Discussing Secure Input Solutions for Web Applications

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Who am I?

- Angelo P. E. Rosiello received the B.S. and M.S. degrees in Computer Science Engineering cum laude from “Politecnico di Milano” in 2004 and 2006, respectively.
- Previously Angelo worked for Accenture in the Security Strategy Service Line and collaborates with Prof. Christopher Kruegel and Prof. Engin Kirda (Technical University of Vienna) in the ICT security field.
- Angelo works for “*The European House – Ambrosetti*” in the management consulting field. He owns the *ITIL Service Management Certification* and he is a specialist of IT Strategy&Governance.
- Master in Marketing & Communication Management.

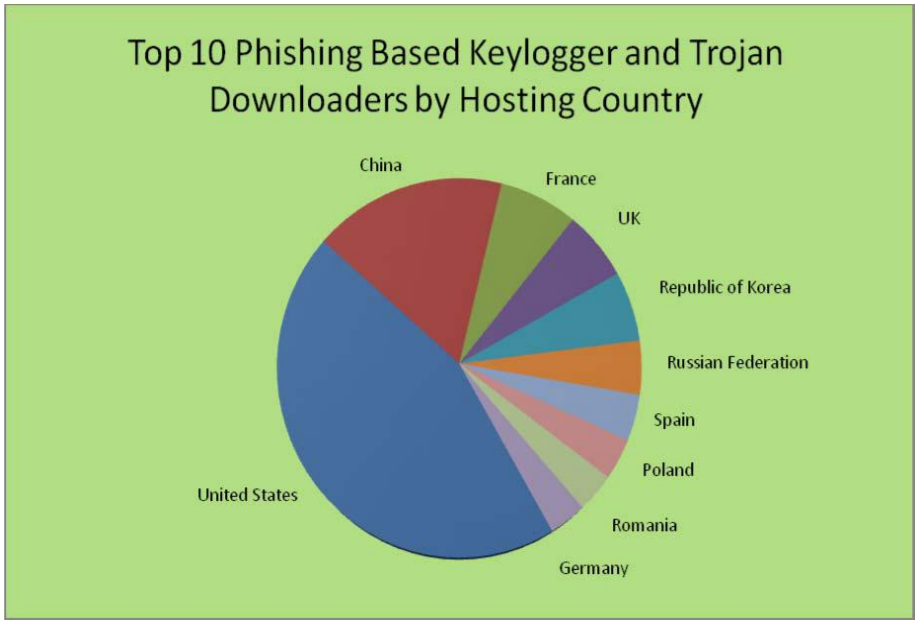
Agenda

1. **Brief introduction to client-side information theft**
2. Strategic defense techniques
3. Some recent secure input solutions
4. Conclusions

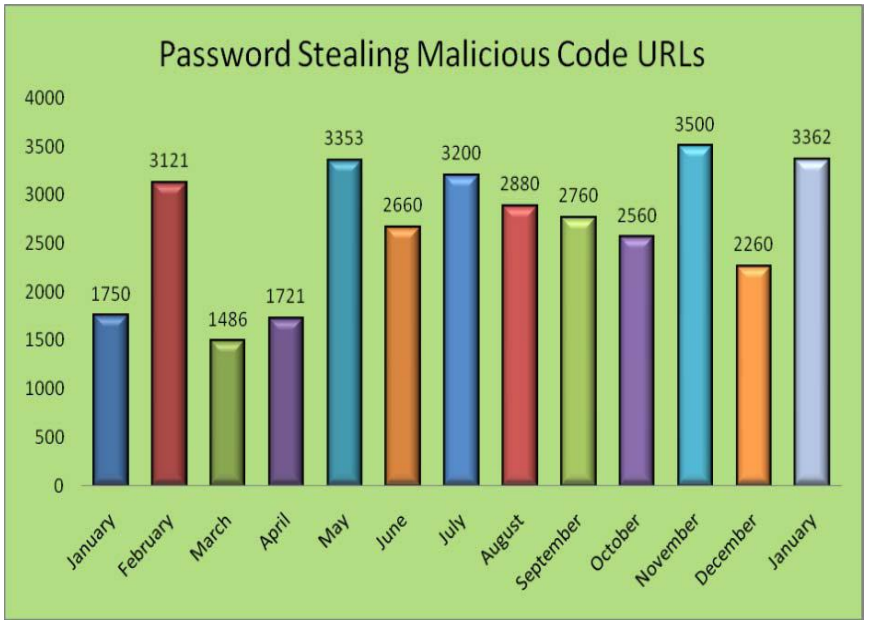
Crimeware: a seriouce menace

Statistics from the Anti Phishing Working Group (AWPG) confirm the global nature of crimeware code.

