A lightweight protocol for the generation and distribution of secure e-coupons

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Outline of the talk

- Motivations
- A PKI based solution
- The lightweight protocol
  - The static model
  - The dynamic model
  - The extended model

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The motivations

- The web and the market
  - E-commerce
  - Advertising
- Advertising on the web
  - Web servers host ads
    - Non-active role
    - Banners, product info, etc.
  - Web servers distribute promotional material
    - Active role
    - Discounts, gifts, etc.

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From coupons to e-coupons

- Paper coupons
  - traditional form of advertisement distributed by
    - mail
    - fliers
    - newspapers and magazines
    - ...
  - redemption at physical store

- Hybrid coupons
  - downloaded from the web or received by e-mail
  - printed out
  - redemption at physical store

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E-coupons

- Truly digital
  - download from advertisers' web sites
  - redemption at stores' web site

- Advantages
  - ✓ Easy to distribute, to store and to use
  - ✓ Target recipients
  - ✓ Feedback on promotional campaign

- Disadvantages
  - ✓ Duplication
  - ✓ Double spending
  - ✓ Forging
  - ✓ Manipulation

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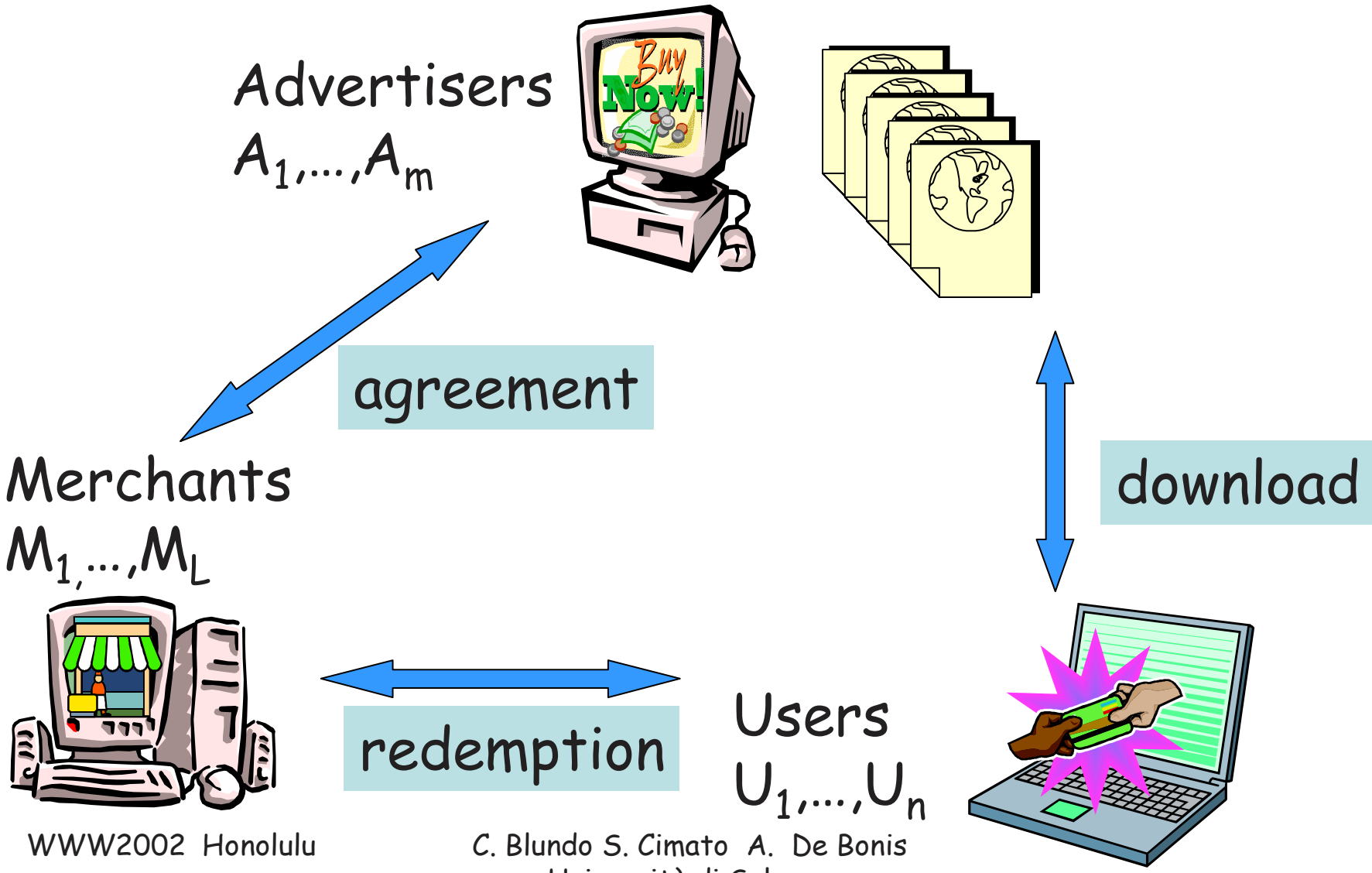
The scenario & life cycle



