Efficient XML

Taking Net-Centric Operations to the Edge

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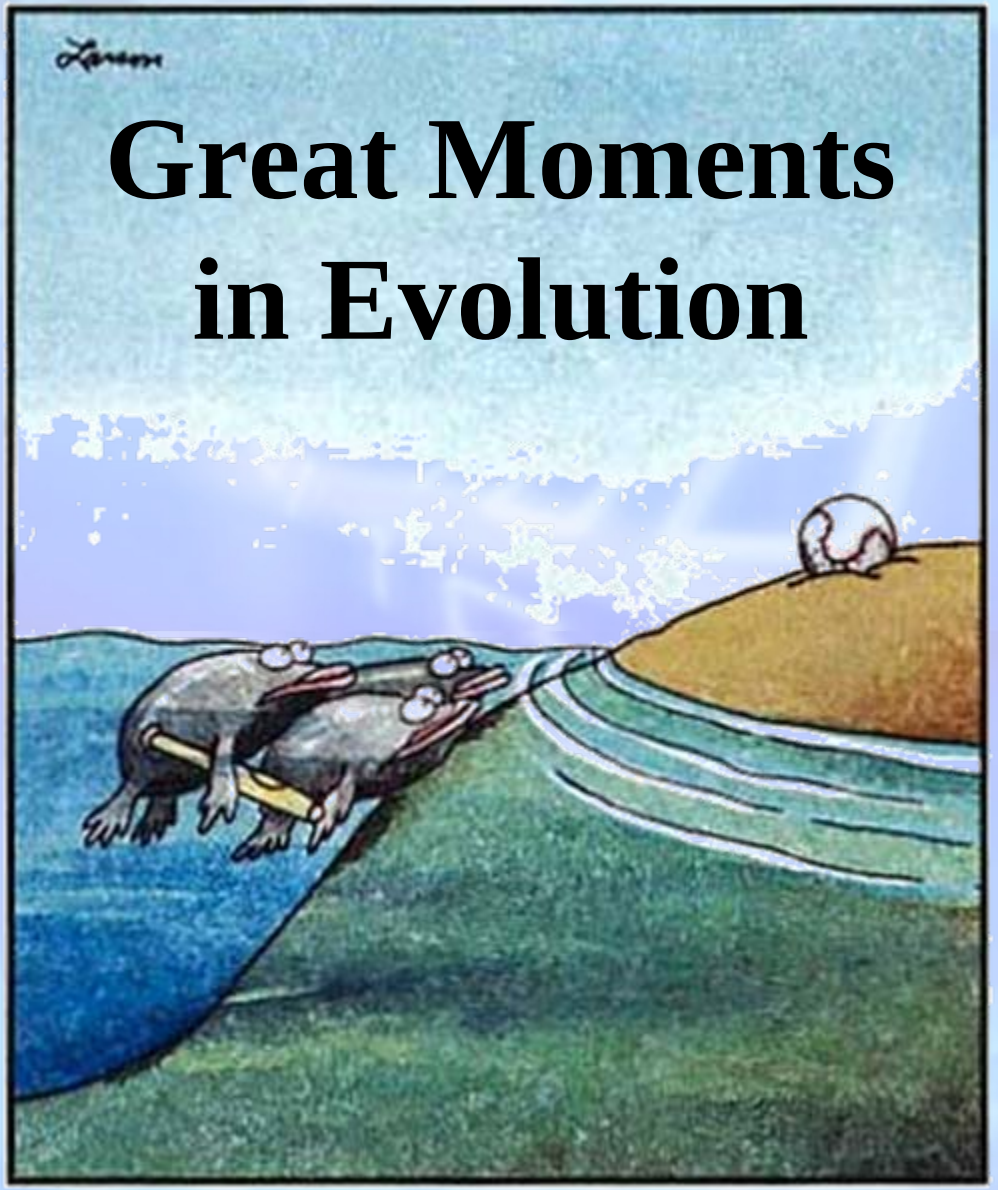
Great Moments in Evolution



Overview

- XML benefits and challenges
- Efficient XML
- JEFX ’06 Results
- JRAE ’06 Results
- Summary and questions

XML is Everywhere

Universal adoption, thriving community, fantastic products, rapid innovation

XML is Everywhere

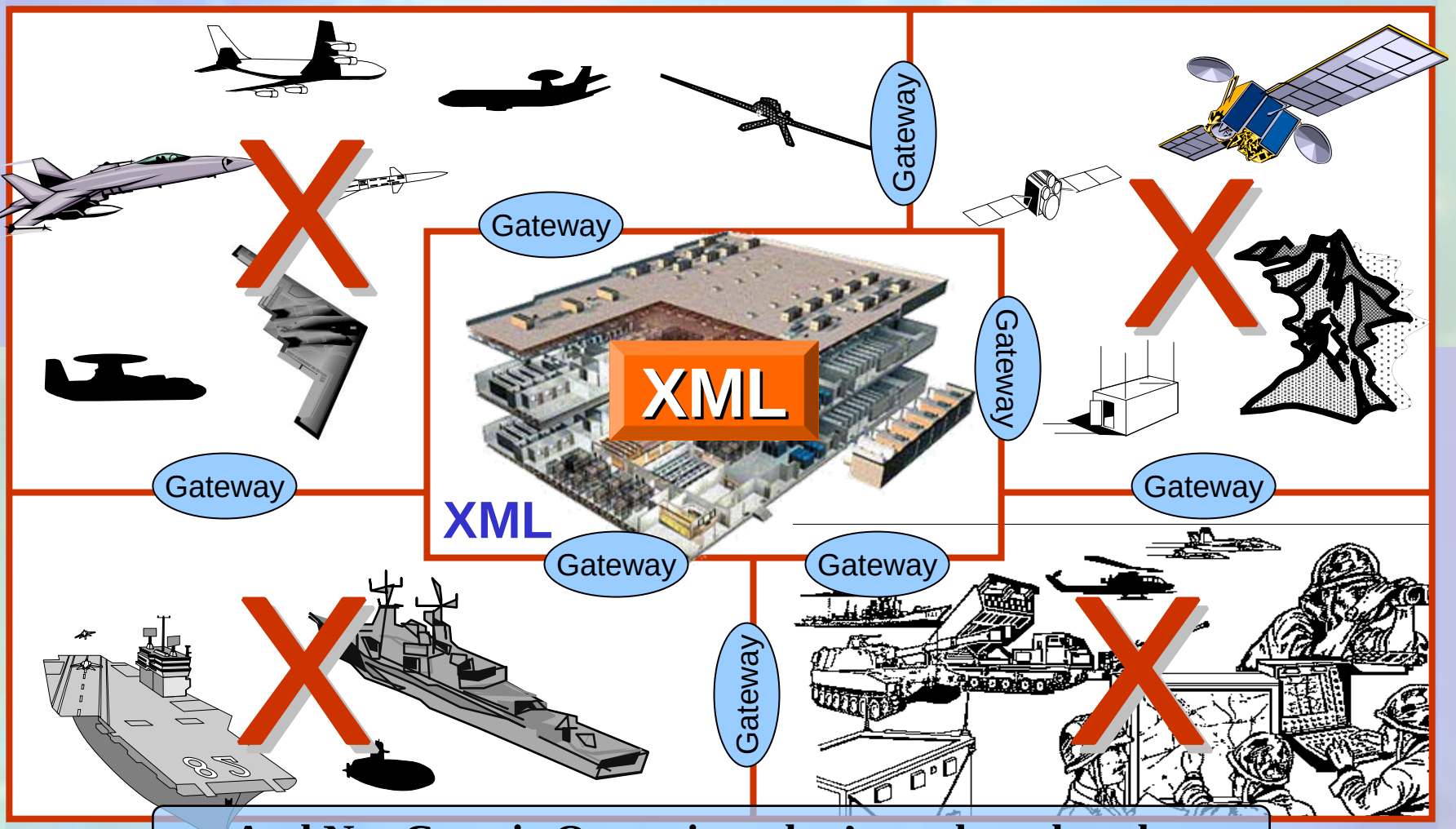
There is a vast range of information and services available via XML

AgileDelta
Finding Information in the Edge

XML is Not Quite Everywhere

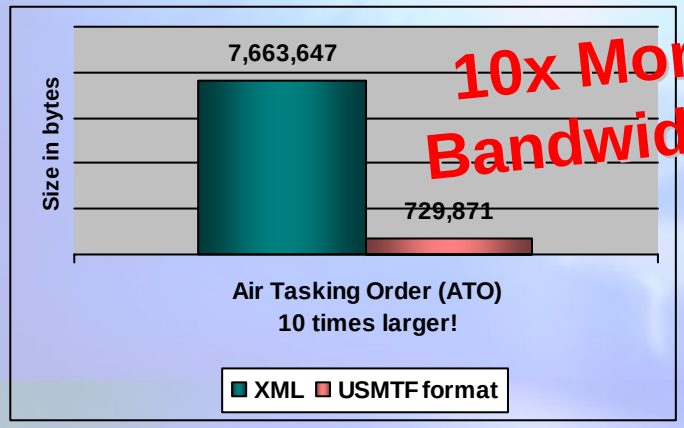
Benefits of XML are not available where efficiency is critical

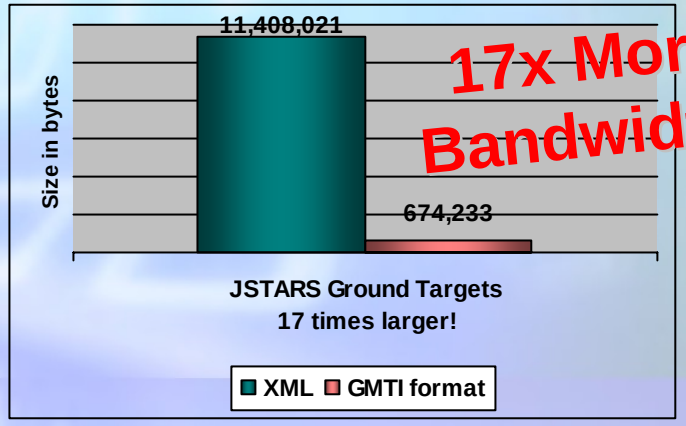
XML is Not Quite Everywhere

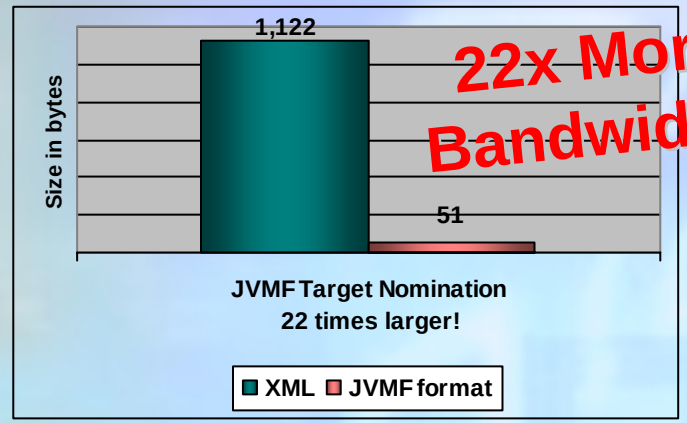


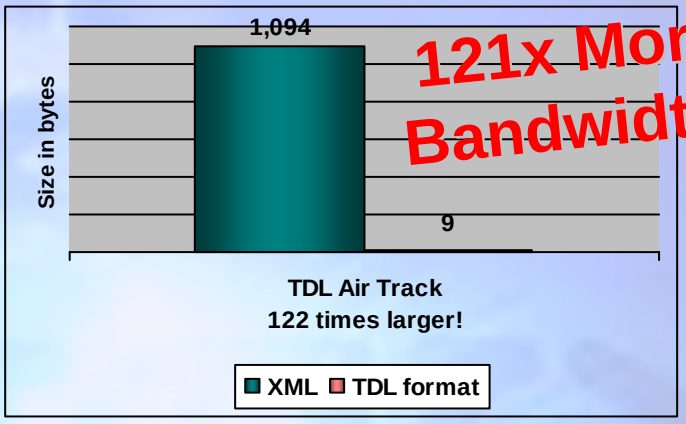
And Net-Centric Operations don't work at the edge

What's the Problem?
XML vs. Existing Tactical Messages









Net-Centric web standards require 10-100x more bandwidth

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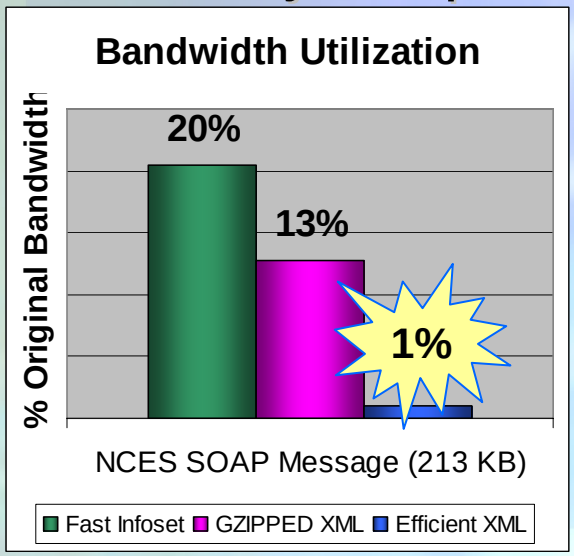
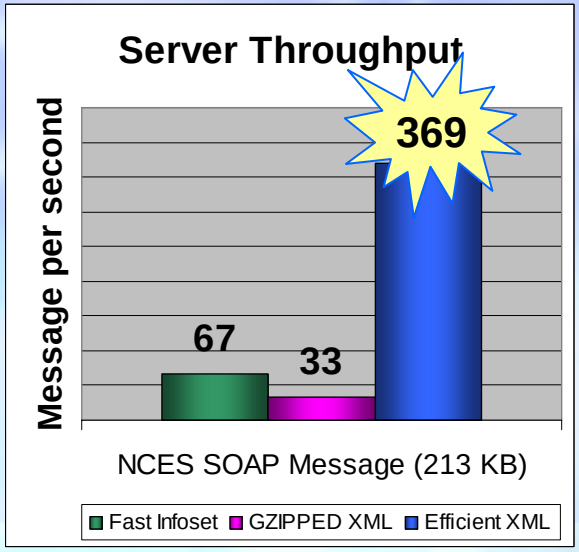
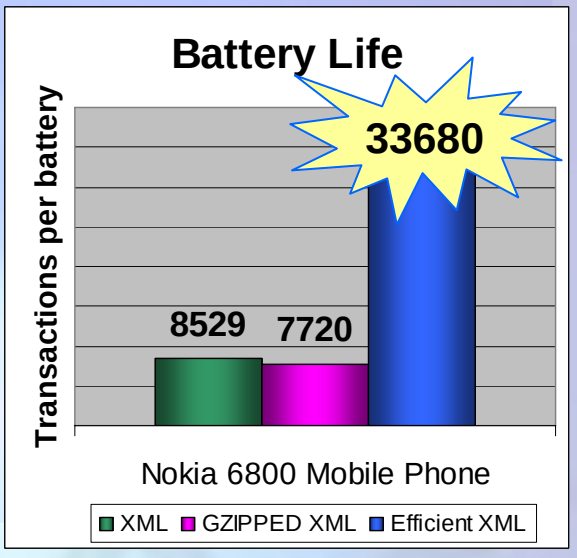
What is Efficient XML (EFX)?

