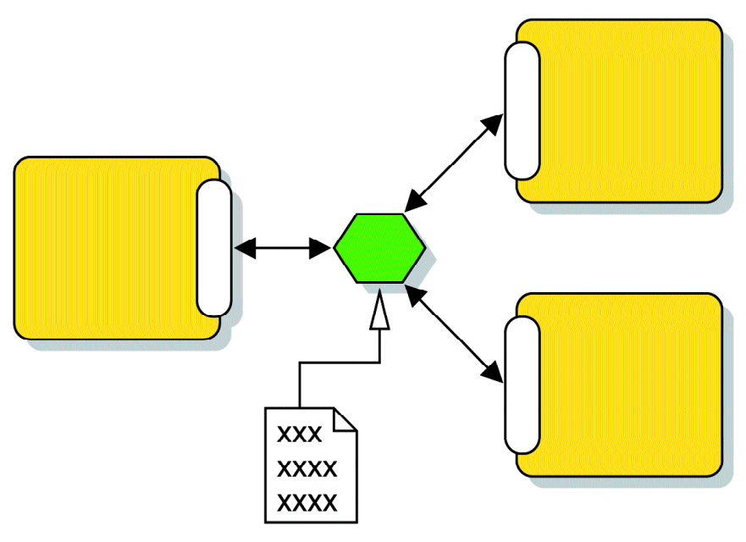
Behavioral Adaptation of Component Compositions based on Process Algebra Encodings

Radu Mateescu
INRIA / VASY project-team
radu.mateescu@inria.fr

Pascal Poizat
INRIA / ARLES project-team
pascal.poizat@inria.fr

Gwen Salaün
University of Málaga
salaun@lcc.uma.es

Model-Based Adaptation



❑ systems are built by reuse and composition of components developed by different third-parties

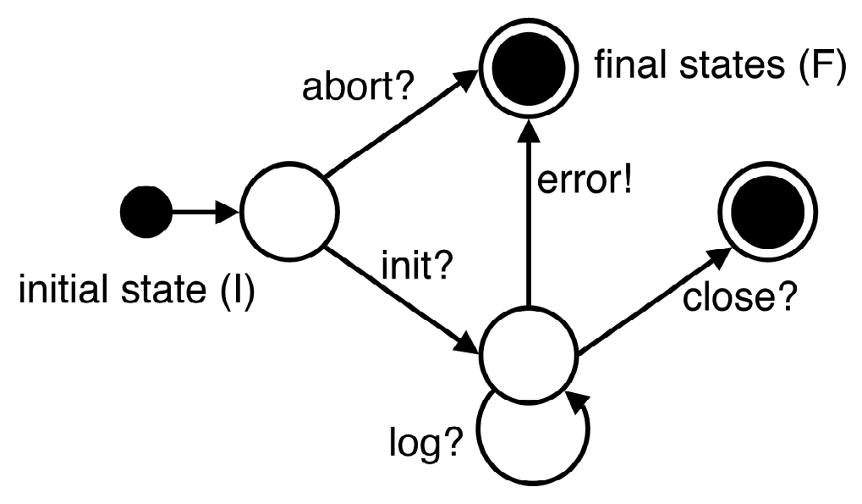
❑ adaptation is required to solve mismatch and to ensure interoperability

❑ model-based adaptation generates adaptors, automatically from a composition specification

❑ interoperability levels in component interfaces:
- ● signature (operations), behavior (protocol)
- ● semantics (ontologies), non functional (QoS)

Behavioral Interfaces

❑ operations' signatures
❑ LTS: (A, S, I, F, T)
Labelled Transition System
(Alphabet, States, Initial states, Final states, Transitions)
reception: _? emission: _!

