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# JLIFF, Creating a JSON Serialization of OASIS XLIFF

Lossless exchange between asynchronous XML based and real time JSON based pipelines

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## Abstract

*JLIFF* [JLIFF] is the JSON serialization of XLIFF. Currently JLIFF only exists as a reasonably stable JSON schema that is very close to being a full bidirectional mapping to both XLIFF 2 Versions. *XLIFF* is the XML Localization Interchange File Format. The current OASIS Standard version is *XLIFF Version 2.1* [XLIFF21]. The major new features added to [XLIFF21] compared to *XLIFF Version 2.0* [XLIFF20] are the native *W3C ITS 2.0* [ITS20] support and the Advanced Validation feature via NVDL and Schematron. This paper describes how XLIFF was ported to JSON via an abstract object model. Challenges and design principles of transforming a multi-namespace business vocabulary into JSON while preserving lossless machine to machine interchange between the serializations are described in this paper. While we do explain about the *Internationalization (I18n)* and *Localization (L10n)* business specifics, we are also striving to provide general takeaways useful when porting XML based vocabularies into semantically and behaviorally interoperable JSON serializations.

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This research was conducted at the ADAPT Centre, Trinity College Dublin, Ireland.

The ADAPT Centre is funded under the SFI (Science Foundation Ireland) Research Centres Programme (Grant 13/RC/2106) and is co-funded under the European Regional Development Fund.

## Introduction

In this paper and XML Prague presentation, we will explain about *JLIFF* [JLIFF], the JSON serialization of XLIFF. JLIFF is designed to start with the 2.0 version number and bidirectional mapping for both XLIFF 2.0 and XLIFF 2.1 is being built in parallel in the initial version. The design is extensible to support any future XLIFF 2.n+1 Version. The XLIFF 2 series has been designed to be backwards and forwards compatible. XLIFF 2.n+1 versions can add orthogonal features such as the Advanced Validation added in XLIFF 2.1 or the Rendering Requirements to be added in XLIFF 2.2. All XLIFF 2.n specifications share the core namespace `urn:oasis:names:tc:xliff:document:2.0`.

OASIS XLIFF OMOS TC only recently started developing JLIFF prose specification that should be released for the 1st public review by April 2019. It is however clear that the specification largely mimics the logical structure of the XLIFF 2 specifications. JLIFF is designed to mirror XLIFF including its numerous modules, albeit via the abstract object model. The modular design of XLIFF 2 makes critical use of XML's namespace support. Each XLIFF 2 module has elements or attributes defined in namespaces other than the core XLIFF 2 namespace. This allows the involved agents (conformance application targets) to handle all and only those areas of XLIFF data that are relevant for their area of expertise (for instance *Translation Memory* matching, *Terminology*, *Text Analysis* or entity recognition, *Size and Length Restrictions*, and so on). Now, how do you handle multi-namespace in JSON that doesn't support namespaces? This is covered in The design of JLIFF.

The data formats we are describing in this paper are for managing *Internationalization* and *Localization* payloads and metadata throughout the multilingual content lifecycle. Even though corporations and governments routinely need to present the same, equivalent, or comparable content in various languages, *multilingual content* is usually not consumed in more than one language at the same time by the same end user. Typically the target audience consumes the content in their preferred language and if everything works well they don't even need to be aware that the monolingual content they consume is part of a multilingual content repository or a result of a *Translation*, *Localization*, or cultural adaptation process.

Thus *Multilingualism* is transparent to the end user if implemented properly. To achieve end user transparency the corporations, governments, inter- or extra-national agencies need to develop and employ *Internationalization*, *Localization*, and *Translation* capabilities. While *Internationalization* is primarily done on a monolingual content or product, *Localization*, and *Translation* when done at a certain level of maturity -- as a repeatable process possibly aspiring to efficiencies of scale and automation -- requires a persistent *Bitext* format. Bitext in turn requires that *Localizable* or *Translatable* parts of the source or native format are *Extracted* into the Bitext format, which has provisions for storing the Translated or Localized target parts in an aligned way that allows for efficient and automated processing of content during the Localization roundtrip.

Our paper presented to XML Prague 2017 [3] made a detailed introduction of XLIFF ([XLIFF21prd02] as the then current predecessor of [XLIFF21] backwards compatible with [XLIFF20]) as the open standard Bitext format used in the Localization industry. This paper describes how the complete open transparent bitext capability of XLIFF can be ported to JSON environments using the JLIFF format. We also demonstrate that JLIFF and XLIFF can be used interchangeably, effectively allowing to switch between XML and JSON pipelines at will.

