TLS-Tandem

TLS-TANDEM

Goal

Learn how to design highly trusted WEB applications based on the popular TLS protocol, whose security is enforced by the Java Card technology.

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Agenda

Introduction, about TLS and WEB applications

TLS-Tandem concepts.

TLS-Tandem package.

DEMO: TLS-Tandem at work !

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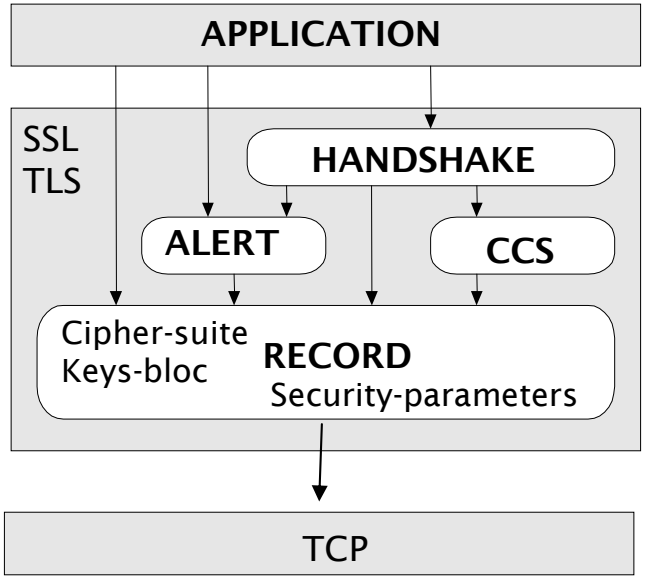
About TLS and WEB applications

- SSL was designed by Netscape in 1994
  - SSLv2 (1994), SSLv3(1996)
- TLS is the IETF version of SSL
  - TLS (RFC 2246, 1999)
- TLS is widely used for WEB applications security



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How does TLS Work ?

- A TLS stack comprises four entities :
  - The Record layer, delivers all TLS packets, whose content is produced by application, handshake, alert or CCS entities.
    - In the secure mode it provide a protected channel whose data privacy and integrity are enforced by encryption (RC4,…) and MAC (HMAC-MD5, HMAC-SHA1,..)
  - The Handshake layer, performs authentication operations, negotiates cryptographic algorithms (*CipherSuite*), computes cryptographic keys (*KeysBloc*).
  - The Alert layer notifies errors
  - The Change Cipher Spec (CCS) layer, indicates that the Record layer is going to work in a secure mode, according to the cryptographic algorithms (*CipherSuite*) and associated keys (*KeysBloc),* previously negotiated.

