Towards Trustworthy Multiparty Sessions

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1. Introduction & Motivation

2. A Glimpse of $\mu$se, graphically

3. Something About Types

4. Concluding Remarks
# A Shared Vision (Hopefully!)

## 1st Fact

*Trustworthy Service Oriented Computing is hard:* services are autonomous, heterogeneous, separately designed computational entities to be dynamically assembled.

## 2nd Fact

*Process Calculi can help:* they allow to focus on salient features at a convenient level of abstraction.

## 3rd Fact

*Behavioural types can help:* syntactic descriptions of services are not expressive enough to guarantee their trustworthy assembly.

## 4th Fact (or mere conjecture?)

*Existing techniques must be adapted:* SOC has specific features like endpoints, sessions, dynamicity.
A Shared Vision (Hopefully!)

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Our Proposal

µse (after MUltiparty SEssions)

µse is a process calculus for expressing computations where endpoints dynamically join existing multiparty sessions (as seen on Emilio’s talk @ Munich meeting)

Types for

- Semantic description of services (for discovery)
- Compatibility check (for dynamic assembly)
- Early detection of possible sources of problems (trustworthiness)

Disclaim

- We restrict to consider a “bare bones” fragment of µse
- We present a parametric type system w.r.t. 3 notions (task separation, dual type compatibility, session completion)
- We conjecture subject reduction + all non-typeable processes can deadlock
- We look for stronger guarantees
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Sites, Service Invocation and Sessions

Bruni et al. (PI, BO, UBA, IMT, UL)

Typing $\mu$se

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Sites, Service Invocation and Sessions

- service call
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Outline

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Types for Dynamic Multiparty Sessions

Type judgments

Γ; Δ ⊢ P : \{σ ↦ ρ\}

- we call σ the current type, and ρ the delegated type
- P provides communication activities in σ and ρ
- activities σ concern the current participants of its session,
- activities ρ concern other endpoints that P itself will allow to join its session (via service invocation or merge)
- Γ is a finite partial mapping from variables X and polarized service / entry-point names n^p (with p ∈ \{+,−\}) to type pairs σ ↦ ρ, with the understanding that actions in ρ are delegated to n^\overline{p}.
- Δ is a finite partial mapping from session names r to types σ, such that Δ(r) is the parallel composition of the current types of all endpoints of r

Self typeable systems

Γ; Δ ⊢ S : \{0 ↦ 0\}
Task separation

Task separation $c \ast \sigma$ is used to project the activities of $P$ in separate threads for later delegation.

Our choice

Here we take the most relaxed form of separation, where $c \ast \sigma = c|\sigma$.

Used in

\[(\text{ACTION})\]
\[
\Gamma; \Delta \vdash P : \{\sigma \rightarrow \rho\} \\
\Gamma; \Delta \vdash c. P : \{c \ast \sigma \rightarrow \rho\}
\]
Type compatibility

Type compatibility $\sigma \approx \rho$ says that $\sigma$ and $\rho$ are complementary.

Our choice

Let $I(\sigma) = \{ c | \exists \sigma' : \sigma \leftarrow c \sigma' \}$ be the set of initial actions of $\sigma$. Here we take the largest relation on types such that whenever $\sigma \approx \rho$:

- either $I(\sigma) = I(\rho) = \emptyset$,
- or $K = I(\sigma) \cap \overline{I(\rho)} \neq \emptyset$ and, for each $x \in K$ and for each $\sigma'$ and $\rho'$ such that $\sigma \leftarrow x \sigma'$ and $\rho \leftarrow x \rho'$, then $\sigma' \approx \rho'$.

Used in

$\Gamma$ is well-formed if:

- whenever $\Gamma(n^P) = \sigma \rightarrow \rho$, then $\Gamma(n\overline{P}) = \sigma' \rightarrow \rho'$ for some $\rho' \approx \rho$,
- whenever $\Gamma(a^-) = \sigma \rightarrow \rho$, then $\sigma = 0$. 
Session completion

The completion set \( \triangledown_0 \) contains those types \( \sigma \) that express admissible interactions of multiple endpoints.

