
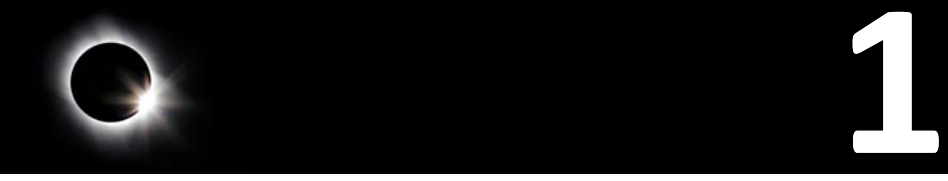


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**Textual DSLs**  
and  
**Code Generation**  
with  
**Eclipse** and **oAW**

A black header bar containing a white eclipse on the left and a large white number '1' on the right.

# Context: Architecture DSLs

A photograph of network cables plugged into a server rack, showing a dense array of connections.

As you  
**understand**  
and  
**develop**  
your architecture...

...develop a  
**language**  
to express it



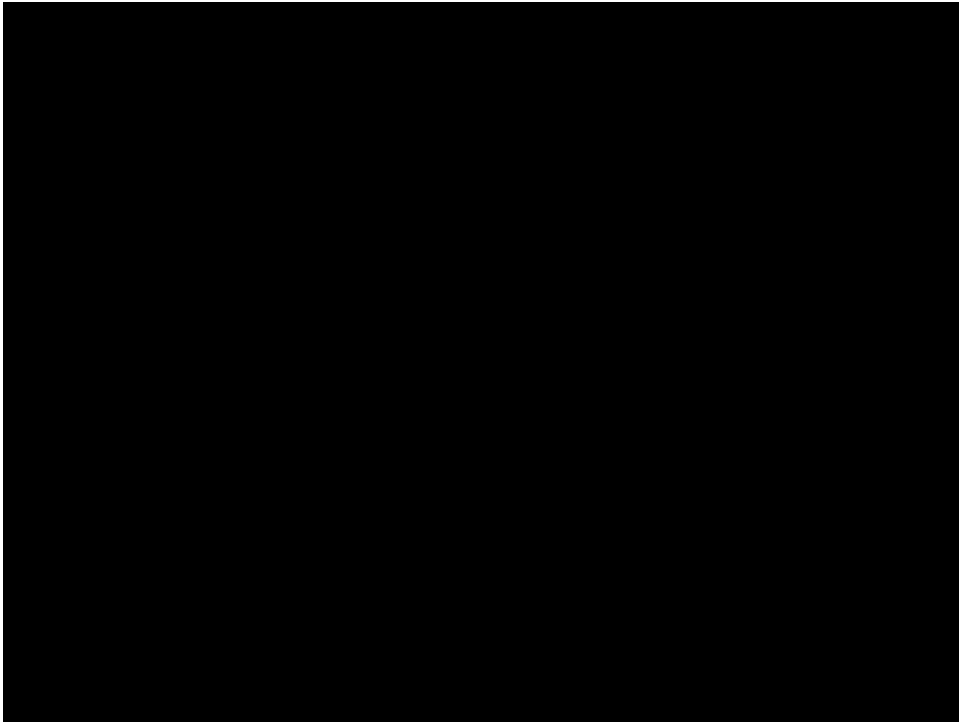
The language resembles  
**architectural**  
concepts...



and we describe  
**the application(s)**  
with the language



Architecture  
**DSL**



2

**Architecture DSL  
Example**

A decorative header bar with a black background. On the left, there is a glowing planet with a bright ring of light. On the right, the number '2' is displayed in a large, white, sans-serif font. Below the header, the text 'Architecture DSL Example' is centered in a bold, black, sans-serif font.

# Components



```
component DelayCalculator {
  provides IDelayCalculator
  requires IInfoScreen
}
component InfoScreen {
  provides IInfoScreen
}
component AircraftModule {
  provides IAircraftModule
  requires IDelayCalculator
}

interface IDelayCalculator {}
interface IInfoScreen {}
interface IAircraftModule {}
```

```
namespace com.mycompany.test {  
  system testSystem {  
    instance dc: DelayCalculator  
    instance screen1: InfoScreen  
    instance screen2: InfoScreen  
    connect dc.screens  
      to (screen1.default, screen2.default)  
  }  
}
```

# Data Replication

```
struct FlightInfo {  
  from: Airport  
  to: Airport  
  scheduled: Time  
  expected: Time  
  ...  
}  
  
replicated singleton flights {  
  flights: FlightInfo[]  
}  
  
component DelayCalculator {  
  publishes flights  
}  
  
component InfoScreen {  
  consumes flights  
}
```

# Pre- and Post- Conditions



```
interface IAircraftStatus {  
  
    oneway message reportPosition(aircraft: ID,  
                                   pos: Position ) {  
        pre aircraft != null: "aircraft not specified"  
        pre pos != null: "position not specified"  
    }  
  
    request-reply message reportProblem {  
        request (aircraft: ID, problem: Problem,  
                comment: String)  
        reply (repairProcedure: ID)  
        pre aircraft != null: "aircraft not specified"  
        pre problem != null: "problem not specified"  
        post repairProcedure != null  
    }  
}
```

