



XML and UML - What they are and Why We Need to Know Them?

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Sochi, Russia, June 2015*

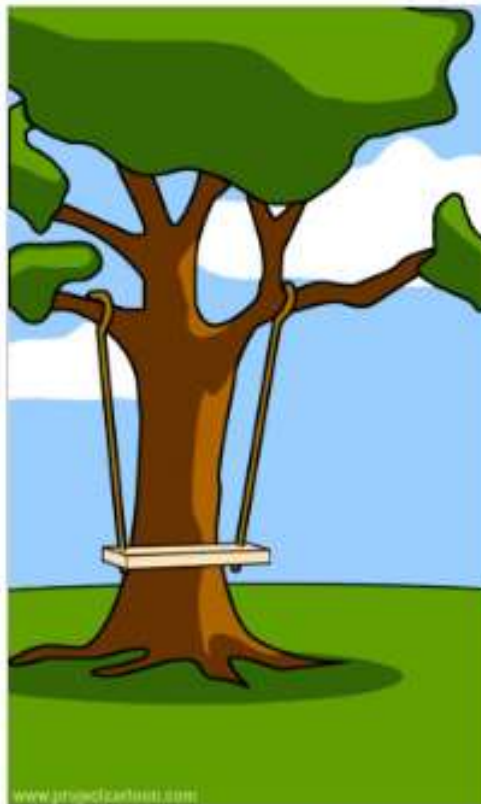
Questions

- What are we doing?
- Why are we doing it?
- How are we doing it?

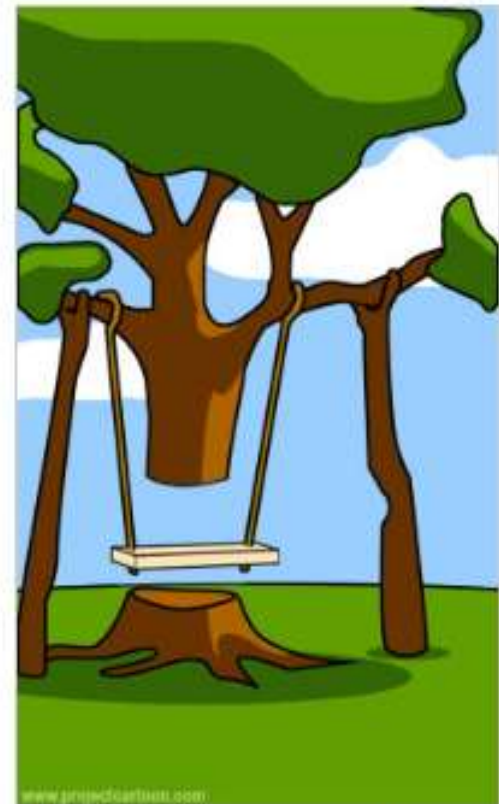
What are we doing?



How the customer explained it

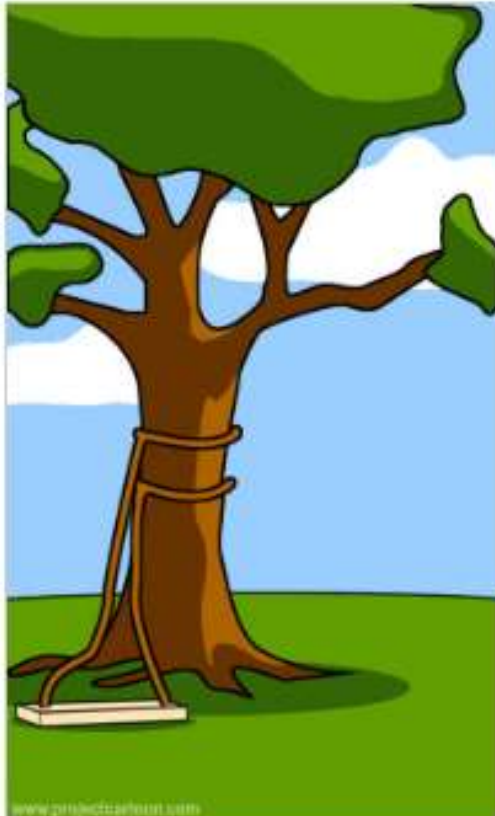


How the project leader understood it



How the analyst designed it

What are we doing?



How the programmer wrote it

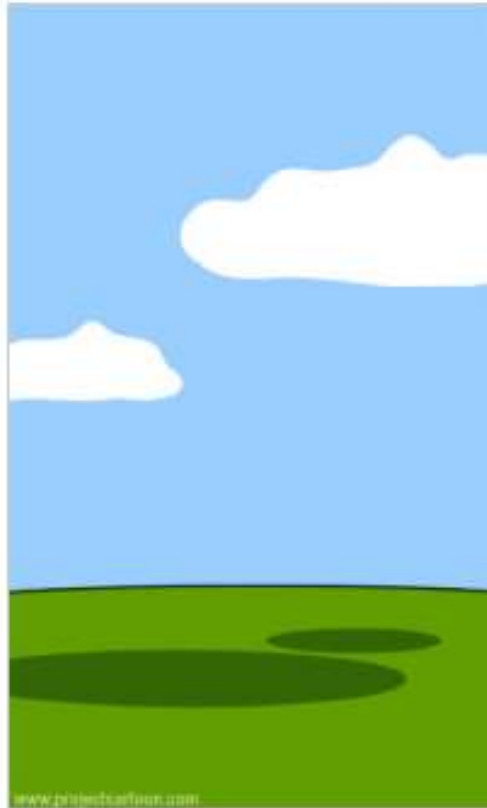


What the beta testers received

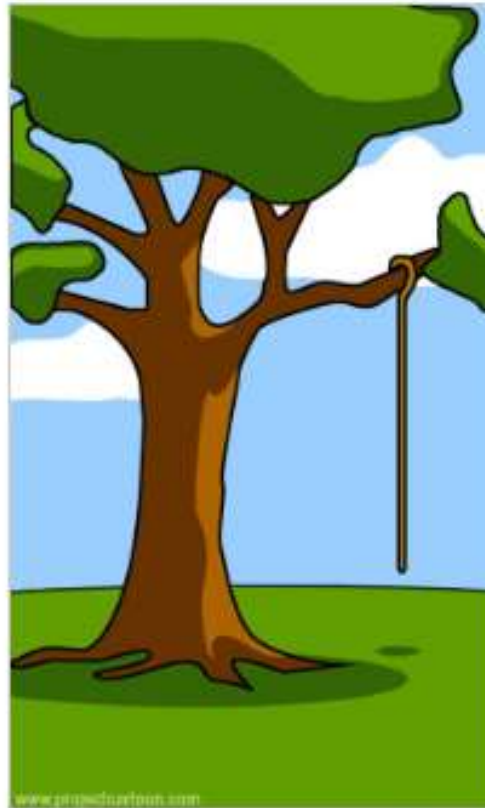


How the business consultant described it

What are we doing?



How the project was documented

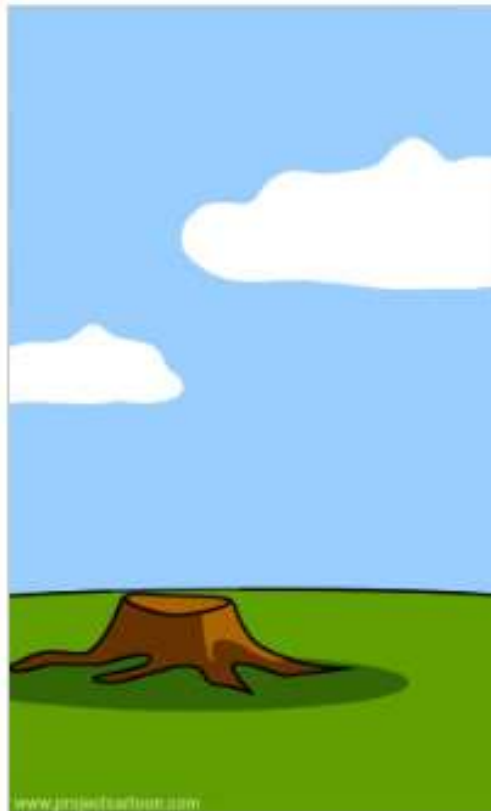


What operations installed



How the customer was billed

What are we doing?



How it was supported



What marketing advertised



What the customer really needed

What is XML?

- **SGML** - **S**tructured **G**eneralized **M**arkup **L**anguage
- **HTML** – **H**yper**T**ext **M**arkup **L**anguage
- **XML** - e**X**tensible **M**arkup **L**anguage
- **W3C** – **W**orld **W**ide **W**eb **C**onsortium
- **XSL** - e**X**tensible **S**tylesheet **L**anguage
- **CSS** - **C**ascading **S**tye **S**heets

