FAC
Fractal Aspect Component

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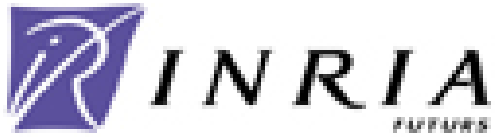
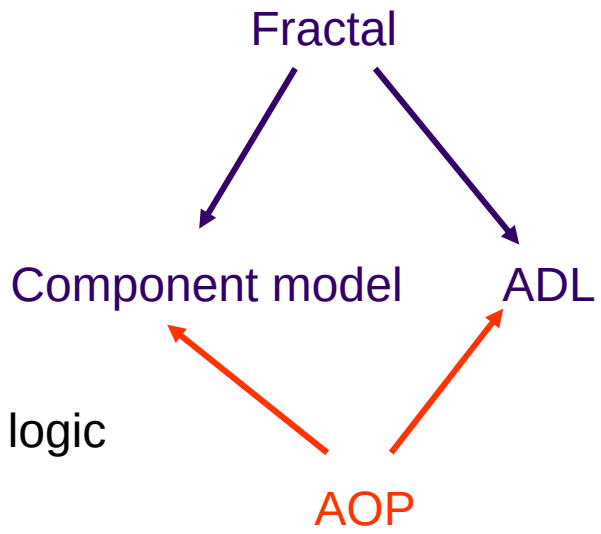
Jacquard project



FAC project & context

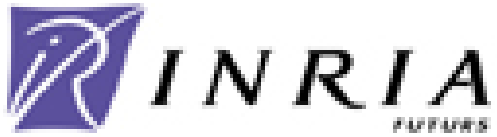
- Get 2 development styles closer:
  - Component assembly:
    - Packages software entities in modules
    - Increases reusability
    - Architecture Description Language (ADL):
      - Clarifies software entities interactions
    - Fractal component model
  - Aspect-Oriented Programming (AOP):
    - Separation of Concerns (SoC)
    - Separates technical services from business logic
    - Modularizes crosscutting concerns
    - JAC model
- Fractal Aspect Component:
  - enhance Fractal component model and Fractal-ADL with AOP principles



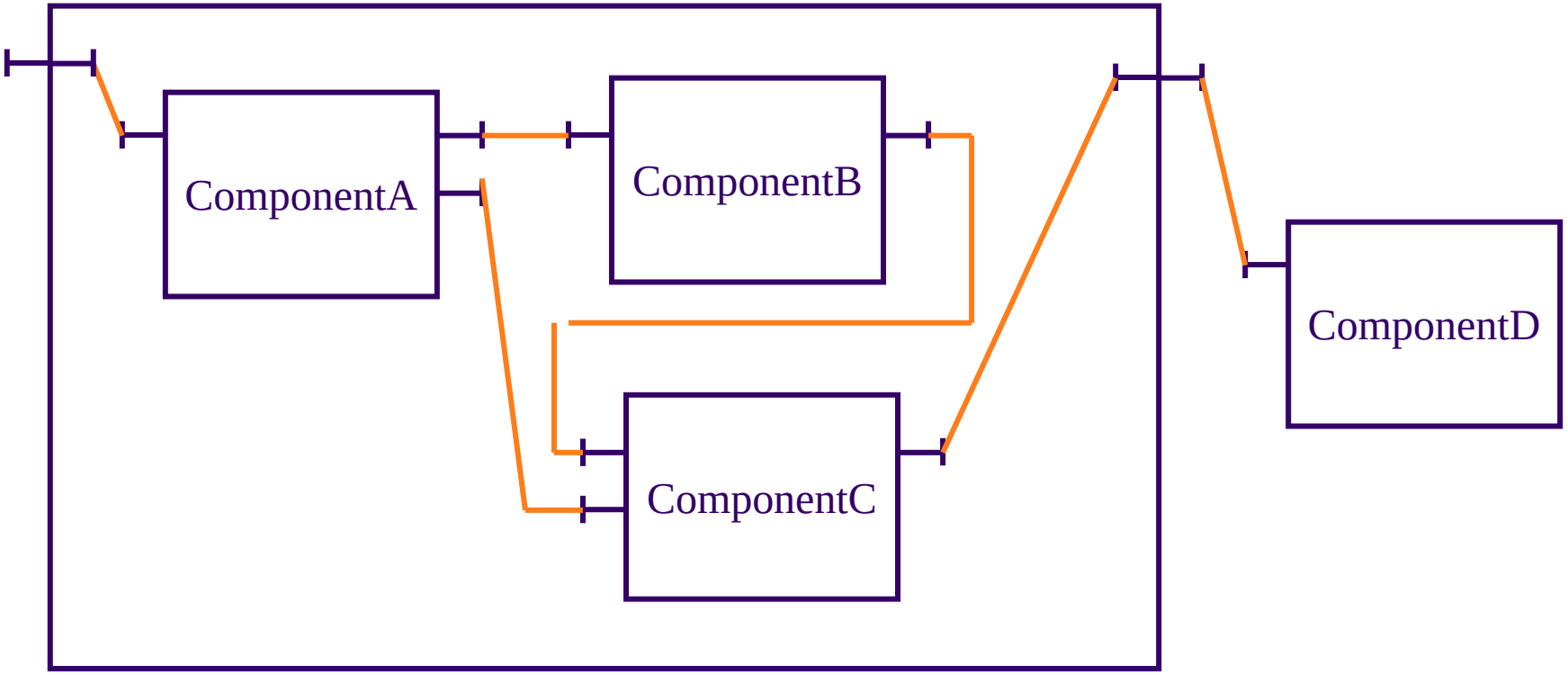
Roadmap

- Fractal Crosscutting Issues
- FAC Abstract Model
- FAC Concrete Model
- Tools:
  - Fractal-ADL extension
  - Fractal Explorer extension
- Conclusion & Future Work

