

Service-oriented Distributed Applications in the Future Internet: The Case for Interaction Paradigm Interoperability

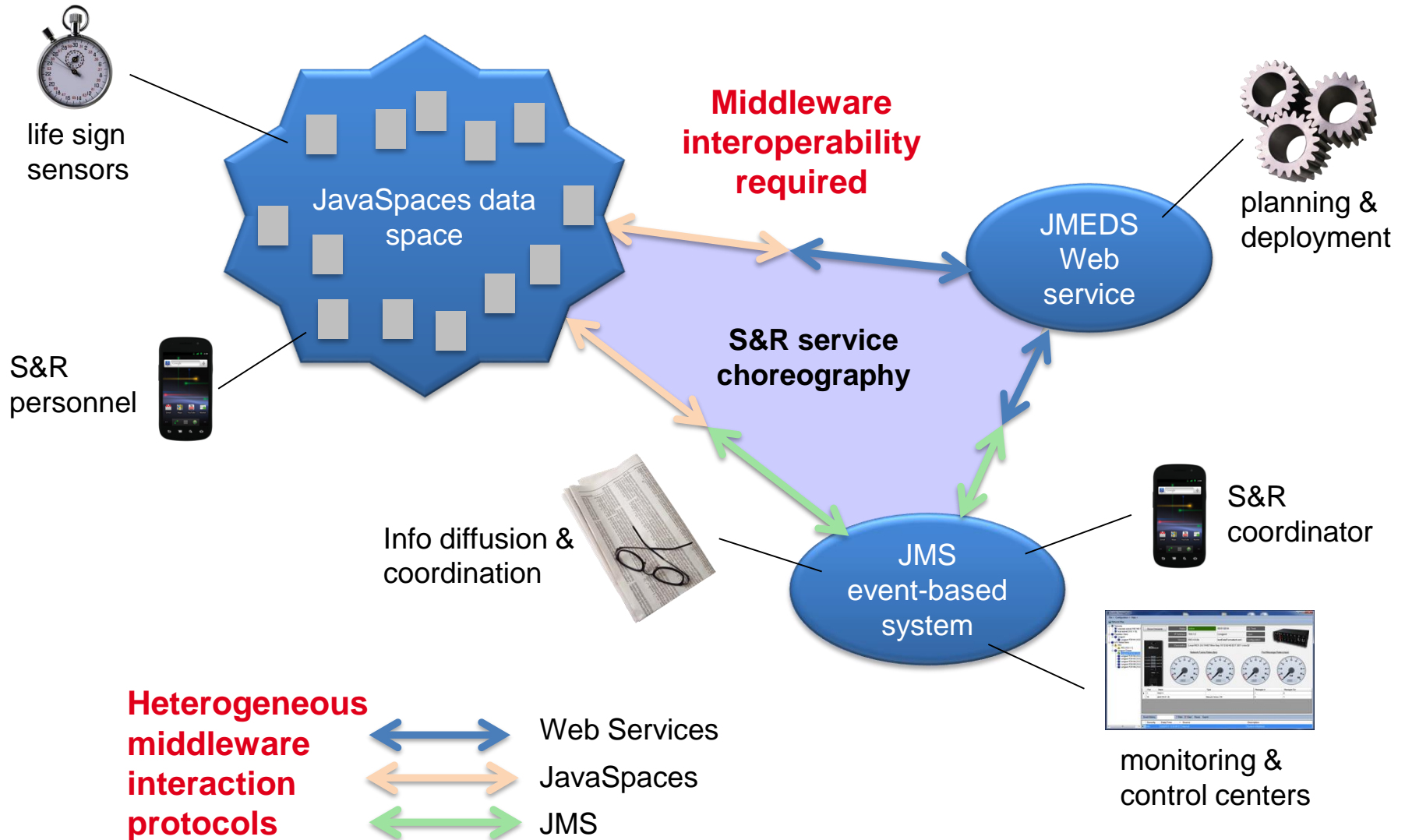
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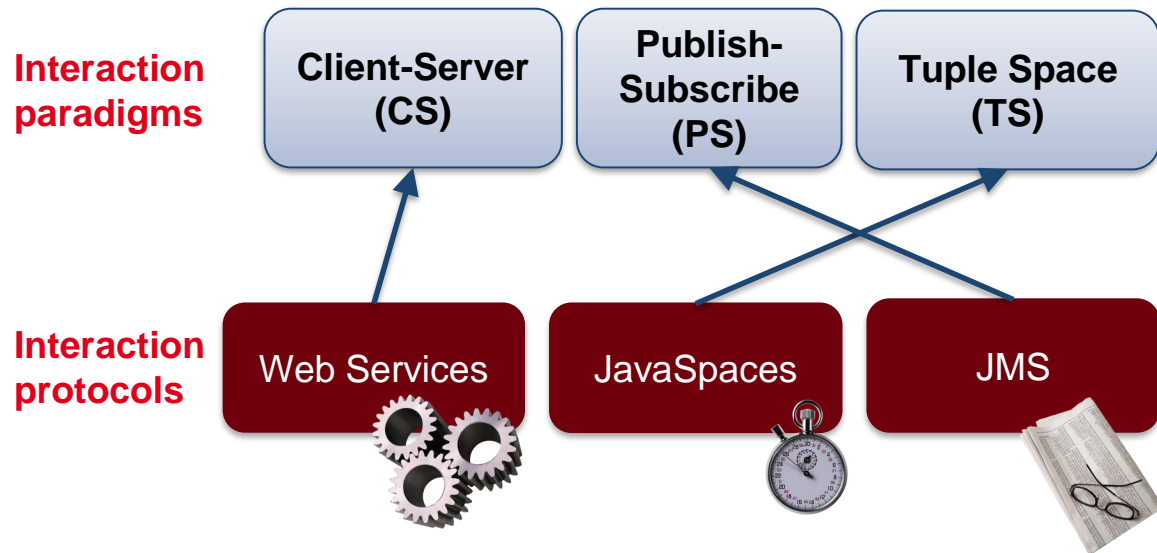
ESOCC 2013, Malaga, 13/09/13

