Liquid Stream Processing Across Web Browsers and Web Servers

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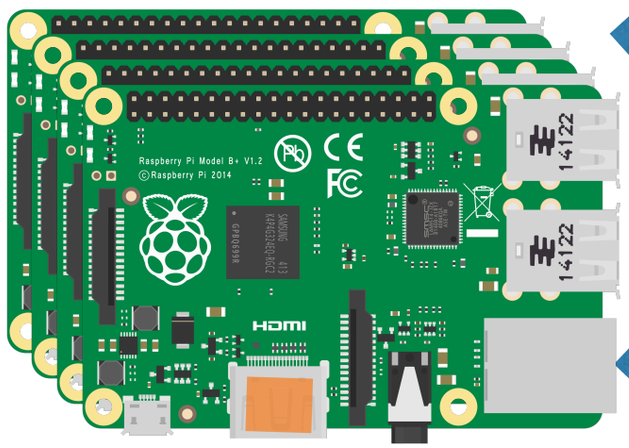
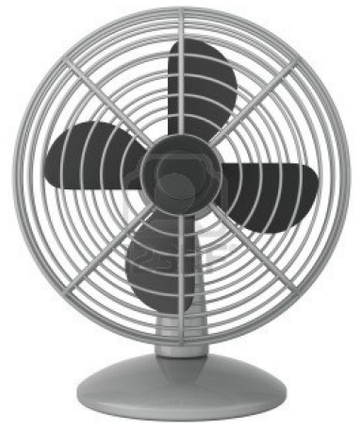
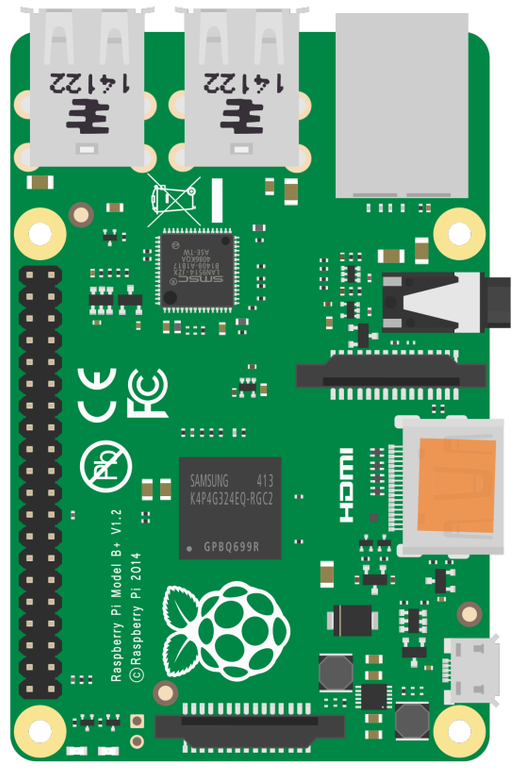




JS

Web Liquid Streams

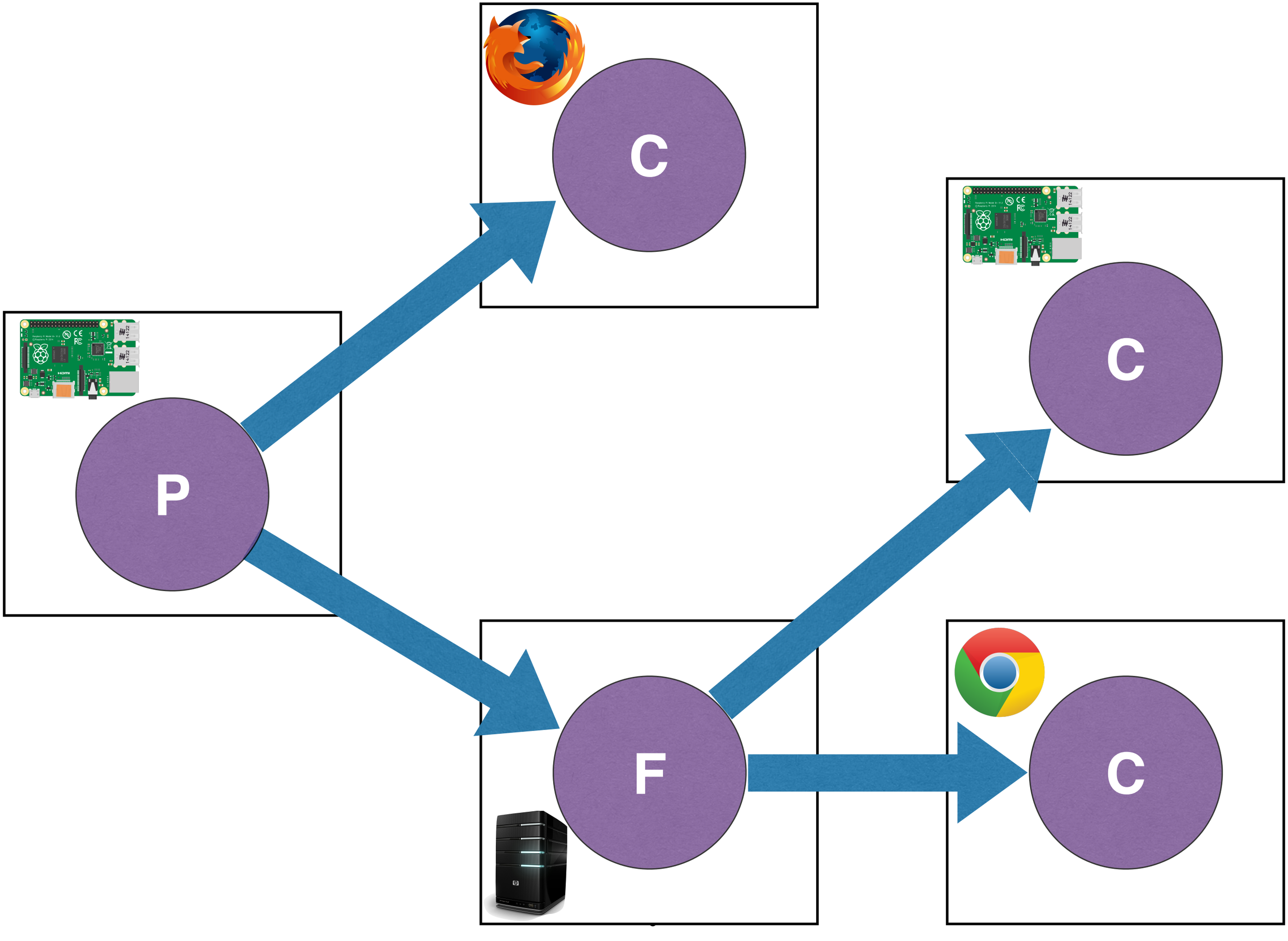

WebRTC


SAMSUNG 413
K4P4G324EQ-RGC2
GPBQ699R
Raspberry Pi Model B+ V1.2
©Raspberry Pi 2014
HDMI

```
var k = require('wls.js');
setInterval(function(){
     getTemperature(
       function(temp, sensor_id){
          k.send({
           "temperature" : temp,
           "id" : sensor_id,
           "ts" : new Date().getTime(),
           });
         }
     );
}, 1000);
```


JS

```
{
    topology : {
        id : “HAS_topology”,
        operators : [
            {
                id : “producer”,
                script : “pi_prod.js”,
                constraints : [“temperature”],
            },
            …
           ],
           bindings : [
              {
                 from : “producer”,
                 to : [“filter”, “web_consumer_1”]
                 type : “broadcast”
              },
              …
           ]
    }
}
```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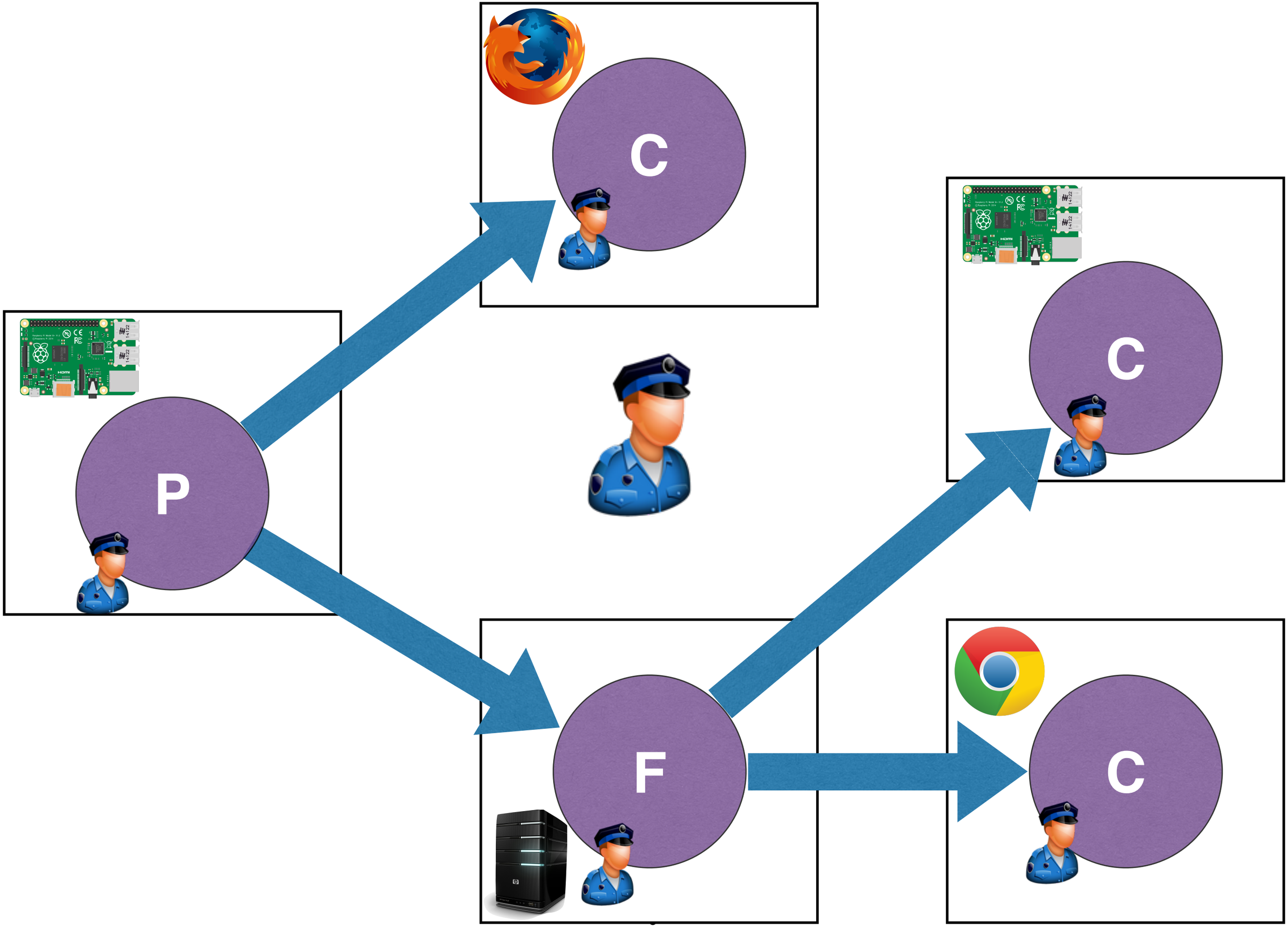
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			R_1	R_2	R_3
Peer	*Con.*	Hardware	x	x	x
		CPU		x	
	Variables	Plugged		x	
		Battery		x	
		Parallelism		x	
		Deployment Cost			
		Queue Size			x
		Execution Time			x
Connector	*Con.*	Network Typology			x
		Bandwidth (Upload)			x
		Bandwidth (Download)			x
	Var.	Message size (incoming)			x
		Message size (outgoing)			x
		Message rate (incoming)			x
		Message rate (outgoing)			x
		RTT			x
Topology	*Con.*	Hardware Dependencies	x	x	x
		Whitelist	x	x	x
		Blacklist	x	x	x
	Var.	Delay			
		Throughput			

Algorithm 1: Peer Ranking for Topology Initialization

```
Data: Known Peers, Topology
Result: Peers Ranking
P ← Known Peers ;
foreach Operator o in Topology do
    foreach Peer p in P do
        if !compatible(o, p) then
            P ← P \ p ;
        end
    end
end
if P = ∅ then
    return cannot deploy Topology
else
    foreach Peer p in P do
        Poll p for its current metrics M_i(p);
        Compute ranking function r(p) according to Eq. (1);
    end
    return Sorted list of available Peers P according to their rank r(p)
end
```

$$r(p) = \sum_{i=1}^{n} \alpha_i M_i(p)$$

Algorithm 1: Peer Ranking for Topology Initialization

Data: Known Peers, Topology
Result: Peers Ranking
$P \leftarrow$ Known Peers ;
foreach *Operator o in Topology* **do**
  foreach *Peer p in P* **do**
    if $!compatible(o, p)$ **then**
      $P \leftarrow P \setminus p$;
    end
  end
end
if $P = \emptyset$ **then**
  return cannot deploy Topology
else
  foreach *Peer p in P* **do**
    Poll p for its current metrics $M_i(p)$;
    Compute ranking function $r(p)$ according to Eq. (1);
  end
  return Sorted list of available Peers P according to their rank $r(p)$
end

Filter Peers

$$r(p) = \sum_{i=1}^{n} \alpha_i M_i(p)$$

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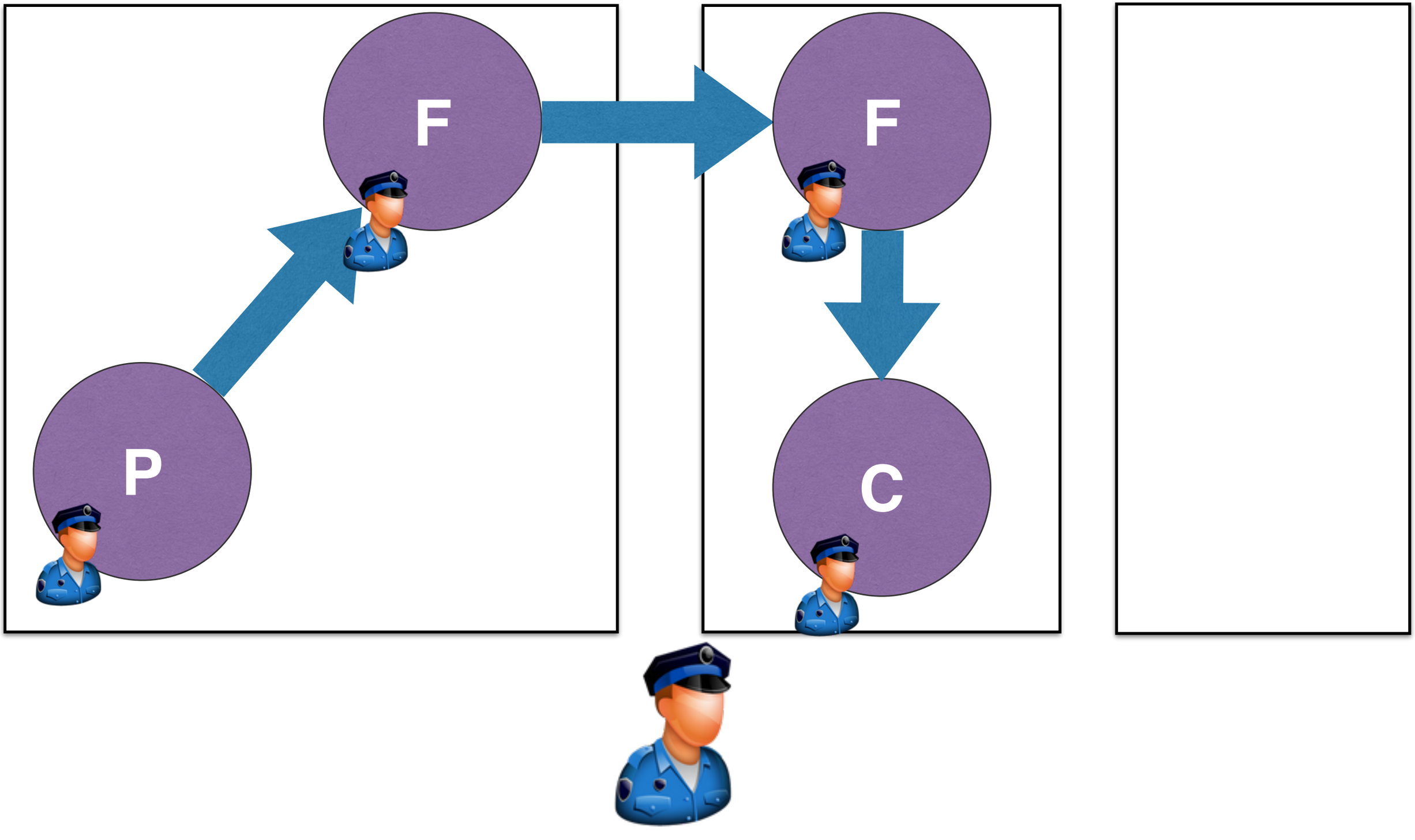
Filter Peers

