An API for Autonomous and Client-Side Service Substitution

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Objective

Client side solution to deal with dynamicity in OSGi

- Client side: *No assumption on services*
- Dynamics: *Used services can be unregistered*
  - *knowing it*
  - *silently substitute it*
- Consider also state-full services
  - How to keep their internal state?

Context: OSGi

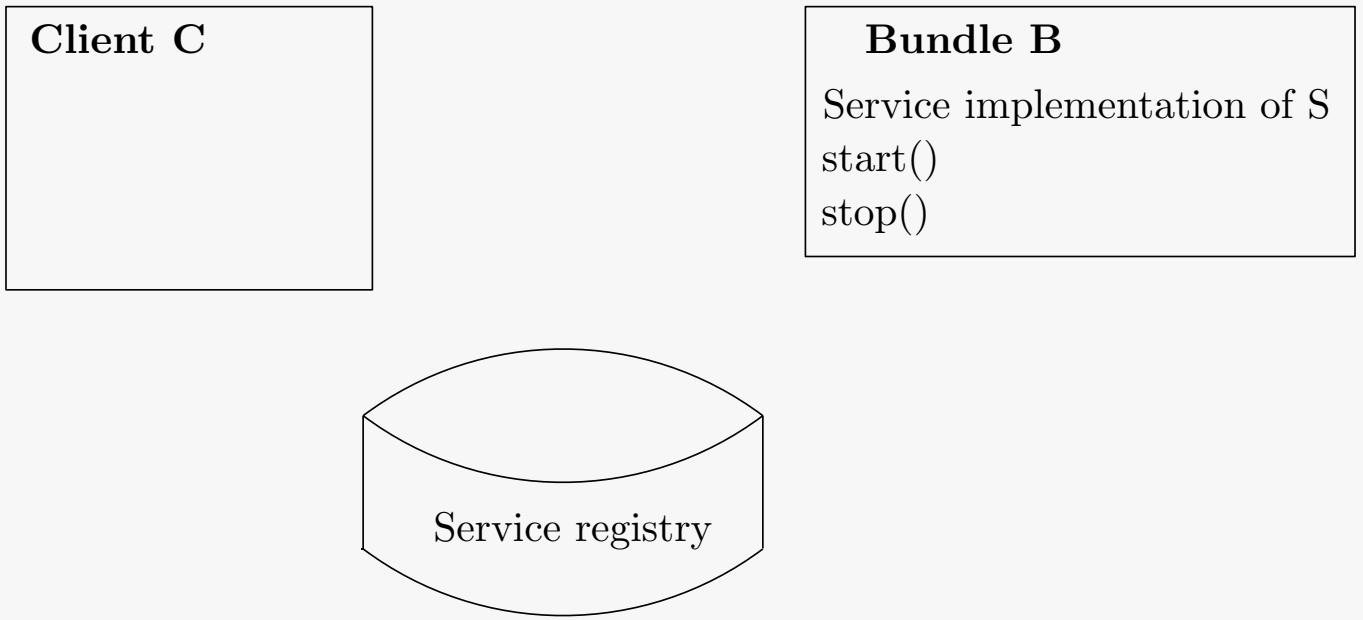
Service Oriented Architectures

- Dynamic load/unload of service
- Loosely coupled client-server through interfaces

Stale references: it's a feature

- Unloading a service does not garbage collect it
- References to the service still usable

Stale Reference: example



- Stale reference: *reference to a no more registered service*
- Service stopped: *does it still work?*
- OSGi specification: *never use a stale reference*

