# GridCOMP - Tutorial
# GCM Component Programming

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# GCM Components

- GCM: Grid Component Model
  - GCM was defined in the NoE CoreGRID
  - GCM extends Fractal with Grid specificities

- Open Source ObjectWeb *ProActive*
  - implements a preliminary version of GCM

- GridCOMP takes:
  - GCM as a first specification,
  - *ProActive* as a starting point, and Open Source reference implementation.

- **Scopes and Objectives:**
- **Grid Codes to Compose and Deploy**
- **No programming, No Scripting, …**

# GridCOMP Partners

European Research Consortium for Informatics and Mathematics
ERCIM

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GRIDSYSTEMS
Simplify Complexity

IBM

Atos Origin
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# Introduction to Components

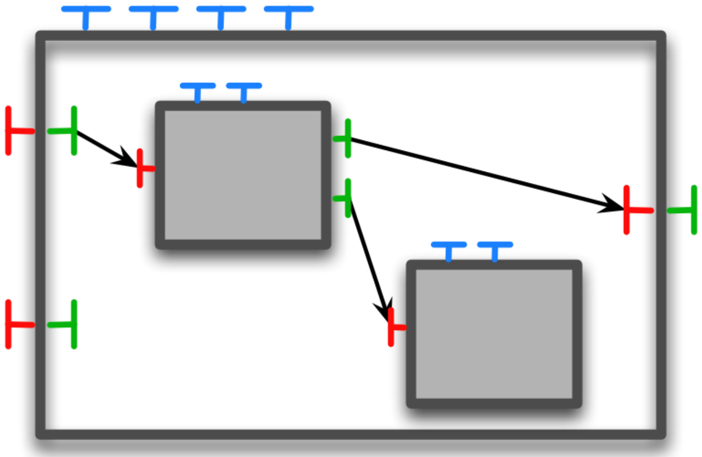
- What are software components?
  - Modules exposing the interaction with the environment
    - Provided (server) interfaces
    - Required (client) interfaces
  - Black-boxes (from outside)
- Advantages
  - Encapsulation (black-boxes)
  - Composition
  - Standardized Description ⇨ ADL ⇨ GUI, Verification
  - Units of deployment
  - Programming in the large vs. programming in the small (objects)
- Goal
  - Reuse and compose
  - Commercial Off-The-Shelf (COTS)

# Rationale: Grid applications

| Requirements | Solutions with ProActive/GCM |
|---|---|
| Distribution | Distributed components |
| Multiple administrative domains | Handled by the middleware |
| Heterogeneity | Portable implementations, interoperability |
| Legacy code | Encapsulation, interoperability |
| Performance | Legacy code, parallelism |
| Complexity | Hierarchies, collective interfaces |
| Dynamicity | Adaptation and coherent reconfigurations |
| Tools | ADL, GUI, Packaging |

# Approach Based on the Fractal Model

- INRIA - France Telecom, V1 in ’02
  - General model, core concepts
    - Encapsulation
    - Strict Definition
    - Assembly and deployment units
  - Simple, extensible, hierarchical, dynamic
  - Separation of concerns (controllers)
  - However:
    - Distribution ?
    - Deployment ?
    - Parallelism ?



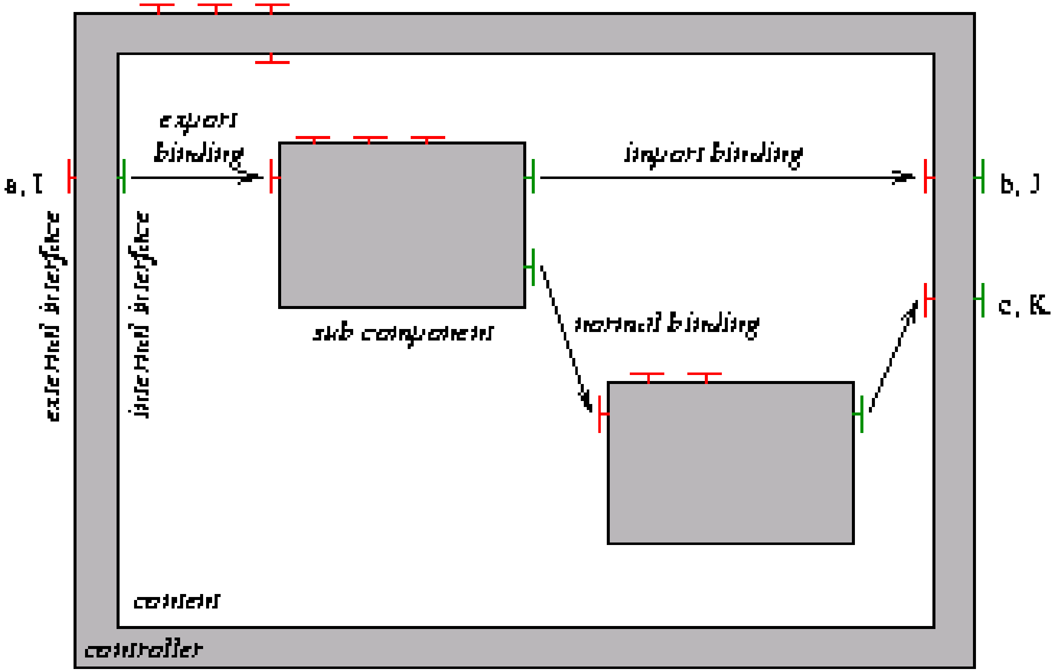
⇨ Fractal requires extensions for Grid Computing

