



Seamlessly Distributed & Mobile Workflow or: the right processes at the right places

Thomas Hildebrandt

Arne J. Glenstrup, Henning Niss, Mikkel Bundgaard,
Espen Højsgaard, Hugo A. López, Karen M. Lyng, Rao M. Rhagavan

Programming, Logic and Semantics Group
IT University of Copenhagen

PLACES'08: Workshop on Programming Language Approaches to Concurrency
and Communication-cEntric Software
Oslo, June 7th, 2008



Road Map

- ◆ The CosmoBiz and TrustCare projects
 - ◆ cross-fertilization between software development in industry and research in formal models, computer supported work and HCI
- ◆ Application domains, Motivations & Challenges
- ◆ Work so far
- ◆ Future work and conclusions



Computer Supported Mobile Adaptive Business Processes *≡ CosmoBiz*

Funded by the Danish Research Agency (2007- 2011)

- ◆ **Aim:** Extensible formalization and implementation of business process language that supports mobile & adaptive business processes
- ◆ **Partners:** IT University of Copenhagen (ITU), Microsoft Development Center Copenhagen (MDCC) and Copenhagen Business School (CBS)
- ◆ **Size:** ITU: Arne J. Glenstrup, Mikkel Bundgaard, Espen Højsgaard, CBS: Kjeld Schmidt + Post doc in CSCW
- ◆ **Approach:** Formal models (bigraphs) + SWD + CSCW

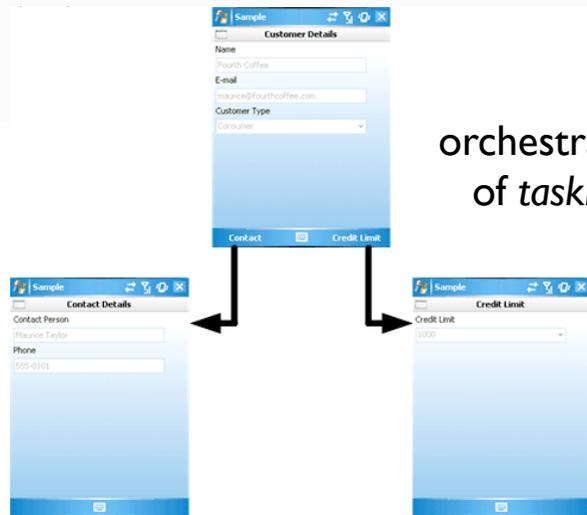
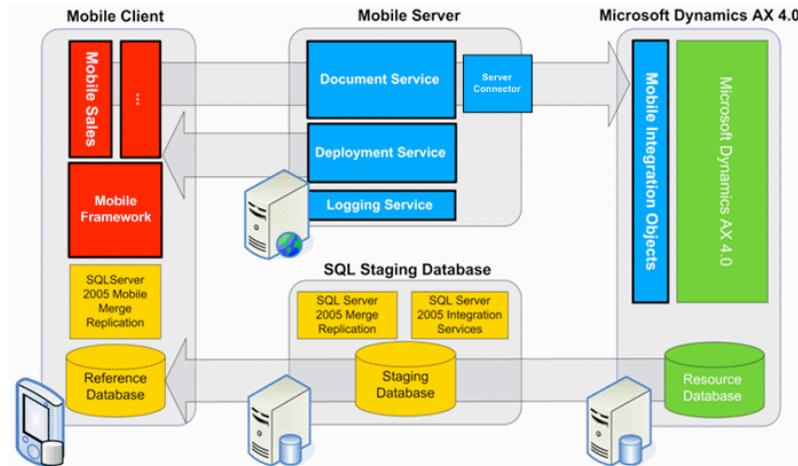