Compute the ranking

$$r(p) = \sum_{i=1}^{n} \alpha_i M_i(p)$$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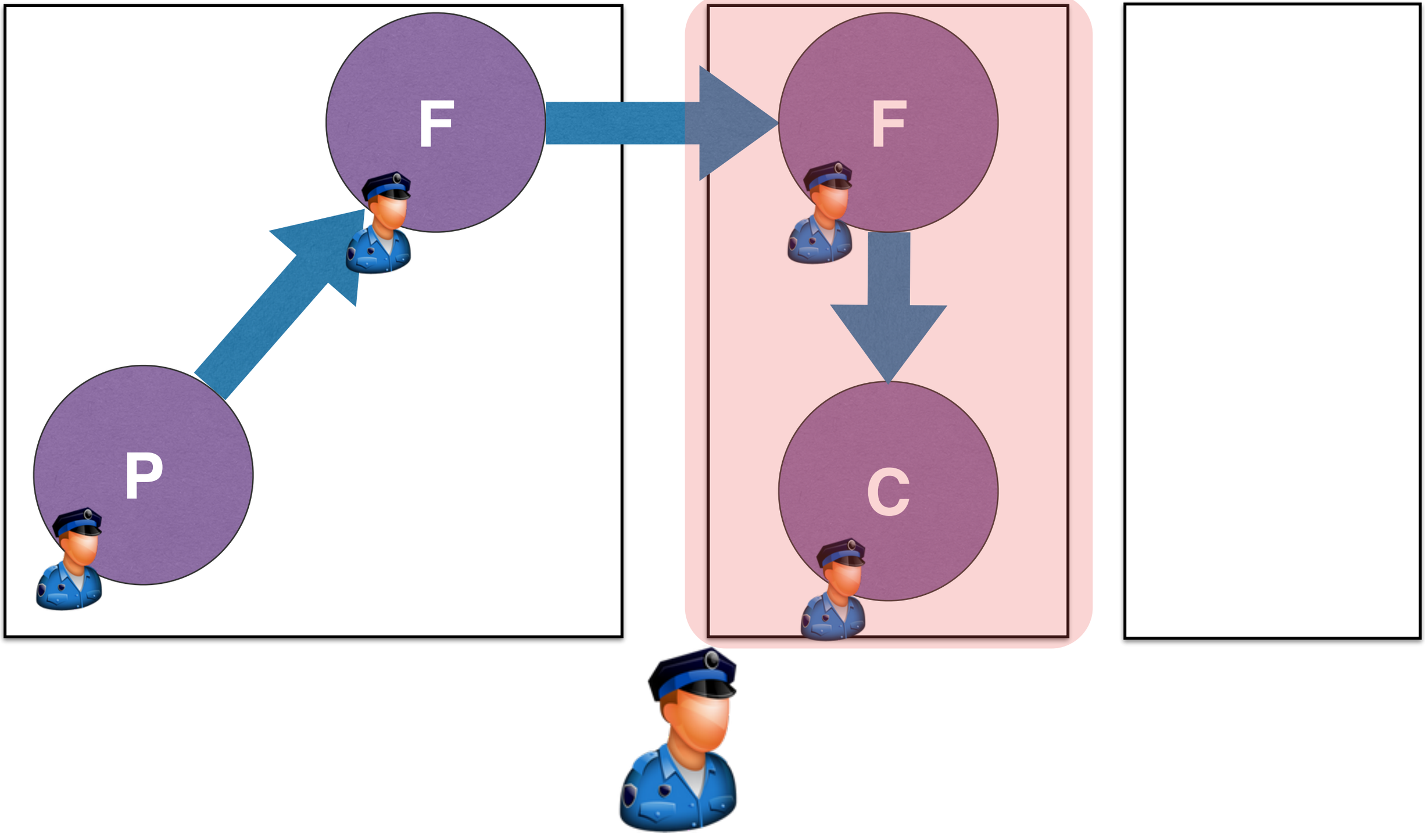
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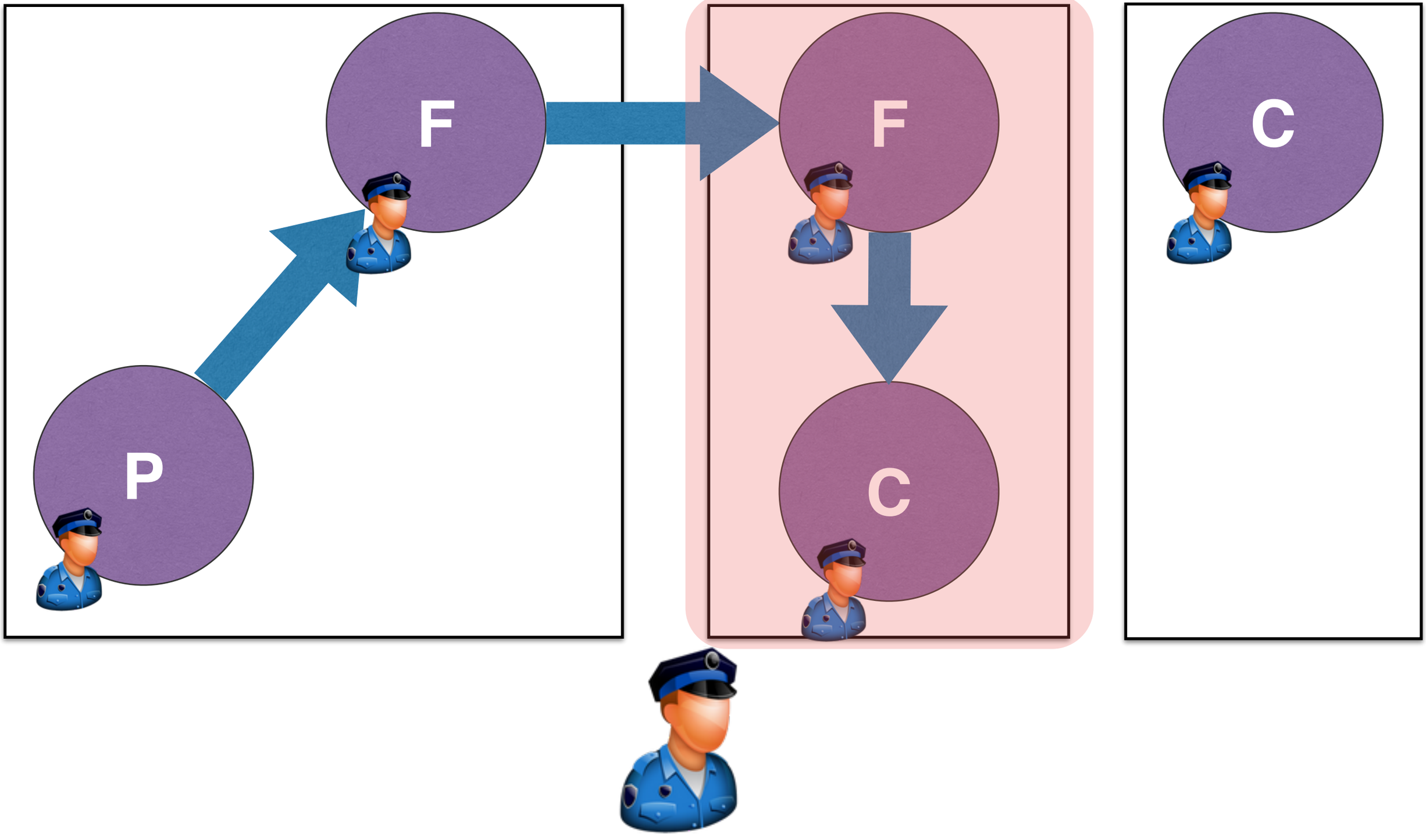
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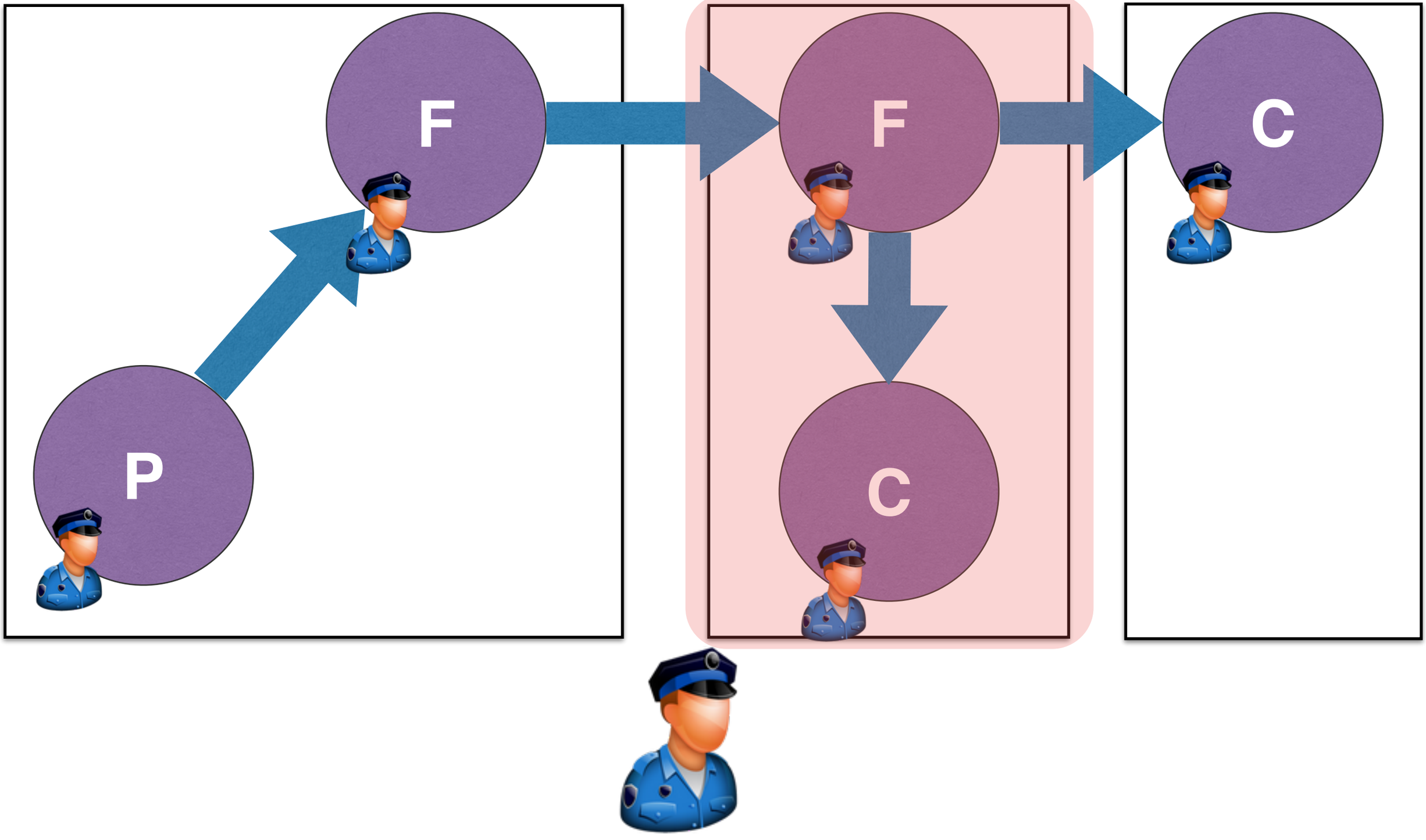
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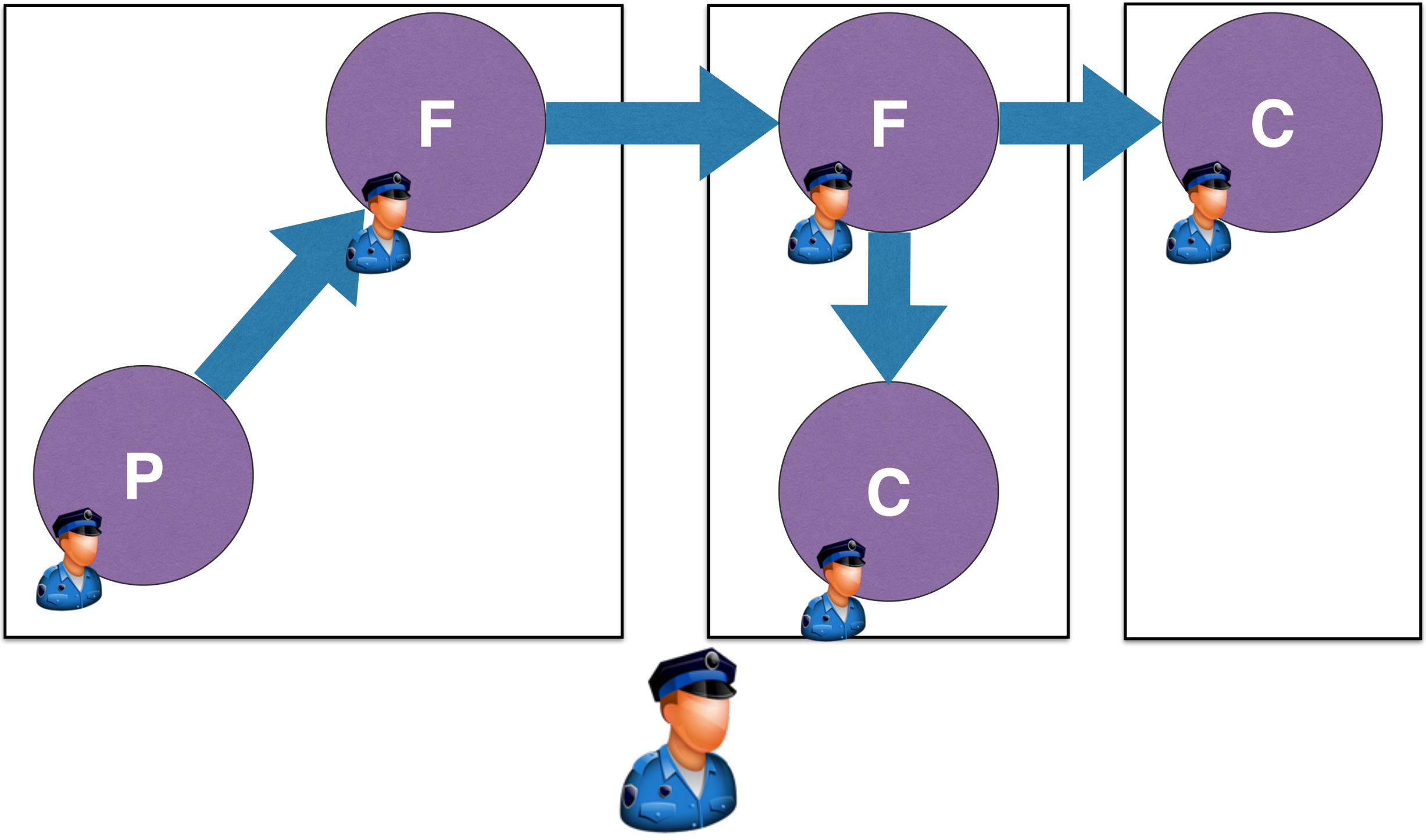
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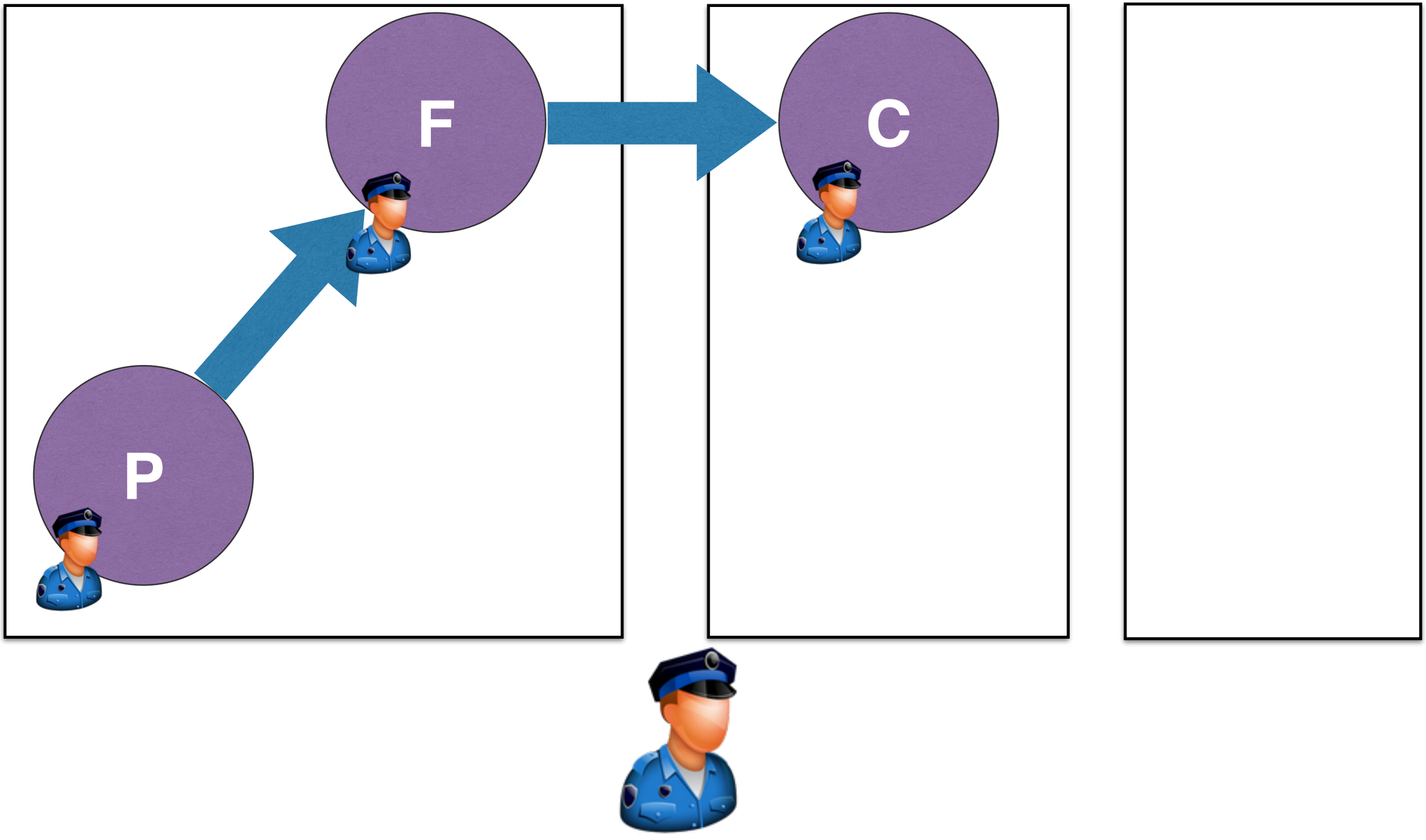
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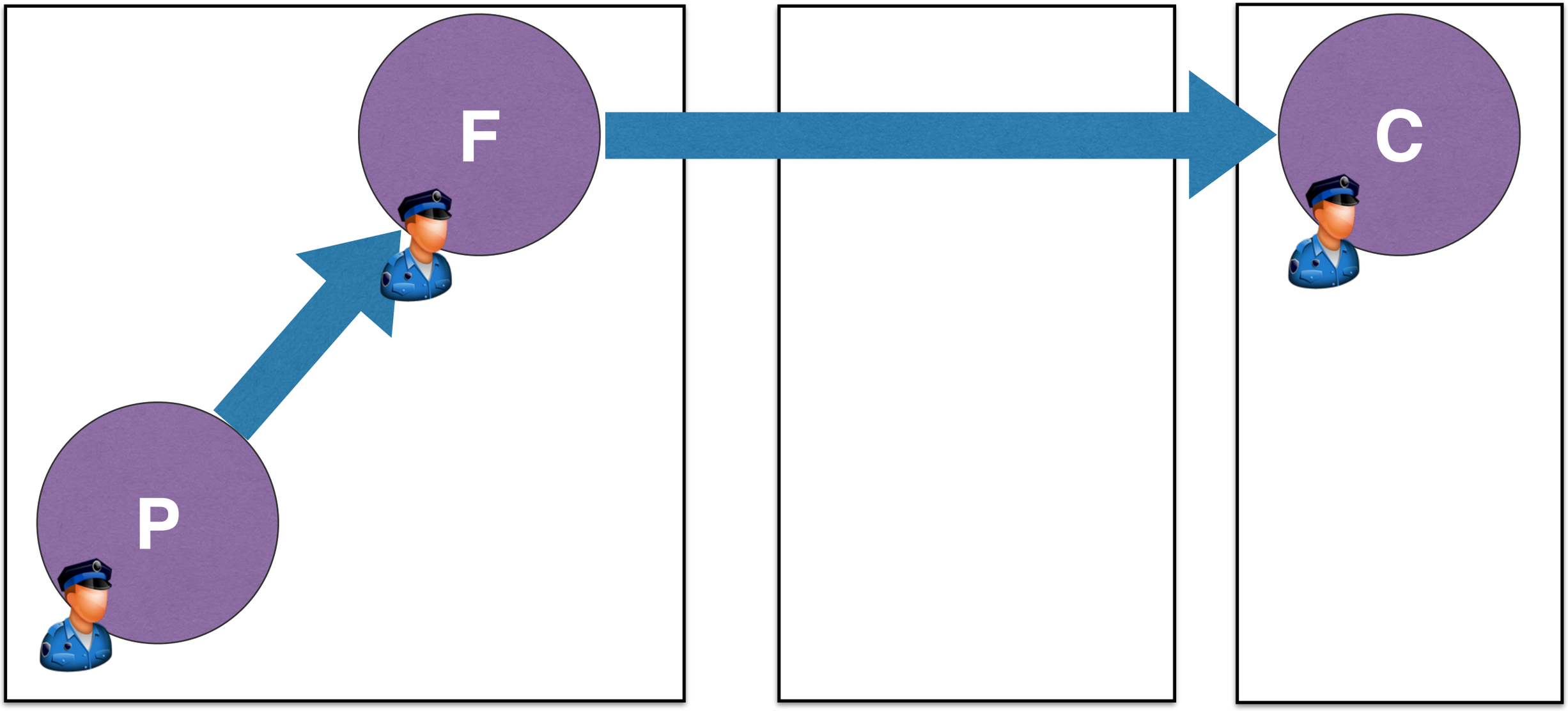
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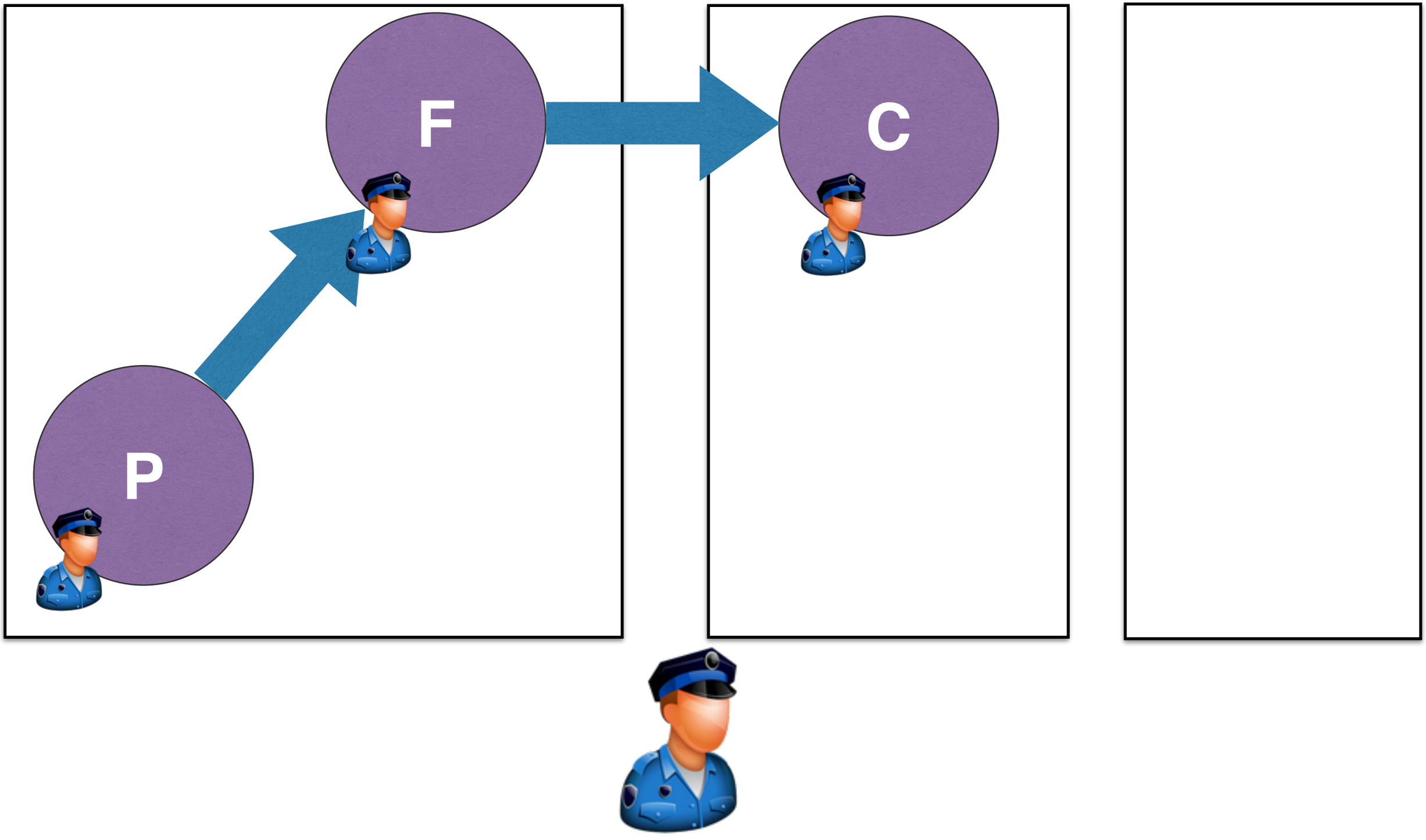
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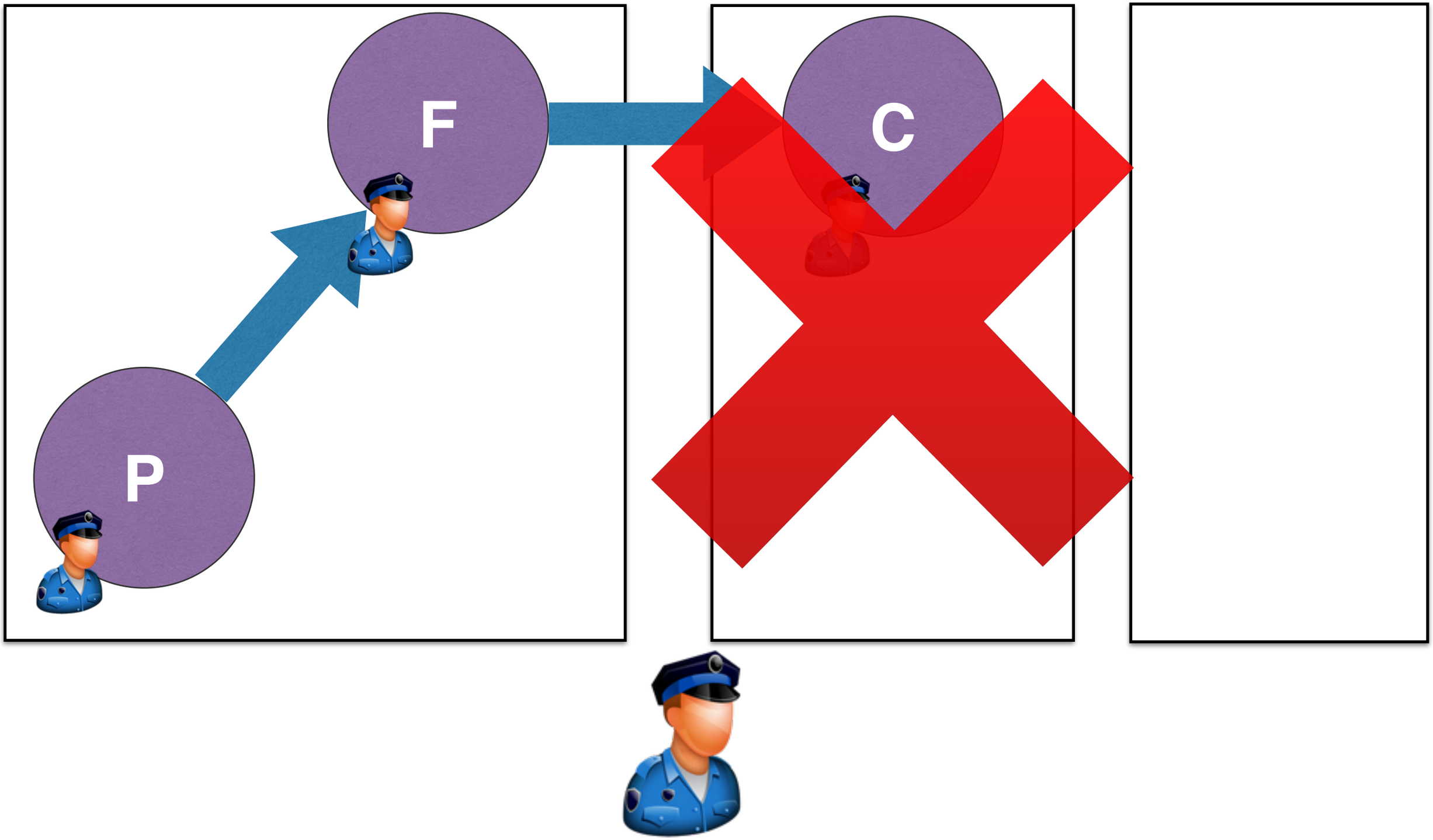
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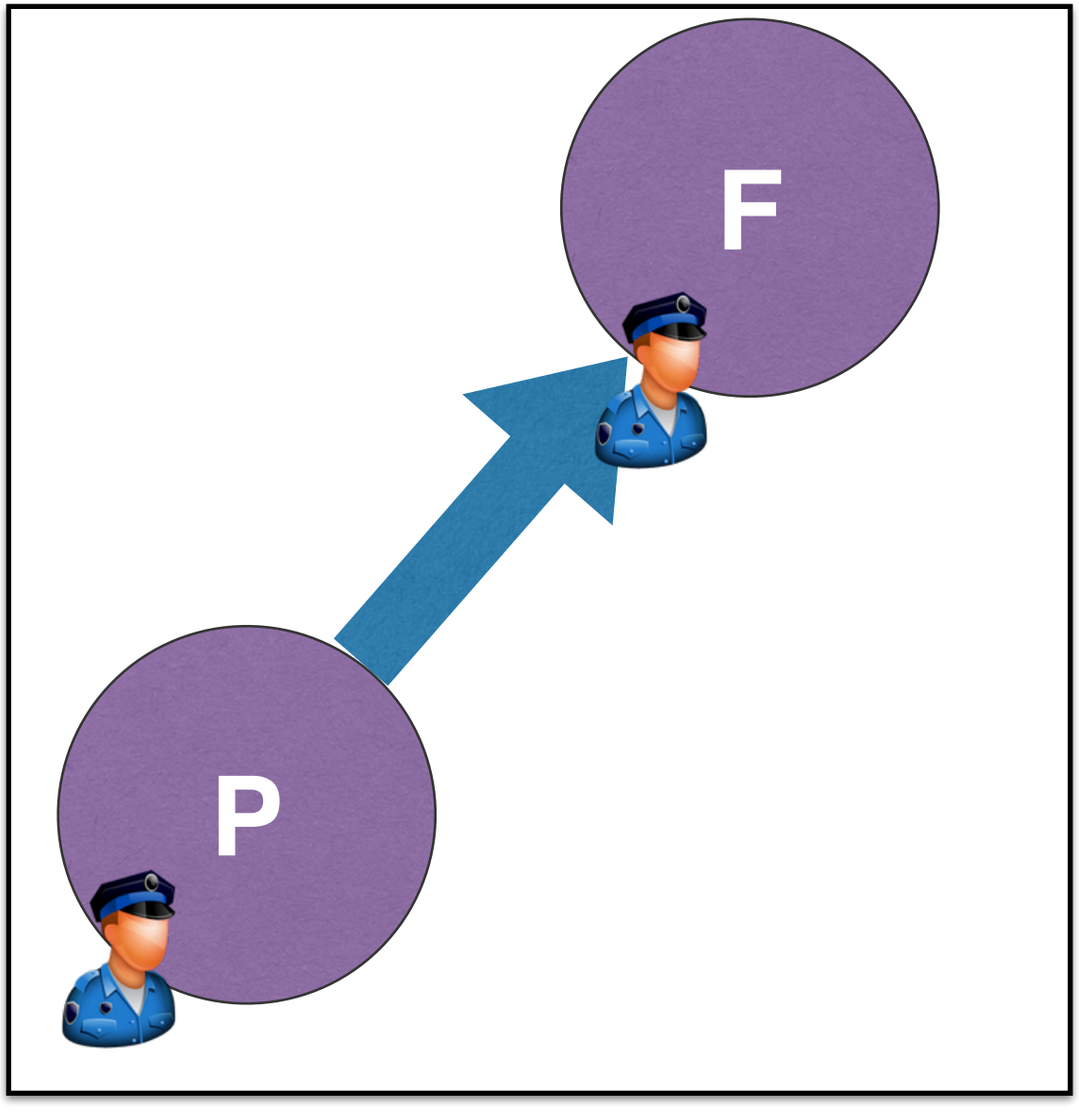
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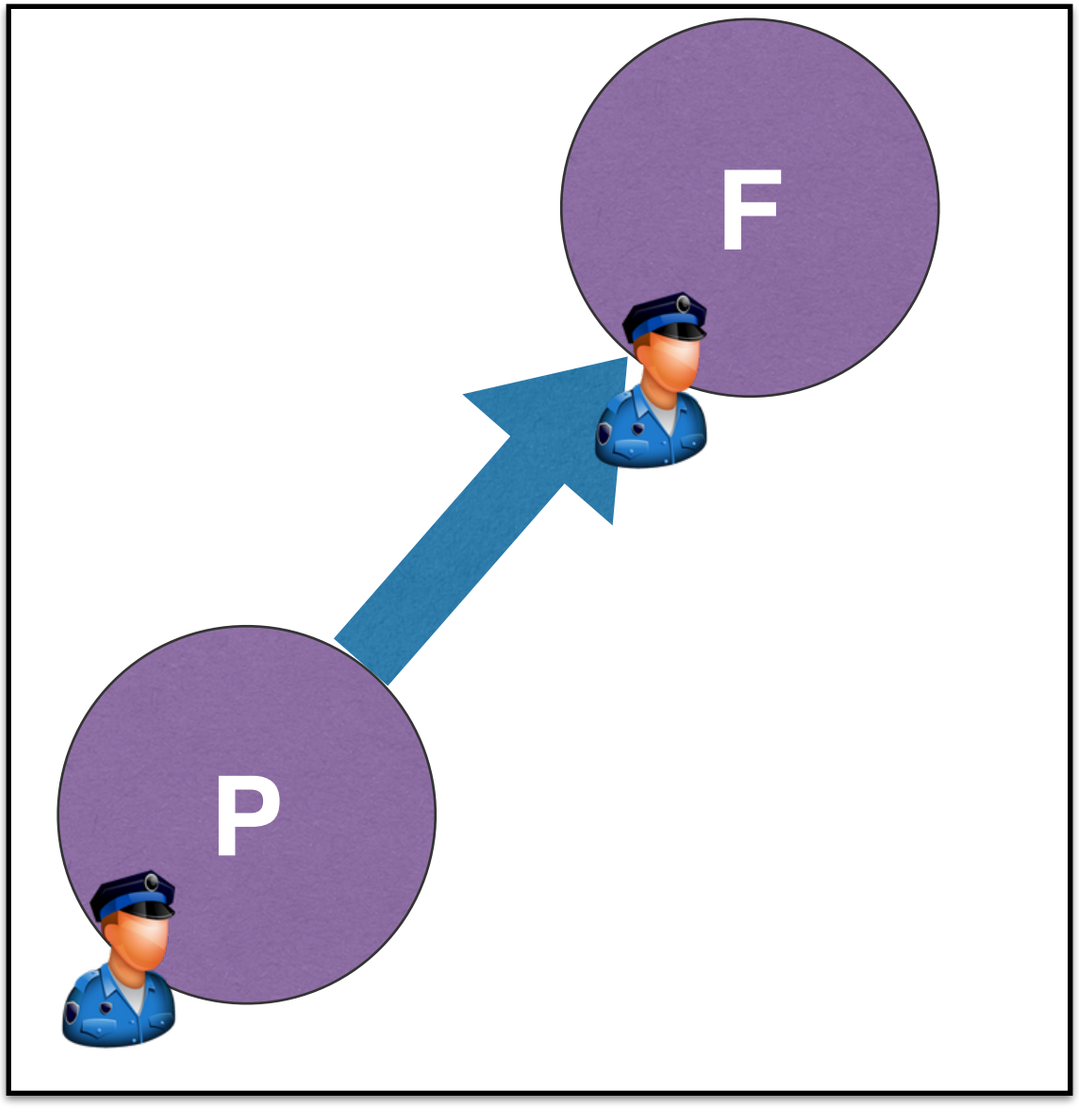
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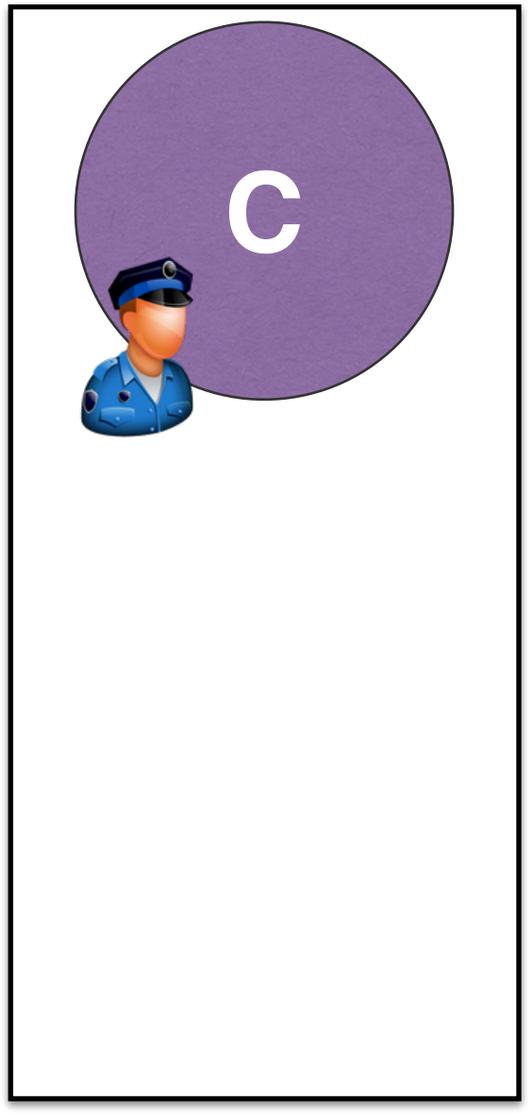
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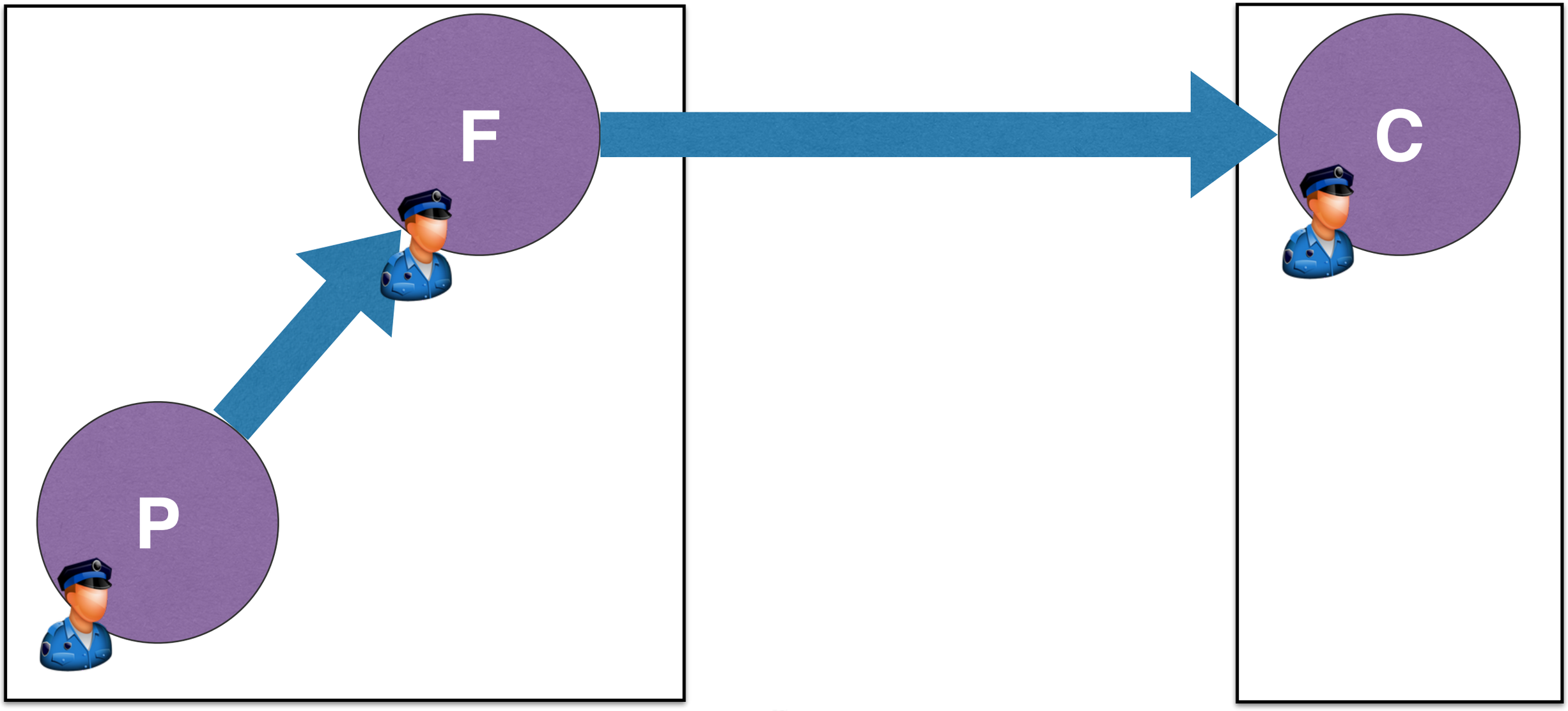
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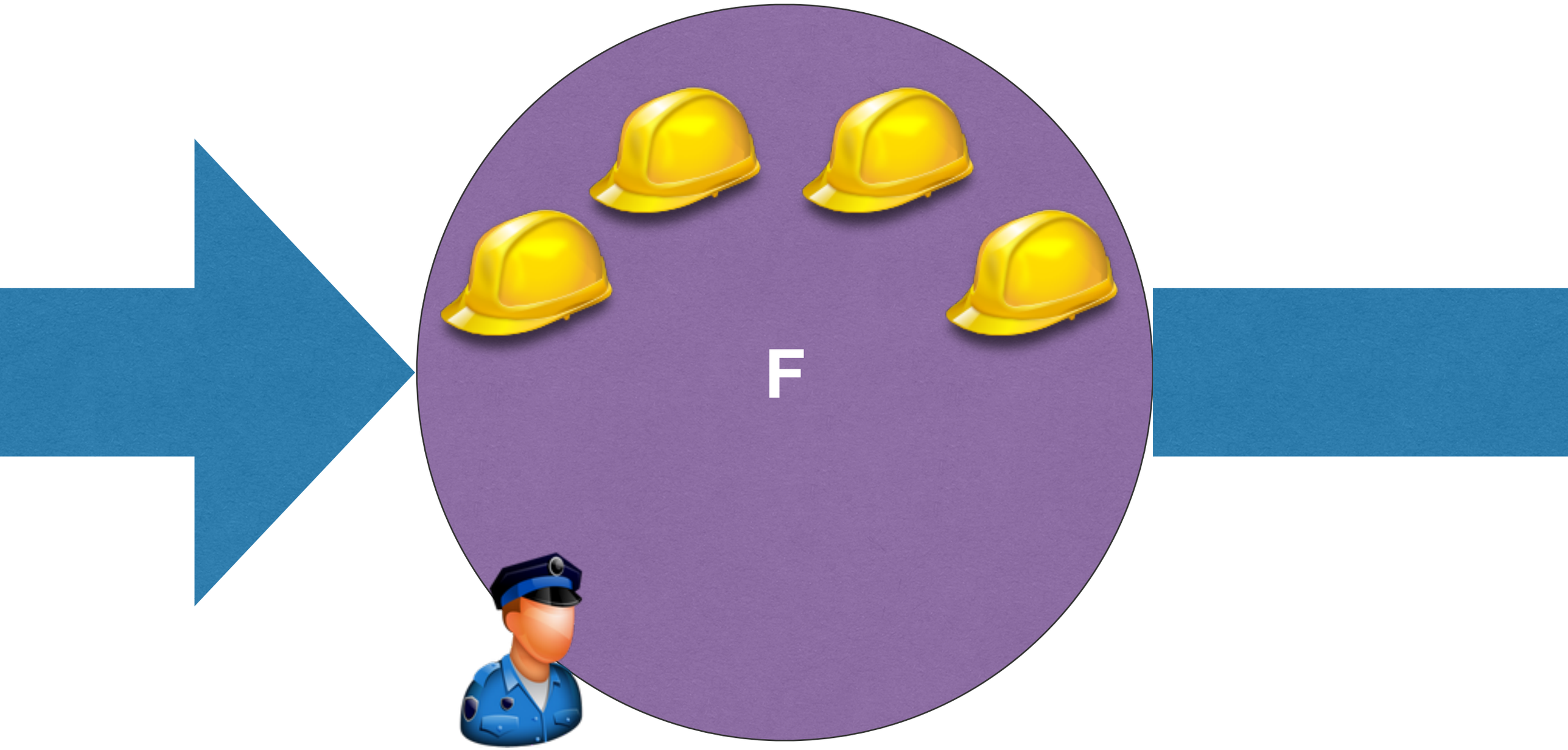
Operator Elasticity



