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

Linda Brodo[1] Pierpaolo Degano[2] Corrado Priami[3]

[1] ITC-IRST via Sommarive,18 I-38050 Povo (Trento). Email: brodo@itc.it
[2] Dipartimento di Informatica, Università di Pisa via F.Buonarroti,2 I-56127 Pisa. Email: degano@di.unipi.it
[3] Dipartimento di Informatica e Telecomunicazioni, Università di Trento via Sommarive,14 I-38050 Povo (Trento). Email: priami@dit.unitn.it

Many process algebras, based on different primitives, has been proposed to describe mobile systems. We can roughly identify two main families of calculi, the π-calculus family and the ambient family. The first one groups the calculi which are based on the notion of name and which use the *channel passing* mechanism. The ambient family consists of those calculi that adopt the ambient abstraction. Here, we want to investigate the relation between the mechanisms that the two families of calculi use in expressing the mobility, relying on the Mobile Ambient [1] (MA for short) and on the π-calculus [4,3] as representatives.

As a method of analysis we choose to map the MA primitives into the input/output primitives of the π-calculus. Our approach requires the definition of a technical framework to strictly control the application of the congruence rules and to univocally select sub-terms in both the calculi. More in details, we introduce a particular notation for the application of the congruences to know which rule has been applied and which sub-terms have been involved. Also, we define a *selection operator* which localizes sub-terms using the syntax tree paths.
Then we translate the MA syntax into the syntax of the π-calculus. In particular, we render the capabilities and the input/output primitives of the MA as π-calculus prefixes and we translate the ambient constructor $n[\_]$ into the π-calculus process $\_ \mid \mathbf{0}_n$, where the process $\mathbf{0}_n$ cannot perform any action. Our translation function is proved to be invertible on its image. This property guarantees us that we correctly map the ambient nesting in the π-calculus translated processes.

Our next step is to define an auxiliary semantics for the π-calculus, relying on the Degano and Priami's enhanced operational semantics [5,2] (EOS for short), to execute the translated processes. The EOS is built upon the operational semantics by enriching the transition labels with the encodings of their proofs.
In defining our auxiliary semantics we add some *side conditions* on the EOS enriched labels to control the execution of actions. We want to prevent those π-calculus communications that do not respect the ambient nesting configuration required by the MA semantic rules. Then, we mimic the modifications in the ambient nesting, that occur after the firing of a MA capability, by forcing the application of some congruences. It is proved that our auxiliary semantics generates a transition system which differs from the π-calculus one only because some transitions between states are cut.

The correctness of our translation is given in terms of a one-to-one correspondence between the MA transition system and the transition system generated by the π-calculus translated processes running with our semantics.
The main result we got is that the transition system of the Mobile Ambient is strictly contained into the one of the π-calculus.

The ground property we have obtained between the two transition systems allows us to rely in one transition system for both the Mobile Ambient and the π-calculus.
As future works we are planning to reflect the relations that have been already defined for the π-calculus, as *causality*, *enabling*, ..., see [2] for details, in the MA code. Also we claim that we can easily apply the performance studies developed for the π-calculus specifications to the mobile ambient specifications.

References

1. L. Cardelli and A. Gordon. Mobile Ambients. *Lecture Notes in Computer Science*, 1378:140–155, 1998.
2. P. Degano and C. Priami. Enhanced operational semantics: a tool for describing and analyzing concurrent systems. *ACM Computing Surveys*, 33(2):135–176, 2001.
3. R. Milner. *Communicating and Mobile Systems: The π Calculus.* Cambridge University Press, 1999.
4. R. Milner, J. Parrow, and D. Walker. A calculus of mobile processes. *Information and Computation*, 100(1):1–77, 1992.
5. C. Priami. *Enhanced Operational Semantics for Concurrency.* PhD thesis, Università di Pisa, 1996.