Aonix

Your partner when introducing and using modern software development tools

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Aonix - Worldwide Presence

- In business since 1980
- HQ in San Diego
- In Software TOP 500
- 300+ employees
- Offices in Germany, France, Sweden, UK and US
- Represented in 28 countries
- A Gores Technology Group (GTG) company

Aonix GmbH - Close to You

with **Consulting, Sales, Support** and **Training** about our **Products**

Region D A CH
including Eastern Europe

Offices in Karlsruhe, München and Düsseldorf

25 Employees

Aonix Product Families

- **Software through Pictures (StP)**
  Family of modeling tools
  - /UML for object oriented analysis and design
  - /ACD template driven codegeneration
  - /SE for structured analysis and design
- **ObjectAda**
  Software development environment for Ada 95
- **Raven**
  Certifiable runtime kernel for safety critical real-time applications
- **TeleUSE**
  Generator for graphical user interfaces based on Motif

Ada-Development

- ObjectAda
  - Ada 95 development environment for PCs and Unix
  - ObjectAda Windows and ObjectAda Real-Time
- Real-Time/Raven:
  - implements Ravenscar Profile (RP)
  - Checks the RP properties during compilation
  - Certification documents for highest criticality (DO-178B) with warranty available
  - supporting partitioning

Raven Certification

- December 2001:
  Pratt & Whitney certification was achieved at software Level-A of RTCA's DO-178B for the PW6000 commercial jet engine

- June 2002:
  Pratt &Whitney has selected Aonix ObjectAda®/Raven™ for its next generation military jet engine for JSF

From UML Design Pattern to Safety Critical Software

- Introduction
- Elements of Design Pattern
- Model elements from the Ravenscar Profile
- Automatic code generation
- Example
- Conclusion

UML Introduction

- UML language with powerful graphical expressiveness
  concentration on
  - class diagrams
  - state diagrams
- Semantical interpretation freedom
  - Commercial Software
  - Real-time Software
- Concentration on Real-time Systems

Real-time System - Characteristics

- Natural paralellism in design structures
- Historical solutions: sequentialized fixed time frames
- Typical example
  - cyclic readout of a sensor value
  - put into a buffer
  - then processed by controllers and visualized on displays

Real-time System - Items

- Active items - active classes
  (state automata)
  => own control flow
  => Thread, Ada Task
- Passive items
  (Ex: buffer)
  => no independant control flow
  => Module, Ada Package
- How are they modelled with UML?

UML Stereotype

- Defines meta-property
- Used to classify UML items
- Constraints, Tagged Values for the refinement of the meta-properties

