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DFDL 1.0 – Specification and Implementation Update

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Admin

- DFDL-WG co-chairs:
  - Steve Hanson, IBM UK
  - Mike Beckerle, Tresys Technology
- Two note takers please
- Sign the attendance sheet
- Note: OGF Intellectual Property Rules apply

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Agenda

- DFDL Overview
- Specification Update
- Implementation: IBM DFDL
- Implementation: Daffodil
- Demonstration
- Next steps

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Why DFDL?

- Grids and clouds are about universal data interchange
- Most of the world's data is semi-structured text or binary data residing in files
- There has been no accepted standard for describing this text and binary data
  - XML -> use XML Schema
  - RDBMS -> use database schema
  - Other text/binary -> ??

Every data handling product in the marketplace has its own proprietary way of importing/accessing data and describing data format.

- Existing standards are not flexible enough
  - Prescriptive: "Put your data in this format!"
  - Examples: ASN.1, XDR, GPB, Thrift, Avro, …
  - You must use one of the defined encodings & syntax

✓ ***DFDL:*** *a universal, shareable, non-prescriptive, description for general text & binary data formats*

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Data Format Description Language (DFDL)

- An ***open*** standard from OGF
  - Version 1.0
  - 'Proposed Recommendation' status
- A way of ***describing*** data…
  - It is NOT a data format itself!
- A ***powerful*** modeling language …
  - Text, binary and bit
  - Commercial record-oriented
  - Scientific and numeric
  - Modern and legacy
  - Industry standards
- While allowing ***high performance*** …
  - You choose the right data format for the job

- Leverage ***XML Schema*** technology
  - Uses W3C XML Schema 1.0 subset & type system to describe the ***logical*** structure of the data
  - Uses XSDL annotations to describe the ***physical*** representation of the data
  - The result is a ***DFDL schema***
- Keep simple cases ***simple***
- Annotations are ***human readable***
- Both ***read and write***
  - A ***DFDL processor*** can parse and serialize data in described format from same DFDL schema
- ***Intelligent*** parsing
  - Automatically resolve choice and optionality
- ***Validation*** of data when parsing and serializing

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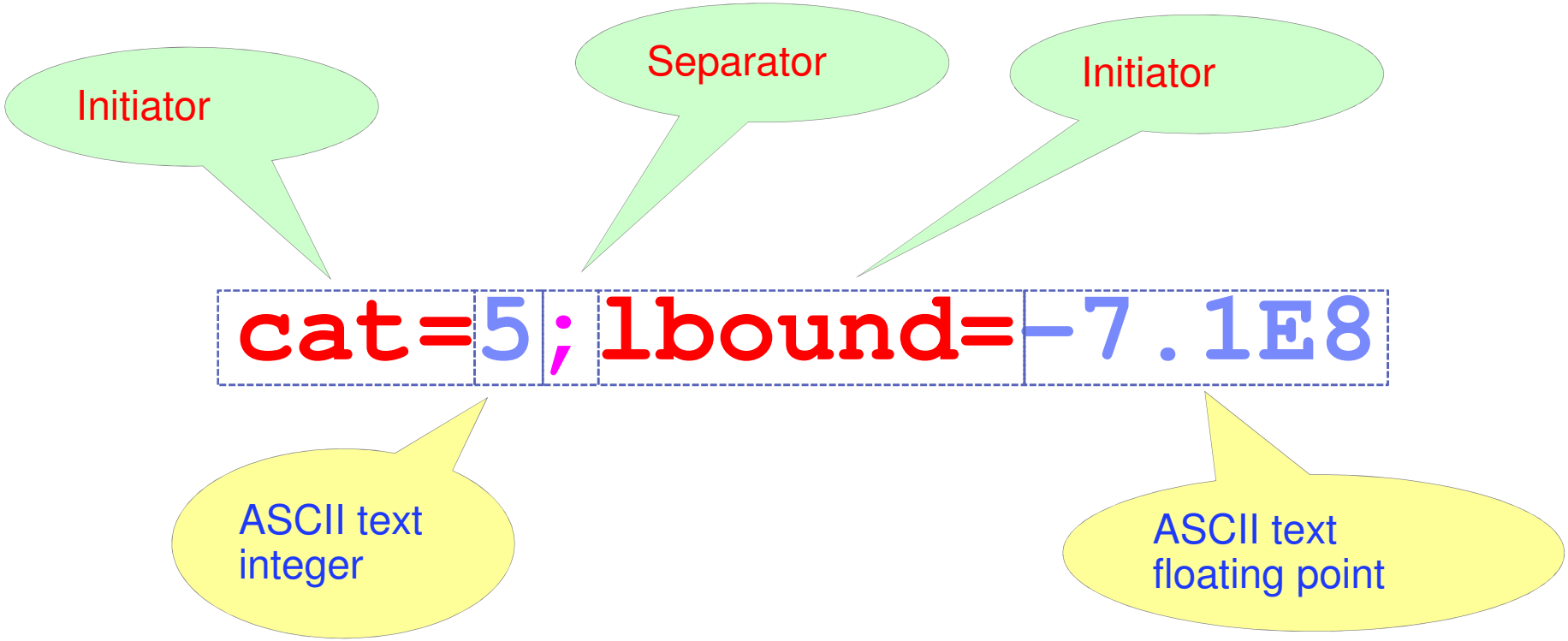
Example – Delimited Text Data



