XRPC: Interoperable and Efficient Distributed XQuery

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Peter Boncz

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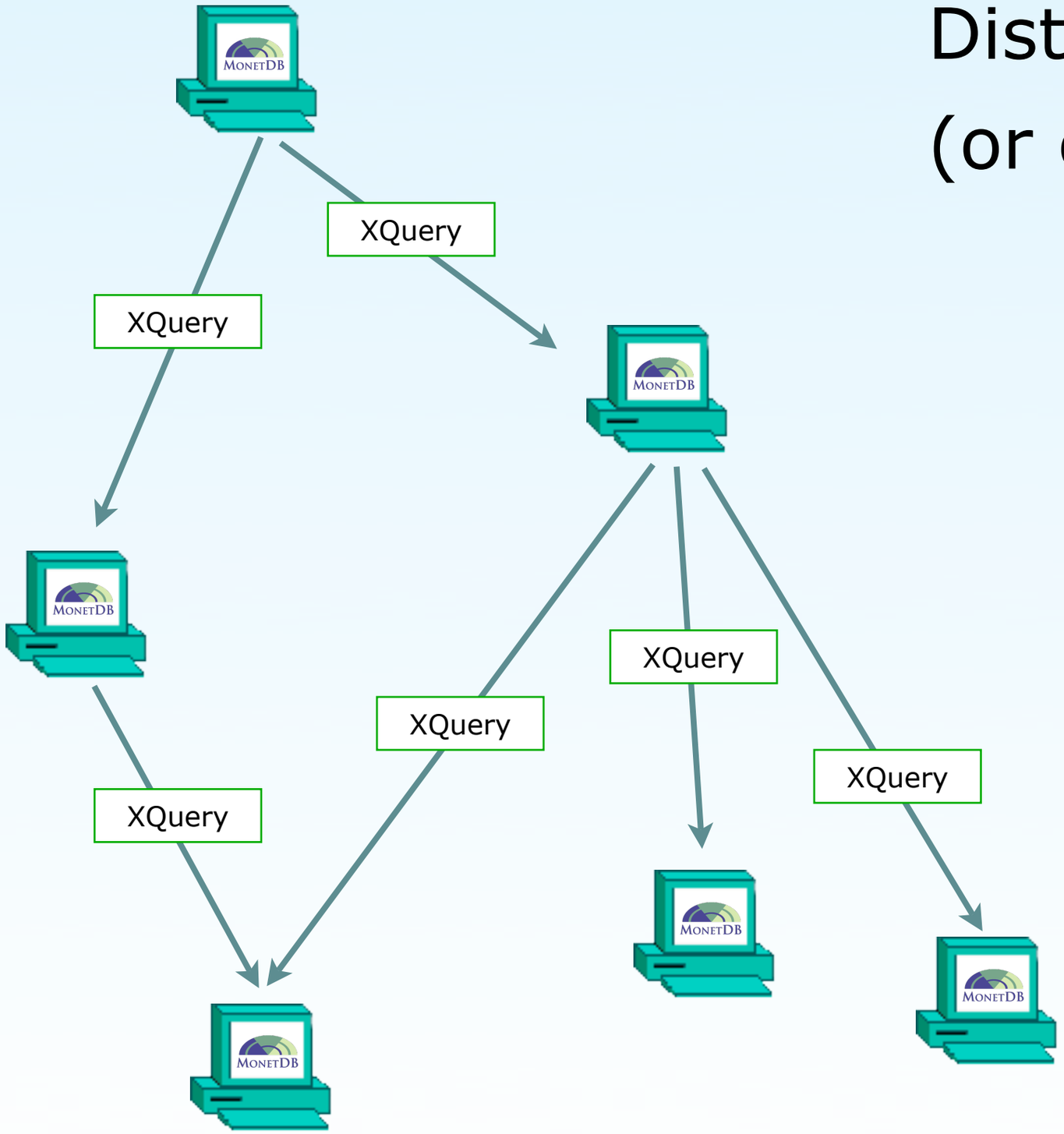
Goals of XRPC



Distributed XQuery

(or even P2P)

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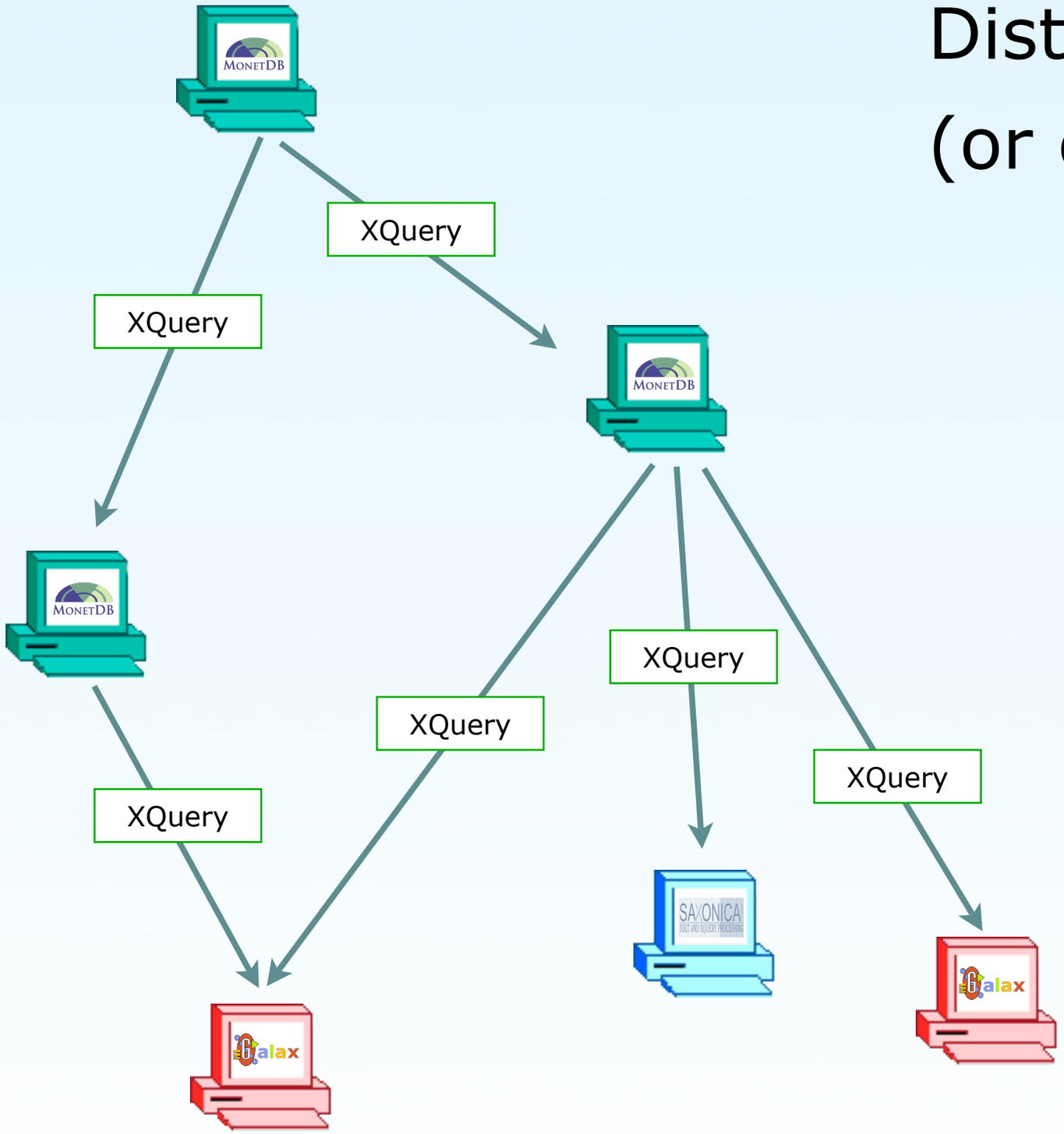


Distributed XQuery

(or even P2P)

Design Goals

- Orthogonal
  - All XQuery semantics, typing and validation
  - also including XQuery Update Facility
- Interoperable
  - Network-layer specification!
    - SOAP-based, of course
- Potential for efficiency
  - Protocol exposes set-at-a-time opportunities
- Keep it simple
  - A minimal extension

XRPC Syntax Extension

`execute at` { *Expr* } { *FunApp(ParamList)* }

XRPC: XQuery + RPC

Distributed XQuery with XRPC: Possibilities

Peer3

for each `person` from `Vienna` in `doc1.xml`
who has bought something (`item`)
from `doc2.xml`
return ... something ...

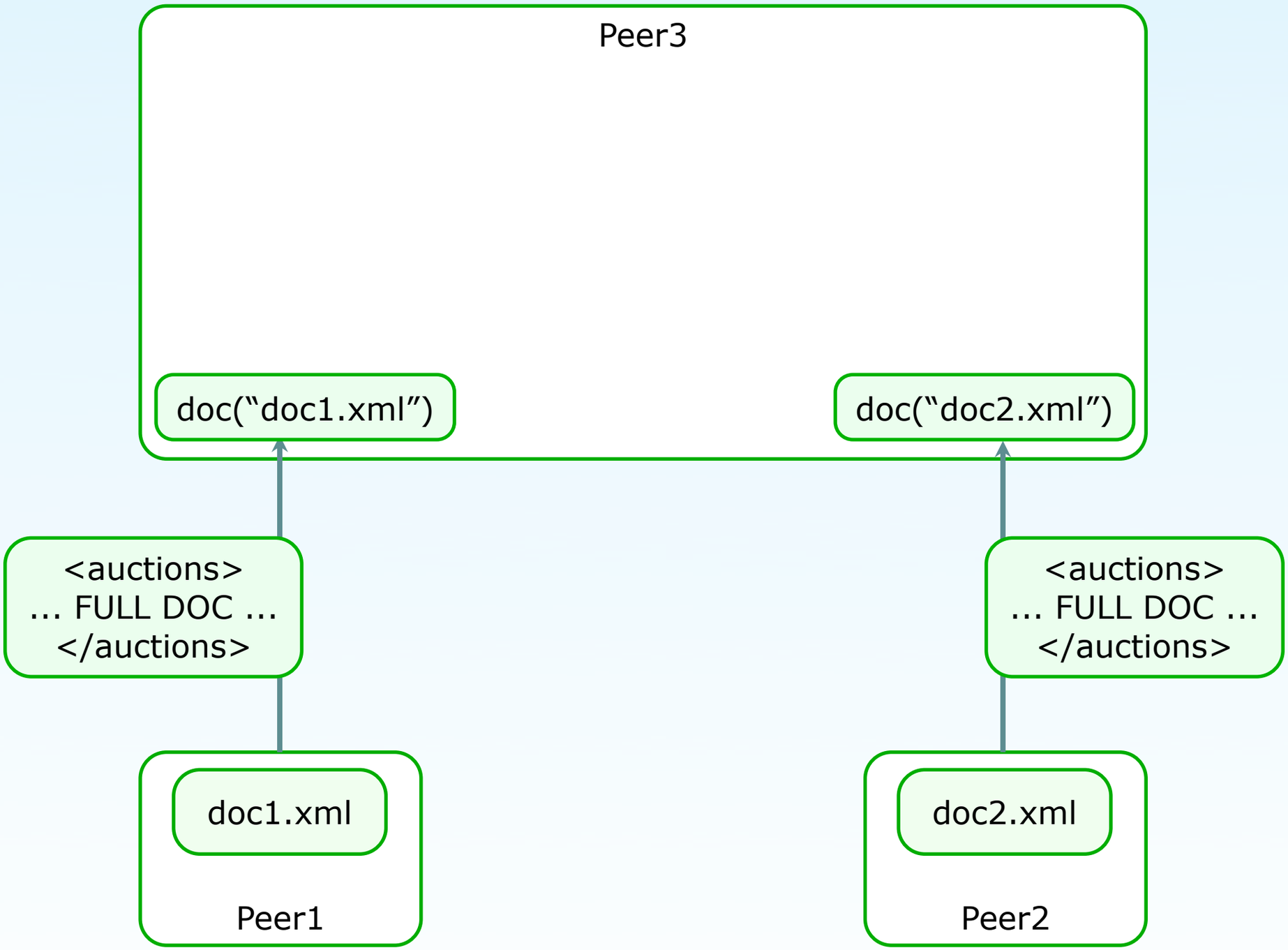
doc1.xml

Peer1

doc2.xml

Peer2

Distributed XQuery with XRPC: Possibilities



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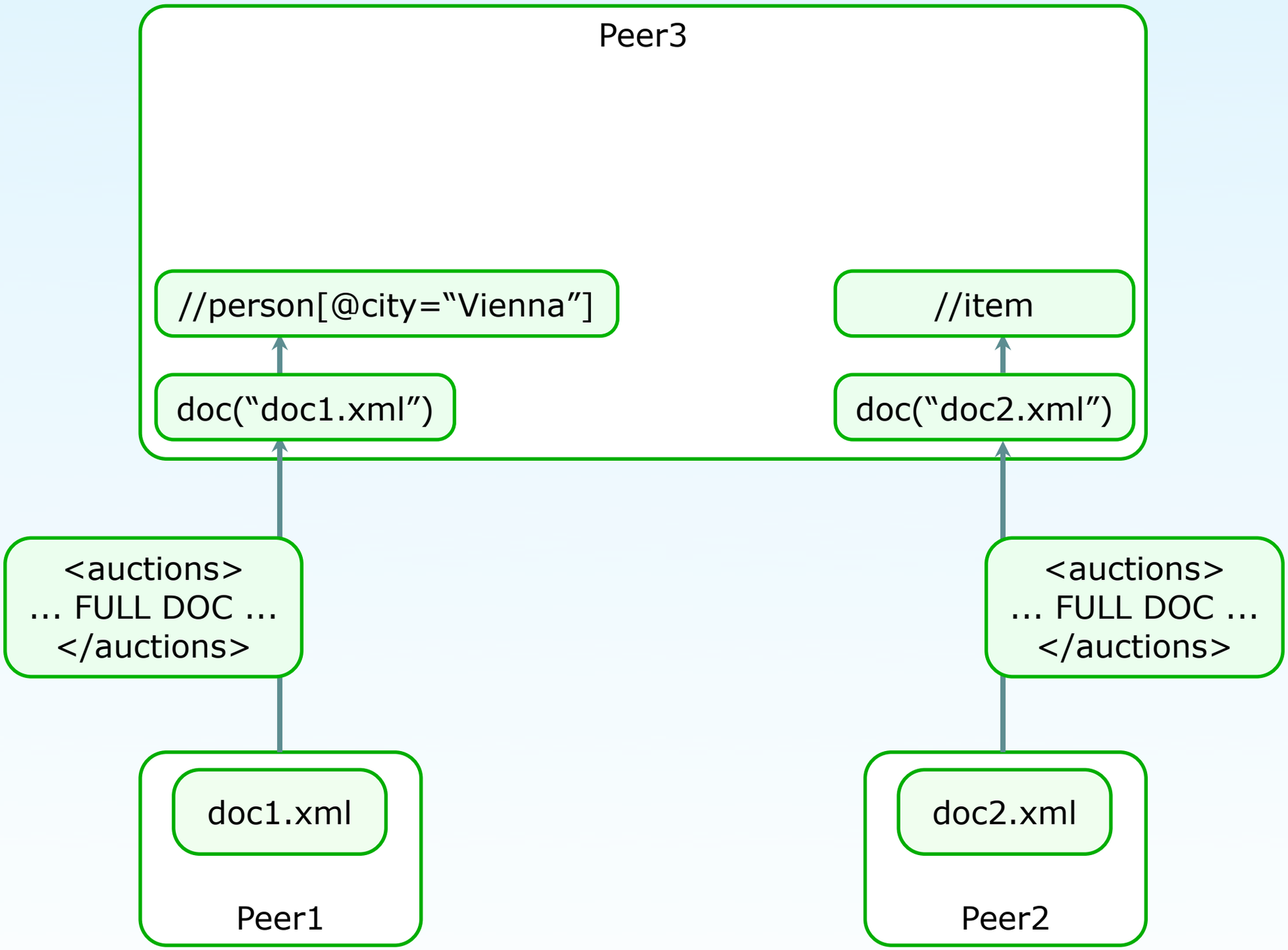