⇨ Specified in the Grid Component Model - GCM (CoreGRID)

# Some important Fractal Concepts

- Content
- Controller (or membrane)
- Server Interface
- Client Interface

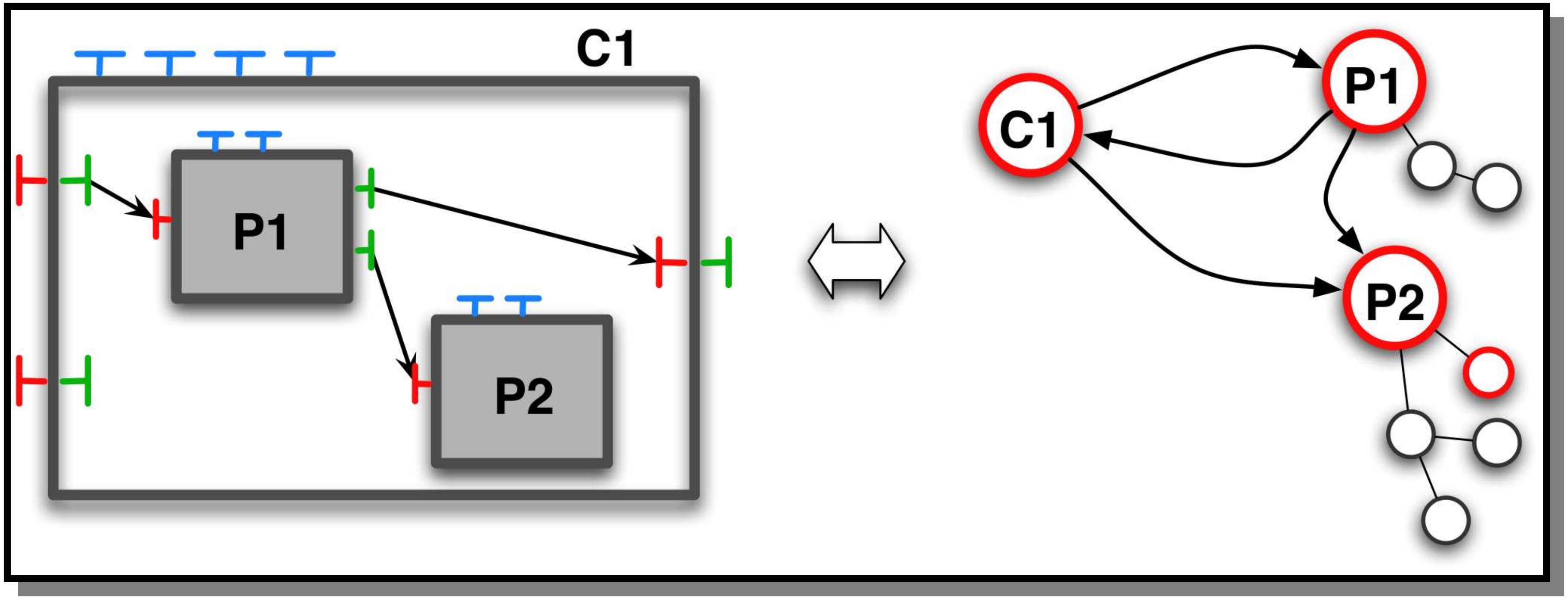
- Bind(ing)
- Functional interface
- Control (or non-functional) Interface