Fractal Crosscutting Issues



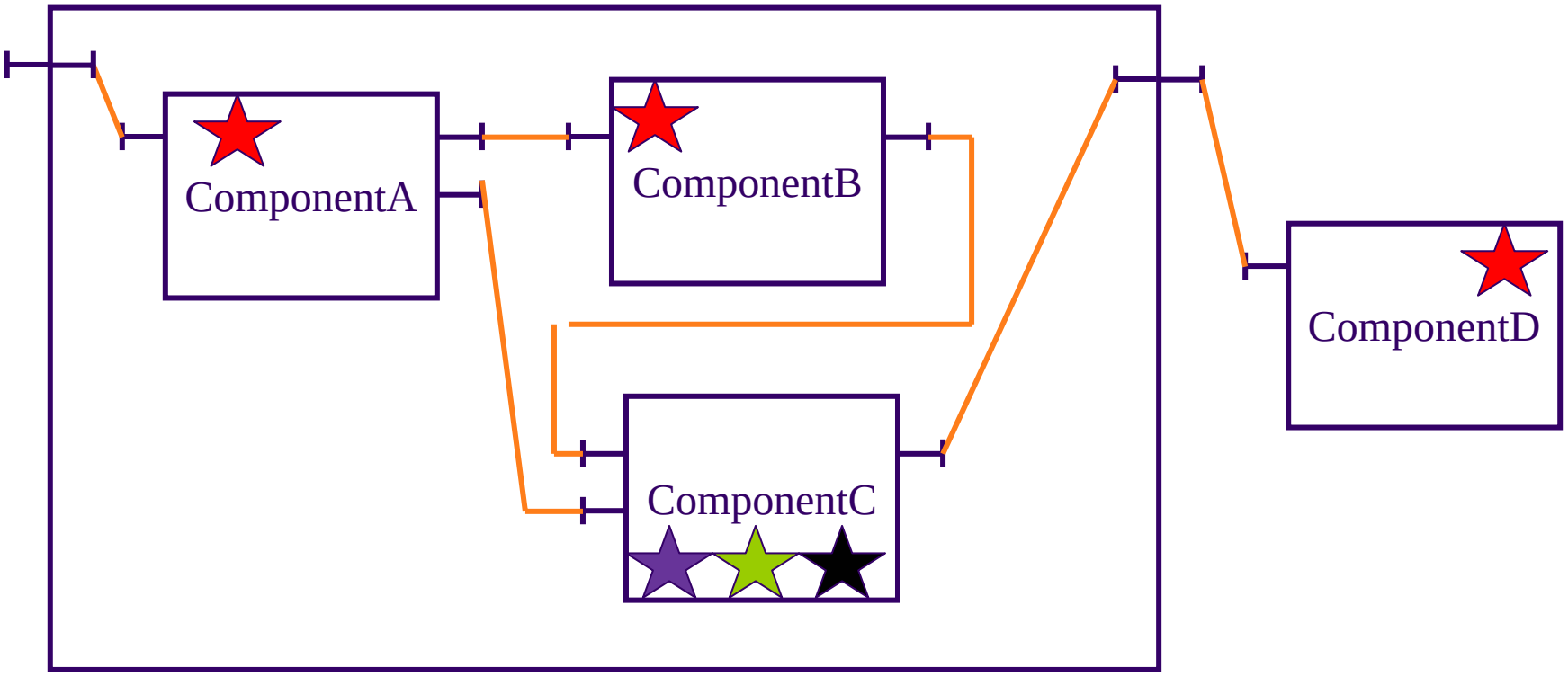
Crosscutting issues (1/3)



Crosscutting issues (2/3)

Code scattering

Code tangling

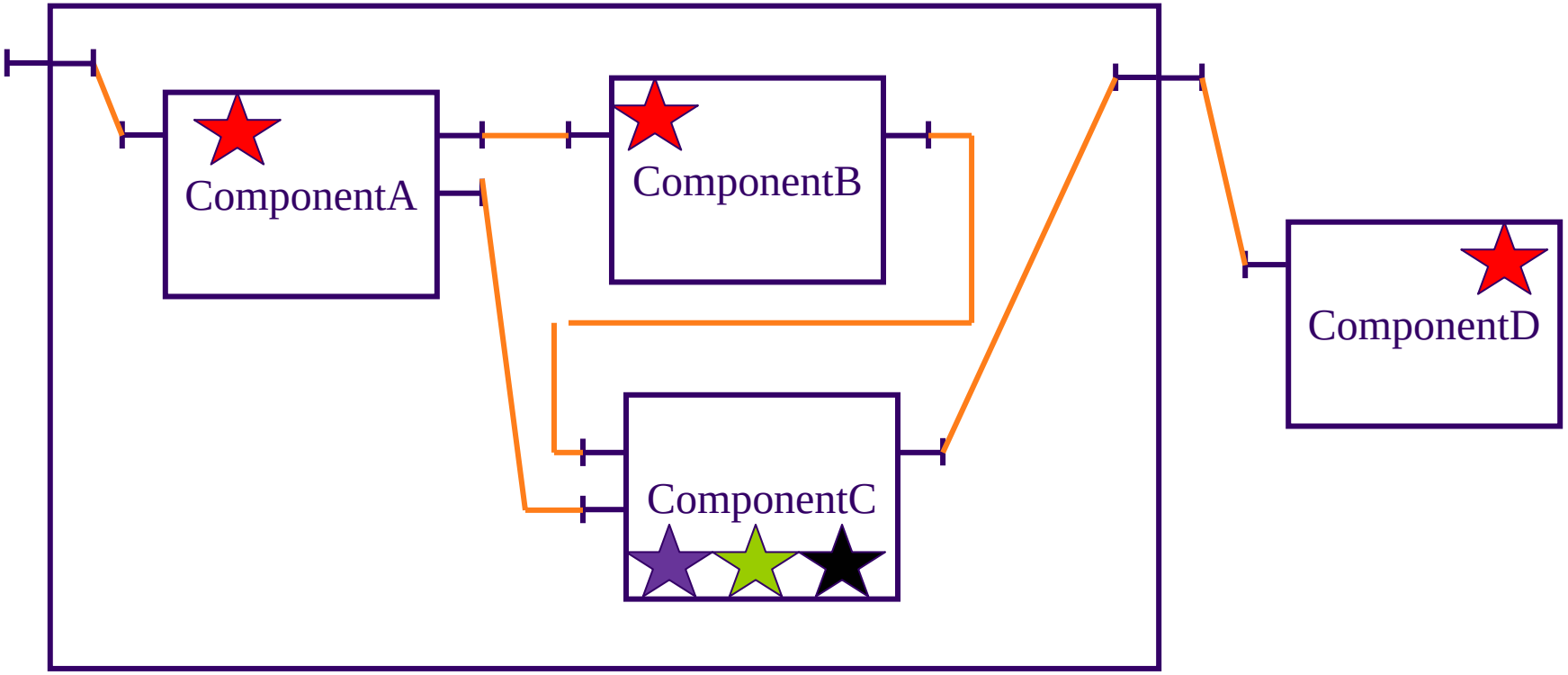


Crosscutting issues (3/3)

