LaCoMoCo IT University of Copenhagen
Laboratory for Context-dependent Mobile Communication

Bigraphical Programming Languages

A LaCoMoCo research project, January 2004 - 2008

2nd UK-UbiNet Workshop, May 2004

Thomas Hildebrandt
ITU University of Copenhagen

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- *Context-dependent Mobile Communication* is a strategic research theme at ITU, ranging from social and cultural implications, over applications to technological infrastructure
- WLAN positioning system at ITU used by >100 students in projects
- Courses in *Mobile Business*, *Location-Based Applications and CSCW*, *peer-to-peer systems* and *Model-based design of distributed and mobile systems (calculi)*
- 8 research projects* initiated January 2004, ranging from *Context-aware Computing*, *HCI* and *Location Based Gaming* to *Bigraphical Programming Languages*

* 5 with funding from the Danish Research Council, CIT, Danish Broadcasting Corporation, and Nokia

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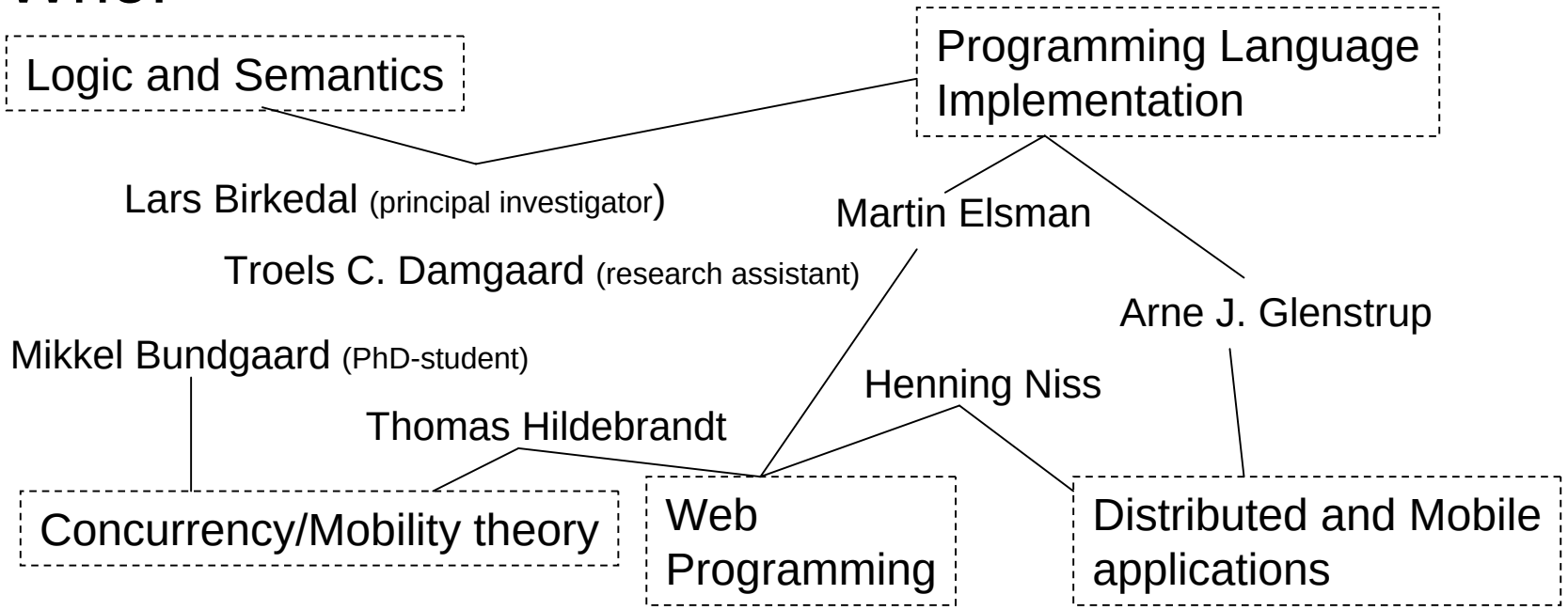
Bigraphical Programming Languages