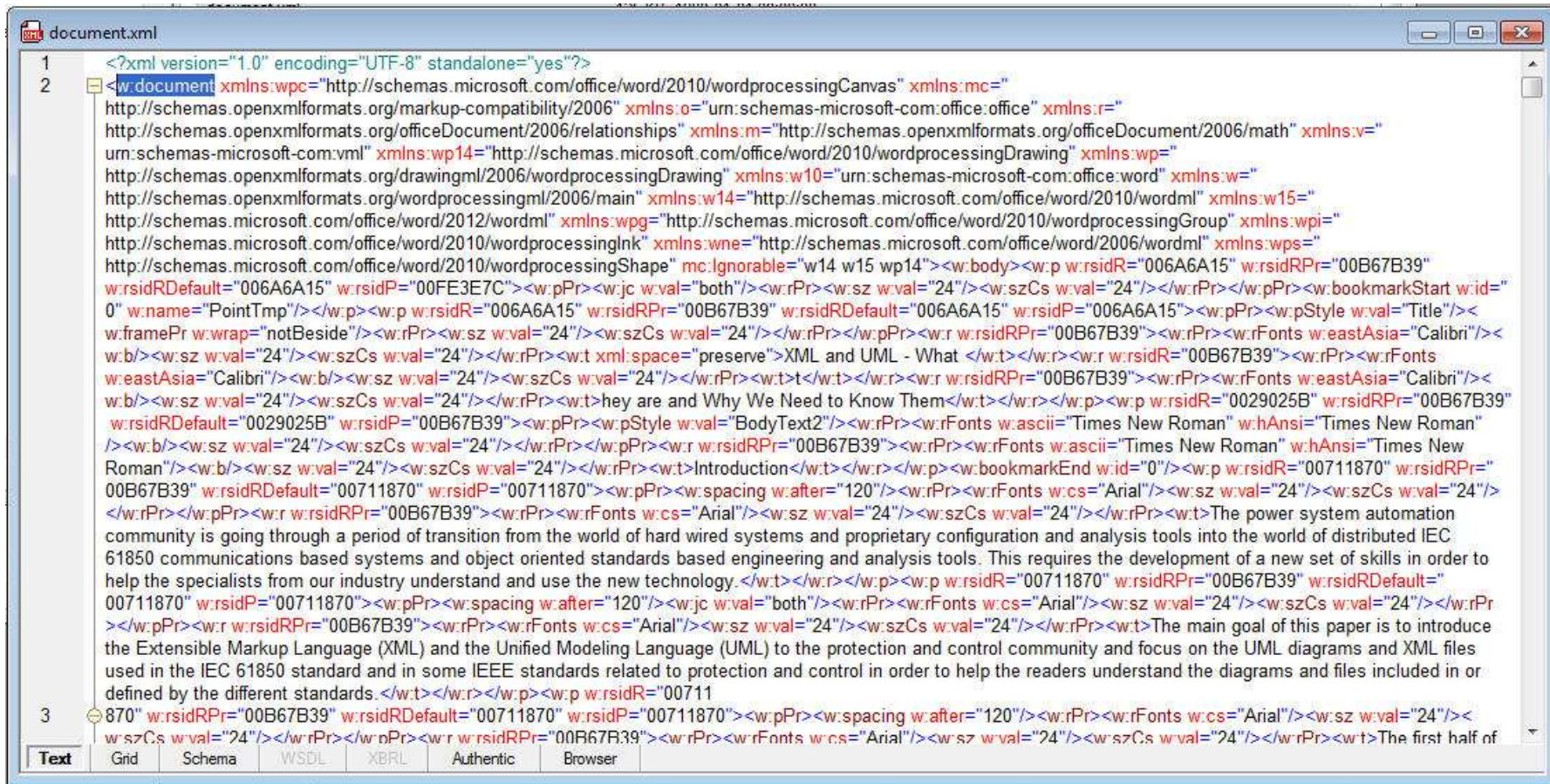
What is XML?

- XML was developed by members of the W3C and released as a recommendation by the W3C in February 1998.
- It is a simplified version of SGML and a cousin of HTML.
- SGML was developed to standardize the production process for large document sets and is an international standard (ISO 8879) that has been in use as a markup language primarily for technical documentation and government applications since the early 1980s.

What is XML?

- Well-formatted documents
- It is not sufficient.
- Constraints enforce rules that determine the presence of elements and their attributes, as well as the order of these elements.
- These rules are part of what is defined as a Data Type Definition (DTD) or XML schema.
- This is the oldest schema inherited from SGML.

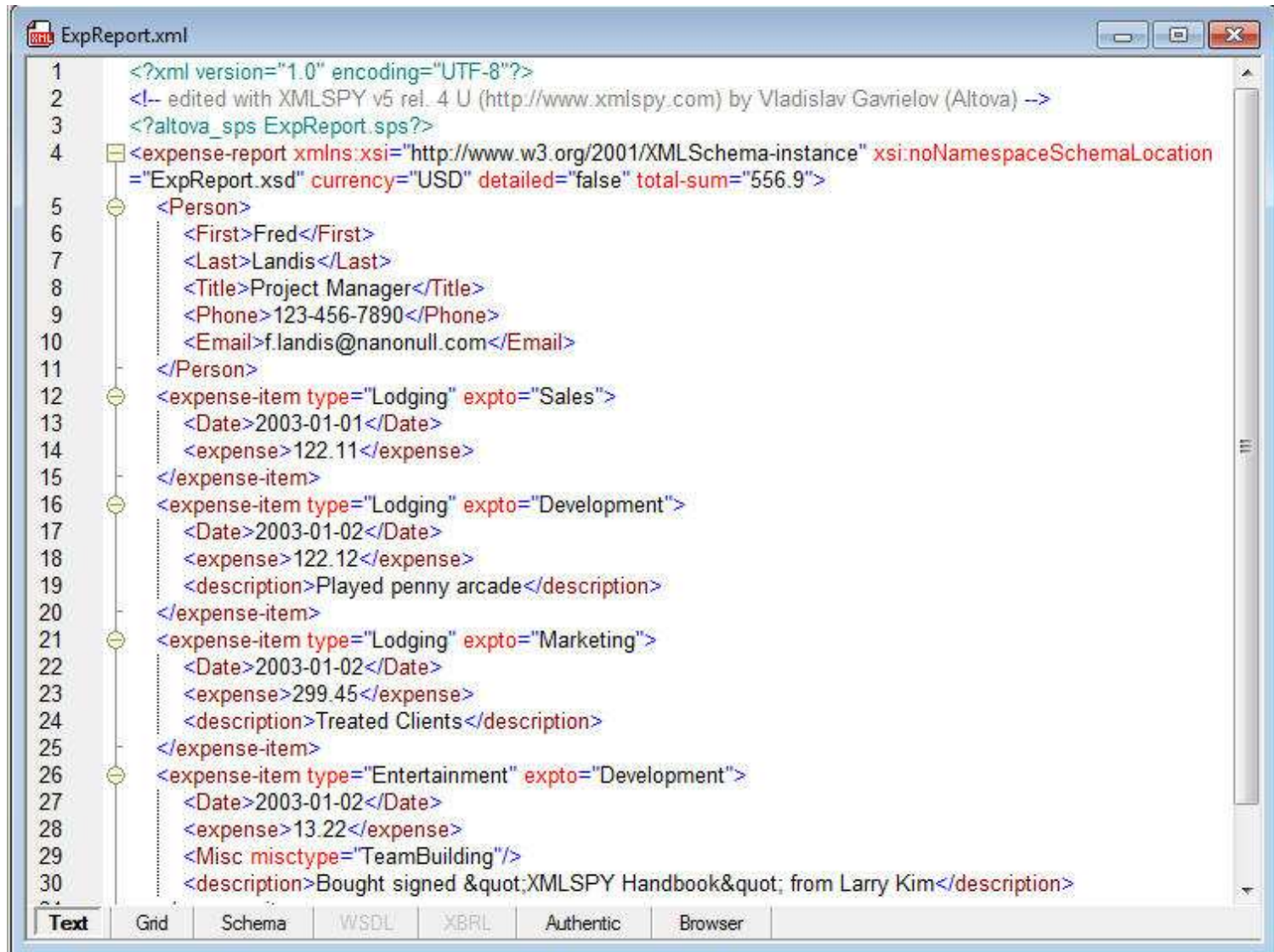
XML Files



```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<w:document xmlns:wpc="http://schemas.microsoft.com/office/word/2010/wordprocessingCanvas" xmlns:mc="
http://schemas.openxmlformats.org/markup-compatibility/2006" xmlns:o="urn:schemas-microsoft-com:office:office" xmlns:r="
http://schemas.openxmlformats.org/officeDocument/2006/relationships" xmlns:m="http://schemas.openxmlformats.org/officeDocument/2006/math" xmlns:v="
urn:schemas-microsoft-com:vml" xmlns:wp14="http://schemas.microsoft.com/office/word/2010/wordprocessingDrawing" xmlns:wp="
http://schemas.openxmlformats.org/drawingml/2006/wordprocessingDrawing" xmlns:w10="urn:schemas-microsoft-com:office:word" xmlns:w="
http://schemas.openxmlformats.org/wordprocessingml/2006/main" xmlns:w14="http://schemas.microsoft.com/office/word/2010/wordml" xmlns:w15="
http://schemas.microsoft.com/office/word/2012/wordml" xmlns:wpg="http://schemas.microsoft.com/office/word/2010/wordprocessingGroup" xmlns:wpi="
http://schemas.microsoft.com/office/word/2010/wordprocessinglnk" xmlns:wne="http://schemas.microsoft.com/office/word/2006/wordml" xmlns:wps="
http://schemas.microsoft.com/office/word/2010/wordprocessingShape" mc:Ignorable="w14 w15 wp14"><w:body><w:p w:rsidR="006A6A15" w:rsidRP="00B67B39"
w:rsidRDefault="006A6A15" w:rsidP="00FE3E7C"><w:pPr><w:jc w:val="both"/><w:rPr><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr></w:pPr><w:bookmarkStart w:id="
0" w:name="PointTmp"/></w:p><w:p w:rsidR="006A6A15" w:rsidRP="00B67B39" w:rsidRDefault="006A6A15" w:rsidP="006A6A15"><w:pPr><w:pStyle w:val="Title"/><
w:framePr w:wrap="notBeside"/><w:rPr><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr></w:pPr><w:r w:rsidRPr="00B67B39"><w:rPr><w:rFonts w:eastAsia="Calibri"/><
w:b/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr><w:t xml:space="preserve">XML and UML - What </w:t></w:r><w:r w:rsidR="00B67B39"><w:rPr><w:rFonts
w:eastAsia="Calibri"/><w:b/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr><w:t></w:t></w:r><w:r w:rsidRPr="00B67B39"><w:rPr><w:rFonts w:eastAsia="Calibri"/><
w:b/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr><w:t>hey are and Why We Need to Know Them</w:t></w:r></w:p><w:p w:rsidR="0029025B" w:rsidRP="00B67B39"
w:rsidRDefault="0029025B" w:rsidP="00B67B39"><w:pPr><w:pStyle w:val="BodyText2"/><w:rPr><w:rFonts w:ascii="Times New Roman" w:hAnsi="Times New Roman"
/><w:b/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr></w:pPr><w:r w:rsidRPr="00B67B39"><w:rPr><w:rFonts w:ascii="Times New Roman" w:hAnsi="Times New
Roman"/><w:b/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr><w:t>Introduction</w:t></w:r></w:p><w:bookmarkEnd w:id="0"/><w:p w:rsidR="00711870" w:rsidRP="
00B67B39" w:rsidRDefault="00711870" w:rsidP="00711870"><w:pPr><w:spacing w:after="120"/><w:rPr><w:rFonts w:cs="Arial"/><w:sz w:val="24"/><w:szCs w:val="24"/>
</w:rPr></w:pPr><w:r w:rsidRPr="00B67B39"><w:rPr><w:rFonts w:cs="Arial"/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr><w:t>The power system automation
community is going through a period of transition from the world of hard wired systems and proprietary configuration and analysis tools into the world of distributed IEC
61850 communications based systems and object oriented standards based engineering and analysis tools. This requires the development of a new set of skills in order to
help the specialists from our industry understand and use the new technology.</w:t></w:r></w:p><w:p w:rsidR="00711870" w:rsidRP="00B67B39" w:rsidRDefault="
00711870" w:rsidP="00711870"><w:pPr><w:spacing w:after="120"/><w:jc w:val="both"/><w:rPr><w:rFonts w:cs="Arial"/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr>
</w:pPr><w:r w:rsidRPr="00B67B39"><w:rPr><w:rFonts w:cs="Arial"/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr><w:t>The main goal of this paper is to introduce
the Extensible Markup Language (XML) and the Unified Modeling Language (UML) to the protection and control community and focus on the UML diagrams and XML files
used in the IEC 61850 standard and in some IEEE standards related to protection and control in order to help the readers understand the diagrams and files included in or
defined by the different standards.</w:t></w:r></w:p><w:p w:rsidR="00711
870" w:rsidRP="00B67B39" w:rsidRDefault="00711870" w:rsidP="00711870"><w:pPr><w:spacing w:after="120"/><w:rPr><w:rFonts w:cs="Arial"/><w:sz w:val="24"/><
w:szCs w:val="24"/></w:rPr></w:pPr><w:r w:rsidRPr="00B67B39"><w:rPr><w:rFonts w:cs="Arial"/><w:sz w:val="24"/><w:szCs w:val="24"/></w:rPr><w:t>The first half of
```