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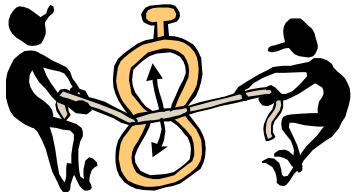
Requirements



Practical Requirements

- Soundness
- Efficiency
- Ease to use
- Interoperability
- Customers' anonymity

Security Requirements

- No unauthorized issuance
- No manipulation
- No double spending

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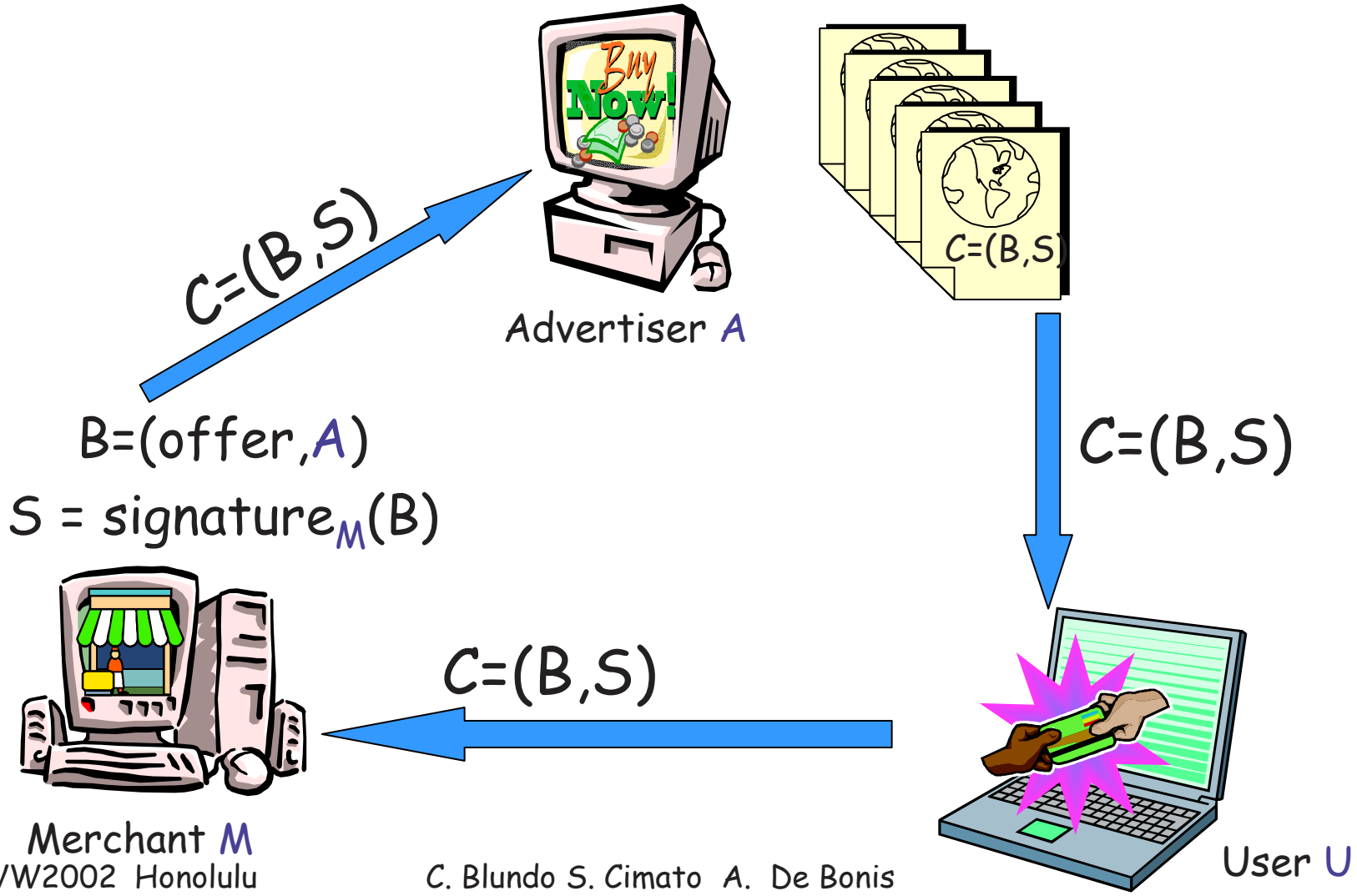
A solution based on digital signature

