Eventuation properties and interaction contracts

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SCRIPT WS

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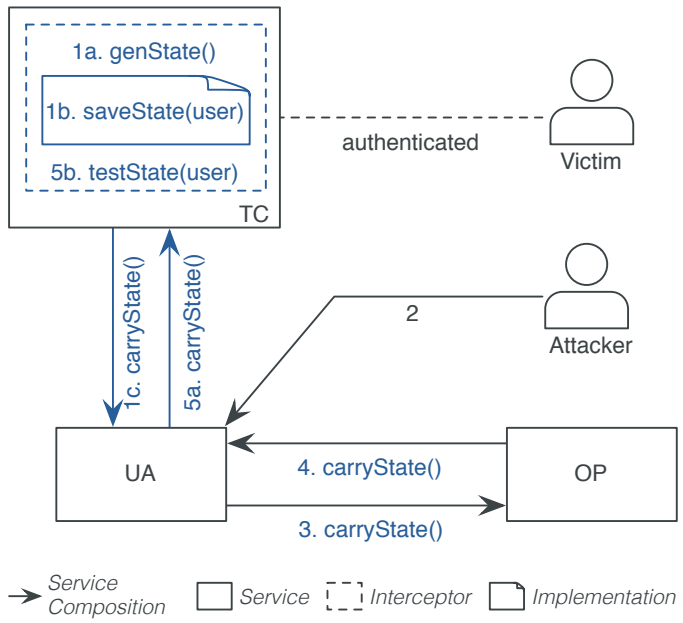
1. Interaction contracts for the Cloud

- Interactions
  - Clients/servers, service compositions, ...
  - Existing support: languages/libraries, orchestration
- Our goal
  - Declarative and formal multi-level, cross-site protocols
  - Effective implementation support
  - Support legacy applications

OAuth 2.0 CSRF attacks



"Eventuation Properties"

- Motivation: intermittent inconsistent states in complex interacting systems
  - Mobile, ambient devices with limited connectivity
  - Intermittent property violation in service compositions
- Eventuation properties
  - Enforce properties after inconsistent situation
  - Identify inconsistency?
  - Pass info across inconsistent phase?
- Common examples
  - Eventual consistency
  - Accountability in service compositions
  - Error handling

Eventual consistency

- Handling data(base) replication in large distributed systems
- Applications
  - Managing intermittent connectivity
  - Code versioning systems
    - Independency of ordering of change history
    - Git and subversion are not eventually consistent
    - Darcs is
- Hot topic in language design
  - Ex.: recent notions of revision histories, Cloud types

Accountable service compositions

- After-the-fact verification of of security, privacy, economic properties, etc.
- Frequently requires anticipated information gathering
- Ex.: missing id information
  1. initial service injects data with id (signature, etc.)
  2. intermediate service strips id for privacy reasons
  3. final service requires id for audit
- Frequently defined using declarative obligation specs.
  - Eventuation properties over choreographies as operational intermediate form

Error handling

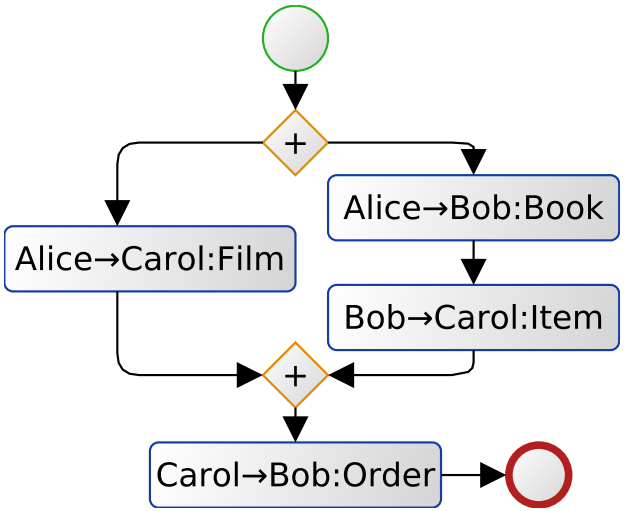
- Frequently errors occur silently
  - Inconsistent phase from occurence to observable effects
- EP: enforce well-defined state after error occurrence
  - Enable or improve handling by shortening inconsistency
- Interest (to us): errors and security/accountability issues

What's next?

