Enacting BPEL4WS Specified Workflows with Multiagent Systems

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BPEL4WS and Workflows

- The Business Process Execution Language for Web Services is a workflow language.
- XML language.
- Uses WSDL.
- Assumes SOAP.
- Widely adopted.
- Centrally and statically enacted.

GOAL

Enact BPEL4WS workflows using dynamically created multiagent systems.

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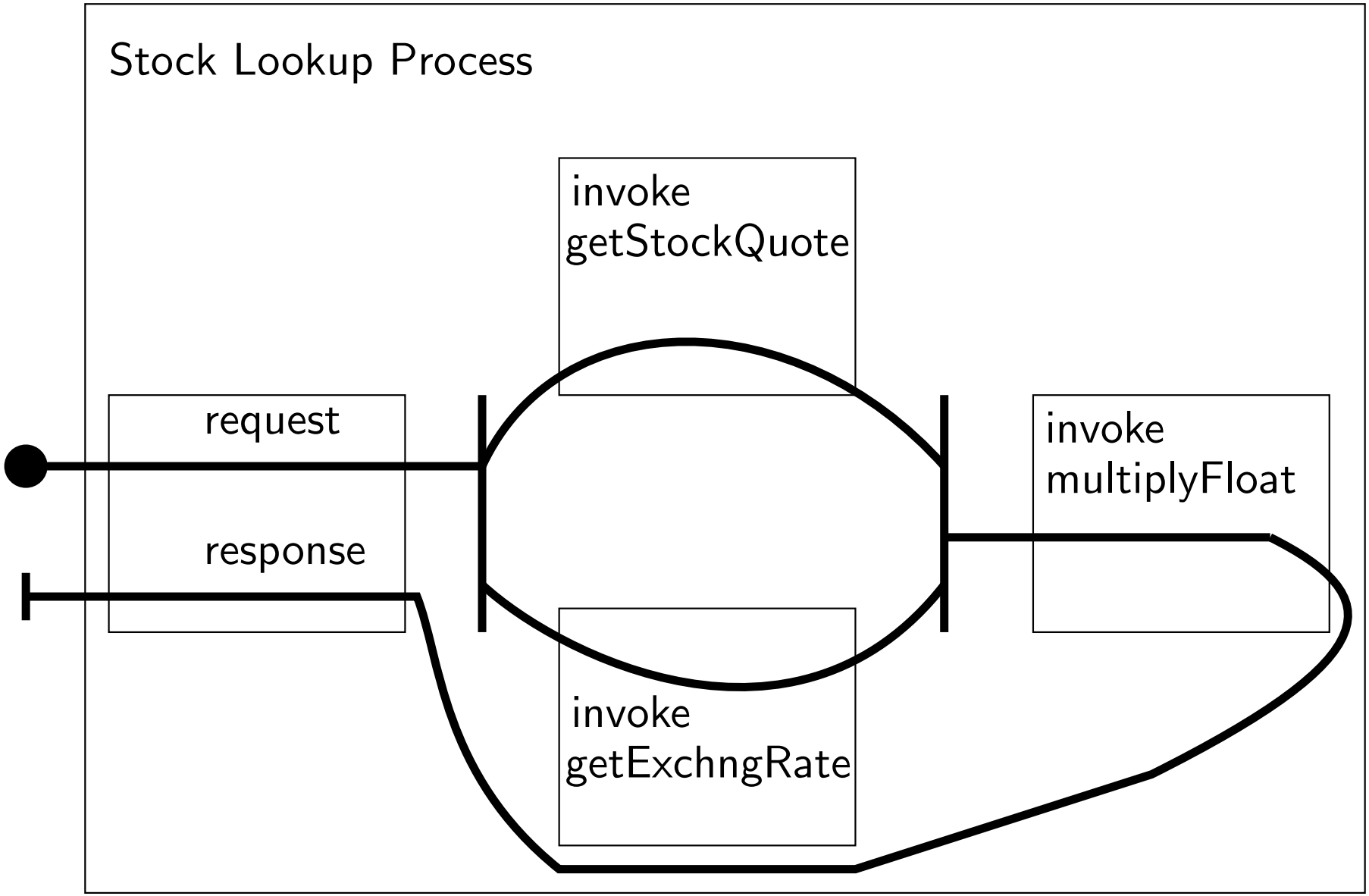
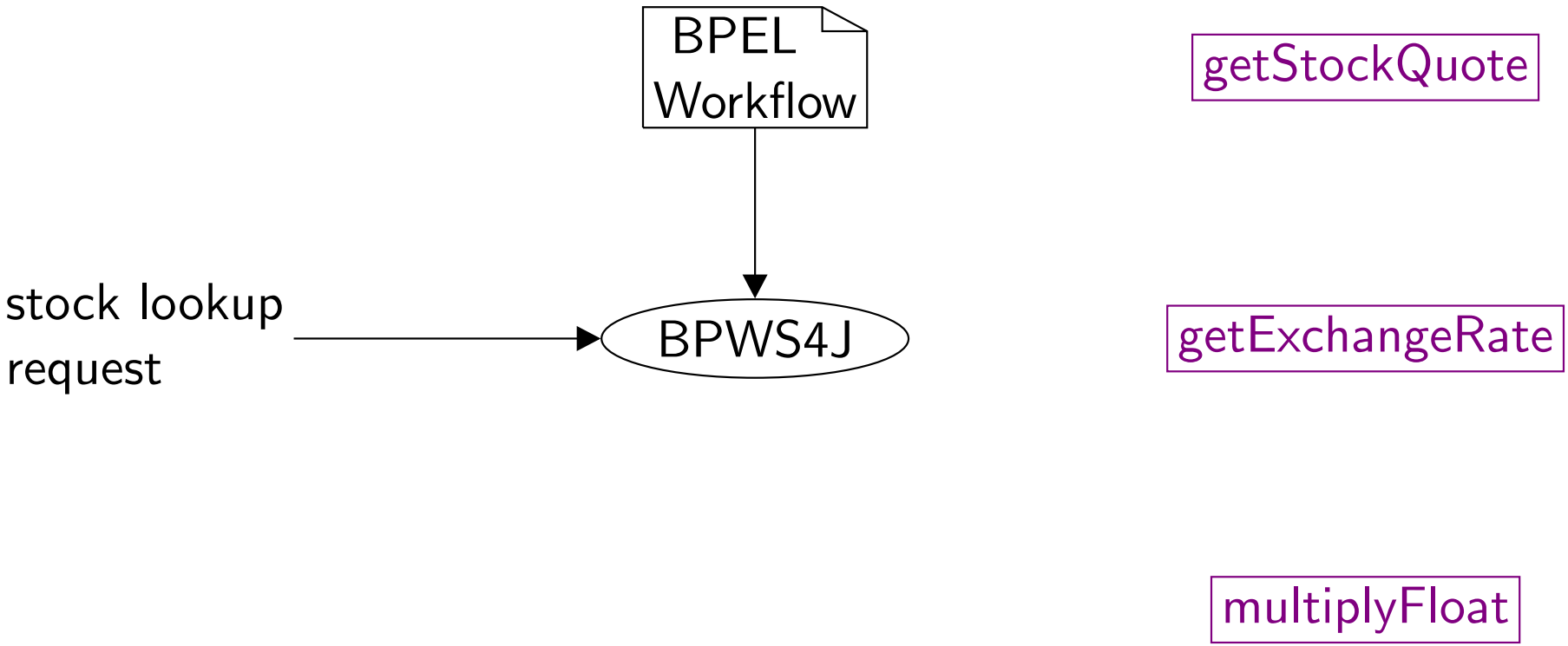
Sample Workflow



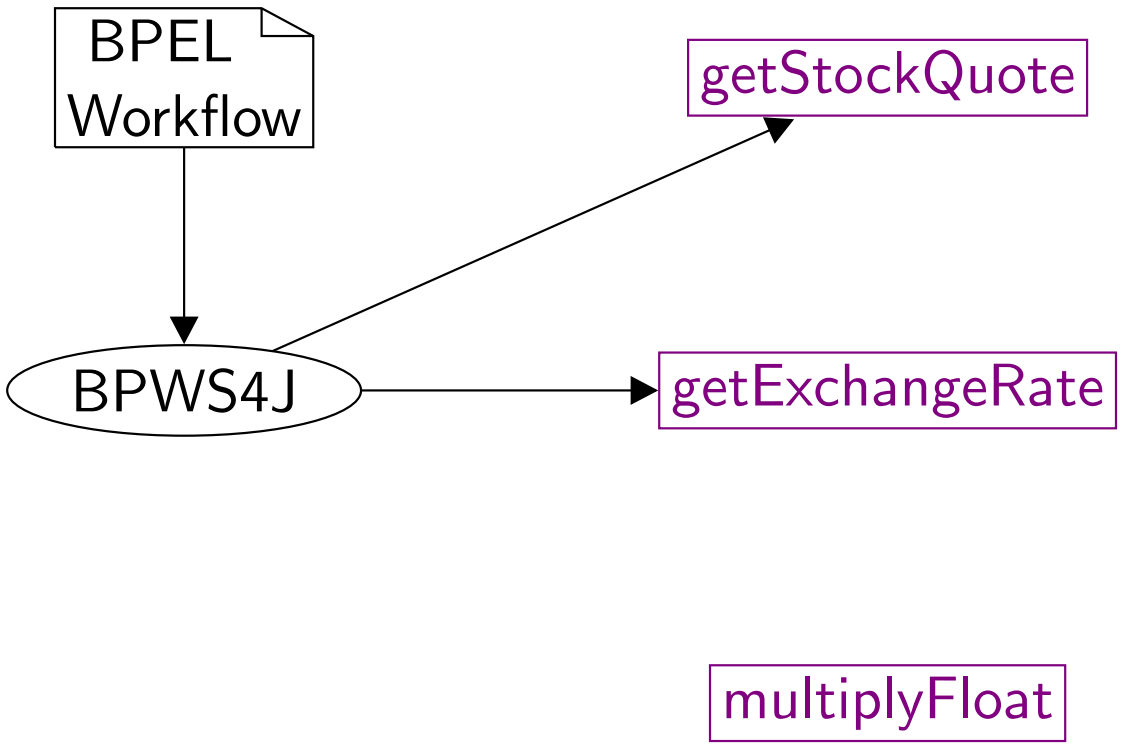
Centralized Enactment



- BPWS4J enactment engine from IBM AlphaWorks.

Centralized Enactment

stock lookup request



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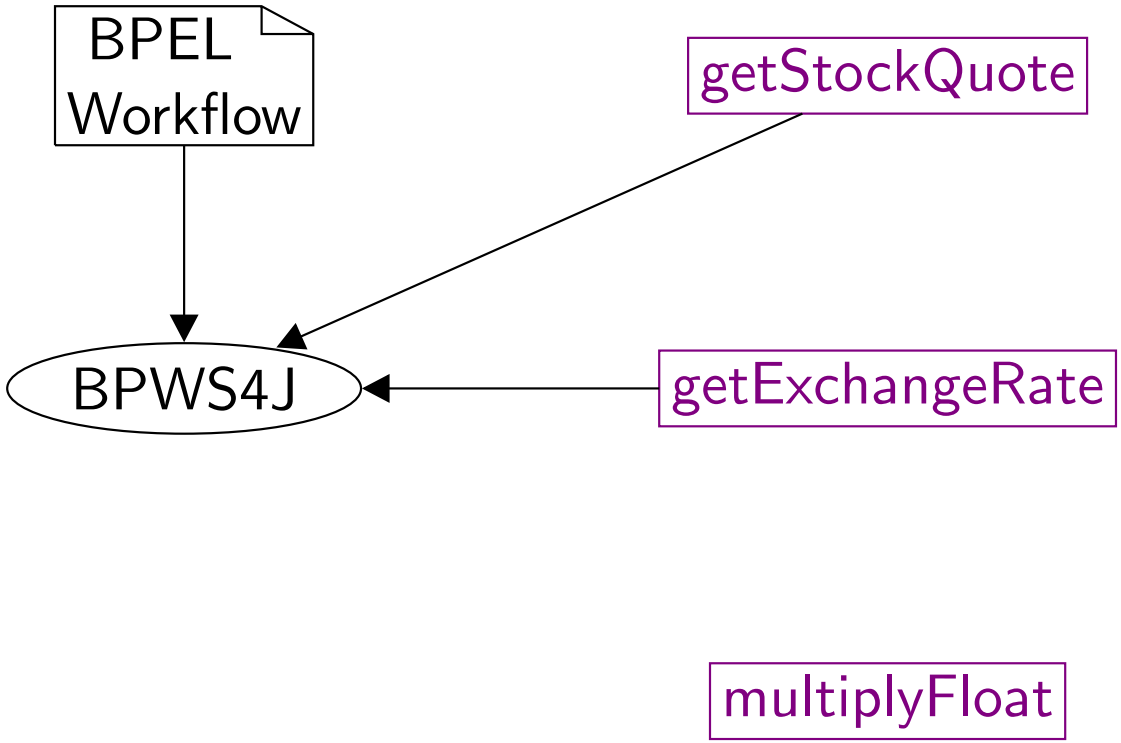

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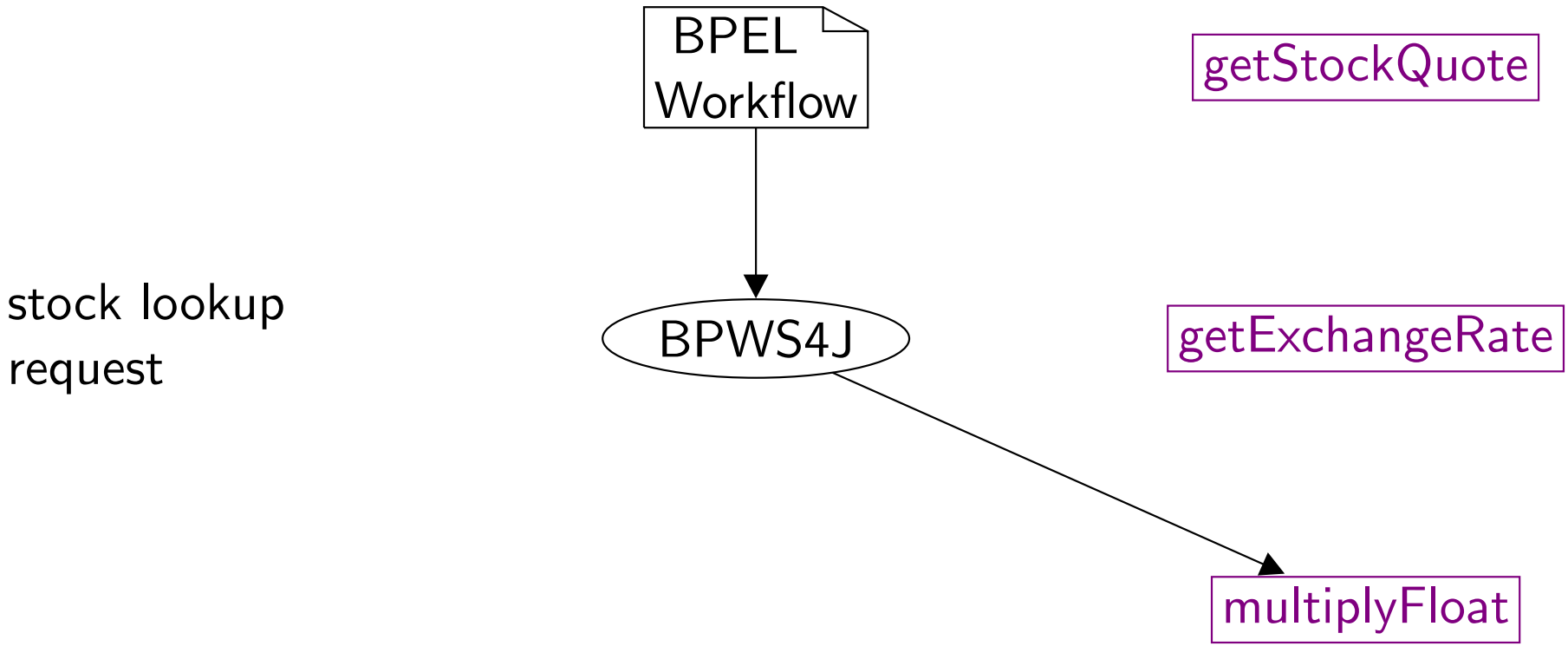