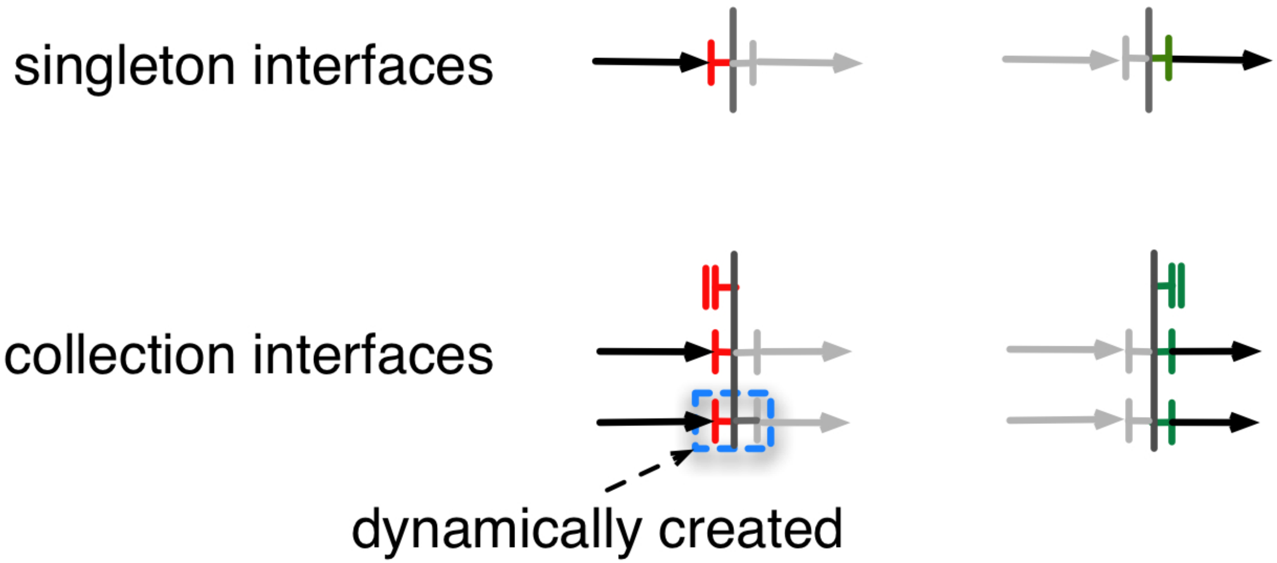
# ProActive/Fractal

- Implementation of Fractal based on ProActive middleware Model
  - Based on MOP architecture: Component as Active Object
  - Distributed components, asynchronous communications (futures)
  - Benefits from underlying features of the middleware
    - Middleware services (Fault Tolerance, Security, Mobility etc..)
    - Deployment framework (in development GCM deployment, being standardized at ETSI)
  - Sequential processing of requests in each component
  - Main extensions to Fractal: deployment, collective interfaces
  - Configurable and extensible

# ProActive/Fractal



# Standard Fractal Interfaces



singleton interfaces

collection interfaces

dynamically created

Only 1 to 1 communications!

