

Second Workshop on Process Algebra and Stochastically
Timed Activities (PASTA secondi piatti)

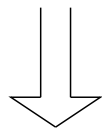
A framework to compare the Mobile
Ambient and the π -calculus behaviours

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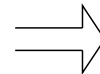
> *Context* <

global interconnections

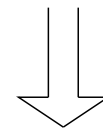
global networks (wireless wired)
local free access, firewall, cryptography...



the connection structure is not flat



global applications
reachability, security
performance



communications
depends on locations

other
features

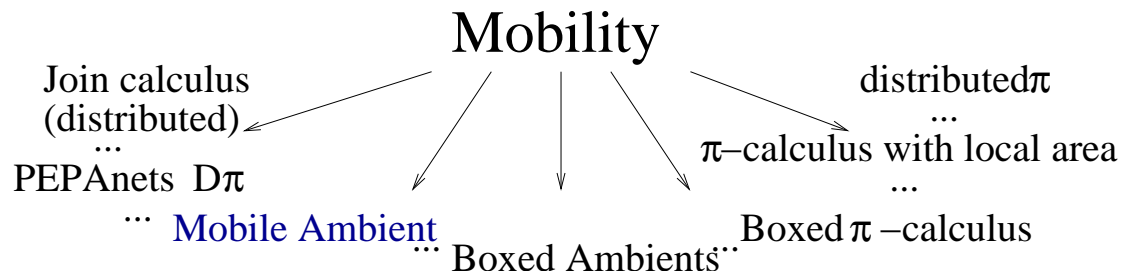
location
changes

distributed
control

partial
knowledge



} *Motivations*_{1/3} {



locations ambient-abstraction *limiting* shared resources

Encodings:

asyn. π-calculus → MA; MA → Join Calculus; MA → SA;

MA → π-calculus (?)

