

Optimisation of Component Based Applications within a Grid Environment

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Outline

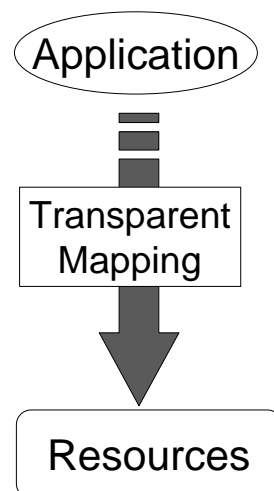
- E-Science and The Grid
- ICEN I extensible framework
- Using Meta -data for Run -Time Optimisation
- Example: Linear Systems
- Further developments

E-Science

- NetworkedResources:TheGrid
- UtilisationoftheGrid
- EnablingDomainSpecialists

E-Science&TheGrid: Challenges

- ComplexApplications
 - ComputationallyIntensive
 - VeryLargeDataSets
- ComplexResources
 - Dynamic
 - Unreliable
- Accessibility
 - Portals



Information!

- User:
 - Who, what, when, where
- Resources:
 - Availability, character, policy
- Application:
 - Composition, behaviour, performance

Software Abstraction: Components

- Implementation+Interface
- Abstraction: Expressability
 - Connection Oriented Programming
 - Mobility
- Encapsulation: Native Code
 - High Performance
 - Multiple Implementations

UserRoles

- End-User
 - Customisation:types → instances
 - Composition:instances → applications
- Scientist
 - Developcomponenttypes
 - Annotatewithmeta -information
- Developer
 - Developcomponentimplementations
 - Annotatewithmeta -information

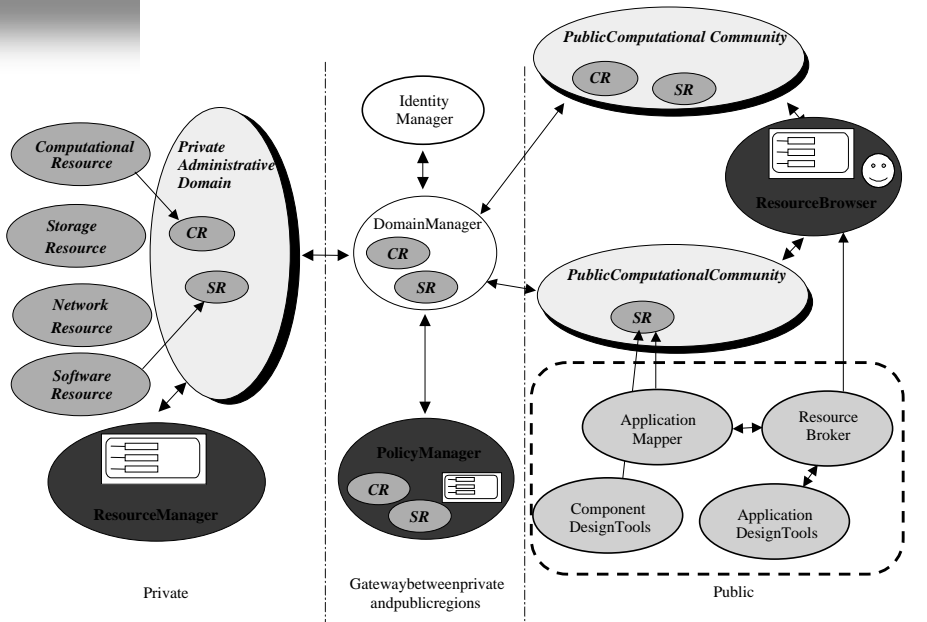
ICENI

The Iceni, under Queen Boudicca, united the tribes of South-East England in a revolt against the occupying Roman forces in AD 60.