Service-oriented applications in the FI: Search & Rescue (S&R)



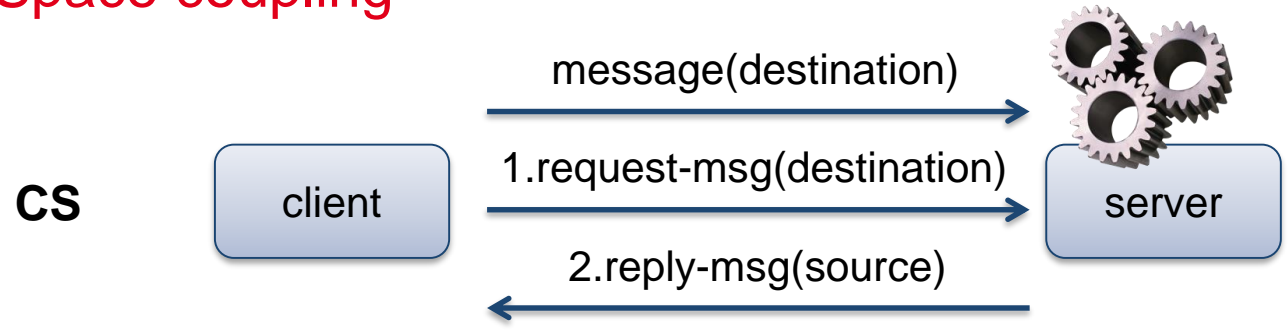
Interaction paradigms in middleware

- Look for comprehensive systematic solution to middleware interoperability
- Classify middleware implementations into *families*
- Families follow well-known *interaction paradigms*