investigating expressivity **capturing mobility**

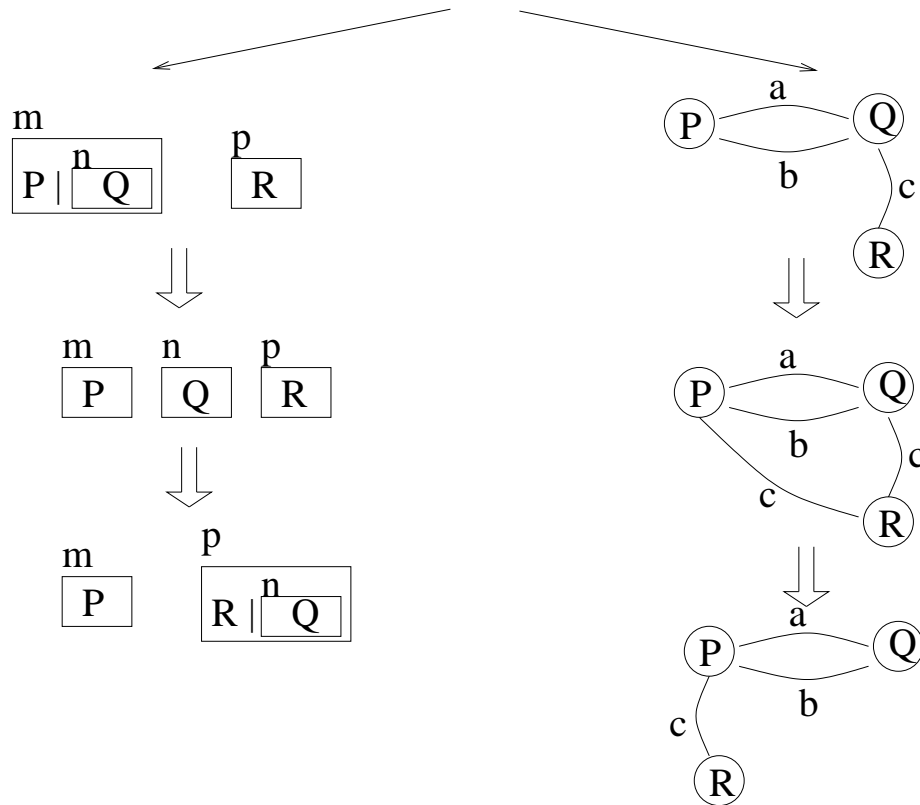


> *Motivations*_{2/3} <

ambient abstraction

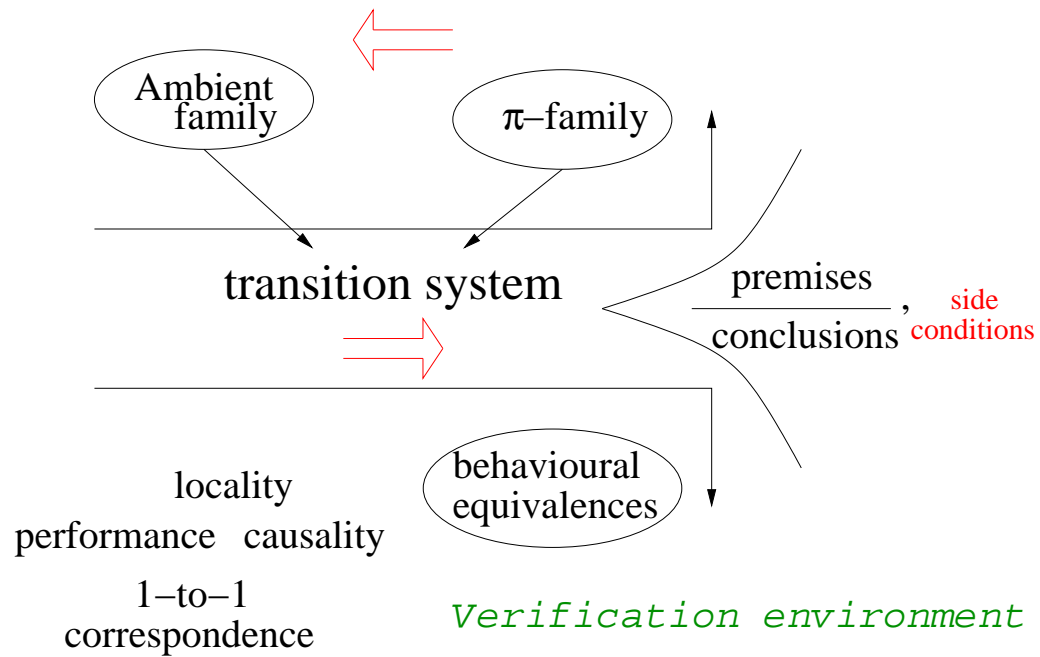
input/output primitives

definition of mobility



> Motivations_{3/3} <

Specification environment



Edinburgh, June 12th 2003



> Plan of the presentation <

background

the technique developed

the operational correctness

results



} *Mobile Ambients* {

	Capabilities		Processes
M	$:= x$ variable	P, Q, R	$:= \mathbf{0}$ inactivity
	n name		$(\nu n)P$ restriction
	$in\ M$ can enter into M		$P Q$ composition
	$out\ M$ can exit out of M		$!P$ replication
	$open\ M$ can open M		$M[P]$ ambient
	ϵ null		$M.P$ capability action
	$M.M'$ path		$(x).P$ input action
			$\langle M \rangle$ async output action

keeping all processes in ν -form:

~~in $m . \epsilon . \mathbf{0} | (\nu m) m[P|R]$~~

(v n) in m.0 | n[P | Q]



} π -calculus (HO π) {

a very limited form of higher order

$$\pi_s ::= \epsilon \mid \pi.\pi_s \quad T ::= \mathbf{0} \mid \pi_s.T \mid T|T \mid (\nu x)T \mid !T \mid Y$$

$$\pi ::= x(Y) \mid \bar{x}\langle K \rangle$$

keeping all processes in ν -form:

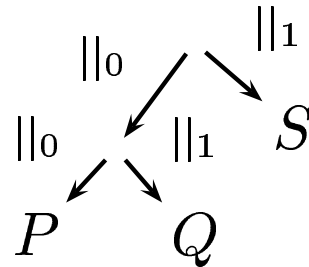
~~$$a\langle x \rangle.b\langle y \rangle \mid (\nu a) a(x).\epsilon.0 \quad (\nu c) (a\langle x \rangle.b\langle y \rangle \mid c(x).0)$$~~

..for convention: $\mathbf{0}_m = (\nu a)\bar{a}\langle m \rangle$



\rangle *EOS labels for π -calculus* \langle

- Consider π -calculus processes where $|$ is no longer associative and commutative
- $T = (P | Q) | S$ has the following syntax tree:



