LightningFilter: Traffic Filtering at 100 Gbps

Presented by:
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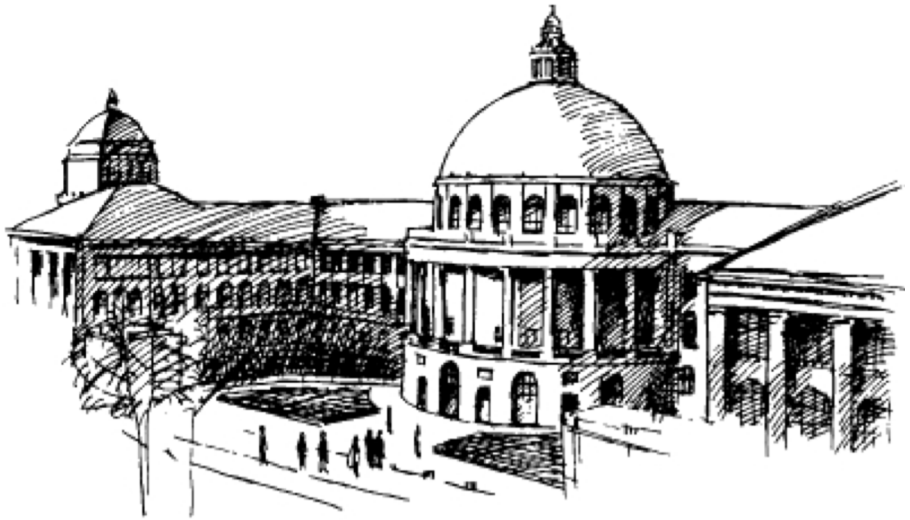

In collaboration with:

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Jonas Gude, Pascal Sprenger, Florian Jacky

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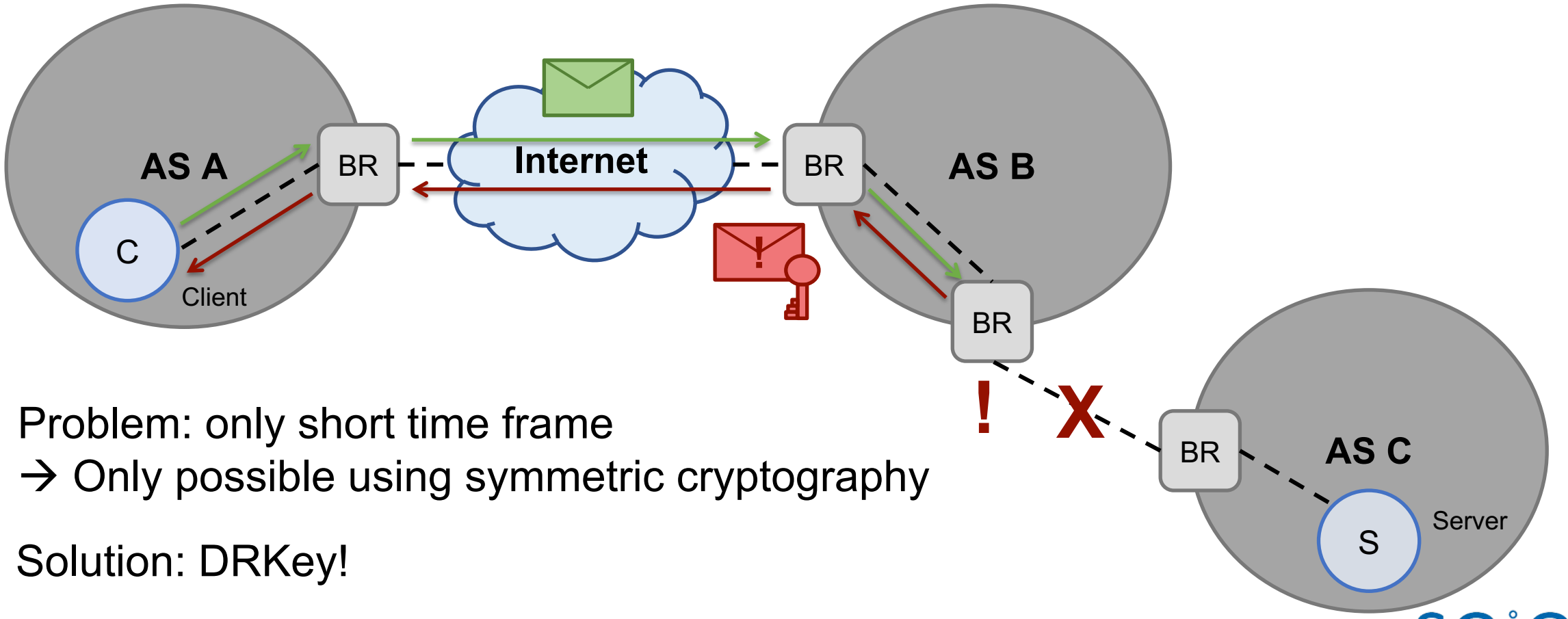
Project Goals