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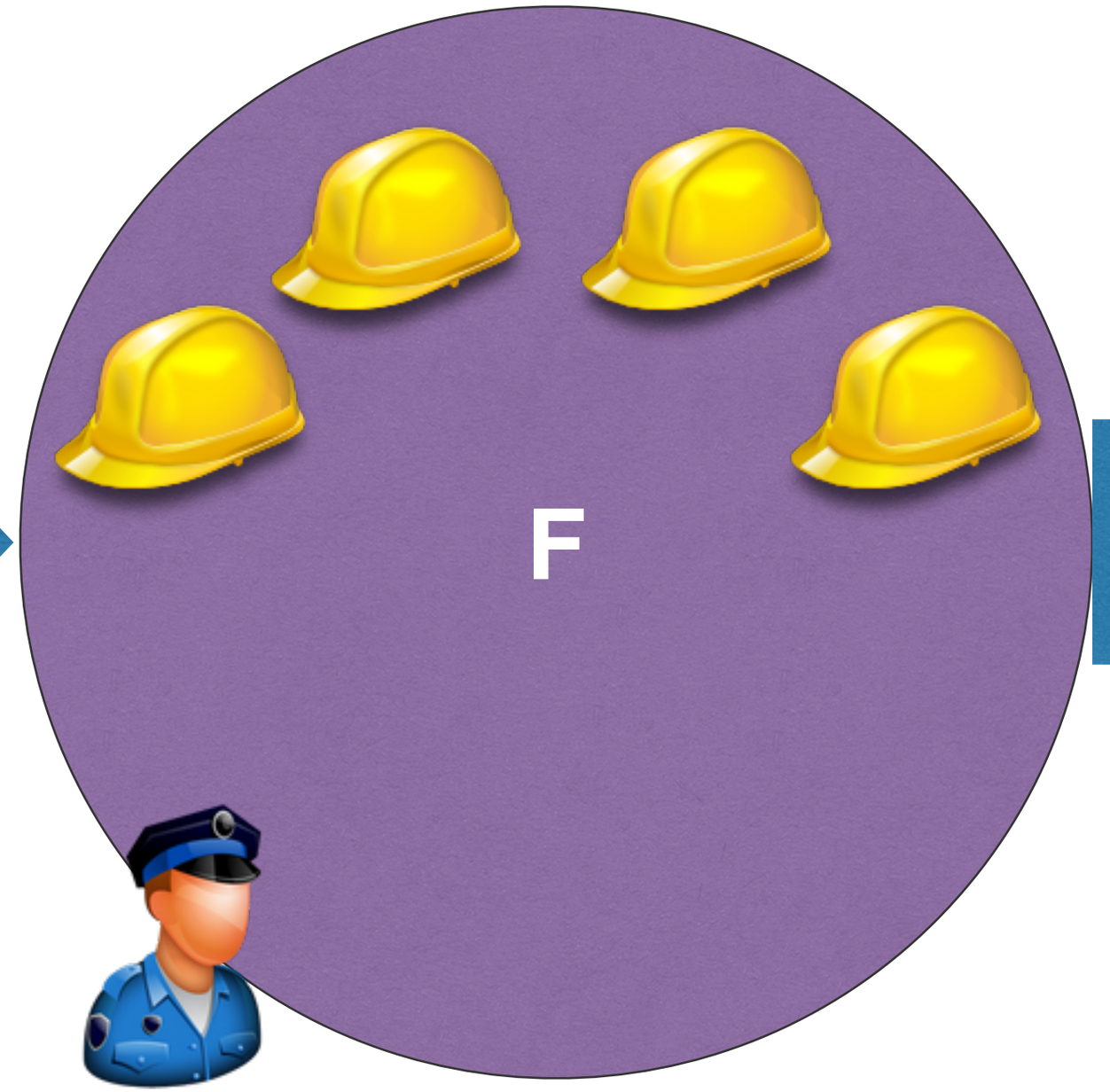