[Jakobsson et al., WWW8]



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Analysis of Jakobsson et al. solution

- Security Requirements:

Yes No unauthorized issuance
Yes No manipulation
Yes Double spending (if record of each e-coupon is mantained)

- Practical Requirements:

Yes Soundness
Yes Ease to use
Yes Interoperability
Yes Customers' anonymity
No Efficiency : Public key operations are very costly

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A lightweight protocol

Idea: Use Mac Algorithms instead of digital signatures

Mac Algorithm:

- encoding functions $h_k(\cdot)$ parameterized by secret key k
  - easy to compute
  - compression: finite bit length output string
  - computational resistance: if k unknown, it is computationally infeasible to compute $h_k(x)$

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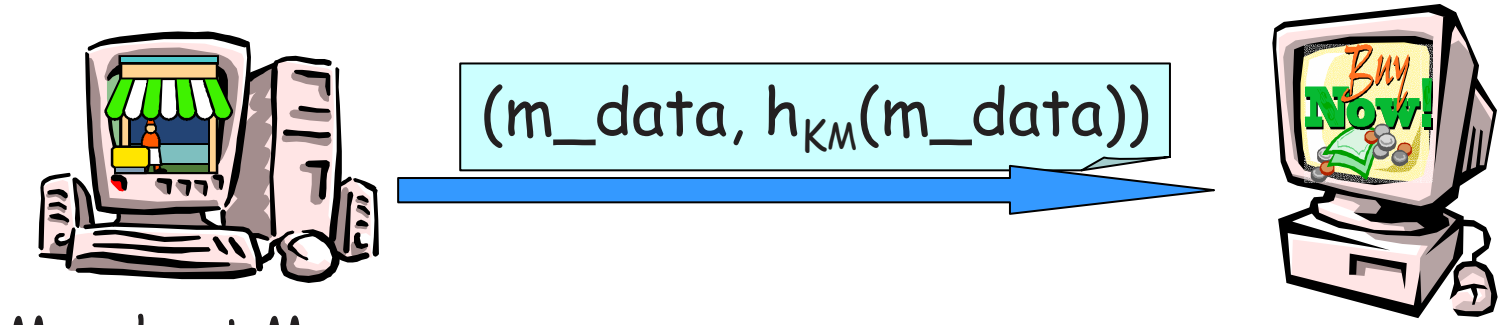
Initialization phase

- Merchant M sends the e-coupon framework to advertiser A



- K_M : secret key known only to M
- h_{kM} : MAC algorithm with parameter k_M
- m_data : merchant id, advertiser id, offer info,...

