Universally Composable Network Time Protocol

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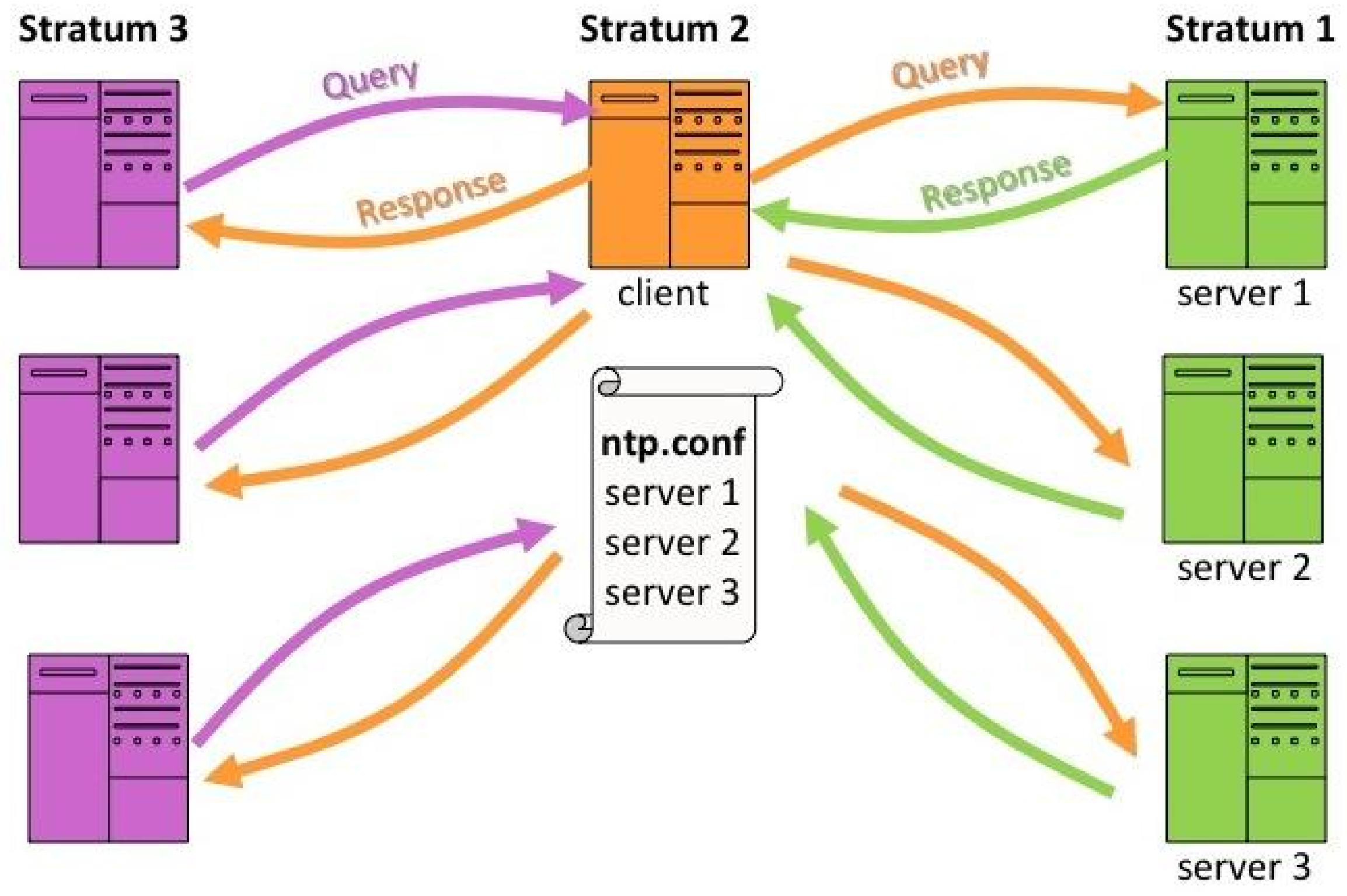
Network Time Protocol (NTP) gives time to computer systems on the Internet in a query-response fashion.



Why do we care about NTP security?

