

Interoperability of Asynchronous Relational Nets using Communicating machines

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Intro (The Motivation)

- * In **Service-Oriented Computing (SOC)**, the structure of software systems is intrinsically dynamic since: **a)** computational elements are bound in the form of services that are procured at run-time to collectively fulfil business goals, and **b)** a repository could have many service providers offering “the same” service
- * The **discovery** and **binding** of services is done at run-time by a middleware which is transparent from the perspective of the executing software artefact and should **automatically** choose a service that satisfies the contract associated to the requires point

Intro (The Motivation)

What is out there

WS-I

Web-Service Interoperability Organisation
[founded by Microsoft]

Founder

**“The standard for Web Service interoperability by developing OASIS
business interoperability Web services Profiles, Sample Applications and
Testing Tools”**

IBM SOAP

IBM Service-Oriented Architecture Assembly

Founder

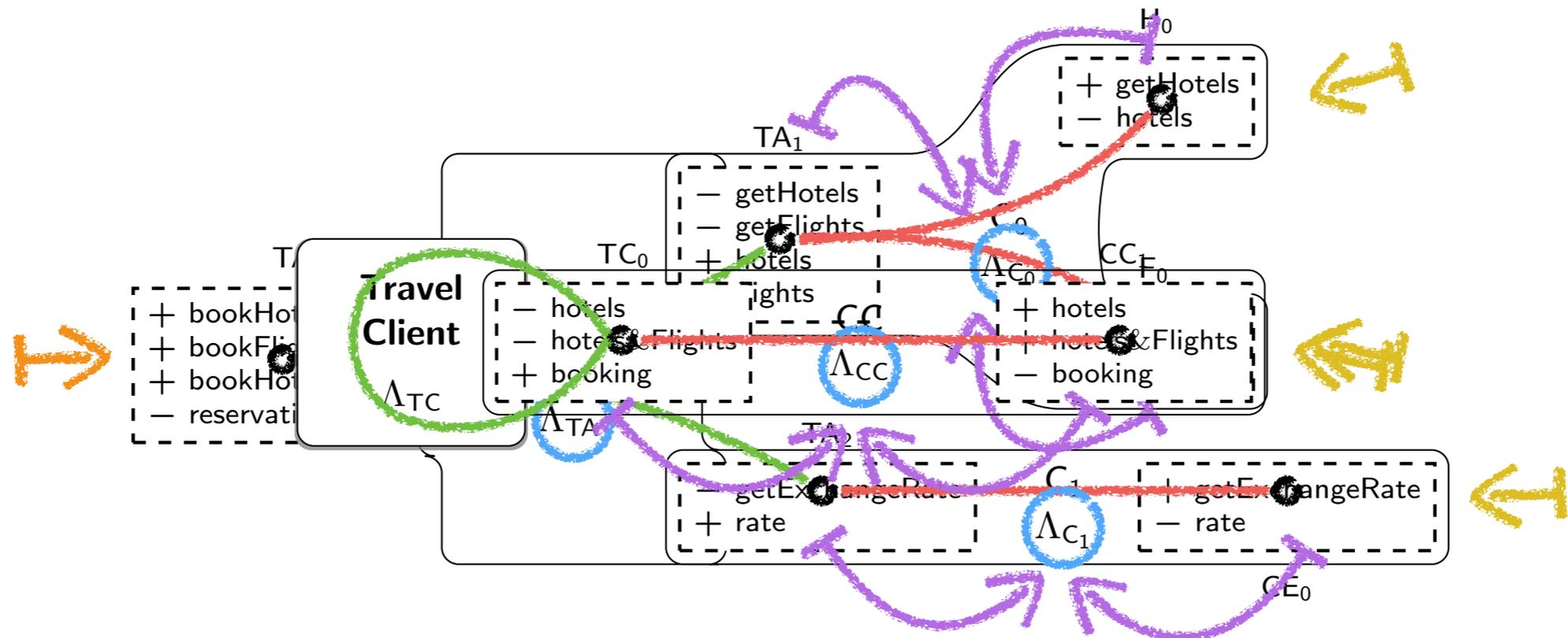
Sponsor

Oracle Fusion Middleware

OASIS

Intro (Elements)

