Verifying security protocols using the ProVerif tool

Security protocols (bmevihim132)

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Proverif verification tool

**Input**
- Security protocol specified in syntax of applied pi-calculus

**Automatic verification**
- Protocol rules
- Attacker rules
- automatic verification algorithm

**Output**
- Yes
- No (attack trace)

**PROVERIF tool**

- A kind of theorem prover (based on logic), but fully automated.
- Security protocols are specified in a simplified form of applied pi calculus.
- Can verify strong secrecy, weak secrecy, forward secrecy, authenticity, anonymity.
Variants of the pi-calculus

- **Pure pi-calculus** [Robin Milner. 1990]
  - Calculus for concurrent computation.
  - Main features: fresh names, communication channels, name passing, recursion.

- **Spi-calculus** [Martin Abadi, Andrew Gordon. 1997]
  - Extend the pure pi-calculus with fixed number of crypto primitives.
  - Main features: prove security properties using bisimulations.

- **Applied pi-calculus** [Martin Abadi, Cédric Fournet. 2001]
  - Extend spi-calculus with additional bisimilarities, more crypto primitives.
  - Main features: much easier usage to prove security properties.
Typed applied pi-calculus

\[ M, N ::= \]
\[ a, b, c, k, m, n, s \]
\[ x, y, z \]
\[ (M_1, \ldots, M_k) \]
\[ h(M_1, \ldots, M_k) \]

\[ C ::= \]
\[ M = N \]
\[ M <> N \]
\[ M \]
\[ C \&\& C \]
\[ C || C \]
\[ not(C) \]

\[ P, Q ::= \]
\[ 0 \]
\[ P | Q \]
\[ !P \]
\[ new n : t; \ P \]
\[ in(M, x : t); \ P \]
\[ out(M, N); \ P \]
\[ if \ C \ then \ P \ else \ Q \]
\[ let \ x = M \ in \ P \ else \ Q \]
\[ R(M_1, \ldots, M_k) \]

Terms

- names
- variables
- tuple
- constructor/destructor application

Conditions

- term equality
- term inequality
- term (of type bool)
- conjunction
- disjunction
- negation

Processes

- null process
- parallel composition
- replication
- name restriction
- message input
- message output
- conditional
- term evaluation
- macro usage

Formal analysis of security protocols
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Pattern matching

\[ T ::= \begin{align*}
    & x : t \\
    & x \\
    & (T_1, ..., T_n) \\
    & =M 
\end{align*} \]

**patterns**
- typed variable
- variable without explicit type
- tuple
- equality test

- Variable pattern \( x : t \) matches any term of type \( t \) and binds the matched term to \( x \).
- \( x \) can be used only when the type of \( x \) can be inferred from the context.
- Tuple pattern \( (T_1, ..., T_n) \) matches tuples \( (M_1, ..., M_n) \) where each component \( M_i \) is recursively matched with \( T_i \).
- The pattern \( =M \) matches terms \( N \) where \( M = N \).
  - \( \text{in}(=M); P \) waits a term that matches pattern \( M \), then behaves as \( P \).

Input e.g.,: \( \text{in}(c, x:t); Q \) can be written as \( \text{in}(c, =M); Q \)
Formal analysis of security protocols

ProVerif’s input file – 1

- **Declaration, process definition, queries**

\[
<\text{decl}> ::= \\
\text{type } t \\
\text{free name : } t \\
\text{free name : } t \ [\text{private}] \\
\text{const } c : t \\
\text{table } d(t_1, \ldots, t_n) \\
\text{fun } f(t_1, \ldots, t_n) : t \\
\text{fun } f(t_1, \ldots, t_n) : t \ [\text{private}] \\
\text{reduc forall } x_1 : t_1, \ldots, x_n : t_n; \ g(M_1, \ldots, M_k) = M \\
\text{reduc forall } x_1 : t_1, \ldots, x_n : t_n; \ g(M_1, \ldots, M_k) = M \ [\text{private}]
\]

