Securing Interactive Sessions Using Mobile Device through Visual Channel and Visual Inspection

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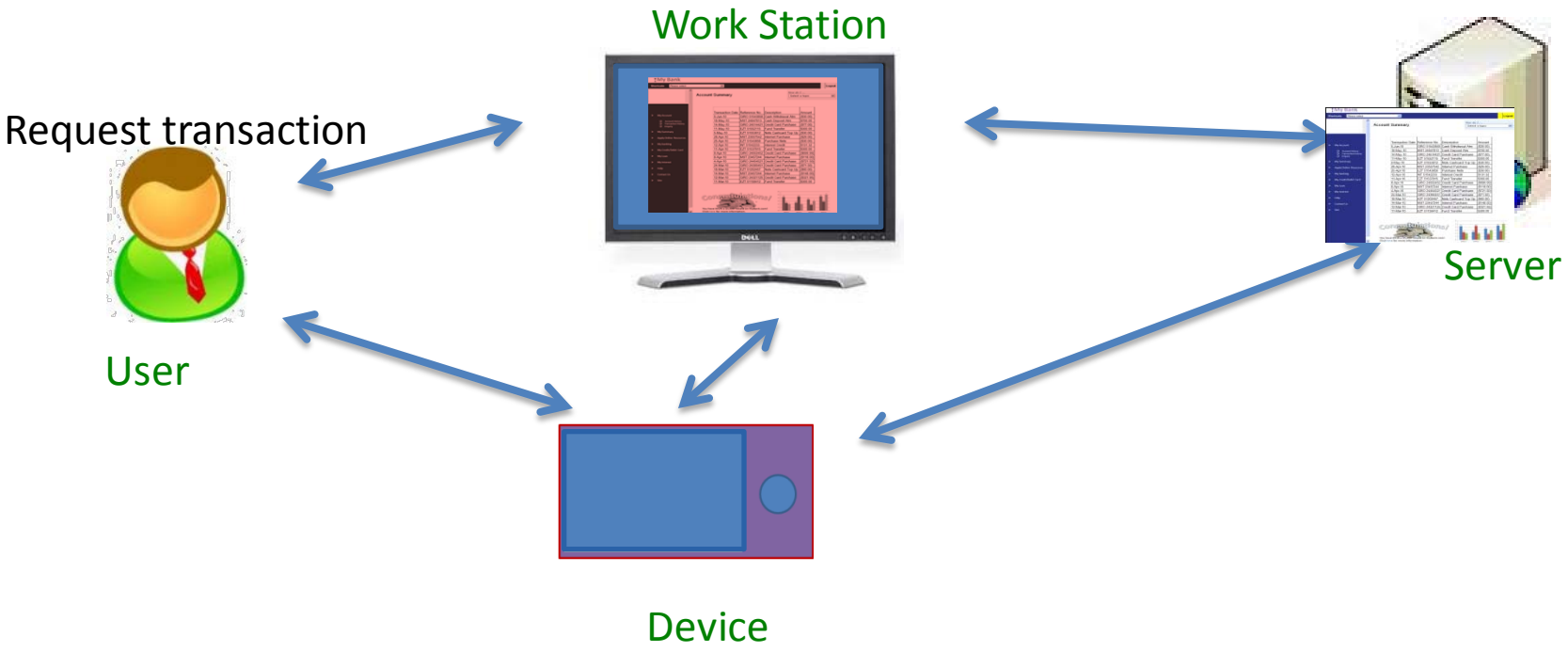
Authenticating a Message

