Universally Composable Network Time Protocol

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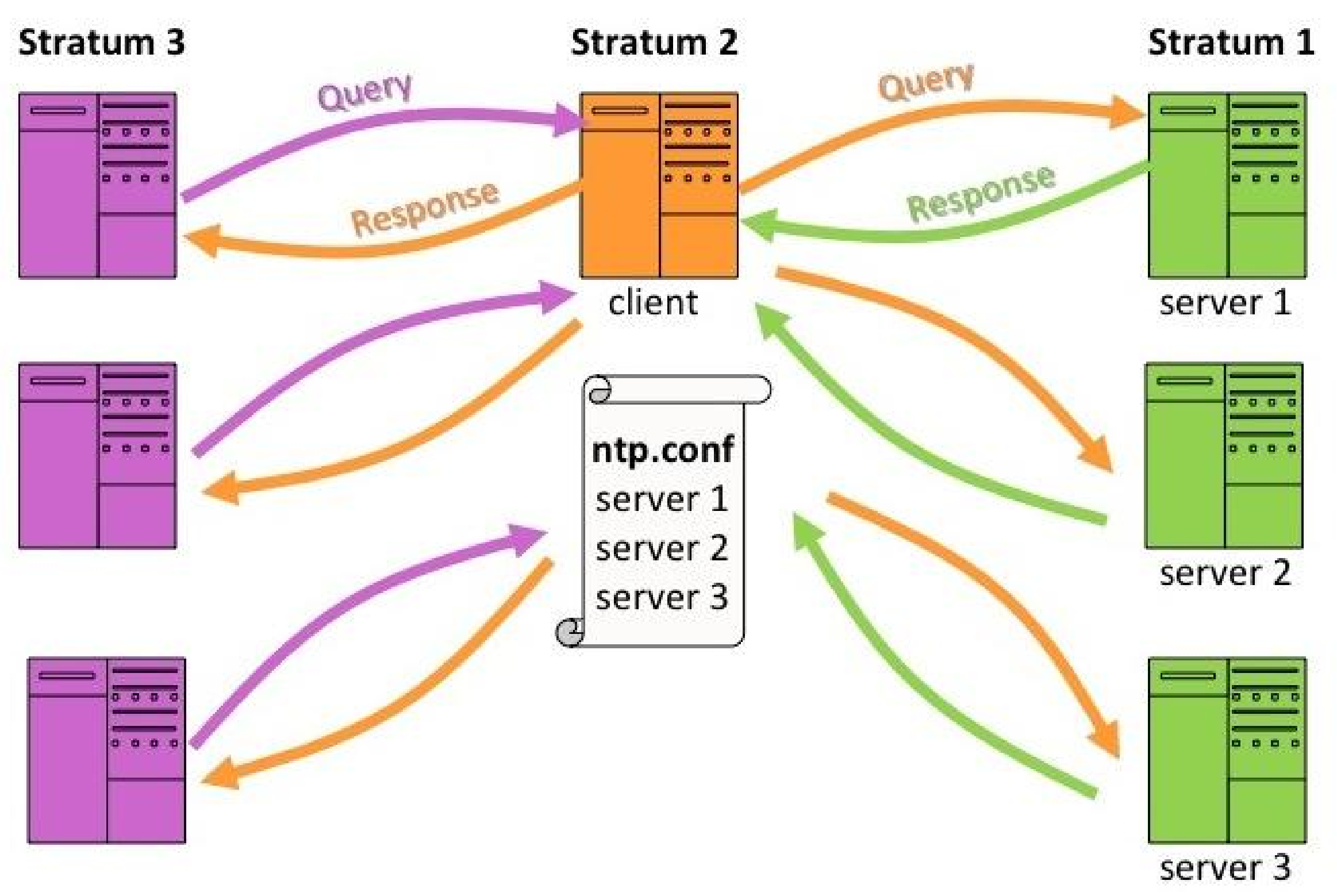
Network Time Protocol (NTP) gives time to computer systems on the Internet in a query-response fashion.



Why do we care about NTP security?

