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Data Format Description Language (DFDL)

DFDL 1.0 – Proposed Recommendation

Steve Hanson, IBM (smh@uk.ibm.com)

Admin

- DFDL WG co-chairs:
  - Steve Hanson, IBM UK
  - Mike Beckerle, Oco Inc
- Two note takers please
- Sign the attendance sheet
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Agenda

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- Why DFDL?
  - The problem it solves
- What is DFDL?
  - Quick overview for newbies
- DFDL 1.0 status
  - Specification & implementations

- Backup: DFDL Language

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Why DFDL?

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- Much of the data in the world
  - Resides in files
  - Is not XML
  - Is a mixture of textual and binary
  - Has custom syntax and encodings
  - Does not have a shareable description

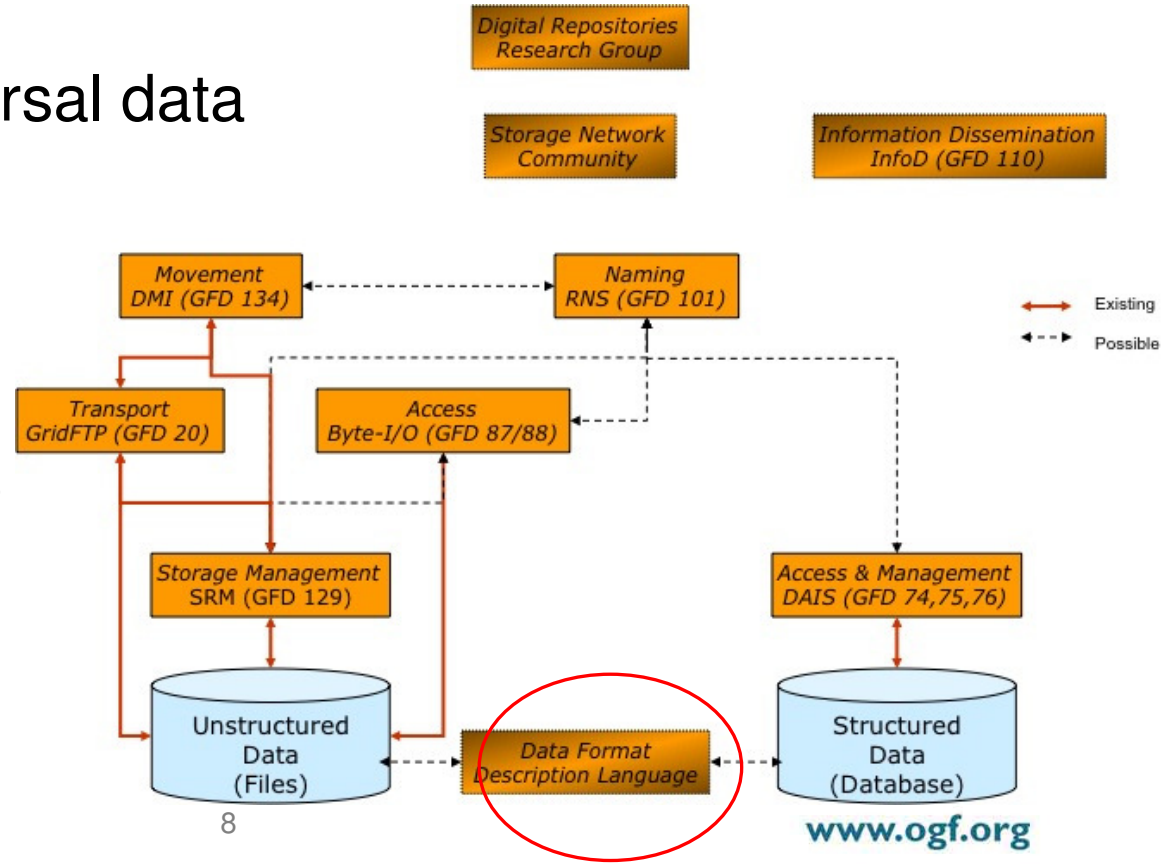
- Existing standards are not flexible enough
  - Prescriptive: “Put your data in this format!”
  - Textual – XML, JSON, EDI
  - Binary – ASN.1, XDR, EBML, …
  - You use the defined encodings, syntax, …
  - But descriptions are shareable

✓ **DFDL:** a universal, shareable, description for any data format

Grids and DFDL

- Grids are about big-data and big-computation problems
  - Simplistic solutions like “use XML” won’t cut it!
  - Performance and space usage

- Grids are about universal data interchange
  - XML
    - use XML Schema
  - Relational
    - use RDBMS schema
  - Other
    - ✓ use **DFDL Schema**



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What is DFDL?

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1. A way of *describing* data…
   - It is NOT a data format itself!
2. That can describe any data format…
   - Textual and binary
   - Commercial and scientific
   - Modern and legacy
   - Fixed length and delimited
3. While allowing high performance…
   - Choose the right data format for the job
   - High density, optimized I/O, random access
   - No need to use DFDL libraries

Benefits of DFDL

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1. Data format independent
2. Prescriptive standards not always best for job
3. Descriptions can be shared
4. Interoperability
5. Allows after-the-event description
6. Supports move to SOA
7. Spans commercial and scientific worlds
8. Supports grid and cloud computing

DFDL Goals

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- Build on existing standards
  - Leverage XML technology and concepts
- Support very efficient parsers/serializers
- Support round-tripping
  - Read and write data in described format from same description
- Keep simple cases simple
  - Simple descriptions should be "human readable"
- Generality
  - Can describe any data format
  - Allow extensions for new data formats

XML Synergy

- Use XML Schema subset & type system to describe the ***logical*** format of the data
- Use annotations within the XSD to describe the ***physical*** representation of the data
- Use XPath when referencing fields within the data

- Same approach actively used today:
  - IBM WebSphere Message Broker
  - Microsoft BizTalk flat file
  - Others

What DFDL is Not: FAQ

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- I have a pre-defined XML Schema.
- Q: Can I use DFDL to populate it from a non-XML data file?