≡ *CosmoBiz* motivations, application domain and challenges

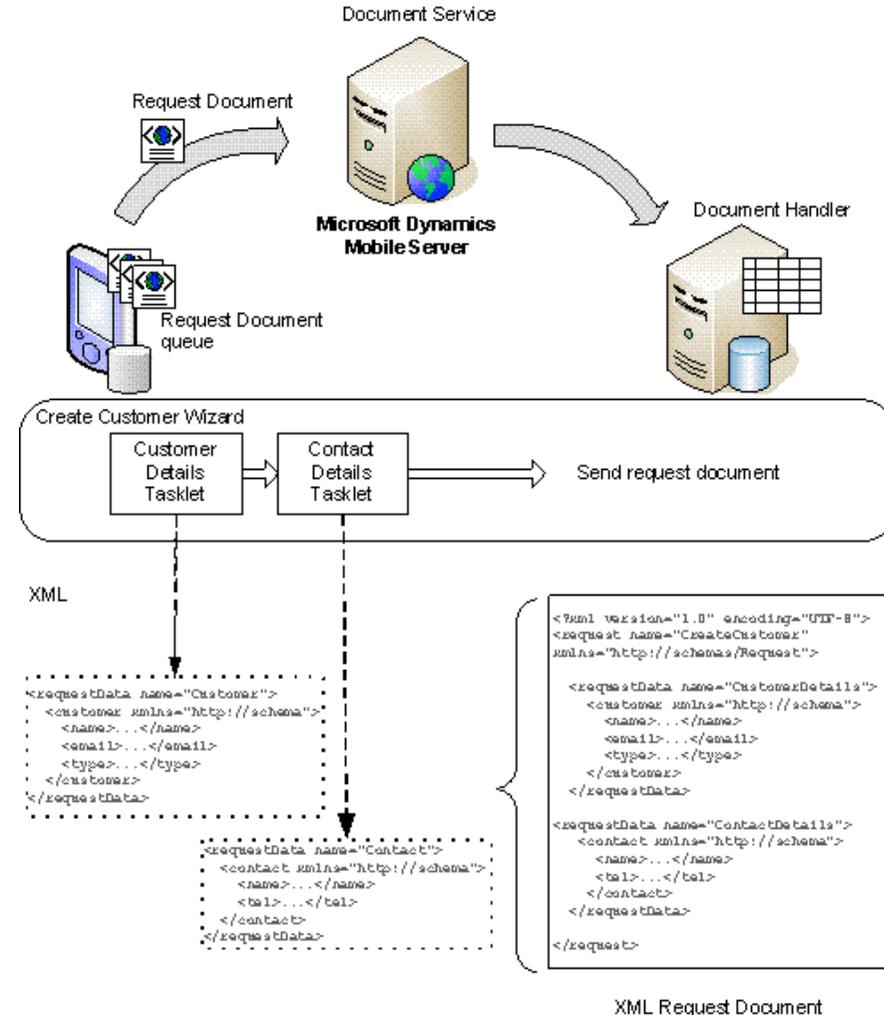
- ◆ Give mobile workers access to the ERP system
- ◆ Mobile Salespersons, Home-care
- ◆ Focused & specific tasks => role-based & task-driven
- ◆ Confusing, time consuming and beyond capacity of mobile device to replicate entire ERP system
- ◆ Must allow for disconnected operation
- ◆ Must be flexible and (re)configurable



Microsoft Dynamics Mobile Development Tools (June 2007)