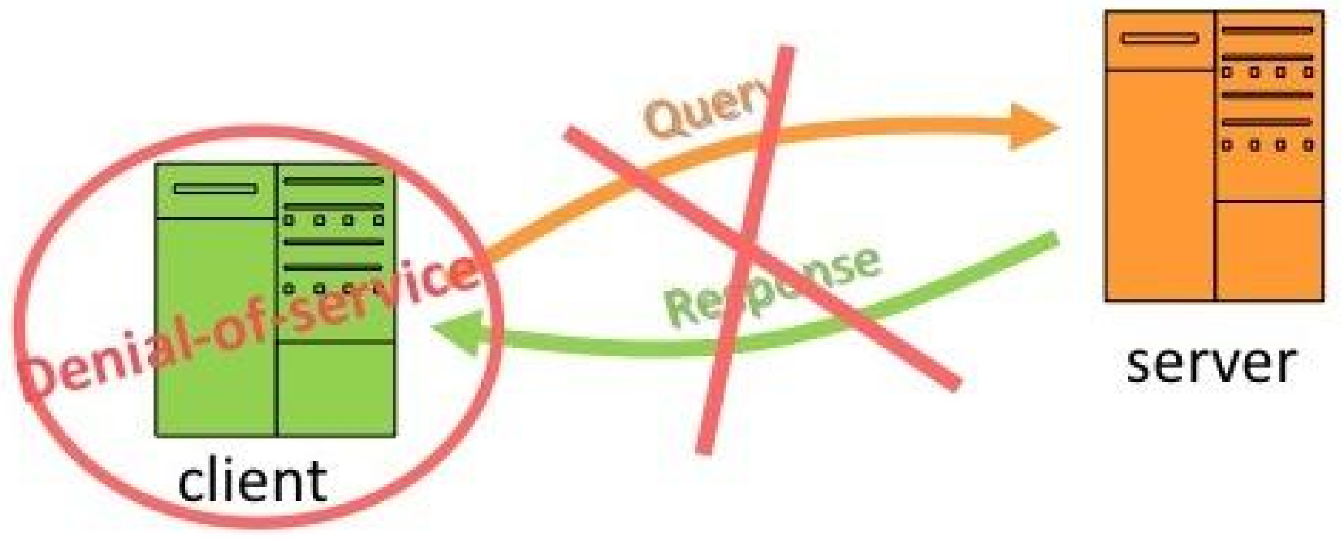
Most Internet protocols rely on PKI for security, which in turn relies on NTP security

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



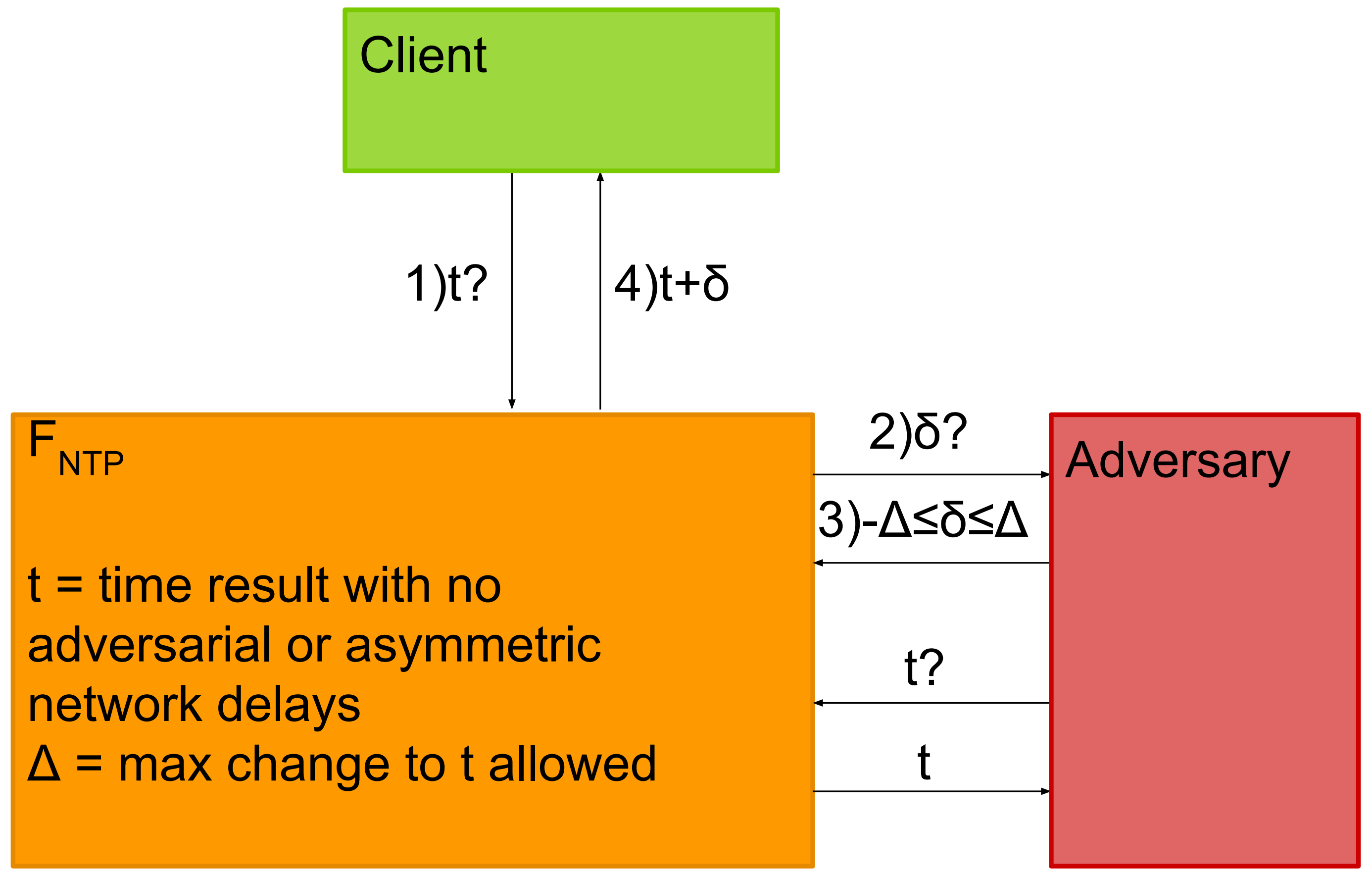
- Following work points out flaws in current protocol, proposes a new unauthenticated NTP protocol & proves its security