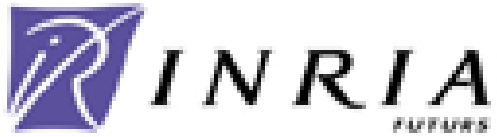
Code scattering

Code tangling

Apply AOP to components ? Fractal Aspect Component



FAC Abstract Model



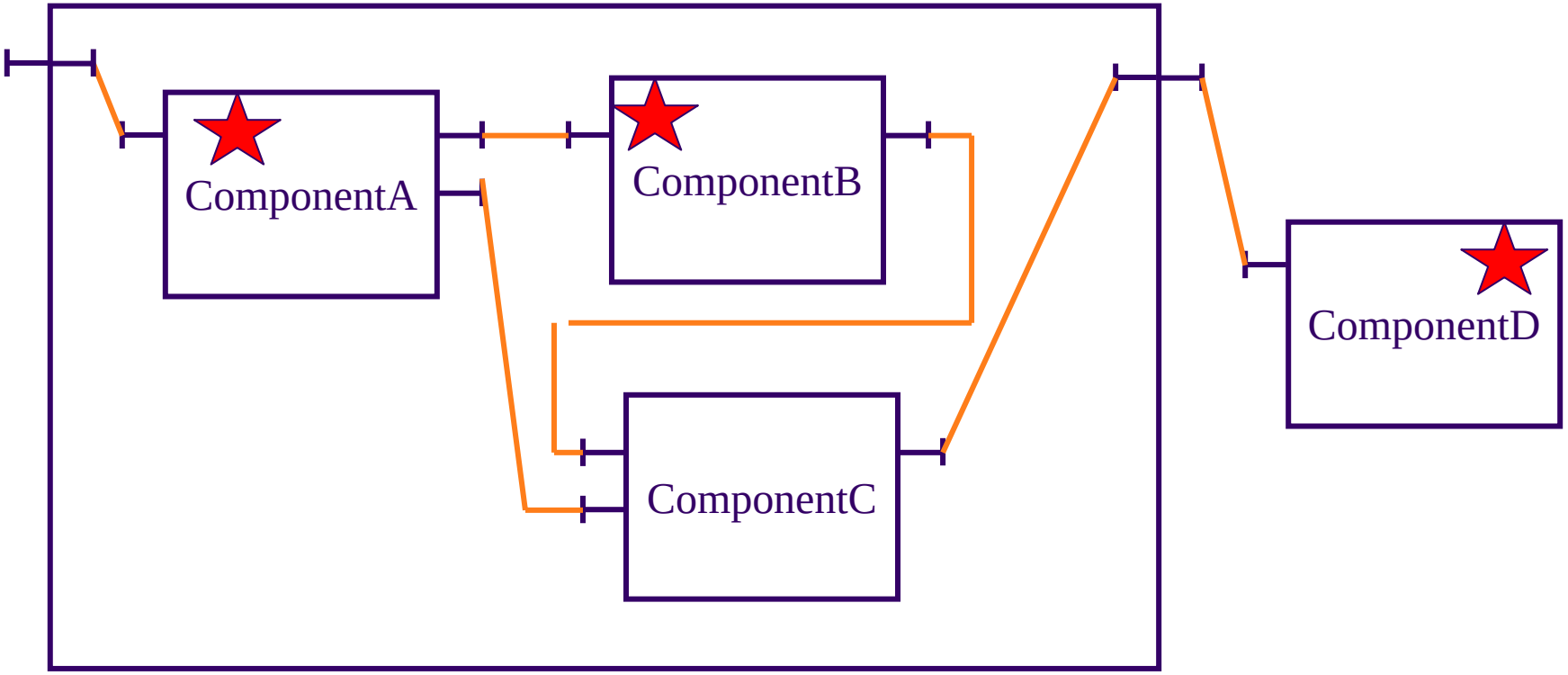
FAC Overview

- 2 main notions:
  - Aspect Component (AC): --> WHAT ?
    - Embodies a crosscutting concern
    - Is a Fractal component with a server interface that describes the behavior to apply
    - Components and Aspects are components:
      - Symmetric approach
  - Crosscutting Binding (CB): --> WHERE ?
    - A new kind of binding between an aspect controller and an AC
    - New control interface: the aspect controller

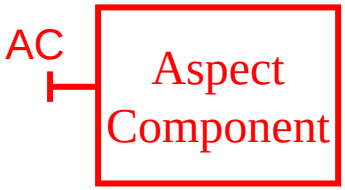
Abstract model (1/4)

Server interface *AspectComponent*

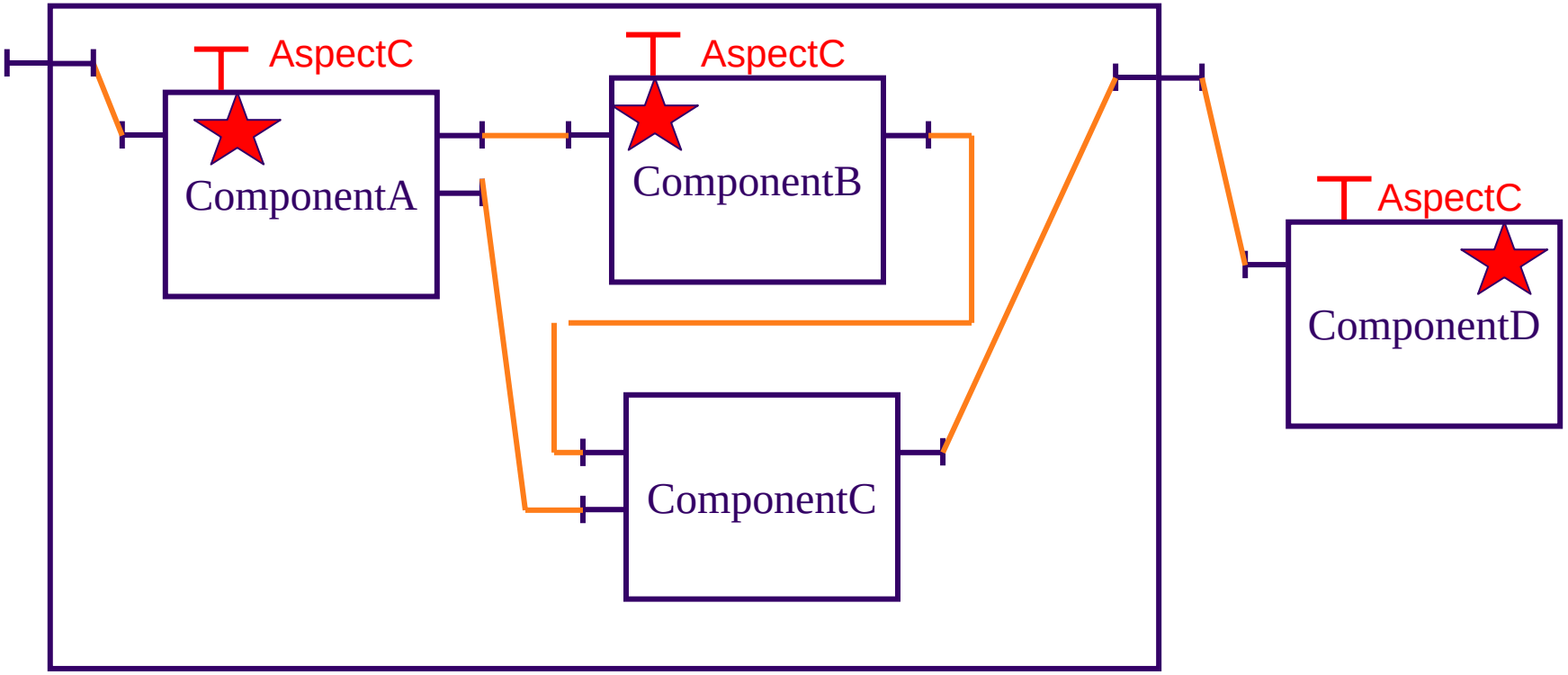
An Aspect Component (AC) embodies a crosscutting concern



Abstract model (2/4)