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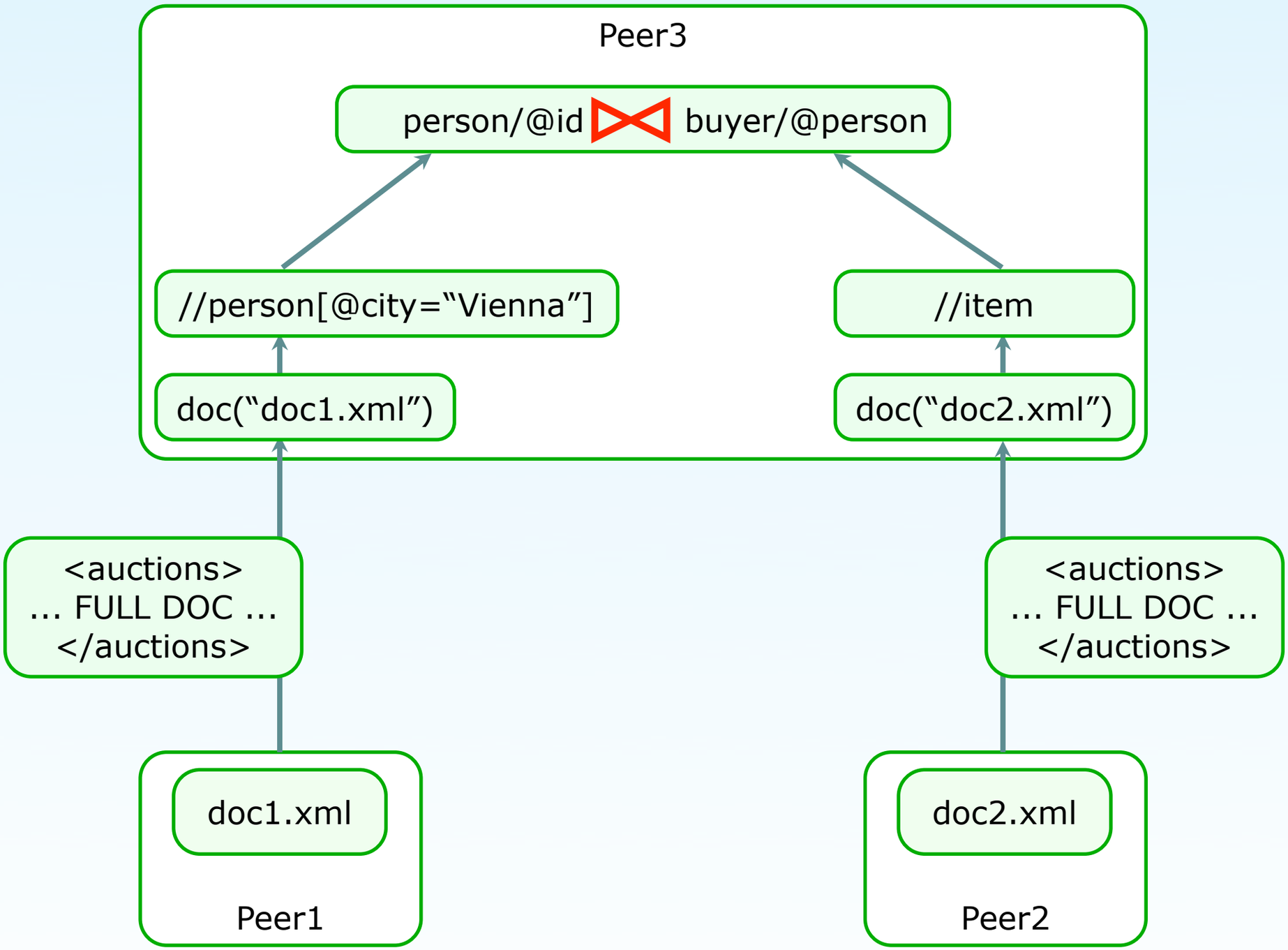

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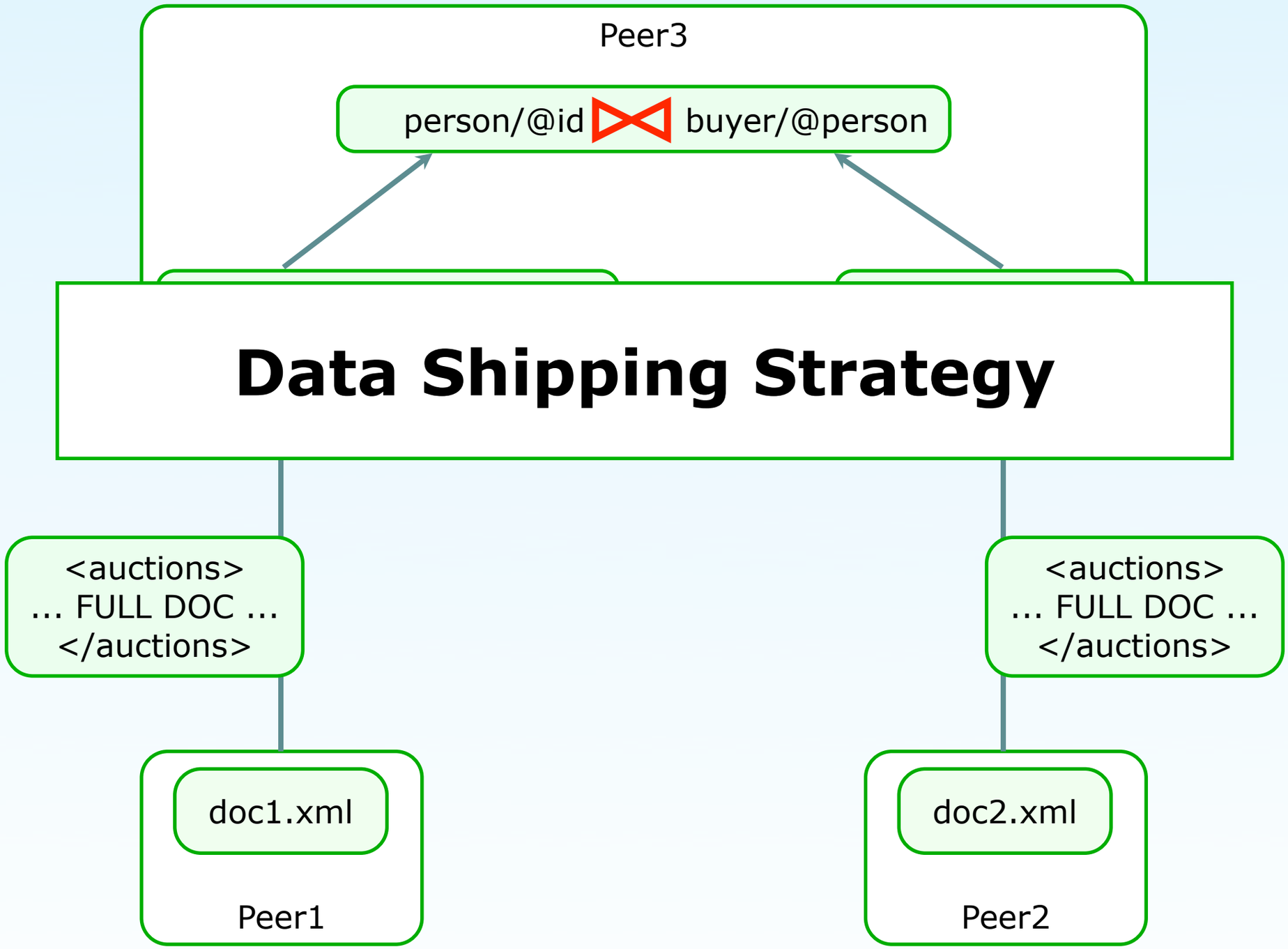

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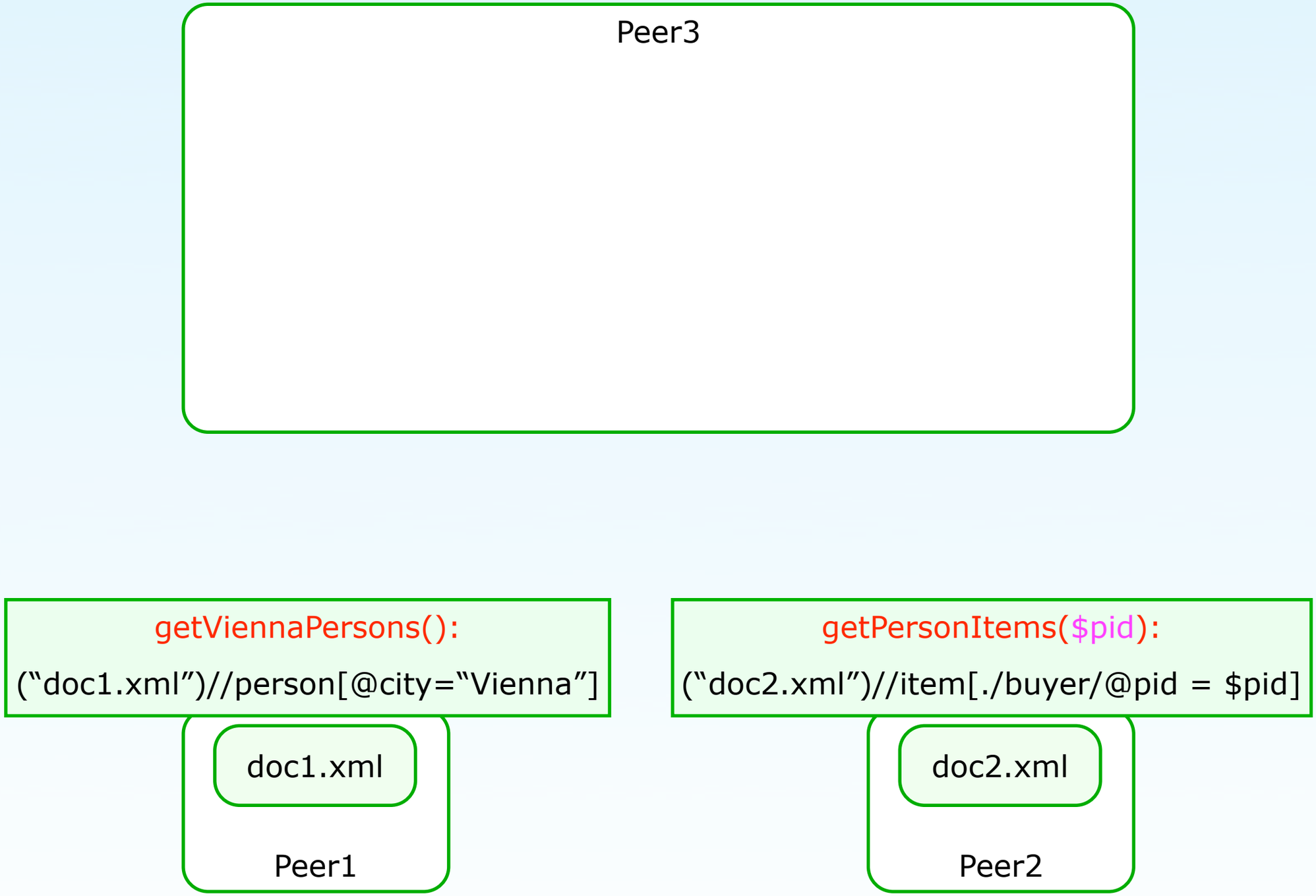

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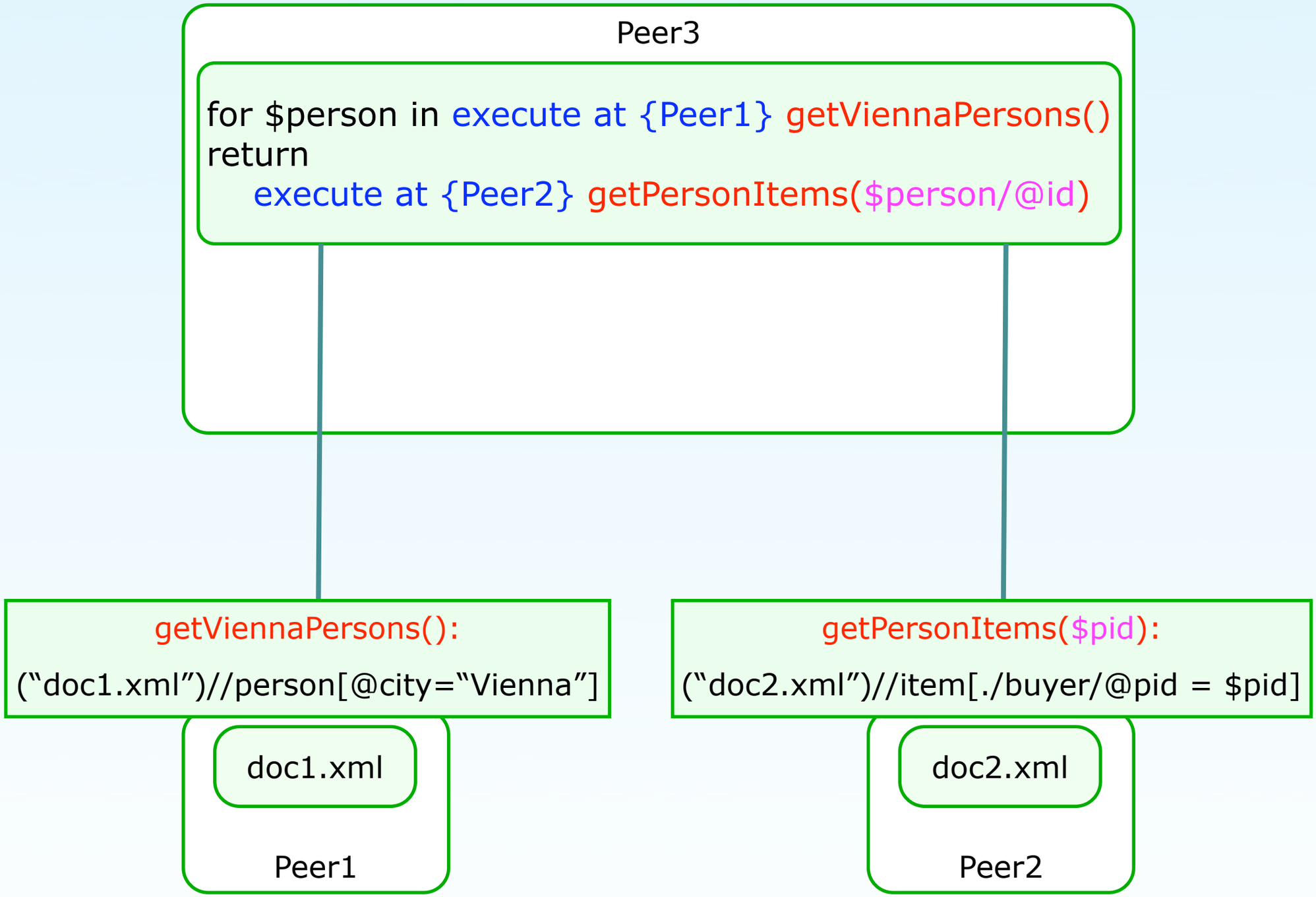