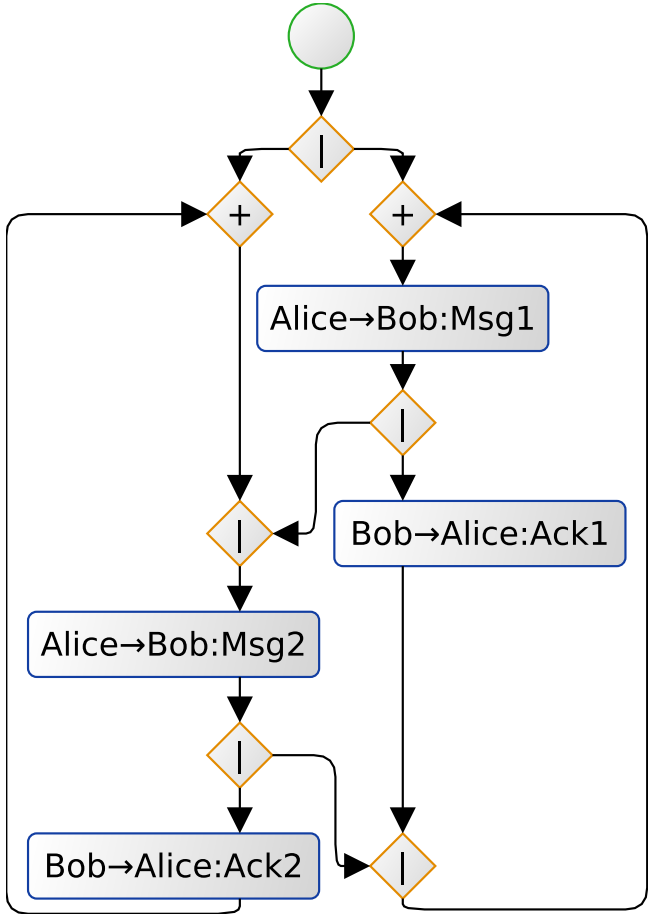
- Overall project
  - Define EPs declaratively
  - Provide effective implementation support
- First steps
  - Def.: generalization of session types
  - Impl.: multi-level, cross-site accountability properties

2. Session types

Multiparty protocols



Expressive interaction structures



Characteristics

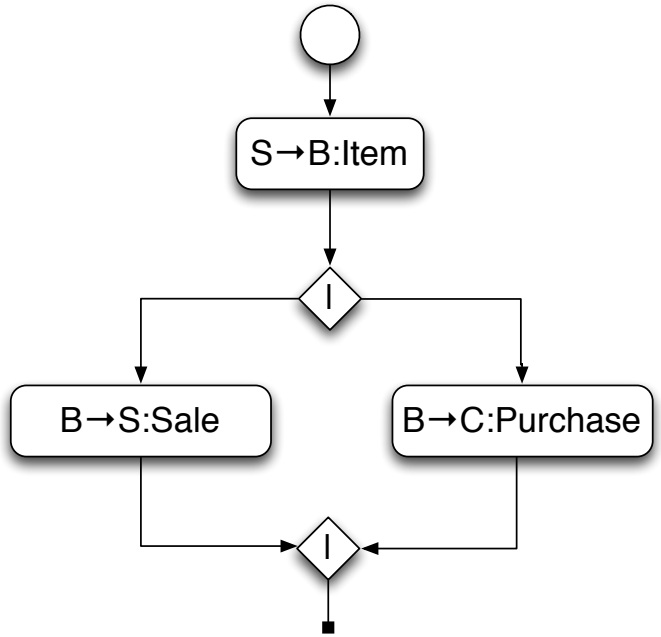
- Recent advances in expressivity
  - Binary sessions (1990s)
  - Multiparty sessions [Honda, Yoshida, Carbone; POPL'08]
  - Roles [Daniélou, Yoshida; POPL'11]
  - Generalized merge/fork structures [Daniélou, Yoshida; ESOP'12]
- Properties
  - Strongly typed
  - Projection: automatic "transformation" to correct implementation
    - Global types: specification
    - Local types: implementation
  - Absence of deadlocks