- High-speed packet processing requires nanosecond operations
  - Example: 64-byte packets @ 100Gbps: ~5ns processing time

- Nanosecond scale key establishment
- Nanosecond scale packet authentication

- Trivia: how “long” is a nanosecond?
  - Answer: light travels about 30cm in 1ns

Use Case:
Network Error Message Authentication



Problem: only short time frame
→ Only possible using symmetric cryptography

Solution: DRKey!

DRKey

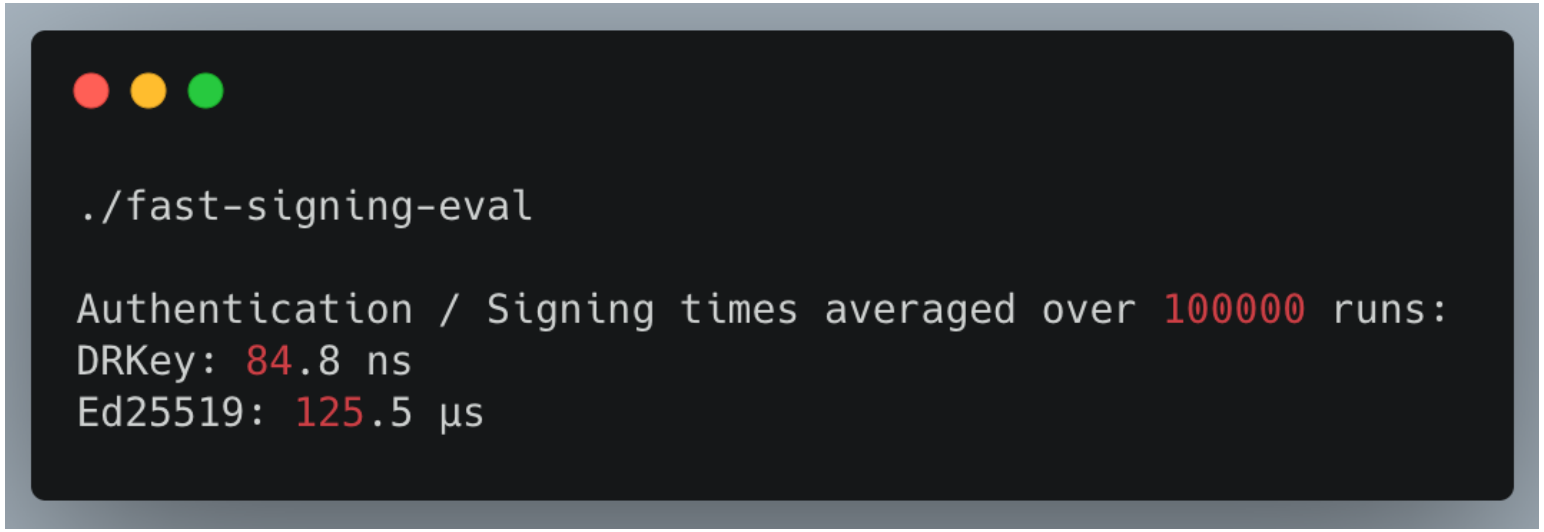
- Novel protocol based on symmetric cryptography
- Intel AES-NI instructions enable key derivation within **~50** cycles

  → *Nanosecond* scale!
- Key computation is up to **3 times** faster than DRAM lookup!

  → Computing the key is faster than storing it in memory!

