# Bigraphical Programming Languages
## A LaCoMoCo research project
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## 1 Background

Context-dependent Mobile Communication is a strategic research theme at the IT University of Copenhagen. It consists of research activities within a value chain ranging from social and cultural implications of mobile communication to the technological infrastructure needed to make context-dependent mobile communication a reality. We believe that it is important to address such whole chains of research questions, such that different projects of may be informed and influenced by each other. The research is done in cooperation with private companies and university researchers from a broad range of fields. A key difference to other research on mobile computing is the incorporation of "context," that is, information that characterizes a situation related to the interaction between users, applications, and the surrounding environment.

A concrete example of context is physical location and several of the research projects are concerned with investigations of how to best provide and make use of location information. Examples include calculi and programming languages for mobile systems with locations, location-based services in industrial settings, and location-based games.

To connect the research with teaching we have installed and implemented a WLAN positioning system at the IT University, which makes it possible for students and researchers to experiment with location-based systems indoors. Over the last year, more than 100 students have worked on such experiments in their projects. We also have other technologies (GSM, Bluetooth, etc.) for students to experiment with. Jointly with our partners in Crossroads Copenhagen (a network of private and public companies and institutions), we plan to create a living laboratory in Ørestad North, a new district in Copenhagen situated between the City Centre and the airport. Over the next few years, several big institutions (including the IT University of Copenhagen (ITU), Danish Broadcasting Corporation (DR), the University of Copenhagen, the Royal Library, Consumer Information) will have moved to Ørestad, which will have approximately 20000 daily users. We will connect the buildings and the open areas in

between the buildings in Ørestad North into a joint laboratory by establishing a joint IT and communication infrastructure equipped with a positioning system that makes it possible to locate mobile devices, both indoors and outdoors.

We refer to the integrated effort in research and teaching as "Laboratory for Context-dependent Mobile Communication (LaCoMoCo)," where we understand "Laboratory" broadly as "a place providing opportunity for experimentation, observation, or practice" in Context-Dependent Mobile Communication.

Several of the research projects have just started and some are still awaiting financial support. Below we briefly describe one of the research projects, which is related to security and theory in ubiquitous computing and which has just started in January 2004.

## 2 Bigraphical Programming Languages

The goal of this project is to design bigraphical programming languages for programming mobile distributed systems, as needed for the implementation of context-dependent mobile services. In the future, context-dependent mobile services will pervade our lives more and more and thus it is absolutely crucial that these mobile and distributed IT systems are secure, correct and easily maintainable. To obtain such properties, it is essential that the systems are built on sound theoretical models and that programming languages provide the proper abstractions for programming such systems. We believe that such programming languages should be based directly on a theory for modelling and reasoning about mobile distributed systems, in such a way that the concepts of the theory for modelling and reasoning about mobile distributed systems are mapped in as direct a way as possible to concepts in the programming language. We will research the design of bigraphical programming languages, i.e., programming languages based on Milner's theory of bigraphs, which has been developed over the last decade with the aim of providing a model of computation on a global scale. The theory of bigraphs focuses simultaneously on two of the most important aspects of mobile distributed systems, namely connectivity and mobile locality and is thus highly relevant for the overall aims of LaCoMoCo. The project will include the implementation of prototypes of the bigraphical programming language. The research will be done in collaboration with Milner and coworkers in Cambridge and is related to joint research between some members of the project group and researchers at Sussex. The project group consists of five researchers and three Ph.D. students.