- A COTS XML optimization product that improves:
  - **Network** bandwidth, throughput and scalability
  - **Server** scalability, throughput and CPU utilization
  - **Device** battery life, storage, heat and responsiveness
  - **Data center** power consumption, heat, bandwidth
- Requires no proprietary interfaces or protocols
- A major improvement over previous approaches

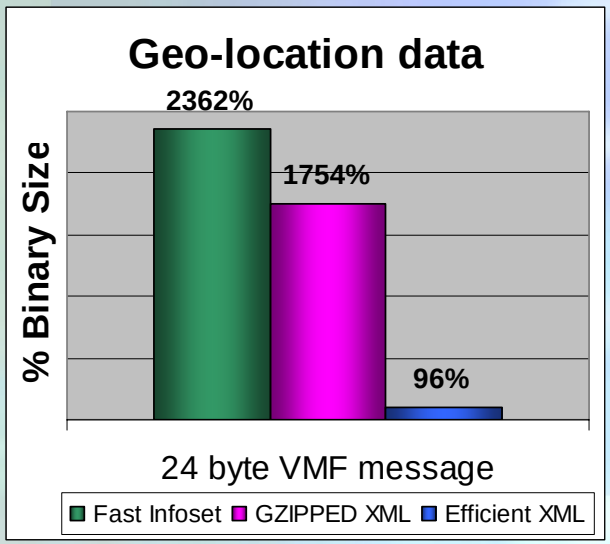


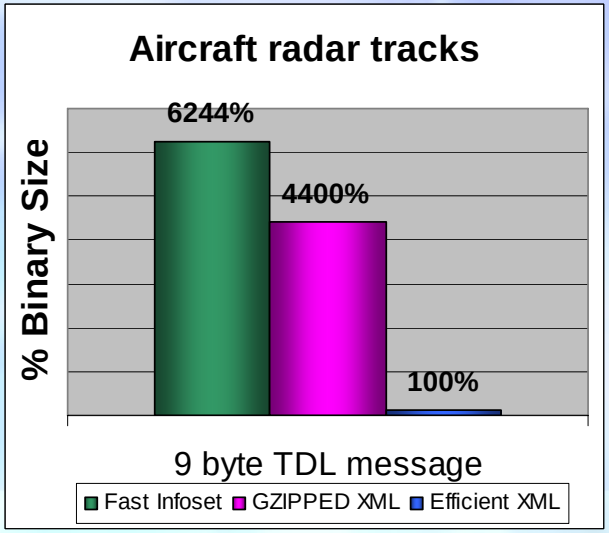


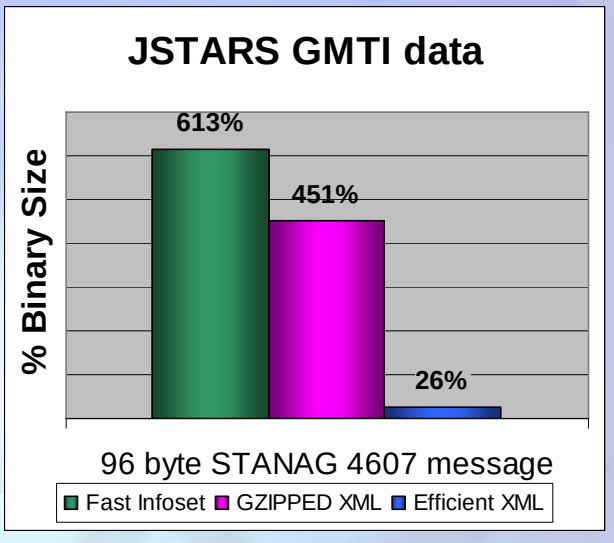


What is Efficient XML (EFX)?

- Works very well where previous approaches fail (e.g., high volume streams of small messages)
  - Tactical messages (VMF, TDL, IBS, GMTI, etc.)
  - Geo-location data
  - Sensor data
  - Asynchronous event processing
- Extends Net-Centric Operations to far edge of network







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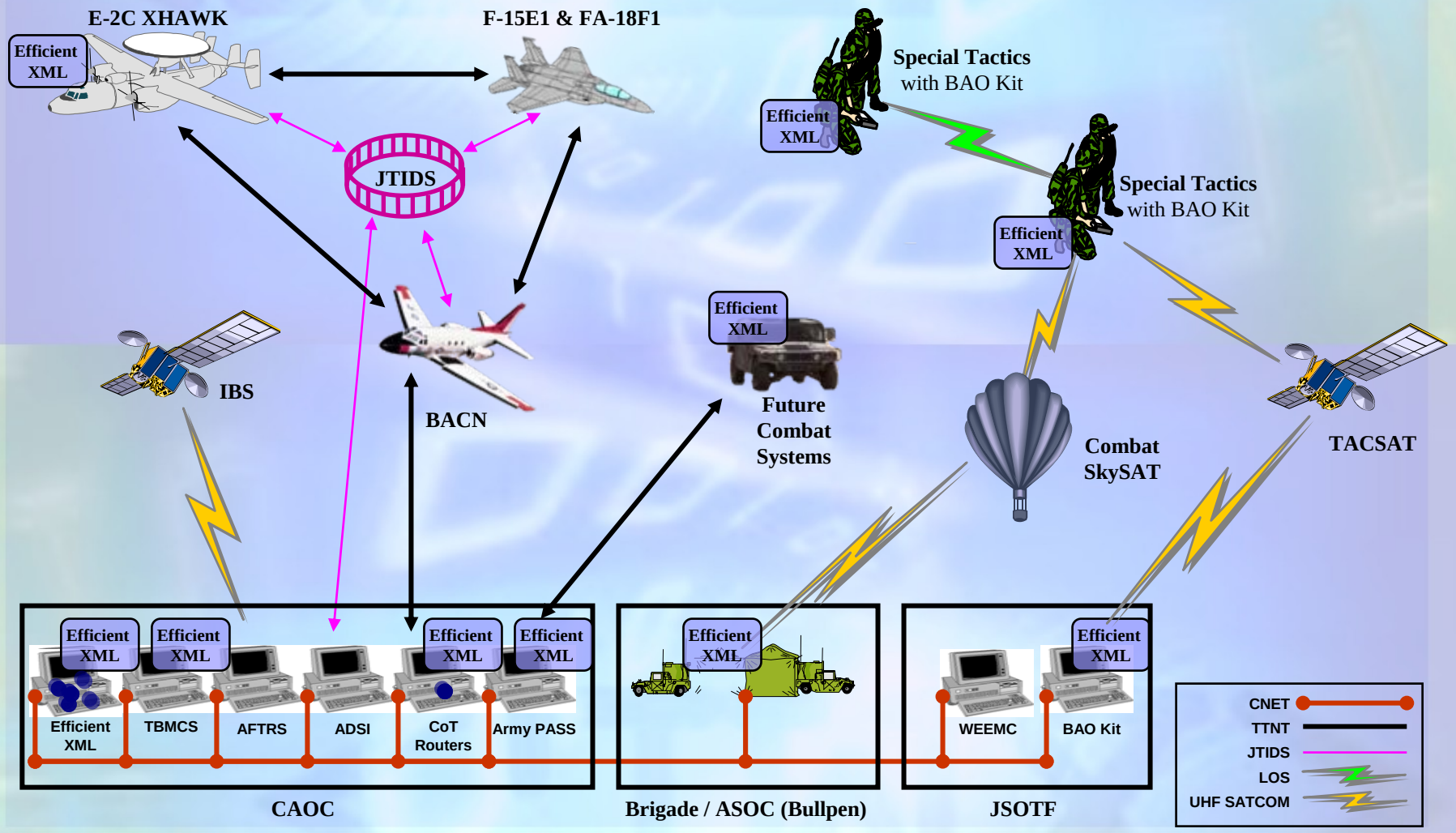
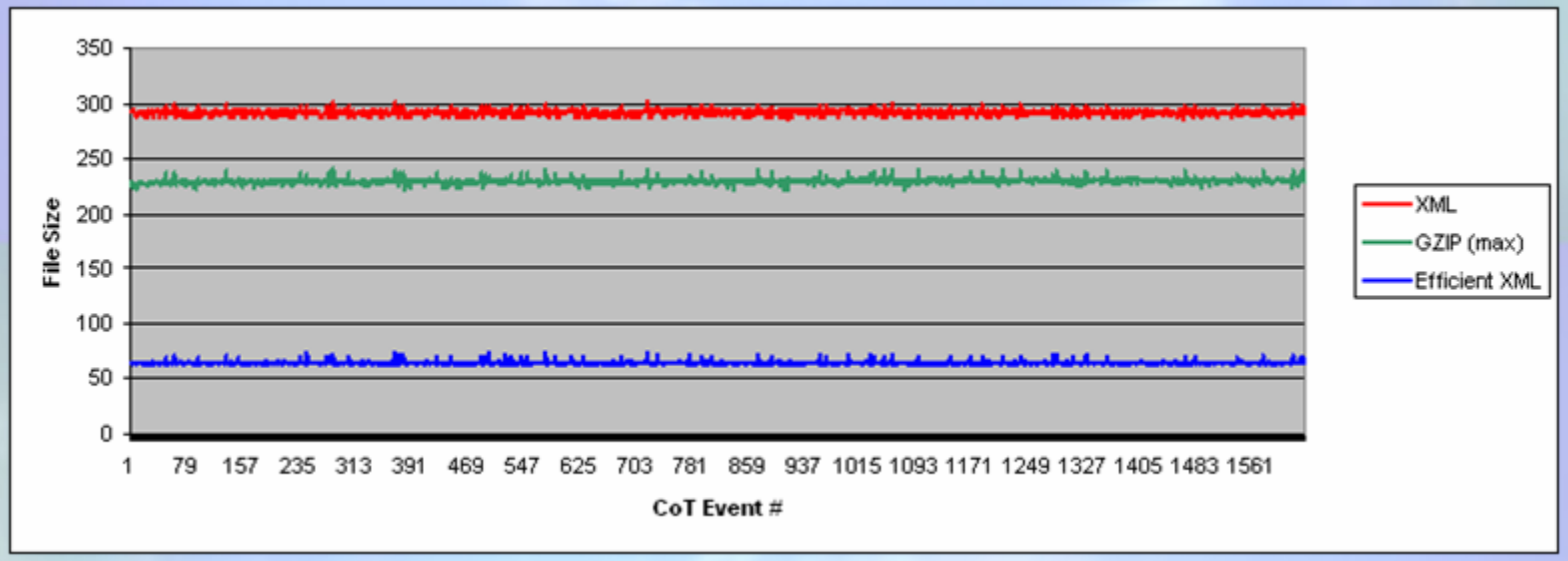
Efficient XML in JEFX ’06

