

BinaryNotes

Developers Guide

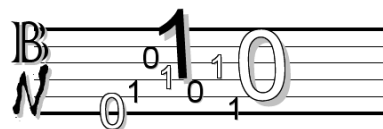


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1. Overview

BinaryNotes is the Open Source ASN.1 (Abstract Syntax Notation One) framework for Java and .NET.

In telecommunications and computer networking, Abstract Syntax Notation One (ASN.1) is a standard and flexible notation that describes data structures for representing, encoding, transmitting, and decoding data. It provides a set of formal rules for describing the structure of objects that are independent of machine-specific encoding techniques and is a precise, formal notation that removes ambiguities.

ASN.1 is a joint ISO and ITU-T standard, originally defined in 1984 as part of CCITT X.409:1984. ASN.1 moved to its own standard, X.208, in 1988 due to wide applicability. The substantially revised 1995 version is covered by the X.680 series.

ASN.1 defines the abstract syntax of information but does not restrict the way the information is encoded. Various ASN.1 encoding rules provide the transfer syntax (a concrete representation) of the data values whose abstract syntax is described in ASN.1.

The standard ASN.1 encoding rules include¹:

- * Basic Encoding Rules (BER)
- * Canonical Encoding Rules (CER)
- * Distinguished Encoding Rules (DER)
- * XML Encoding Rules (XER) and Extended XML Encoding Rules (EXER)
- * Packed Encoding Rules (PER)
- * Generic String Encoding Rules (GSER)

ASN.1 together with specific ASN.1 encoding rules facilitates the exchange of structured data especially between application programs over networks by describing data structures in a way that is independent of machine architecture and implementation language.

Application layer protocols such as X.400 electronic mail, X.500 and LDAP directory services, H.323 (VoIP) and SNMP use ASN.1 to describe the PDUs they exchange. It is also extensively used in the Access and Non-Access Strata of UMTS. There are many other application domains of ASN.1

Materials from <http://en.wikipedia.org/wiki/ASN.1> are used for writing this section. For more details please go to at this reference.

¹ CER, XER/EXER, GSER is not supported by BinaryNotes.

2. Introduction

The framework contains:

- Encoding/decoding library. The library has BER (Basic Encoding Rules), PER (Packet Encoding Rules) and DER (experimental) implementation.
- BNCompiler - the extensible (based on XSL) ASN.1 compiler which is able to generate the simple Java or C# classes for the specified ASN.1 input file. The generated code has annotations/attributes that uses the compiler in runtime. You can customize the generated files by change the original XSL-templates or create your own templates.
- Message Queues – the own simple and high performance MQ implementation based on ASN.1 encoding.

1. Requirements

BinaryNotes requires:

- Java Platform Standard Edition v1.5 (.NET developer can use JRE instead JDK²).
- .NET 2.0 (Only for .NET developers)

² .NET developer needs JVM too. The compiler run only under Java and haven't implementation for .NET. But the runtime library is native for .NET

1. BinaryNotes Compiler

BinaryNotes Compiler (BNCompiler) is a tool for generating the class/method declarations for the specified ASN.1 specification (as input file). The compiler generates ready to use code with the BinaryNotes library. But developer may not to use the compiler and create own classes manually. But it's usually more difficult than the ASN.1 based work.

1.1. Generating process

The generated classes has annotations/attributes and simple properties which uses by runtime library. For Java it's JavaBean properties, for .NET - native C# property declarations ³.

For example the following simple ASN.1 declaration:

```
FOOBAR
DEFINITIONS IMPLICIT TAGS ::= BEGIN
  TestSequence ::= SEQUENCE {
    field1 INTEGER,
    field2 PrintableString,
    field3 UTF8String OPTIONAL,
    fieldb BOOLEAN DEFAULT false,
    field4 CHOICE {
      field1 INTEGER,
      field2 REAL
    }
  }
END
```

translating to the following Java-code:

```
package foobar;
//
// This file was generated by the BinaryNotes compiler.
// See http://bnotes.sourceforge.net
// Any modifications to this file will be lost upon recompilation of the source ASN.1.
//

import org.bn.*;
import org.bn.annotations.*;
import org.bn.annotations.constraints.*;
import org.bn.coders.*;
import org.bn.types.*;

@ASN1Sequence ( name = "TestSequence", isSet = false )
public class TestSequence {

    @ASN1Integer( name = "" )
    @ASN1Element ( name = "field1", isOptional = false , hasTag = false , hasDefaultValue = false )
    private Long field1 = null;

    @ASN1String( name = "", stringType = UniversalTag.PrintableString , isUCS = false )
    @ASN1Element ( name = "field2", isOptional = false , hasTag = false , hasDefaultValue = false )
    private String field2 = null;

    @ASN1String( name = "", stringType = UniversalTag.UTF8String , isUCS = false )
    @ASN1Element ( name = "field3", isOptional = true , hasTag = false , hasDefaultValue = false )
    private String field3 = null;

    @ASN1Boolean( name = "" )
    @ASN1Element ( name = "fieldb", isOptional = false , hasTag = false , hasDefaultValue = true )
    private Boolean fieldb = null;

    @ASN1Choice ( name = "field4" )
    public static class Field4ChoiceType {
```