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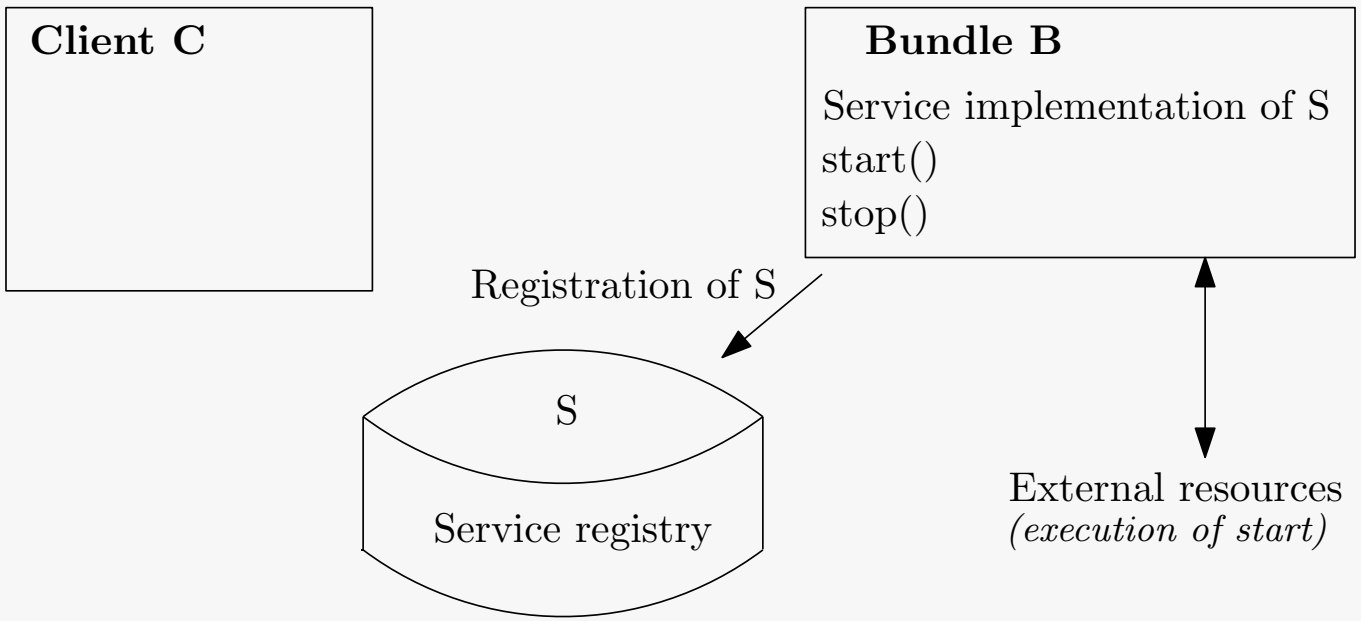

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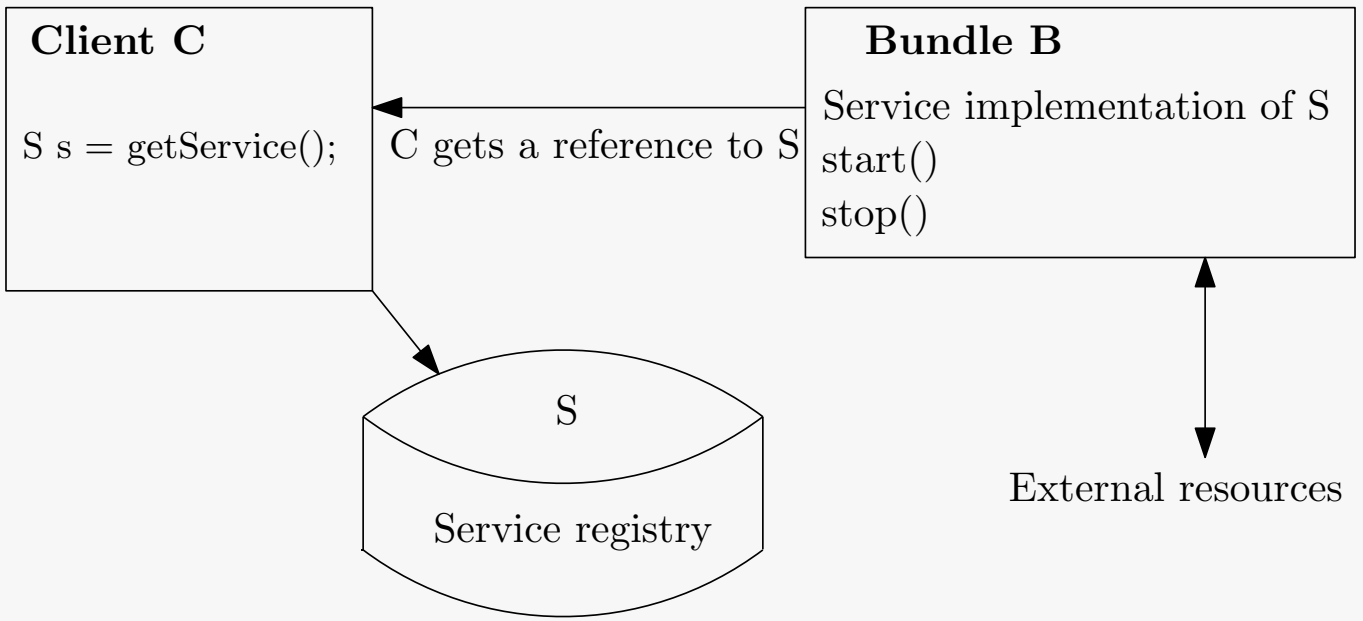