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



Client

1)t?

4)t+δ

F_{NTP}

t = time result with no adversarial or asymmetric network delays

Δ = max change to t allowed

2)δ?

3)-Δ≤δ≤Δ

t?

t

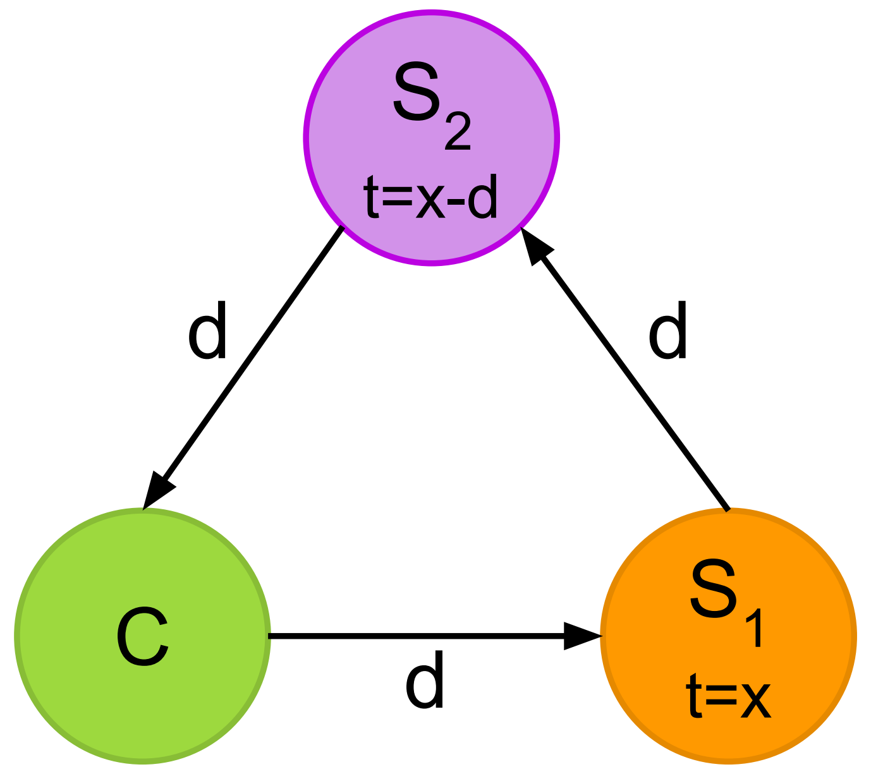
Adversary

Ideal Functionality F_{NTP}

- models NTP behaviour in order to provide necessary security guarantees
- any real world implementation of NTP that realizes this functionality provides the same guarantees.

Challenges Realizing F_{NTP}

- Achieving secure communication channels between NTP clients and servers:
  - TLS needs synchronous time for cert verification
  - But there is no synchronous time without NTP!
- Asymmetric network delay between client & server:
  - can arbitrarily alter the time the client gets from NTP
  - with current design it is impossible to identify asymmetric network delay



C cannot determine from times sent by S_1 and S_2 that one server took longer to receive the query while the other took longer to return it

Having a timeout on the client side limits the delay introduced to the length of the timeout

Impact of Our Work

- **Certificate Revocation**
  - expired certificates should be kept on revocation list for at least as long as Δ that could be introduced in client's time
  - prevents a client with slow clock (showing time before the certificate expired) 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.