

# Orchestrated compliance for session-based client/server interactions

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ICE 2015, Grenoble, June 4 2015

# Overview

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- **Session Contracts and Compliance**

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- **Orchestrated Compliance**
- **Decidability Results**

# (first-order) Session-Contracts

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**Session Contracts:** a "session" restriction of contracts.

$\sigma, \tau ::=$	$\mathbf{1}$	success
	$  a_1.\sigma_1 + \cdots + a_n.\sigma_n$	external choice
	$  \bar{a}_1.\sigma_1 \oplus \cdots \oplus \bar{a}_n.\sigma_n$	internal choice
	$  x$	variable
	$  \text{rec } x.\sigma$	recursion

the  $a_i$  and the  $\bar{a}_i$  are, respectively, pairwise distinct  
recursion is *guarded*.

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### References

- Bernardi and Hennessy: *Modelling session types using contracts*
- Bartoletti, Scalas and Zunino *A semantic deconstruction of session types.*
- Barbanera and de' Liguoro: *Sub-behaviour relations for session-based client/server systems (with higher-order)*

# LTS's

As usual:

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**For session contracts:**

$$\bar{a}_1.\sigma_1 \oplus \cdots \oplus \bar{a}_n.\sigma_n \longrightarrow \bar{a}_k.\sigma_k$$

$$\bar{a}.\sigma \xrightarrow{\bar{a}} \sigma$$

$$a_1.\sigma_1 + \cdots + a_n.\sigma_n \xrightarrow{a_k} \sigma_k$$

**we equate**

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**For Client-Server pairs:**

$$\frac{\rho \xrightarrow{\alpha} \rho' \quad \sigma \xrightarrow{\bar{\alpha}} \sigma'}{\rho \parallel \sigma \longrightarrow_{\parallel} \rho' \parallel \sigma'} \quad \frac{\rho \longrightarrow \rho'}{\rho \parallel \sigma \longrightarrow_{\parallel} \rho' \parallel \sigma} \quad \frac{\sigma \longrightarrow \sigma'}{\rho \parallel \sigma \longrightarrow_{\parallel} \rho \parallel \sigma'}$$

where  $\alpha \in \mathcal{N} \cup \bar{\mathcal{N}}$  and  $\bar{\alpha}$  is the usual involution:  $\bar{\bar{\alpha}} = \alpha$ .

# Compliance



# Compliance

A client complies with a server if all her requirements are fulfilled

- by reaching the success state (**1**) or
- by running an infinite interaction without ever getting stuck

A client that does not comply with its server may get stuck

Formally,  $\rho$  *complies* with  $\sigma$  ( $\rho \dashv \sigma$ ) if

$$\forall \rho', \sigma'. \rho \parallel \sigma \Longrightarrow \rho' \parallel \sigma' \not\rightarrow \quad \Rightarrow \quad \rho' = \mathbf{1}$$

# Compliance

## WEATHERSTATION

WEATHERSTATION

rec x.

tempReq.humReq. $\overline{\text{temp}}$ . $\overline{\text{hum}}$ .x

METEO DATAPROCESSING SYSTEM

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MDPS  $\dashv$  WS

# Compliance



**new**WEATHERSTATION

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rec x.

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( $\overline{\text{temp.hum.wind.x}}$

$\oplus$

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METEO DATAPROCESSING SYSTEM

rec x.  
 $\overline{\text{tempReq.humReq.temp.hum.x}}$

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## Inspired by:

Luca Padovani :

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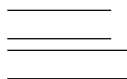


# Orchestrated interactions

MDPS

f

WS



$$\begin{aligned} f &= \text{rec } x. \langle \overline{\text{tempReq}}, \overline{\text{tempReq}} \rangle. \langle \overline{\text{humReq}}, \overline{\text{humReq}} \rangle. \\ &\quad (\langle \overline{\text{temp}}, \text{temp} \rangle. \langle \overline{\text{hum}}, \text{hum} \rangle. \langle \varepsilon, \text{wind} \rangle. x) \\ &\quad \vee \\ &\quad \langle \varepsilon, \text{hum} \rangle. \langle \overline{\text{temp}}, \text{temp} \rangle. \langle \overline{\text{hum}}, \varepsilon \rangle. \langle \varepsilon, \text{wind} \rangle. x) \end{aligned}$$

# Orchestrated interactions

!tempReq  
MDPS

f  
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\_\_\_\_\_  
\_\_\_\_\_

?tempReq  
WS

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MDPS

tempReq▷

f

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MDPS

f \_\_\_\_\_ tempReq▷  
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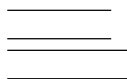
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# Orchestrated interactions

!humReq  
MDPS

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?humReq  
WS

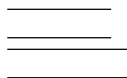
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MDPS

humReq▷

f



?humReq  
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MDPS

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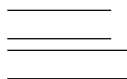
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?temp  
MDPS

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!hum  
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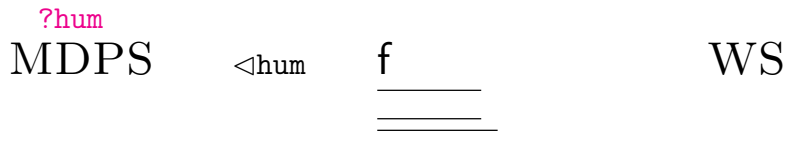
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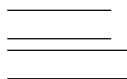


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MDPS

f

WS



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f  
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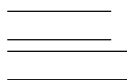
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\_\_\_\_\_

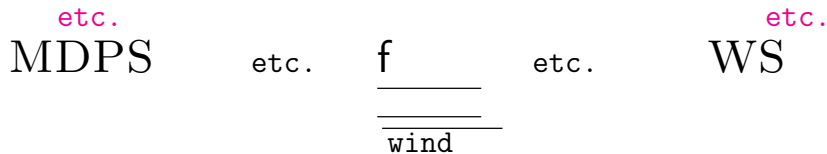
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Let  $\mu$  be an orchestration action:

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if  $f \xrightarrow{\mu_1} f_1 \xrightarrow{\mu_2} f_2 \dots \xrightarrow{\mu_n} f_n$

from the state of the buffers of  $f$  and from  $\mu_1 \dots \mu_n$  we can get the state of the buffers of  $f_n$ .

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- $f : \rho \dashv\!\!\dashv \sigma$  if :

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We must consider only *well behaved* (**respectful**) orchestrators.

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(i.e. wind from WS in the metereological example)

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## Orchestrated Compliance [RIGHT ONE]

- $f : \rho \dashv\!\!\dashv \sigma$  if  $f$  is **respectful** and:

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*Proof search in  $\triangleright$  is terminating.*

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Out of system  $\triangleright$  it is possible to devise a terminating algorithm **Synth**( $\rho, \sigma$ ) producing all the *relevant* orchestrators  $f$ , the respectful ones, if any, and the unrespectful ones, if any (always a finite number, modulo *unwinding* of *rec*) such that  $f : \rho \dashv\vdash \sigma$ .

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- Compute **Synth**( $\rho, \sigma$ )
- For any  $f \in \mathbf{Synth}(\rho, \sigma)$ , check for the respectfulness of  $f$ .



THANKS!