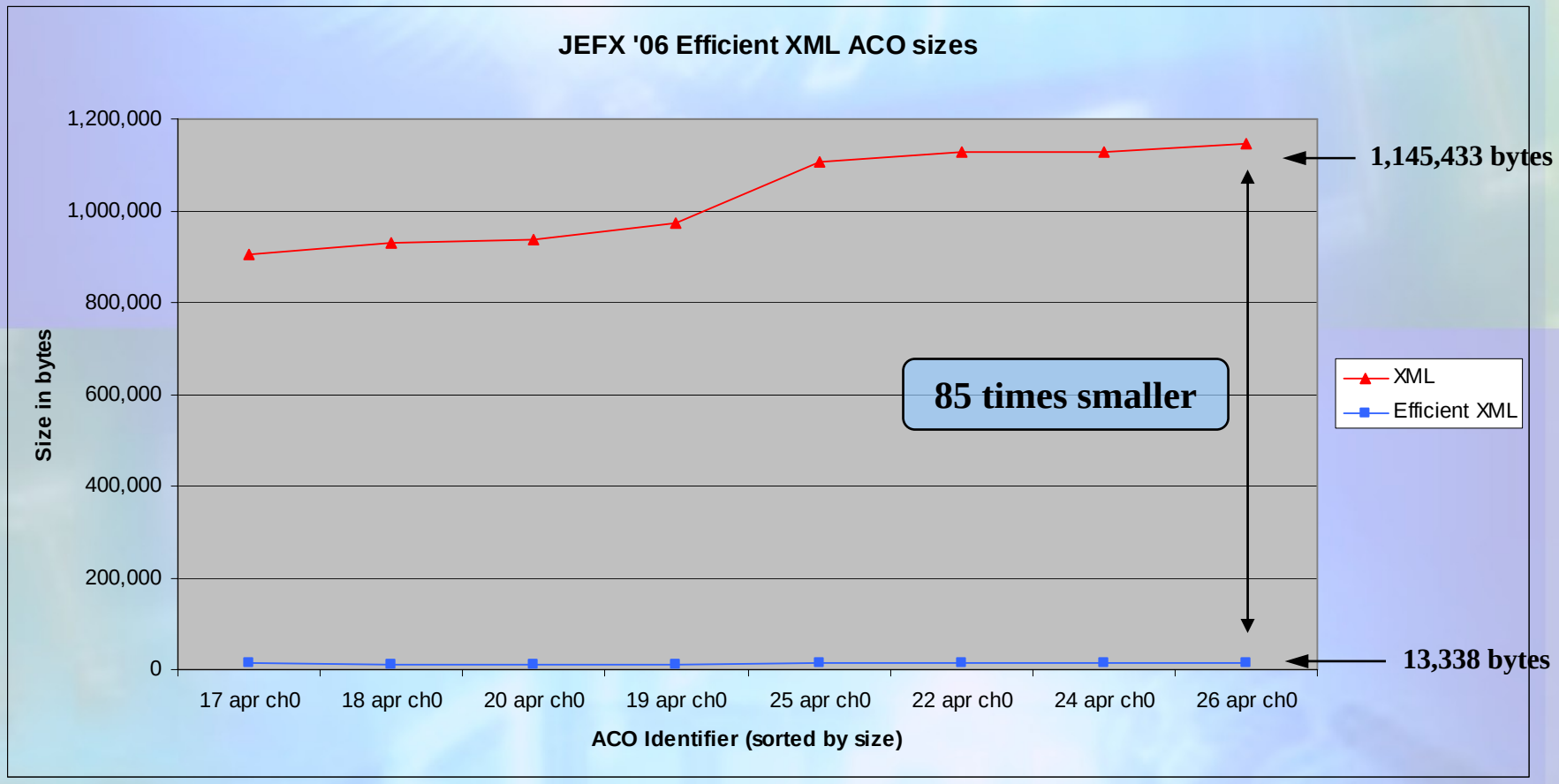


JEFX ’06 Performance Example Cursor-on-Target (CoT) Tracks



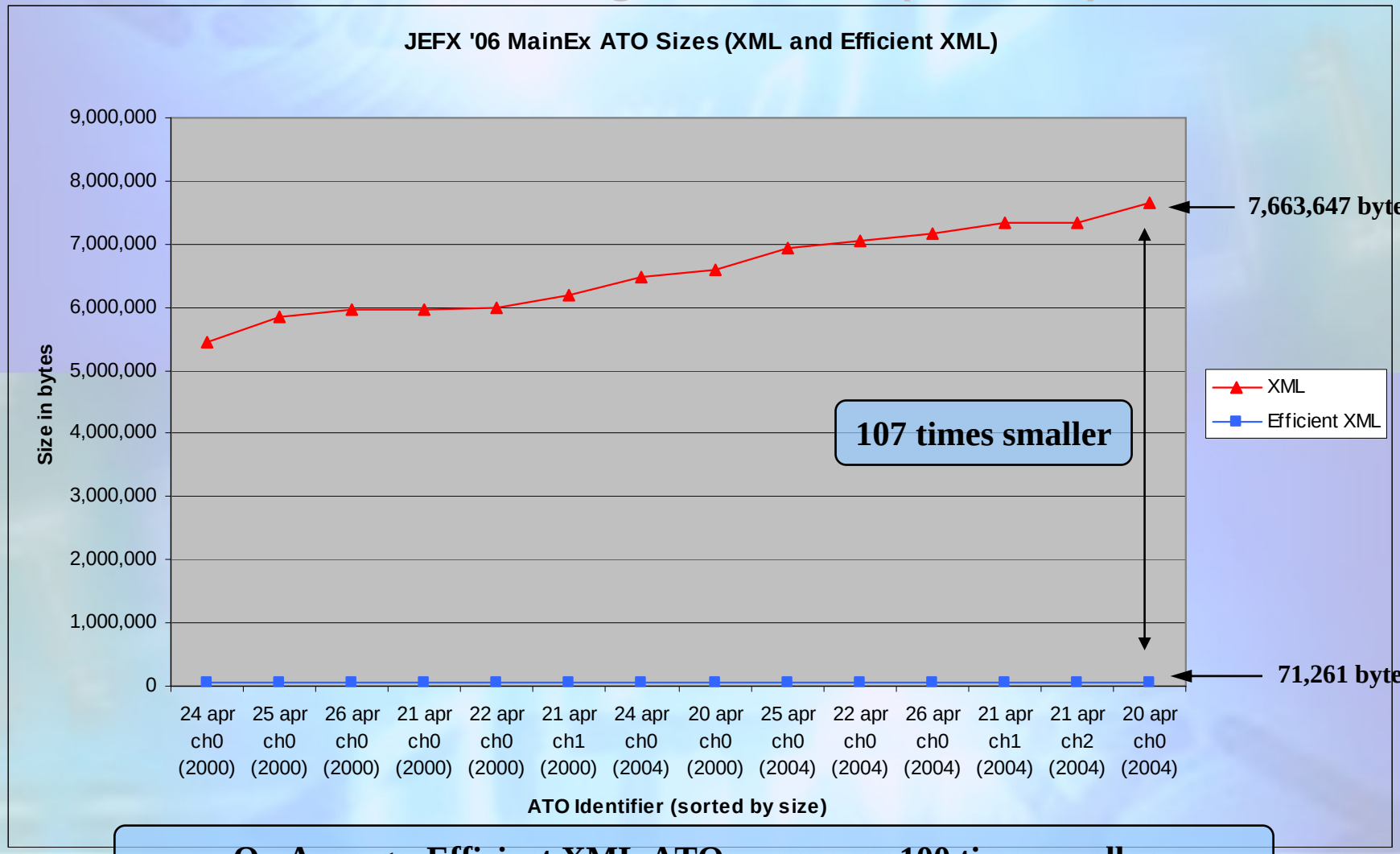
100,000+ CoT Efficient XML messages processed per day during JEFX

JEFX ’06 Performance Example Airspace Control Orders (ACOs)



On Average, Efficient XML ACOs were over 80 times smaller

JEFX ’06 Performance Example
Air Tasking Orders (ATOs)



On Average, Efficient XML ATOs were over 100 times smaller

Transfer Speed Measured in JEFX '06

ACO to E-2C over TTNT airborne network

0:01

Efficient XML

2:23

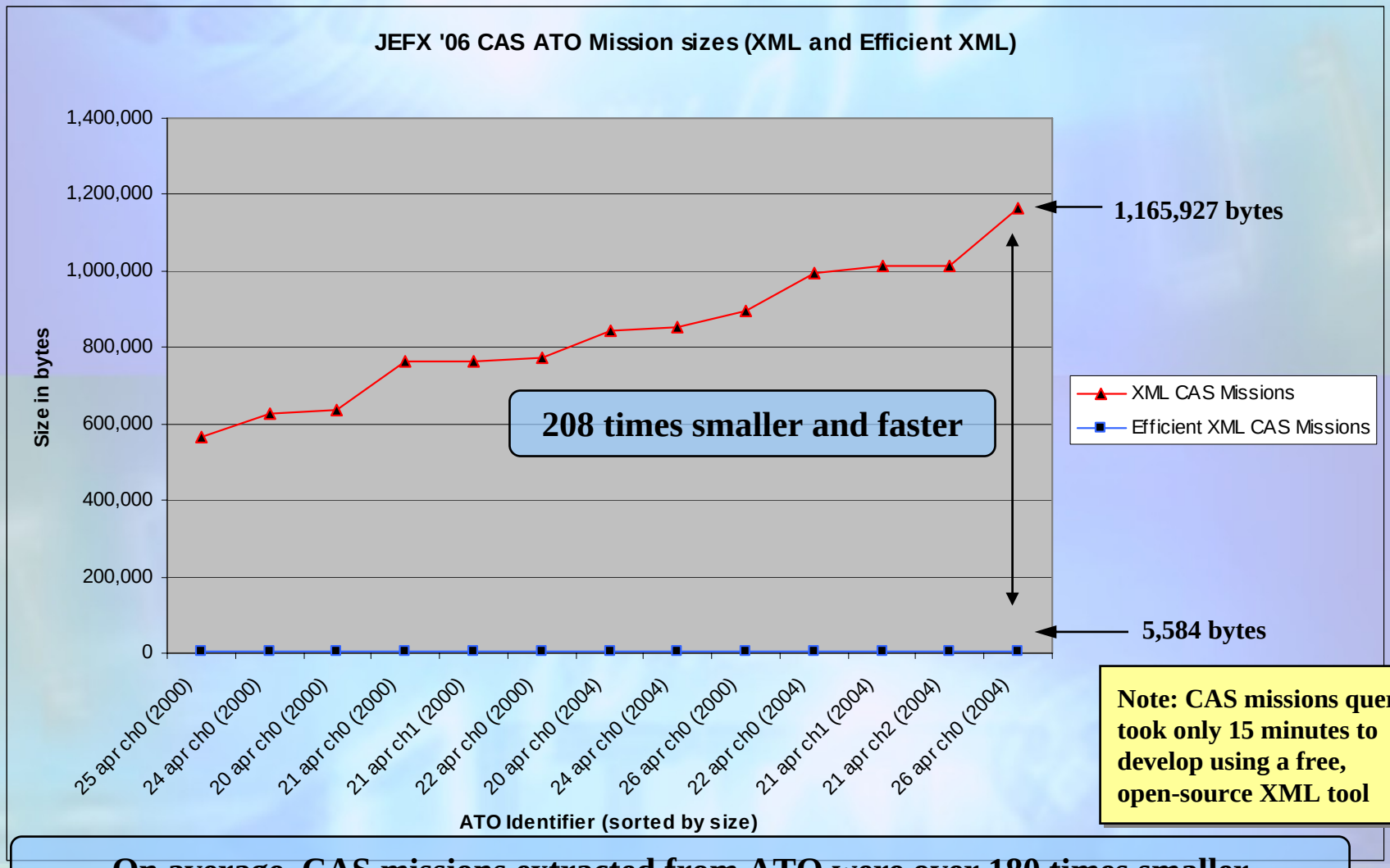
XML

Notes:

- Without Efficient XML, transmission is impossible with current radios
- ATOs are 5-7 times larger than the ACO shown here

JEFX ’06 Performance Example

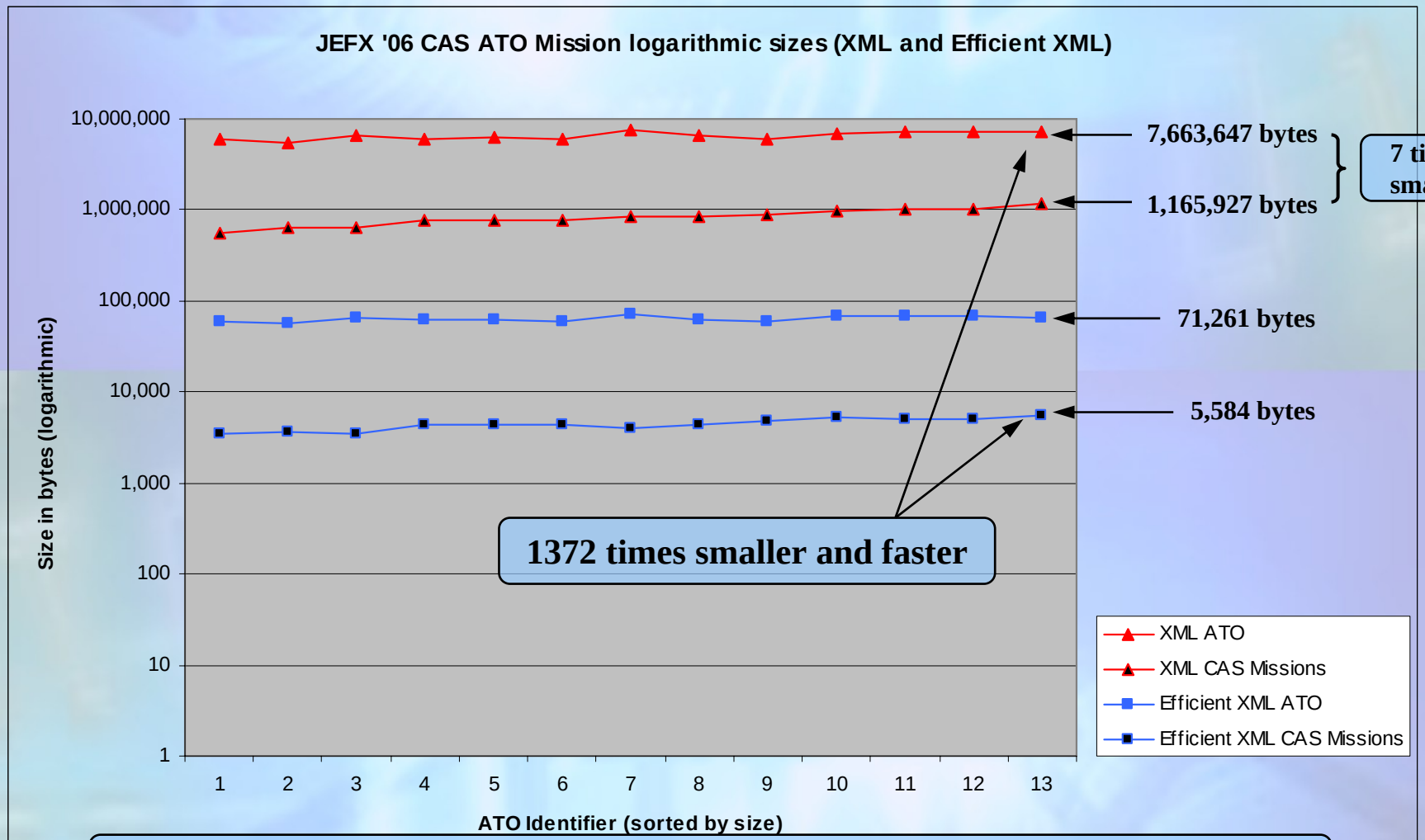
ATO CAS missions extracted from ATO



Note: CAS missions query took only 15 minutes to develop using a free, open-source XML tool