- A: Only partly:
  - DFDL is focused on data *format*
  - DFDL does *not* provide general data transformation
  - Populating a pre-defined XML Schema involves two separate problems:
    1. Using DFDL to describe the data file format
    2. Using a transformation system to transform that to conform to the pre-defined schema (not DFDL's job)

DFDL is only about Format !

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- The structure of the DFDL schema is dictated by the logical structure of the data

- You must work bottom up.
- Start from the data format, not from what you want to turn it into.

DFDL Features

Release 1.0:

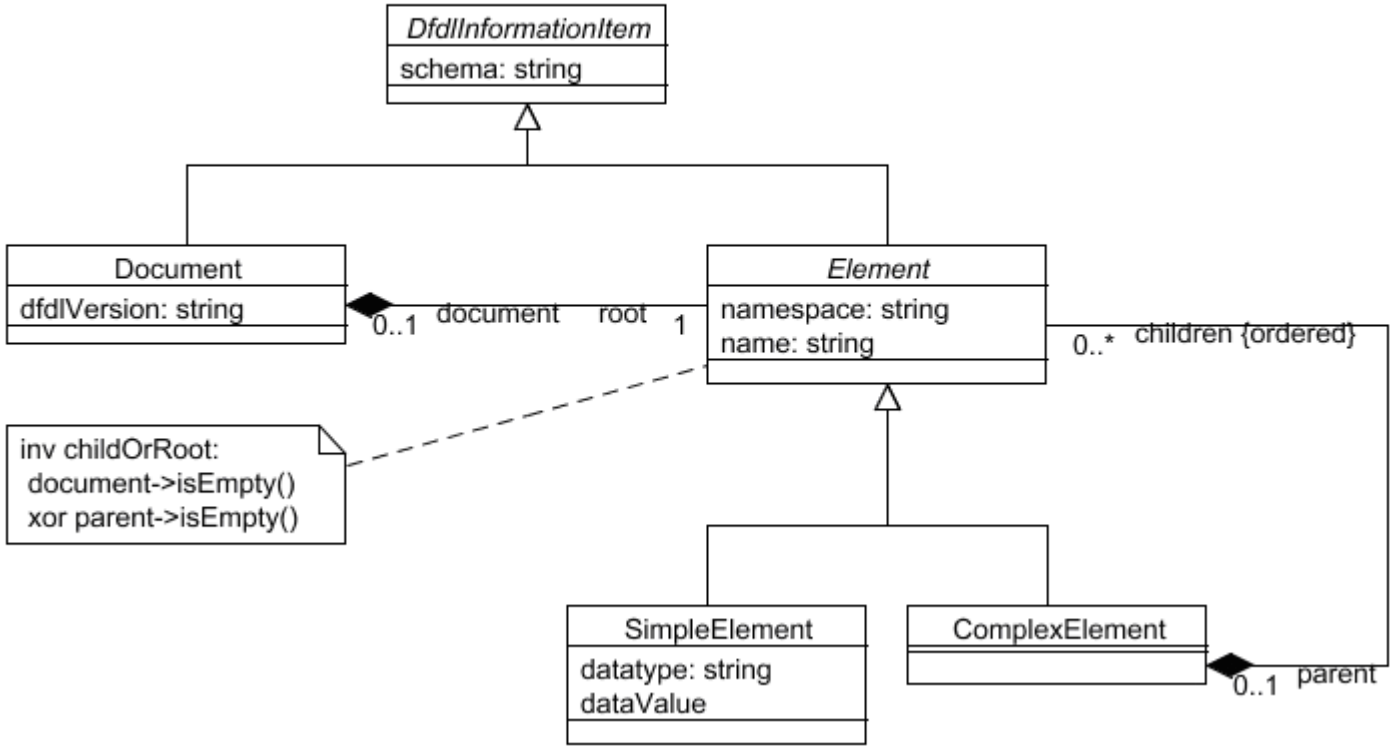
- Subset of XML Schema 1.0
- Rich textual & binary data capabilities including bit support
- Scoping rules that govern how the annotations apply
- Validated input and output - from XML Schema
- Defaults - for missing values
- ‘Nil’ capability - for out-of-band values
- Reference – use of a previously read value in subsequent expressions
- Expression language including variables
- Uncertainty – stratagems to resolve choices, optionality
- Arrays – one dimension
- Very general parsing/writing capability

Future:

- Multi-layer – intermediate representation not exposed in final result
- Extensibility – new type/transform specification
- Arrays - multi-dimension

DFDL Information Set

- An abstract data set defining the content that must be provided
  - To an application by a DFDL parser
  - To a DFDL unparser by an application
- Similar to XML Data Model (XDM)



DFDL Specification Conformance

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- We want to make it easier to create conforming DFDL processors

- To assist, the specification allows omission of:
  1. DFDL serializer
  2. Optional features

- Three levels of conformance for a DFDL processor with respect to optional features:
  - Minimal
  - Extended
  - Full

Example: Binary Data

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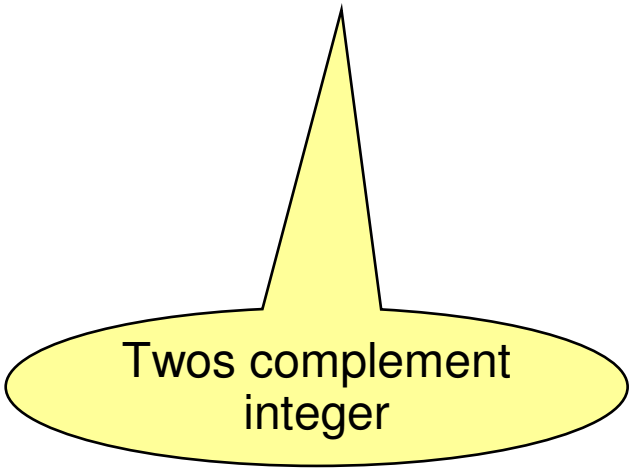
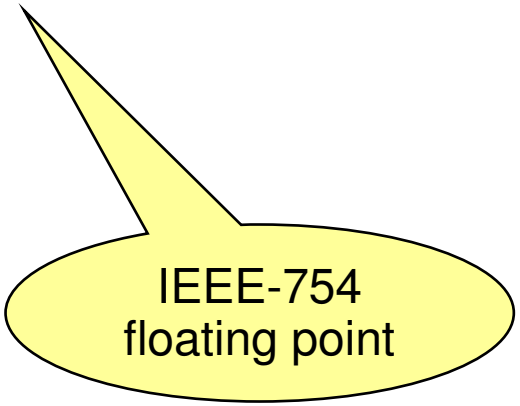
```
0000 0005 ce29 46f6
```