Cyclic Class Characteristics

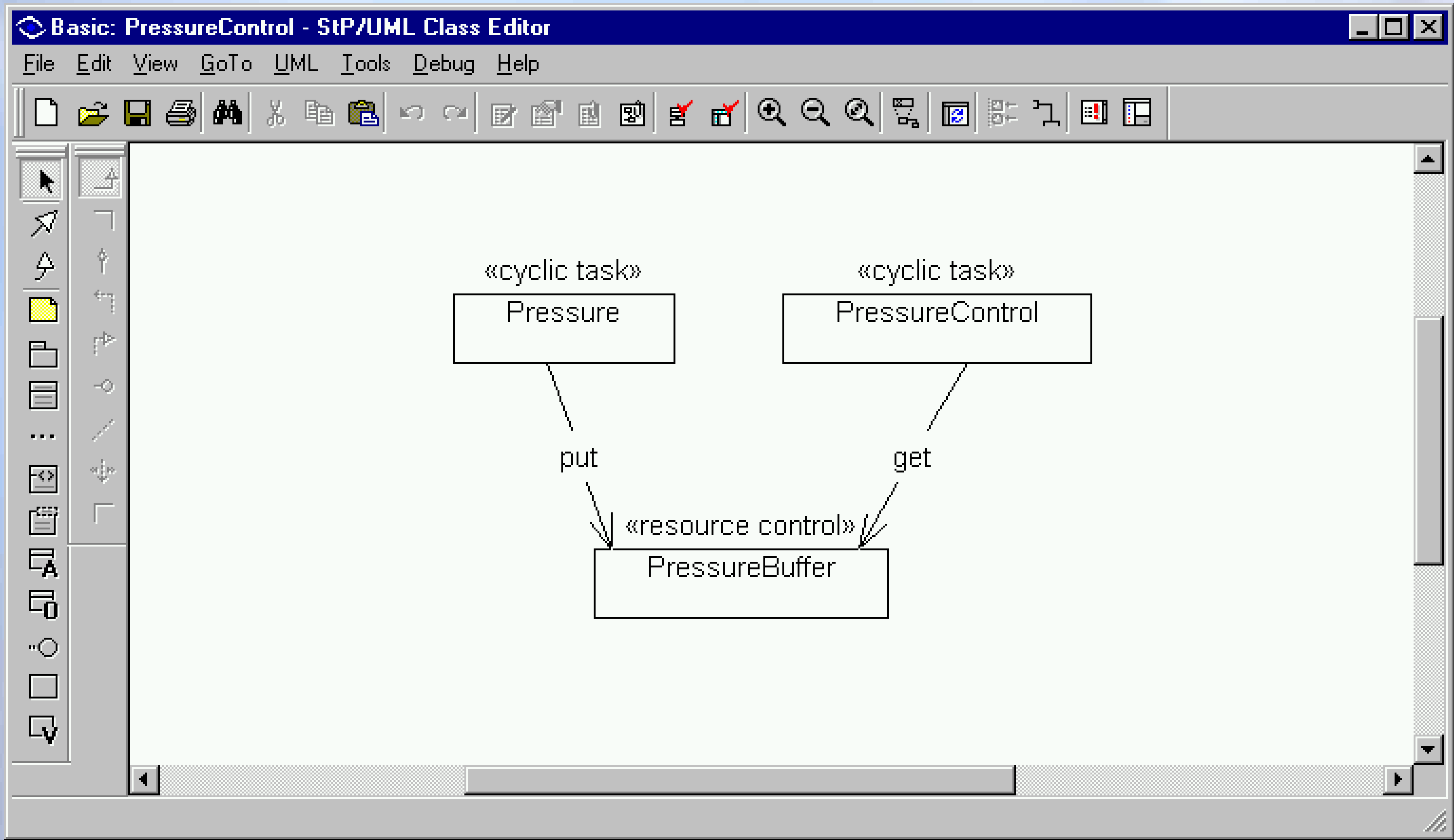
- Stereotype = „CyclicTask“
  - has its own control flow
  - runs endless
  - Priority
  - Periodicity

Buffer Characteristics

- Stereotype = „resource control“
  - no independant control flow
  - implicit put method
  - implicit get method
  - synchronisation of methods

  - Tagged Value: Element type
  - Tagged Value: Number_of_Elements

Simple Design Pattern



communication between parallel activities

Details: Tagged Values

- Class *Pressure*
  - priority = 1
  - period = milliseconds(100)
- Class *PressureControl*
  - priority = 2
  - period = milliseconds(200)
- Class *PressureBuffer*
  - ItemType = Pressure_Type
  - No_Of_Elements = 100

Ravenscar Profile

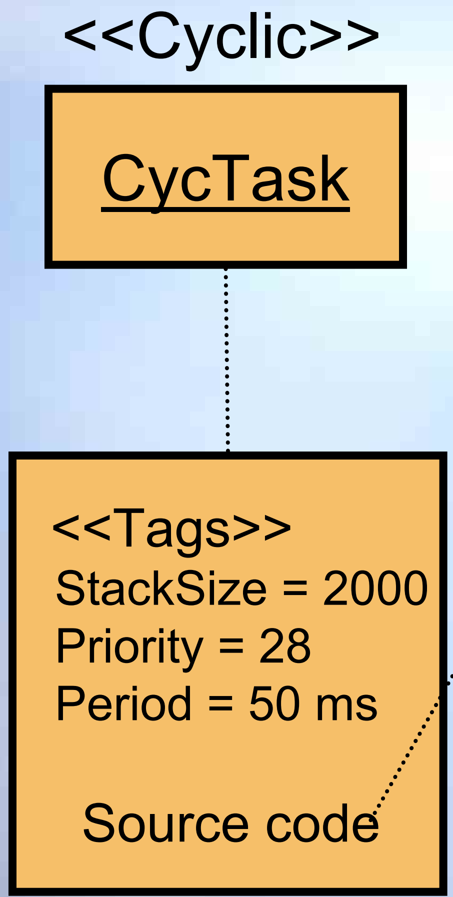
- Industrial standard for safety critical real-time systems with Ada
- Idea: structuring an application with a set of tasks
  - cyclic
  - sporadic
  - cooperating
- communicating through events and buffers