Text	Grid	Schema	WSDL	XBRL	Authentic	Browser
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XML Files



```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <!-- edited with XMLSPY v5 rel. 4 U (http://www.xmlspy.com) by Vladislav Gavrielov (Altova) -->
3 <?altova_sps ExpReport.sps?>
4 <expense-report xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation
   = "ExpReport.xsd" currency="USD" detailed="false" total-sum="556.9">
5   <Person>
6     <First>Fred</First>
7     <Last>Landis</Last>
8     <Title>Project Manager</Title>
9     <Phone>123-456-7890</Phone>
10    <Email>f.landis@nanonull.com</Email>
11  </Person>
12  <expense-item type="Lodging" expto="Sales">
13    <Date>2003-01-01</Date>
14    <expense>122.11</expense>
15  </expense-item>
16  <expense-item type="Lodging" expto="Development">
17    <Date>2003-01-02</Date>
18    <expense>122.12</expense>
19    <description>Played penny arcade</description>
20  </expense-item>
21  <expense-item type="Lodging" expto="Marketing">
22    <Date>2003-01-02</Date>
23    <expense>299.45</expense>
24    <description>Treated Clients</description>
25  </expense-item>
26  <expense-item type="Entertainment" expto="Development">
27    <Date>2003-01-02</Date>
28    <expense>13.22</expense>
29    <Misc misctype="TeamBuilding"/>
30    <description>Bought signed "XMLSPY Handbook" from Larry Kim</description>
```

What is UML?

- **U**nified **M**odeling **L**anguage
 - Software engineering
 - Standard way to visualize the design of a system
- Elements visualized
 - Activities
 - Components and interactions
 - How the system is expected to be used

Why UML?

- Changes in Software Engineering
 - Distributed applications
 - Client / Server architectures
 - More complex tasks
- Enables the communication between the user and the developer
- Used today in many relevant standards

