Architectural Design Rewriting

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Outline

Premises and Promises

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D5.3a Reconfigurations preserving architectural types and shapes.

Promises

"In future, results of Deliverable 5.3a will be applied to help in deducting rules for reconfiguration."

- D6.1a

"We will develop a formal model for [...] reconfiguration ..."

- Wiki's T5.3 description

"The objective of WP5 is to provide rigorous mathematical foundations for combining services, including [...] reconfiguration."

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"*We will develop a formal model for [. . .] reconfiguration . . .*"

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The recipe

Ingredients

- 20mg (Dynamic) Software Architectures;
- 3 Architectural Styles;
- 10dl Reconfigurations;
- Some Graphs;
- QoS (at will).

Preparation

Put the ingredients together and mix.

What are (software) architectures?

The experts say...

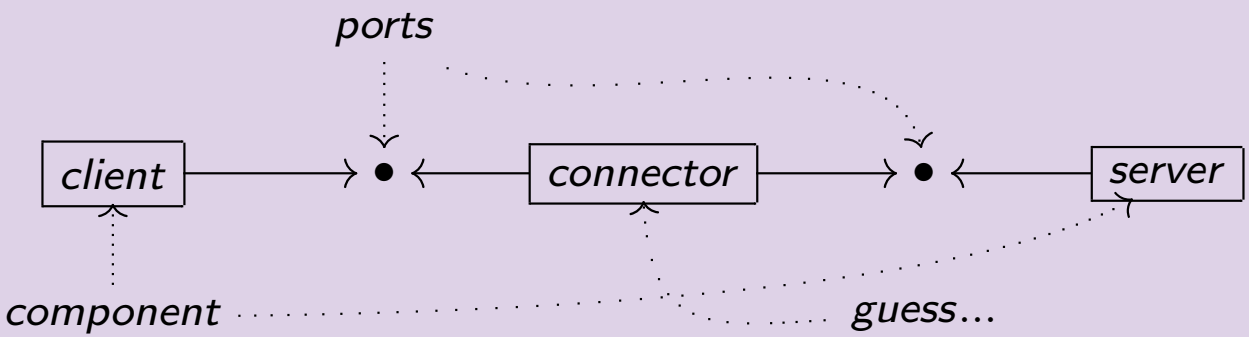
"... the structure of the components of a program / system, their interrelationship, and principles and guidelines governing their design and evolution over time."

- D. Garlan & D. Perry, 1995

A suitable model for architectures

Graphs as model of typical architectural models

- E.g. Components and Connectors.



Graphs as model of Sensoria languages

- SRML diagrams (see SRML-P(v1.3)).
- Graphical encodings of process calculi.

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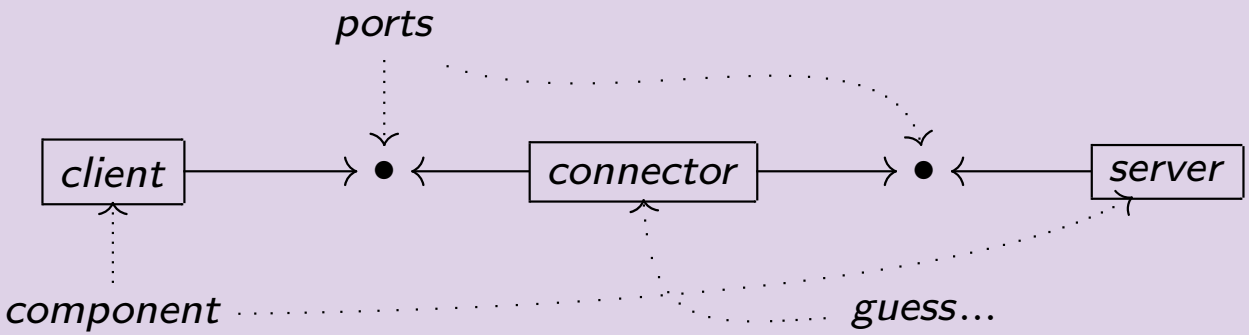

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Architectural Styles

A style is . . .

". . . a set of patterns or rules for creating one or more architectures in a consistent fashion."

- IEEE standard 1471

Roughly... Style = Vocabulary + Rules

Benefits?

Understanding, Reuse, Construction, etc.