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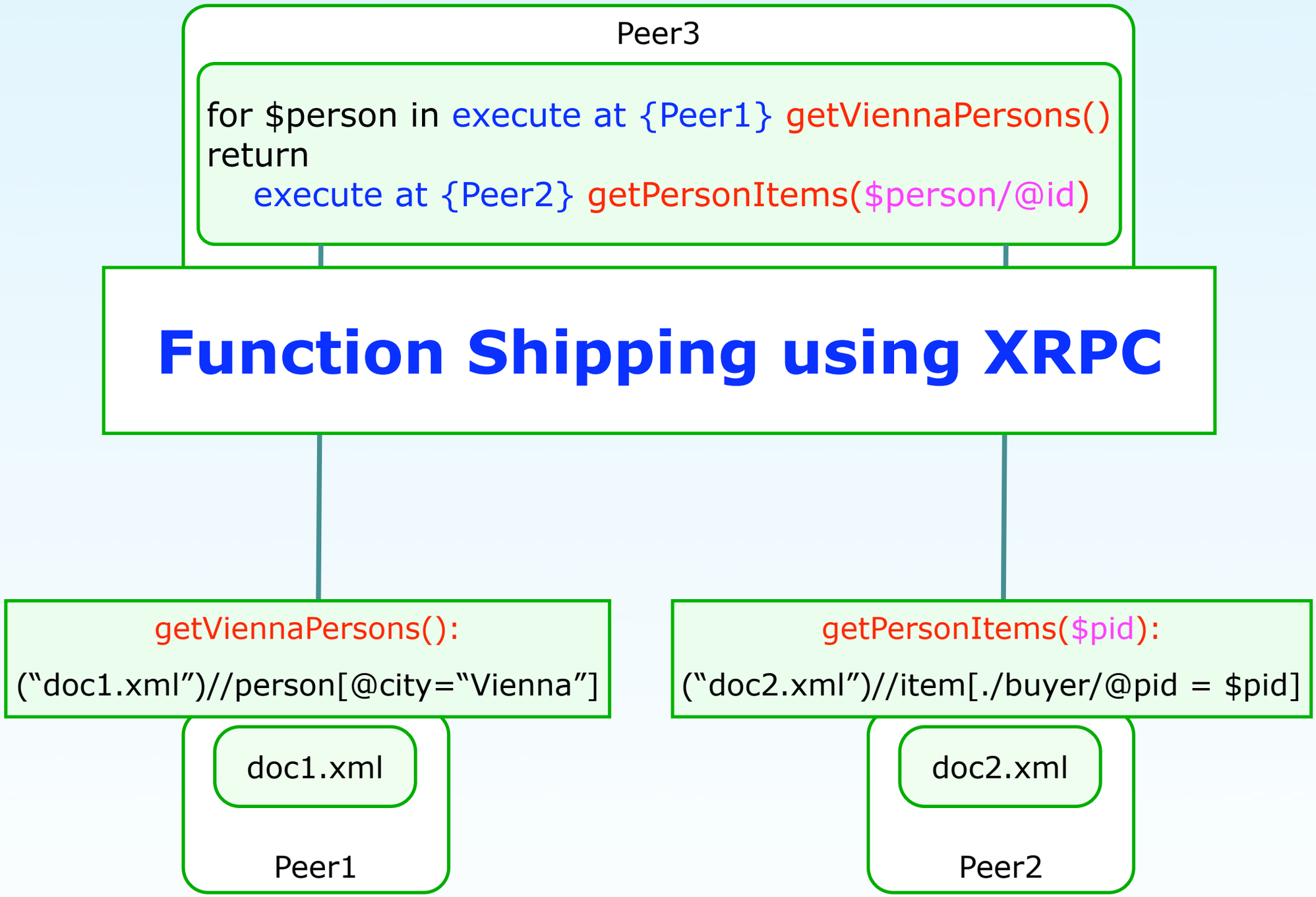

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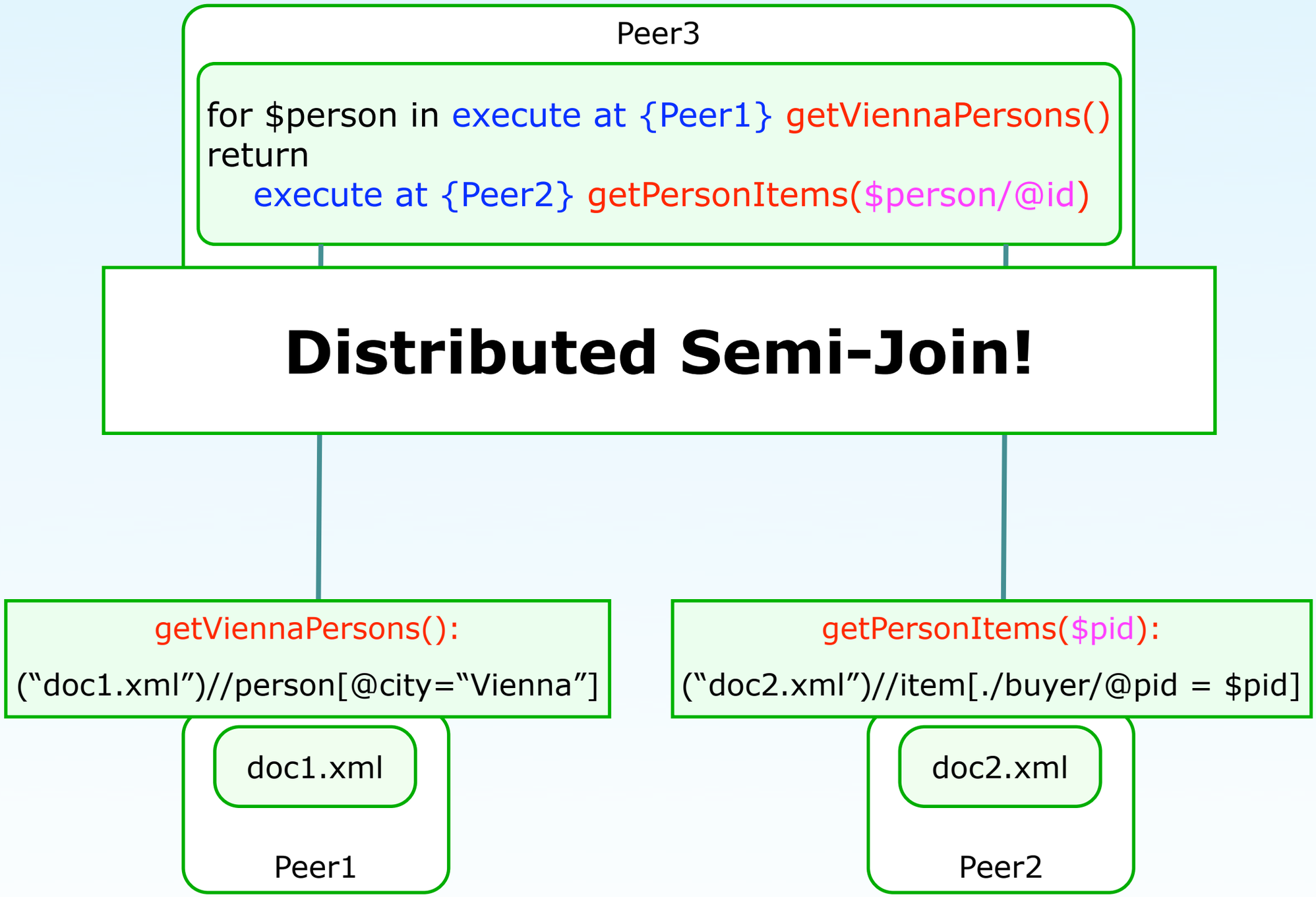


Distributed XQuery with XRPC: Possibilities

Peer3

```
for $person in execute at {Peer1} getViennaPersons()
return
    execute at {Peer2} getPersonItems($person/@id)
```

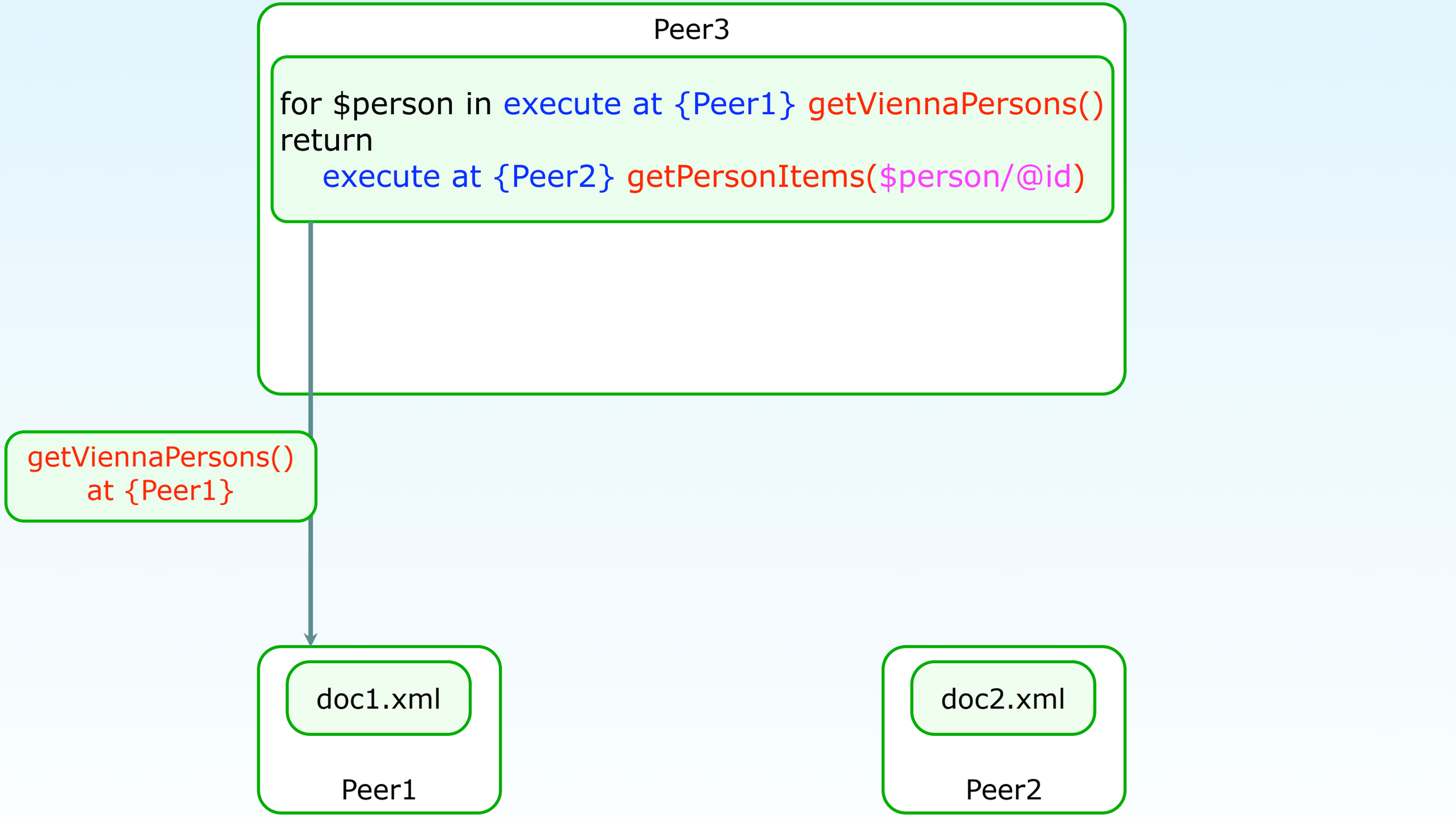
doc1.xml

Peer1

doc2.xml

Peer2

Distributed XQuery with XRPC: Possibilities



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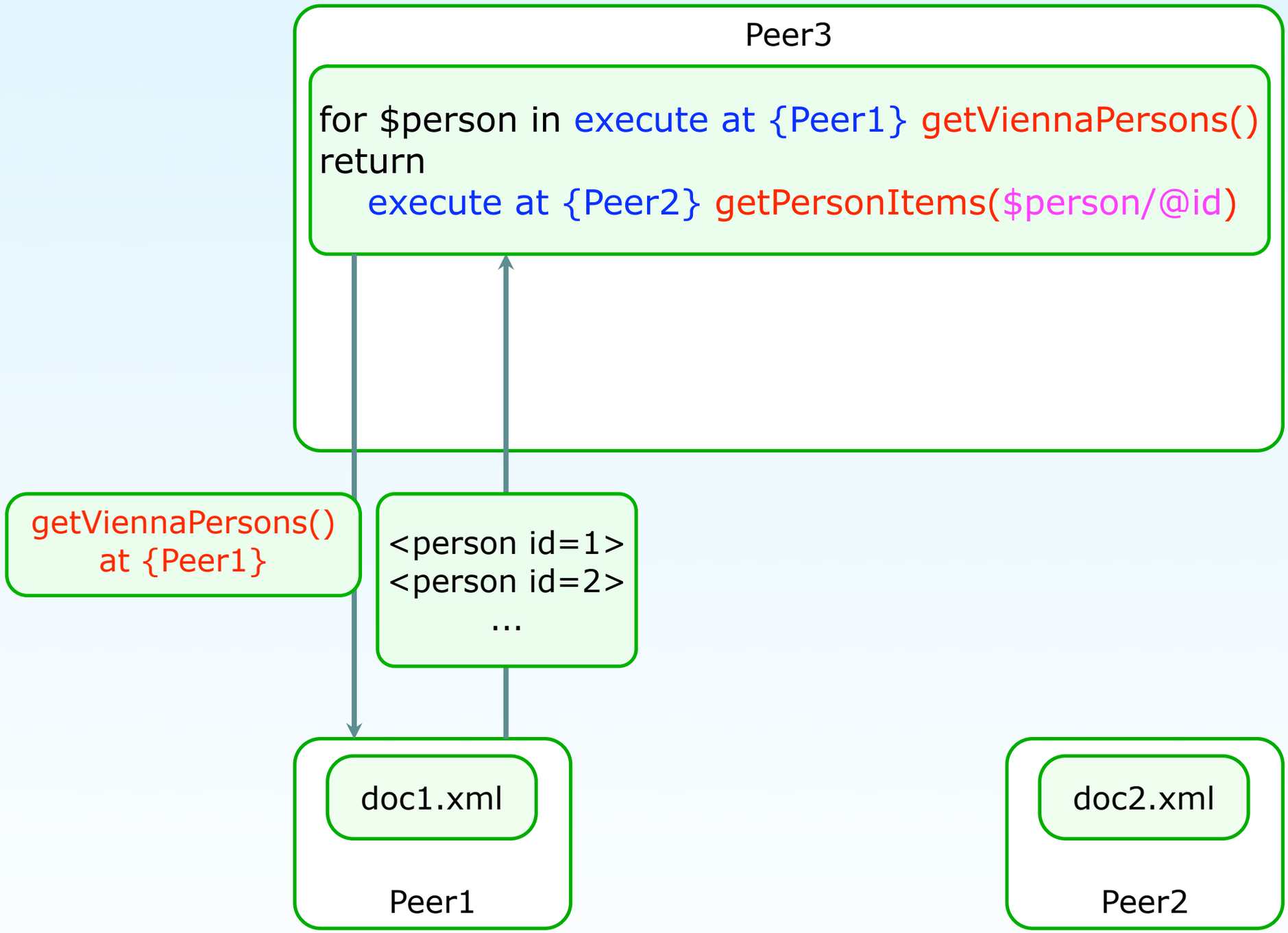

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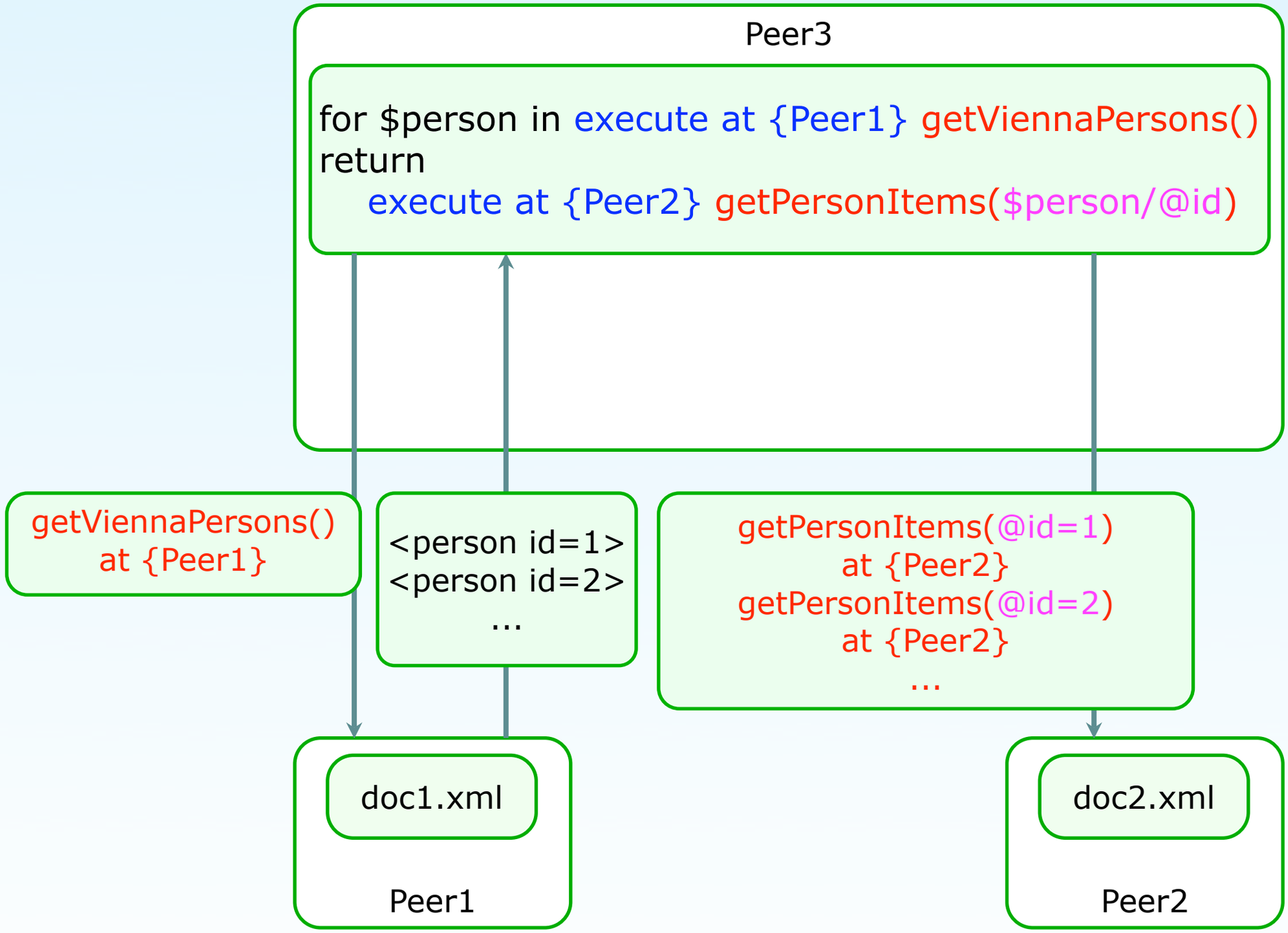