orchestration of tasklets



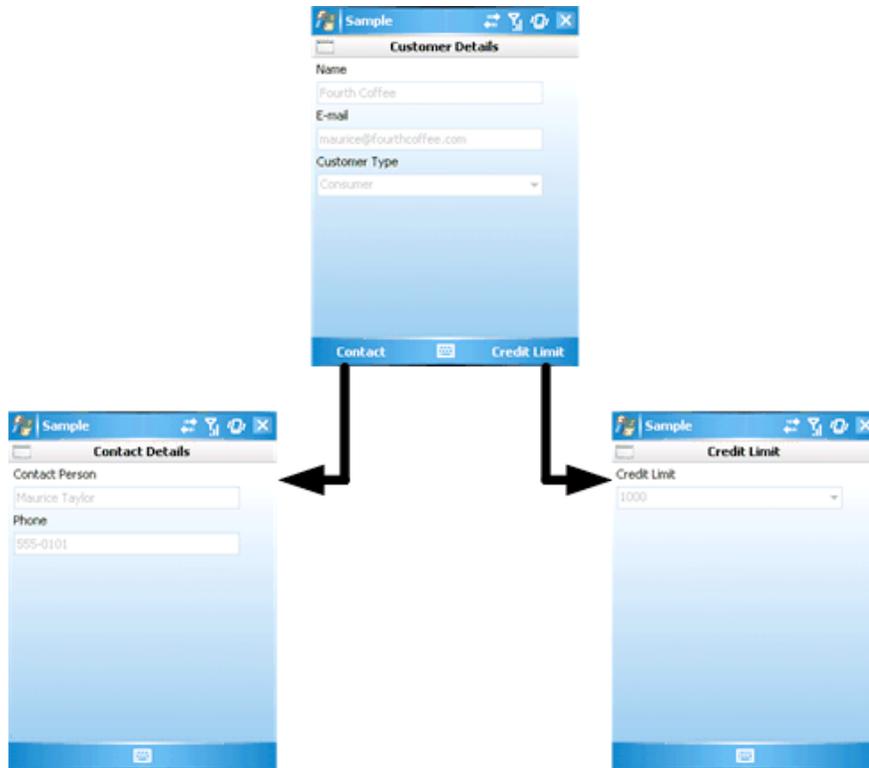
XML Request Document

Note The XML has been simplified and is for illustration purposes only

<http://msdn.microsoft.com/en-us/library/cc160851.aspx>



Orchestration example



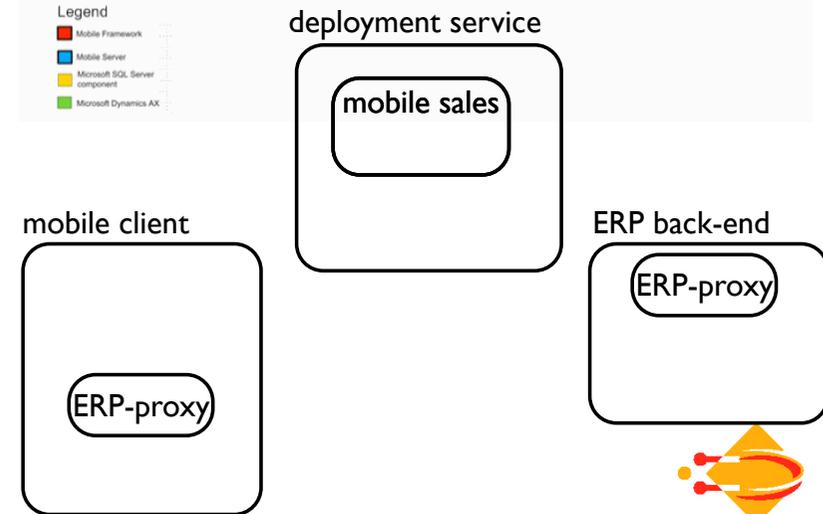
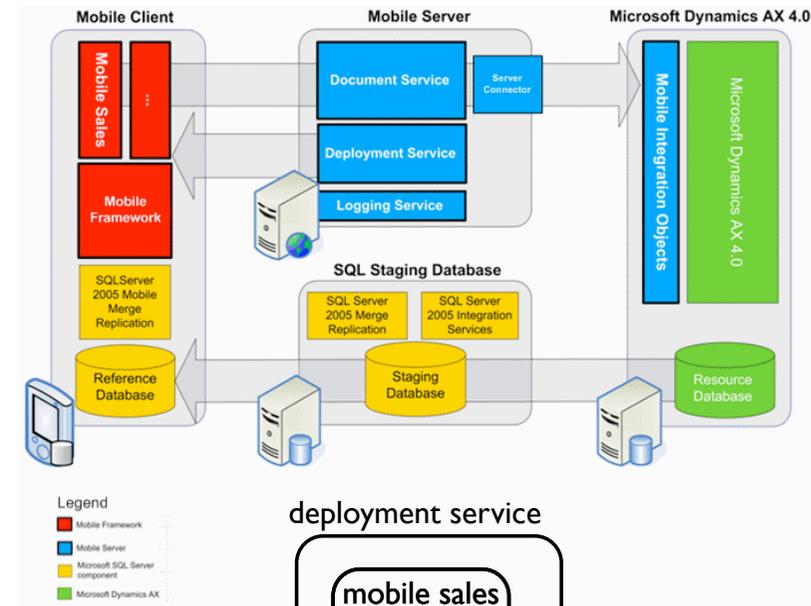
```

<userRole xmlns="http://schemas.microsoft.com/Dynamics/Mobile/2007/04/Flow">
  <orchestrations>
    <orchestration text="Customer detail">
      <tasklets>
        <tasklet name="CustomerDetailTasklet">
          <actions>
            <open text="Contact" tasklet="CustomerContactDetailTasklet">
              </open>
            <open text="Credit Limit" tasklet="CustomerCreditLimitDetailTasklet">
              </open>
            </actions>
          </tasklet>
          <tasklet name="CustomerContactDetailTasklet">
            </tasklet>
          <tasklet name="CustomerCreditLimitDetailTasklet">
            </tasklet>
          </tasklets>
        </orchestration>
        <orchestration text="New Customer">
          ...
          <!-- Contact Details -->
          <tasklet name="ContactDetails" text="Contact Details"
            type="CustomerContactDetailTasklet.CustomerContactDetailTasklet,
            CustomerContactDetailTasklet">
            <actions>
              <previous priority="1" text="Previous">
                </previous>
              <exitOrchestration text="Finish"/>
            </actions>
          </tasklet>
        </tasklets>
      </orchestration>
    </orchestrations>
  </userRole>
  