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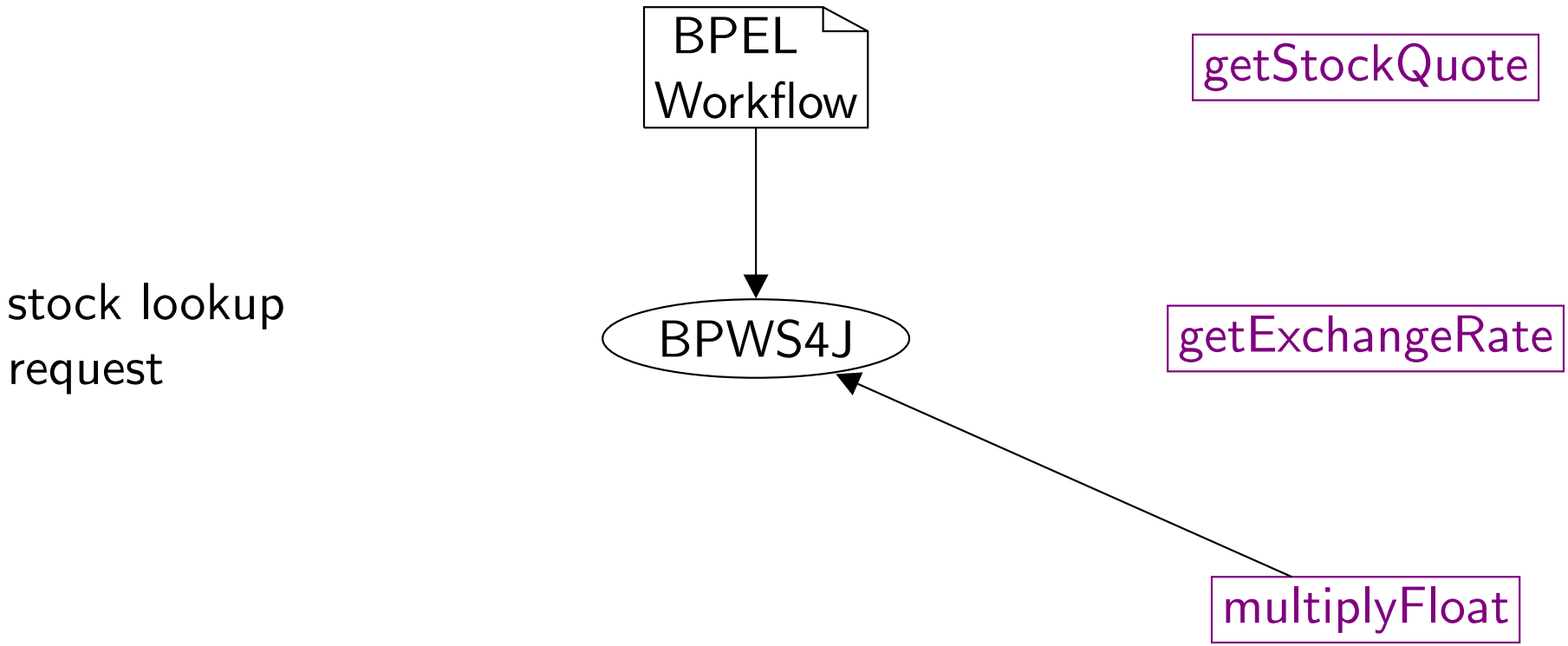

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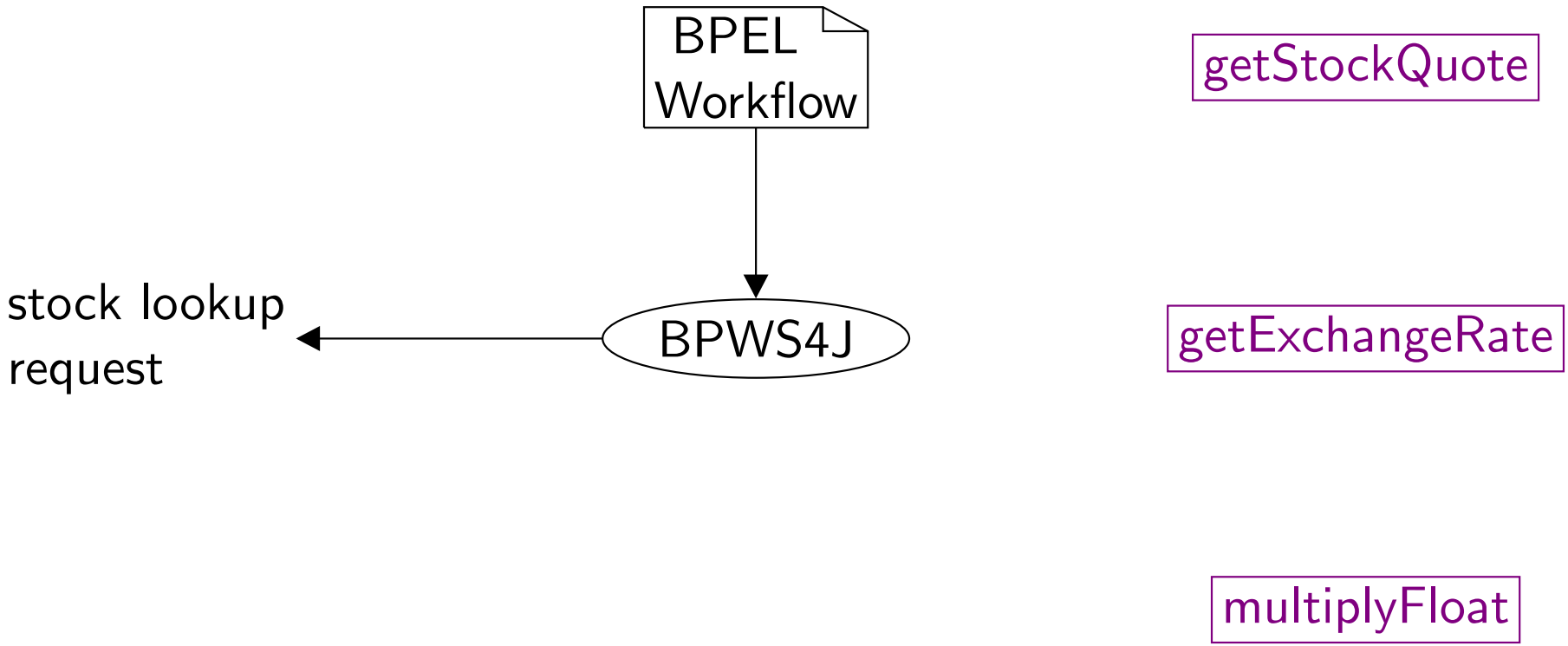

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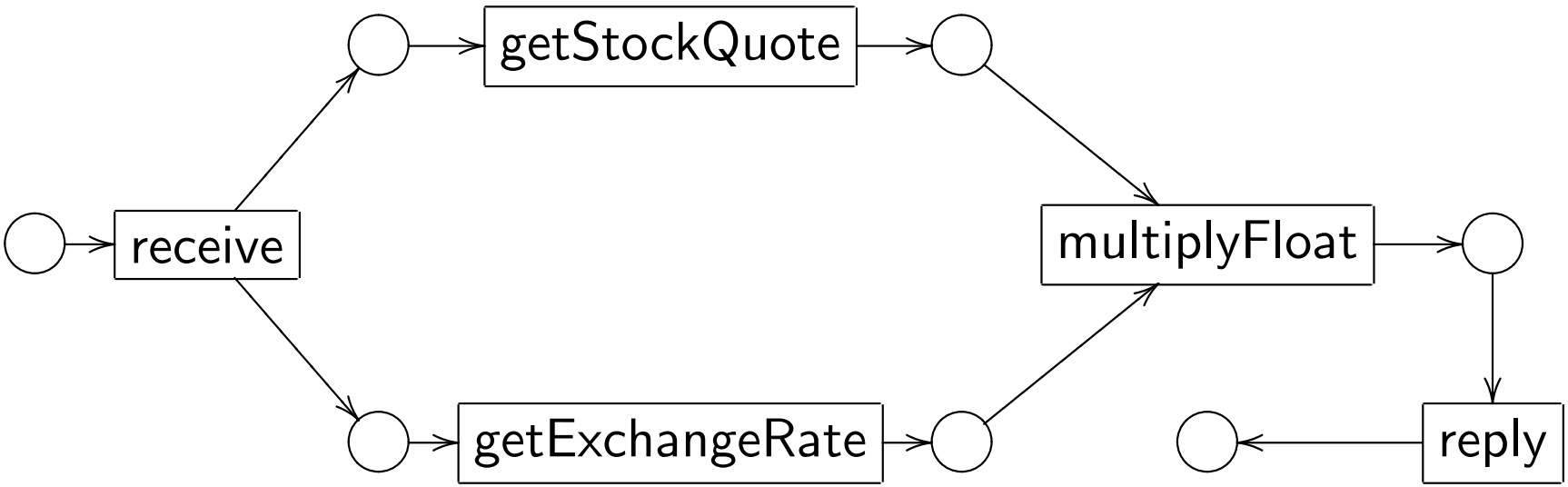
Centralized to Decentralized Enactment

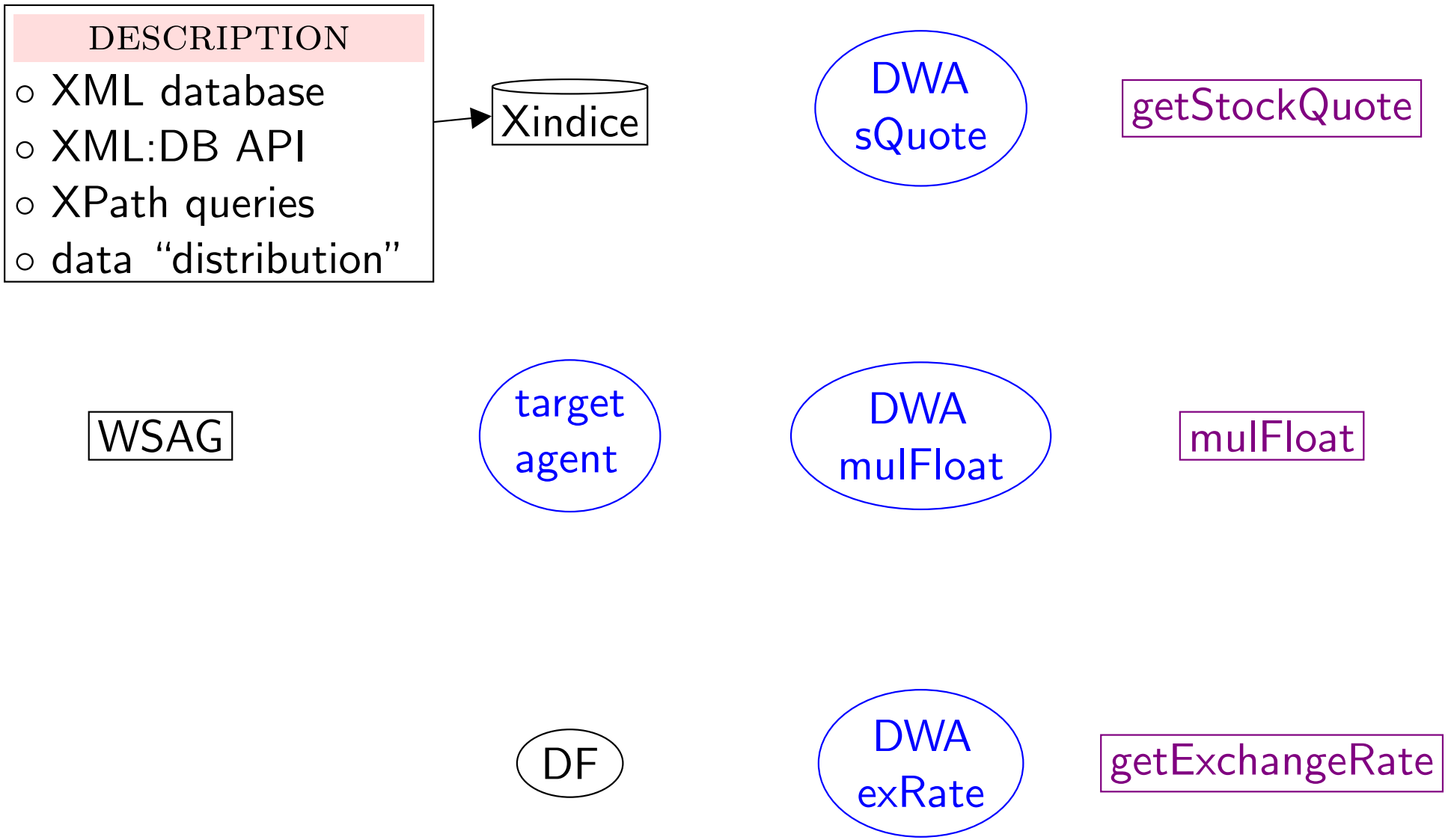
- Needed to coordinate agents.
- Used Colored Petri Nets and a native XML database.
- Agents decide who to call next: distributed control.

Colored Petri Mapping



- Tokens carry data: control information.

