Predictive Mitigation of Timing Channels for Interactive Systems

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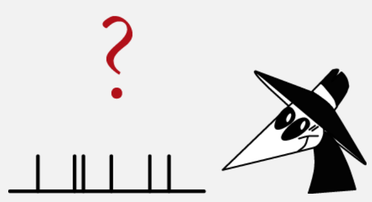
Theoretical and empirical results show predictive mitigation of timing channels is practical for interactive systems

Timing channel threats

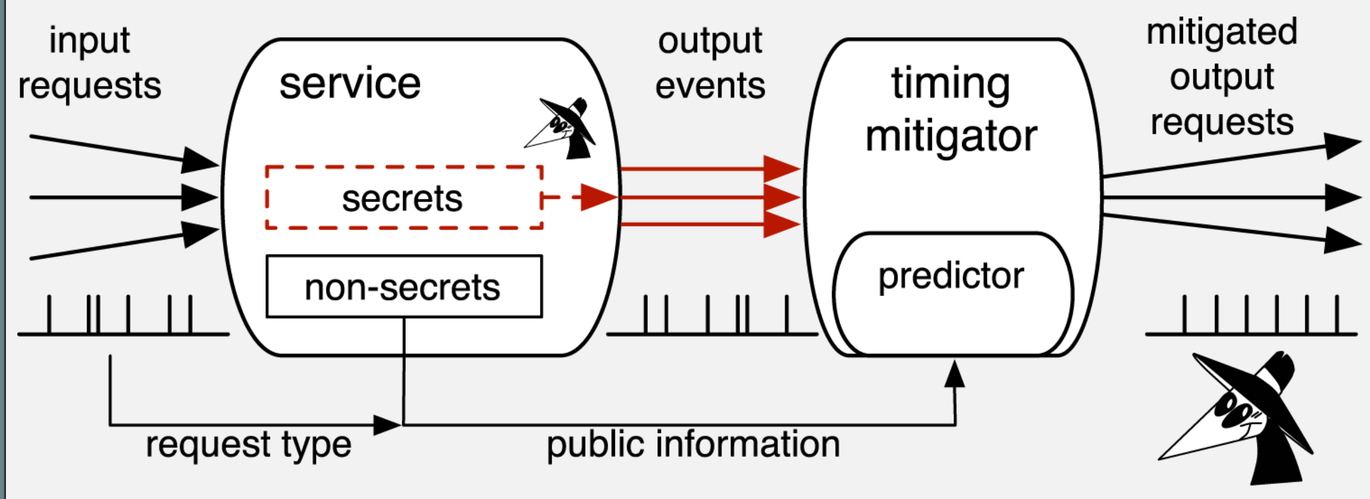
- **Side channel:** infer key from decryption time (RSA, AES)
- **Covert channel**: transmit data by controlling timing



Predictive mitigation (CCS'10)

- **Goal**
  - bound information leakage through timing channels
- **Main idea**
  - delay events according to predefined schedules
  - when events are not ready at predicted times, change to a new schedule

Interactive system model

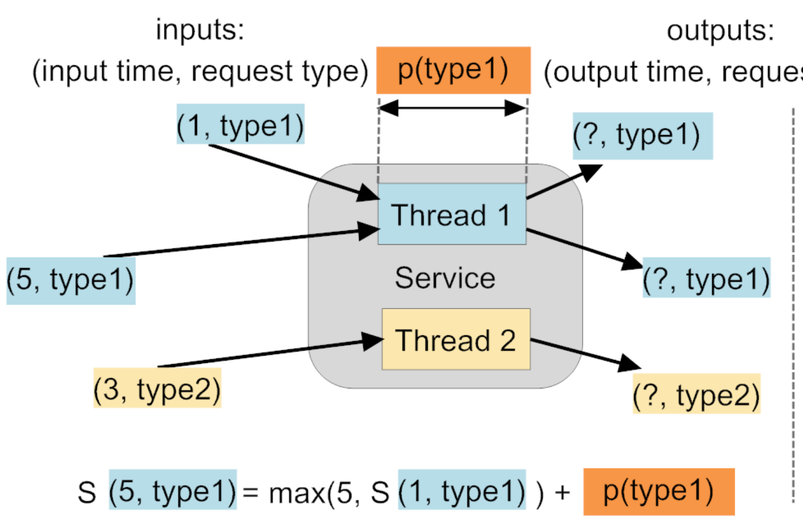


- **Attacker model**
  - attacker may influence output time
  - attacker can observe mitigated output time
- **Request type:** public payloads, e.g., URLs
- **Public information:** input time, request types