# Message Sequences: Protocol State Machines

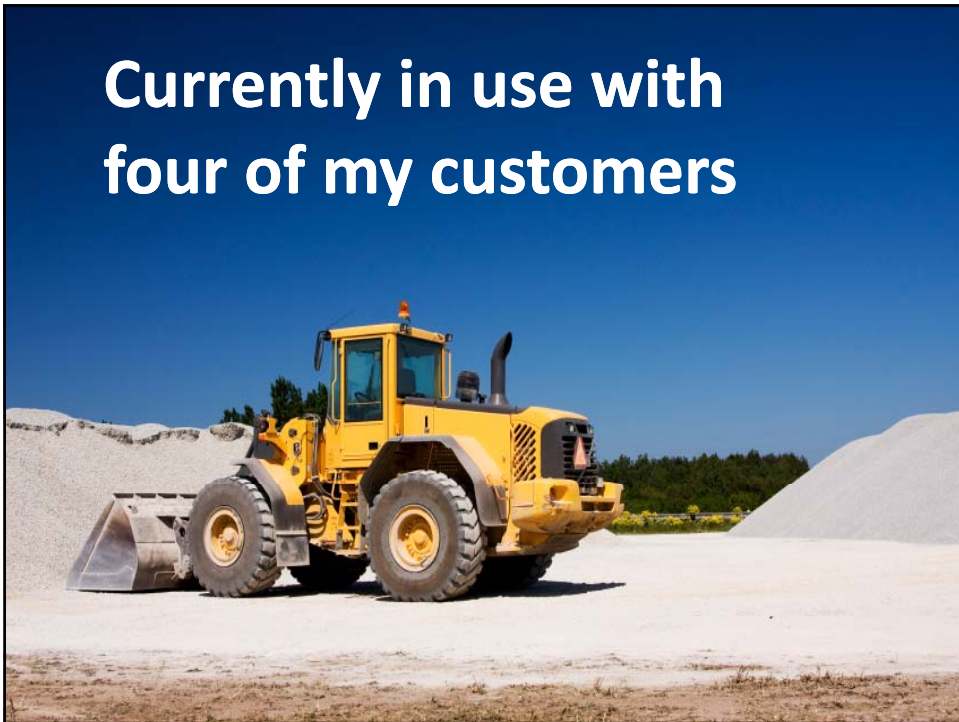
```
interface IAircraftStatus {
  oneway message registerAircraft(aircraft: ID! )
  oneway message unregisterAircraft(aircraft: ID! )
  oneway message reportPosition(aircraft: ID!,
    pos: Position! )
  request-reply message reportProblem {
    request (aircraft: ID!, problem: Problem!,
      comment: String!)
    reply (repairProcedure: !ID)
  }
}

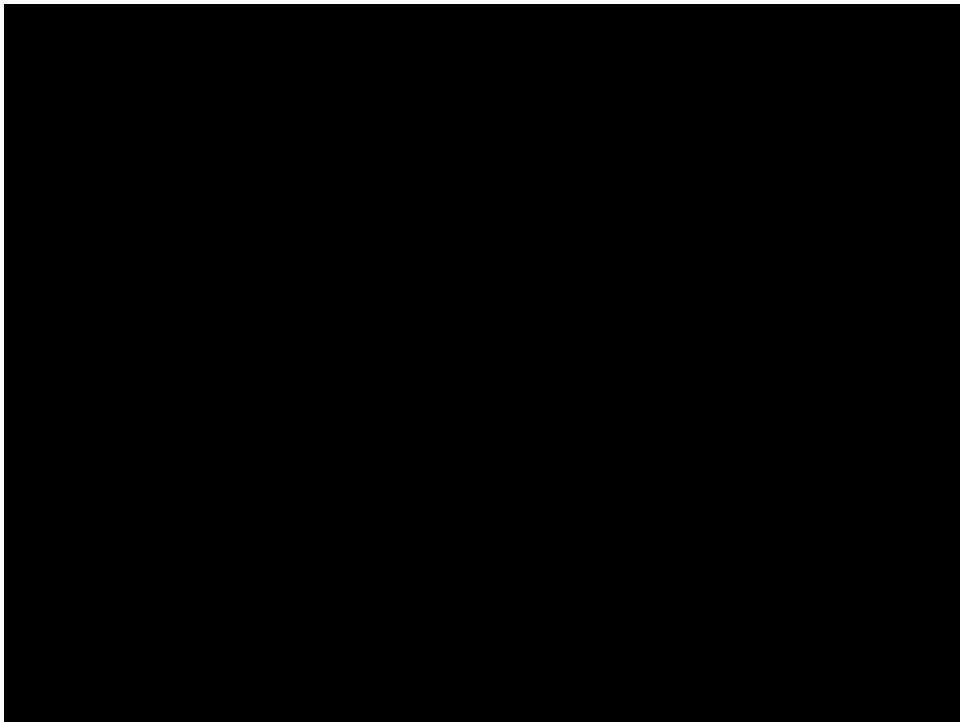
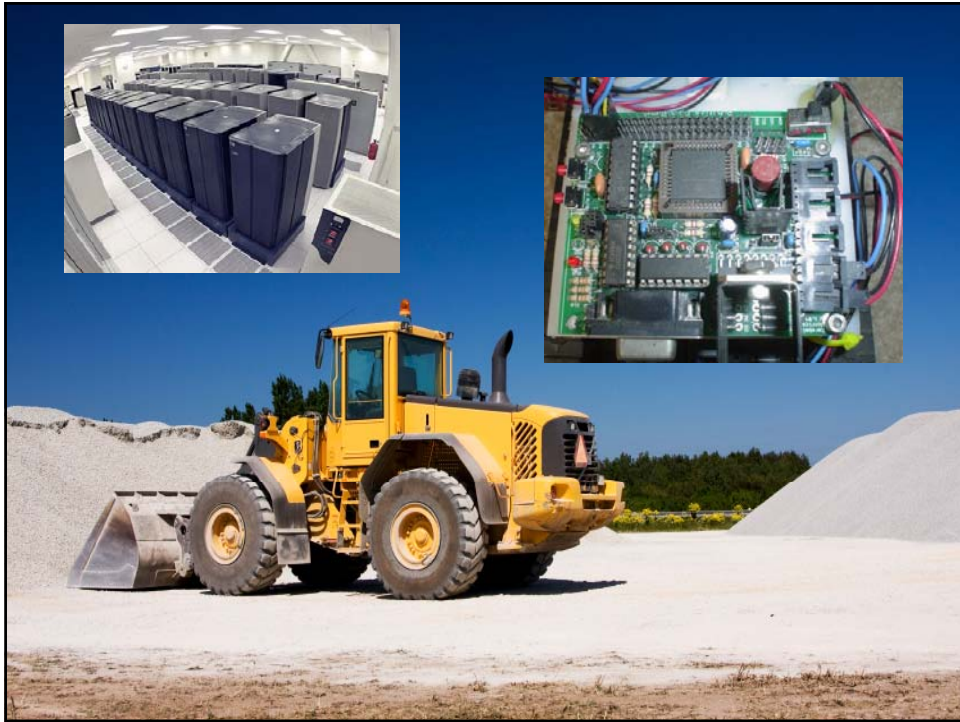
protocol initial = new {
  state new {
    registerAircraft => registered
  }
  state registered {
    unregisterAircraft => new
    reportPosition
    reportProblem
  }
}
}
```


**Based on actual  
practical experience**



**Currently in use with  
four of my customers**








**3**

**Why Textual?**



**3**

**... or: why not graphical?**

**Languages and Editors  
are easier to build**

**Languages and Editors  
are easier to build**

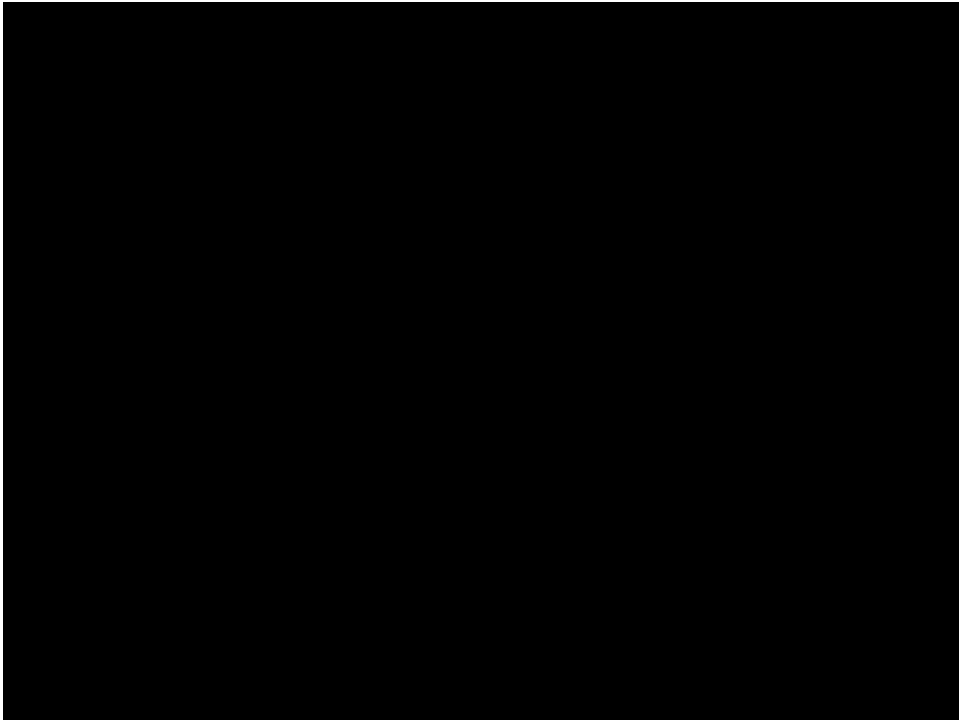
**Evolve Language and simple editor  
as you understand and discuss the  
architecture, in real time!**