Separators, initiators (aka tags), & terminators are all examples in DFDL of *delimiters*

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Example – DFDL schema

```
intval=5;fltval=-7.1E8
```

```
<xs:complexType name="numbers">
  <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="category" type="xs:int">
      <xs:annotation>
        <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
           <dfdl:element representation="text"
             textNumberPattern="#0" encoding="ascii"
             lengthKind="delimited" initiator="cat=" .../>
       </xs:appinfo>
      </xs:annotation>
   </xs:element>
    <xs:element name="lowerBound" type="xs:float">
      <xs:annotation>
        <xs:appinfo source="http://www.ogf.org/dfdl/v1.0">
           <dfdl:element representation="text"
             textNumberPattern="#0.0#E0" encoding="ascii"
             lengthKind="delimited" initiator="lbound=" .../>
       </xs:appinfo>
      </xs:annotation>
    </xs:element>
  </xs:sequence>
</xs:complexType>
```

DFDL annotation

DFDL properties

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Example – DFDL schema (short form)

```
<xs:complexType name="numbers">
  <xs:sequence dfdl:separator=";" dfdl:encoding="ascii" ... >
    <xs:element name="category" type="xs:int"
                dfdl:representation="text"
                dfdl:textNumberPattern="#0" dfdl:encoding="ascii"
                dfdl:lengthKind="delimited" dfdl:initiator="cat=" ... />
     <xs:element name="lowerBound" type="xs:float"
                dfdl:representation="text"
                dfdl:textNumberPattern="#0.0#E0" dfdl:encoding="ascii"
                dfdl:lengthKind="delimited" dfdl:initiator="lbound=" ... />
</xs:sequence>
</xs:complexType>
```

DFDL properties

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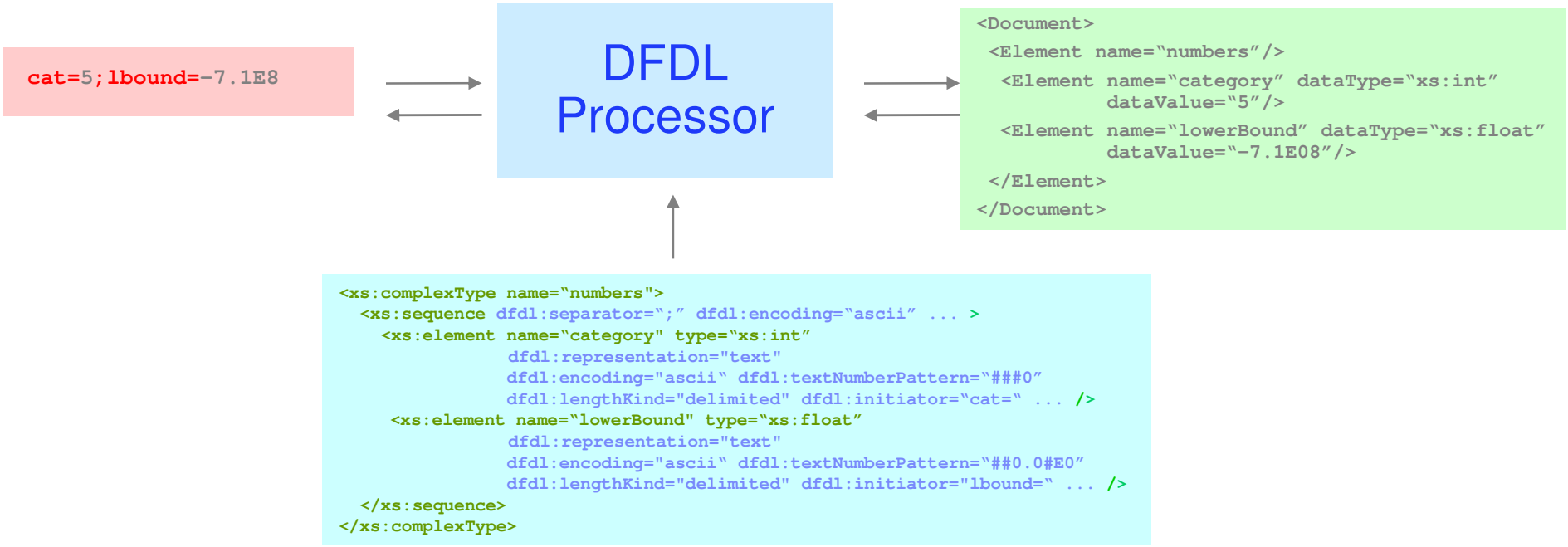
DFDL Processor