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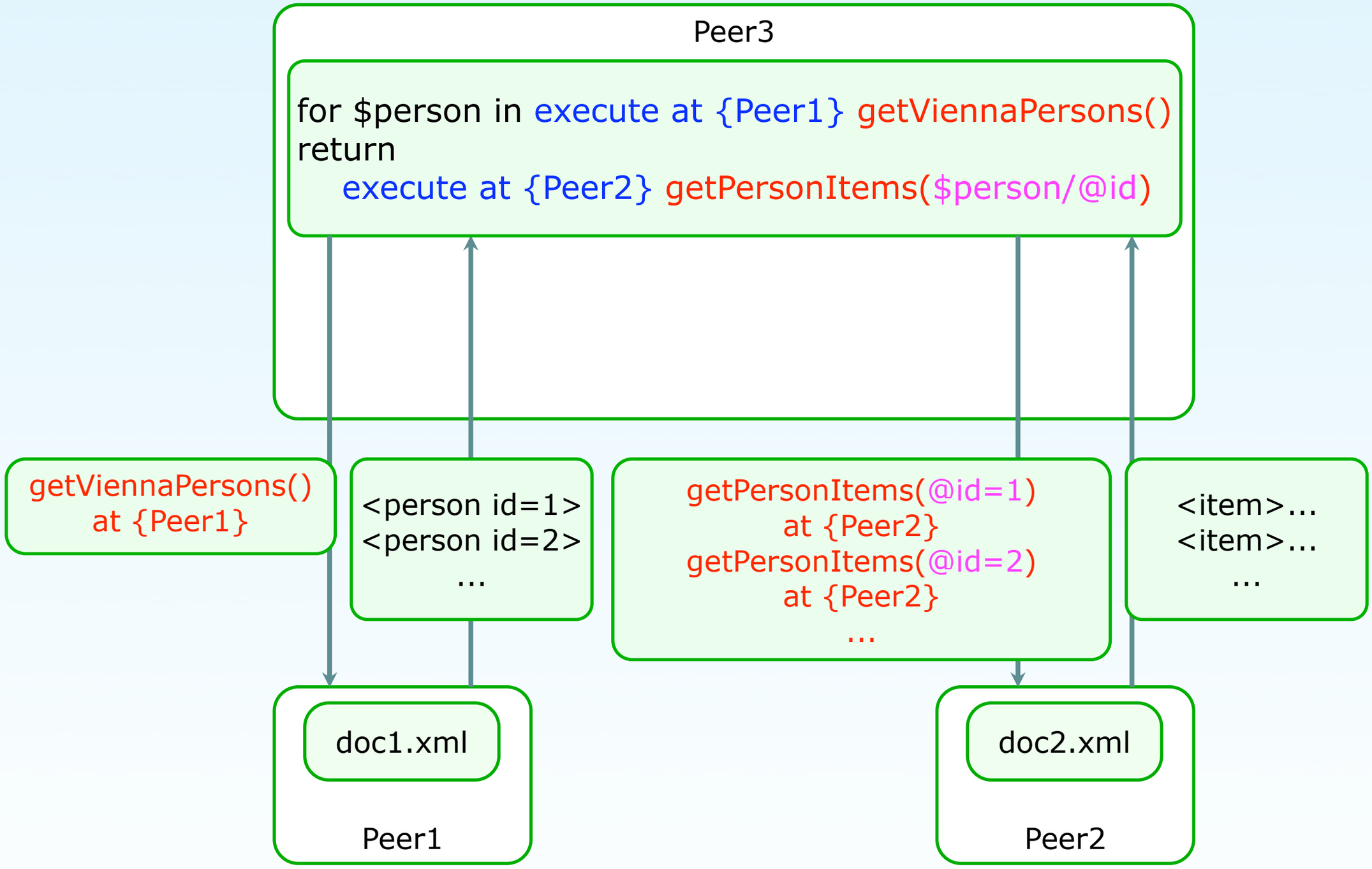

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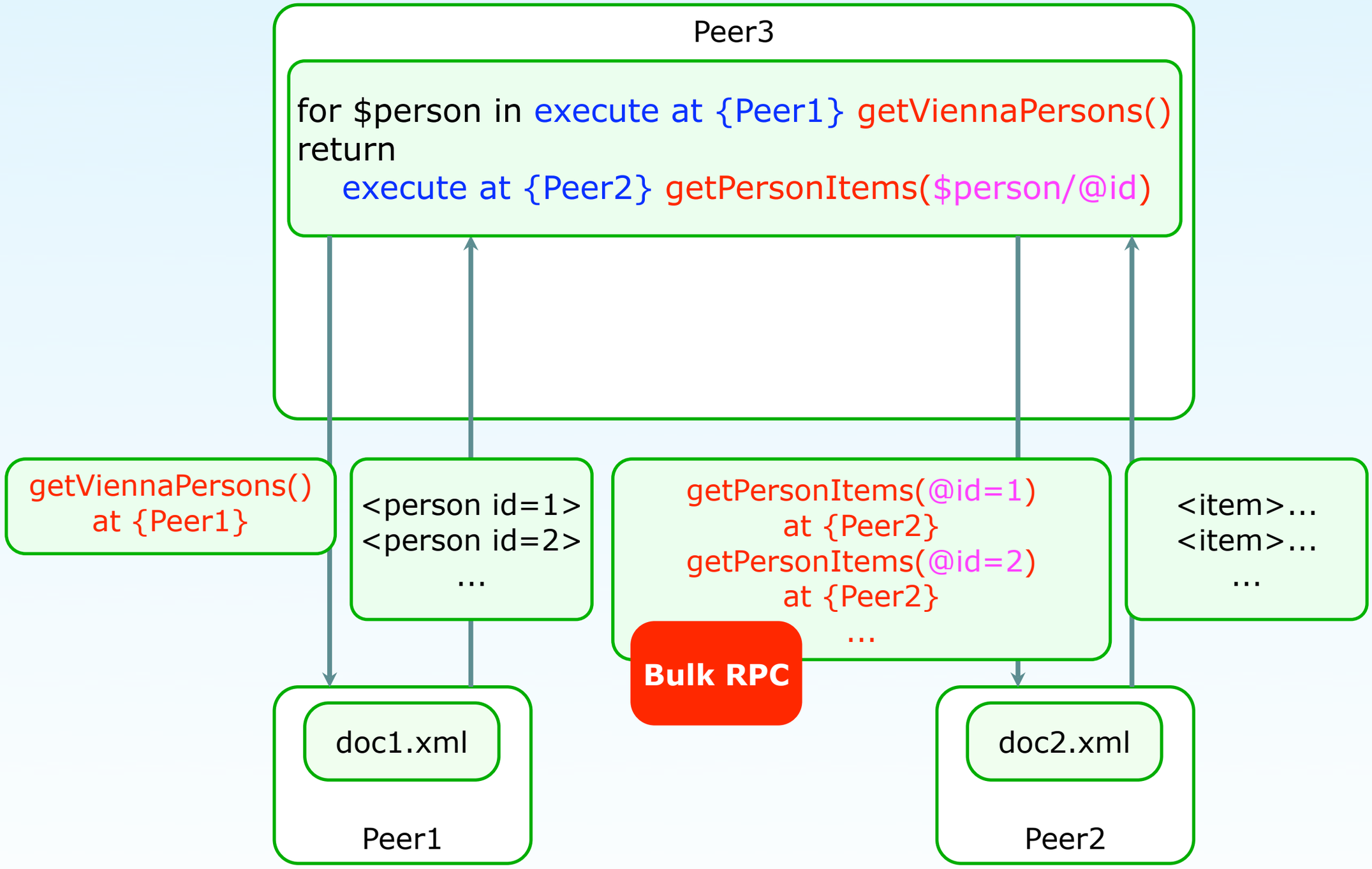

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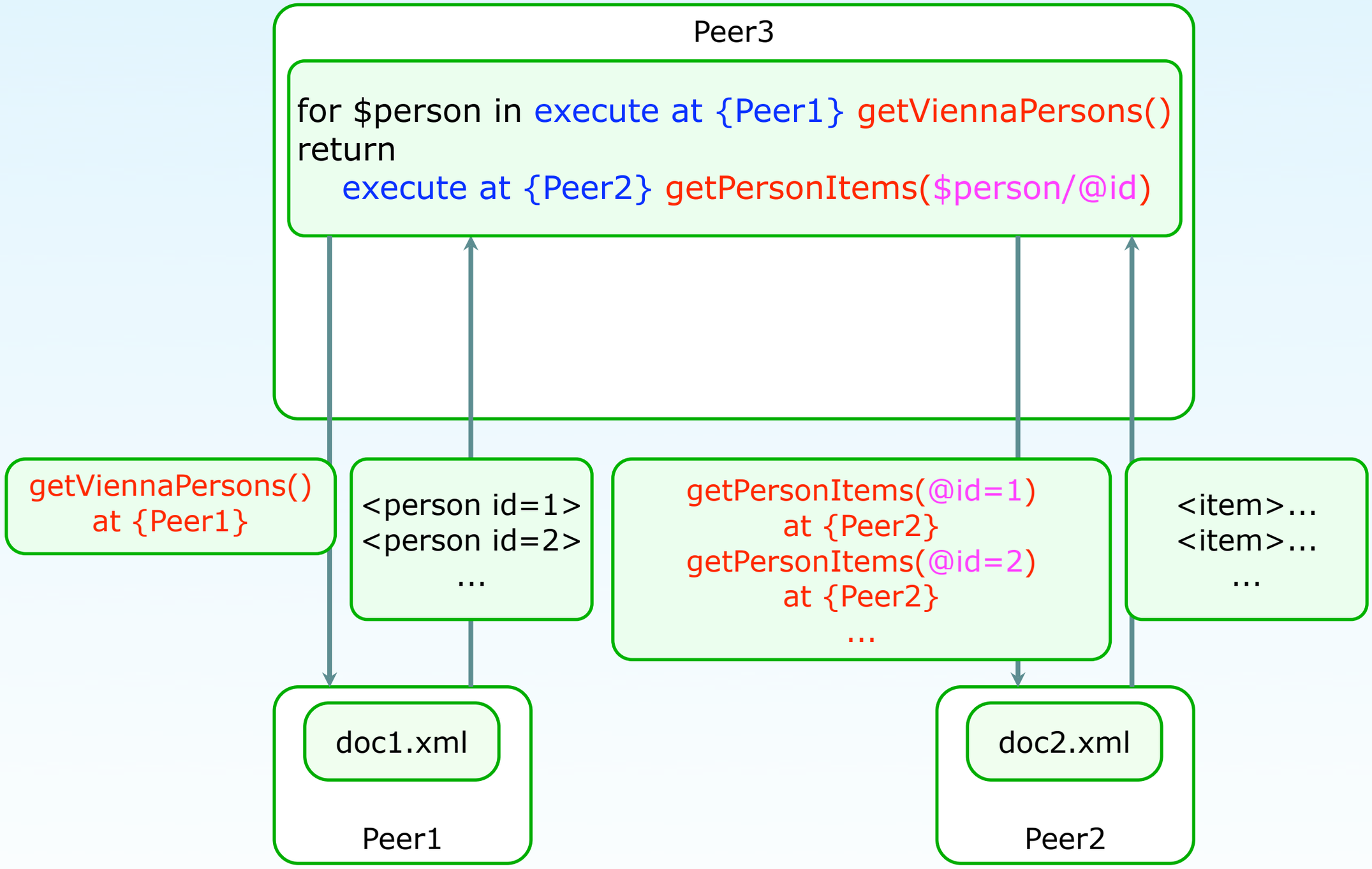

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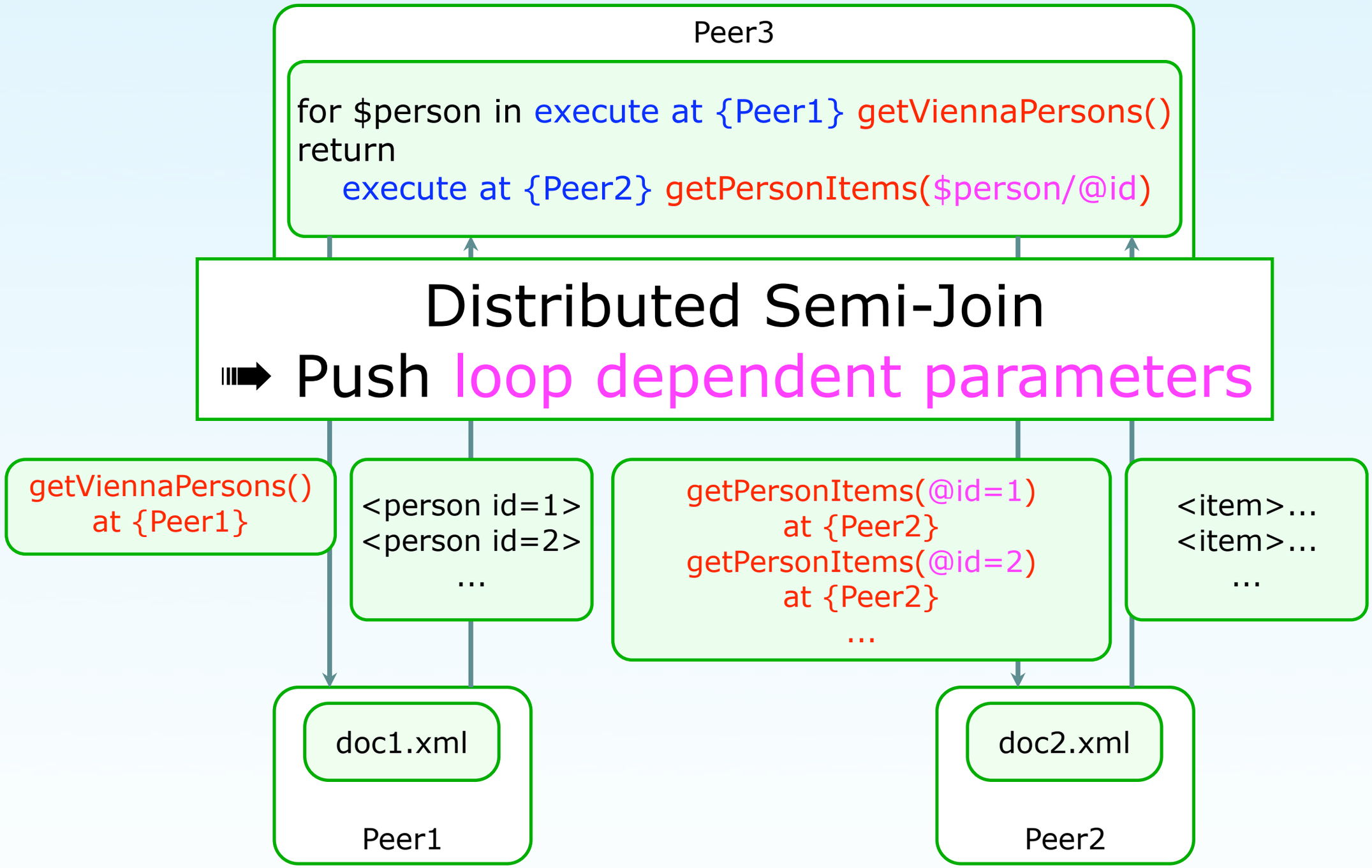