**Integrates easily with  
current **infrastructure**:  
CVS/SVN diff/merge**

adapting existing  
models as the DSL  
evolves

**Model **evolution**  
is trivial, you can  
always use *grep*.**

**Many developers  
prefer textual  
notations**







4

# Tooling

**Eclipse**  
**TMF / Xtext**  
**openArchitectureWare**



# Specify Grammar

```

Namespace:
  "namespace" name=ID (featureclause=FeatureClause)? "("
  (usings+-Using) *
  ( subNamespaces+=Namespace |
    components+=Component |
    datatypes+=DataType |
    interfaces+=Interface |
    compositions+=Composition ) *
  ")";

Using:
  "using" namespace=[Namespace|qualID];

Component:
  (pointcut=Pointcut)? "component" name=ID (tags=TagsClause)? (featurec
  (ports+=Port) *
  ")";

Port:
  MessagePort | DataPort;

MessagePort:
  ProvidedPort | RequiredPort;

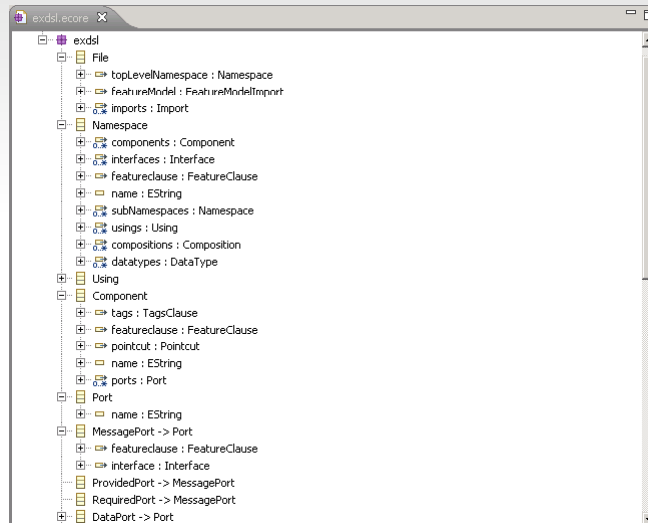
ProvidedPort:
  "provides" name=ID ":" interface=[Interface] (featureclause=FeatureCl

RequiredPort:

```

**Antlr Grammar and  
Parser is generated  
from this specification**

# Generated Metamodel



# Specify Semantics

```

semantic annotation for "platform:/resource/org.openarchitectureaware.seman.test/src-gen/org.openarchitectureaware
class Configuration {
    template templateRef (
        properties
        singleOverrideParam
        join( singleJoinParam )
        multiOverride
        join( multiJoin );
        mode accessorFunctions;
    )
}

class Entity {
    parents
    uniqueNames attrs
    scope primaryAttr allInSiblingProperty attrs
}

class Reference {
    scope entity allUnderParent System
    //referenceScope Reference.entity custom
}

class Attribute {
    parents
}

class ValueObject {
    parents
}

class StateMachine {
    uniqueNames events
    uniqueNames states
    scope initial allInSiblingProperty states
    scope baseMachine allUnderParent World excludeSelf
}

```

# Specify Constraints

```

Checks.chk
import exdsl;

extension net::ample::adsl::exdsl::Extensions;
extension org::openarchitectureware::util::stdlib::io;

context Component ERROR "Qualified Name "+qualifiedName()+" must be unique"
  allComponents().select( c | c.qualifiedName() == qualifiedName() ).size == 1;

context DataType ERROR "Qualified Name "+qualifiedName()+" must be unique"
  allDataTypes().select( c | c.qualifiedName() == qualifiedName() ).size == 1;

context Namespace if !isEmpty() ERROR "Qualified Name "+qualifiedName()+" must be unique"
  allNamespaces().select( c | c.qualifiedName() == qualifiedName() ).size == 1;

context emf::EObject if metaType.getProperty("name") != null ERROR "name not defined"
  metaType.getProperty("name").get(this) != "Unnamed";

context Interface ERROR "interface names must start with a capital I":
  name.startsWith("I");

context MessagePort ERROR "interface not defined. Missing a 'using?': ":
  visibleInstancesOfType(this, Interface).contains(interface);

context Attribute ERROR "no type defined: "+type.name:
  visibleInstancesOfType(this, DataType).contains(type);

context DataPort ERROR "data not defined: "+type.name:
  visibleInstancesOfType(this, ComplexType).contains(type);

```

# Generated Editor

The screenshot shows a code editor window titled 'components.exdsl' with the following XSD code:

```

namespace com (
  namespace airwizard (
    using com.airwizard.domaintypes
    using com.airwizard.types

    namespace shared (
      struct aaa (
        x : FlightAIDI
        y : Flights
      )

      typedef String FlightID

      struct FlightStatus (
        f : FlightStatus
        eta:
      )
    )
  )
  interface Time -- com.airwizard.domaintypes
  interface aaa -- com.airwizard.shared
  boolean -- com.airwizard.types
  int -- com.airwizard.types
)

```

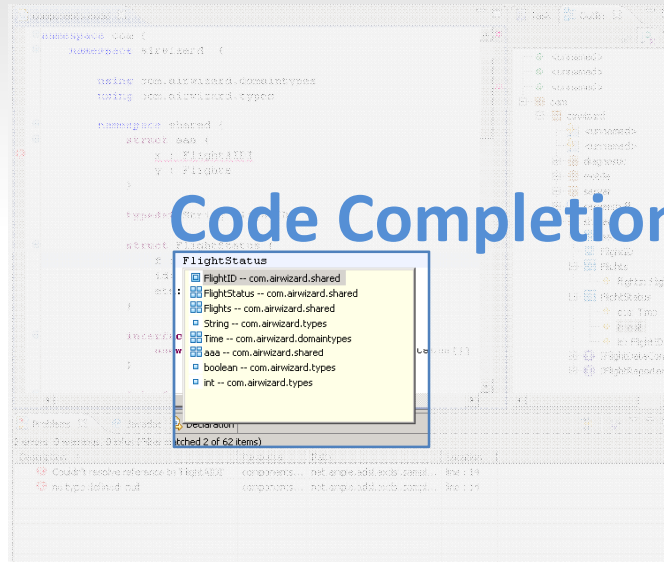
On the right, a tree view shows the project structure:

- <unnamed>
- <unnamed>
- <unnamed>
- com
  - airwizard
    - <unnamed>
    - <unnamed>
    - diagnostic
    - mobile
    - server
    - serverstuff
    - shared
      - aaa
      - FlightID
      - Flights
      - Flights: Flights
      - eta: Time
      - f: null
      - id: FlightID
      - IFlightDataConsu
      - IFlightReporter

At the bottom, a 'Problems' window shows two errors:

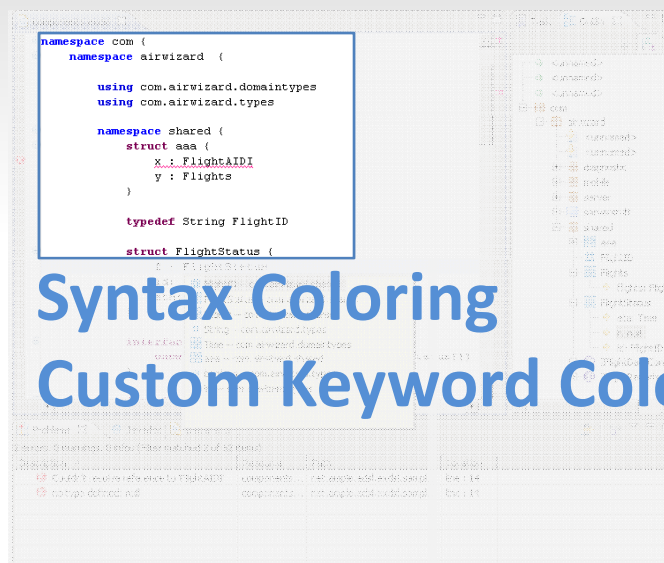
Description	Resource	Path	Location
Couldn't resolve reference to 'FlightAIDI'	components...	net.ample.adsl.exdsl.sampl...	line : 14
no type defined: null	components...	net.ample.adsl.exdsl.sampl...	line : 14

# Generated Editor



Code Completion

# Generated Editor



Syntax Coloring  
Custom Keyword Coloring

# Generated Editor

**Realtime Constraint Validation**

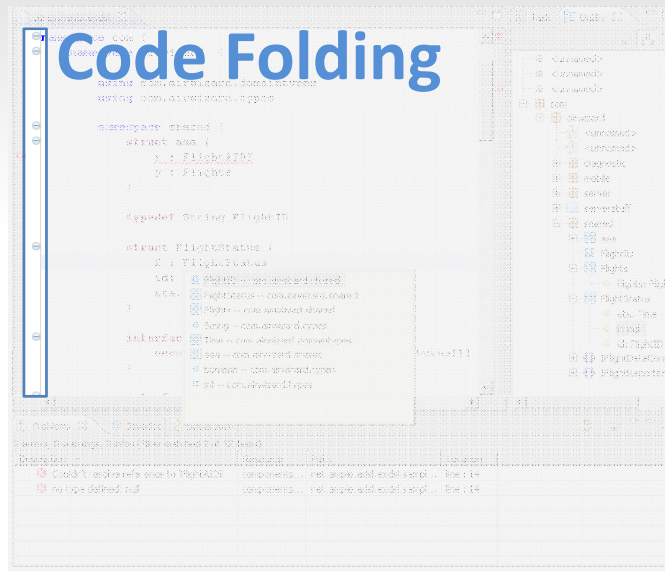
Description	Resource	Path	Location
Couldn't resolve reference to "FlightAIDI"	components...	net:ampl:add:exdsl:sampl...	line : 14
no type defined: null	components...	net:ampl:add:exdsl:sampl...	line : 14

# Generated Editor

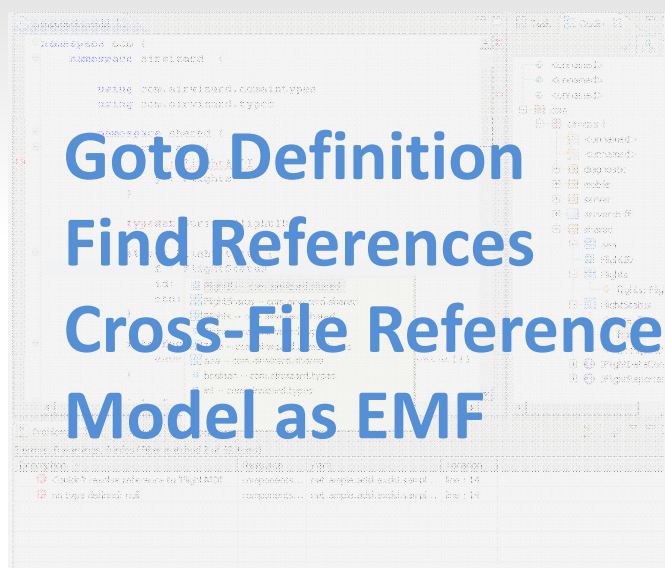
**Customizable Outlines**

- <unnamed>
- <unnamed>
- <unnamed>
- com
  - airwizard
  - <unnamed>
  - <unnamed>
  - diagnostic
  - mobile
  - server
  - serverstuff
  - shared
  - aaa
    - FlightID
    - Flights
    - Flights: Flight
      - FlightStatus
        - eta: Time
        - fn: null
      - id: FlightID
      - IFlightDataConsu
      - IFlightReporter