Prediction function with public information

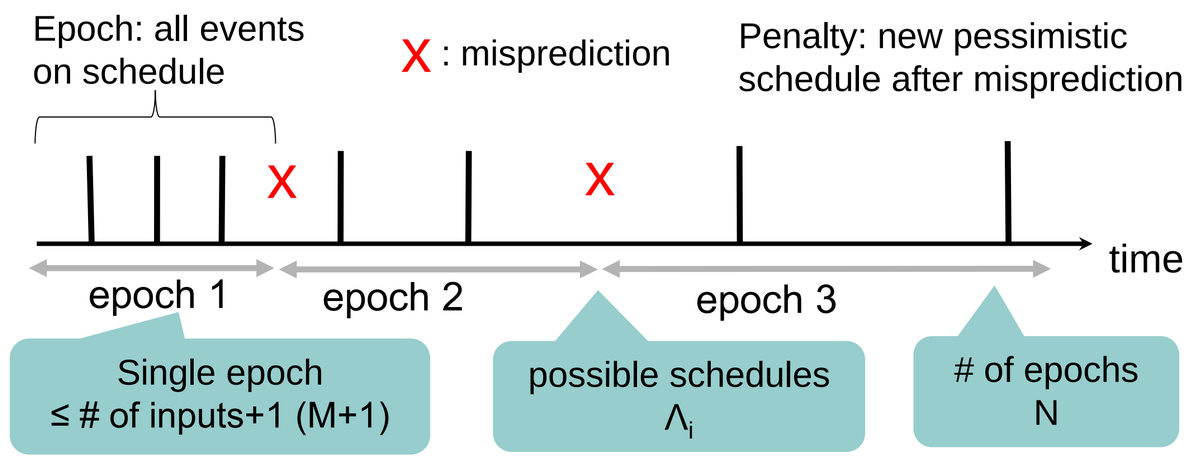
Time of outputs is predicted by public information