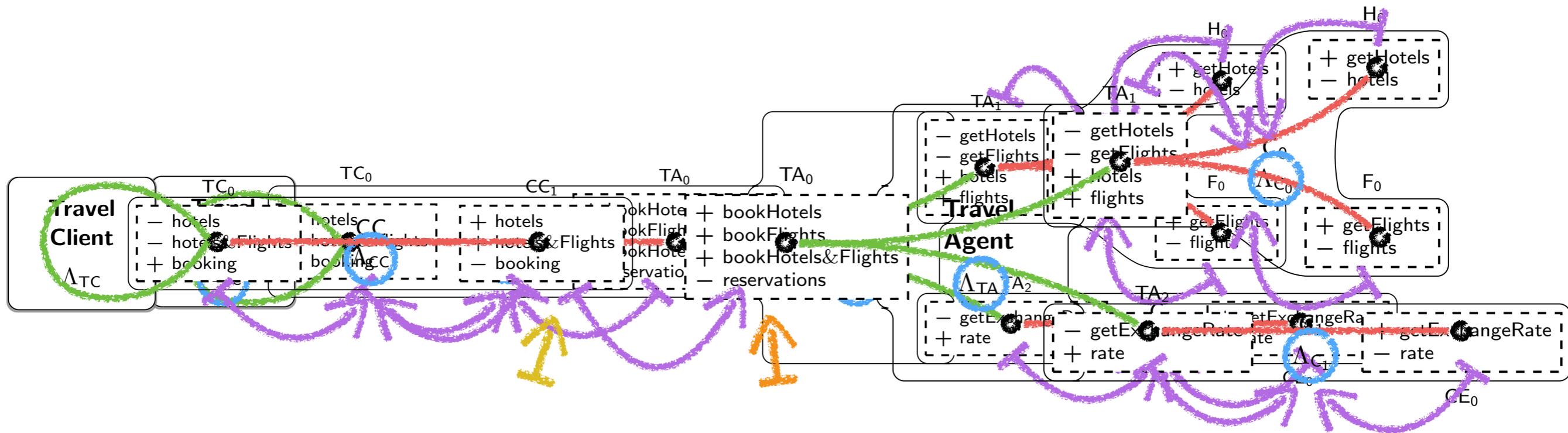
Asynchronous Relational Nets



Nodes that provide points, it is said to be a service as
 An ARN is a hypergraph-based structure whose nodes are
 provides points, it is said to be a service as
 the ports, and has two types of hyperedges:
 while those only have requires points, communication
 communication channels and processes
 activity, and the ports that can not be invoked,

Intro (Composition)