³ This documentation haven't detail description of annotation for now.

```
@ASN1Integer( name = "" )
@ASN1Element ( name = "field1", isOptional = false , hasTag = false , hasDefaultValue = false )
private Long field1 = null;

@ASN1Real( name = "" )
@ASN1Element ( name = "field2", isOptional = false , hasTag = false , hasDefaultValue = false )
private Double field2 = null;

public Long getField1 () {
    return this.field1;
}

public boolean isField1Selected () {
    return this.field1 != null;
}

private void setField1 (Long value) {
    this.field1 = value;
}

public void selectField1 (Long value) {
    this.field1 = value;
    setField2(null);
}

public Double getField2 () {
    return this.field2;
}

public boolean isField2Selected () {
    return this.field2 != null;
}

private void setField2 (Double value) {
    this.field2 = value;
}

public void selectField2 (Double value) {
    this.field2 = value;
    setField1(null);
}
}

@ASN1Element ( name = "field4", isOptional = false , hasTag = false , hasDefaultValue = false )
private Field4ChoiceType field4 = null;

public Long getField1 () {
    return this.field1;
}

public void setField1 (Long value) {
    this.field1 = value;
}

public String getField2 () {
    return this.field2;
}

public void setField2 (String value) {
    this.field2 = value;
}

public String getField3 () {
    return this.field3;
}

public boolean isField3Present () {
    return this.field3 == null;
}

public void setField3 (String value) {
    this.field3 = value;
}
```

```
}

public Boolean getFieldb () {
    return this.fieldb;
}

public void setFieldb (Boolean value) {
    this.fieldb = value;
}

public Field4ChoiceType getField4 () {
    return this.field4;
}

public void setField4 (Field4ChoiceType value) {
    this.field4 = value;
}

public void initWithDefaults() {
    Boolean param_Fieldb = new Boolean (false);
    setFieldb(param_Field4);
}

}
```

And the following for C# (.Net):

```
//
// This file was generated by the BinaryNotes compiler.
// See http://bnotes.sourceforge.net
// Any modifications to this file will be lost upon recompilation of the source ASN.1.
//

using System;
using org.bn.attributes;
using org.bn.attributes.constraints;
using org.bn.coders;
using org.bn.types;

namespace foobar {

    [ASN1Sequence ( Name = "TestSequence", IsSet = false )]
    public class TestSequence {

        private long field1_ ;
        [ASN1Integer( Name = "" )]
        [ASN1Element ( Name = "field1", IsOptional = false , HasTag = false , HasDefaultValue = false ) ]
        public long Field1
        {
            get { return field1_ ; }
            set { field1_ = value; }
        }

        private string field2_ ;
        [ASN1String( Name = "", StringType = UniversalTags.PrintableString , IsUCS = false )]
        [ASN1Element ( Name = "field2", IsOptional = false , HasTag = false , HasDefaultValue = false ) ]
        public string Field2
        {
            get { return field2_ ; }
            set { field2_ = value; }
        }

        private string field3_ ;
        private bool field3_present = false ;
        [ASN1String( Name = "", StringType = UniversalTags.UTF8String , IsUCS = false )]
        [ASN1Element ( Name = "field3", IsOptional = true , HasTag = false , HasDefaultValue = false ) ]
        public string Field3
        {
            get { return field3_ ; }
            set { field3_ = value; field3_present = true; }
        }
    }
}
```

```
}

private bool fieldb_ ;
[ASN1Boolean( Name = "" )]
[ASN1Element ( Name = "fieldb", IsOptional = false , HasTag = false , HasDefaultValue = true ) ]
public bool Field4
{
    get { return fieldb_ ; }
    set { fieldb_ = value; }
}

private Field4ChoiceType field4_ ;
[ASN1Choice ( Name = "field4" )]
public class Field4ChoiceType {

    private long field1_ ;
    private bool field1_selected = false ;

    [ASN1Element ( Name = "field1", IsOptional = false , HasTag = false , HasDefaultValue = false ) ]
    [ASN1Integer( Name = "" )]
    public long Field1
    {
        get { return field1_ ; }
        set { selectField1(value); }
    }

    private double field2_ ;
    private bool field2_selected = false ;

    [ASN1Element ( Name = "field2", IsOptional = false , HasTag = false , HasDefaultValue = false ) ]
    [ASN1Real( Name = "" )]
    public double Field2
    {
        get { return field2_ ; }
        set { selectField2(value); }
    }

    public bool isField1Selected () {
        return this.field1_selected ;
    }

    public void selectField1 (long val) {
        this.field1_ = val;
        this.field1_selected = true;
        this.field2_selected = false;
    }

    public bool isField2Selected () {
        return this.field2_selected ;
    }

    public void selectField2 (double val) {
        this.field2_ = val;
        this.field2_selected = true;
        this.field1_selected = false;
    }
}

[ASN1Element ( Name = "field4", IsOptional = false , HasTag = false , HasDefaultValue = false ) ]
public Field4ChoiceType Field4
{
    get { return field4_ ; }
    set { field4_ = value; }
}

public bool isField3Present () {
    return this.field3_present == true;
}

public void initWithDefaults() {
    bool param_Fieldb = false;
    Fieldb = param_Fieldb;
}
```



```
}  
}  
}
```