## Lay of the land

The foundational Internationalization Standard is of course [Unicode] along with some related Unicode Annexes (such as [UAX9]). However, in this paper we are taking the Unicode support for granted and will be looking at the domain standards W3C ITS and OASIS XLIFF along with its upcoming JSON serialization JLIFF that are the open standards relevant for covering the industry process areas outlined in the second part of the Introduction.

For a long time, XML has been another unchallenged foundation of the multilingual content interoperability and hence practically all Localization and Internationalization standards started as or became at some point XML vocabularies. Paramount industry wisdom is stored in data models that had been developed over decades as XML vocabularies at OASIS, W3C, LISA (RIP) and elsewhere. Although ITS is based on *abstract metadata categories*, [ITS 1.0] had only provided specific implementable recommendation for XML. The simple yet ingenious idea of ITS is to provide a reusable namespace that can be injected into existing formats. Although the notion of a namespace is not confined to XML, again ITS 1.0 was only specifically injectable into XML vocabularies.

[ITS20] provides local and global methods for metadata storage not only in XML but also in [HTML5], it also looked at mapping into non-XML formats such as [NIF], albeit in a non-normative way. Because native HTML does not support the notion of namespaces, ITS 2.0 has to use attributes that are prefixed with the string `its-` for the purpose of being recognized as an HTML 5 module. In JLIFF, we are using `its_` to indicate the ITS Module data.

[ITS20] also introduced many new metadata categories compared with [ITS10]. ITS 1.0 only looked at metadata in source content that would somehow help inform the Internationalization and Localization processes down the line. ITS 2.0 brought brand new and sometimes complex metadata categories that contain information produced during the localization processes or during the language service transformations that are necessary to produce target content and are typically facilitated by Bitext. This naturally led to a non-normative mapping of [ITS20] to [XLIFF12] and to [XLIFF20]. Thus ITS 2.0 became a very useful extension to XLIFF. And here comes the modular design that allows to turn useful extensions into modules as part of a dot-release. Not only module data is better protected but also describing a data model addition as part of the broader spec gives an opportunity to tie lots of loose ends that are at play when using only a partially formalized extension mapping.

One of the main reasons why [XLIFF20] is not backwards compatible with [XLIFF12] is that the OASIS XLIFF TC and the wider stakeholder community wanted to create XLIFF 2 with a modularized data model. [XLIFF20] has a small non-negotiable core but at the same time it brings 8 namespace based modules for advanced functionality. The modular and extensible design aims at easy production of "dot" revisions or releases of the standard. XLIFF Version 2.0 was intended as the first in the future family of backwards compatible XLIFF 2 standards that will share the maximally interoperable core (as well as successful modules surviving from 2.0). XLIFF 2 makes a distinction between modules and extensions. While module features are optional, *Conformant XLIFF Agents* are bound by an absolute prohibition to delete module based metadata (MUST NOT), whereas deletion of extension based data is discouraged but not prohibited (the SHOULD NOT normative keyword is used, see [BCP14]). The *ITS Module* is the biggest feature that was requested by the industry community and approved by the TC for specification as part of [XLIFF21].

So in a nutshell the difference between XLIFF 2.1 and XLIFF 2.0 can be explained and demonstrated as the two overlapping listings of namespaces.

### Example 1. Namespaces that appear both in XLIFF 2.1 and XLIFF 2.0

<code>urn:oasis:names:tc:xliff:document:2.0</code>	<code>&lt;!-- Core [http://docs.oasis-...</code>
<code>urn:oasis:names:tc:xliff:matches:2.0</code>	<code>&lt;!-- Translation Candidates Mo...</code>
<code>urn:oasis:names:tc:xliff:glossary:2.0</code>	<code>&lt;!-- Glossary Module [http://d...</code>
<code>urn:oasis:names:tc:xliff:fs:2.0</code>	<code>&lt;!-- Format Style Module [http...</code>
<code>urn:oasis:names:tc:xliff:metadata:2.0</code>	<code>&lt;!-- Metadata Module [http://d...</code>
<code>urn:oasis:names:tc:xliff:resourcedata:2.0</code>	<code>&lt;!-- Resource Data Module [http...</code>
<code>urn:oasis:names:tc:xliff:sizerestriction:2.0</code>	<code>&lt;!-- Size and Length Restricti...</code>
<code>urn:oasis:names:tc:xliff:validation:2.0</code>	<code>&lt;!-- Validation Module [http://...</code>

### Example 2. Namespaces that appear only in XLIFF 2.1

<code>http://www.w3.org/2005/11/its</code>	<code>&lt;!-- ITS Module [http://docs.o...</code>
<code>urn:oasis:names:tc:xliff:itsm:2.1</code>	<code>&lt;!-- ITS Module [http://docs.o...</code>

### Example 3. Namespaces that appear only in XLIFF 2.0

<code>urn:oasis:names:tc:xliff:changetracking:2.0</code>	<code>&lt;!-- Change Tracking Module [h...</code>
--	---

Apart from the 11 listed namespaces, both XLIFF Core and the W3C ITS namespace reuse the xml namespace. This is still not all namespaces that you can encounter in an XLIFF Document. XLIFF 2 Core defines 4 element extension points (`<file>`, `<skeleton>`, `<group>`, and `<unit>`) and 4

more attribute extension points (<xliff>, <note>, <mrk>, and <sm>). Most of XLIFF's modules are also extensible by elements or by attributes. We will explain in the JLIFF design section how we dealt with the inherent multi-namespace character of XLIFF.

