AXL Introduction

A practical approach using Python

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AXL Introduction

AXL API Introduction

- The **Administrative XML Web Service (AXL)** is an XML/SOAP based interface that provides a mechanism for inserting, retrieving, updating and removing data from the Unified Communication configuration database.
- https://developer.cisco.com/site/axl/
- Thick AXL – API defines specific objects that can be created, removed, queried, or updated
- Thin AXL – Provides a mechanism to perform direct SQL queries / updates

Administrative XML Configuration API

- Read/Modify UCM Configuration Database
- Methods for All Database Objects
  - list*
  - add*
  - update*
  - get*
  - remove*
- Thin AXL methods:
  - ExecuteSQLupdate
  - ExecuteSQLquery
- Service port: https://<server>:8443/axl/
- Authentication:
  - Member of **AXL API Access** Group
  - Create group with custom permissions or use **Standard AXL Read Only API Access** Role

XML

- eXtensible Markup Language
- Opening / Closing tag for elements
- Not validated against schema
- Example:

```
<person>
    <lastname>Robbins</lastname>
    <givenname>Chuck</givenname>
</person>
```

- http://www.w3.org/TR/2006/REC-xml-20060816/

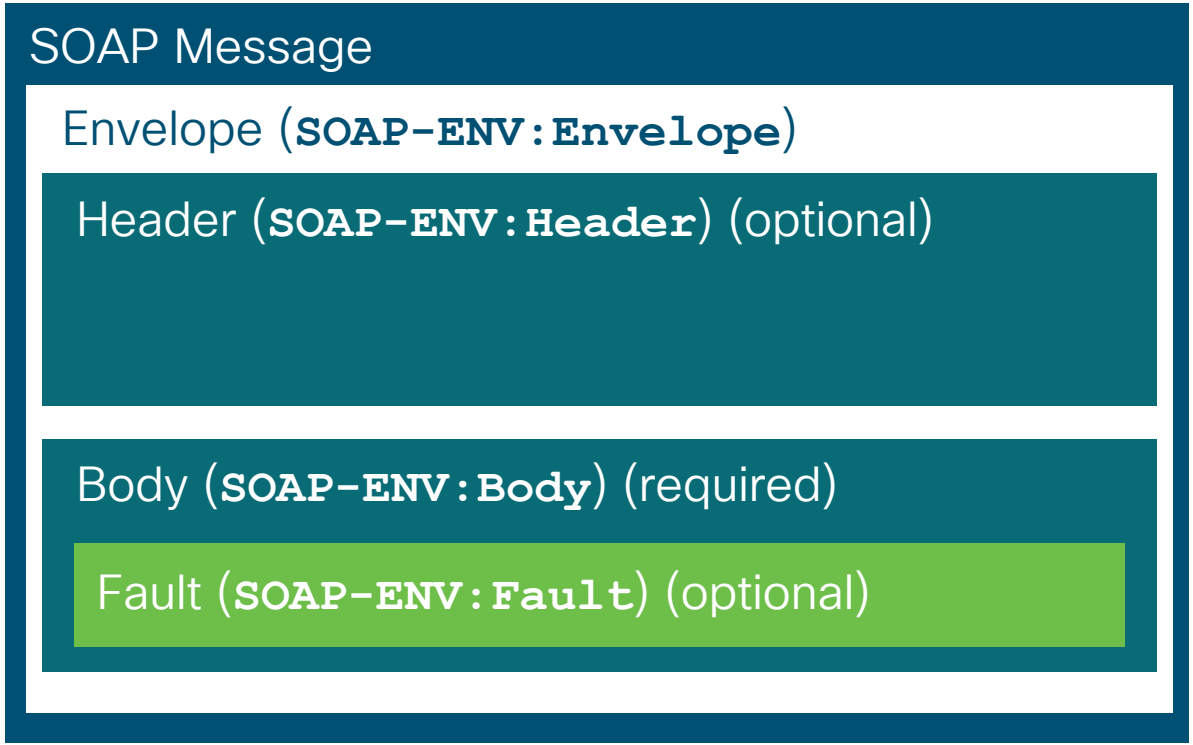
XML – Schema Definition

- Names, hierarchy, meaning of elements and attributes defined by Schema
- XML schema defined by W3C
- Primer: http://www.w3.org/TR/xmlschema-0/
- Example:
  - ```
    <xsd:element name="person" type="PersonType"/>
    <xsd:complexType name="PersonType">
      <xsd:sequence>
            <xsd:element name="lastname" type="xsd:string"/>
            <xsd:element name="givenname" type="xsd:string"/>
      </xsd:sequence>
    </xsd:complexType>
    ```
    ```

SOAP

- The specification formerly known as **Simple Object Access Protocol**
- W3C specification: http://www.w3.org/TR/soap/
- Exchange of structured and typed information based on XML
- SOAP specification defines
  - SOAP message format
  - How to send and receive messages
  - Data encoding

SOAP Message Structure



Web Services Definition Language (WSDL)

- W3C: http://www.w3.org/TR/wsdl20/
- XML-based format (grammar) to describe web services
- Defines four pieces of data:
  - Publicly available methods; interface description, formats
  - Data type information for requests and responses
  - Binding; which transport protocol
  - Address information – where to find the service

AXL Request Schema - addPhone

AXLAPI.wsdl