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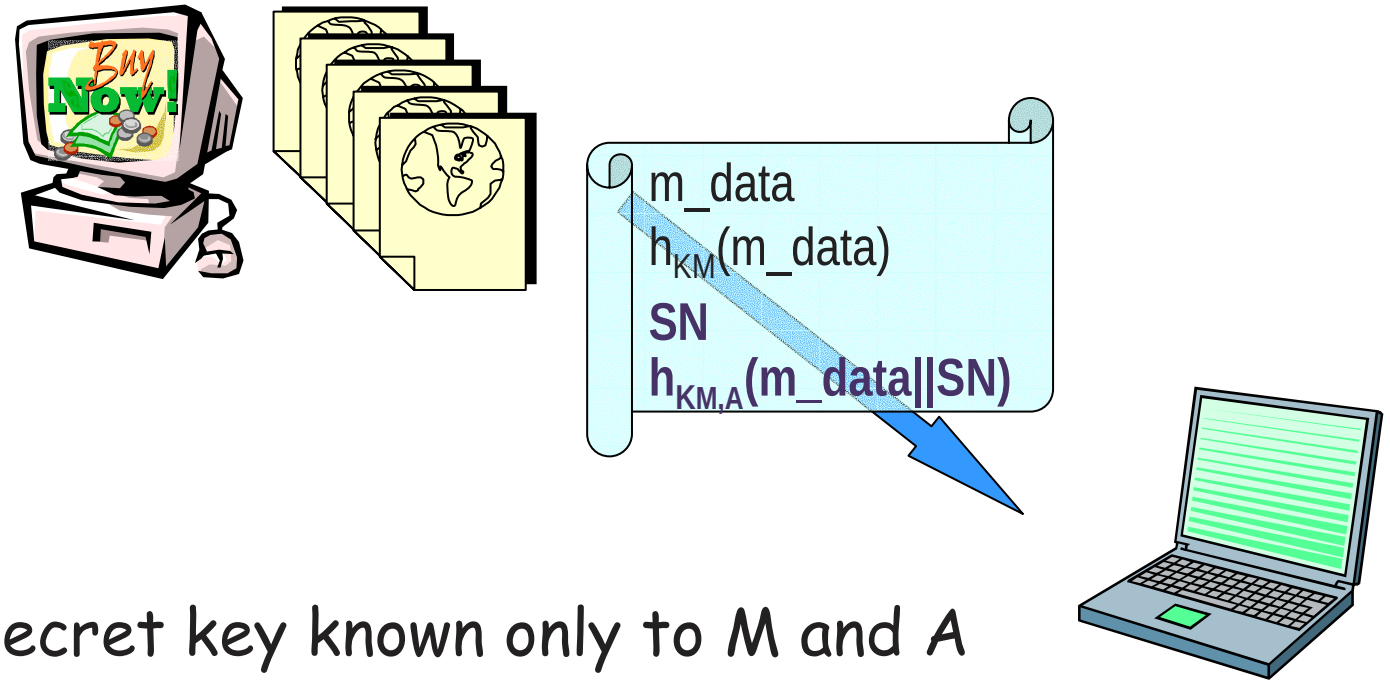
Generation phase

Advertiser A generates e-coupons using M's framework



- $k_{M,A}$: secret key known only to M and A
- h_{KMA}: MAC algorithm with parameter $k_{M,A}$
- SN : e-coupon serial number