UML Diagram Types

Structural diagram types

Class diagram

Component diagram

Composite Structure Diagram

Deployment Diagram

Package Diagram

Object Diagram

Behavioral diagram types

Activity Diagram

Communication Diagram

Interaction Overview Diagram

Sequence Diagram

State Machine Diagram

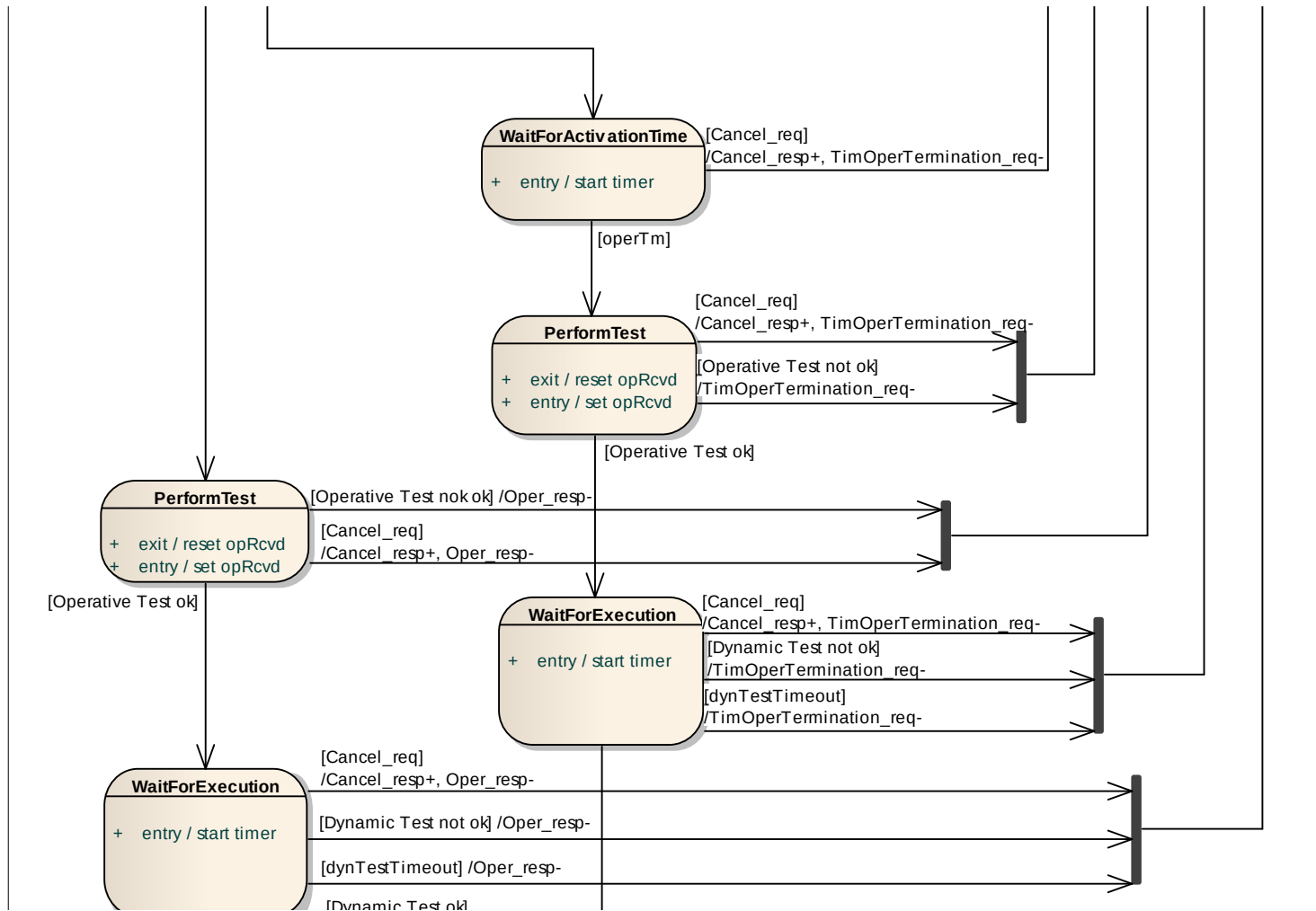
Timing Diagram

Use Case Diagram

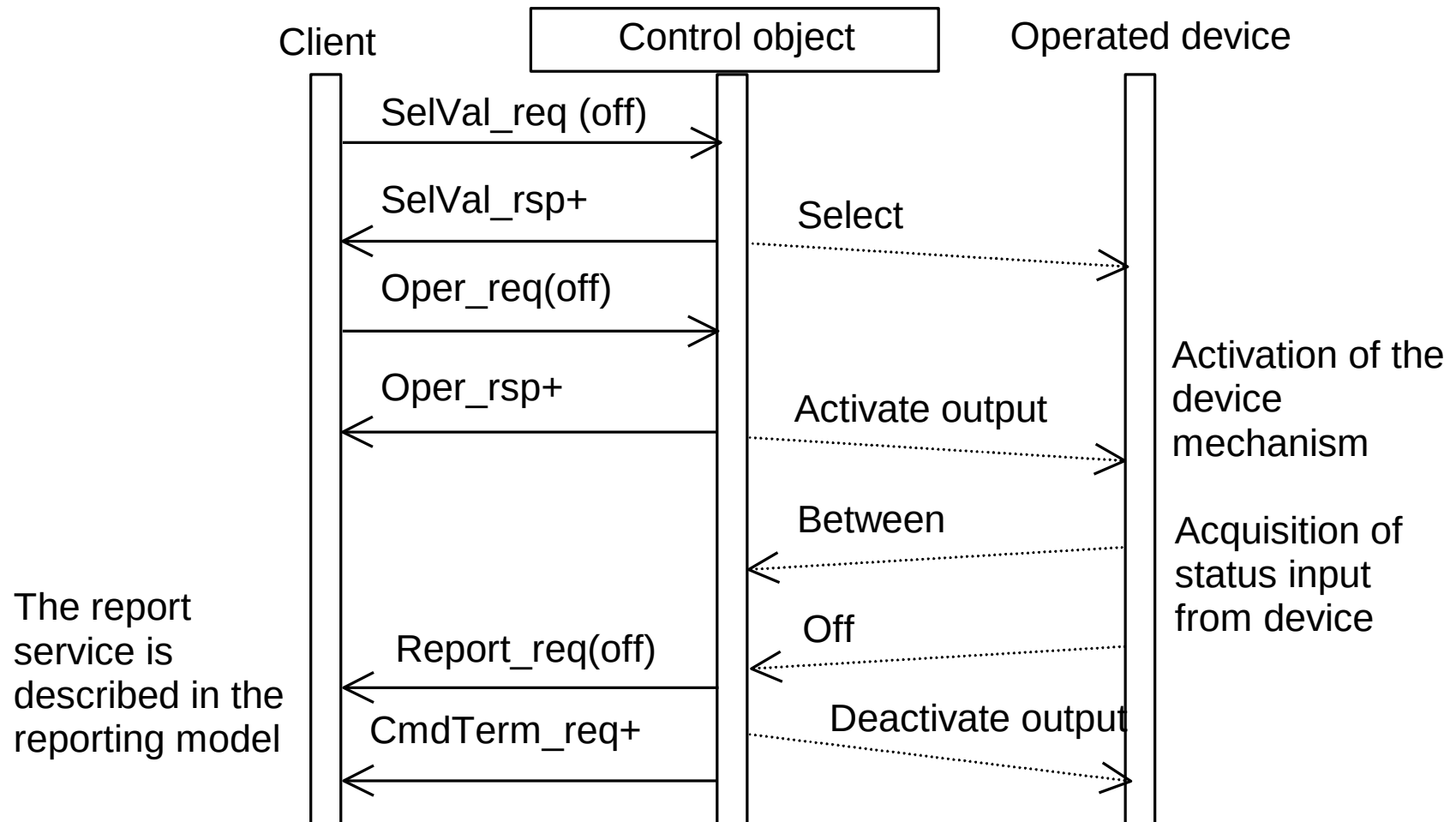
Understand UML

- Relevant standards for PAC use UML diagrams...
 - IEC 61850 core standards
 - IEC 61850 technical reports
 - CIM
- ... to describe
 - Functional behavior
 - Data structures
 - Use cases