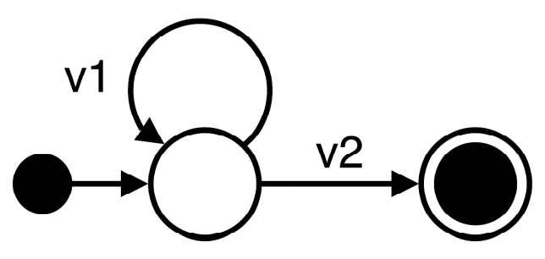


Composition Specifications

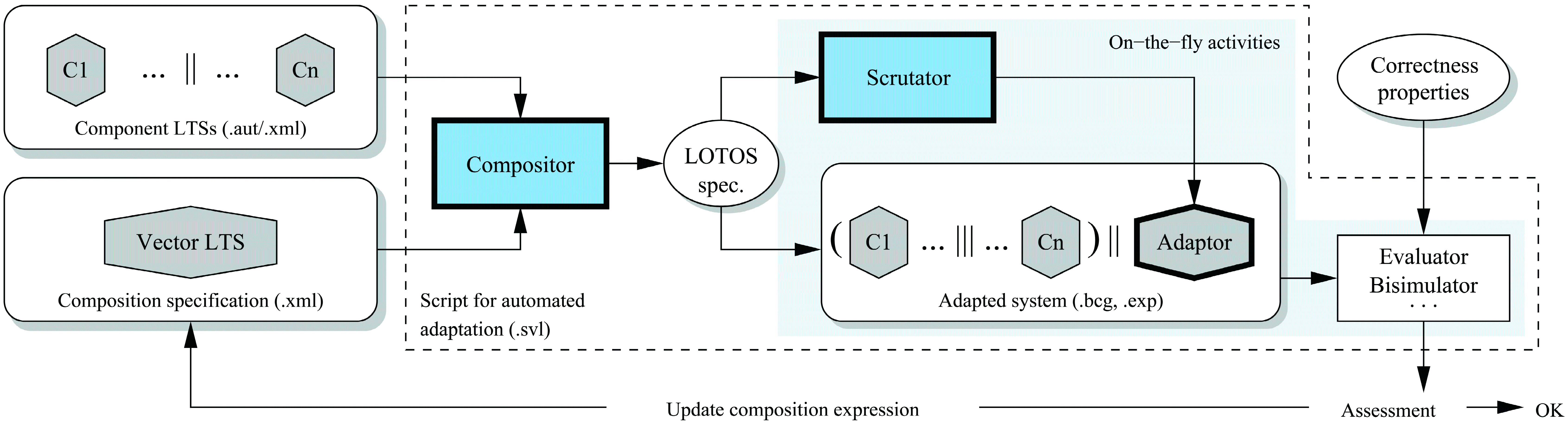
❑ n-ary name correspondences using vectors:
given n components with LTSi = (Ai, Si, Ii, Fi, Ti),
a vector is an element of $A1 \cup \{\varepsilon\}$ x ... x $An \cup \{\varepsilon\}$

v1:<server:send!,client:recv?,logfile:log?,*display*:ε>
v1:<server:send!,client:recv?,logfile:log?> (ε omitted)
v2:<client:exit!,logfile:close?> (ε omitted)

❑ dynamicity and ordering using a vector LTS
(LTS labelled with vectors)



Contribution - first model-based behavioral adaptation approach performing adaptor computation on-the-fly (without computing the complete system state space)


C1
... || ...
Cn
Component LTSs (.aut/.xml)
Vector LTS
Composition specification (.xml)
Compositor
LOTOS spec.
Script for automated adaptation (.svl)
On−the−fly activities
Scrutator
(C1 ... ||| ... Cn) || Adaptor
Adapted system (.bcg, .exp)
Correctness properties
Evaluator
Bisimulator
. . .
Update composition expression
Assessment
OK