- Breakdown of the websites hosting malicious code -



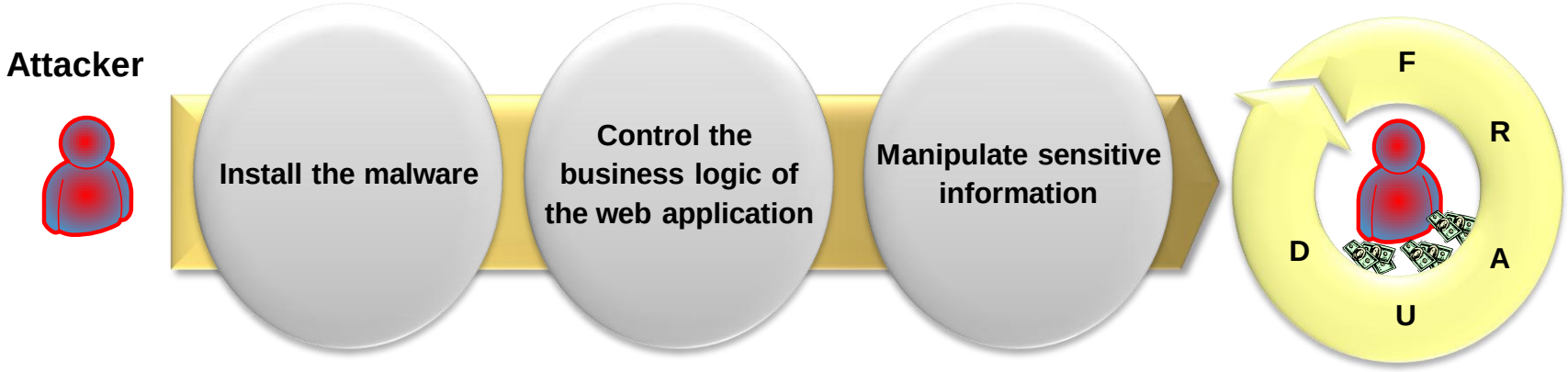
- Unique Websites Hosting Keyloggers -



APWG reports over 170 different types of keyloggers distributed on thousands of web sites!