```
<operation name="addPhone">
    <soap:operation soapAction="CUCM:DB ver=11.5 addPhone" style="document"/>
    <input>
        <soap:body use="literal"/>
    </input>
    <output>
        <soap:body use="literal"/>
    </output>
    <fault name="fault">
        <soap:fault name="fault" use="literal"/>
    </fault>
</operation>

<operation name="addPhone">
    <input message="s0:addPhoneIn"/>
    <output message="s0:addPhoneOut"/>
    <fault name="fault" message="s0:AXLError"/>
</operation>
```

AXL Request Schema - addPhone

AXLAPI.wsdl

```
<message name="addPhoneIn">
    <part element="xsd1:addPhone" name="axlParams"/>
</message>
<message name="addPhoneOut">
    <part element="xsd1:addPhoneResponse" name="axlParams"/>
</message>
```

AXL Request Schema - addPhone

AXLSoap.xsd

```
<xsd:element name="addPhone" type="axlapi:AddPhoneReq"/>
<xsd:element name="addPhoneResponse" type="axlapi:StandardResponse"/>

<xsd:complexType name="AddPhoneReq">
    <xsd:complexContent>
        <xsd:extension base="axlapi:APIRequest">
            <xsd:sequence>
                <xsd:element name="phone" type="axlapi:XPhone"/>
            </xsd:sequence>
        </xsd:extension>
    </xsd:complexContent>
</xsd:complexType>
```

AXL Request Schema - addPhone

AXLSoap.xsd