```



CosmoBiz research so far

- ◆ Extensible formalization of WS-BPEL (subset) as a *bigraphical reactive system*
- ◆ Higher-order mobile embedded BPEL (HomeBPEL)
 - ◆ business process management (deployment)
 - ◆ disconnected operation using mobile embedded sub instances

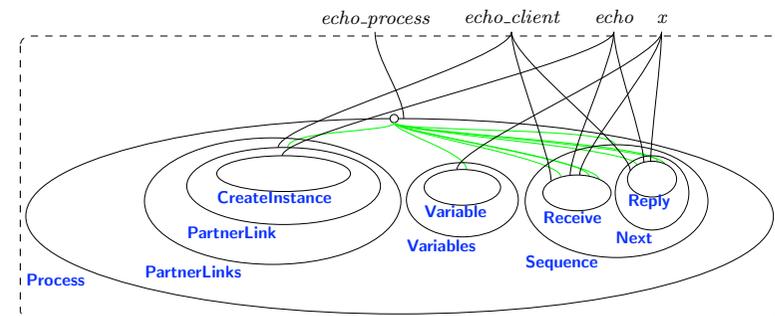


Remarks on HomeBPEL

- ◆ Imperative process descriptions and mobility
- ◆ Based on ideas similar to HO mobility calculi such as Homer, Kells, Seal
- ◆ Bigraphical formalization very close to XML source language

```
<process name="echo_process">
  <partnerLinks><partnerLink name="echo_client" /></partnerLinks>
  <variables><variable name="x" /></variables>
  <sequence>
    <receive partnerLink="echo_client" operation="echo"
      createInstance="yes" variable="x" />
    <reply partnerLink="echo_client" operation="echo" variable="x" />
  </sequence>
</process>
```

(a) Example WS-BPEL process.



(c) BPL Tool visualization of example process.

