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Using NFFI Web Services on the tactical level: An evaluation of compression techniques

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Outline

- Motivation
- NFFI
- XML / binary XML
- Reducing overhead
  - compression
- Evaluation
- Summary

Motivation

- The aim of NEC is to increase mission effectiveness
  - networking military entities
  - enhancing information sharing and situational awareness
- Blue force tracking is recognized as one of the most important aspects of NEC.
  - NATO friendly force tracking information; NFFI
    - Part of the specification is an XML schema;
    - allows using a Web service

Motivation

- Interoperability at all levels
  - Use XML at the tactical level
    - bandwidth is scarce, use compression
- NATO CWID 2007
  - We have evaluated different compression techniques
    - NFFI XML tracks was our experiment case

NATO Friendly Force Information (NFFI)

- NFFI blue force tracking
  - simplified alternative to Command and Control Information Exchange Data Model (C2IEDM)
  - Current version is 1.3 as published in draft STANAG 5527.
- Mandatory data in an NFFI message
  - position data (longitude, latitude, altitude)
  - velocity
  - ID (name and text string; APP-6A/Mil STD 2525B)
  - status field (operational status)
- Optional fields exist
  - not needed to show the unit on a map.

The importance of XML

- XML is a simple, very flexible text format
- Multiple XML standards, the two most are XML itself, and XML Schema.
- XML Schema
  - Enables validation of XML documents.
  - NFFI defines an XML schema, allowing track information to be represented in a standardized way for exchange.
- In its basic form, *XML can be seen as a structured, human readable way to organize data*.

Towards a standard for binary XML

- Sacrifice human readability for more efficient encoding
- Use another representation of the XML document
  - “binary” or “efficient XML”
- *So far there is no standard for efficient XML*
- Standardization process
  - W3C working group; *Efficient XML Interchange* (EXI)
  - Objective:
    - Develop a specification for an encoding format
    - Illustrate effective implementations of that encoding
  - The group has so far released a working draft.

Reducing communication overhead

- Different means to reduce communication overhead:
  - changing the representation (e.g. the XML schema)
  - discarding information
  - compression
- Our case study was NFFI
  - XML schema defined in the standard
    - keep it as-is and remain compliant
  - NFFI has some mandatory and a lot of optional fields.
    - We removed all optional fields
  - The remaining information was compressed

Compression

- Lossless compression
  - retain the exact representation
- Lossy compression
  - used on data that can tolerate some loss
  - allowed to modify the data
  - higher compression rates than lossless compression
- XML documents
  - All the information must be intact
  - *lossless compression should be used*

Lossless XML compression

- We tested several combinations of lossless compression methods:
  - Generic compression
    - GZIP
  - XML conscious compression methods
    - EFX – generic vs schema specific
    - XMLPPM
- We only looked at compression ratio and not other resource use (memory and CPU usage).
  - bandwidth is the most limited resource in tactical networks

Evalutation: Compressing NFFI XML (sizes in bytes)

#tracks	original size	EFX	XMLPPM	GZIP	EFX + GZIP	EFX own ZIP	XMLPPM + GZIP
1	776	310	275	367	465	286	444
2	1429	353	315	392	522	313	496
3	2082	396	340	412	546	339	525
4	2738	460	385	460	611	372	581
5	3394	514	411	484	664	384	614
6	4041	560	430	500	715	397	638
7	4697	614	449	514	774	409	665
8	5353	668	468	529	839	417	686
9	6000	714	485	540	893	423	706
10	6656	768	502	554	915	431	730
11	7304	824	540	593	971	463	777
12	7960	879	558	615	994	472	797
13	8607	924	576	632	1017	479	818
14	9263	986	597	647	1074	489	852
15	9915	1028	620	673	1103	504	884
...							
570	393066	26396	12931	11691	14447	7203	16368

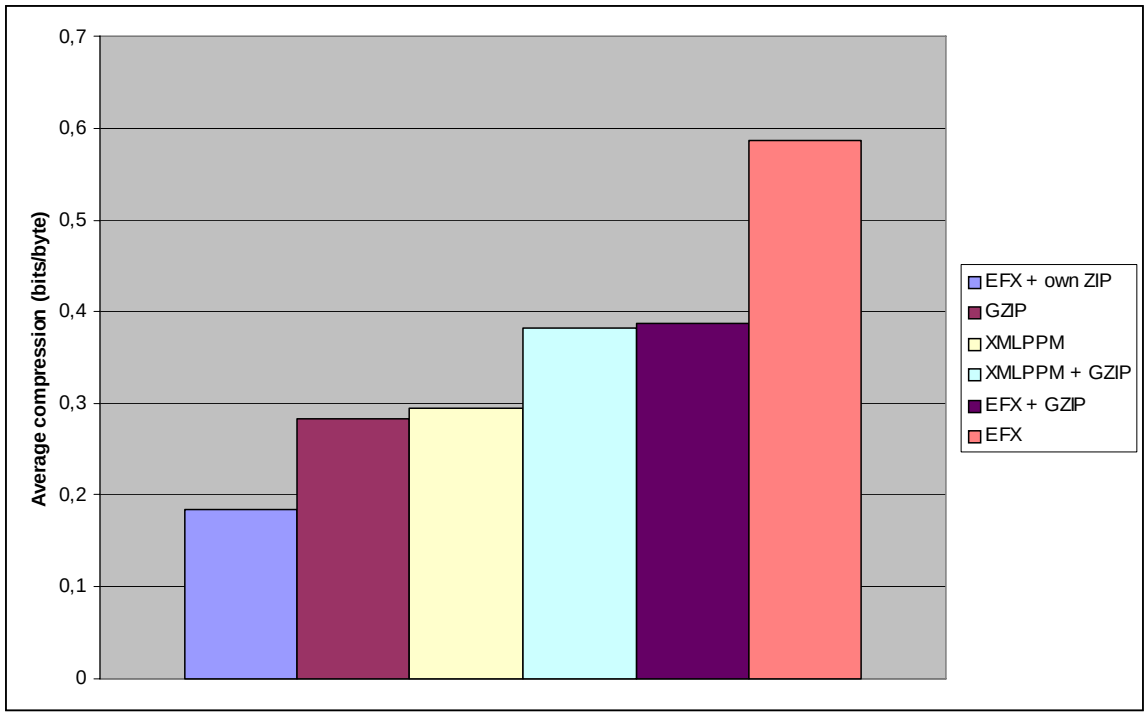
Compression ratio calculation

- Compression ratio in terms of number of bits per byte.
  - expresses the number of bits needed to represent each byte in the uncompressed data format.

$$CR_1 = \frac{sizeof(compressed\ file) \times 8}{sizeof(original\ file)}\ bits/byte$$

- For formula and discussion, see
  - W. Ng, W.-Y. Lam, and J. Cheng, "*Comparative Analysis of XML Compression Technologies*", WWW 9(1), pages 5-33, Kluwer Academic Publishers, March 2006.

Evalutation: Compressing NFFI XML (in terms of average compression ratio)



Summary

- There are significant gains when using compression of XML data.
- Tactical networks
  - compression of some form should be employed
  - Using the emerging standard for XML compression is probably a good idea.
    - Standards based COTS products will be available.
  - (However, all the algorithms we tested reduced the XML document size significantly.)