The easiest metadata category to explain the idea of Extraction from the native format with the help of ITS is *Translate*. This is simply a boolean flag that can be used to indicate Translatability or not in source content.

#### Example 4. Translate expressed locally in HTML

```
<!DOCTYPE html>
<html>
  <head>
    <meta charset=utf-8>
    <title>Translate flag test: Default</title>
  </head>
  <body>
    <p>The <span translate=no>World Wide Web Consortium</span> is
      making the World Wide Web worldwide!</p>
  </body>
</html>
```

#### Example 5. Translate expressed locally in XML

```
<messages its:version="2.0" xmlns:its="http://www.w3.org/2005/11/its">
  <msg num="123">Click Resume Button on Status Display or <panelmsg its:translate="no">
    >CONTINUE</panelmsg> Button on printer panel</msg>
</messages>
```

Since it is not always practically possible to create local annotations, or the given source format or XML vocabulary has elements or attributes with clear semantics with regards to some Internationalization data categories such as Translate, in most cases, ITS 2.0 also defines a way to express a given data category globally.

#### Example 6. Translate expressed globally in XML

```
<its:rules version="2.0" xmlns:its="http://www.w3.org/2005/11/its">
  <its:translateRule translate="no" selector="//code"/>
</its:rules>
```

In the above the global `its:translateRule` indicates that the content of `<code>` elements is not to be translated.

XLIFF 2 Core has its own native local method how to express Translatability, it uses the `xlf:translate` attribute. Here and henceforth the prefix `xlf:` indicates this OASIS namespace `urn:oasis:names:tc:xliff:document:2.0`. Because XLIFF is the Bibtex format that is used to manage the content structure during the service roundtrip in a source format agnostic way, XLIFF needs to make a hard distinction between the structural and the inline data. We know the structural vs inline distinction from many XML vocabularies and HTML. Some typical structural elements are Docbook `<section>` or `<para>` as well as HTML `<p>`. This is how XLIFF 2 will encode non-Translatability of a structural element:

#### Example 7. XLIFF Core @translate on a structural leaf element

```
<unit id='1' translate="yes">
  <segment>
    <source>Translatable text</source>
```

```
        </segment>
    </unit>
    <unit id='2' translate="no">
        <segment>
            <source>Non-translatable text</source>
        </segment>
    </unit>
```

The above could be an *Extraction* of the following HTML snippet:

```
<p translate='yes'>Translatable text</p>
<p translate='no'>Non-translatable text</p>
```

The same snippet could be also represented like this:

### **Example 8. XLIFF representing ITS Translate by Extraction behavior w/o explicit metadata**

```
<unit id='1'>
    <segment>
        <source>Translatable text</source>
    </segment>
</unit>
```

However, it is quite likely that the non-translatable structural elements could provide the translators with some critical context information. Hence the non-extraction behavior can only be recommended if the *Extracting Agent* human or machine can make the call if there is or isn't some sort of contextual or linguistic relationship.

In case of the Translate metadata category being expressed inline, XLIFF has to use its *Translate Annotation*:

### **Example 9. XLIFF Core @translate used inline**

```
<unit id='1'>
    <segment>
        <source>Text <pc id='1' /><mrk id='m1' translate='no'>Code</mrk></pc>
    </segment>
</unit>
```

The above could be an *Extraction* of the following HTML snippet:

```
<p>Text <code translate='no'>Code</code></p>
```

Also inline, there is an option to "hide" the non-translatable content like this:

### **Example 10. XLIFF representing ITS Translate by Extraction behavior w/o explicit metadata**

```
<unit id='1'>
    <segment>
        <source>Text <ph id='1' /></source>
    </segment>
</unit>
```

Again not displaying of the non-translatable content can be detrimental to the process, as both human and machine translation agents would produce unsuitable translations in case there is some linguistic relationship between the displayed translatable text and the content hidden by the placeholder code.

