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A technique of protocol construction for detecting compromises of secret keys

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The purpose and objectives of the study

The purpose of the study:

Increasing the resistance of information protection tools and systems to the effects of an active intruder capable of gaining access to confidential user information.

The object of the study:

The process of ensuring the security of cryptographic keys in the exchange of information.

The subject of the research:

The detection of compromise of cryptographic keys.

The relevance of research

- the inability to detect an attacker in the early stages of the attack
- the inability to detect compromised accounts and subsequent unauthorized access to a system
- high duration and complexity of information security incident investigations

Cryptographic keys can be compromised in various ways:

System compromise

Viruses

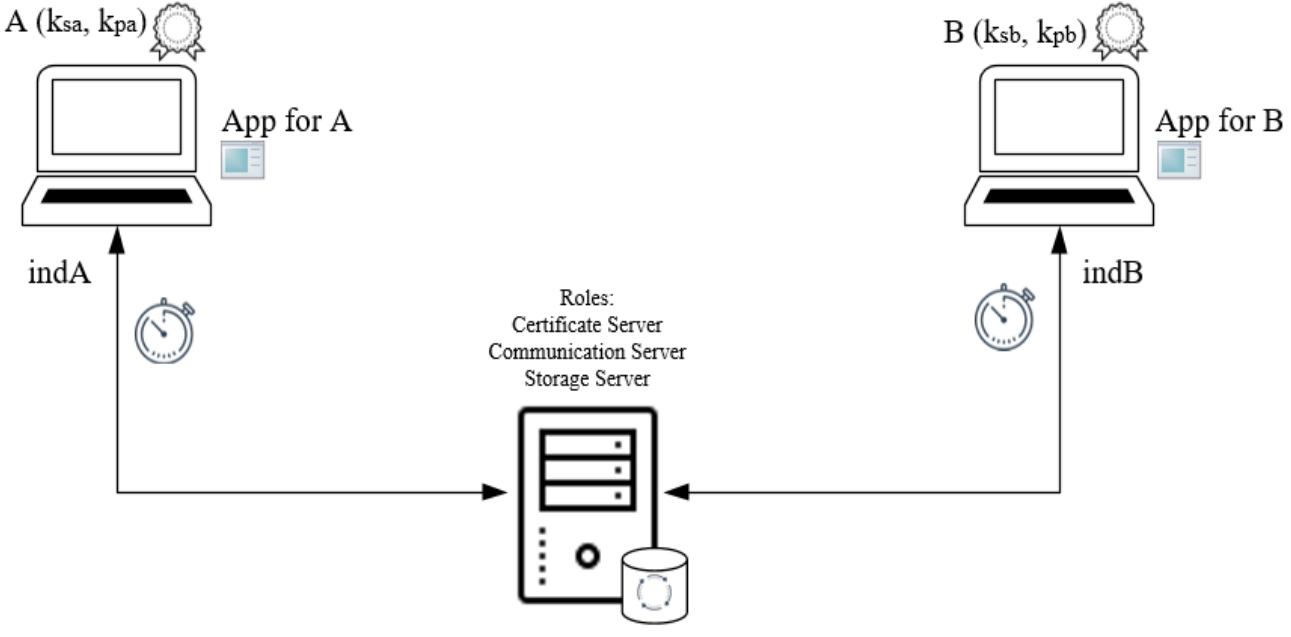
Cryptanalysis

Approaches to identifying compromise on the protocol level

Detection method	Method Features	Disadvantages of the method
Trace-independent inconsistency	A message was received but it isn't specific to the current message set.	The method is theoretical.
Observation of a contradiction	The counter is transmitted in the message, it's allowing participants to control the sequence of messages.	The method gives a false result in case of compromising the key values of both opponents.
Observation of acausality	The message includes a chain of hash-codes of previous messages	• The method allows you to identify an attacker if he left the protocol • Increasing the amount of data transmitted using hash codes

Blockchain-based secret key compromise detection protocol

(sk, pk) – private and a public key of protocol
ind – protocol participant ID



Role Model Messaging Protocol

Client component:

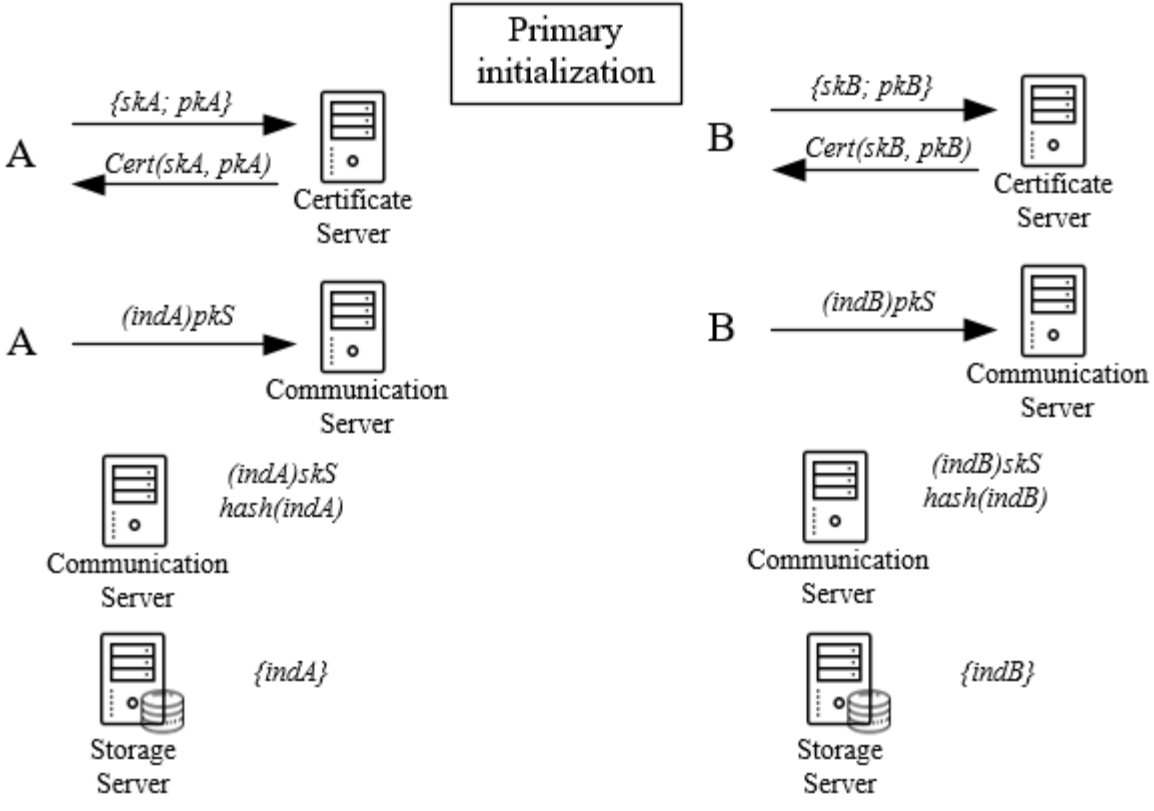
- *The initiator of the sending process* - the role of the device sending the message
- *The recipient of the message* - the role of the device receiving the message

Server component:

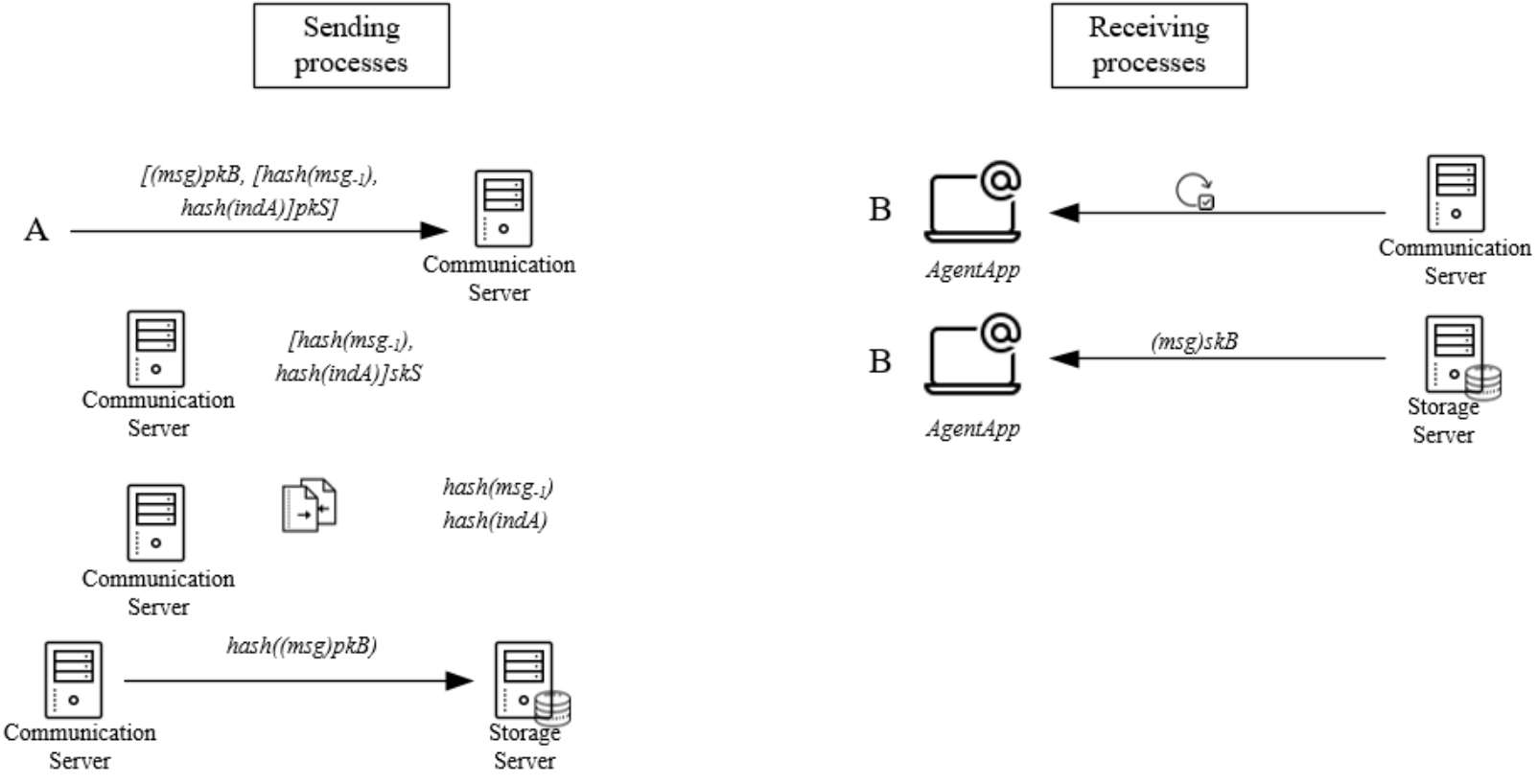
- *Information storage server* - the role of the server component, storing information transmitted between users through blockchain technology.
- *Information transfer server* - the role of the server component, processing the message queue for exchanging information between users.
- *Certification Authority Server* - the role of the server component, combining the roles of a certification authority and a registration center.

Working with keys: primary initialization

- *A* – Initiator
- *B* – Recipient
- *Serv* – server with roles Information storage server, Information transfer server, Certification Authority Server *cert(skS, pkS)*



Sending and receiving messages



Attack Detection Principle

The protocol allows you to detect a compromise of key information in the following cases:

- message sequence mismatch: the hash codes of the current and previous messages are checked in the blockchain
- inability to authenticate a participant by identifier

Modeling in Tamarin Prover

The main properties of the proposed protocol are formulated in the work:

Client authentication - this lemma demonstrates the property of using authentication by an identifier in a simulated protocol;

The correctness of the protocol - this lemma helps us verify the situation when the recipient receives a message without the participation of an attacker;

Secrecy of a client session key - this lemma means the ability to have a session key in secret without the participation of an attacker;

Storage Server Processing Security - this lemma demonstrates the security feature of the interaction of the storage server with data.

Modeling in Tamarin Prover

Using Tamarin Prover utility, a protocol security analysis was performed. Highlighted situations:

- An attacker gains access to one of the client identifiers - the situation does not lead to a compromise of the protocol, the identifier hash is stored

- An attacker gains access to the server's secret key - the situation leads to a compromise of the protocol because the server key is stored in a single place and its additional verification is not performed

Results

As part of the research work, the following tasks were completed:

- ✓ The architecture and description of the protocol for detecting the compromise of cryptographic keys is proposed.
- ✓ Analysis of protocol security by the model in Tamarin Prover is defined.

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Thank you for attention!

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