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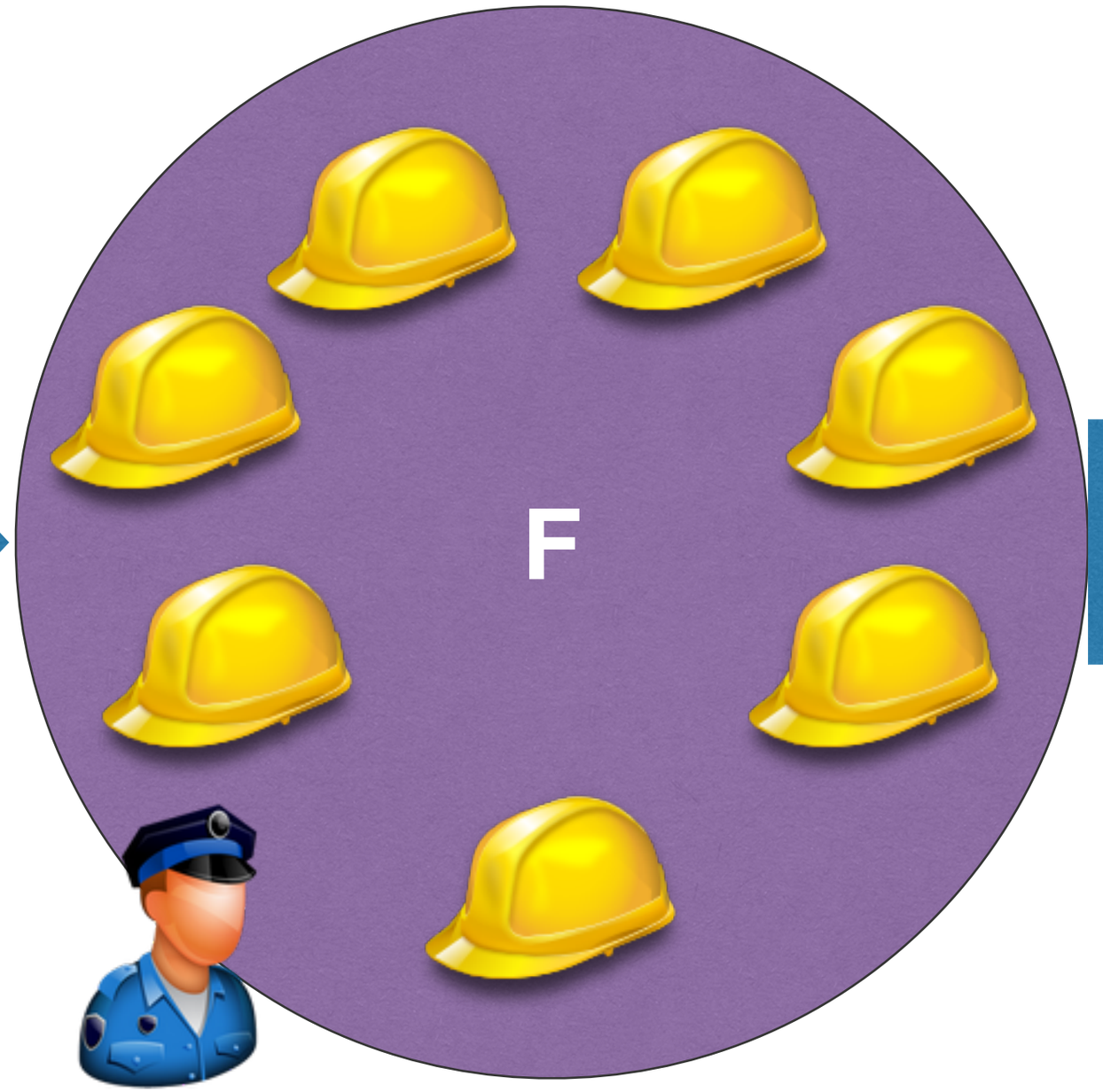

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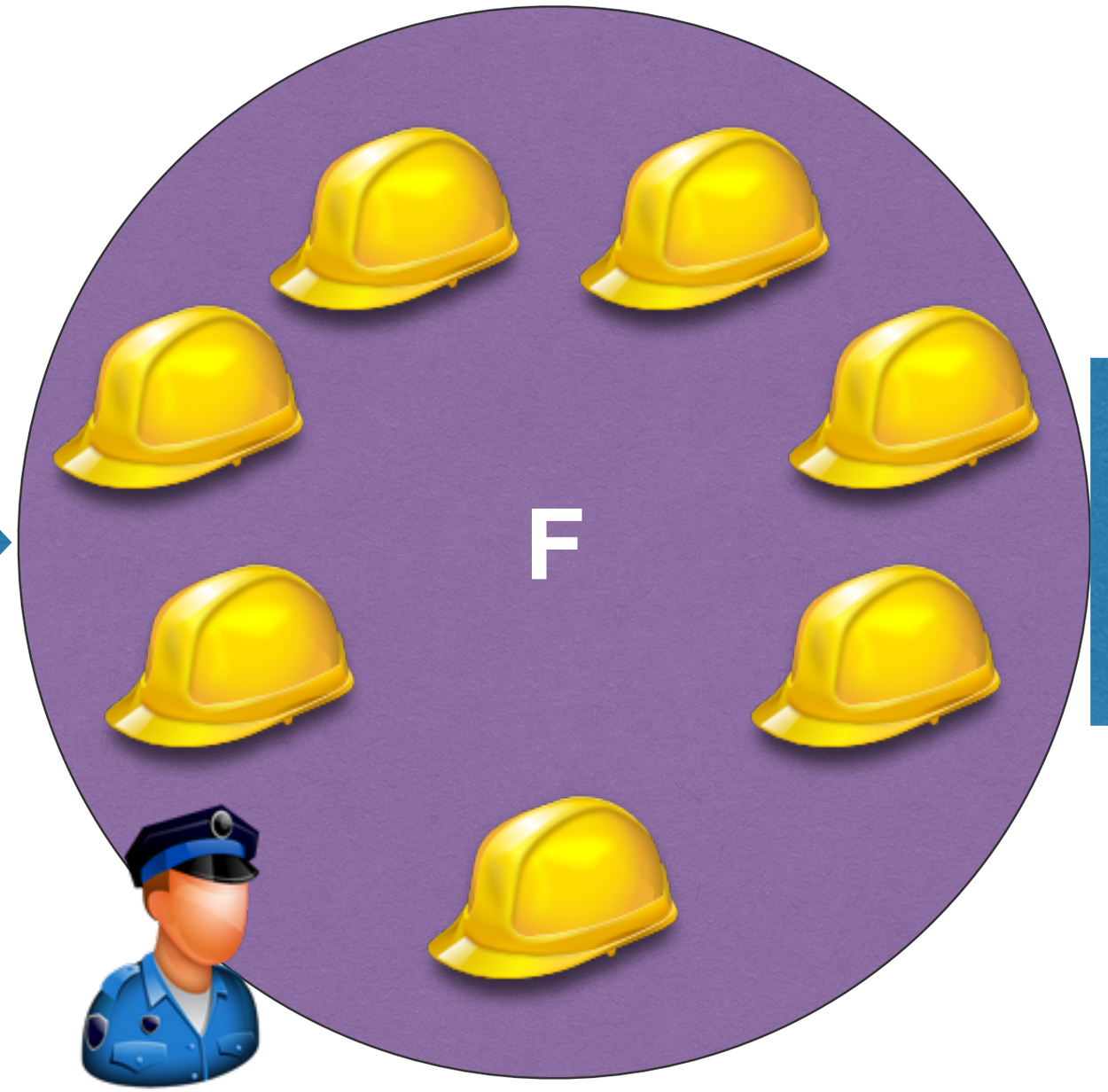

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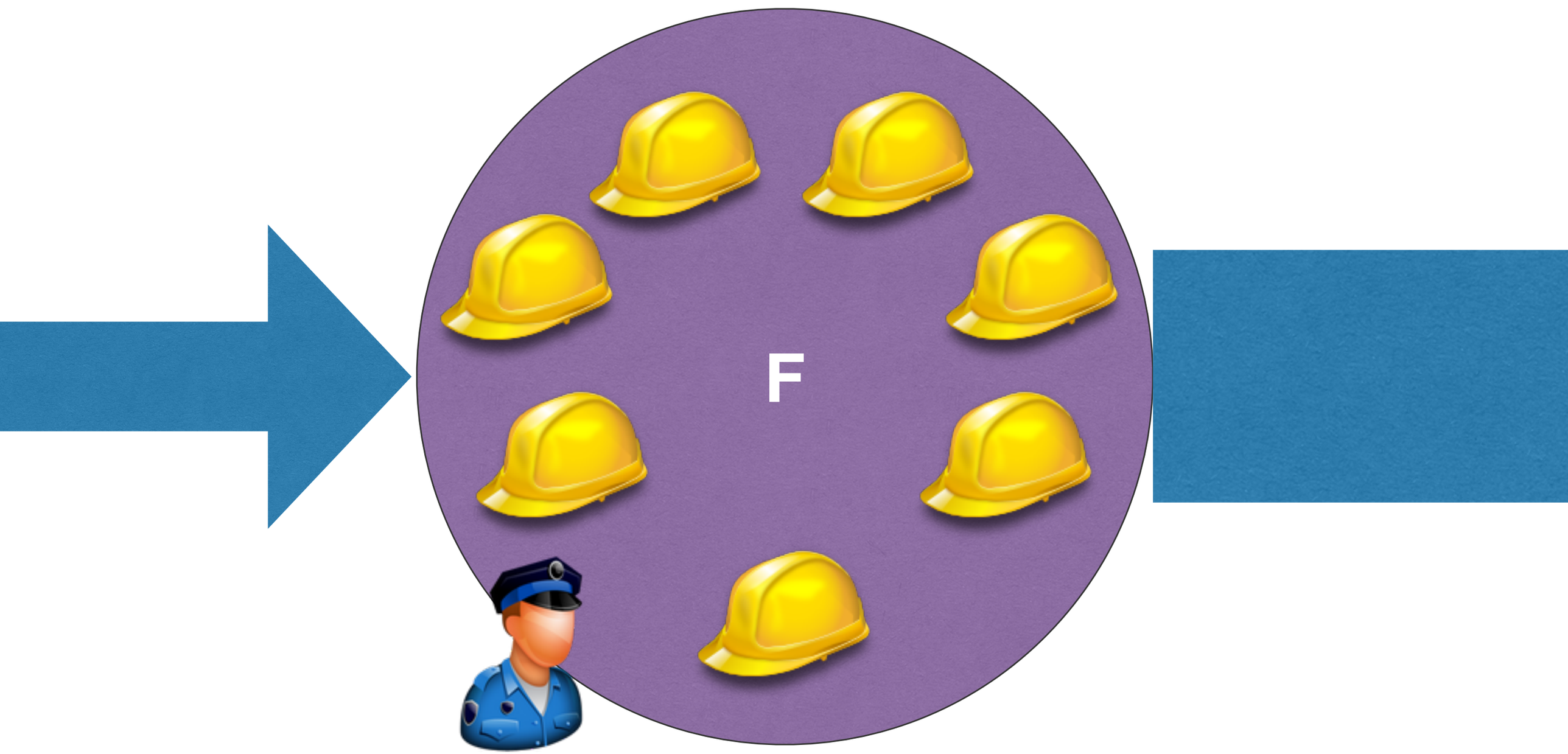

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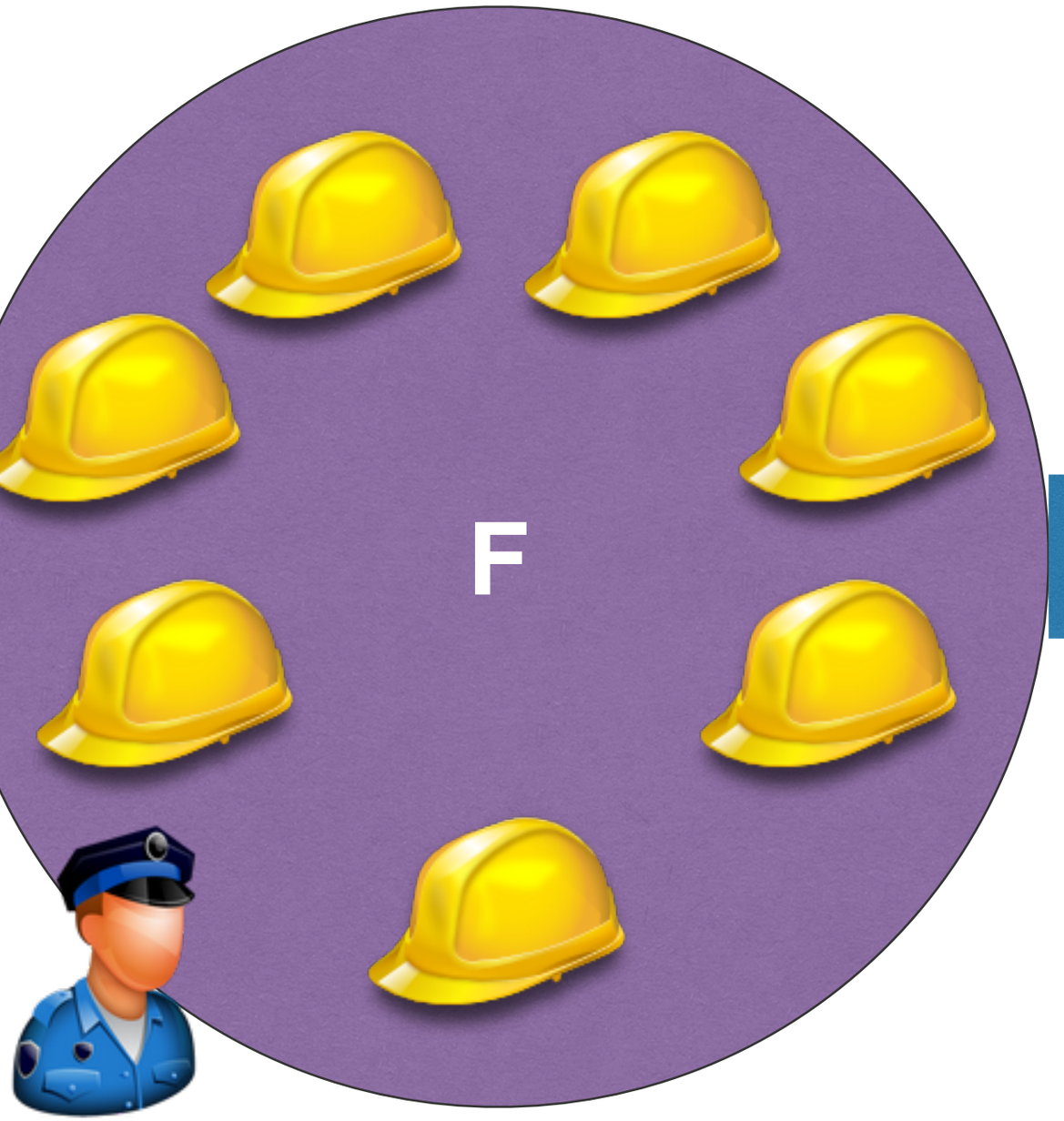

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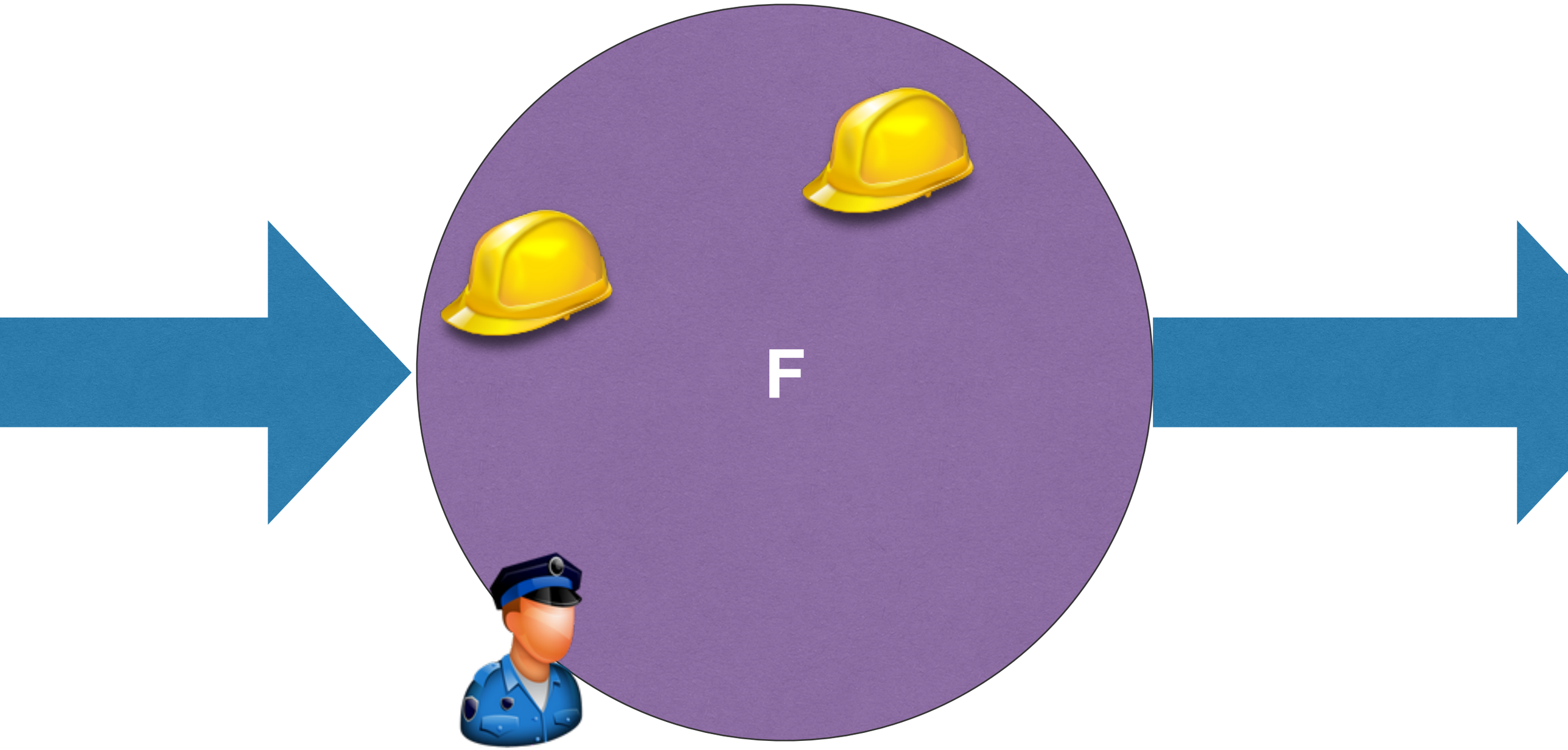