**declaration**

- user defined type
- public free names
- private free names
- constant \( c \) of type \( t \)
- table \( d \) takes records of type \( t_1, \ldots, t_n \)
- public constructor function
- private constructor function
- public destructor application
- private destructor application
ProVerif’s input file – 2

\[ < \text{procmacro} > ::= \]
\[ \text{let } R(x_1, \ldots, x_n) = P. \]

\[ < \text{mainproc} > ::= \]
\[ \text{process } P \]

\[ < \text{query} > ::= \]
\[ \text{query attacker}(M). \]
\[ \text{query event}(M) \rightarrow \text{event}(N). \]
\[ \text{query inj \text{– event}}: M \rightarrow \text{inj \text{– event}}: N. \]
\[ \text{noninterf } x \]
\[ \text{noninterf } x \text{ among } \{ M_1, \ldots, M_k \} \]

\text{sub-process definition}

\text{define a process with the name } R.

\text{main process definition}

\text{define properties to be verified.}

\text{want to verify weak secrecy of } M.

\text{in any trace : event } N \text{ is always before event } M.

\text{in any trace : at least as many } N\text{-events as } M\text{-events.}

\text{want to verify strong secrecy of } x.

\text{want to verify strong secrecy of } x \text{ taken value from a set.}

The structure of the whole ProVerif source file is

\[ < \text{decl} > ^* < \text{query} > ^* < \text{procmacro} > ^* < \text{mainproc} > \]
<table>
<thead>
<tr>
<th>Expression</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>type ( t )</td>
<td>user defined type.</td>
</tr>
<tr>
<td>free name: ( t )</td>
<td>free names.</td>
</tr>
<tr>
<td>free name: ( t ) [private]</td>
<td>private free names.</td>
</tr>
</tbody>
</table>

- User defined type can be anything except for pre-defined, built-in types.
  - User defined: bitstring, skey, pkey, etc.
- Free names model public data, which are available for the attacker.
  - public keys, communication channels, participant IDs, etc.
- Private names model secret data, which are not known by the attacker.
  - secret keys, etc.
- Identifiers range over an unlimited sequence of letters (a-z, A-Z), digits (0-9), underscores (_), singlequotes (‘), and accented letters from the ISO Latin 1 character set.
  - E.g. free **secretKey**:skey.
### Constructor functions

- **Constructor function:**
  - $f$ is a function of arity $n$.
  - $t$ is a type of the returned value, and $t_1, \ldots, t_n$ are types of the arguments.
  - Constructor functions are available to all participants (honest and attacker).
  - Private constructor function are available to only honest participants.
    - E.g., key databased (table) stored by the honest nodes.

\[
\begin{align*}
\text{fun } f(t_1, \ldots, t_n) : t & \quad \text{public constructor function} \\
\text{fun } f(t_1, \ldots, t_n) : t \ [\text{private}] & \quad \text{private constructor function}
\end{align*}
\]
Destructor applications

\[ \text{reduc } \forall x_i:t_1,\ldots, x_n:t_n; \ g(M_1,\ldots,M_k) = M \]
\[ \text{reduc } \forall x_i:t_1,\ldots, x_n:t_n; \ g(M_1,\ldots,M_k) = M \ [\text{private}] \]

- Destructor applications:
  - \( g \) is a function of arity \( k \).
  - \( t_1,\ldots, t_n \) are types of the variables \( x_1, \ldots, x_n \).
  - \( x_1, \ldots, x_n \) are variables in terms \( M_1, \ldots, M_k \).
  - Destructor applications are available to all participants (honest and attacker).
  - Private destructor applications are available to only honest participants.
Constructor and Destructor examples

Symmetric encryption (User defined)

\[
\text{type bitstring, key.} \\
\text{fun senc(bitstring,key):bitstring} \\
\text{reduc forall m: bitstring, k : key;sdec (senc (m, k ), k ) = m.}
\]

Asymmetric encryption (User defined)

\[
\text{type bitstring, skey, pkey.} \\
\text{fun pk(skey):pkey} \\
\text{fun penc(bitstring, pkey):bitstring} \\
\text{reduc forall m : bitstring, k : skey; pdec (penc (m, pk(k) ), k) = m.}
\]
Constructor and Destructor examples

Digital signatures (User defined)

```ml


fun spk(sskey):spkey

fun sign(bitstring, sskey):bitstring

reduc forall m: bitstring, k : sskey; checksign (sign(m, spk(k) ), k) = m.