On average, CAS missions extracted from ATO were over 180 times smaller

JEFX ’06 Performance Example
Combined effect of Efficient XML with queries



Combining Efficient XML with query results produced extremely good results

Efficient XML

- ATO size reduction
- ATO CAS fragments

> Demo

JEFX ’06 Assessment Results

U.S. AIR FORCE

Assessment Results

JOINT EXPEDITIONARY FORCE EXPERIMENT — JEFX 06 — NETWORKED WARFIGHTING

CSAF Initiatives

Operational Assessment
Technical Readiness
Fielding Recommendation

Field

	Operational Assessment	Technical Readiness	Fielding Recommendation
BACN**	Fills warfighter need	Mature capability / Ready for testing	Ready for transition *
CSS	Fills warfighter need	Mature capability / Ready for testing	Ready for transition
NTISR-IS	Fills warfighter need	Limited utility	Ready for transition
SWIPE			
GSAT	Fills warfighter need	Mature capability / Ready for testing	Ready for transition
SOFTNet	Fills warfighter need	Mature capability / Ready for testing	Ready for transition
NCWI	Fills warfighter need	Limited utility	Ready for transition
BaS&E	Fills warfighter need	Mature capability / Ready for testing	Ready for transition

More Work

	Operational Assessment	Technical Readiness	Fielding Recommendation
FAOC ****	Fills warfighter need	Limited utility	Limited utility

AOC 10.1.1

	Operational Assessment	Technical Readiness	Fielding Recommendation
TBONE	Fills warfighter need	Limited utility	Ready for transition
WEEMC	Fills warfighter need	Limited utility	Ready for transition
IWPC	Fills warfighter need	Limited utility	Ready for transition
DLARS	Fills warfighter need	Limited utility	Ready for transition

Cross Cutting Tech

	Operational Assessment	Technical Readiness	Fielding Recommendation
Binary XML***	Fills warfighter need	Mature capability / Ready for testing	Ready for transition
TTNT	Fills warfighter need	Mature capability / Ready for testing	Ready for transition
RAIDER	Fills warfighter need		Ready for transition

* BACN – Long-term platform to be determined

** Merge BACN & Adaptive Joint C4ISR Node (AJCN)

*** Binary XML - Immediate, interim DoD fielding while waiting on commercial standard

**** Require more testing / sensor availability to evaluate

Operational Assessment
- Fills warfighter need
- Limited utility
- No benefit to warfighter

Technical Readiness
- Mature capability / Ready for testing
- Require system/subsystem development
- More research required

Fielding Recommendation
- Ready for transition
- Incomplete programmatics
- No sustainment path

Taken from JEFX ’06 CSAF Fielding Recommendations Briefing

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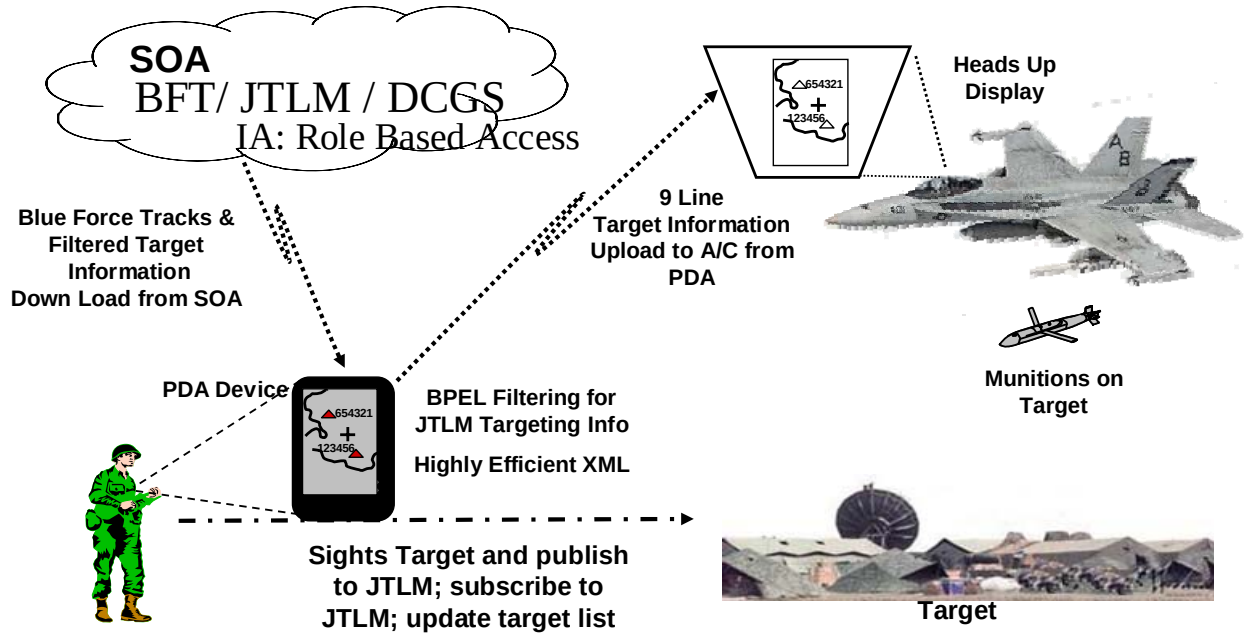
Efficient XML in JRAE ’06
Scenario : Joint Target Management (JTM)

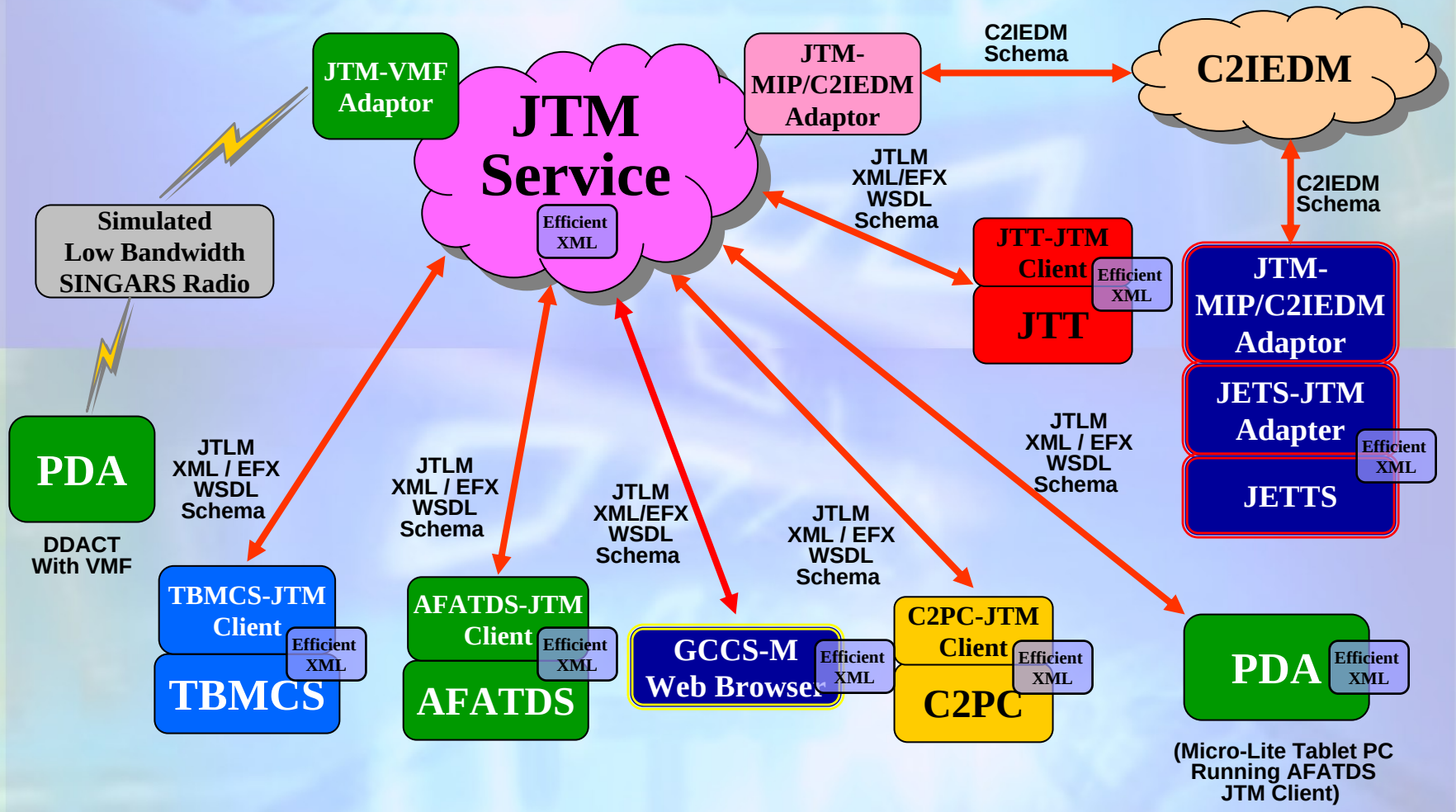
Compressed XML
Notional JCAS MISSION



NCCP II C2 services: Orchestration, Op Context, Adaptors, Association

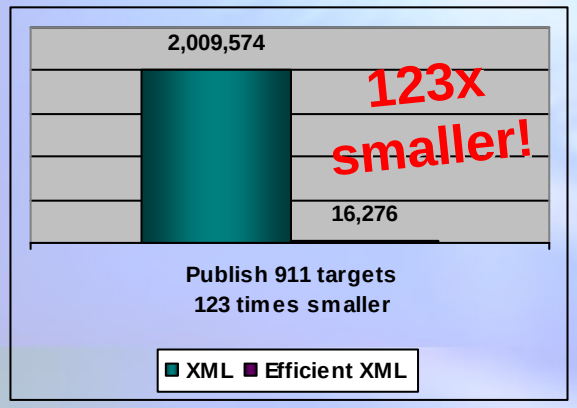
JRAE ’06 focused on a NCES SOA pub-sub architecture for nominating, coordinating and prosecuting targets

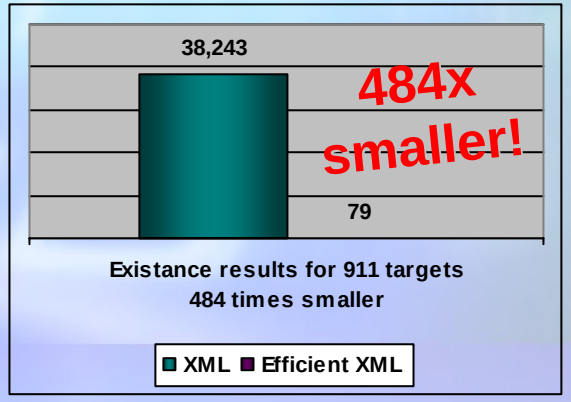
Efficient XML in JRAE ’06 Tactical Web Services

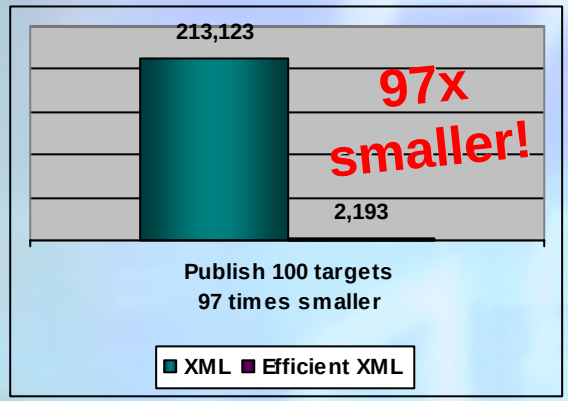


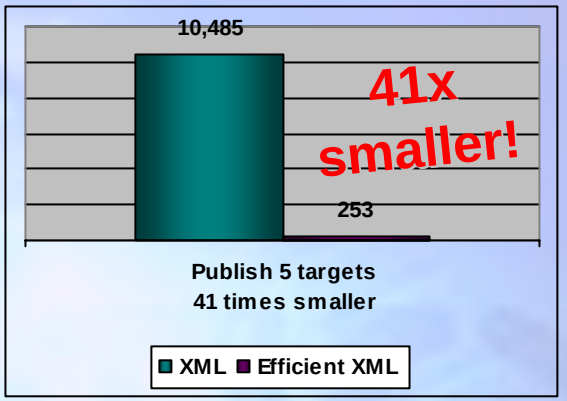
JRAE ’06 successfully used Efficient XML to extend the reach of web services to tactical users