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Models for styles

As a language

- Implicit style rules.
- Intuitive style-driven design.
- E.g. Graph grammars approaches [Le Métayer, 1996]

As additional constraints

- Explicit style rules.
- Complex structural rules easier to express.
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Reconfigurations

What?

A reconfiguration is a change in a (dynamic) architecture.

Why?

Security policies, load balancing, mobility, QoS assurance, etc.

E.g.?

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What is ADR?

$$\text{ADR} = \text{Term Rewriting} + \text{Designs}.$$
$$\text{Designs} = \text{Typed Graphs with Interfaces}.$$

Goal

A unifying model for . . .

- Design;
- Execution;
- Reconfiguration.

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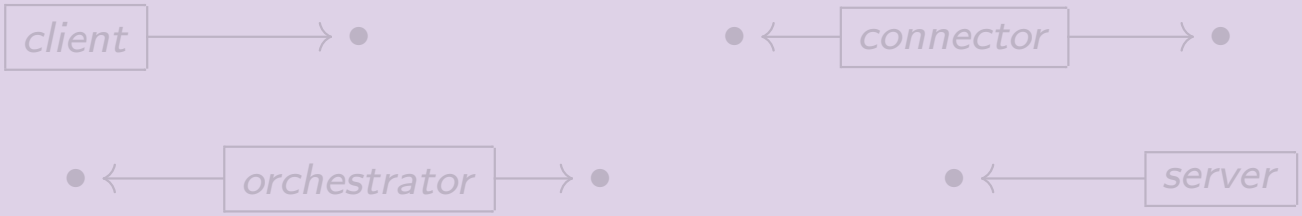
A Client-Server Example. Sorts

Sorts (Vocabulary of Architectural Elements)

The sorts of the client server style are

- Ports (nodes): $\bullet$.
- Component types (edges, designs)

- Actual components (edges)



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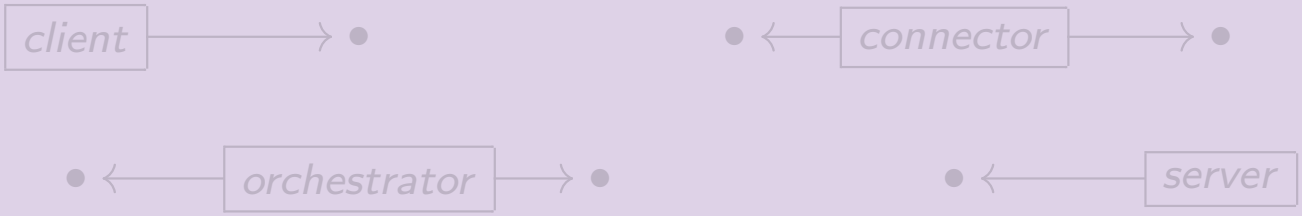

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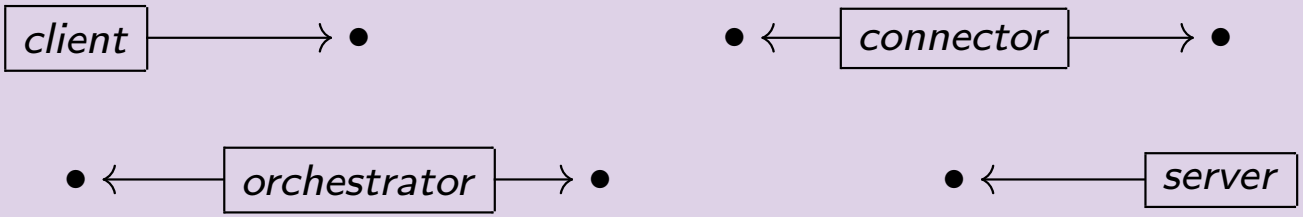
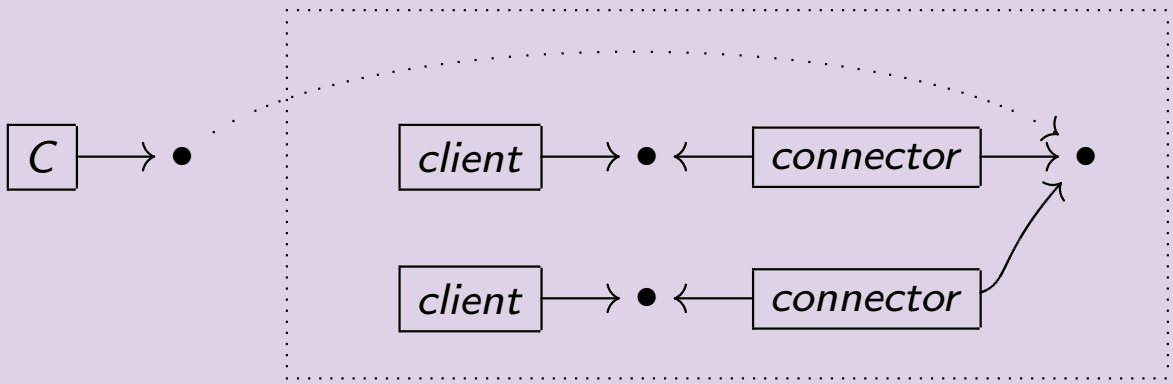