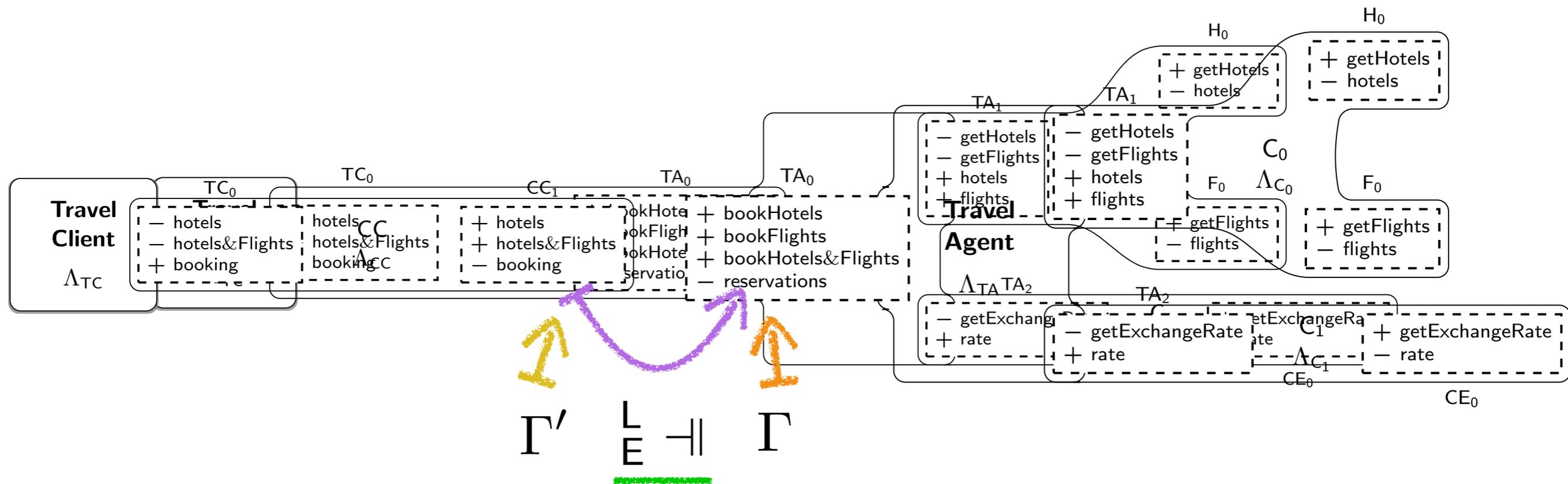
Asynchronous Relational Nets



The composition of an **activity** with a **service** is done by **injectively mapping** the language of a **requires points** of an activity to the language of a **provides point** of a service.

Binding

Asynchronous Relational Nets



Both **requires points** and **provides points** are labeled with contracts written in language **L** using signature **E** with a predefined **checking mechanism**.

Only then, points are fused using the **injective map**.

Binding (LTL contracts)

- * Computational aspects of ARNs were defined as a set of execution traces, thus contracts were conceived as LTL theory presentations, being the checking mechanism the traditional strong entailment [**Fiadeiro et al FASE2011**]
- * Later, the sets of traces were replaced by Müller Automata but preserving the contracts and checking mechanism [**Fiadeiro & Tutu CALCO2013**]

Binding (LTL contracts)

UP side

- * Combining LTL contracts with the semantics of the computational elements of ARNs is straightforward, and
- * There is an automatic procedure implementing the checking mechanism for LTL strong satisfaction

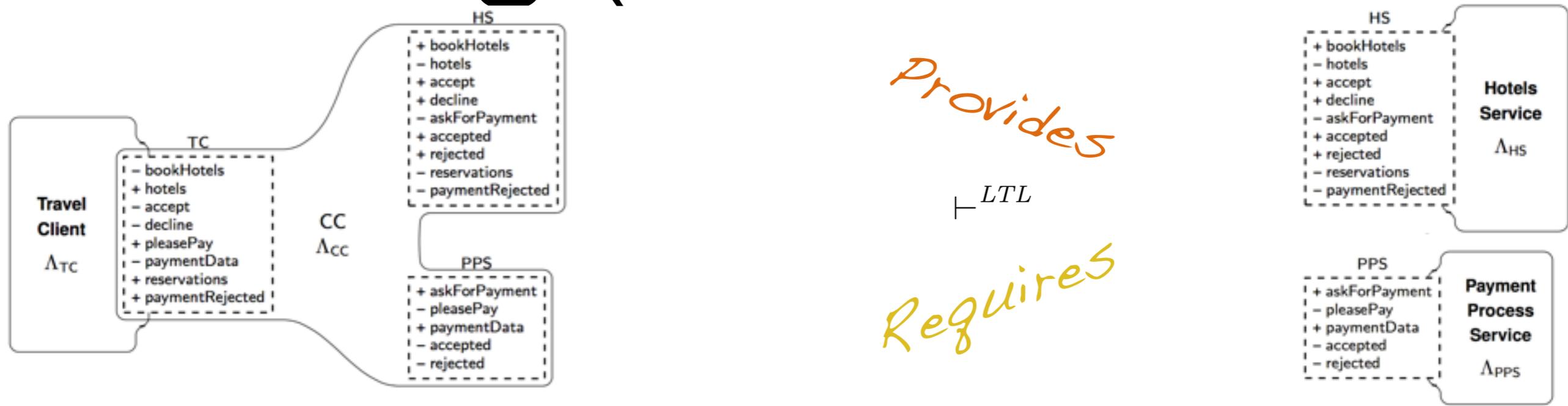
Down side

- * It does not guaranty that the service acting as provider implements all the behaviour required by the executing activity