Active model elements

- RepetetiveTask
  - recurrent activity without fixed period
  - tagged values: priority, stacksize
- CyclicTask
  - like RepetetiveTask, but with fixed period
  - tagged values: priority, stacksize, period

Cyclic Task Stereotype with attributes

UML Class



Generated Code (part)

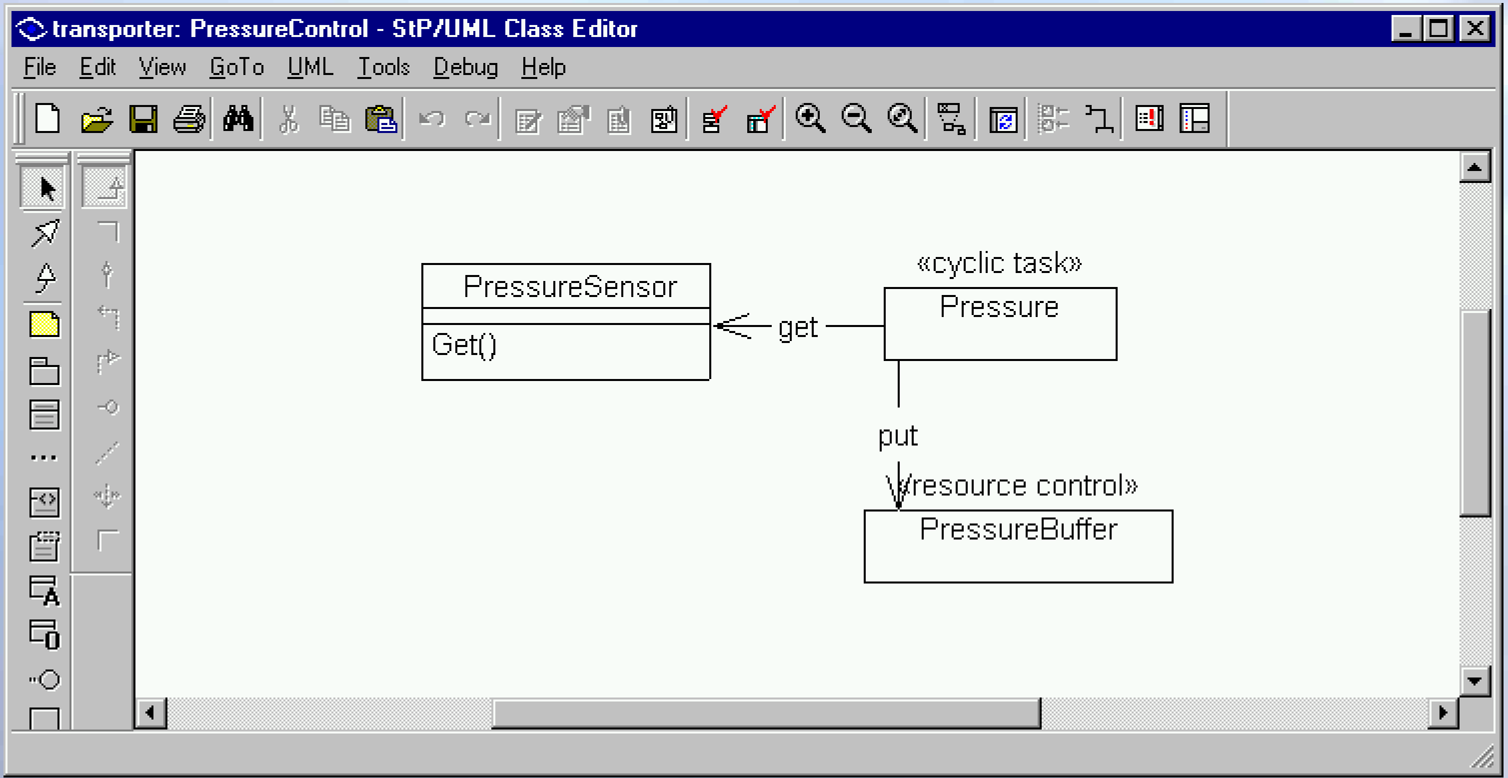
```
task CycTask is
   pragma Priority (28);
   pragma Storage_Size (2000);
end CycTask;

task body CycTask is
  Next_Time : Time;
  Period : Time_Span := Milliseconds(50);
begin
   Next_Time := Clock;
   loop
      delay until Next_Time;
      --  body
      Next_Time := Next_Time + Period;
   end loop;
end CycTask;
```