JRAE ’06 Performance Examples
JTM Tactical Web Services



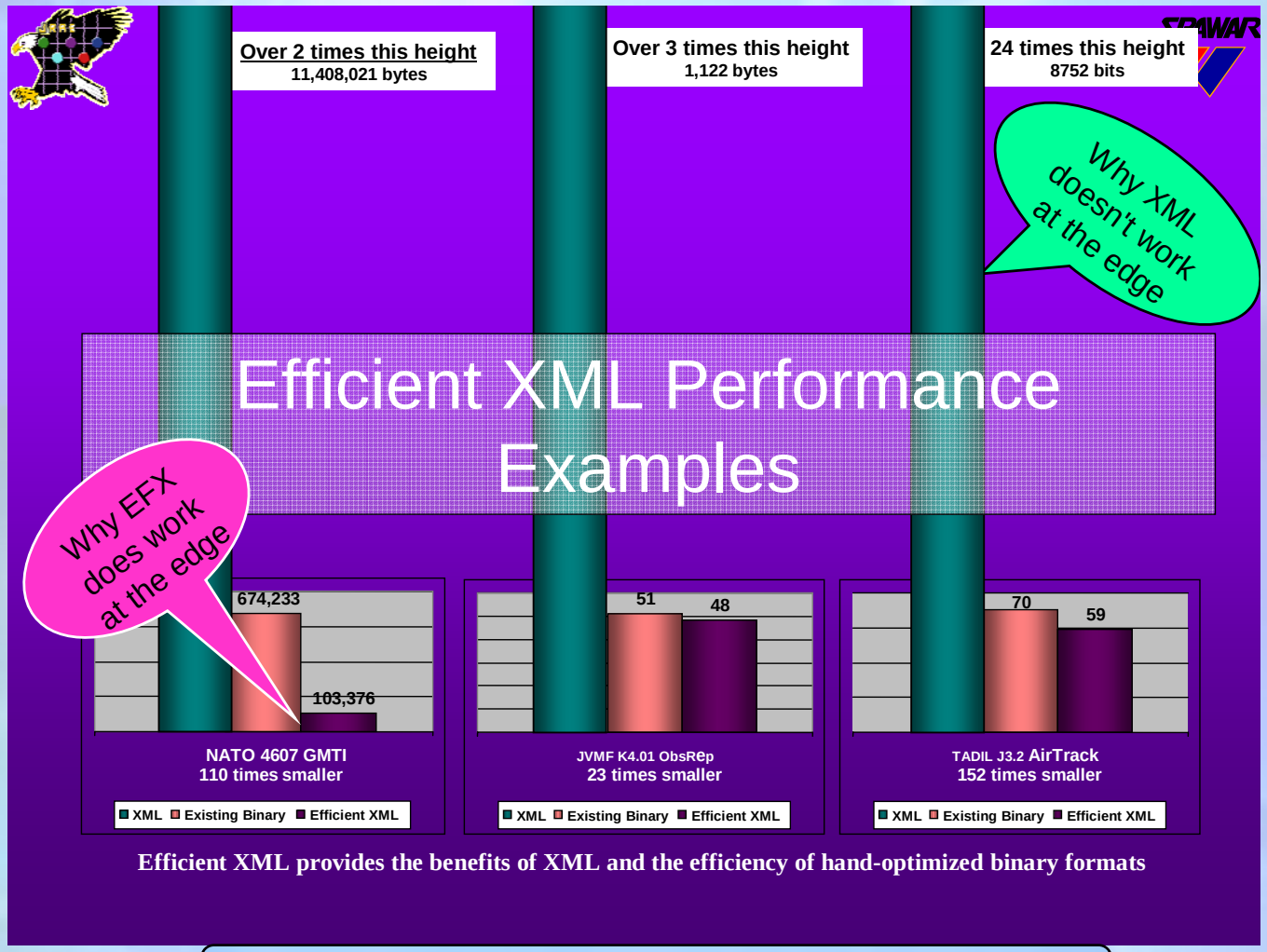






In aggregate, Efficient XML messages were 100+ times smaller

JRAE ’06 Performance Examples TADIL, JVMF and GMTI



Taken from SPAWAR JRAE ’06 Results Presentation

Efficient XML

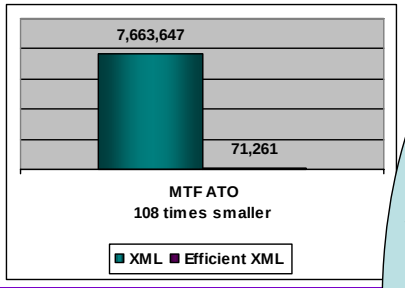
- JTM, VMF and TDL compactness
- Performance and browser integration

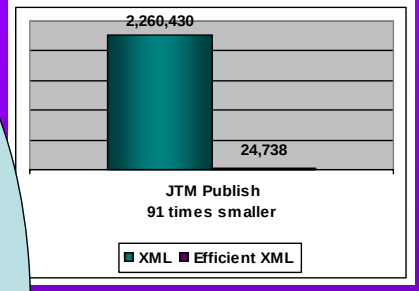
> Demo

JRAE ’06 Recommendation
A single standard for data transfer

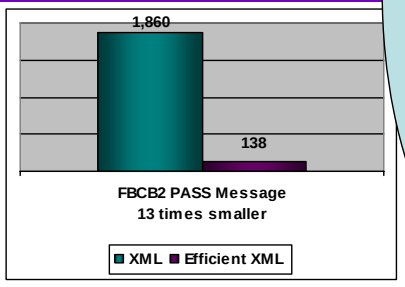
Efficient XML Performance Examples

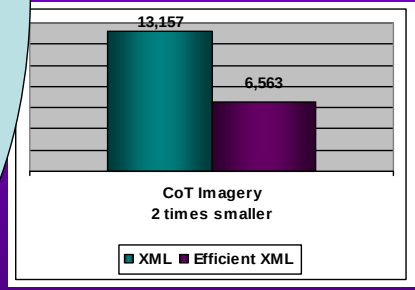
Efficient XML compared to existing binary formats and XML





To fight using the web as a weapon system
We must a have a ***single standard***
For all data transfer Needs:
MTF, TADIL, JVMF,CoT, etc.
EFX
provides that standard





EFX ACROSS THE BOARD

WITH A *SINGLE* STANDARD

DATA EXCHANGE BETWEEN SYSTEMS BECOMES A NON ISSUE

Taken from SPAWAR JRAE ’06 Results Presentation

JRAE ’06 Recommendations

Quick Look Recommendations

1) Joint Target Management Service – support planned transition path and promote it as model for other services to use in migration from “as is” to “to be”
2) Efficient XML (EFX) - Military Services / Acquisition Agencies move to require EFX be incorporated as a standard for all future near real time applications; and current applications as feasible
   - OSD / DISA / Services / Acquisition Agencies **require** that EFX be incorporated into a variety of applications and utilized by the warfighter during the final stage of W^3C Standards Approval Process (approximately 2 years) to ensure military needs are included
   - DISA / DoD become actively involved in the W3C Standards Approval Process for this capability
   - Applicability to real time applications be assessed
3) C2IEDM Data Dictionary be a required starting point for developing common data elements across the Services and Coalition in support of SOA operations
4) NSA investigate integration with EFX and digital signature approaches that support bandwidth disadvantaged users (under 14Kb)
5) For current IA capability in low bandwidth operations, a secure circuit and/or SSL architecture be offered as an SOA option
6) An individual message (data package) prioritization capability must be developed that operates across the GIG if time sensitive tactical missions are to be executable on an IP based network

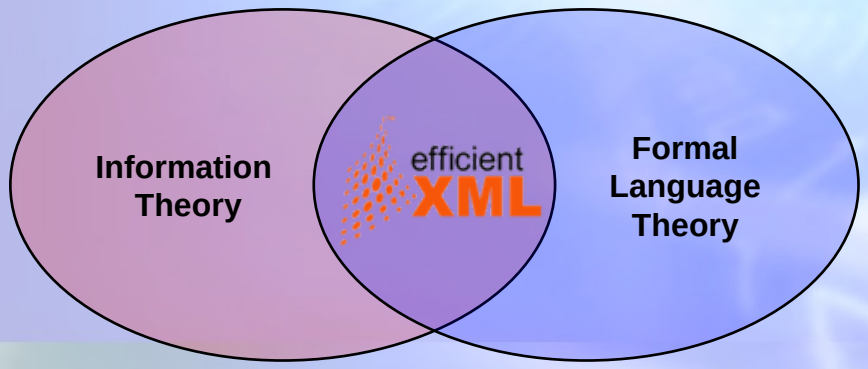
MUST HAVE!

The warfighter must *consistently* get the right information at the right time if he is expected to embrace net-centric warfare operations

Taken from SPAWAR JRAE ’06 Results Presentation

Efficient XML Summary

A new breed of technology



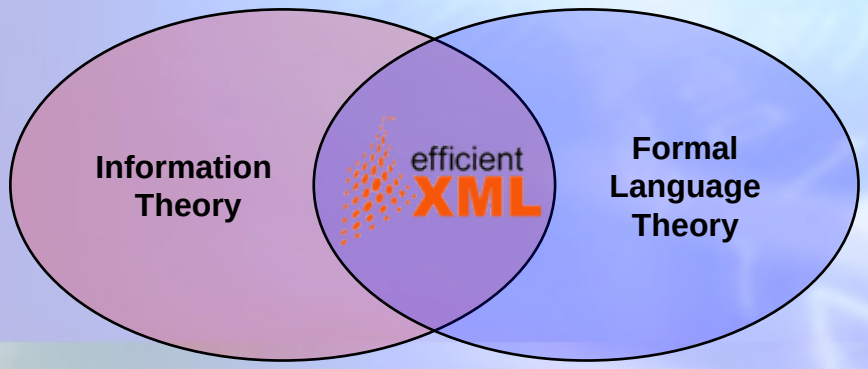
Efficiency

Interoperability

Reduced Costs

Efficient XML Summary

A new breed of technology



Efficiency

- Achieves unprecedented compression and speed
- Up to 100-400 times smaller and faster
- More bandwidth, battery life, storage, memory
- Less CPU, power, heat

Interoperability

- One web data format for <u>all</u> data and <u>all</u> devices
- Efficient enough to replace hand-optimized formats
- Can plug transparently into app servers and XML interfaces
- Can interoperate with systems still using plain-old-XML

Reduced Costs

- Lower bandwidth costs
- Lower device costs
- Replace proprietary binaries with open web technologies
- Eliminate format gateways

Questions?

Resources:

Efficient XML: http://www.agiledelta.com/product_efx.html

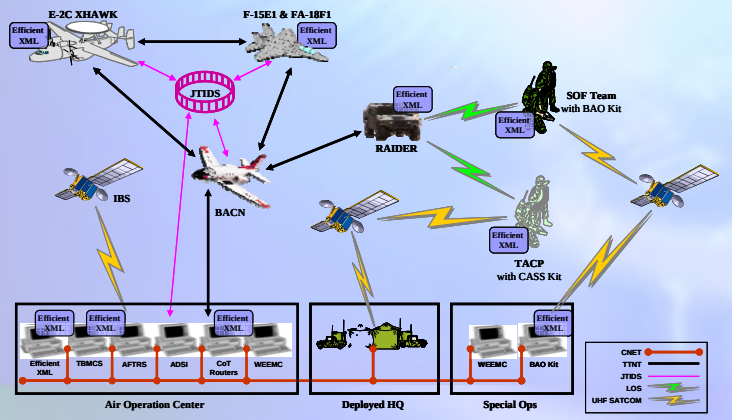
Download: http://www.agiledelta.com/efx_download.html

W3C Standard: http://www.w3.org/TR/exi/

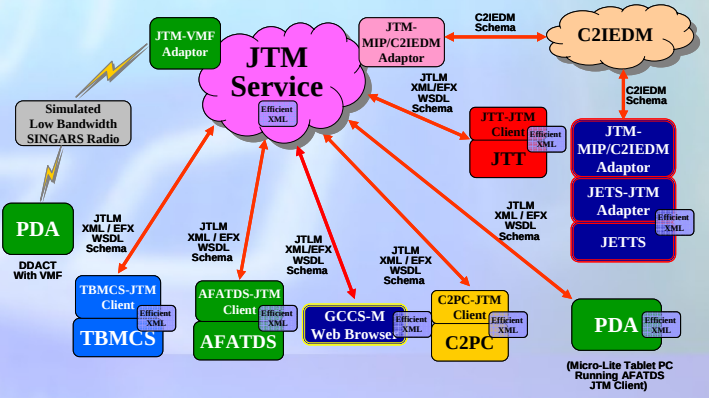
Backup Slides

Independent Assessment and Adoption

U.S. Air Force



U.S. Navy



World Wide Web Consortium

Example Customers

Independent Assessment and Adoption

U.S. Air Force

"The real winners in JEFX '06 that filled our capability goals are BACN and Binary XML"

Recommendation

Immediate fielding

U.S. Navy

"Efficient XML is a transformational capability"

"… should be incorporated as a standard in all future data sharing systems …"

World Wide Web Consortium

"the best performer for nearly all test documents in all application classes"

Selected as basis for global web standard for binary XML

Example Customers

SAIC

LOCKHEED MARTIN

NATO C3 AGENCY

Australian Government Department of Defence

BAE SYSTEMS

SPAWAR

NORTHROP GRUMMAN

Norwegian Defence Research Establishment

MITRE

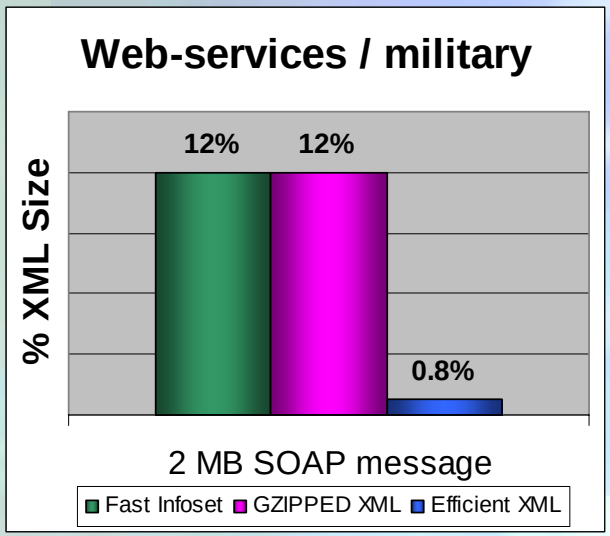
FUJITSU

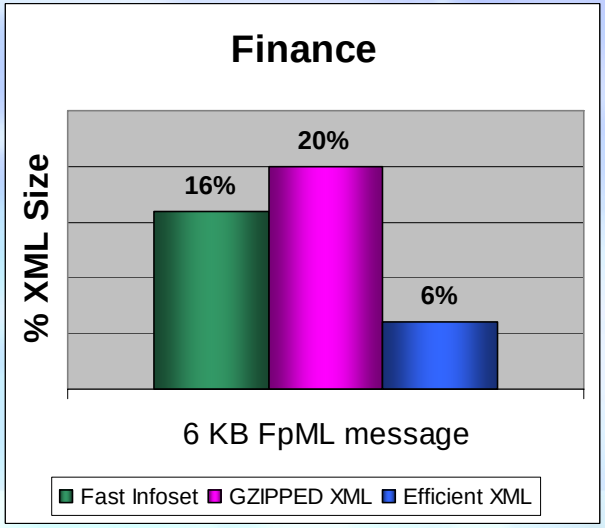
FAQ

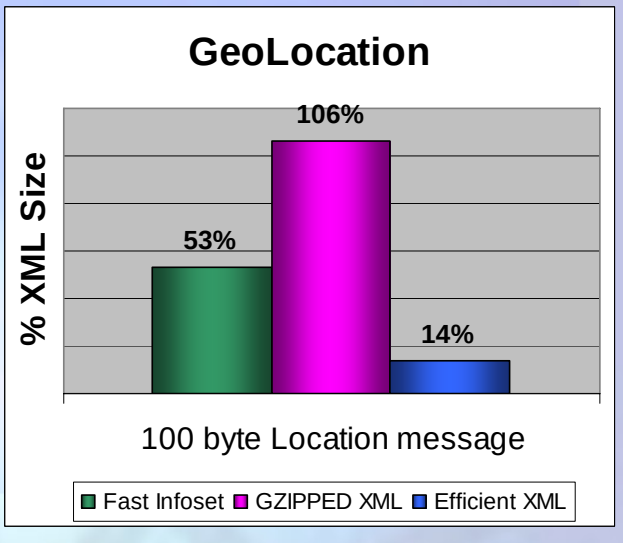
FAQ

How does EFX size compare to previous approaches?