Aspectual session types

- Limitations of existing session types
  - Strong restrictions on race conditions
    - Interesting protocols cannot be expressed
  - No support for modular definition
    - New functionality: extensive rewrites
- Both hinder enrichement of existing types
- Aspectual session types
  - Extend session types modularly
  - Allow uniform behavior in parallel threads

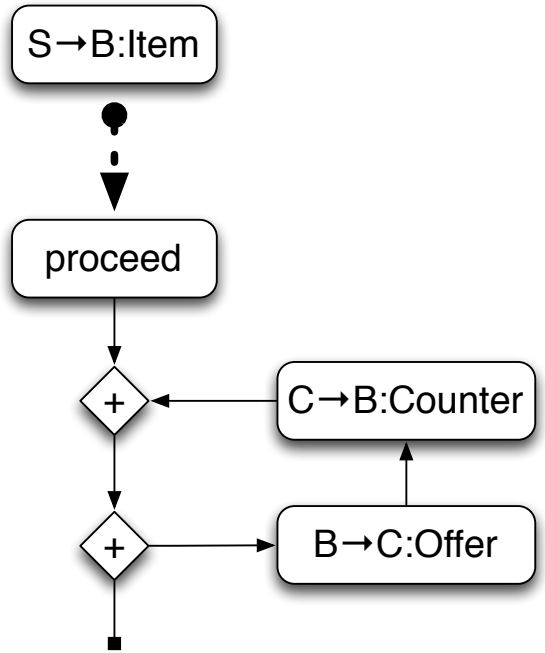
Ex.: simple trade session

- 3 participants: seller (S), broker (B), client (C)
- Broker indicates sale to S and purchase actions to C



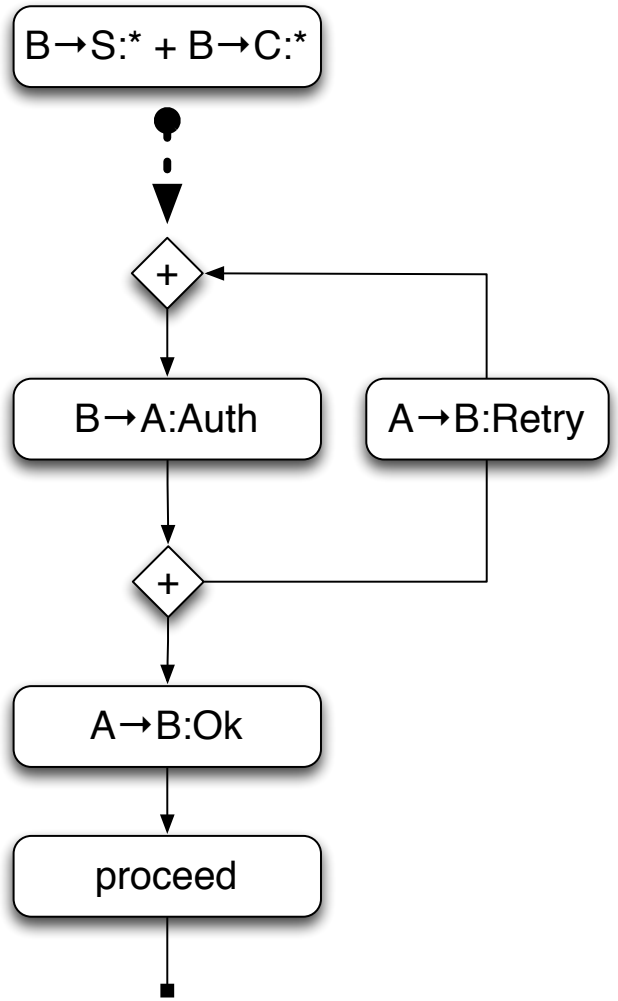
Ex.: add negotiation (modular extension)