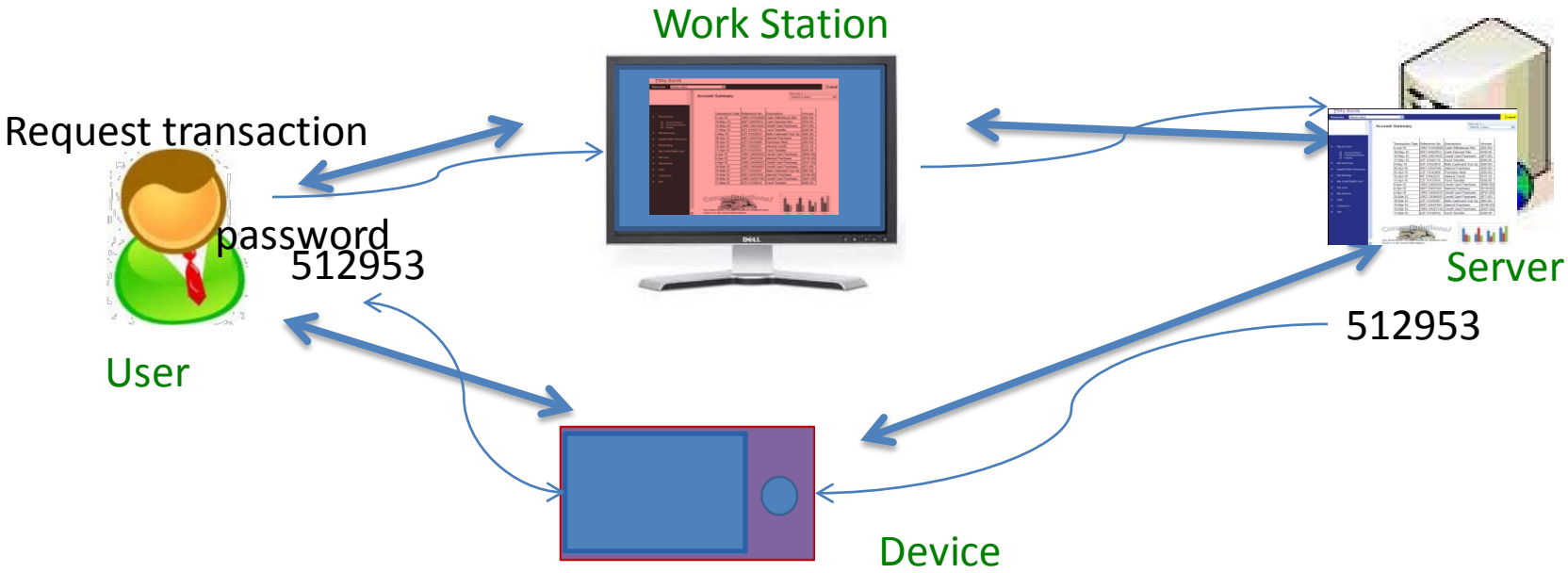
We are interested in securing interactions with a server via an work station using a mobile device.



Outline

- Background and related methods
- Our method
- Design Challenges
- Proof of concept demonstration
- Conclusion and future work

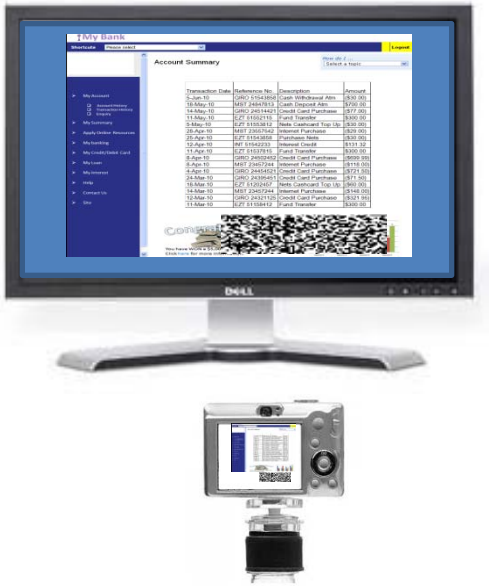
One Time Password



However, it does not verify the transaction content, thus the work station is able to modify the transaction.