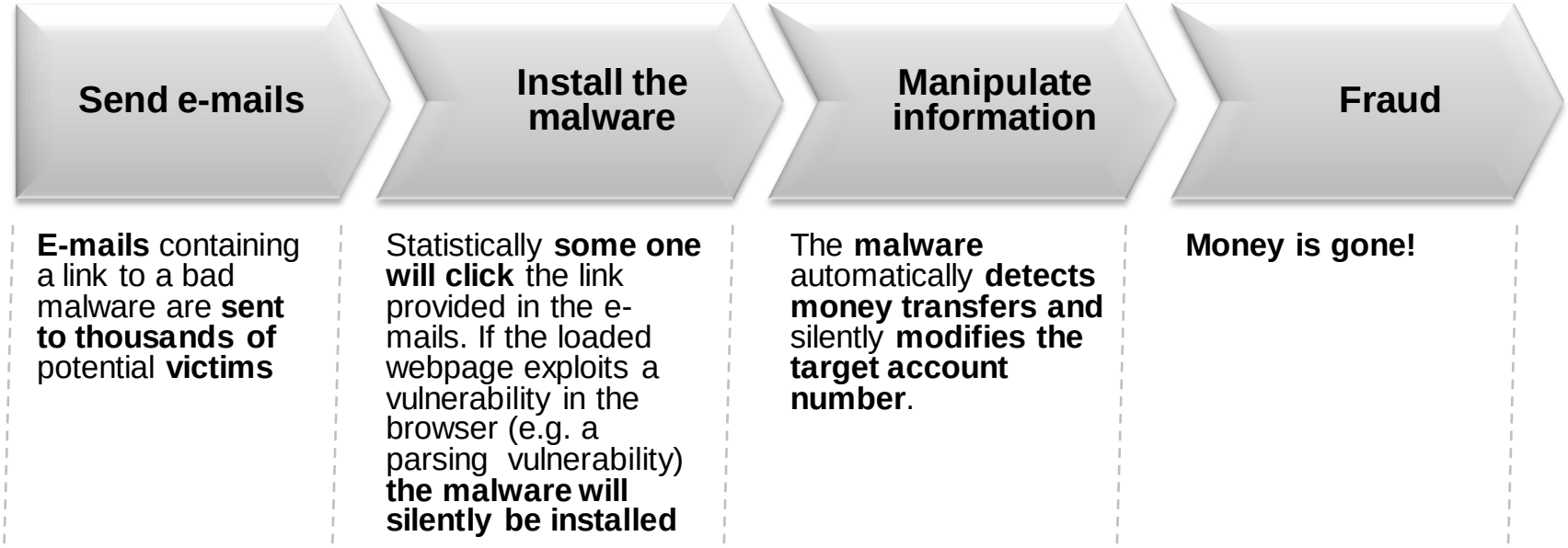
The Attack Process

- In a typical attack, the **aim of the attacker** is to take control of the user's web client in order to **manipulate** the client's **interaction with the web application** (attacking the integrity of the information).
- It is possible to distinguish **three main phases** of a typical **attack**:
  1. The attacker **installs the malware** in the machine of the victim
  2. The attacker **controls the business logic** of the victim's web application
  3. The attacker **manipulates sensitive information** to realize a fraud



Simple but effective

The attack is not complex, it starts from a simple e-mail sent to the victims and ends with a real fraud.



Remember that when the client has been compromised even security protocols, such as SSL, are completely useless!

Transaction Generators

Transaction generators (TGs) let the attacker execute “ordinary” transactions.

- Transaction Generator Code for Firefox -

```
<?xml version="1.0"?>
<overlay xmlns="http://www.mozilla.org/keymaster/gatekeeper/there.is.only.xul">
<script>
document.getElementById("appcontent").addEventListener("load", function() {
var currentLocation = getBrowser().selectedBrowser.contentDocument.location;
if(currentLocation.href.indexOf("www.retailer.com/loggedin") > 0)
{
  var xhr = new XMLHttpRequest();
  xhr.open("POST", "https://www.retailer.com/buy");
  xhr.send("item=blender&amp;quantity=10&amp;address=Kansas");
}
}, true);
</script> </overlay>
```

The TG issues a purchase request to www.retailer.com/buy and orders ten blenders to be sent to some address in Kansas.

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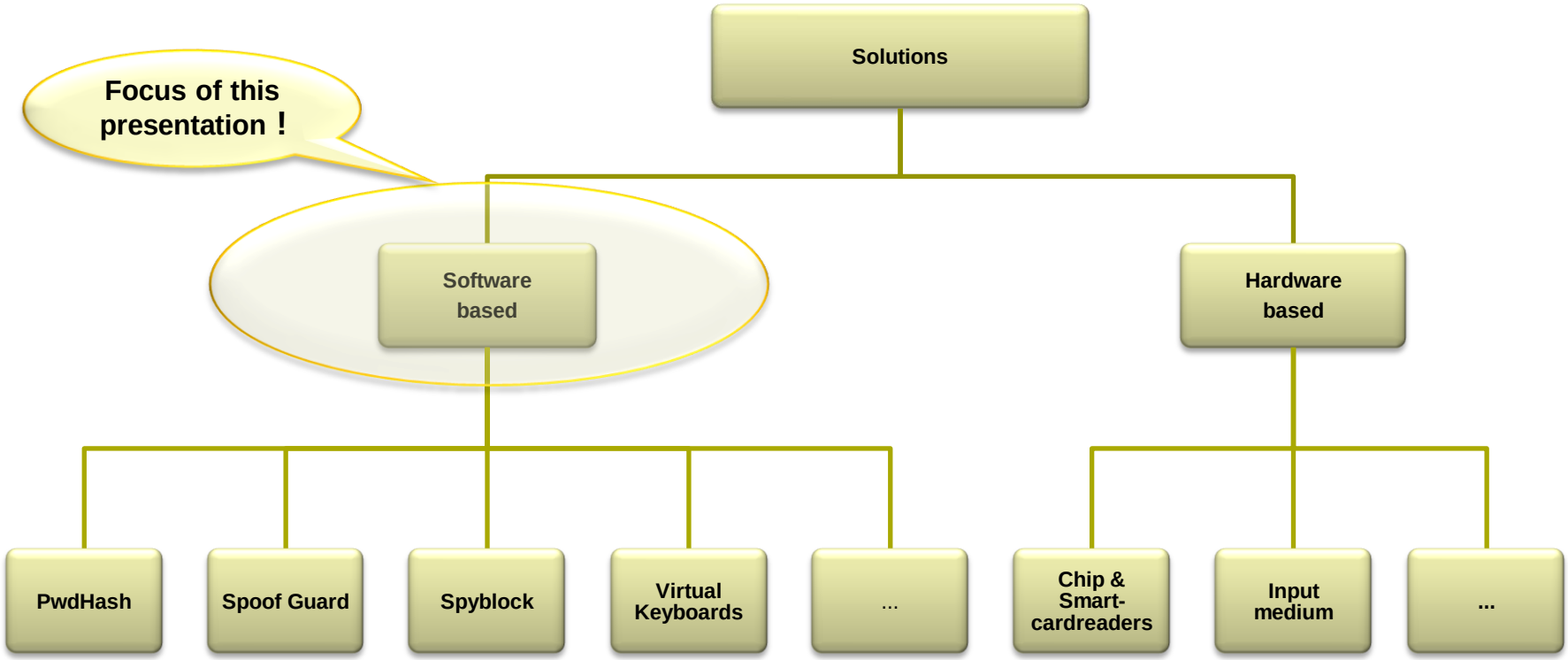
Defense Solutions: a Taxonomy

