ambientIntensity="0.0" diffuseColor="0.4 0.4 0.4"
          shininess="1.0" specularColor="0.5 0.5 0.5"/>
      </2>
      <4 DEF="pCubeShape1_ifs" solid="false" colorPerVertex="false"
        coordIndex="0 1 3 2 -1 2 3 5 4 -1 4 5 7 6 -1 6 7 1 0 -1 1 7 5 3 -1 6 0 2 4 -1"
        normalIndex="0 0 0 0 -1 1 1 1 1 -1 2 2 2 2 -1 3 3 3 3 -1 4 4 4 4 -1 5 5 5 5 -1"
        creaseAngle="1.57">
        <9 DEF="pCubeShape1_coord" point="-0.5 -0.5 0.5 0.5 -0.5 0.5 -0.5 0.5 0.5 0.5 0.5
          0.5 -0.5 0.5 -0.5 0.5 0.5 -0.5 -0.5 -0.5 0.5 -0.5 -0.5"/>
        <10 DEF="pCubeShape1_normal" vector="0 0 1 0 1 0 0 0 -1 0 -1 0 1 0 0 -1 0 0 0"/>
      </4>
    </1>
  </6>
  <52 DEF="directionalLightShape1" intensity="0.1" direction="-0.597679 -0.634059 -0.49066"/>
</119>
</139>
```

Fast Infoset

Encoding of attributes

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- Use attribute index as defined in X3D specification

```
<?xml version="1.0" encoding="fif" ?>
<139 240="Immersive" 315="3.1">
<143>
  <145 8="created_with" 46="Actor3D"/>
</143>
<119>
  <6 1="pCube1">
    <1 1="pCubeShape1">
      <2 1="phong1SG">
        <3 1="phong1" 28="0.0" 29="0.4 0.4 0.4" 31="1.0" 32="0.5 0.5 0.5"/>
      </2>
      <4 1="pCubeShape1_ifs" 44="false" 15="false"
        12="0 1 3 2 -1 2 3 5 4 -1 4 5 7 6 -1 6 7 1 0 -1 1 7 5 3 -1 6 0 2 4 -1"
        14="0 0 0 0 -1 1 1 1 1 -1 2 2 2 2 -1 3 3 3 3 -1 4 4 4 4 -1 5 5 5 5 -1"
        97="1.57">
      <9 1="pCubeShape1_coord" 25="-0.5 -0.5 0.5 0.5 -0.5 0.5 -0.5 0.5 0.5 0.5
        0.5 0.5 -0.5 0.5 -0.5 0.5 0.5 -0.5 -0.5 -0.5 -0.5 0.5 -0.5 -0.5"/>
      <10 1="pCubeShape1_normal" 26="0 0 1 0 1 0 0 0 -1 0 -1 0 1 0 0 -1 0 0 0 -1 0 0"/>
    </4>
  </1>
</6>
<52 1="directionalLightShape1" 172="0.1" 49="-0.597679 -0.634059 -0.49066"/>
</119>
</139>
```

Fast Infoset

Encoding of attribute values

- Either use attribute value index as defined in X3D specification
or ...