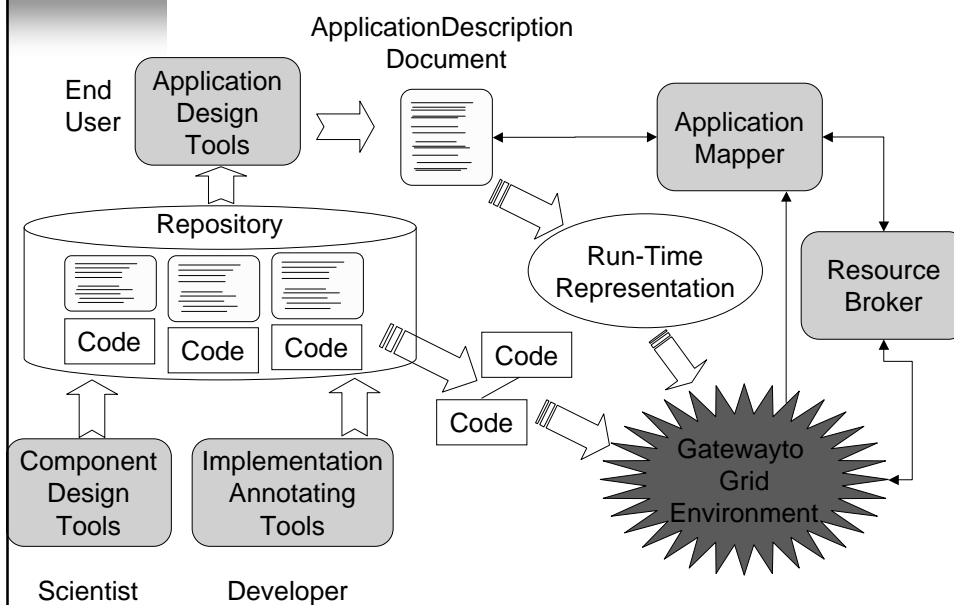


- IC E-Science Networked Infrastructure
- Developed by Grid Middleware Group
- Collect and provide relevant Grid meta -data
- Used to define and develop higher -level services

ICENIOverview



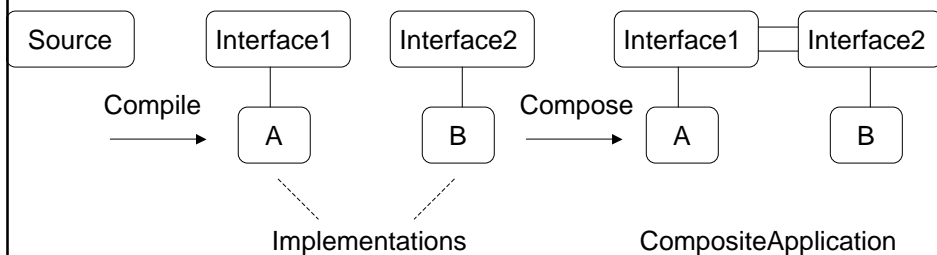
ICENIComponents



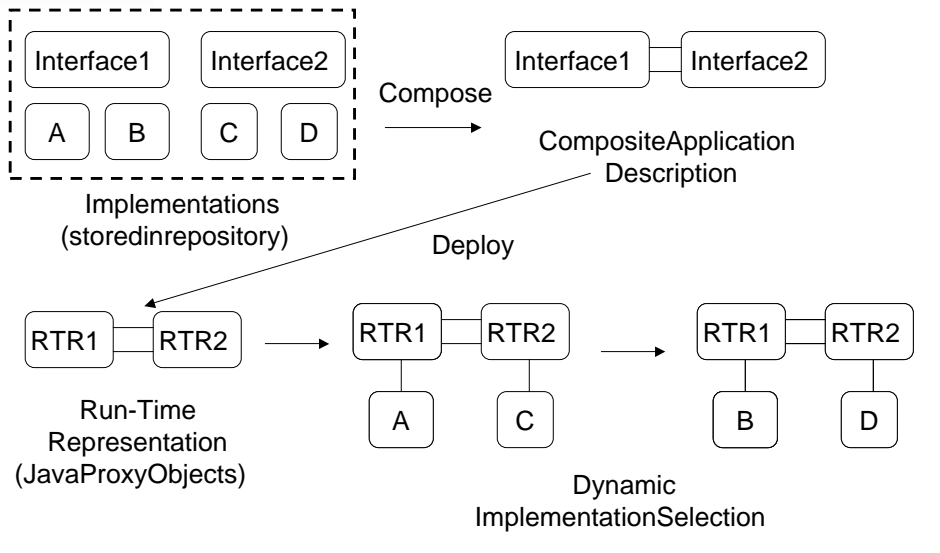
Static Application Information: ComponentXML(CXML)

- Application as network of components:
 - Application Description Document
- Component Interfaces & Behaviour:
 - Repository
- Implementation Performance Characteristics:
 - Repository

