Captcha as Graphical Passwords

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Abstract - Many security primitives are based on hard mathematical problems. Using hard AI problems for security is emerging as an exciting new paradigm, but has been underexplored. In this paper, we present a new security primitive based on hard AI problems, namely, a novel family of graphical password systems built on top of Captcha technology, which we call Captcha as graphical passwords (CaRP). CaRP is both a Captcha and a graphical password scheme. CaRP addresses a number of security problems altogether, such as online guessing attacks, relay attacks, and, if combined with dual-view technologies, shoulder-surfing attacks. Notably, a CaRP password can be found only probabilistically by automatic online guessing attacks even if the password is in the search set. CaRP also offers a novel approach to address the well-known image hotspot problem in popular graphical password systems, such as Pass Points, that often leads to weak password choices. Carp is not a panacea, but it offers reasonable security and usability and appears to fit well with some practical applications for improving online security.

keyword:Graphical password, password, hotspots, CaRP, Captcha, dictionary attack, password guessing attack, security primitive.

I. INTRODUCTION

FUNDAMENTAL task in security is to create crypto- graphic primitives based on hard mathematical problems that are computationally intractable. For example, the problem of integer factorization is fundamental to the RSA public-key cryptosystem and the Rabin encryption. The discrete logarithm problem is fundamental to the ElGamal encryption, the Diffie-Hellman key exchange, the Digital Signature Algorithm, the elliptic curve cryptography and so on.

II. GRAPHICAL PASSWORDS

A large number of graphical password schemes have been proposed. They can be classified into three categories accord- ing to the task involved in memorizing and entering passwords: recognition, recall, and cued recall. Each type will be briefly described here. More can be found in a recent review of graphical passwords.

III. CAPTCHA

Captcha relies on the gap of capabilities between humans and bots in solving certain hard AI problems. There are two types of visual Captcha: text Captcha and Image-Recognition Captcha (IRC). The former relies on character recogni- tion while the latter relies on recognition of non-character objects. Security of text Captchas has been extensively studied [26]–[30]. The following principle has been established: Text Captcha should rely on the difficulty of character segmentation, which is computationally expensive and combinatorially hard.

IV. CAPTCHA IN AUTHENTICATION

It was introduced in to use both Captcha and password in a user authentication protocol, which we call Captcha-based Password Authentication (CbPA) protocol, to counter online dictionary attacks. The CbPA-protocol in requires solving a Captcha challenge after inputting a valid pair of user ID and password unless a valid browser cookie is received. For an invalid pair of user ID and password, the user has a certain probability to solve a Captcha challenge before being denied access.

V. OTHER RELATED WORK

Captcha is used to protect sensitive user inputs on an untrusted client . This scheme protects the communication channel between user and Web server from keyloggers and spyware, while CaRP is a family of graphical password schemes for user authentication.

The capability gap between humans and machines can be exploited to generate images so that they are computationally- independent yet retain invariants that only humans can iden- tify, and thus use as passwords. The invariants among images must be intractable to machines to thwart automatic guessing attacks. This requirement is the same as that of an ideal Captcha [25], leading to creation of CaRP, a new family of graphical passwords robust to online guessing attacks.

VI. CARP

An Overview: In CaRP, a new image is generated for every login attempt, even for the same user. CaRP uses an alphabet of visual objects (e.g., alphanumerical characters, similar animals) to generate a CaRP image, which is also a Captcha challenge. A major difference between CaRP images and Captcha images is that all the visual objects in the alphabet should appear in a CaRP image to allow a user to input any password but not necessarily in a Captcha image. Many Captcha schemes can be converted to CaRP schemes, as described in the next subsection. CaRP schemes are clicked-based graphical passwords. According to the memory tasks in memorizing and enter- ing a password, CaRP schemes can be classified into two categories: recognition and a new category, recognition-recall, which requires recognizing an image and using the recog- nized objects as cues to enter a password. Recognition-recall combines the tasks of both recognition and cued-recall, and retains both the recognition-based advantage of being easy for human memory and the cued-recall advantage of a large password space. Exemplary CaRP schemes of each type will be presented later.

VII. CONVERTING CAPTCHA TO CARP

In principle, any visual Captcha scheme relying on recogniz- ing two or more predefined types of objects can be converted to a CaRP. All text Captcha schemes and most IRCs meet this requirement. Those IRCs that rely on recognizing a single predefined type of objects can also be converted to CaRPs in general by adding more types of objects. In practice, conversion of a specific Captcha scheme to a CaRP scheme typically requires a case by case study, in order to ensure both security and usability. We will present in Sections IV and V several CaRPs built on top of text and image-recognition Captcha schemes. Some IRCs rely on identifying objects whose types are not predefined. A typical example is Cortcha which relies on context-based object recognition wherein the object to be recognized can be of any type. These IRCs cannot be converted into CaRP since a set of pre-defined object types is essential for constructing a password.

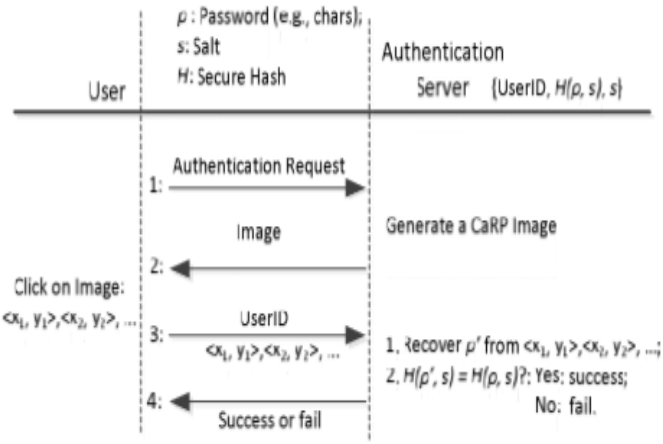

Fig. 1. Flowchart of basic CaRP authentication.

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Fig. 2. A ClickText image with 33 characters.

Fig. 3. Captcha Zoo with horses circled red.

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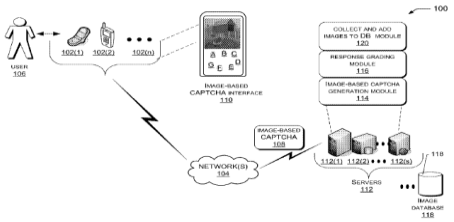
Architecture:



VIII. CONCLUSION

We have proposed CaRP, a new security primitive relying on unsolved hard AI problems. CaRP is both a Captcha and a graphical password scheme. The notion of CaRP intro- duces a new family of graphical passwords, which adopts a new approach to counter online guessing attacks: a new CaRP image, which is also a Captcha challenge, is used for every login attempt to make trials of an online guessing attack computationally independent of each other. A password of CaRP can be found only probabilistically by automatic online guessing attacks including brute-force attacks, a desired security property that other graphical password schemes lack

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