Because XLIFF has its own native method of expressing translatability, generic ITS decorators could not succeed. ITS processors can however access the translatability information within XLIFF using the following global rule:

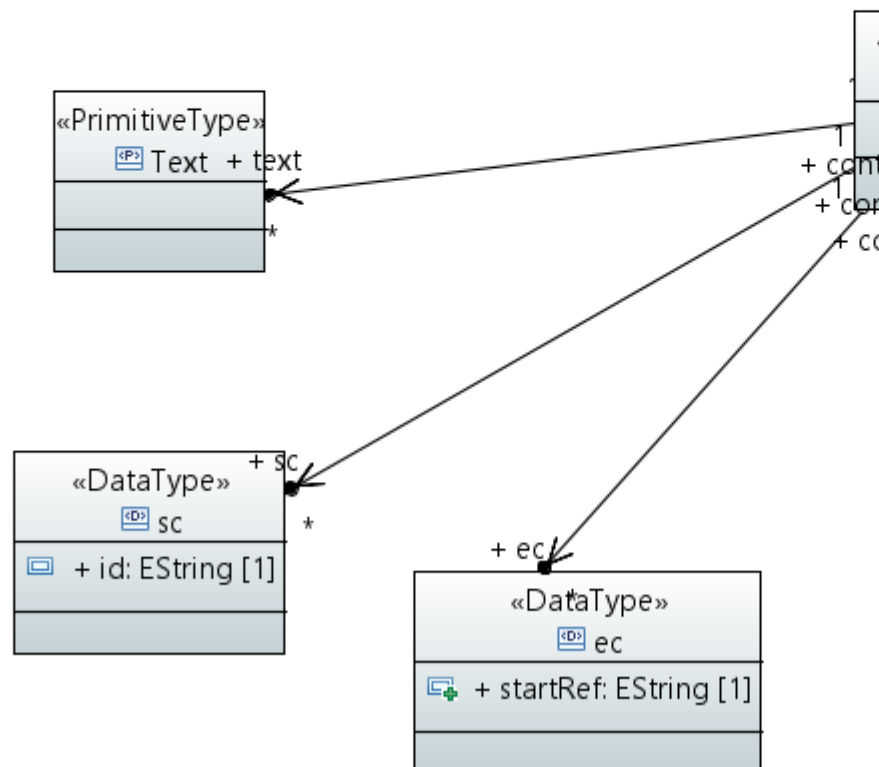
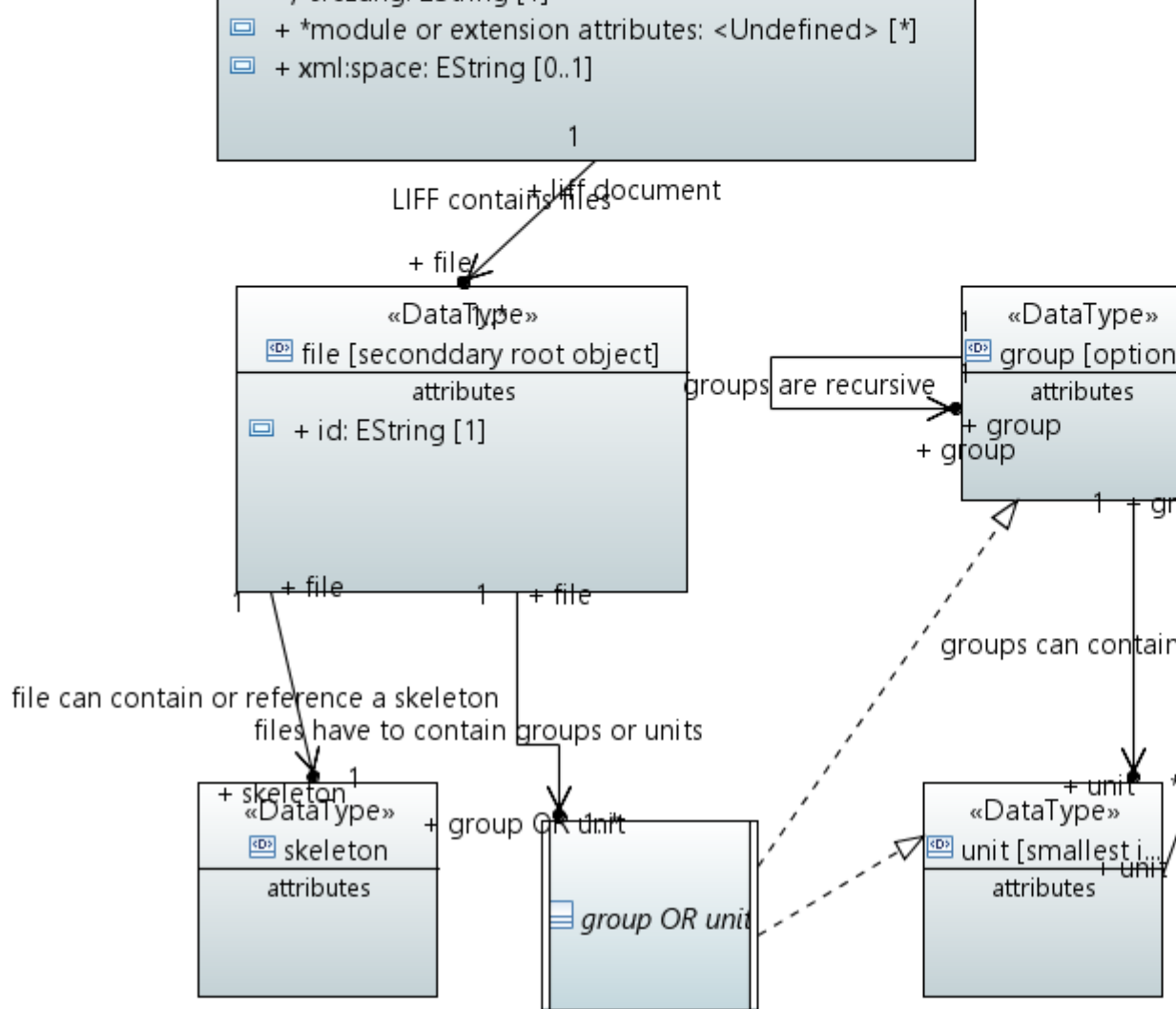
**Example 11. ITS global rule to detect translatability in XLIFF**

```
<its:rules version="2.0" queryLanguage="xpath">
  <!-- Rules for Translate -->
  <its:translateRule selector="//xlf:*[@translate='no']" translate='no' />
  <its:translateRule selector="//xlf:*[@translate='yes']" translate='yes' />
</its:rules>
```