- Call a sequence of \parallel_0 and \parallel_1 **address**, denoted by ϑ
- Transitions carry rich labels that **include addresses**



> The two families <

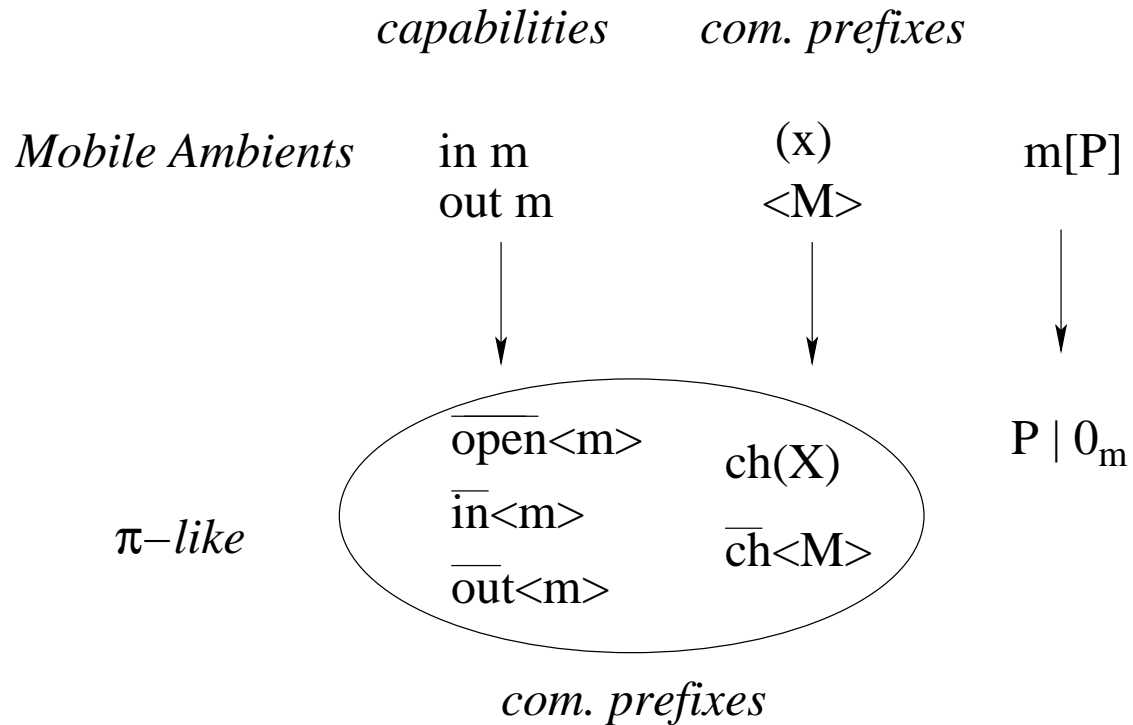
- Mobile Ambients - two kinds of actions: capabilities and communications; (ambient names, anonymous channels)
- π -calculus - only inputs and outputs (a unique set of names)

goal: reflecting the two kinds of actions into pure communication calculus

(there are some works which prove the expressiveness of capability actions)



> The translation $MA \rightarrow \pi$ -calculus <



$$\widehat{T}(P) = (\nu I)(\mathcal{T}(P')|\widehat{T}),$$

where $P = (\nu I)P'$ and $\widehat{T} = !in(X) | !out(X) | !open(X)$



} *The semantics of Mobile Ambients* <

modifying semantics rules : $\text{Red} \equiv : \frac{P \equiv P', P' \Rightarrow Q', Q' \equiv Q}{P \rightarrow Q}$

imposing an ordering on congruences:

$$\frac{
 \frac{
 \frac{
 n[in\ m.P|\mathbf{0}] | m[R] \rightarrow m[n[P|\mathbf{0}] | R]
 }{
 n[in\ m.P|\mathbf{0}] | m[R] | P_0 \rightarrow m[n[P|\mathbf{0}] | R] | P_0
 }{
 n[in\ m.P|\mathbf{0}] | m[R] | P_0 | Q_0 \rightarrow m[n[P|\mathbf{0}] | R] | P_0 | Q_0
 }
 }{
 P_0 | n[in\ m.P] | m[R] | Q_0 \rightarrow m[n[P] | R] | P_0 | Q_0
 }
 }{
 P_0 | n[in\ m.P] | m[R] | Q_0 \rightarrow m[n[P] | R] | P_0 | Q_0
 }
 }{
 P_0 | n[in\ m.P] | m[R] | Q_0 \rightarrow m[n[P] | R] | P_0 | Q_0
 }$$

