Embedded SSL

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Introduction

- TLS/SSL is the Holy Grail of WEB security
  - Many applications may be secured by SSL
    - HTTP, FTP, SIP, SMTP, POP, …
- TLS is secured, but what about trust ?
  - *Branch Prediction Attacks* (2006) may recover an RSA key during a single calculation
  - *Instruction Cache Attacks* (2005) may recover an AES key in 65 milliseconds
  - These attacks work with OpenSSL, which runs on more than 60 percent of the world's server installations.
- TLS/SSL stacks are running on untrustworthy computers

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Security issues to be addressed

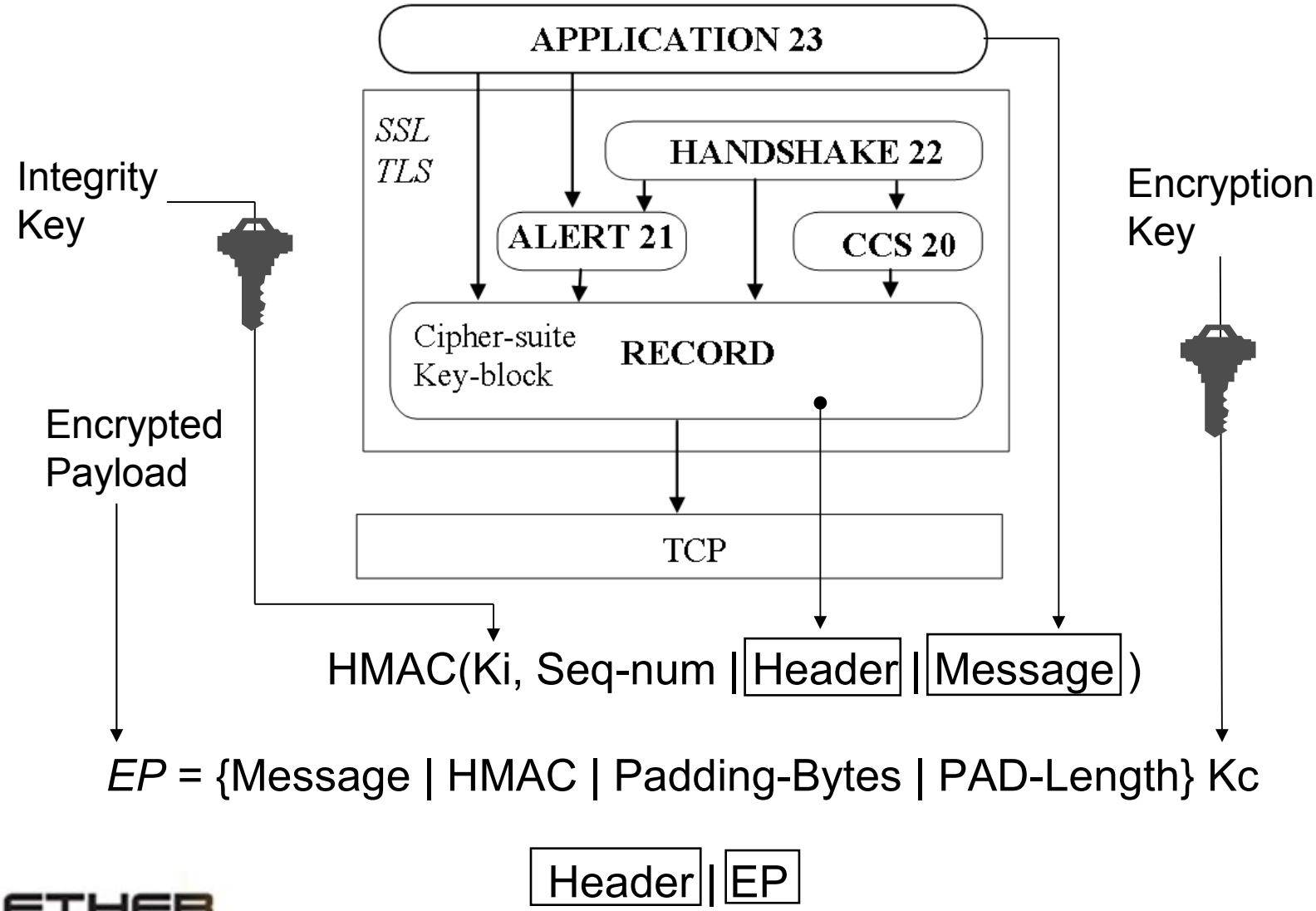
- Certificates are checked by host computers
- Unknown certificates are approved by users
- RSA private key may be recovered (client's side)
- TLS master secret may be recovered
  - Session hijacking
- No plug and play architecture
  - Host computer must be configured with the CA Certificate