```
<xsd:complexType name="XPhone">
    <xsd:sequence minOccurs="0">
        <xsd:element maxOccurs="1" minOccurs="1" name="name" nillable="false" type="axlapi:UniqueString128">
            <xsd:annotation>
                <xsd:documentation>The device name,using only URL-friendly characters</xsd:documentation>
            </xsd:annotation>
        </xsd:element>
        <xsd:element maxOccurs="1" minOccurs="0" name="description" nillable="false" type="axlapi:String128">
            <xsd:annotation>
                <xsd:documentation>Optional description of the device</xsd:documentation>
            </xsd:annotation>
        </xsd:element>
        <xsd:element maxOccurs="1" minOccurs="1" name="product" nillable="false" type="axlapi:XProduct">
            <xsd:annotation>
                <xsd:documentation>Product ID string. read-only except when creating a device.</xsd:documentation>
            </xsd:annotation>
        </xsd:element>
        <xsd:element maxOccurs="1" minOccurs="1" name="class" nillable="false" type="axlapi:XClass">
            <xsd:annotation>
                <xsd:documentation>Class ID string. Class information is read-only except when creating a device.</xsd:documentation>
            </xsd:annotation>
        </xsd:element>
```

AXL Versioning

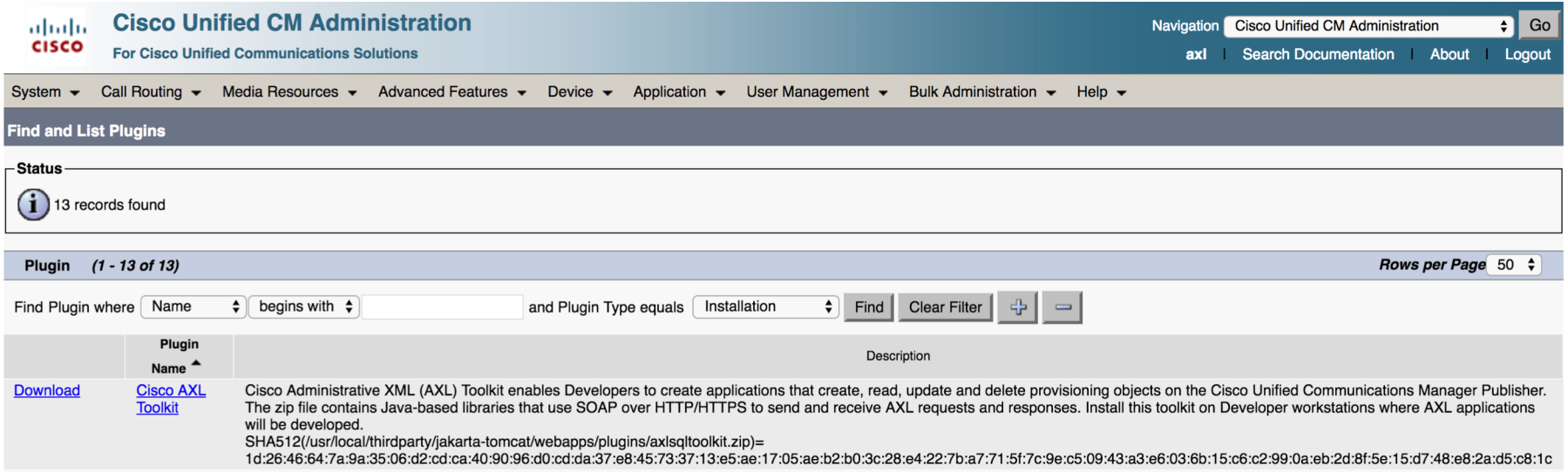
- Abstracts developer from DB schema changes
  - Thick AXL methods only, Thin AXL (direct SQL) does not offer backward compatibility
- Maintains Release minus 2 backward compatibility
  - Developers writing to Unified CM 12.0(1) will not have to make changes until 15.0(1)
  - Oldest supported schema is always the default
- Developer specifies desired schema version via the **SOAPAction** header
  - E.g., SOAPAction: **CUCM:DB ver=12.0**

Performance

- Dynamic throttling
  - Single request limited to <8MB data
  - Concurrent request limited to <16MB
- Up to 1500 writes per minute
- Intelligently accepts or rejects requests
  - Row fetch returned when data limits are exceeded
- Always enabled

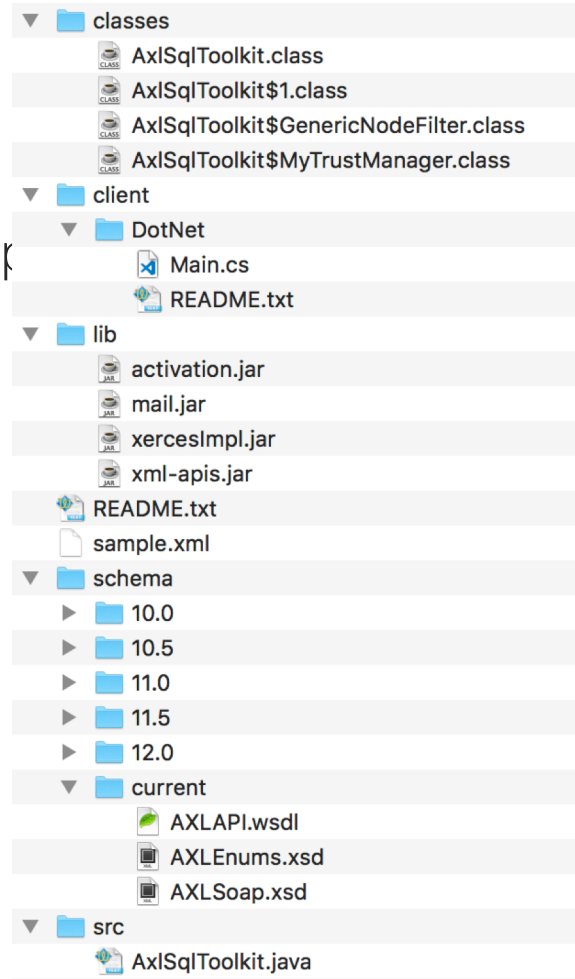
Cisco AXL Toolkit

- Download from **Unified CM Administration** > **Application** > **Plugins**



Cisco AXL Toolkit

- Schema folder contains AXL API schema for sup
  - AXLAPI.wsdl – WSDL file
  - AXLEnums.xsd – Enum type definitions
  - AXLSoap.xsd – Type definitions
- Sample Java classes and .NET code



Documentation

- AXL Schema Reference
  - https://developer.cisco.com/docs/axl-schema-reference/
- AXL Developer Guide
  - https://developer.cisco.com/docs/axl/#12-0-axl-developer-guide
- UCM Data Dictionary
  - https://developer.cisco.com/docs/axl/#12-0-cucm-data-dictionary

Unified CM Serviceability APIs

https://developer.cisco.com/site/sxml/

- Real-Time Information (RisPort) – Provides the current connection status of phones, devices, and applications connected to Cisco Unified Communications Manager (Unified CM).

  https://<server>:8443/realtimeservice2/services/RISService70?wsdl

- Performance Monitoring (PerfMon) – Provides real-time event feeds to monitor the status and health of Cisco Unified CM.

  https://<server>:8443/perfmonservice2/services/PerfmonService?wsdl

- CDRonDemand – SOAP/HTTPS interface to query the Unified CM Call Detail Records (CDR) Repository.

  https://<server>:8443/realtimeservice2/services/CDRonDemandService?wsdl

- Log Collection – Retrieval of trace files and logs

  https://<server>:8443/logcollectionservice2/services/LogCollectionPortTypeService?wsdl

- Service Control – Activate / Deactivate / Start / Stop Services

  https://<server>:8443/controlcenterservice2/services/ControlCenterServices?wsdl

Troubleshooting

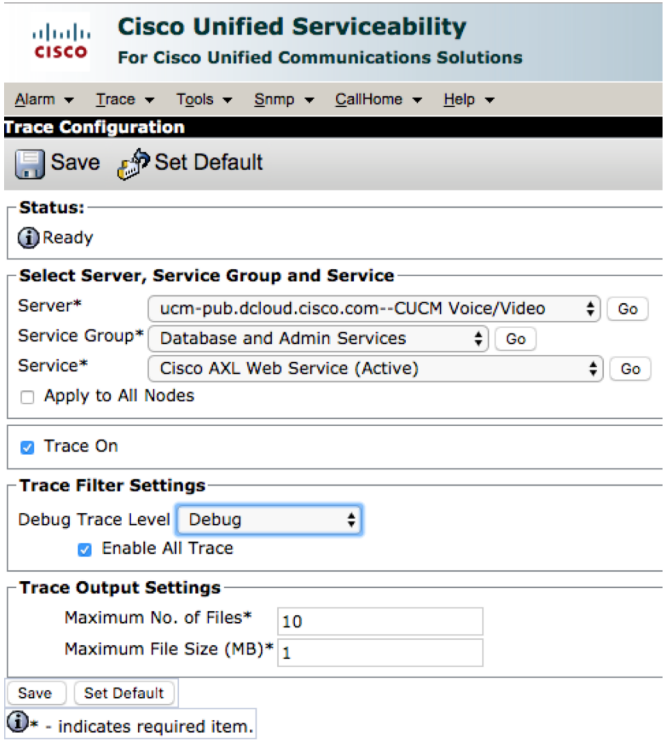
Quick Functionality Check

- Go to the AXL API URL via a web browser
- For instance, enter https://cm1:8443/axl/ in the address text box
- When prompted for user name and password, use the standard administrator login, or use the configured AXL user
- Look for a plain page that states the AXL listener is working and accepting requests, but only communicates via POST

- This verifies functionality and user access

Enable AXL Traces

- Detailed AXL traces can be enabled in Cisco Unified Serviceability settings



Analyze AXL logs

- Use Real-Time Monitoring Tool to access AXL log
- log contains incoming AXL requests and outgoing responses

Analyze AXL logs