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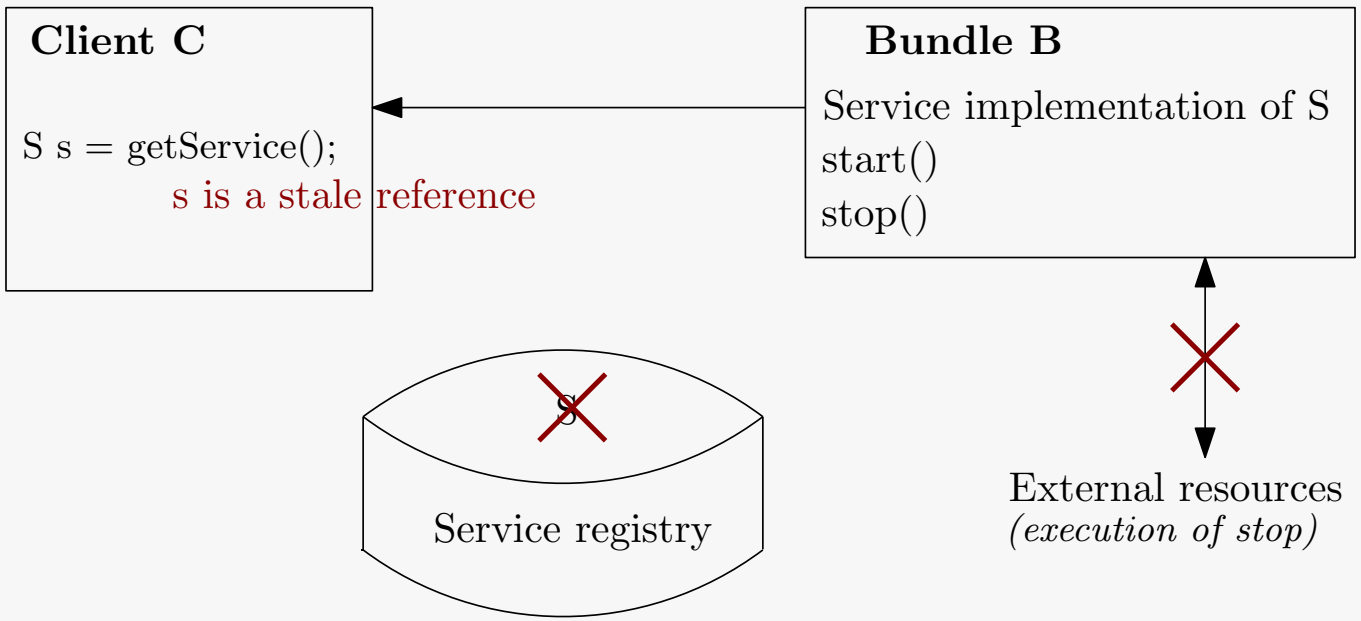