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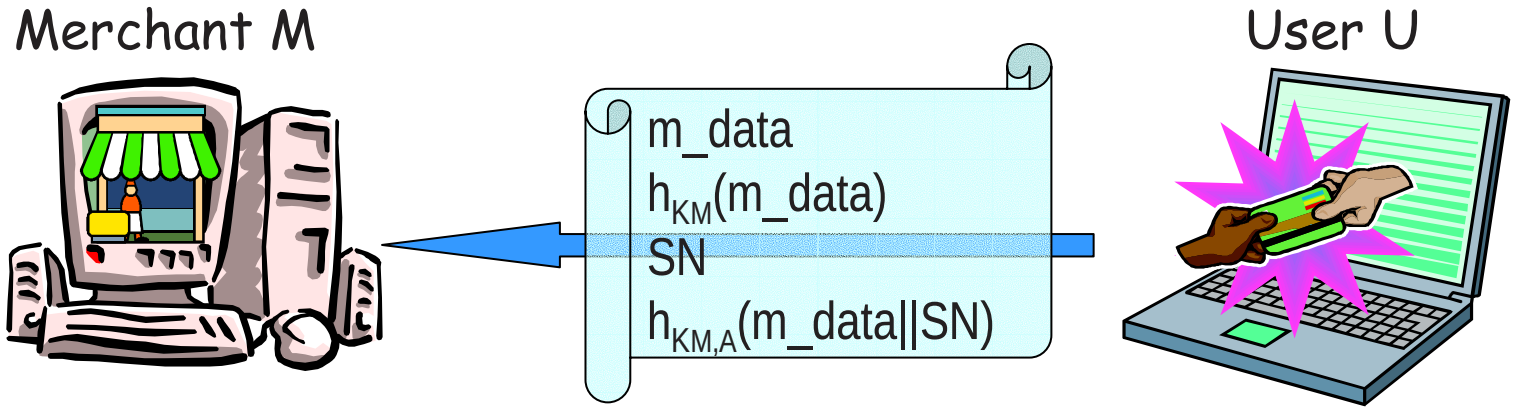
Redemption phase

User U sends the e-coupon to merchant M



M computes h_{KM}(m_data) and $h_{KM,A}$(m_data||SN) and accepts e-coupon iff

- computed values = values stored in e-coupon
- SN has not been seen before

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Security

- No unauthorized issuance:
  - Users cannot compute h_{KM}(m_data) and $h_{KM,A}$(m_data||SN)
  - Advertiser cannot compute h_{KM}(m_data||SN)
- No manipulation:
  - Changing e-coupon data requires to compute new values of h_{KM}(m_data) and $h_{KM,A}$(m_data||SN)
- No double-spending:
  - No two accepted e-coupons with the same Serial Number

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Dynamic e-coupons

- Dynamic e-coupons contain information on the release time:
  - *Aging e-coupon:* offer decreases from the moment e-coupon is downloaded
- Dynamic e-coupons are released for marketing purposes:
  - Discourage users from shopping around for better offers
  - Give immediate feedback on advertisement campaign

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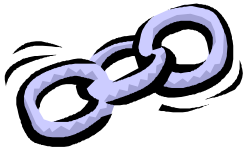
Dynamic e-coupons

Idea: released e-coupons form a dependence chain

$q_1, q_2, q_3, \ldots,$



- Advertiser computes:
  - chain "ring" for released e-coupon
    - $q_{SN} = q(u\_data||q_{SN-1})$ (SN = serial number)
- Needed:
  - u_data: info released by user (e.g., IP address)
  - q: collision resistant hash function
    - It is computationally infeasible to find distinct x and y such that q(x)= q(y)