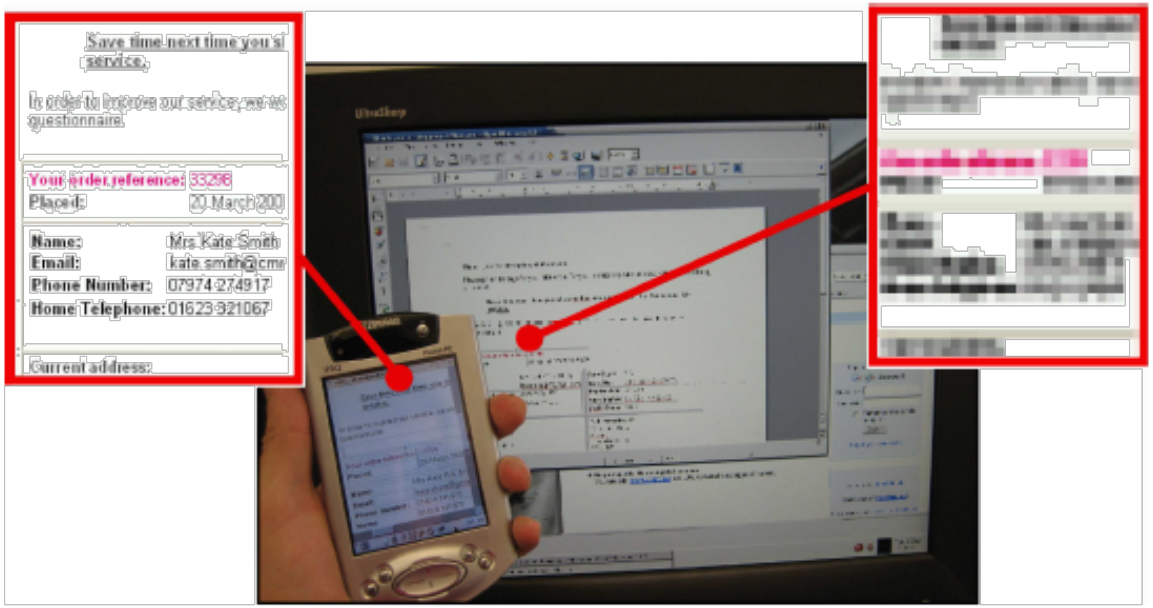
Related Work

- [Clarke2002] : Capture every pixel and verify the pixels (or perform OCR and verify the message) with a MAC barcode on the screen.