More active model elements

- Transporter
  - like cyclic, but including
  - a Get-Association and
  - a Put-Association
  - priority, stacksize, period
  - Item_Type

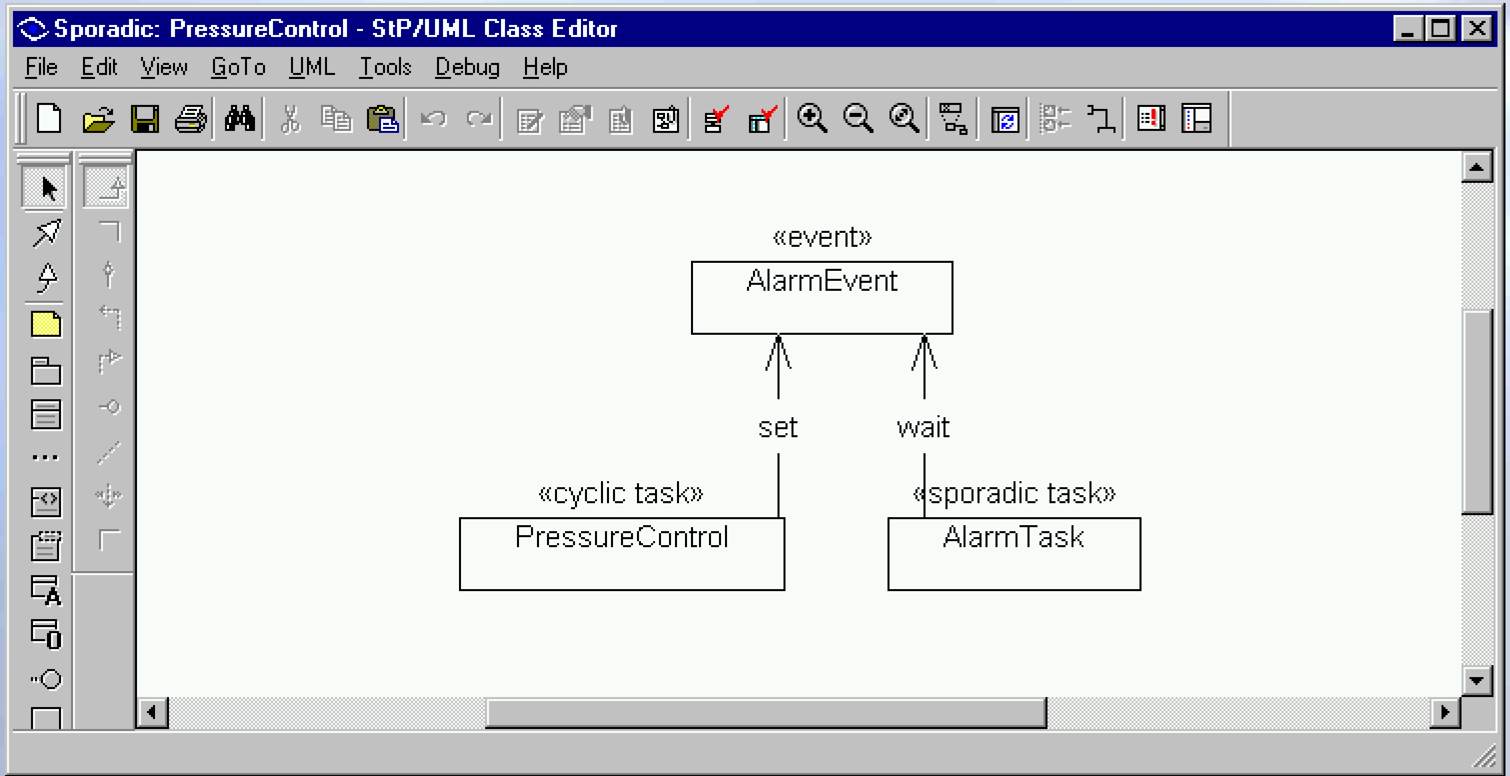
Example: Transporter



More active model elements

- SporadicTask
  - waits for an event or interrupt
  - has an association to a class which represents the event

Example: Alarm



Code Generation

- Template based Code generator
  - simple mapping of patterns to code, selection via stereotypes
  - implementation of complicated pattern
  - semantic checking
  - easy modifiability
    => new patterns

Code generation

- Static semantic
  => class diagrams
- dynamic semantic
  => State automata
- Patterns are language independant
- Ada provides convient language concepts
- Mapping to C, C++, Java and other languages possible

Template: Cyclic Task

```
template CyclicTaskBody(MClass)
 [OutputWiths([MClass])]
with Ada.Real_Time; use  Ada.Real_Time; -- To get visibility to the "+" operator.
package body [MClass.name]_Pkg is
[genStateMachine([MClass])]
task body [MClass.name] is
   Next_Time : Ada.Real_Time.Time;
