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COMPUTATIONAL RESEARCH DIVISION

A Quantitative Comparison of Binary XML Encodings

Wolfgang Hoschek

Lawrence Berkeley National Laboratory

whoschek@lbl.gov

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Outline

- XML established for interop. data exchange
- Grid and Web services
  - Large numbers of XML messages at high frequency
  - XML serialization & deserialization bottlenecks
    - Markup verbose in size
    - Expensive to produce and parse
    - ➢ Restricts XML adoption
  - Alternative: Binary XML?
- Novel binary XML encoding (*bnux*)
- Quantitative evaluation
  - Production-quality XML and Binary XML toolkits
  - Tree and streaming deserialization, serialization, compression

CRD Bnux Properties

- Faithful to XML
  - General purpose
  - Preserves all information without loss or change
  - Preserves W3C XML InfoSet and W3C Canonical XML
- Self-contained
  - No external resources required (e.g. no schema)
- Tree and streaming deserialization mode
  - For end user applications and filter pipelines
- Tunable for either performance or size
  - High vs. low bandwidth networks
  - Moderate compression via simple FAST means (tokenization)
  - Additional strong GZIP (ZLIB) compression (optional)
- Production quality implementation
  - Serialization of XOM XML object model (~DOM)
  - http://dsd.lbl.gov/nux

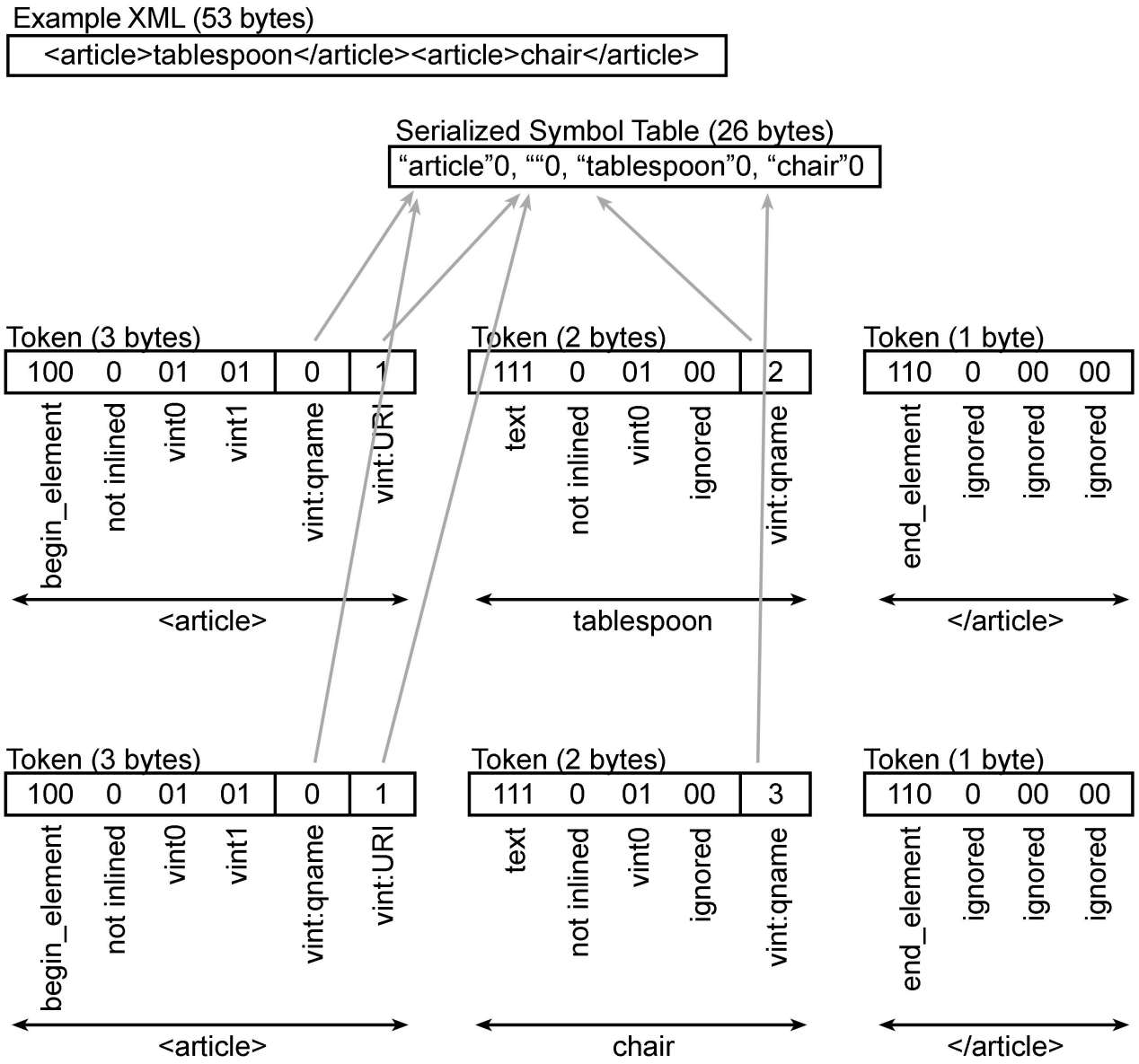
CRD Bnux Data Format

- Serialization

- Extract unique symbols (strings) via hash table
- Sort symbols by frequency (top N)
- Encode symbol table as zero terminated UTF8
- Encode each XML node as binary token, with compact pointers into symbol table (Vint)

- Deserialization

- Decode UTF-8 symbol table
- Decode tokens, hand info to app handler (e.g. type, prefix, name, URI)



Experiments / Methodology

- **Workloads: 60 distinct test document flavours**
  - Wide range of real-world documents
  - File size
    - Small (0.2 - 1 KB), medium (1KB - 4 MB), large (4 - 100 MB)
  - Documents
    - Messaging-oriented, record-oriented (database), narrative text
    - E.g. WSDL, SOAP, RSS, ATOM, DB, Shakespeare, P2PIO, …
  - With and without namespaces, attributes, whitespace, repetitions, nesting depth, …
- **Memory-to-memory tests (no I/O perturbation)**
- **Setup**
  - Sun Java 1.5.0_04, server VM, PentiumIV Xeon@2.8 Ghz, 2GB memory, Linux 2.4.20
  - xom-1.1, nux-1.4, saxonb-8.5.1, java.net-fastinfoset-CVS (ISO/ITU), xerces-2.7.1 for SAX and DOM, woodstox-2.0.2 for STAX

CRD XML Models Studied

Model	Description
xom-NV	XOM via SAX/Xerces with XML verification performed by Xerces. **Comparison baseline** for tree speedup**.**
xom-V	Same as xom-NV except with XML verification performed by XOM instead of Xerces. More expensive than xom-NV
saxon	Saxon tinytree model with shared namepool (via SAX/Xerces)
dom	Xerces Document Object Model without "deferred node expansion"
bnux0	Bnux binary XML with XML verification; no GZIP compression
bnux0-NV	Same as bnux0, except that PCDATA verification is omitted
bnux1	Same as bnux0, plus weak GZIP compression at level 1
bnux9	Same as bnux0, plus strong GZIP compression at level 9
fi0	FastInfoset binary XML with default indexing (via SAX)
fi1	FastInfoset binary XML with "full indexing" feature (via SAX)
xom-NNF	**Streaming** XOM via SAX/Xerces with NullNodeFactory handler, throwing away all data, building an empty tree instead. **Comparison baseline** for streaming speedup.
bnux0-NNF	Same as xom-NNF except that bnux0 is used; no verification
fi0-NNF	Same as xom-NNF except that fastinfoset is used

