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Using HIPs to secure human-machine interactions via untrusted intermediaries

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Agenda

1. **The problem**
2. HIPs
3. Using HIPs
4. Use scenarios
5. Conclusions

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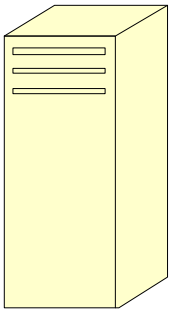
Model

Communications enabled by untrusted third party



User

Machine (no user interface)

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Examples

- Access to a smart card using a merchant terminal. Must rely on terminal to correctly display amount of transaction (and not record PIN).
- Access to email server (or other Internet service) using Internet café PC – must rely on terminal not to record password.

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Prior art

- Prior art has mostly addressed the smart card/user interaction issue.
  - Gobioff, Smith, Tygar and Yee (1996) considered theoretical aspects of the problem.
  - Stabell-Kulø, Arild and Myrvang (1999) looked at solutions using a third party verification server.
  - Berta, Buttyan and Vajda (2004) proposed the use of a special type of signatures.

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What are HIPs?

- Human Interactive Proofs (HIPs) – otherwise known as CAPTCHAs (Completely Automated Public Turing tests to tell Computers and Humans Apart) – are basically tests set by computers which only humans can solve.
- One simple and widely used example of a HIP is to display characters (e.g. letters and/or numbers) in a form that humans can read them but image processing software cannot.

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Example

This CAPTCHA of ‘smwm’ obscures its message from computer interpretation by twisting the letters and adding a background colour gradient.

It is taken from Wikipedia.

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Techniques

- Motivation is to choose probloems which are known to be hard for computers to solve.
- As previously mentioned, one method is to display distorted characters. [This is the basis of this paper].
- Many other techniques have been proposed, e.g. to choose images showing the same person, or to count objects of a particular type in a scene.

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Applications

- Many applications have been proposed.
- Probably the best known is the use by Yahoo to protect free email accounts.
- Here, a user must solve a HIP before obtaining an email account – this prevents automatic harvesting of HIPs for use by spammers.

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A new use

- In some sense, a HIP provides a (low bandwidth) communications channel between the computer and the human, which no other computer can intercept.
- This is because the human readable symbols shown by the computer are not readable by any other computer.
- This is a confidentiality-protected but not authenticated channel.

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A reverse channel

- We can also use HIPs to provide a confidential but unauthenticated reverse channel.
- One approach involves the target machine sending a sequence of distorted messages, of which the user chooses one (or more).
- This could, for example, enable the user to enter a PIN in an unobservable (to a computer) fashion, e.g. by pressing a button next to a distorted digit.
- More generally, for password entry, the target machine could ask a password-related question (in distorted text) and get the answer via the selection of one of a series of distorted images.

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Using the secure channels

- The use of HIPs therefore allows us to establish a two-way confidential channel between user and computer, even when communications pass via an untrusted intermediary.
- However, this channel is:
  - unauthenticated;
  - only confidential against machine eavesdroppers (also can be read by humans if exchanges are recorded).
- What can we do with this?

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General remark

- In all the scenarios, the use of the confidential channel by no means solves all security issues (since channel always observable by a human).
- However, it does offer an additional layer of protection against machine-only attacks.

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A. Smart card PIN entry

- PIN could be sent to card via a confidential channel, e.g. by displaying concealed digits next to buttons.
- However:
  - channel unauthenticated – so the terminal could put up its own images and learn the PIN; however it could not tell the card the PIN.
  - PIN could be learnt by humans processing a recorded transaction.

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PIN entry: continued

- Another option would be for the card to provide a PIN offset in a distorted image, which the user simply adds to his PIN before entering it.
- This again has the problem that, because the channel is unauthenticated, the user does not know where the offset comes from.
- However, perhaps the distorted images sent by the card could be combined with the visual authentication notions of Dhamija and Tygar (2005).

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B. Smart card transaction authorisation

- The smart card could enable the user to enter the transaction amount (to be authorised) via the selection of distorted digits.
- The card would then display a distorted image of the total value to be authorised.
- The authorisation process (e.g. involving PIN entry) could then be managed in the context of the authorisation image.

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C. Context establishment

- It may be possible to use the confidential unauthenticated channel to enhance the security of 'imprinting' of mobile devices.
- This involves setting up a security context between two devices (which may not have their own user interfaces).
- It might be possible to combine human entry of PINs into two devices (via untrusted intermediaries) with a Diffie-Hellman key exchange.

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Context establishment: continued

- Use of a Diffie-Hellman key exchange should protect against later inspection of the (recorded) exchange by a human.
- However, as previously, the fact that the human-machine channel is unauthenticated may present security problems.

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Enhancing the channels

- What bandwidth can be achieved?
- What are the best HIPs to use for this purpose?
- Most importantly, can HIPs (perhaps with visual authentication) be used to provide an authenticated human/machine channel?

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Addressing the scenarios

- Can the confidential channels provided by HIPs be used more effectively in the identified use scenarios?
- Are there other more appropriate use scenarios?

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