Multiagent Workflow Enactment Example



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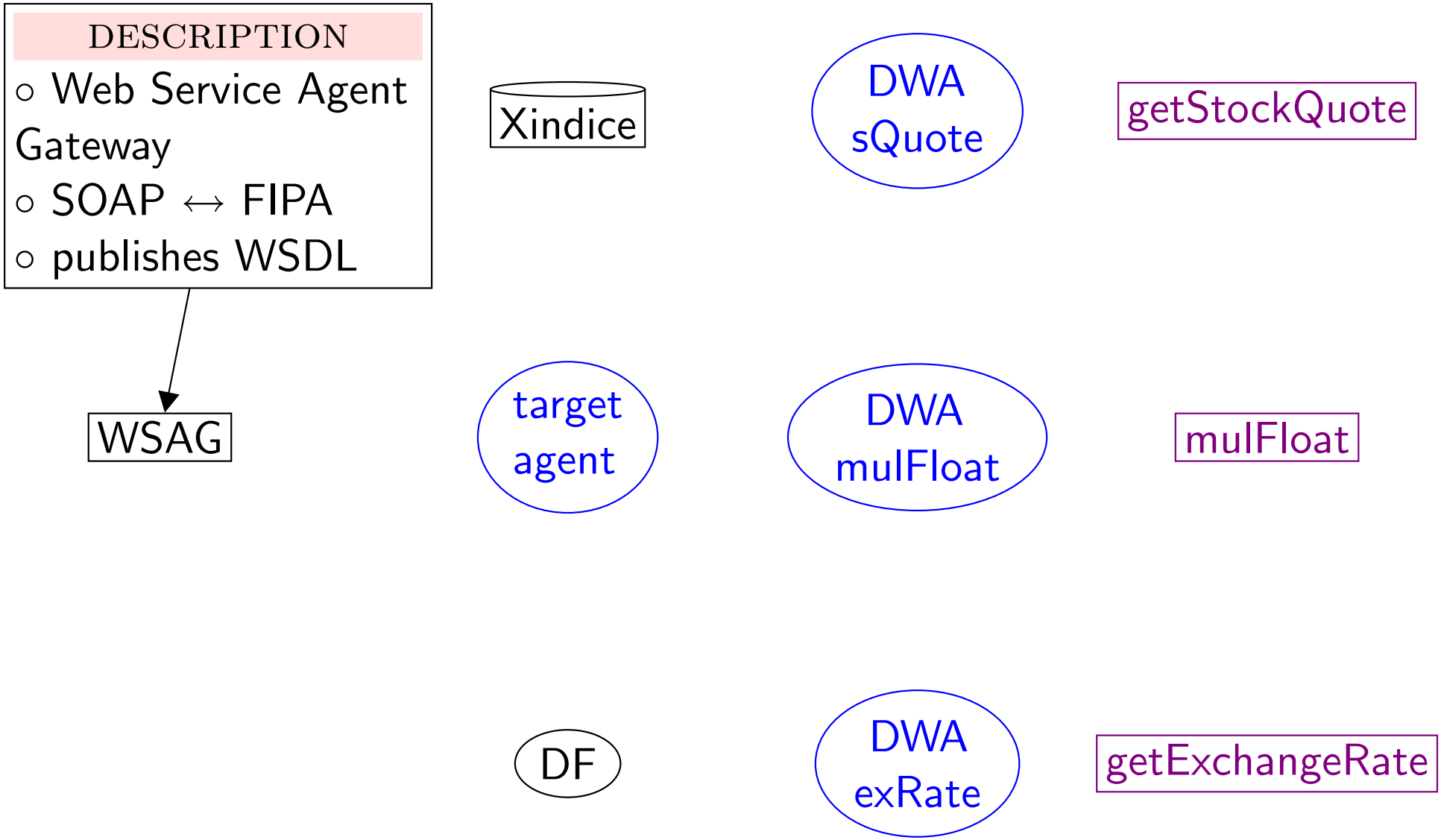

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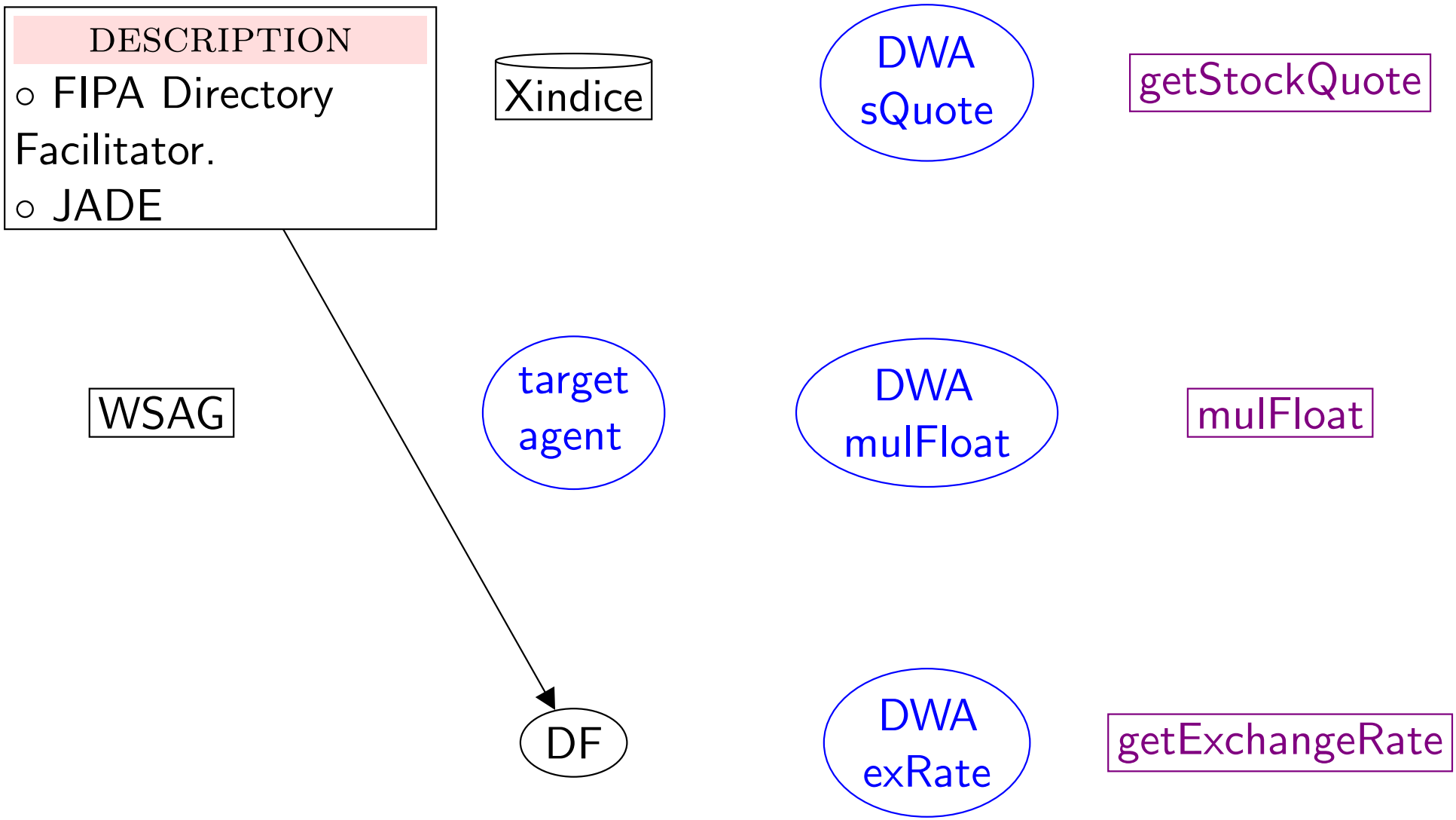

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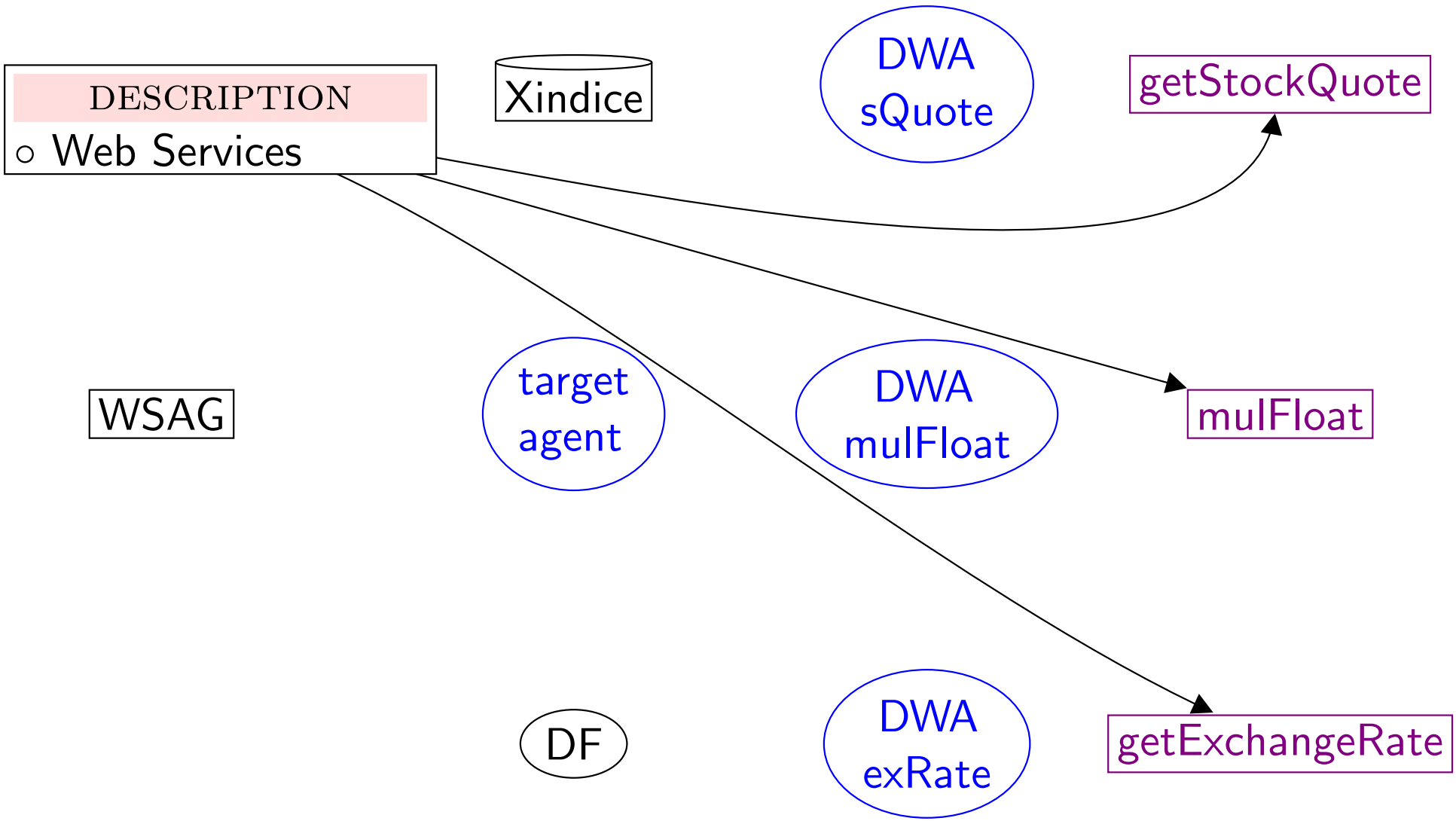

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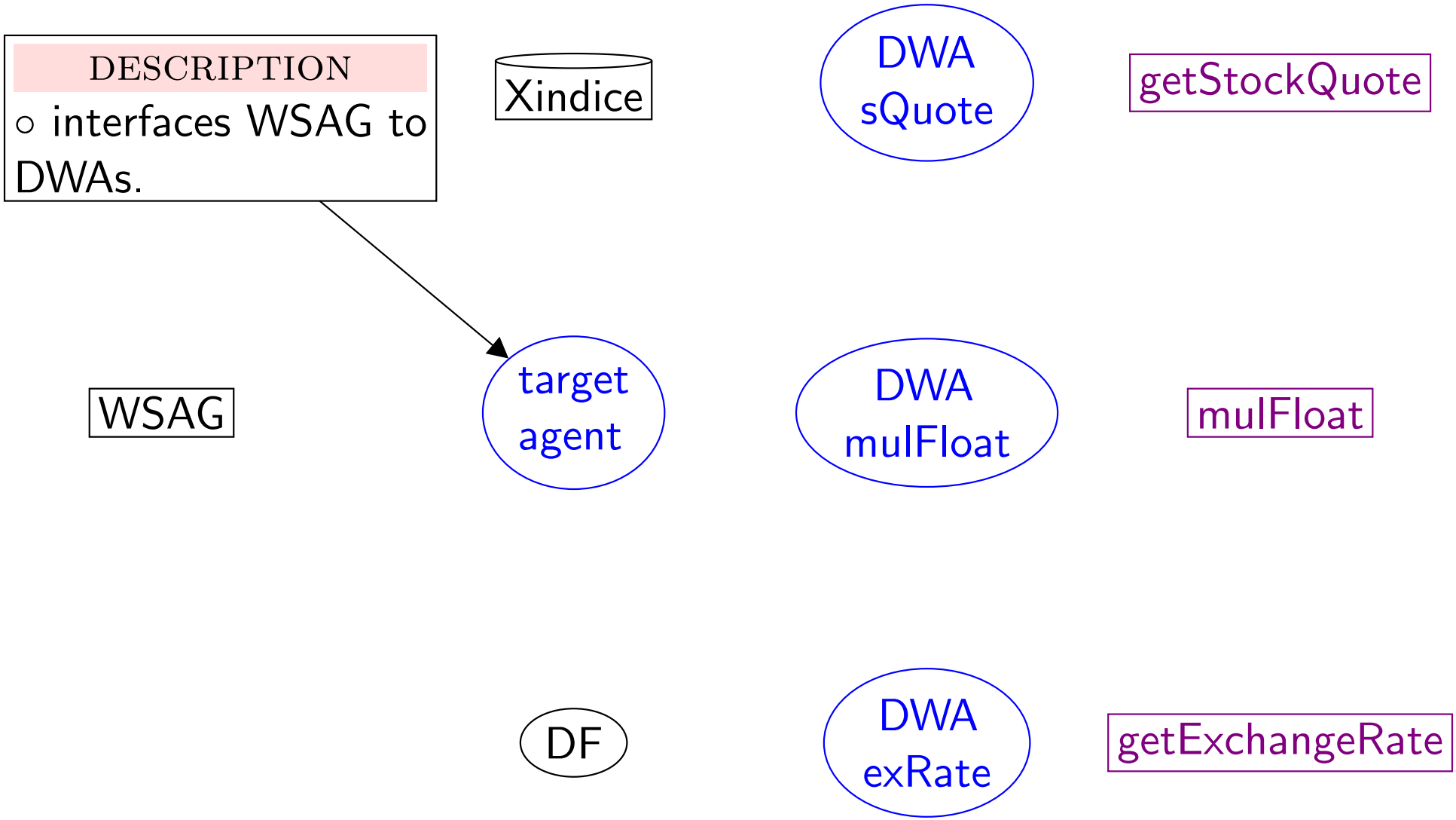