Adaptor Generation

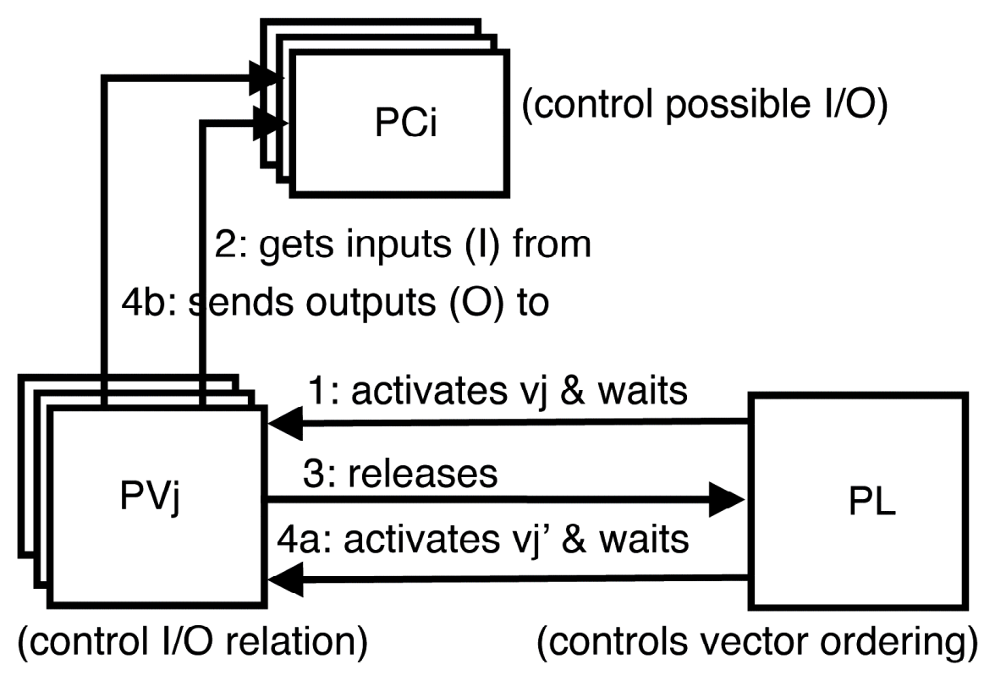
Step 1 – Compositor tool

encoding adaptation constraints into LOTOS processes

❑ component interfaces
(the adaptor must respect them)
- ● PCi - component processes (n)

❑ composition specification
(the way to solve mismatch)
- ● PVj - vector processes (1/vect.)
- ● PL - vector LTS process (1)

❑ system architecture
(centralized adaptation)
- ● LOTOS specification



Step 2 – Scrutator tool

on-the-fly adaptor generation using CADP and Open/Caesar

❑ compilation of LOTOS specification (components' interfaces and vector LTS) into an implicit LTS using Caesar

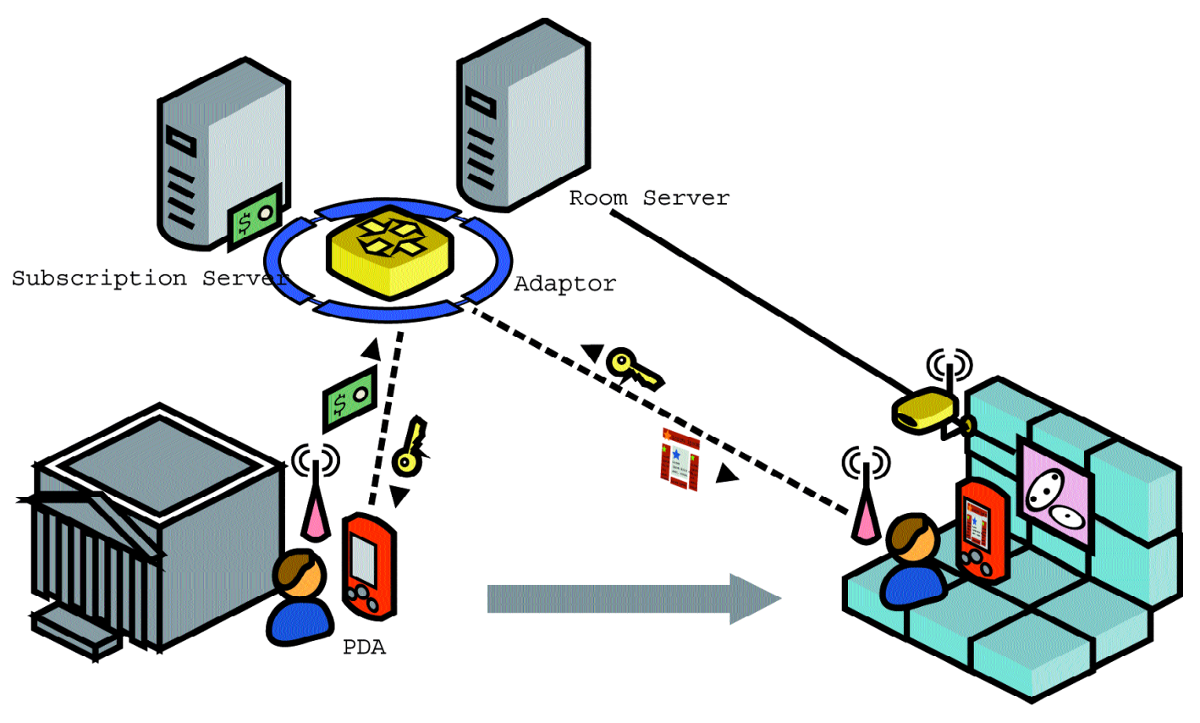
❑ forward LTS exploration

❑ on-the-fly detection of states potentially reaching successful termination
- ● problem encoding in terms of a Boolean Equation System (BES)
- ● local BES resolution using the Caesar_Solve library