# GCM Collective Interfaces

- ⇨ collective interfaces
  - Multicast
  - Gathercast
    gather-multicast

- Simplify the design and configuration of component systems

- Expose the collective nature of interfaces

- Interface typing ➔ Verifications

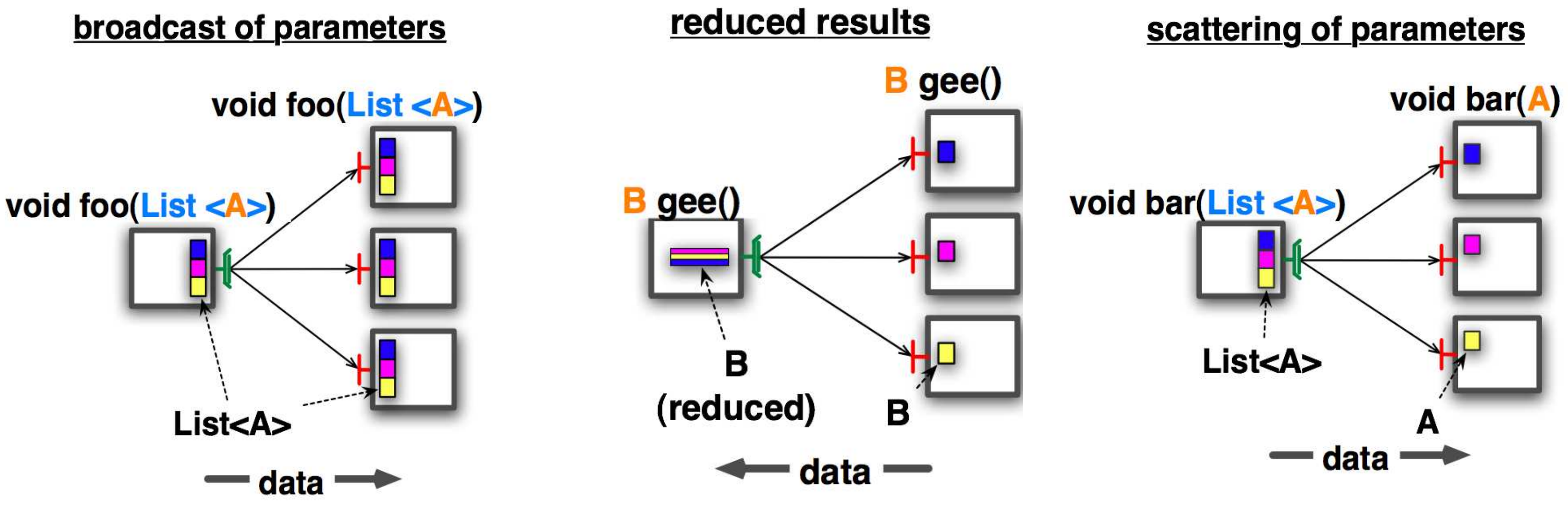
➔ **The framework handles collective behavior**
**at the level of the interface**

# GCM Multicast interfaces

## single invocation ⇨ list of invocations

- Multiple invocations
  - Parallel
  - Asynchronous
  - Selective
  - Dynamic
- Data distribution
  - Automatic
  - Customized distribution function
    - Broadcast, scattering, reduction
  - Explicit typing,
    - Parameterized collections
    - Compatibility verified at runtime when binding

# Multicast Interfaces Illustrated



Configurable distribution policies

Parallelism

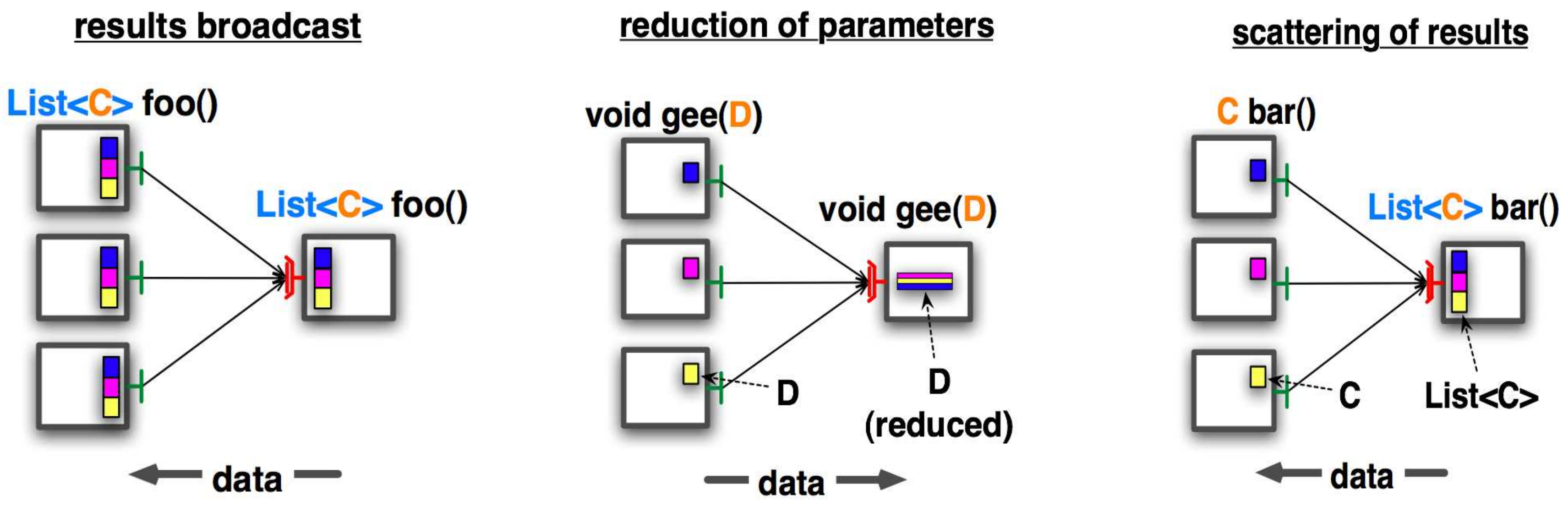
Strong typing

# GCM Gathercast Interfaces

list of invocations ⇨ single invocation

- Synchronization
  - ~ “join” invocations
  - Customizable: wait-for-all, wait-for-some
  - Timeout
- Data distribution
  - Aggregation / reduction of parameters
  - Redistribution of results
  - Symmetrical to multicast