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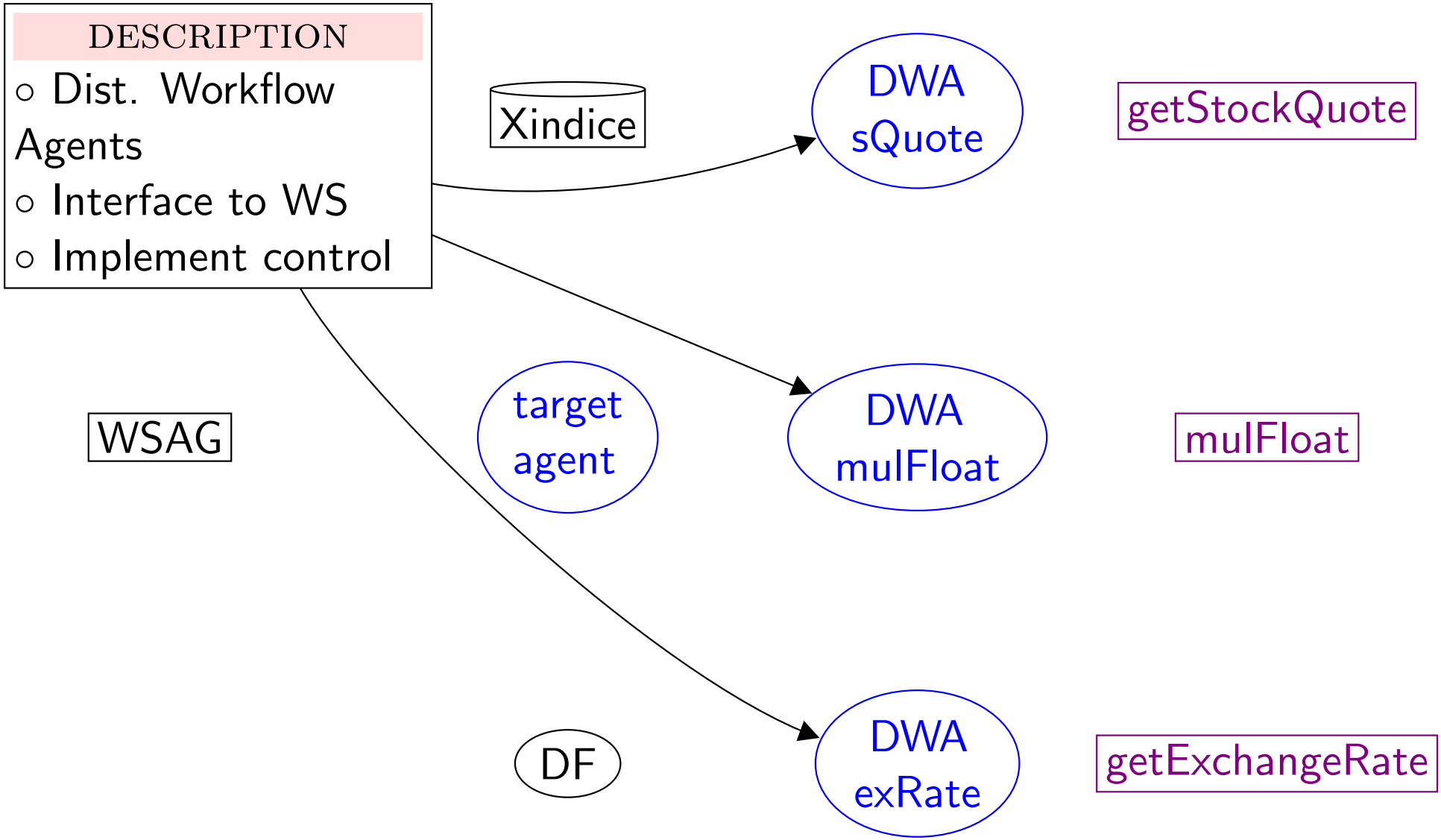
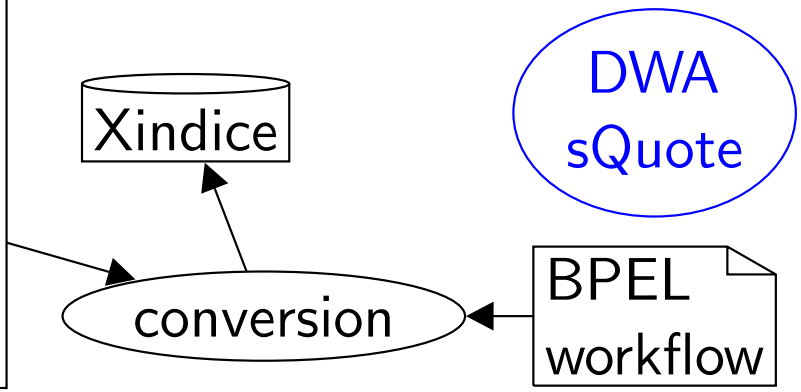


Multiagent Workflow Enactment Example

DESCRIPTION

- Distributed Wkflow Agent configuration
- could be automated
- need only one agent program



DWA
sQuote

getStockQuote

WSAG

target
agent

DWA
mulFloat

mulFloat

DF

DWA
exRate

getExchangeRate

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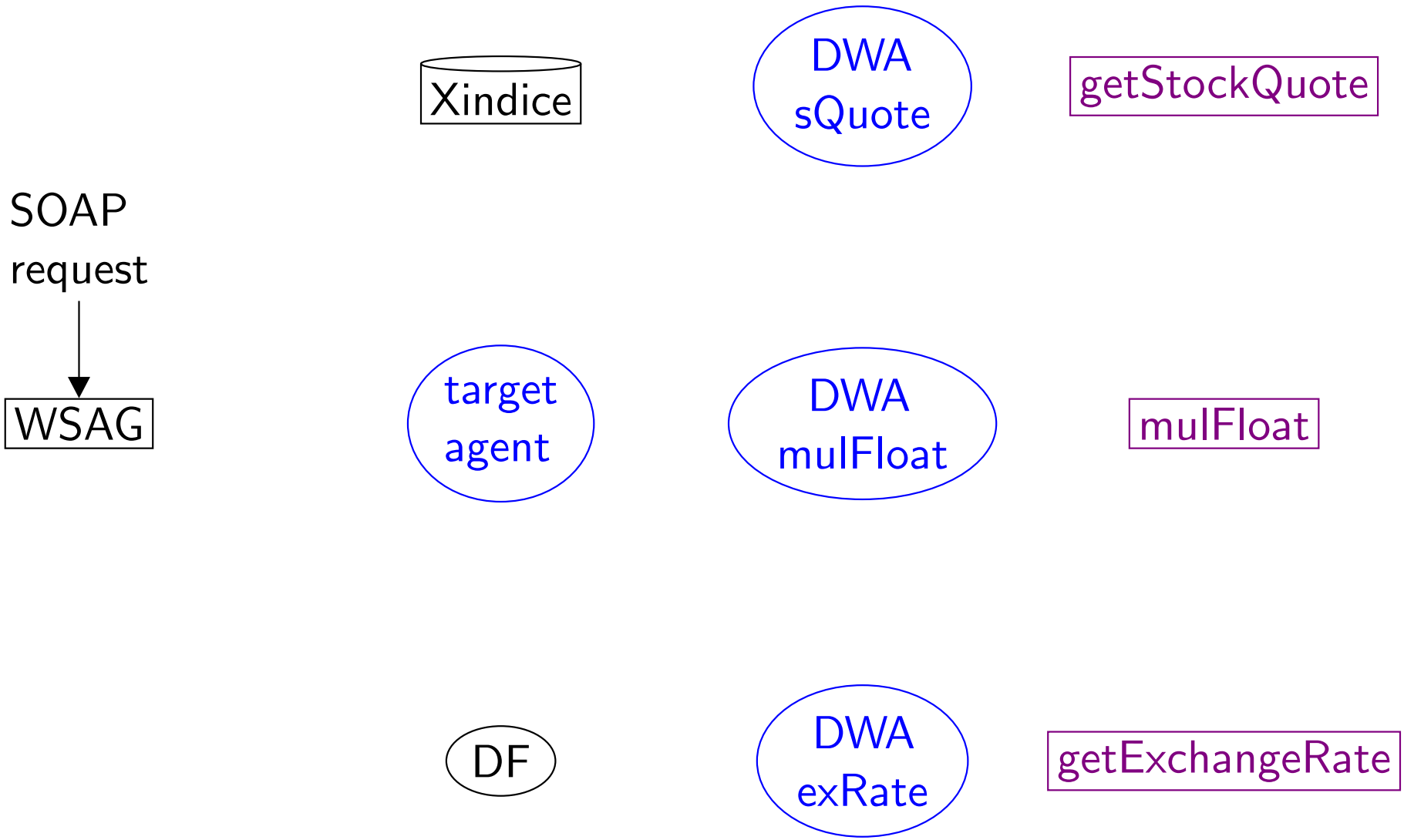

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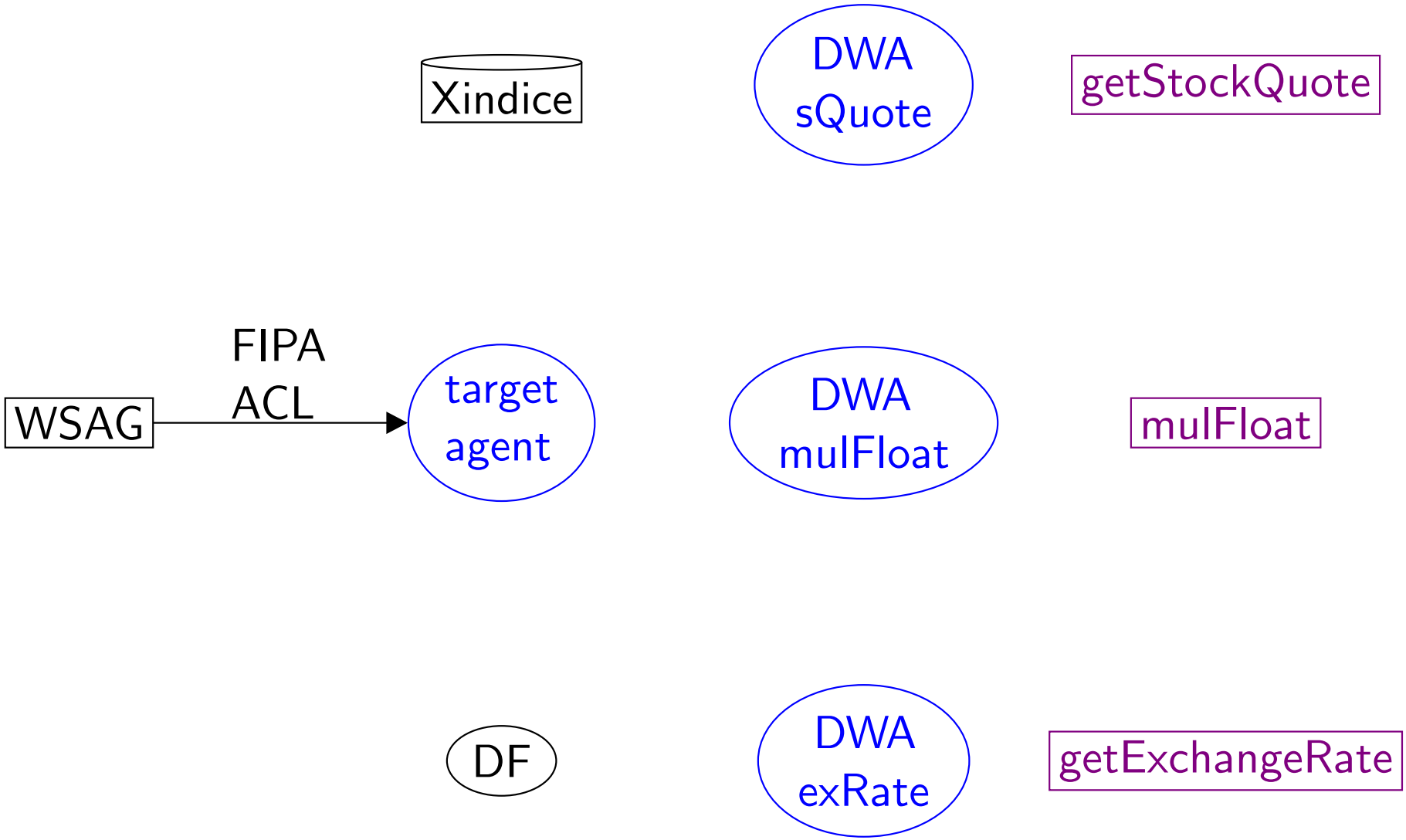

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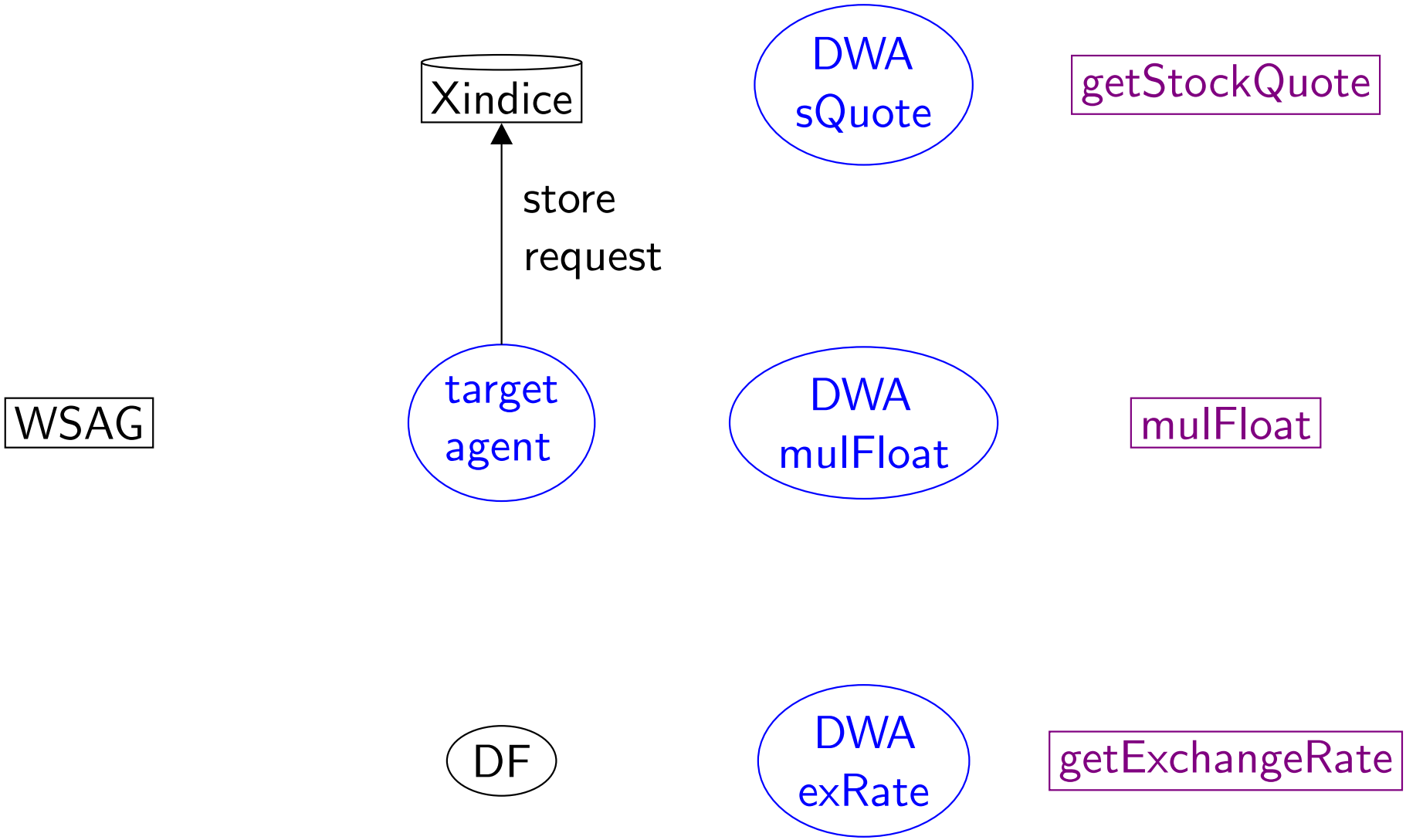