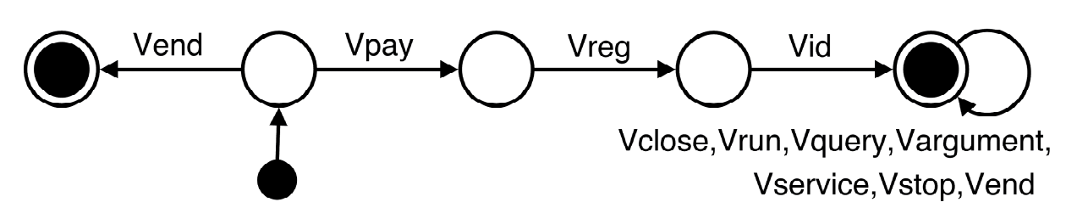
❑ linear complexity wrt LTS size

for CADP and Open/Caesar, see:
http://www.inrialpes.fr/vasy/cadp

Application

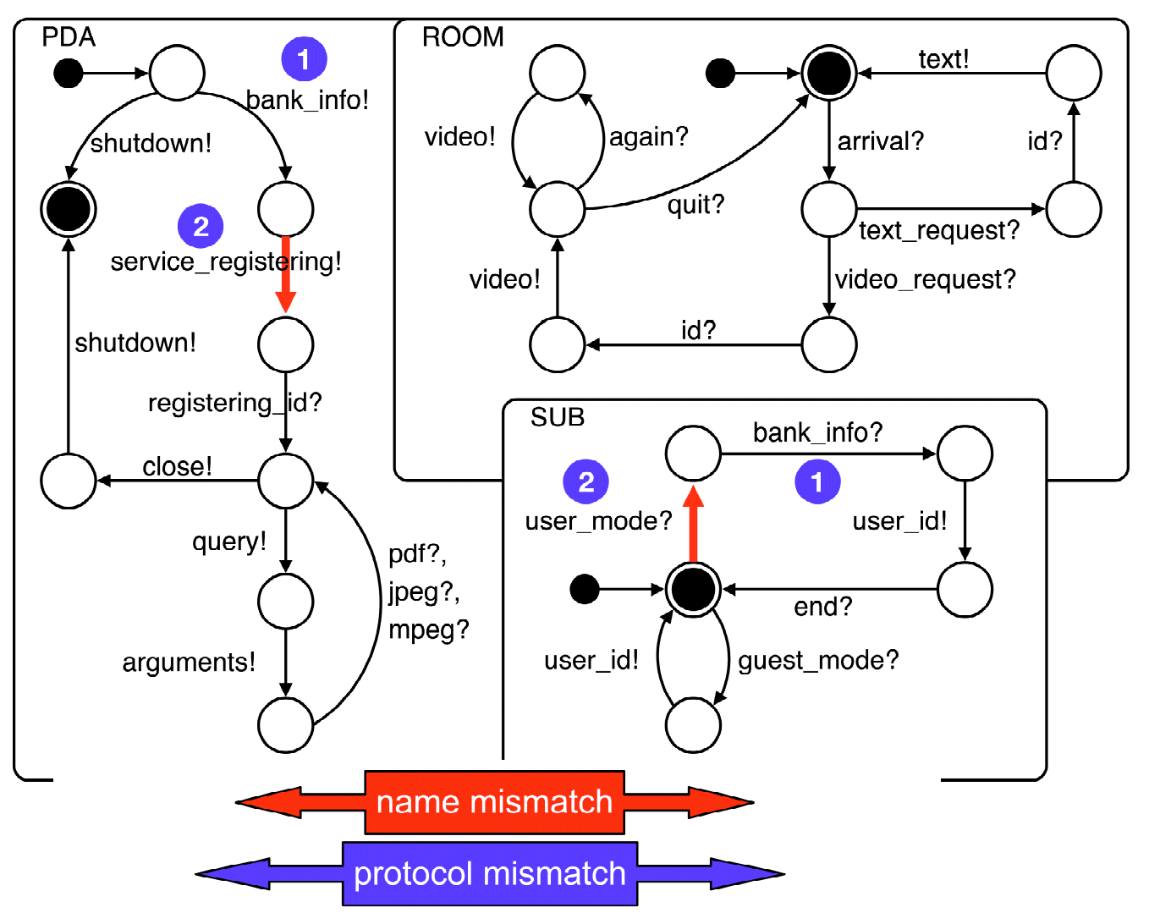


eMuseum - Typical adaptation example. Three components (subscription server, room information displayer and universal service access GUI on PDA) are reused to build an added-value application. The adaptor is in charge of resolving mismatches between the component protocols (service names, ordering,...).