Conventional Component Software Lifecycle



AugmentedComponent SoftwareLifecycle



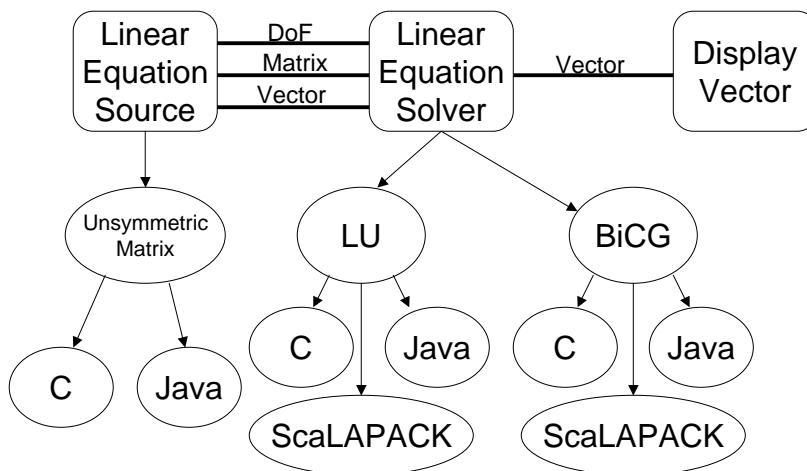
Advantages of Very Late Binding

- Mobility of the high-level representation
- Performance of low-level implementation
- Dynamic Implementation Selection
- Cross-component Optimisation

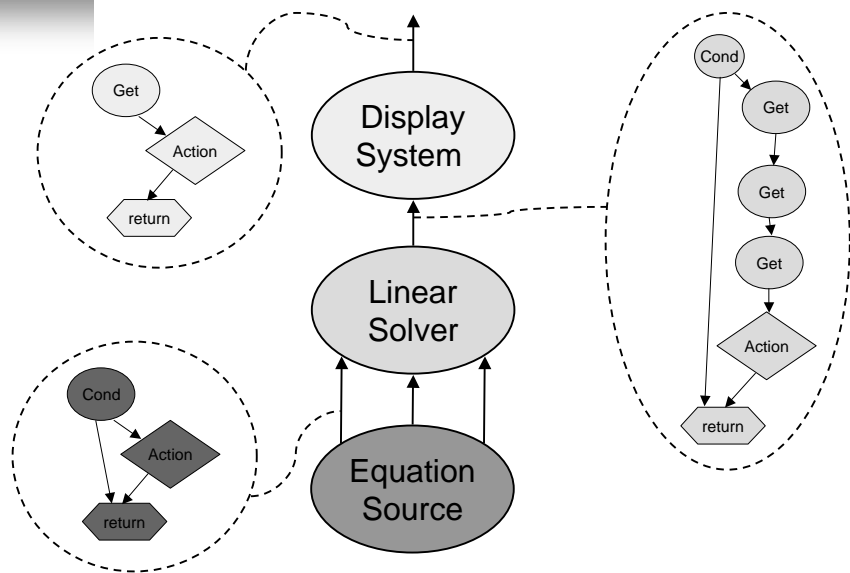
Performance Guided Implementation Selection

1. ApplicationComposition
 - FromRun -TimeRepresentation
2. ImplementationPerformanceModels
 - FromRun -TimeRepresentation
3. ResourceInformation
 - FromGridInfrastructure
4. SelectionPolicy
 - FromComponentFramework