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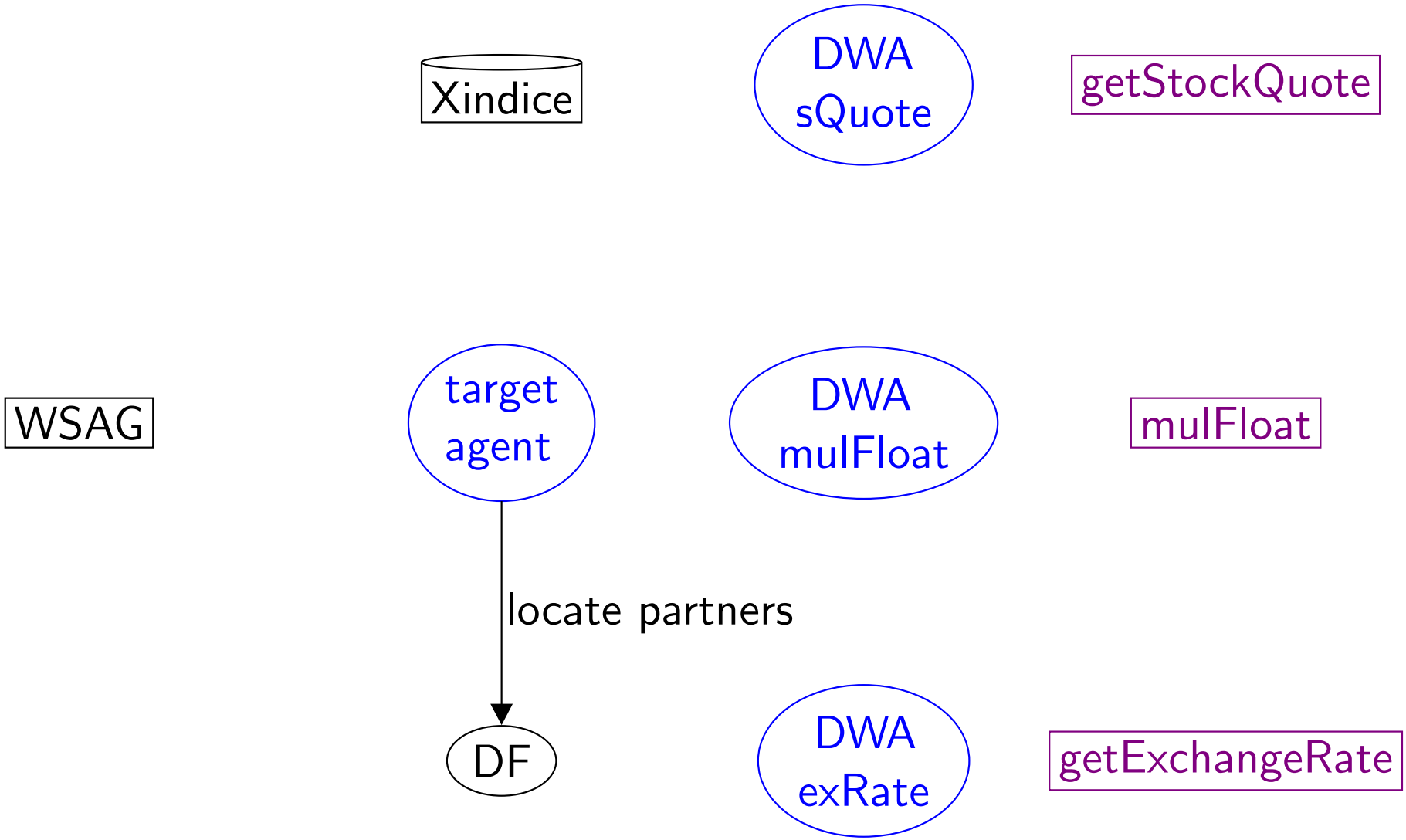

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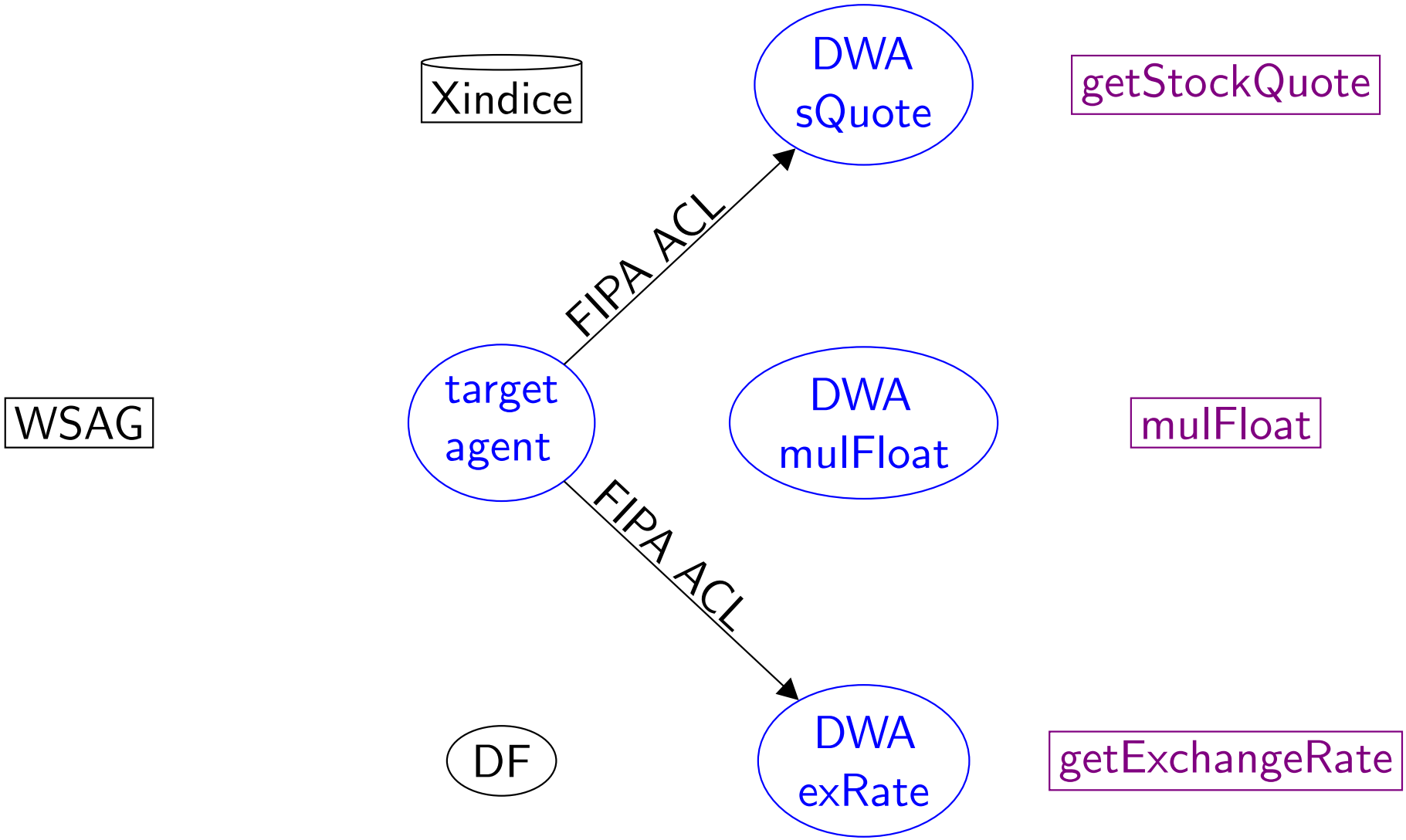

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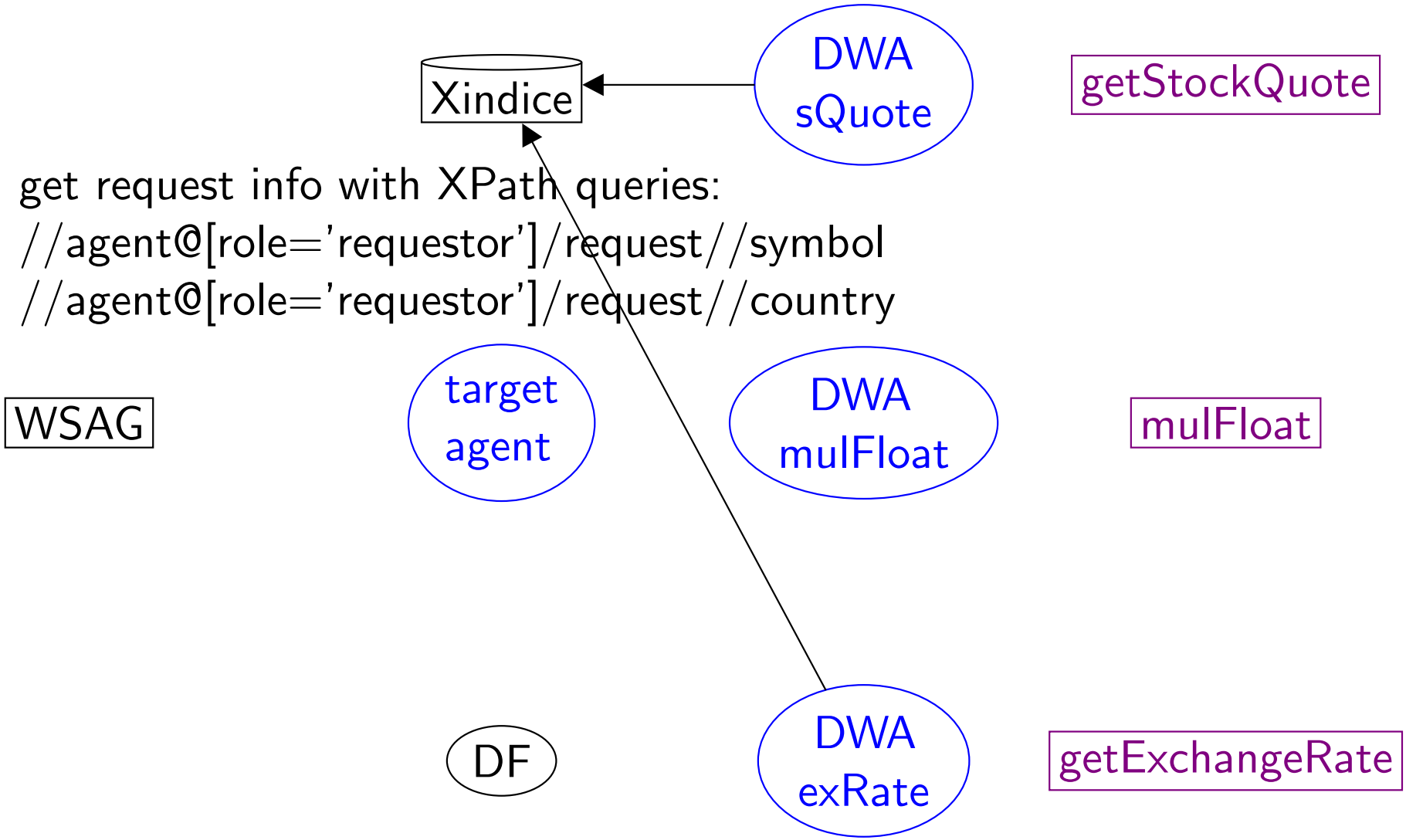

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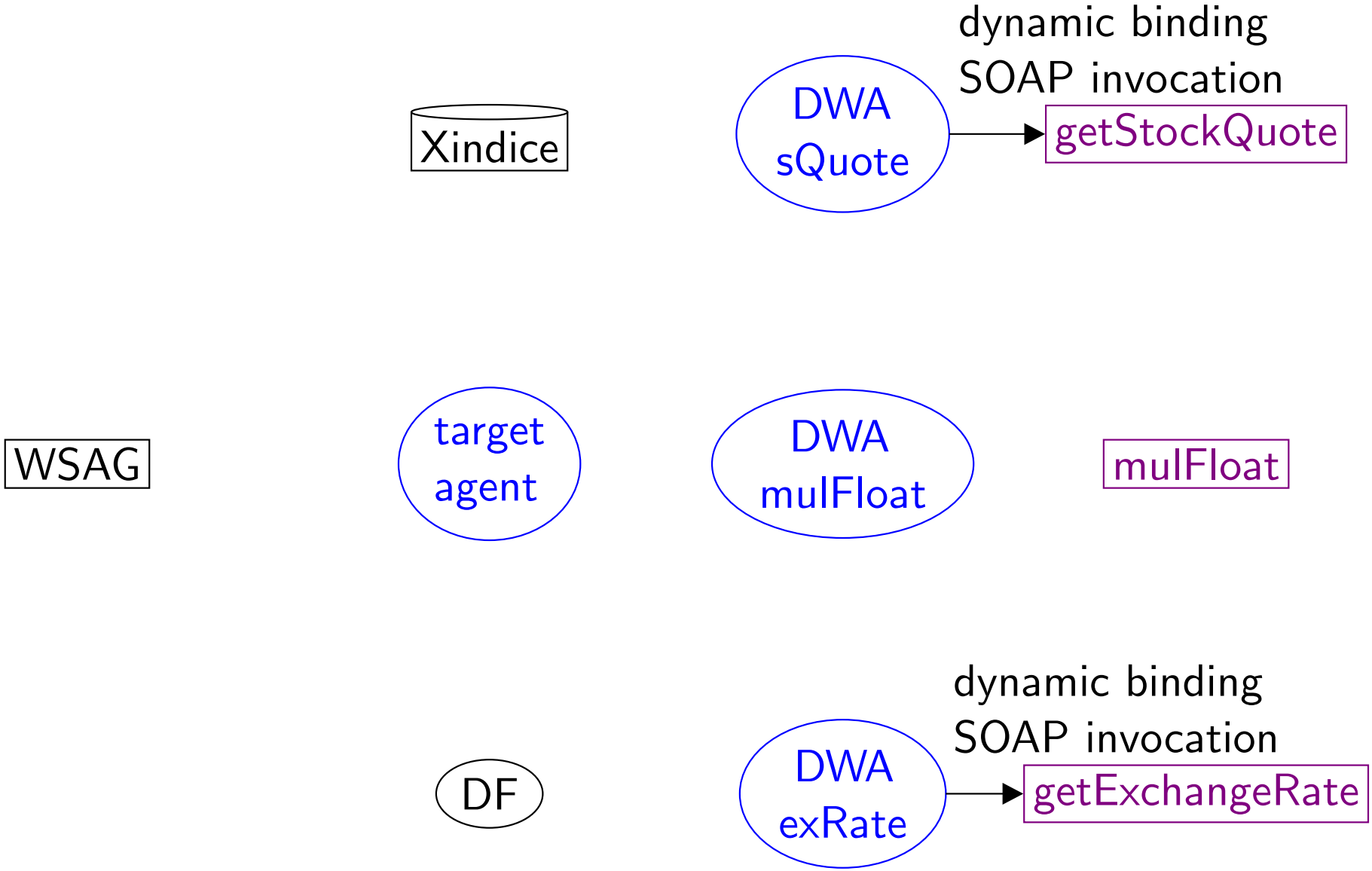