```
2019-04-18 03:15:46,157 DEBUG [http-bio-443-exec-5] filters.TimingFilter - Received request 1555496324288 from administrator at IP 10.16.66.88
2019-04-18 03:15:46,158 DEBUG [http-bio-443-exec-5] wrappers.RequestHeaderWrapper - Inside Request Header Wrapper
2019-04-18 03:15:46,158 DEBUG [http-bio-443-exec-5] filters.AuthenticationFilter - Operation:get api:getCCMVersion
2019-04-18 03:15:46,158 DEBUG [http-bio-443-exec-5] filters.ThrottlingFilter - Successfully set the value of counter: 4 value: 0
2019-04-18 03:15:46,158 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - Checking request version [10.0]
2019-04-18 03:15:46,158 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - Checking if requested api [getCCMVersion] the implementedHandlers
list
2019-04-18 03:15:46,158 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - [getCCMVersion] is not in the implementedHandlers list
2019-04-18 03:15:46,159 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - Checking if version is 8.x
2019-04-18 03:15:46,159 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - function to check if the version is 8.x
2019-04-18 03:15:46,160 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - version is not 8.x
2019-04-18 03:15:46,160 INFO  [http-bio-443-exec-5] servletRouters.AXLAlpha - Executing api: getCCMVersion in axis
2019-04-18 03:15:46,160 DEBUG [http-bio-443-exec-5] wrappers.RequestNamespaceWrapper - Inside Request Wrapper
2019-04-18 03:15:46,160 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - AXL REQUEST :
 <soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/" xmlns:ns="http://www.cisco.com/AXL/API/10.0">
           <soapenv:Header/>
           <soapenv:Body>
               <ns:getCCMVersion>
               </ns:getCCMVersion>
           </soapenv:Body>
       </soapenv:Envelope>
2019-04-18 03:15:46,160 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - Request processed by AXIS
2019-04-18 03:15:46,162 DEBUG [http-bio-443-exec-5] axlapiservice.Handler - dbConnector Initialization in handler.java
2019-04-18 03:15:46,162 DEBUG [http-bio-443-exec-5] axlapiservice.Axl - Connection given to current thread
2019-04-18 03:15:46,163 DEBUG [http-bio-443-exec-5] axlapiservice.GetCCMVersionHandler - select cv.version, pn.nodeid from componentversion as
cv, processnode as pn where cv.softwarecomponent = 'cm-ver' and pn.pkid = cv.fkprocessnode order by nodeid
2019-04-18 03:15:46,171 DEBUG [http-bio-443-exec-5] axlapiservice.Axl - Connection closed and hashmap entry removed in AXL.java closing
connection
2019-04-18 03:15:46,174 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - <?xml version='1.0' encoding='UTF-8'?><soapenv:Envelope
xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"><soapenv:Body><ns:getCCMVersionResponse
xmlns:ns="http://www.cisco.com/AXL/API/10.0"><return><componentVersion><version>11.5.1.12900(21)</version></componentVersion></return></ns:getC
CMVersionResponse></soapenv:Body></soapenv:Envelope>
2019-04-18 03:15:46,174 DEBUG [http-bio-443-exec-5] servletRouters.AXLAlpha - Finished processing request
```

Database Access

Database Dictionary

- Configuration in Communications Manager is stored in relational database
- Database Dictionary documents all existing tables in Communications Manager Database
  - field types
  - database constraints
  - relations
- Common Table Relationships
- Schema changes in recent releases

Table relations (1)

- pkid is the primary key ID. It is always of type GUID.
- Fields that begin with the letters "fk" represent foreign keys into another table. The name of the field following the "fk" prefix up to but not including an underscore character is the name of the related table. The field in related table is always pkid. and is a GUID.
- Examples in table device:

  device.fkenduser → enduser.pkid

  - device.fkenduser_mobility → enduser.pkid
  - device.fkcallingsearchspace → callingsearchspace.pkid
  - device.fkcallingsearchspace_aar → callingsearchspace.pkid

Table relations (2)

- Fields that begin with the letters "ik" represent internal keys into the same table.
- Example in table device:
  - device.ikdevice_primaryphone → device.pkid

Table relations (3)

- Fields that begin with a "tk" represent an enumerated type. This field is related to a table whose name begins with "Type" and ends with the name of the field following the prefix up to but not including an underscore character. The field in the related table is always "enum" and is an integer.
- Examples in table device
  - tkclass
  - tkdeviceprotocol → typedeviceprotocol.enum
  - tkmodel → typemodel.enum
  - tkproduct → typeproduct.enum

SQL

- language for retrieval and management of data stored in relational database management systems
- originally called SEQUEL (structured english query language)
- standardized by ISO/IEC

SQL Statements on the CLI

- SQL statements can be executed on the CLI using „run sql“
- “&” can´t be used on the CLI
- Can be used to test SQL statements to be used in scripts
- Example:

```
admin:run sql select enum,name from typemodel where tksubclass=1
enum  name
===== ===================================
20    SCCP Phone
134   Remote Destination Profile
30027 Analog Phone
30028 ISDN BRI Phone
2     Cisco 12 SP+
3     Cisco 12 SP
...
```

Example: dialplan

- All DNs and patterns are stored in table numplan

```
admin:run sql select dnorpattern, fkroutepartition, tkpatternusage from numplan
dnorpattern                                fkroutepartition                     tkpatternusage
========================================== ==================================== ==============
Sample Line Template with TAG usage examples NULL                                11
1111                                       a5a6c703-1191-c371-9563-7822f04f5d3f 2
AutoReg_ULT                                a5a6c703-1191-c371-9563-7822f04f5d3f 11
2000                                       a5a6c703-1191-c371-9563-7822f04f5d3f 5
\+!                                        f4d2a38f-490f-0f76-f740-b1a5b7d170d1 5
\+!#                                       f4d2a38f-490f-0f76-f740-b1a5b7d170d1 5
\+1[2-9]XX[2-9]XXXXXX                      7463df44-6b77-fa70-7576-a3bbd8c6084c 5
\+14085554006                              a5a6c703-1191-c371-9563-7822f04f5d3f 2
\+14085554019                              a5a6c703-1191-c371-9563-7822f04f5d3f 2
911                                        05a1e0ee-b7f8-b688-942c-1d9bedb872c9 5
\+19195551055                              a5a6c703-1191-c371-9563-7822f04f5d3f 2
```

- Which partition? What type of pattern?
- Let's look in tables routepartition and typepatternusage

Example: dialplan

```
admin:run sql select dnorpattern, routepartition.name, typepatternusage.name from
numplan,routepartition,typepatternusage where fkroutepartition=routepartition.pkid and
tkpatternusage=typepatternusage.enum

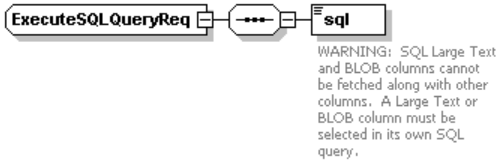
   dnorpattern            name              name
====================== ================= ==================================
\+!                     PSTNInternational Route
\+!#                    PSTNInternational Route
\+1[2-9]XX[2-9]XXXXXX   USPSTNNational    Route
1111                    DN                Device
AutoReg_ULT             DN                Device template
2000                    DN                Route
\+14085554006           DN                Device
\+14085554019           DN                Device
\+19195551055           DN                Device
```

- Assignment of DNs to devices is in table devicenumplanmap

Database access via AXL (Thin AXL)

- AXL provides methods to execute SQL queries and updates:
- executeSQLQuery (SELECT)
- executeSQLUpdate (INSERT, UPDATE, DELETE)
- both methods take a SQL command as argument

executeSQLQuery

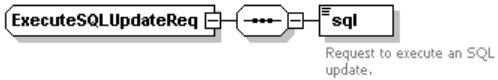


- Result is a sequence of rows
- each row has a number of sub-elements, one per column of the resulting table