# Gathercast Interfaces Illustrated



Configurable distribution policies

Synchronization

Strong typing

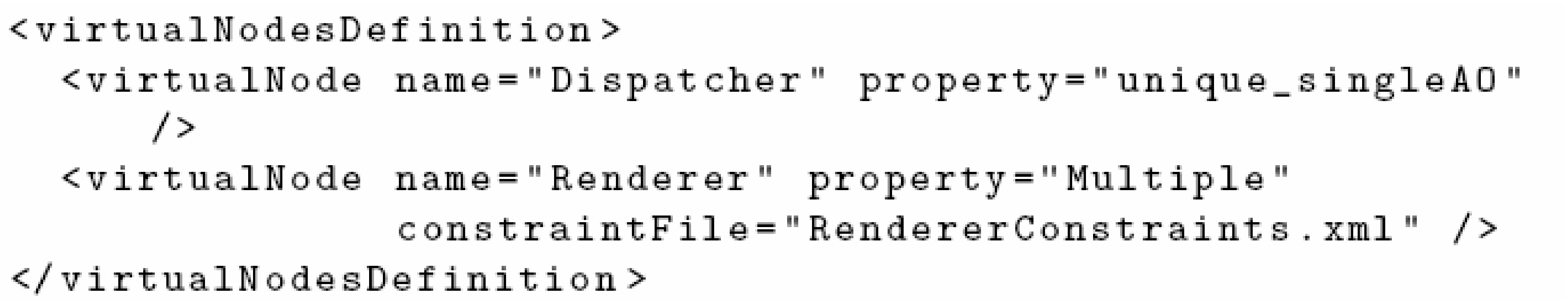
# Architecture Description Language (ADL)

- Specifies the system architecture
  - Components, subcomponents
  - Bindings
  - Interfaces (IDL)
- Used to configure and deploy component systems

# Architecture Description Language (ADL)

- In GCM, the Fractal ADL has been extended:
  - allows to reuse ProActive-specific features like deployment
  - supports Collective Interfaces

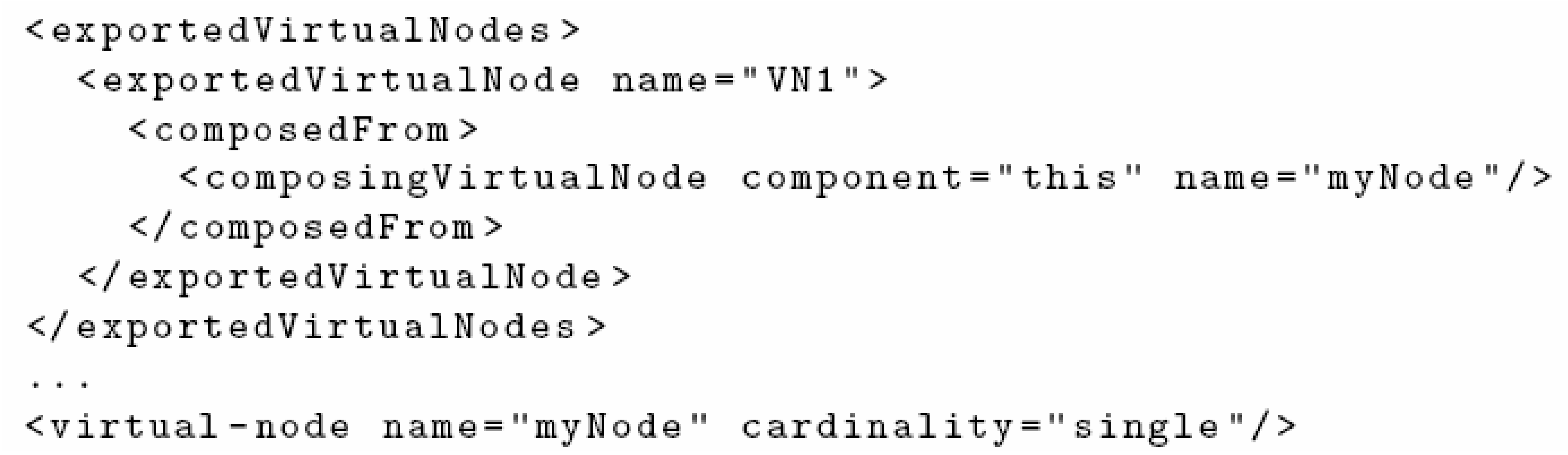
# Virtual Nodes



```
<virtualNodesDefinition>
  <virtualNode name="Dispatcher" property="unique_singleAO"
      />
  <virtualNode name="Renderer" property="Multiple"
               constraintFile="RendererConstraints.xml" />
</virtualNodesDefinition>
```