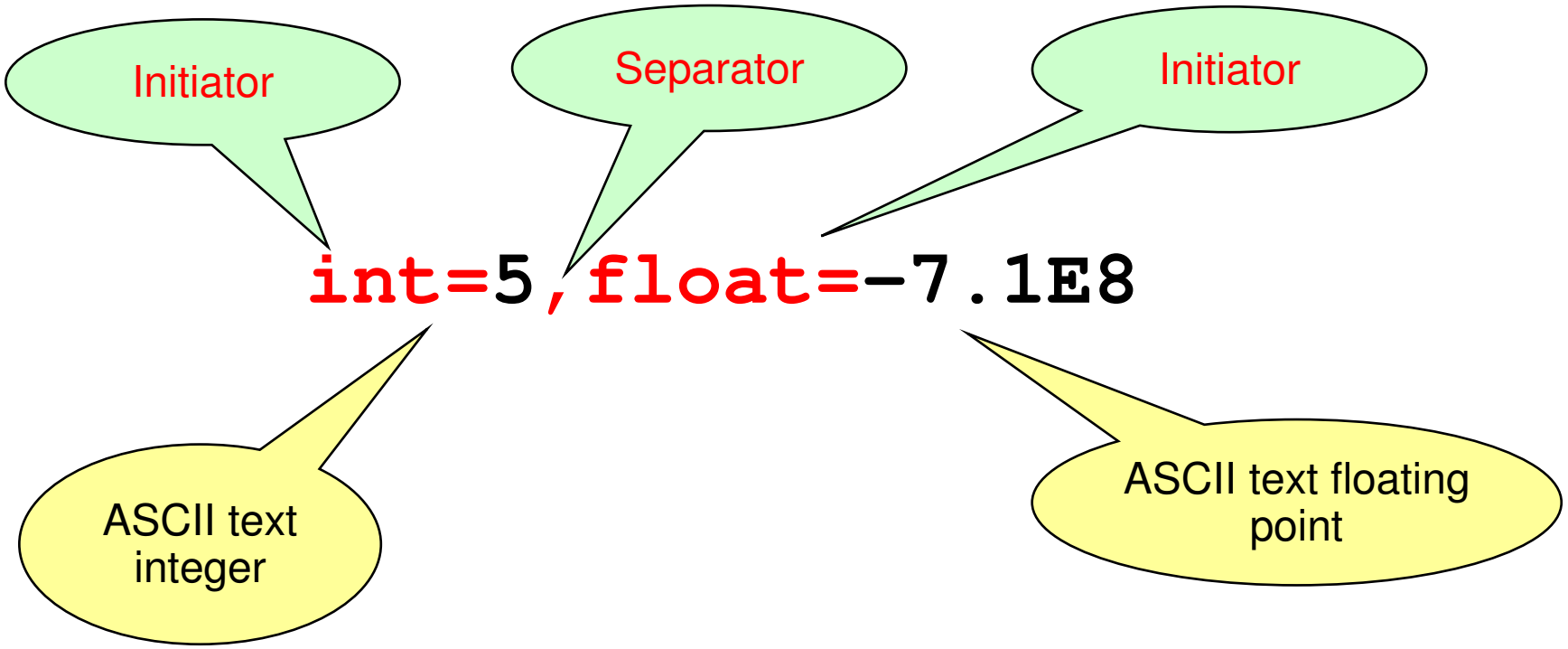
Example DFDL: Binary Data

```
<xs:complexType name="myBinary">
  <xs:sequence>
    <xs:element name="myInt" type="xs:int">
      <xs:annotation>
        <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
          <dfdl:element representation="binary"
              binaryNumberRep="binary" byteOrder="bigEndian"
              lengthKind="explicit" length="4"/>
        </xs:appinfo>
      </xs:annotation>
    </xs:element>
    <xs:element name="myFloat" type="xs:float">
      <xs:annotation>
        <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
          <dfdl:element representation="binary"
              binaryFloatRep="ieee" byteOrder="bigEndian"
              lengthKind="explicit" length="4"/>
        </xs:appinfo>
      </xs:annotation>
    </xs:element>
  </xs:sequence>
</xs:complexType>
```

DFDL annotation

DFDL properties

Example: Textual Data



Separators, initiators, terminators are all examples in DFDL of *delimiters*

Example DFDL: Textual Data

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```
<xs:complexType name="myText">
  <xs:sequence>
    <xs:annotation>
      <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
        <dfdl:sequence separator="," encoding="ascii"/>
      </xs:appinfo>
    </xs:annotation>
    <xs:element name="myInt" type="xs:int">
      <xs:annotation>
        <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
          <dfdl:element representation="text"
             textNumberRep="standard" encoding="ascii"
             lengthKind="delimited" initiator="int=" …/>
        </xs:appinfo>
      </xs:annotation>
    </xs:element>
    <xs:element name="myFloat" type="xs:float">
      <xs:annotation>
        <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
          <dfdl:element representation="text"
             textNumberRep="standard" encoding="ascii"
             lengthKind="delimited" initiator="float=" …/>
        </xs:appinfo>
      </xs:annotation>
    </xs:element>
  </xs:sequence>
</xs:complexType>
```

Example DFDL: Short Form


