**Contract-Oriented
Software Development
for Internet Services –
*What is it?***

NorduNet3 Project 2006 - 2010

FLACOS'09
Toledo September 2009

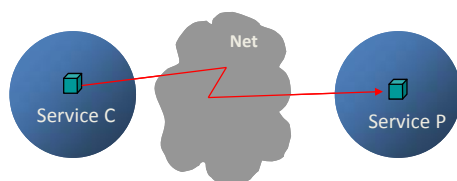Olaf Owe, Cristian Prisacariu,, Gerardo Schneider,   Oslo University
Gordon Pace, University of Malta
Björn Bjurling,Swedish Institute of Computer Science
Joseph C. Okika, and Anders P. Ravn, Aalborg University

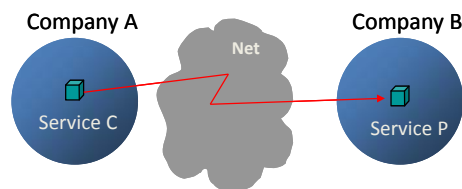**www.ifi.uio.no/cosodis/**

Why Internet Services ?

Technology allows collaboration across the net.

CS background:
- **Concurrency Theory 1970 –**
- **Distributed databases, transactions etc. 1980 -**
- **Distributed Operating Systems 1990 –**   **+ Internet**
- **CORBA 2000 -**

Why Contracts ?

Company A   Net   Company B

Service C   Service P

Collaboration across organizational domains presumes trust, but…

When trust is insufficient, use contracts

Software Development ?

- Developers need language support to program services that are:

  – Distributed
  – Interoperable
  – Discoverable
  – Contract-aware

Contract-Oriented Software Development for Internet Services
What is it?

COSoDIS Mission

1. develop novel approaches to implement and reason about **contracts** in a **service oriented architecture**.

2. design and give proof of usefulness of **system modeling tools** and **programming language tools**

3. to empower SOA developers to deploy **highly-dynamic, negotiable** and **monitorable** Internet services.

1. Pablo Giambiagi, Olaf Owe, Anders P. Ravn, and Gerardo Schneider, **Language-Based Support for Service Oriented Architectures: Future Directions**

2. Pablo Giambiagi , Olaf Owe, Anders P. Ravn and Gerardo Schneider, **Contract-Oriented Software Development for Internet Services**

Key Issues for Contracts

- Definition C Cristian Prisacariu and Gerardo Schneider, CL: An Action-based Logic for Reasoning about Contracts, **LNCS 5514 ,** June 2009

- Contract checking $C \neq \varnothing \, , C_1 \leq C_2$
  Stephen Fenech, G. Pace, and G. Schneider. Clan: A tool for contract analysis and conflict discovery. **LNCS 5799,** October 2009.

- Conformance checking $P \models C *$

- Monitoring $M(P) \parallel I(C)$
  Christian Colombo, G. Pace, and G. Schneider. Dynamic event-based runtime monitoring of real-time and contextual properties, **LNCS 5996**, September 2009
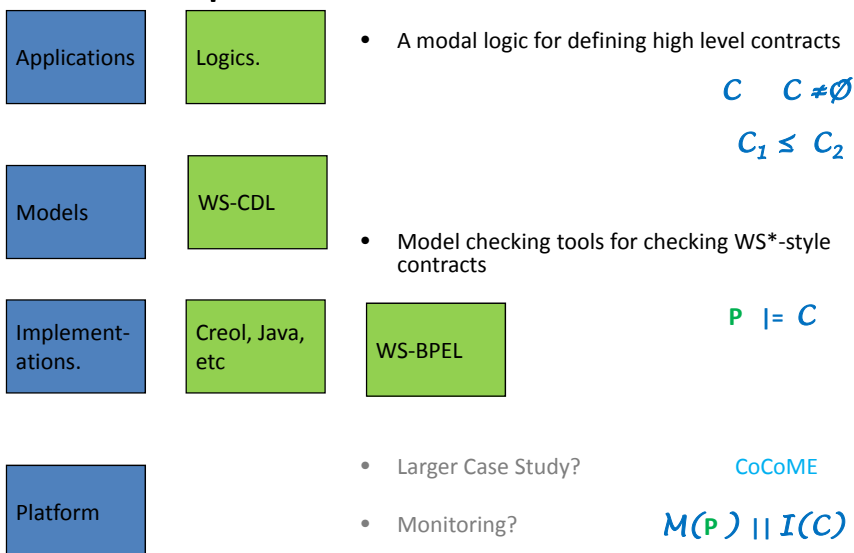
P,C   The Marketplace

| Aspect | Language/Approach | | |
	Web Services (WS-*)	Semantic Web (*-S)	Electronic Business (eb-*)
Interface	WSDL	OWL-S	ebBSI
Functionality	WS-BPEL, WSOL	OWL-S (IOPE), WSMO	ebBPSS
Protocol	WS-BPEL, WS-CDL	WSMO, OWL-S	ebBPSS
Security	WS-Security	OWL-S	ebCPA(SecurityPolicy)
QoS	WS-Policy WS-Trust WSOL WSLA	OWL-S WSMO WSML	ebCPP(XMLDSIG) ebCPA

1. Joseph C. Okika and Anders P. Ravn, **Classification of SOA Contract Specification Languages**
2. Emilia Cambronero, Joseph C. Okika, and Anders P. Ravn, **Consistency Checking of Web Service Contracts**

Expected Results - 2010

Applications	Logics.
Models	WS-CDL
Implement-ations.	Creol, Java, etc
Platform	

- A modal logic for defining high level contracts

$$C \quad C \neq \emptyset$$
$$C_1 \leq C_2$$

- Model checking tools for checking WS*-style contracts

$$P \models C$$

WS-BPEL

- Larger Case Study?   CoCoME
- Monitoring? $M(P) \parallel I(C)$

SOA is really New! (Wolfgang Reisig)

Aspect	Application Area		
	Enterprise Computing	Embedded Systems	Service Oriented
Interface	DataBase Schema	RT-profile	Dist. Objects
Functionality	Queries	Control algorithms	Components
Protocol	Workflow	Reactive processes	Orchestration
Dependability	Integrity	Timeliness	Availability
Fault Tolerance	Transactions	Replicated Processes	Compensation
QoS	Performance	Firm/Hard R-T	Reliability

A Beautiful Service (Wolfgang Reisig)

$$s : I \times S \rightarrow S \times O$$

or

$$u : I \times S \rightarrow O$$
$$t : I \times S \rightarrow S$$

And the Ugly Reality (Flaviu Cristian*)

$$u \subseteq I \times S \times O$$
$$t \subseteq I \times S \times S$$
$$u(i, s) = \emptyset,$$
$$u(i, s) = \{o, \bot\}, \ldots$$
$$t(i, s) = S,$$
$$t(i, s) = s,$$
$$t(i, s) = \{s, s'\}, \ldots$$

* Flaviu Cristian: Software Fault Tolerance, 1995

The only Real Beauty ?
(Transactions, Backward recovery)

$$s \subseteq I \times S \times S \times O$$

$$s(i, s) = \{(o, s_o), (\bot, s)\}$$

Implement and verify it