pyang Tutorial

Ladislav Lhotka
⟨lhotka@nic.cz⟩

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Agenda

- Required software,
- Editing YANG modules,
- *pyang* plugins,
- Preparing a sample instance document,
- DSDL-based validation of instance documents,
- Converting XML instance documents to JSON.

An extended version of this tutorial is available at
https://github.com/mbj4668/pyang/wiki/Tutorial

Required Software

- *pyang*

  https://github.com/mbj4668/pyang

- Libxml2 tools (*xmllint*, *xsltproc*). Packages available for most operating systems and distributions.

  http://www.xmlsoft.org/

Optional:

- *Jing* and *Trang*

  https://code.google.com/p/jing-trang/

- *GNU Emacs* (*Aquamacs* on OS X)

About *pyang*

Command-line tool written in Python, XSLT and sh/bash.

Extensible via plugins.

Under active development, some plugins and bugfixes only available on GitHub.

Last stable version: 1.6 (2015-10-06), installable via *pip*.

RTFM: Unix man pages

- pyang (1)
- yang2dsdl (1)

Plugins

Conversions to various formats, activated with `-f`.

Most plugins have specific command-line switches and arguments.

- `yin`, `yang` – YIN and YANG syntax,
- `dsdl` – DSDL hybrid schema (RFC 6110),
- `xsd` – W3C XML Schema (incomplete, deprecated),
- `tree` – schema tree (ASCII art),
- `xmi`, `uml` – UML diagrams,
- `omni` – input to *OmniGraffle* (OS X and iOS only),
- `jstree` – HTML/JavaScript YANG browser,
- `hypertree` – Hyperbolic YANG browser, to be used with *Treebolic*,
- `jsonxsl`, `jtox` – XML↔JSON instance document conversion,
- `sample-xml-skeleton` – skeleton of a sample instance document.

Editing YANG Modules

Commercial editors and development environments exist but standard editors mostly suffice.

Special support for popular editors:

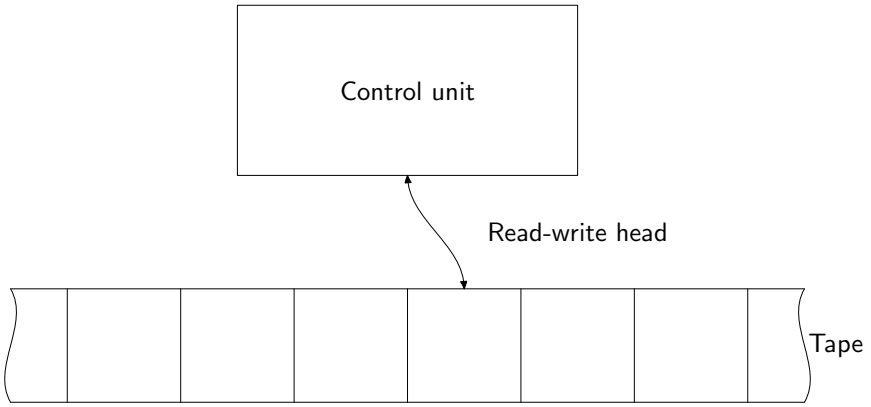
http://www.yang-central.org/twiki/bin/view/Main/YangTools

- *Emacs* – yang-mode
- *Vim* syntax file

With Emacs and nXML mode, it is also quite effective to use YIN syntax as the source format, see

https://gitlab.labs.nic.cz/labs/yang-tools/wikis/editing_yang

Example Module: Turing Machine



Available in pyang distribution: *doc/tutorial/examples*

Radek Krejčí wrote a Turing Machine simulator that can be managed via NETCONF:

https://github.com/CESNET/netopeer/tree/master/transAPI/turing

Essential Steps

- check module correctness

  ```
  $ pyang turing-machine.yang
  ```

- stricter check, mandatory for all IETF modules (RFC 6087 rules)

  ```
  $ pyang --ietf turing-machine.yang
  ```

- generate tree diagram

  ```
  $ pyang -f tree turing-machine.yang
  ```

  Help on tree symbols:

  ```
  $ pyang --tree-help
  ```

```
$ pyang -f tree turing-machine.yang
module: turing-machine
   +--rw turing-machine
      +--ro state                  state-index
      +--ro head-position          cell-index
      +--ro tape
      |  +--ro cell* [coord]
      |     +--ro coord     cell-index
      |     +--ro symbol?   tape-symbol
      +--rw transition-function
         +--rw delta* [label]
            +--rw label     string
            +--rw input
            |  +--rw state     state-index
            |  +--rw symbol    tape-symbol
            +--rw output
               +--rw state?       state-index
               +--rw symbol?      tape-symbol
               +--rw head-move?   head-dir
rpcs:
   +---x initialize
   |  +---w input
   |     +---w tape-content?   string
   +---x run
notifications:
   +---n halted
      +--ro state    state-index
```

DSDL Schemas

DSDL = Document Schema Definition Languages

International Standard ISO/IEC 19757, see *http://dsdl.org*.