   Period    : constant Ada.Real_Time.Time_Span := [Period([MClass])];
[transporter_decl([MClass])]
  begin
     Next_Time := Ada.Real_Time.Clock;
     loop
         delay until Next_Time;
        [transporter_get([MClass])]
        [genStateMachineCall([MClass])]
        [mergeOut("UCOD:: "getUniqueId([Mclass,"User Def Code", "")]
        Next_Time := Next_Time + Period;
    end loop;
  end [MClass.name];
end [MClass.name]_Pkg;
end template
```

Generated Code: Cyclic Task

```
with PressureSensor_Pkg; with PressureBuffer_Pkg;
with Ada.Real_Time;  use Ada.Real_Time;
package body Pressure_Pkg is
   task body Pressure is
     Next_Time : Ada.Real_Time.Time;
     Period    : constant Ada.Real_Time.Time_Span := Milliseconds(100);
     Item : Pressure_Type;
   begin
     Next_Time := Ada.Real_Time.Clock;
     loop
        delay until Next_Time;
        Item := PressureSensor_Pkg.Get; -- Raven Class Package
        PressureBuffer_Pkg.Put (Item); -- Raven Class Package
        --#ACD# M(UCOD:: 102:BOTTOM) User Defined Code
              -- Section for  User Defined Code
        --#end ACD#
        Next_Time := Next_Time + Period;
     end loop;
   end Pressure;
end Pressure_Pkg;
```