→ Foundation for many DDOS defense mechanisms

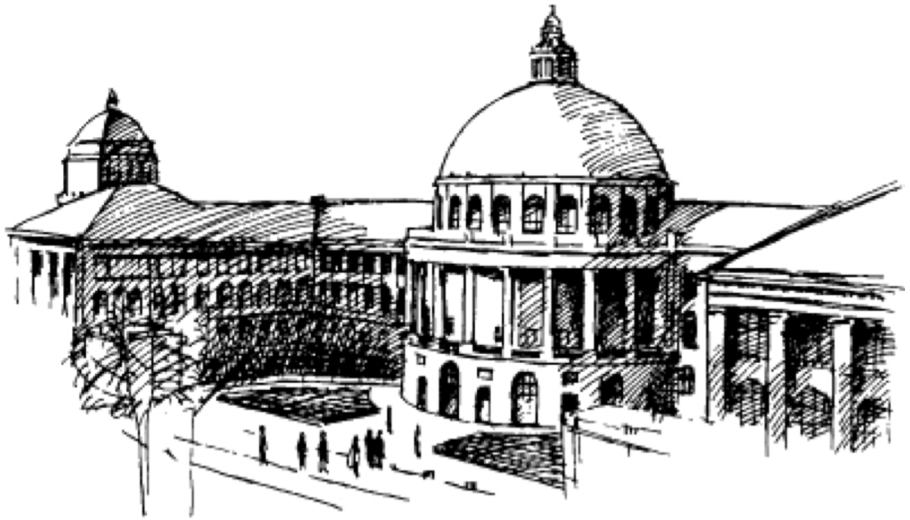
DRKey Performance



Factor:
~ 1450x

Lightning Filter

Traffic Filtering at 100 Gbps