RFC 6110 defines the mapping of YANG data models to three schemas of the DSDL family:

- RELAX NG – schema (grammar) and types
- Schematron – semantic constraints
- DSRL (Document Schema Renaming Language) – defaults

```
$ yang2dsdl -t config turing-machine.yang
== Generating RELAX NG schema './turing-machine-config.rng'
Done.
== Generating Schematron schema './turing-machine-config.sch'
Done.
== Generating DSRL schema './turing-machine-config.dsrl'
Done.
```

Preparing Sample XML Configuration

In an I-D describing a data model, it is often useful to include a sample document showing instance data such as the contents of a configuration datastore.

1. Generate a skeleton document:

   ```
   $ pyang -f sample-xml-skeleton turing-machine.yang \
   > --sample-skeleton-annotations --sample-skeleton-doctype=config | \
   > xmllint -o turing-machine-config.xml --format -
   ```

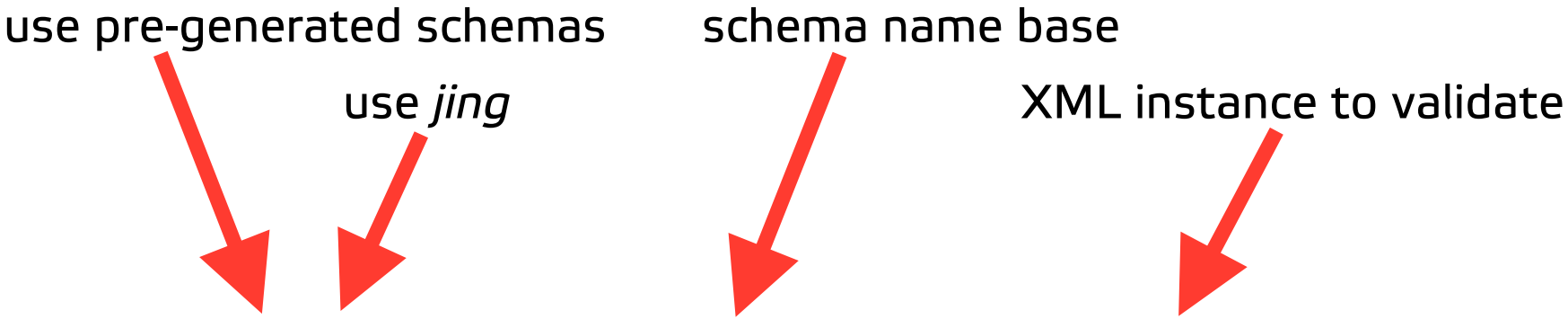
   The skeleton document has to be edited!

2. Convert the RELAX NG schema to the compact syntax:

   ```
   $ trang -I rng -O rnc turing-machine-config.rng turing-machine-config.rnc
   ```