```
<xs:complexType name="myText">
  <xs:sequence dfdl:separator="," dfdl:encoding="ascii" >
    <xs:element name="myInt" type="xs:int"
                dfdl:representation="text"
                dfdl:textNumberRep="standard" dfdl:encoding="ascii"
                dfdl:lengthKind="delimited" dfdl:initiator="int=" … />
    <xs:element name="myFloat" type="xs:float"
               dfdl:representation="text"
                dfdl:textNumberRep="standard" dfdl:encoding="ascii"
                dfdl:lengthKind="delimited" dfdl:initiator="float=" … />
  </xs:sequence>
</xs:complexType>
```

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History

- 2003: Initial DFDL proposal at GGF9
- 2004: XML Schema based approach
- 2004: IBM joins WG at GGF12
- 2004: Prototypes started
- 2007: Progress report at OGF 20
- 2008: Progress report at OGF 21
- 2009: Full-time author
- 2009: IBM implementation started
- 2010: Present specification at OGF 28 & 29
- 2010: OGF Public Comment phase
- 2010: NCSA implementation
- *2010: OGF Proposed Recommendation*

Status

- Spec is currently at draft 044
  - https://forge.gridforum.org/sf/go/doc16073?nav=1
- Process
  - ✓ Editor & AD review
  - ✓ Standards Council review
  - ✓ Public Comment stage
  - ✓ Respond to comments
  - ✓ Standards Council review ***← we are here***
  - *Final Editor review*
  - *Proposed Recommendation*

Public Comment Stage Updates

- Optional features and Minimal, Extended and Full conformance
- Changes to some property names
- Limitations on forward references
- Fixed length choices
- Rewrite of ‘nils and defaults’ section
- Properties nilIndicatorPath/Index dropped
- Packed and BCD representations may be delimited
- Leading/Trailing skip region may be specified in bits or bytes
- Alignment units unrestricted
- New DFDL functions for test/set bits
- Clarification of schema definition error scenarios
- Formally add PrefixLength region to grammar and list constraints
- Allow UTF-16 encoding to be fixed or variable width
- Revise assert and discriminator syntax and behaviour
- Assert and discriminator can use regular expressions
- Assert and discriminator can use schema facets
- Formalize regular expression language to be Java or Perl
- Simplify syntax for hidden elements
- More rounding options for text decimals
- Calculated values only apply to simple elements

Optional Features

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Feature	Detection
Validation	External switch
Simple type restrictions	xs:simpleType in xsd
Nils	xs:nillable='yes' in xsd
Defaults	xs:default or xs:fixed in xsd
Bi-Directional text.	dfdl:textBiDi='yes'
Lengths in Bits	dfdl:alignmentUnits='bits' or dfdl:lengthUnits='bits'
Delimited lengths and representation binary	dfdl:representation='binary' (or implied) and dfdl:lengthKind='delimited'
Regular expressions	dfdl:lengthKind='pattern', dfdl:assert testkind 'pattern', dfdl:discriminator testkind 'pattern'
Zoned numbers	dfdl:textNumberRep='zoned'
Packed numbers	dfdl:binaryNumberRep='packed'
Packed calendars	dfdl:binaryCalendarRep='packed'
S/390 floats	dfdl:binaryFloatRep='ibm390Hex'
Unordered sequences	dfdl:sequenceKind='unordered'
Floating elements	dfdl:floating='yes'

Feature	Detection
DFDL functions in expression language	dfdl: functions in expression
Hidden groups	dfdl:hiddenRef <> ''
Calculated values	dfdl:inputValueCalc <> '' or dfdl:outputValueCalc <> ''
Escape schemes	dfd:defineEscapeScheme in xsd
Extended encodings	Any dfdl:encoding value beyond the core list
Asserts annotations	dfdl:assert in xsd
Discriminators annotations	dfdl:discriminator in xsd