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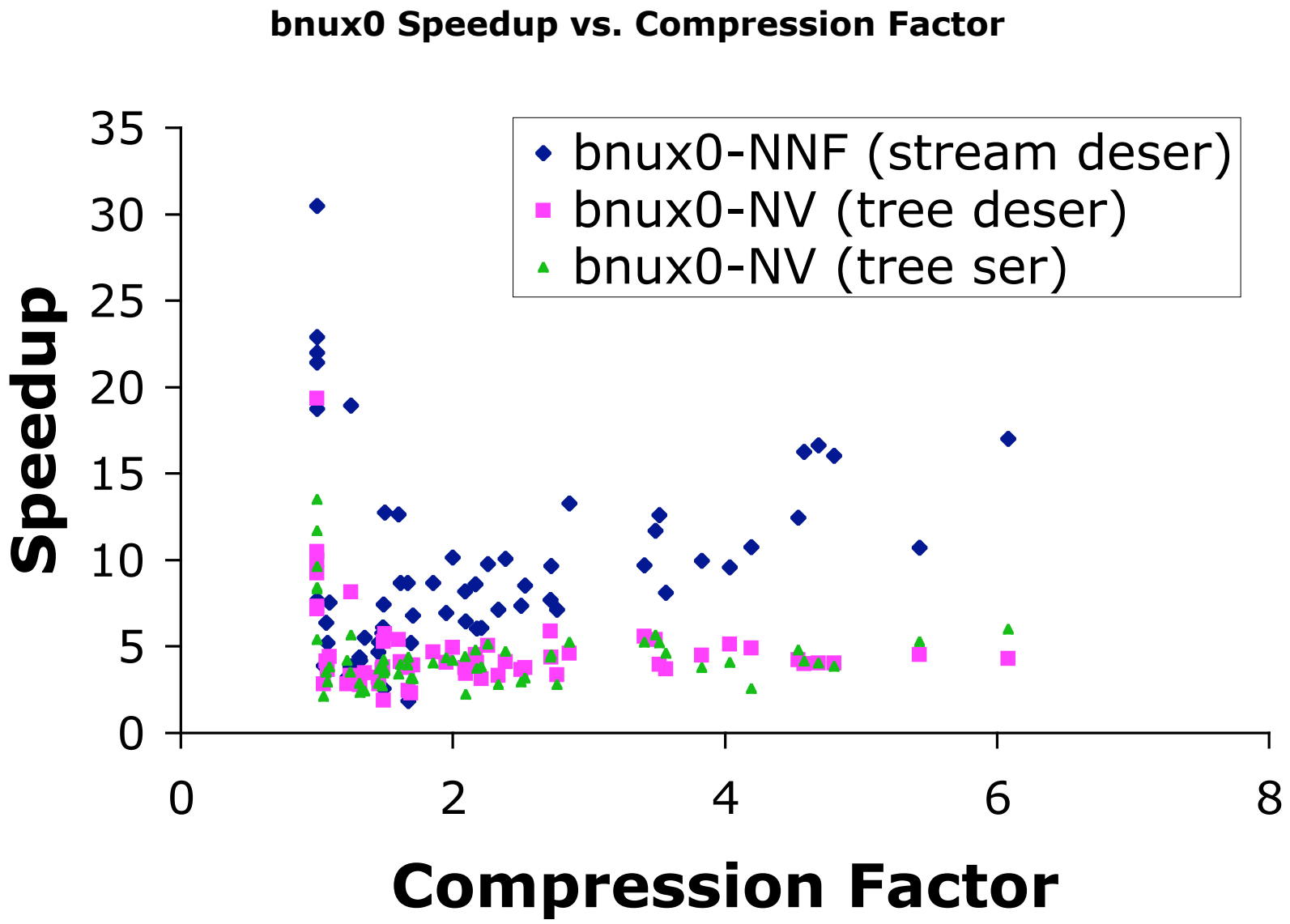
bnux0 Speedup vs. Compression Factor



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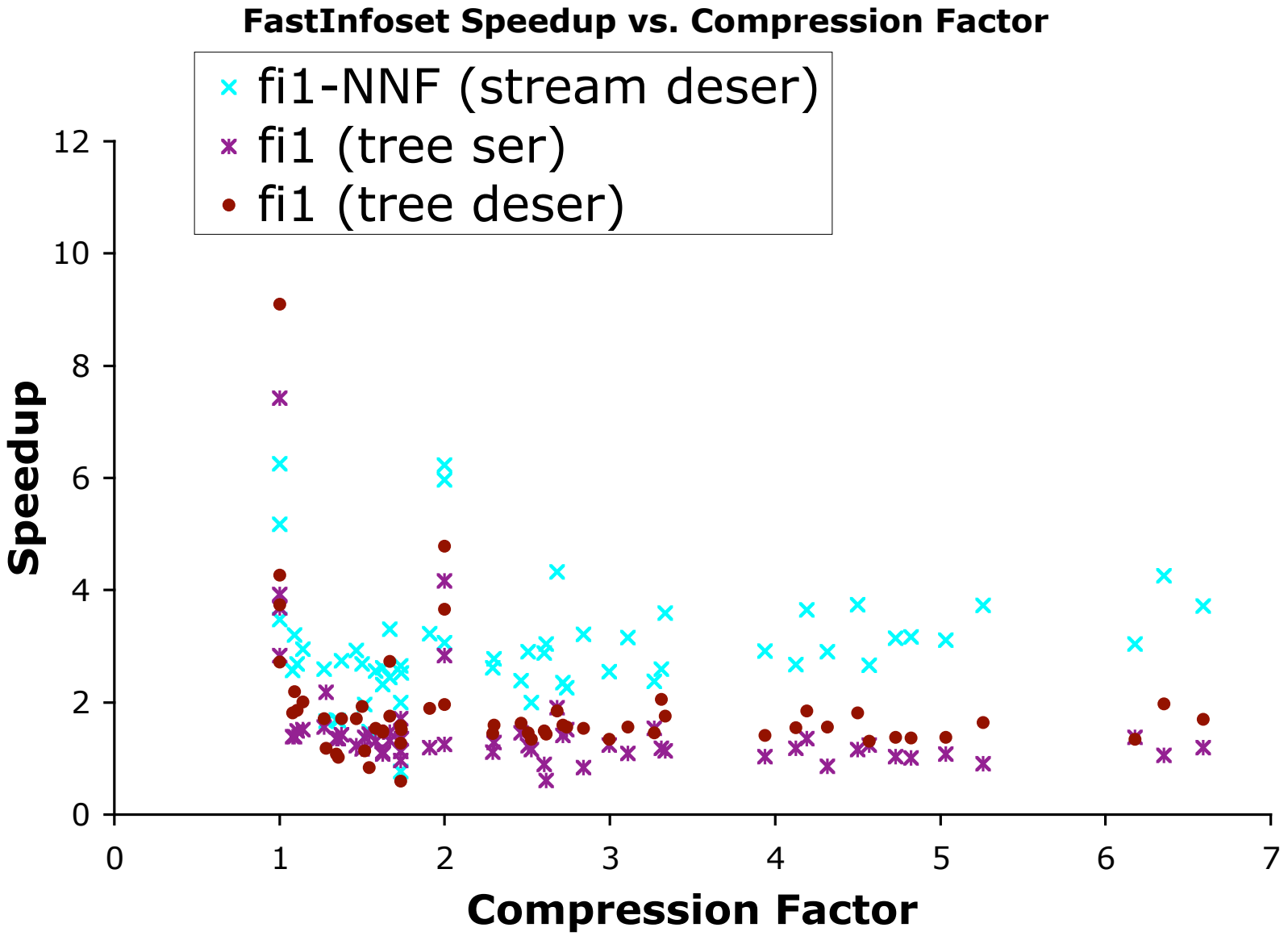
FastInfoset Speedup vs. Compression Factor



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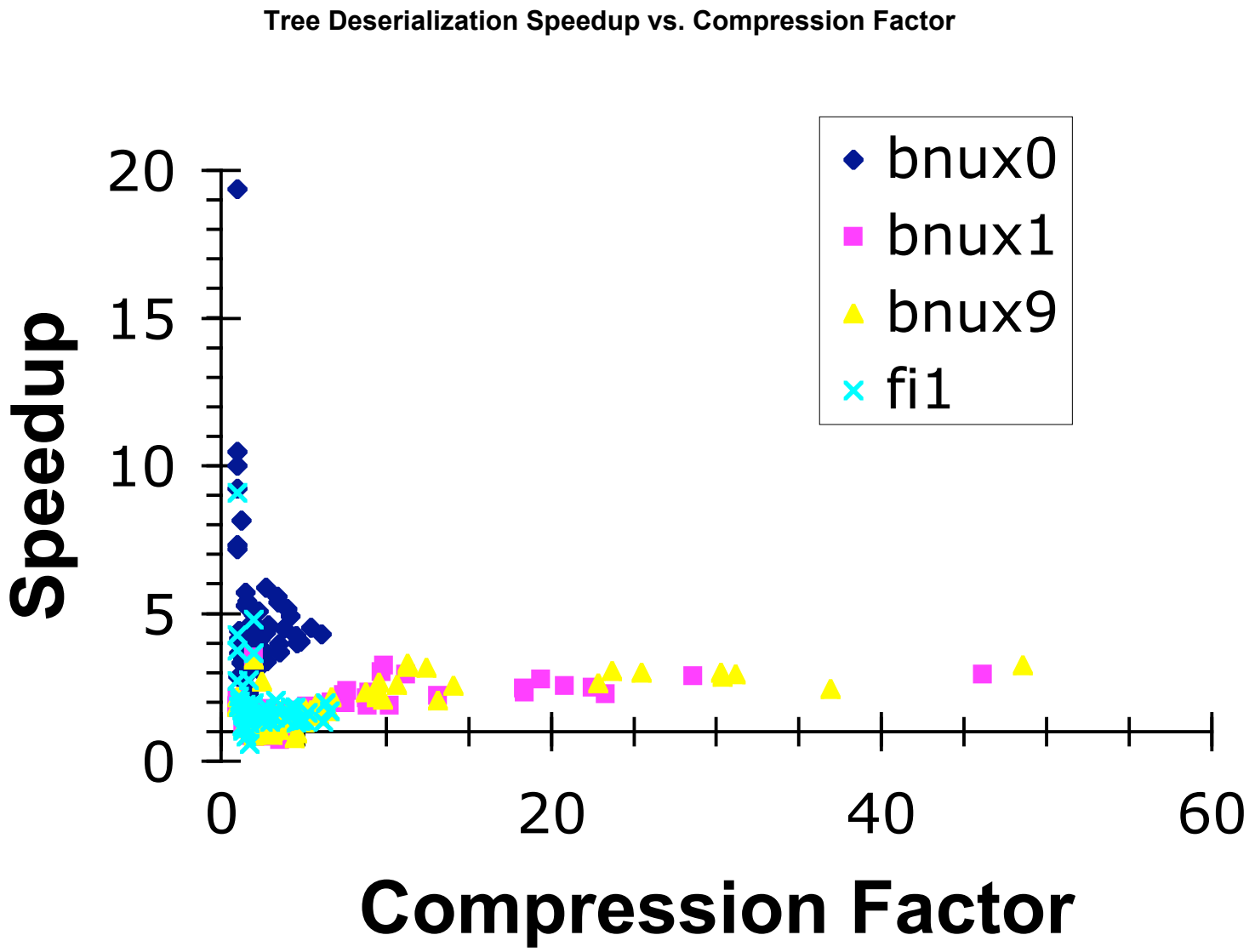
Tree Deserialization Speedup vs. Compression Factor