```
<SOAP-ENV:Envelope ...>
<SOAP-ENV:Header/>
<SOAP-ENV:Body><axl:executeSQLQueryResponse ...>
<return>
     <row>
          <pkid>8555d448-5818-8494-e16a-de099e9a403c</pkid>
          <realm>jkrohn</realm>
          <userid>jkrohn</userid>
          <passwordreverse>...</passwordreverse>
     </row>
</return>
</axl:executeSQLQueryResponse>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

- sequence can be empty!
  - `<SOAP-ENV:Body><axl:executeSQLQueryResponse ...>`
    `<return/>`
    `</axl:executeSQLQueryResponse>`
    `</SOAP-ENV:Body>`

executeSQLUpdate



- Writing to the database can destroy database integrity and thus compromise core functionality!
- Very limited to no integrity checks!
- delete means deleted ☺
- result is an element indicating the number of rows updated

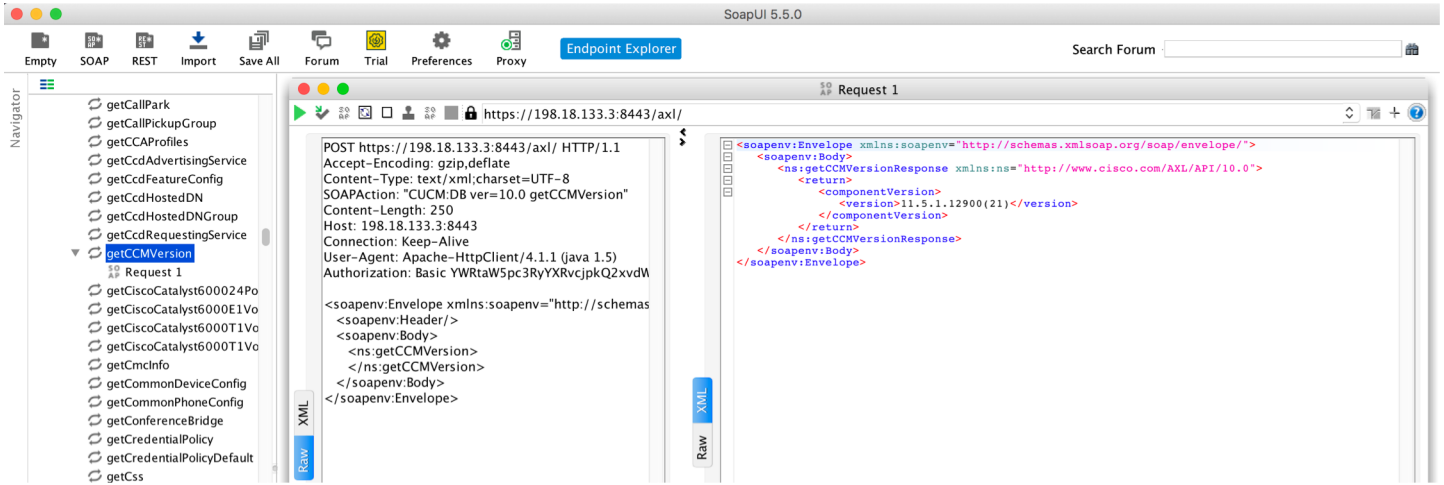
```
<SOAP-ENV:Envelope ...>
<SOAP-ENV:Header/>
     <SOAP-ENV:Body>
            <axl:executeSQLUpdateResponse ...>
                   <return>
                          <rowsUpdated>1</rowsUpdated>
                   </return>
            </axl:executeSQLUpdateResponse>
     </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Tools

SoapUI, https://www.soapui.org/

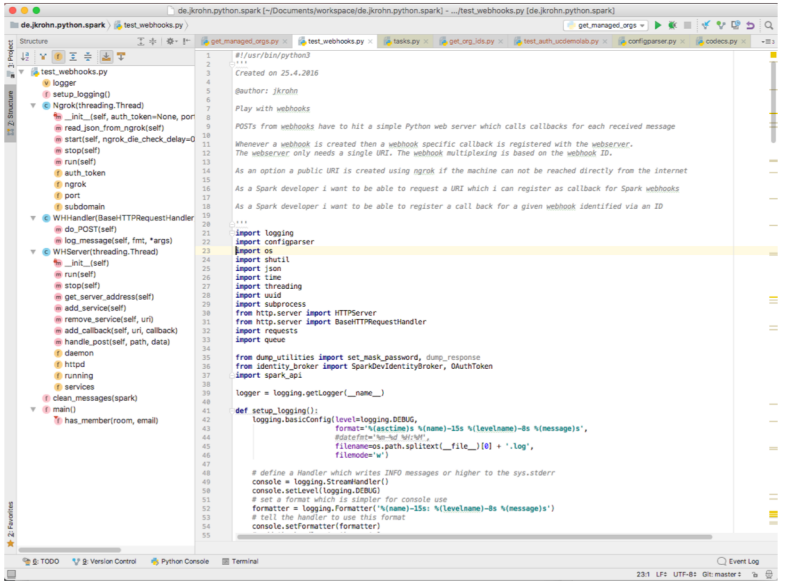
SoapUI Supported by SMARTBEAR

- API test automation framework
- Free (open source) version availability
- Great tool to inspect the AXL WSDL, create, and execute AXL requests



IDE – Integrated Development Environment

- Helps to develop and test your application
- Features
  - GUI
  - Editor
  - Build automation
  - Syntax highlighting
  - Debugger
  - Integration w/ revision control system (e.g. Git)



Syntax Highlighting

- What Do you prefer?
- This?