Example



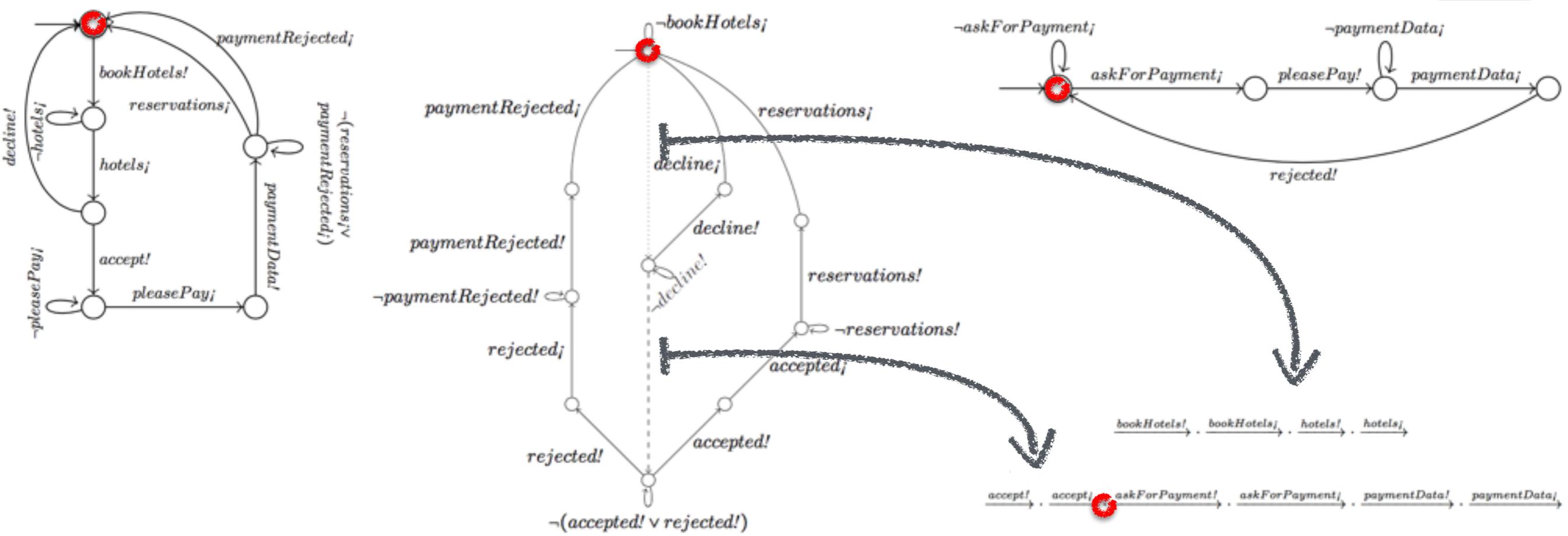
Binding (LTL contracts)



Provides

\vdash_{LTL}

Requires



Binding

Orchestration

(**local** view of the communication)