- Negotiation
  - Offers from the broker to the client
  - Counteroffers by the client
- Modular extension
  - Choice operator +



Ex.: add authentication (race conditions)

- Authentication
  - Add authentication server A
  - Verify credentials before a purchase
- Modular extension
  - Disjunction of triggers (B→ S:* + B→ C:*)
- Problem: inserts race condition in branches of | of original session



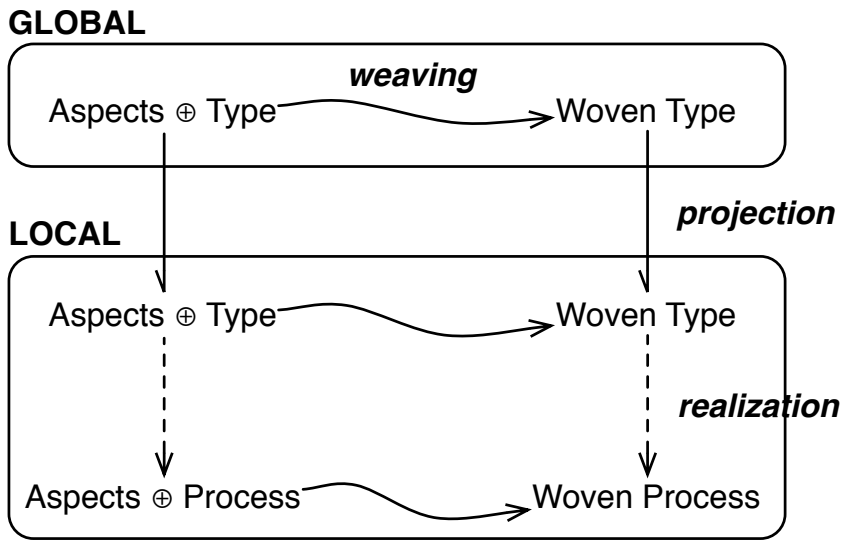
Session types technically (ESOP'12)

- Main conditions
  - Linearity: parallel activities are triggered by different messages
  - Local choice: any choice can be resolved by one local process
  - Active senders: no different senders from same state
- Multiparty session automata
  - Subclass of communicating automata

Our technical contributions

- Aspectual linearity
  - Admit same thread-neutral functionality in parallel threads
  - Relax linearity condition
- Extension of multisession automata to aspectual sessions