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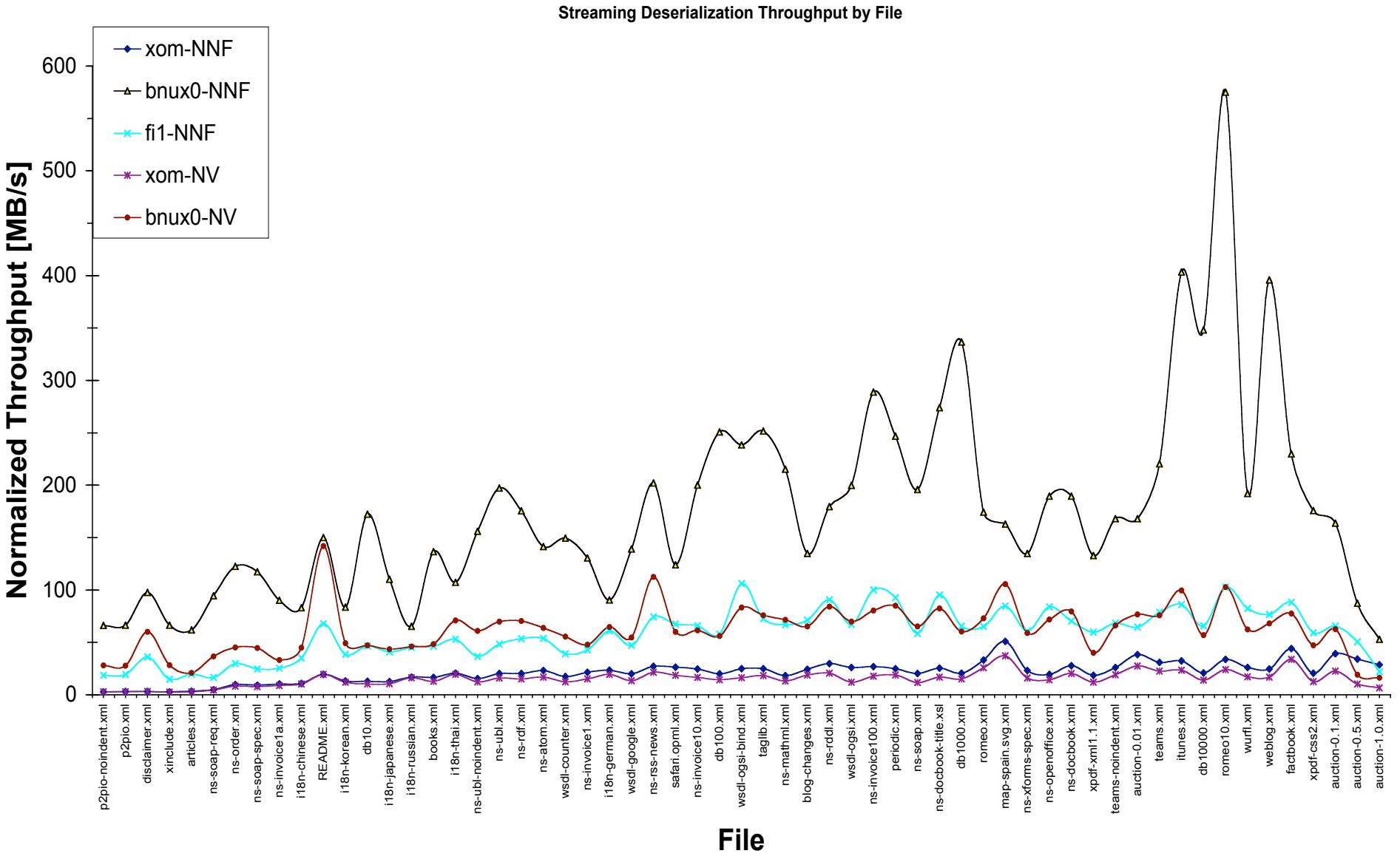
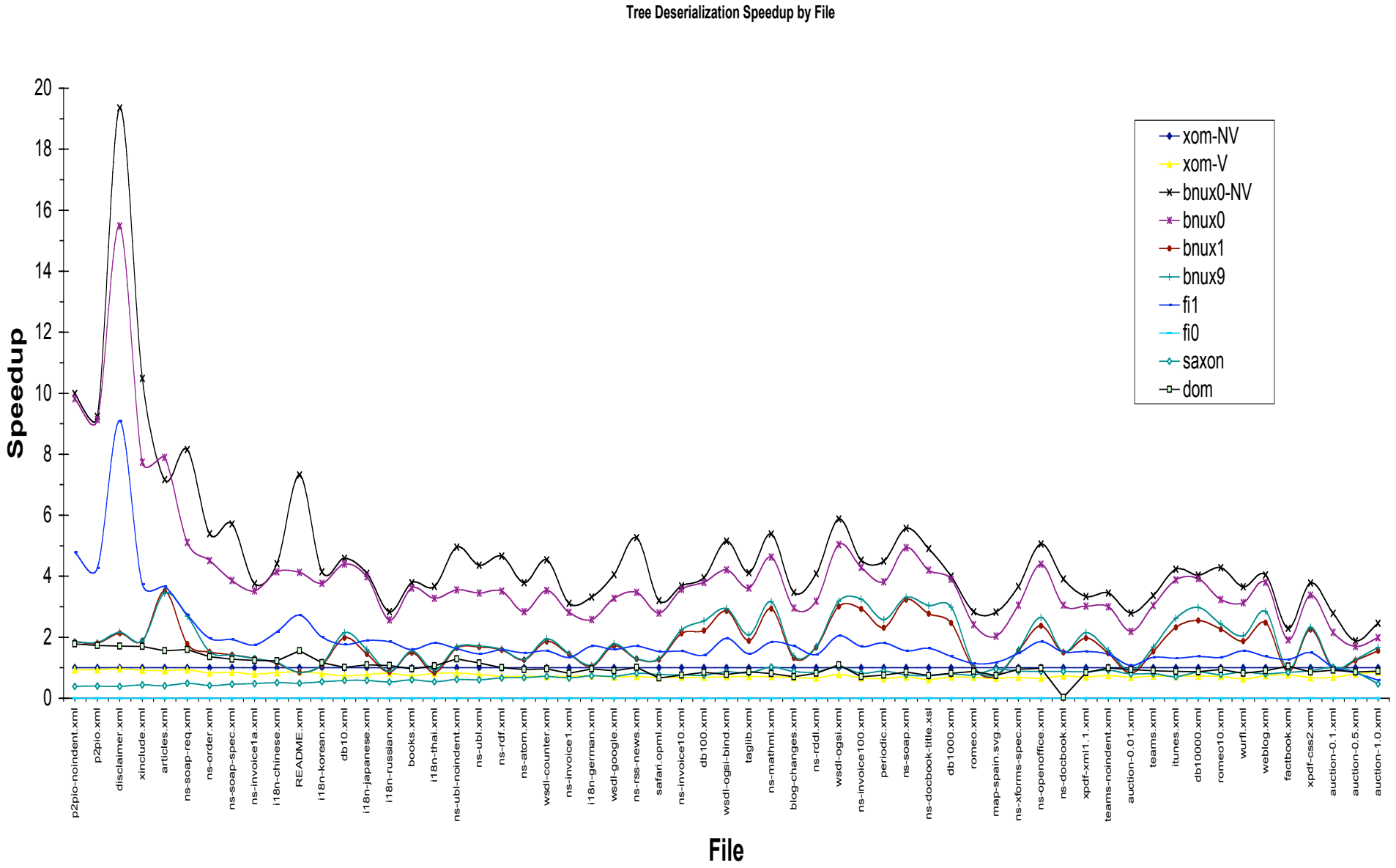
Streaming Deserialization Throughput



