

Analysis of an Incentives-based Secrets Protection System

N. Boris Margolin
Matthew K. Wright
Brian N. Levine

University of Massachusetts at Amherst

Protecting Passwords

- Passwords grant access to e.g. a paid subscription service
- Passwords can be easily copied, posted online, shared with friends...
- Service provider loses money / potential customers

Approaches to Protect Access to Accounts

- Enforcement: turn off account, sue subscriber
 - detect inappropriate use: too many simultaneous logins, disparate IP addresses
 - problem of false positives
- Prevention:
 - only one login at a time
 - but you can still have sharing...
 - Tie login to one computer by hardware signatures, IP address, MAC address
- Incentives

Our approach: SPIES

(Secret Protection Incentive Based Escrow System)

- Provide financial incentive not to share
- Applicable to content that
 - is not widely available
 - needs to be protected a short while
- Best application: protecting passwords

Features of SPIES

- no hardware or software restrictions
 - compatible with any type of device
 - password can be backed up
 - password can be stored on different devices
- password can be shared with anyone trusted
 - friend keeps a copy for emergencies, like house-keys
 - can have third-party backups

Players in SPIES

- Alice, a password provider
- Bob, a customer
- A trusted escrow service
- A charity

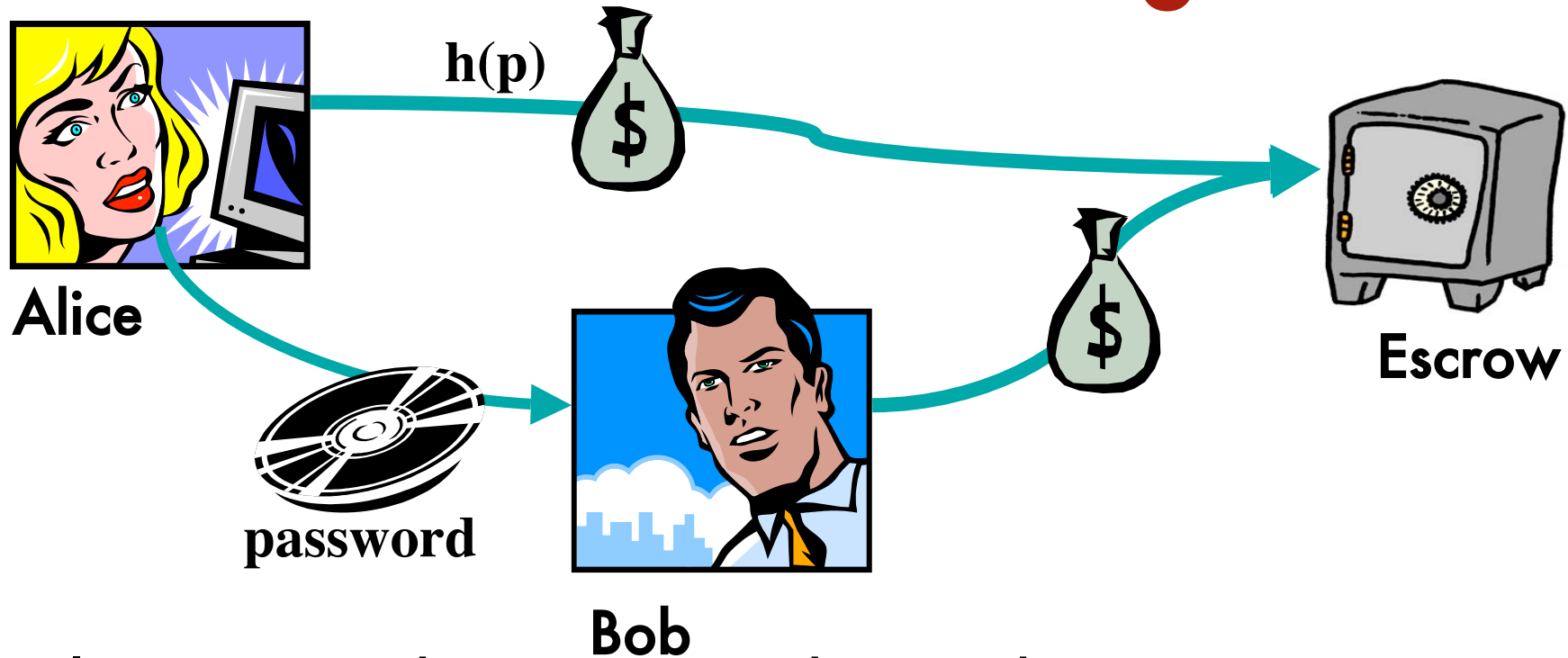
Basic Operation of SPIES

- Bob gives a security deposit to an Escrow service
- Anyone who has the password can present proof of possession to the Escrow service (“register”) for a payment.
- At the end of a protection period, Bob’s security deposit is returned. It is reduced if someone presents such proof.

SPIES Protocol Phases

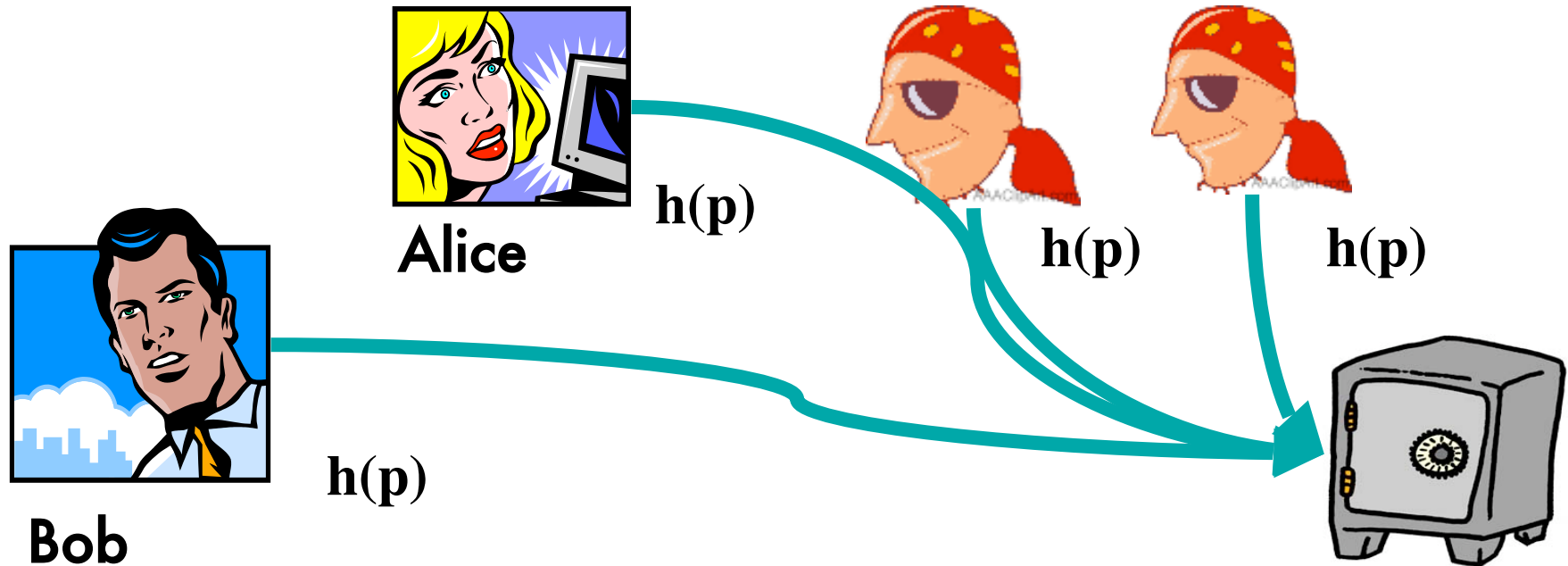
- Exchange
 - Registration
 - Payment
- } Protection Period