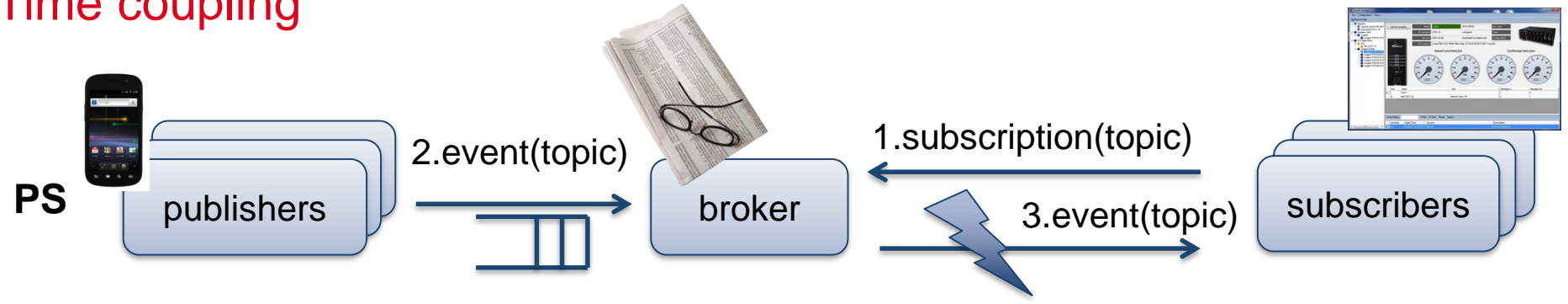


Some informal semantics of interaction paradigms

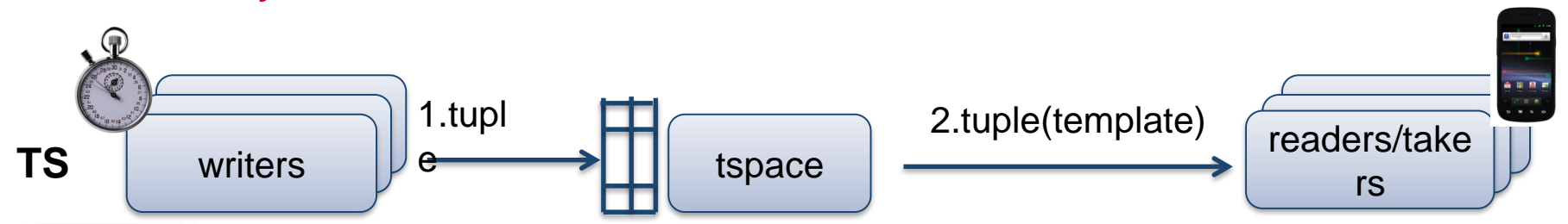
Space coupling



Time coupling



Concurrency



State-of-the-art in interaction paradigm interoperability

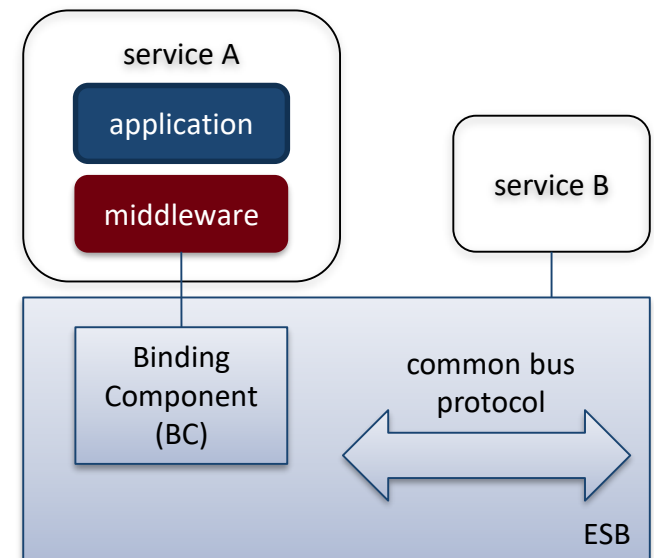
Theoretical approaches for individual paradigms

- Rely on concurrency theory, process algebras, architectural connectors
- No study of semantics *across interconnected paradigms*

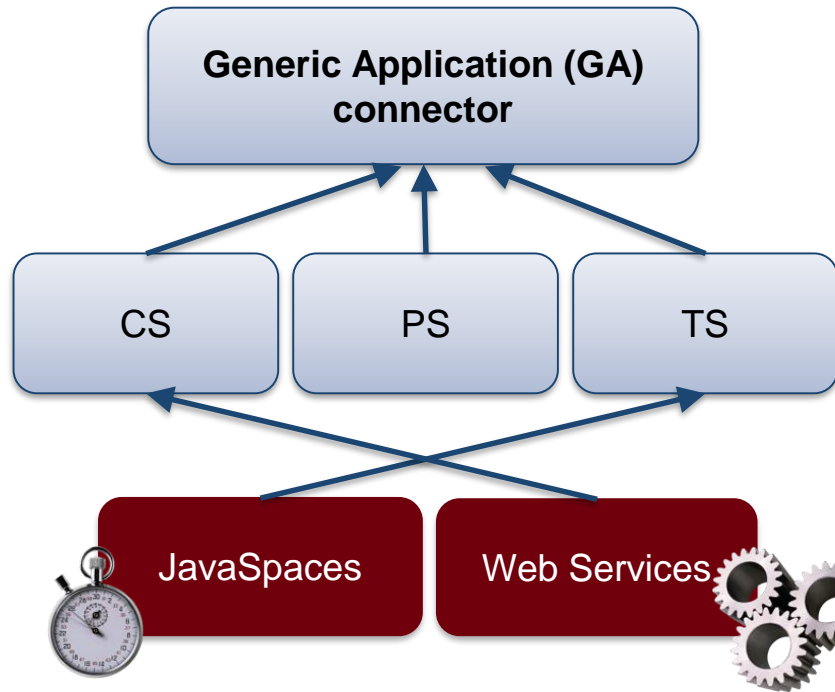
Practical cross-paradigm approaches

- Typically apply to specific middleware implementations
- No *assessment of end-to-end semantics*