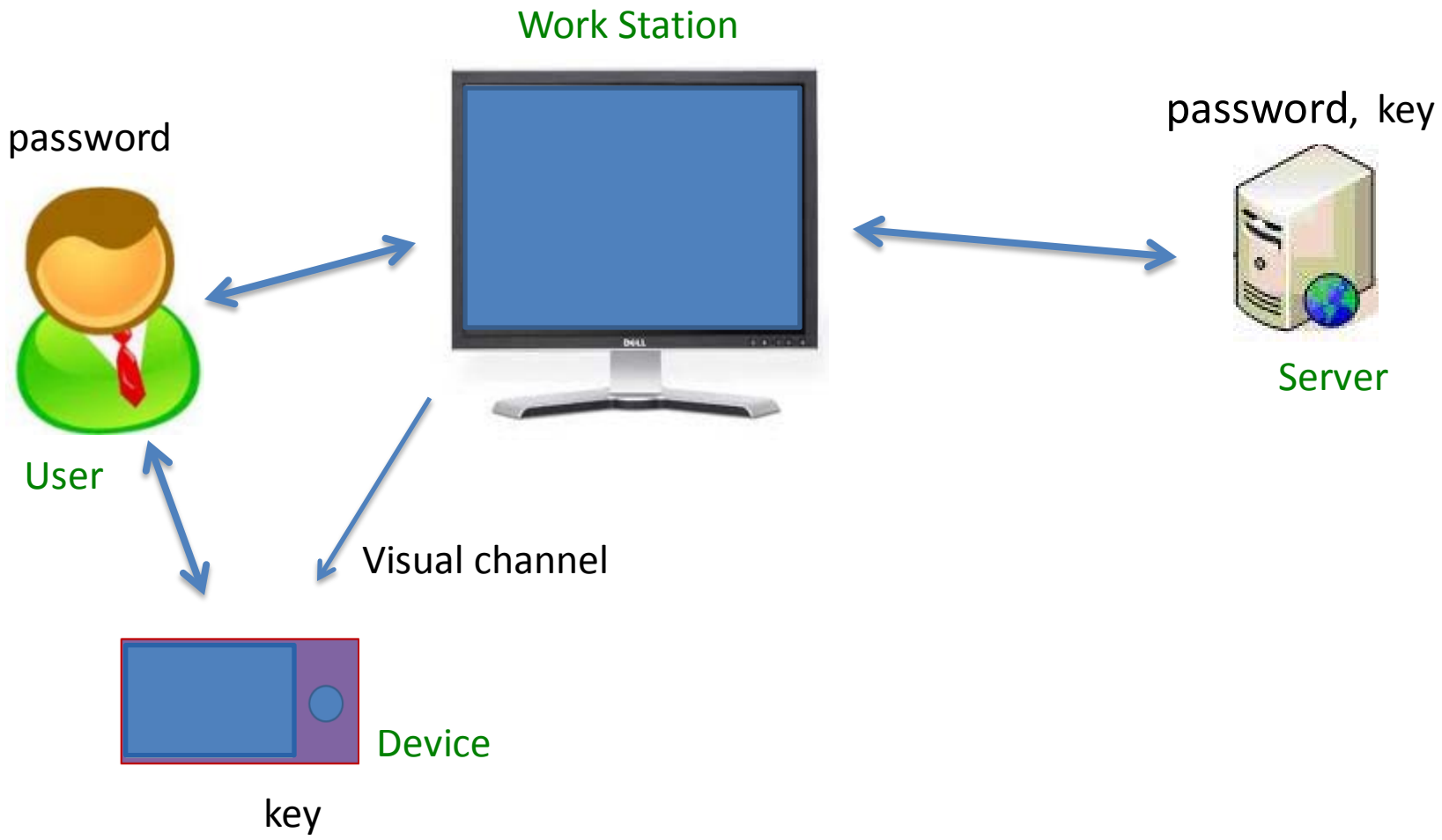


Related Work

- [Sharp2006]: Blur the sensitive information in the work station, display the region around the mouse pointer in mobile device.