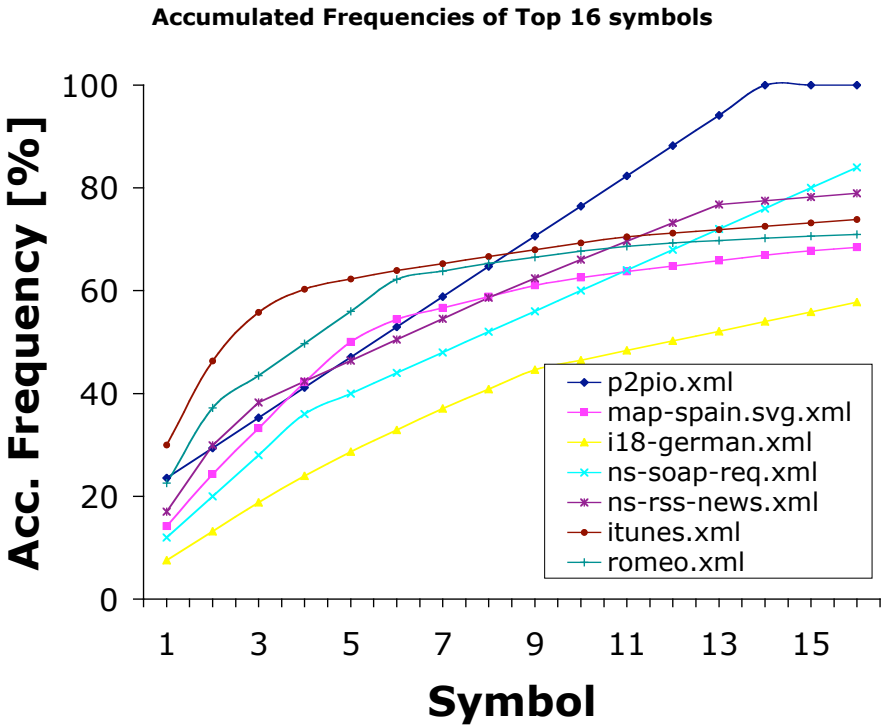
CRD Tree Deserialization Speedup



Conclusions

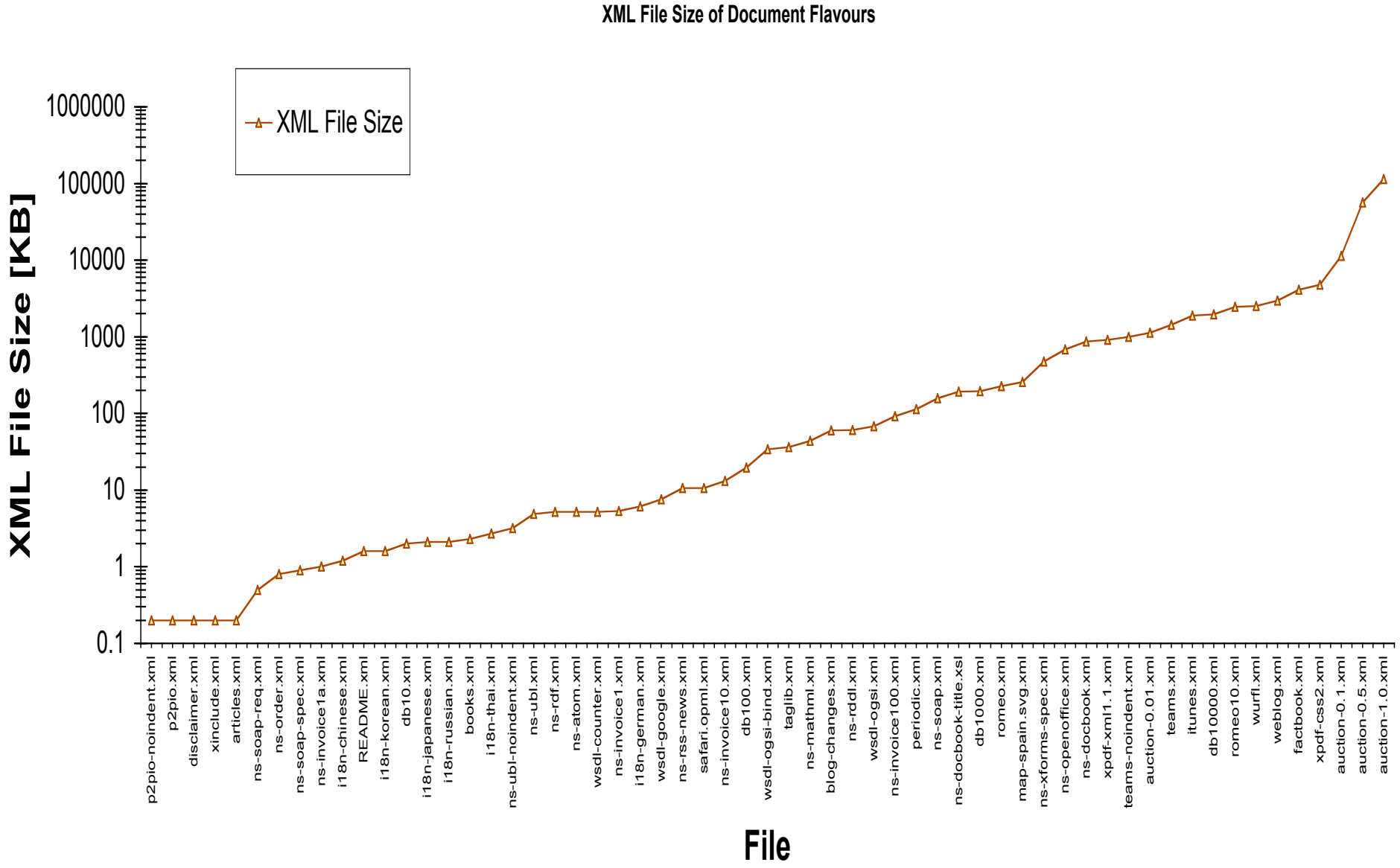
- Standard textual XML satisfactory for many commodity use cases
  - But requires non-intuitive configuration wizardry
- Binary XML significantly faster for demanding data-intensive use cases
  - Small to medium sized messages: 5-20x
  - Large variance stemming from document flavour
- Moderate compression via tokenization (1-5x) is fast
- Strong compression via GZIP (5-50x) is too slow
- Trading efficiency for standardization?
- Input for potential W3C standardization?

Backup slides



File	Compression Factor	Streaming Deser Speedup	XML File Size [KB]	Unique Symbols [%]
p2pio.xml	1	21.4	0.2	92.6
map-spain.svg.xml	1.2	3.2	258.4	81.5
i18n-german.xml	1.2	3.8	6.1	64.1
ns-soap-req.xml	1.3	18.9	0.5	80
ns-rss-news.xml	1.5	7.4	10.6	57.3
romeo.xml	1.5	5.2	228.2	97
itunes.xml	4.5	12.4	1882	83.7
romeo10.xml	6	17	2470	0.1