- EFX consistently performs better than previous approaches
- W3C tests found Efficient XML consistently performed better than *every* candidate on *every* test group and *every* application class
  - **Candidates:** FastInfoset, ASN.1 PER, ASN.1 BER, FXDI, Xebu, esXML, gzipped XML, gzipped FastInfoset, gzipped ASN.1 PER/BER, etc.
  - **Test groups:** web-services, finance, geo-location, scientific, military, electronic documents (OpenOffice, SVG), broadcast, data storage
  - **Applications:** With and without schemas. With and without compression.



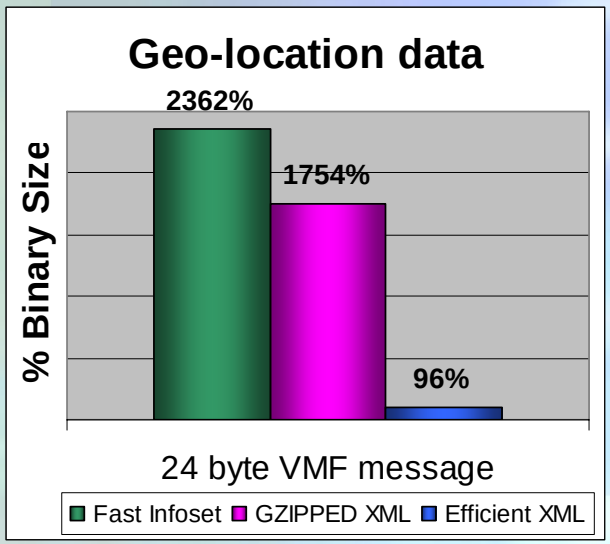


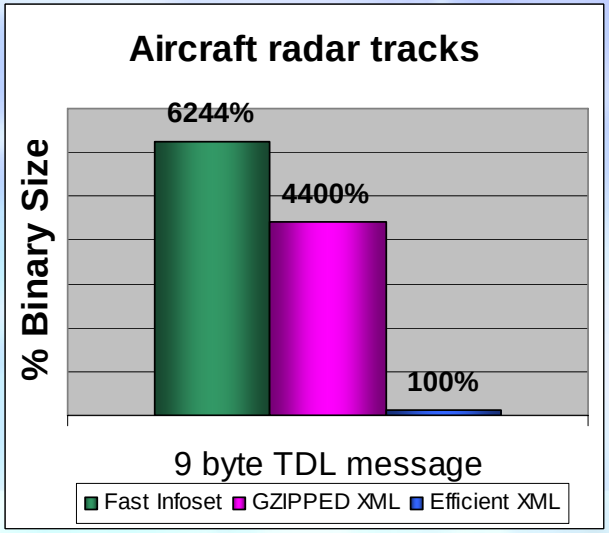


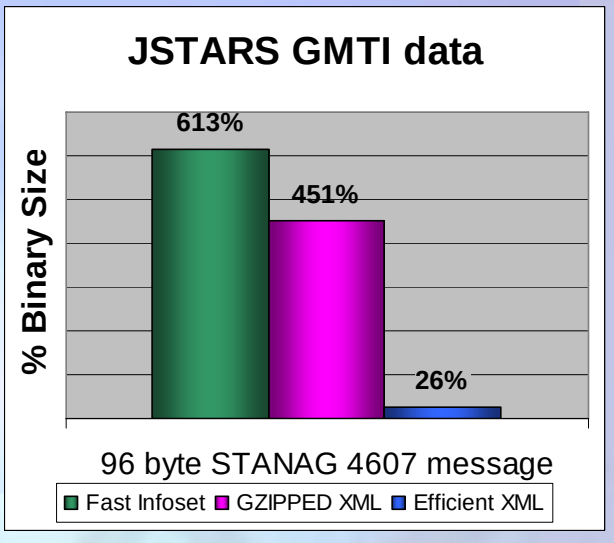
FAQ

How does EFX size compare to previous approaches?

- EFX works well where data compression fails (e.g., high volume streams of small messages)
  - Financial exchange data
  - Geo-location data
  - Sensor data
  - Asynchronous event processing
- Can replace best proprietary binary formats with open web standards

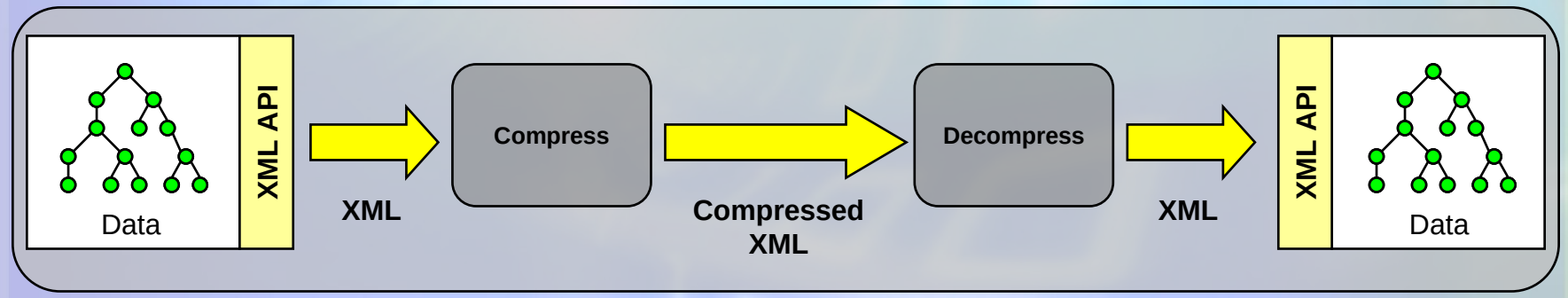




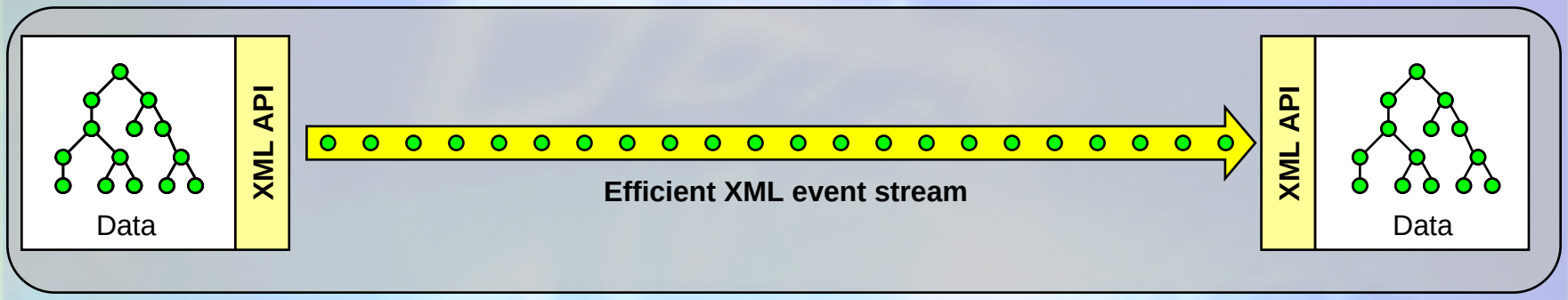


FAQ

How much processing overhead does EFX introduce?



Traditional compression adds processing overhead for compression/decompression

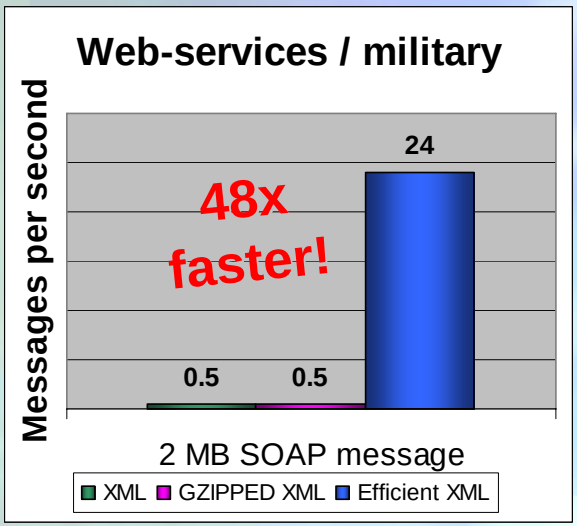


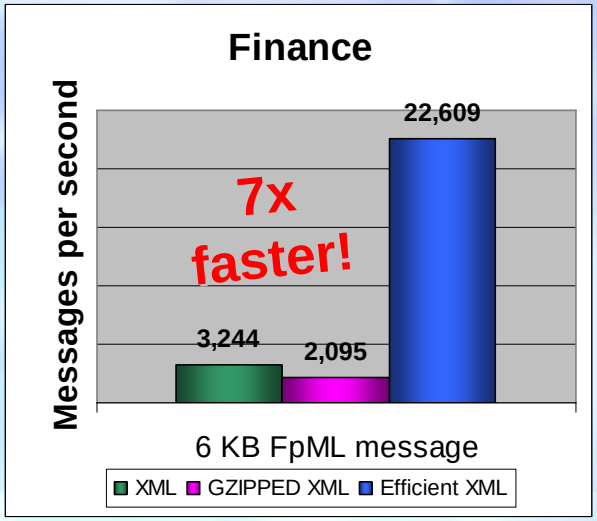
EFX event streams are read/written directly via standard XML APIs

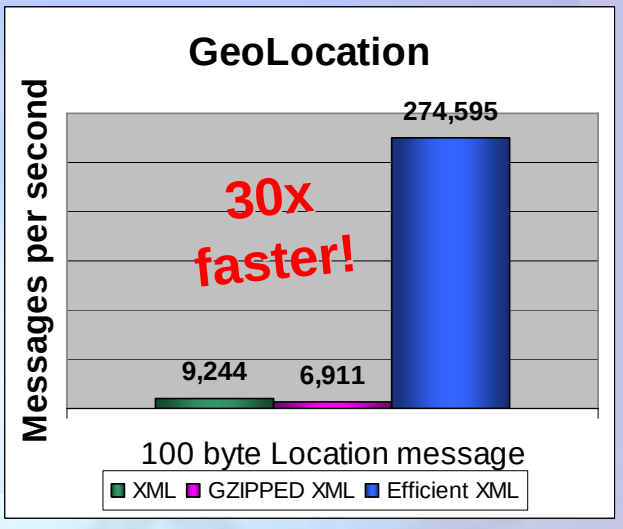
FAQ

How much processing overhead does EFX introduce?

- It depends on your implementation
  - EFX 1.0 was slower than gzipped XML
  - EFX 2.0 was faster than gzipped XML *and* XML (up to 9x)
  - EFX 3.0 is up to 90x faster than XML!
- W3C tests found EFX 3.0 was one of the fastest processors, even compared to those optimized for speed over compactness



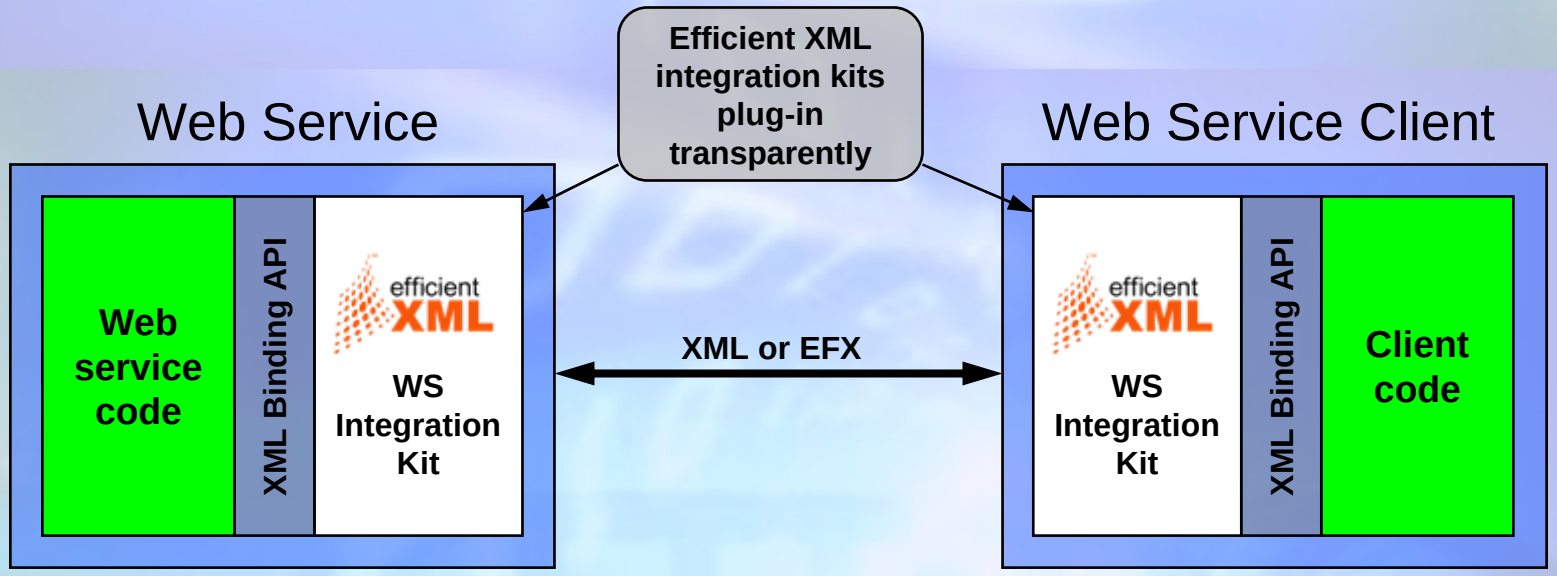




FAQ

Do I have to change my code to use EFX?