About TLS

- Server authentication or mutual authentication
- Authentication based on X509 certificates
- Once the certificates have been verified, keying material is generated on both client and server for encryption of subsequent messages
- HTTP and SSL can be split in two parts
  - An HTTPS session begins by a pure SSL exchange, 4 ways (full session) or 3 ways (resume session) handshake
  - Afterwards HTTP messages are tunneled in SSL packets

➢ Embedded SSL exploits this idea

TLS Stack Structure



Basic key calculations

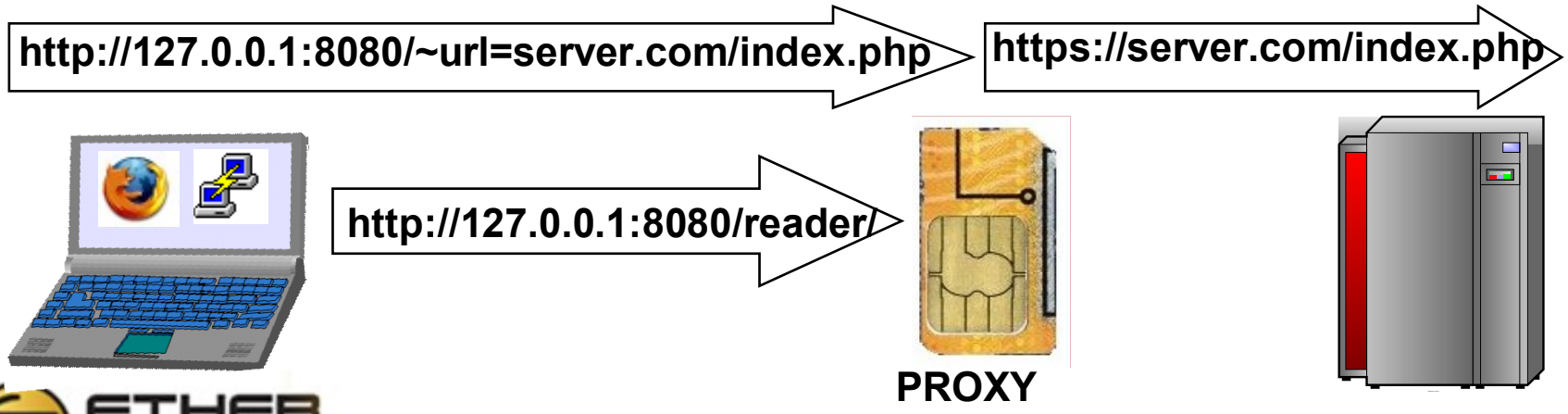
- For Full Sessions
  - A *PreMasterSecret* is sent by the client encrypted with the server public key
    - { PreMasterSecret } KPubS
  - master-secret = PRF(PreMasterSecret, "master secret", ClientRandom | ServerRandom)
  - If a client certificate is required (mutual authentication) it is forwarded to the server, and authenticated by a signature generated with the client private key.
- For Resume Sessions
  - A master secret has already been computed, it is identified by an index, named the Session-ID
- Negotiated cryptographic algorithms are identified by a two bytes value labeled CipherSuite.
- key-block = PRF(master-secret, "key expansion", ServerRandom | ClientRandom)