Our choice

Here we define \( \triangledown_0 \) as the largest set of types \( \sigma \) such that:

1. for each \( c \in I(\sigma) \) such that \( \overline{c} \not\in I(\sigma) \) and for each \( \sigma \xrightarrow{\tau} \sigma' \) there exists \( \sigma'' \) such that \( \overline{c} \in I(\sigma'') \) and \( \sigma' \xrightarrow{\tau^*} \sigma'' \),
2. if \( \sigma \xrightarrow{\tau} \sigma' \) then \( \sigma' \in \triangledown_0 \).

Used in

We say that \( \Delta \) is *fully-formed* if whenever \( \Delta(r) = \sigma \), then \( \sigma \in \triangledown_0 \).
Example: Two Buyers
\((\nu r_1, r_2)(l_s :: Sell \mid l_1 :: Buy_1 \mid l_2 :: Buy_2)\)

\[
Sell = sell \Rightarrow title.\text{install}[\text{Offer}].\text{merge}^- \; e
\]
The service \(sell\) waits for a buyer to require a quote for a book \((title)\), installs a new service \(offer\) for a second buyer and prepares for merging with an instance of \(offer\).

\[
Offer = offer \Rightarrow \text{merge}^+ \; e.(\text{title.}(\text{quote}.Q_3|\text{quote}.Q_4))
\]
\(offer\) provides the book’s \(title\) so that quotes are communicated to both buyers after the sessions are merged.

\[
Buy_1 = r_1 \triangleright \text{invoke } sell.title.quote.bid.Q_1
\]
\[
Buy_2 = r_2 \triangleright \text{invoke } offer.title.quote.bid.Q_2
\]

Buyers communicate over \(bid\) and the negotiation is concluded by the interactions among \(Q, Q_1\) and \(Q_2\) (not modeled here).
Example: Typing the Two Buyers

\[
\Gamma = \{ 
\begin{aligned}
sell^+ &: (0 \not\rightarrow b \mid t \mid \overline{q} \mid Q_3), \\
offer^+ &: (0 \not\rightarrow \overline{b} \mid \overline{t} \mid \overline{q} \mid Q_4), \\
e^- &: (\overline{b} \not\rightarrow 0), \\
e^+ &: (\overline{q} \mid b \mid Q_3 \not\rightarrow 0)
\end{aligned}
\}
\]

**(T\text{INVOKE})**

\[
\Gamma; \Delta \vdash P : \{ \sigma_1 \mid \sigma_2 \not\rightarrow \rho \} \quad \Gamma(a^+) = \sigma \not\rightarrow \rho' \quad \Gamma(a^-) = 0 \not\rightarrow \sigma_2 \\
\Gamma; \Delta \vdash \text{invoke } a. P : \{ \sigma \mid \sigma_1 \not\rightarrow \sigma_2 \mid \rho \}
\]

**(T\text{MERGE})**

\[
\Gamma; \Delta \vdash P : \{ \sigma_1 \mid \sigma_2 \mid \sigma_3 \not\rightarrow \rho \} \quad \Gamma(e^p) = \sigma \mid \sigma_2 \not\rightarrow \sigma_3 \quad \Gamma(e^\overline{p}) = \sigma' \mid \sigma'' \not\rightarrow \rho' \quad \sigma \approx \sigma''
\]

\[
\Gamma; \Delta \vdash \text{merge}^p e. P : \{ \sigma' \mid \sigma_1 \mid \sigma'' \not\rightarrow \sigma_2 \mid \sigma_3 \mid \rho \}
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Conclude

Preliminary study

Some self typeable systems can behave “badly” (no check on availability of services, entry points, etc).

Future work

- Suitable syntactic restrictions to obtain stronger guarantees.
- Change the notions of $c * \sigma$, $\approx$ and $\downarrow_0$ if needed
- Address intra-site communications

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- Towards trustworthy multiparty sessions (extended abstract)

Thanks for the attention!!
Conclusion

Preliminary study
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