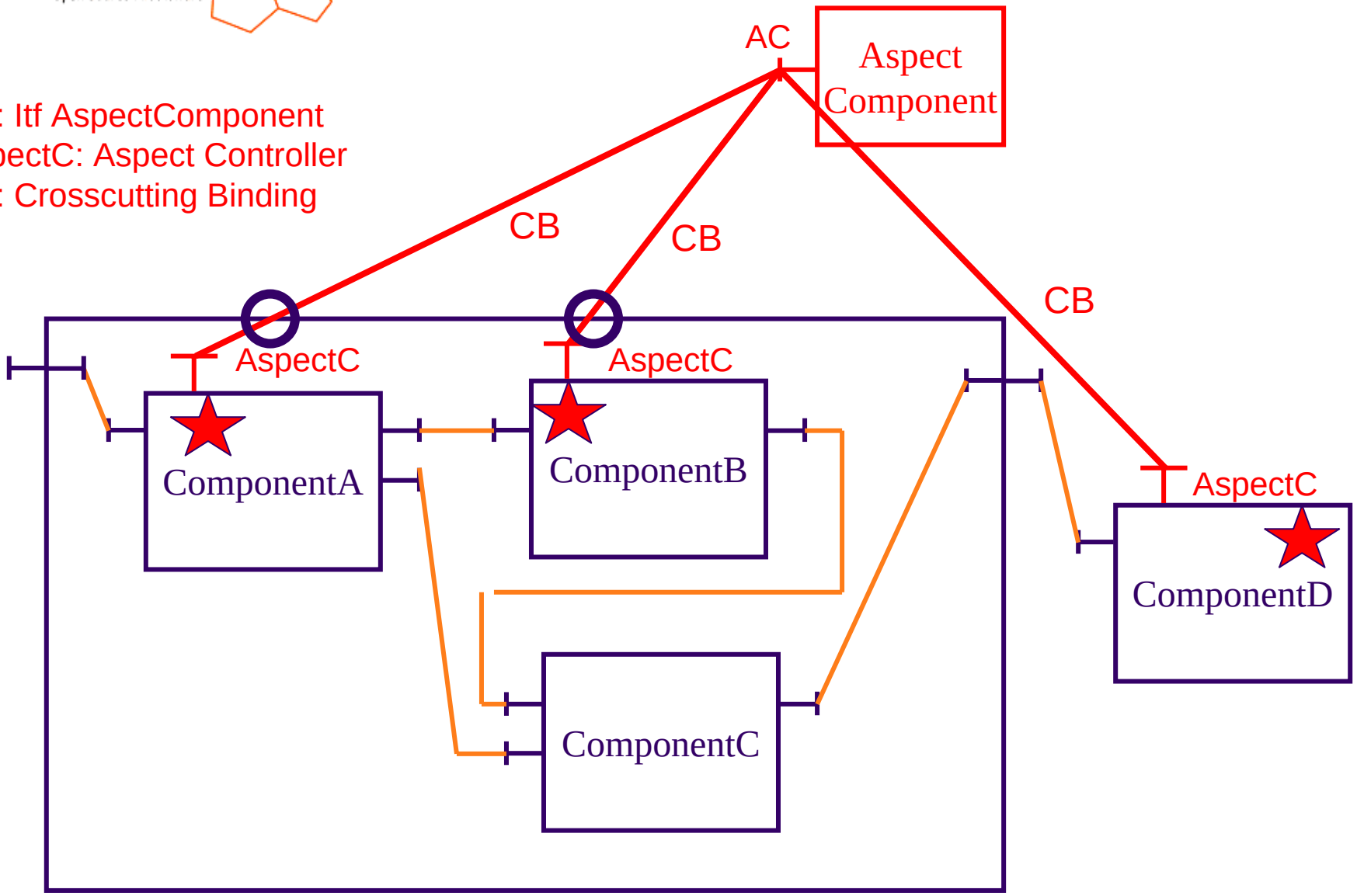


AC: Itf AspectComponent
AspectC: Aspect Controller



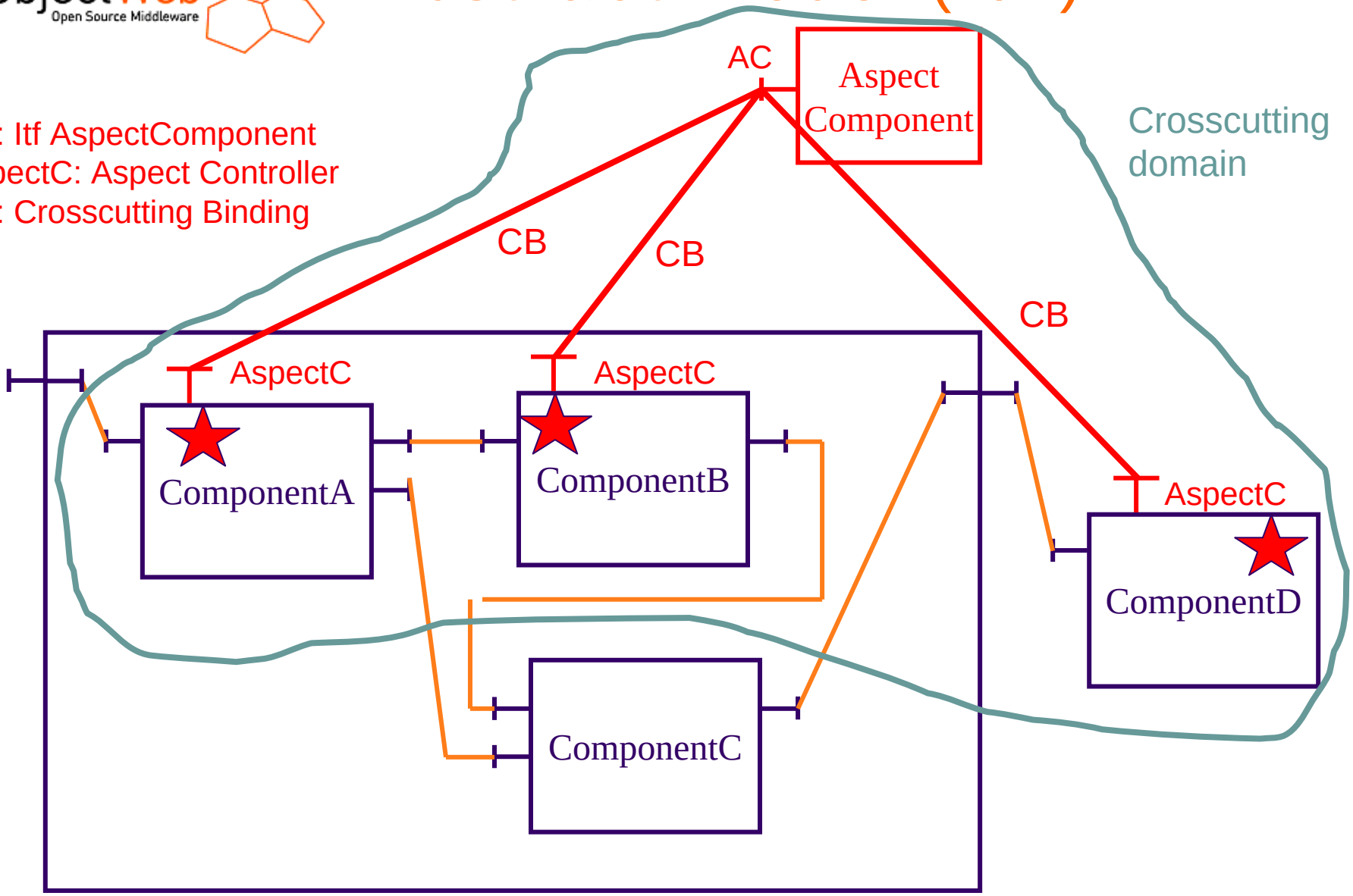
Abstract model (3/4)