Future Work

- ◆ Runtime engine based on bigraphical abstract machine
- ◆ Types for HomeBPEL (sessions, access control, interference?)
- ◆ Supporting process changes/composition?
- ◆ Extending and relating formalizations at varying degrees of abstraction



Trustworthy Pervasive Healthcare Services: TrustCare

Funded by the Danish Research Agency (2008- 2012)

- ◆ **Aim:** Extend foundations for workflow systems to support trustworthy pervasive healthcare services
- ◆ **Partners:** IT University of Copenhagen, Computer Science Department at Copenhagen University and Resultmaker A/S (+ collaborators in Bologna & Dortmund)
- ◆ **Size:** ITU: Carsten Schürmann +1-2 PhD students Jakob Bardram + Post doc, DIKU: Fritz Henglein, Andrzej Filinski, 2 PhD students
 - ◆ 3 related PhD projects (Hugo A. Lopéz, K. M. Lyng and R. M. Raghavan)
- ◆ **Approach:** Formal models & languages + SWD + Pervasive HCI



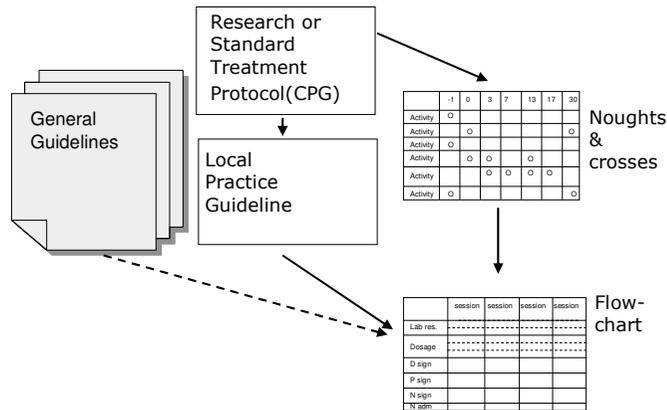


TrustCare motivations, application domain and challenges

- ◆ IT-supported pervasive healthcare services, i.e. coordination of treatment processes
- ◆ Distributed, mobile and heterogeneous actors
- ◆ Highly safety critical and deal with sensitive data
- ◆ Must be flexible (dynamic changes & composition)



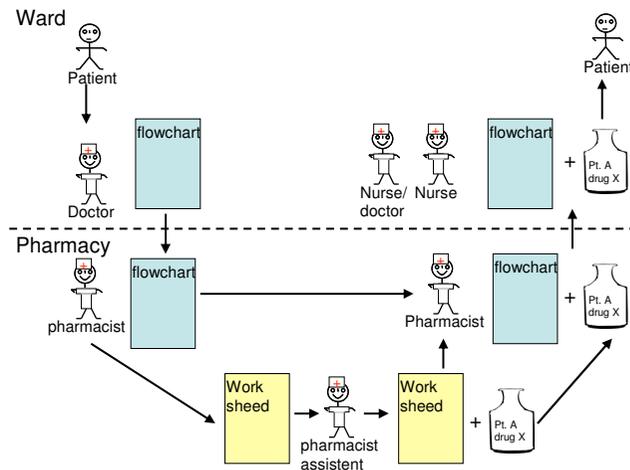
Paper-based workflows



S No	Activities	Roles				
		D	N1	N2	CP	PA
1.1	BASIC INFO					
1.1.1	Basic info registration*	W	W	R	R	N
1.1.2	lab. Results *	W	W	R	R	N
1.1.3	Patient history*	W	R	R	R	N
1.2	ORDINATION					
1.2.1	Calculate the therapeutic doses of chemo-therapy*	W	R	R	R	N
1.2.2	Sign	W	R	R	R	N
1.2.3	Verify ordination	W	R	R	R	N
1.3	CONTROL					
1.3.1	Control calculation	R	R	R	W	R
1.4	PREPARE					
1.4.1	Quantity and batch nr of products are registered*	D	D	D	R	W
1.4.2	Sign	R	R	R	R	W
1.4.3	Check out drip bottle	R	R	R	W	R
1.4.4	Sign	R	R	R	W	
1.4.5	Verify preparation	R	R	R	W	
1.5	MEDICIN ADM.					
1.5.1	Check that preparation, order and patient match	R	W	R		
1.5.2	Check that preparation, order and patient match	W	R	W		
	Sign	R	W	R		
1.5.3	Admin preparation to patient*	R	W	W		

only verify ordination if control in 1.3.1 fails

doctor can recalculate at any time, but then he *must* sign again (and the following steps must also be carried out again)