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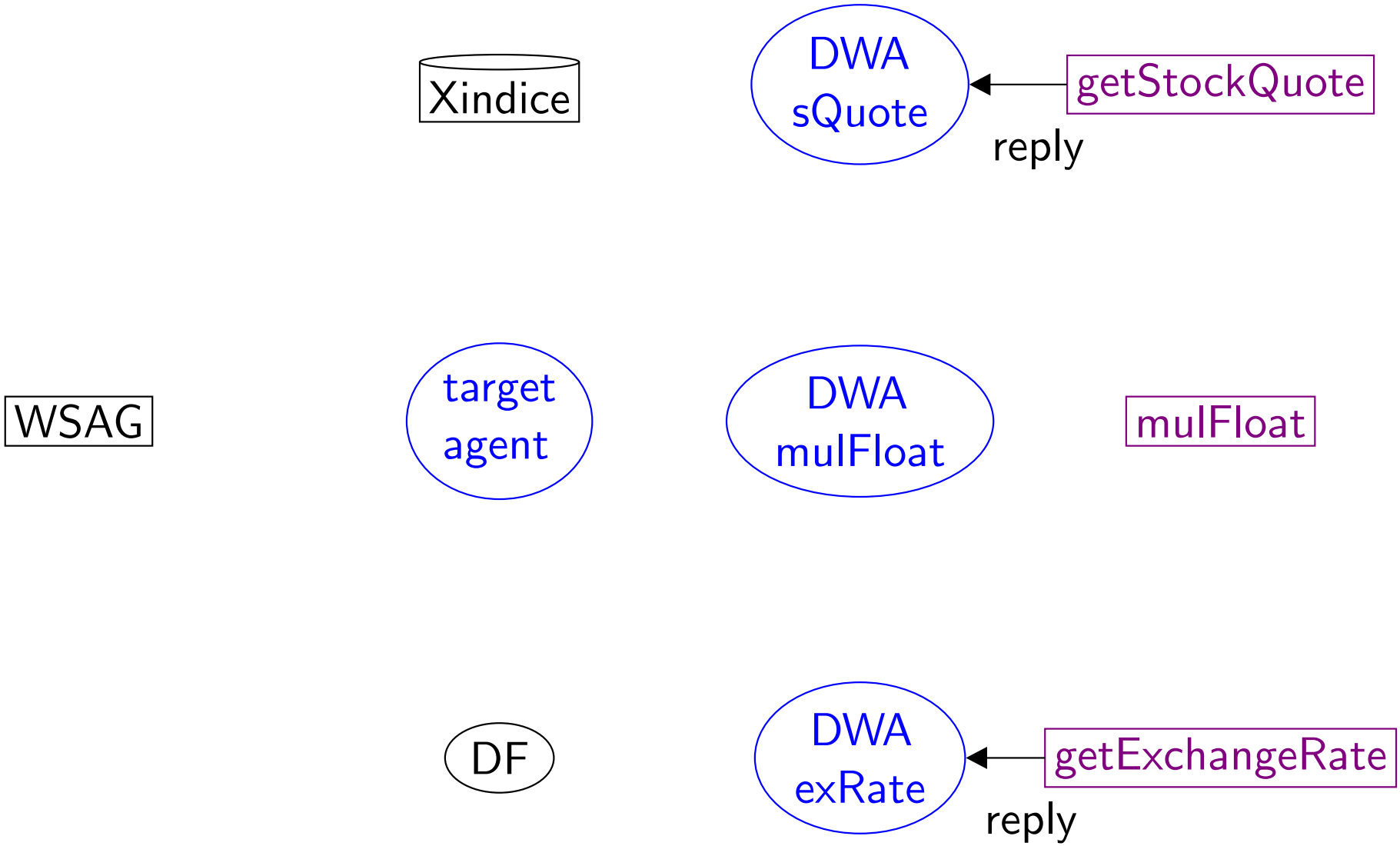

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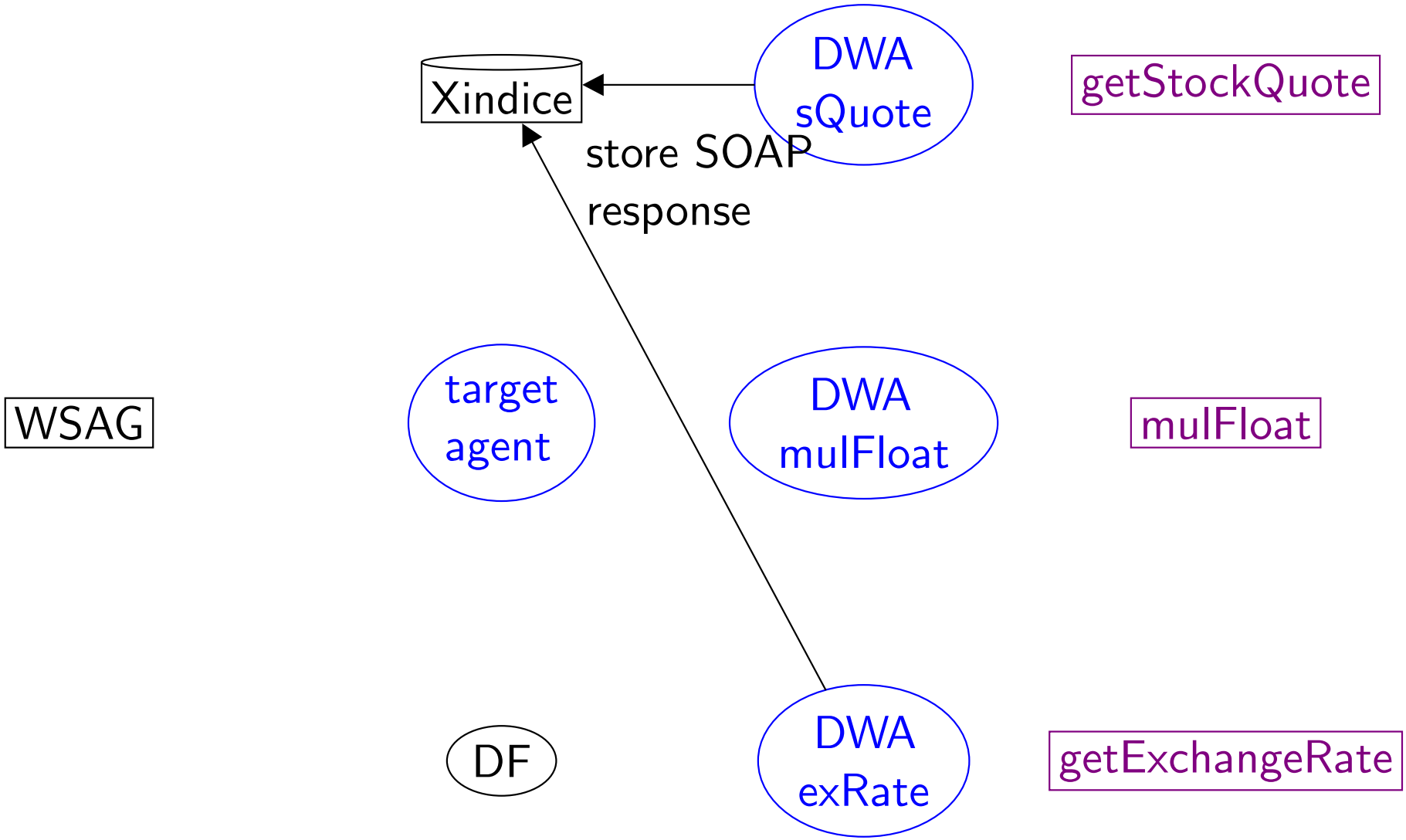

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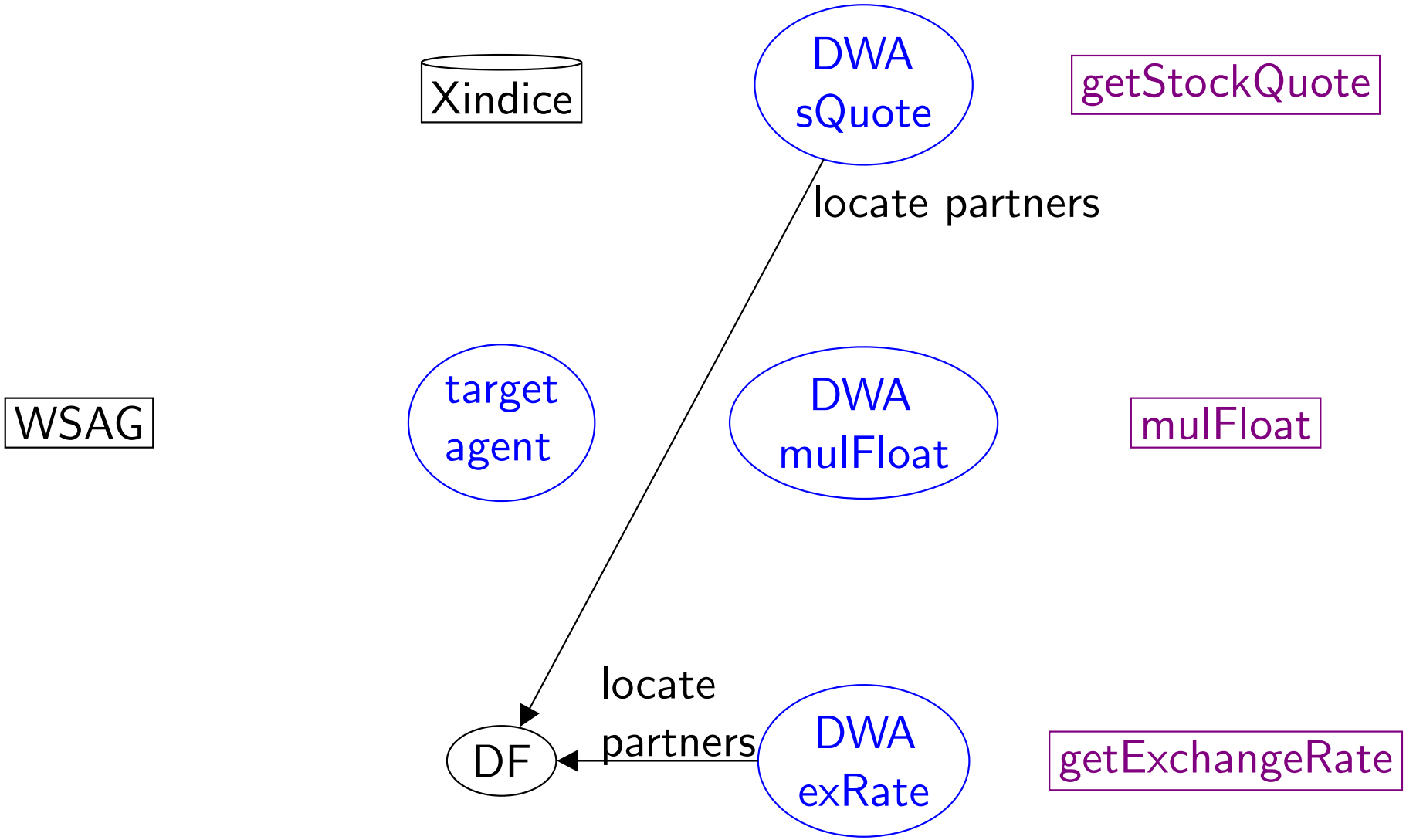

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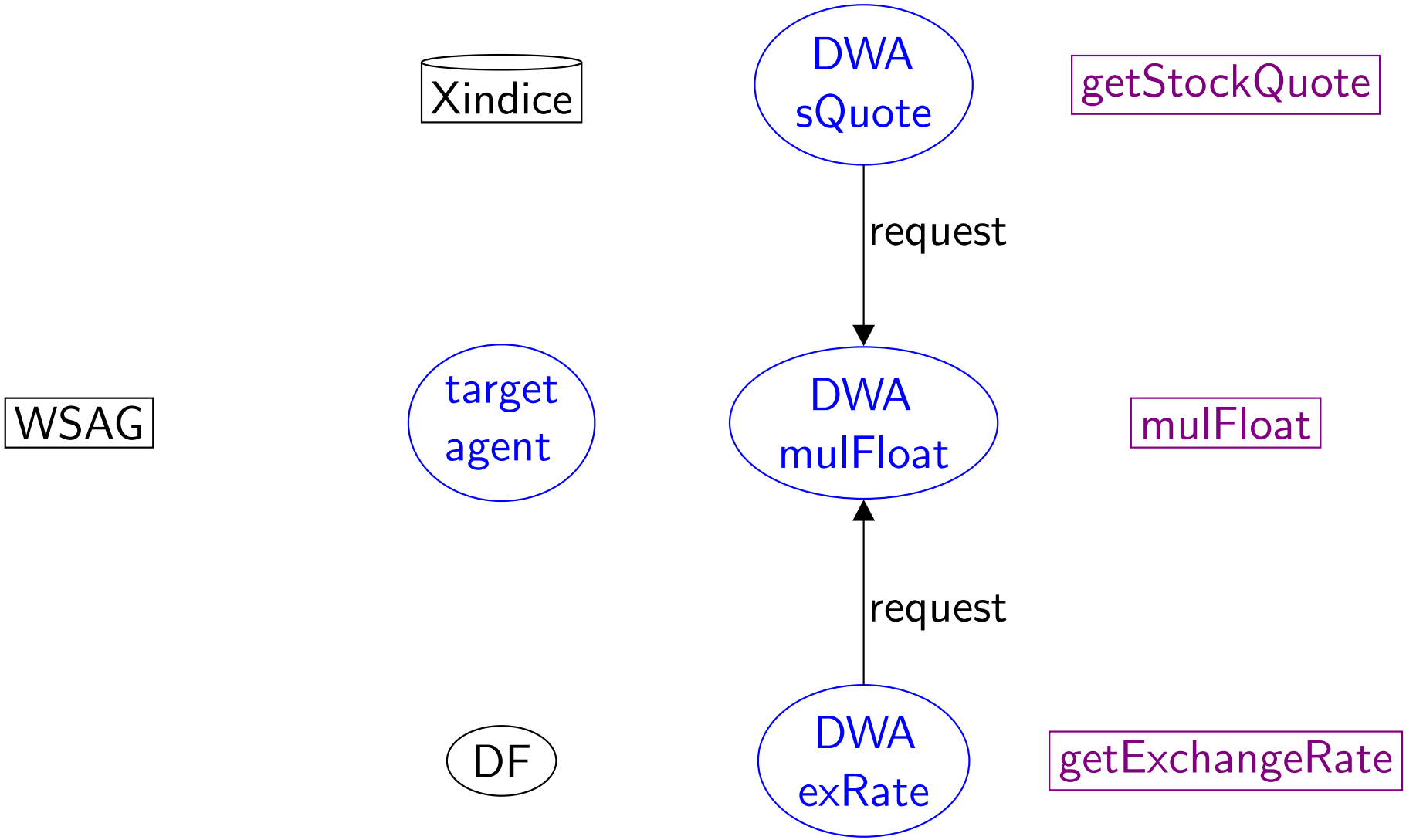