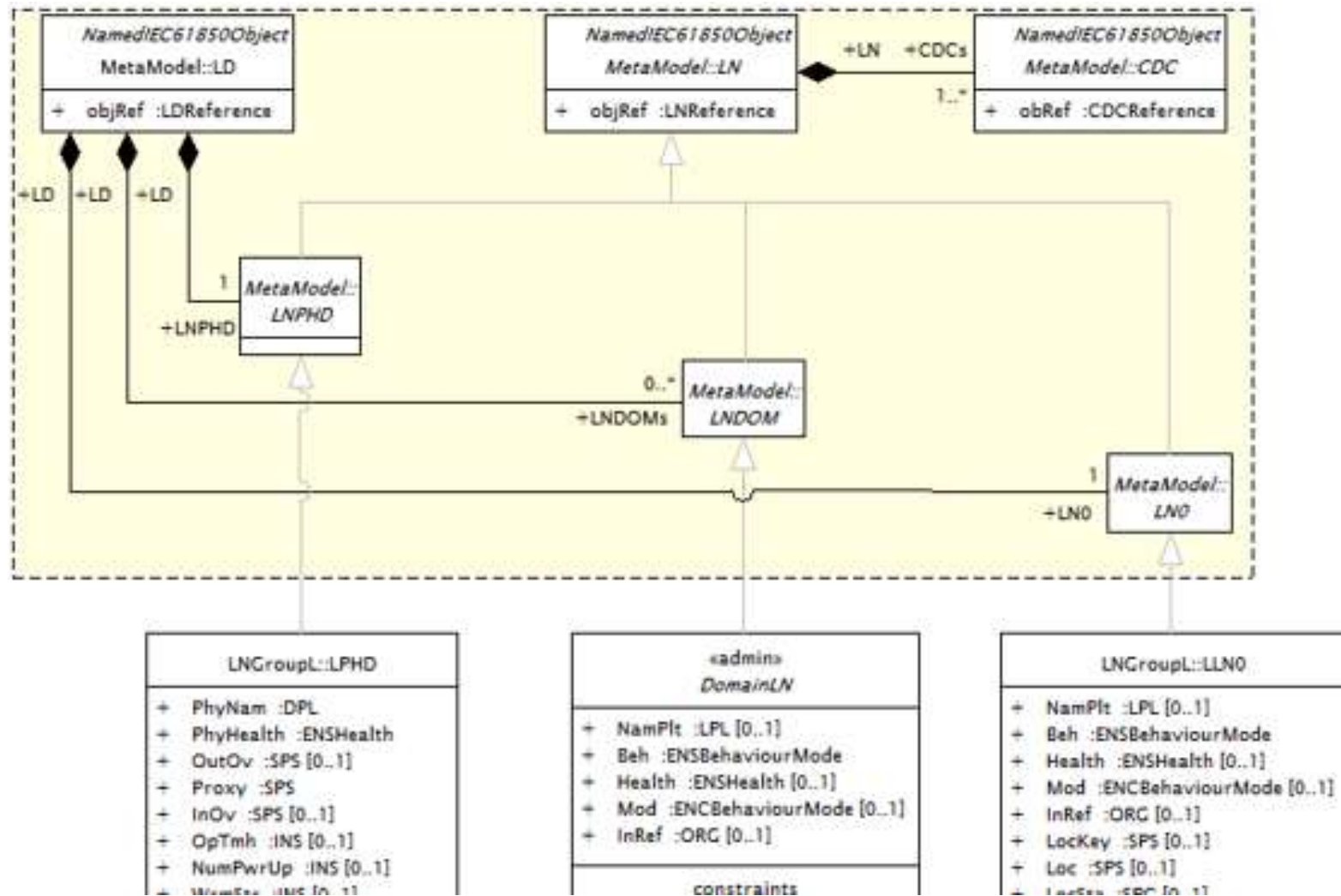
State Machine Diagram



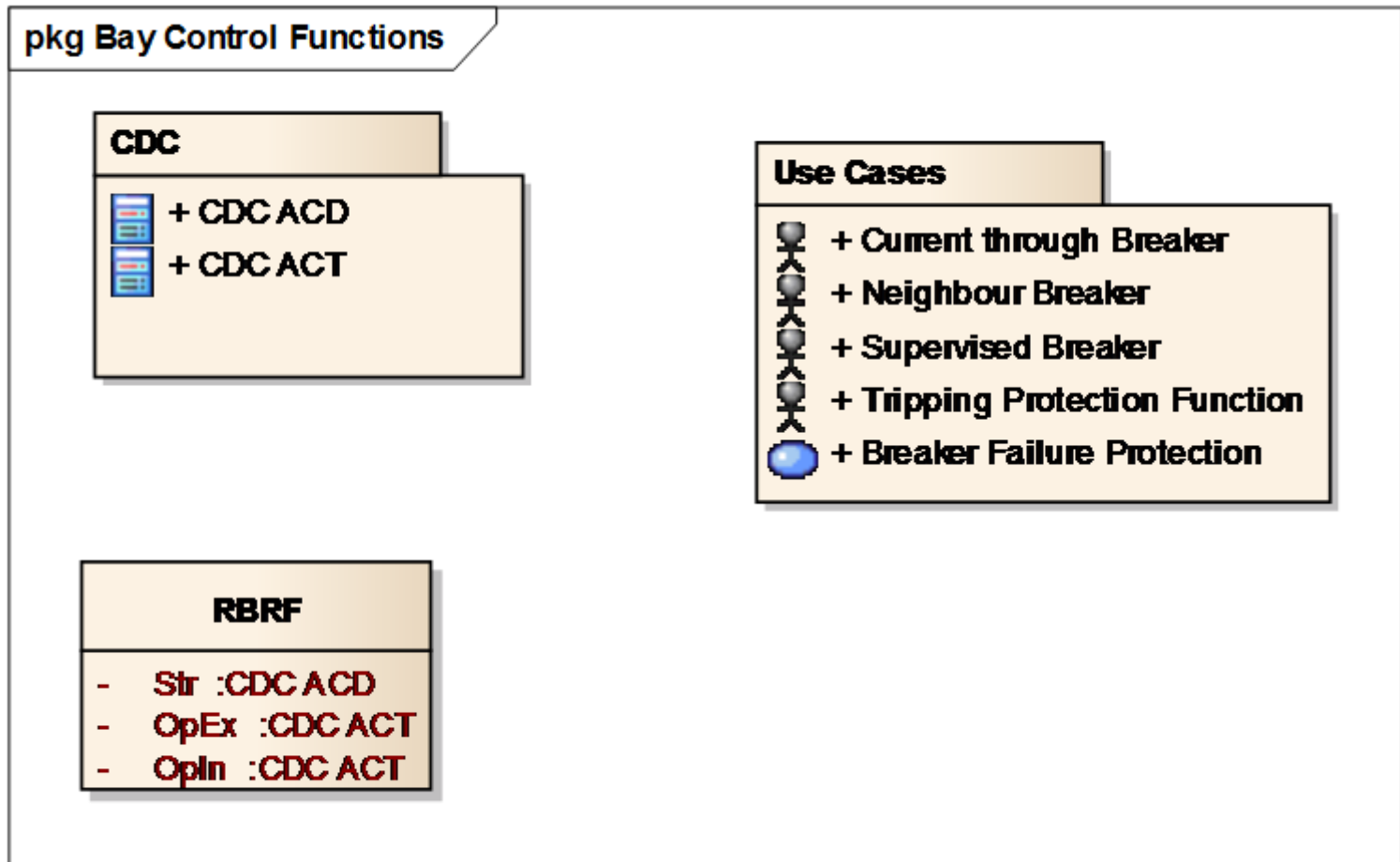
Sequence Diagram



Class Diagram

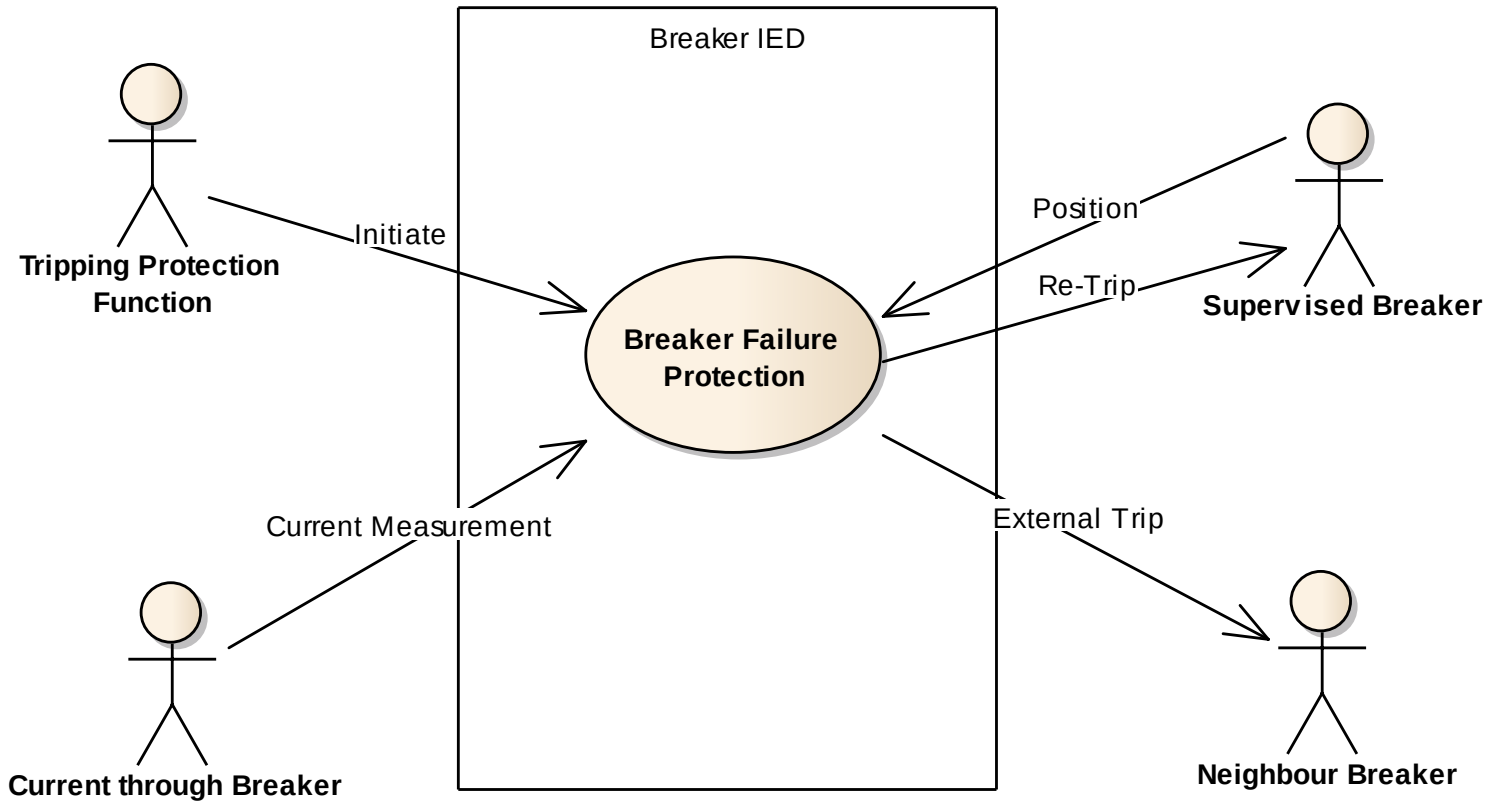


Use UML – Example BF Function

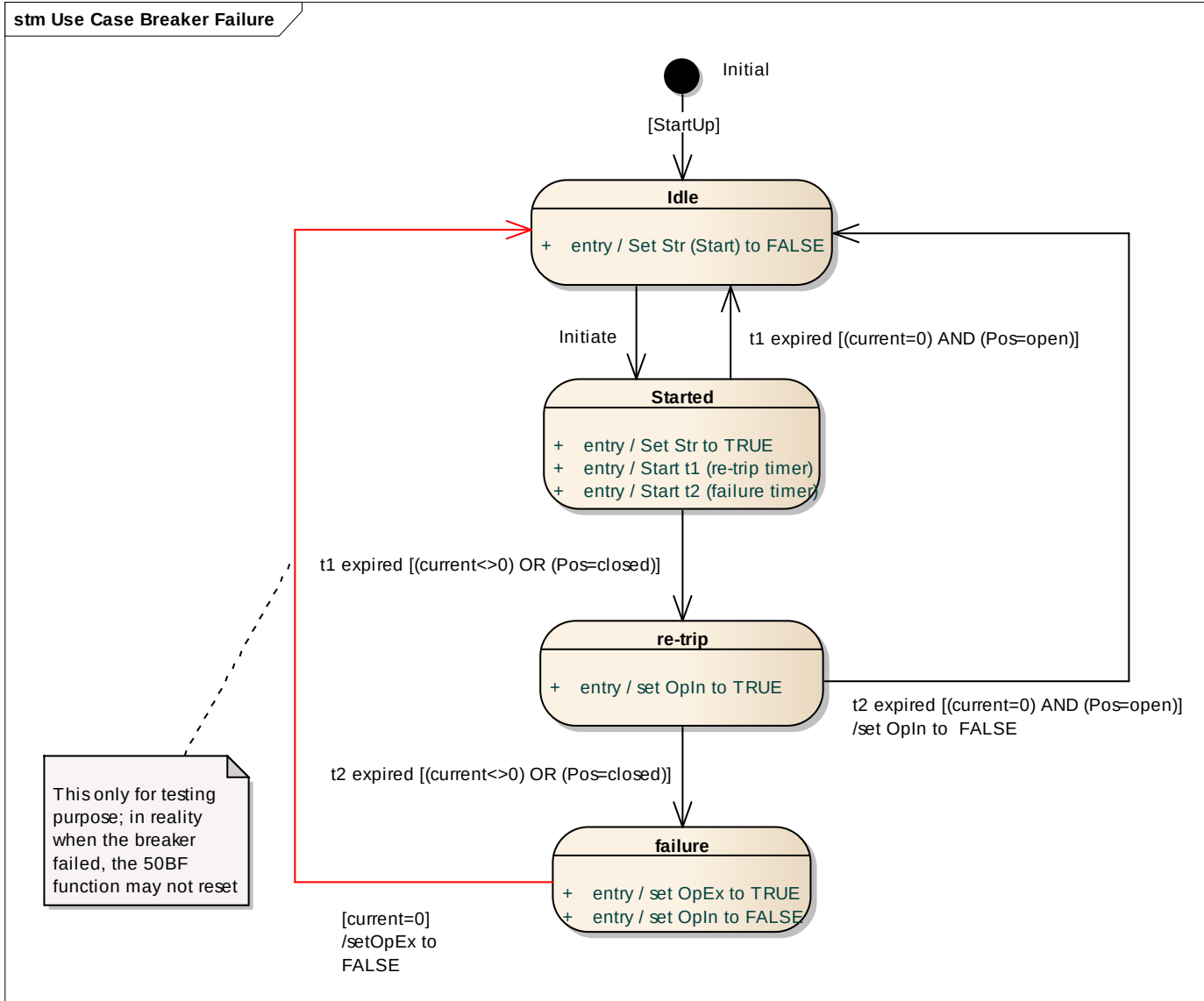


Use Case and Actors

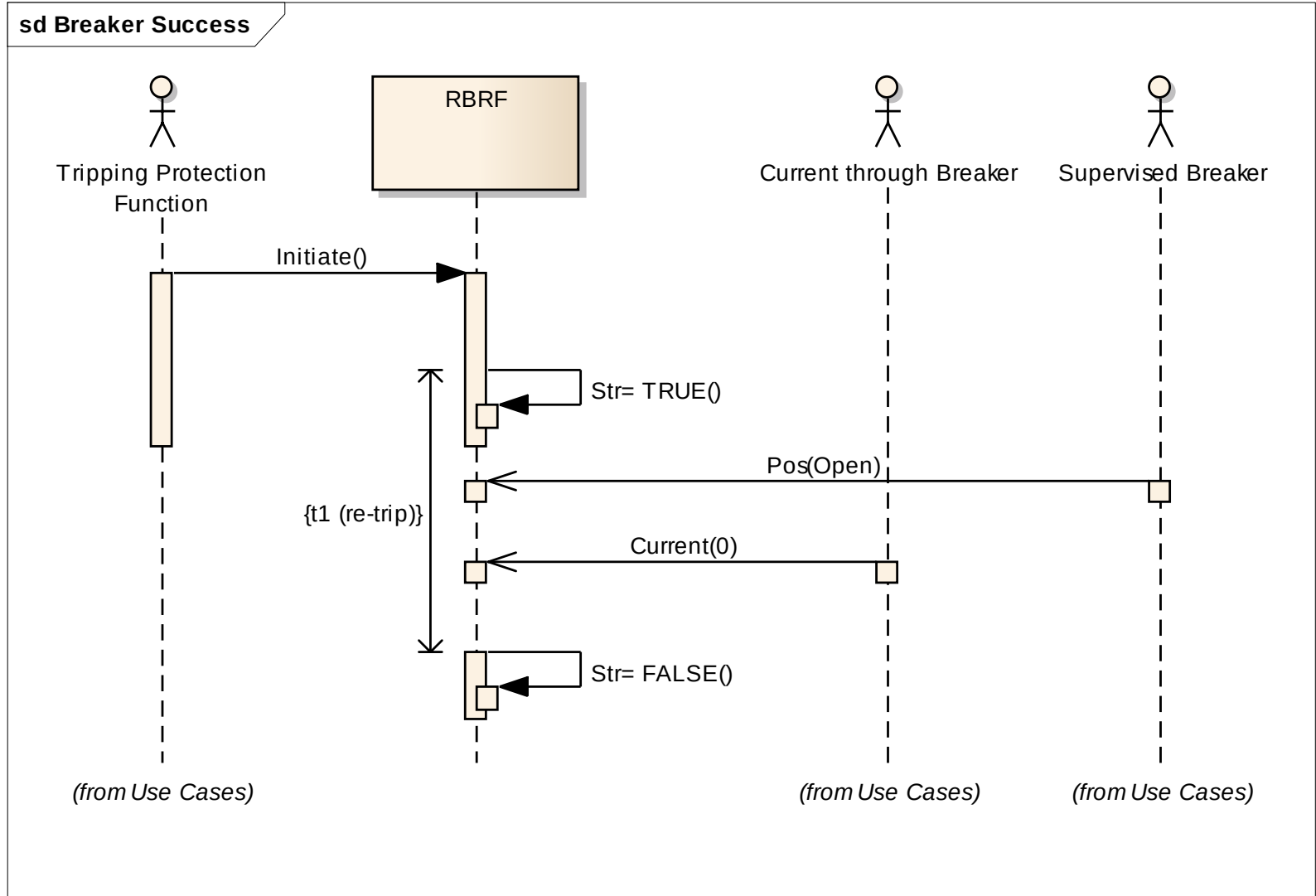
uc Use Case Breaker Failure



State Machine of BF Function

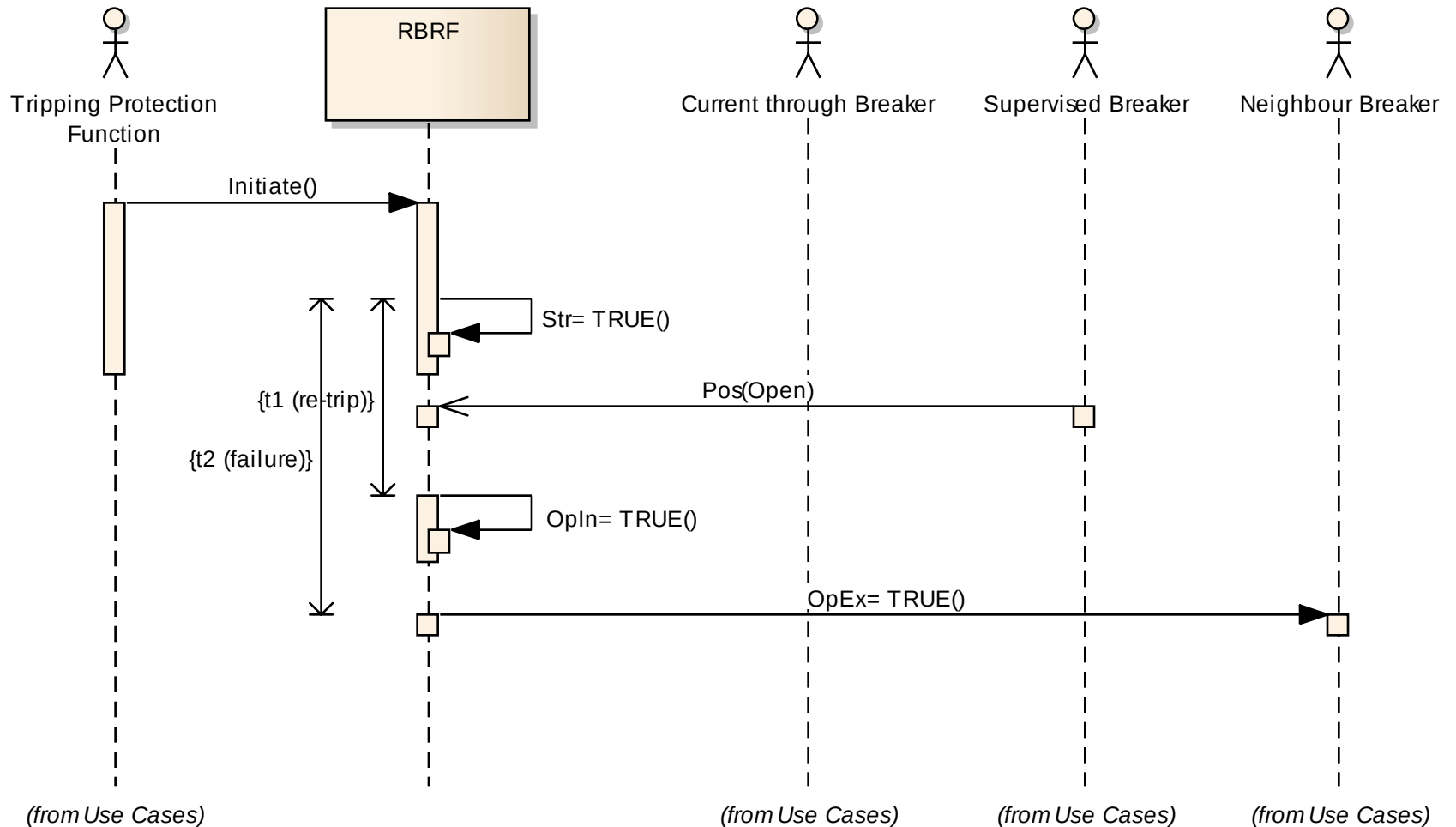


Sequence Diagram - Scenarios



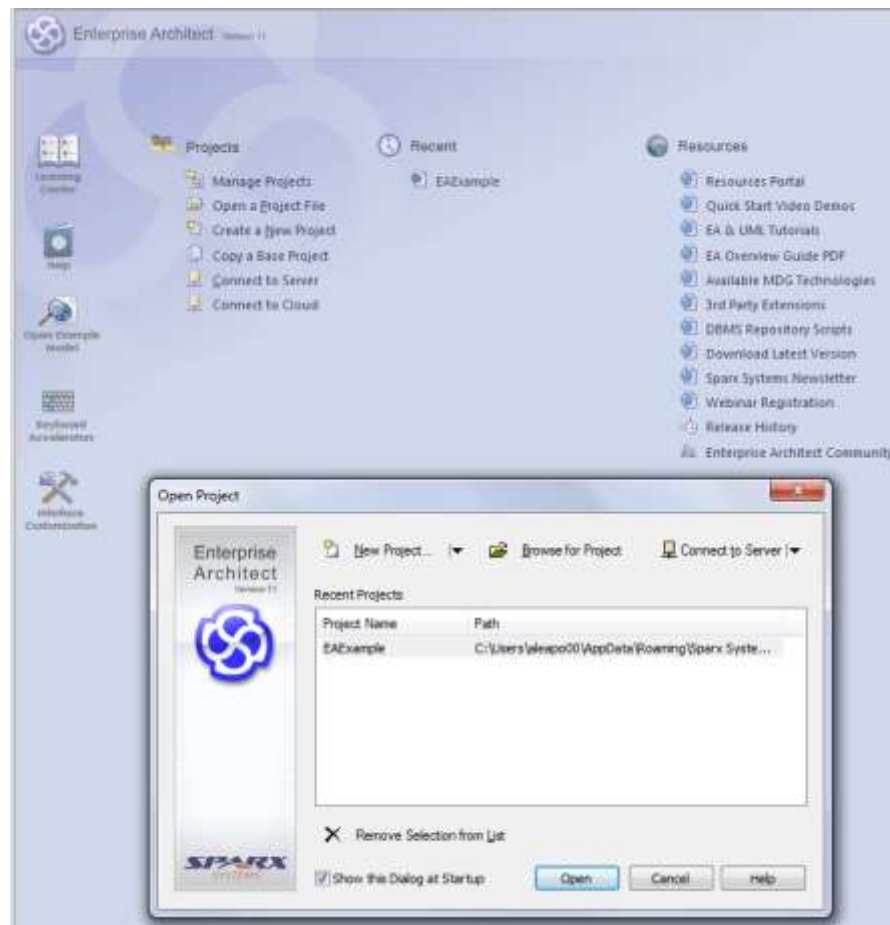
Sequence Diagram - Scenarios

sd Breaker Failure

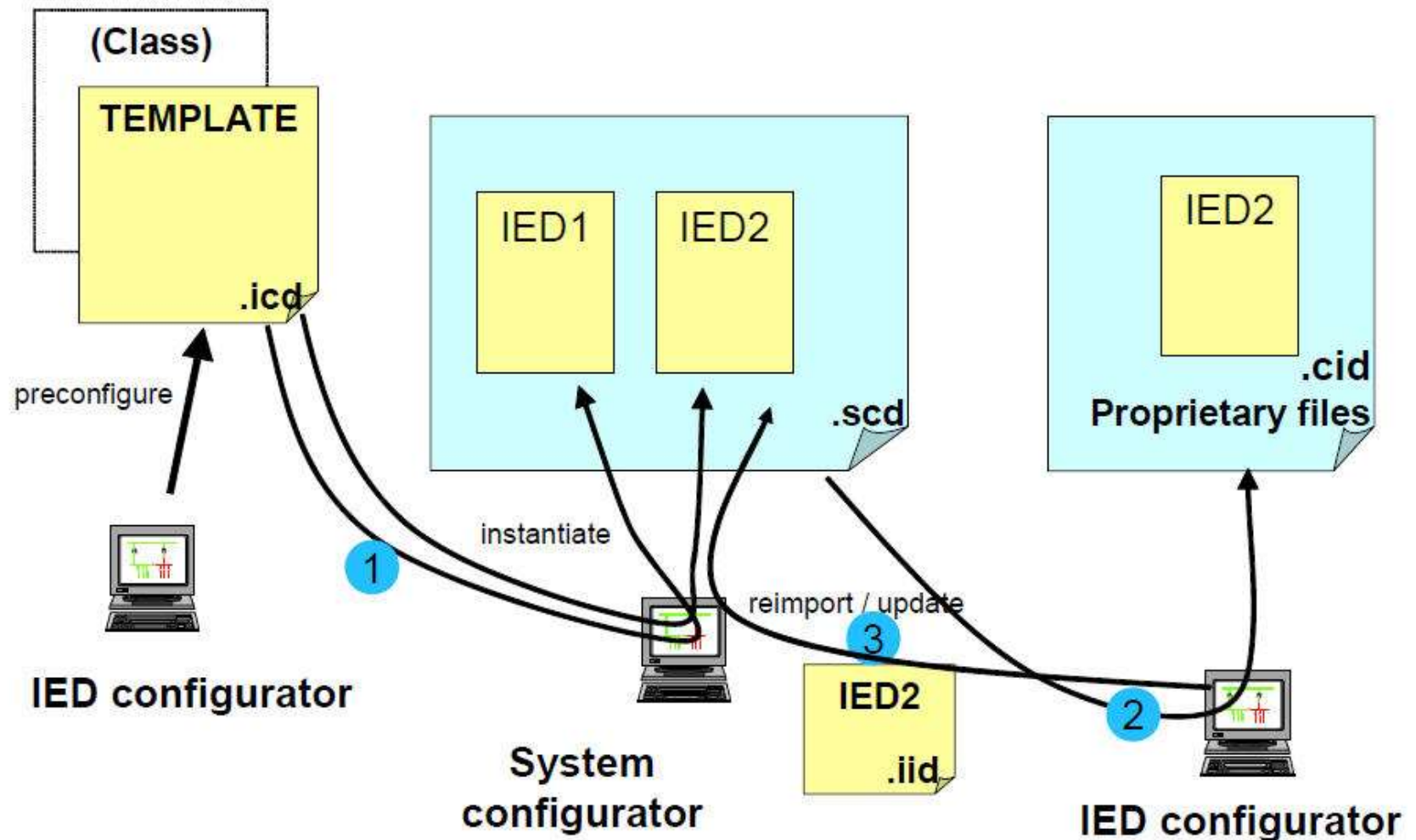


IEC Tool of choice

- Enterprise Architect from Sparxsystems



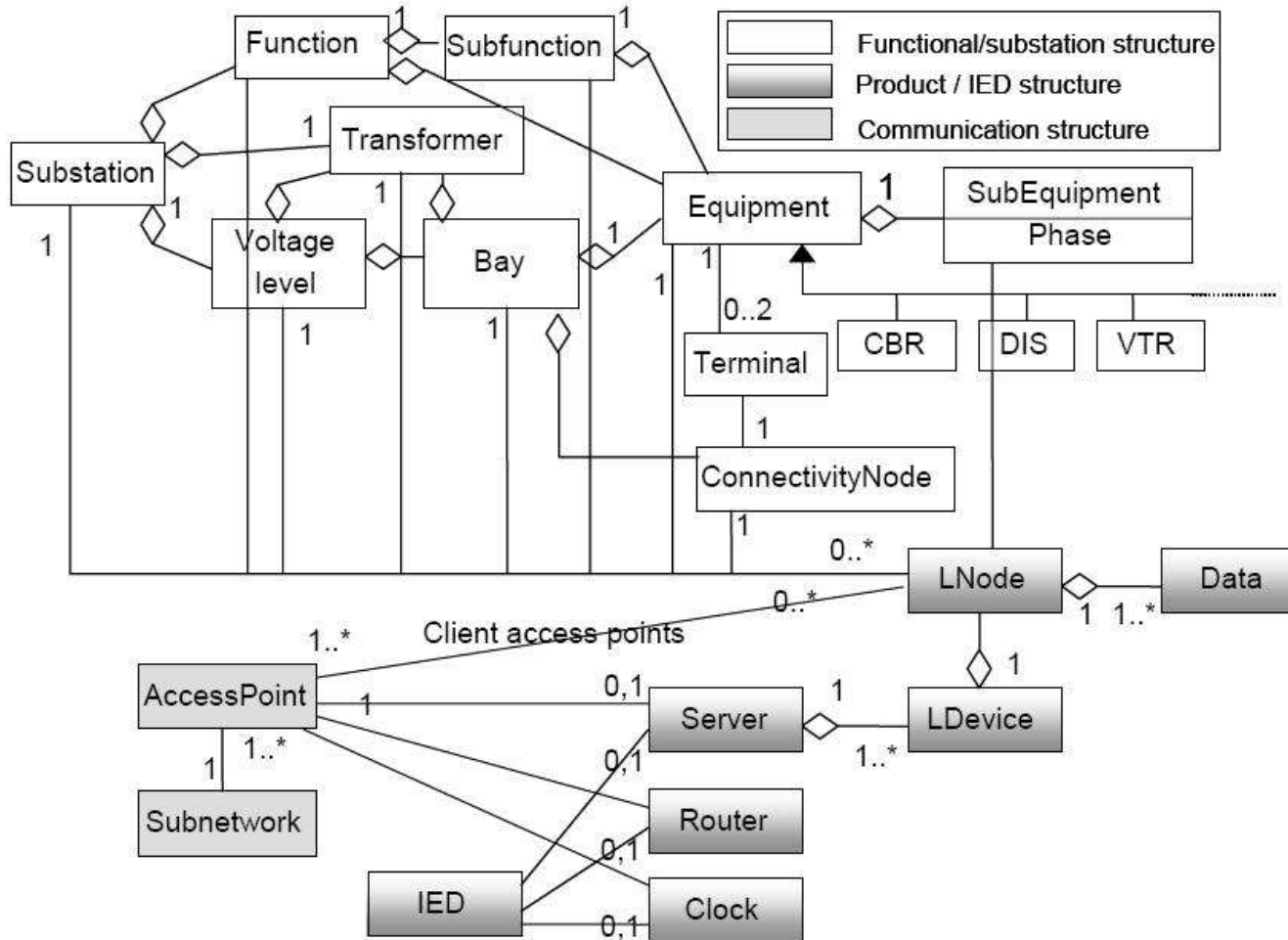
SCL Files in Engineering Process



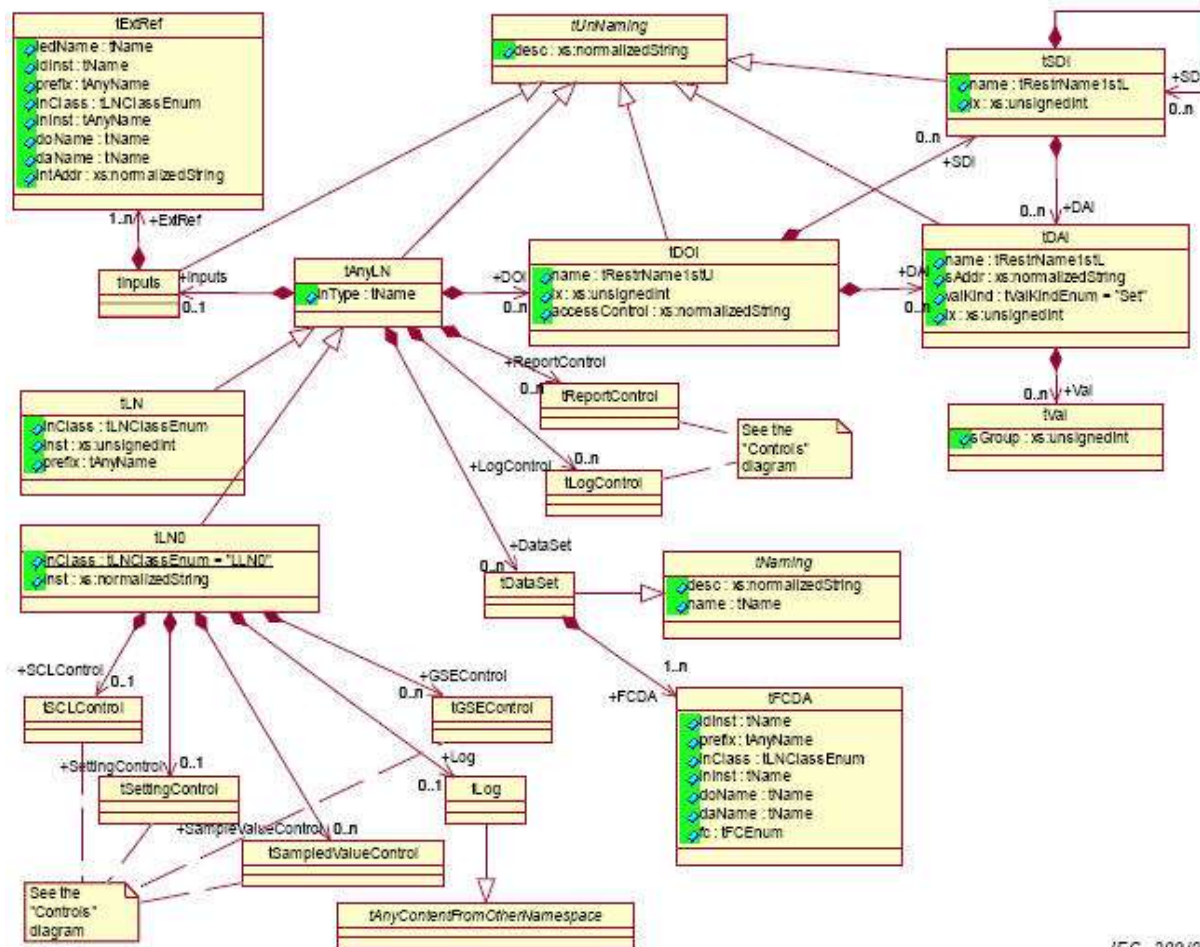
The use of XML and UML

```
<xs:complexType name="tIED">
  <xs:complexContent>
    <xs:extension base="tNaming">
      <xs:sequence>
        <xs:element name="Services" type="tServices" minOccurs="0"/>
        <xs:element name="AccessPoint" type="tAccessPoint" maxOccurs="unbounded">
          <xs:unique name="uniqueLNInAccessPoint">
            <xs:selector xpath="//scl:LN"/>
            <xs:field xpath="@inst"/>
            <xs:field xpath="@lnClass"/>
            <xs:field xpath="@prefix"/>
          </xs:unique>
        </xs:element>
      </xs:sequence>
      <xs:attribute name="type" type="xs:normalizedString" use="optional"/>