Phase 1: Exchange



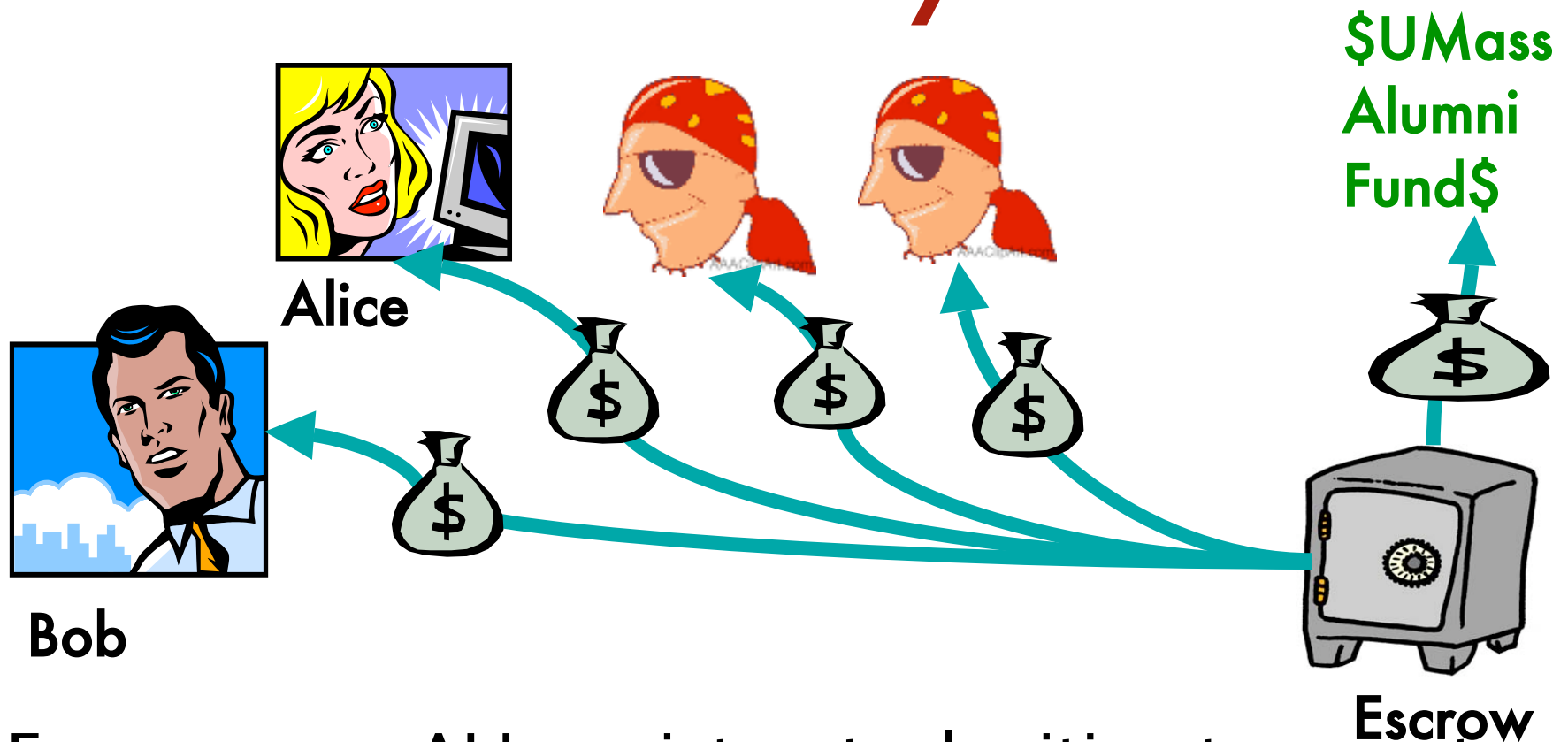
- Alice gives the password to Bob
 - typically: Bob gives some payment to Alice too
- Alice and Bob give a security deposit to Escrow,
- Alice sends a hash of the password to Escrow
- Alice and Bob are the “legitimate possessors”

