

Will Computers Ever Be Secure?

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Pint of Science
Accessing The World's Information
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Will Computers Ever Be Secure?:

Abstract

These days, it feels like news reports about data security breaches are commonplace. It looks like as if the attackers won and securing IT systems is a Sisyphean task. In this talk, I will motivate the challenges of building secure systems and provide insights into the (fundamental) questions if we can build a computer program that decides if a system secure or not.

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Example (LinkedIn, May 2016)

- 164 million email addresses and passwords
- from an attack in 2012, offered for sale May 2016
- Compromised data:
 - email addresses
 - passwords

Information of more than
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Example (TalkTalk, October 2015)

TalkTalk

- nearly 157,000 customer records leaked
- nearly 16,000 records included bank details
- more than 150,000 customers lost (home services market share fall by 4.4 percent in terms of new customers)
- Costs for TalkTalk: around any £60 million

Information of more than
000

Example (Ashley Madison, July 2015)

- more than 30 million email addresses and much more
- Compromised data:
 - Dates of birth
 - Email addresses
 - Ethnicities, Genders
 - Sexual preferences
 - Home addresses, Phone numbers
 - Payment histories
 - Passwords, Usernames, Security questions and answers
 - Website activity
- **Similar Leak:** Mate1 in February 2016: 27 million records with even more personal details (e.g., drinking/drug habits, parenting plans, political views)



How Would You Attack An IT Systems?



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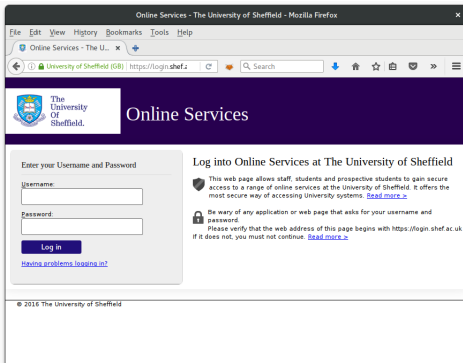
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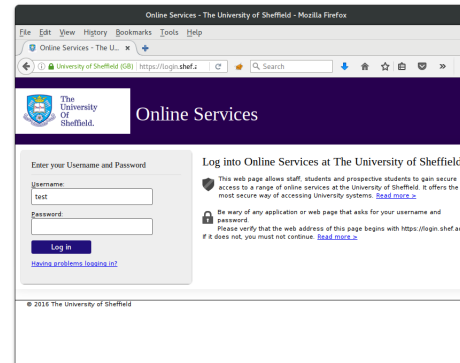
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Internal program:

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'name' = 'Username' AND 'pwd' = 'Password';
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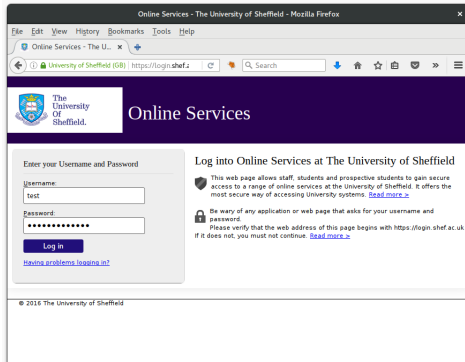
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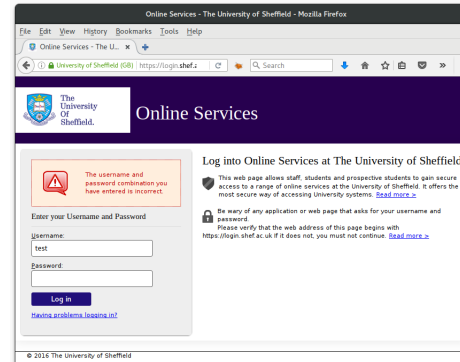
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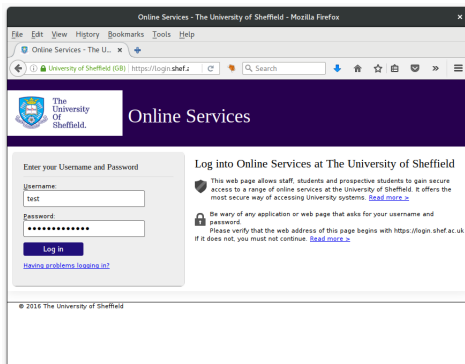
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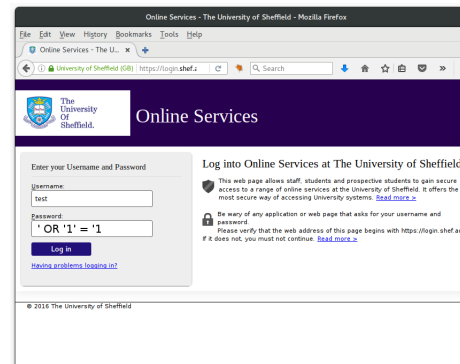
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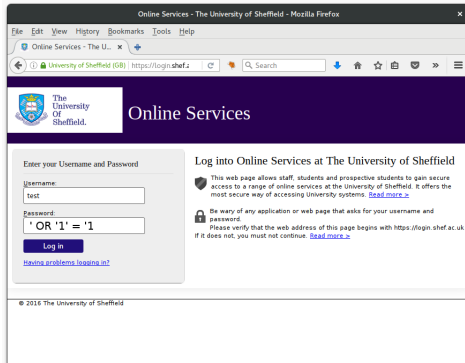
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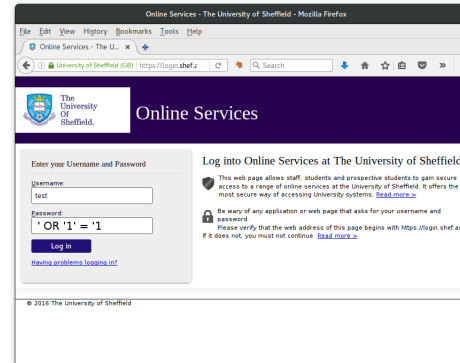
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```
SELECT * FROM 'users' WHERE  
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```