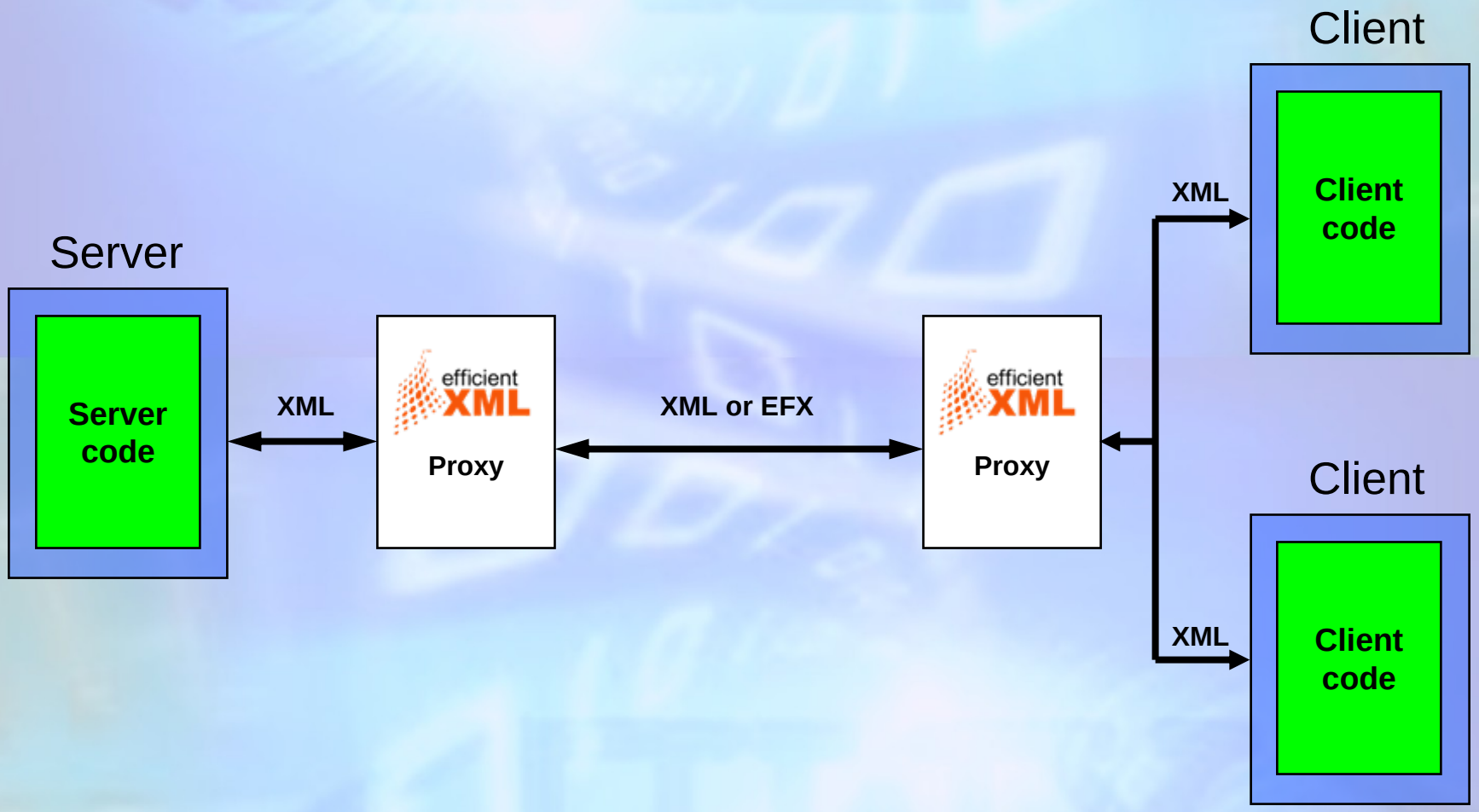
- No.
  - EFX web service plug-ins add EFX natively to web service platforms
  - EFX proxies (HTTP, TCP and UDP) add EFX to existing applications



Integration using Efficient XML Integration Kits requires <u>no code modifications</u>

FAQ

Do I have to change my code to use EFX?



Integration using Efficient XML Proxies requires <u>no code modifications</u>

FAQ

Won't EFX break compatibility with plain-old-XML?

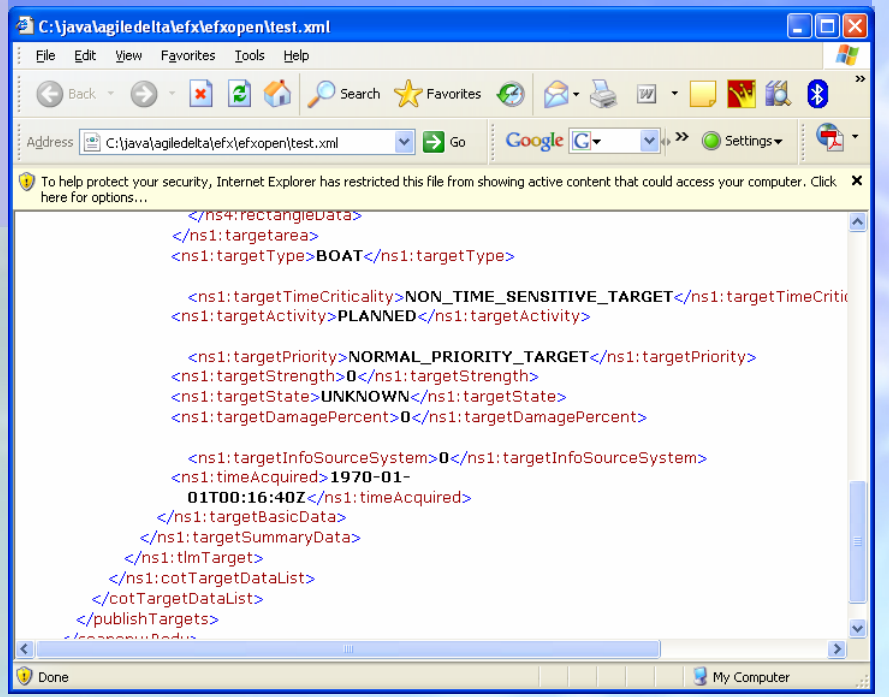
- No.
  - EFX tools detect and use EFX when available and automatically fall-back to XML otherwise
  - Clients that don't support EFX never see it

FAQ

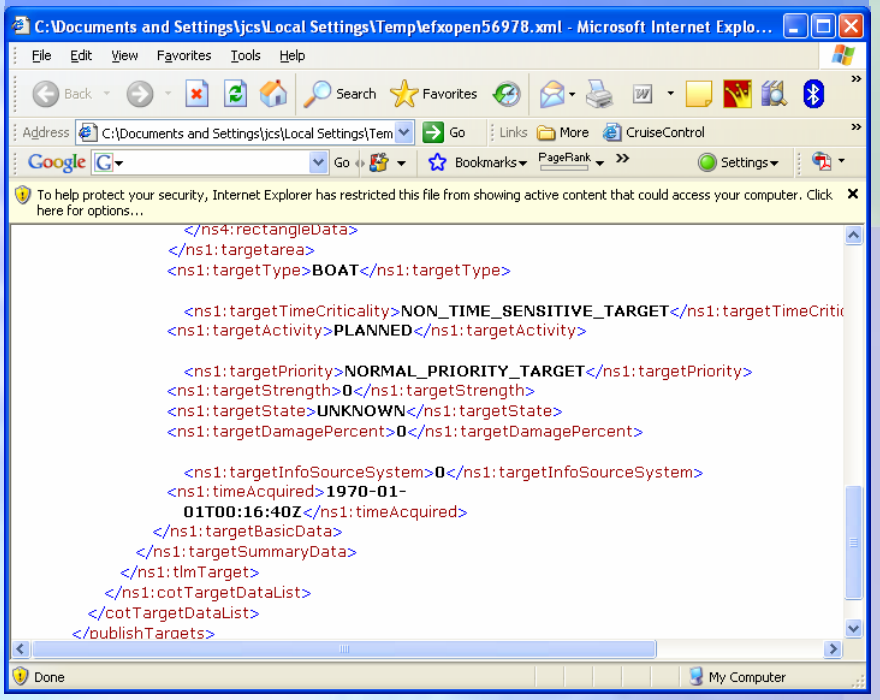
Can I read EFX with standard XML tools?

- Yes. With appropriate plug-ins and converters.

XML in Internet Explorer



Efficient XML in Internet Explorer



This kind of transparency and tool support makes testing, debugging and using Efficient XML far easier than other binary formats

FAQ

Does EFX work with XML Security?

- Yes. Unlike most binary XML technologies, EFX was designed to work with existing XML Security standards and libraries, including XML Digital Signatures and XML Encryption.

- AgileDelta also provides Efficient XML Digital Signature and Efficient XML Encryption products that leverage EFX to eliminate significant XML Security processing bottlenecks and increase the bandwidth efficiency of XML Security protocols.

Efficient XML SDK: http://www.agiledelta.com/efx_download.html

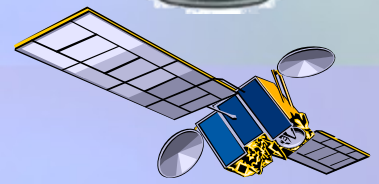
Includes all the following:

- Developer API docs and tools
- Runtime for Java EE/SE
- Runtime for Java ME
- Runtime for Microsoft .NET
- Runtime for Microsoft .NET Compact Framework
- Integration Kit for Apache Axis1
- Integration Kit for Apache Axis2
- Integration Kit for Microsoft WCF
- Integration Kit for BEA WebLogic
- HTTP Server and Client Proxies
- EFX command-line
- EFXPerf micro-benchmark

> Download

Efficient XML Integrations
Examples of where its been used

JBoss
a division of Red Hat



Apache <Web Services /> Project

bea WebLogic

Efficiency

What do we Mean by Efficiency?

- Dictionary definition:
  - Acting or producing effectively with a minimum of waste, expense, or unnecessary effort.
  - Exhibiting a high ratio of output [results] to input [resources]
- Mathematical definition:

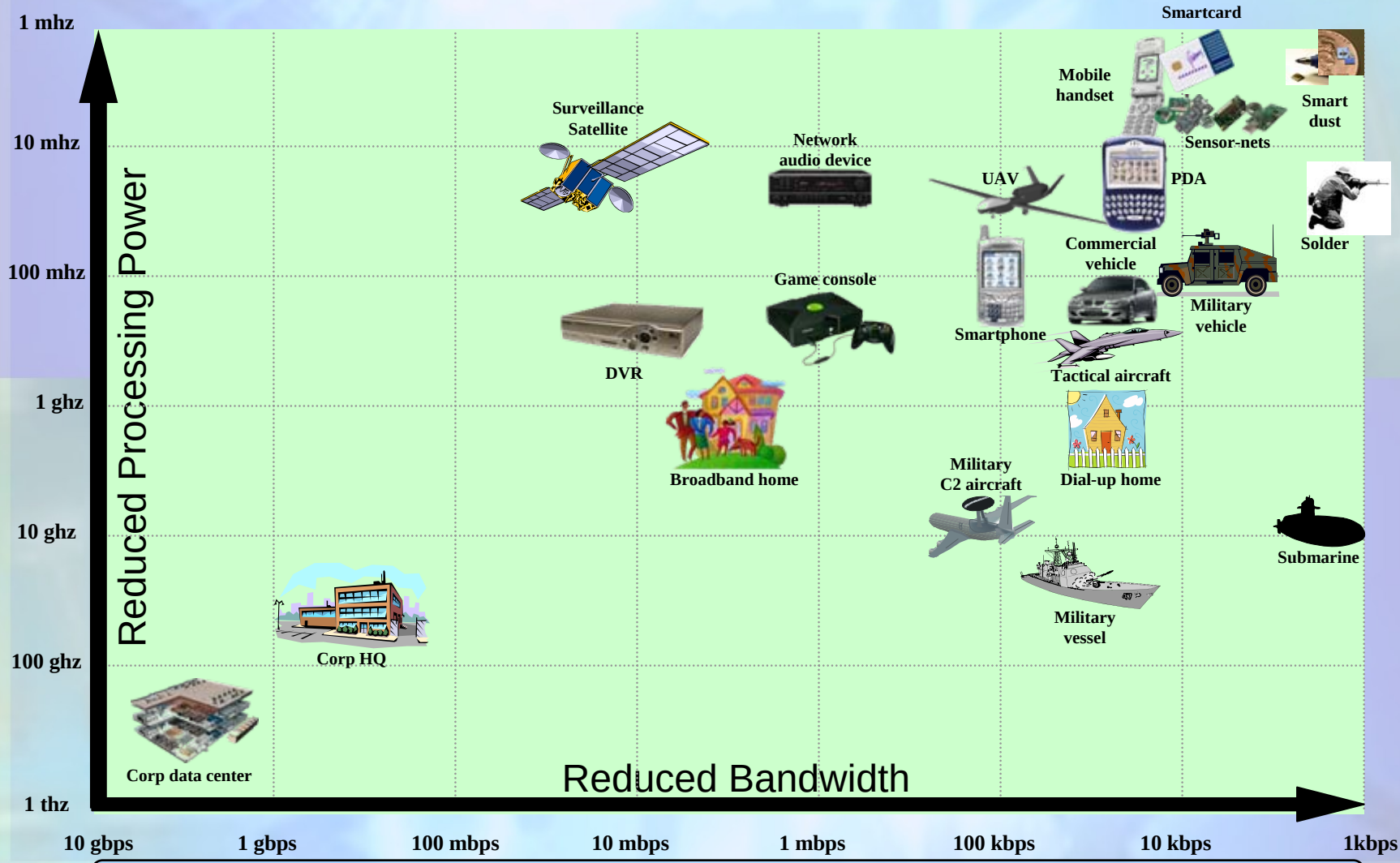
$$\text{Efficiency} = \frac{\text{Results}}{\text{Resources}}$$

- **Results** include web pages, web service calls, messages, etc.
- **Resources** include bandwidth, processor cycles, memory (code, data and heap limits), battery life, disk space, etc.
- So, for example, system A is *more efficient* than system B if
  - A produces the same result as B using fewer resources
  - A produces more results than B using the same resources
  - A produces more results than B using fewer resources

Why Worry About Efficiency?

