Improving Stateful Encryption Schemes

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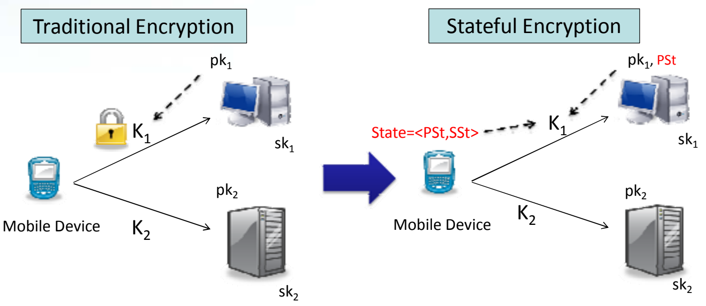
Secure Communication for Mobile Environment



Efficiency Improvement

- Modular exponentiations dominate the computational cost of public key encryption
  - ❖Power consumption / Bandwidth
- Stateful encryption can improve the computational cost of traditional PKE dramatically

Example: Stateful PKE

- DHIES: (DH-StEnc, USK-CCA-secure with RO)
  - ❖ Public parameter: DSA group or elliptic curve group with prime order p, with generator "g"
  - ❖ PK: $<y\ (=g^x), H>$ SK: $<x>$
  - ❖ Enc: $r \leftarrow Zq, (c_0 = g^r)\ K=H(c_0,y,y^r),\ c_1=E_{sym}(K,m)$
  - ❖ Ciphertext: $<c_0,c_1>$
  - ❖ Dec: $K=H(c_0,\ y,\ c_0^x),\ m = D_{sym}(K,c_1)$
- Noticing that $c_0=g^r$ is independent from y (Receiver's PK)
  - ❖ $PSt = <c_0>$ $SSt = <r>$
  - ❖ For encryption, it is sufficient to compute K for each Receiver
  - ❖ For decryption, it remains unchanged

Security Notions

- Indistinguishability against Adaptive Chosen Ciphertext Attack (IND-CCA)
  - ❖ Multi-Receiver setting
    - o Each Receiver sets up his public key
  - ❖ Known Secret Key (KSK)
    - o Attacker knows
  - ❖ Unknown Secret Key (USK)
    - o Attacker may not know the secret key of its public key

Our Results

1. Improving efficiency of DH-StEnc:

- ❖ Underlying assumption
  - o Gap-DH (Strong) ➔ Computational DH (Weak)
  - o Idea: twin public keys
- ❖ Implementation (80-bit security)
  - o Elliptic curve: 512 bit -> 160 bit
  - o Public key size: 512 bit -> 320 bit
  - o Slightly worse computational cost
    - ▪1 -> 1.5 modular exponentiation

2. Generalization of the model:

- ❖ Stateful Key Encapsulation Mechanism (KEM)
- ❖ Tag-based Stateful KEM

3. ID-based Setting:

- ❖ Generic construction from Identity-Based Non-Interactive Key Exchange (IBNIKE)
  - o With (additional) mild assumptions
    - ❑ Satisfied by all known schemes
  - o Stateful IBE without pairings (inefficient)
- ❖ Avoiding the gap-BDH assumption
  - o No known implementation for Gap-BDH assumption exists

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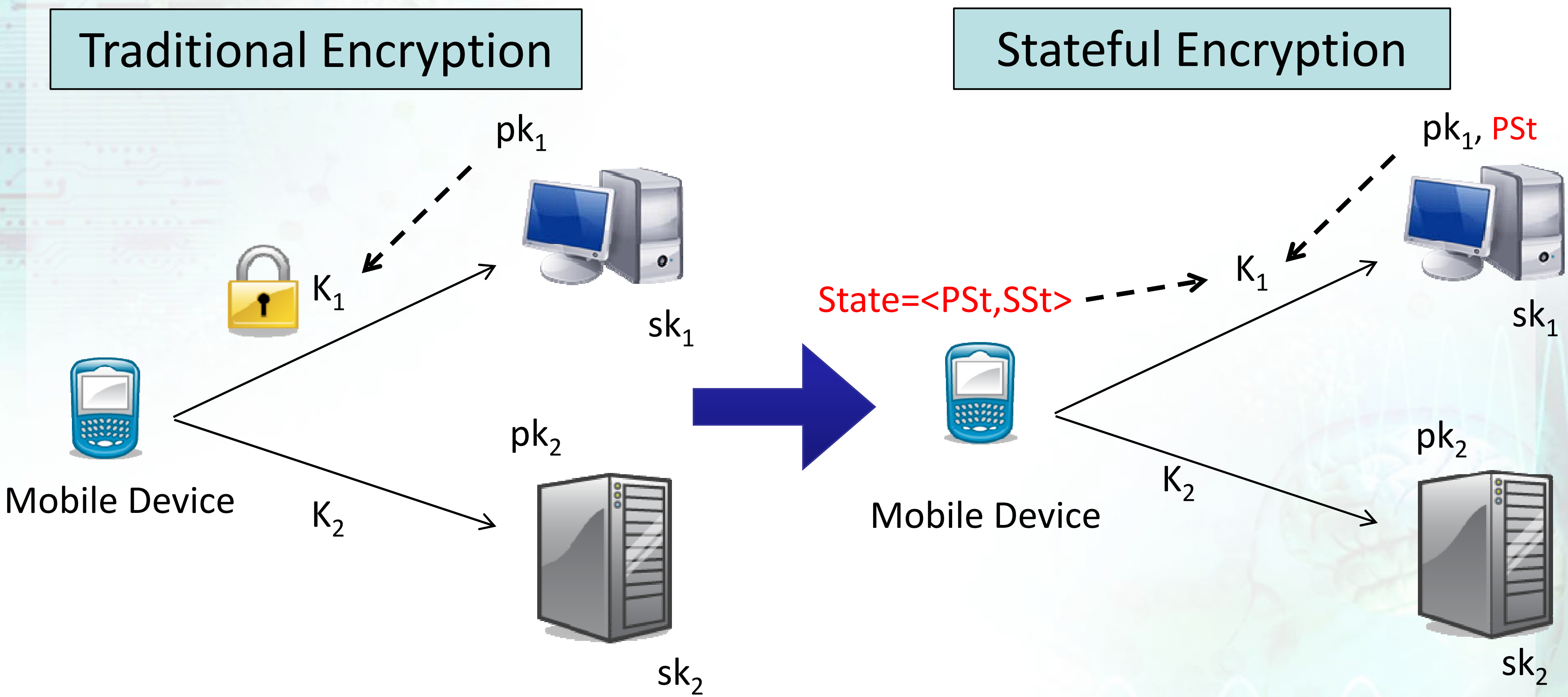
Secure Communication



Stateful encryption can improve the computational cost of the sender dramatically

Results

- Weakening assumptions of known schemes
  - Stateful PKE/IBE
  - Easier design
- Generalization of the model and generic constructions