Prefixed lengths	dfdl:lengthKind='prefixed'
Variables	dfdl:defineVariable, dfdl:newVariableInstances, dfdl:setVariable Variables in DFDL expression language

Implementations

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- Early prototypes (out of date)
  - PNNL/NCSA ‘Defuddle’
    - http://defuddle.pnl.gov/
  - IBM ‘Virtual XML Garden’
    - http://www.alphaworks.ibm.com/tech/virtualxml
- 1.0 specification
  - IBM DFDL
    - Internal IBM implementation at the moment
    - Full conformance, parser & serializer
    - Intend to make test cases public
  - NCSA ‘Daffodil’
    - Extended conformance, parser only
    - Possible reference implementation ?

NCSA 'Daffodil'

- Implemented at the National Center for Supercomputing Applications, at the University of Illinois, Urbana-Champaign, USA
- 'Daffodil v1' will be released this year as open source
- For more information, please see:
  Rodriguez, Alejandro and Robert E. McGrath, *Daffodil: A New DFDL Parser. NCSA, 2010.*
  http://cet.ncsa.illinois.edu/publications/Daffodil-ANewDFDLParser.pdf
- Thanks for substantial support from the U.S. National Archives and Records Administration (NARA)

This work was supported through National Science Foundation Cooperative Agreement NSF OCI 05-25308 and Cooperative Support Agreements NSF OCI 04-38712 and NSF OCI 05- 04064by the National Archives and Records Administration.

NCSA 'Daffodil'

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- Built using SCALA v2.8
  - Functional language that compiles to Java byte code
- DFDL parser generator
  - Takes a DFDL schema
  - Generates a DFDL parser
- Parser creates a DOM tree
  - Implemented in JDOM
- Implements 90% of specification
  - Extended conformance, no serializer

Tutorial

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- Easier, non-normative way to learn DFDL
  - Same idea as XML Schema 1.0 Primer
- Divided into example-based Lessons so you can learn at your own pace
  - Lesson 1: Introduction
  - Lesson 2: Language Basics
  - Lesson 3: DFDL Properties
  - …
- Drafts available for Lessons 1 to 3

Next Steps

- Working Group meetings will continue, as there is still work to do!
  - Create OGF hosted web pages
  - Complete Tutorial
  - Make ‘Daffodil’ into freely available reference implementation
  - Define certification process
- Contributions welcome!
  - Join the mailing list
    - http://www.ogf.org/mailman/listinfo/dfdl-wg
  - Attend the Wednesday phone conferences

Questions?

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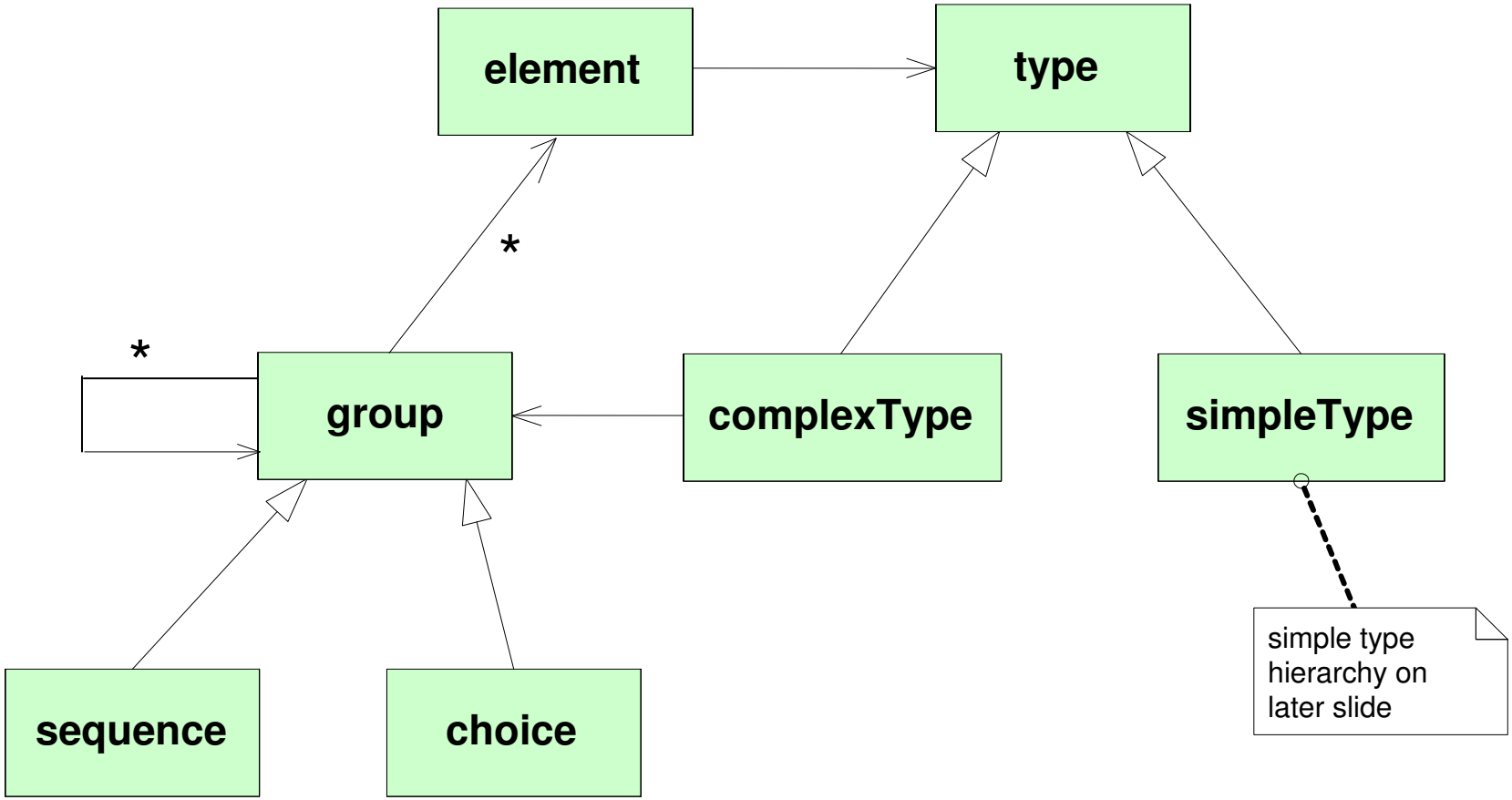
DFDL Schema Component Model



DFDL Schema Component Model

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- Simple Types
  - Represent data values
- Complex Types
  - Represent structures
- Elements
  - Represent named fields
  - Can be data fields or structural fields
  - Can repeat (arrays)
- Sequence groups
  - Structures where the children occur in order
- Choice groups
  - Structures where just one of the children occurs (eg: C union, COBOL redefines)

XML Schema 1.0 - Subset

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- Namespace management
- xs:import/xs:include file management
- Local and global xs:element declarations
  - Optional dimensionality via maxOccurs and minOccurs
  - Optional default value
  - Optional nillable attribute (nil value support)
- Local and global xs:complexType definitions
- Most built-in xs:simpleTypes – see later slide
- Local and global user-defined xs:simpleTypes by derivation
- Local and global xs:sequence groups (no dimensionality)