+

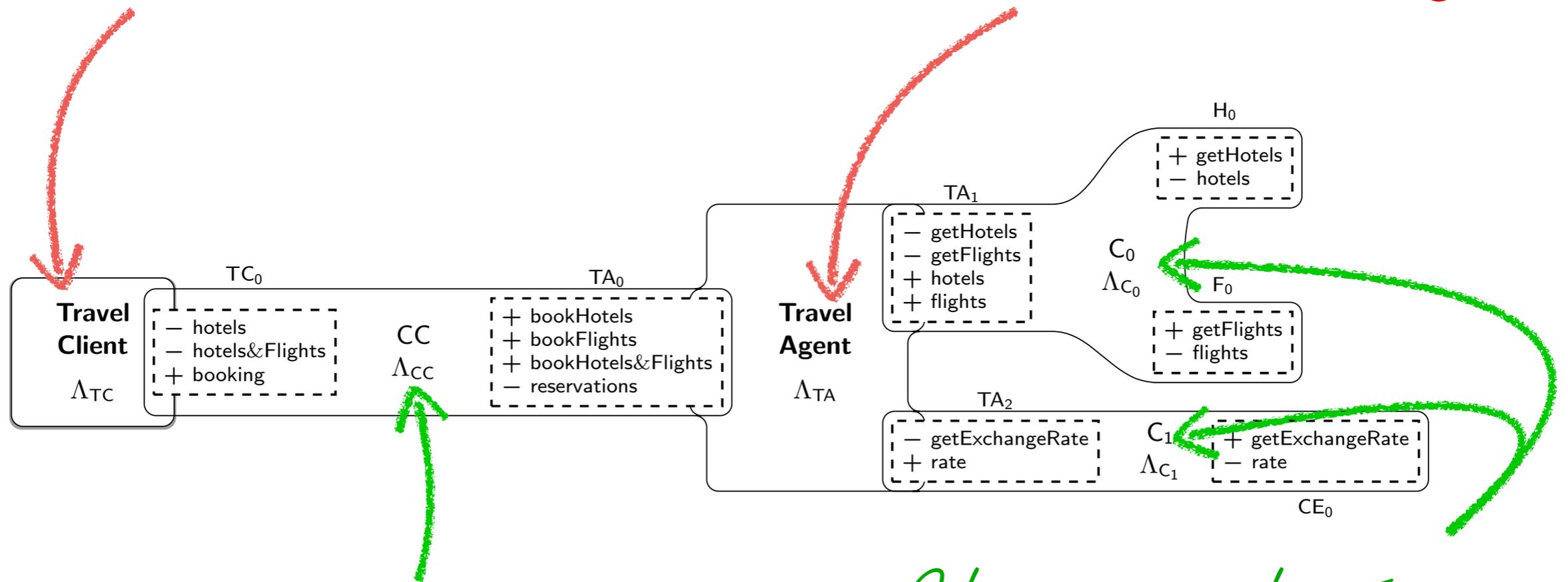
Choreographies

(**global** view of the communication)