AC: Itf AspectComponent
AspectC: Aspect Controller
CB: Crosscutting Binding



Abstract model (4/4)

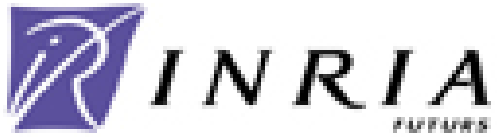
AC: Itf AspectComponent
AspectC: Aspect Controller
CB: Crosscutting Binding



FAC 3 levels

- 3 levels to apply AOP:
  - Object:
    - Content of components
    - Traditional AOP: AspectJ
  - Component:
    - Aspect component (AC)
    - Crosscutting binding (CB)
    - Current FAC
  - Architecture:
    - Architectural pattern transformation
    - Future work

FAC Concrete Model

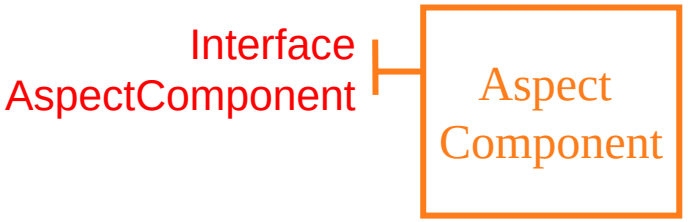


FAC Concrete Model

- AspectComponent server inferface
  - Defines an Aspect Component
- Aspect Control Interface
  - Supports the Crosscutting Bindings
- FAC Pointcut Language
  - Captures a set of components and interfaces

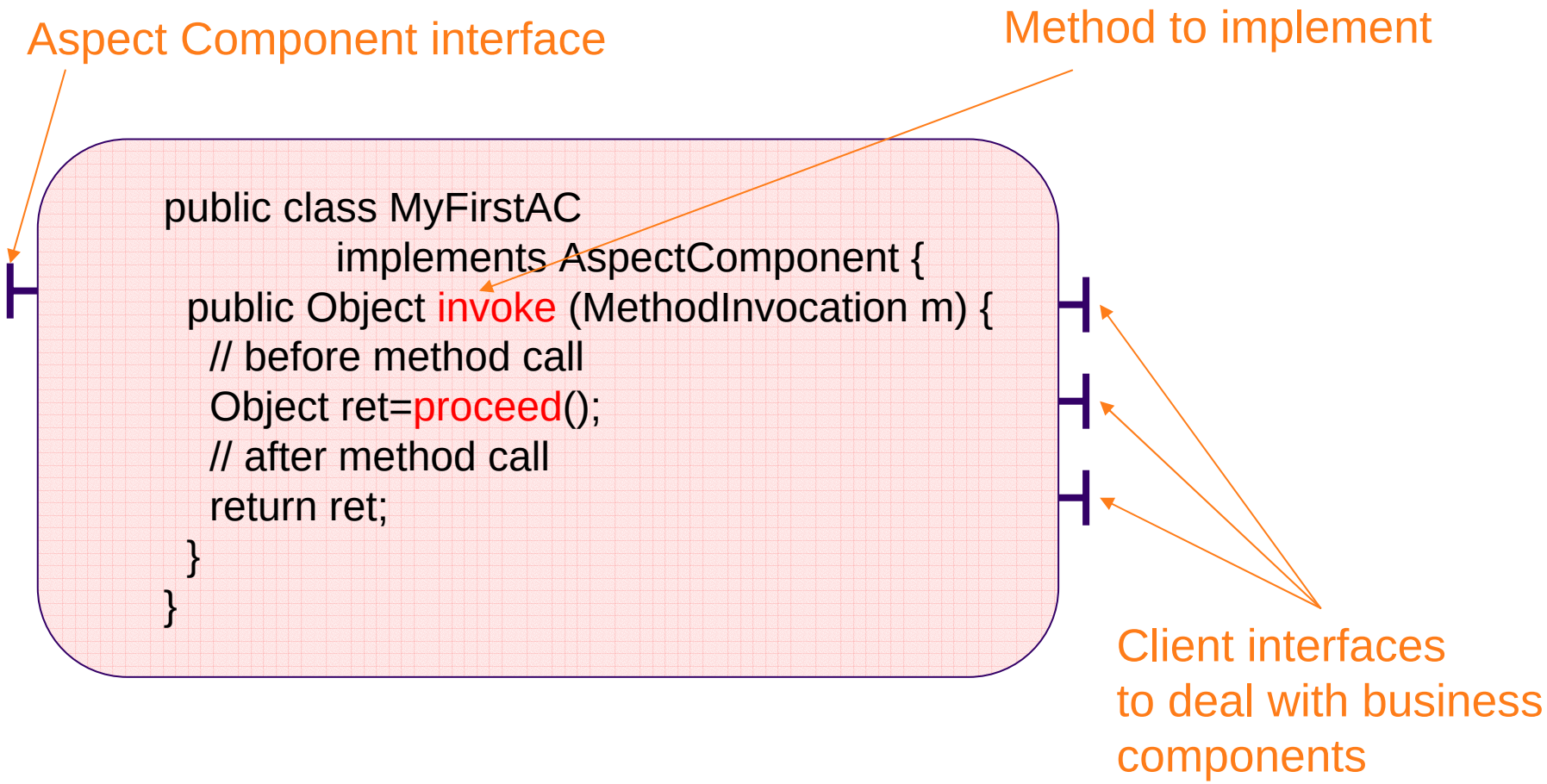
Aspect Component Interface

- An AC embodies a crosscutting concern
- ACs can be bound to business components



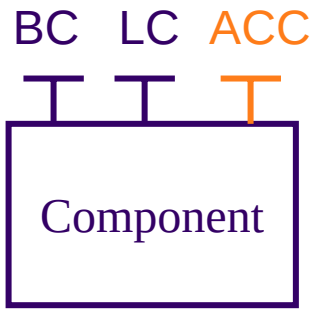
- Server interface *AspectComponent*:
  - Relies on AOP Alliance API: open source initiative to define a common API for AOP frameworks (Spring, Dynaop, Joyaop, JAC)
  - Applies on client and server component interfaces

Aspect Component (AC)



Aspect Control Interface

- The Aspect Controller supports Crosscutting Bindings:
  - Manages a list of ACs
  - Allows local order policy on each component
  - Relies on interception mechanism :
    - Julius (**Julia** extension): byte code transformation with ASM
    - FACAOKell (**AOKell** extension): AspectJ around advice.