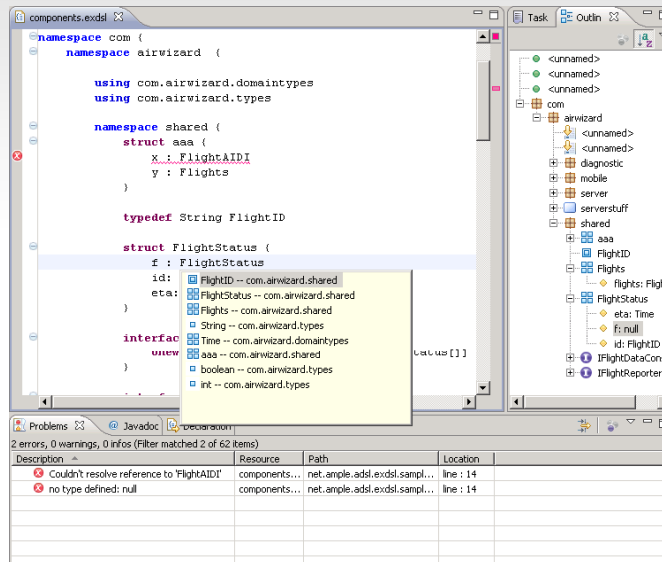
# Generated Editor



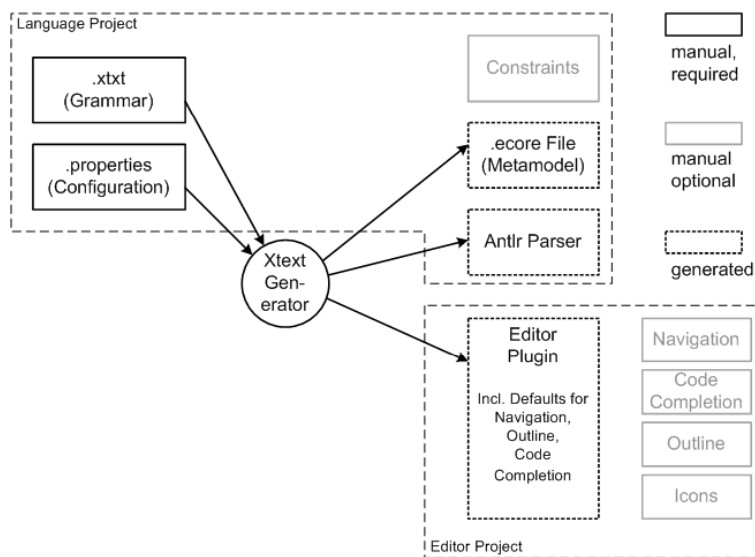
# Generated Editor



# Generated Editor



# Xtext Overview





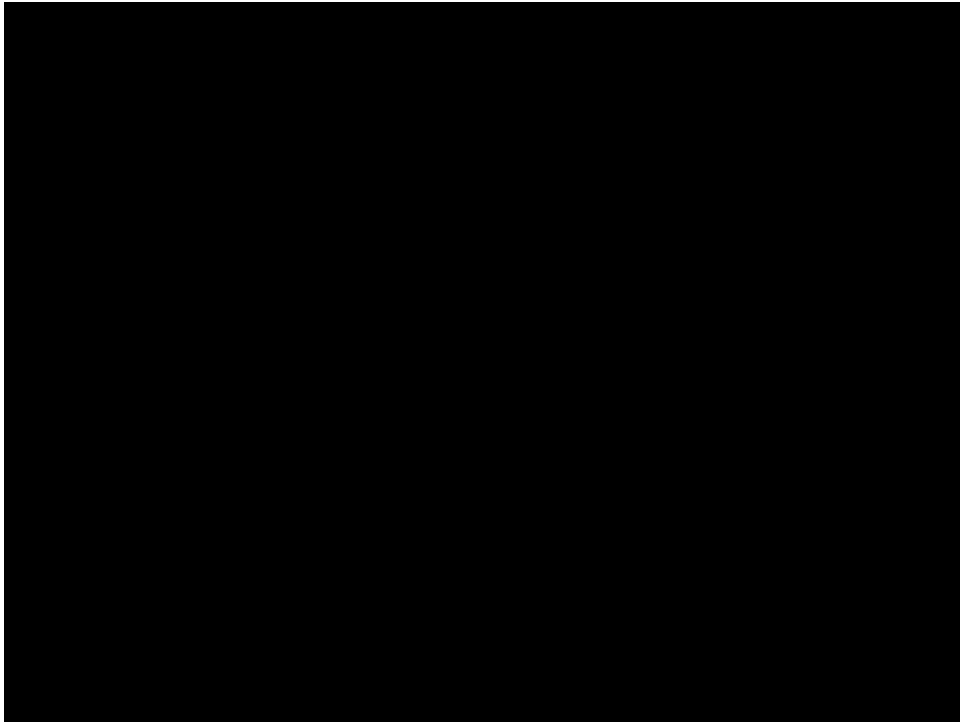


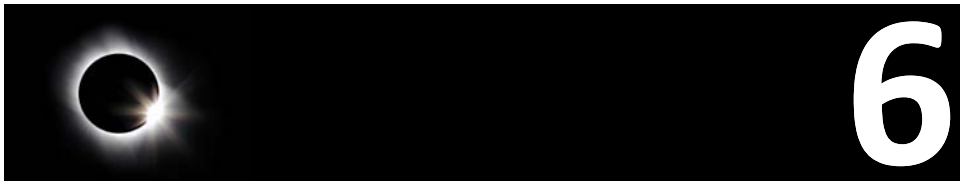
# 5



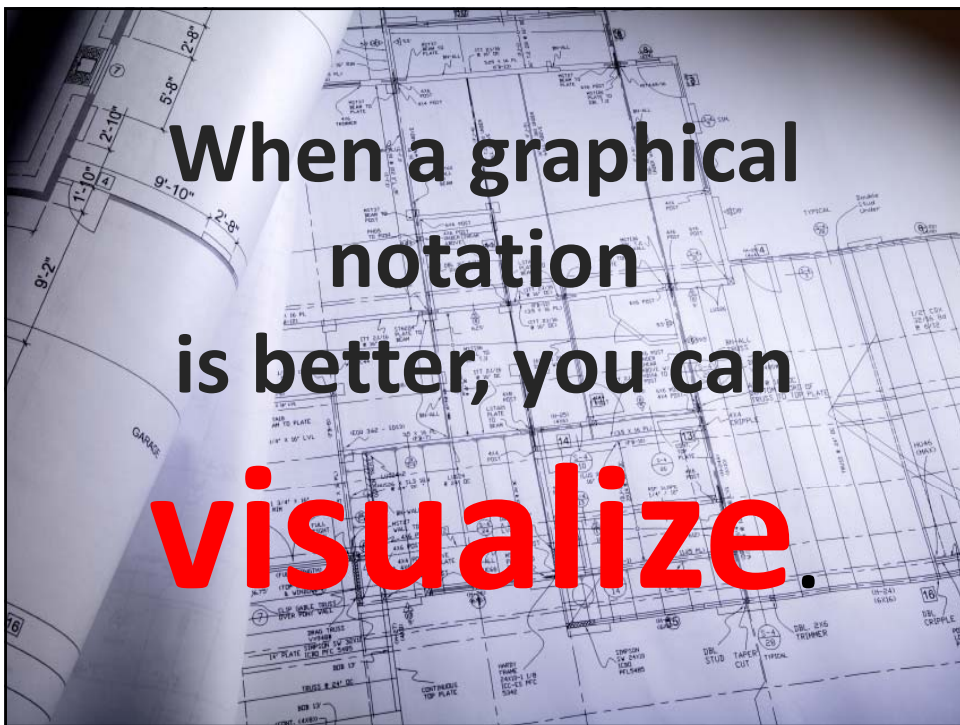
# DEMO

## Building a DSL



A black horizontal bar at the top of the slide. On the left side, there is a small, bright image of a solar eclipse. On the right side, the number '6' is written in a large, white, sans-serif font.

# Graphical? Visualization!

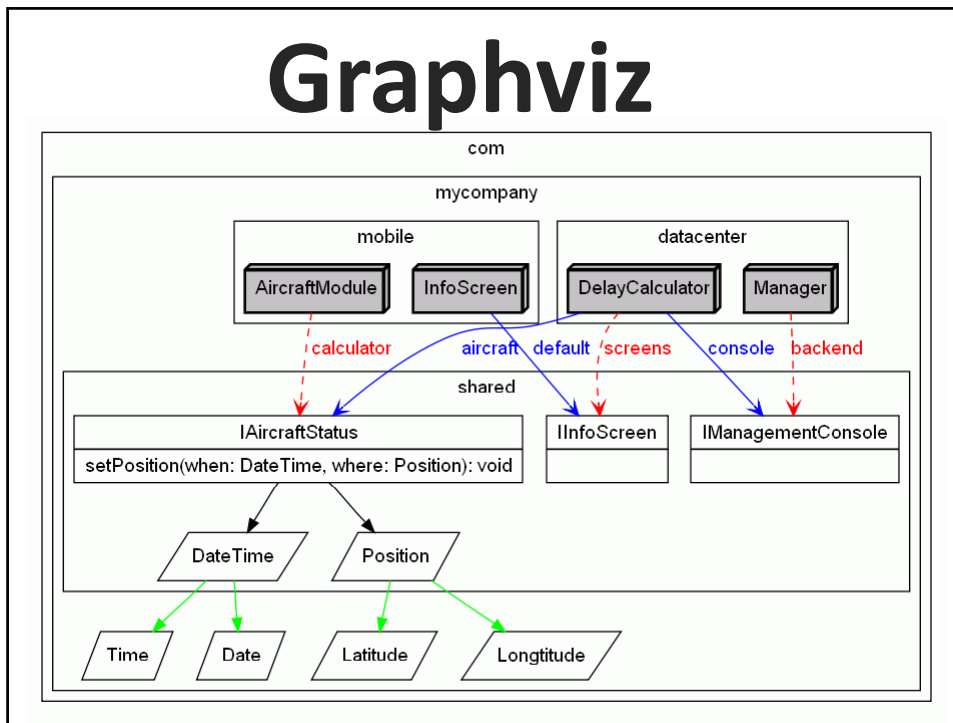
A detailed architectural floor plan or technical drawing is shown, featuring various lines, dimensions, and annotations. The drawing is partially unrolled, showing a curved edge on the left side.