- A DFDL processor uses a DFDL schema to understand a data stream
- It consists of a DFDL parser and (optionally) a DFDL serializer
- The DFDL parser reads a data stream and creates a DFDL ‘infoset’
- The DFDL serializer takes a DFDL ‘infoset’ and writes a data stream



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DFDL 1.0 Features

- Text data types such as strings, numbers, zoned decimals, calendars, booleans
- Binary data types such as integers, floats, BCD, packed decimals, calendars, booleans
- Fixed length data and data delimited by text or binary markup
- Bi-directional text
- Bit data of arbitrary length
- Pattern languages for text numbers and calendars
- Ordered, unordered and floating content
- Default values on parsing and serializing
- Nil values for handling out-of-band data
- Fixed and variable arrays
- XPath 2.0 expression language including variables to model dynamic data
- Speculative parsing to resolve choices and optional content
- Validation to XML Schema 1.0 rules
- Scoping mechanism to allow common property values to be applied at multiple points
- Hide elements in the data
- Calculate element values

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When should I use DFDL?

- DFDL's sweet spot is when you need to model and parse a text or binary data format and where either:
  - You have a specification of the data format 'on the wire'
  - You have actual wire examples of the data format

- DFDL is recommended to model:
  - Binary data from COBOL, C, PL/1, ASM programs
  - Text data with delimiters such as CSV
  - Text industry standards such as SWIFT, HL7, EDIFACT, X12, …
  - Binary industry standards such as ISO8583, Tlog, PCAP, ...

- DFDL is not recommended to model:
  - XML
    - Already have XML parsers and XML Schema / DTDs
  - JSON
    - Already have JSON parsers, and JSON schema under design
  - GPB, HDF5, …
    - With serialization formats like GPB, the wire format is never exposed to the consumer and access to the data is using APIs

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Agenda

- DFDL Overview
- Specification Update
- Implementation: IBM DFDL
- Implementation: Daffodil
- Demonstration

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Status

- DFDL 1.0 spec is currently a *Proposed Recommendation*
  - GFD.174 P-REC published Feb 2011
  - GWD.207 P-REC public comment Sept 2013
- Progress towards *Recommendation*
  - Two implementations underway – IBM® DFDL & Daffodil
- Supplementary OGF publications
  - GFD.190 INFO Mapping between DFDL 1.0 Infoset and XDM
  - GFD.197 INFO Example set of DFDL 1.0 properties
  - GWD.xxx EXP #1 Errata for DFDL 1.0 Specification GFD-P-R.174
  - GWD.xxx EXP #2 Empty, Missing, Defaults, Arrays
  - GWD.xxx EXP #3 Bit Order
- Errata are tracked in GWD EXP #1 on Redmine and are incorporated into GWD.207

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Conformance

- DFDL 1.0 specification is not small! (nearly 200 pages)
- DFDL-WG want to make it easier to create conforming processors
- Conformance can be claimed separately for DFDL Parser & Unparser
- The features of DFDL are divided into Core and Optional
- A DFDL Parser, Unparser or Processor can claim to be:
  - Minimal
  - Extended
  - Full
- Example: A *Minimal DFDL Parser* implements just the parser and all Core features
- Example: An *Extended DFDL Processor* implements both parser and unparser, all Core features plus some Optional features
- Conformance test suite desirable (major undertaking)

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Tutorial

- 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
  1. Introduction
  2. Language Basics
  3. DFDL Properties
  4. Modeling Basic Structures
  5. Modeling Alternative Structures
  6. Modeling Optional and Repeating Data
  7. …
- Lessons 1 to 6 available on Redmine