```

One-way functions (User defined)

```ml

	

type bitstring, key.

fun hash(bitstring) : bitstring.

fun mac(bitstring, key).

```

Tuples (built-in)

```ml

fun (t_1,...,t_k) : bitstring

reduc forall x_1:t_1,...,x_k:t_k; ith((M_1,...,M_k )) = M_i.

```


Tables and operations

- *table d(t₁,...,tₙ)*  (* declation*)
- *insert d(M₁,...,Mₙ); P*
- *get d(T₁,...,Tₘ) in  P*
- *get d(T₁,...,Tₘ) suchthat C in  P*

- d is the name of the table which takes records of type t₁, . . . , tn.
- Processes may populate and access tables, but deletion is forbidden.
- Process *insert d(M₁, . . . ,Mₙ); P* inserts the record M₁, . . . ,Mₙ into the table d and then executes P.
- Process *get d(T₁, . . . , Tₙ) in  P* attempts to retrieve a record in accordance with patterns T₁, . . . , Tₙ.
  - When no such record is found, the process blocks.
  - In case there are several identical records, one is chosen from them.
- C is an additional condition for the records.
Process Macros, subprocesses

- Defining sub-processes that will be used in the main process.
- $R$ is a macro name, $P$ is a sub-process being defined, $x_1, \ldots, x_n$ of type $t_1, \ldots, t_n$ are variables of $P$.
- $R(M_1, \ldots, M_n)$ will then expand to $P$ with $M_1$ substituted for $x_1$, \ldots, $M_n$ substituted for $x_n$.

\[
\text{let } R(x_1 : t_1, \ldots, x_n : t_n) = P
\]
Bracketing, precedence

- P | Q binds most closely, ! P | Q is equal to !(P | Q)
- if C then Q else P
- let x=M in P else Q
- unary processes bind least closely.

1. new n : t; out(c, n) | new n : t; in(c, x : t); 0 | if x = n then 0 | out(c, n), is bracketed as
   new n : t; (out(c, n) | new n : t; (in(c, x : t); 0 | if x = n then (0 | out(c, n) )))

2. if M = M’ then if N = N’ then P else Q, is bracketed as
   if M = M’ then (if N = N’ then P else Q)

3. let x = M in let y = N then P else Q, is bracketed as
   let x = M in (let y = N then P else Q)
Hello word script

1. (* hello.pv: Hello World Script *)
2. free c : channel.
3. free K₁ : bitstring [private].
4. free K₂ : bitstring [private].
5. query attacker(K₁).
6. query attacker(K₂).
7. process
8. out(c,K₂);
9. 0

• The verification algorithm attempts to prove that the states in which the keys are obtained by the attacker are unreachable. not attacker(K₁) is true/false
Hello world with process macros

1. (* Hello World Script with Macros *)
2. free c : channel.
3. free $K_1$ : bitstring [private].
4. free $K_2$ : bitstring [private].
5. query attacker($K_1$).
6. query attacker($K_2$).
7.
8. let $R(x : \text{bitstring}) = \text{out}(c, x); 0$. 
9. let $R'(y : \text{bitstring}) = 0$. 
10. process $R(K_1) \mid R'(K_2)$
ProVerif output

Process: [Process]

-- Query [Query]
Completing...
Starting query [Query]
RESULT [un]reachable : Goal.

[Attack derivation]

set traceDisplay = long.
[Attack trace]

RESULT [Query][result].