A₁, A₂, A₃, A₄, C₁, C₂

The two operational semantics coincide



> *The selector @operator on parse trees* <

acts on the parallel structure of the terms:

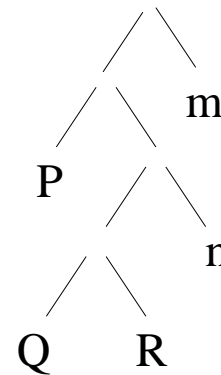
$$\text{Proc} = \boxed{\text{P} \mid \overset{\text{n}}{\boxed{\text{Q} \mid \text{R}}}}$$

$$\text{Proc} @||_0 = \text{P} \mid \overset{\text{n}}{\boxed{\text{Q} \mid \text{R}}}$$

$$\text{Proc} @||_0||_0 = \text{P}$$

$$\text{Proc} @||_0||_1 = \overset{\text{n}}{\boxed{\text{Q} \mid \text{R}}}$$

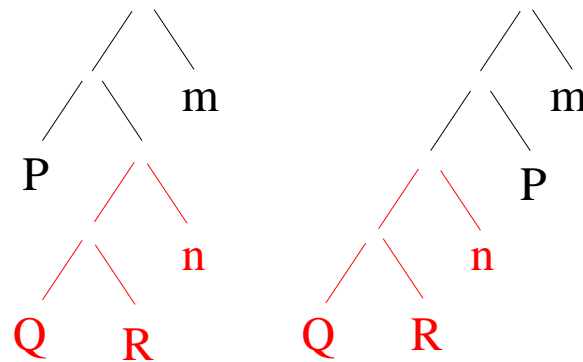
$$\text{Proc} @||_1 = \text{m}$$



⟩ notations ‹

where applying a congruence

$$Proc = m[P|n[Q|R]] \equiv_{comm, ||_0} m[n[Q|R]|P]$$



A semantics for the π -calculus

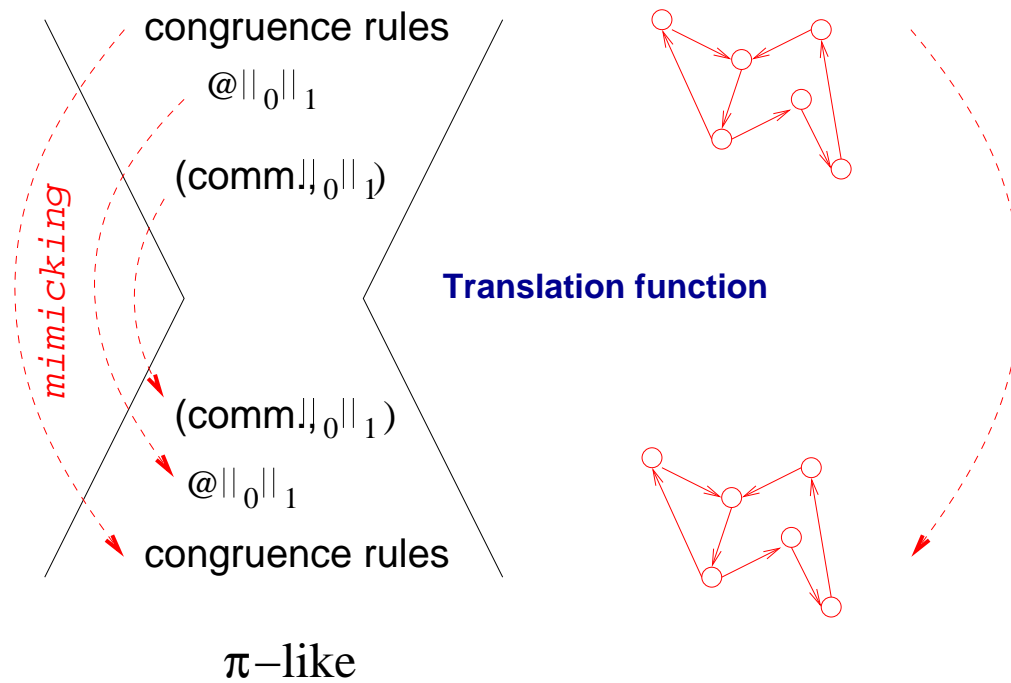
We want to:

- mimic the MA syntactic movements;
- fire an actions under *certain* conditions on the configuration of the terms;
- maintain an *operational* equivalence (MA \leftrightarrow π -calculus);
- investigate the relation between the auxiliary semantics and the *classical* semantics for the π -calculus;



> *The Framework* <

Source language (ambient-family)

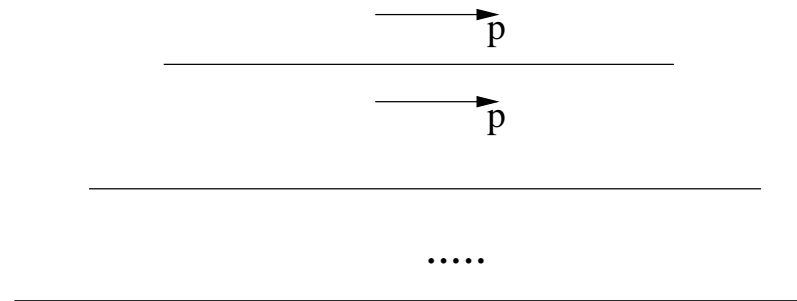


> *Our semantics rules for the π -calculus* <

a standard derivation

HO π semantic rules

\longrightarrow_p



semantics for mimicking ambients

\Longrightarrow_π

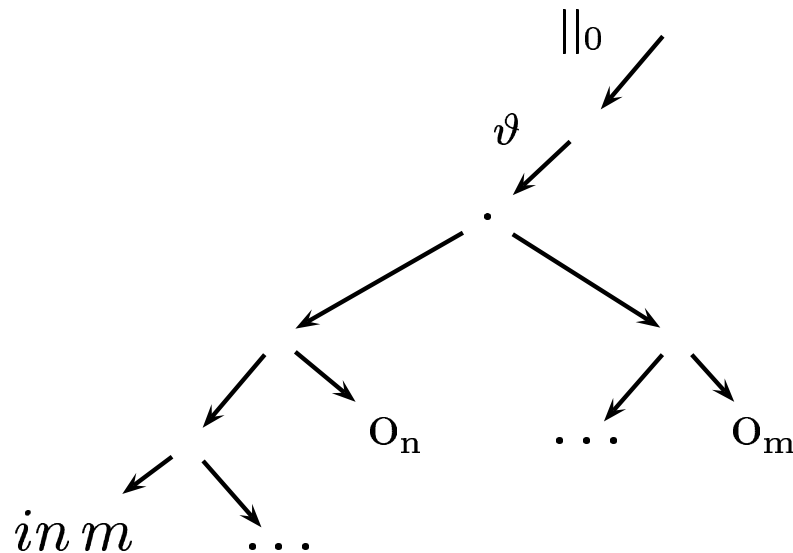
\Longrightarrow_π

No congruence are admitted, but ν -form



the rules for "ambients" (part I)

$$\frac{T \xrightarrow{\langle \|\mathbf{0}\vartheta\|_0 \|\mathbf{0}\|_0 \|\mathbf{0}\overline{\text{in}}\langle m \rangle, \|\mathbf{1}\|_0 \text{in}(Y) \rangle} T'}{T \Rightarrow_{\pi} T''}, \text{ side conditions on the labels}$$