## The abstract Localization Interchange Object Model (LIOM)

### The Core Structure

This figure [LIOM] is a UML class diagram rendering of the abstract object model behind XLIFF 2 Core and hence also JLIFF core.



The above can be described in a natural language as follows:

A *LIOM* instance contains at least one file. Each file can contain an optional recursive group structure of an arbitrary depth. Because grouping is fully optional, files can contain only a flat series of units. But also any file or group can contain either a flat structure of units or an array of groups and units (subgroups). Each unit contains at least one sub-unit of the type segment (rather than ignorable). Each sub-unit contains exactly one source and at most one target. Bitext is designed to represent the localizable source structure and only later in the process is expected to be Enriched with aligned target content. The content data type can contain character data mixed with inline elements. It is worth noting that XLIFF even in its XML serialization only preserves a treelike document object model (DOM) down to unit. Inline markup present in the source and target content data can form spans that can and often have to overlap the tree structure given by the well-formed `<mrk>` and `<pc>`, but also notably the structural `<source>`, `<target>`, `<segment>`, and `<ignorable>` tags. The `<unit>` tag separates the upper clean XML well-formed structure from the transient structure of segments where "non-well-formed" pseudo-spans formed by related empty tags (`<sc/>` and `<ec/>`, as well as `<sm/>` and `<em/>` pairs) need to be recognized and processed by XLIFF Agents.

The above class diagram shows that a LIOM has four options of logical roots. The original XML serialization, i.e. XLIFF 2, can only use the top level root object according to its own grammar. On the other hand, the abstract object model caters for use cases where LIOM fragments could be exchanged. Such scenarios include real time unit exchange between translation tools such as between a *Translation Management System (TMS)* and a translation or review workbench (browser based or standalone), a TMS and a *Machine Translation (MT)* engine, two different TMSes, and so on.

Based on the above, a LIOM instance can represent a number of *source files* intended for Localization. The top level wrapper in the XML serialization is the `<xliff>` element, the top level object in the JSON serialization is an anonymous to level object with the required `jliff` property.

### Example 12. XLIFF top level element

```
<xliff xmlns="urn:oasis:names:tc:xliff:document:2.0"
xmlns:uext1="http://example.com/userextension/1.0"
xmlns:uext2="http://example.com/userextension/2.0"
version="2.1" srcLang="en" trgLang="fr">
  <file ... >
    <group ... >
      /arbitrary group depth including 0/
      <unit ... >
        [ ... /truncated payload structure / ... ]
      </unit>
    </group>
  </file>
</xliff>
```

### Example 13. JLIFF anonymous top level object

```
{
  "jliff": "2.1",
  "@context": {
    "uext1": "http://example.com/userextension/1.0",
    "uext2": "http://example.com/userextension/2.0"
  },
  "srcLang": "en",
  "trgLang": "fr",
  "files | subitems | subunits": [ ... /truncated payload structure / ... ]
}
```

Comparing the two examples above, it is clear that XLIFF in its original XML serialization doesn't have another legal option but to represent the whole project structure of source files. JLIFF has been



conceived from the beginning as the JSON Localization *Fragment* Format, so that top level JLIFF object (`jliiff`) can wrap an array of files (within the `files` object), an array of groups or units (within the `subitems` object), or an array of sub-units (within the `subunits` object).