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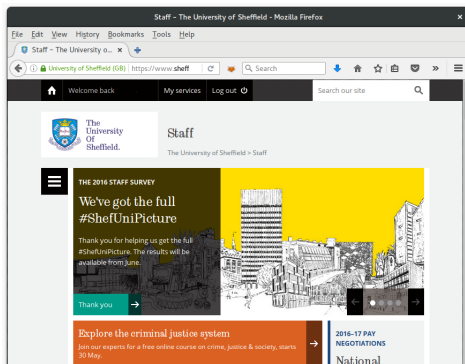
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```
SELECT * FROM 'users' WHERE  
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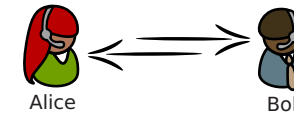
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```
SELECT * FROM 'users' WHERE  
TRUE;
```

- disabling the WHERE-clause (condition)

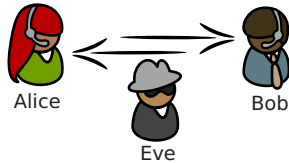
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- Alice wants to be sure that she talks to Bob (authenticity)



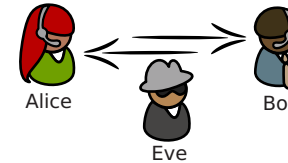
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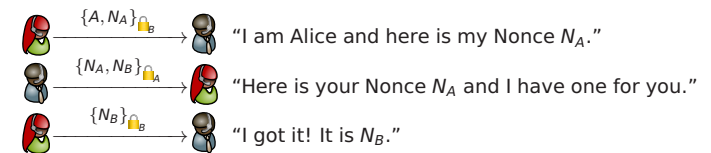


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- Needham and Schroeder proposed in 1978 the following protocol (NSPK):



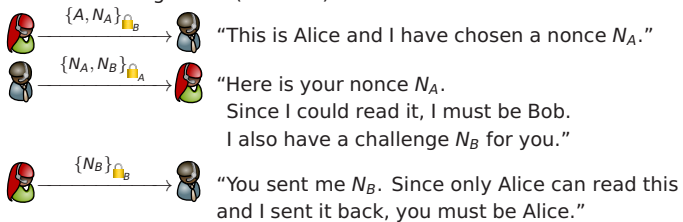
A Nonce is a fresh secret only known to the person generating it.

Example 2: How To Pretend To Be Somebody Else? (Correctness)

Goal

After executing the protocol successfully,
Alice and **Bob** can be sure to talk to each other (and not to somebody else).

Correctness argument (informal):

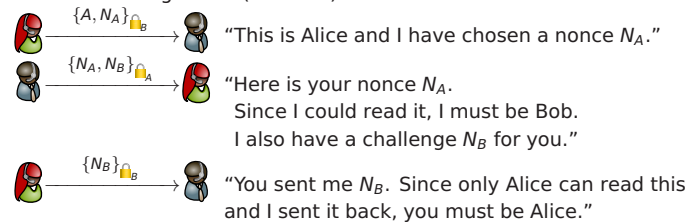


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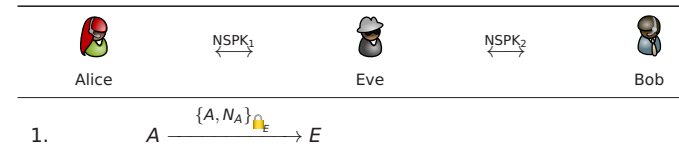
 $\xrightarrow{\{A, N_A\}_B}$  "This is Alice and I have chosen a nonce N_A ."

 $\xrightarrow{\{N_A, N_B\}_A}$  "Here is your nonce N_A .
 Since I could read it, I must be Bob.
 I also have a challenge N_B for you."

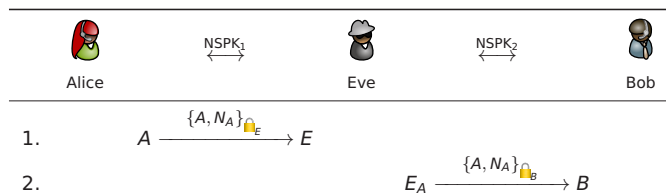
 $\xrightarrow{\{N_B\}_B}$  "You sent me N_B . Since only Alice can read this
 and I sent it back, you must be Alice."