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Web Community for DFDL Schemas

- Free public repository for DFDL models
- Hosted on GitHub
- Unlimited read-only access
- Evolving content
- Industry standard formats
- Collaboration encouraged

Getting Started with DFDL

developerWorks® Technical topics Evaluation software Community Events Search developerWorks

developerWorks > Technical topics > WebSphere > Technical library >

Get started with the Data Format Description Language

An open standard for data modeling

In this age of big data, the bulk of the data begging to be analyzed is not XML, but rather it is other structured and semi-structured formats, both text and binary. Until now, no open standard has been developed that is capable of describing a wide variety of such data formats. Learn about the Open Grid Forum (OGF) proposed recommendation for a powerful language that describes many different data formats, the Data Format Description Language (DFDL).

PDF (102 KB) | 1 Comment

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

02 December 2013

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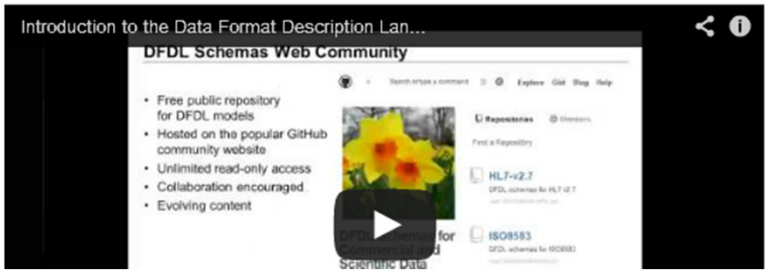
+ Table of contents

Introduction to DFDL

In this first video, Steve Hanson introduces you to the motivations and design goals for DFDL and shows you some of the key features of the specification. He also describes the features of the IBM DFDL component and discusses the open source implementation of DFDL called Daffodil. Finally, he gives you a quick guided tour of the IBM DFDL component in an example with IBM Integration Bus.

IBM Integration Bus for Developers

See the IBM DFDL component in action by downloading the "IBM Integration Bus for Developers."



http://www.ibm.com/developerworks/library/se-dfdl/

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- Designed as an embeddable component for IBM products including:
  - IBM Integration Bus v9
  - Rational® Test Workbench v8.0.1
  - InfoSphere® Master Data Management v11
  - Other IBM products will adopt
- DFDL processor
  - High performance parser and unparser
  - Java and C
  - Pre-compiles DFDL schema for performance
  - Parser emits SAX-like events
  - Streaming, on-demand, speculative
  - Compliance test suite (17000+) using .tdml files
- Tools for creating DFDL schema
  - Graphical DFDL schema editor
  - Wizards for CSV, COBOL & C
  - Graphical DFDL schema tester
  - Shipped as eclipse plugins

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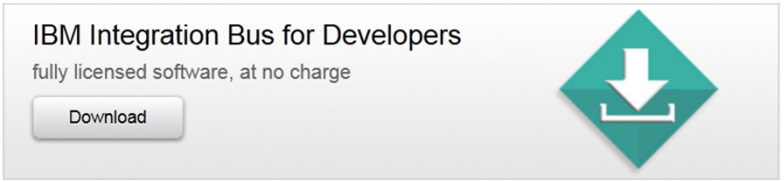
IBM DFDL - Status

- IBM DFDL implements about 85% of the OGF DFDL 1.0 specification
  - Support for rest will be added in future IBM DFDL releases
- Currently unsupported:
  - Bi-directional text
  - Floating elements
  - Hidden groups
  - Calculated values
  - Certain XPath functions
  - Arrays with stop values
  - Default values (parser)



- IBM DFDL implements many of the identified spec errata
- In production use by many IBM customers!
- Can I use it?
  - Yes. IBM DFDL Java parser & unparser can be unbundled from IBM Integration Bus and used in stand-alone applications
  - Free developer edition available
  - http://www-03.ibm.com/software/products/en/ibm-integration-bus/