- Local and global xs:choice groups (no dimensionality)
- xs:appinfo annotations to carry the DFDL information

XML Schema 1.0 – Not Used

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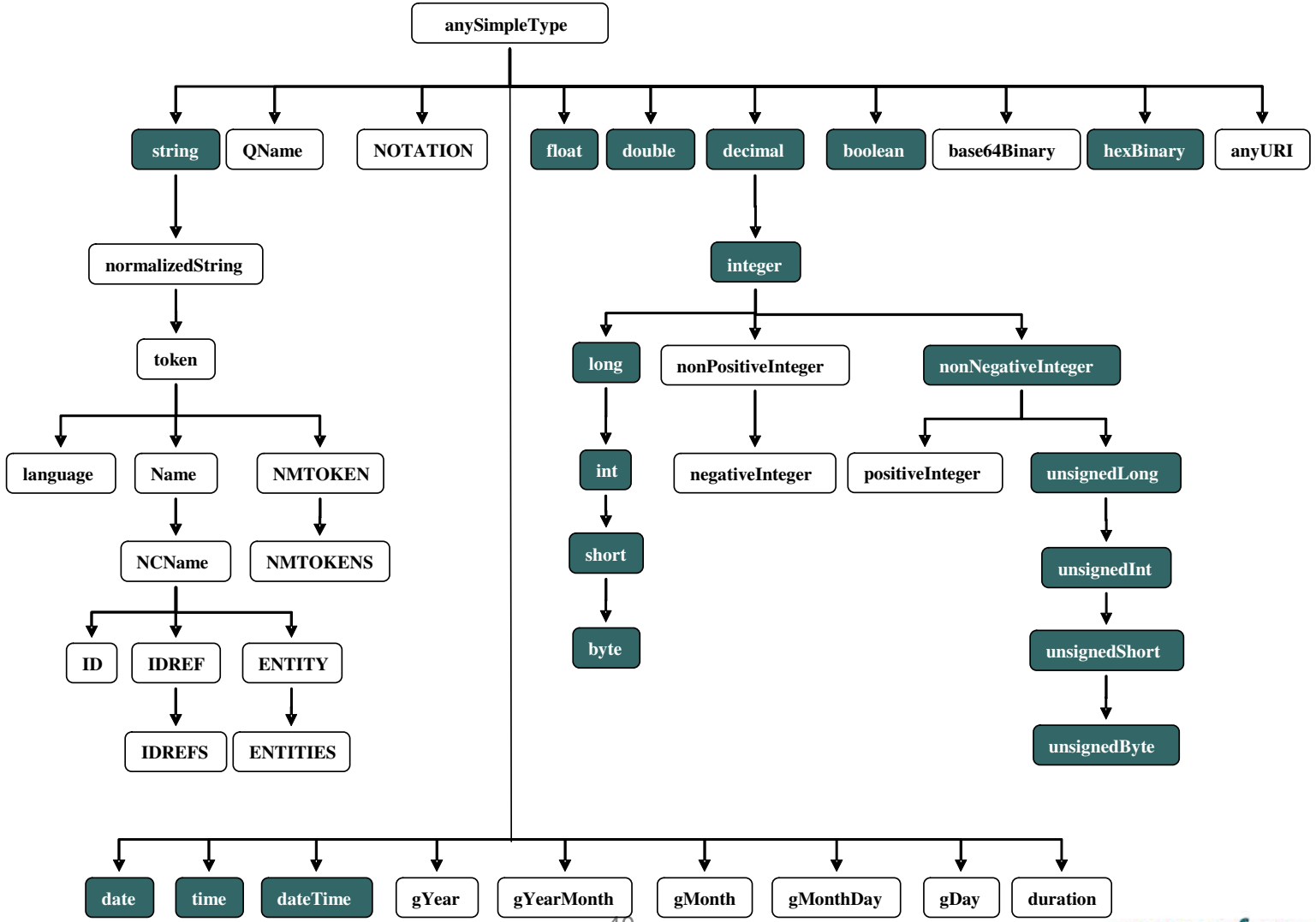
- Local and global xs:attribute declarations
- xs:attribute groups
- xs:complexType derivations or with simple/mixed content
- xs:union simple types (except for one specific case)
- xs:list simple types
- Built-in xs:simpleTypes specific to XML or otherwise superfluous
- Dimensionality on xs:sequence and xs:choice
- Identity Constraints
- Substitution Groups
- xs:redefine file management
- Local and global xs:all groups
- xs:any (wildcards)
- Recursion

Supported Simple Types



DFDL Annotations (1/2)

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Annotation	*Used on Component*	*Purpose*
dfdl:element	xs:element xs:element reference	Contains the DFDL properties of an xs:element and xs:element reference
dfdl:choice	xs:choice	Contains the DFDL properties of an xs:choice.
dfdl:sequence	xs:sequence	Contains the DFDL properties of an xs:sequence.
dfdl:group	xs:group reference	Contains the DFDL properties of an xs:group reference to a group definition containing an xs:sequence or xs:choice.
dfdl:simpleType	xs:simpleType	Contains the DFDL properties of an xs:simpleType
dfdl:format	xs:schema dfdl:defineFormat	Contains a set of DFDL properties that can be used by multiple DFDL schema components. When used directly on xs:schema, the property values act as defaults for all components in the DFDL schema.
dfdl:defineFormat	xs:schema	Defines a reusable data format by associating a name with a set of DFDL properties contained within a child dfdl:format annotation. The name can be referenced from DFDL annotations on multiple DFDL schema components, using dfdl:ref.

DFDL Annotations (2/2)

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Annotation	*Used on Component*	*Purpose*
dfdl:assert	xs:element, xs:choice xs:sequence, xs:group	Defines a test to be used to ensure the data are well formed. Used only when parsing data.
dfdl:discriminator	xs:element, xs:choice xs:sequence, xs:group	Defines a test to be used when resolving a point of uncertainty such as choice branches or optional elements. Used only when parsing.
dfdl:escapeScheme	dfdl:defineEscape Scheme	Defines a scheme by which quotation marks and escape characters can be specified. This is for use with delimited text formats.
dfdl:defineEscape Scheme	xs:schema	Defines a named, reusable escape scheme. The name can be referenced from DFDL annotations on multiple DFDL schema components.
dfdl:defineVariable	xs:schema	Defines a variable that can be referenced elsewhere. This can be used to communicate a parameter from one part of processing to another part.
dfdl:newVariable Instance	xs:element, xs:choice xs:sequence, xs:group	Creates a new instance of a variable
dfdl:setVariable	xs:element, xs:choice xs:sequence, xs:group	Sets the value of a variable whose declaration is in scope

DFDL Properties

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- Properties on DFDL annotations may be one or more of the following types:
  1. DFDL string literal
     - Can include DFDL entities for special character(s)
  2. DFDL expression
     - XPath to other parts of the data
     - Can use DFDL variables
  3. Regular expression
  4. Enumeration
  5. Logical value
  6. QName
- Some properties can have alternative values
  - Use a space separated list
- Note: DFDL properties do not have defaults!

Properties – 'Attribute' Form