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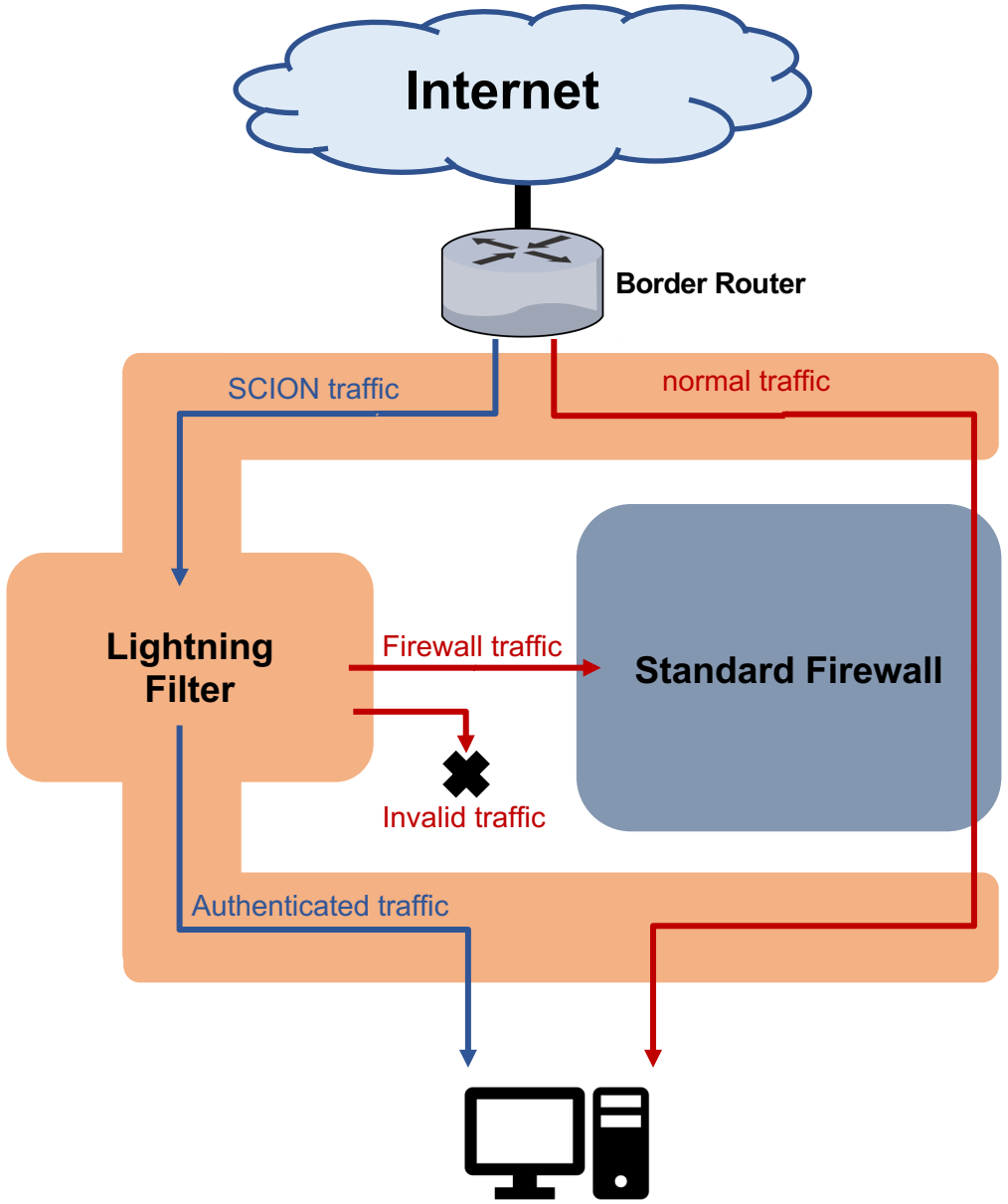
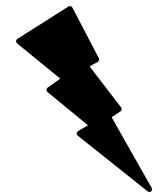
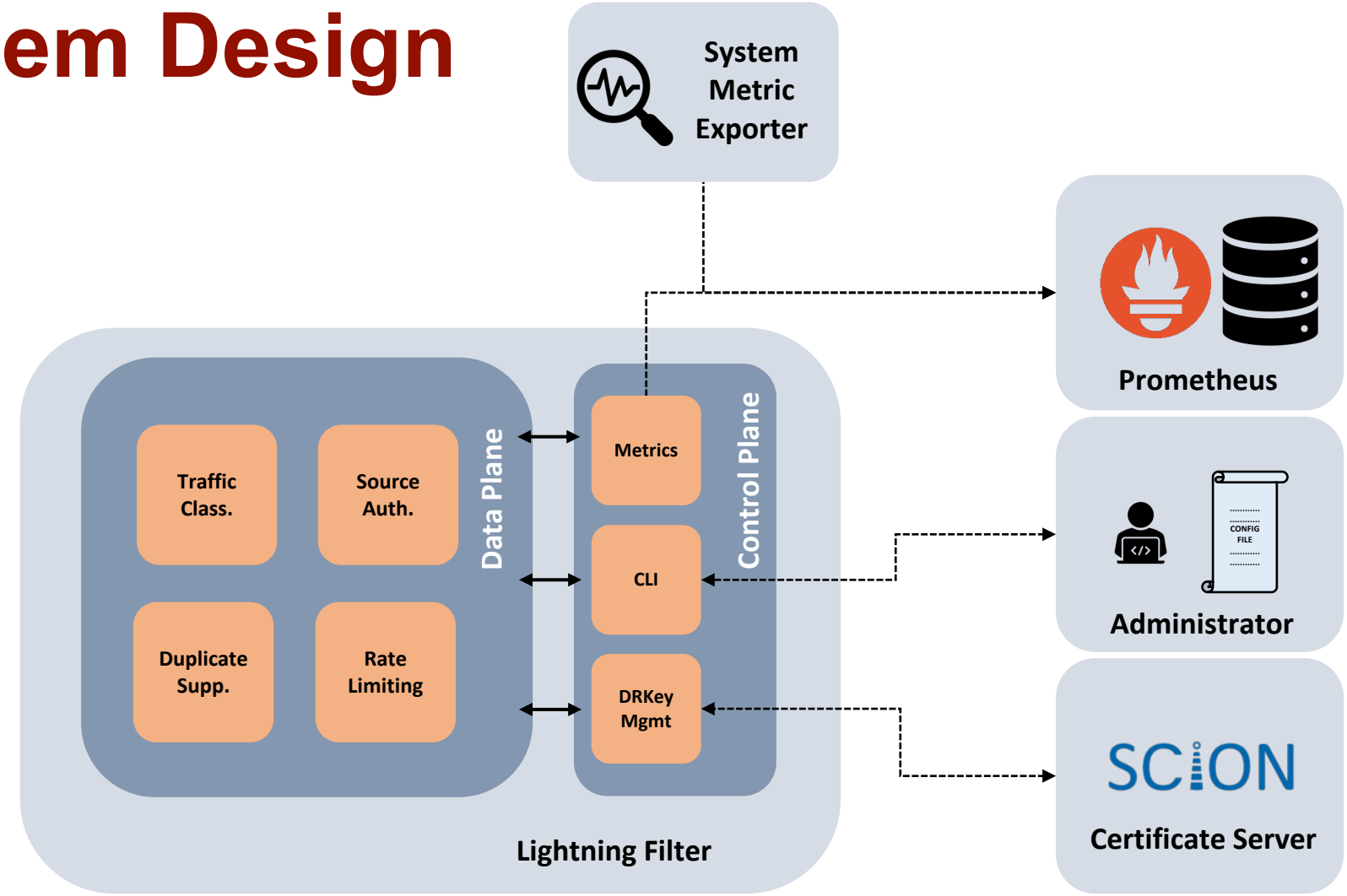
Overview