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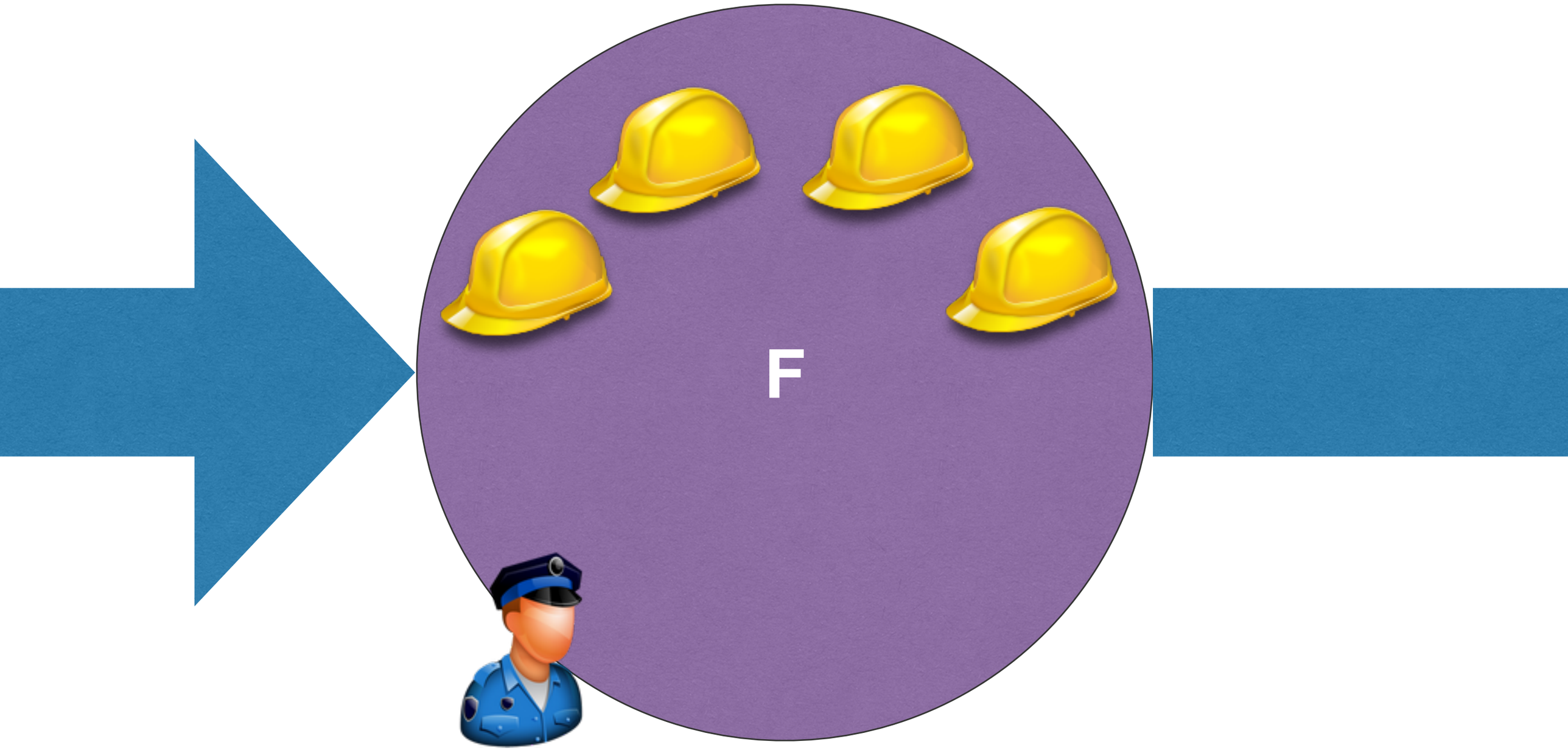

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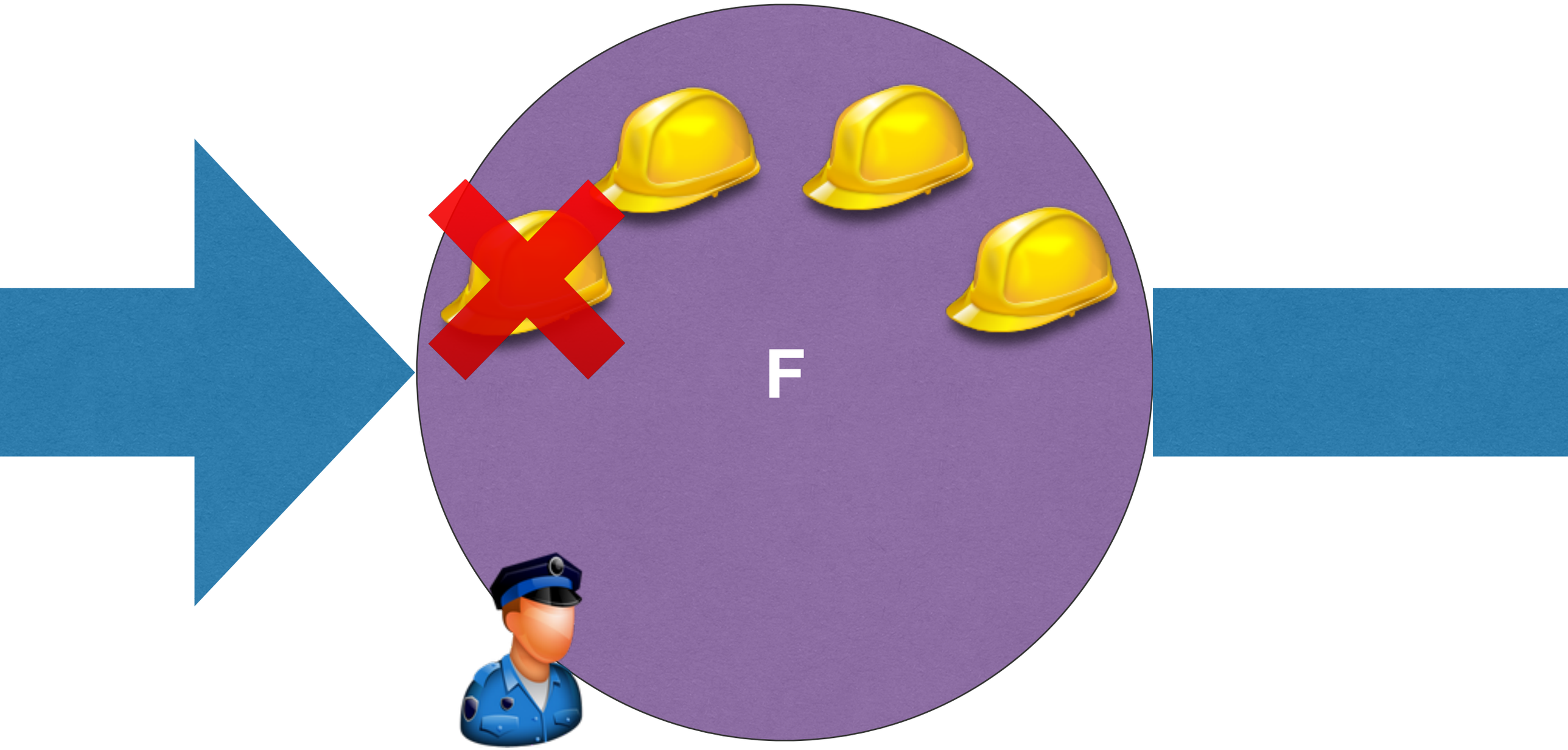

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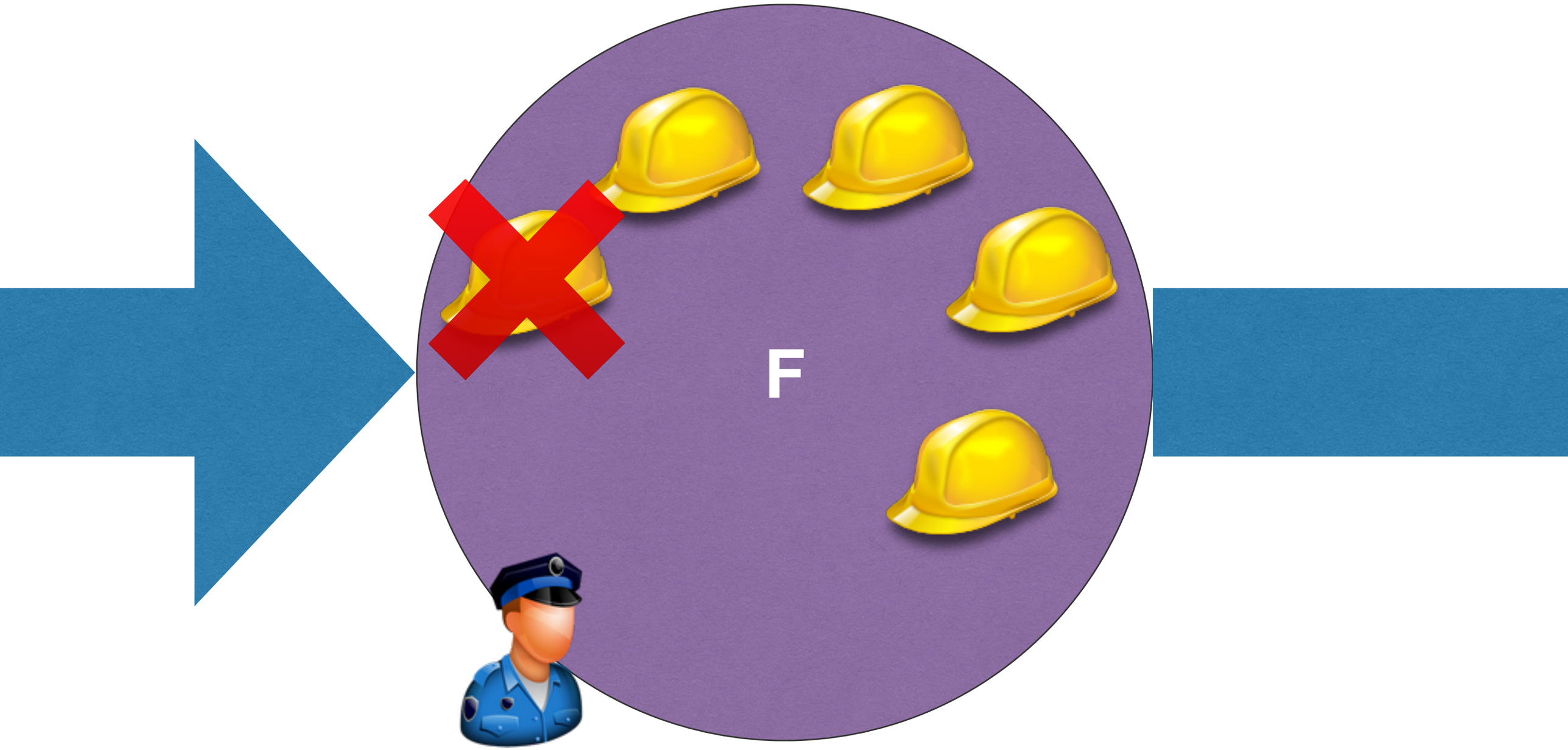

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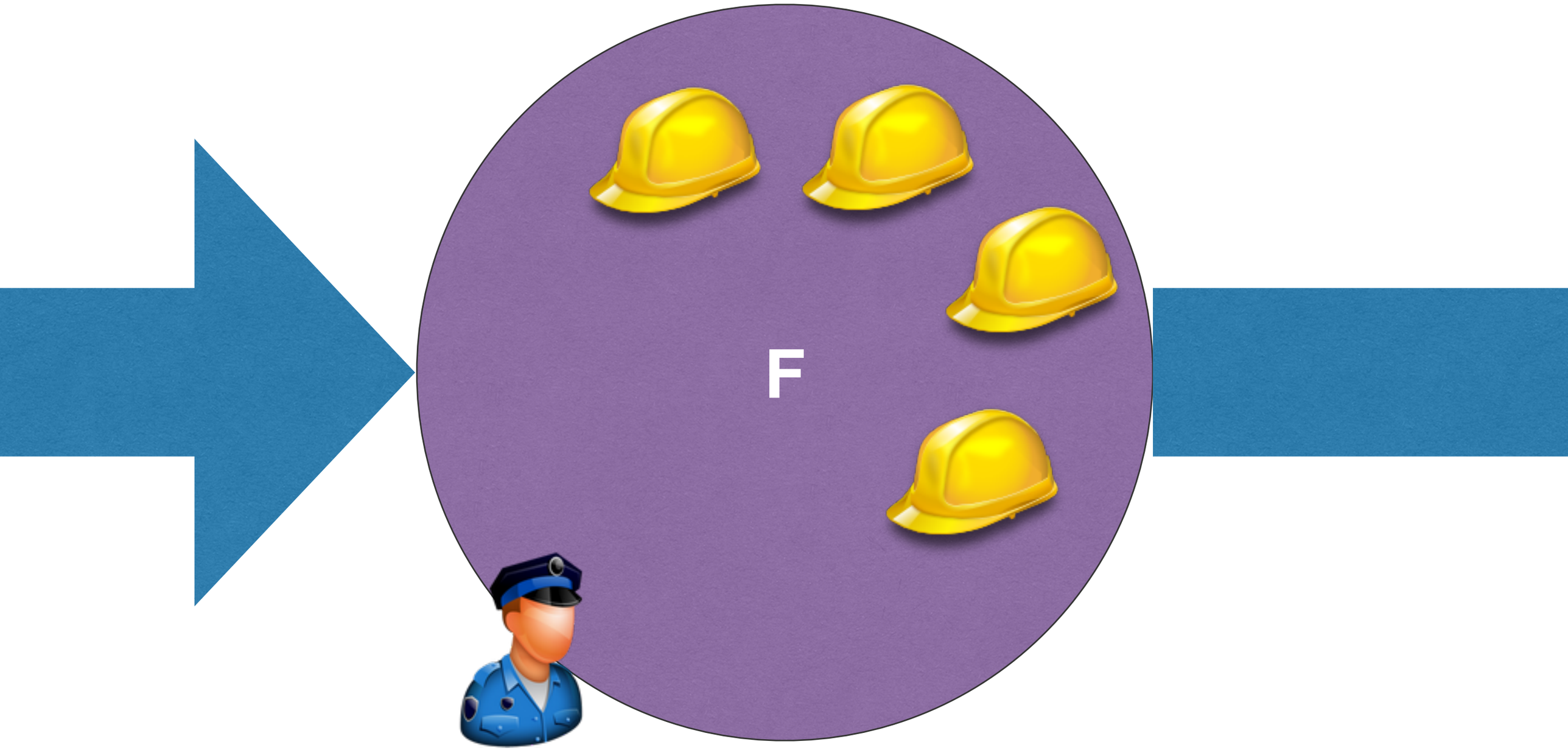

