SEArch: an execution infrastructure for service-based software systems

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Coordination 2024
Tool track
June 19, 2024

– Prelude –

What is this talk about?

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Service Execution Architecture in a nutshell

A PoC platform for semantic-based service composition

Bisimilarity as a semantic notion of compliance

$$\text{to} \begin{cases} \text{search for} \\ \text{and compose} \end{cases} \text{distributed service with support for}$$

multi-language programming

(language-independence via choreographic models)

Plan of the talk

An bird-eye watch of **SEArch**'s choreographic model

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An overview of **SEArch** and it's design

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A "meta-demo"

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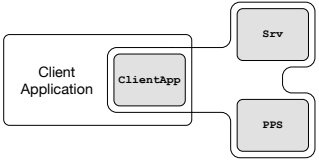
Conclusions

– The underlying theory of **SEArch** –

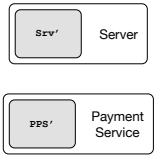
[& it's architecture]

Asynchronous Relational Networks [FL:TCS (503) 2013]

A theory of software architectures of SOAs featuring provide and required interfaces



search and
binding hinge
on contracts



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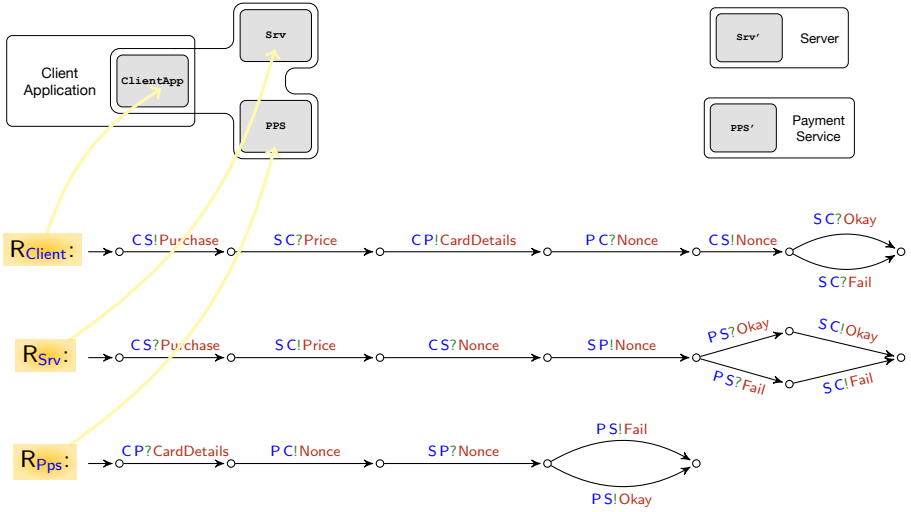

Contracts as CF-SMs [BZ:JACM 1983] according to [PVT:PLACES 2015,Vis:PhD 2018]