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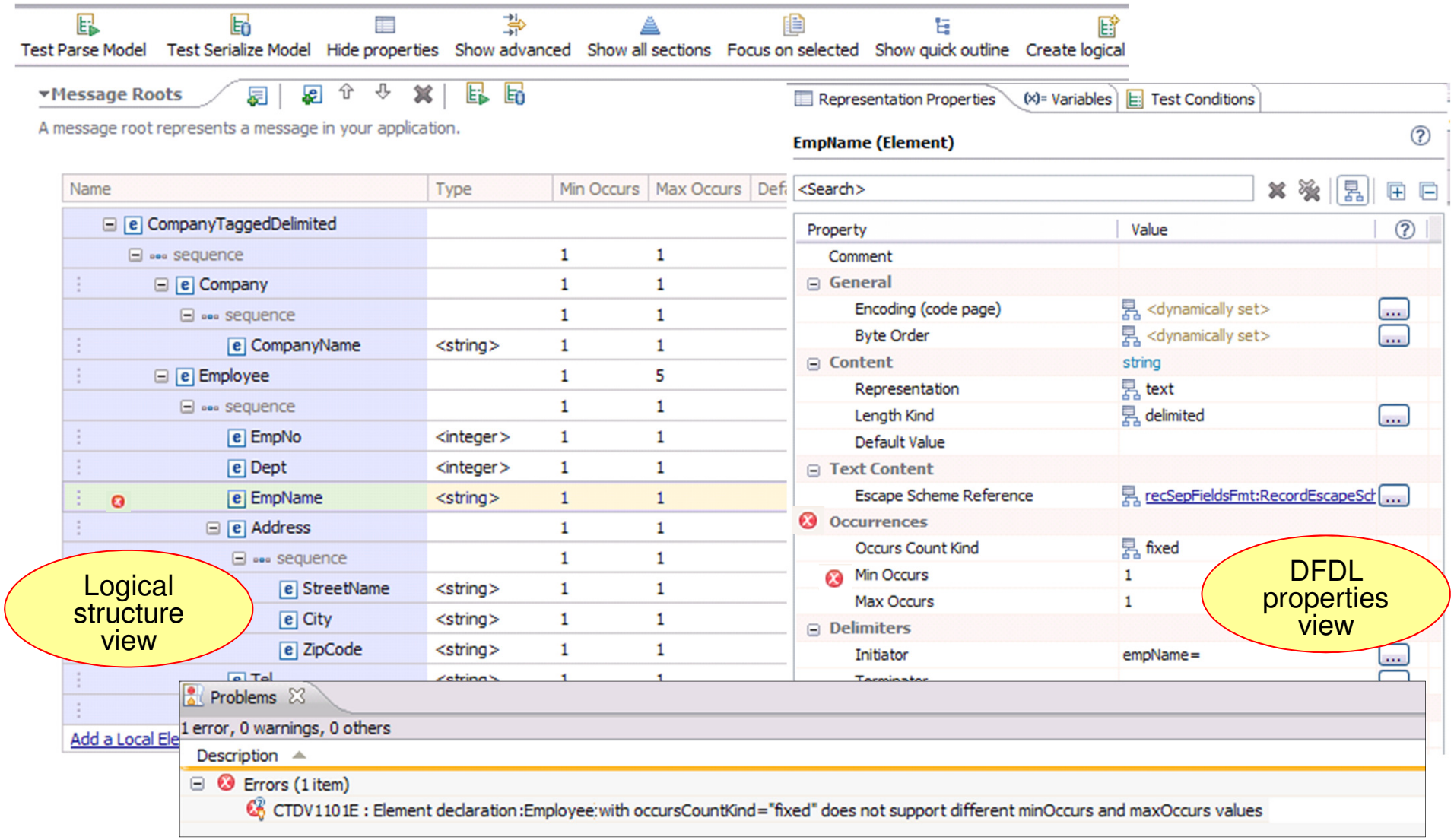
IBM DFDL Tools – Schema Editor



