Advanced Security Protocols - SSL/TLS

Design and Verification of Security Protocols and Security Ceremonies

Programa de Pós-Graduacão em Ciências da Computacão
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- Major websites use TLS to secure all communications between their servers and web browsers;
- Although not common, TLS can be used for mutual authentication.
- TLS aims primarily to provide privacy, data integrity and peer authentication between two communicating computer applications.

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- It builds on the earlier SSL specifications (1994, 1995, 1996) developed by Netscape Communications for adding the HTTPS protocol to their Navigator web browser.

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  - Loss or lack of authentication usually leads to major attacks on TLS;

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- TLS can also provide forward secrecy, ensuring that any future disclosure of encryption keys cannot be used to decrypt any TLS communications recorded in the past.
- Most properties of the protocol are verified by different methods, ensuring no major flaws exist at conceptual level;

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  - All of these have to do with implementation of the pre-conditions that fail in practice.

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- The data encapsulated may be control or procedural messages of the TLS itself, or simply the application data needed to be transferred by TLS.

TLS Record Frame

+	Byte +0	Byte +1	Byte +2	Byte +3
Byte 0	Content type			
Bytes 1..4	Version		Length	
	(Major)	*(Minor)*	*(bits 15..8)*	*(bits 7..0)*
Bytes 5..(*m*-1)	Protocol message(s)			
Bytes *m*..(p-1)	MAC (optional)			
Bytes *p*..(q-1)	Padding (block ciphers only)			

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- This happens between the client requesting the data and the server responding to requests;

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- The server also sends its Certificate message, its ServerKeyExchange message and a ServerHelloDone message, indicating it is done with handshake negotiation;

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- All other key data for this connection is derived from this master secret;

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- Application phase starts using TLS record and parameters established at handshake time.

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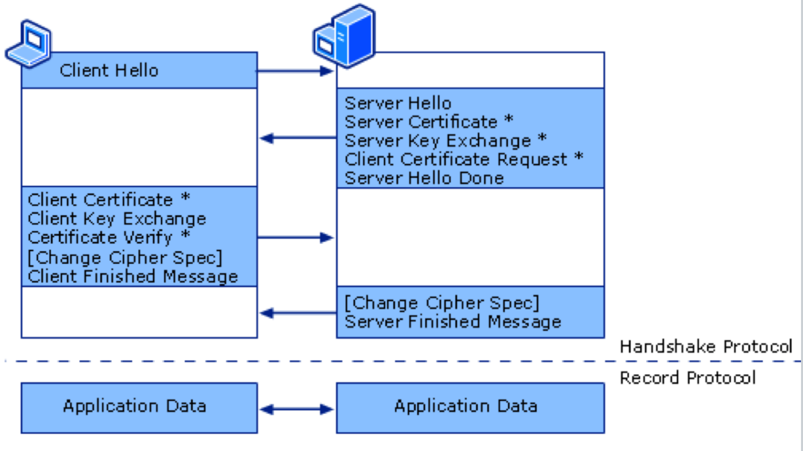
- This is very handy for busy server and it heavily depended on forward secrecy.

TLS Handshake



TLS Handshake Frame

+	Byte +0	Byte +1	Byte +2	Byte +3
Byte 0	22			
Bytes 1..4	Version		Length	
	(Major)	*(Minor)*	*(bits 15..8)*	*(bits 7..0)*
Bytes 5..8	Message type	Handshake message data length		
		(bits 23..16)	*(bits 15..8)*	*(bits 7..0)*
Bytes 9..(*n*-1)	Handshake message data			
Bytes *n*..(*n*+3)	Message type	Handshake message data length		
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- Most of the protocols are badly flawed (no nonces, for example) and the model checker finds many attacks;
- Paulson proved correctness of TLS using Isabelle/HOL and the Inductive method.

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- Is up to-date one of the best abstractions and most precise abstract verification of the suite.

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- How come deeply verified and widely deployed protocols can still have problems?

Questions????

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