BC : *Binding Controller*
LC : *Life Cycle Controller*
ACC : *Aspect Component Controller*

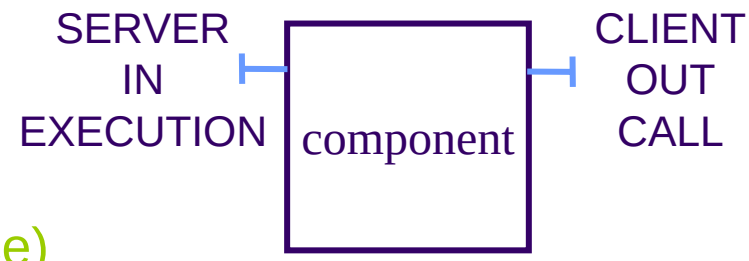
Aspect Controller API

```
Interface AspectComponent{
    // weaving part
    void weave(Component rootComp,
                    AspectComponent ac,
                    ItfPointcutExp pointcutExp,
                    String cbName);
    void unweave(Component rootComp, Component ac);

    // Pointcut introspection part
    Component[] listAC();
    Component[] listCrosscutComps(Component rComp, Component ac);
    Pointcut aspectizableComps(Component rComp,
                                    ItfPointcutExp pExp);
}
```

Pointcut language: structural pointcuts

- Currently, 3 regular expressions declared in the ADL:
  - Component name
  - Interface name
  - Method signature

  CLIENT/SERVER tag (type of interface)

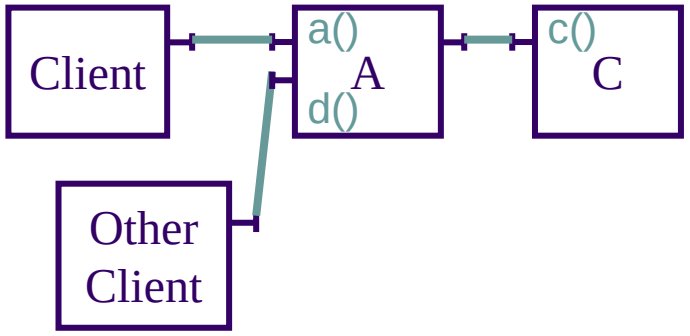


- Pointcut examples :
  - "**.* .* .***"
    - Intercepts every methods on every interfaces of all components
  - "SERVER **server .* print.*:void**"
    - Intercepts incoming void methods that begin with "print" in component "server"

Pointcut language: behavioral pointcuts

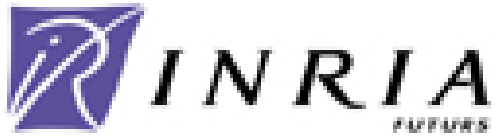
- The Aspect Component behavior is triggered on a sequence of messages (calls and executions of component interfaces)
- Historic/path of a method call

- A state machine is generated
- The expression describes its transitions



- Example:
  - Client.a();compA.b();compC.c() and OtherClient.d();compA.b();methodC.c()
- Wildcards authorized:
  - (a+b);c*;(d+e) matching sequences: ace, acd, bd, bce, …

Tools



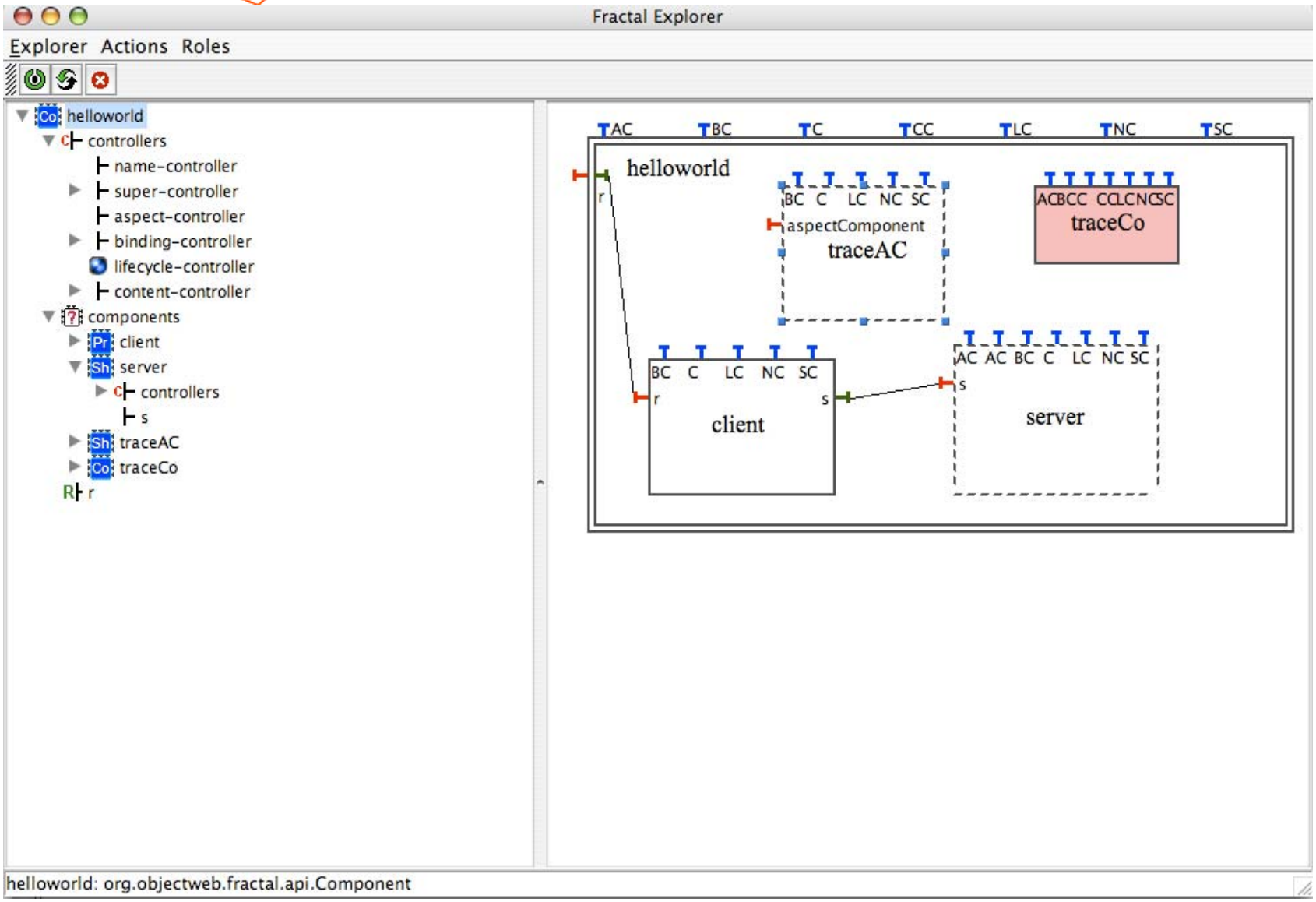
Fractal-ADL Extension

```
<component name="traceAC">
    <interface name="aspectComponent"
    role="server"
    signature="org.objectweb.fractal.fac.api.Aspe
    ctComponent"/>
    <content class="TraceAC"/>
    <controller desc="primitive"/>
 </component>
```

```
<weave
    root="this"
    ac="traceAC"
    componentExp="server"
    interfaceExp="s"
    methodExp=".*"
    pointcutName="traceCo"/>
```