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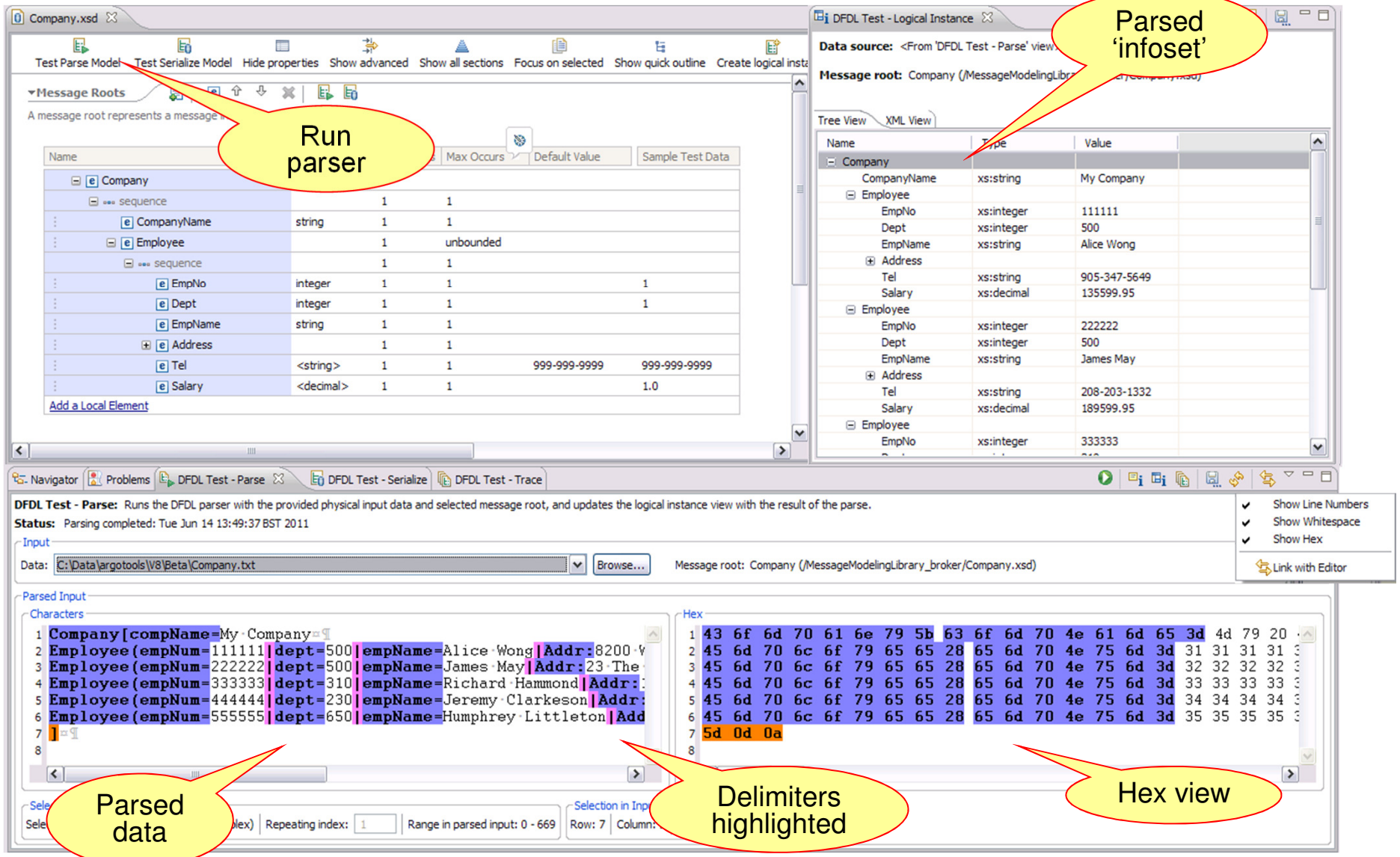
IBM DFDL Tools – Schema Tester