Embedded SSL main idea

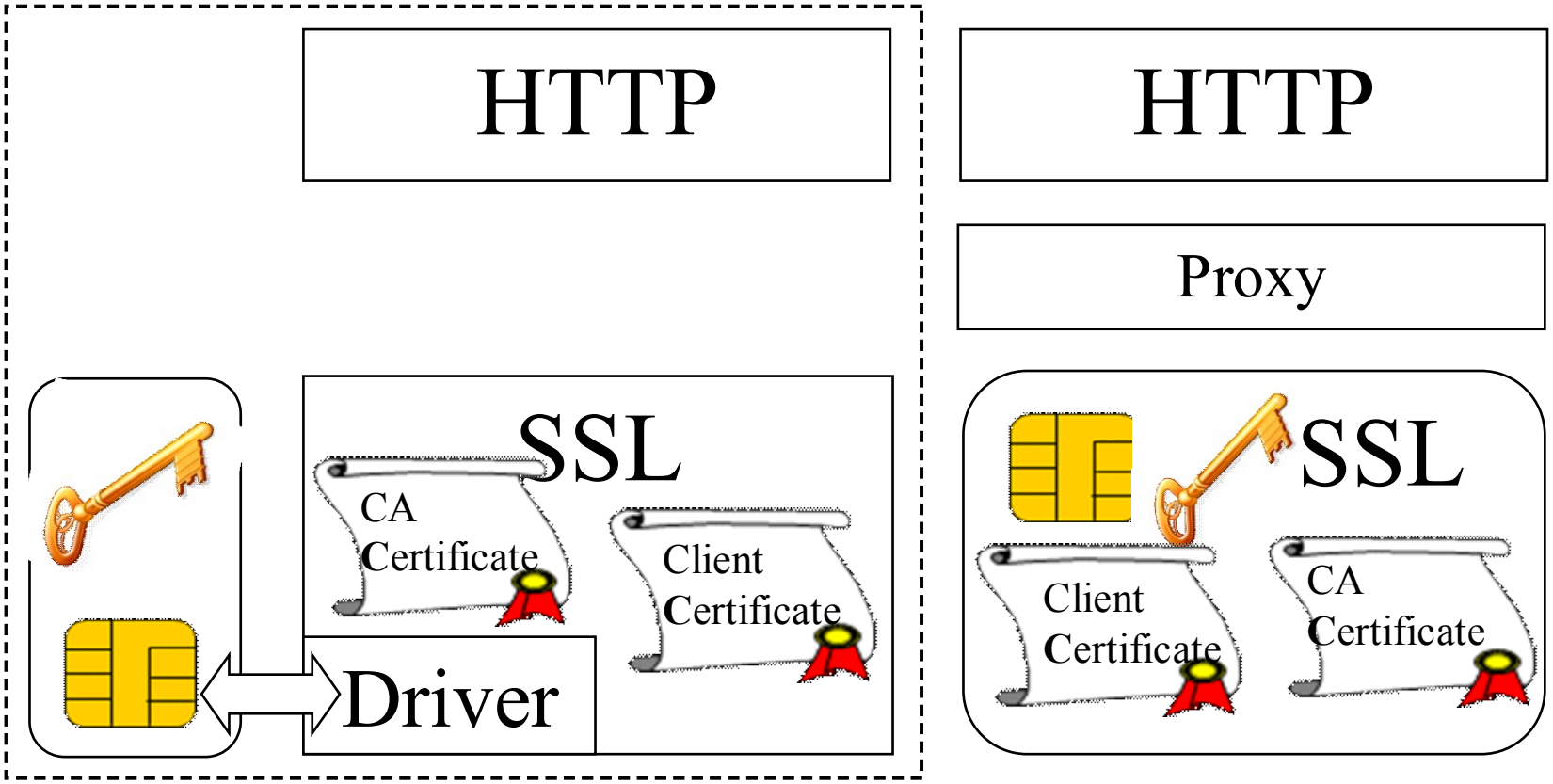
- A TLS session is split in two phases.
  - First (*Phase I*) deals with authentication and cryptographic key calculations
  - Second (*Phase II*) takes advantage of the previously created secure channel, in order to exchange information between applications in a safe context.
- Phase I performed in smartcard
- Phase II performed on client computer
  - If performed in smartcard, throughput is about 10 Kbit/s, incompatible with common multimedia files