- Permits a program to generate automatically a deployment plan:
  - find the appropriate nodes on which processes should be launched.

# Virtual Nodes in the ADL



```
<exportedVirtualNodes>
  <exportedVirtualNode name="VN1">
    <composedFrom>
      <composingVirtualNode component="this" name="myNode"/>
    </composedFrom>
  </exportedVirtualNode>
</exportedVirtualNodes>
...
<virtual-node name="myNode" cardinality="single"/>
```

- Renames a VN
- Exports a VN name

➔final version of the GCM specification will precisely define the syntax for the virtual node definition, and their composition.

ProActive

Programming, Composing, Deploying on the Grid

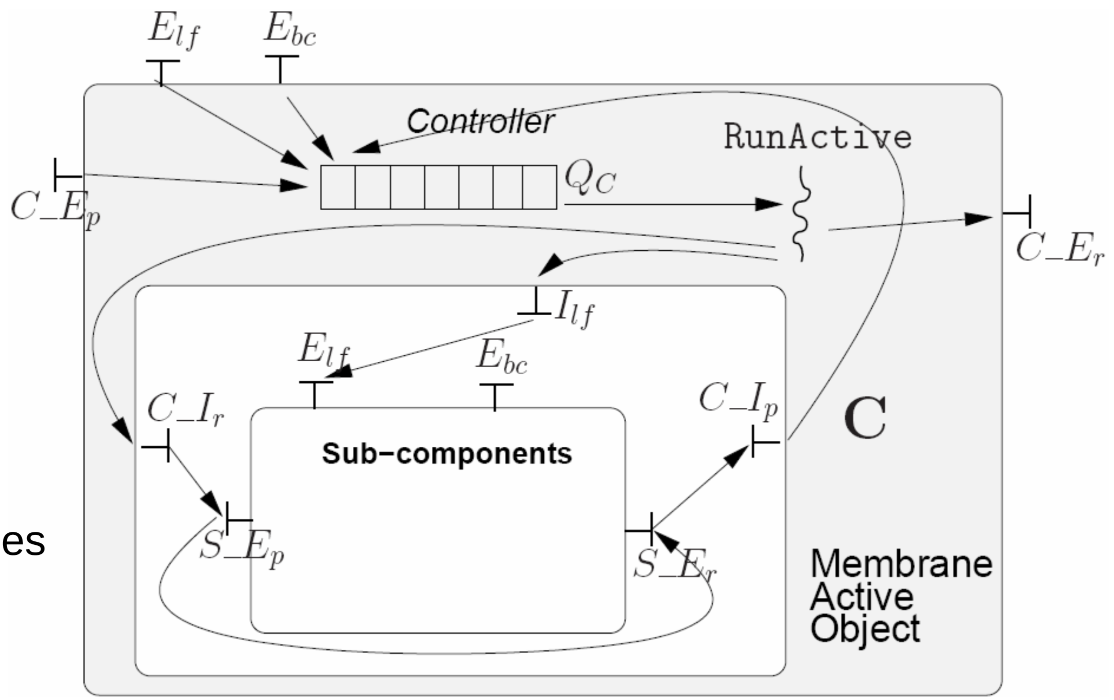
http://proactive.objectweb.org

Let’s practice a little more !

# First-steps in GCM/ProActive Components

- Composite
  - Defined in ADL

- Primitive
  - Defined in ADL
  - Java class
    - implements server interfaces



- Interfaces
  - Cardinality (single or multiple) → ADL
  - Signed by Java interfaces
    - Distribution policy → Java annotations

# Distribution Policy

- Given by Java annotations

```
@ClassDispatchMetadata(
  mode=@ParamDispatchMetadata(
       mode=ParamDispatchMode.BROADCAST))

interface MyMulticastItf {
       public void foo(List<T> parameters);
}
```