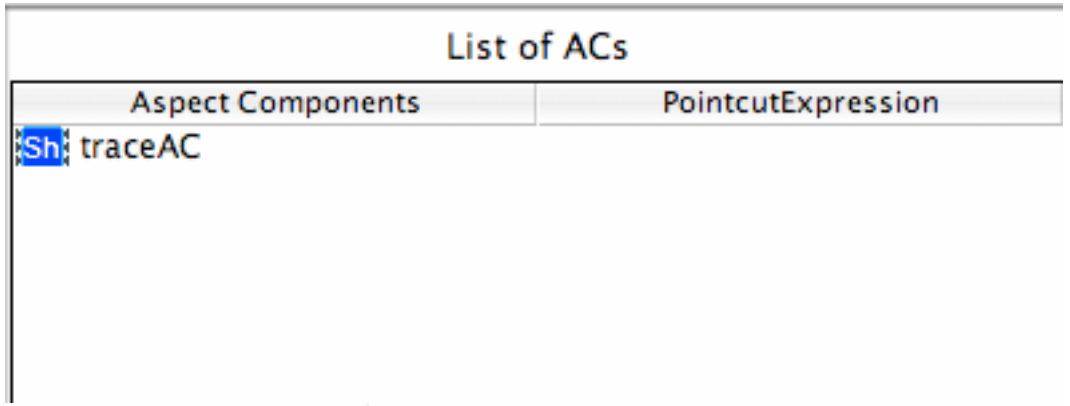
```
<definition name="HelloWorld">
 <component name="client">
    <interface name="r" role="server"
signature="java.lang.Runnable"/>
    <interface name="s" role="client"
signature="Service"/>
    <content class="ClientImpl"/>
    <controller desc="primitive"/>
  </component>

  <component name="server">
    <interface name="s" role="server"
                          signature="Service"/>
    <content class="ServerImpl"/>
    <controller desc="FACprimitive"/>
  </component>
            (…)
  <binding client="client.s"
server="server.s"/>

</definition>
```

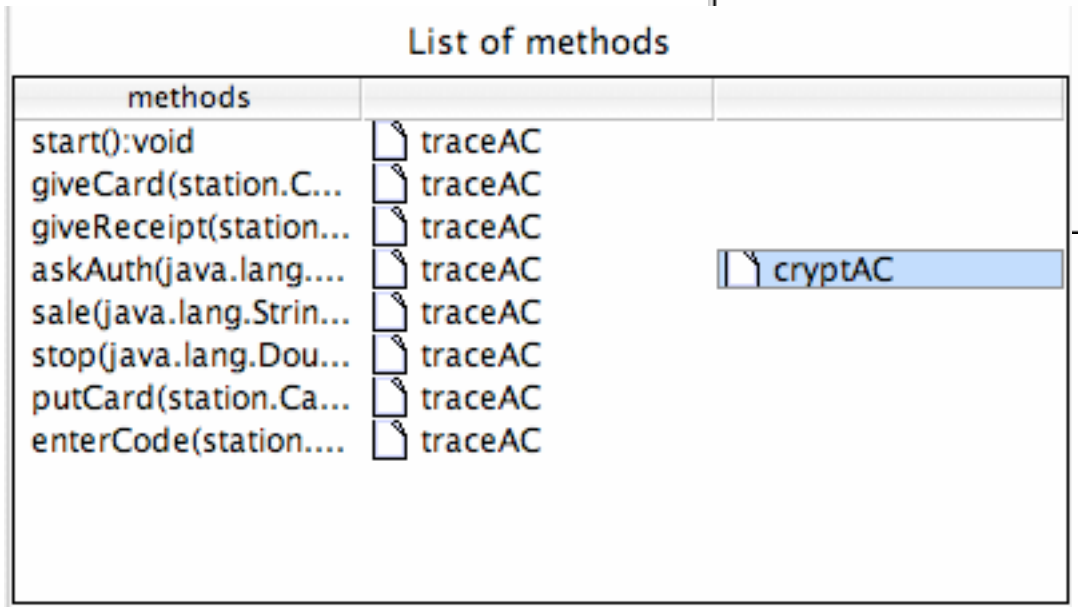
Fractal Explorer Extension



Fractal Explorer: introspection

List of ACs



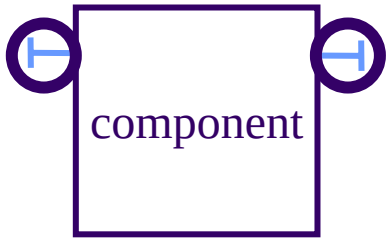


ACs at the method granularity

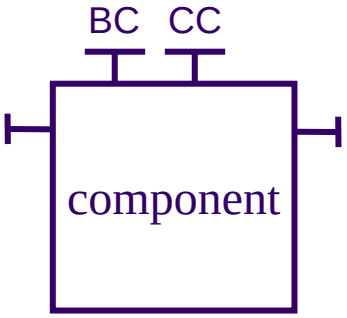
Conclusions

- Weaving + Pointcut = new binding
- Symmetric approach: aspects & components are components
- 2 implementations: Julius & FACAOKell
- 3 levels:
  - Object
  - Component
  - Architecture