```
<?xml version="1.0" encoding="finf"?>
<139 240="Immersive" 315="3.1">
<143>
  <145 8="created_with" 46="Actor3D"/>
</143>
<119>
  <6 1="pCube1">
    <1 1="pCubeShape1">
      <2 1="phong1SG">
        <3 1="phong1" 28="0.0" 29="0.4 0.4 0.4" 31="1.0" 32="0.5 0.5 0.5"/>
      </2>
      <4 1="pCubeShape1_ifs" 44=1 15=1
        12="0 1 3 2 -1 2 3 5 4 -1 4 5 7 6 -1 6 7 1 0 -1 1 7 5 3 -1 6 0 2 4 -1"
        14="0 0 0 0 -1 1 1 1 1 -1 2 2 2 2 -1 3 3 3 3 -1 4 4 4 4 -1 5 5 5 5 -1"
        97="1.57">
      <9 1="pCubeShape1_coord" 25="-0.5 -0.5 0.5 0.5 -0.5 0.5 -0.5 0.5 0.5 0.5
        0.5 0.5 -0.5 0.5 -0.5 0.5 0.5 -0.5 -0.5 -0.5 -0.5 0.5 -0.5 -0.5"/>
      <10 1="pCubeShape1_normal" 26="0 0 1 0 1 0 0 0 -1 0 -1 0 1 0 0 -1 0 0"/>
    </4>
  </1>
</6>
  <52 1="directionalLightShape1" 172="0.1" 49="-0.597679 -0.634059 -0.49066"/>
</119>
</139>
```

Fast Infoset

Encoding of fields

- Use FI- or X3D-specific encoding algorithm for encoding of fields

```
<?xml version="1.0" encoding="utf-8"?>
<139 240="Immersive" 315="3.1">
<143>
  <145 8="created_with" 46="Actor3D"/>
</143>
<119>
  <6 1="pCube1">
    <1 1="pCubeShape1">
      <2 1="phong1SG">
        <3 1="phong1" 28="0.0" 29=ALG:35 31="1.0" 32=ALG:35/>
      </2>
      <4 1="pCubeShape1_ifs" 44=1 15=1 12=ALG:34 14=ALG:34 97="1.57">
        <9 1="pCubeShape1_coord" 25=ALG:35/>
        <10 1="pCubeShape1_normal" 26=ALG:35/>
      </4>
    </1>
  </6>
  <52 1="directionalLightShape1" 172="0.1" 49=ALG:35/>
</119>
</139>
```

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

Fast Infoset

Encoding of fields

Fast Infoset (FI)
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How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- MFFloat, MFVec3f, MFVec2f, MFColor ...
 - Float encoder (FI)
 - zlib float array encoder (X3D)
 - Quantized float array encoder (X3D)
 - Quantized zlib float array encoder (X3D)
- MFInt32, SFImage, MFImage ...
 - Integer encoder (FI)
 - Range integer encoder (X3D)
 - Delta zlib integer array encoder (X3D)

Fast Infoset

Resulting FI

Fast Infoset (FI)
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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

```
00000000 e0 00 00 01 20 10 00 16 75 72 6e 3a 65 78 74 65 |.... ..urn:extel|
00000010 72 6e 61 6c 2d 76 6f 63 61 62 75 6c 61 72 79 60 |rnal-vocabulary'|
00000020 6a 40 af 48 00 49 6d 6d 65 72 73 69 76 65 40 fa |j@.H.Immersive|.l|
00000030 42 33 2e 31 f0 90 0a 20 6e a0 92 00 20 20 20 60 |B3.1... n... '|
00000040 70 07 48 03 63 72 65 61 74 65 64 5f 77 69 74 68 |p.H.created_with|
00000050 2d 46 41 63 74 6f 72 33 44 ff f0 a0 20 56 a0 92 |-Factor3D... V..|
00000060 03 20 20 20 20 20 45 00 45 70 43 75 62 65 31 |. E.EpCube1|
00000070 f0 a0 82 06 20 20 20 20 20 20 20 20 20 40 00 48 |.... @.H|
00000080 02 70 43 75 62 65 53 68 61 70 65 31 f0 a0 82 09 |.pCubeShape1...|
00000090 20 20 20 20 20 20 20 20 20 20 20 20 41 00 47 70 | A.Gp|
000000a0 68 6f 6e 67 31 53 47 f0 a0 82 0c 20 20 20 20 20 |hong1SG.... |
000000b0 20 20 20 20 20 20 20 20 20 20 42 00 45 70 68 6f | B.Epho|
000000c0 6e 67 31 1b 42 30 2e 30 1c 32 28 13 08 11 00 00 |ng1.B0.0.2(....|
000000d0 00 0a 00 00 00 03 78 da b3 f7 39 73 fe b2 b1 f1 |.....x...9s...|
000000e0 97 33 67 00 1d 32 05 ec 1e 42 31 2e 30 1f 32 28 |.3g..2...B1.0.2(|
000000f0 0d 08 00 00 00 00 04 00 00 00 03 78 da b3 9f 7f |.....x....|
00000100 fe 01 00 05 5b 02 8e ff a0 82 09 20 20 20 20 20 |....[..... |
00000110 20 20 20 20 20 20 f0 a0 82 09 20 20 20 20 20 | .. |
00000120 20 20 20 20 20 20 43 00 48 06 70 43 75 62 65 | C.H.pCube|
00000130 53 68 61 70 65 31 5f 69 66 73 2b 80 0e 80 0b 32 |Shape1_ifs+....2|
...