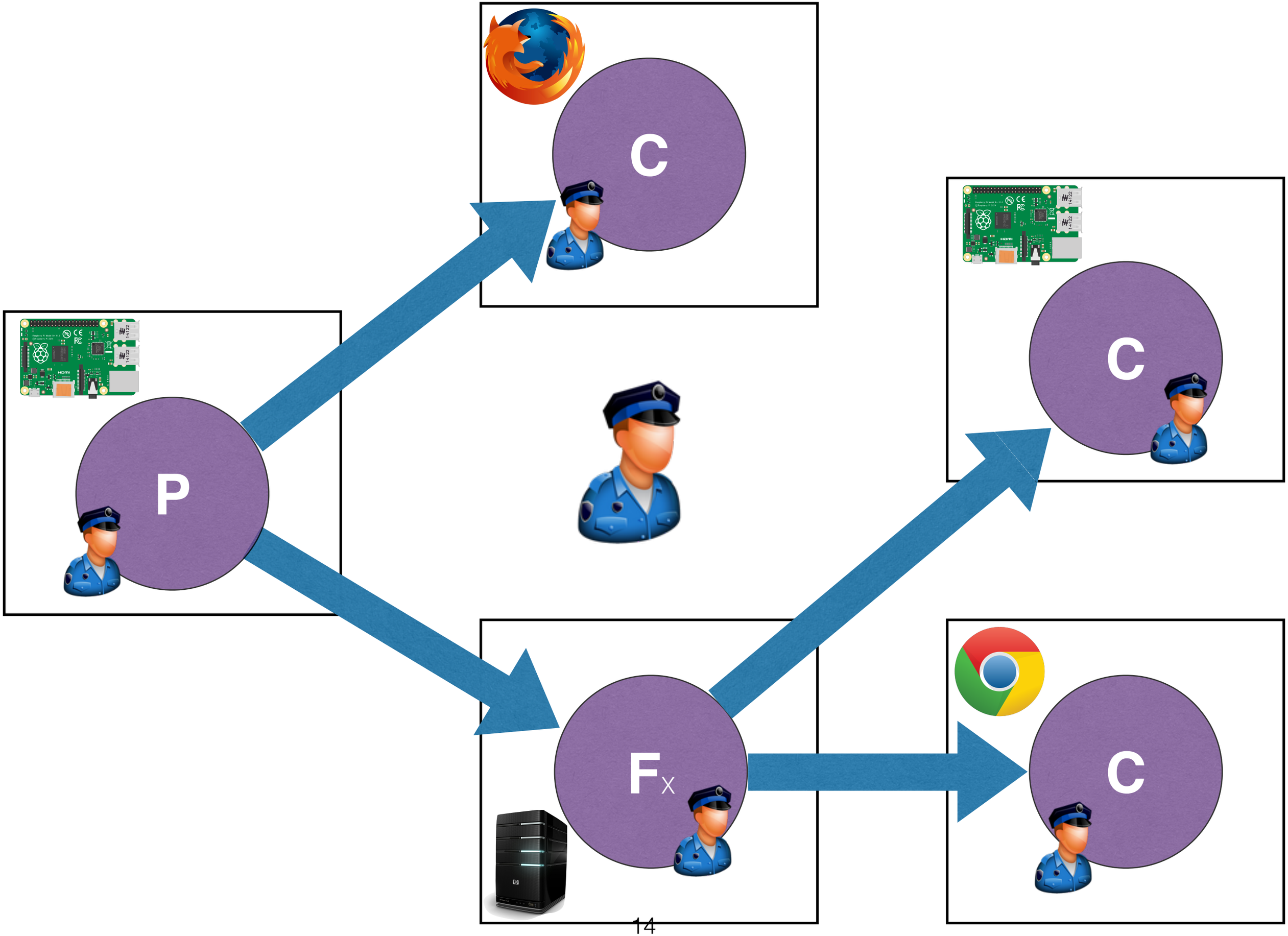
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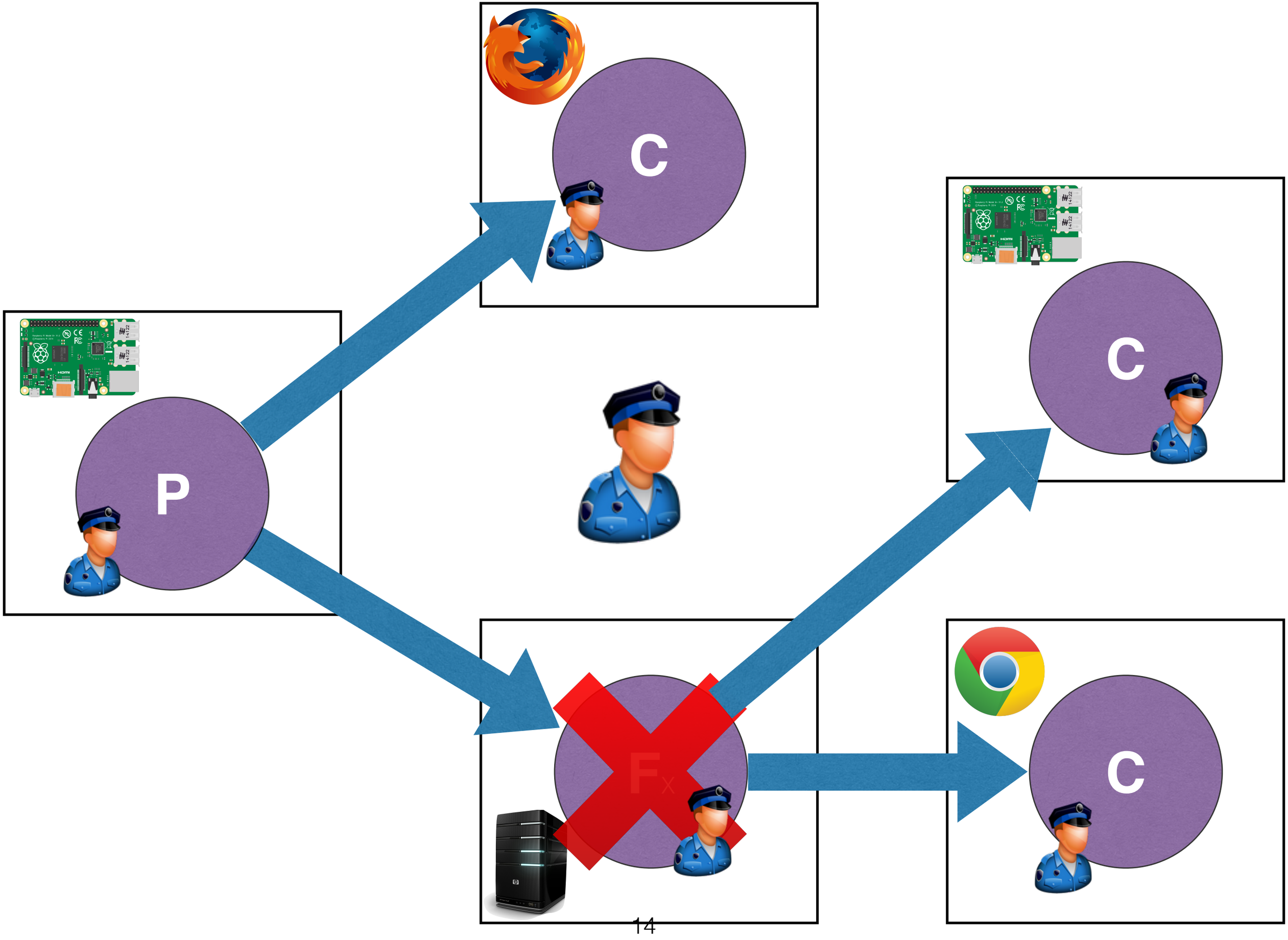
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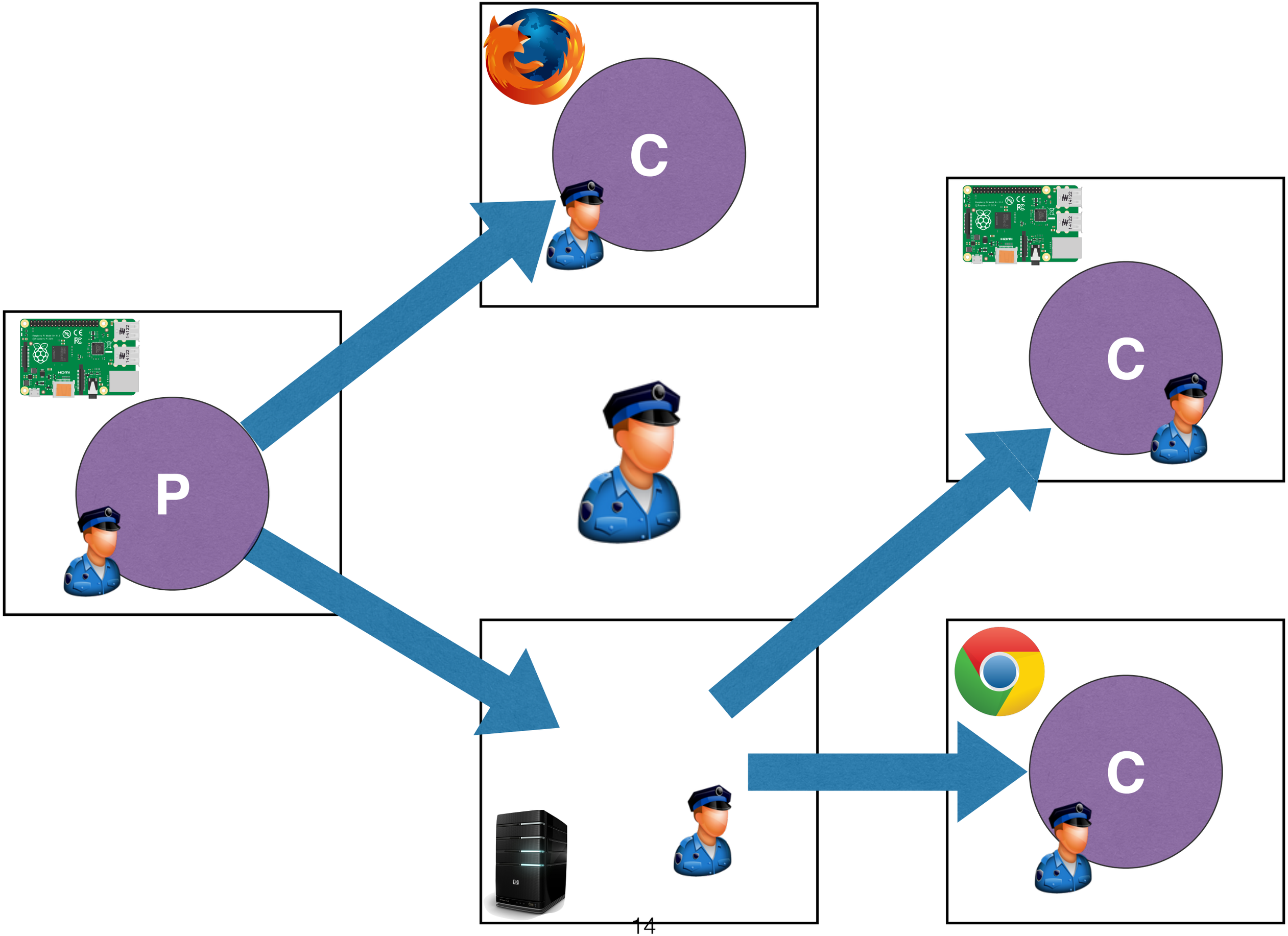
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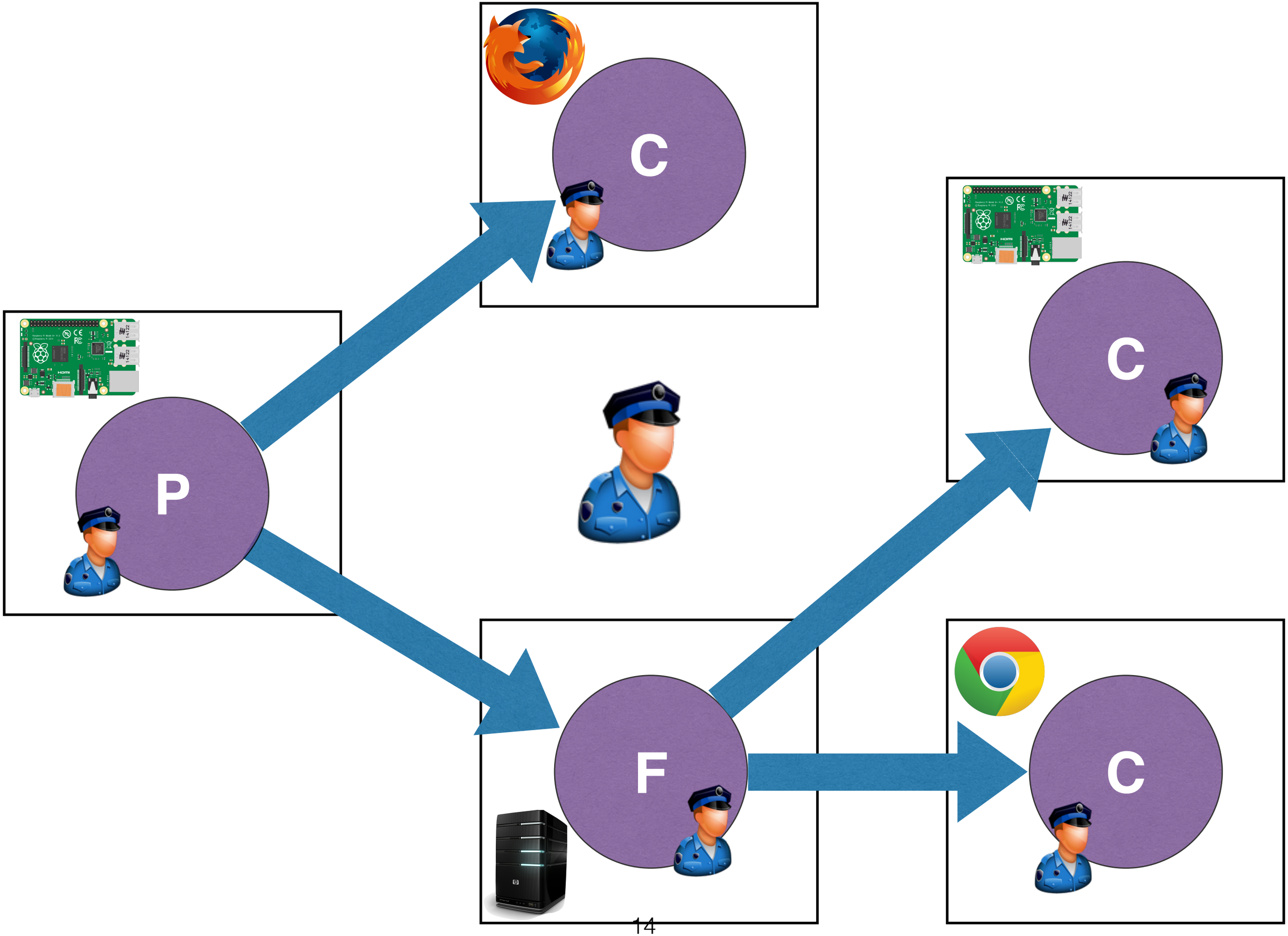
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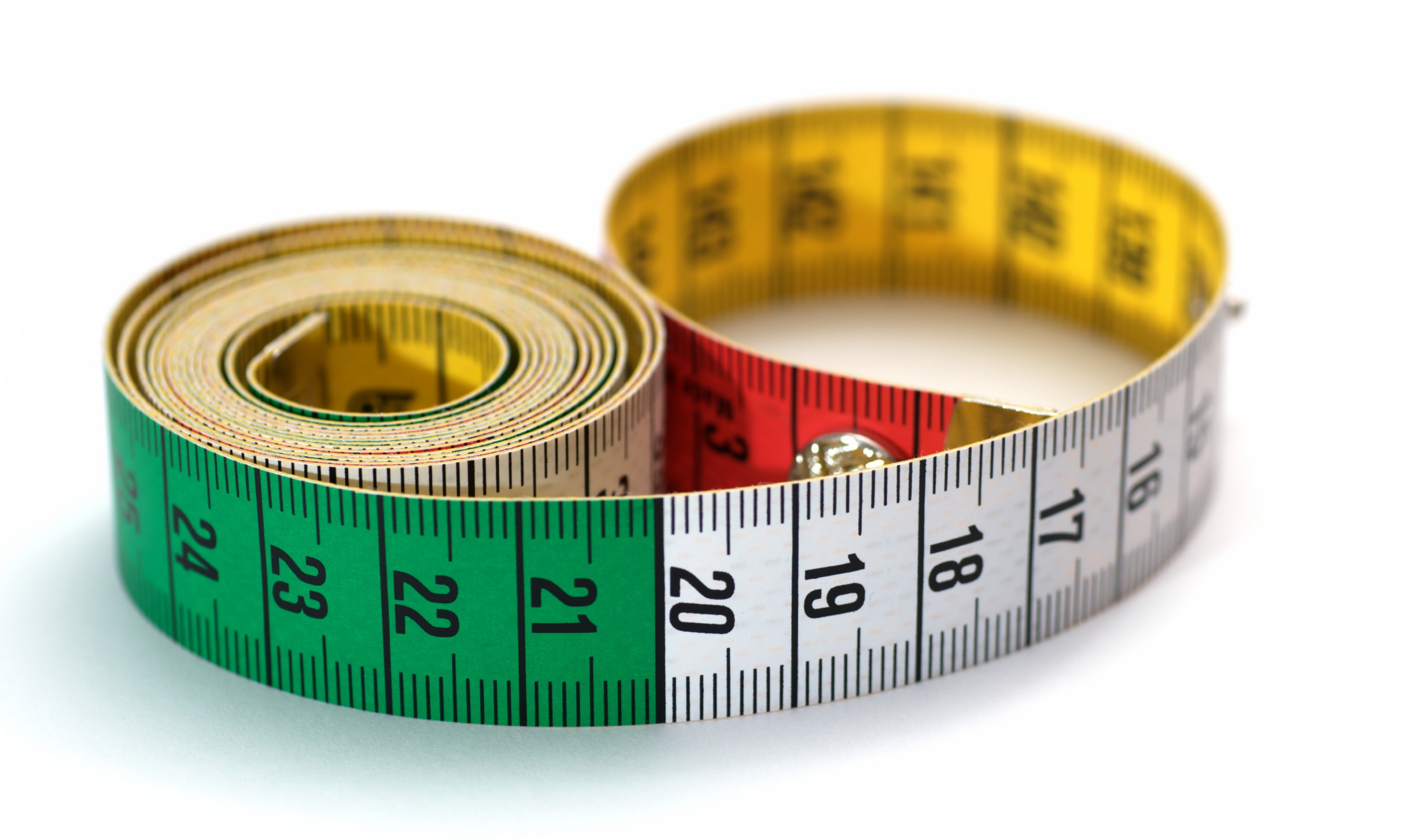
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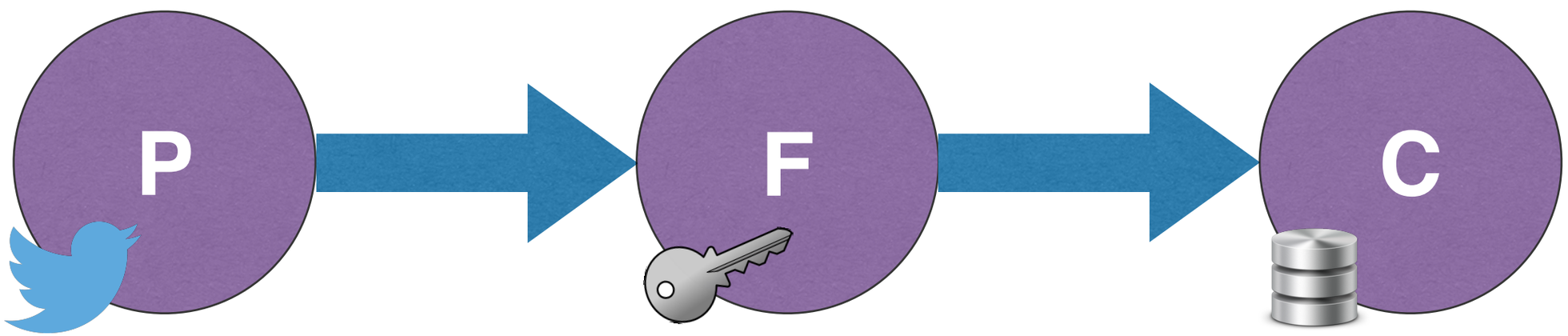
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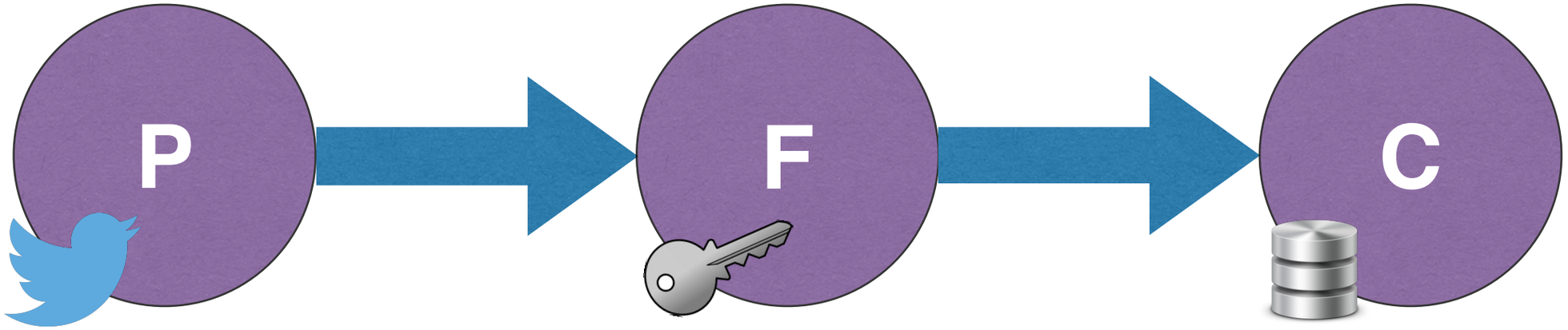
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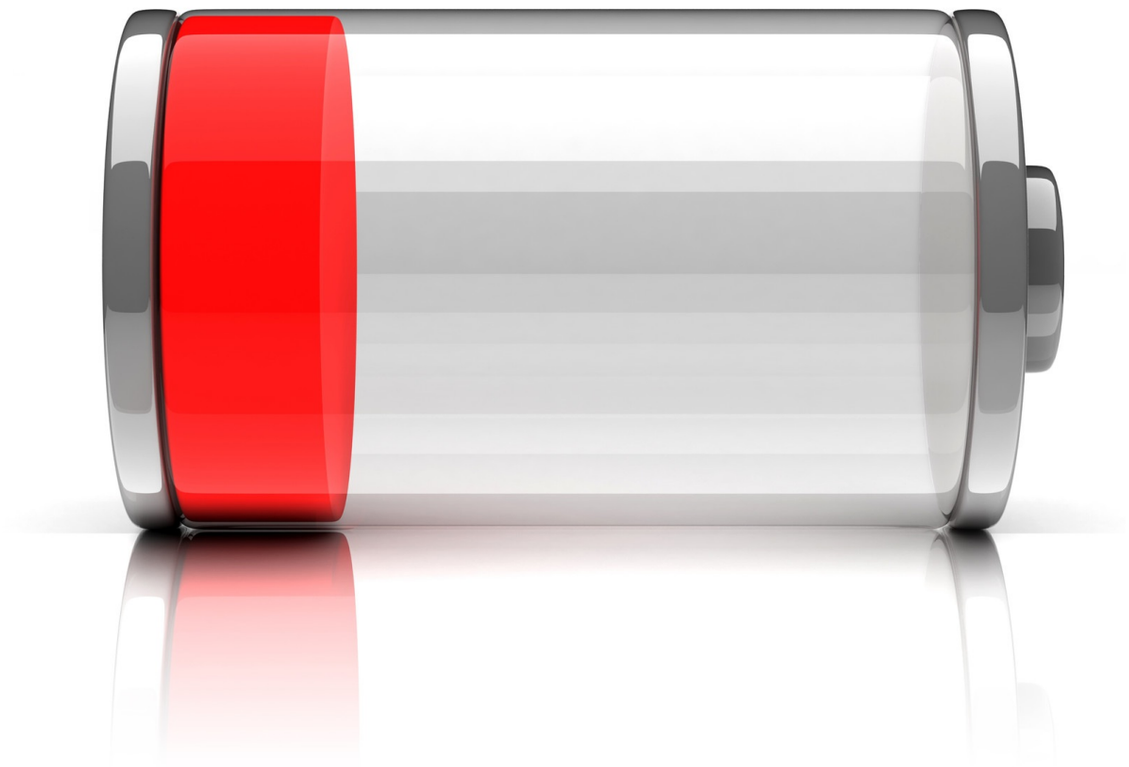
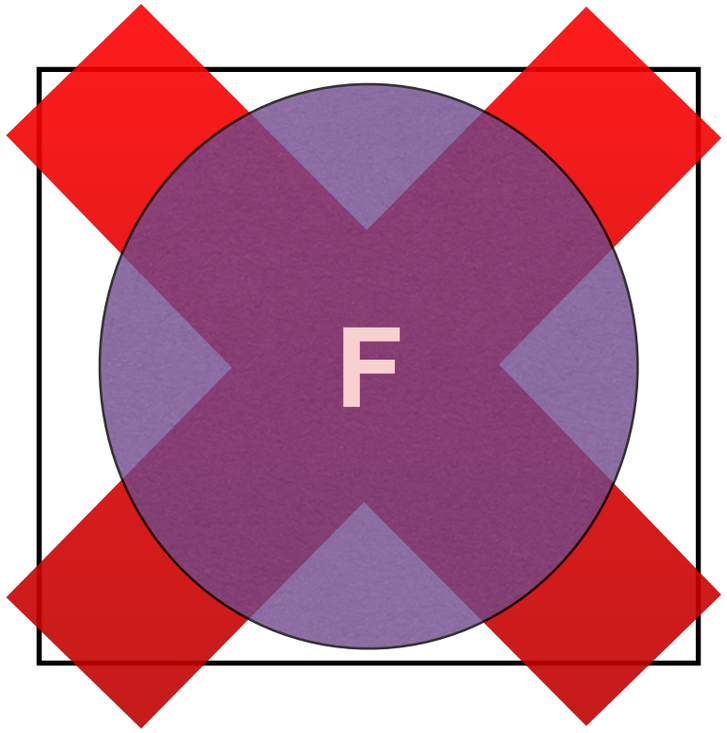
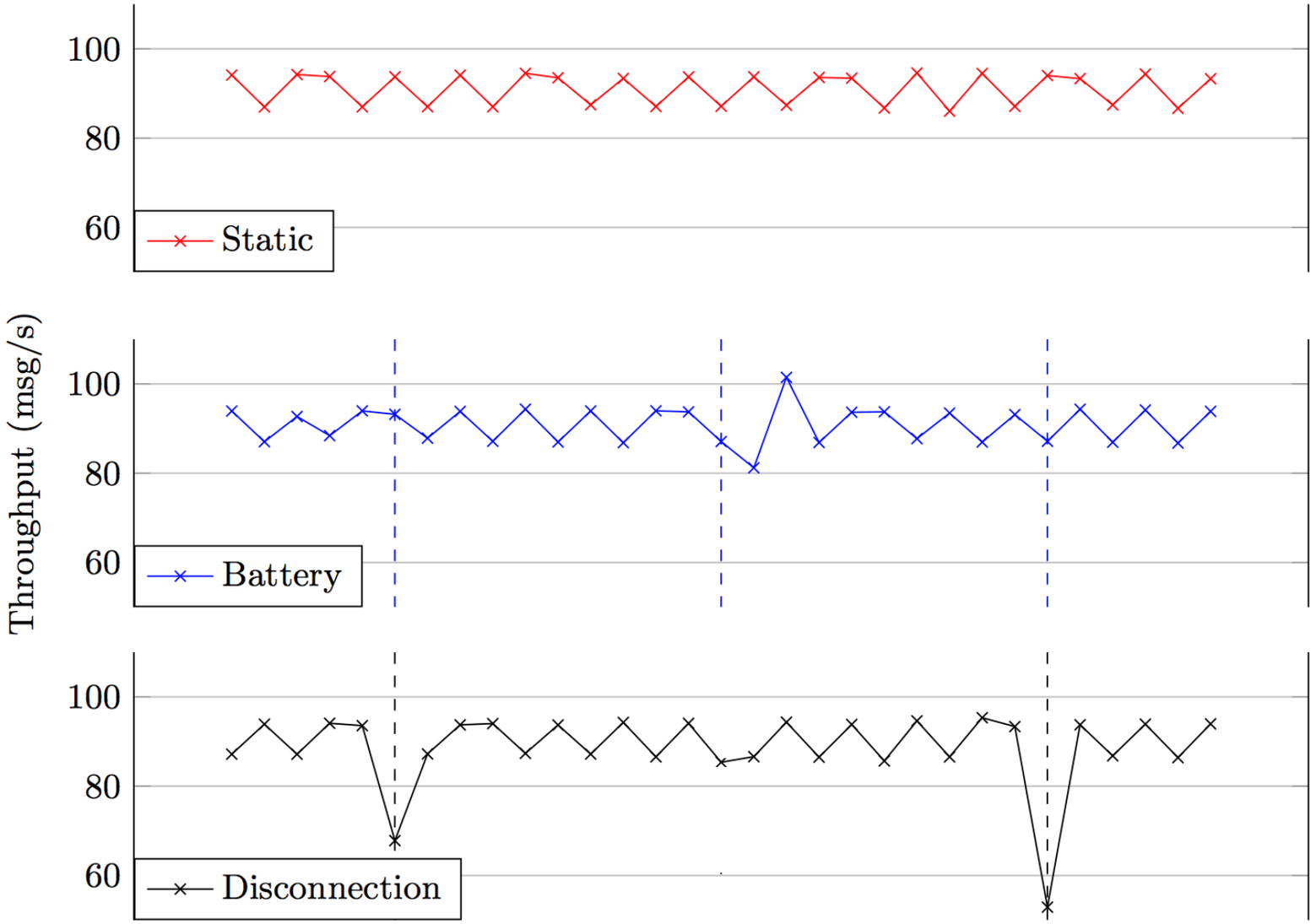