Enterprise Service Bus (ESB)



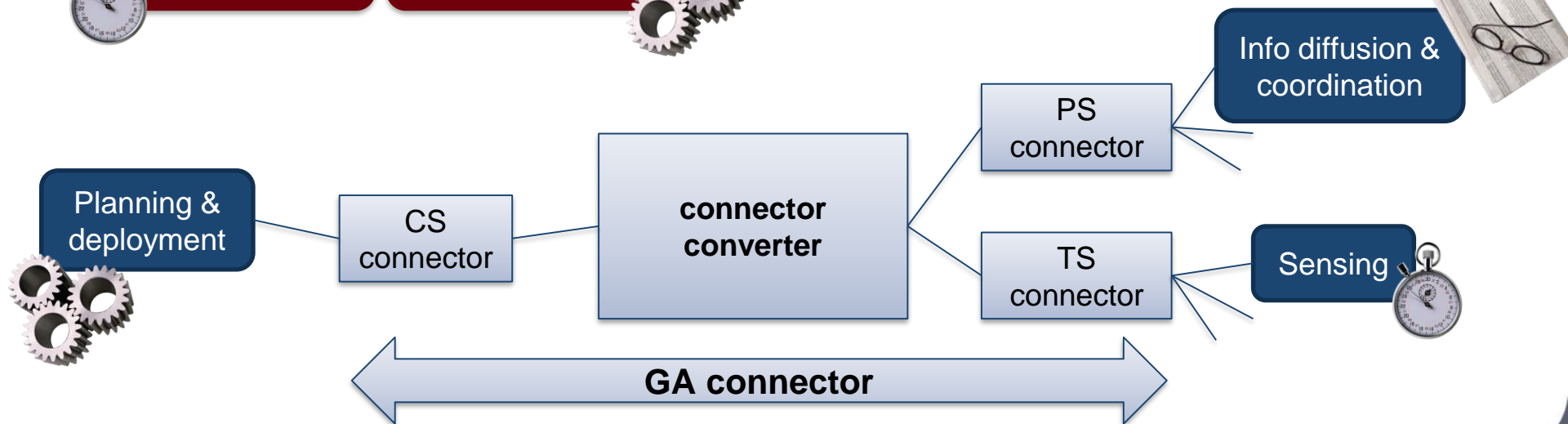
Solution to middleware interoperability



Higher-level connector

Interaction paradigm connectors

Middleware platforms

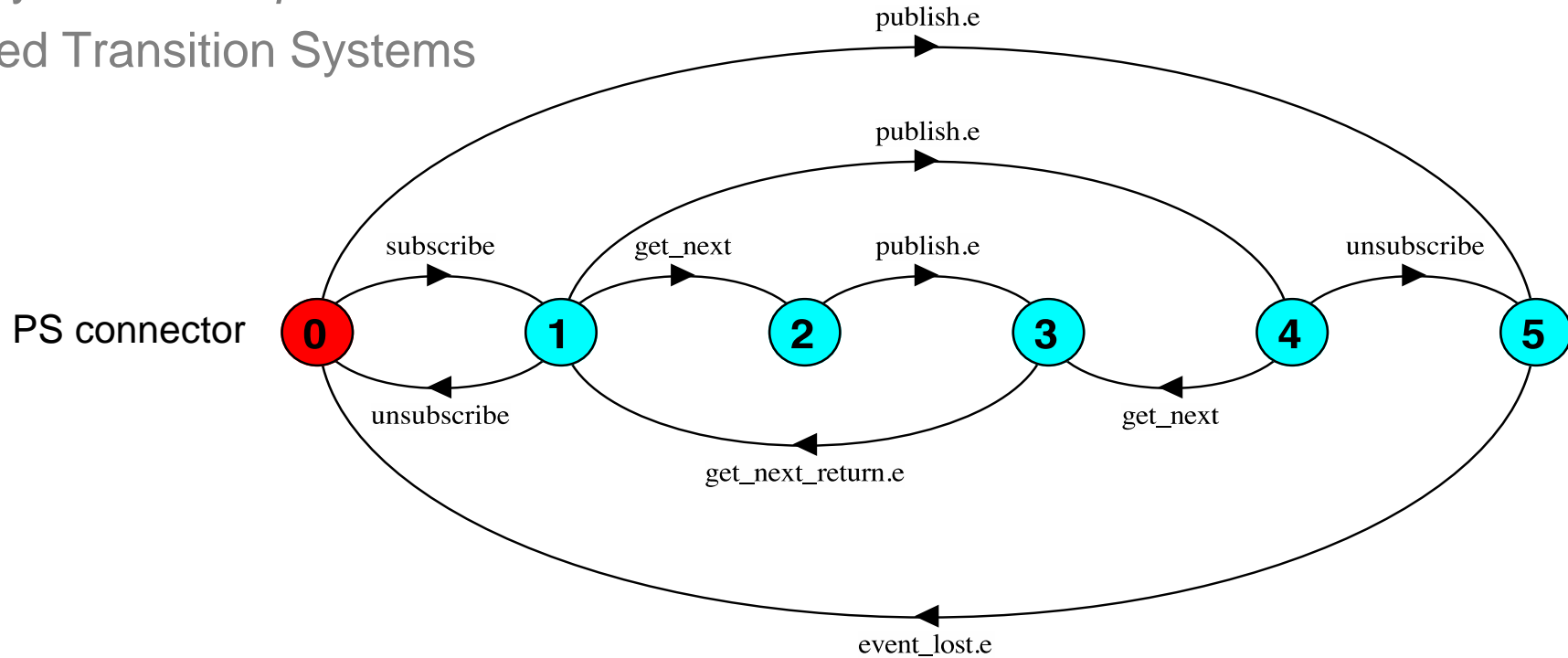


Mapping of space coupling – IDLs

	CS	PS	TS	GA
element	message	event	tuple	data
main scope	system ID	system ID	system ID	system ID
sub-scope	operation	topic	template	<i>data qualifier</i>