**When a graphical  
notation  
is better, you can  
visualize.**

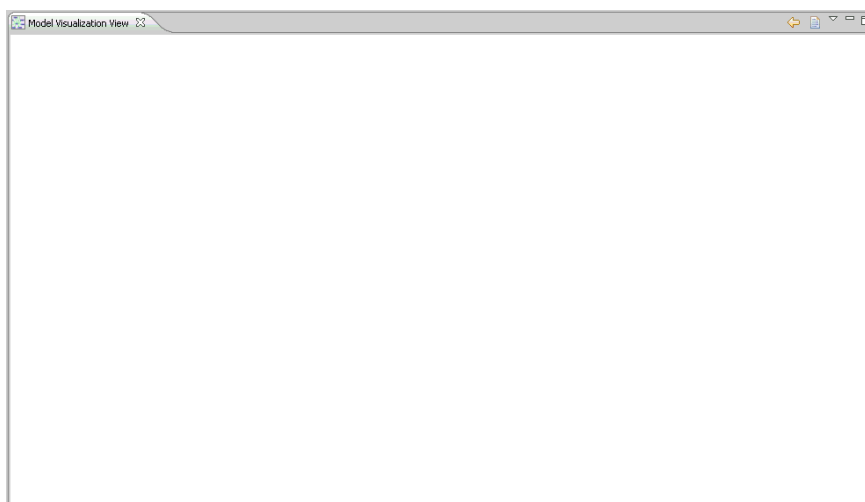
**Via M2M  
Read-Only  
Auto-Layout  
Drill-Down**

**Textual DSLs  
vs.  
Graphical  
vs.  
Visualization**

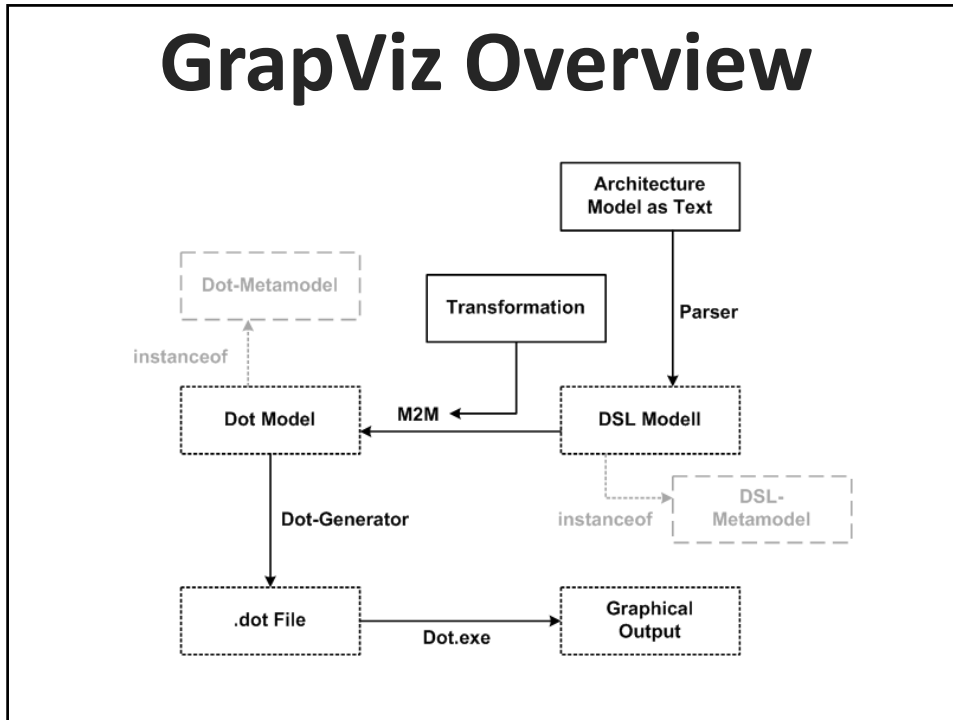
# Graphviz



# Prefuse



# GrapViz Overview



# GrapViz Trafo Code

```

import adsl;
import dot;

extension org:openarchitectureware::util::stdlib::io;
extension org:openarchitectureware::util::stdlib::naming;
extension org:openarchitectureware::util::stdlib::elementprops;

extension dotlib;

Object top(File file):
  toGraph(file);

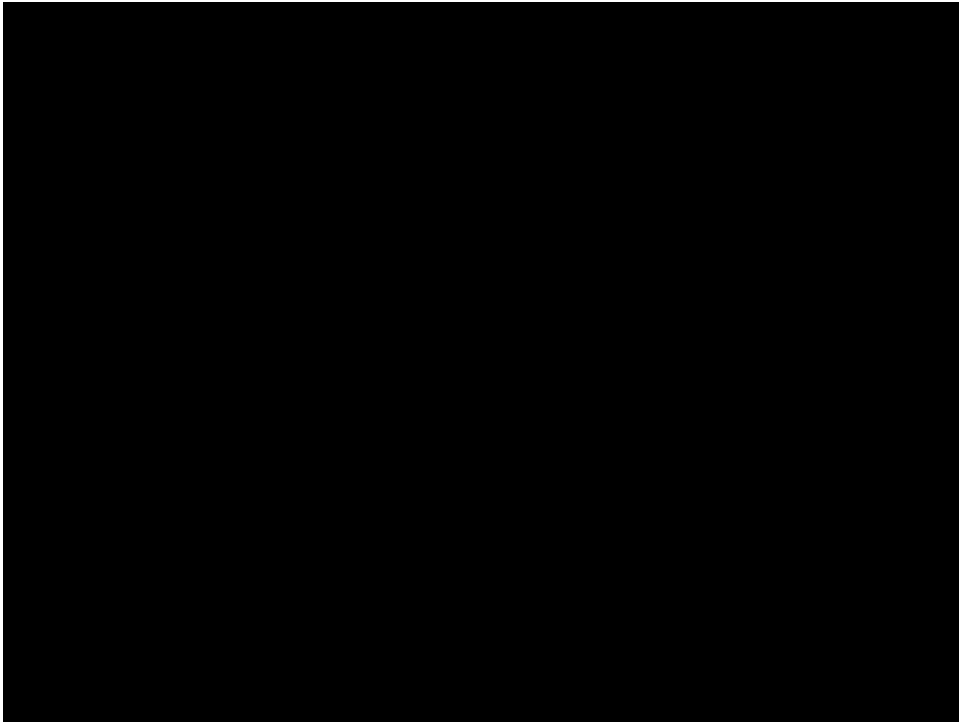
create dot::graph toGraph(File file):
  setType(dot::graphType::digraph) ->
  setName(this.metaType.toString()) ->
  state.add( file.toLevelNamespace.toSubgraph() ) ->
  setFont( "arial" );

create dot::subgraph toSubgraph( Namespace ns ):
  setName( ns.qualifiedName() )
  .setLabel( ns.name )
  .addStatements( ns.subNamespaces.toSubgraph() )
  .addStatements( ns.components.toNode() )
  .addStatements( ns.interfaces.toNode() )
  .addStatements( ns.datatypes.typeSelect(ComplexType).toNode() );

connectPort( Port p ):
  directedEdge( p.container, p.interface, p )
  .setArrowhead( "ss" )
  .setStyle( ProvidesPort.isInstance(p) ? "solid" : "dashed" )
  .setColor( ProvidesPort.isInstance(p) ? "blue" : "red" )
  .setFontColor( ProvidesPort.isInstance(p) ? "blue" : "red" )
  .setLabel( p.name );

create dot::node_start this toNode(ComplexType t):
  .setLabel( t.name )
  .setShape( "parallelogram" )
  .setName( t.qualifiedName() );

create dot::node_start this toNode(Component c):
  .setName( ns.qualifiedName() )
  .setLabel( ns.name )
  .setShape( "oval" )
  .setFillColor( "grey" )
  .setStyle( "filled, bold" );
  