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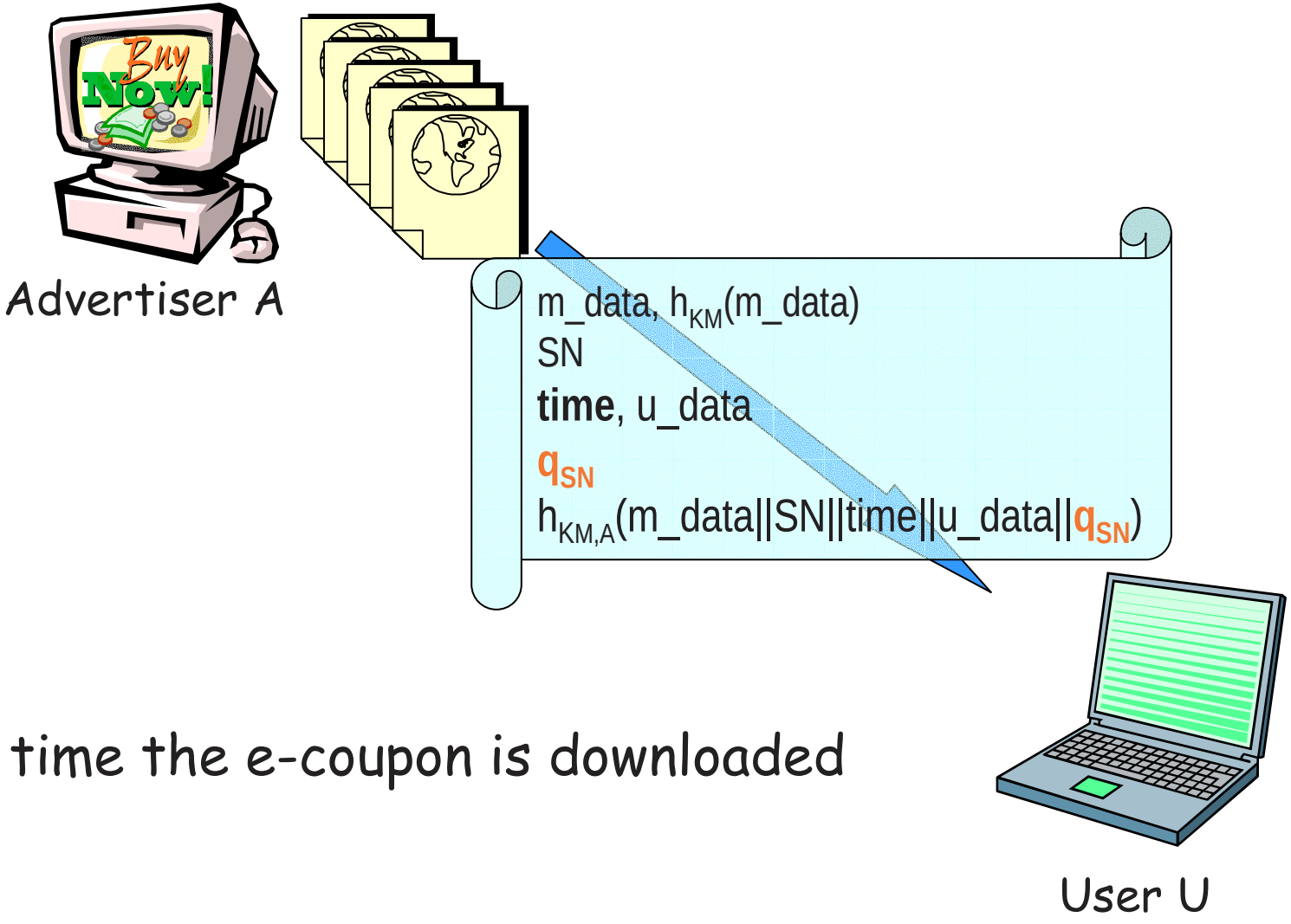
Generation of Dynamic E-coupons