A Record layer message

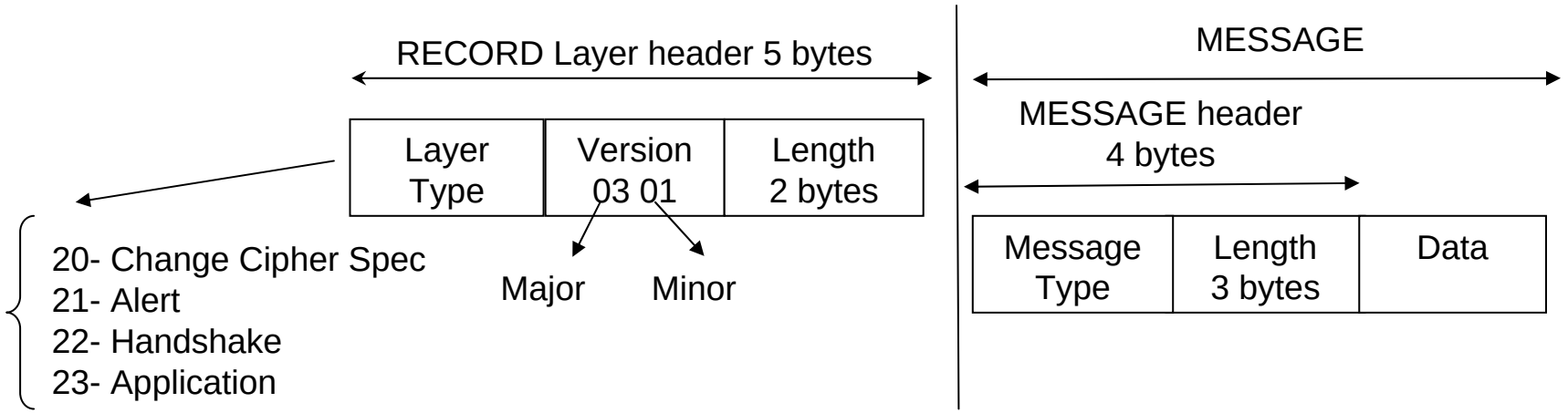

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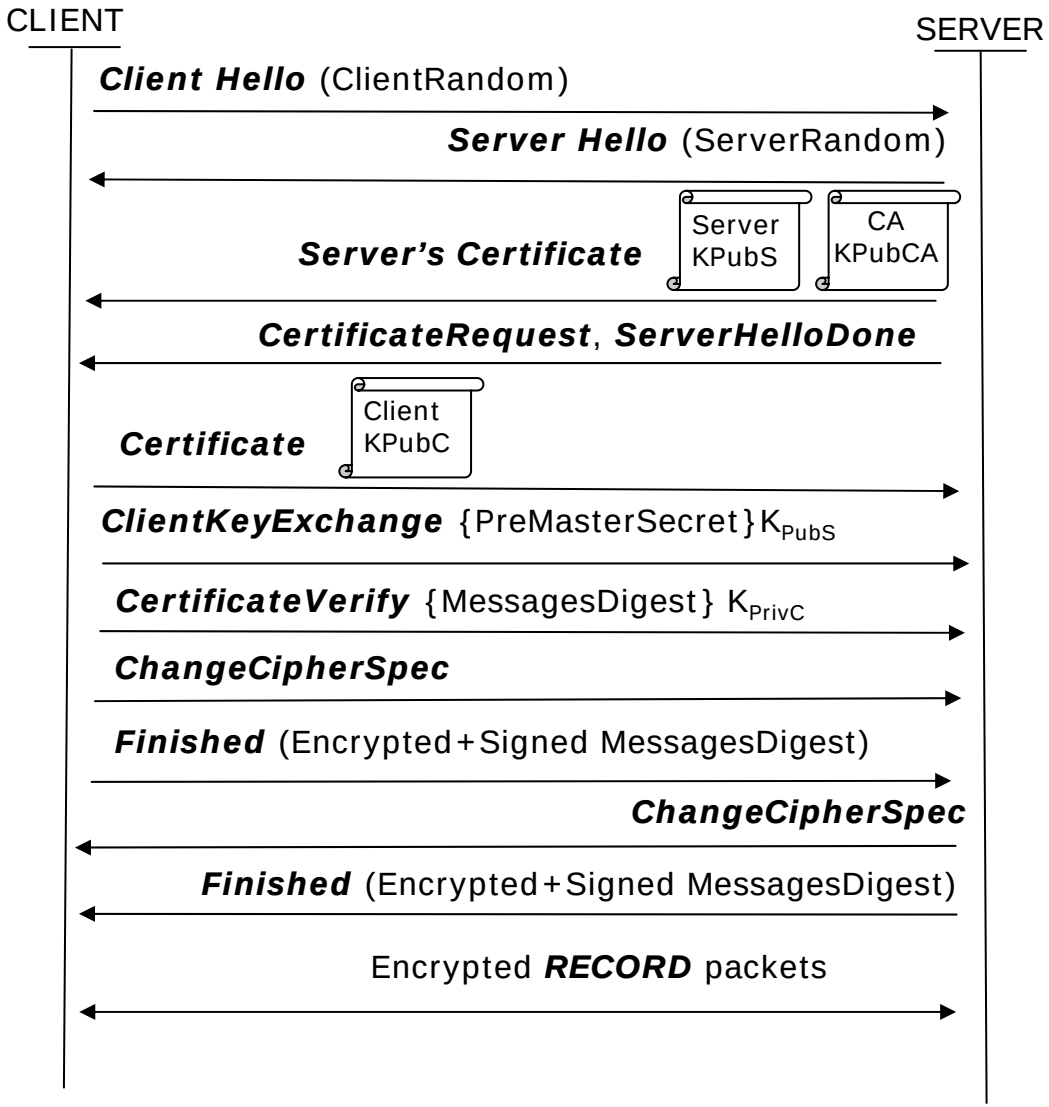
Illustration of a full TLS session

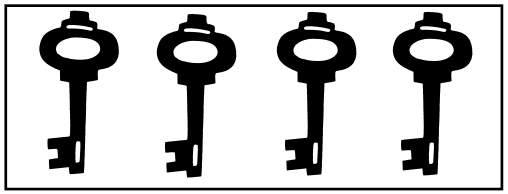
The client chooses a PreMasterSecret. It ciphers this value with the Server public key {PreMasterSecret} K_{PubS}

MasterSecret = PRF(pre_master_secret, “master secret", client_random | server_random)