You can use the generated classes in your application like that:

```
TestSequence sequence = new TestSequence();  
sequence.setField1(10L);  
sequence.setField3("Hello");  
// Inner class for implicit ASN.1 type declaration  
TestSequence.Field4ChoiceType choice = new TestSequence.Field4ChoiceType();  
choice.selectField2(0.5);  
sequence.setField4(choice);
```

For C#:

```
TestSequence sequence = new TestSequence();  
sequence.Field1 = 10L;  
sequence.Field3 = "Hello";  
// Inner class for implicit ASN.1 type declaration  
TestSequence.Field4ChoiceType choice = new TestSequence.Field4ChoiceType ();  
choice.selectField2(0.5);  
sequence.Field4 = choice;
```

1.2. BNCompiler command line options

BNCompiler can be executed by bncompiler.cmd script (Win32), bncompiler.sh script for UNIX-like OS or may be forked from ANT-tool (The compiler main class is *org.bn.compiler.Main*).

The compiler is handling the following command line options:

Long option name	Short name	Mandatory	Description	Example
--file	-f	Yes	The source input ASN.1 file	-f mytest.asn
--moduleName	-m	Yes	The language translating module name (must be available directory in modules path)	-m java -m cs
--modulesPath	-mp	No	Path to modules directory which contains XSL templates for translating. Default is current directory + "modules/"	-mp d:\modules
--outputDir	-o	No	Output path for generating files. Default is current directory + "output/"	-o org/my/superpackage
--namespace	-ns	No	Namespace/Package name for generated files. Default is ASN.1 module name.	-ns org.my.superpackage

Example for usage the compiler for C# (Win32):

```
D:\BinaryNotes\Dist\bin\bncompiler.cmd -m cs -o test/org/company -ns test.org.company -f test.asn
```

Example for usage the compiler with ANT-tool:

```
<path id="library.BN">  
  <pathelement location="{dist.path.lib}/binarynotes.jar"/>  
</path>  
<path id="classpath">  
  <path refid="library.BN"/>  
</path>  
<path id="bndepends.path">  
  <pathelement path="classes"/>  
  <pathelement path="{depends.libs.path}/lineargs.jar"/>  
  <pathelement path="{depends.libs.path}/antlr.jar"/>  
  <pathelement path="{depends.libs.path}/activation.jar"/>  
  <pathelement path="{depends.libs.path}/java5/jaxb-api.jar"/> <!-- Only for Java5 -->  
  <pathelement path="{depends.libs.path}/java5/jaxb-impl.jar"/> <!-- Only for Java5 -->  
  <pathelement path="{depends.libs.path}/java5/jaxb1-impl.jar"/> <!-- Only for Java5 -->  
  <pathelement path="{depends.libs.path}/java5/jsr173_1.0_api.jar"/> <!-- Only for Java5 -->  
</path>
```

```
<pathelement path="${dist.path.lib}/java/binarynotes.jar"/>
<pathelement path="${dist.path.bin}/bncompiler.jar"/>
</path>
<target name="bncompile" depends="init">
  <java classname="org.bn.compiler.Main" fork="true">
    <classpath refid="bndepends.path"/>
    <arg value="-mp"/>
    <arg value="${dist.path.bin}/modules"/>
    <arg value="-m"/>
    <arg value="java"/>
    <arg value="-o"/>
    <arg value="src/org/bn/mq/protocol"/>
    <arg value="-ns"/>
    <arg value="org.bn.mq.protocol"/>
    <arg value="-f"/>
    <arg value="../asn/test.asn"/> <!-- Input file path to your ASN.1 declaration -->
  </java>
</target>
```

1.3. Extending/Customization of BNCompiler

The compiler has predefined templates (language translation modules) for C#/Java. But you can create your own translation modules.