Remarks on healthcare workflows

- ◆ Shared process state rather than communication based
- ◆ Linear flow with conditional inclusion & re-execution of activities controlled by declarative constraints
- ◆ Matches recent proposal by van der Aalst and Pesic suggesting use of graphical templates for LTL formulas as workflow language
- ◆ Also fit well to the patented workflow model used by the industrial partner in the TrustCare project (Resultmaker Online Consultant)



Approach of van der Aalst and Pesic

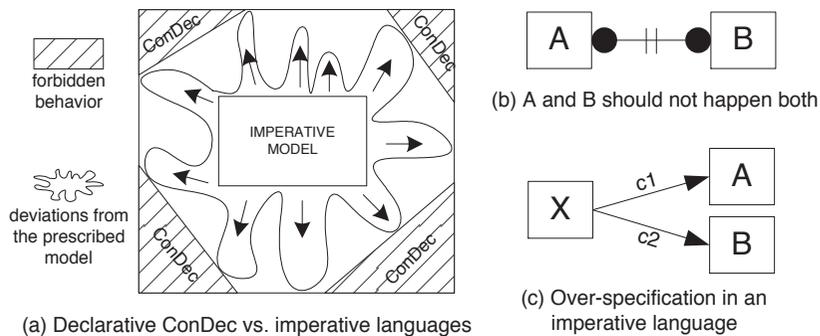


Fig. 1. A shift from imperative to declarative languages.

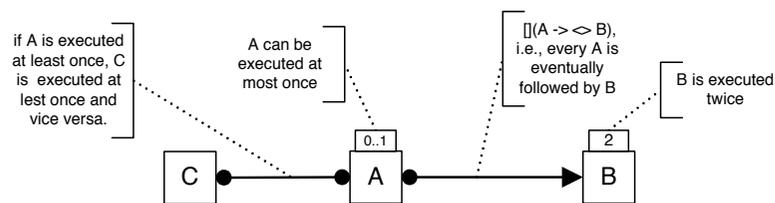


Fig. 2. An simple example of a ConDec model.

- ◆ A set of graphical templates compiled into formulas joined in conjunction
- ◆ Formulas are executed, e.g. by translation to automata

Declarative Past and Imperative Future

Executable Temporal Logic for Interactive Systems

- ◆ In fact a rebirth of an old proposal by Dov Gabbay presented in paper from 1987 (available at: <http://www.dcs.kcl.ac.uk/staff/dg/064.pdf>),
- ◆ also proving that past tense modalities in LTL can be encoded using just future & present



Work in TrustCare

- ◆ So far
 - ◆ Formalized core primitives of the Resultmaker Online Consultant in LTL
- ◆ Future
 - ◆ Distribution, mobility, access rights
 - ◆ Extensions of (timed) concurrent constraint programming
 - ◆ Interfaces/contracts between sub workflows & dynamic changes
 - ◆ Use of logical frameworks, e.g. for type checking (or PCC)
 - ◆ Implement and evaluate prototype systems (including research in HCI)



Conclusions?

- ◆ Distributed & Mobile Process-oriented IT-systems
- ◆ Flexibility in Design, Execution, Management
- ◆ Static and dynamic correctness & security guarantees
- ◆ Bridge gap between formal models and implementation
- ◆ Imperative & declarative models
- ◆ Global coordination/shared state vs. message passing and coordination of end-points



**Thank you for your
attention**