Binding

Participant Travel Client

Participant Travel Agent



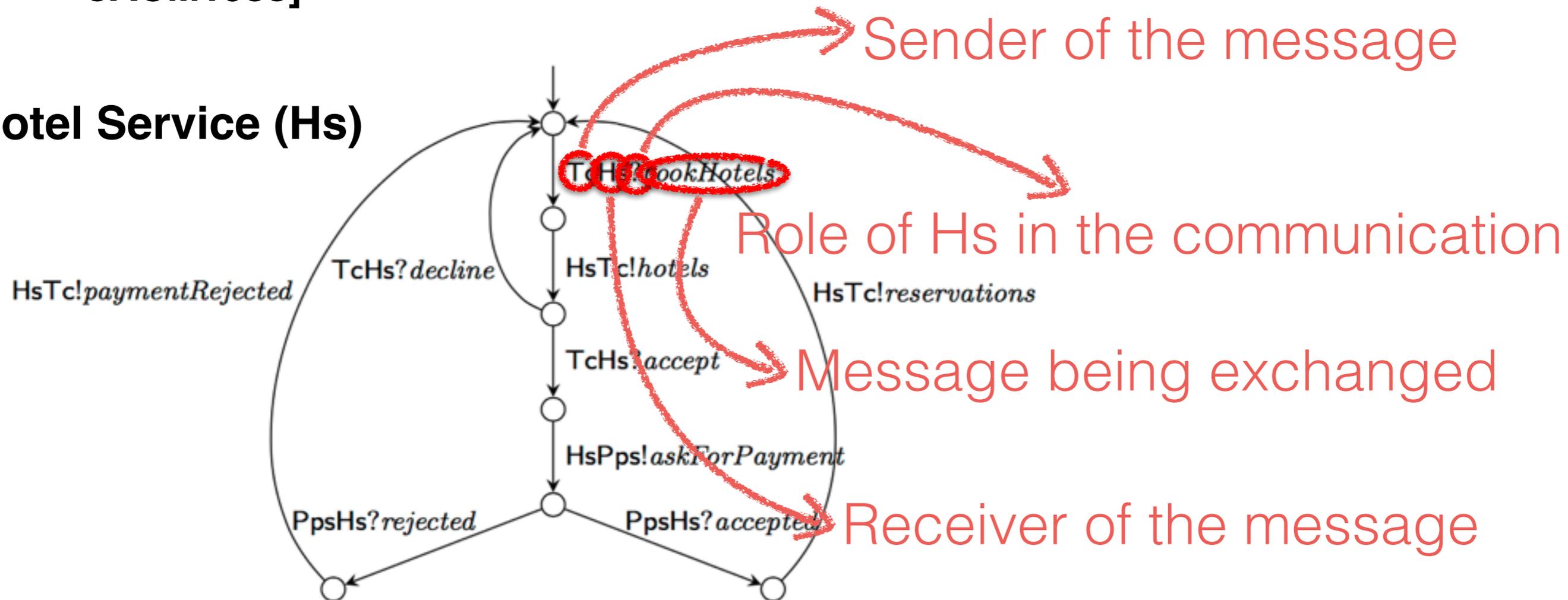
Choreographer of TC and TA behaviour

Choreographers of TA and the expected participants behaviour

Orchestration (Communicating Finite State Machines)

- * A *Communicating Finite State Machines* (CFSM) is a finite automata formalising the communication from the perspective of one of the participants **[Brand & Zafiropulo JACM1983]**

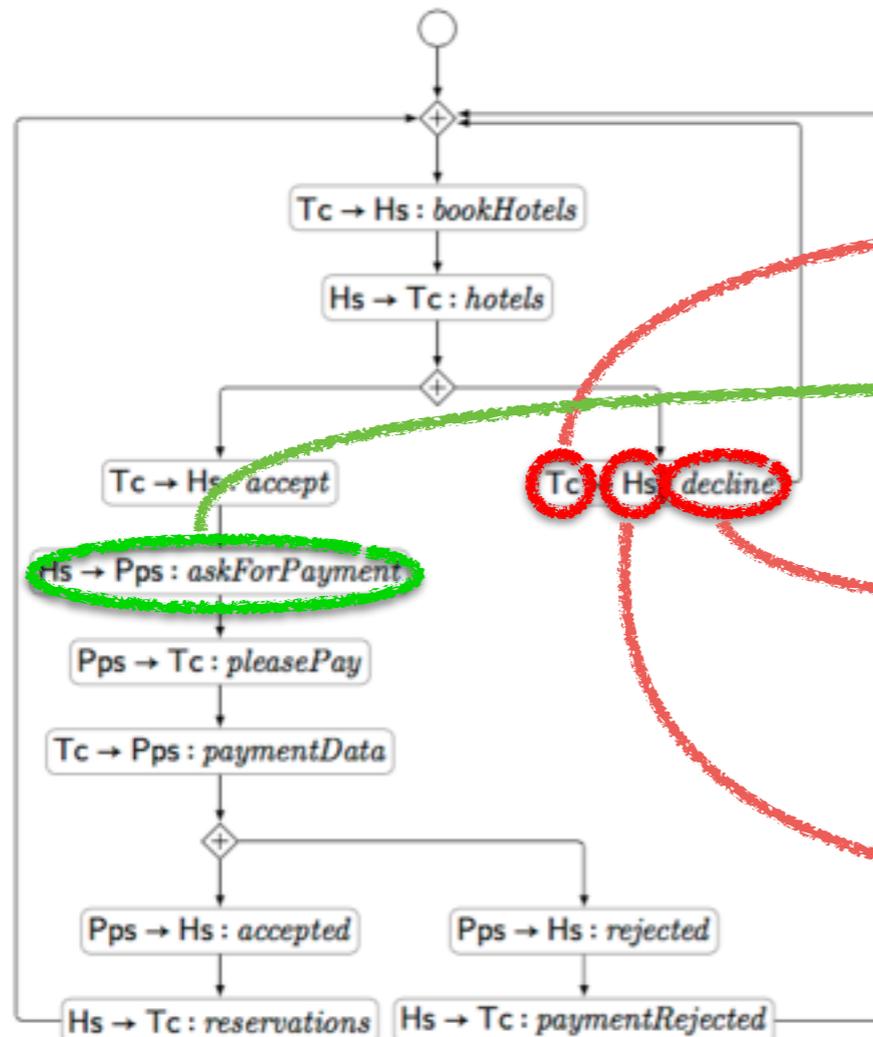
Hotel Service (Hs)



Choreographies (Global graphs)

- * A *Global Graph* is a finite automata formalising the communication from a global perspective showing all exchanges of messages [Denielou & Yoshida ESOP2012]