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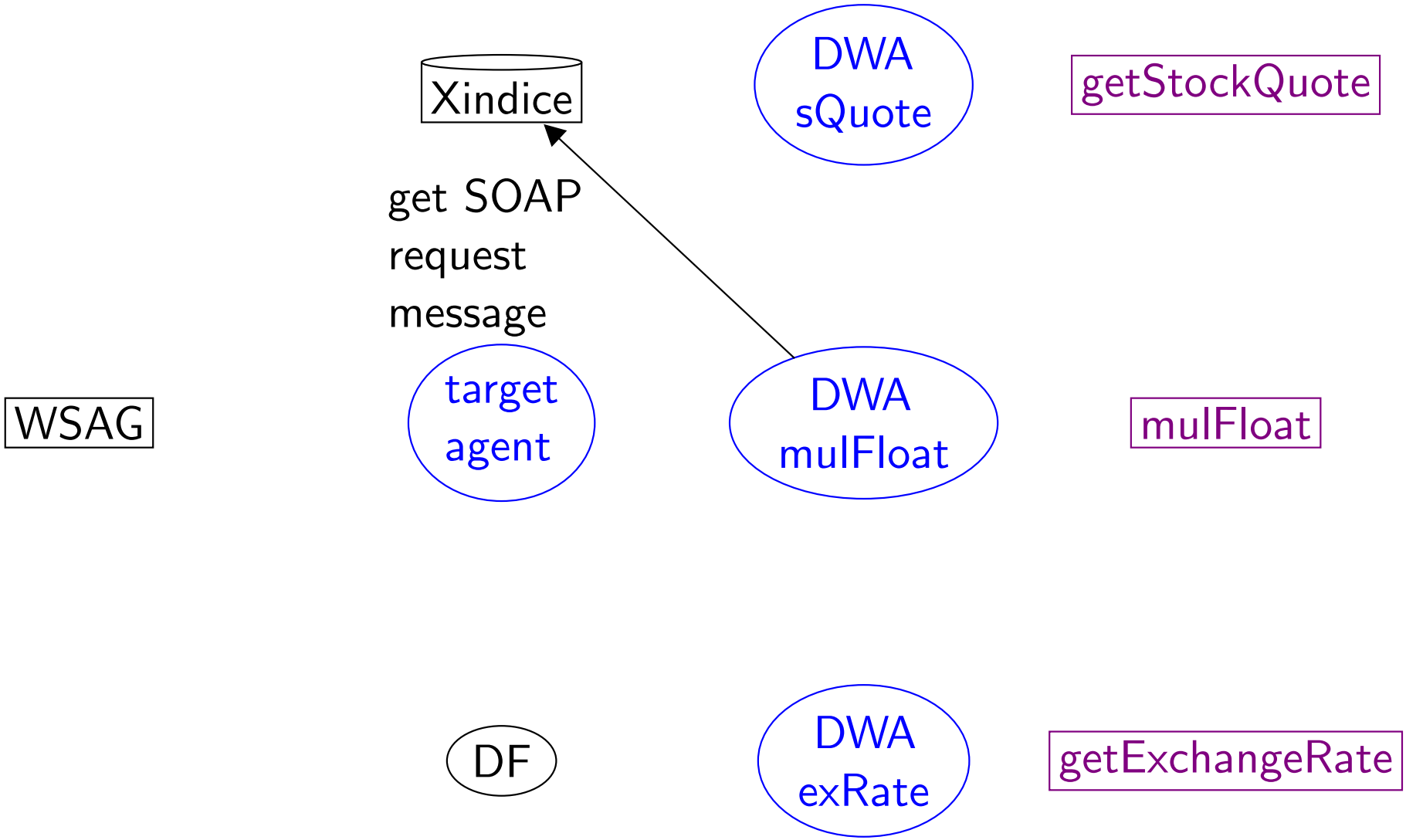

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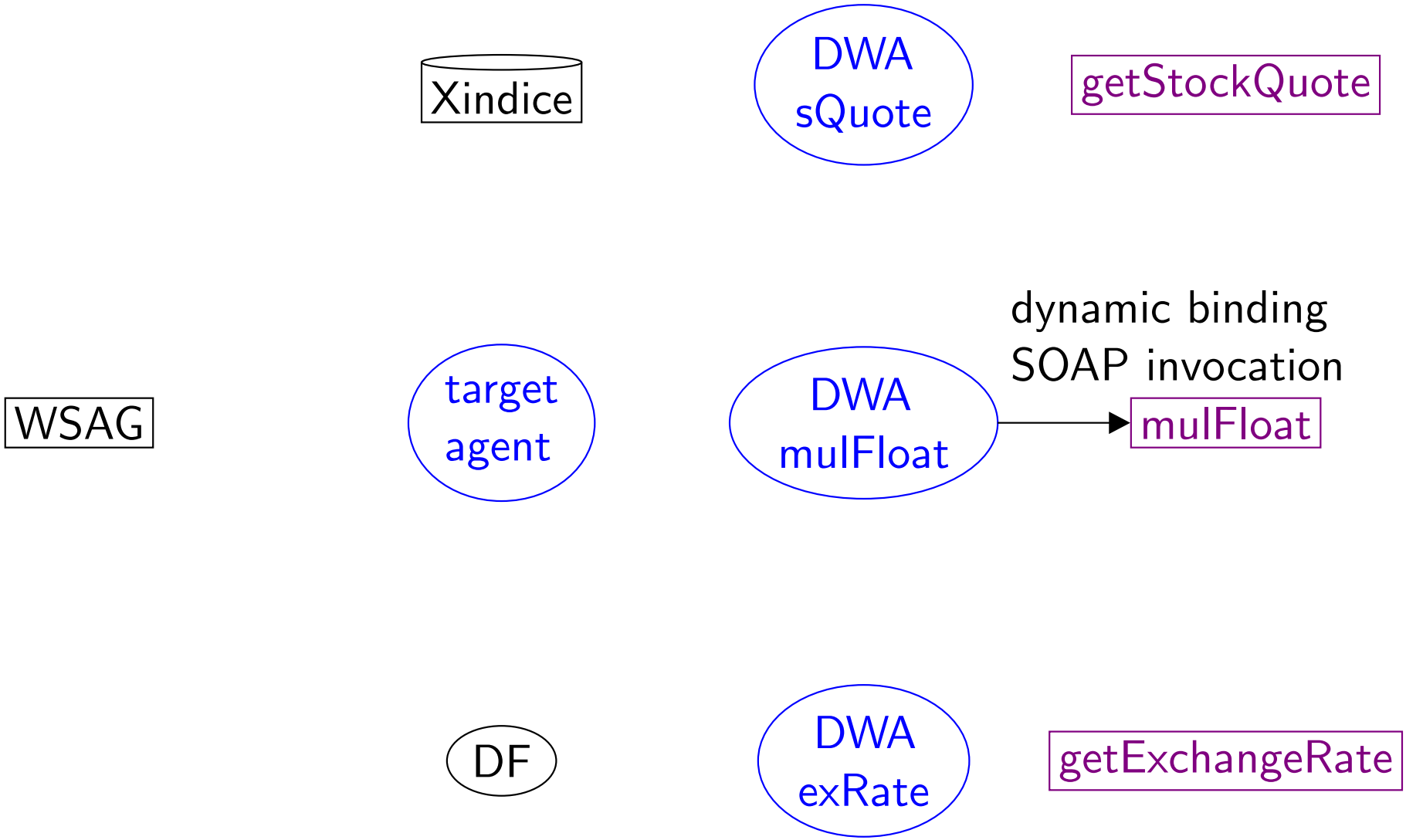

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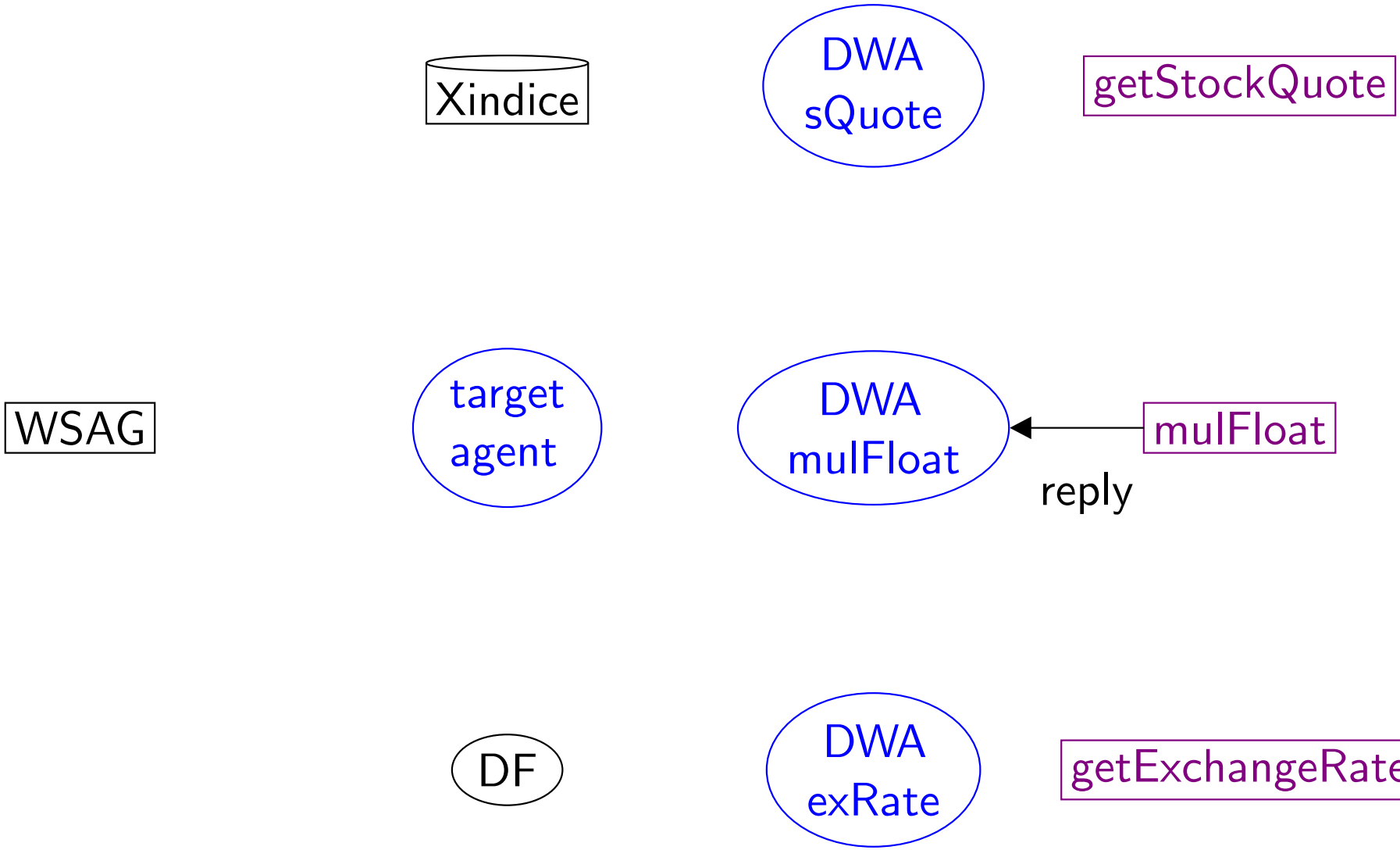

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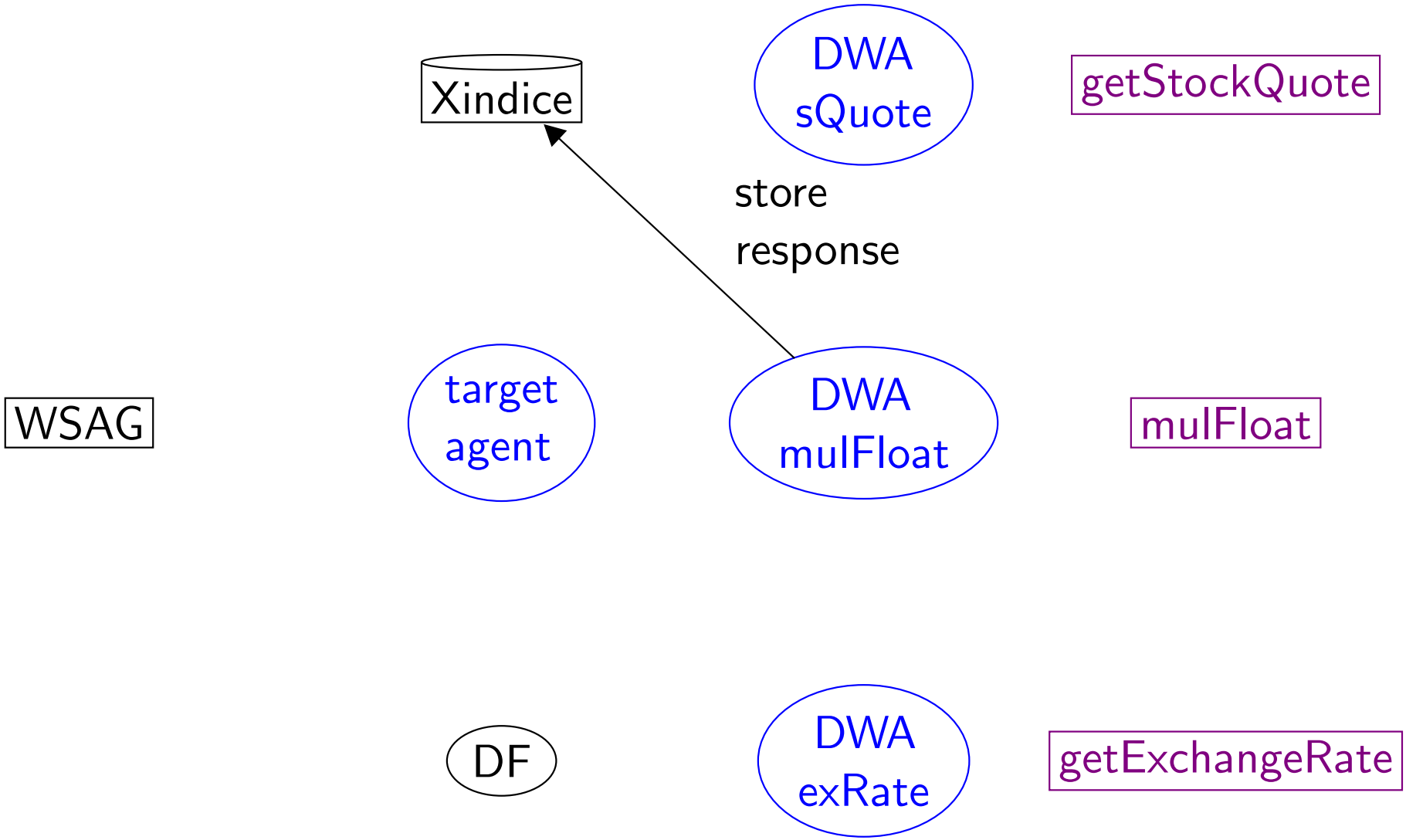