CRD XML File Size of Document Flavours



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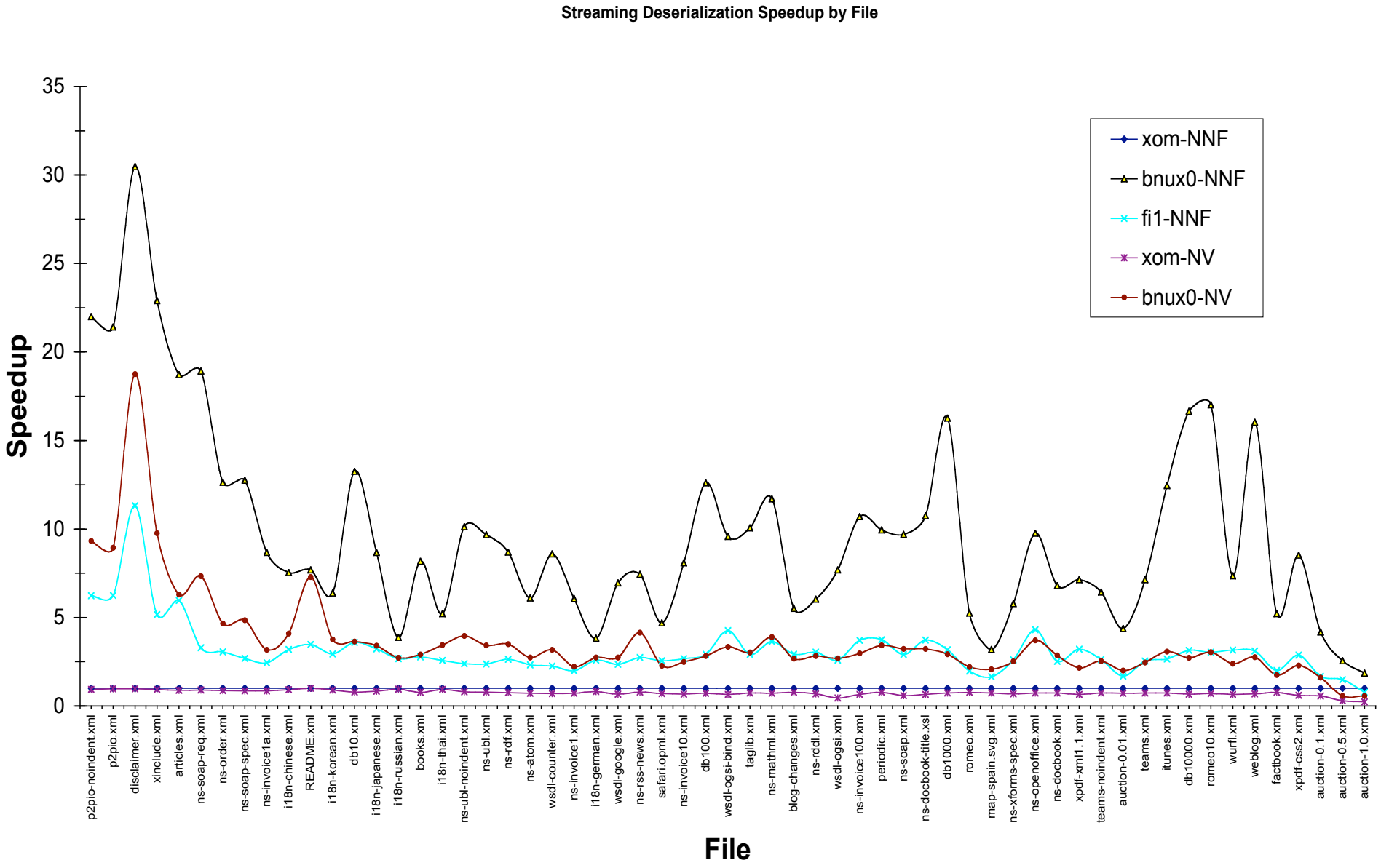
Streaming Deserialization Speedup



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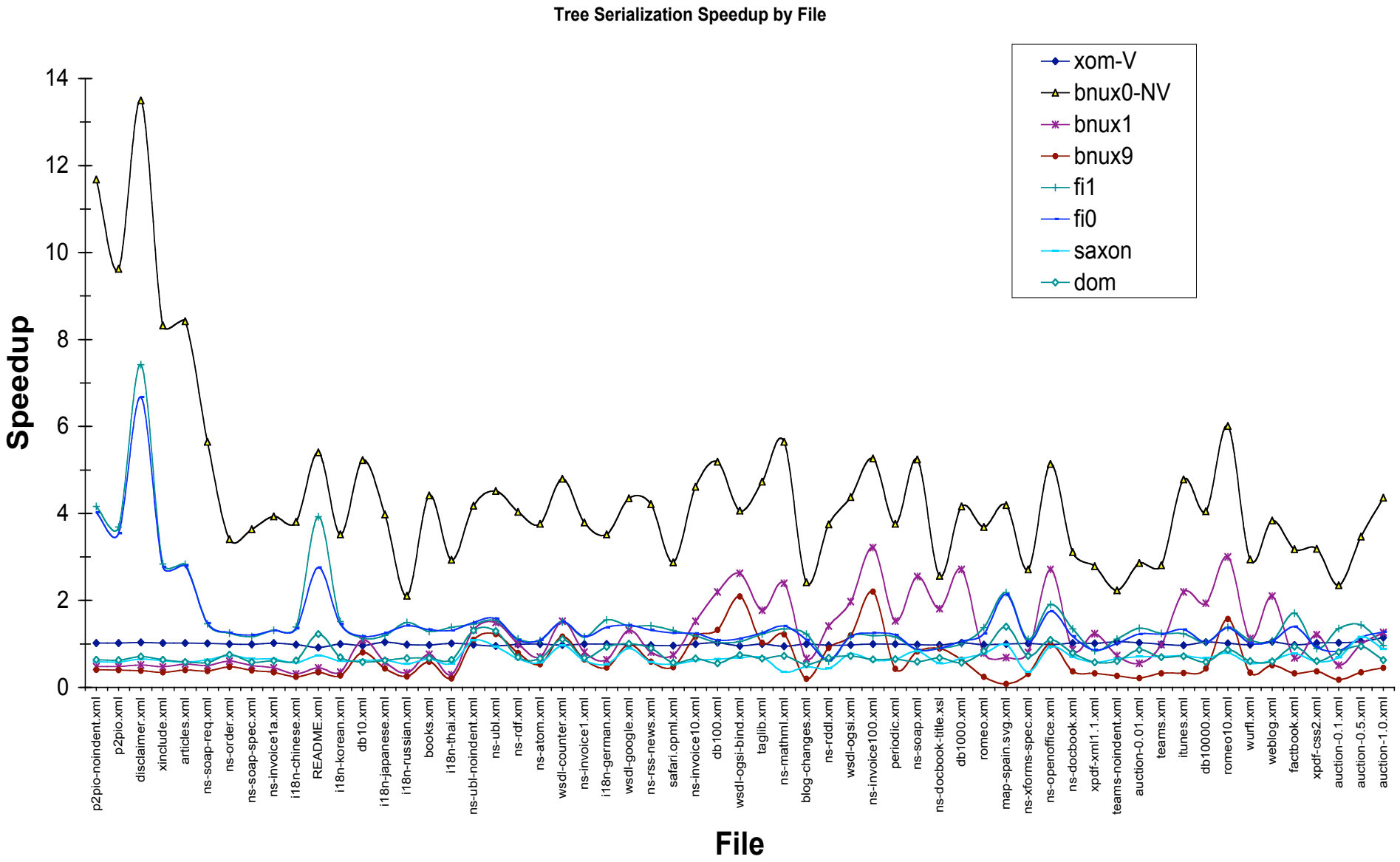
Tree Serialization Speedup