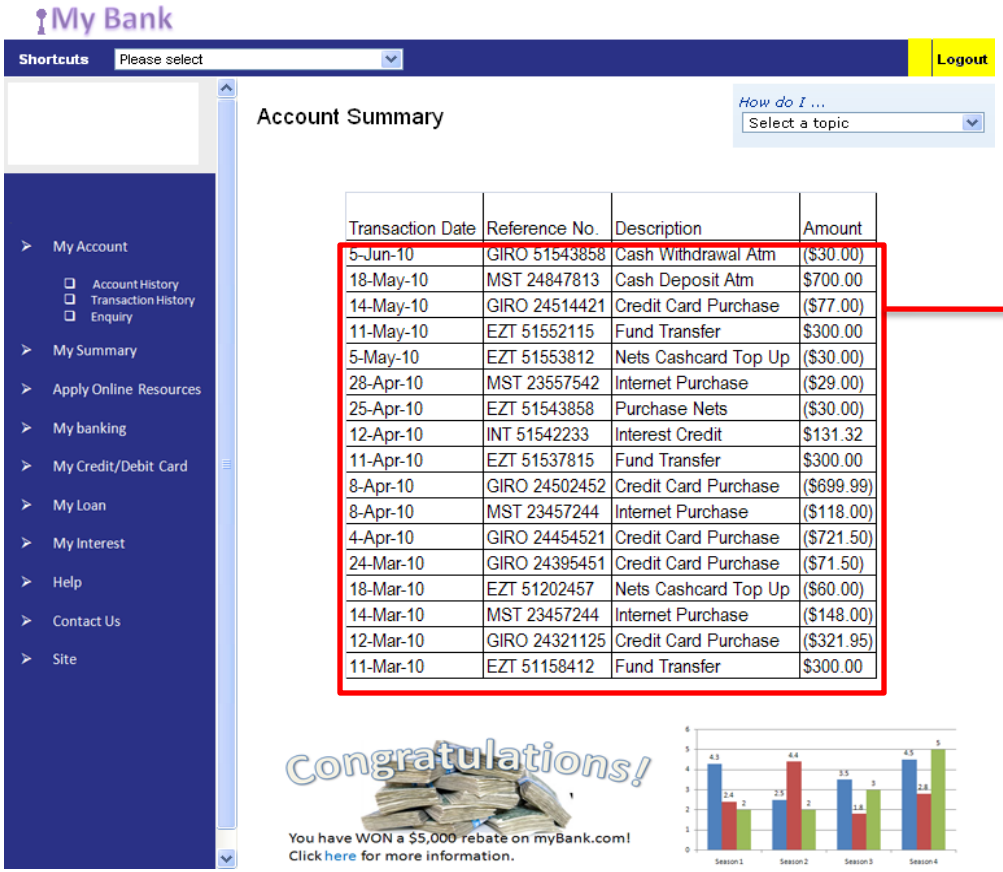
Our Scheme: Setting



Two Adversary Models

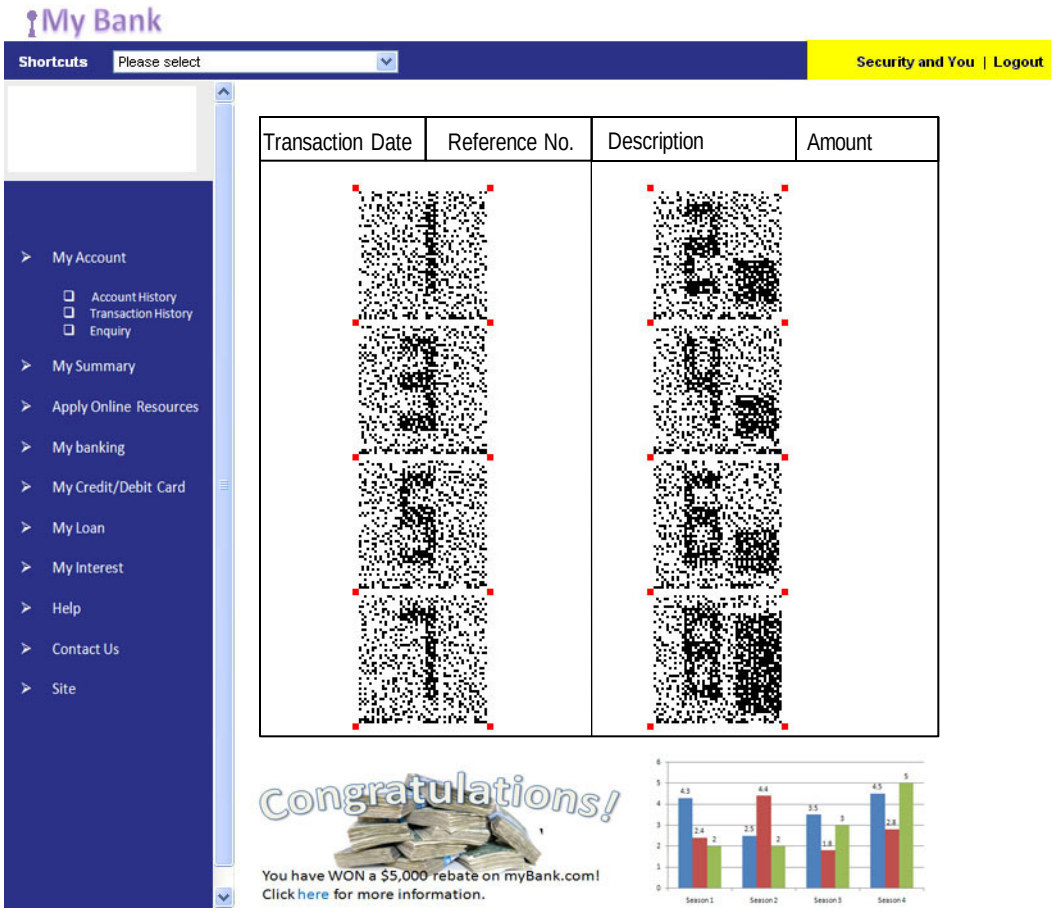
- Model 1: the mobile device is honest the terminal is could be compromised, we want to achieve confidentiality and authenticity;
- Model 2: both the mobile device and the terminal could be compromised, but they cannot collude, we want to achieve authenticity.