The Embedded SSL Platform

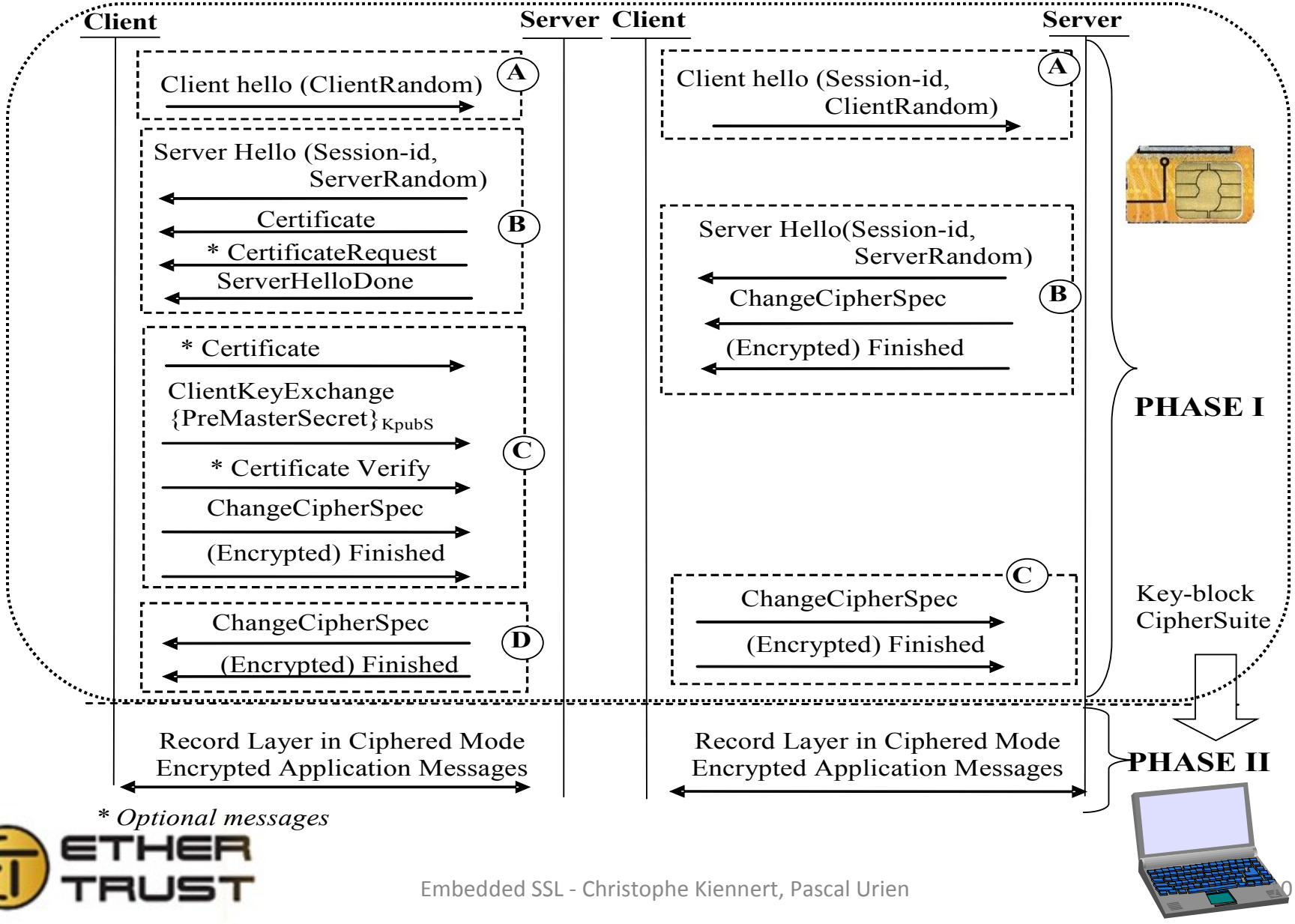
- A Browser
- A Proxy Software
  - Runs the SSL record layer
  - http://127.0.0.1:8080/~url=server.com/index.php
  - http://127.0.0.1:8080/reader/apdu?=data
- A Smart Card
  - Runs the SSL stack
- A WEB Server
  - Configured for SSL session with mutual authentication