3. Load `turing-machine-config.xml` into *Emacs*.

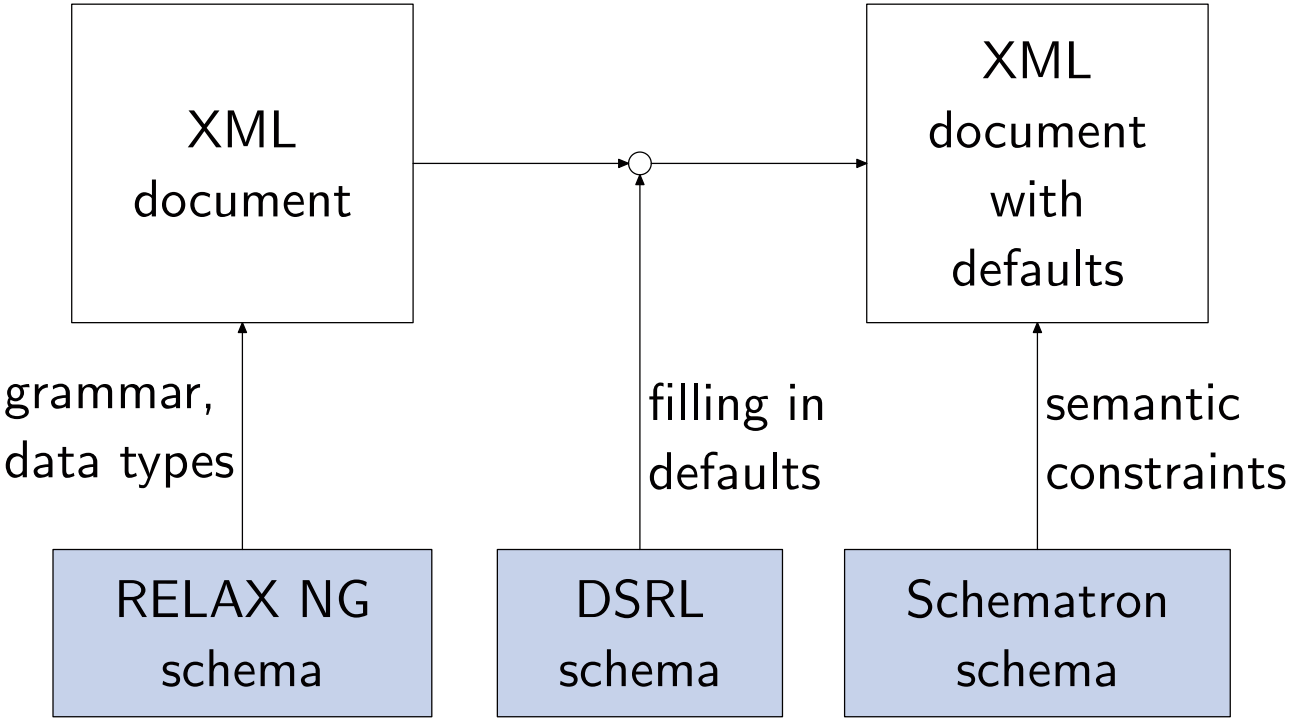
Schema-based Validation




```
$ yang2dsdl -s -j -t config -b turing-machine -v turing-machine-config.xml
== Using pre-generated schemas
== Validating grammar and datatypes ...
turing-machine-config.xml validates.
== Adding default values... done.
== Validating semantic constraints ...
No errors found.
```

Without `-j`, *xmllint* is used by default for RELAX NG validation – it works, too, but often gives inferior/wrong error messages.

DSDL Validation Procedure



Other Targets (Document Types)

```
$ cat turing-machine-notification.xml
<?xml version="1.0" encoding="utf-8"?>
<notification
    xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
  <eventTime>2015-07-08T00:01:00Z</eventTime>
  <halted xmlns="http://example.net/turing-machine">
    <state>4</state>
  </halted>
</notification>

$ yang2dsdl -j -t notification -v turing-machine-notification.xml \
> turing-machine.yang
== Generating RELAX NG schema './turing-machine-notification.rng'
Done.
== Generating Schematron schema './turing-machine-notification.sch'
Done.
== Generating DSRL schema './turing-machine-notification.dsrl'
Done.
== Validating grammar and datatypes ...
turing-machine-notification.xml validates.
== Adding default values... done.
== Validating semantic constraints ...
No errors found.
```

Converting XML Instances to JSON

XML↔JSON mapping is defined in *draft-ietf-netmod-yang-json*.

JSON is an optional media type in RESTCONF:
http://tools.ietf.org/html/draft-ietf-netconf-restconf

1. Generate XSLT 1.0 stylesheet with `jsonxsl` plugin:

   ```
   $ pyang -f jsonxsl -o tmjson.xsl turing-machine.yang
   ```

2. Apply the stylesheet to a valid XML instance document:

   ```
   $ xsltproc tmjson.xsl turing-machine-config.xml
   ```

   The same stylesheets works for **all** document types.

The `jtox` plugin performs the opposite conversion.

Further Information

1. NETMOD WG:

   http://datatracker.ietf.org/wg/netmod/documents/

2. NETCONF Central

   http://www.netconfcentral.org/

3. *pyang* wiki

   https://github.com/mbj4668/pyang/wiki

4. YANG Central

   http://www.yang-central.org/twiki/bin/view/Main/WebHome