Model 1 (Mobile Device is Honest)



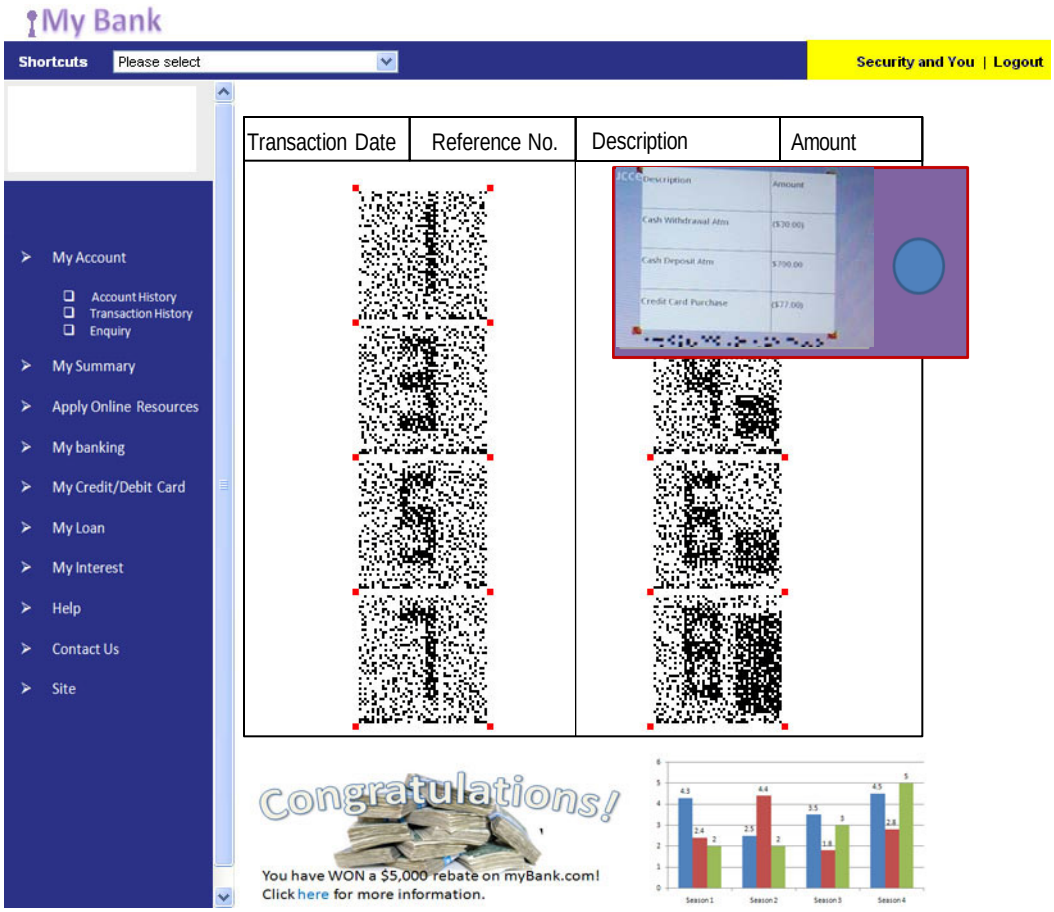
Sensitive information to be presented to the user.