interaction semantics	{one-way, notification, request-response, solicit-response}	{publish, subscribe}	{write, take, read}	{post, get, post-get, get-post}
S&R element	<i>in:</i> {sensorLocation, lifeSign} <i>out:</i> {personnelLocation}	<i>out:</i> {personnelId, personnelLocation}	<i>out:</i> {sensorLocation, lifeSign}	<i>in/out data</i>

Time coupling and concurrency of CS, PS, TS connectors

- Specify connector *protocols* with Labeled Transition Systems



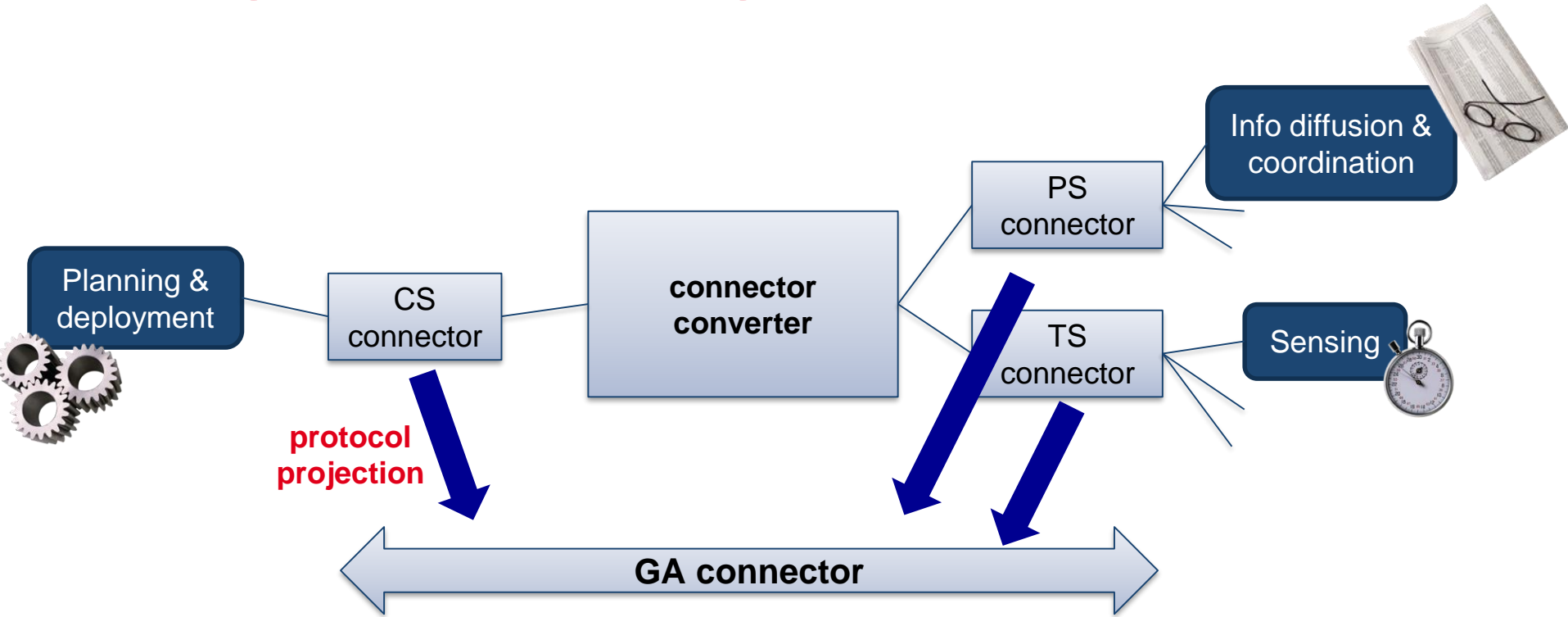
- Express and verify *semantics* in LTL temporal logic