CC



Sender of the message

Tc has no role in this exchange

Message being exchanged

Receiver of the message

Binding

(CFSM + Global graphs)

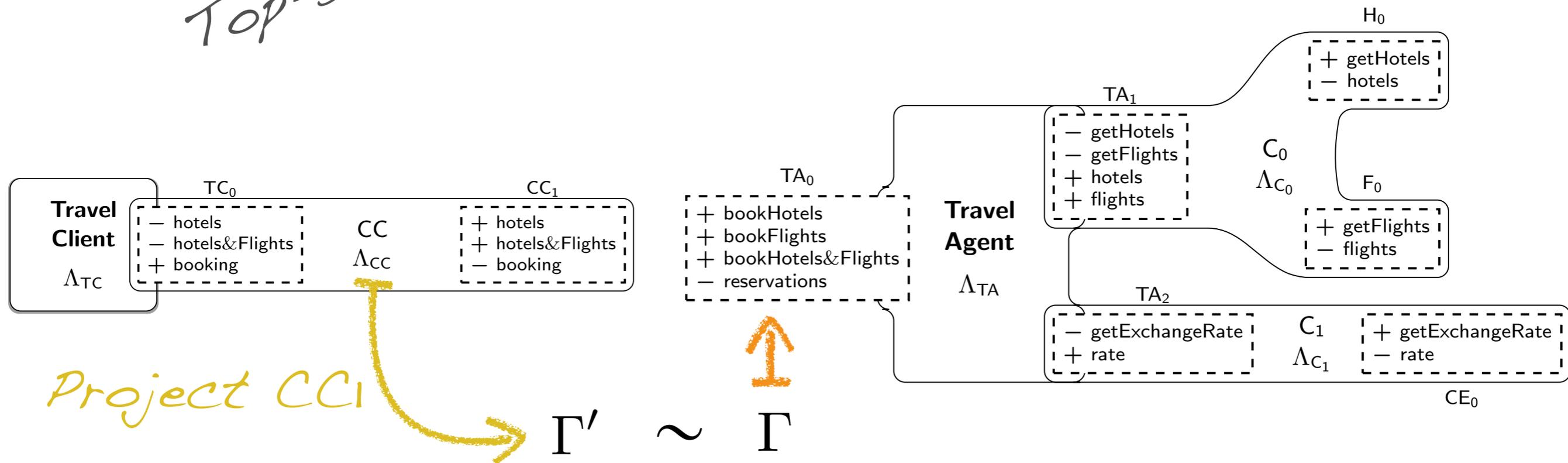
The idea

- * Every provides point (dangling points of a process hyperarc) is labeled with a communicating machine declaring its role in the communication
- * Every communication hyperarc is labeled with a global graph declaring the protocol that the participants must follow

Binding (CFSM + Global graphs)

[Vissani et al PLACES2015]

Top-Down



- 1) Project the global graph labelling the communication hyperarc for all the participants [Lange et al PoPL2015],
- 2) check that the CFSM obtained from the projection for each participant is bisimilar to the CFSM labelling the provides point of each service provider

Outro (Conclusions)

We solved the asymmetry problem of service provision/request by combining global (choreographic) and local (orchestrated) views of communication in a single mechanism for interoperability check of services

Outro (Ongoing work)

- * Addition of values associated to the messages for a more functional interoperability **[Melgratti, Vissani, Tuosto]**
- * Definition/implementation of a model-checking technique for analysing properties of ARNs **[Fiadeiro, ȚuȚu, Vissani]**
- * Automatic analysis of a trace-based semantics for choreographies and global graphs **[Melgratti, Barbeito]**
- * Implementation of a middleware capable of providing support for formal establishing of Service Level Agreement as a part of the process of binding **[Vissani]**

Outro (Further work)

- * Modular checking technique for heterogeneous contracts for Service Level Agreement
- * Degrees of satisfaction of *certain* contracts for Service Level Agreement
- * Probabilistic analysis and prediction of service-oriented system behaviour [**Pedro D'Argenio, me**]

The Encore

? & !



Some other projects

- * The formulation of a canonical proof-theoretic approach to model theory **[Maibaum, me]** and its extension to substructural logics **[Kurz, Maibaum, me]**