- Internally, ProVerif attempts to prove that a state in which a property is violated is unreachable;

- ProVerif shows the (un)reachability of some [Goal].

The specified protocol. Each row is labelled with \{n\}, where n is an integer.

Verifying the property given in [Query] by user.

Reconstruct and return the detected attack

Finally, ProVerif reports if the Query was satisfied.
Running result of the hello world script

Process
{1} out(c, K₂)
-- Query not attacker(K₁[])
Completing...
Starting query not attacker(K₁[])
RESULT not attacker(K₁[]) is true.
-- Query not attacker(K₂[])
Completing...
Starting query not attacker(K₂[])
goal reachable: attacker(K₂[]).

The message K₂[] may be sent to the attacker at output {1}.
attacker(K₂[]).

set traceDisplay = long.
out(c, K₂) at {1}
The attacker has the message K₂.
A trace has been found.
RESULT not attacker(K₂[]) is false

Try to prove not attacker(K₁[])
attacker(K₁[]) is false
The attacker can obtain K2.
Attack trace is returned.
Queries full syntax

\[ q ::= \]
\[ F \]
\[ F ==> H \]

\[ H ::= \]
\[ F \]
\[ H & & H \]
\[ H || H \]
\[ (F ==> H) \]

\[ F ::= \]
\[ \text{attacker}(M) \]
\[ \text{attacker}(M) \text{ phase } n \]
\[ \text{mess}(N,M) \]
\[ \text{mess}(N,M) \text{ phase } n \]
\[ \text{event}(e(M_1,\ldots,M_n)) \]
\[ \text{inj-event}(e(M_1,\ldots,M_n)) \]
\[ M=N \]
\[ M<>N \]

\text{query}
\[ \text{fact} \]
\[ \text{correspondence} \]

\text{hypothesis}
\[ \text{fact} \]
\[ \text{conjunction} \]
\[ \text{disjunction} \]
\[ \text{nested correspondence} \]

\text{fact}
\[ \text{the adversary has } M \text{ (in any phase)} \]
\[ \text{the adversary has } M \text{ in phase } n \]
\[ M \text{ is sent on channel } N \text{ (in the last phase)} \]
\[ M \text{ is sent on channel } N \text{ in phase } n \]
\[ \text{non-injective event} \]
\[ \text{injective event} \]
\[ \text{equality} \]
\[ \text{inequality} \]
Security properties, Queries

• Reachability and weak secrecy
  • which term will be obtained by the attacker during protocol runs.
  • E.g., \texttt{query attacker}(M) - can the attacker obtain term M?
    M is ground term, does not contain destructor applications.

• Correspondence assertions, events, authentication
  • if an event \( e \) has been executed, then event \( e' \) has been previously executed.
  • processes are annotated with \texttt{events}, which mark stages reached by the protocol.
  • but do not affect the behaviour of processes.
  • definition in process: \texttt{Process} …. \texttt{event} \( e(M_1,\ldots,M_n) \); \texttt{P} …. 
  • declaration: \texttt{event} \( e(t_1,\ldots,t_n) \). Where \( t_1,\ldots,t_n \) are types of arguments.
  • Query: \texttt{query} \( x_1:t_1,\ldots, x_n:t_n; \texttt{event} \ e(M_1,\ldots,M_j) \Rightarrow \texttt{event} \ e' (N_1,\ldots,N_i) \)
  • for each occurrence of \( e(M_1,\ldots,M_j) \), event \( e' (N_1,\ldots,N_i) \) has occurred before.