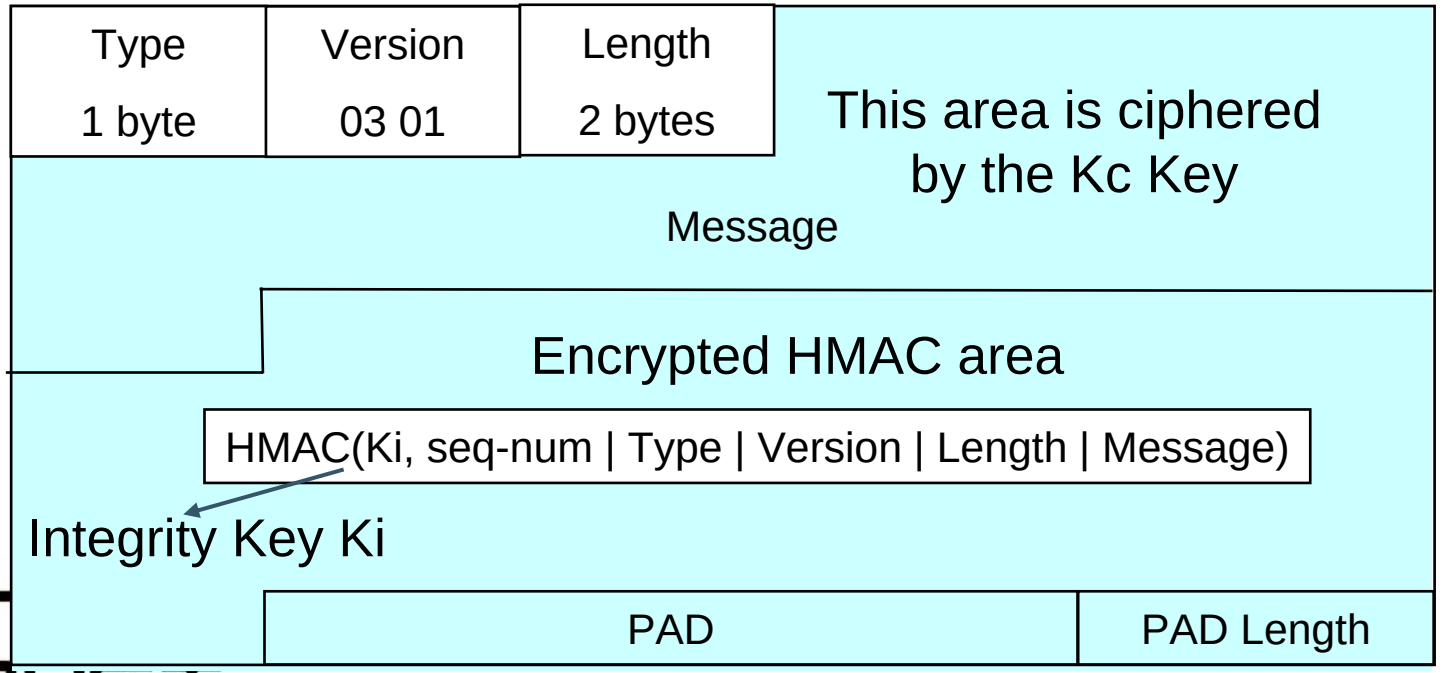
KeysBloc = PRF(master_secret, "key expansion", server_random | client_random)



The Record layer, in secure mode



KeysBloc = Two encryption keys +
two integrity keys



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DEMO: TLS-Tandem at work !

TLS-Tandem main idea.

- The opening of TLS session is fully managed by a Java Card™.
  - Java Cards are highly secure. They may be issued by WEB applications providers.
    - X509 Certificate are stored in Java Cards
    - RSA private keys are only used in this trusted environment.
  - But today smart card components are not able to handle high (encrypted) data rates.
- Once the session has been open, its control is transferred to a JAVA terminal
  - CipherSuite and KeysBloc parameters are collected from the Java Card
  - The *Record Layer* is afterwards fully managed by the JAVA terminal

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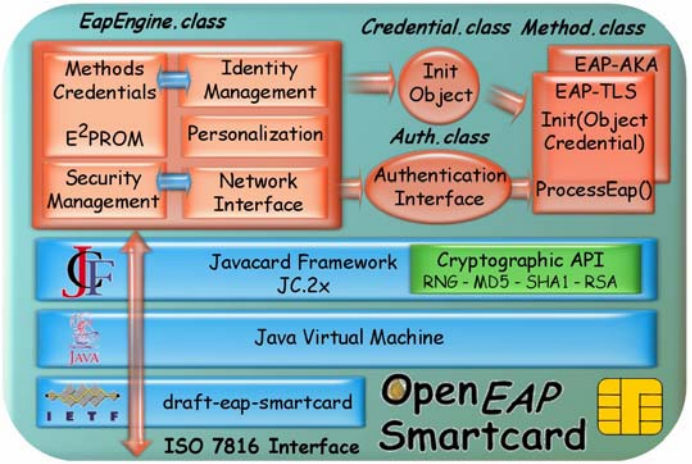
TLS in Java Cards

- EAP-TLS Java Cards were introduced during JavaOne 2007
  - TS-0285, "JavaCard for Emerging WLAN Environments“
- EAP-TLS is a transparent transport TLS
  - Defined by RFC 2716
- EAP-TLS Java Cards are built with the OpenEapSmartcard framework.
  - EAP smart cards are defined by the IETF draft, *draft-urien-eap-smartcard-13.txt*



Example of smart card computing performances with a 32 bits microcontroller

- RSA encryption / decryption operation with 1024 bits public keys: 40 ms
- RSA encryption / decryption operation with 1024 bits private keys: 740 ms
- MD5 calculation: 2,25 ms/bloc
- SHA1 calculation: 1,45 ms/bloc
- 3xDES (2 keys) operation: 11 ms/bloc
- AES (128 bits) encryption/decryption: 6,25 ms/bloc
- Opening of a TLS *full session:* 5 seconds