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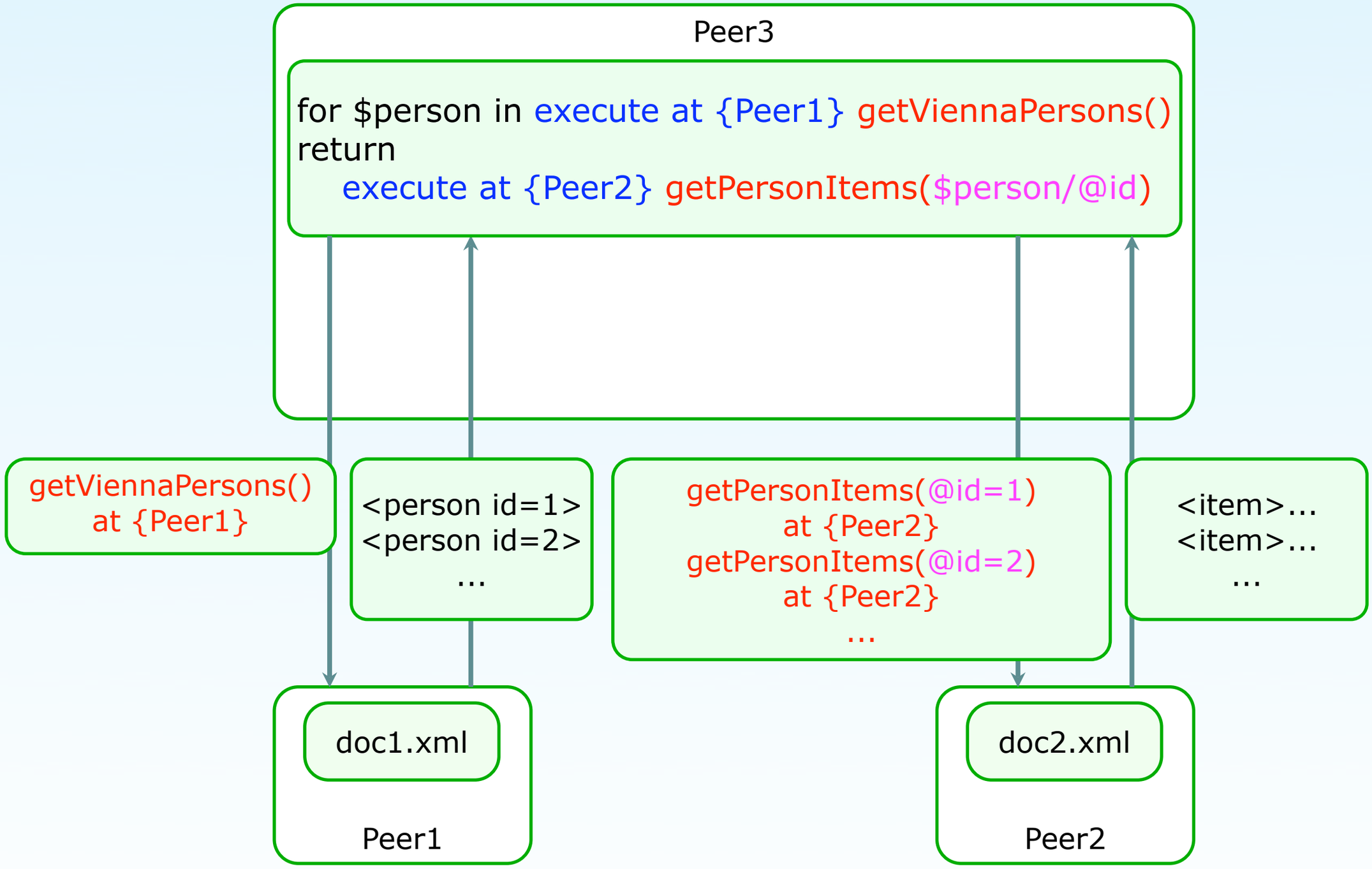

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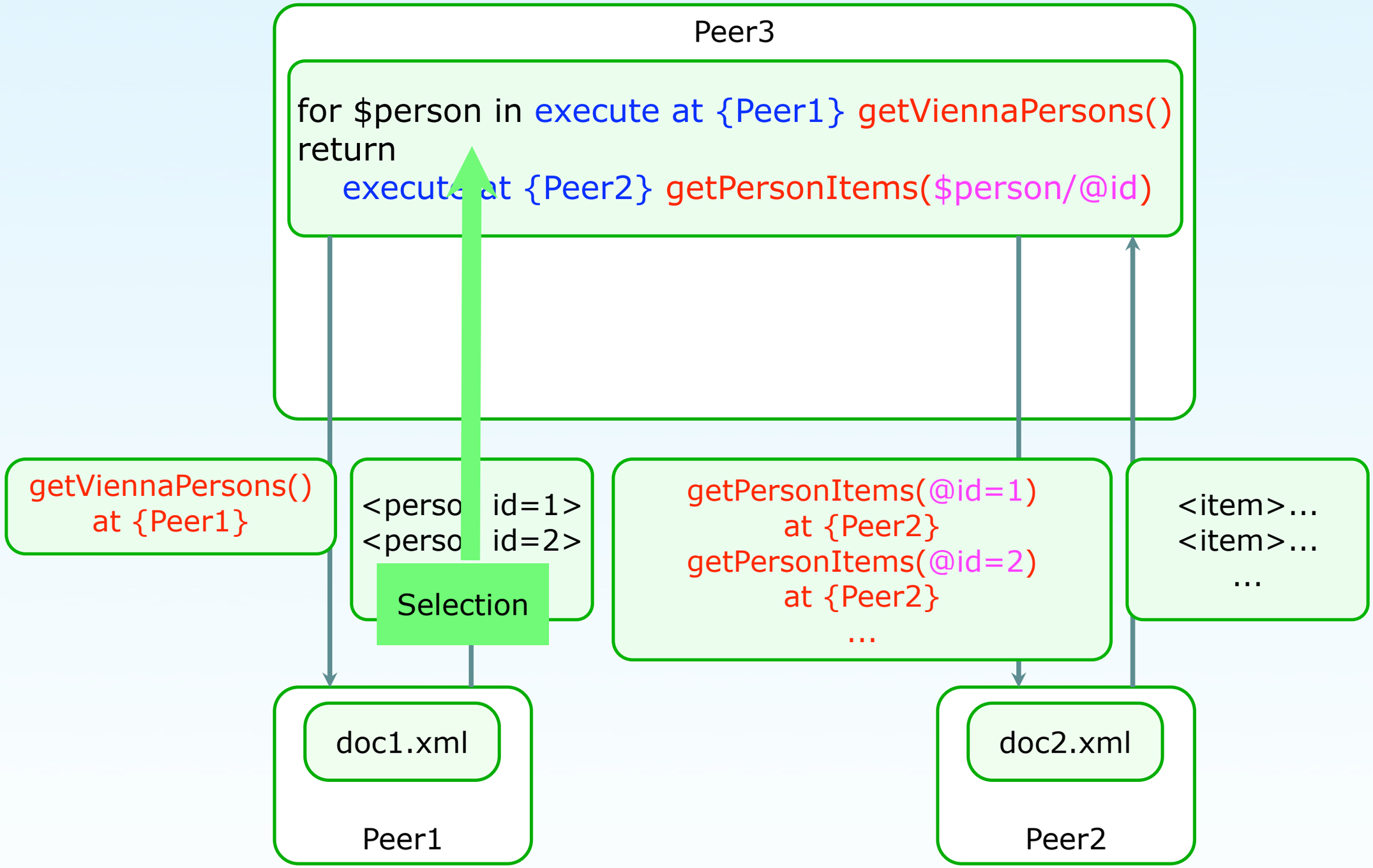

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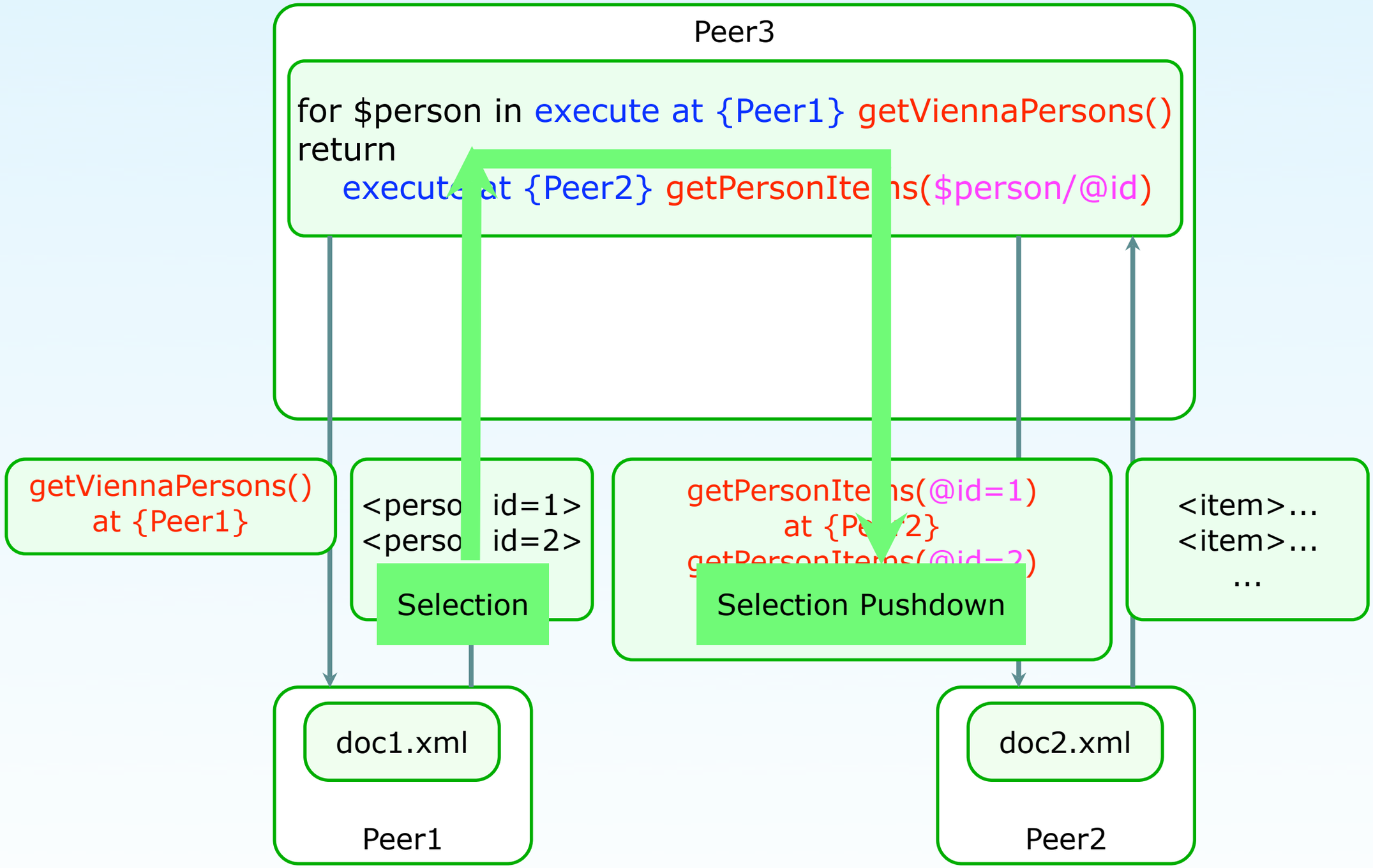

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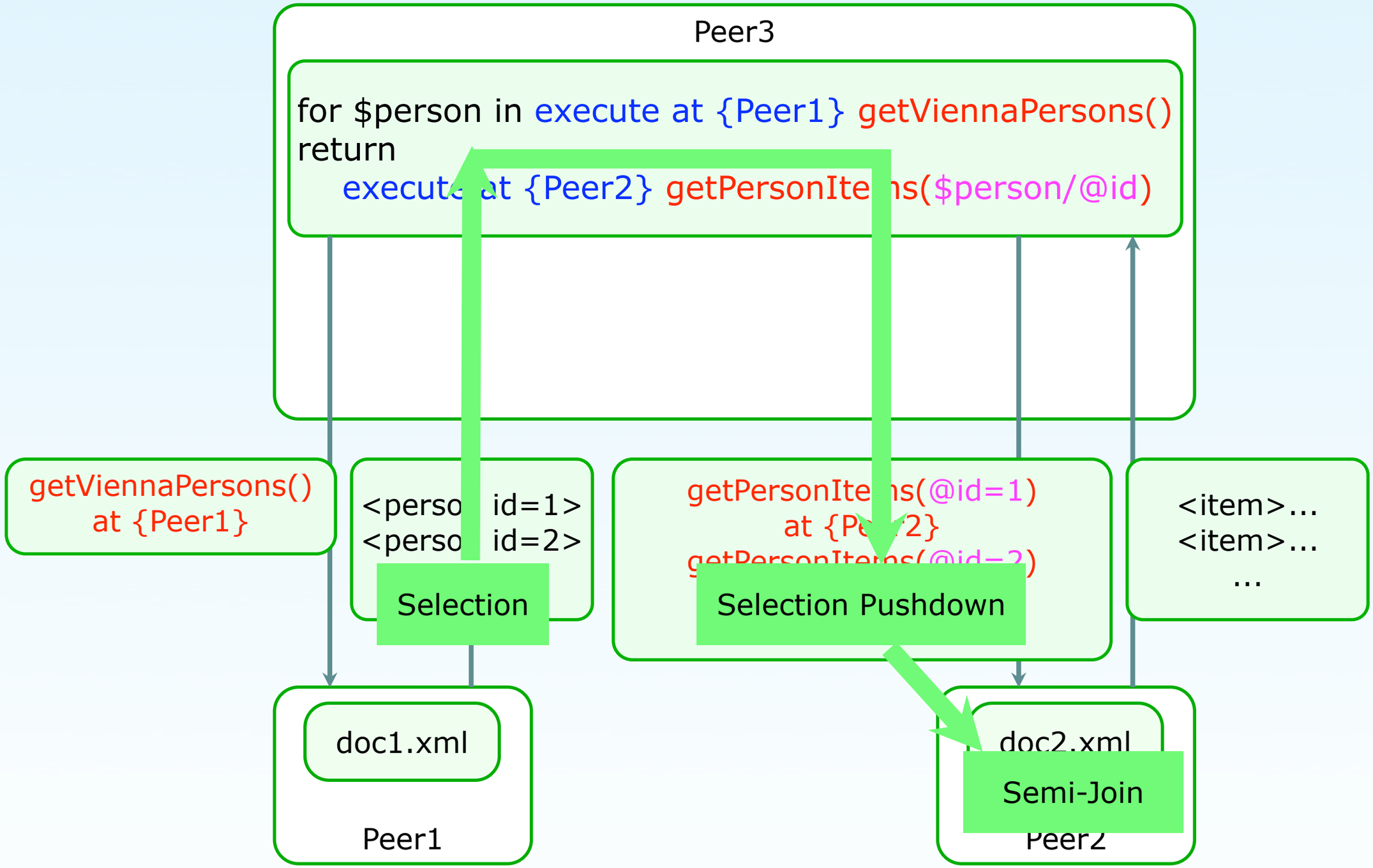