(January 2004 – 2008)

- Goal:

  Design Programming Language(s) for context-dependent mobile services and distributed mobile applications, based on the theory of bigraphs [Milner, H. Jensen]

- Who:



+ two PhD students starting August 2004 (4 year scholarships)

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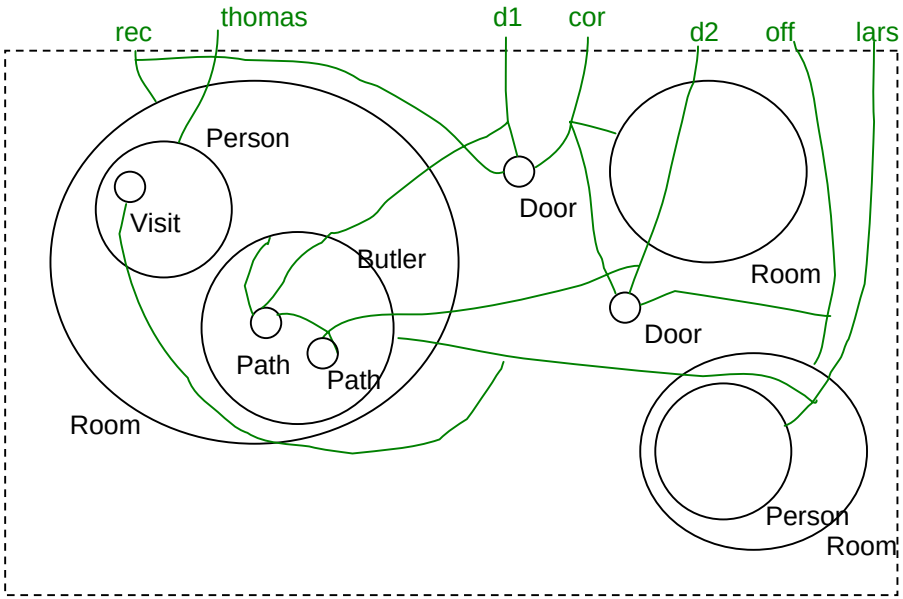
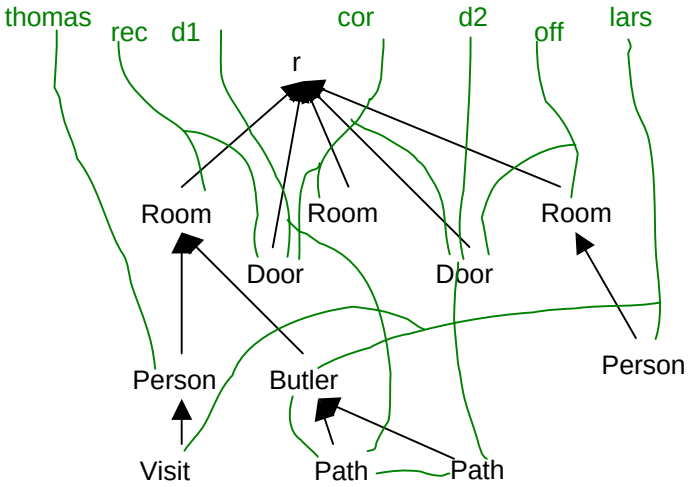
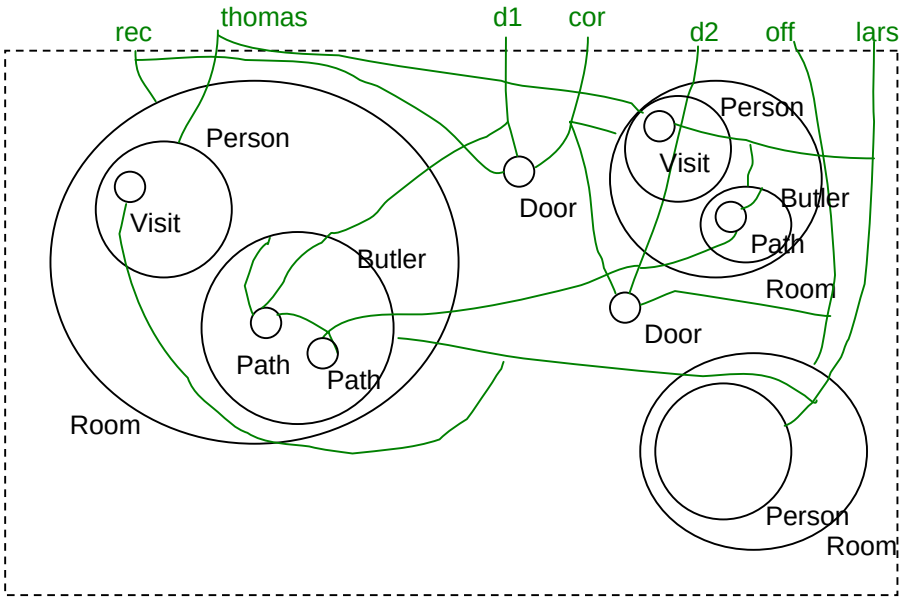
Bigraphical context-dependent mobile services