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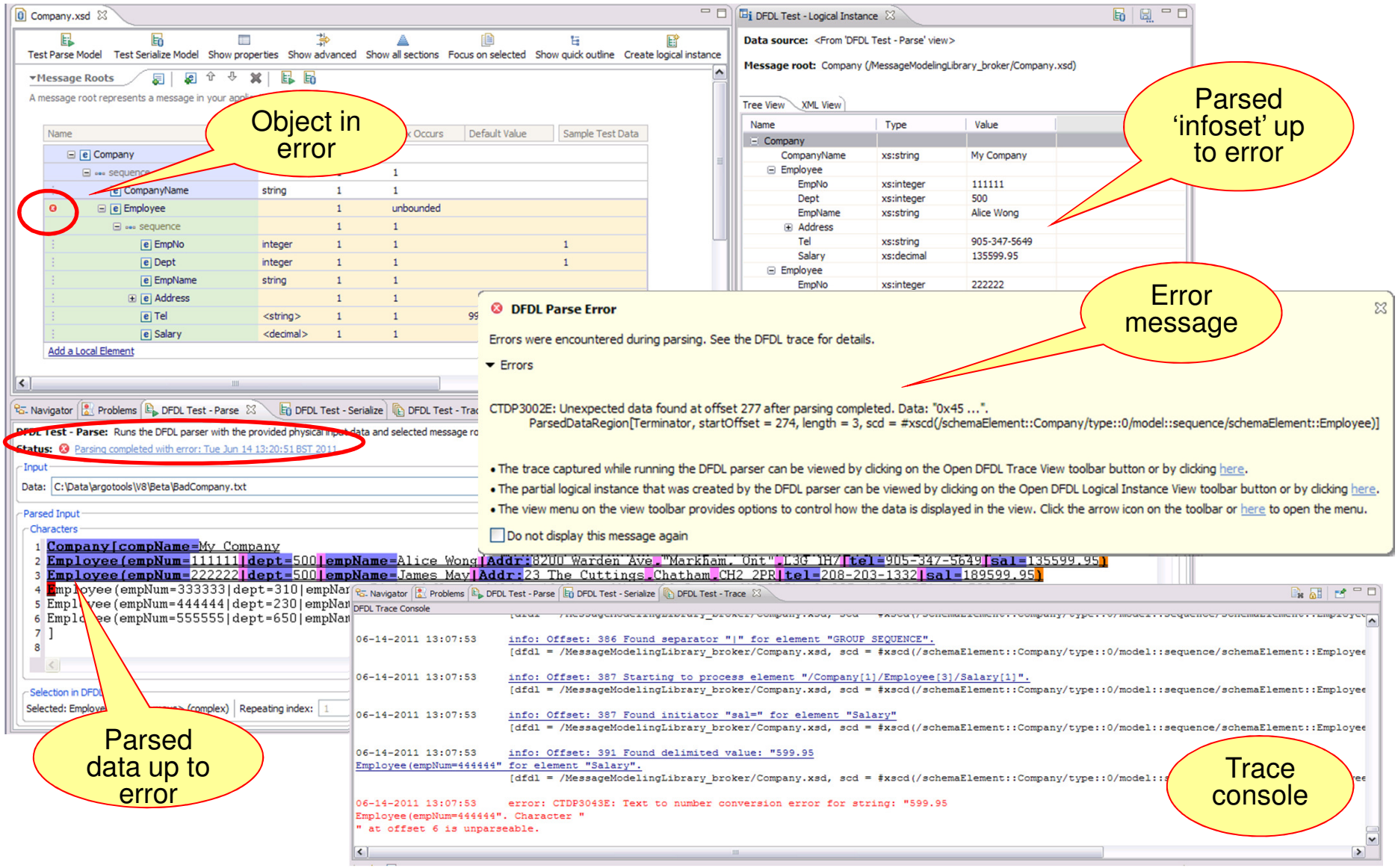
IBM DFDL Tools – Schema Tester



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Daffodil: Open Source DFDL

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- Open source project hosted at University of Illinois
  - Uses *Scala* programming language
    - Java compatible. Runs on JVM. Has Java-callable API
  - Univ of Illinois license (very BSD-like)

- Goal is to implement the entire DFDL specification
  - Parser (first) and unparser (second)
  - DOM-tree-style implementation (now)
  - Streaming/event & random-access (future)
  - Compliance test suite (1800 tests and growing)

- Active contributors from both corporations and US government labs
  - ~3 core funded software developers
  - ~3 core funded test engineers

- Details are available on the project Wiki
  - https://opensource.ncsa.illinois.edu/confluence/display/DFDL

- Contributors and Users are welcome!

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Daffodil - Status

- History
  - Started at the Univ of Illinois' National Center for Supercomputing Applications
    - With funding from US National Archives and Records Administration
  - Designed for an earlier working-copy of the DFDL specification

- Activity
  - Code-base has been rewritten to conform to current DFDL 1.0 specification
  - New compiler-style front-end that parses DFDL schemas and constructs a robust abstract syntax tree of the schema

- Themes
  - Design-for-Test (DFT) - conformance tests means lots of tests
    - Re-using the .tdml test format from IBM DFDL
  - A declarative and functional coding style

- Can I use it?
  - Yes. Initial release April 2013. Approximately monthly ‘spins’ will update.
  - https://opensource.ncsa.illinois.edu/confluence/display/DFDL/Getting+Daffodil

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Daffodil Tools – Command Line Interface

```
$ daffodil --help
daffodil 0.14.0 (build 7f9591a)
Usage: daffodil [GLOBAL_OPTS] <subcommand> [SUBCOMMAND_OPTS]

Global Options:
  -d, --debug  [file]   enable debugging. Optionally, read initial debugger
                        commands from [file] if provided.
  -t, --trace           run the debugger with verbose trace output
  -v, --verbose         increment verbosity level, one level for each -v
                        (default = 0)
      --help            Show help message
      --version         Show version of this program

Subcommands:
  parse          parse data to a DFDL infoset
  test           list or execute TDML tests

Run 'daffodil <subcommand> --help' for subcommand specific options
```