Classical architecture vs our approach



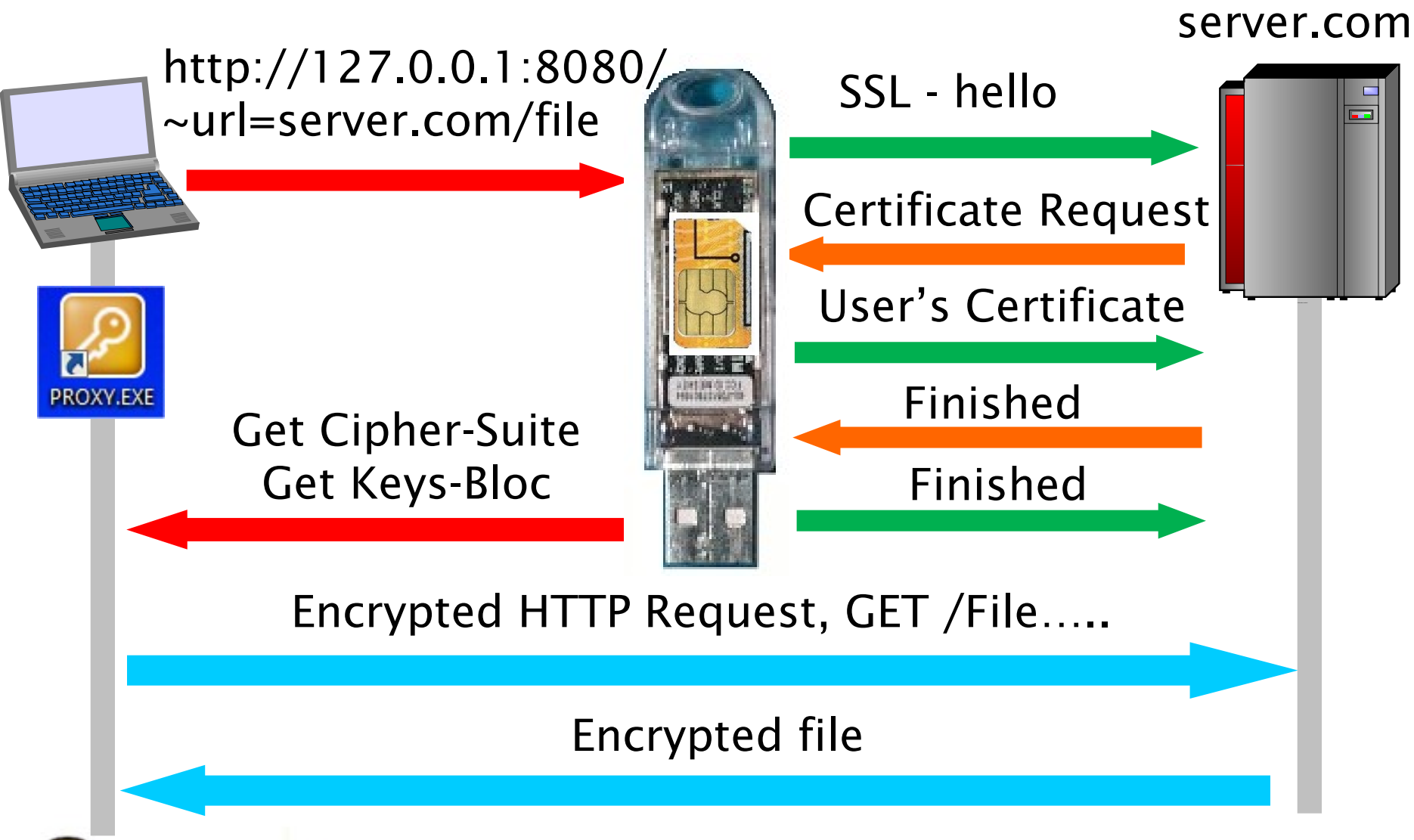
Dual SSL Stack (TLS-Tandem)



Specificities & Benefits

- Based on EAP-TLS smartcards
  - EAP-TLS is a transparent encapsulation of TLS
- Typical performances
  - TLS full mode, 4 s
  - TLS resume mode, 2s
- SSL smart cards present the following security benefits :
  - The server's certificate is checked in a trusted computing environment, ***anti-phising feature***.
  - Client RSA keys are handled by a trusted computing environment, in ***state-full*** way
  - ***Full and Resume*** sessions are managed by a trusted computing environment.