Defense solutions can be distinguished in software and hardware based techniques.



Software-based Solutions

During the last years many software-based solutions were proposed but none is considered as a reference standard, yet.

PwdHash	**PwdHash** is a browser extension that **transparently converts a user's password into a domain-specific password**. PwdHash automatically replaces the contents of these password fields with a one-way hash of the pair <password, domain-name>.
Spoof Guard	**SpoofGuard** looks like a toolbar, after it is installed. When a user enters a username and password on a spoofed site that contains some combination of suspicious URLs, misleading domain name, images from an honest site, and a username and password that have previously been used at an honest site, SpoofGuard **will intercept the post and warn the user with a pop-up that stops the attack**.
Spyblock	**Spyblock aims to protect user passwords against network sniffing and dictionary attacks**. It proposes to use a combination of password-authenticated key exchange and SSL. Furthermore, as additional defense against pharming, cookie sniffing, and session hijacking, it proposes a form of transaction confirmation over an authenticated channel. The tool is distributed as a client-side system that consists of a browser extension and an authentication agent that runs in a virtual machine protected environment.
Virtual Keyboards	A **vitual keyboard** is a program which **simulates a physical keyboard** and provides some degree of protection against keystroke loggers. To evade this defense mechanism attackers coded new advanced logging softwares which take screenshots of where the mouse pointer is to determine what number was clicked.
New Authentication Techniques	New techniques of authentication are under research, such as **using an image during the registration phase** which is shown during every login process

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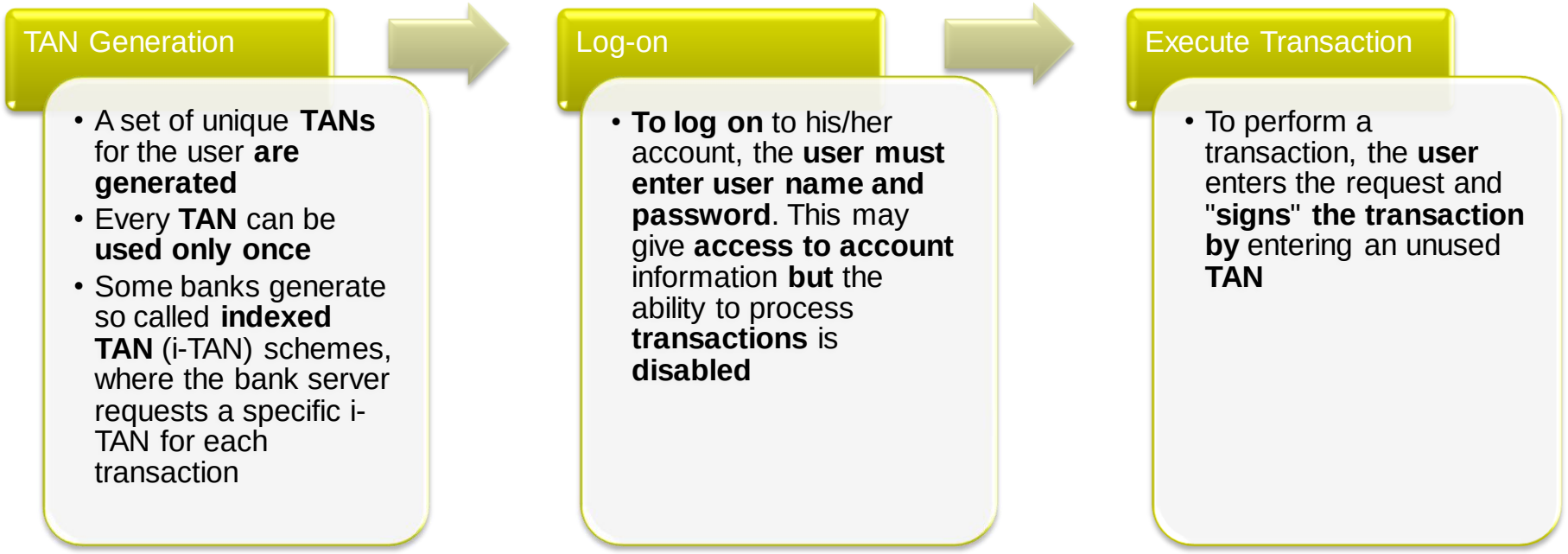
TAN & i-TAN