Weaving and projections commute

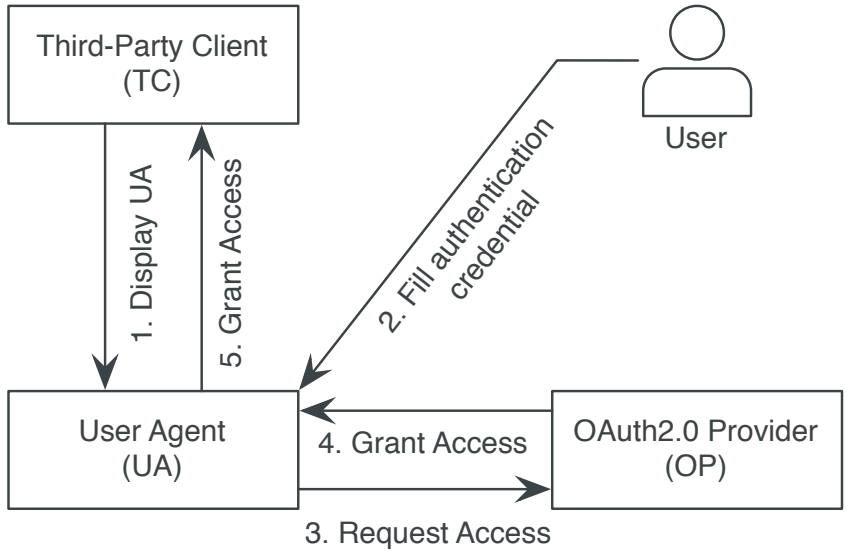


3. Managing workflow adaptations

- EPs over complex workflows
- Need for multi-level and cross-site contracts

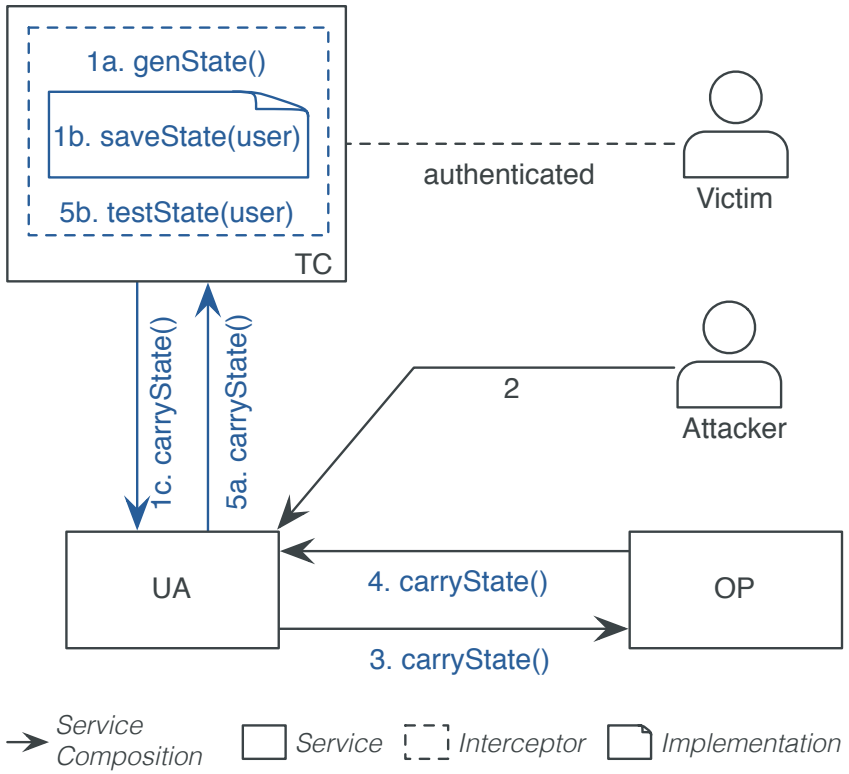
Ex.: OAuth 2.0

- Framework for resource access authorization
  - Used by Facebook, Google, Microsoft, SAP, etc.
- Provider yields access tokens to third-party clients on behalf of user



Secure OAuth

- OAuth 2.0 CSRF exploit: attacker abuses existing authentication
  - Remedy: add session-specific state
- State management needs multi-level contracts
  - Saving: implementation level
  - State generation, test: interceptor level
  - State transfer: service level



Workflow adaptation schemas

```
schema OAuthStateIntroduction
  instantiate schema UpServiceRequests
  < pat↓ TC_c@GenState → DispUA(arg)_s
    pat↓ AcceptGrantTC(ac,st,arg)_s → TC_c@Grant?,
    act CarryState >
```

- Patterns for complex-interactions
  - Multi-level (indices)
  - Cross-site (agent, $\rightarrow$)
- Generic and instantiated schemas
  - Small DSL (ex.: `UpServiceRequests`)
- Implementation on top of Apache CXF

Conclusion

- Expressive and executable typed formalisms for explicit protocols
- Many Cloud/Web applications need multi-level, cross-site protocols
  - Structured expressive protocol transformations?
  - Suitable protocol formalism?
- Eventuation properties for accountability as our major target
  - Remedy lack of information
  - Track errors with

References

- N. Tabareau, M. Südholt, É. Tanter: "Aspectual Session Types", 13th Int. Conférence on Modularity, April 2014. (Ex.-conf. AOSD)
- R. Cherrueau, M. Südholt: "Adapting workflows using generic schemas: ..."; 5th IEEE International Conference on Cloud Technology and Science (CloudCom), Dec. 2013.
- SAdapt: Apache CXF-based implementation of workflow adaptation patterns
  `http://a4cloud.gforge.inria.fr/doku.php?id=start:advservcomp`