fluent SUBSCRIBED = $\langle \{subscribe\}, \{unsubscribe\} \rangle$

assert **EVENT_RECEIVED_IF_SUBSCRIBED_BEFORE_PUBLISH** =

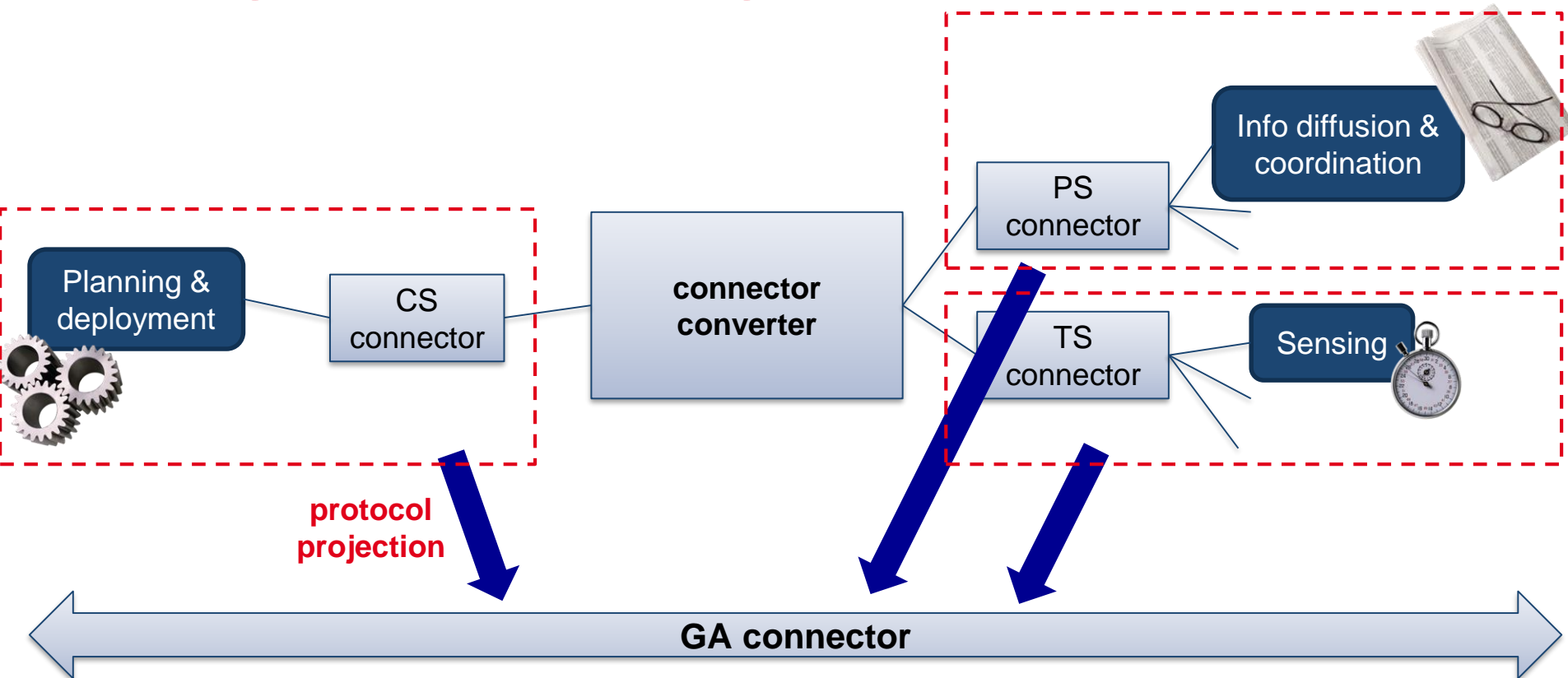
forall [e:EVENT] [] ((SUBSCRIBED && publish[e]) -> (!event_lost[e] U get_next_return[e]))

Mapping of time coupling and concurrency (I)