A Client-Server Example. Values

Values (Designs)

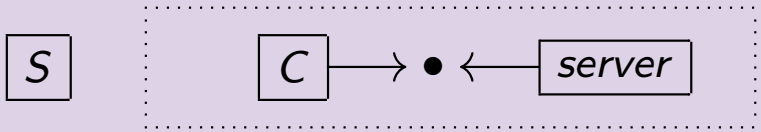
A design is a typed graph with an edge as interface.



... is a design of type C.

A Client-Server Example. Operations

system : $C \longrightarrow S$



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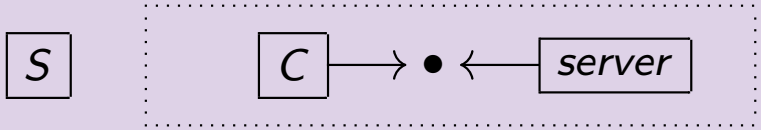

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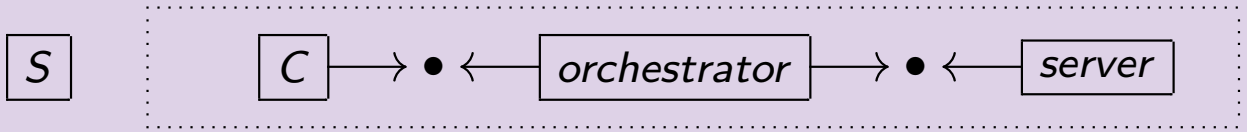
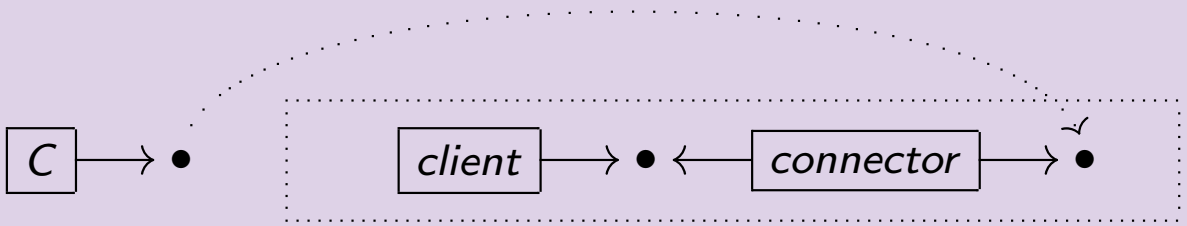


A Client-Server Example. Operations

cclient $:\longrightarrow C$



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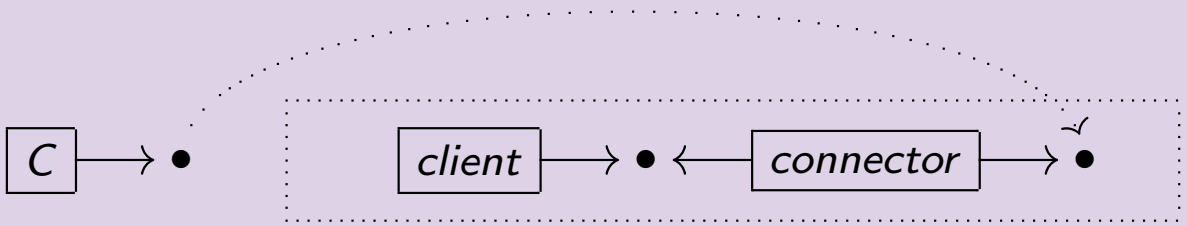