## LIOM Modules

### LIOM modules originating in XLIFF 2.0

XLIFF 2.0 defined 8 namespace based modules, from which 7 survived to XLIFF 2.1. We won't be dealing with the deprecated Change Tracking Module.

The simplest XLIFF module is the Format Style module that consists just of two attributes `fs` and `subFs`. Obviously this is very easy to express both in the abstract LIOM and in the JLIFF serialization. The `subFs` property is only allowed on objects where `fs` has been specified. At the same time `fs` values are restricted to a subset of [HTML5] tag names.

### The ITS Module

[NEEDS ADAPTED - left only datacats suitable to demonstrate the point]

Language Information [<http://www.w3.org/TR/its20/#language-information>] uses the [BCP47] data model via `xml:lang` to indicate the natural language of content. This is obviously very useful in case you want to source translations or even just render the content with proper locale specifics.

Directionality [<http://www.w3.org/TR/its20/#directionality>] has quite a profound Internationalization impact, it lets renderers decide at the protocol level (as opposed to the plain text or script level) whether the content is to be displayed left to right (LTR - Latin script default) or right to left (RTL - Arabic or Hebrew script default). But the Unicode Bidirectional Algorithm [UAX #9] as well as directionality provisions in HTML and many XML vocabularies changed since 2012/2013, so the ITS 2.0 specification text is actually not very helpful here. This obviously doesn't affect the importance of the abstract data category and of having proper display behavior for bidirectional content.

Preserve Space [<http://www.w3.org/TR/its20/#preservespace>] indicates via `xml:space` whether or not whitespace characters are significant. If whitespace is significant in source content it is usually significant also in the target content, this is more often than not an internal property of the content format, but it's important to keep this characteristic through transformation pipelines. The danger that this category is trying to prevent is the loss of significant whitespace characters that could not be recovered.

ID Value [<http://www.w3.org/TR/its20/#idvalue>] indicates via `xml:id` a globally unique identifier that should be preserved during translation and localization transformations mainly for the purposes of reimport of target content to all the right places in the native environment.

Terminology [<http://www.w3.org/TR/its20/#terminology>] can simply indicate words or multi-word expressions as terms or non-terms. This is how the category worked in ITS 1.0. In ITS 2.0, Terminology can be more useful by pointing to definitions or indicating a confidence score, which is especially useful in cases the Terminology entry was seeded automatically. Terminology doesn't belong exclusively here. Together with Text Analysis it can be actually injected into the content during any stage of the lifecycle and is not limited to source. However, it is very important for the localization process, human or machine driven, to have Terminology annotated by it even only the simple Boolean flag.

Text Analysis [<http://www.w3.org/TR/its20/#textanalysis>] is a sister category to Terminology that is new in ITS 2.0. It is intended to hold mostly automatically sourced (possibly semi-supervised) entity disambiguation information. This can be useful for translators and reviewers but can also enrich reading experience in purely monolingual settings.

Domain [] can be used to indicate content topic, specialization or subject matter focus that is required to produce certain translations. This can be for instance used to select a suitably specialized MT engine,

such as one trained on an automotive bilingual corpus in case an automotive domain is indicated or. In another use case, a language service provider will use a sworn translator and require in country legal subject matter review in case the domain was indicated as legal. Although ITS data categories are defined independently and don't have implementation dependencies, Domain information is well suited for usage together with the Terminology and Text Analysis datacats.

## TBW

[NEEDS ADAPTED - left only datacats suitable to demonstrate the point]

It might seem that this type of metadata is completely new in [ITS 2.0], since [ITS 1.0] concentrated almost exclusively on source metadata. However, as mentioned above, Terminology - that was present in already in ITS 1.0 - can be injected at any point and is not confined to source. Also Directionality is a characteristics of source as well as target and has profound importance during the roundtrip. This was however not the focus in ITS 1.0.

MT Confidence [<http://www.w3.org/TR/its20/#mtconfidence>], Localization Quality Issue [<http://www.w3.org/TR/its20/#lqissue>], Localization Quality Rating [<http://www.w3.org/TR/its20/#lqrating>], and Provenance [<http://www.w3.org/TR/its20/#provenance>] - all new categories in ITS 2.0 - can be only produced during Localization transformations; specifically, during Machine Translation, during a review or quality assurance process, during or immediately after a manual or automated translation or revision.