```
<xs:sequence>
  <xs:annotation>
    <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
      <dfdl:sequence separator=“,” encoding=“ascii”/>
     </xs:appinfo>
  </xs:annotation>
</xs:sequence>

<xs:element name="z" type=“xs:float">
  <xs:annotation>
    <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
      <dfdl:element representation="text"
          textNumberRep="standard" encoding="ascii"
          lengthKind="delimited" initiator="float=" …/>
  </xs:appinfo>
 </xs:annotation>
</xs:element>
```

Alternative 'Element' Form:

```
<dfdl:property name=“encoding”>ascii</dfdl:property>
```

Properties – 'Short' Form

```
<xs:sequence dfdl:separator=“,” dfdl:encoding=“ascii”/>

<xs:element name="z" type=“xs:float“
            dfdl:representation="text"
            dfdl:textNumberRep="standard"
            dfdl:encoding="ascii"
            dfdl:lengthKind="delimited"
            dfdl:initiator="float=" … />
```

Non-native attribute syntax,
easy for users to write

Properties - Scoping

```
<xs:sequence dfdl:separator=","
             dfdl:encoding="ebcdic-cp-us">
      <xs:element name="s" type="xs:string"/>
      <xs:element name="m" type="myType"/>
</xs:sequence>

<xs:complexType name="myType">
   <xs:sequence>
      …
   </xs:sequence>
</xs:complexType>
```

- Are the elements of the sequence in EBCDIC, or just the separators? (“lexical scoping”)
- Are the contents of type ‘myType' affected by the sequence’s properties or not? (“referential transparency”)

Properties - Scoping Rules

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- A DFDL property declared in a dfdl:format annotation on the xs:schema itself applies globally to **all** components declared in the schema.
- A local DFDL property declared in a component annotation overrides one obtained from a referenced dfdl:defineFormat annotation via dfdl:ref.
- A local DFDL property declared in a component annotation or obtained via dfdl:ref:
  - applies to that component only
  - does **not** apply to any child components
  - overrides any value from a dfdl:format on the xs:schema
- Algorithm specified for combining properties declared on:
  - xs:simpleType restriction and base xs:simpleType
  - xs:element and referenced xs:simpleType
  - xs:element ref and referenced global xs:element
  - xs:group ref and referenced xs:sequence or xs:choice

Scoping Example

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aaa,bbb,ccc

What encodings ?

```
<xs:schema>
  <xs:annotation>
    <xs:appinfo source="http://www.ogf.org/dfdl/" >
       <dfdl:format encoding="ascii" representation="text"
                    lengthKind="delimited" … />
    </xs:appinfo>
  </xs:annotation>

  <xs:annotation>
    <xs:appinfo source="http://www.ogf.org/dfdl/" >
       <dfdl:defineFormat name="myFormat" />
          <dfdl:format encoding="utf-8" … />
       </dfdl:defineFormat>
    </xs:appinfo>
  </xs:annotation>