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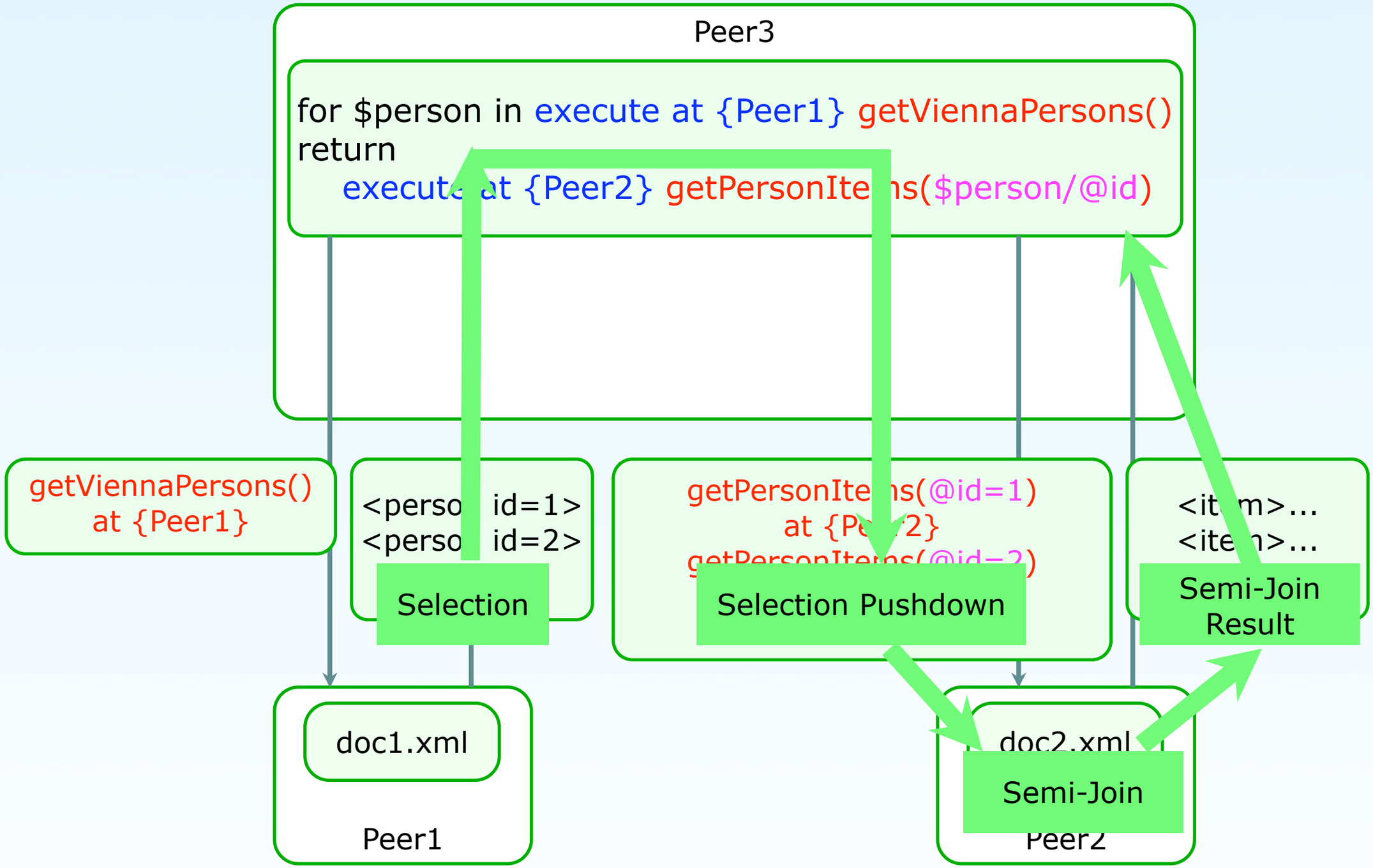

Remote Function Calls

- Functions: unit of distributed execution in XRPC
  - Defined in an XQuery `module`, identified by a URL
- XQuery: a compositional, functional language
  - each sub expression = function of its free variables
  - each function can be executed with XRPC on any peer
- Query decomposition & placement on peers
  - In this paper: by hand
  - Future work: automatic optimizer

The XRPC Network Protocol

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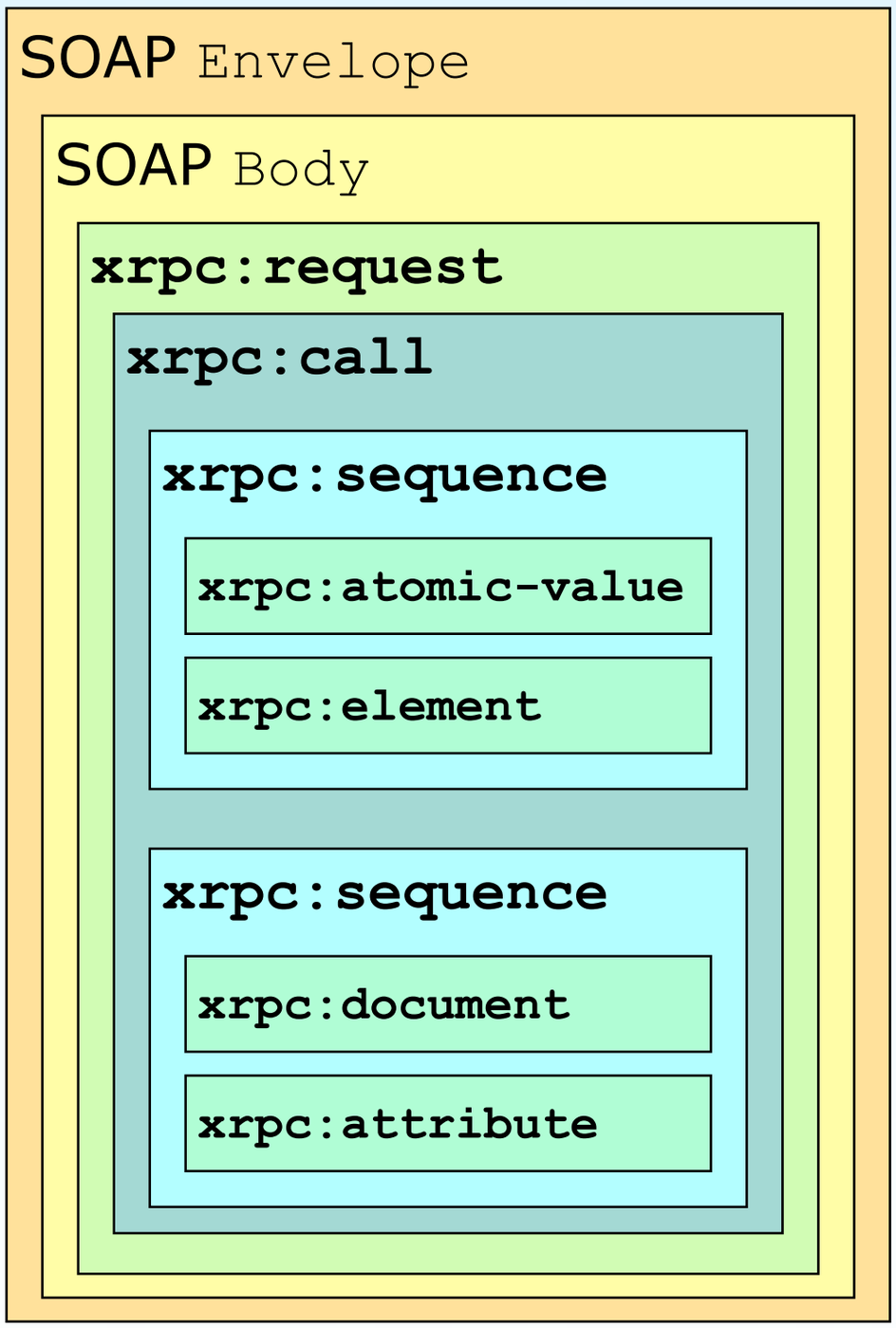

- SOAP XRPC
  - SOAP-based
  - XML over HTTP
- Full support of XDM types
  - All atomic types
  - All nodes types (pass-by-value)
  - User-defined schema types (namespace definition + `xsi:schemaLocation`)
  - Fully validate-able XRPC messages

Distributed Transactions with Isolation

- The basic XRPC protocol is stateless
- Higher level isolation
  - All calls: Repeatable-Reads
  - Updating calls: Distributed 2PC
  - Web Service Transactions Specifications
    - WS-Coordination
    - WS-Atomic Transactions: 2PC

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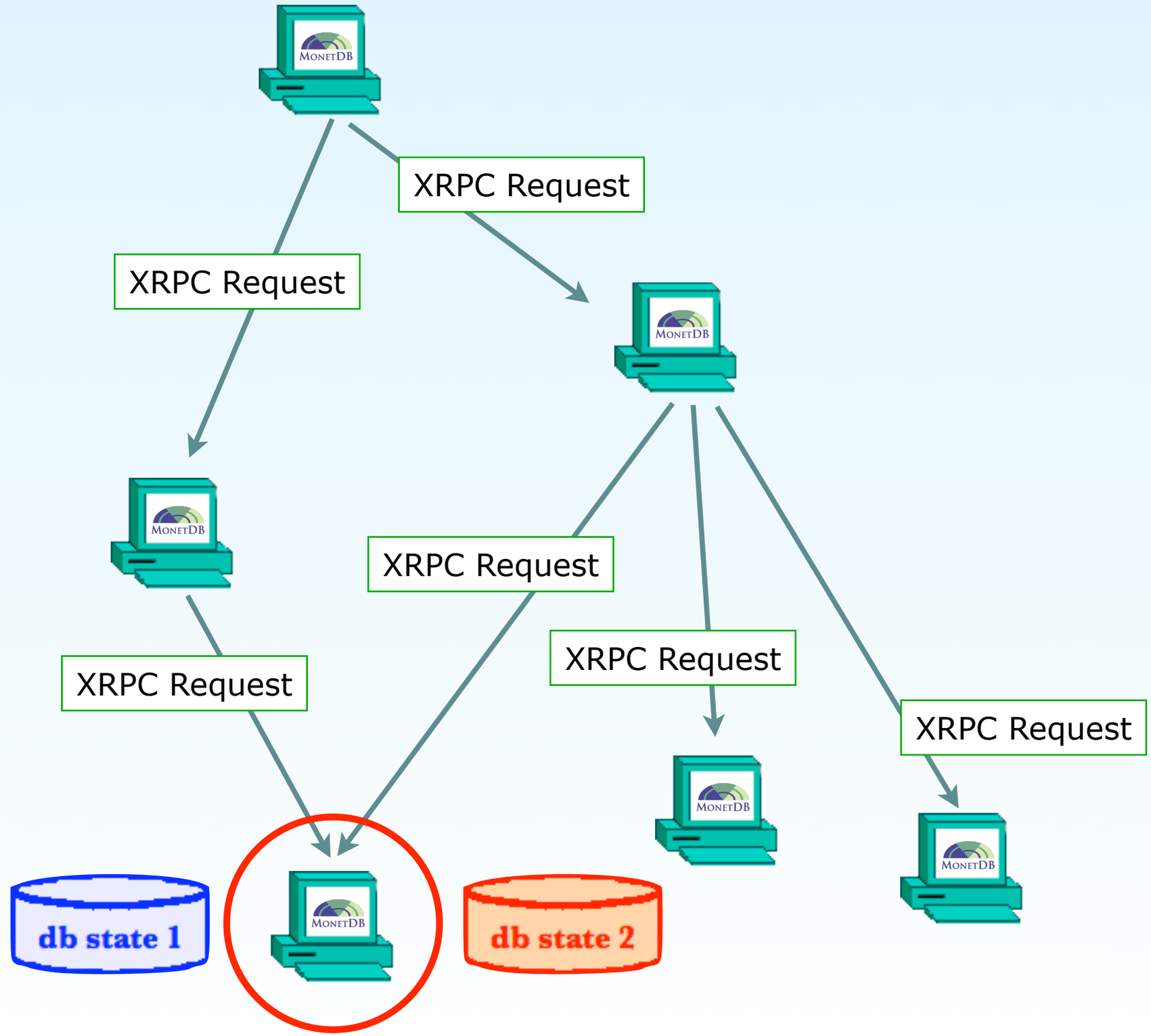

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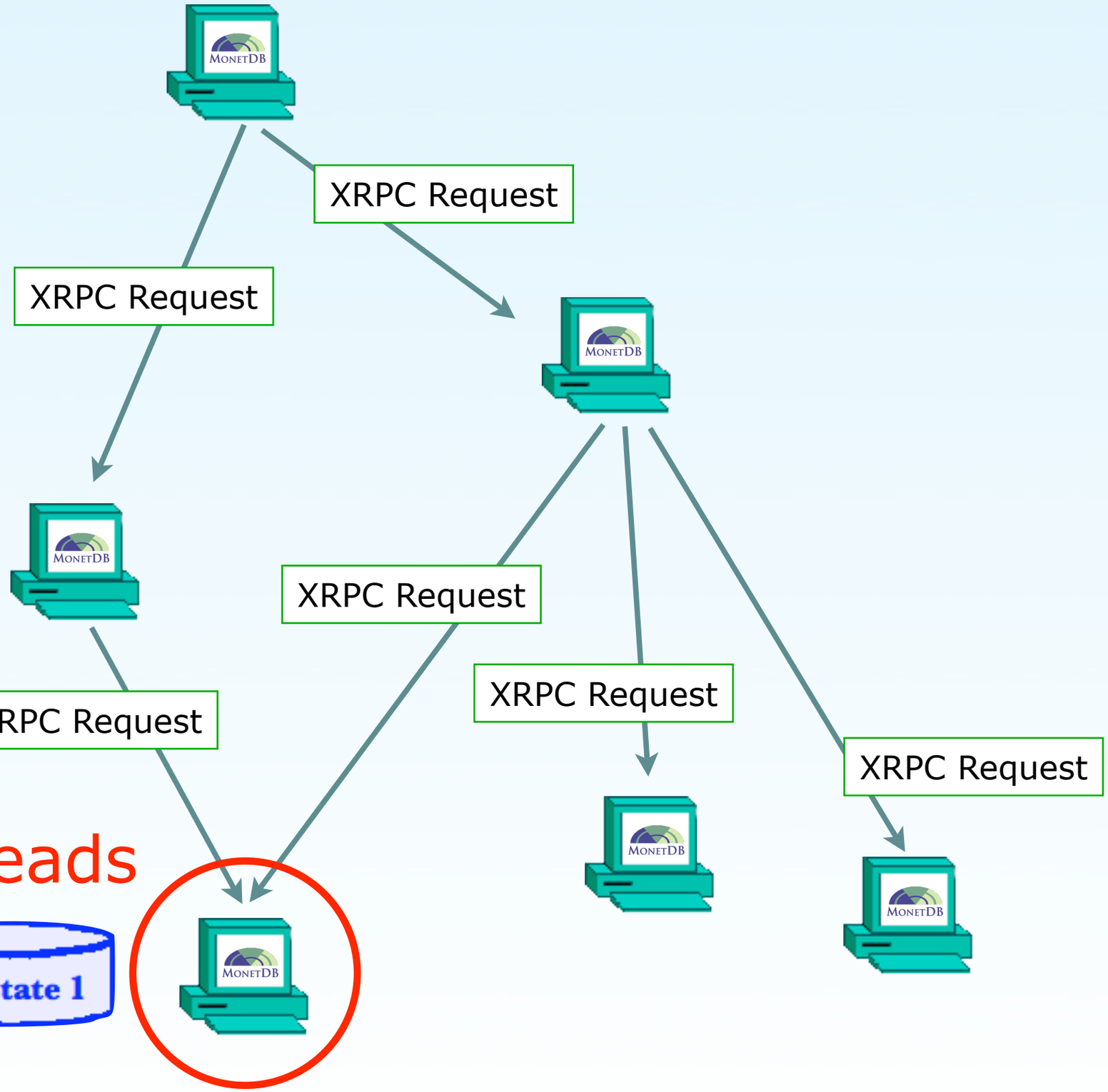