Model 1 Solution



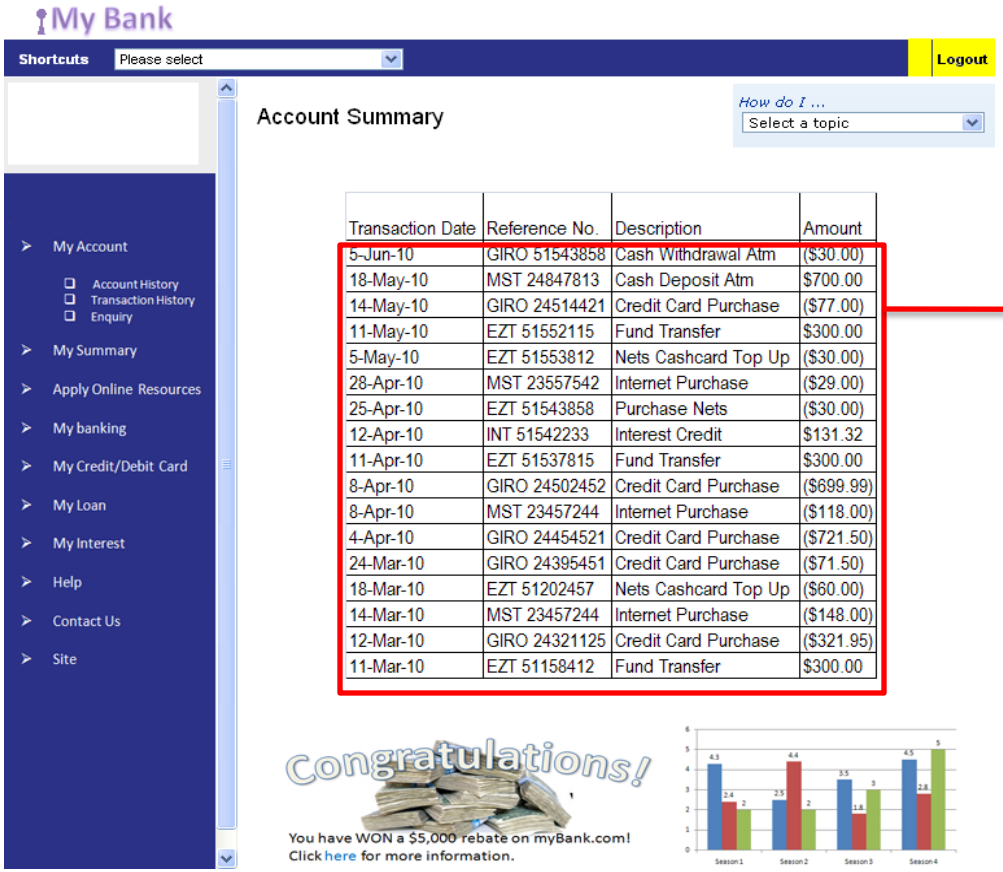
(1)Non sensitive portions will be displayed as they are.
(2) Sensitive information are replaced by specially designed 2D barcodes.