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Main commands of TLS-Tandem Java Cards

- *Reset (imported from the IETF draft)*
  - Reset the EAP-TLS state machine
- *Process-EAP (imported from the IETF draft)*
  - Processing of an EAP-TLS message
- *Get-KeysBloc (new command)*
  - Reading of the TLS *KeysBloc* value
- *Get-CipherSuite (new command)*
  - Reading of the TLS *CipherSuite* value

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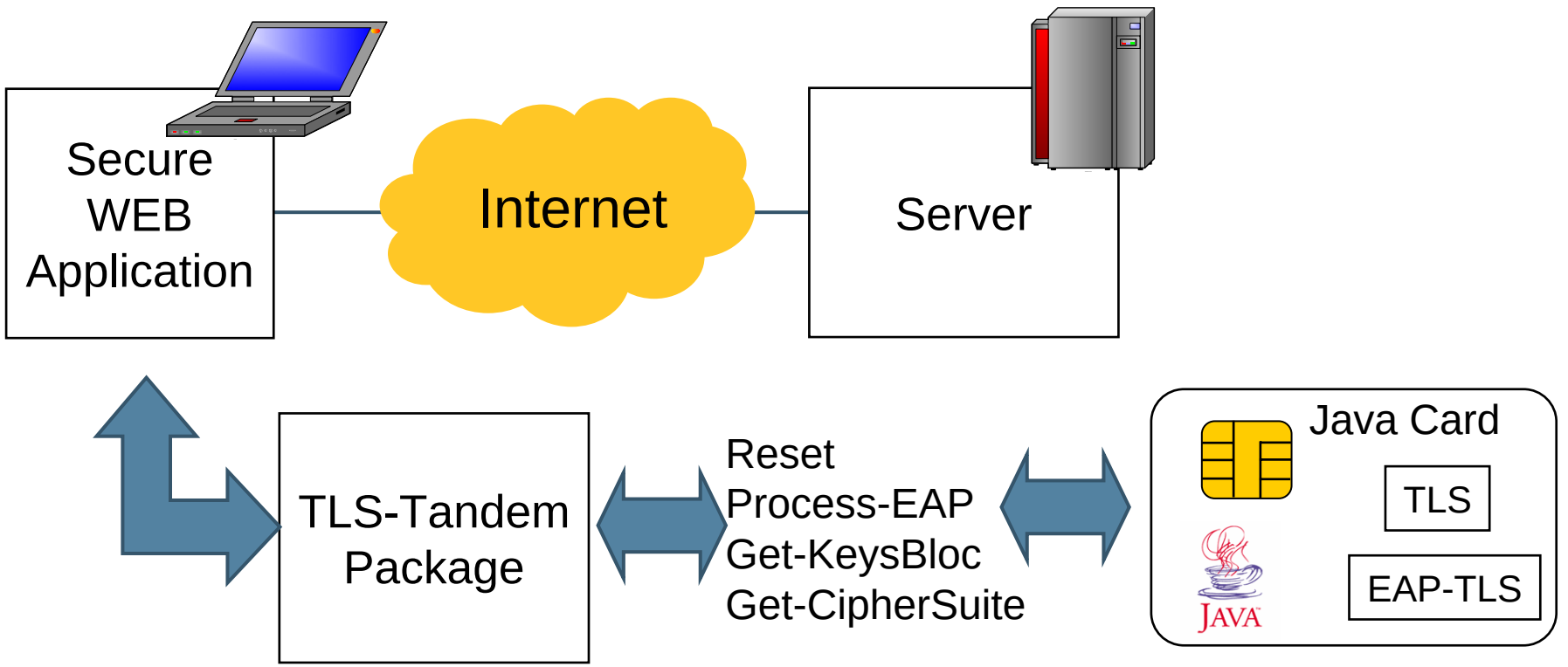
Functional architecture



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The tls-tandem package

- Two main classes, tls-tandem, recordlayer
- The *tls-tandem* class
  - Manages TCP sockets.
  - Translates EAP-TLS messages in pure TLS messages
  - Handles smart card reader operations and dialogs with Java Cards.
- The *recordlayer* class
  - Provides all facilities to send and receive TLS packets when the record layer is in secure mode.

tls-tandem class overview

Field Summary

static int	**CLIENT** CLIENT mode (0)
static int	**SERVER** SERVER mode (1)

Constructor Summary

tls_tandem(int Mode, java.lang.String ReaderName)
TLS-Tandem creation
Mode: tls-tandem.CLIENT or tls-tandem.SERVER
ReaderName: the smart card reader name, null is default

Method Summary

void	**close_reader**(java.lang.String ReaderName) TLS-Tandem end ReaderName: the smart card reader name, null is default
void	**CloseSession**(recordlayer RecordLayer) Close an TLS-Tandem session RecordLayer: The recordlayer object
recordlayer	**OpenSession**(java.lang.String ServerName, short Port) Open a TLS-Tandem session ServerName: the name or the IP address of a TLS server.