Tandem Overview



TLS-Tandem Card Commands

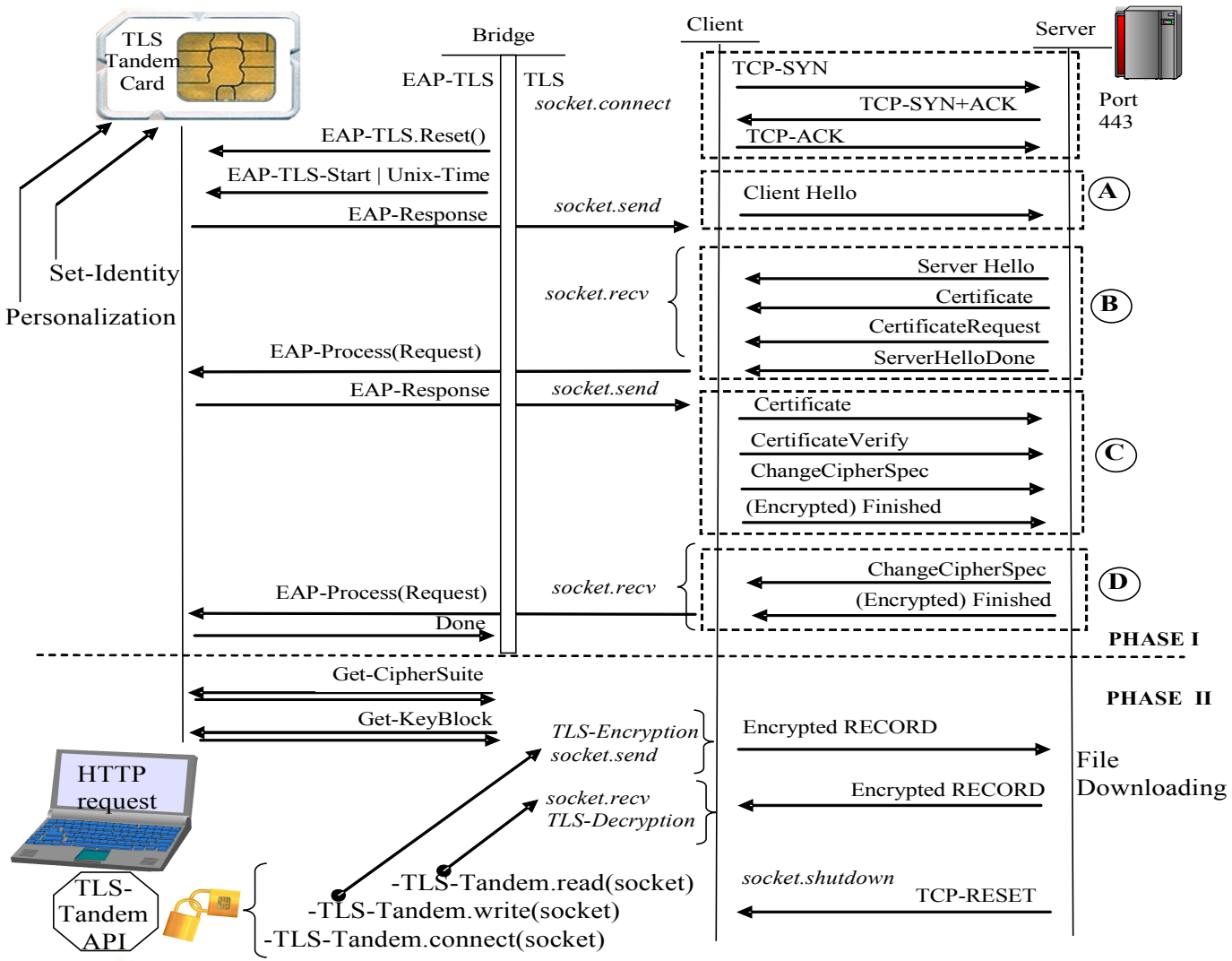
- *Verify-PIN*, unlocks the application via a user's PIN.
- *Set-Identity*, activates an electronic identity e.g. all credentials needed by the TLS session for mutual authentication (Certification Authority certificate, user's certificate, user's RSA private key…).
- *Reset*, resets the EAP-TLS state machine.
- *Process-EAP-TLS*, processes a TLS packet and returns the associated response.
- *Get-CipherSuite*, reads the *CipherSuite* value (a two bytes value)
- *Get-Key-Block*, collects the list of ciphering and integrity keys (typically four values of 16 bytes).

TLS-Tandem API

- The TLS-Tandem API offers three high levels procedures,
  - TLS-Tandem.connect() realizes Phase I operations, either in full or resume mode.
  - TLS-Tandem.write() encrypts and sends data in the Phase II context.
  - TLS-Tandem.read() reads and decrypts data in the Phase II context.
- Close to the OPENSSL paradigm :

```
// creates an SSL context, e.g. sets CA certificate, client's certificate
ssl= new (ctx);
// creates a sbio object linked to socket s
sbio = BIO_new_socket(s, BIO_NOCLOSE);
// links ssl and sbio objects to socket s SSL_set_bio(ssl,sbio,sbio);
// performs TLS PhaseI
SSL_connect(ssl);
// reads data from TLS peer in PhaseII
length= SSL_read(ssl, buffer,sizeof(buffer));
// sends data to TLS peer in PhaseII.
error = SSL_write(ssl,buffer,length);
// releases an SSL context
destroy(ctx);
```

Choreography



Security issues

- The trust relies on the proxy application integrity
- A corrupted software could induce hijacking
- Possible protections :
  - Digest control
  - Signature checking
  - Downloading from trusted servers

Conclusion

- TLS-based applications may be secured with smart cards
- Today, Phase II cannot reasonnably be managed by smartcards (throughput is less than 2000 bytes/s)
- Embedded SSL is applied to identity management (such as OpenID), suppressing the login/password concept
    - http://autoconnect.me/

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