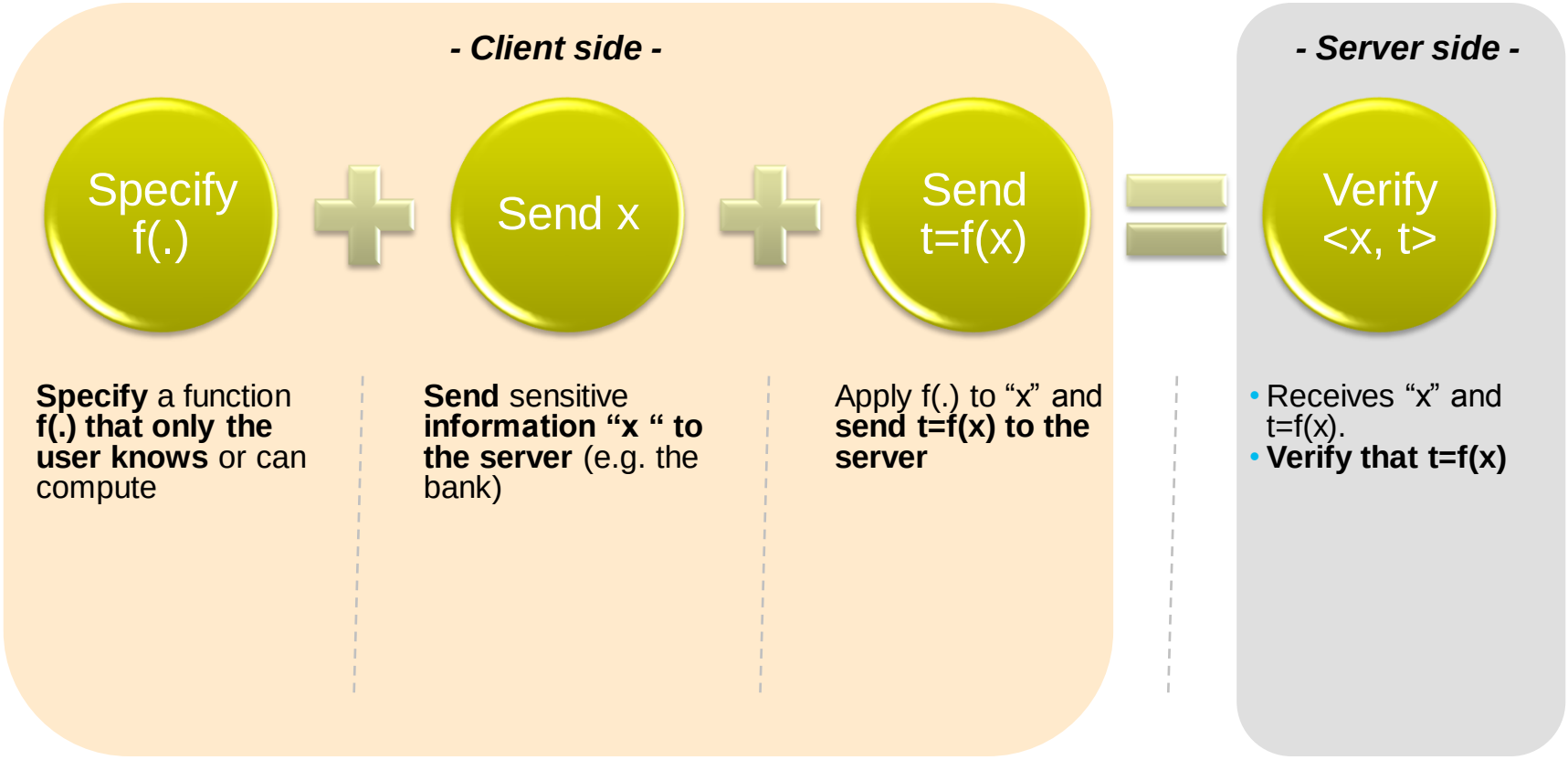
A Transaction authentication number or TAN is used (typically by banks) as a form of single use passwords (OTP) to authorize transactions.