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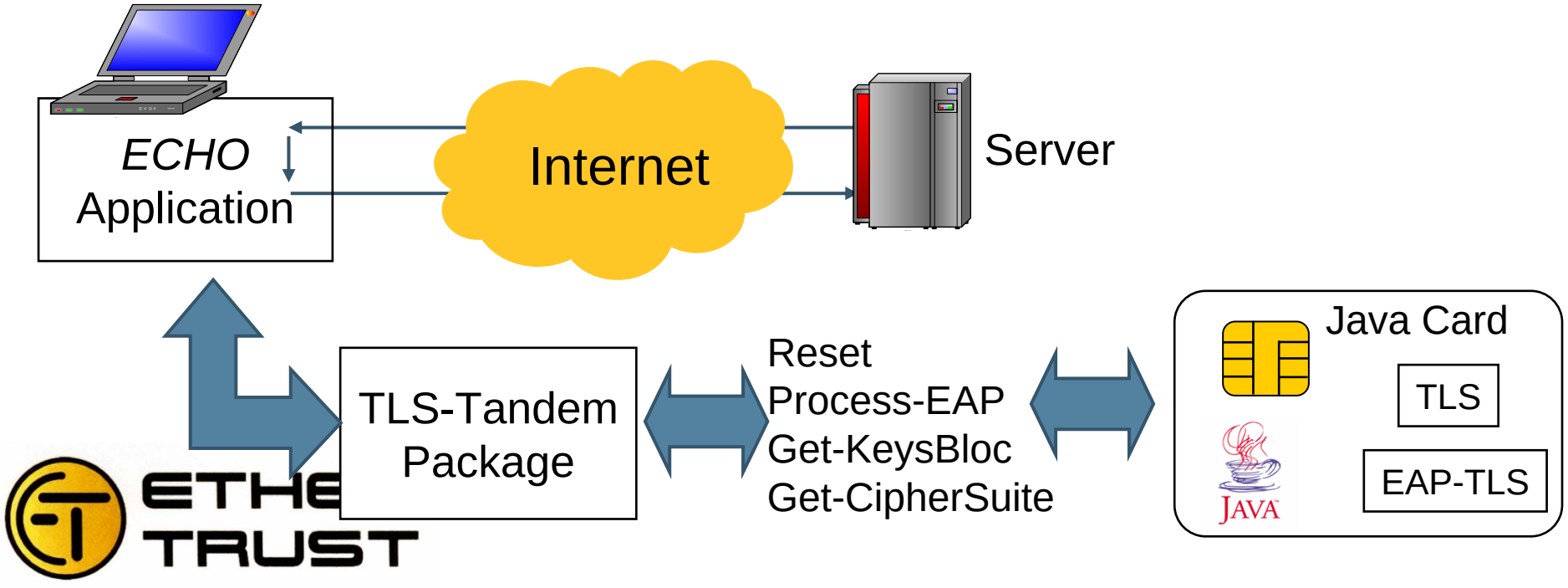
recordlayer class overvi

Field Summary	
short	**CipherSuite** The CipherSuite value RC4_MD5 = (short)0x0004 RC4_SHA1 = (short)0x0005
byte[]	**KeyBloc** The set of keys used by the RecordLayer

