ReSpecT: Reaction Specification Tuples
Advanced

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Academic Year 2014/2015
1. ReSpecT Java APIs
2. ReSpecT Advanced Constructs
3. Bibliography
These slides are adapted, arranged, integrated, starting from the official TuCSoN guide available at

1 ReSpecT Java APIs
   - Java Agents Using ReSpecT

2 ReSpecT Advanced Constructs
   - Timed-ReSpecT
   - ReSpecT-Events Observability
   - Situated Architecture

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Outline

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External APIs

Uniform w.r.t. TuCSoN APIs accessing the ordinary tuples space:

1. build a TucsonAgentId
2. get a TuCSoN ACC allowing ReSpecT programming (e.g. SynchACC extends SpecificationSynchACC)
3. define the tuplecentre target of your meta-coordination operations
4. build a specification tuple for each construct of a ReSpecT reaction
   → LogicTuple event = LogicTuple.parse("out(t(X))");
   → LogicTuple guards = LogicTuple.parse("(completion, success)" behaves);
   → LogicTuple body = LogicTuple.parse("(out(in(t(X))), out(tuple(X)))");
5. perform the meta-coordination operation using a meta-coordination primitive
   → ITucsonOperation op = acc.out_s(tid, event, guards, body, null);
6. check requested operation success
7. get requested operation result
Extension APIs

Again, nothing new should be done except exploiting a suitable ACC:

1. extend `alice.tucson.api.TucsonAgent` base class
2. choose one of the given constructors, e.g.
3. override `main()` method with your agent business logic
4. get your ACC from the super-class
5. do what you want to do following steps 3 – 7 from previous slide
6. instantiate your agent and start its execution cycle (`main()`) by using method `go()`
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ReSpecT Events Revised

By recalling [Omicini, 2007], we may note that a ReSpecT event is not limited to be any ReSpecT (either coordination or meta-coordination) primitive:

\[
\langle SimpleTCEvent \rangle ::= \langle SimpleTCPredicate \rangle \ (\langle Tuple \rangle) \ | \ time(\langle Time \rangle)
\]

1. A \(\text{time}(T)\) event is generated by the ReSpecT VM when its local time (a relative notion of time measured starting from ReSpecT VM boot) reaches \(T\)

2. Then, any reaction having that time value as a triggering event is triggered and (iff guards evaluate to true) executed
Correspondingly, other guard predicates are provided to manage time-related aspects:

- \( \text{before}(\text{Time}) \iff \text{the triggering event occurred before } \text{Time} \)
- \( \text{after}(\text{Time}) \iff \text{the triggering event occurred after } \text{Time} \)
- \( \text{between}(\text{Time}, \text{Time'}) \iff \text{after}(\text{Time}) \& \text{before}(\text{Time'}) \)
Time-Aware Coordination Medium

- **Time-awareness** is an essential feature to enable situatedness, that is the ability of a system to recognize the *temporal* environment in which it lives, thus to react properly to its contingencies and dynamism.

- The other fundamental feature is **Space-awareness**, that is the ability to recognize the *spatial* environment, properly expressing, generating and perceiving *topology-related* aspects.

To learn more... please refer to the following papers:

**Timed ReSpecT** [Omicini et al., 2005]

**Situated ReSpecT** [Casadei and Omicini, 2009]
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Another extension to the original ReSpecT, provided by its A&A interpretation, is in ReSpecT events observability (inspectability of artifacts in the A&A terminology).

**Observation predicates**

In fact, the body of a ReSpecT reaction is not limited to exploit only ReSpecT primitives and Prolog predicates, but can use the so-called observation predicates:

\[
\langle ObservationPredicate \rangle ::= \langle EventView \rangle \_ \langle EventInformation \rangle
\]

\[
\langle EventView \rangle ::= \text{current} \mid \text{event} \mid \text{start}
\]

\[
\langle EventInformation \rangle ::= \text{predicate} \mid \text{tuple} \mid \text{source} \mid \text{target} \mid \text{time}
\]
Observability Semantics

Any combination of the following is admissible in ReSpecT, following formal grammar of $\langle ObservationPredicate \rangle$ in previous slide

$\langle EventView \rangle$ — allow to inspect the events chain triggering the executing reaction:

- **current** — access the ReSpecT event currently under processing
- **event** — access the ReSpecT event which is the direct cause of the event triggering the reaction
- **start** — access the ReSpecT event which is the prime cause of the event triggering the reaction

$\langle EventInformation \rangle$ — allow to inspect all the data ReSpecT events make observable:

- **predicate** — the ReSpecT primitive causing the event
- **tuple** — the logic tuple argument of the predicate
- **source** — who performed the predicate
- **target** — who is directed to the predicate
- **time** — when the predicate was issued
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Distributed systems are *situated*—that is, immersed into an environment, and reactive to events of *any* sort.

Thus, coordination media are required to mediate any activity toward the environment, allowing for a fruitful interaction.

⇒ ReSpecT tuple centres are able to *capture general environment events*, and to generally *mediate process-environment interaction*.
Situating TuCSoN

Thus, *situating* TuCSoN basically means making it capable of *capturing environment events*, and *expressing general MAS-environment interactions* [Casadei and Omicini, 2009, Omicini and Mariani, 2013]

⇒ the TuCSoN middleware and the ReSpecT language

- capture, react to, and observe general environment events
- explicitly interact with the environment
Environment manipulation

- Source and target of a tuple centre event can be any external resource.
- A suitable *identification* scheme – both at the syntax and at the infrastructure level – is introduced for environmental resources.
- The coordination language is extended to express explicit manipulation of environmental resources.
- New *tuple centre predicates* are introduced, whose form is:
  - $\langle EResId \rangle \ ? \ get(\langle Key \rangle, \langle Value \rangle)$
    enabling a tuple centre to get properties of environmental resources.
  - $\langle EResId \rangle \ ? \ set(\langle Key \rangle, \langle Value \rangle)$
    enabling a tuple centre to set properties of environmental resources.
Dealing with Environment Change II

### Transducers

- Specific environment events have to be translated into well-formed ReSpecT tuple centre events.
- This is to be done at the infrastructure level, through a general-purpose schema that could be specialised according to the nature of any specific resource.
- A *transducer* is a component able to bring environment-generated events to a ReSpecT tuple centre (and back), suitably translated according to the general ReSpecT event model.
- Each transducer is specialised according to the specific portion of the environment it is in charge of handling—typically, the specific resource it is aimed at handling, like a temperature sensor, or a heater.
TuCSoN Situated Architecture
An Example: TuCSoN Thermostat

- Package `alice.tucson.examples.situatedness` contains a simple example of how to exploit TuCSoN features for situated coordination.
- A step-by-step *how-to* is reported in the TuCSoN main site at [http://apice.unibo.it/xwiki/bin/download/TuCSoN/Documents/situatedness.pdf](http://apice.unibo.it/xwiki/bin/download/TuCSoN/Documents/situatedness.pdf).
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Situated tuple centres in ReSpecT.

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