```
def get_attachments():

    def assert_folder(p_state, base_path, room_id, room_folder):
        ''' make sure that the folder is created for the room
        '''
        if not os.path.lexists(base_path):
            # base directory needs to be created
            logging.debug('Base directory %s does not exist' % base_path)
            os.mkdir(base_path)

        full_path = os.path.join(base_path, room_folder)

        if room_id not in p_state:
            p_state[room_id] = {}
        room_state = p_state[room_id]

        if 'folder' not in room_state:
            logging.debug('No previous folder for room %s' % room_folder)
            # the folder for this room hasn't been created before
            i = 0
            base_folder = room_folder
            while True:
                full_path = os.path.join(base_path, room_folder)
                try:
                    os.mkdir(full_path)
                    logging.debug('Created folder %s' % full_path)
                except FileExistsError:
```

Syntax Highlighting

- What Do you prefer?
- Or this?

```
def get_attachments():

    def assert_folder(p_state, base_path, room_id, room_folder):
        ''' make sure that the folder is created for the room
        '''
        if not os.path.lexists(base_path):
            # base directory needs to be created
            logging.debug('Base directory %s does not exist' % base_path)
            os.mkdir(base_path)

        full_path = os.path.join(base_path, room_folder)

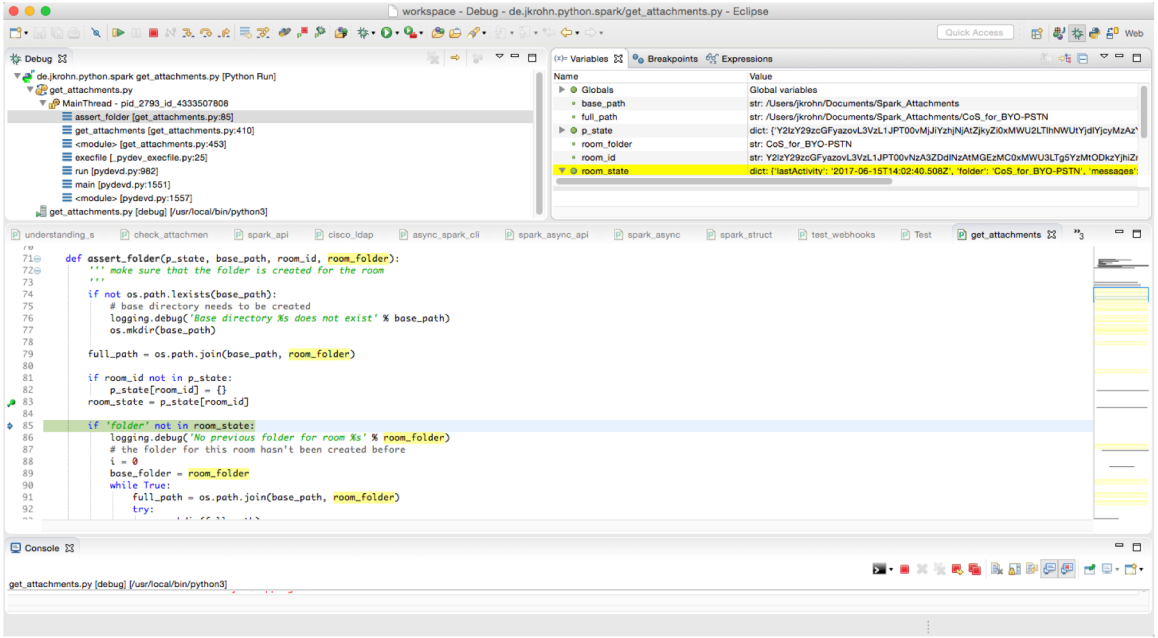
        if room_id not in p_state:
            p_state[room_id] = {}
        room_state = p_state[room_id]