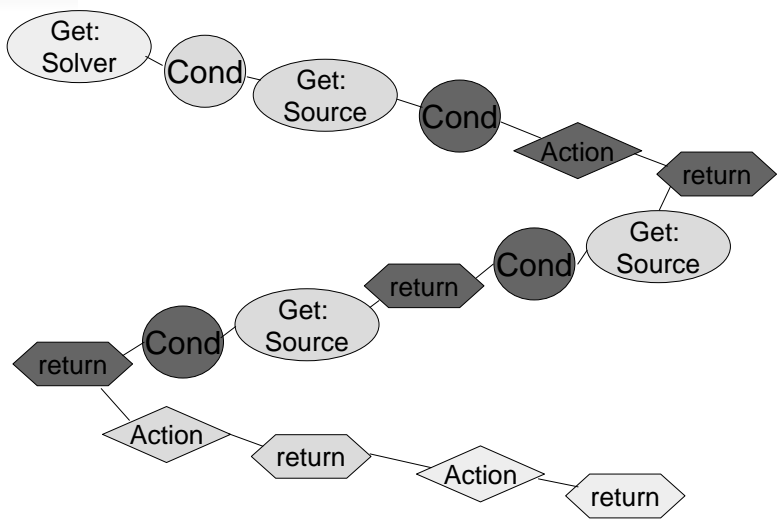
Example: Linear Solver



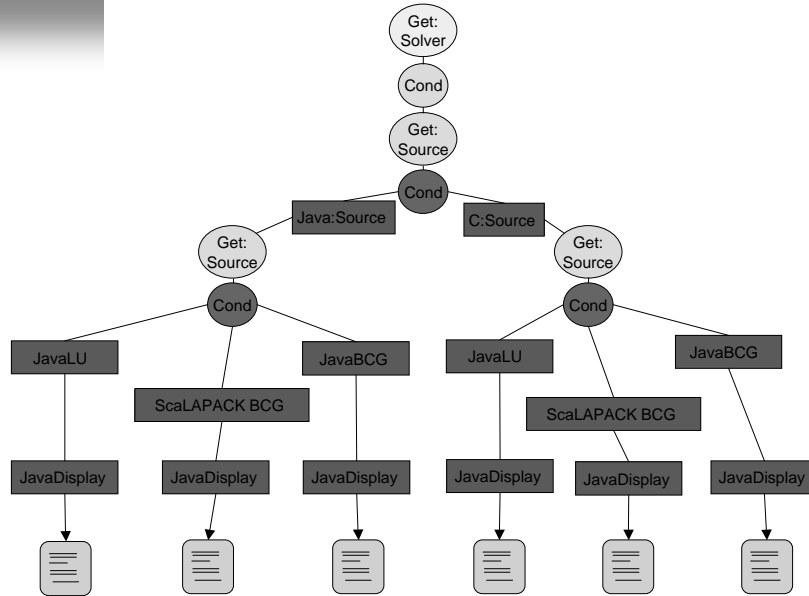
DecisionMaking(1)



DecisionMaking(2)



DecisionMaking(3)



LinearSolver: ComponentXML

```

<repository>
  <component package="icpc.LinearEquationSolver"
    name="LinearSolverRowsColumnsUnsymmetric" version="1">
    <parent package="icpc.framework.core" name="Component" />
    <inPort objectPackage="icpc.core" objectName="Integer" portName="unknowns"/>
    <inPort objectPackage="icpc.Matrix" objectName="DgerCj" portName="matrix"/>
    <inPort objectPackage="icpc.Matrix" objectName="RealVector" portName="vector"/>
    <data exposure="public" objectPackage="icpc.Matrix" objectName="RealVector"
      dataName="solution" >
    <outPort>
      <behaviour method="getVector">
        <block execute="sequential">
          <get name="m1" portName="matrix" method="getMatrix"/>
          <get name="dof" portName="unknowns" method="getInteger">
          <get name="v1" portName="vector" method="getVector"/>
          <call portName="solution" method="getVector"/>
        </block>
      </behaviour>
    </outPort>
    </data>
    <implementation>
      .....
    </implementation>
  </component>
</repository>

```

LinearSolver: OtherRepositoryCXML

```

<repository>
  <component package="icpc.LinearEquationSolver"
    name="LinearSolverRowsColumnsUnsymmetric" version="1">
    <implementation language="java" platform="java" url="file:.">
      <action portName="matrix">
        <binding method="getMatrix"> ... </binding>
        <classPerformanceModel type="initial" url="http:..." />
      </action>
    </implementation>
    <implementation language="C" platform="Linux" url="file:.">
      ...
    </implementation>
  </component>
  <object package="icpc.Matrix.real" name="MatrixRowsColumnsUnsymmetric"
    version="1">
    <method name="getMatrix" type="action">
      <argument mode="out" typeName="MatrixRowsColumnsUnsymmetric"
        typePackage="icpc.matrix.real" />
    </method>
  </object>
</repository>