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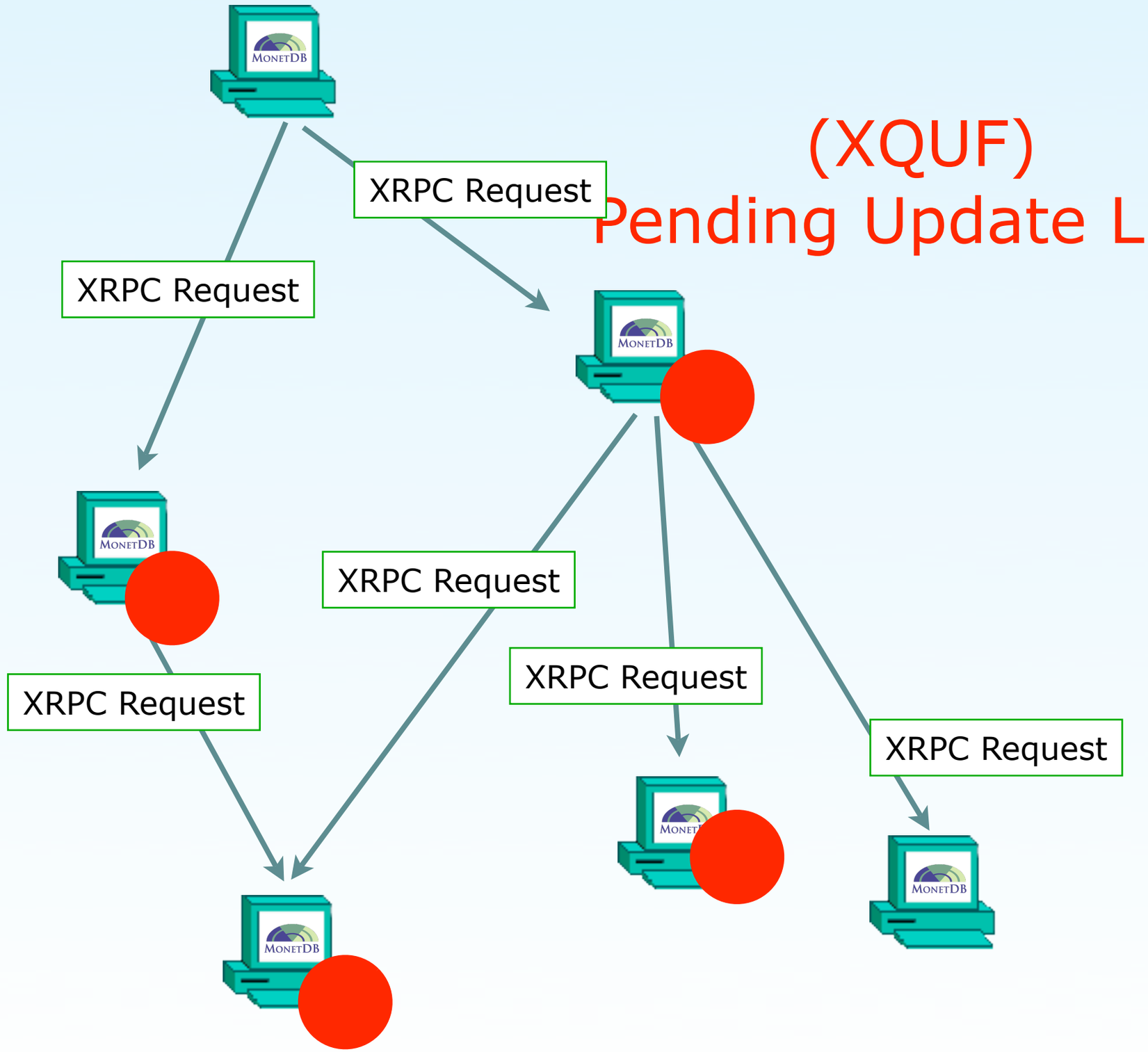

Distributed Transactions with Isolation

- The basic XRPC protocol is stateless
- Higher level isolation
  - All calls: Repeatable-Reads
  - Updating calls: Distributed 2PC
  - **Web Service Transactions Specifications**
    - **SOAP based, of course**
    - **WS-Coordination**
    - **WS-Atomic Transactions: 2PC**

Bulk RPC

- What is it?
  - Inside a for-loop,
  - multiple requests ➠ single message
- Advantages:
  - Network latency + bandwidth
  - Exploit DBMS set-at-a-time infrastructure:
    bulk selections ➠ SOAP message ⋈ XML document

MonetDB/XQuery

- A pure relational XML DBMS
  - open-source, http://monetdb.cwi.nl
- The ***Pathfinder*** XQuery compiler
  - T. Grust, TUM
  - open-source, http://pathfinder-xquery.org
  - the ***Loop-Lifting*** technique

Performance

```
echoVoid() {() };
```

```
for $i in (1 to $x) return
execute at {"y.example.org" }{ t:echoVoid() }
```

	$x = 1	$x = 1000
one-at-a-time	2.6	2696
bulk	2.7	4

XRPC time of echoVoid() in msec

Distributed XQuery Standard?

Ideally:

Different XDBMS cooperatively answer queries

➠ standardize distributed XQuery

- If such a standard would be based on ideas like XRPC:
  - **Glue-less** integration
    - No middle-ware
    - No ODBC, JDBC

XRPC: Easy to Implement

- ☑ Serializer / Parser for SOAP messages
- ☐ Stub code (client) + request handler (server)

Meanwhile: XRPC Wrapper

- Plug-able component on top of the XQuery system
- No integration needed
  - Limitation: can not make XRPC calls

XRPC

MonetDB/XQuery

Saxon

Galax

other XQuery engines

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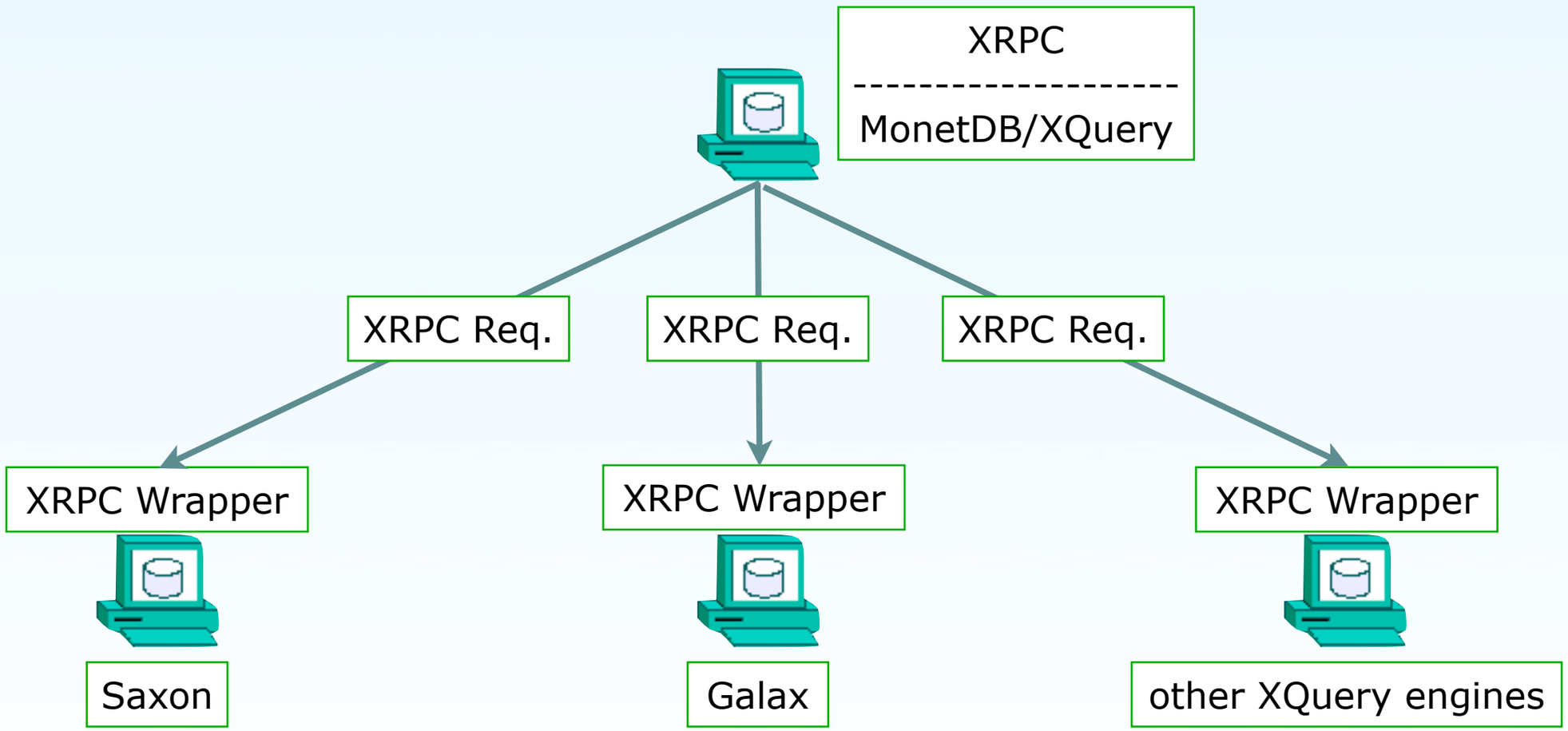
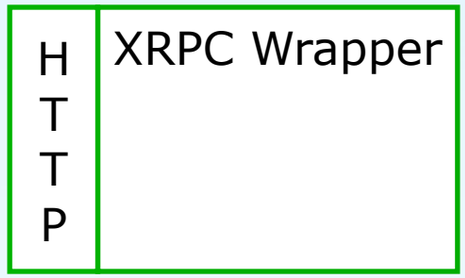
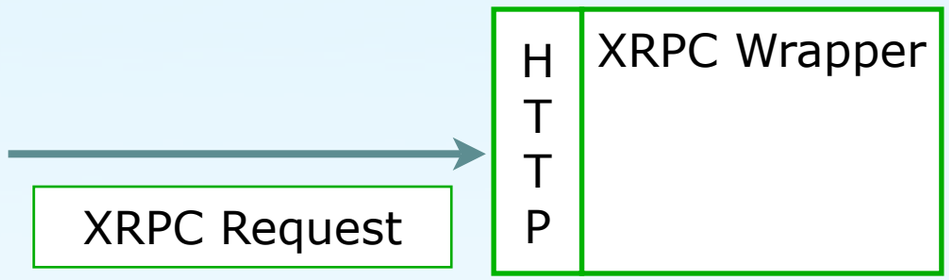


XRPC Wrapper Inside



External XQuery Engine

XRPC Wrapper Inside



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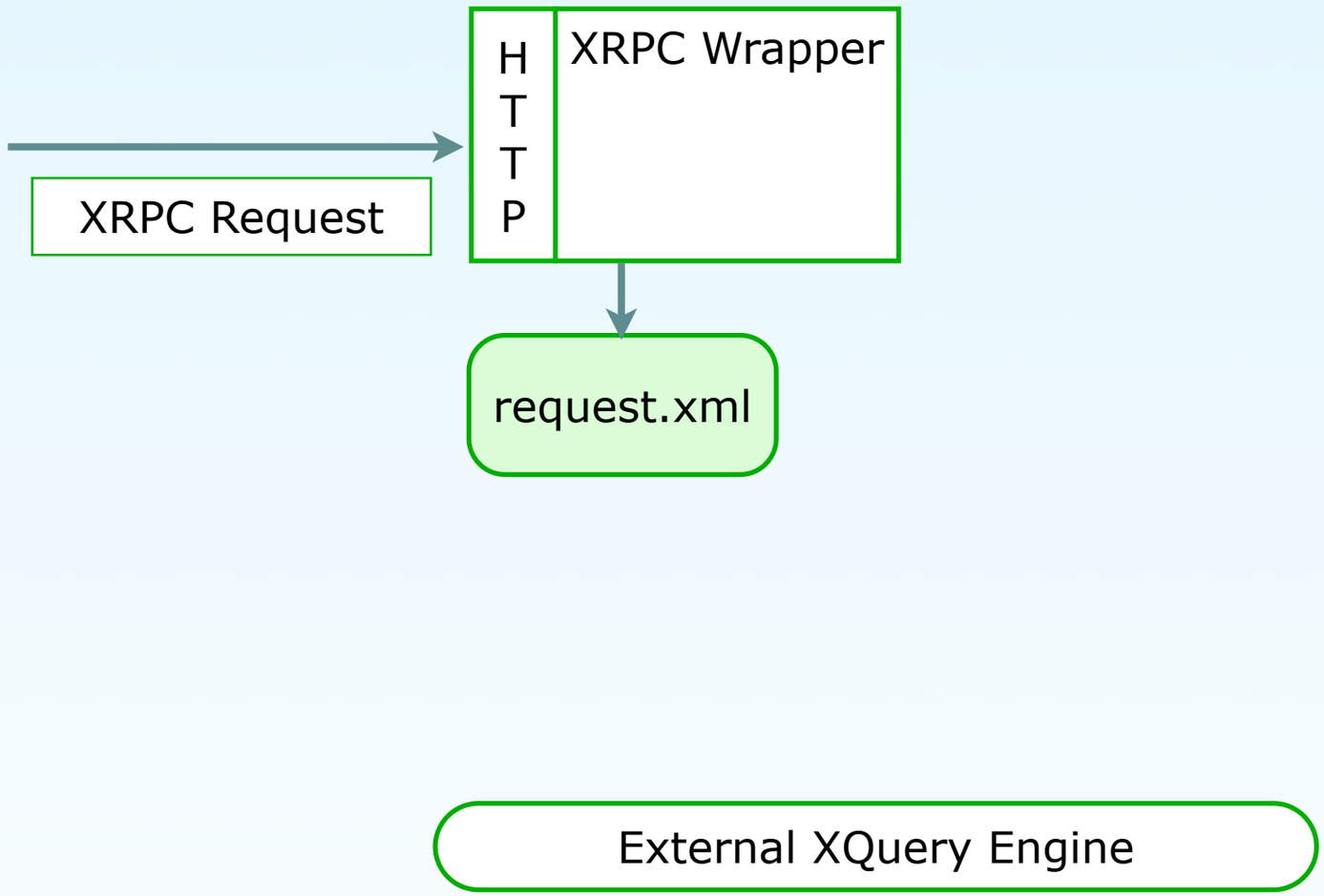

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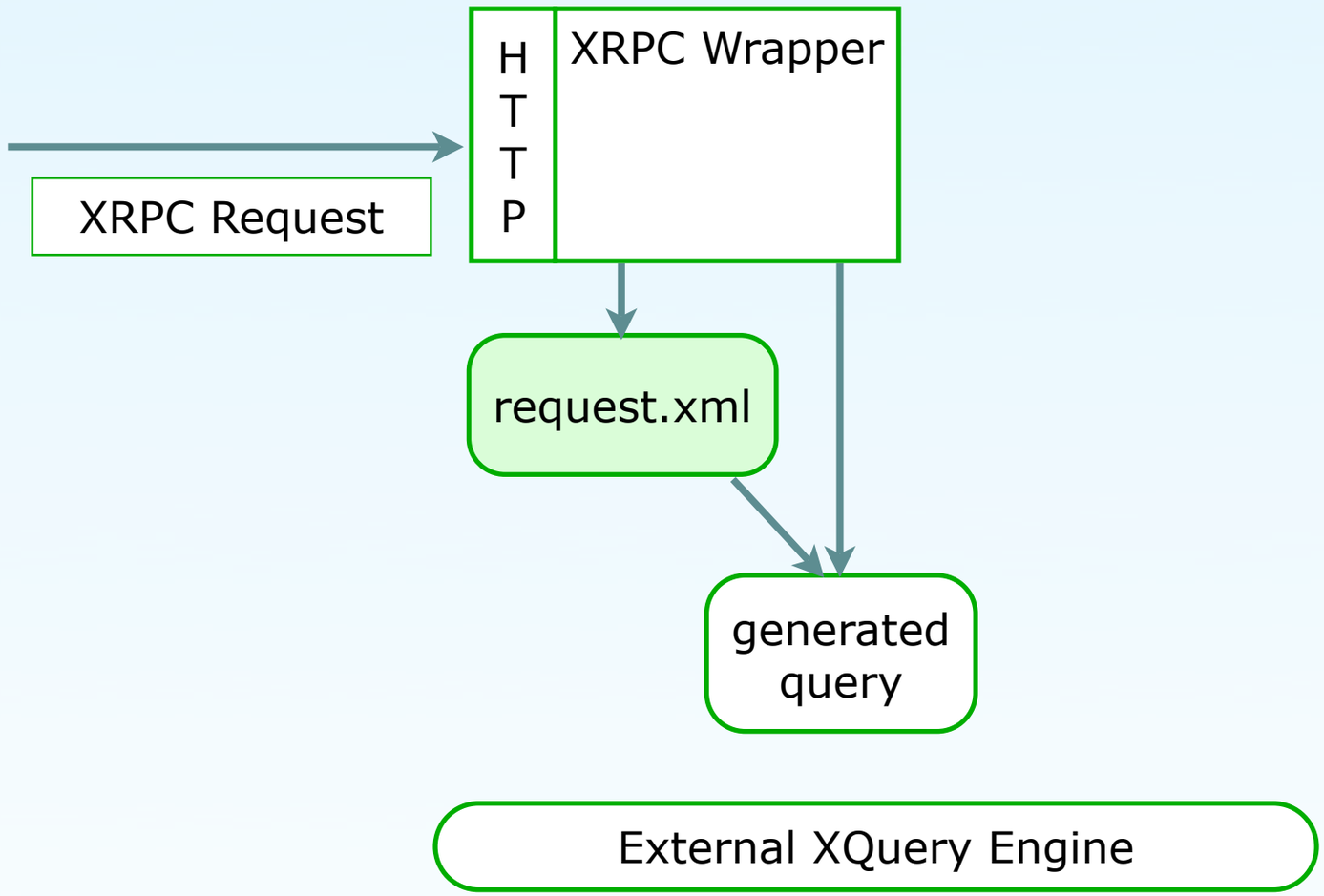