- time: time the e-coupon is downloaded

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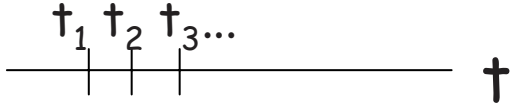
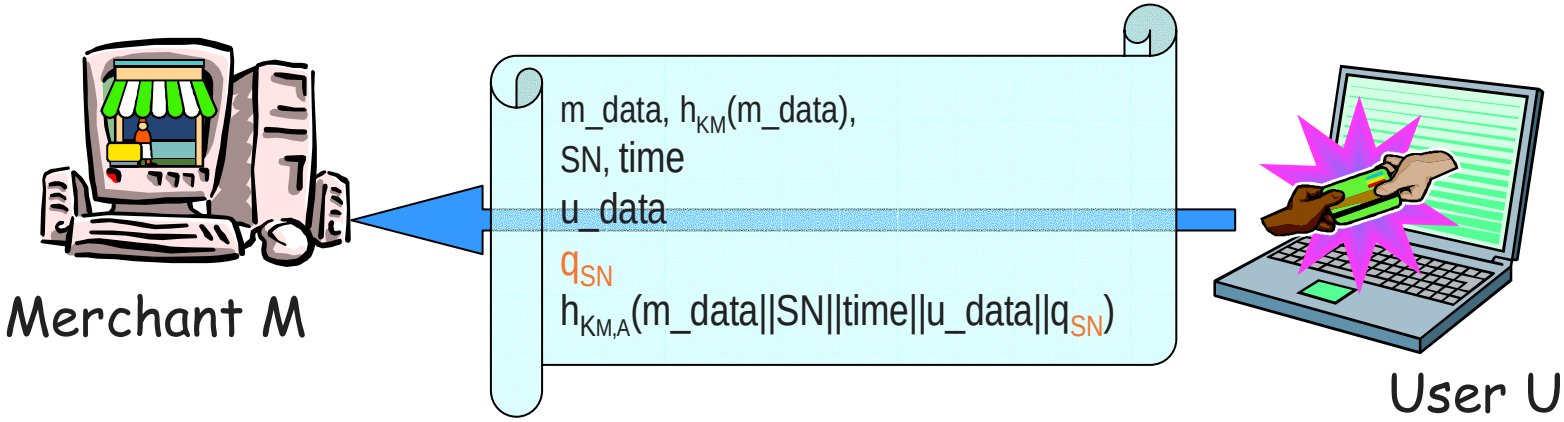
Redemption phase

- Time is divided in time frames $t_1, t_2, t_3, \ldots,$



- *A gives M the dependence chains for previous time frames*



M computes $h_{KM}(m\_data||q_{SN})$ and $h_{KM,A}(m\_data||\ldots||q_{SN})$ and accepts e-coupon iff

- computed values = values stored in e-coupon
- SN has not been seen before
- q_{SN} in e-coupon = q_{SN} in dependence chain (when dependence chain is available)