```


LinearSolver:Application CXML

```

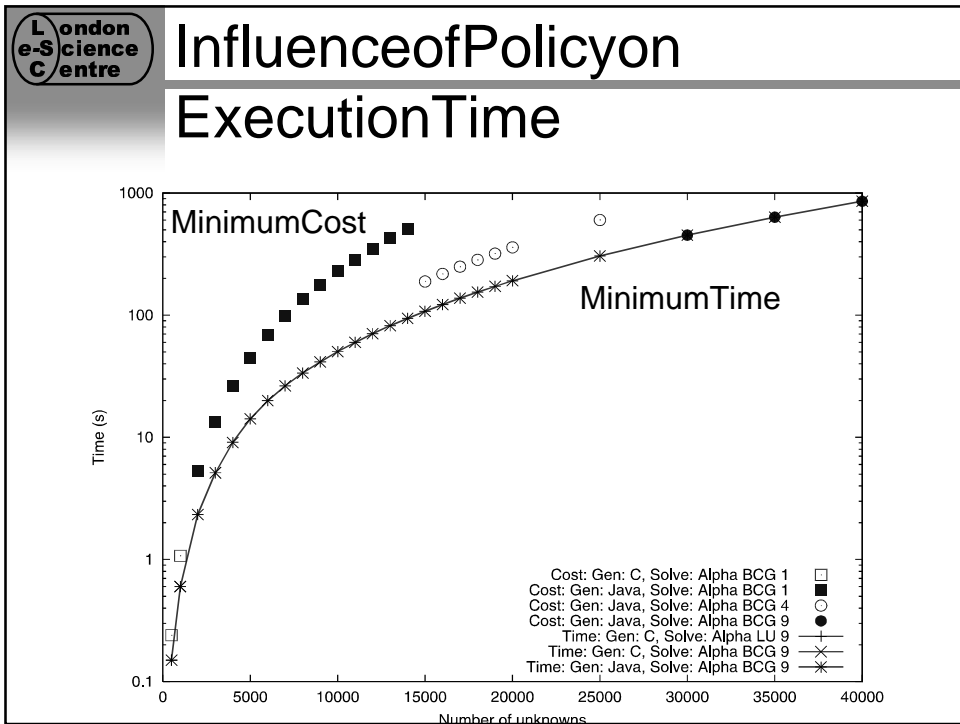
<application>
  <network>
    <instance componentName="LinearEquationSourceRowsColumnsUnsymmetric"
      componentPackage="icpc.denseLinearAlgebra.real" id="1">
      <property name="degrees of freedom" value="100"/>
    </instance>
    <instance componentName="LinearSolverRowsColumnsUnsymmetric"
      componentPackage="icpc.denseLinearAlgebra.real" id="2"/>
    <instance componentName="DisplayVector"
      componentPackage="icpc.vector.real" id="3"/>

    <dataflow sinkComponent="2" sinkPort="matrix"
      sourceComponent="1" sourcePort="matrix"/>
    <dataflow sinkComponent="2" sinkPort="vector"
      sourceComponent="1" sourcePort="vector"/>
    <dataflow sinkComponent="3" sinkPort="vector"
      sourceComponent="2" sourcePort="solution"/>
  </network>
</application>

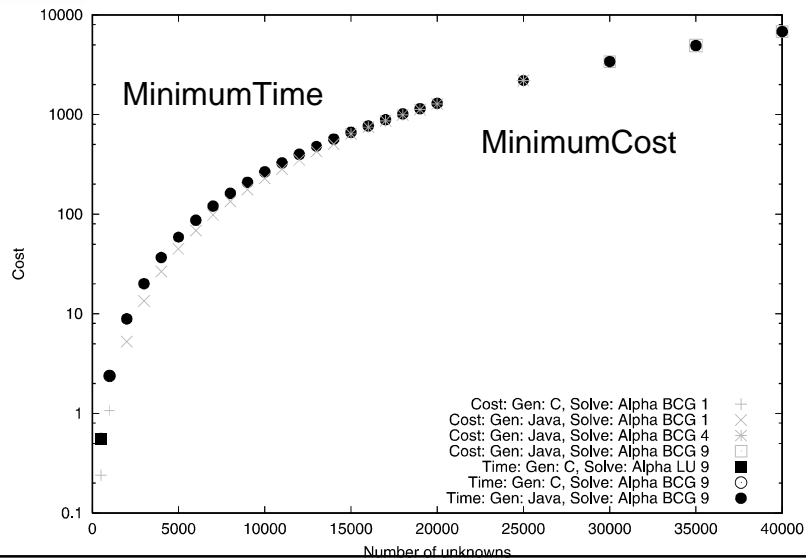
```

|  Local Computational Community | | | | |
|--|---------------------|--------|------------------|--------------|
| System | Processor | Number | Language | Solution |
| PC (Linux) | AMD 900MHz | 1 | Java+C LAPACK | LU+BCG LU |
| Atlas | Alpha 667MHz | 1,4,9 | ScaLAPACK | LU+BCG |
| AP3000 | UltraSparcII 300MHz | 4,9,16 | ScaLAPACK | LU+BCG |

All processors have equal cost



Influence of Policy on Execution Cost



Extensibility

- OpenXML -based Schema
- Multiple Selection Policies
- Dynamic Cost Models
- Integration with ICENI Jini-based Computational Community Grid framework
- Further use of run -time information:
 - Verification/optimisation at application level
 - Partial evaluation of implementation selections

Summary

- Components for E -Science
- ICENI extensible architecture
 - Layered Abstractions
 - Information for Optimisation
- Implementation selection through composite performance modelling

Acknowledgements

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 - Steven Newhouse
 - Anthony Mayer
 - Nathalie Furmento
 - Stephen McGough
 - Tony Field
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- Further Information:
 - <http://www-icpc.doc.ic.ac.uk/components>
 - email: icpc-sw@doc.ic.ac.uk