        if 'folder' not in room_state:
            logging.debug('No previous folder for room %s' % room_folder)
            # the folder for this room hasn't been created before
            i = 0
            base_folder = room_folder
            while True:
                full_path = os.path.join(base_path, room_folder)
                try:
                    os.mkdir(full_path)
                    logging.debug('Created folder %s' % full_path)
                except FileExistsError:
```

Live Debugger

- Live Debugger allows to
  - Set breakpoints
  - Check variables
  - Evaluate expressions

→ Essential for effective SW development



IDEs for Python

- IDLE (Standard IDE)
- PyCharm
- PyDev in Eclipse
- PythonAnywhere
- Cloud9

PyCharm

Github

- Git repository hosting service
- Offers
  - Revision control
  - Source code management
- THE place to share your code

Python

Python – The Language

- Friendly and easy to learn, pleasant
- Readable
- Open
- Free
- Runs everywhere
- Flexible
- Fast
- Powerful; Modules for everything! (https://pypi.python.org/pypi)

Python Characteristics

- Multi-purpose; not only “scripting”
  - GUI
  - Web development
  - Apps
  - ..
- Interpreted language .. actually compiled byte-code is executed
- Object Oriented
- Strongly typed
- Widely used: https://www.python.org/about/success/

Python Releases

- History
  - 1989: created by Guido Van Rossum
  - 1994: Python 1.0 released

  ..
  - 2000: Python 2.0 released – latest 2.x release is 2.7; released 2010

  ..
  - 2008: Python 3.0 released – broke backward compatibility

  ..
  - 2015: Python 3.5 released
  - 2016: Python 3.6 released
  - 2018: Python 3.7 released
- New feature development only in 3.x
- Recommendation: start with latest Python release (3.7)

Learning Python

- Beginner's Guide: https://wiki.python.org/moin/BeginnersGuide
- The Hitchhiker's Guide to Python: http://python-guide-pt-br.readthedocs.io/en/latest/intro/learning/
- Online Courses
  - https://www.edx.org/course/subject/computer-science/python
  - https://www.coursera.org/specializations/python
  - https://www.codecademy.com/learn/python
- Great Book: "Learning Python, 5th Edition", Mark Lutz; PDF available online
- Start with fun stuff (Sudoku?, ..)
- Code, Play, have fun!

Executing Python Code

- Interactive: simply start python from the CLI

```
~ jkrohn$ python3
Python 3.5.0 (v3.5.0:374f501f4567, Sep 12 2015, 11:00:19)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print('Hello world!')
Hello world!
```

- Run python file from the CLI

```
~ jkrohn$ python hello_world.py
Hello World!
```

- Demos: Interactive Jupyter Notebooks
  - "The Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and explanatory text"

Demo – Python Basics

```
>>>
>>> s = "hello"
>>> s
'hello'
>>> s = 1
>>> s
1
>>> dict = {'name':'Bob', 'age':35, 'sex':'male'}
>>> dict
{'age': 35, 'sex': 'male', 'name': 'Bob'}
>>> dict['age']
35
>>> import json
>>> print(json.dumps(dict, indent=4))
{
    "age": 35,
    "sex": "male",
    "name": "Bob"
}
>>>
```

Docker

Docker

- "Open source container software platform that packages applications in containers"
- The live Notebooks run in a Docker container
- Docker needs to be installed on the local machine.
- Installation:
  - Mac: https://www.docker.com/docker-mac
  - Windows: https://www.docker.com/docker-windows
- Free Community Edition is sufficient to run the Notebook container

Live Jupyter Demo Notebooks

- You can build your own Docker image with a Jupyter server and the session Notebooks: see Readme on GitHub
- .. or use the prepared image (easiest option, single command)
  `docker run -it --rm --name axl -p 8888:8888 jeokrohn/axl_workshop`
- Point your browser to http://localhost:8888 to access the notebooks
- The password to access the server is: 'axl'
- If port 8888 on your local machine is not available then use different port mappings (for example -p 8889:8888 to use local port 8889)
- Take a look at file `start.sh` on GitHub for an example start script

Starting a Docker Container

- Prepared Scripts in GitHub repository:
  - start.sh

```
#!/usr/bin/env bash
docker run -it --rm --name axl -p 8888:8888 \
   jeokrohn/axl_workshop
```

  - start_mount_local.sh:

```
#!/usr/bin/env bash
docker run -it --rm --name axl -p 8888:8888 \
    --mount type=bind,src="$(pwd)",dst=/home/jovyan \
    jeokrohn/axl_workshop
```

Starting a Docker Container

- Prepared Scripts in GitHub repository:
  - start.sh

```
#!/usr/bin/env bash
docker run -it --rm --name axl -p 8888:8888 \
   jeokrohn/axl_workshop
```

  - start_mount_local.sh:

```
#!/usr/bin/env bash
docker run -it --rm --name axl -p 8888:8888 \
    --mount type=bind,src="$(pwd)",dst=/home/jovyan \
    jeokrohn/axl_workshop
```

- Run image
- Interactive
- Remove container on exit
- Set name of container
- Map local port 8890 to port 8888 of container

Starting a Docker Container

- Prepared Scripts in GitHub repository:
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   jeokrohn/axl_workshop
```

Map Docker host path
to path in Docker container
$(pwd): inserts the current path; might need to replace with static path definition on other platforms

Time to Play!

Time to play

- All lab content is available at: https://github.com/jeokrohn/axl_workshop
- Start by downloading “Lab guide.pdf“ and following the steps described there


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