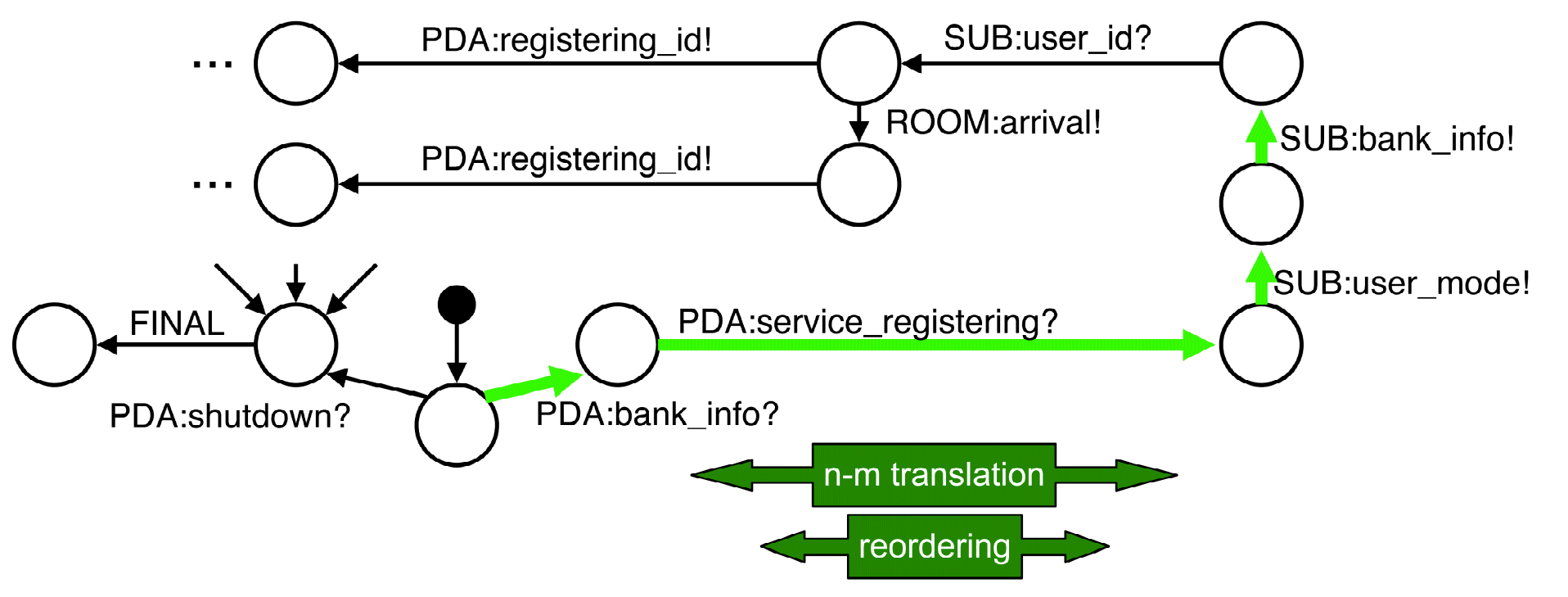


vend=<PDA:shutdown!>,
vpay=<PDA:bank_info!, SUB:bank_info?>,
vreg=<PDA:service_registering!, SUB:user_mode?>,
vid=<PDA:registering_id?, SUB:user_id!>,
vclose=<PDA:close!, SUB:end?>,
vrun=<ROOM:arrival?>,
vquery=<PDA:query!, ROOM:video_request?>,
vargument=<PDA:arguments!, ROOM:id?>,
vservice=<PDA:mpeg?, ROOM:video!>,
vstop=<ROOM:quit!>.

eMuseum adaptation mapping



eMuseum components' behavioral interfaces



eMuseum adaptor (registration prefix)

	Adaptor LTS				* : LTS portion explored for adaptor generation			
	raw		Scrutator (*)					
	states	trans.	states	trans.	states	%	trans.	%
eMuseum (subscribers)	246681	1247961	84	156	9952	4,00%	20715	1,60%
eMuseum (guests)	19117	71005	25	32	1186	6,20%	1988	2,70%

For more details, see http://www.inrialpes.fr/vasy/ - http://www-rocq.inria.fr/arles/ - http://www.gisum.uma.es/

INSTITUT NATIONAL
DE RECHERCHE
EN INFORMATIQUE
ET EN AUTOMATIQUE

INRIA