MT Confidence [<http://www.w3.org/TR/its20/#mtconfidence>] gives a simple score between 0 and 1 that encodes the automated translation system's internal confidence that the produced translation is correct. This score isn't interoperable but can be used in single engine scenarios for instance to color code the translations for readers or post-editors. It can also be used for storing the data for several engines and running comparative studies to make the score interoperable first in specific environments and later on maybe generally.

Localization Quality Issue [<http://www.w3.org/TR/its20/#lqissue>] contains a taxonomy of possible Translation and Localization errors that can be applied in annotations of arbitrary content spans. The taxonomy ensures that this information can be exchanged among various Localization roundtrip agents. Although this mark up is typically introduced in a Bilingual environment on target spans, marking up source isn't exclude and can be very practical, especially when implementing the feedback or even reporting a source issue. Importantly, the issues and their descriptions can be Extracted into target content and consumed by monolingual reviewers in the native environment.

Localization Quality Rating [<http://www.w3.org/TR/its20/#lqrating>] is again a simple score that gives a percentage indicating the quality of any portion of content. This score is obviously only interoperable within an indicated Localization Quality Rating system or metrics. Typically flawless quality is considered 100 % and various issue rates per translated volume would strike down percentages, possibly dropping under an acceptance threshold that can be also specified.

Provenance [<http://www.w3.org/TR/its20/#provenance>] in ITS is strictly specialized to indicate only translation and revision agents. Agents can be organizations, people or tools or described by combinations of those. For instance, Provenance can indicate that the Reviser John Doe from ACME Language Quality Assurance Inc. produced a content revision with the Perfect Cloud Revision Tool.

In spite of [XLIFF 2.1] now using the W3C namespace for the ITS Module, there is a systematic scope mismatch between the XLIFF defined ITS attributes and the ITS defined XML attributes. Because ITS 2.0 has no provision to parse pseudo-spans, it will necessarily fail to identify spans formed by XLIFF Core `<sm/>` and `<em/>` markers.

In XLIFF, Modifiers can always transform `<mrk id="1">span of text</mrk>` into `<sm id="1"/>span of text <em startRef="1"/>`, which is fundamentally inaccessible by ITS Processors without extended provisions. Unmodified or unextended ITS Rules will find the `<sm/>` nodes, if those nodes do hold the W3C ITS namespace based attributes or native XLIFF attributes that can be globally pointed to by ITS rules, yet they will fail to identify the pseudo-spans and will consider the `<sm/>` nodes empty, ultimately failing to identify the proper scope of the correctly identified

datacat. XLIFF implementers who want to make their XLIFF Stores maximally accessible to ITS processors are encouraged to avoid forming of `<sm/>` based spans, it is however often not possible. Had it been possible, XLIFF would have not needed to define `<sm/>` and `<em/>` delimited pseudo-spans in the first place.

Principal reasons to form pseudospans include the following requirements: 1) capability to represent non-XML content, 2) need for overlapping annotations, 3) capability to represent annotations overlapping with formatting spans as well as 4) annotations broken by segmentation (which has to be represented as well formed structural albeit transient nodes).

## The design of JLIFF

The design of JLIFF follows the design of XLIFF 2 closely. As with XLIFF 2, the JLIFF 2 Core is the abstract Localization Interchange Object Model - LIOM. One of the primary goals of JLIFF 2 is compatibility with XLIFF 2. While JLIFF is structurally different compared to XLIFF 2 due to the much simpler JSON representation format, compatibility is made possible through the following mappings:

1. As a general rule, JSON object property names are used to represent XLIFF elements and attributes, with the exception of element sequences that must be represented by JSON arrays. JSON object properties should be unique and are unordered, whereas these constraints are not generally imposed on XML elements;
2. It was decided to use JSON arrays to represent element sequences, for example a sequence of `<file>` elements becomes an array identified by the JSON object property `"files": [...]` where each array item is an anonymous file object that may contain an array of `"subfiles": [...]`. It was decided to use plural forms to refer to arrays in JLIFF and as a reminder of the structural differences with XLIFF;
3. To store units and groups of files, JSON object property `"subfiles": [...]` is an array of unit and group objects representing XLIFF `<unit>` and `<group>` elements, where an anonymous unit object is identified by a `"kind": "unit"` and an anonymous group object is identified by `"kind": "group"`;
4. Likewise, `"subunits": [...]` is an array of subunits of a unit object, where a segment subunit is identified as an object with `"kind": "segment"` and a ignorable object is identified by `"kind": "ignorable"`;
5. A subset of XSD types that are used in XLIFF are also adopted in the JLIFF schema by defining corresponding JSON schema string types with restricted value spaces defined by regex patterns for NCName, NMTOKEN, NMTOKENS, and URI/IRI. The latter is not restricted by a regex pattern due to the lax validation of URI and IRI values by processors;
6. Because JSON intrinsically lacks namespace support, it was decided to use qualified JSON object property names to represent XLIFF modules, which is purely syntactic to enhance JLIFF document readability and processing. For example, ITS module properties are identified by prefix `its_`, such as `"its_locQualityIssues"`;
7. JLIFF extensions are defined by the optional JSON-LD context `"@context": {...}` as a property of the anonymous JLIFF root object. JSON-LD offers a suitable replacement of XML namespaces required for extension identification and processing. A JSON-LD context is a mapping of prefixes to IRIs. A JSON-LD processor resolves the prefix in an object property name to a fully qualified name with corresponding IRI qualifier;
8. To identify JLIFF documents, the anonymous JLIFF root object has property `"jliiff": "2.0"` or `"jliiff": "2.1"`;
9. One of the decisions taken in relation to element mappings was not to explicitly support XLIFF `<pc/>` and `<mrk/>` elements, therefore it was decided that `<mrk/>` is mapped to `<sm/>` and `<em/>` pairs, and `<pc/>` is mapped to `<sc/>` and `<ec/>` pairs.