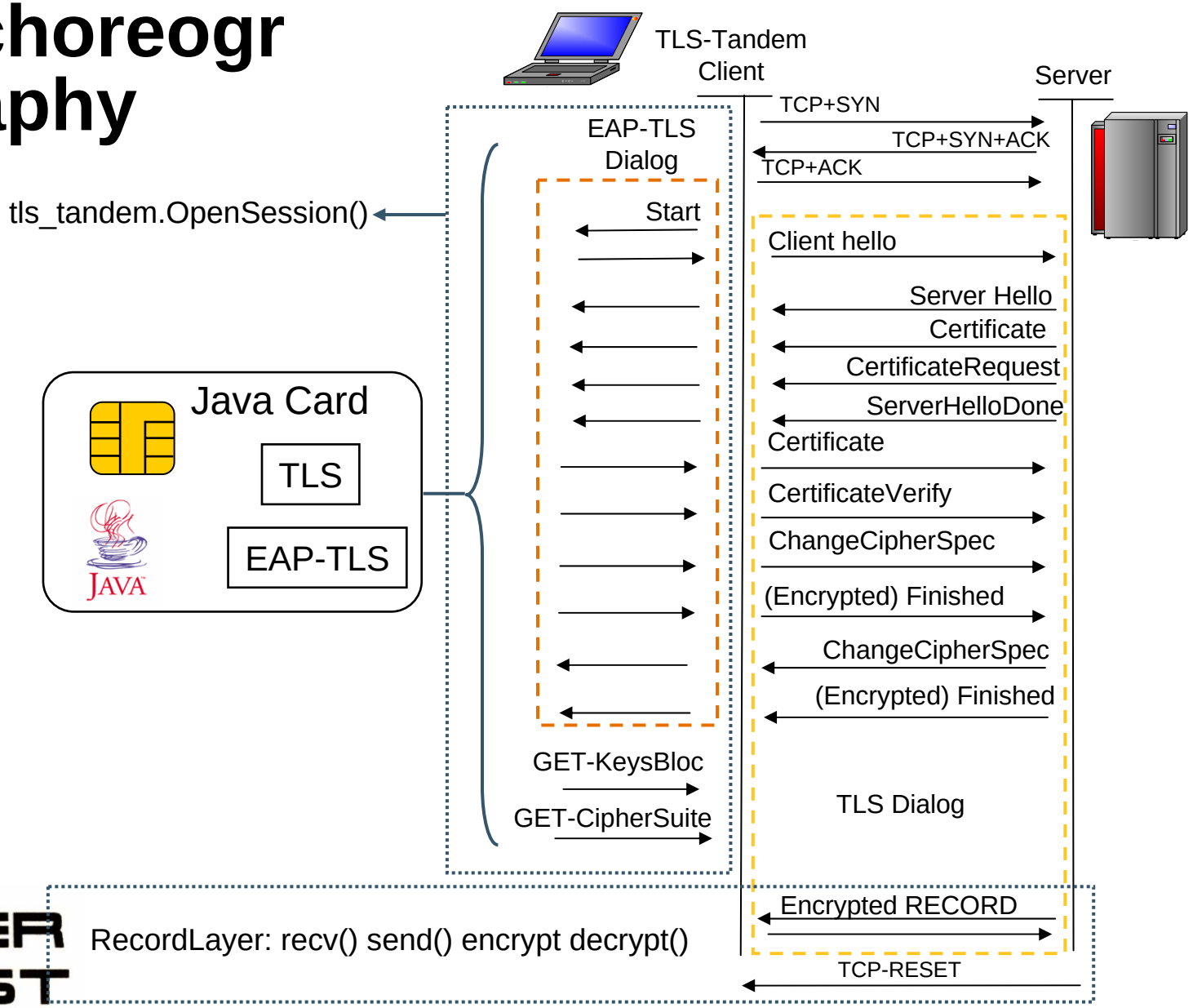
Method Summary	
byte[]	**decrypt**(byte[] msg) Decryption and integrity checking of a RecordLayer packet.
static java.lang.String	**dump**(byte[] Value, int Offset, int Length) Translation of a binary value in an hexadecimal format value: a binary array offset: offset of the value to dump len: length of the value to dump
byte[]	**encrypt**(byte[] msg) Building of a RecordLayer encrypted packet.
byte[]	**recv**() Return an incoming RecordLayer (encrypted) packet
(package private) int	**send**(byte[] buf) Send an encrypted RecordLayer packet

The “echo” application

- A TLS session is opened thanks to a Java Card and the tls-tandem ***OpenSession*** method that returns a ***recordlayer*** object.
- Once the session has been opened the *echo* application decrypts and echoes all incoming TLS packets, thanks to ***recordlayer*** facilities.



TLS-Tandem choreography



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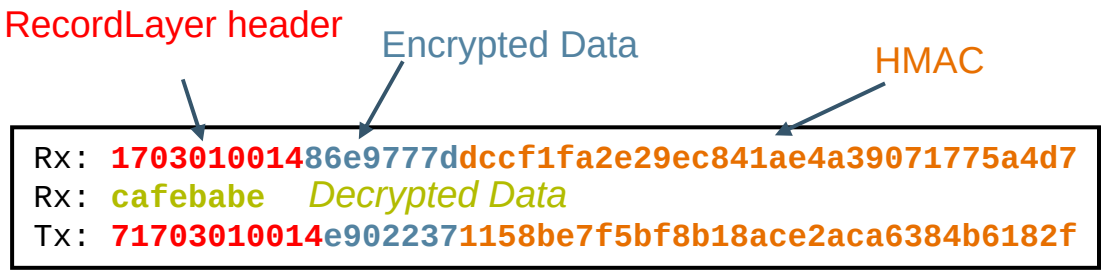
The “echo” code source

```
import java.io.* ; import tls_tandem.* ;
public class console  {
public static void  main(String args[])
{ tls_tandem thistest = new tls_tandem(tls_tandem.CLIENT,null);
  recordlayer RecordLayer = thistest.OpenSession("127.0.0.1",(short)443);

   while(true) {
   byte[] buf1 = RecordLayer.recv(); if (buf1==null) break;

   System.out.println("Rx: " + recordlayer.dump(buf1,0,buf1.length));
   byte[] buf2 = RecordLayer.decrypt(buf1); if (buf2==null) break;

   System.out.println("Rx: " + recordlayer.dump(buf2,0,buf2.length));

   buf2=RecordLayer.encrypt(buf2); if (buf2==null) break;

   System.out.println("Tx: " + recordlayer.dump(buf2,0,buf2.length));

   int err = RecordLayer.send(buf2); if (err == 0) break;}

   thistest.CloseSession(RecordLayer);
   thistest.close_reader(null);
   System.out.println("TLS-Tandem Session End"); }}
```