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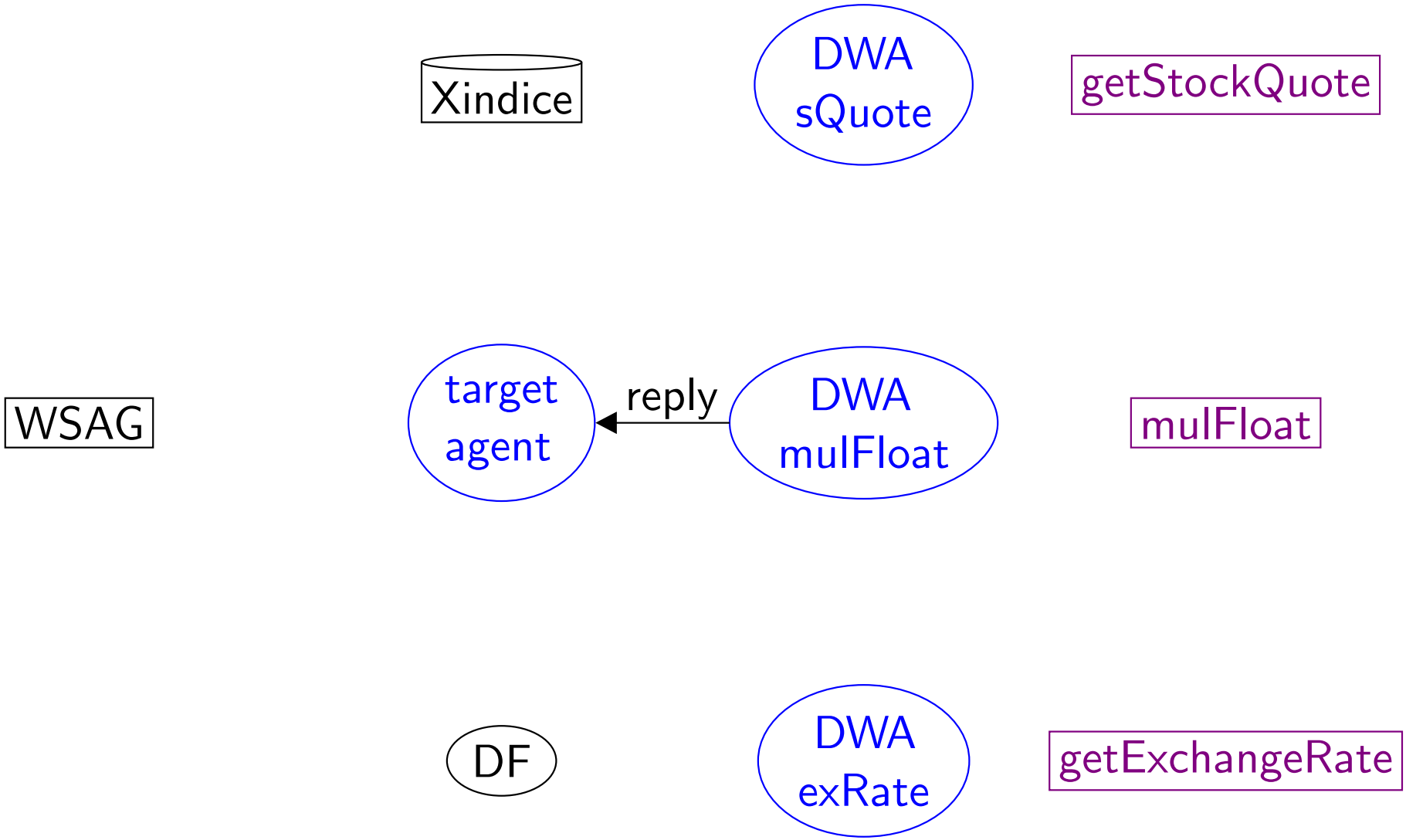

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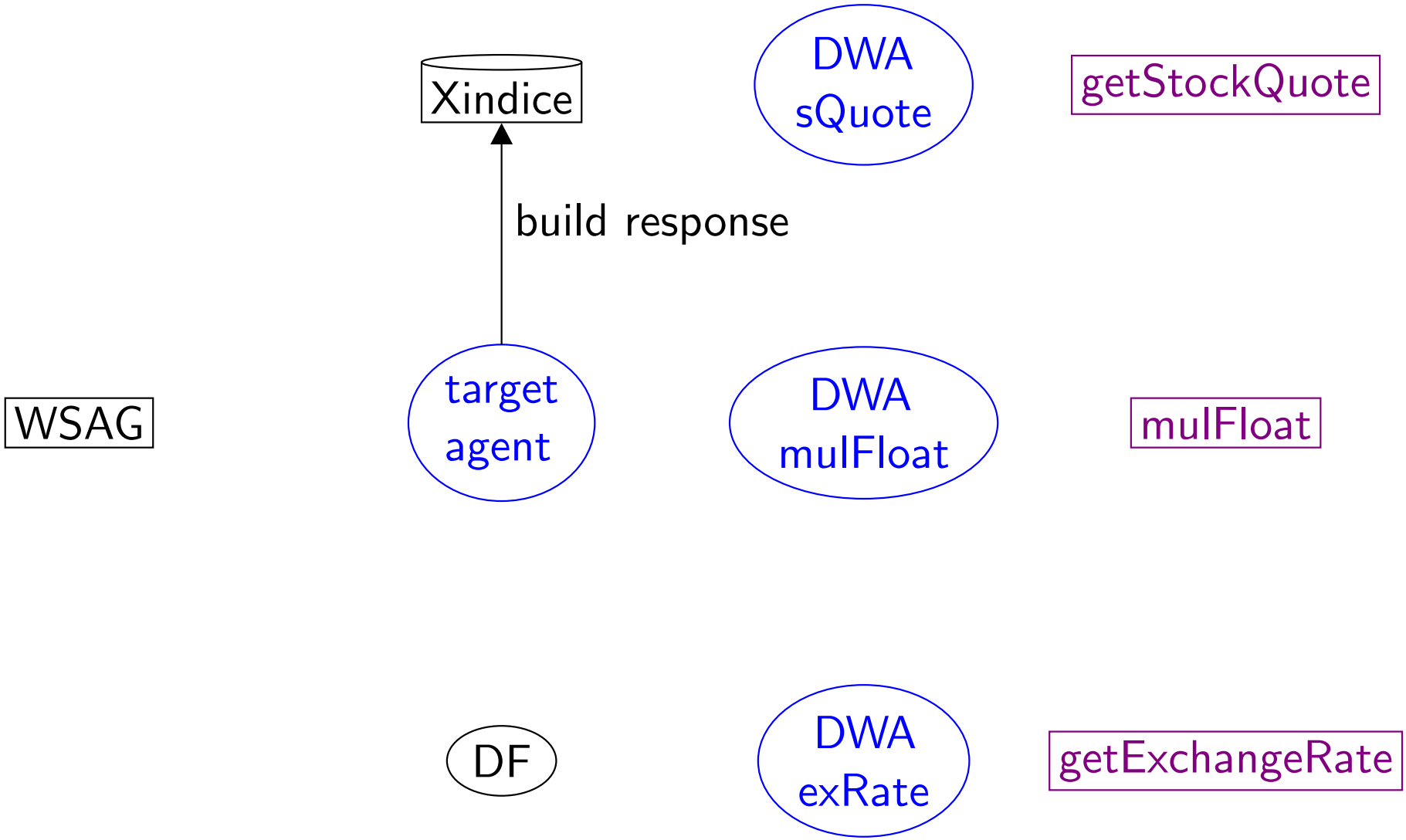

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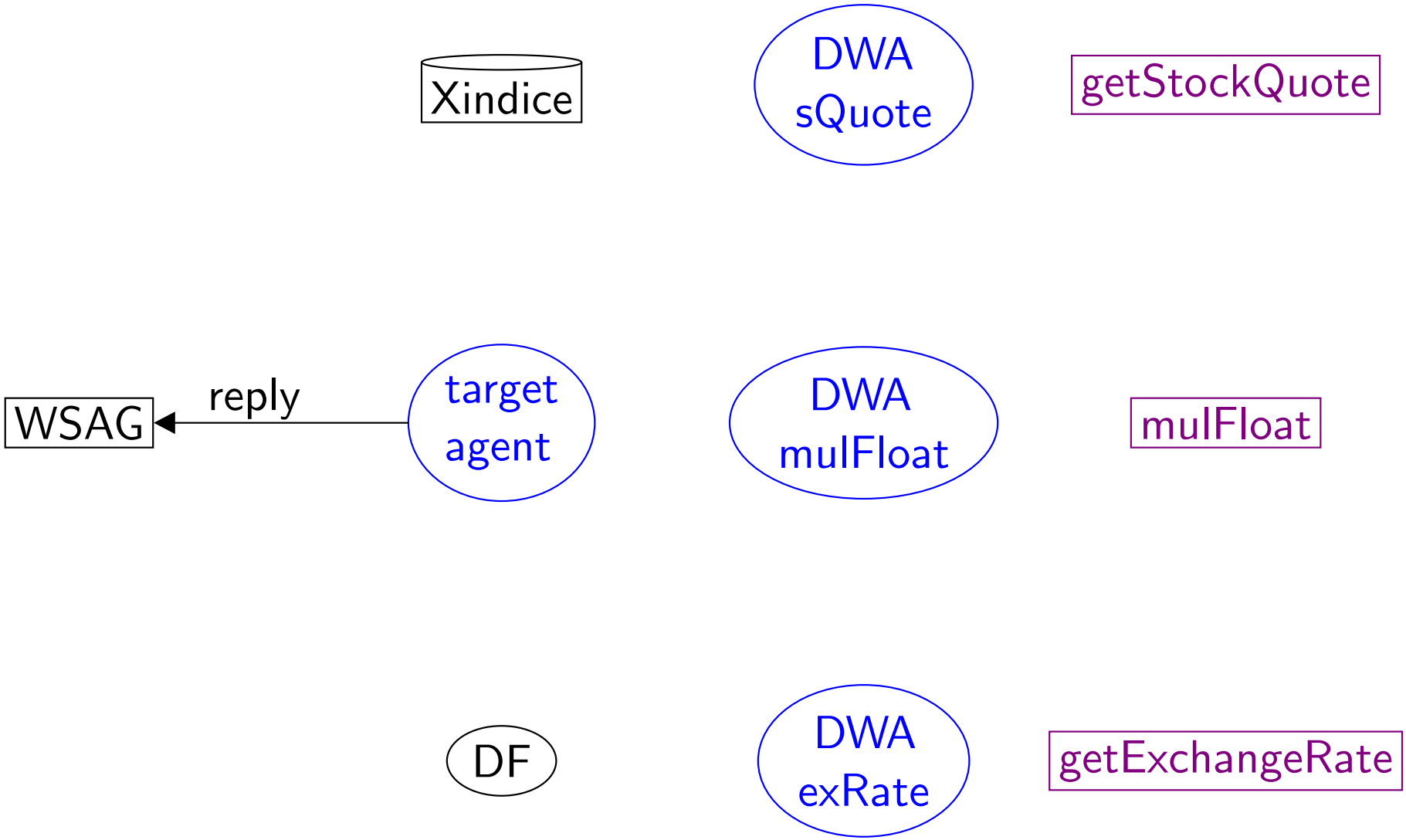

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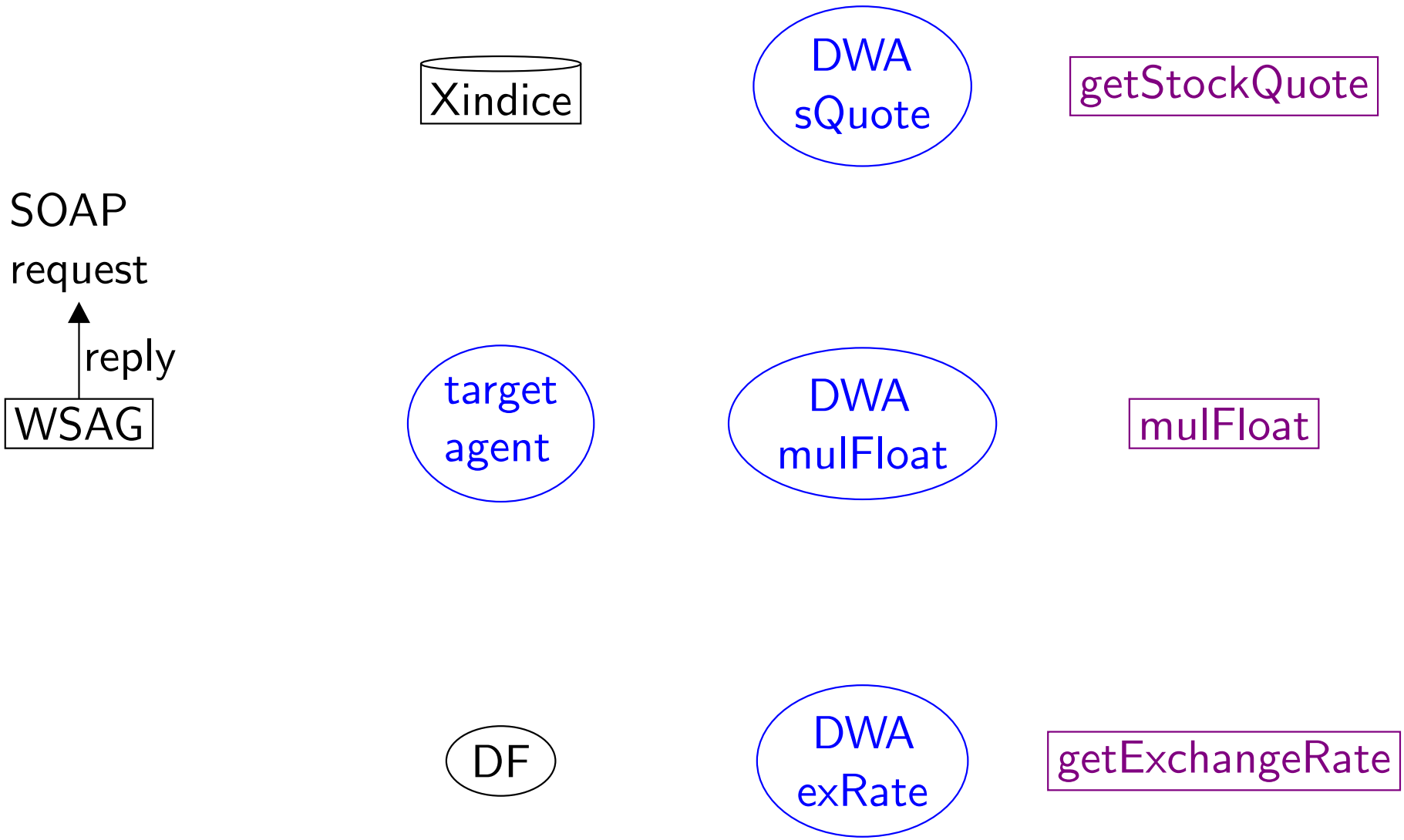

Lessons Learned

- It is possible and practical to use Web services as external behaviors, allowing for generic agent code.
- Not unmarshalling SOAP responses insulates code from differences in RPC versus DOC SOAP styles.
  - XML database is natural.
  - Allows for fully stubless dynamic invocation as no class is required to hold unmarshalled response.
  - Preserves namespace information which in the future will likely have semantic importance.
- DF useful for dynamic allocation.
- Hybrid coordination model proved to be flexible.
- WSAG allows WS clients to interact with the MAS transparently and enables MAS to be used as a sub-process within another workflow enacted by a commercial workflow engine.

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Future Work

- Implement `switch` and `pick` BPEL4WS constructs.
- Aggressive dynamic allocation.
- Integrate with Semantic Discovery Services.
- Workflow as skeletons for adaptive multiagent systems?