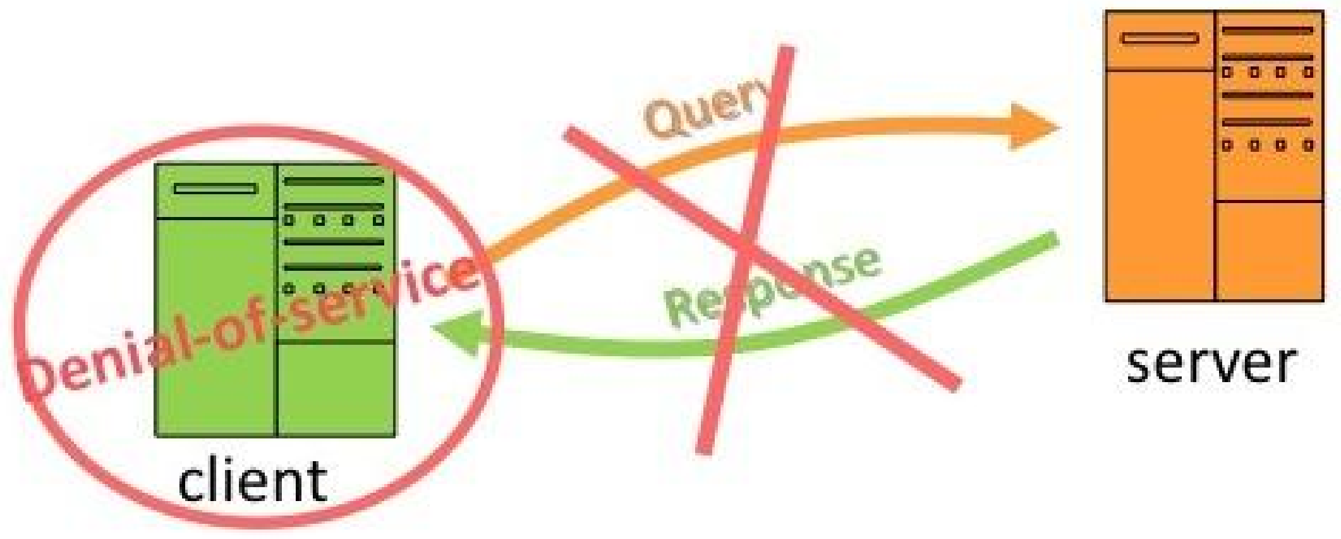
Most Internet protocols rely on PKI for security, which in turn relies on NTP security

If time goes bad, one can:

- Replay old (potentially compromised) certificates
- Expire valid certificates (potential DoS)
- Similar shenanigans for Certificate Revocation Lists

MACS Project Work on NTP security

- [1], [2] exploits protocol flaws for DoS attacks and IPv4 flaws for timeshifting attacks on NTP clients



