Privacy-Preserving Attribution and Provenance

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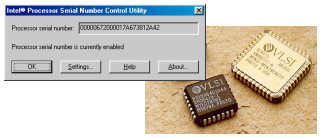
We want to be here…

The crisis of anonymity on the Internet

and simultaneously here

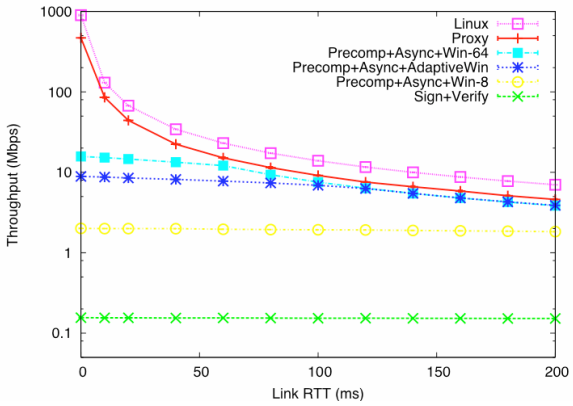
Complete anonymity — We are here — Fingerprints & DNA

- Prima Facie, digital objects like packets are not unique
  - Contrast to physical objects/actions which tend to carry/acquire distinguishing attributes
  - E.g. Location/Time, Weight, Size, Fingerprints/DNA…
- Thus, there is a heavier burden to attribute digital actions
  - Yet, users have an expectation or rights to privacy
  - Hence, we don't want to leak physical identity
- Must not repeat notable historic failures
  - Clipper/Capstone chip (1993) encrypted voice/data; keys escrowed with the government
  - Intel Pentium III PSN (1999) had unique per-processor serial number
  - Both abandoned in face of huge pressure from civil liberties groups

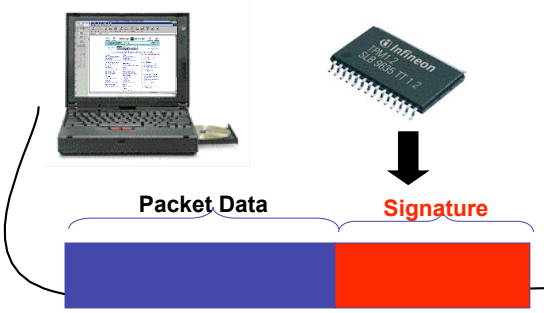


A first step towards accountability

- Provide **network support** to tie a digital action (packet) to a physical machine
  - Link different criminal actions
  - User attribution via ownership records/physical forensics
- **Any** network element can vet a packet as being "attributable," but can't identify physical machine (privacy preserving)
- **Authorized** actor can reveal origin for any attributable packet at any point in future
- Key mechanism: **short group signature**
  - PK cryptosystem; *n* secret keys, one public verification key, and one opener key
  - Verify(): signature was generated with *one* of the group's secret keys
  - Open(): reveals *which* secret key generated this signature
  - Standard symmetric-key crypto is *not* sufficient: no way to verify signatures



Our prototype implementation: CLUE



- Assume secure hardware (TPM) on each device (secure key & computation)
- Digitally sign each packet; signature identifies physical origin
- Expensive in naive implementation : 24ms sign, 28ms verify
- We have implemented several optimizations
  - **Precomputation**: Most of signature can be pre-computed in advance (during idle cycles); sign 35us
  - **Windowed verification**: Modify signature so you can verify this packet or window of the last *n* packets
  - **Asynchronous verification**: Overlap verification with communications

This work is supported by the National Science Foundation FIND program through grants CNS-0722031 & CNS-0722000