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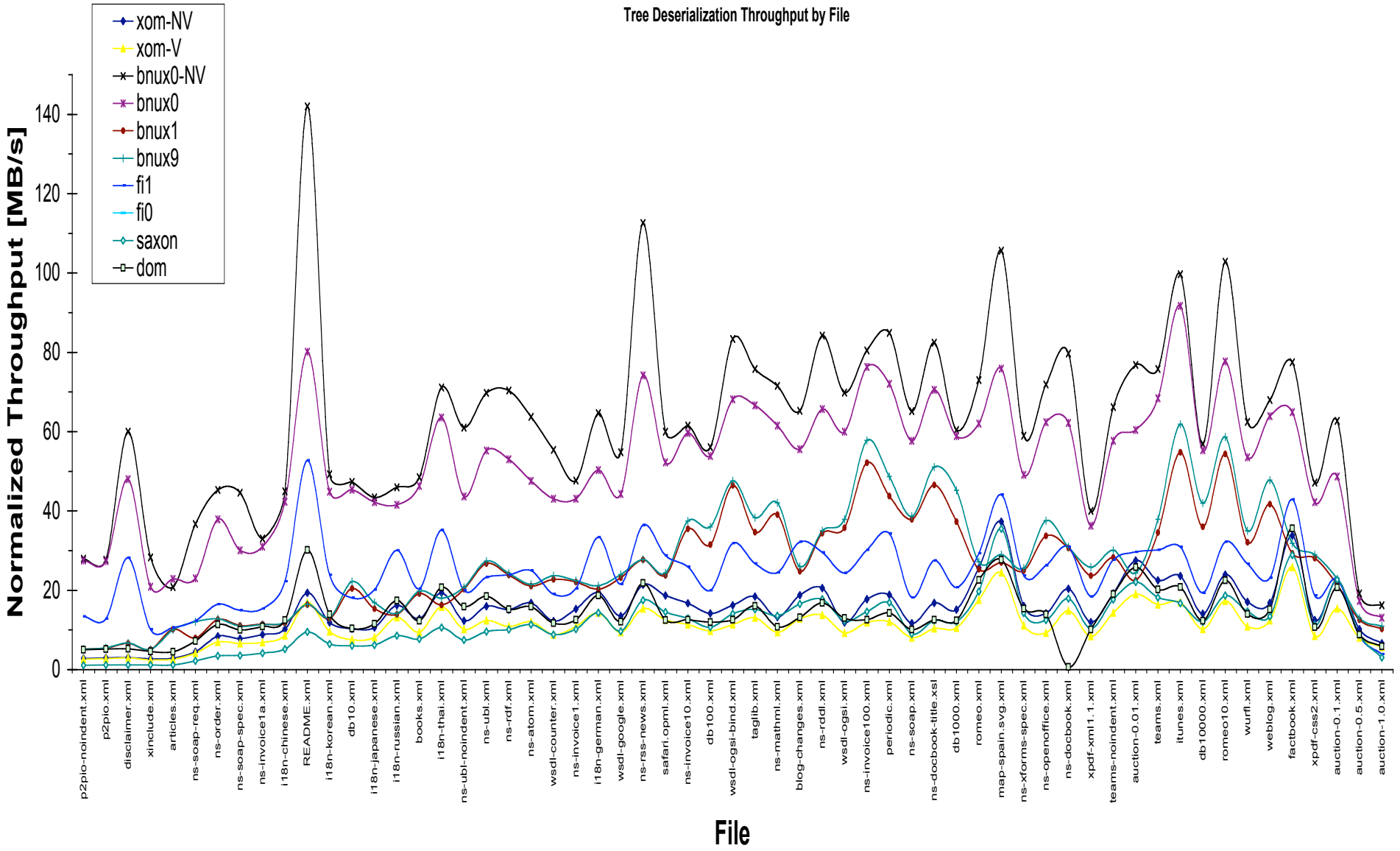
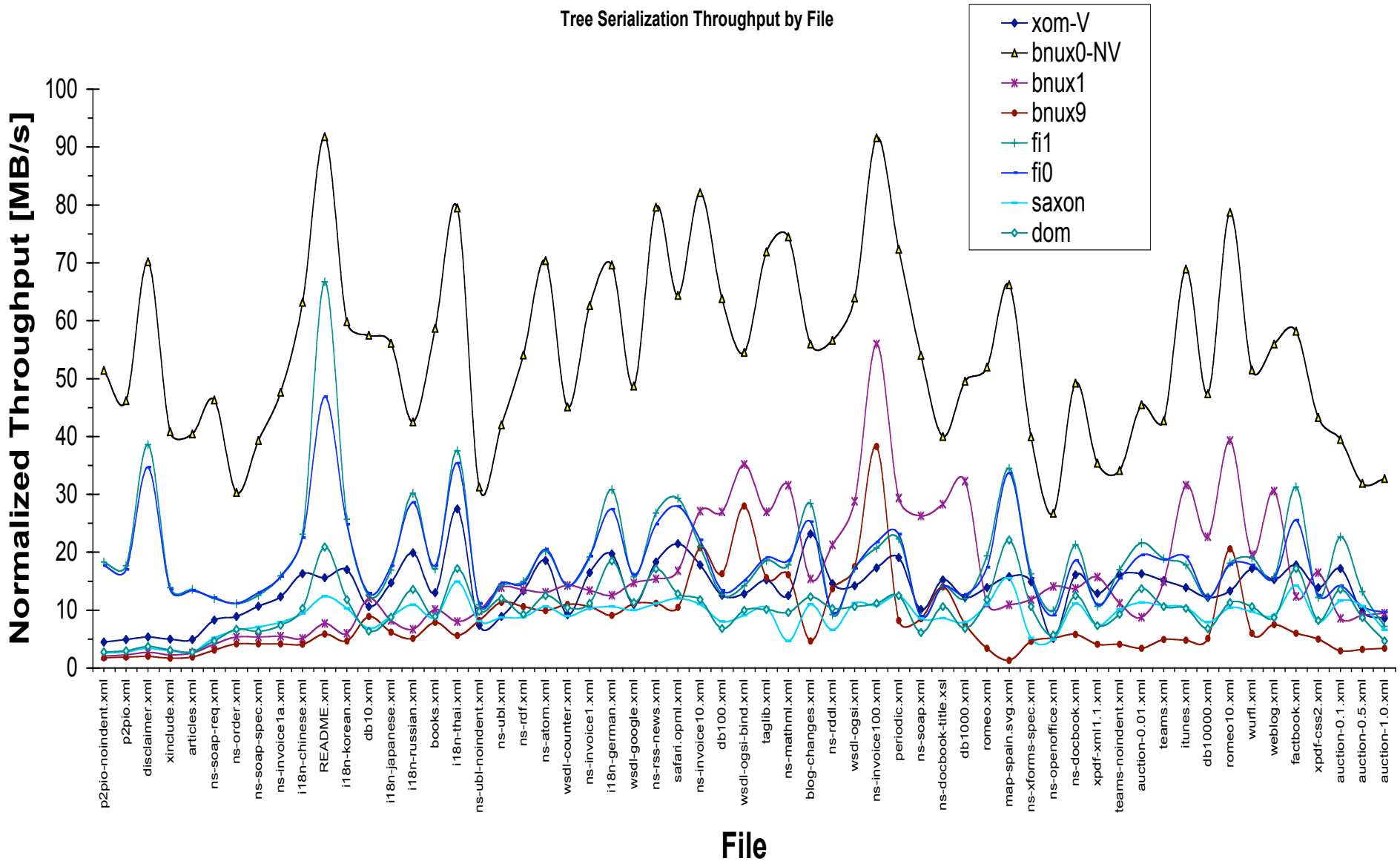
Tree Deserialization Throughput