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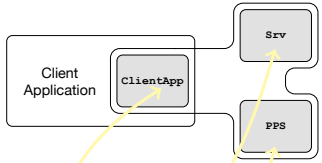
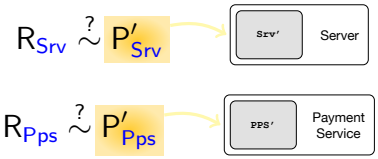
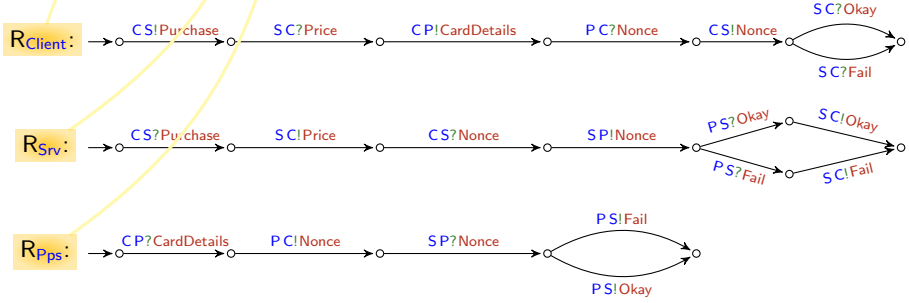
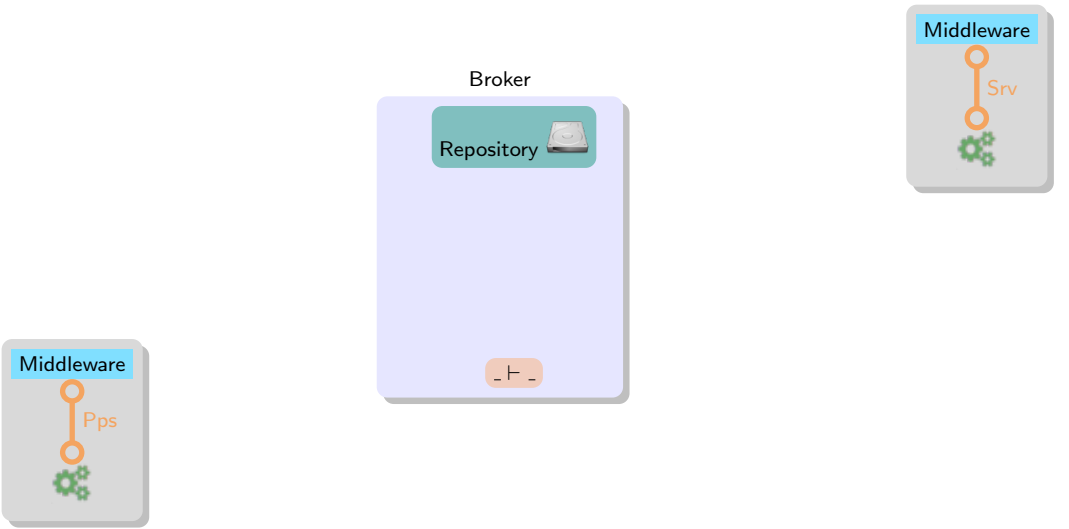




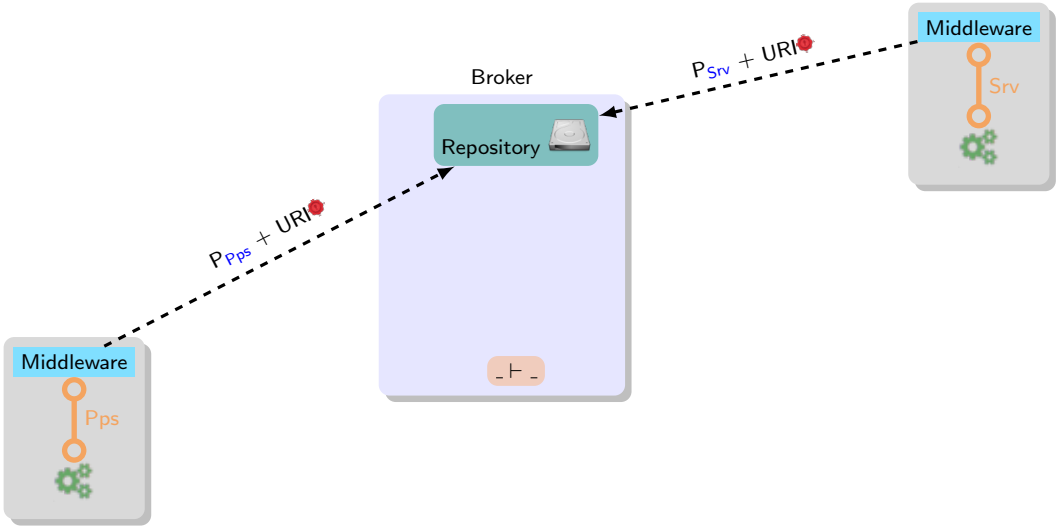


Contracts as CF-SMs [BZ:JACM 1983] according to [PVT:PLACES 2015,Vis:PhD 2018]