• Injective correspondence
  • one-to-one relationship between the number of protocol runs performed by each participant.
  • E.g., Financial transaction
    • server request payment from the client.
    • server should complete payment only once for each transaction started by the client.
  • Query: \texttt{query} \( x_1:t_1,\ldots, x_n:t_n; \texttt{inj-event} \ e(M_1,\ldots,M_j) \Rightarrow \texttt{inj-event} \ e' (N_1,\ldots,N_i) \)
Naiv handshake protocol

\[
\begin{align*}
C \rightarrow S &: pk_C \\
S \rightarrow C &: \{ \{ pk_S, k \}^s \}^p k_C \\
C \rightarrow S &: \{ s \}^k
\end{align*}
\]

• Each principal has a public/private keypair.
• The client knows the server’s public key.
• The aim of the protocol: client shares the secret \( s \) with the server.

• Security properties would like to provide
  • **Secrecy**: the value \( s \) is known only to Client and Server.
  • **Authentication of Client to Server**: if Server reaches the end of the protocol and he believes he has shared the key \( k \) with Client, then Client was indeed his interlocutor and she has shared \( k \).
  • **Authentication of Server to Client**: if Client reaches the end of the protocol with shared key \( k \) then Server indeed proposed \( k \) for use to Client.
Naiv handshake prot. Declaration

Symmetric encryption

- **type** key.
- **fun** senc(bitstring, key) : bitstring.
- **reduc for all** m: bitstring, k:key; sdec(senc(m, k), k) = m.

Assymmetric encryption

- **type** skey.
- **type** pkey.
- **fun** pk(skey) : pkey.
- **fun** aenc(bitstring, pkey) : bitstring.
- **reduc for all** m: bitstring, k:skey; adec(aenc(m, pk(k)), k) = m.

Digital signature

- **type** sskey.
- **type** spkey.
- **fun** spk(sskey) : spkey.
- **fun** sign(bitstring, sskey) : bitstring.
- **reduc for all** m: bitstring, k:sskey; getmess(sign(m, k)) = m.
- **reduc for all** m: bitstring, k:sskey; checksign(sign(m, k), spk(k)) = m.
Verifying weak secrecy in the Handshake protocol.

```plaintext
1  free c : channel .
2  free s : bitstring [private] .
3  query attacker(s) .
4
5  let clientC(pkC: pkey, skC : skey, pkS: spkey ) =
6    out(c, pkC) ;
7    in(c, x : bitstring);
8    let y = adec(x, skC) in
9    let (=pkS, k : key) = checksign(y, pkS) in
10   out(c, senc(s, k )).
11
12  let serverS(pkS: spkey, skS : sskey) =
13    in(c, pkX: pkey);
14    new k : key;
15    out(c, aenc(sign((pkS, k), skS), pkX));
16    in(c, x : bitstring);
17    let z = sdec(x, k) in 0.
18
19  process
20  new skC : skey;
21  new skS : sskey;
22  let pkC = pk(skC) in out(c, pkC);
23  let pkS = spk(skS) in out(c, pkS);
24  ( (! clientC(pkC, skC , pkS)) | ( ! serverS(pkS, skS)) )
```

Client subprocess (Process Macro)

Server subprocess (Process Macro)

Main process
Verifying authenticity in the Handshake protocol.

Client believes it has terminated a protocol run with parameters `symm. key` and *its pub. key*. Server believes it has terminated a protocol run with Client using `symm. key`.

Client wants to be sure that when it completes the protocol it has *indeed shared its secret with Server*. Not injective: Server's msg can be replayed.

Injective corresp.: Server believes that at the end of the prot. **Client was indeed its partner.**

One-to-one relation

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Formal analysis of security protocols

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Attack against the naive handshake protocol

\[
A \rightarrow S : pk_A \\
S \rightarrow A : \{ \{ pk_S , k \}_{sk_S} \}_{pk_A} \\
C \rightarrow S : pk_C \\
A \rightarrow C : \{ \{ pk_S , k \}_{sk_S} \}_{pk_C} \\
C \rightarrow S : \{ s \}_k
\]

- **Man-in-the-middle** (and Interleaving) attack
  - The attacker **starts a session with the server.**
  - Server send the session key to the attacker.
  - The attacker decrypts the received message with its public key, and then encrypts the result with \( pk_C \).
  - When Client initiates a session with Server, the attacker impersonates Server.
  - The attacker knows the session key \( k \), and can later use it to decrypt messages that Client sends to Server.
Observational equivalence - noninterf

- Intuitively, two processes P and Q are observationally equivalent, written $P \approx Q$, when an active adversary cannot distinguish P from Q.