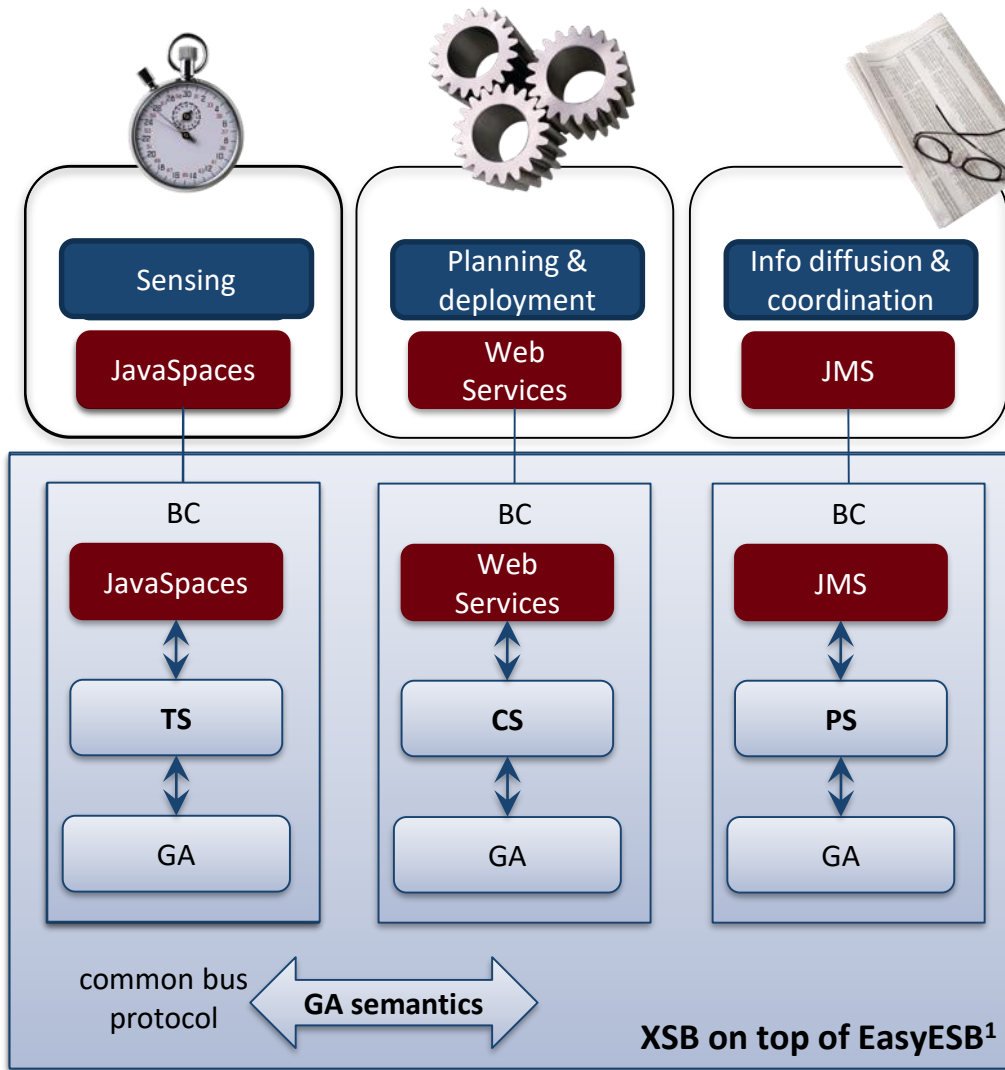
- Rely on the method of *protocol conversion via projections*¹
- Common semantics of CS, PS, TS apply to GA *end-to-end*

Mapping of time coupling and concurrency (II)



- Certain semantics of CS, PS, TS not directly compatible
- Applications should appropriately constrain/complement the connector semantics
- Consider the combined semantics