      <xs:attribute name="manufacturer" type="xs:normalizedString" use="optional"/>
      <xs:attribute name="configVersion" type="xs:normalizedString" use="optional"/>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

The use of XML and UML

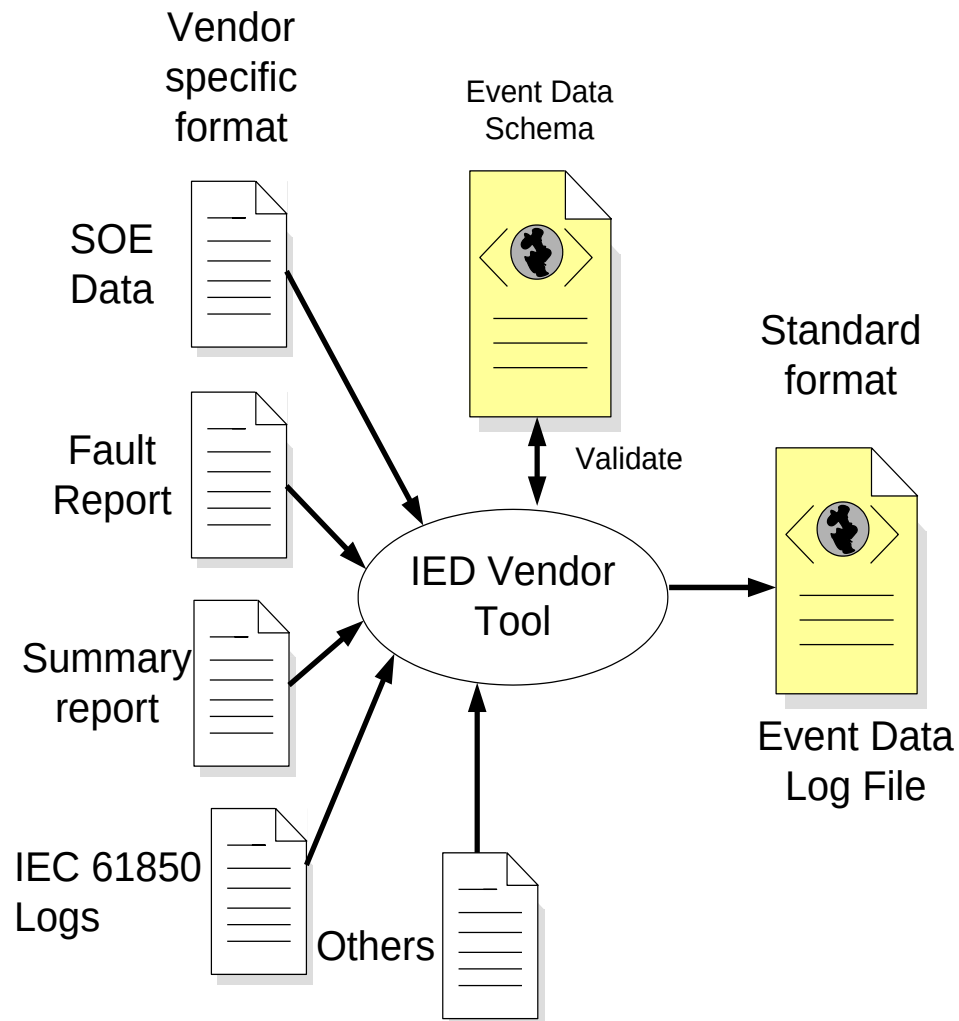


The use of XML and UML

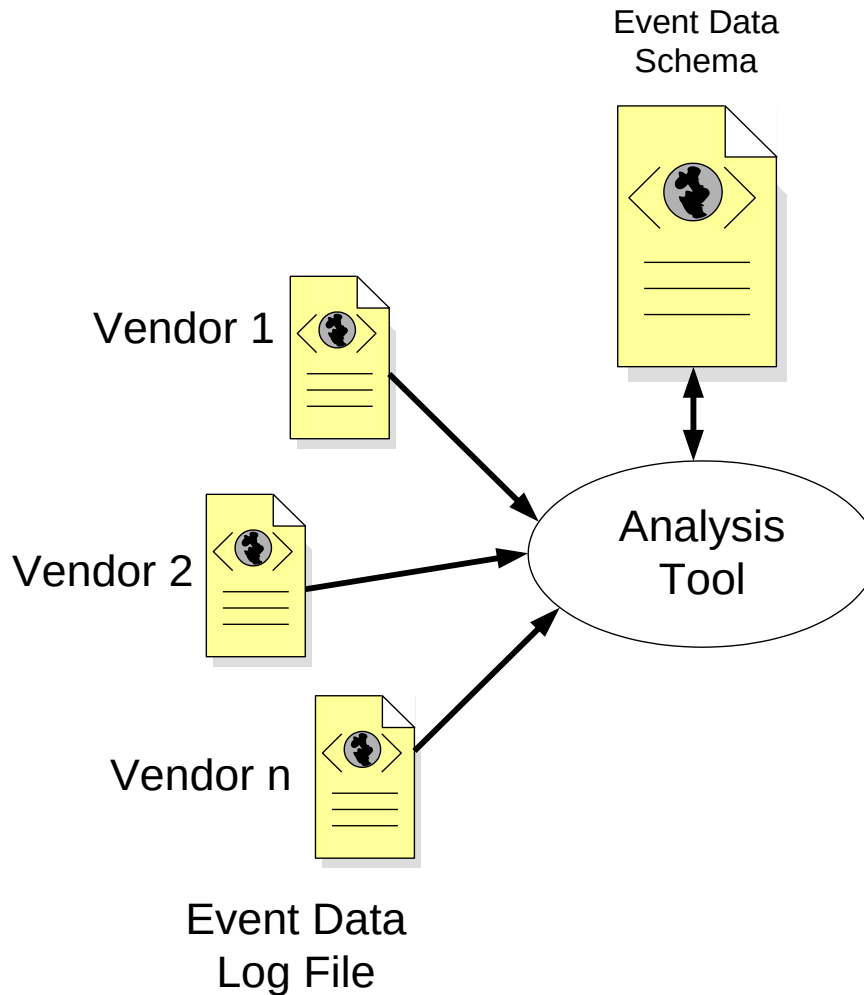


IEC 209/04

Exporting Event Data to COMFEDE



Integrating Vendors



The use of XML and UML

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited by Brian Li (GE Digital Energy) -->
<?xml-stylesheet type="text/xsl" href="briantest.xsl"?>
<Log xmlns="http://www.pes-psrc.org/Subcommittee/H/COMFEDE"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:SC-H_ComTypes="http://www.pes-psrc.org/Subcommittee/H/CommonTypes"
  xsi:schemaLocation="http://www.pes-psrc.org/Subcommittee/H/COMFEDE COMFEDE.xsd"
  version="2008" revision="A"
  LogName="testLogName" LogRef="testLogRef" OldEntr="1" OldEntrTm="2009-09-09T13:24:36.638303Z" NewEntr="9" NewEntrTm="2009-09-09T14:24:33.961444Z">
  <Location stationName="Test Station" companyName="GE Digital Energy"
    bayName="testBayName" companyIdentificationCode="00" latitude="45.5" longitude="35.2" tmDT="true" tmOffSet="-300" tmUseDT="false">
    <SC-H_ComTypes:VoltageLevel unit="V">120</SC-H_ComTypes:VoltageLevel>
    <SC-H_ComTypes:IEDNameplate name="F35 Demo" vendor="GE Digital Energy"