SEArch, conceptually

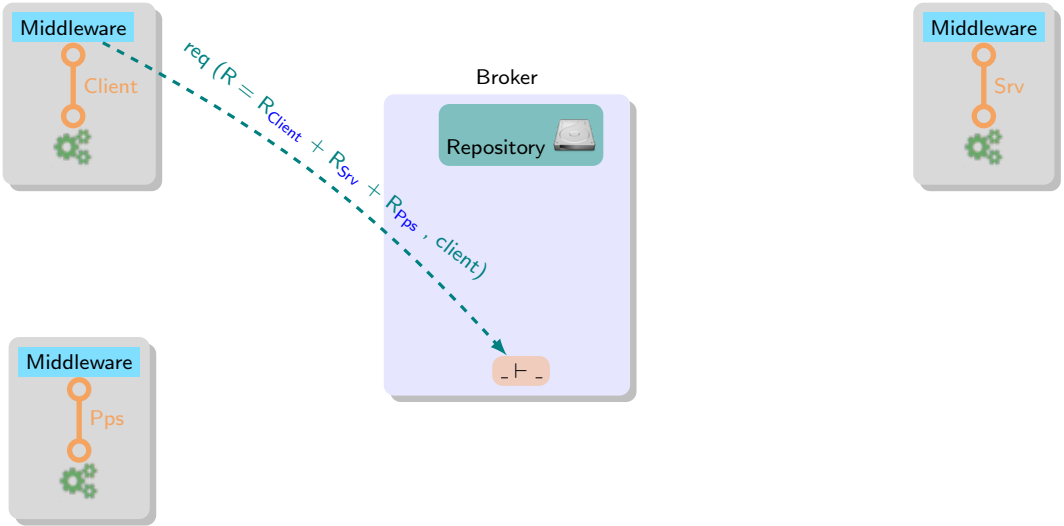


Service providers register their contract and URI to a broker

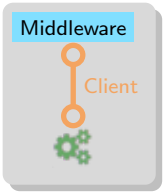


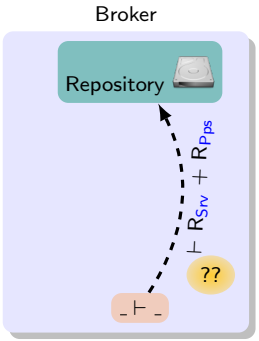
SEArch, conceptually

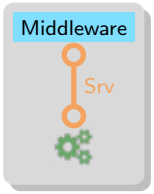
a client's request specifies the (set) of contracts partners should fulfil

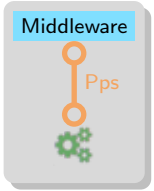


The broker searches for compatible providers...



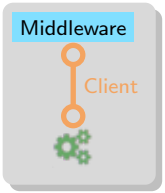


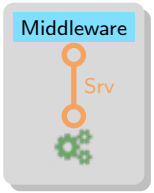


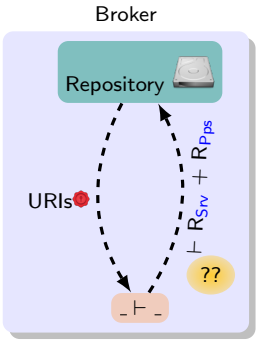


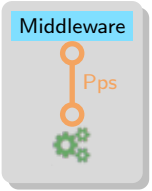
SEArch, conceptually

...collects the compatible providers...