When the bank requests a certain TAN, malicious code can replace the user's input without invalidating this transaction number!

Confirmation Tokens

TAN and i-TAN are vulnerable to integrity attacks, this is why the information should be bind to confirmation tokens



Confirmation Tokens: Token Calculation

Two schemes were proposed in practice to compute f(.) using both a code book*.

- Description -

- The code book contains **a collection of simple algorithms that can be used by users** to manually compute confirmation tokens
- The **server** (e.g. the bank) **will** randomly **choose an algorithm** from the user's code book to let him/her execute the transaction
- The **user will apply the algorithm** to his/her input executing the transaction

- Token Calculation Scheme -

...
Token ID 4:
Create a number using the 5th and 7th digits of the target account and add 542 to it.
Token ID 5 :
Create a number using the 3rd and 5th digits of the target account and add 262 to it.
Token ID 6:
Multiply the 4th and 8th digits of the target account and add 17 to the result.
Token ID 7:
Create a number using the 3rd, 6th and 7th digits of the target account.
...

***) Authors: Szydlowski, Kruegel, Kirda.**

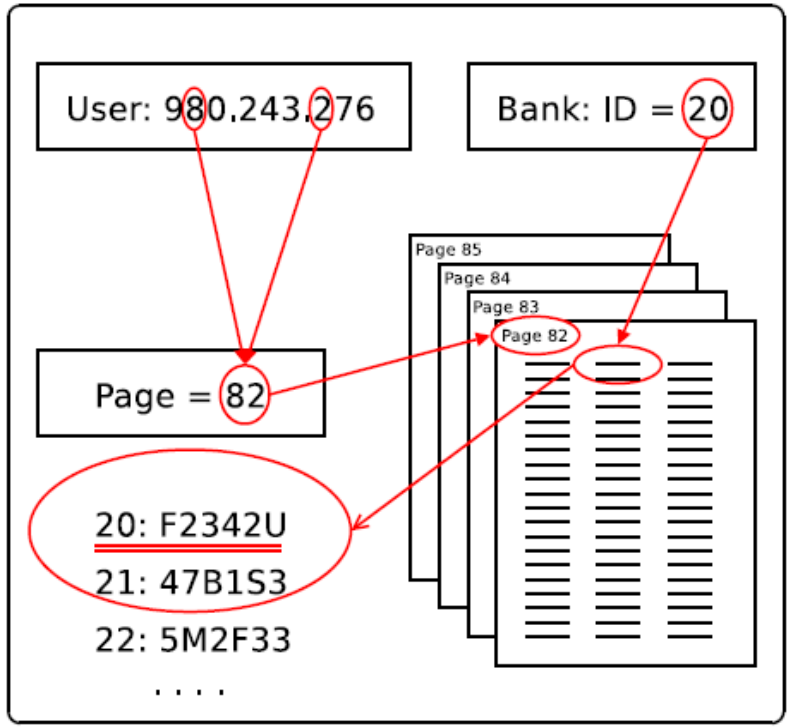
Confirmation Tokens: Token Lookup

Two schemes were proposed in practice to compute f(.) using both a code book*.

- Description -

- The code book will consist of **a large number of random tokens** that are **organized in *pages***
- The **server** side (e.g. the bank) **and the user** previously and secretly **agree on which digits** of the account number **are relevant** for choosing the correct page
- The bank then requests the **user** to **confirm a transaction by** asking him/her to enter the value of **a specific token** on that page