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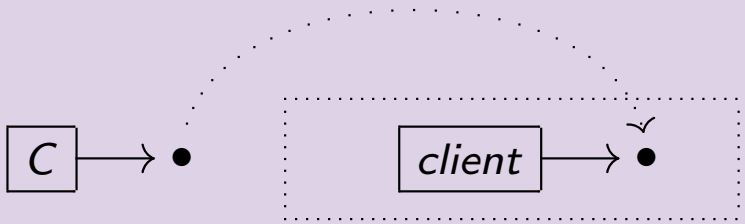

A Client-Server Example. Operations

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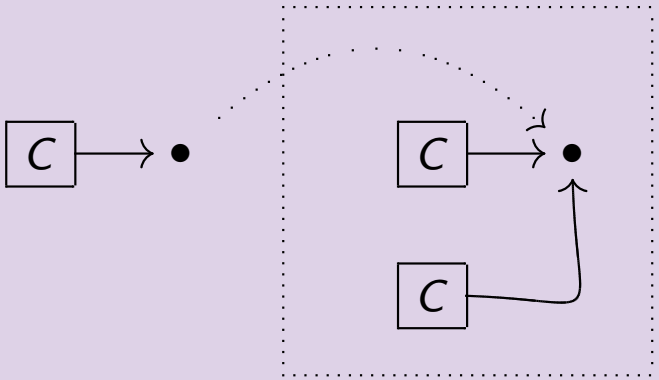

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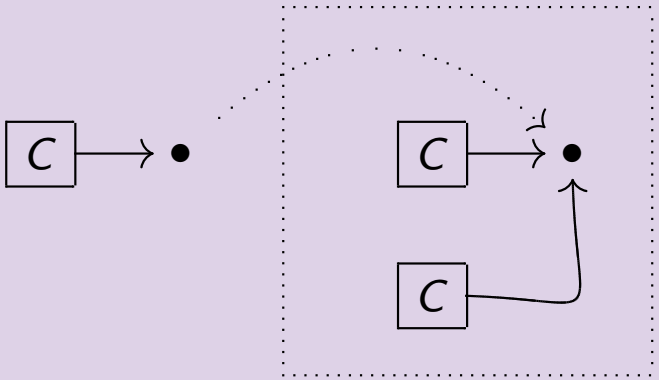

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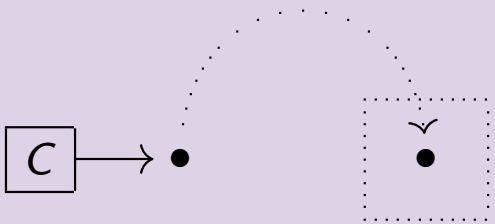
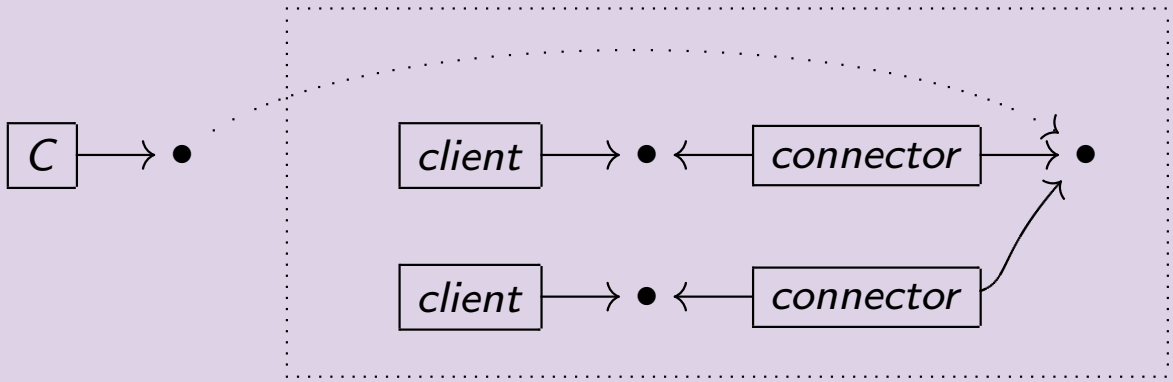


A Client-Server Example. Values (again)

Values (evaluation of terms)

The value of `clients(cclient, cclient)` is ...