Phase 2: Registration



- Bob and Alice present proof of password possession to the Escrow Service
 - hash of the password
- So does anyone else who somehow has access to the password, whether stolen or bought
 - this registration can be anonymous

Phase 3: Payment



- Escrow pays ALL registrants, legitimate or not.
- Alice & Bob lose some of their deposits if there are illegitimate registrations
- Charity gets excess money if sharing occurred

Setting the Security Deposit

- It should not be so high that Bob won't participate
- It should be more than Bob can get in total by selling the password
 - Can be difficult to determine
- One way to determine security deposit level: detect multiple people using an account

Account Limits for Setting the Security Deposit

- Suppose that use of an account by x or more people can be detected, and account disabled
- Set escrow amount so Bob would need to sell to more than x to recover escrow
- Unauthorized possessors shouldn't buy
 - Bob is probably selling a worthless password
 - Other buyers may have resold as well
- Bob probably won't be able to make a net profit. He shouldn't sell at all.

Attacks on SPIES

- Alice registers twice to get Bob in trouble
 - she loses her escrow
- Alice shares the data with someone else
 - she loses her escrow
- Someone registers many times
 - exponential payout function: they get **less** money total
 - charity gets non-distributed money

Exponential Payout Function

- Each registrant gets only $1/2^{x-2}$ of the amount they would get where x is the number of registrations.
- Example: \$5 deposit
 - Alice and Bob register once; each gets $1/2^0$ of \$5, i.e. \$5
 - Bob makes 5
 - there are 6 shares (Alice's 1 plus 6 for Bob)
 - Each share gets $1/2^{(6-2)} = 1/16$ th of \$5
 - Bob gets $5/16$ of \$5 or about **\$1.56**, not \$5.
 - Alice only gets \$0.31!
- Details in paper

Strategies of Content Possessors

- Authorized Possessors
 - Don't share unless you think someone else has
 - sharing reduces the returned security deposit
 - Different from Prisoner's Dilemma!
 - register exactly once
- Unauthorized Possessors
 - If you have the content, register exactly once
 - don't spread the content further – maybe.
 - depends on benefit, escrow amount, number of unauthorized possessors

Strategies of other participants

- Escrow: assumed to be honest
 - It can collaborate with a charity to get security deposits
- Charity: can get all the money if it gets the content
 - Use a large number of charities; secure coin flip to choose one

Nash Equilibria and Rationalization

- Def: given other's actions, no one can improve their utility with different action
- We found two Nash equilibria: neither shares and both share.
 - Both do best if they don't sell
 - If one sells the other does better to sell too
 - Still works with more than two participants
- Depends on being able to make a fixed, limited amount of money by selling
- If Bob knows Alice is rational & vice-versa, no-one shares: "rationalized" outcome

Key: Incentives Levels

- Can always ensure non-sharing
 - death penalty for authorized possessors if there are too many registrations
- To get users to participate, their expected utility must be positive
- Again, Alice prefers a high security deposit, Bob a low one; these must be balanced.

Other uses

- Non-disclosure agreements between companies
- Entertainment content shared to a reviewer pre-release
- Exclusive photographs shared with a newspaper by the photographer
- In these cases, the hash serves as a commitment: a human must determine if the content is identical
 - content can be obscured in many ways

Conclusion

- SPIES Provides an incentive to users
 - not to share
 - to protect their content
- useable as an additional layer of protection with other technologies and policies
 - DRM, Watermarking, lawsuits
- Applicable to passwords and other content