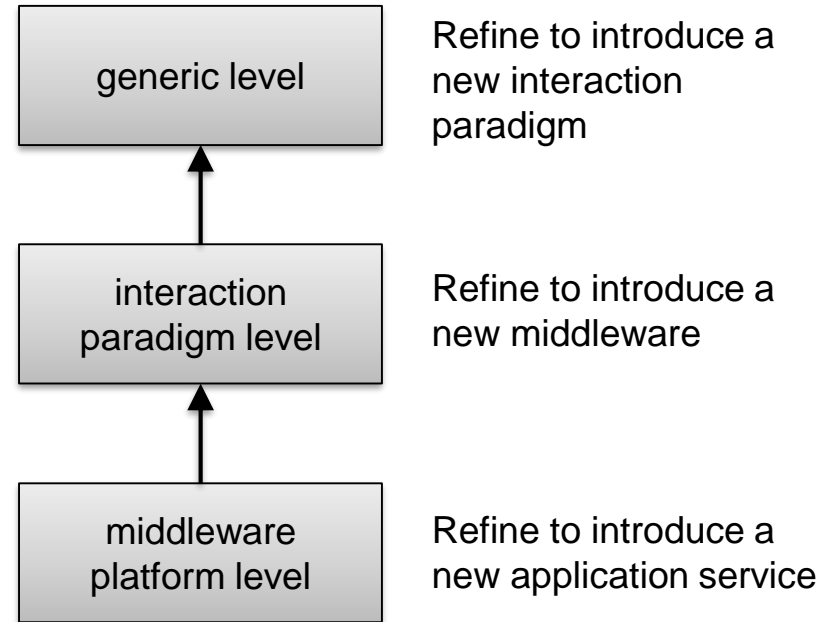
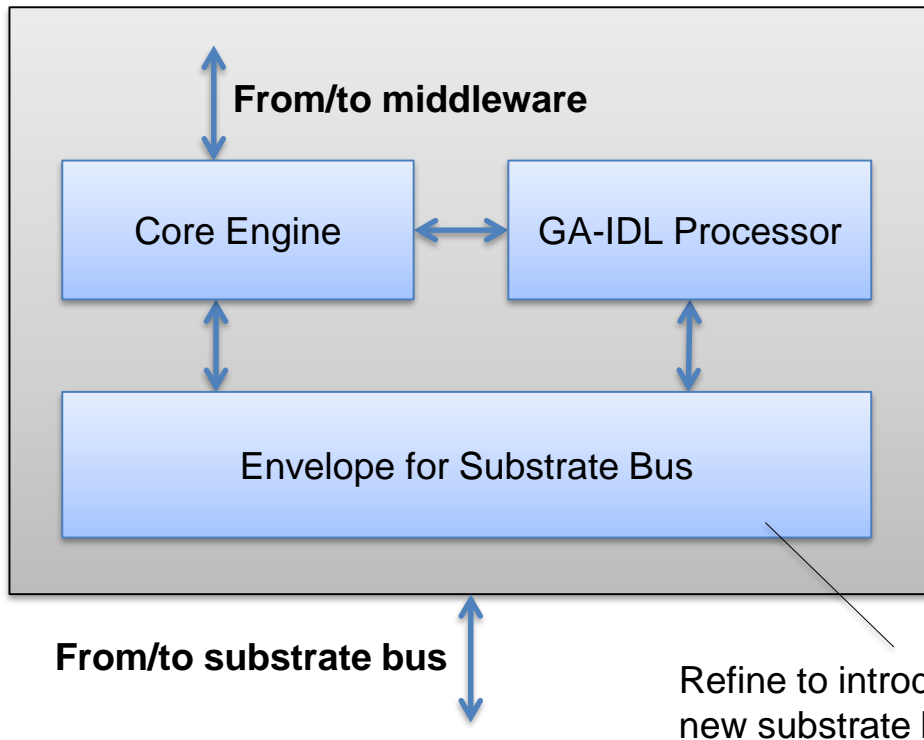
Implementation of the GA connector: an eXtensible Service Bus (XSB)



- XSB is a generic bus
- Build on top of a *substrate bus*
- Cross-paradigm integration in the S&R application

XSB architectural framework

BC extensible architecture



Evaluation – Effort for S&R application design

Development effort for composing the three available application services into the S&R application

	CS-, PS-, TS-IDL descriptions (XML lines)	Generated GA-IDL descriptions (XML lines)	Data mapping directives (XML lines)
All 3 application services	407	249	226

Evaluation – Extensibility of the XSB framework

Development effort for the JMS binding component

	Lines of code	PS-, GA-IDL schemas (XML lines)	Configuration files (XML lines)
Total effort	18021	2836	248
Developer's effort	1162	191	12
Developer's effort ratio	6%	6%	4%

Evaluation - Performance

- Latency overhead introduced by the bus for all interconnection combinations
- Comparison between XSB and substrate bus

Interconnection	Latency overhead (ms)	Comparison
CS-CS via EasyESB	258	–
CS-CS via XSB	261,5	+1,4%
CS-PS via XSB	283	+9,7%
CS-TS via XSB	276	+7,0%
PS-TS via XSB	298	+15,5%

Conclusion and future perspective

- Service-oriented applications in the Future Internet
 - Require cross-middleware interoperability
 - Tackle this challenge via
 - Abstractions and mappings for interaction paradigms
 - Assessment of end-to-end semantics
 - Implementation into an extensible service bus
- Next step
- Extend with support for continuous interactions – data streaming protocols

Thank you

Further information:

XSB: xsb.inria.fr

CHOReOS: www.choreos.eu

Inria ARLES: www.rocq.inria.fr/arles