```

Result Fast Infoset encoded: 689 Byte

Fast Infoset

Results

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- XML: 1516 Bytes
- XML (gzipped): 655 Bytes
- FI: 689 Bytes

Fast Infoset

Standard XML encoding

Fast Infoset (FI)
encoding for X3D

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

```
<?xml version="1.0" encoding="utf-8"?>
<X3D profile="Immersive" version="3.1">
<head>
  <meta name="created_with" key="Actor3D"/>
</head>
<Scene>
  <Transform DEF="pCube1">
    <Shape DEF="pCubeShape1">
      <Appearance DEF="phong1SG">
        <Material DEF="phong1" ambientIntensity="0.0" diffuseColor="0.4 0.4 0.4"
          shininess="1.0" specularColor="0.5 0.5 0.5"/>
      </Appearance>
      <IndexedFaceSet DEF="pCubeShape1_ifs" solid="false" colorPerVertex="false"
        coordIndex="0 1 3 2 -1 2 3 5 4 -1 4 5 7 6 -1 6 7 1 0 -1 1 7 5 3 -1 6 0 2 4 -1"
        normalIndex="0 0 0 0 -1 1 1 1 1 -1 2 2 2 2 -1 3 3 3 3 -1 4 4 4 4 -1 5 5 5 5 -1"
        creaseAngle="1.57">
        <Coordinate DEF="pCubeShape1_coord" point="-0.5 -0.5 0.5 0.5 -0.5 0.5 -0.5 0.5 0.5
          0.5 0.5 0.5 -0.5 0.5 -0.5 0.5 0.5 -0.5 -0.5 -0.5 0.5 -0.5 -0.5"/>
        <Normal DEF="pCubeShape1_normal" vector="0 0 1 0 1 0 0 0 -1 0 -1 0 1 0 0 -1 0 0 0"/>
      </IndexedFaceSet>
    </Shape>
  </Transform>
  <DirectionalLight DEF="directionalLightShape1" intensity="0.1"
    direction="-0.597679 -0.634059 -0.49066"/>
</Scene>
</X3D>
```

FI Performance

Size

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encoding for X3D

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- Compression rate up to 95% for large files (lossless)
- Comparable to GZIP text compression
- Compression rate depends on algorithm selection

FI Performance

Memory - XML

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encoding for X3D

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Fast Infoset
How does FI
work?
Example
Result

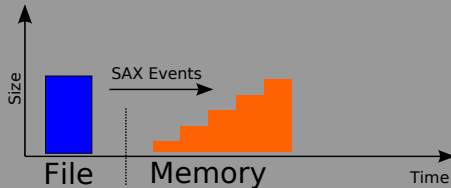
Performance
Size

Memory
Processing

Implementations

Overview
ParaView
libfi

- Start with large file size
- Event driven XML parser (SAX) generates one event per element
- Max. Memory overhead is size of one element



FI Performance

Memory - FI

Fast Infoset (FI)
encoding for X3D

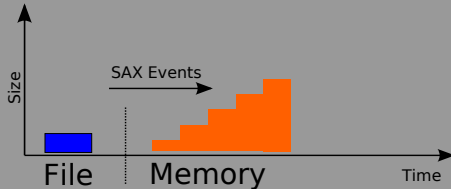
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Fast Infoset
How does FI
work?
Example
Result

Performance
Size
Memory
Processing

Implementations
Overview
ParaView
libfi

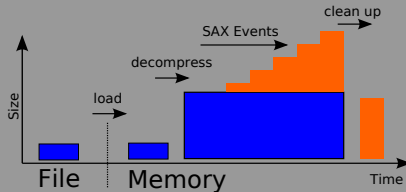
- Start with small file size
- Event driven XML parser (SAX) generates one event per element
- Max. Memory overhead is size of one element + overhead for decompression



FI Performance

Memory - ZIP

- Start with small file size
- Load file into memory
- Decompress file into memory
- Max. Memory overhead is size of decompressed file + size of one element



Fast Infoset (FI)
encoding for X3D

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Fast Infoset
How does FI
work?