Internet
Border Router
SCION traffic
normal traffic
Lightning Filter
Firewall traffic
Standard Firewall
Invalid traffic
Authenticated traffic

$$$



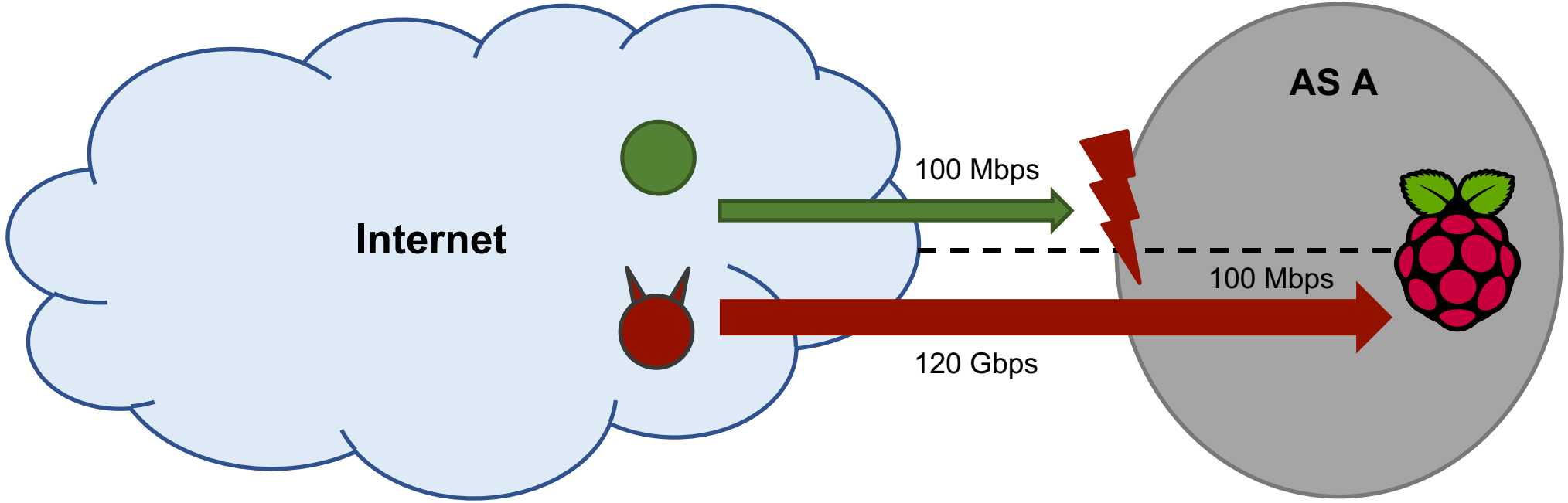
System Design



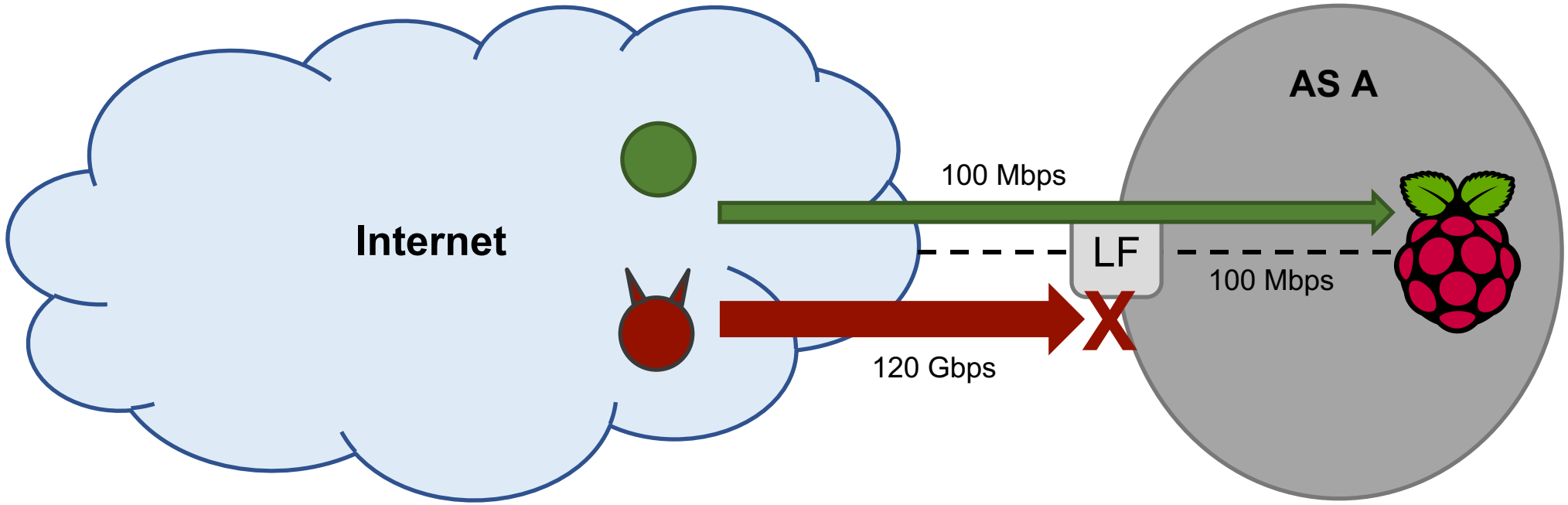
Demo Outline

1. Attack scenario
   - Attacker located anywhere in Internet → Source authentication
2. Bandwidth capacity
   - 120 Gbps traffic volumne
3. Filtering based on source authentication
   - Alternate between filtering and bypass every 30s
4. Duplicate suppression
   - 80 Gbps duplicates traffic, 40 Gbps legitimate traffic