F

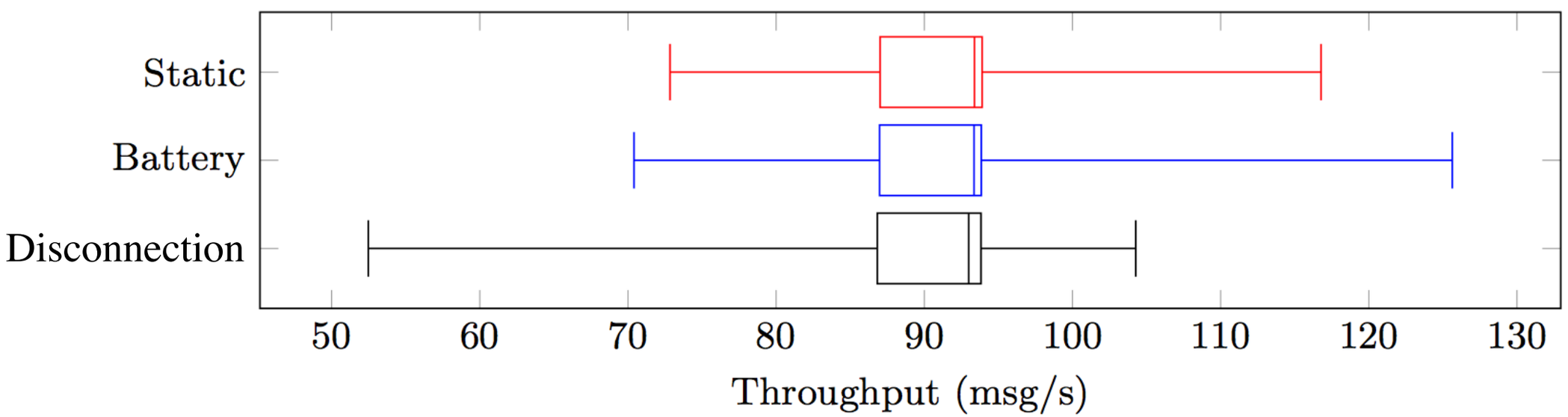
1

Every 5k msgs

Every 10k msgs

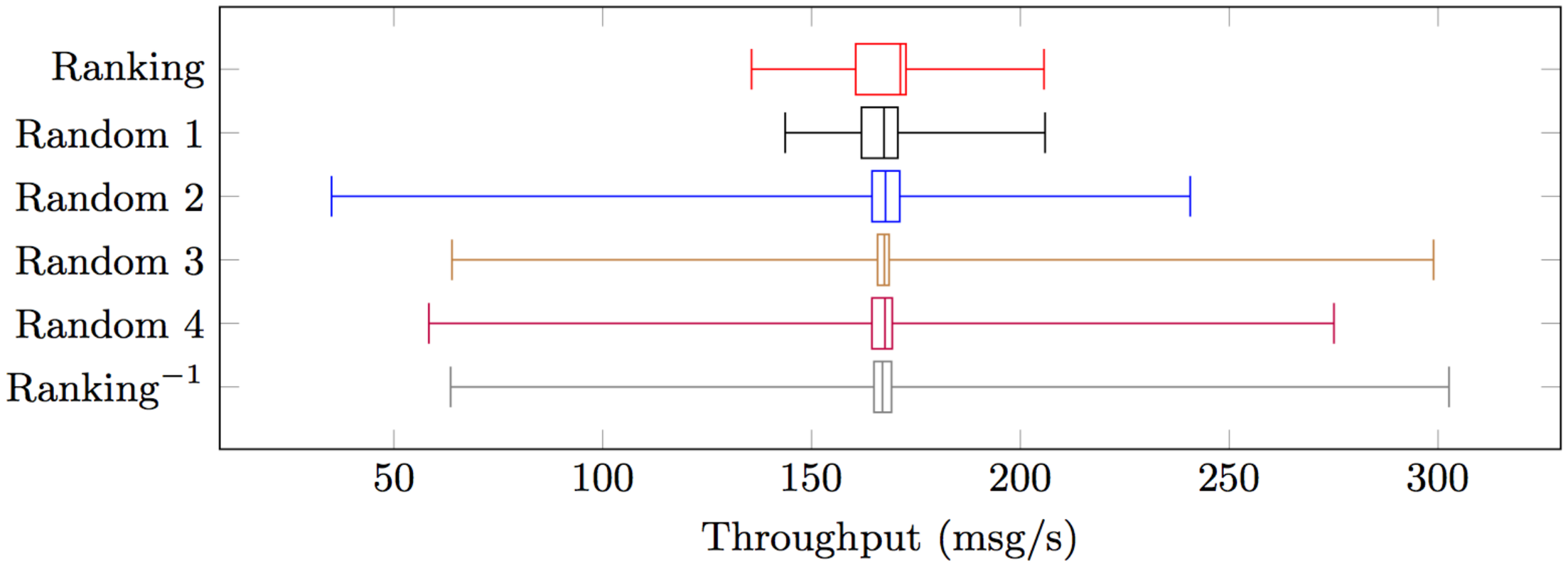


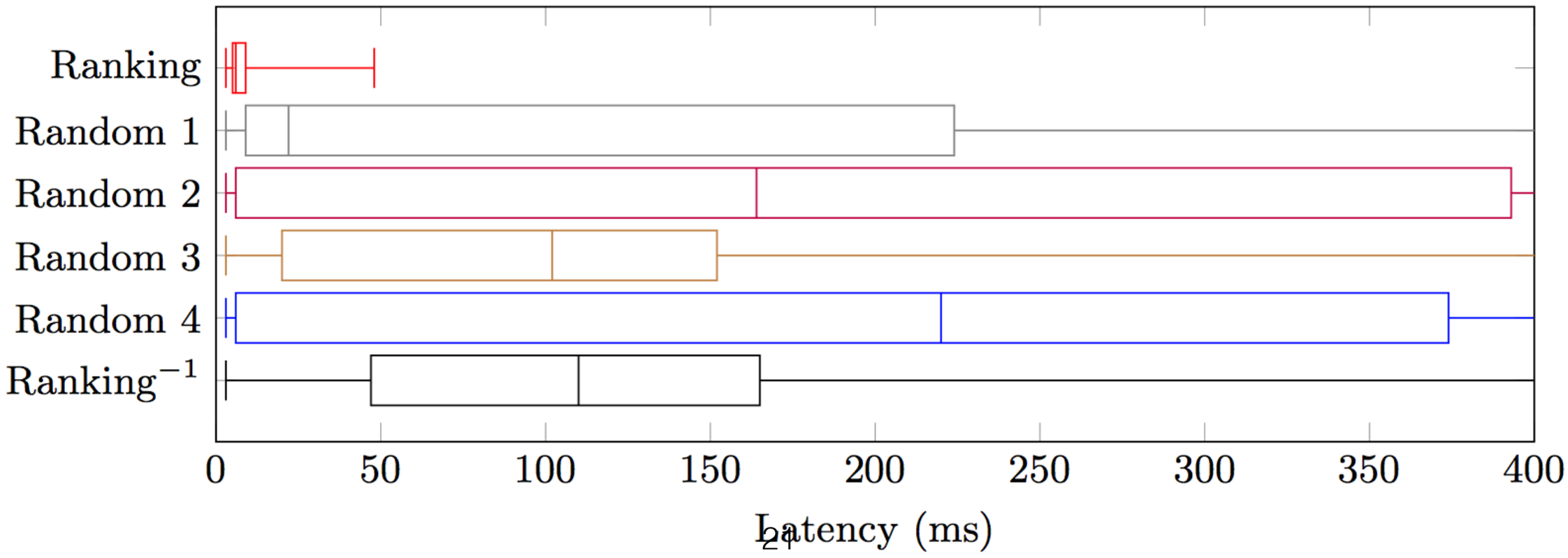
Experiment Time

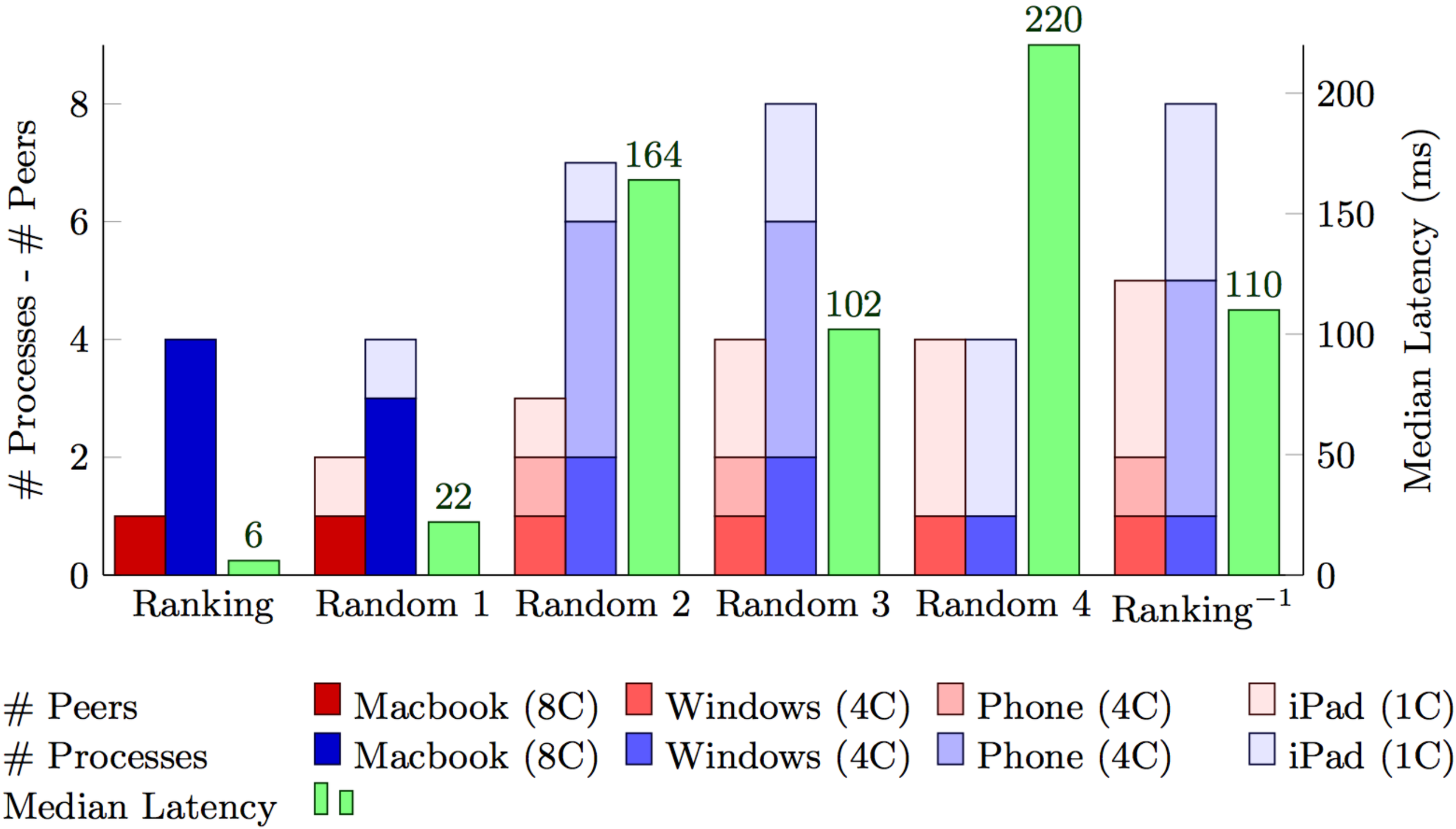


2

2


Ranking
Random 1
Random 2
Random 3
Random 4
Ranking^{-1}
50
100
150
200
250
300
Throughput (msg/s)


Ranking
Random 1
Random 2
Random 3
Random 4
Ranking^{-1}
0
50
100
150
200
250
300
350
400
Latency (ms)


220
164
110
102
22
6
Processes - # Peers
Median Latency (ms)
0
2
4
6
8
0
50
100
150
200
Ranking
Random 1
Random 2
Random 3
Random 4
Ranking^{-1}
Peers
Processes
Median Latency
Macbook (8C)
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Windows (4C)
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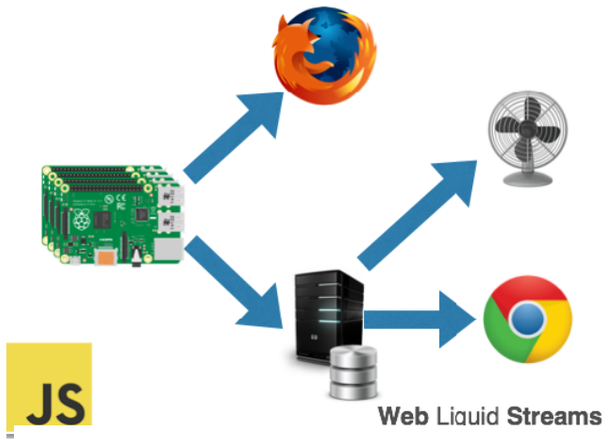
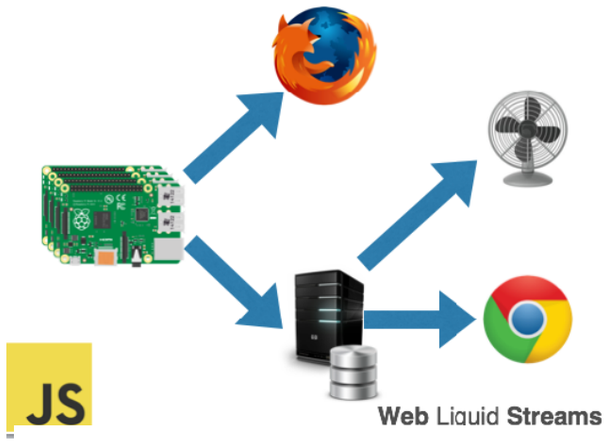
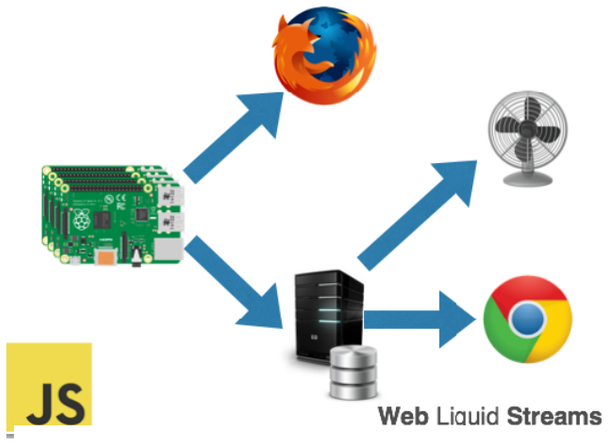
Phone (4C)
iPad (1C)
iPad (1C)

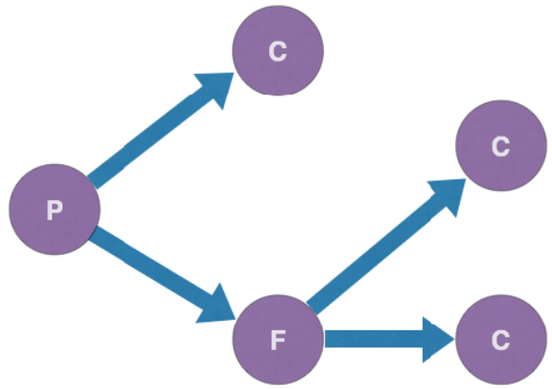

JS
Web Liquid Streams

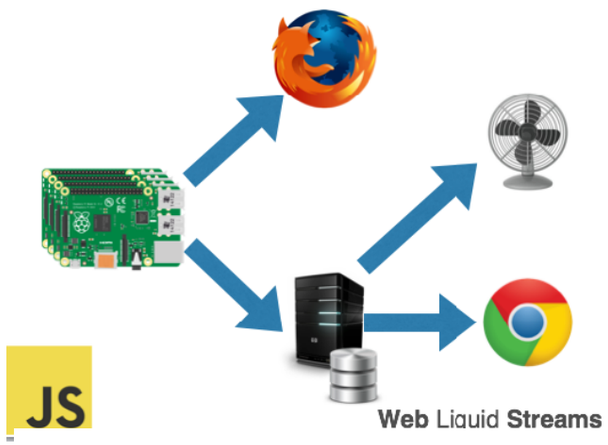

JS
Web Liquid Streams


WebRTC
JS

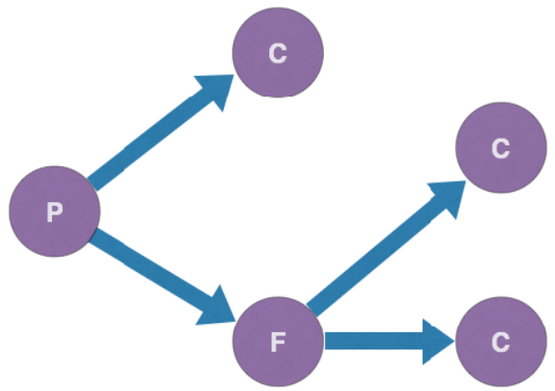

JS
Web Liquid Streams


WebRTC


C
C
P
F
C


JS
Web Liquid Streams


WebRTC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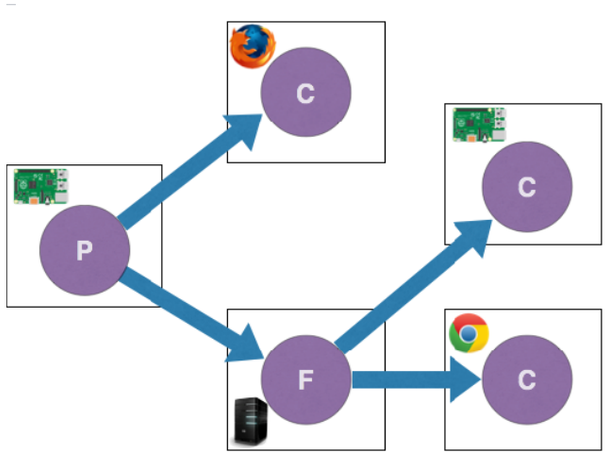
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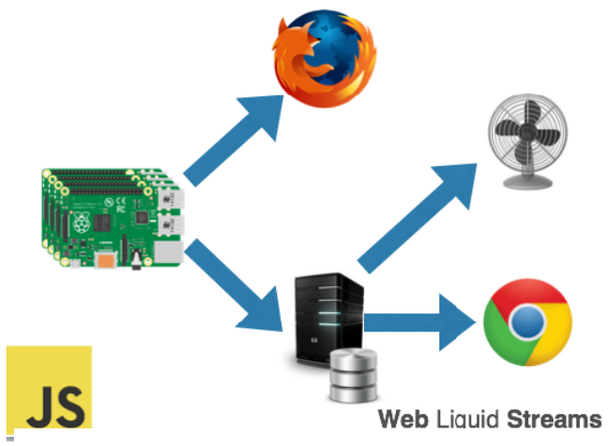
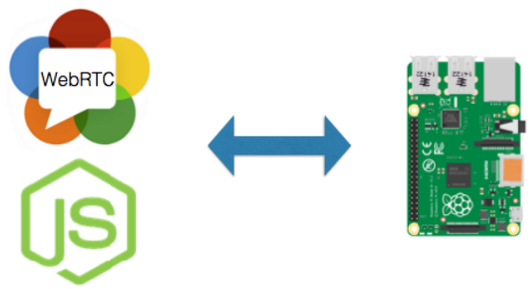
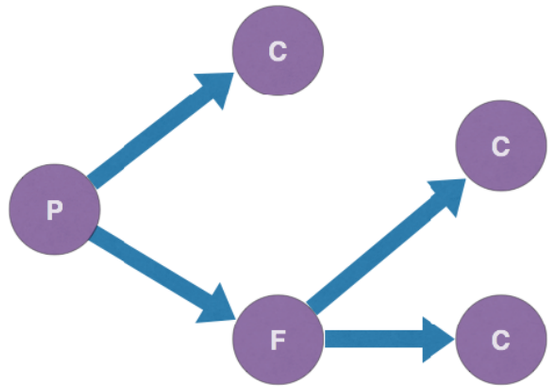
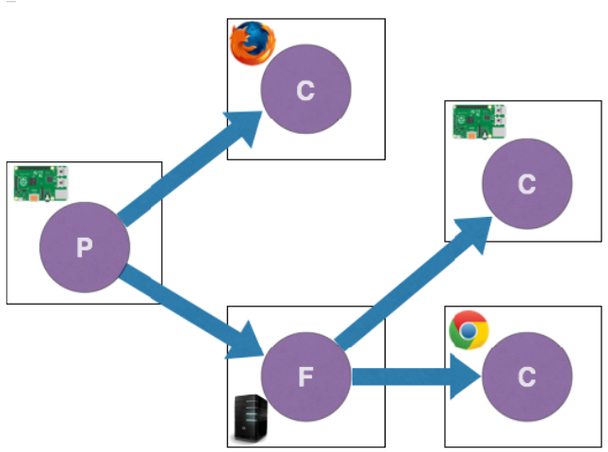
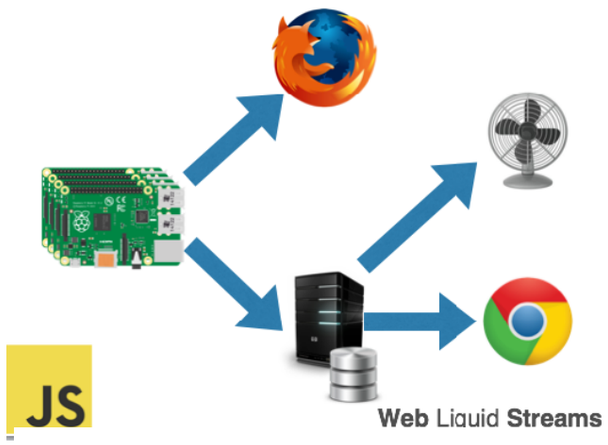