Some dumps from “echo”



Operations managed by the echo application, thanks to the recordlayer facilities

Hidden operations managed by the tls-tandem class

```
TLS channel opened
Get KeysBloc
>> A0 82 CA 00 40
<< B3 C7 9E A4 60 32 3A 0B 2F 71 2E 75 D7 7D 1D C2
   F9 38 96 90 0F 04 BD BE 7A 4D E1 62 59 29 69 A1
   1A D4 A3 58 4C 40 FC 51 C8 8B 75 7A A2 F0 AE ED
   39 6B 02 8E 31 0A 3C 32 52 AC 4E 1A 6A 32 C0 1D
   90 00
Get CipherSuite
>> A0 82 CC 00 00
<< 6C 03
>> A0 82 CC 00 03
<< 02 00 04 90 00
TLS-Tandem is Ready
```

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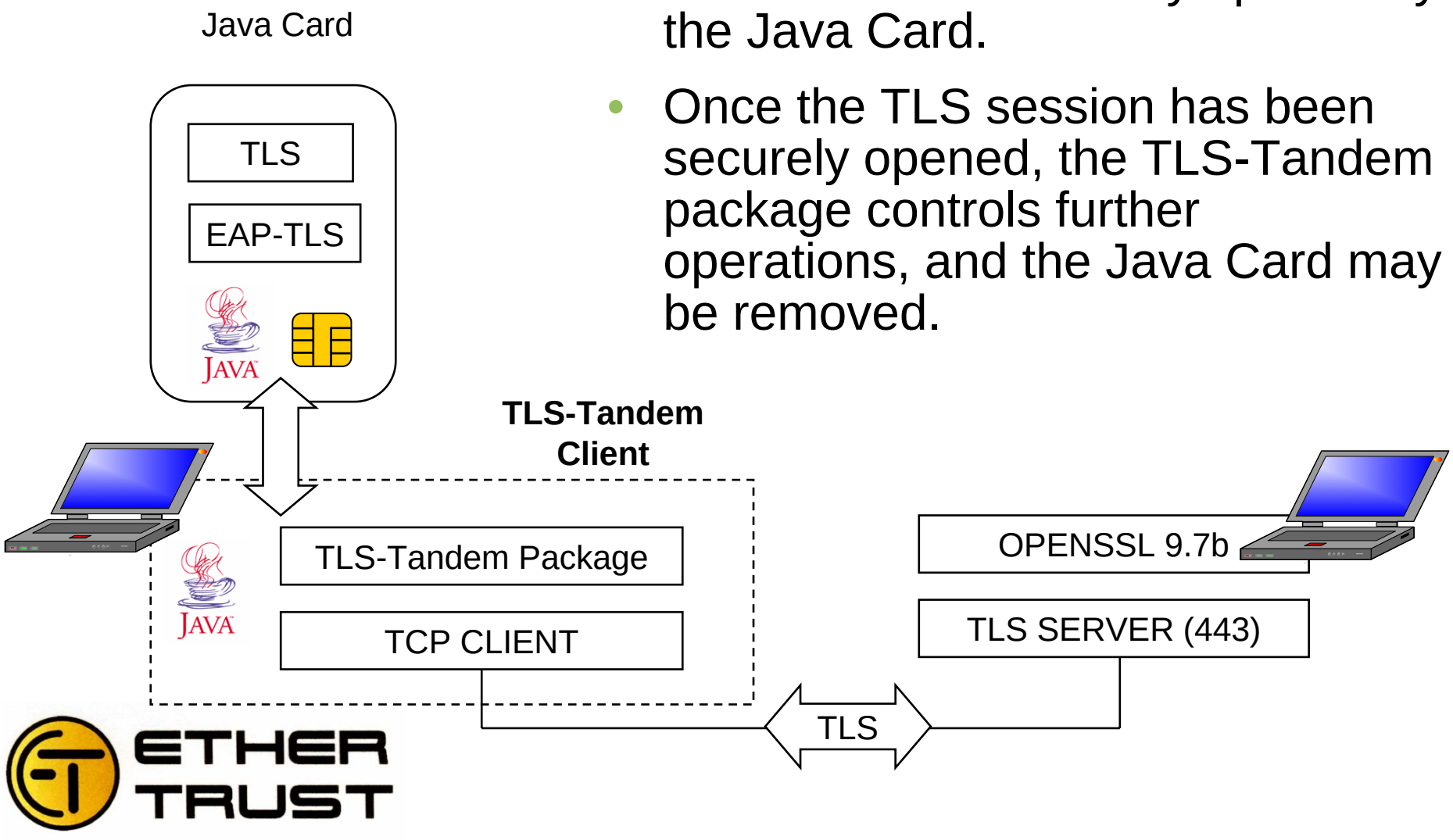
DEMO

TLS-Tandem at work !