A Client-Server Example. Reconfiguration rules

join(Y)

$$X \longrightarrow \texttt{clients}(X, Y)$$

leave(Y)

$$\texttt{clients}(X, Y) \longrightarrow X$$

orchestrate

$$\texttt{system}(X) \longrightarrow \texttt{osystem}(X)$$

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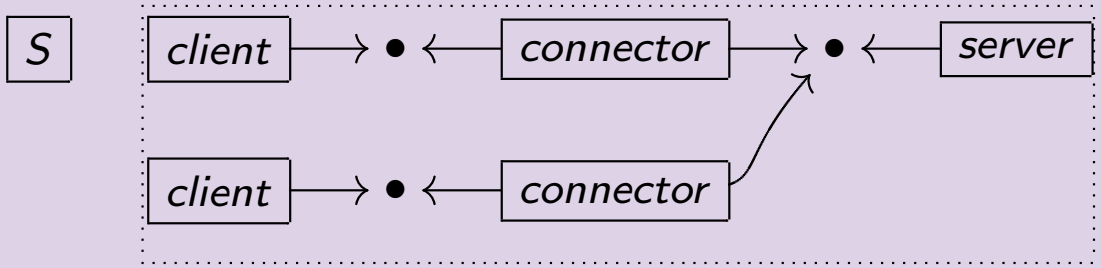
A Client-Server Example. A reconfiguration

Applying rule orchestrate...

If we have system(clients(cclient, cclient)) ...



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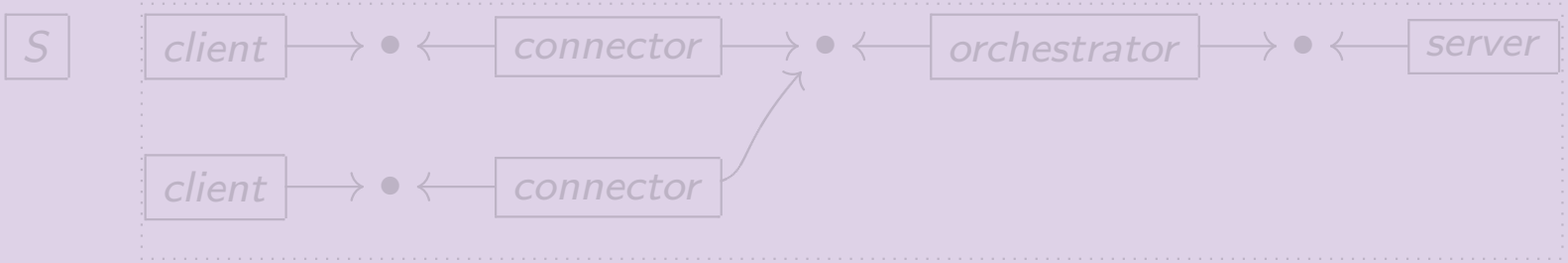

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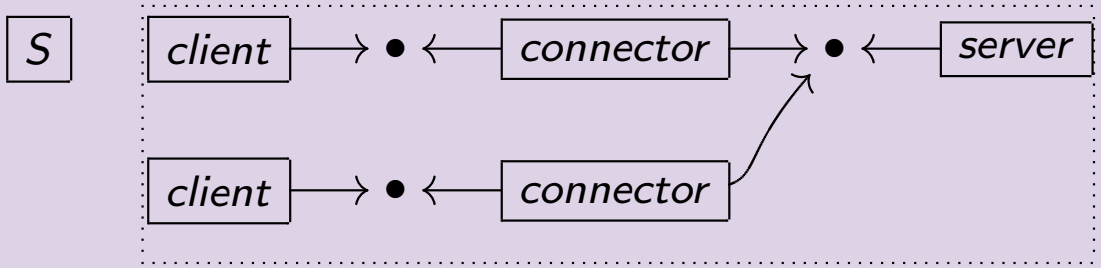