  <xs:complexType>
    <xs:sequence dfdl:separator="," dfdl:ref="myFormat" >
       <xs:element name="a" type="xs:string" />
       <xs:element name="b" type="xs:string" dfdl:encoding="iso-8859-1" />
       <xs:element name="c" type="xs:string" dfdl:ref="myFormat"
                                             dfdl:encoding="iso-8859-1" />
     </xs:sequence>
   </xs:complexType>
</xs:schema>
```

Answers:
separator: utf-8
aaa: ascii
bbb: iso-8859-1
ccc: iso-8859-1

DFDL Data Syntax Grammar

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- Data in a format describable using a DFDL schema obeys the DFDL syntax grammar
- Data is divided into:
  - Content – used to compute logical values
  - Framing – delimiters, alignment, etc
- The specification organises DFDL properties according to the grammar productions.

Grammar - Productions

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Productions
Document = Element
Element = SimpleElement | ComplexElement SimpleElement = ElementLeftFraming SimpleContent RightFraming ComplexElement = ElementLeftFraming ComplexContent RightFraming LeftElementFraming = LeftFraming PrefixLength PrefixLength = SimpleContent
LeftFraming = LeadingAlignment ***Initiator*** RightFraming = ***Terminator*** TrailingAlignment LeadingAlignment = ***LeadingSkip AlignmentFill*** TrailingAlignment = ***TrailingSkip***
ComplexContent = Sequence | Choice SimpleContent = ***LeftPadding SimpleRepresentation RightPadOrFill***
Sequence = LeftFraming SequenceContent RightFraming SequenceContent = [***PrefixSeparator*** SequenceItem [***Separator*** SequenceItem]* ***PostfixSeparator***] ***FinalUnusedRegion*** SequenceItem = Element | Array | ComplexContent
Choice = LeftFraming ChoiceContent RightFraming ChoiceContent = [Element | Array | ComplexContent] ***FinalUnusedRegion***
Array = [Element [***Separator*** Element]* [***Separator*** StopValue]] StopValue = SimpleElement

Properties - Groupings

- Properties on DFDL annotations are organized according to the grammar productions:

1. Common to Content & Framing
   - encoding, byte order
2. Framing
   - alignment, initiator, terminator
   - length extraction ***(dfdl:lengthKind)***
3. Simple types
   - Number, Calendar, String, Opaque, Boolean
   - text, binary ***(dfdl:representation)***
   - further representation properties
   - nil value, default value
4. Sequences
   - separator, ordering, floating elements
5. Choices
6. Arrays
7. Calculated values

Controls how data values are extracted

Controls how data values are interpreted

Nils & Defaults

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- A *nil value* is used to handle 'out of band' values
- A *default value* is used when a required element is missing

- **Nil values**
  - Used on parsing and unparsing
  - Simple elements only, xs:nillable must be true
  - Nil value can be logical value, literal value or literal character
  - Specified by dfdl:nilKind & dfdl:nilValue properties

- **Default values**
  - Used on parsing and unparsing
  - For simple elements, xs:default or xs:fixed gives the value
    - Can also specify that nil value is to be used as default value
  - A complex element has a 'default' if all its required children have
    - Allows 'sparse' infosets to be supplied when unparsing
  - Definition of 'required':
    - Scalar (minOccurs=maxOccurs=1)
    - Array of fixed occurences
    - Array of variable occurrences and index <= minOccurs)

Calculated Values

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- Parsing
  - Sometimes you want to insert an item into the infoset that is not directly in the data
  - Example: create a simple infoset item from several other data values
  - Use dfdl:inputValueCalc="{ expr }"
  - Often used alongside 'hidden' elements
- Unparsing
  - Sometimes you want to set a data value where there is no corresponding infoset item
  - Example: a value that contains the length of another data value
  - Use dfdl:outputValueCalc="{ expr }"

Points of Uncertainty

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- A point of uncertainty occurs in the data stream when there is more than one schema component that might occur at that point.
- A point of uncertainty is caused when one of the following constructs is used in a DFDL schema:
  - xs:choice
  - Unordered xs:sequence (dfdl:sequenceKind="unordered")
  - xs:element which is optional (minOccurs="0", maxOccurs="1)"
  - xs:element is an array with a variable number of occurrences (minOccurs <> maxOccurs & maxOccurs>"1")
  - xs:sequence containing one or more "floating" elements

Resolving Points of Uncertainty

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- A DFDL parser is a recursive-descent parser with look ahead used to resolve points of uncertainty.
- The parser must speculatively attempt to parse data until a component is either ‘known to exist’ or ‘known not to exist’.
- Until that applies, the occurrence of a processing error causes the parser to suppress the error, back track and make another attempt.
- A component is ‘known to exist’ if either:
  - All the syntax and content of the component are successfully parsed and any dfdl:assert on the component evaluates to true.
  - A dfdl:discriminator on the component evaluates to true
  - The parent xs:sequence or xs:choice has dfdl:initiatedContent “Yes” and the initiator for the component is found
- Each point of uncertainty construct has its own rules.

DFDL Expressions

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- Can use a DFDL expression:
  - When a property value needs to be set dynamically at parse time from the contents of one or more elements of the data (eg, dfdl:separator, dfdl:length)
  - In a dfdl:assert annotation
  - In a dfdl:discriminator annotation to resolve uncertainty
  - In a dfdl:inputValueCalc property to derive the value of an element in the infoset that doesn't exist in the data
  - In a dfdl:outputValueCalc property to compute the value of an element on output
  - As the value in a dfdl:setVariable annotation or the defaultValue in a dfdl:defineVariable
- Eg: dfdl:length = "{ $mylen + 1 }"

Expression Language

- Subset of XPath 2.0
  - Only *if* and *path* expression types
  - Only *child*, *parent* and *self* axes
  - Predicates but only to index arrays
  - Subset of functions and operators
- Plus some extensions
  - Additional constructor functions
  - DFDL functions for representation lengths, property values, bit manipulation
- Variables
  - Use values of variables set up by dfdl:defineVariable, dfdl:newVariableInstance and dfdl:setVariable annotations
- Operates on *augmented* infoset so that hidden elements can be accessed

Expressions Example (1/2)

```
<xs:sequence>
  <xs:sequence
     dfdl:hiddenGroupref="hiddenpDate" />


  <xs:element name="d" type="xs:date">
    <xs:annotation><xs:appinfo source="http://www.ogf.org/dfdl/">
      <dfdl:element>
        <dfdl:property name="inputValueCalc">
         { fn:date(fn:concat(if (../pdate/yy gt 50) then "19" else "20",
                             if (../pdate/yy gt 9)
                                then fn:string(../pdate/yy)
                                else fn:concat("0", fn:string(../pdate/yy)),
                             "-",
                             fn:string(../pdate/mm),
                             "-",
                             fn:string(../pdate/dd)))
         }
        </dfdl:property>
      </dfdl:element>
    </xs:appinfo></xs:annotation>
  </xs:element>
</xs:sequence>
```

dfdl:hiddenGroupRef wraps complex "pDate" element that we don't want in the infoset

dfdl:inputValueCalc expression creates an xs:date from hidden "pDate"

Expressions Example (2/2)

```
<xs:group name="hiddenpDate">
   <xs:sequence>
     <xs:element name="pdate">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="mm" type="xs:byte"
               dfdl:lengthKind="explicit" dfdl:length="1"
               dfdl:representation="binary" dfdl:binaryNumberRep="binary"
               dfdl:outputValueCalc="{ fn:month-from-date(../d) }" />
            <xs:element name="dd" type="xs:byte"
               dfdl:lengthKind="explicit" dfdl:length="1"
               dfdl:representation="binary" dfdl:binaryNumberRep="binary"
               dfdl:outputValueCalc="{ fn:day-from-date(../d) }" />
            <xs:element name="yy" type="xs:byte"
               dfdl:lengthKind="explicit" dfdl:length="1"
               dfdl:representation="binary" dfdl:binaryNumberRep="binary"
               dfdl:outputValueCalc="{ fn:year-from-date(../d) idivmod 100 }"/>
          </xs:sequence>
        </xs:complexType>
     </xs:element>
  </xs:sequence>
</xs:group>
```

Complex “pDate” element models a date as 3 x 1 byte integers

dfdl:outputValueCalc expression gets the value from the “d” xs:date element

Questions?