Protocols are typically *small* and *convincing* . . . **and often wrong!**

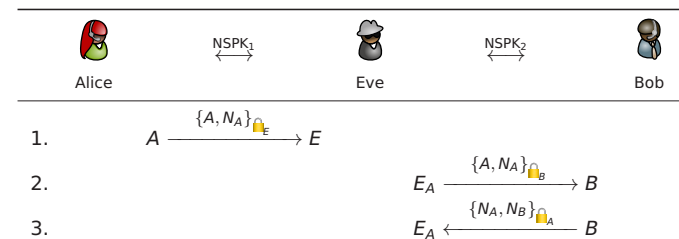
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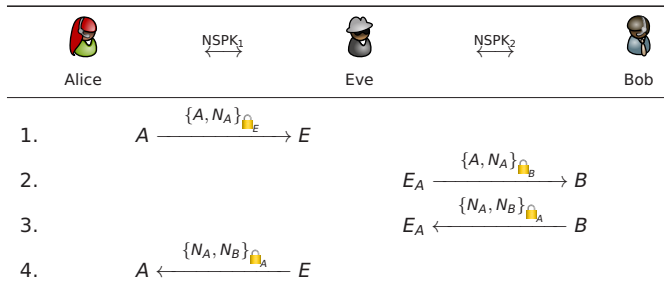
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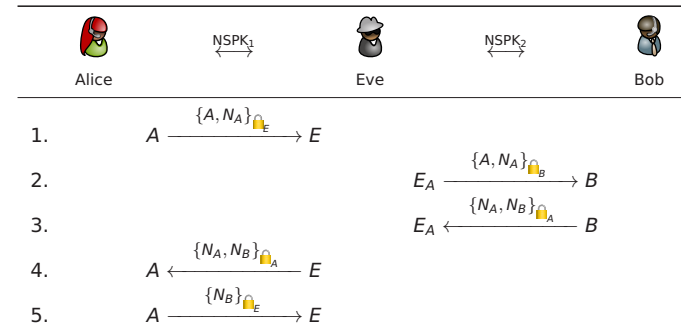
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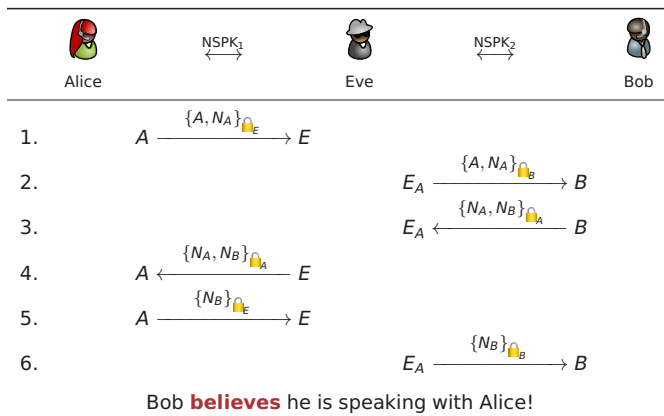
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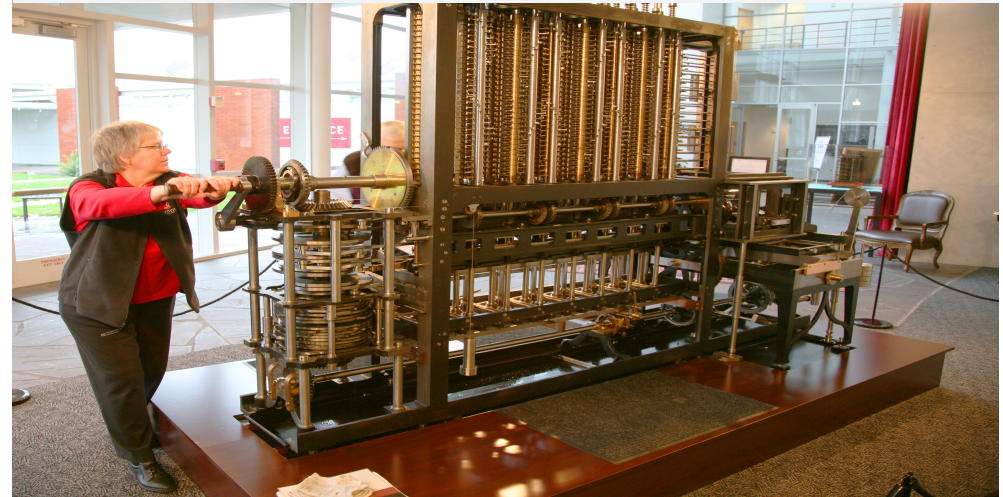
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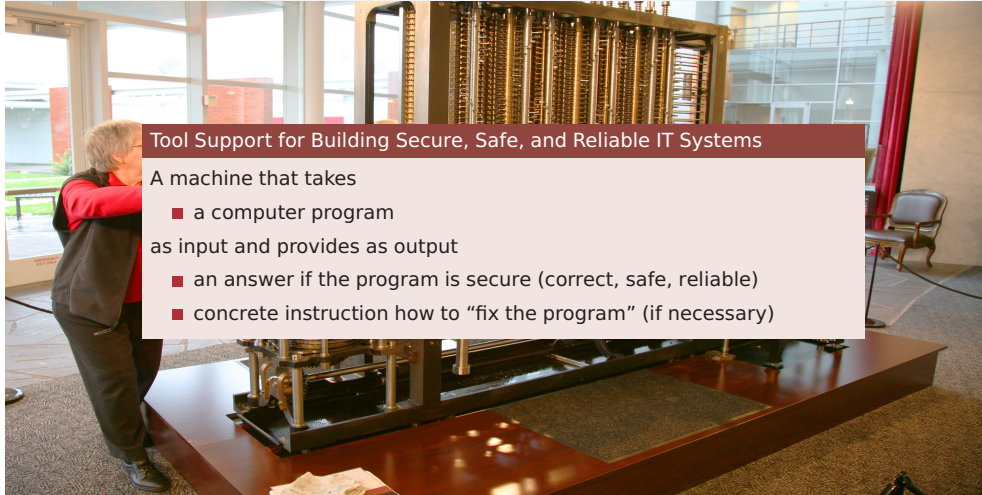
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My Research Vision



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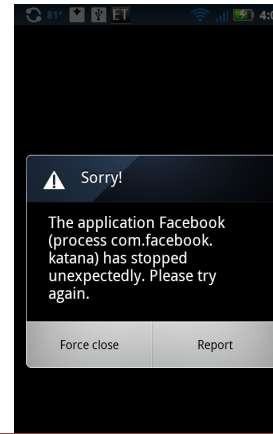
Tool Support for Building Secure, Safe, and Reliable IT Systems

A machine that takes

- a computer program as input and provides as output
- an answer if the program is secure (correct, safe, reliable)
- concrete instruction how to “fix the program” (if necessary)

Question: Can We Realise My Dream?

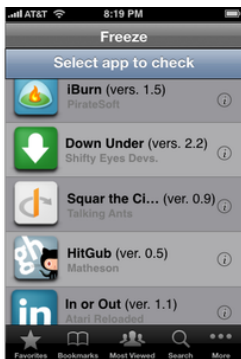
<https://thorehusfeldt.net/2012/06/25/the-freeze-app-does-not-exist/>



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Detect if an app crashes (or freezes your phone)

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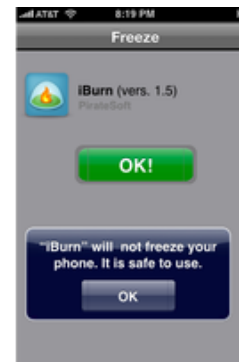
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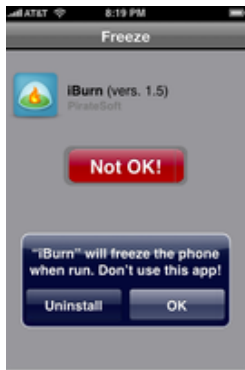
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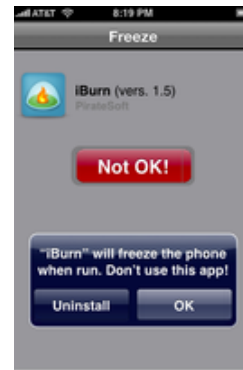
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  end tell
if Result is "OK" then
  display 5/0
else display "Freeze_detected
_____that_Paradox_freezes"
end if