Perspectives: reach the architecture level

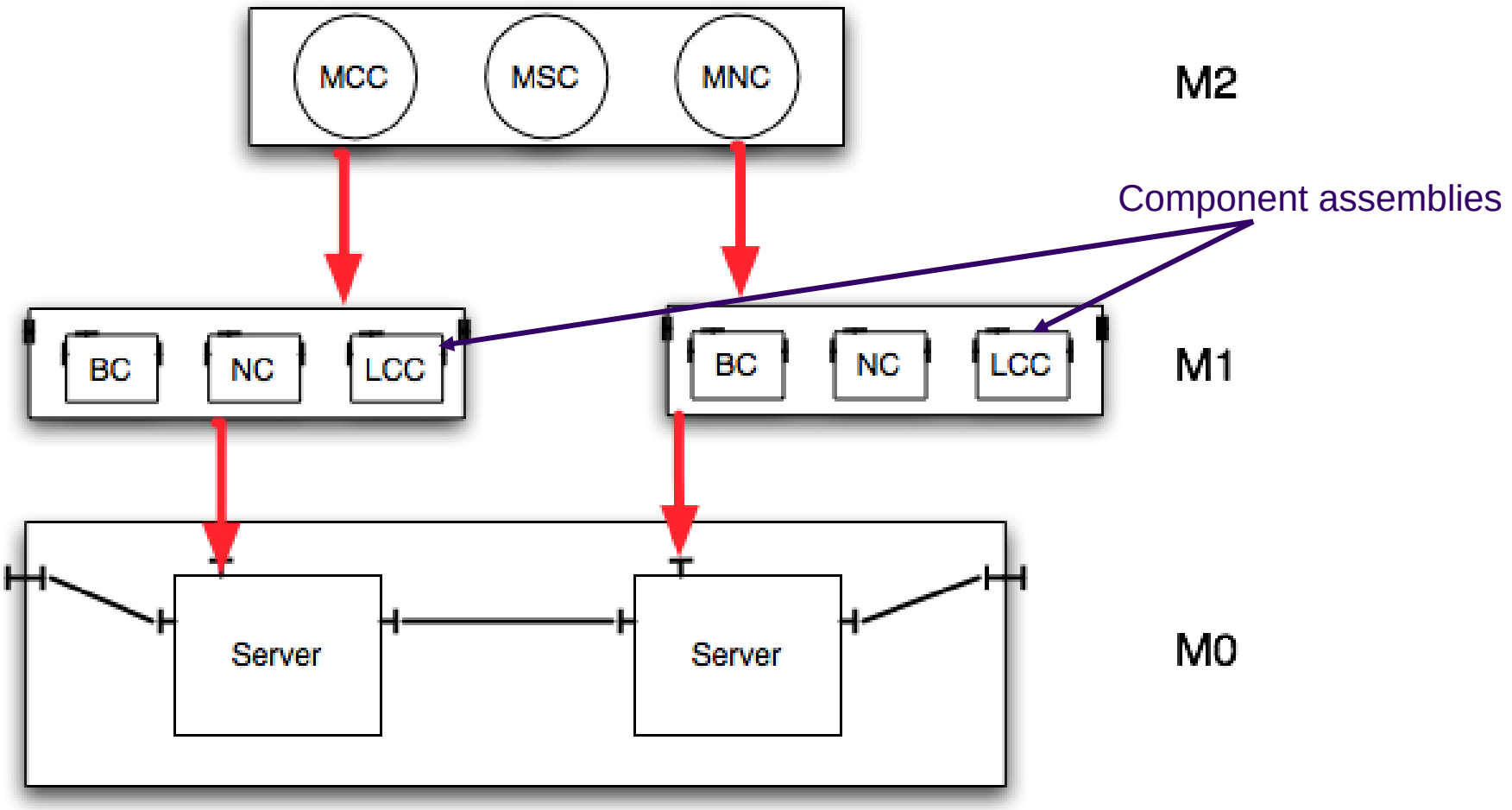


- Currently, advising of incoming and outgoing method calls on a component

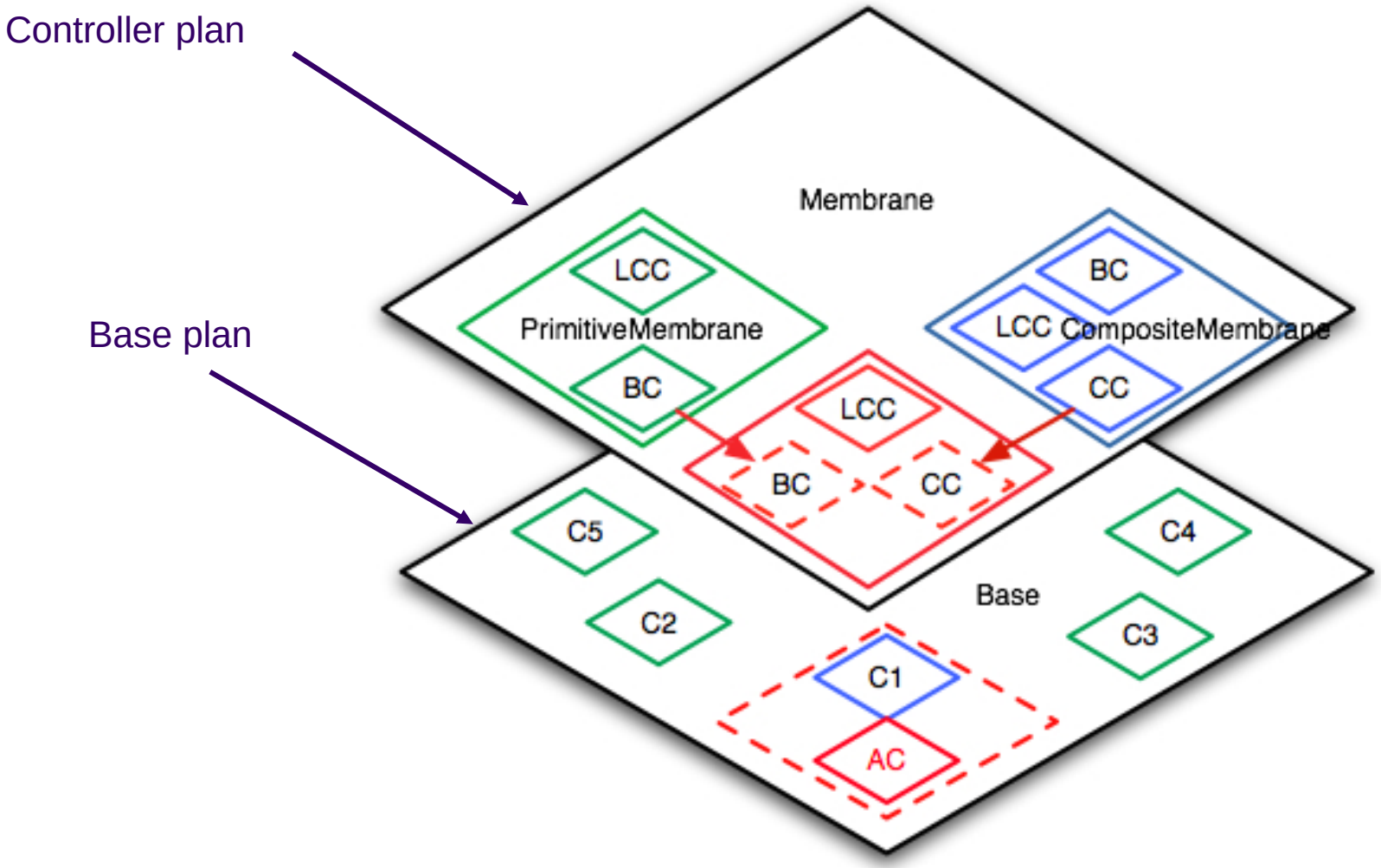


- Get the pointcut language richer ?
- Capture a binding ?
- Capture a component that contains exactly 2 components ?

Perspectives: reach the architecture level



Perspectives: reach the architecture level



Perspectives: reach the architecture level

- The composite membrane is an independent composite
- Build a new component type is like adding a new composite in level M1
- Different policies:
  - One instance per component type
  - One instance per station
  - …
- Advising at level M1:
  - Capture the bindings?
  - Capture the recomposition?