- Can be used to prove strong secrecy of some value $s$.

- Capture the adversary’s ability to learn **partial information** about the secret.
  - A protocol provides strong secrecy of secret if the attacker cannot distinguish Protocol{$0/secret$} from Protocol{$1/secret$}, that is, Protocol{$0/secret$} $\approx$ Protocol{$1/secret$}.

---

The strong secrecy of values $x_1, \ldots, x_n$ is defined in ProVerif by:

```c
/* free $x_1, \ldots, x_n$ [private]. */
1. noninterf $x_1, \ldots, x_n$ or
2. noninterf $x_1$ among $(N_1, \ldots, N_k)$
   ...
   $x_n$ among $(M_1, \ldots, M_t)$
```

- When the process under consideration is P, this query is true if and only if $P\{M_1/x_1, \ldots, M_n/x_n\} \approx P\{N_1/x_1, \ldots, N_n/x_n\}$
Observation equivalent examples

1. Prove that the attacker cannot obtain partial information (guess) of secret.

```plaintext
1  free c : channel.
2  (* Types *)
3  type key.
4  type bitstring.

(* Shared key encryption, decryption *)
5  fun senc(bitsring, key): bitstring
6  reduc forall x: bitstring, y: key; sdec(senc(x,y),y) = x.

7. (* The shared key *)
8  free k : key [private].

9  (* Query *)
10 free secret : bitstring [private].

11. (* Prove strong secrecy of secret *)
12 noninterf secret.

13  (* Main process *)
14 process
15  (!out(c, senc(secret, k))) | (!lin(c, x : bitstring); let s = sdec(x, k) in 0)
```
Observation equivalent examples cont’d

1 \textbf{free} \ c : \text{channel} .

2 \textit{(* Types *)}
3 \textbf{type} \ key
4 \textbf{type} \ bitstring

\textit{(* Hash *)}
5 \textbf{fun} \ hash(\text{bitsring}) : \text{bitstring}

6 \textit{(* The shared key *)}
7 \textbf{free} \ x, \ n : \text{bitstring} \ [\text{private}] .

8 \textit{(* Prove strong secrecy of secret *)}
9 \textbf{noninterf} \ x \ among \ ( n , \ hash(n) ) .

\textit{(* Main process *)}
10 \textbf{process} \ \textbf{out}(c, x)

\begin{itemize}
  \item \textbf{Prove} that the attacker cannot distinguish \textit{n} from \textit{hash(n)}.
\end{itemize}
Observation equivalent examples cont’d

1  free c : channel .

2  (* Types *)
3  type skey .
4  type pkey .

(* Hash *)
5  fun pk(skey): pkey .
6  fun aenc(bitstring, pkey): bitstring .
7  reduc forall m: bitstring, k: skey; adec(adec(m, pk(k)), k) = m .

8  (* The shared key *)
9  free vote: bitstring [private] .
10  weaksecret vote .

(* Process macros, that is, sub-processes. *)
11  let Voter(pkA: pkey) = out(c, aenc(vote, pkA)) .
12  let Administrator(pkA: skey) = in(c, x: bitstring); let v’ = adec(x, skA) in 0 .

(* Main process *)
13  process
14      new skA : skey ;
15      let skA = pk(skA) in
16      out(c, pkA) ;
17      ! ( Voter(pkA) | Administrator(skA) )

• Voters encrypt their votes with the administrator’s public key.
• Prove that the attacker cannot guess voter’s vote.
Observational equivalence - choice

• Prove two processes $P$ and $Q$ are observationally equivalent.
• $P$ and $Q$ have the same structure but differ only in the choice of terms.
• ProVerif provides encoding both $P$ and $Q$ using a „biprocess”.

