software studio

analyzing origins

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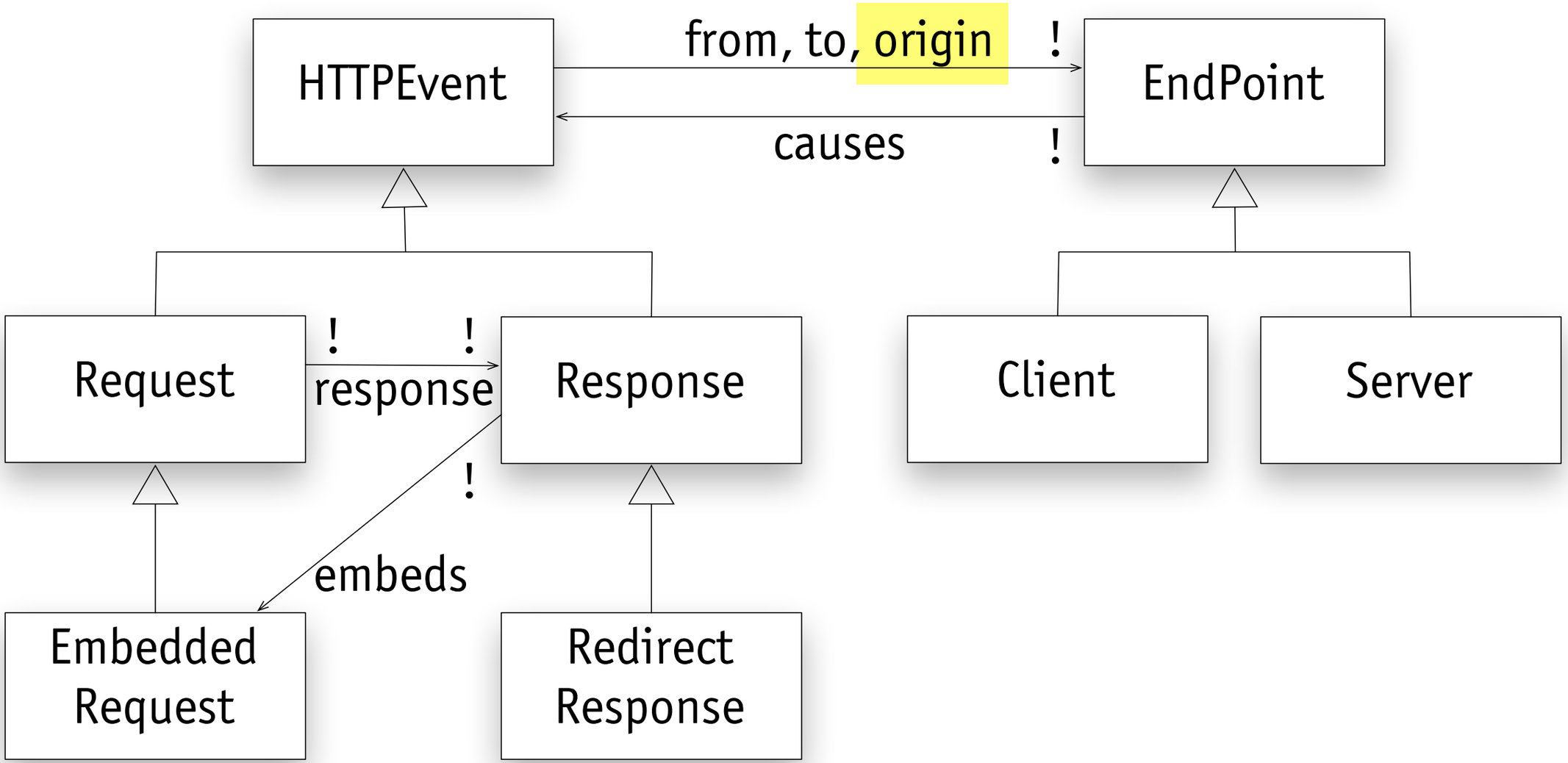
adding origins to our model



analysis steps

- define origin tracking & policy
- express security property
- check that policy implies property

define origin tracking

```
abstract sig EndPoint { causes: set HTTPEvent }
sig Client, Server extends EndPoint {}
abstract sig HTTPEvent {from, to: EndPoint}
sig Request extends HTTPEvent { response: Response }
sig Response extends HTTPEvent { embeds: set Request }
sig Embedded extends Request {}
sig Redirect extends Response { }
```

```
fact Origin {
    // for a redirect, origin is same as request; else server
    all r: Request | r.response.origin =
        (r.response in Redirect implies r.origin else r.response.from)

    // embedded requests have the same origin as the response
    all r: Response, e: r.embeds | e.origin = r.origin

    // requests that are not embedded come from the client
    all r: Request - Embedded | r.origin = r.from
    }
```

define policy

```
pred appliesSOP (s: Server) {
        // request is only accepted if origin is server itself or sender
        all r: Request | r.to = s implies r.origin = r.to or r.origin = r.from
        }
```