      hwrRev="P" model="F35-G03-HCH-F8L-U5A-VV7C" serNum="AURC04001333" swRev="5.71"/>
  </Location>
  <Entry EntryId="1" TimeOfEntry="2009-09-09T13:24:36.638303Z">
    <EntryData eventType="IEDEvt">
      <DataRef description="EVENTS CLEARED">EVENTS CLEARED</DataRef>
      <Value></Value>
      <Timestamp>2009-09-09T13:24:36.638303Z</Timestamp>
      <Quality validity="good"/>
      <ReasonCode dchg="true" qchg="false"/>
    </EntryData>
  </Entry>
  <Entry EntryId="2" TimeOfEntry="2009-09-09T13:25:19.070881Z">
    <EntryData eventType="SysEvt">
      <DataRef description="POWER ON">POWER ON</DataRef>
      <Value></Value>
      <Timestamp>2009-09-09T13:25:19.070881Z</Timestamp>
      <Quality validity="good"/>
      <ReasonCode dchg="false" qchg="false"/>
    </EntryData>
  </Entry>
```

The use of XML and UML

UR Event Log

File Edit View Favorites Tools Help

Address: D:\Files\IEEE\PSRC\H16 Common Format for Event Data Exchange\GE Example\BrianTest.xml

Google Search

Sequence Of Events (SOE)

Company: GE Digital Energy
Station: Test Station **Bay:** testBayName **Voltage Level:** 120V
Latitude: 45.5° **Longitude:** 35.2° **UTC Time Offset (in mins):** -300
IED Name: F35 Demo **Vendor:** GE Digital Energy
Model: F35-G03-HCH-F8L-U5A-W7C **Firmware:** 5.71

Event ID	Time of Entry	Type	Description	Quality
1	2009-09-09T13:24:36.638303Z	IEDEvt	EVENTS CLEARED	good