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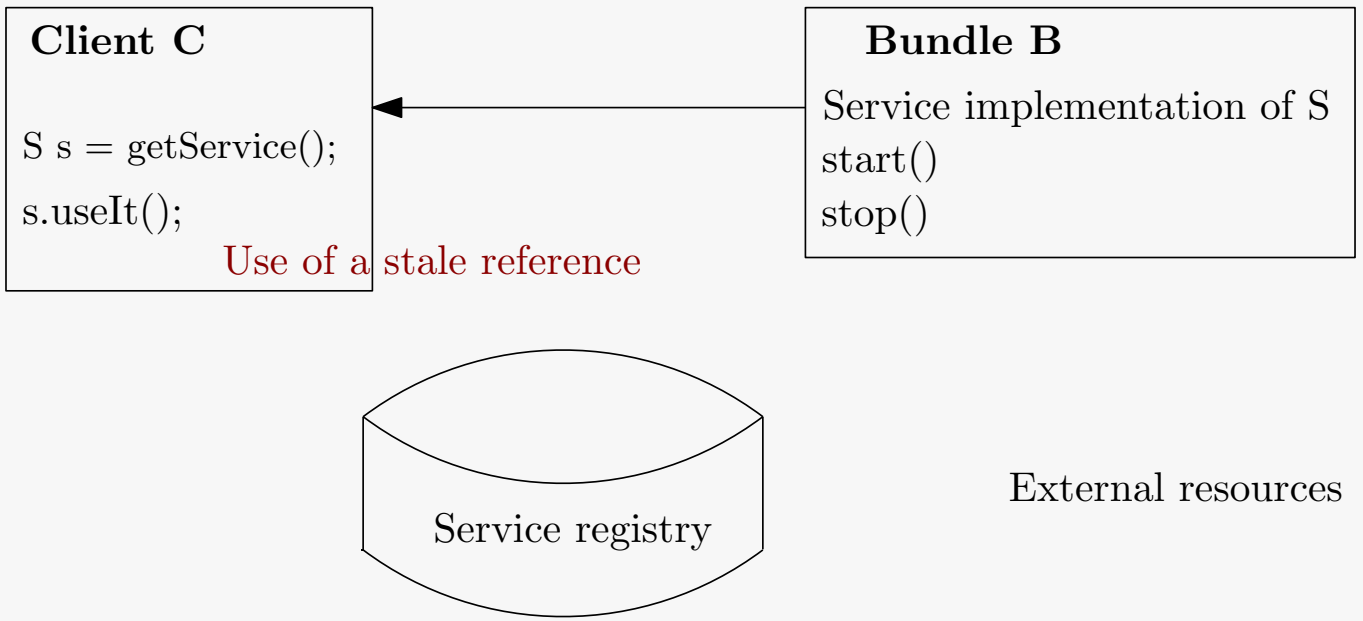

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Some Related Works

Server side approaches

- CORBA service reconfiguration [BISZ98]
  - based on the capabilities to passivate a links
  - substitution of state-full services by setting internal state
- SIROCO framework [FGIZ08]
  - each service provide get/set internal state

OSGi solutions

- Service Coroner [GD08]
  - Aspect Oriented solution to observe stale references
  - Tool for test
- Using a proxy [AOH07]
  - Current works only support state-less services

Contribution

Inspired from self healing software techniques

- Usually 3 families of treatment to recover an error:
  - to mask the error: *Redundant information*
  - to roll-forward: *Jump forward until coherent state*
  - to roll-back: *Jump backward to a previous coherent state*

Our proposition

- Introduce a proxy between service and client
- Add a registry listener
- Implement two treatments:
  - Roll-forward policy: *to throw an exception*
  - Roll-back policy: *to make a silent substitution*

Roll-forward policy: Exception

```
EchoService echoService =
    serviceProxyBuilder.getService(EchoService.class,
                                   DISABLED_AFTER_UNREGISTERED);

try {
     echoService.echo("Fail␣explicitly␣if␣the␣echo␣service"+
                      "is␣no␣more␣available");
} catch (UnregisteredServiceException ignored) {
     // Executed if the service is unregistered
     ignored.printStackTrace();
}
```

- The code of the client is kept simple (only a try catch)
- If multiple state-full services:
  - *catch* can be used to reset the state of each service

Roll-back policy: Service Substitution

Two cases

1. Use of state-less services
   - No constraints.
   - The same call can be replayed
2. Use of state-full services
   - Need to define a transaction
   - If multiple services: *need to provide a roll-back for other services*