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- Let's call this app Freeze, it
 - allows to select an app and "computes" if
 - an app is safe to use
 - an app freezes your phone
- Can you build Freeze?
- I cannot, but I can build "Paradox", which
 - 1 runs Freeze and ask it to inspect Paradox.
 - 2 if Freeze returns "OK" then freeze the phone (e.g., by computing 5/0)
 - 3 if Freeze returns "Not OK" then print "Freeze detected that Paradox freezes" and terminate gracefully

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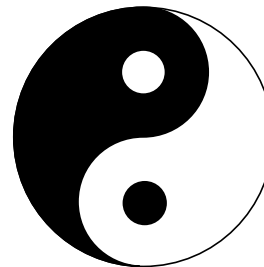
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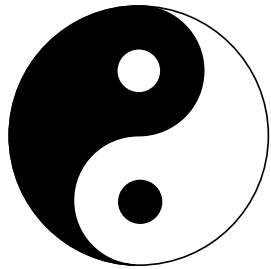
There is no app for that.

Where Do We Go From Here?



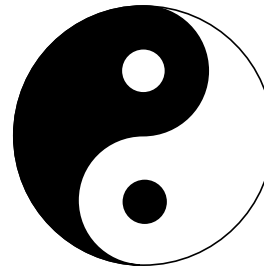
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- This is a negative result, right?
- No, it is not. It
 - motivates and
 - provides opportunities for research
- Possible solutions:
 - Analyses that approximate
 - i.e., missing a few problems
 - i.e., reporting a few spurious issues
 - Interactive analysis methods
 - Make it easier to build secure systems

Thank you for your attention!

Any questions or remarks?

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Fixing NSPK

- “
1. $A \rightarrow B: \{A, N_A\}_{\mathcal{K}_B}$
 2. $B \rightarrow A: \{N_A, N_B\}_{\mathcal{K}_A}$
 3. $A \rightarrow B: \{N_B\}_{\mathcal{K}_B}$

- Problem in step 2:

$$B \rightarrow A: \{N_A, N_B\}_{\mathcal{K}_A}$$

- Fix (proposed by Lowe):

Agent B should also give his name: $\{B, N_A, N_B\}_{\mathcal{K}_A}$:

1. $A \rightarrow B: \{A, N_A\}_{\mathcal{K}_B}$
2. $B \rightarrow A: \{B, N_A, N_B\}_{\mathcal{K}_A}$
3. $A \rightarrow B: \{N_B\}_{\mathcal{K}_B}$