Bigraphical Reactions



A Core Syntax for Bigraphical Reactive Systems

```
/* Example Bigraph for context-dependent mobile butler service */
using sig Room:active (1); Butler:passive (2); Person:passive (1); Door:atomic (3);
                Visit:atomic(1); Path:atomic (3) end
local
   val butler = Butler<lars,e1> (Path<e1,d1,e2>|Path<e2,d2,e3>){/e1/,/e2/,/e3/} in
local
 val reception = Room <rec> (butler| Person <thomas>(Visit <lars>))
 val corridor = Room <cor> ()
 val office =  Room <off> (Person<lars>())
 val door1 = Door <rec,d1,cor>
 val door2 = Door <cor,d2,off>
 val redex = Room<a>(Person<x>(Visit<y>)|Butler<y,e>(Path<e,d,e'>|[0]) |[1])
|Door<a,d,b> |Room<b>([2])
val reactum = Room<a>([1])|Door<a,d,b> |
                      Room<b>(Person<x>(Visit<y>)|Butler<y,e'>([0]) |[2])
 rule redex=>reactum
in
  val itu = (reception | corridor | office | door1 | door2)
end
```

Why Bigraphs?

- The theory of Bigraphs focuses *simultaneously* on two of the most important aspects of mobile distributed systems: *connectivity* and *locality*
- A *meta-language* which (analogously to XML) allows definition of domain specific languages, while benefiting from a general theory (e.g. for contextual equivalences)
- A *graphical* model: Eases communication and avoids introduction of syntactical distinctions