Case 1: state-less service with API and substitution

```
// Let some echo services implementation be in memory
EchoService echoService =
    serviceProxyBuilder.getService(EchoService.class,
                                   RELOAD_AFTER_UNREGISTERED);

try {
     echoService.echo("You never fail while an echo service"+
                      "is available");
} catch (UnregisteredServiceException ignored) {
     // Executed if no more services are available
     ignored.printStackTrace();
}
```

Case 2: Roll-back using state-full services

Transaction mechanism

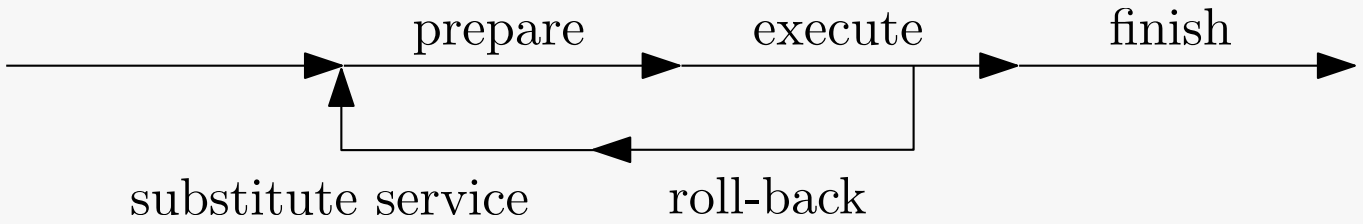
- Transacted Block: *code manipulating one or some state-full services*
- If a used service disappears during **TB** execution :
  - If another service is available
    - (Undo the transaction effects on other services)
    - Make substitution
    - Start again the transaction
  - Else (no other service available): throw an exception

Constraints

- Define a pure transacted block *(from the client point of view)*
- *(Define a service roll-back code for other services)*

Case 2: Roll-back using state-full services

Transaction diagram for multiple services



Inspired from transactional memory

Provided by the developer of the client:

- prepare
- execute
- finish
- roll-back

Case 2: using 2 services with API and substitution

```
ServiceReference reference = bundleContext.getServiceReference(
    TransactedServiceExecutor.class.getName());
transactedServiceExecutor =  (TransactedServiceExecutor)
    bundleContext.getService(reference);

TransactedExecution<String> myExecution =
    new TransactedExecution<String>() {
        @ServiceInjection FooService service1;
        @ServiceInjection BarService service2;

        public void  prepare()  { /* Initialization */ }
        public <...> execute()  { /* Transaction body */ }
        public void  finish()   { /* Closing accesses */ }
        public void  rollback() { /* In case of subst. */ }
    };

String echo = transactedServiceExecutor.executeInTransaction(
    myExecution, new RetryForeverPolicy());
```

Proof of Concept

- API for client developer
- 2 main functionalities:
  - single service use: ServiceBuilderProxy
  - multiple services use: TransactedServiceExecutor
- Freely downloadable

  https://bitbucket.org/jponge/osgi-substitution

Conclusion

Contributions

- Approach and tool to develop services affected by stale references
  - Be actively notified in case of service unload
  - Have another service in case of service unload
- Main properties of this contribution are:
  - Client side
  - No any assumption on used services
  - Can be used even if used services are state-full
  - Low development cost
  - Not expressiveness restriction of services
- Constraints
  - Client designer need to provide a roll-back method
  - Transacted block without side effects on client state

Future Work

- Propose more autonomy:
  - Use of a service logger
  - Use of a behavioral specification
  - Generate a replay behavior to not roll-back other services

Questions ?

H. Ahn, H. Oh, and J. Hong, *Towards Reliable OSGi Operating Framework and Applications*, Journal of Information Science and Engineering **23** (2007), no. 5, 1379.

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Manel Fredj, Nikolaos Georgantas, Valerie Issarny, and Apostolos Zarras, *Dynamic Service Substitution in Service-Oriented Architectures*, IEEE Computer Society, 2008, pp. 101–104.

Kiev Gama and Didier Donsez, *Service Coroner: A Diagnostic Tool for Locating OSGi Stale References*, 34th Euromicro Conference on Software Engineering and Advanced Applications, SEAA, IEEE, 2008, pp. 108–115.