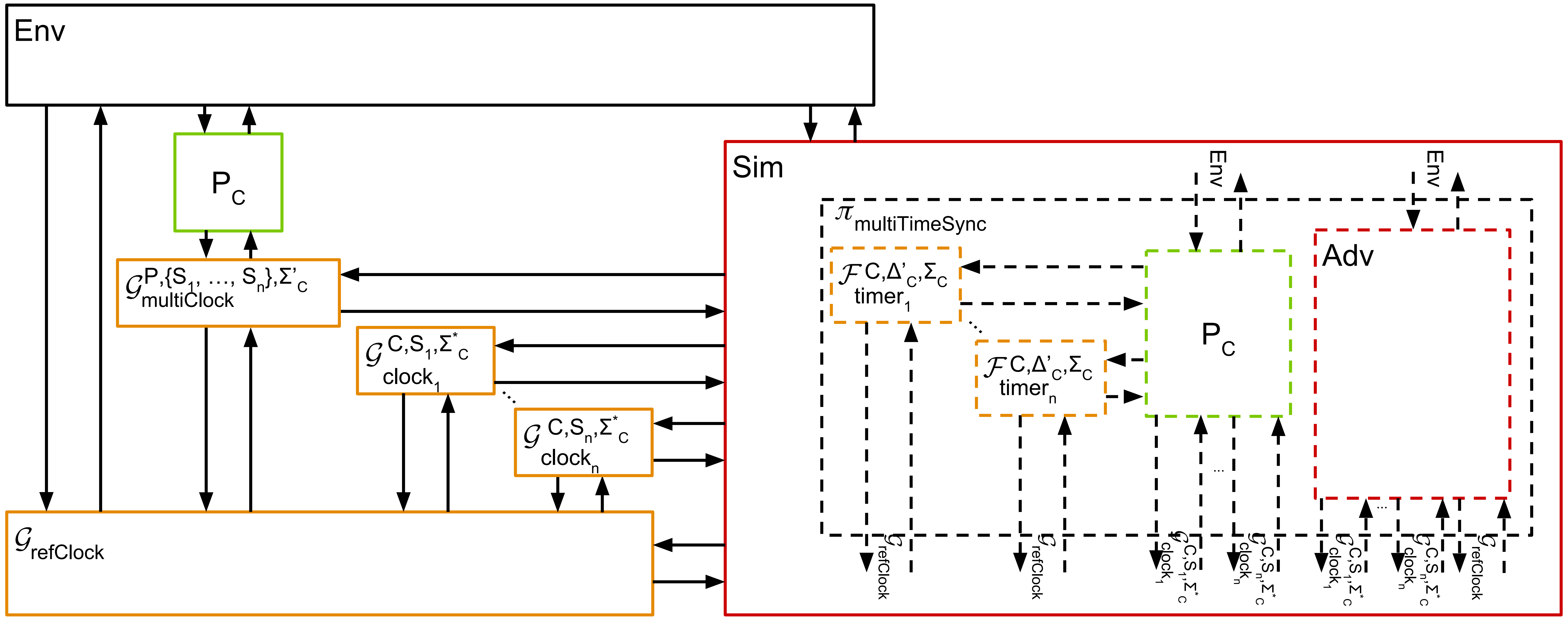
- Following work points out flaws in current protocol, proposes a new unauthenticated NTP protocol & proves its security

Our Proposed Security Model

- shows NTP security when composed with other protocols
- previous security analysis only guarantees NTP security as stand-alone protocol

Universal Composability

- provides protocol security under concurrent composition with itself or other protocols
- useful for NTP as synchronous time is important for many other protocols


Env
P_C
$\mathcal{G}^{P,\{S_1,\ldots,S_n\},\Sigma'_C}_{multiClock}$
$\mathcal{G}^{C,S_1,\Sigma^*_C}_{clock_1}$
$\mathcal{G}^{C,S_n,\Sigma^*_C}_{clock_n}$
$\mathcal{G}_{refClock}$
Sim
Env
Env
$\pi_{multiTimeSync}$
$\mathcal{F}^{C,\Delta'_C,\Sigma_C}_{timer_1}$
$\mathcal{F}^{C,\Delta'_C,\Sigma_C}_{timer_n}$
P_C
Adv
...
...
$\mathcal{G}_{refClock}$
$\mathcal{G}_{refClock}$
$\mathcal{G}^{C,S_1,\Sigma^*_C}_{clock_1}$
$\mathcal{G}^{C,S_n,\Sigma^*_C}_{clock_n}$
$\mathcal{G}^{C,S_1,\Sigma^*_C}_{clock_1}$
$\mathcal{G}^{C,S_n,\Sigma^*_C}_{clock_n}$
$\mathcal{G}_{refClock}$

Ideal Functionality $G_{MultiClock}$

- models NTP behaviour in order to provide necessary security guarantees
  - bounds the shift and drift in a party's clock from participating in the protocol
- any real world implementation of NTP that realizes this functionality provides the same guarantees.

Impact of Our Work

- **Certificate Revocation**
  - expired certificates should be kept on revocation list for at least as long as the offset that could be introduced in client's time
  - prevents a client with slow clock from being unable to tell that it had been revoked
- **New NTP Protocol**
  - unauthenticated - secure against off path attackers
  - authenticated - secure against on path attackers

References:

1. A. Malhotra, I. E. Cohen, E. Brakke, and S. Goldberg. Attacking the Network Time Protocol. In *Network and Distributed System Security Symposium* (NDSS), Feb. 2016.
2. A. Malhotra, and S. Goldberg. Attacking NTP's Authenticated Broadcast Mode. *SIGCOMM Computer Communication Review*, April 2016.