Daffodil Tools – Command Line Interface

```
$
$ # Let's parse some PCAP data
$
$ daffodil parse -s examples/pcap/pcap.dfdl.xsd examples/pcap/icmp.cap

<pcap:PCAP xmlns:pcap="urn:pcap:2.4">
  <pcap:PCAPHeader>
    <pcap:MagicNumber>D4C3B2A1</pcap:MagicNumber>
    <pcap:Version>
      <pcap:Major>2</pcap:Major>
      <pcap:Minor>4</pcap:Minor>
    </pcap:Version>
    <pcap:Zone>0</pcap:Zone>
    <pcap:SigFigs>0</pcap:SigFigs>
... Many more lines of XML here ...
</pcap:PCAP>
$
```


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Daffodil Tools – Command Line Interface

```
$
$ # Let's run a TDML (i.e., self contained) test file
$ # TDML is best way to create small tests, report bugs, etc.
$
$ daffodil test examples/pcap/pcap.tdml
[Pass] pcap_test_dns
[Pass] pcap_test_http_ipv6
[Pass] pcap_test_icmp
[Pass] pcap_test_tcp_ecn

Total: 4, Pass: 4, Fail: 0, Not Found: 0
$
```


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Daffodil Tools – Interactive Debugger

```
$
$ # Let's do some single step debugging
$
$ daffodil -d parse -s examples/pcap/pcap.dfdl.xsd examples/pcap/icmp.cap
(debug) help
    break      create a breakpoint
    clear      clear the screen
    complete   disable all debugger actions and continue
    condition  set a DFDL expression to stop at breakpoint
    continue   continue parsing until a breakpoint is found
    delete     delete breakpoints and displays
    disable    disable breakpoints and displays
    display    show value of expression each time program stops
    enable     enable breakpoints and displays
    eval       evaluate a DFDL expression
    help       display information about a command
    history    display the history of commands
    info       display information
    quit       immediately abort all processing
    set        modify debugger configuration
    step       execute a single parser step
    trace      same as continue, but runs display commands during every step
(debug)
```


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Daffodil Tools – Interactive Debugger

```
... Bunch of steps ...
(debug) display eval .
(debug) display info diff
(debug) display info data
(debug) step
step
  <pcap:Version xmlns:pcap="urn:pcap:2.4">
    <pcap:Major>2</pcap:Major>
  </pcap:Version>
  diff:
    position (bytes): 4 -> 6
data:

0xD4C3B2A1020004000000000000000000FFFF000001000000C46FC151F8CC0C004A0000004A000
000005056E01449000C29340BDE08004500003CD743000080012B73C0A89E8B
(debug)
```

Setup what you want to see displayed on each step

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Daffodil Tools – Interactive Debugger

Can evaluate expressions and “look around” at the data resulting from the parse.

```
(debug) eval ../..
<pcap:PCAPHeader xmlns:pcap="urn:pcap:2.4">
    <pcap:MagicNumber>D4C3B2A1</pcap:MagicNumber>
    <pcap:Version>
      <pcap:Major/>
    </pcap:Version>
  </pcap:PCAPHeader>
(debug) eval ../../pcap:MagicNumber
<pcap:MagicNumber xmlns:pcap="urn:pcap:2.4">D4C3B2A1</pcap:MagicNumber>
(debug)
```


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Links

- OGF DFDL home page: http://www.ogf.org/dfdl/
- DFDL 1.0 specification (pdf): http://www.ogf.org/documents/GFD.174.pdf
- DFDL 1.0 specification (html): http://www.ogf.org/dfdl/spec.php
- DFDL tutorial: http://redmine.ogf.org/dmsf/dfdl-wg?folder_id=5485
- DFDL-WG project: http://redmine.ogf.org/projects/dfdl-wg
- DFDL Wikipedia page: http://en.wikipedia.org/wiki/DFDL
- Getting Started: http://www.ibm.com/developerworks/library/se-dfdl/
- IBM DFDL via IBM Integration Bus:

  http://www-03.ibm.com/software/products/en/ibm-integration-bus/
- Open Source Daffodil:
  http://opensource.ncsa.illinois.edu/confluence/display/DFDL
- DFDL Schemas on GitHub: https://github.com/DFDLSchemas

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DFDL Evolved from….

- Products/Technologies
  - –Mercator, Ascential, Torrent, IBM Message Broker, OMG CORBA, Microsoft BizTalk, SAS, and others.
  - –Database loaders
  - –COBOL/Legacy
- Data formats:
  - –SWIFT, HL7, EDIFACT, FIX, X12, ISO8583(CCards), ASN.1 PER, Thomson Financial,…. many others

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