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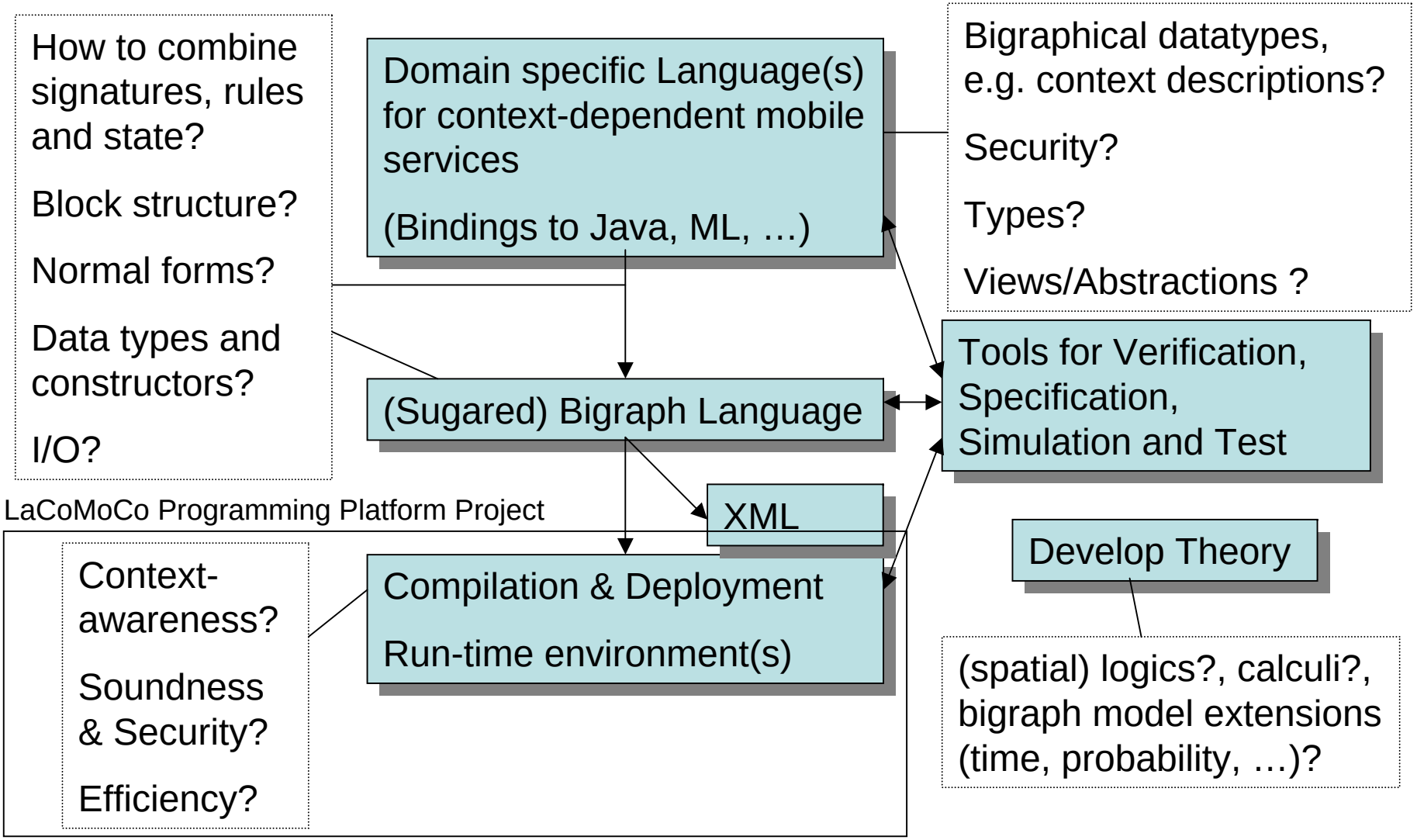
Research Goals and Questions



Activities so far…

- Weekly BPL seminars (where theory meets practice)
- Implemented parsers and compilers in ML and Java (runs as an applet) for prototype BPL language
  - compiles to XML or internal data structure
  - so far no runtime environment
  - indeed only prototypes!
- Related masters thesis projects:
  - XML rewriting (“XML reactive systems”)
  - Context-dependent/Location-based Systems
- Plenty of student project proposals (XML helps here!)

Links

- IT University of Copenhagen: www.itu.dk
- LaCoMoCO: lacomoco.itu.dk
- BPL Project: www.itu.dk/research/theory/bpl/
- Bigraph applet: www.itu.dk/research/theory/bpl/software/bip/
- Bigraphs and mobile processes (revised) [Milner, Høgh Jensen]: www.cl.cam.ac.uk/TechReports/UCAM-CL-TR-580.pdf
- Axioms for bigraphical structure [Milner]: www.cl.cam.ac.uk/TechReports/UCAM-CL-TR-581.pdf