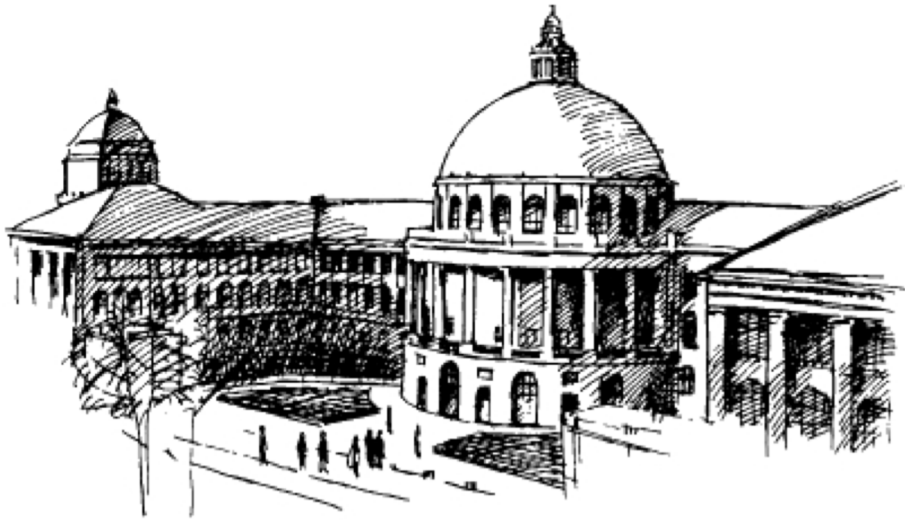
Attack Scenario: Internet Attacker



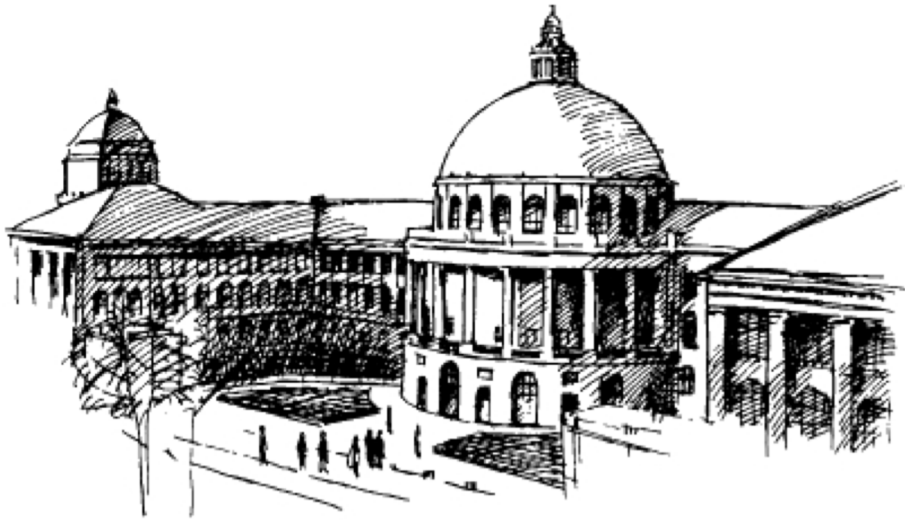
Attack Scenario: Internet Attacker



Questions?

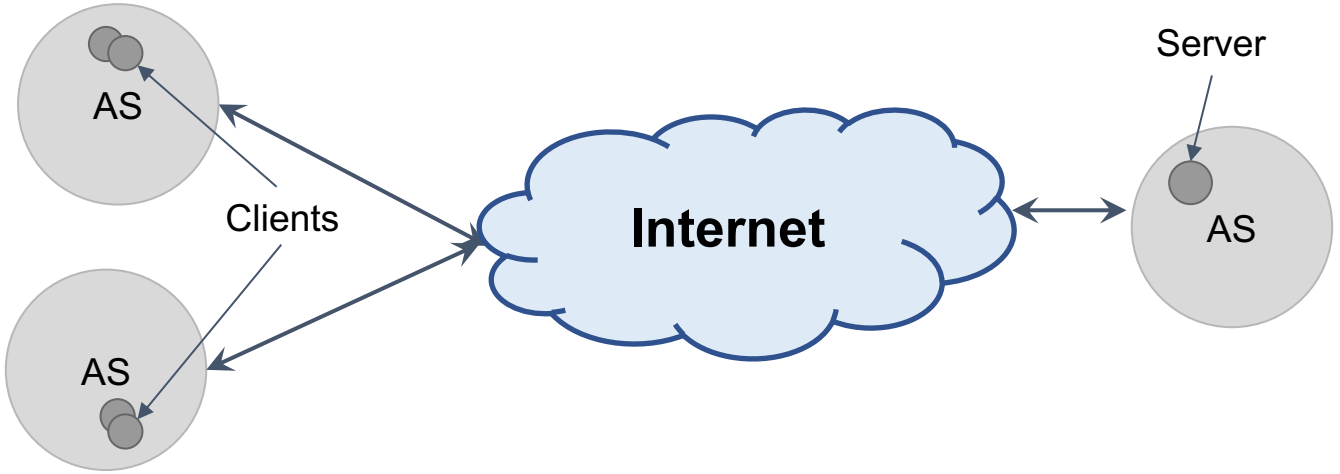


Backup Slides



DRKey Scenario

- Communication between clients and server is *authenticated* using DRKey
- Key derivation for L2 keys is delegated to server