DEMO 1 – The echo application

A TLS-Tandem Client

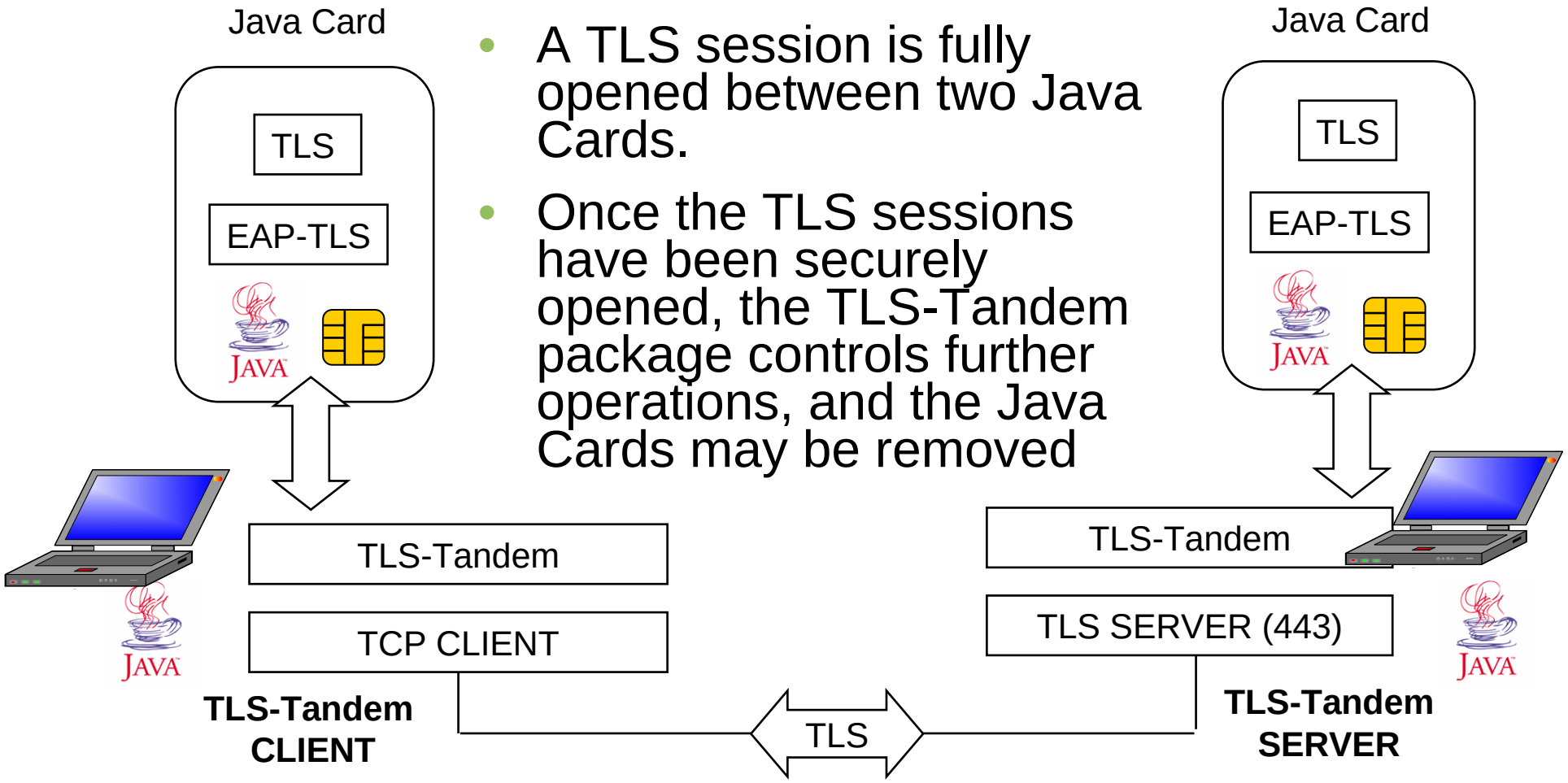
- The TLS session is fully opened by the Java Card.
- Once the TLS session has been securely opened, the TLS-Tandem package controls further operations, and the Java Card may be removed.



A Peer To Peer application.

DEMO 2

- A TLS session is fully opened between two Java Cards.
- Once the TLS sessions have been securely opened, the TLS-Tandem package controls further operations, and the Java Cards may be removed



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Summary

- We have introduced the TLS-Tandem concepts.
- We have presented TLS-Tandem Java Cards.
- We have introduced JAVA package used by TLS-Tandem.
- We have demonstrated a working TLS-Tandem platform.

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For More Information

- http://www.enst.fr/~urien
- “TLS-Tandem”, technical paper to appear
- http://www.ethertrust.com

Q&A

- Pascal Urien