Translation modules is XSL-scripts with predefined structure. BNCompiler, depending on moduleName command line option, execute the specified translation module.

Warning: The predetermined (standard) modules periodically changes, and if you want to customize them please create own module and don't change standard modules. You can risk to lose your work later with the new BinaryNotes version. Also don't forget about the original bugfix updates.

2. BinaryNotes Library

The library supports various encodings standards.

The version 1.3 supports:

- BER
- DER (experimental)
- PER (Aligned/Unaligned)

The library defines a factory *org.bn.CoderFactory* for creating encoder/decoder implementation. The encoder interface is defined as *org.bn.IEncoder*, and the decoder interface accordingly as *org.bn.IDecoder*.

CoderFactory is a singleton⁴ and you may get encoder and decoder by the specified encoding schema name in the string manner/form:

- "BER" for BER encoding
- "DER" for DER encoding
- "PER" or "PER/Aligned" or "PER/A" for PER Aligned encoding
- "PER/Unaligned" or "PER/U" for PER Unaligned encoding

The following code describes creating encoder and decoder.

For Java:

```
// Encoder for Java
IEncoder<DataSeq> encoder = CoderFactory.getInstance().newEncoder("BER");

// Decoder for Java
IDecoder decoder = CoderFactory.getInstance().newDecoder("BER");
```

For C#:

```
// Encoder for C#
IEncoder encoder = CoderFactory.getInstance().newEncoder("BER");

// Decoder for C#
IDecoder decoder = CoderFactory.getInstance().newDecoder("BER");
```

IEncoder contain primary method `<T> encode(T obj, OutputStream stream)`, and IDecoder contain primary method `decode<T>(InputStream stream, Class<T> objClass)`.

Java example:

```
...
// Encoding for Java
TestSequence sequence = new TestSequence();
sequence.setField1(10L);
sequence.setField3("Hello");
// Inner class for implicitly ASN.1 type declaration
TestSequence.Field4ChoiceType choice = sequence.new Field4ChoiceType();
choice.selectField2(0.5);
sequence.setField4(choice);
IEncoder< TestSequence> encoder = CoderFactory.getInstance().newEncoder("BER");
ByteArrayOutputStream outputStream = new ByteArrayOutputStream();
encoder.encode(sequence, outputStream);

...
// Decoding for Java
IDecoder decoder = CoderFactory.getInstance().newDecoder("BER");
// Decoding the specified input stream
```

⁴ From the GoF (Gang-Of-Four) Design Pattern Book definitions

```
TestSequence seq = decoder.decode(stream, TestSequence.class);
System.out.println(seq.getField1());
if(seq.isField3Present())
    System.out.println(seq.getField3());
...
```

C# example:

```
...
// Encoding for C#
TestSequence sequence = new TestSequence();
sequence.Field1 = 10L;
sequence.Field3 = "Hello";
// Inner class for implicitly ASN.1 type declaration
TestSequence.Field4ChoiceType choice = new TestSequence.Field4ChoiceType ();
choice.selectField2(0.5);
sequence.Field4 = choice;
IEncoder encoder = CodeFactory.getInstance().newEncoder("BER");
ByteArrayOutputStream outputStream = new ByteArrayOutputStream();
encoder.encode<TestSequence>(sequence, outputStream);
...

// Decoding for .NET
IDecoder decoder = CodeFactory.getInstance().newDecoder("BER");
// Decoding the specified input stream
TestSequence seq = decoder.decode<TestSequence>(stream);
System.Console.WriteLine(seq.Field1);
if(seq.isField3Present()) {
    System.Console.WriteLine(seq.Field3);
}
...
```

1.1. Metadata and data type mappings

The library supported following Java/.NET types and annotations/attributes:

ASN1 type	Java	.NET	Metadata must be specified	Metadata (annotation / attribute)	Constraints supports	Definition Examples
INTEGER	Integer Long	int long	no	ASN1Integer (@ASN1Integer for Java, [ASN1Integer] for .NET)	ASN1ValueRangeConstraint	1. int value; // .net 2. Integer value; // java 3. // Java with annotation @ASN1Integer(name="fieldName") private Integer value; // field declaration public int getValue() { return this.value}; public void setValue(int param) { this.value = param}; 4. // .NET with constraints attribute @ASN1Integer(name="fieldName") [ASN1ValueRangeConstraint(Min = 120, Max = 1000)] public int Value { ... }; // Property
REAL	Double	Double	no	ASN1Real	-	1. Double value; // java 2. double value; // .net 3. // .net with attributes [ASN1Real name="fieldName"] public double Value { ... }; // property
PrintableString UTF8String TeletexString VideotexString IA5String VisibleString GeneralString UniversalString NumericString BMPString	String	string	No, by default is expected Printable String	ASN1String	ASN1SizeConstraint	1. String value; // java 2. // .net [ASN1String name="fieldName" stringType=UniversalTags.UTF8String] public string Value { ... }; // property
BOOLEAN	Boolean	bool	No	ASN1	-	
SEQUENCE	class ...	class ...	Yes	ASN1Sequence	-	See to 4.1 for example
CHOICE	class ...	class ...	Yes	ASN1Choice	-	See to 4.1 for example
SEQUENCE OF	Collection<...>	ICollection<...>	Yes	ASN1SequenceOf	ASN1SizeConstraint	1. // Java @ASN1SequenceOf private Collection<String> myCollection;

ASN1 type	Java	.NET	Metadata must be specified	Metadata (annotation / attribute)	Constraints supports	Definition Examples
						2. // .NET @ASN1SequenceOf public ICollection<String> myCollection { ... }; // property
ANY	byte[]	byte[]	Yes	ASN1Any	-	-
OCTET STRING	byte[]	byte[]	No	ASN1OctetString	-	-
ENUMERATED	class with Enum	class with Enum	Yes	ASN1Enum	-	-
BITSTRING	special class org.bn.types.BitString	special class org.bn.types.BitString	No	ASN1BitString	ASN1SizeConstraints	-
OBJECT IDENTIFIER	special class org.bn.types.ObjectIdIdentifier	special class org.bn.types.ObjectIdIdentifier	No	ASN1ObjectIdentifier	-	-

1.2. Prepared elements (High performed encoding mode)

The annotations/attributes have performance problems for a critical processes. The version 1.4 and later presents a new feature – Prepared Elements.

The BNCompiler now for generated files has some static declarations for increase performance. If you aren't using BNCompiler and coding your classes manually, you can use the following declaration for increase performance (example for .NET):

```
[ASN1PreparedElement]
[...]
```

```
class MyClass : IASN1PreparedElement {
    public void initWithDefaults() {
        // initialization object with default values when decoding
    }

    ...

    // Creating static class metainformation
    private static IASN1PreparedElementData preparedData =
        CoderFactory.GetInstance().newPreparedElementData(typeof(MyClass));

    public IASN1PreparedElementData PreparedData {
        get { return preparedData; }
    }
}
```

1. License

-- License --

* The BinaryNotes version 1.5.3 or greater licensed under Apache Licence v2

<http://www.apache.org/licenses/LICENSE-2.0.html>

(Older versions were licensed under LGPL/GPL)

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<http://bnotes.sourceforge.net>

-- 3rd-party licenses --

* The BinaryNotes compiler uses JAXB Reference implementation (<http://jaxb.dev.java.net>) licensed under COMMON DEVELOPMENT AND DISTRIBUTION LICENSE (CDDL) Version 1.0 (see to licenses\3rdparty\cddl.txt for details)

* The BinaryNotesMQ uses HSQLDB implementation as default, but it's optionally, and maybe changed by another developer to another SQL DB.

Web site: <http://www.hsqldb.org>

Licensed under own license terms:

See to licenses\3rdparty\hsqldb_lic.txt and licenses\3rdparty\hypersonic_lic.txt.

* BinaryNotes uses JUnit for Java (only for Unit-tests, doesn't used in runtime).

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(<http://www.opensource.org/licenses/cpl.php>)

* BinaryNotes uses CSUnit for .NET (only for Unit-tests, doesn't used in runtime)

Licensed under own license

See to licenses\3rdparty\csunit_license.txt

* The BinaryNotesMQ uses ADO.NET 2.0 Provider for SQLite implementation as default, but it's optionally, and maybe changed by to another SQL DB.

Web site: <http://sqlite.phxsoftware.com/>

There are zero licensing restrictions for private or commercial use.

* The first version of the ASN.1 grammar was based upon the one posted by Vivek Gupta Tue Nov 11, 2003 14:29 on the ANTLR site. (ASN1_grammar.zip)

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