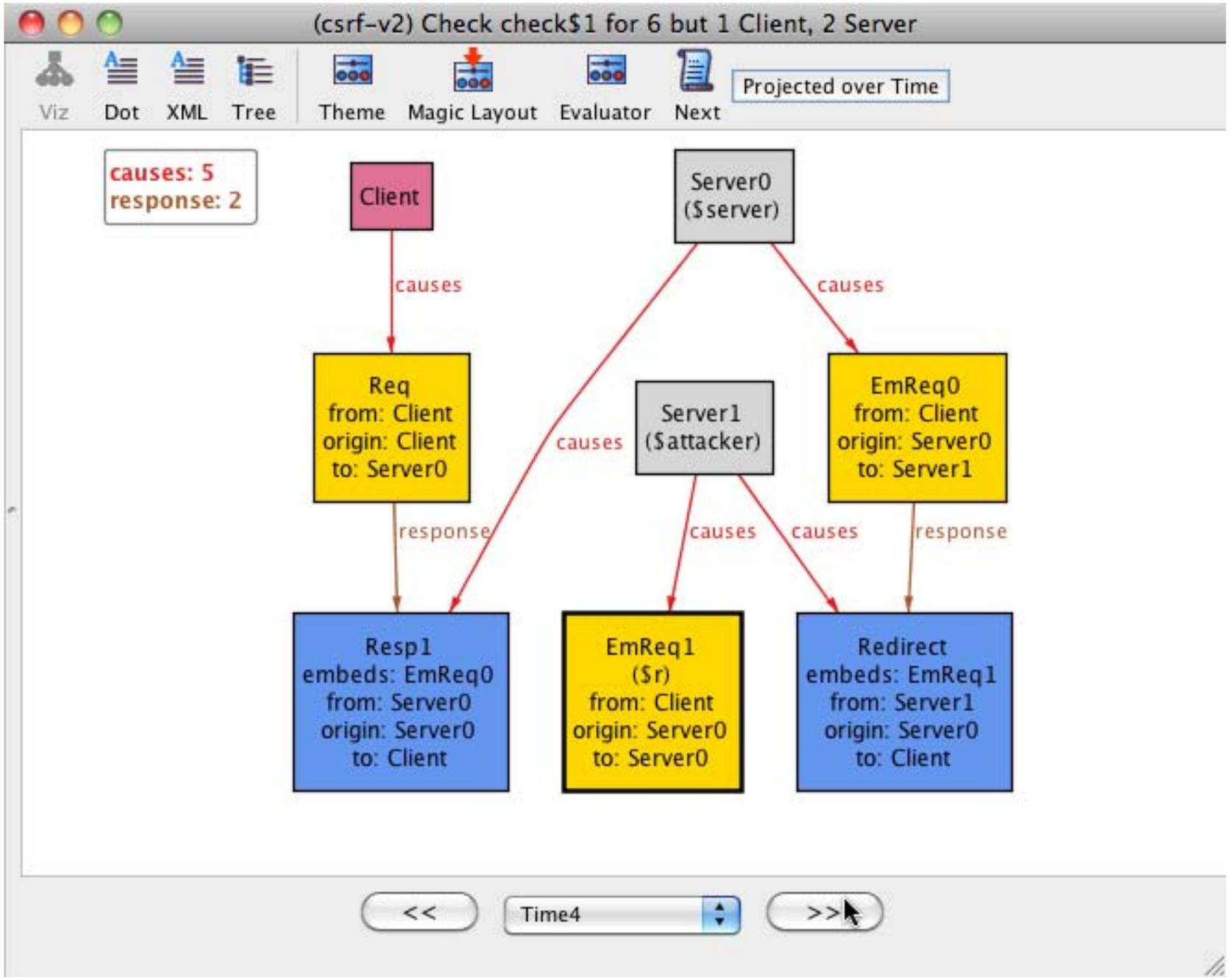
express policy

```
check {
    no server: Server, attacker: Server - server {
        // no direct request to attacker
        no r: Request | r.to = attacker and r.origin in Client

        // trusted server obeys origin policy
        server.appliesSOP

        // and attacker still gets request through
        some r: attacker.causes | r.to = server
        }
} for 6 but 1 Client, 2 Server
```

attack!


(csrf-v2) Check check$1 for 6 but 1 Client, 2 Server
Viz
Dot
XML
Tree
Theme
Magic Layout
Evaluator
Next
Projected over Time
causes: 5
response: 2
Client
Server0
($server)
causes
causes
Req
from: Client
origin: Client
to: Server0
causes
Server1
($attacker)
EmReq0
from: Client
origin: Server0
to: Server1
response
causes
causes
response
Resp1
embeds: EmReq0
from: Server0
origin: Server0
to: Client
EmReq1
($r)
from: Client
origin: Server0
to: Server0
Redirect
embeds: EmReq1
from: Server1
origin: Server0
to: Client
<<
Time4
>>

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