2	2009-09-09T13:25:19.070881Z	SysEvt	POWER ON	good
3	2009-09-09T13:25:19.070881Z	SysEvt	UNIT NOT PROGRAMMED	questionable
4	2009-09-09T13:25:19.070881Z	ComEvt	RELAY OUT OF SERVICE	invalid
5	2009-09-09T13:25:19.070881Z	IEDEvt	OSCILLOGRAPHY CLEAR	good
6	2009-09-09T13:26:22.566851Z	SysEvt	RELAY IN SERVICE	good
7	2009-09-09T13:27:14.312323Z	SysEvt	F35Demo/PDIS1.Op	good
8	2009-09-09T13:30:52.495898Z	IEDEvt	OSCILLOGRAPHY TRIG'D	good
9	2009-09-09T14:24:33.961444Z	IEDEvt	FAULT RPT TRIG	good

Payload Data:
Event ID: 9 **Type:** Distribution Feeder Protection **Group#:** 1 **Fault Type:** AB **Trip:** true

Signal	Prefault Magnitude	Prefault Angle	Fault Magnitude	Fault Angle
Ia	0.536A	180.6deg	0.535A	180.6deg
Ib	0.537A	179.7deg	0.536A	179.7deg
Ic	0.536A	180.3deg	0.535A	180.3deg
Va	24.154V	0deg	24.135	0deg
Vb	24.134V	0.2deg	24.111V	0.2deg
Vc	24.148V	0.1deg	24.125V	0.1deg

Done

Start Search Res... Adobe Reader H5-b_Repor... CIGRE B5 R... 2 Internet... 4:05 AM

Conclusions

- XML and UML are some of the key technologies currently used in many domains and helping to improve the efficiency of different business processes.
- With the wide spread acceptance of IEC 61850 and the engineering process supported by it, it becomes essential for protection and control specialists to have a good understanding of what XML and UML are, so they can use them in their everyday work.