CRD Tree Serialization Throughput



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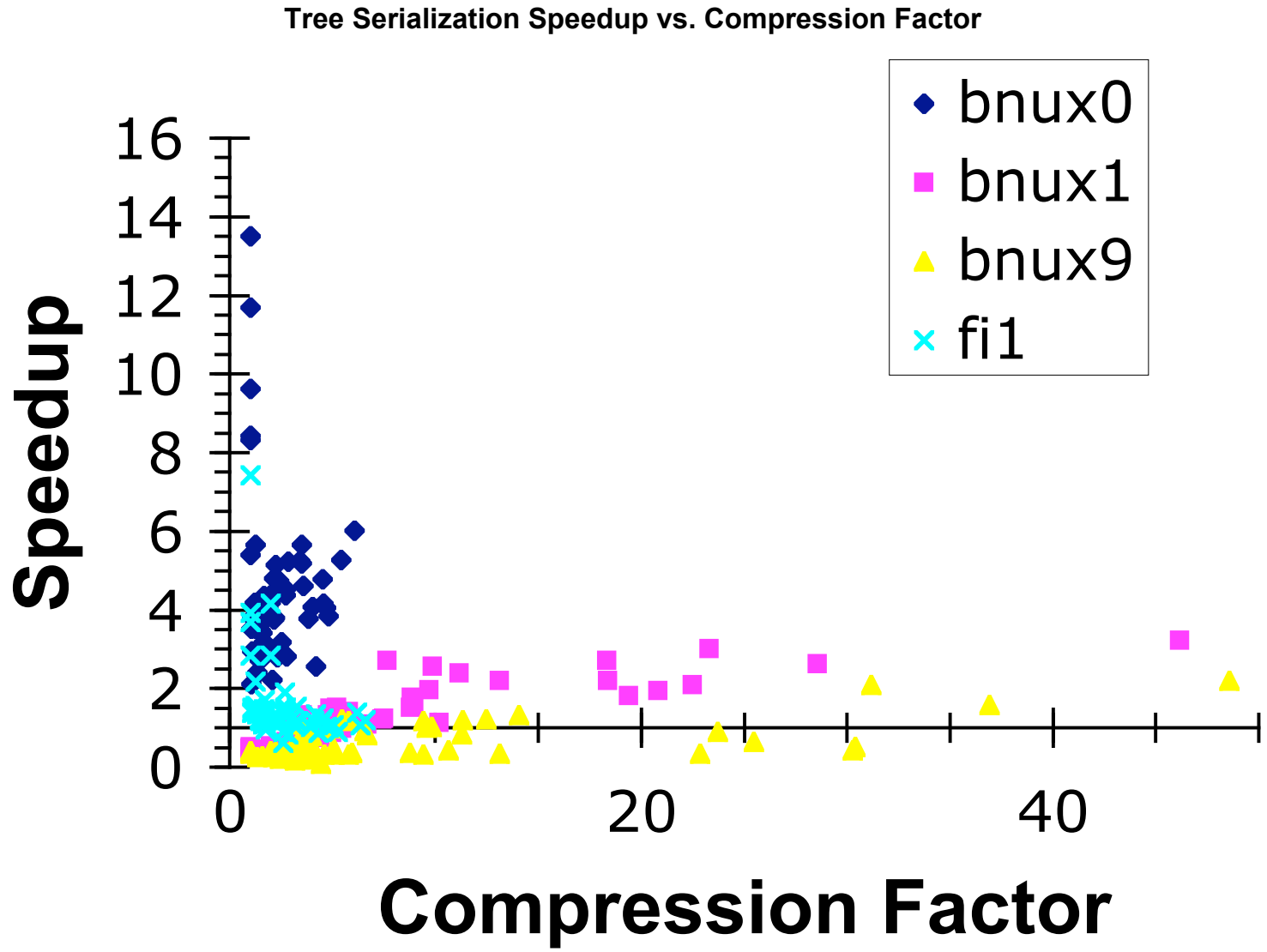
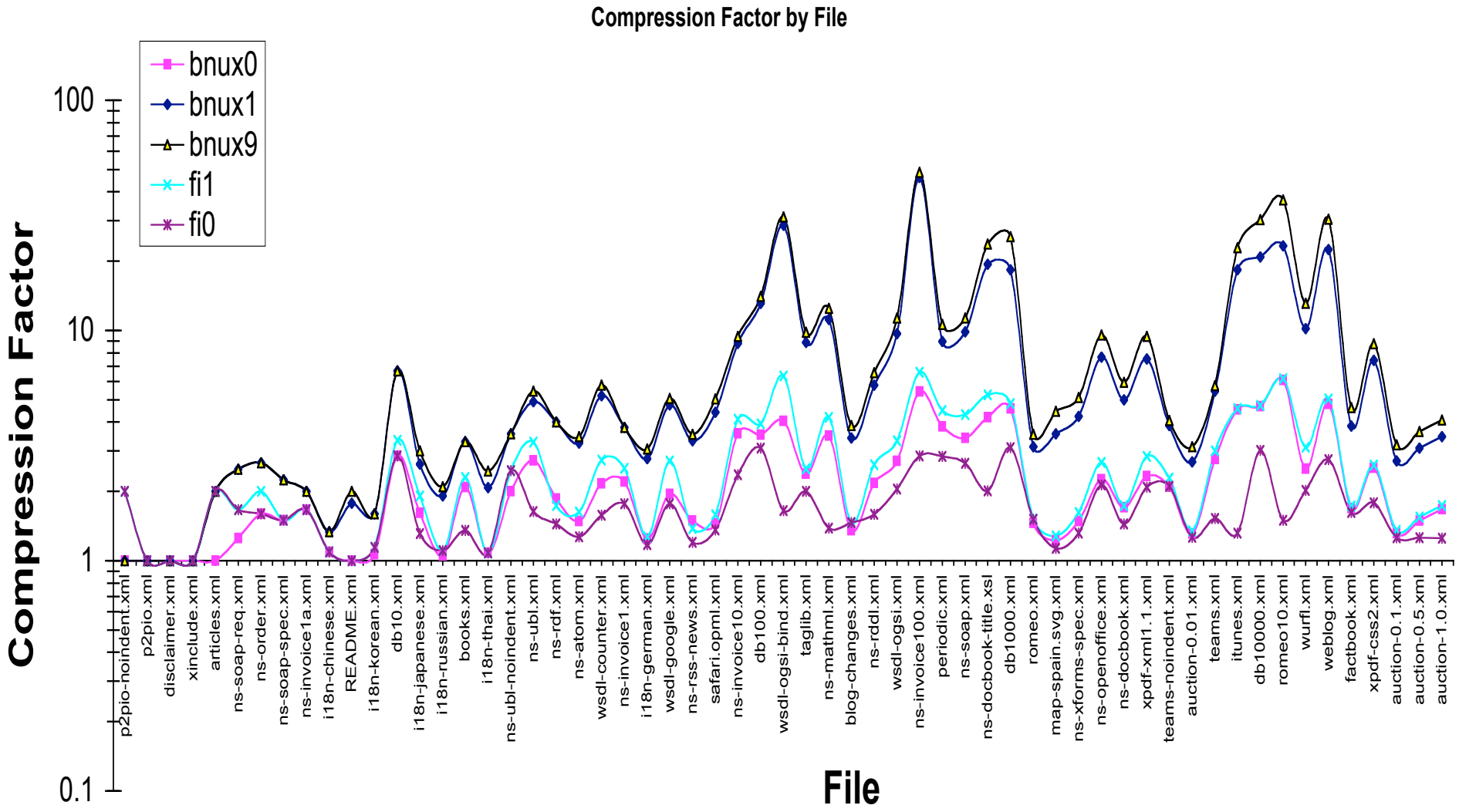
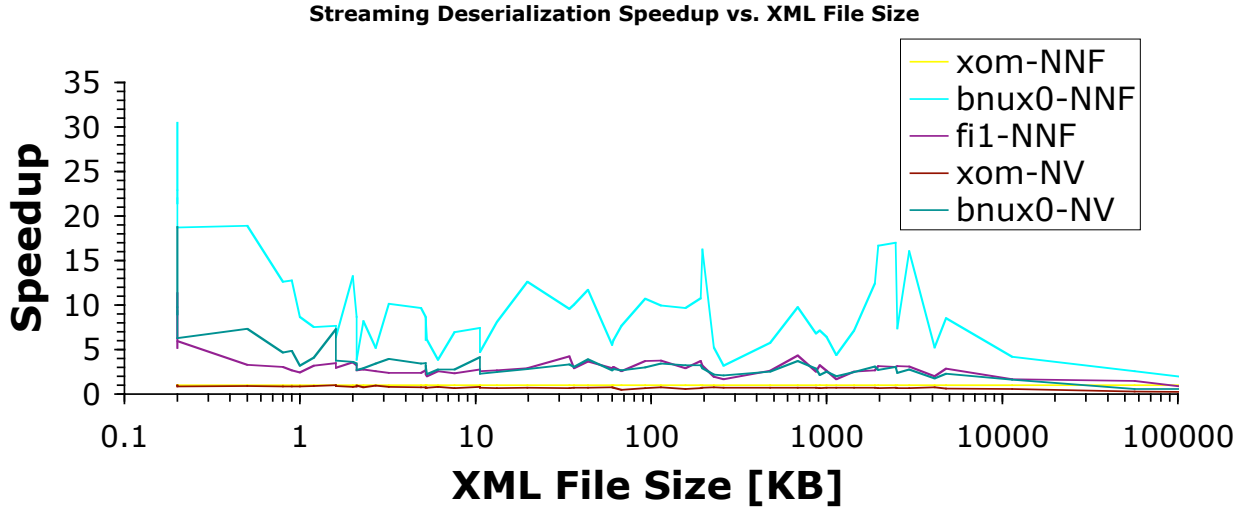
Tree Serialization Speedup vs. Compression Factor