## Reference Implementation

It was an early goal to work on a concrete implementation of JLIFF in parallel to the development of the schema. It would give us an early opportunity to find and work through any design flaws or limitations. Fortunately, the [JliffGraphTools] (JGT) reference implementation has been open source since early on.

It was a wish that JLIFF should be easy to implement and serialize/deserialize using well-known Json libraries.

Another noticeable difference in the structure of JLIFF and XLIFF is inline markup. In XLIFF inline markup is nested within the segment text as child elements of the `<segment />` elements. In JLIFF the segment text and inline markup are stored as an array of objects property of the Unit's source and target properties. MAYBE ADD SOME EXAMPLES. This has an impact on how rendering tools may display strings for translation, see below on the approach taken in JGT.

Having got the priority of JSON serialization and deserialization working we then looked at roundtripping. JliffGraphTools supports bidirectional serialization between XLIFF and JLIFF and it is this library which powers the [Xliff2Jliff] web application made public at <http://xliff2jliff.azurewebsites.net/>.

At present when segments for translation are rendered in JGT, there is an option to flatten the array of text and inline markup objects and render them in a way which is based upon the approach taken in the [Okapi Framework] XLIFF library. That is inline markup tags are converted to coded text which uses characters from the private use area of Unicode to delimit inline markup tags. (see <http://okapiframework.org/devguide/gettingstarted.html#textUnits>).

## Conclusions

In the above we tried to show how we ported into JSON XLIFF 2, a complex business vocabulary from the area of Translation and Localization. While the paper deals in detail only with XLIFF and JLIFF, we believe that important topics were covered that will be useful for designer who will endeavor porting their own specialized multi-namespace business vocabularies into JSON.

The major takeaway we'd like to suggest is not to port directly from XML to JSON. It is worth the time to start your exercise with expressing your XML data model in an abstract way, we used UML class diagram as the serialization independent abstract method.

XML serializations are as a rule fraught with "XMLism" or "SGMLism". While some of the XML capabilities such as the multi-namespace support are clear XML advantages that will force the JSON-equivalent-designer into complex and more or less elegant workarounds and compromises. Some other XML traits and constraints are arbitrary from the point of view of other languages and serialization methods.

To name just a few examples of XMLism that doesn't need maintained in JSON. You don't need to support well formed versions of inline markup in JSON, it is easier to serialize everything linearly. In JSON, all payload space is significant, so you don't need to keep the `preserve | default` flag in your JSON serialization. Instead make sure that all inline data is normalized and set to `preserve` in your XML data. JSON data types are much poorer than XML datatypes, nevertheless, you can make up for this with relative ease with the usage of regular expression patterns in your JSON schema. For instance

### Example 14. NCName pattern in JSON schema

```
"NCName": {  
  "description": "XSD NCName type for xml:id interoperability",  
  "type": "string",  
  "pattern": "^[ _A-Za-z][-._A-Za-z0-9]*$"
```

}

Namespaces support workarounds in JSON are worth an extra mention. While JSON doesn't support namespaces *per se*. We identified the JSON-LD methods for introducing and shortening fully qualified names quite useful as a namespaces support surrogate. For practical reasons (like prevention of hammering of OASIS servers to read XLIFF module context files) we decided to use the full blown JSON-LD method for expanding prefixes into fully qualified names only for extensions. We decided to use an arbitrary "\_" (underscore) prefix separator to make the XLIFF modules human discernable. There goes the disadvantage of losing the modularity of XLIFF modules in JLIFF, yet we felt that JSON-LD-coding of each of the modules data would be very oblique and heavyweight with minor benefits to outweigh the drawbacks.

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