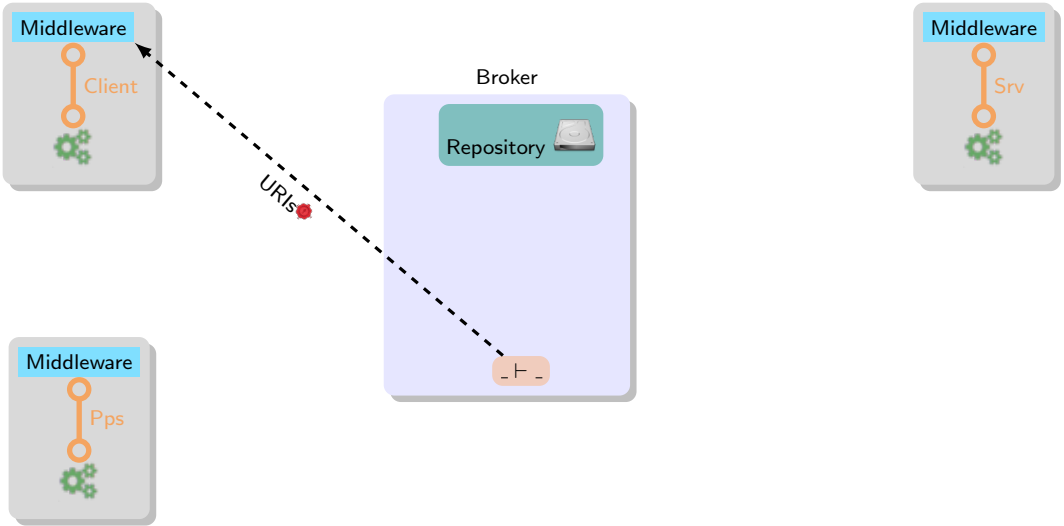






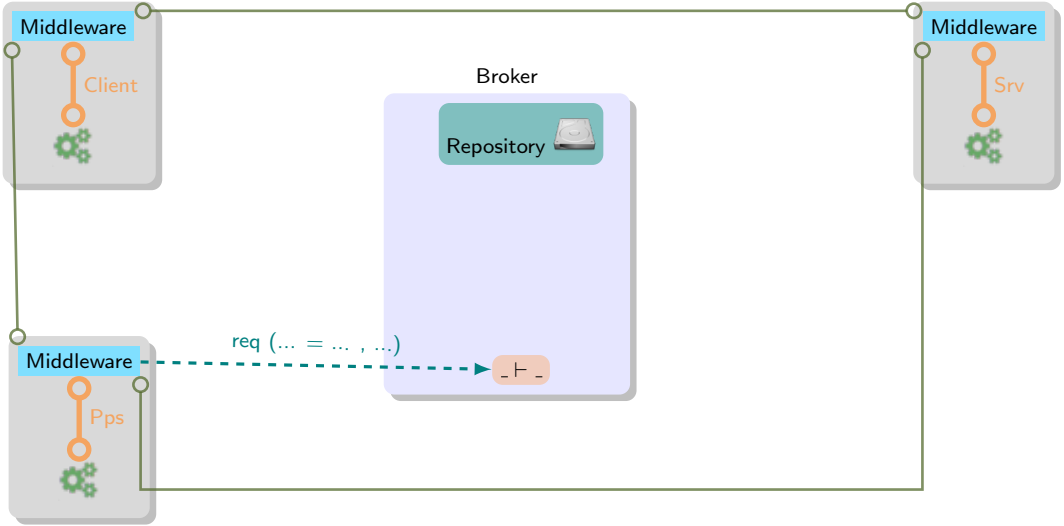


...and returns them to the client



All components can now interact

A provider may require other services; just ask the broker...



– From theory to practice –

PYTHON,

```python
async def main(grpc_channel):
    stub = search.PrivateMiddlewareServiceStub(grpc_channel)
    registered = False
    logger.info("Connected to middleware. Waiting for registration...")
    async for r in stub.register_app(
        search.RegisterAppRequest(
            provider_contract=search.LocalContract(
                format=search.LocalContractFormat.LOCAL_CONTRACT_FORMAT_FSA,
                contract=PROVIDER_CONTRACT,
            )
        )
    ):
        if registered and r.notification:
            logger.info(f"Notification received: {r.notification}")
            # Start a new session for this channel.
            asyncio.create_task(session(grpc_channel, r.notification))
        elif not registered and r.app_id:
            # This should only happen once, in the first iteration.
            registered = True
            logger.info(f"App registered with id {r.app_id}")
            # Create temp file for Docker Compose healthcheck.
            with open("/tmp/registered", "w") as f:
                f.write("OK")
        else:
            logger.error(f"Unexpected response: {r}. Exiting.")
            break

    grpc_channel.close()
```