XRPC Wrapper Inside

```
<xrpc:response>
for $call in doc("request.xml")//xrpc:call
  $param1:= deserialize($call/xrpc:sequence[1])
  return getAuctions($param1)
</xrpc:response>
```

Generated XQuery

request.xml

```
...
<xrpc:call>
  <xrpc:sequence>
    "person1"

<xrpc:call>
  <xrpc:sequence>
    "person3"
...
```

auctions.xml

```
...
<closed_auction>
  <price>...
  <buyer "person1">

<closed_auction>
  <price>...
  <buyer "person3">
...
```

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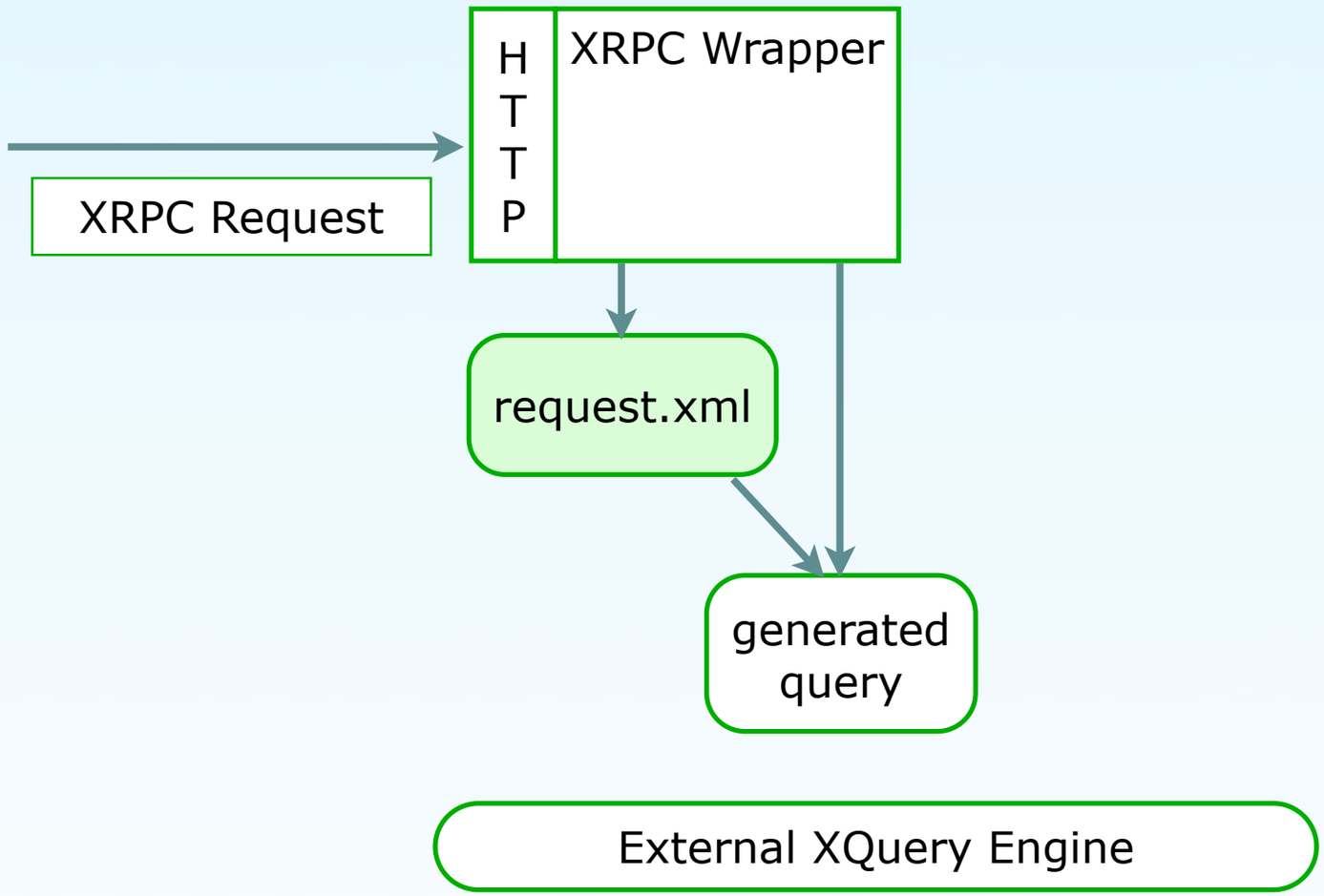

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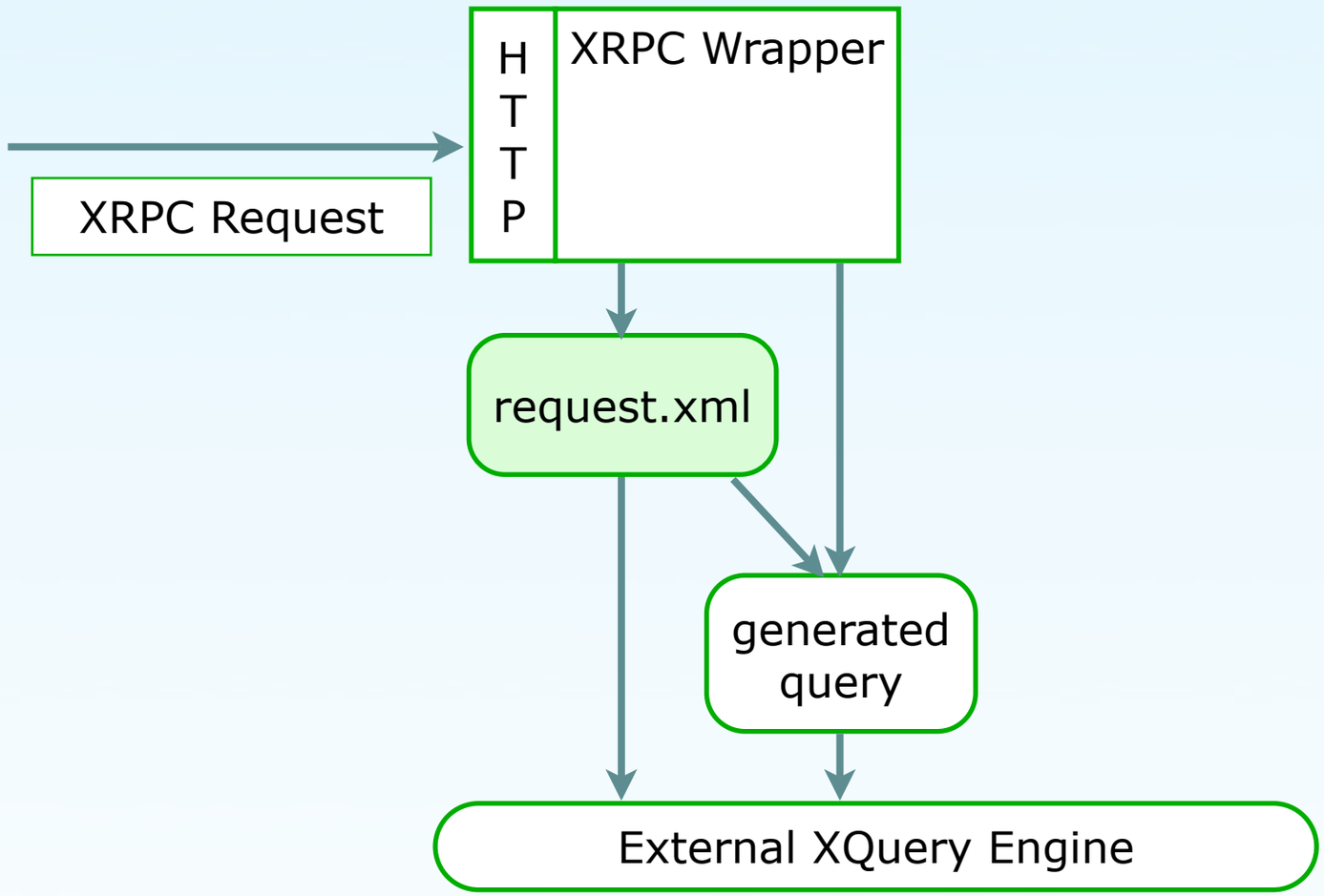

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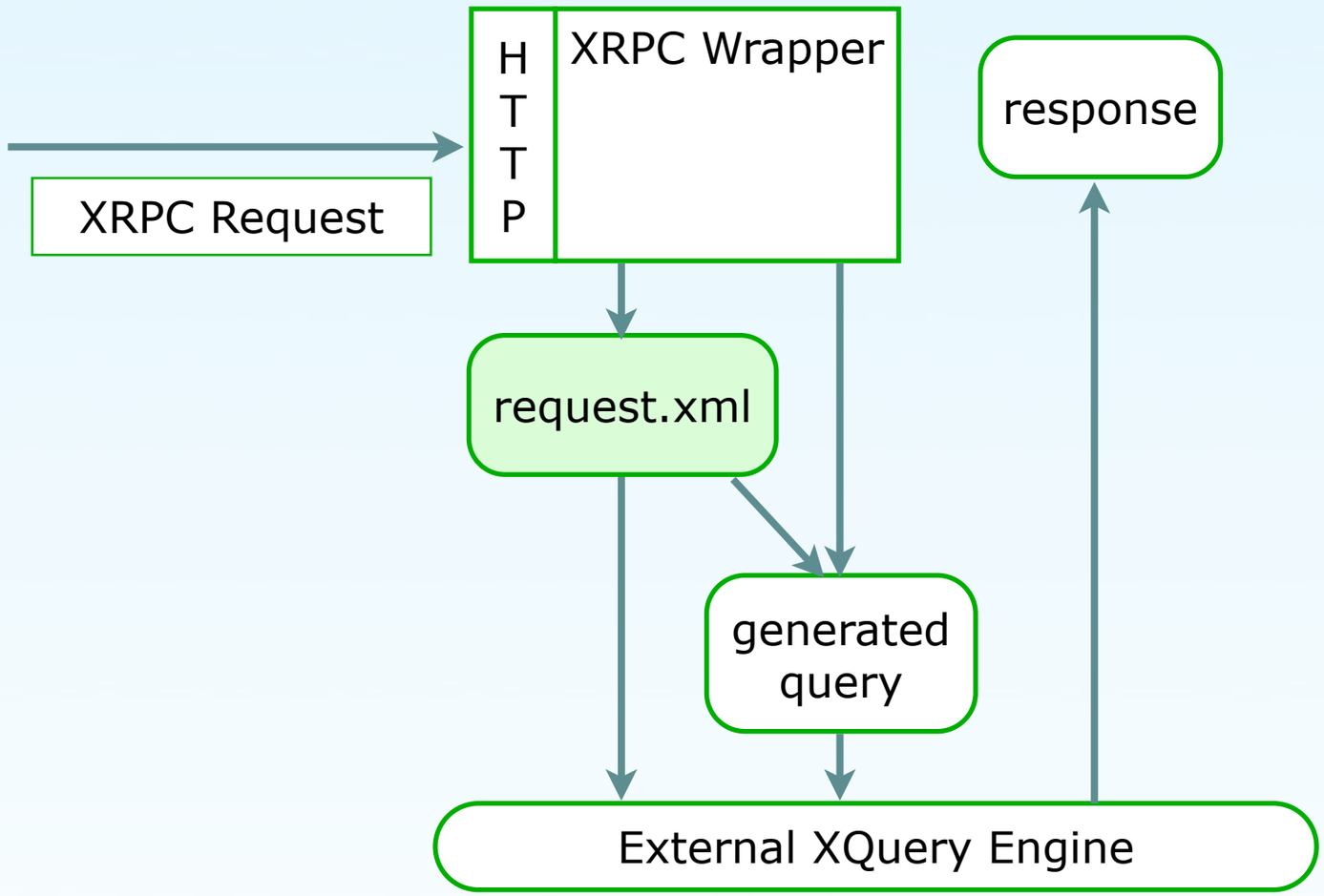

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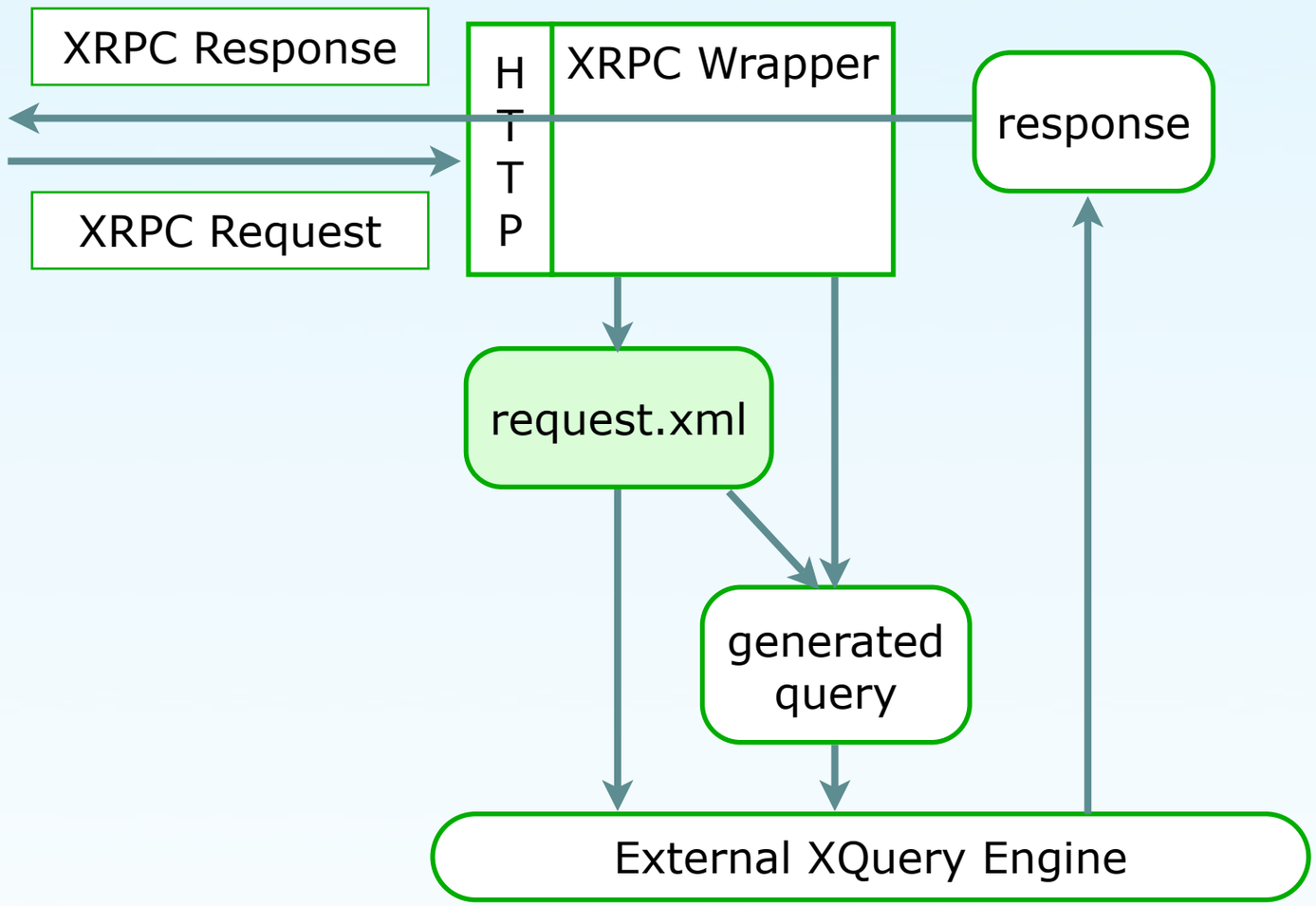

Selection ➠ Join

	Total
getPerson $x = 1	**4276**
getPerson $x = 1000	**8167**

Query time XRPCWrapper/Saxon (msec)

```
getPerson($pid):

doc("xmark.xml")//person[@id = $pid]
```

Conclusion

- XRPC is a clean ***orthogonal*** extension of XQuery
  - Full XDM support and XQuery Update Facility
- It aims for ***interoperability*** in Distributed XQuery
  - Open SOAP based network protocol
  - Different XQuery engines can cooperate
- XRPC can be ***efficient*** thanks to Bulk RPC
  - Optimizes network & exposes bulk opportunities
- With XRPC, distributed XQuery can be ***simple***