Prove $P(M) \approx P(N)$ for some different $M, N$ then

$P(\text{choice}[M,N])$

• $P$ is the voter process, $skA$ and $skB$ are secret key of the voters.
• $vote1$ and $vote2$ are votes made by voters.
• **Goal: to prove privacy property.**
  • The attacker cannot distinguish the situation when $A$ makes $vote1$ and $B$ votes $vote2$, and the situation when $A$ makes $vote2$ and $B$ votes $vote2$

To prove $P(skA,vote1) \parallel P(skB,vote2) \approx P(skA,vote2) \parallel P(skB,vote1):

$P(skA,\text{choice}[vote1,vote2]) \parallel P(skB,\text{choice}[vote2,vote1])$
Summary

• Relevant webpages
  Official page: http://www.proverif.ens.fr/
  Online demos: http://server1.dsuresearch.org/ProVerif/demo/index2.php/
  GUI Editor: http://sourceforge.net/projects/proverifeditor/

• The full manual of ProVerif (by Bruno Blanchet) will be uploaded to the course’s page.

• Instructions:
  1. Download ProVerif’s newest version: 1.86pl3 (archive file)
  2. Extract the archive file and install the program as shown in slides 16-17.
  3. Try examples that can be found in the archive file.
     • The best way to understand ProVerif is to play with example files.
     • Example files can be found in the directory docs: docs/<filename>.pv
     • Several examples with detailed comments: Needham-Schroeder, Diffie-Hellman, etc.

If do you have any question please contact me via mail: thong[@]crysys[.]hu (* remove [ and ] *)
ProVerif installation

- Webpages
  - Online demos: [http://server1.dsuresearch.org/ProVerif/demo/index2.php/](http://server1.dsuresearch.org/ProVerif/demo/index2.php/)
  - GUI Editor: [http://sourceforge.net/projects/proverifeditor/](http://sourceforge.net/projects/proverifeditor/)

- ProVerif’s versions: 1.85; 1.86pl3; 1.87beta6 (newest)
  - Devepoders: Bruno Blanchet, and his group. Ecole Normale Supérieure, France.
  - Developed in Ocaml logic programming language.
  - By default, has no GUI interface.

- Installation in Linux/Mac (download Ocaml 3.0, [http://caml.inria.fr/](http://caml.inria.fr/))
  - Create a directory `proverif1.86pl3` in the current directory.
    - Using GNU tar: 1) `tar -xzf proverif1.86pl3.tar.gz`; 2) `tar -xzf proverifdoc1.86pl3.tar.gz`
    - Using tar: 1.) `gunzip proverif1.86pl3.tar.gz`; 2.) `tar -xf proverif1.86pl3.tar`; 3.) `gunzip proverifdoc1.86pl3.tar.gz`; 4) `tar -xf proverifdoc1.86pl3.tar`.
  - Build the ProVerif
    - `cd proverif1.86pl3`
    - `.build`
ProVerif installation, execution

- Installation in Windows
  - From binary
    • Does not require Ocaml !!!
    • Decomposes: `proverifbsd1.86pl3.tar.gz` and `proverifdoc1.86pl3.tar.gz` archives in the same directory.
  - From source
    • Requires Ocaml installation, OCaml bytecode compiler.
    • Decomposes: `proverif1.86pl3.tar.gz` and `proverifdoc1.86.tar.gz` archives in the same directory.
    • In the command shell go to the directory where the two files were extracted and build 
      `./build.bat`

- Execution
  - Command line: `./proverif [options] < filename.pv`
    Windows: 1) open cmd; 2) cd to the directory; 3) `./proverif [options] < filename.pv`
    • `./proverif`: ProVerif’s binary
    • `< filename.pv>`: ProVerif’s source file.
      – By default, only honest processes should be defined by users.
    • `[options]`: options
Kérdések?

KÖSZÖNÖM A FIGYELMET!

Híradástechnikai Tanszék

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