PYTHON, GO

```
const ppsContract = `
.outputs PPS
.state graph
q0 ClientApp ? CardDetailsWithTotalAmount q1
q1 ClientApp ! PaymentNonce q2
q2 Srv ? RequestChargeWithNonce q3
q3 Srv ! ChargeOK q4
q3 Srv ! ChargeFail q5
.marking q0
.end
`                                                    // the CFSM in ChorGram syntax
func main() {
        flag.Parse()
        var logger = log.New(os.Stderr, fmt.Sprintf("[PPS] - "), log.LstdFlags|log.Lmsgprefix|log.Lshortfile)
        var opts []grpc.DialOption
        opts = append(opts, grpc.WithTransportCredentials(insecure.NewCredentials()))
        conn, err := grpc.Dial(*middlewareURL, opts...)
        if err != nil {
                logger.Fatalf("Error connecting to middleware URL %s", *middlewareURL)
        }
        defer conn.Close()
        stub := pb.NewPrivateMiddlewareServiceClient(conn)

        // Register provider contract with registry.
        req := pb.RegisterAppRequest{
                ProviderContract: &pb.LocalContract{
                        Contract: []byte(ppsContract),   // passed to the broker upon registration
                        Format:   pb.LocalContractFormat_LOCAL_CONTRACT_FORMAT_FSA,
                },
        }
        streamCtx, streamCtxCancel := context.WithCancel(context.Background())
        defer streamCtxCancel()
        stream, err := stub.RegisterApp(streamCtx, &req)
        if err != nil {
```

PYTHON, GO to JAVA!

```java
public class Main {
  public static void main(String[] args) {
        ...// get book selection and shipping address from the user
        ByteString contractBytes = null; // Load file contract.fsa into a GlobalContract
        try {
              contractBytes = ByteString.readFrom(new FileInputStream("contract.fsa"));
        } catch (IOException e) {
              e.printStackTrace();
        }
        GlobalContract contract = GlobalContract.newBuilder().setContract(contractBytes).setFormat(
          GlobalContractFormat.GLOBAL_CONTRACT_FORMAT_FSA
        ).setInitiatorName("ClientApp").build();
        ...
  }
}
```

where in `contract.fsa` we find:

```
.outputs ClientApp
.state graph
q0 Srv ! PurchaseRequest q1
q1 Srv ? TotalAmount q2
q2 PPS ! CardDetailsWithTotalAmount q3
q3 PPS ? PaymentNonce q4
q4 Srv ! PurchaseWithPaymentNonce q5
q5 Srv ? PurchaseOK q6
q5 Srv ? PurchaseFail q7
.marking q0
.end
```

```
.outputs Srv
.state graph
q0 ClientApp ? PurchaseRequest q1
q1 ClientApp ! TotalAmount q2
q2 ClientApp ? PurchaseWithPaymentNonce q3
q3 PPS ! RequestChargeWithNonce q4
q4 PPS ? ChargeOK q5
q4 PPS ? ChargeFail q6
q5 ClientApp ! PurchaseOK q7
q6 ClientApp ! PurchaseFail q8
.marking q0
.end
```

```
.outputs PPS
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q0 ClientApp ? CardDetailsWithTotalAmount q1
q1 ClientApp ! PaymentNonce q2
q2 Srv ? RequestChargeWithNonce q3
q3 Srv ! ChargeOK q4
q3 Srv ! ChargeFail q5
.marking q0
.end
```
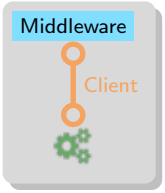
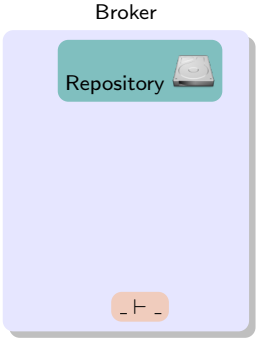
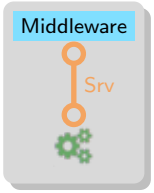

– A meta-demo –

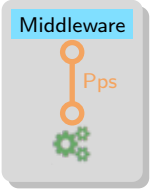
[courtesy of Pablo Montepagano]