Thread/request type model



Leakage analysis

Idea: bound possible # of observations

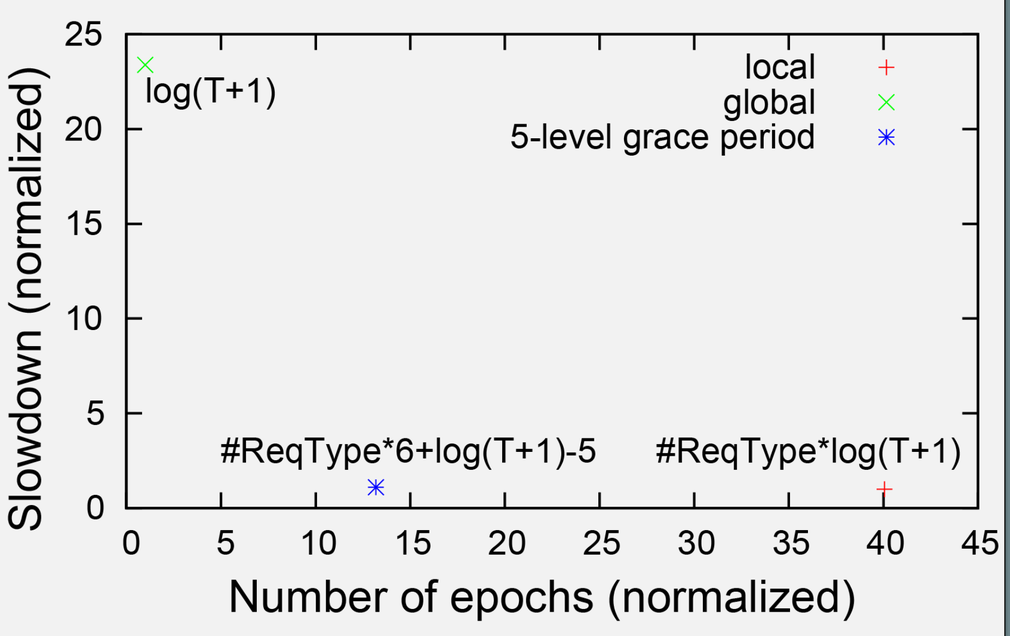


Variation ≤ $(M+1)^N \times \Pi\Lambda_i$

⟹ Leakage in bits: $N \times \log_2(M+1) + \Sigma\log_2(\Lambda_i)$

Penalty policies (bound on N)

When request type 1 has a misprediction, do we penalize request type 2?



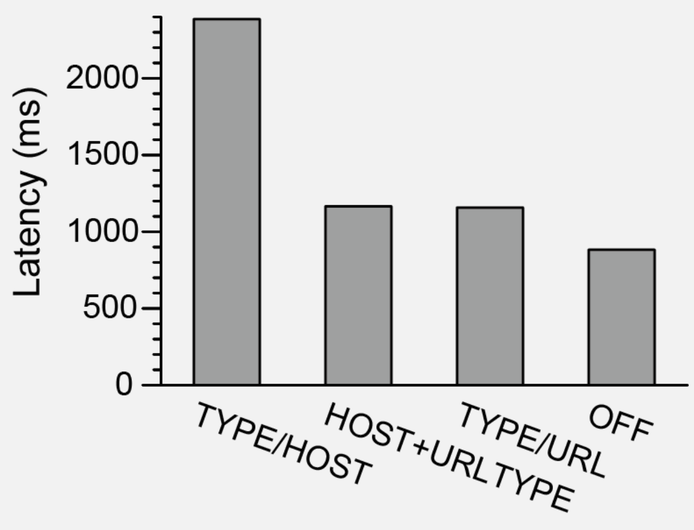
Local: only type 1 is penalized
Global: both type 1 and 2 are penalized
5-level grace period: penalize type 2 only when # of type 2's mispredictions is greater than 5

Intuition: request types with few mispredictions should receive little penalty since they leak little information

Results

Performance

- HTTP(S) proxy server that mitigates MIT CSAIL homepage (49 URLs)
- 5-level grace period
- Various request types
  - Type/Host (2)
  - Type/URL (49)
  - Host+URL type (7)

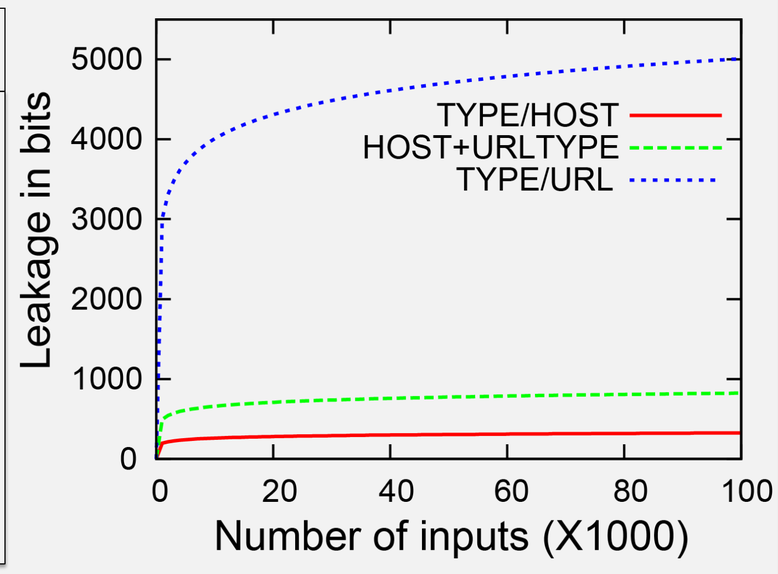


Security

Fast doubling

- start with q
- double q after misprediction
- $\Lambda_i = 1$
- Leakage bound $(6R+\log_2(T_w+1)-5)\times\log_2(M+1)$

R: # of request types
T_w: worst-case execution time (300s, the default timeout setting of Firefox)



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