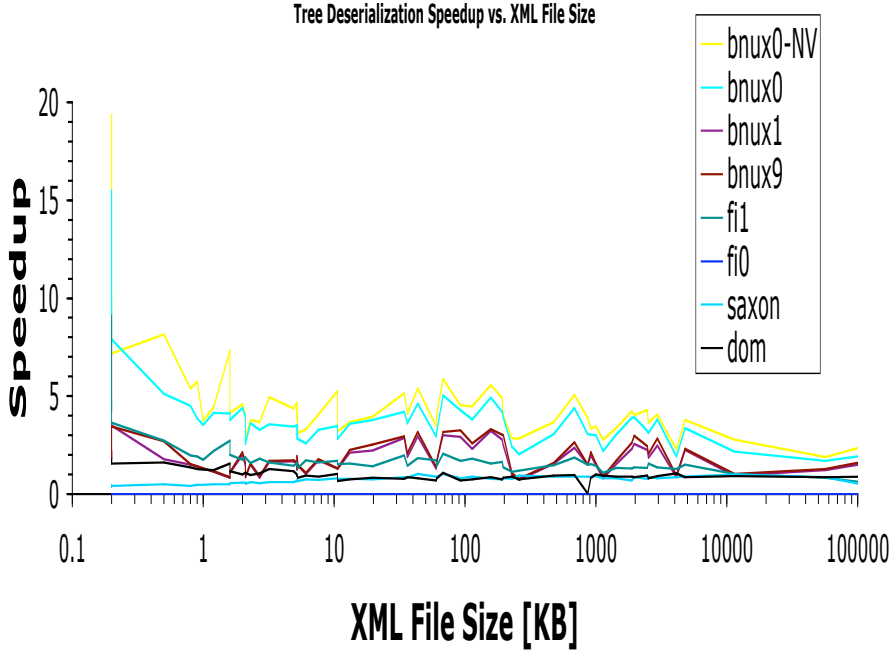


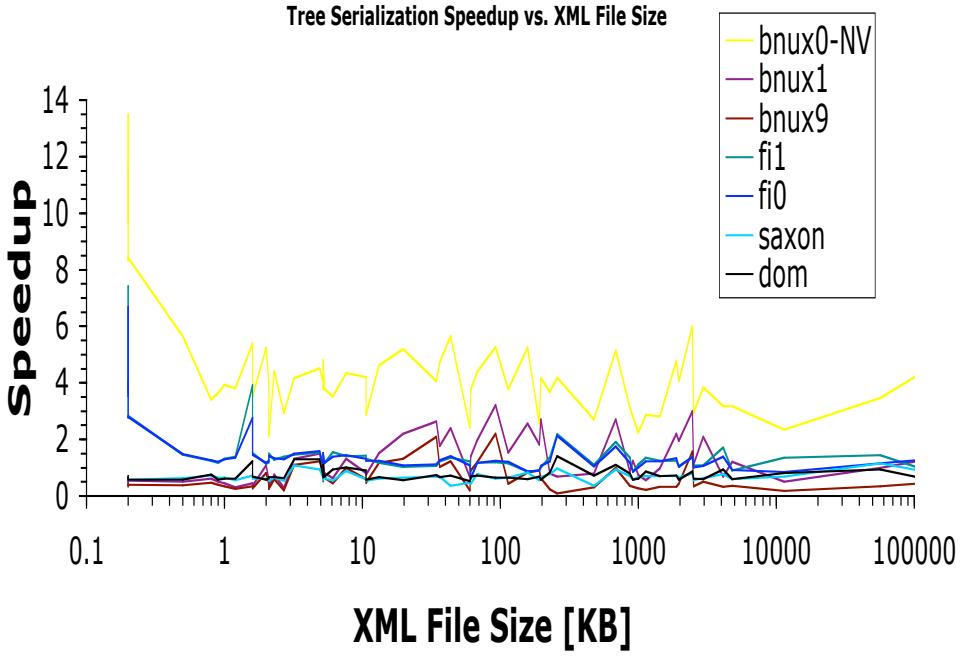
Backup


Compression Factor by File
bnux0
bnux1
bnux9
fi1
fi0
Compression Factor
100
10
1
0.1
File
p2pio-noindent.xml
p2pio.xml
disclaimer.xml
xinclude.xml
articles.xml
ns-soap-req.xml
ns-order.xml
ns-soap-spec.xml
ns-invoice1a.xml
i18n-chinese.xml
README.xml
i18n-korean.xml
db10.xml
i18n-japanese.xml
i18n-russian.xml
books.xml
i18n-thai.xml
ns-ubl-noindent.xml
ns-ubl.xml
ns-rdf.xml
ns-atom.xml
wsdl-counter.xml
ns-invoice1.xml
i18n-german.xml
wsdl-google.xml
ns-rss-news.xml
safari.opml.xml
ns-invoice10.xml
db100.xml
wsdl-ogsi-bind.xml
taglib.xml
ns-mathml.xml
blog-changes.xml
ns-rddl.xml
wsdl-ogsi.xml
ns-invoice100.xml
periodic.xml
ns-soap.xml
ns-docbook-title.xsl
db1000.xml
romeo.xml
map-spain.svg.xml
ns-xforms-spec.xml
ns-openoffice.xml
ns-docbook.xml
xpdf-xml1.1.xml
teams-noindent.xml
auction-0.01.xml
teams.xml
itunes.xml
db10000.xml
romeo10.xml
wurfl.xml
weblog.xml
factbook.xml
xpdf-css2.xml
auction-0.1.xml
auction-0.5.xml
auction-1.0.xml

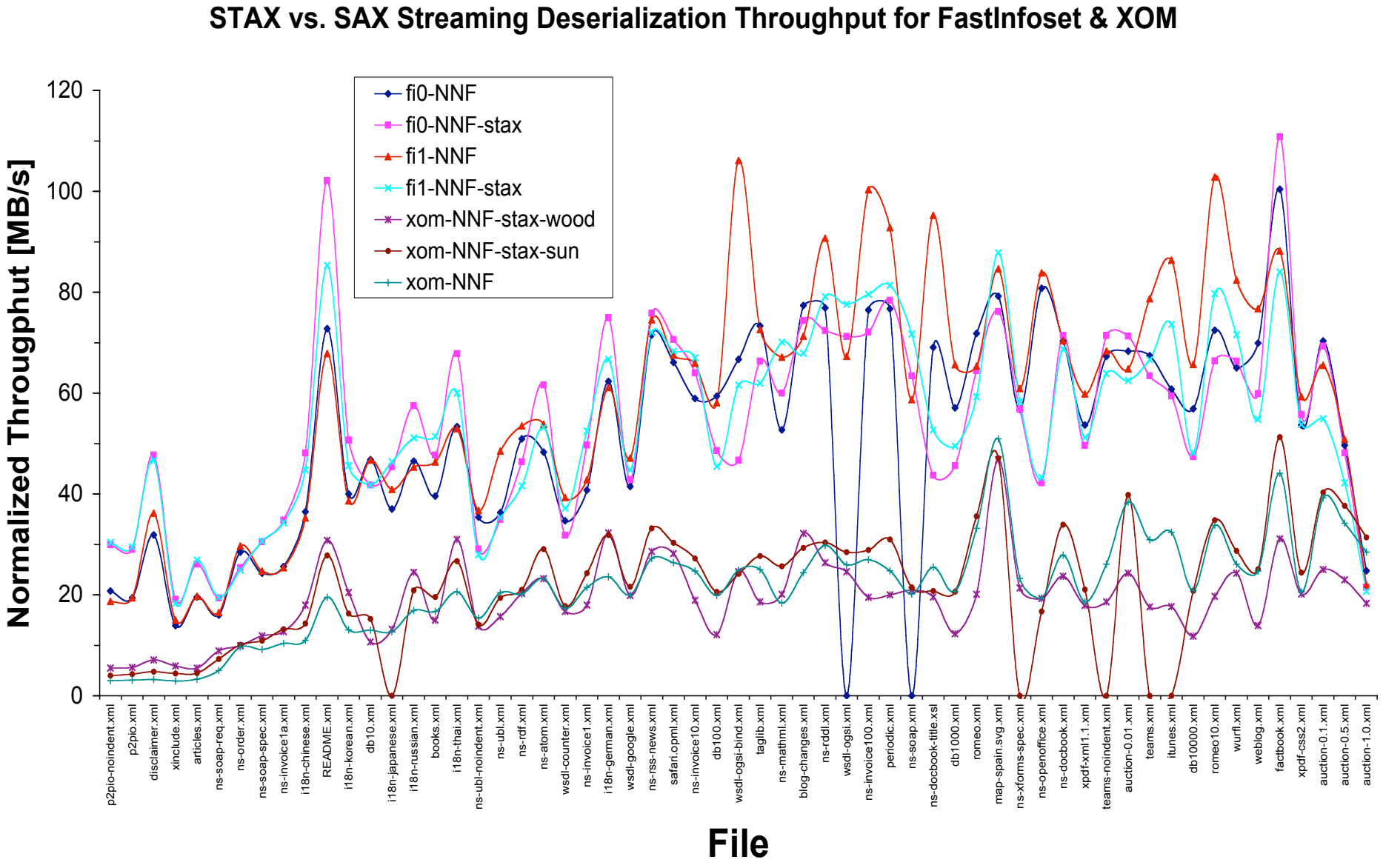
Backup


Streaming Deserialization Speedup vs. XML File Size
Speedup
35
30
25
20
15
10
5
0
0.1
1
10
100
1000
10000
100000
XML File Size [KB]
xom-NNF
bnux0-NNF
fi1-NNF
xom-NV
bnux0-NV


Tree Deserialization Speedup vs. XML File Size
Speedup
20
15
10
5
0
0.1
1
10
100
1000
10000
100000
XML File Size [KB]
bnux0-NV
bnux0
bnux1
bnux9
fi1
fi0
saxon
dom


Tree Serialization Speedup vs. XML File Size
Speedup
14
12
10
8
6
4
2
0
0.1
1
10
100
1000
10000
100000
XML File Size [KB]
bnux0-NV
bnux1
bnux9
fi1
fi0
saxon
dom

CRD STAX vs. SAX Streaming Deser. for FastInfoset & XOM



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STAX vs. SAX Tree Deser. for FastInfoset & XOM

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