Bookkeeping









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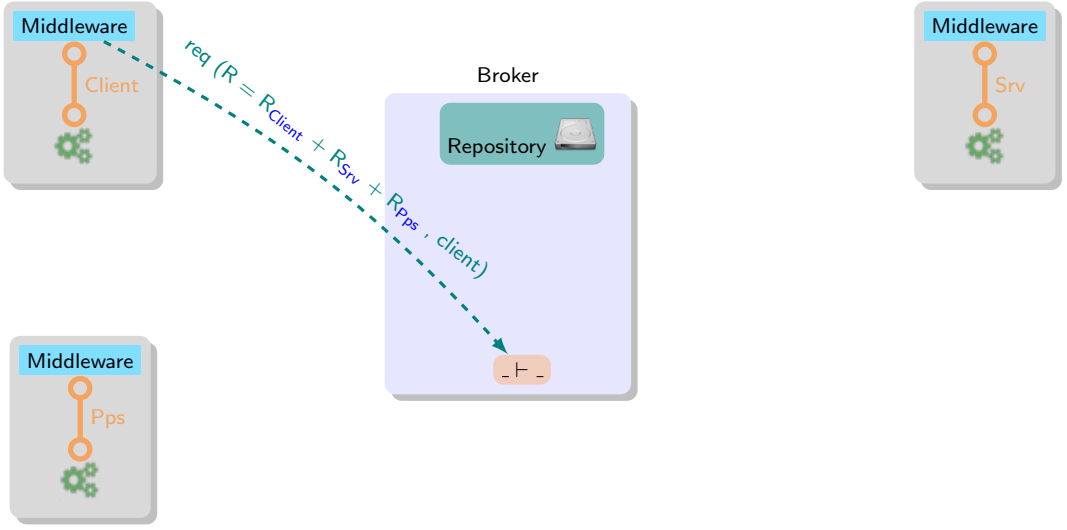

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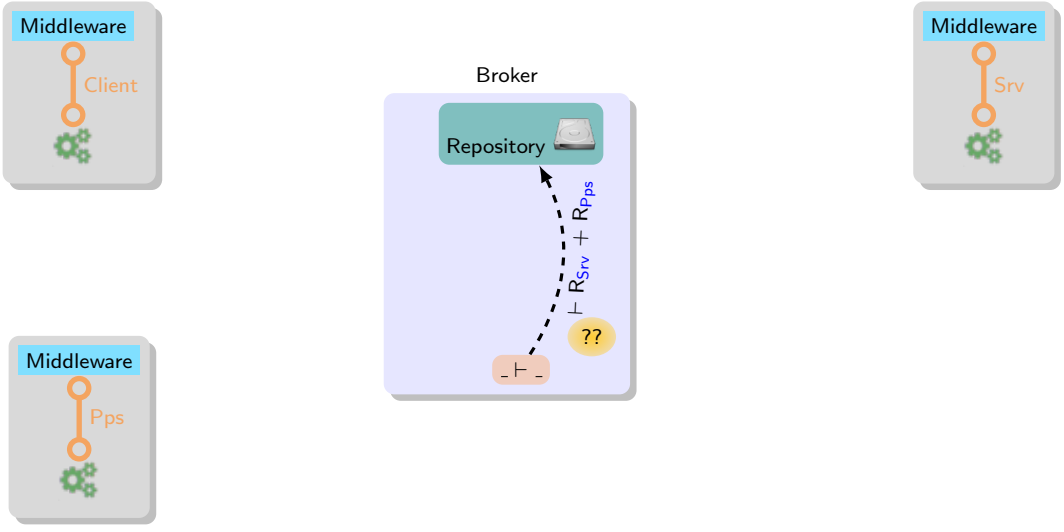

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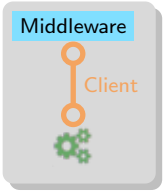