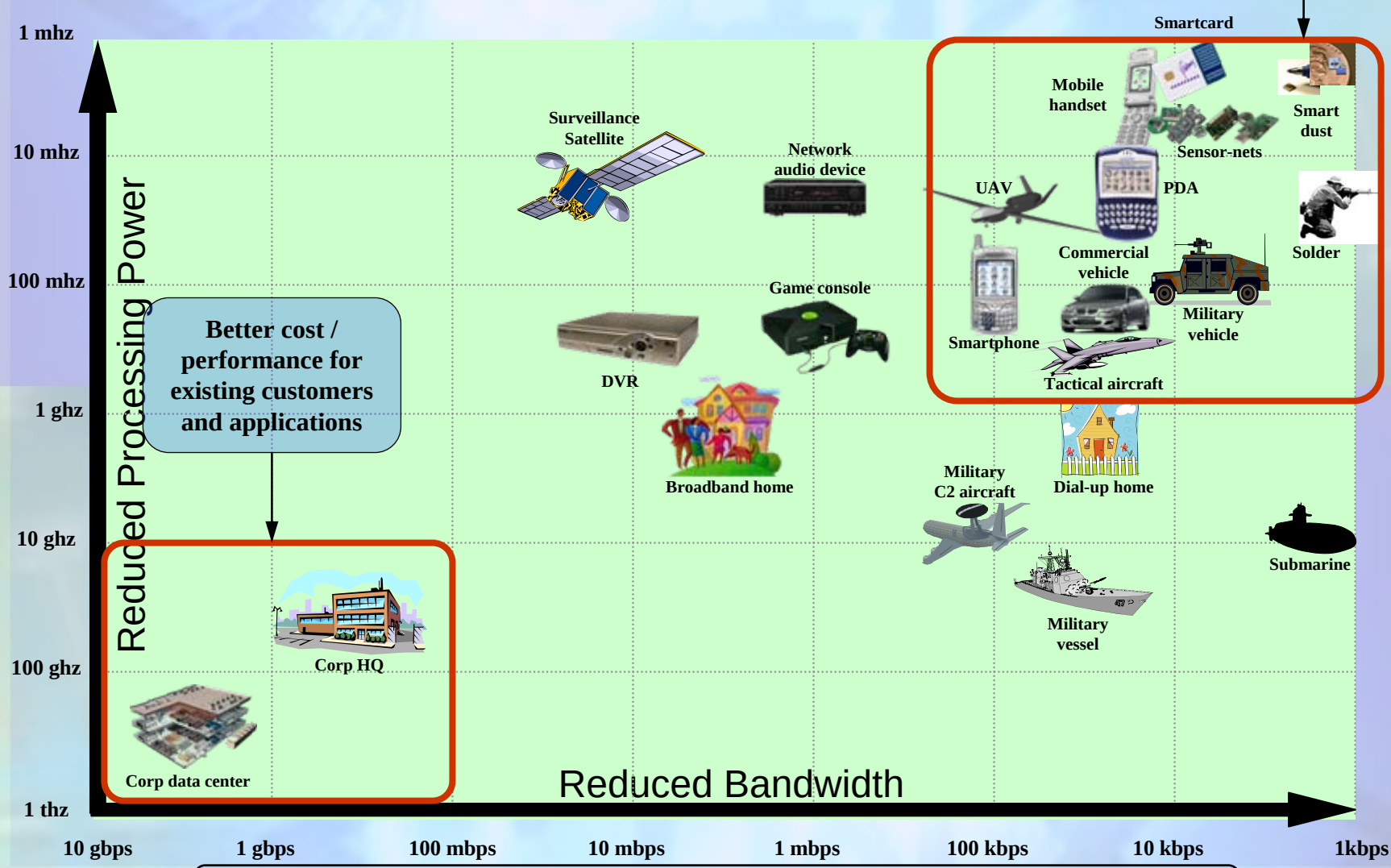
- Resources cost money
  - Bandwidth, processor power, memory (code, data and heap), battery life, disk space, etc.
  - Less resources == better cost / performance ratio
    == lower prices and/or more profit
- Many systems don't have resources to spare
  - Cost sensitive, mass market devices: mobile handsets, set-top boxes, consumer electronics, game consoles, automobiles, etc.
  - Physical constraints: battery life, size, weight, heat, etc.
  - Less resources == cheaper, smaller, lighter, cooler, etc.
- Faster & more scalable without more hardware

The Value of Efficiency



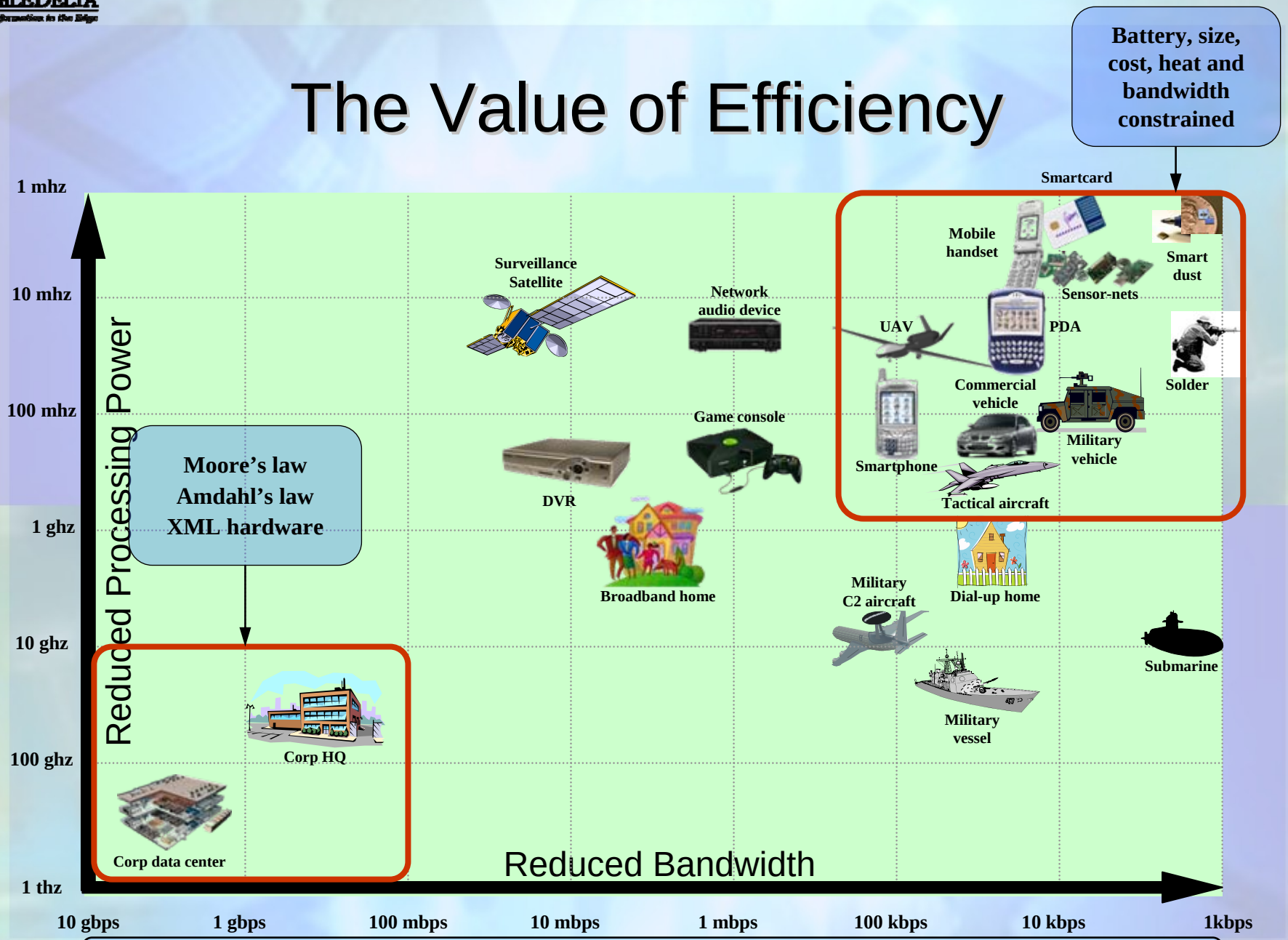
Value of efficiency increases as available bandwidth and processing power decrease

The Value of Efficiency



Benefits of efficiency are widely applicable, but unevenly distributed

The Value of Efficiency



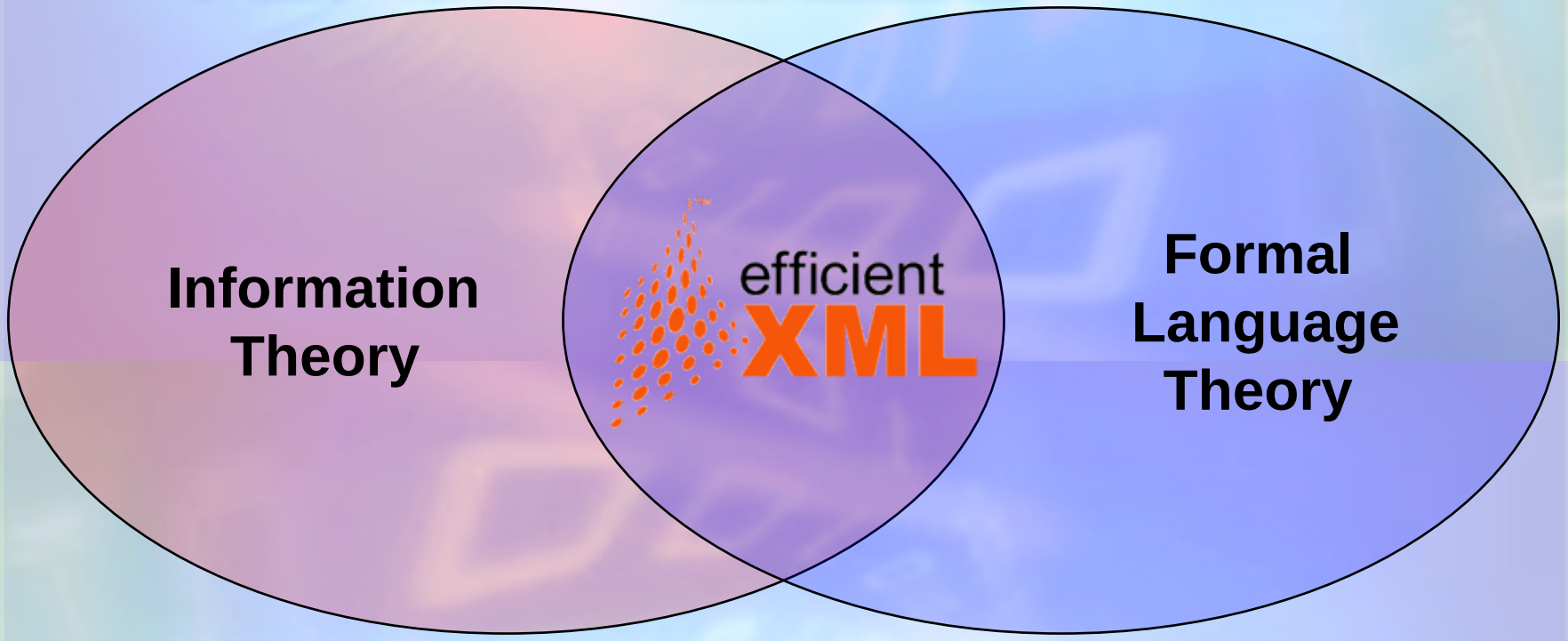
Battery, bandwidth, size, cost and other constraints will widen the value gap

Design

Efficient XML Design Principles

- Generality
  - *One* format for *all* applications
- Performance
  - Replace hand-optimized binary formats with XML
- Simplicity
  - Small footprint for mobile and embedded applications
- Efficiency
  - Bandwidth, battery, CPU, memory, storage
- Robust
  - Always works, regardless of data & schema issues

Efficient XML Roots



Efficient XML a new breed of technology that unifies concepts from formal language theory and information theory

Efficient XML Approach

- Generalized Algorithm
  - Use a grammar to determine the language constructs (not characters) most likely to occur at any given point in the stream
  - Assign variable-length codes to represent most likely language constructs in fewer bits
  - Concept works for any regular language that can be described by a grammar (e.g., XML, HTTP, CORBA IDL, Java, …)
- Efficient XML is specialized for XML
  - Built-in knowledge of XML grammar
  - Built-in knowledge of XML data types
  - Can augment grammar and type knowledge using schemas
  - Refines grammar knowledge based on experience
  - Does not require accurate, complete or current schemas (schemas describe things that are *likely* to occur)