- Token Lookup Scheme -



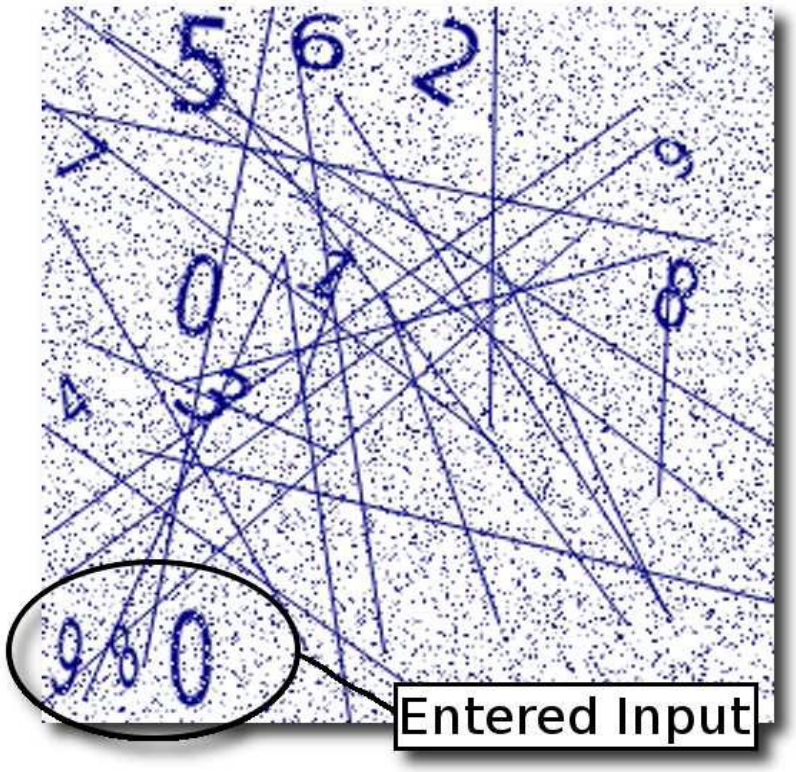
*) Authors: Szydlowski, Kruegel, Kirda.

The idea of this solution* is to extend graphical input with CAPTCHAs.

- Description -

- Generate a graphical **input field with randomly placed CAPTCHA characters**
- The **customer** uses the mouse to **click on the area that corresponds to the first character** that should be sent
- **Clicking** on the image **generates a web request that contains the coordinates on the image** where the user has **clicked** with the mouse
- **After the first character** is transmitted, the web application generates another image with a different placement of the characters, **and the process is repeated**
- Since the **CAPTCHA** characters **cannot be identified** automatically **by** machines, a **malware** program has no way to know which information was selected by the user to corrupt its integrity