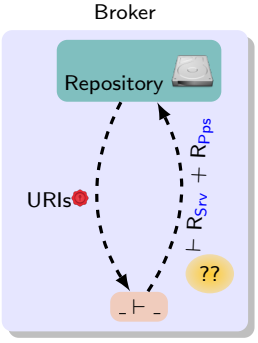

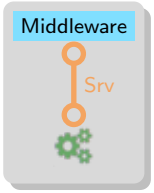

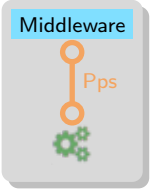

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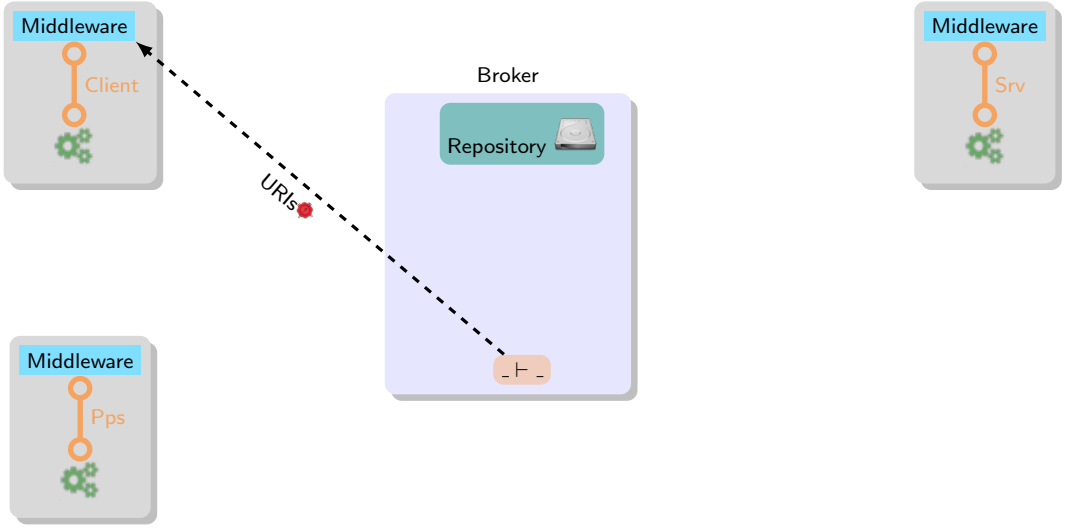

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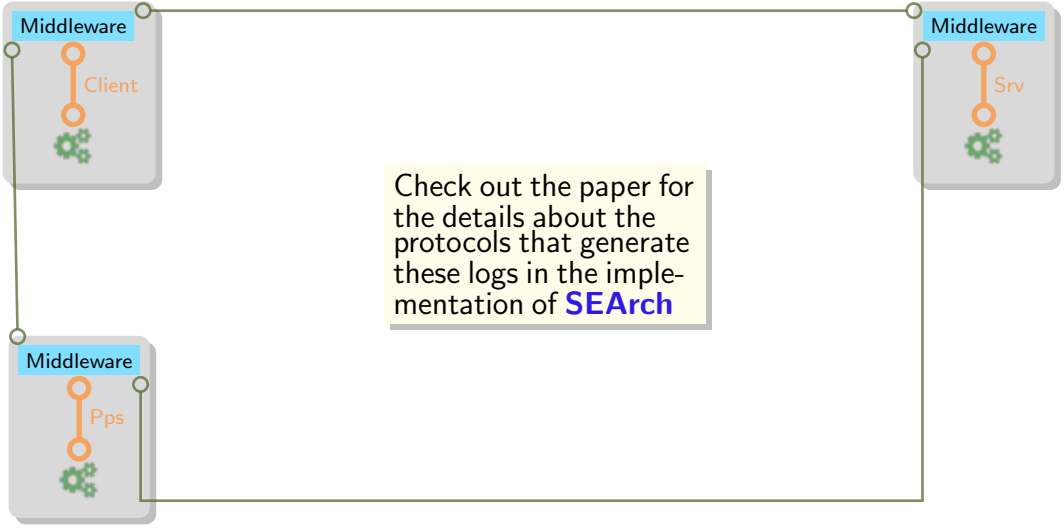

Check out the paper for the details about the protocols that generate these logs in the implementation of **SEArch**

– Epilogue –

Recap

SEArch combines

- SOAs
- semantic models (ARNs + CFSMs)
- and tools for choreographic development (D. Senarruzza's extension of **ChorGram**)

to enable dynamic and semantic-based discovery and composition of distributed services

There's space for improvement

- data-aware CFSMs
- decouple broker and service repository
- $\Longrightarrow$ distributed bisimulation checks!
- parameterise the compliance check
- what about mistakes/attacks?

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Dipartimento di Eccellenza

Many thanks to the reviewers and to Ilaria & Francesco for helping us addressing a reviewer's concerns