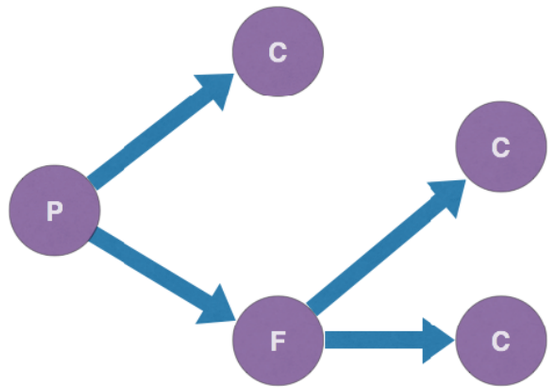






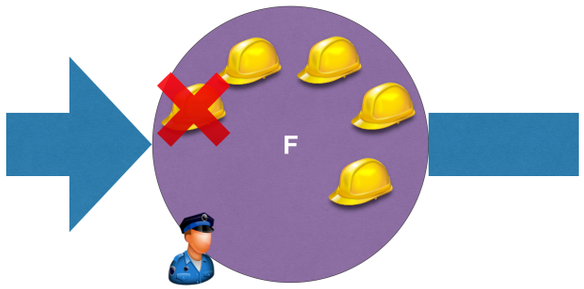
			R_1	R_2	R_3
Peer	*Con.*	Hardware	x	x	x
		CPU		x	
	Variables	Energy		x	
		Battery		x	
		Parallelism		x	
		Deployment Cost			
		Queue Size			x
		Execution Time			x
Connector	*Con.*	Network Typology			x
		Bandwidth (Upload)			x
		Bandwidth (Download)			x
	Var.	Message size (incoming)			x
		Message size (outgoing)			x
		Message rate (incoming)			x
		Message rate (outgoing)			x
		RTT			x
Topology	*Con.*	Hardware Dependencies	x	x	x
		Whitelist	x	x	x
		Blacklist	x	x	x
	Var.	Delay			
		Throughput			

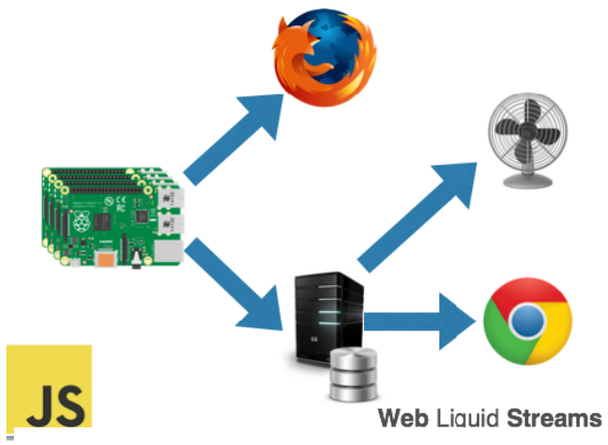


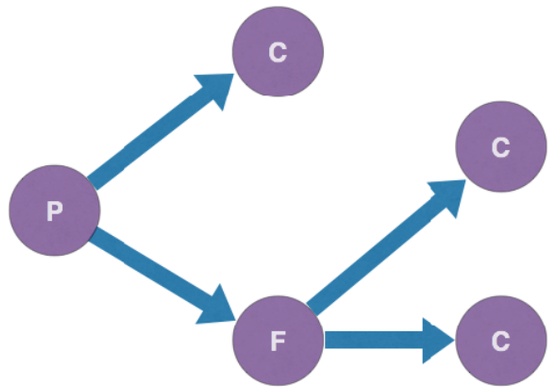


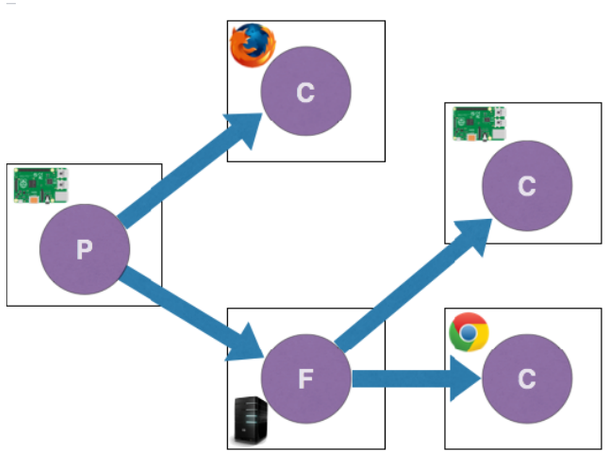
			R_1	R_2	R_3
Peer	*Con.*	Hardware	x	x	x
	Variables	CPU		x	
		Energy		x	
		Battery		x	
		Parallelism		x	
		Deployment Cost			
		Queue Size			x
		Execution Time			x
Connector	*Con.*	Network Typology			x
		Bandwidth (Upload)			x
		Bandwidth (Download)			x
	Var.	Message size (incoming)			x
		Message size (outgoing)			x
		Message rate (incoming)			x
		Message rate (outgoing)			x
		RTT			x
Topology	*Con.*	Hardware Dependencies	x	x	x
		Whitelist	x	x	x
		Blacklist	x	x	x
	Var.	Delay			
		Throughput			

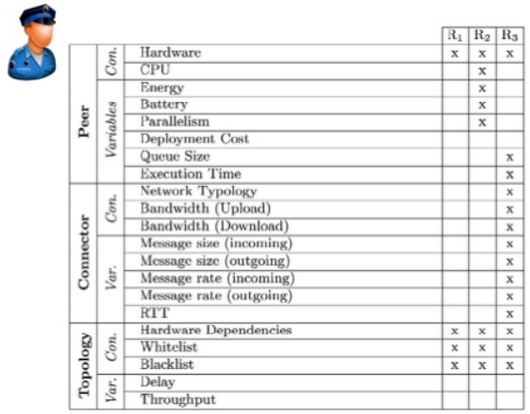
Fault Tolerance





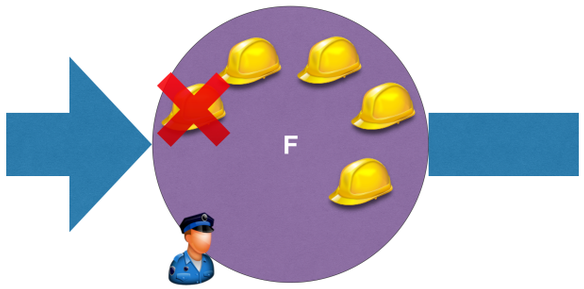


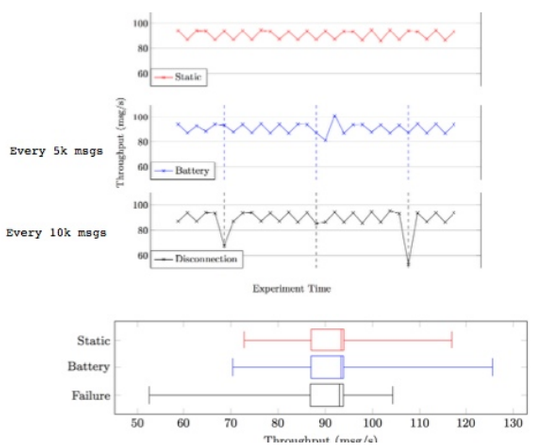


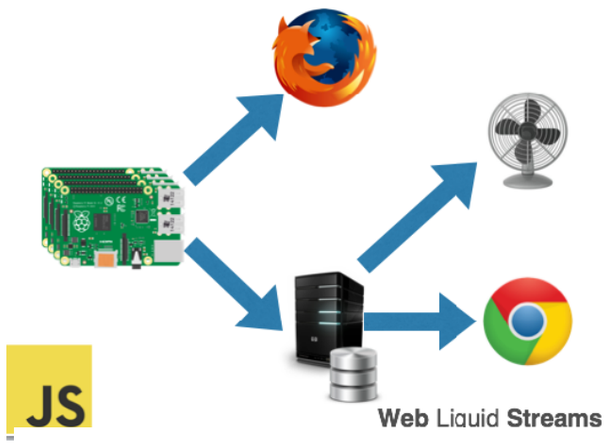


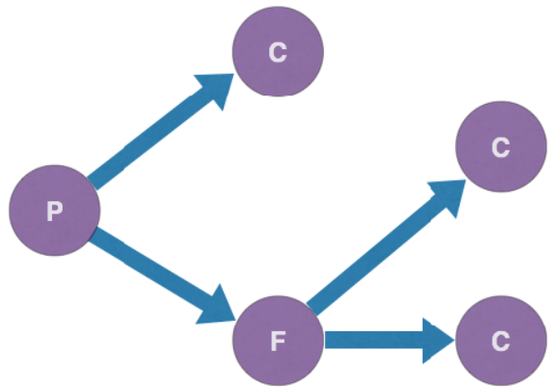
			R_1	R_2	R_3
Peer	*Con.*	Hardware	x	x	x
	Variables	CPU		x	
		Energy		x	
		Battery		x	
		Parallelism		x	
		Deployment Cost			
		Queue Size			x
		Execution Time			x
Connector	*Con.*	Network Typology			x
		Bandwidth (Upload)			x
		Bandwidth (Download)			x
	Var.	Message size (incoming)			x
		Message size (outgoing)			x
		Message rate (incoming)			x
		Message rate (outgoing)			x
		RTT			x
Topology	*Con.*	Hardware Dependencies	x	x	x
		Whitelist	x	x	x
		Blacklist	x	x	x
	Var.	Delay			
		Throughput			

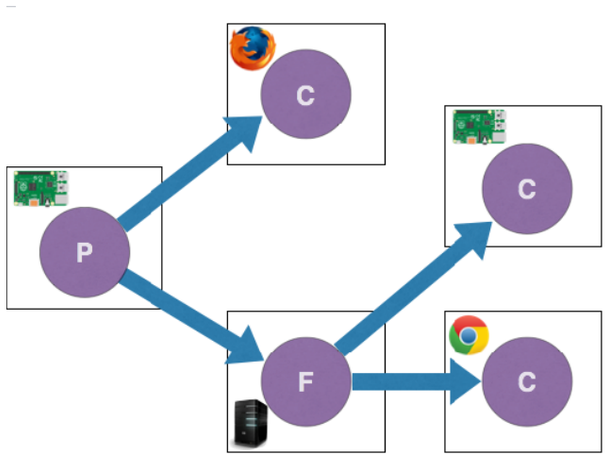
Fault Tolerance





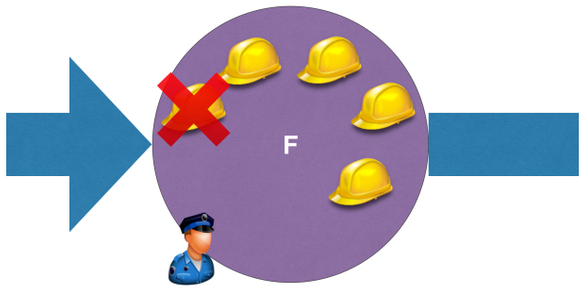


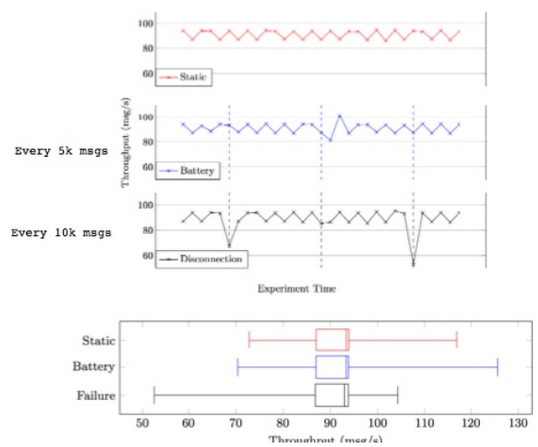


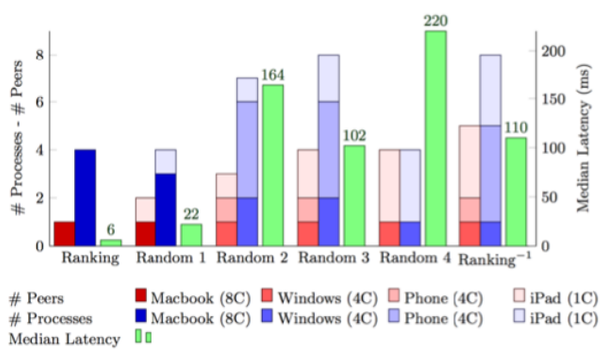


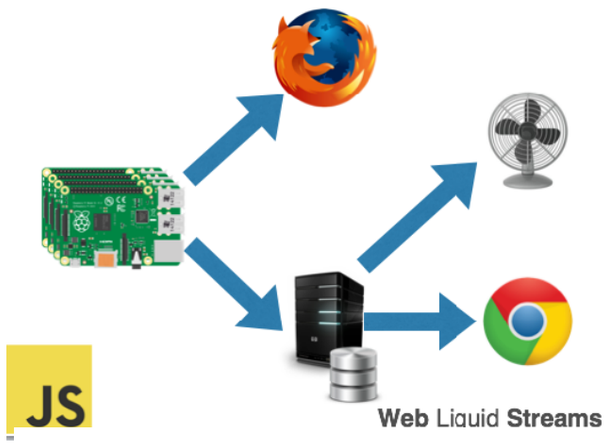
			R_1	R_2	R_3
Peer	*Con.*	Hardware	x	x	x
	Variables	CPU		x	
		Energy		x	
		Battery		x	
		Parallelism		x	
		Deployment Cost			
		Queue Size			x
		Execution Time			x
Connector	*Con.*	Network Typology			x
		Bandwidth (Upload)			x
		Bandwidth (Download)			x
	Var.	Message size (incoming)			x
		Message size (outgoing)			x
		Message rate (incoming)			x
		Message rate (outgoing)			x
		RTT			x
Topology	*Con.*	Hardware Dependencies	x	x	x
		Whitelist	x	x	x
		Blacklist	x	x	x
	Var.	Delay			
		Throughput			

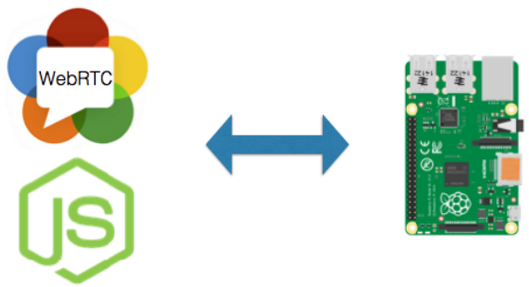
Fault Tolerance

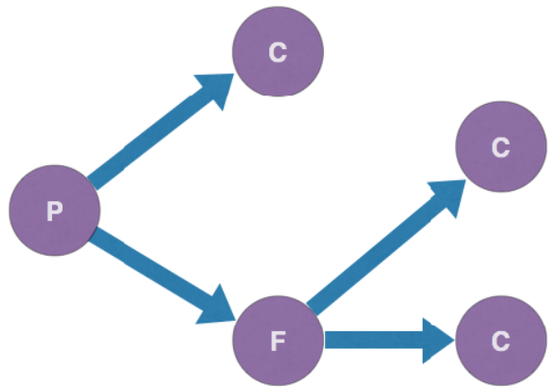


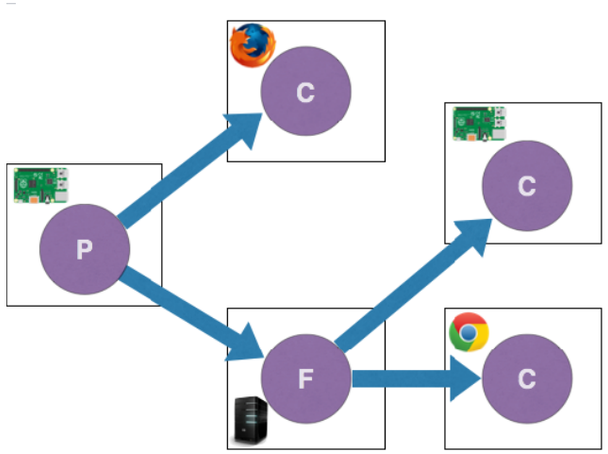


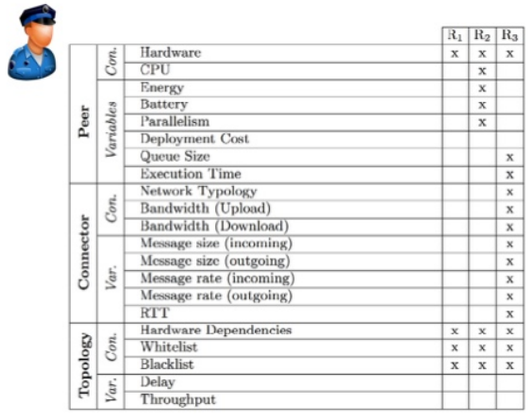






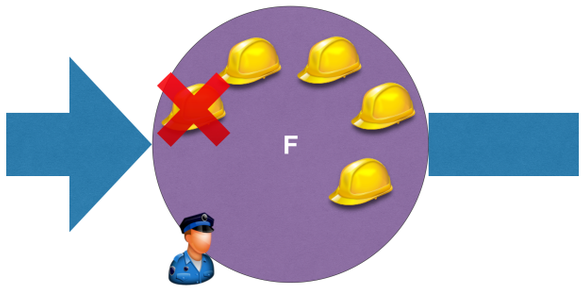


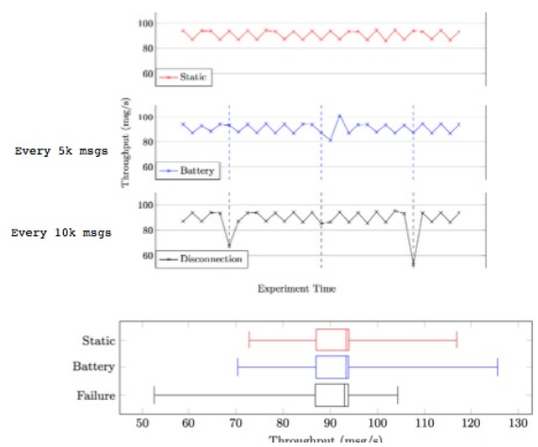


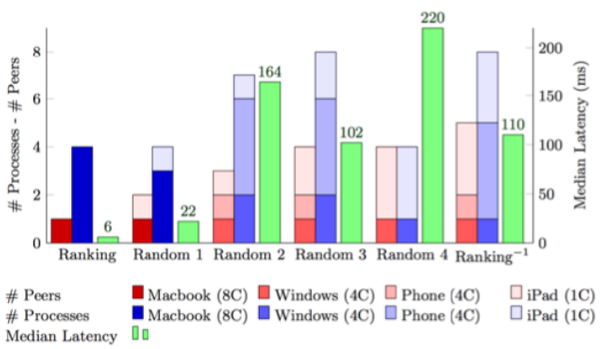


			R_1	R_2	R_3
Peer	*Con.*	Hardware	x	x	x
	Variables	CPU		x	
		Energy		x	
		Battery		x	
		Parallelism		x	
		Deployment Cost			
		Queue Size			x
		Execution Time			x
Connector	*Con.*	Network Typology			x
		Bandwidth (Upload)			x
		Bandwidth (Download)			x
	Var.	Message size (incoming)			x
		Message size (outgoing)			x
		Message rate (incoming)			x
		Message rate (outgoing)			x
		RTT			x
Topology	*Con.*	Hardware Dependencies	x	x	x
		Whitelist	x	x	x
		Blacklist	x	x	x
	Var.	Delay			
		Throughput			

Fault Tolerance








WebR
DEMO

Liquid Stream Processing Across Web Browsers and Web Servers

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Thank you.