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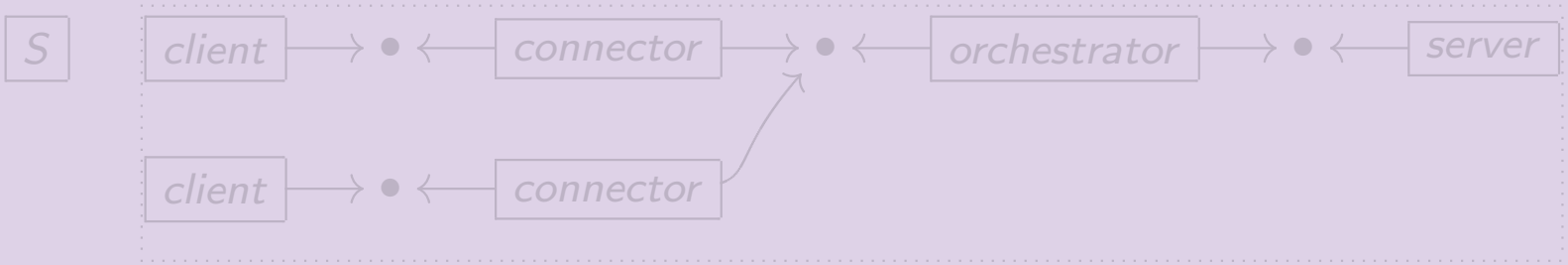

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Applying rule `orchestrate`...

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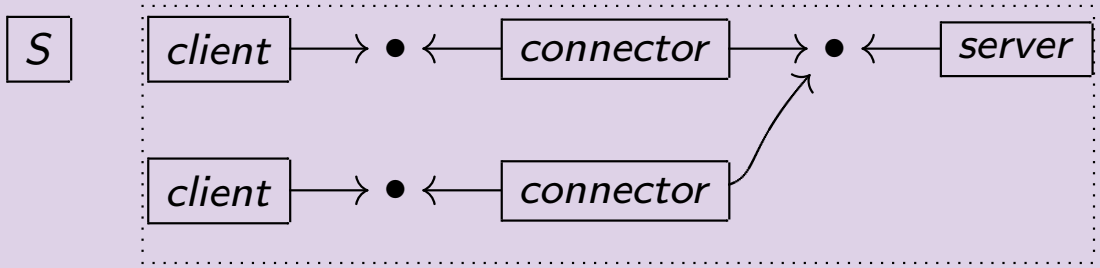

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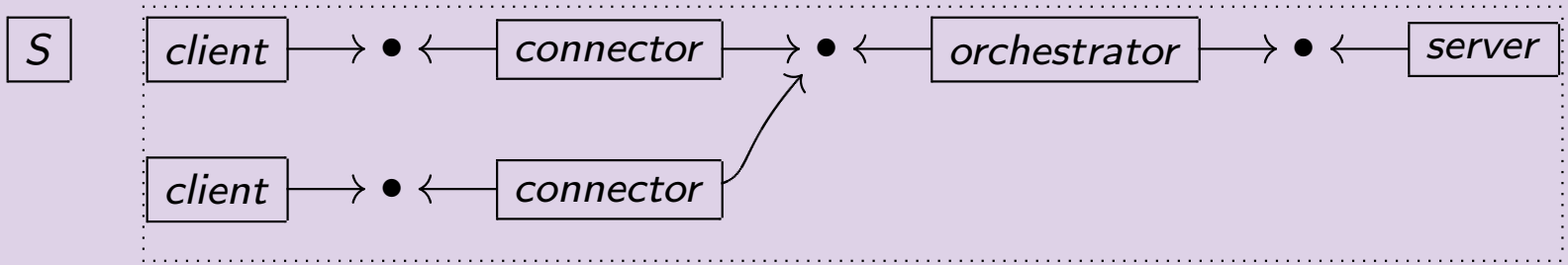

A Client-Server Example. More reconfigurations

disconnect

Labeled rule to model individual disconnection:

$$\texttt{cclient} \xrightarrow{\texttt{disc}} \texttt{client}$$

Dummy labeled rule:

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Conditional labeled rule for complex disconnections:

$$\frac{X \xrightarrow{\texttt{disc}} X' \quad Y \xrightarrow{\texttt{disc}} Y'}{\texttt{clients}(X, Y) \xrightarrow{\texttt{disc}} \texttt{clients}(X', Y')}$$