```

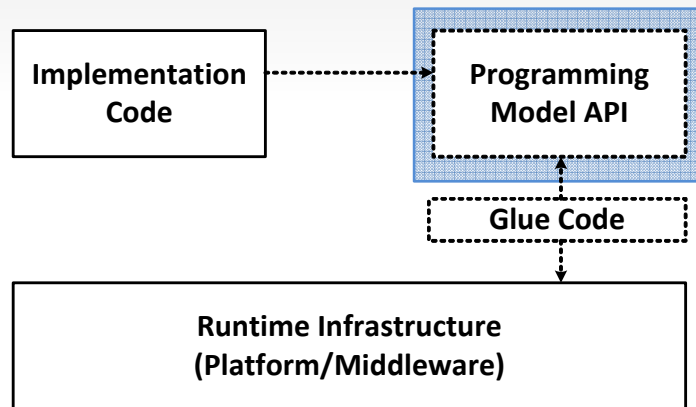
A decorative header bar with a black background. On the left side, there is a glowing planet with a bright ring of light around it. On the right side, the number '7' is displayed in a large, white, sans-serif font.

**7**

## **Generating Code**

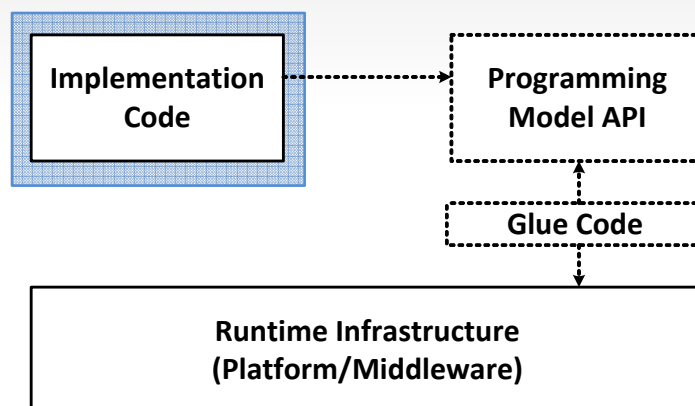
# Generate API

Maps Architectural Concepts to  
Implementation language (non-trivial!)



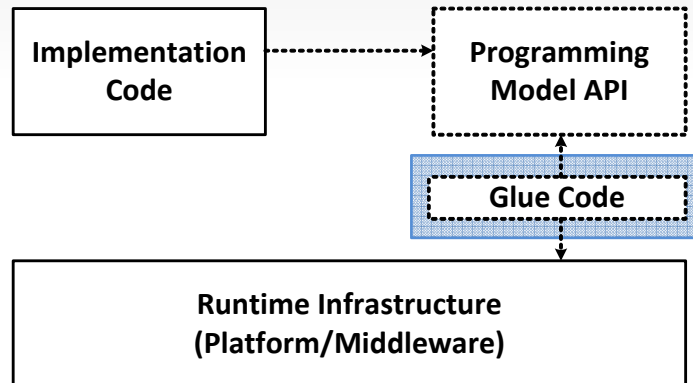
# Implementation

Implementation only depends on  
the generated programming model API



# Glue Code

Aka Technology Mapping Code  
Maps API to selected platform



# Templates

```

data.xpt
1<<IMPORT imp>>
2
3<<EXTENSION dataimport::dsl::impUtil>>
4
5<<DEFINE root FOR DataStructure>>
6<<FILE filename()>>
7
8import java.util.List;
9import java.util.ArrayList;
10import dataimport.platform.DataBase;
11
12
13public class <<classname()>> extends dataimport.platform.DataBase
14
15    <<FOREACH attributes AS a>>
16        private <<a.type>> <<a.name>>;
17    <<ENDFOREACH>>
18
19    <<FOREACH references AS r>>
20        <<IF r.ismulti>>
21            private List<<r.type.fqClassname()>> <<r.name>>List = ;
22        <<ELSE>>
23            private <<r.type.fqClassname()>> <<r.name>>;
24        <<ENDIF>>
25    <<ENDFOREACH>>
26
27    <<FOREACH attributes AS a>>
28        public void set<<a.name.toFirstUpper()>>(<<a.type>> value )
29
30
  
```



# Extensions

```

Extensions.ext
1 import imp;
2
3 extension dataimport::dsl::GenExtensions reexport;
4
5 Collection[Instance] instancesInScope( RecordHandler this ):
6     parentHandler() != null ? instances.union( parentHandler().instancesInScope() ) : instances;
7
8 parentHandler( RecordHandler this ):
9     eContainer != null ? ( RecordHandler.isInstance(eContainer) ? ((RecordHandler)eContainer) : null ) :
10     null;
11

```

stdutil

```

arrayindexopt
<<EXTENSION templates::util>>
<<DEFINE roo
<<FILE 1
pac
pub
extends

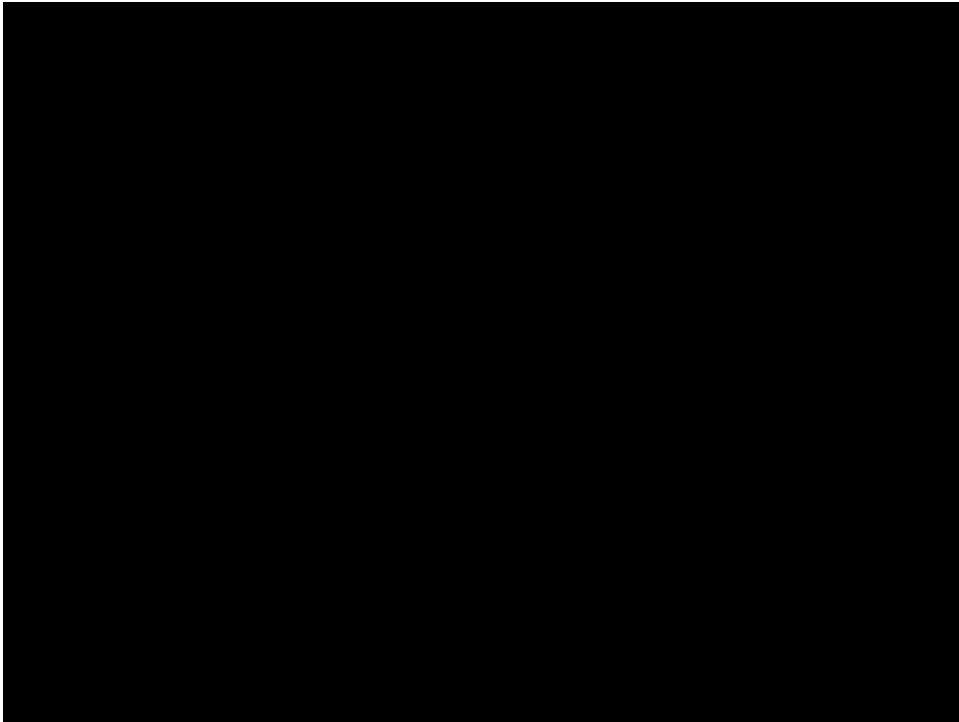
```



# DEMO

## A Code Generator

# 8

A slide header consisting of a black horizontal bar. On the left side of the bar is a glowing planet with a bright ring of light around its equator. On the right side of the bar is a large, white, bold number '9'. Below the black bar is a white rectangular area with a thin black border.