DRKey Exchange Demo

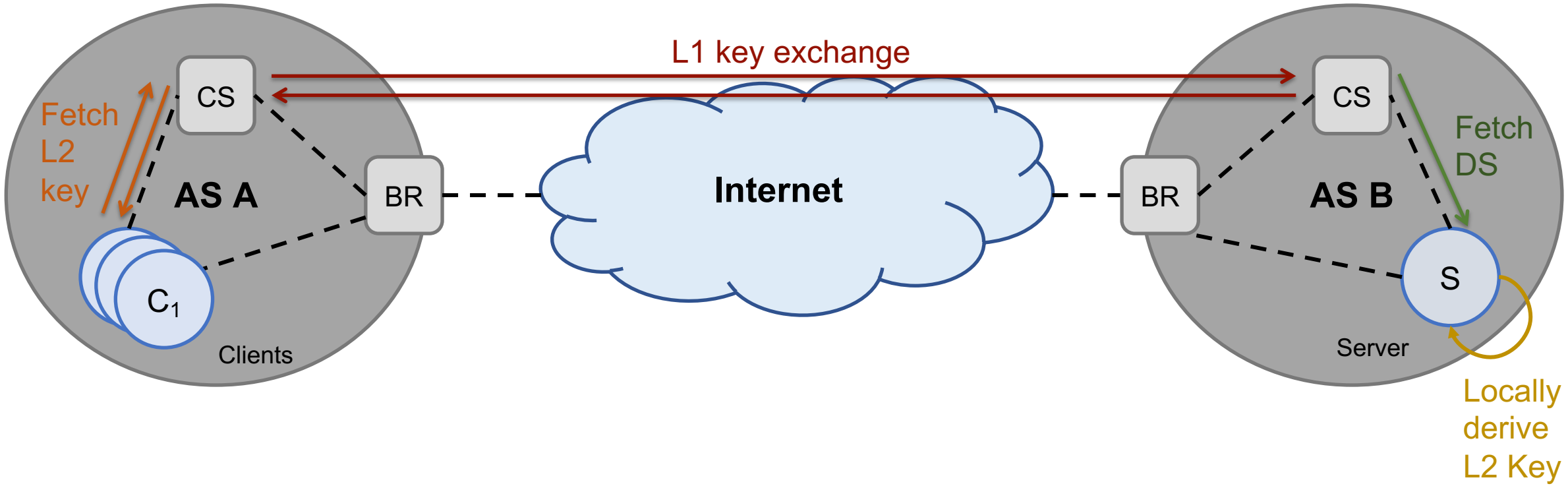
1. Client requests the L2 key to communicate to the server from its local CS
2. L1 key has not been prefetched → L1 key exchange
3. Server fetches the derivation secret for its delegation from CS
4. Server then derives the same L2 key locally
5. Do 100 runs and calculate average execution time

DRKey Hierarchy

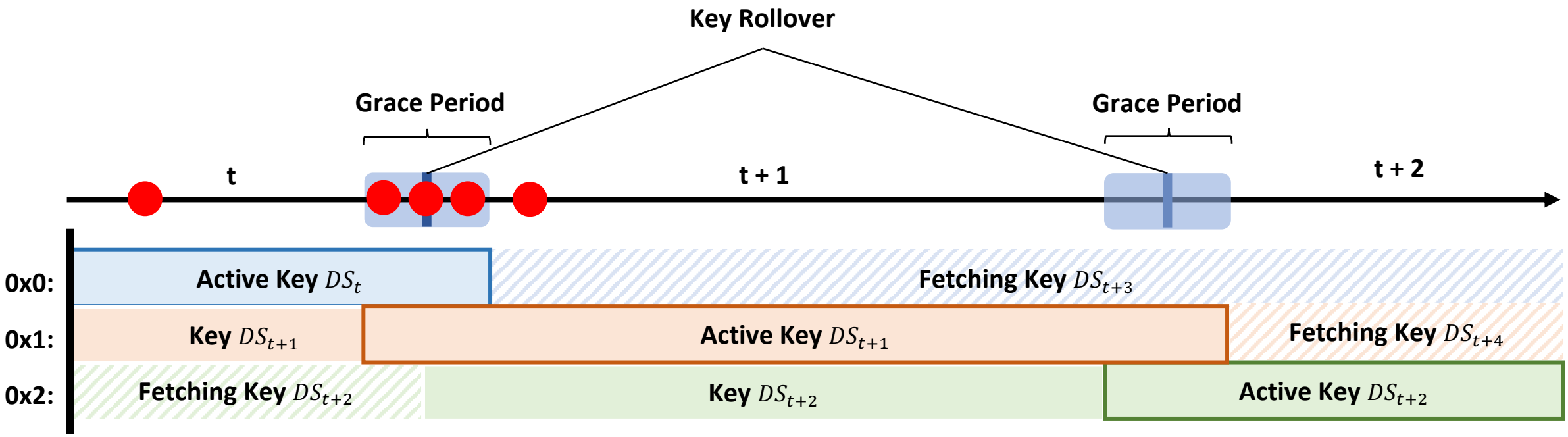
- Key establishment using a multi-level key hierarchy

- **L0**: per-AS local secret key & per-AS public/private key pair
- **L1**: AS-level key establishment (typically prefetched!)
- **L2**: *locally* derive symmetric keys for end hosts

DRKey Key Exchange



Key Rollover



Rate Limiting