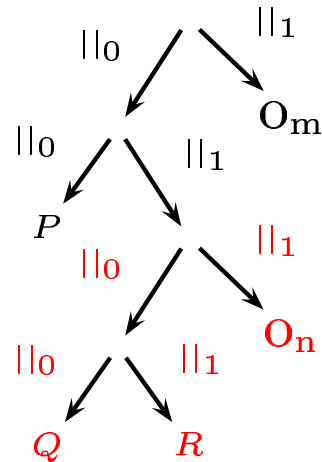


$$T @ \|\mathbf{0}\vartheta\|_1 \|\mathbf{1}\|_1 = \mathbf{0}_m \dots$$

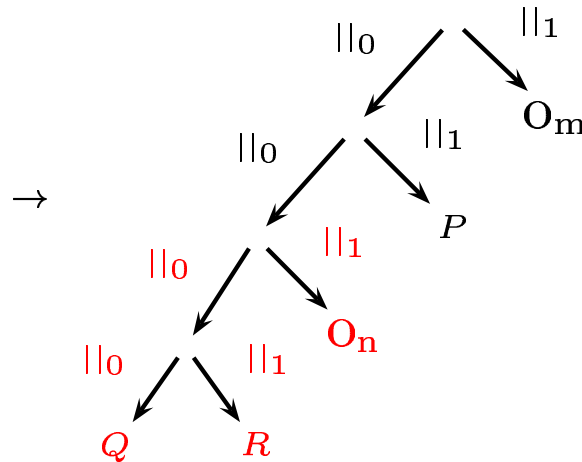


> *The "localized" replacements: $T\{\|_0 \mapsto T'\}$* <

$$T_0 = (P|((Q|R)|O_n))|O_m$$



$$T_1 = (((Q|R)|O_n)|P)|O_m$$



$$T_1 = T_0\{\|_0\|_1 \mapsto T_0@|_0|_0\}\{\|_0|_0 \mapsto T_0@|_0\|_1\}$$



summarizing...

- an *MA* process P as a π -calculus processes T , through the translation function $\widehat{T}()$
- an ambient $n[P]$ becomes $\mathcal{T}(P) \mid \mathbf{O}_n$, where \mathbf{O}_n is $(\nu a)\bar{a}\langle n \rangle.\mathbf{O}$
- a capability becomes an output on distinguished channels.
(to be read by an auxiliary process on the form
 $!in(Y) \mid !out(Y) \mid !open(Y)$)
- (implicitly) the tree of ambients of P through the syntactic tree of the EOS π -calculus process $\mathcal{T}(P)$.
Transitions have the form $\mathcal{T}(P) \rightarrow \mathcal{T}(Q)$
(Alternative: explicit representation, where a configuration is a pair $\langle \mathcal{T}(P), \text{TREE} \rangle$, and TREE is a partial order of addresses)

CAVEAT: structural congruence may *alter* the tree of ambients!!



> The results: ₁ <

- 1 The translation preserves the selectors:

$$\mathcal{T}(P@v) = \mathcal{T}(P)@v$$

- 2 The translation preserves structural congruence:

$$P \equiv_{\phi} Q \text{ iff } \mathcal{T}(P) \equiv_{\Phi} \mathcal{T}(Q)$$

(ϕ is the list (congruence rule applied, MA sub-process affected), and Φ is the corresponding list on π -calculus processes)

- 3 On rigid transitions:

$$P \Rightarrow_{MA} Q \text{ iff } \mathcal{T}(P) \Rightarrow_{\pi} \mathcal{T}(Q)$$



> *The results:*₂ <

4 On transitions tout court: the following diagram commutes

$$\begin{array}{ccccccc}
 P & \equiv_{\phi} & P' & \Rightarrow_{MA} & Q' & \equiv_{\phi'} & Q \\
 \downarrow & & \downarrow & & \downarrow & & \downarrow \\
 \mathcal{T}(P) & \equiv_{\Phi} & \mathcal{T}(P') & \Rightarrow_{\pi} & \mathcal{T}(Q') & \equiv_{\Phi'} & \mathcal{T}(Q)
 \end{array}$$

$$\rightarrow_{\pi} = \equiv_{\Phi} \Rightarrow_{\pi} \equiv_{\Phi'}$$



> The results:3 <

Theorem

Let \equiv_M be the minimal congruence induced by the standard congruence of the $\text{HO}\pi$, and by the rule

$$\text{P-Par New } (\nu a)\bar{a}\langle m\rangle.\mathbf{0} \equiv_M \mathbf{0}.$$

$$T_0 \rightarrow_\pi T_1 \text{ implies } T_0 \xrightarrow{\tau}_M T_1.$$

Corollary

Let $T_0 = \hat{\mathcal{T}}(P_0), T_1 = \hat{\mathcal{T}}(P_1)$ then

$$T_0 \rightarrow_\pi T_1 \text{ implies } T_0 \xrightarrow{\tau}_M T_1.$$



> The results:₄ <

Therefore, the transition system of the MA is a fragment of the transition system of the π -calculus

(actually one has to get rid of $(\nu a)\bar{a}\langle n \rangle.\mathbf{0}$ which does nothing: add a congruence rule).

The same construction can be applied to other calculi, e.g. variants of MA :

- first define a translation into π ,
- then filter the wanted transitions

The basic ingredient: EOS



› Acknowledgments ‹

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