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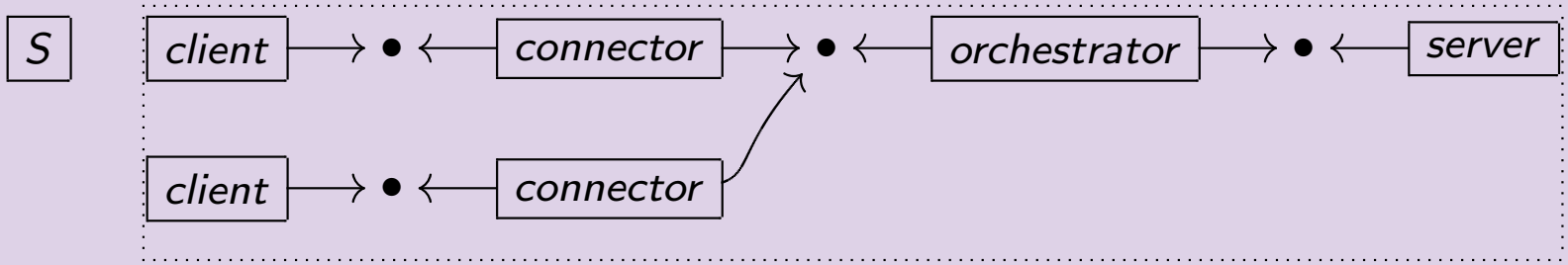

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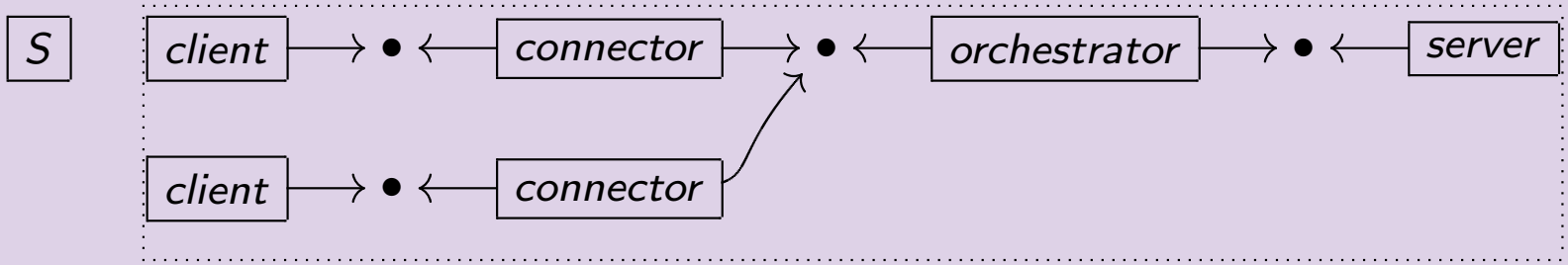

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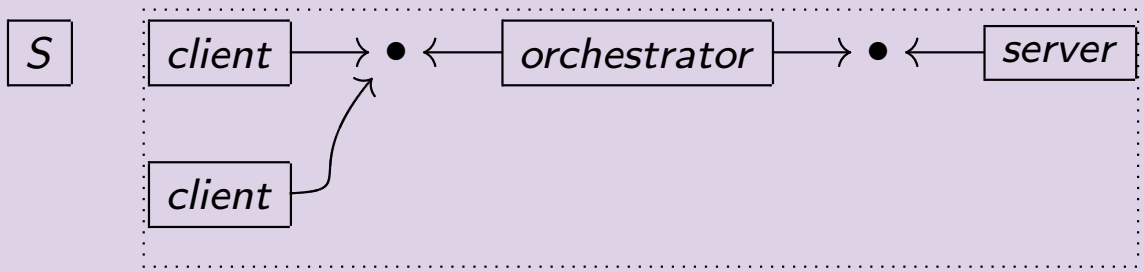

Constrained Designs

Designs with Constraints

- Nodes as QoS attributes.
- Edges as (c-semiring based) constraints.

Purpose

- Postpone design decisions.
- Trigger reconfigurations.
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ADR in detail

ADR is . . .

- Sorts: Vocabulary, Types (Edge and node labels).
- Values: Designs (graphs with interfaces).
- Operations: grammar-like style rules.
- Terms: proofs of construction.
- Terms (with variables): partial Designs.
- Axioms: properties of operations.
- Membership equations: additional style rules.
- Rewriting rules: behaviour, reconfigurations.
- Rewriting strategies: style conformance, style analysis, etc.

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- Implementation in Maude.
- Style for a graphical encoding of the π-calculus.
- Styles for SHR variants.

Future... (Sensorize the Approach)

- Not just symbolic types: service, behavioural, spatial, etc.
- Application to SRML architectures.
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Further reading

Two drafts

- Style-Based Reconfigurations of Software Architectures with QoS Constraints.
- Architectural Styles for Graphical Encodings of Process Algebras.

I got the idea but I have some...

- Questions?
- Remarks?
- Criticism?
- Suggestions?