- CAPTCHA for Secure User Input -

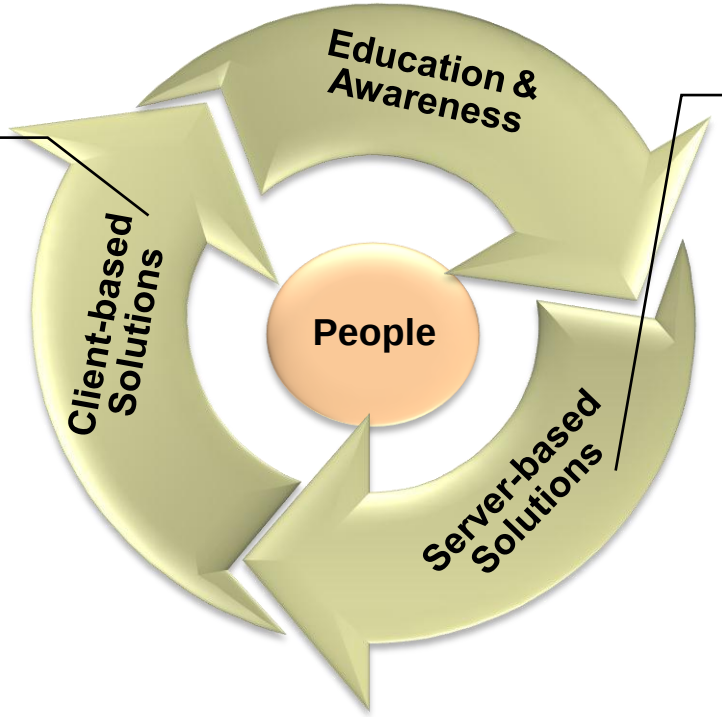


***) Authors: Szydlowski, Kruegel, Kirda.**

Conclusions

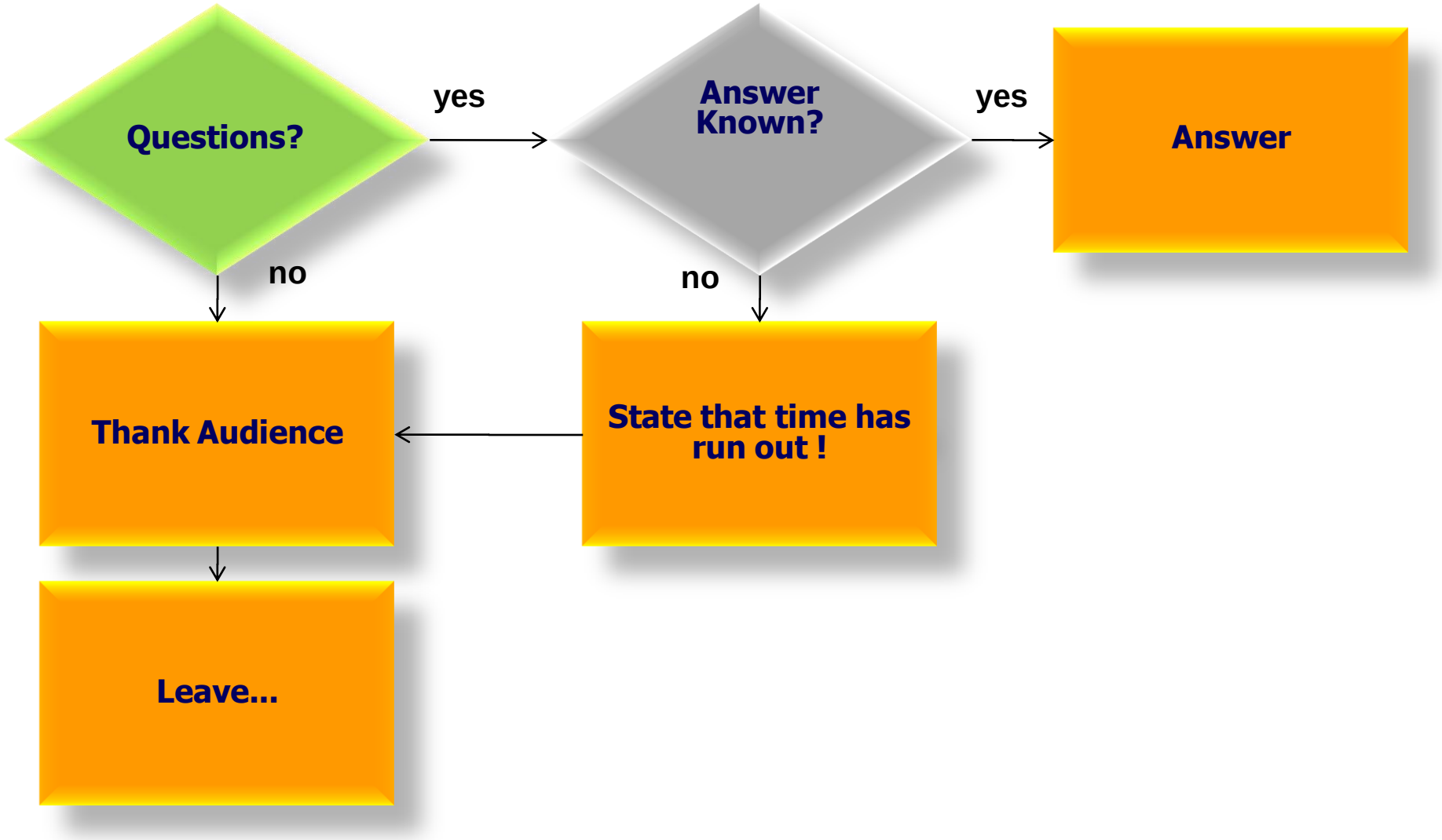
As for every IT attack, web application attacks can be prevented, detected and mitigated through server-based and client-based approaches, supported by education and awareness.

Client-based techniques try to protect users implementing local solutions, software and hardware-based ones.



Server based techniques are applied on servers or providers that offer services to customers

Questions & Answers



References

- Angelo P. E. Rosiello, Engin Kirda, Christopher Kruegel, and Fabrizio Ferrandi. *"A Layout-Similarity-Based Approach for Detecting Phishing Pages"*. IEEE International Conference on Security and Privacy in Communication Networks (SecureComm), Nice, France, September 2007
- Christian Ludl, Sean McAllister, Engin Kirda, and Christopher Kruegel. *"On the Effectiveness of Techniques to Detect Phishing Sites"*. Detection of Intrusions and Malware and Vulnerability Assessment (DIMVA) 2007 Conference, Lucerne, Switzerland, July 2007
- Engin Kirda and Christopher Kruegel. *"Protecting Users against Phishing Attacks"*. The Computer Journal, 2006.
- Neil Chou, Robert Ledesma, Yuka Teraguchi, Dan Boneh, and John Mitchell. *"Client-side defense against web-based identity theft"*. In 11th Annual Network and Distributed System Security Symposium (NDSS '04), San Diego, 2005.
- Anti-Phishing Working Group (APWG). APWG Homepage. http://www.antiphishing.org/, 2007.
- Collin Jackson, Dan Boneh, John Mitchell. Transaction Generators: Root Kits forWeb. Stanford.