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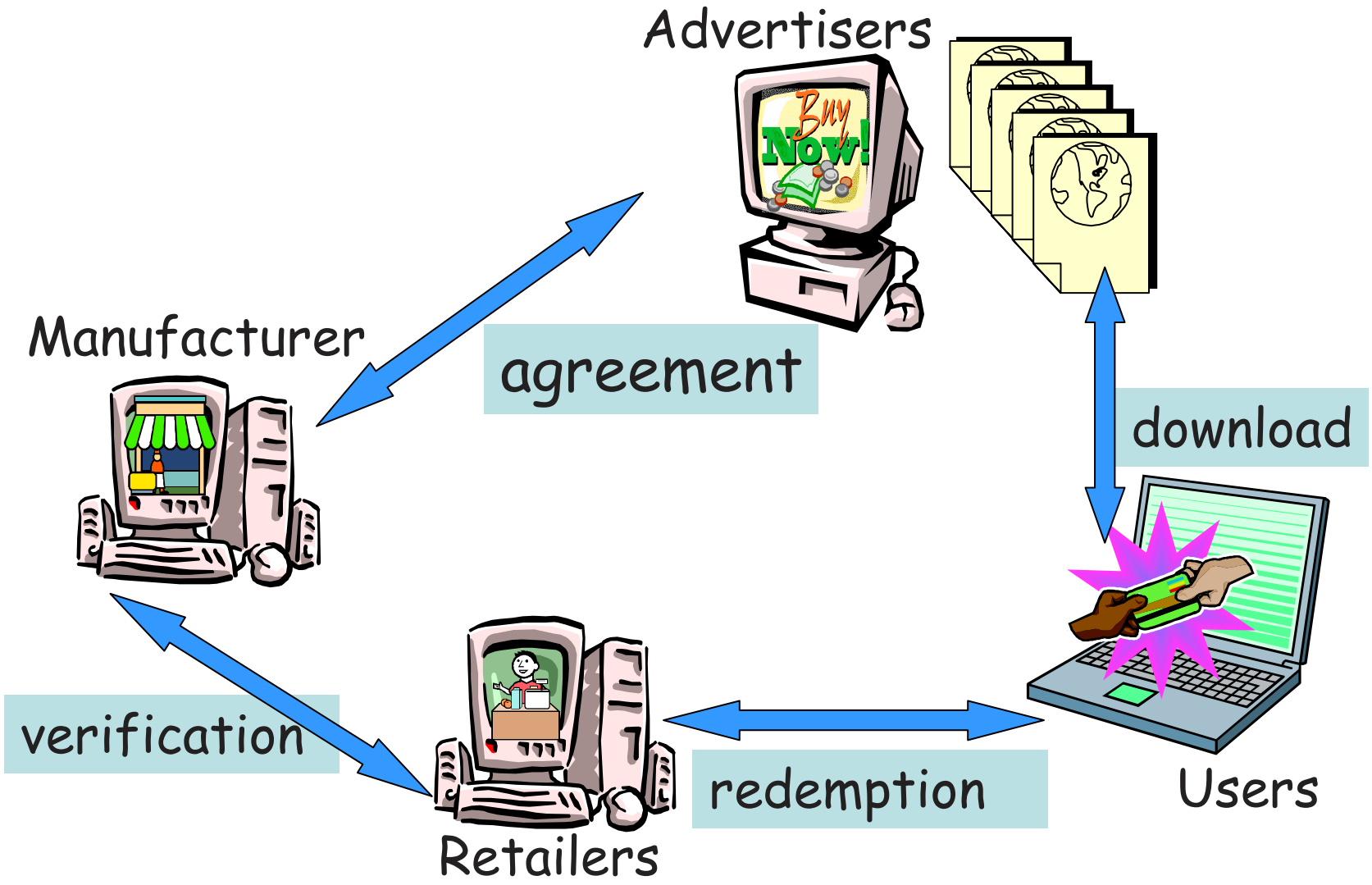
The extended model



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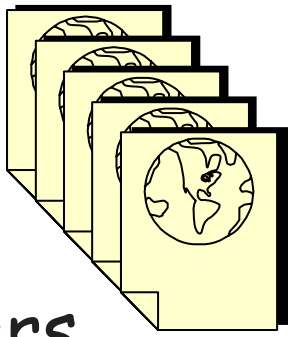
Implementation

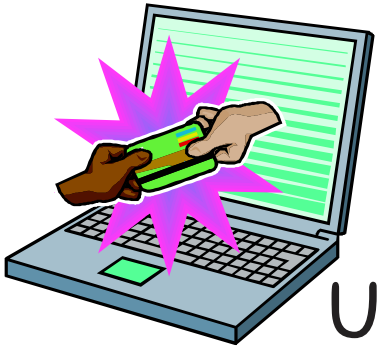
Advertisers



plugin

Coup$_1$
Coup$_2$
Coup$_3$
...
Coup$_n$

Wallet



Users

Merchants

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Conclusions

- Our protocol is
  - ***secure:***
    - no unauthorized issuance
    - no manipulation
    - no double spending
  - ***lightweight:***
    - no need of public key infrastructure
  - ***practically implementable:***
    - it exploits HTTP protocol
  - ***respects user's privacy:***
    - no registration required

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