Example
Result

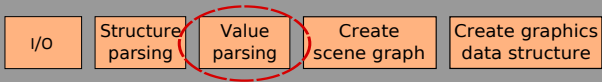
Performance
Size

Memory
Processing

Implementations
Overview
ParaView
libfi

FI Performance

Processing speed



Fast Infoset (FI)
encoding for X3D

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

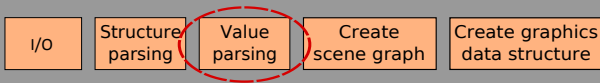
Overview

ParaView

libfi

FI Performance

Processing speed



- 4-7x faster than XML processing
- Depends on XML parser
- Performance boost: No value parsing required

Fast Infoset (FI)
encoding for X3D

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

Implementations

Overview

■ Xj3D

Fast Infoset (FI)
encoding for X3D

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How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

Implementations

Overview

Fast Infoset (FI)
encoding for X3D

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- Xj3D
- InstantReality (partly)

Implementations

Overview

Fast Infoset (FI)
encoding for X3D

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- Xj3D
- InstantReality (partly)
- X3Db Exporter in VTK and ParaView

Implementations

Overview

Fast Infoset (FI)
encoding for X3D

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Fast Infoset
How does FI
work?
Example
Result

Performance
Size
Memory
Processing

Implementations

Overview
ParaView
libfi

- Xj3D
- InstantReality (partly)
- X3Db Exporter in VTK and ParaView
- XIOT (X3D I/O Toolkit)
 - Funded by EDF R&D in the context of the COLLAVIZ project
 - Provide API that is encoding independent
 - Supports XML and FI encoding
 - Open Source (LGPL)
 - Used in third party products
 - <http://forge.collaviz.org/community/xiot>

Implementation

XIOT - X3D I/O Toolkit

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encoding for X3D

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Fast Infoset

How does FI
work?

Example

Result

Performance

Size

Memory

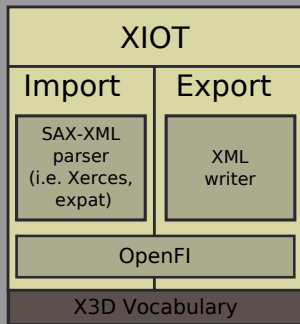
Processing

Implementations

Overview

ParaView

libfi



Implementations

Overview

Fast Infoset (FI)
encoding for X3D

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Fast Infoset
How does FI
work?
Example
Result

Performance
Size
Memory
Processing

Implementations

Overview
ParaView
libfi

- Xj3D
- InstantReality (partly)
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Implementations

Overview

Fast Infoset (FI)
encoding for X3D

Kristian Söns

Fast Infoset
How does FI
work?
Example
Result

Performance
Size
Memory
Processing

Implementations

Overview
ParaView
libfi

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 - Funded by EDF R&D in the context of the COLLAVIZ project
 - Provide API that is encoding independent
 - Supports XML and FI encoding
 - Open Source (LGPL)
 - Used in third party products
 - <http://forge.collaviz.org/community/xiot>
- jXIOT (Java-port of XIOT reader)

Implementations

ParaView X3D(b) import

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Fast Infoset
How does FI
work?
Example
Result

Performance
Size
Memory
Processing

Implementations
Overview
ParaView
libfi

- Added XIOT as third party library
- Uses (vtk-)expat for UTF-8 XML parsing
- Easy for VTK: Build up VTK scene graph including geometry, shading and textures
- Not applicable for ParaView
 - Content pipeline and representations run on different servers
 - Source can not have dynamic number of input geometries
 - Solution:
 - Source imports one (selectable) geometry
 - Use python script to import whole file

Implementation

libfi

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Fast Infoset

How does FI
work?

Example
Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

- Implementation of Fast Infoset parser
- Independent of X3D
- Aims to support the whole standard
- Open Source (Apache License 2.0)
- <http://sourceforge.net/projects/libfi>

The End

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work?

Example

Result

Performance

Size

Memory

Processing

Implementations

Overview

ParaView

libfi

Thank you for your attention!

Kristian Sons

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