**Tools Summary**

# EMF



Ecore meta meta model

+

Editing

Transactions

Validation

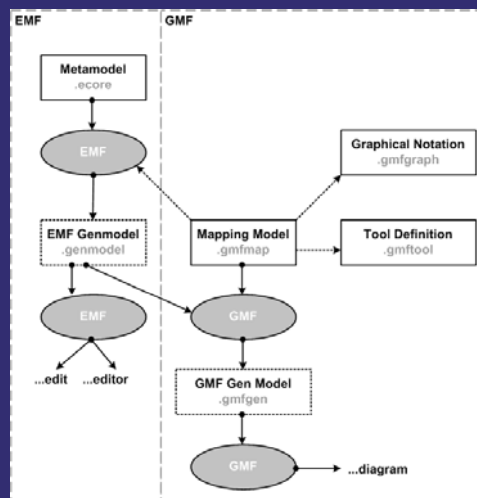
Query

Distribution/Persistence

# GMF



Graphical  
Box/Line  
editors based  
on EMF



## TMF



### Building Textual Editors

currently being built from oAW Xtext

## M2M



### Model-to-Model Transformations

INRIA's ATL

Several QVT implementations

## M2T

### Model-to-Text Transformations

JET: Java Emitter Templates

Xpand: oAW's template engine

# openArchitectureWare

www.openarchitectureware.org



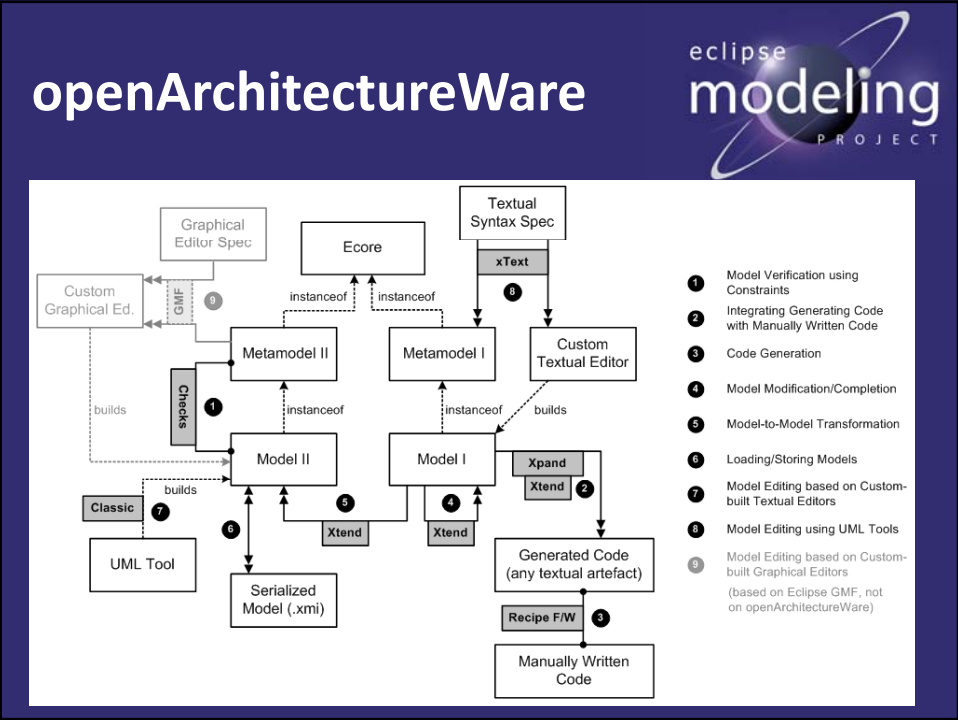
## One Stop Toolkit for DSLs + X

Version **4.3.1** is current

- Lively ecosystem of tools and extensions**
- Proven track record** in various domains & project contexts
- Stable, productive and helpful** developer, support and user communities

Integration with Eclipse:

- Uses EMF as a basis
- Graphical editors based on GMF
- All editors and tooling based on Eclipse



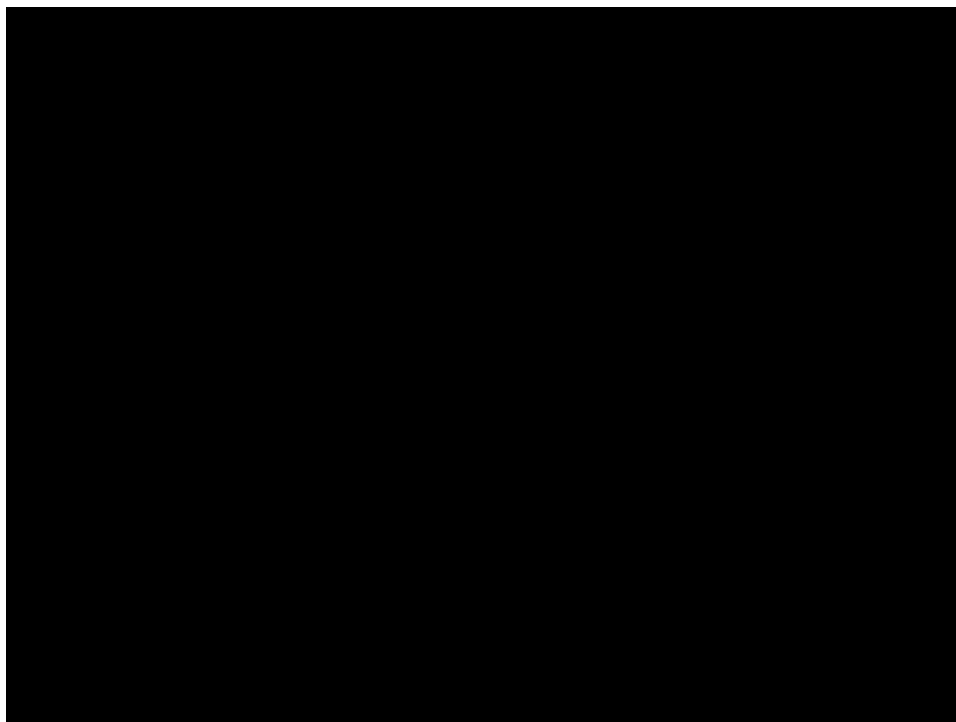
## oAW 5



To be released in June

Xpand, Xtend, Check, MWE migrated to Eclipse projects

Completely new, much more powerful Xtext/TMF





# The End

**THE END.  
Thank you.  
Questions?**



# The End



**.coordinates**

web	<a href="http://www.voelter.de">www.voelter.de</a>
email	<a href="mailto:voelter@acm.org">voelter@acm.org</a>
skype	schogglad
xing	<a href="http://www.xing.com/profile/Markus_Voelter">http://www.xing.com/profile/Markus_Voelter</a>
linkedin	<a href="http://www.linkedin.com/pub/0/377/a31">http://www.linkedin.com/pub/0/377/a31</a>