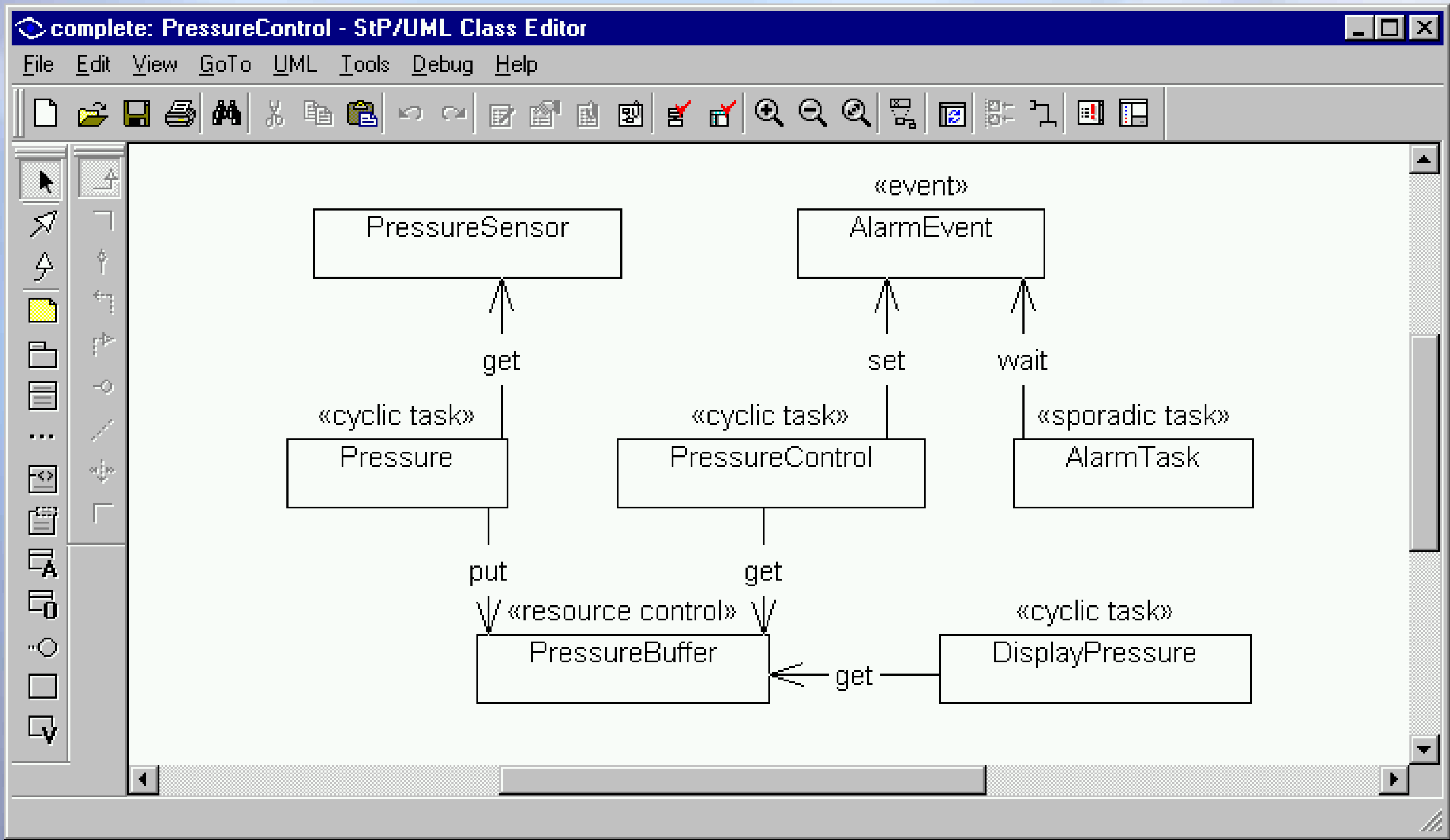
Passive Element: RC

```
template ResourceControlSpec(MClass)
with System; -- for Priority value.
[if (HasInterruptId([MClass]))]
with Ada.Interrupts; use  Ada.Interrupts;
[end if]
package [MClass.name]_Pkg is
   protected [MClass.name] is
   function  Get return [SharedDataType([MClass])];
   procedure Put(Item : [SharedDataType([MClass])]);
[if (HasInterruptId([MClass]))]
  [HandlerSpec([MClass])]
[end if]
 [ProtectedPriority([MClass])]
  private
     Shared_Data : [SharedDataType([MClass])];
  end [MClass.name];
end [MClass.name]_Pkg;
end template
```

Generated Code: RC

```
package body PressureBuffer_Pkg is
    protected body PressureBuffer is
    function Get return Pressure_Type is
    begin
        return Shared_Data;
    end Get;
    procedure Put(Item : Pressure_Type) is
    begin
        Shared_Data := Item;
    end Put;
  end PressureBuffer;
end PressureBuffer_Pkg;
```

Example: Pressure Control



Conclusion

- Ravenscar profile patterns
  - language independant
  - easy mapping to Ada
- Easy composition of patterns
- High level of abstraction
- Mapping to target language realized thru template driven code generation
  => OMG Model Driven Architecture