Model 1 Solution



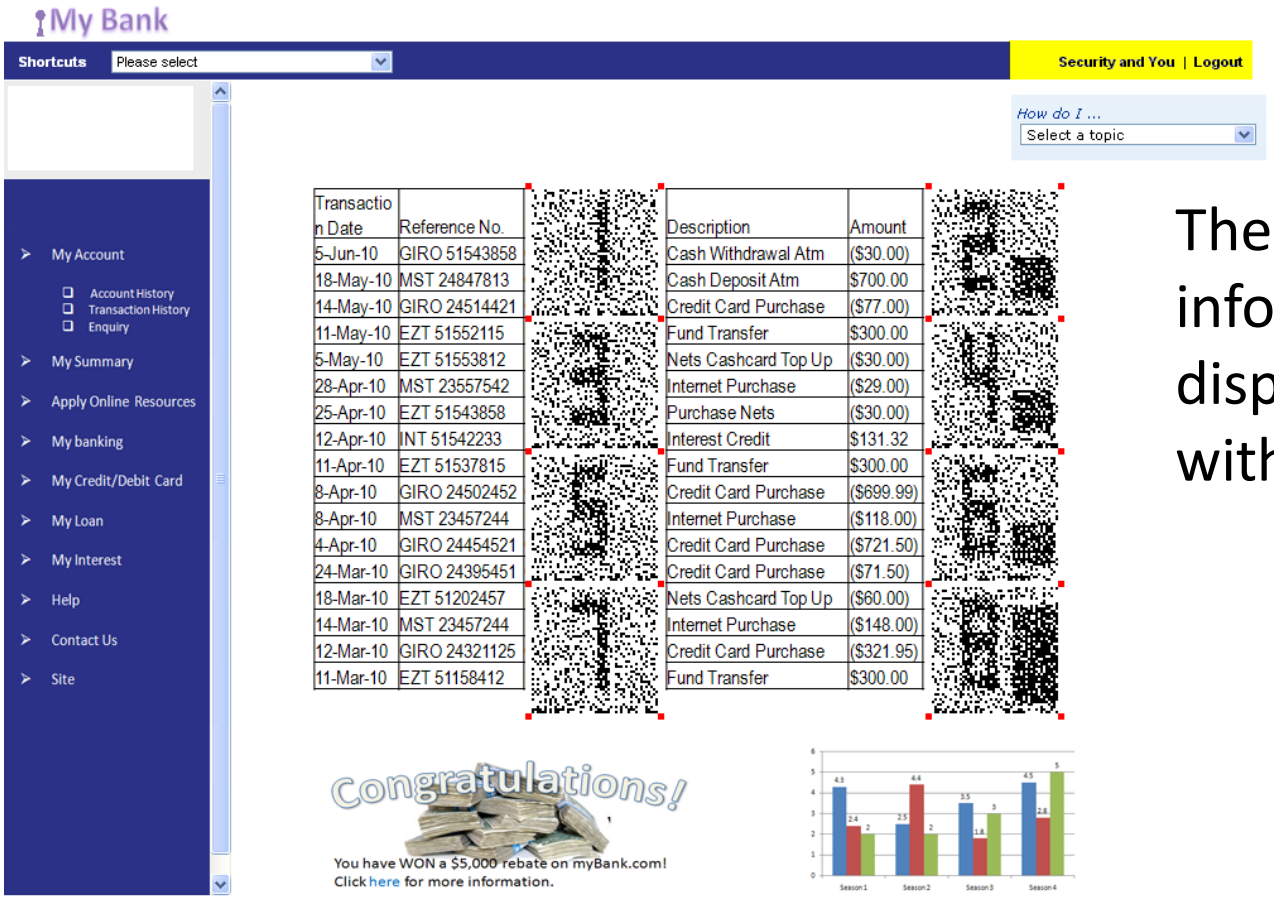
(1)User verifies the order of the barcodes.
(2) User moves the mobile device over the barcode.
(3) Mobile device captures and verifies the barcodes, and displays the content.

Model 2 (Both Could Cheat)



Information which requires protection on authenticity.

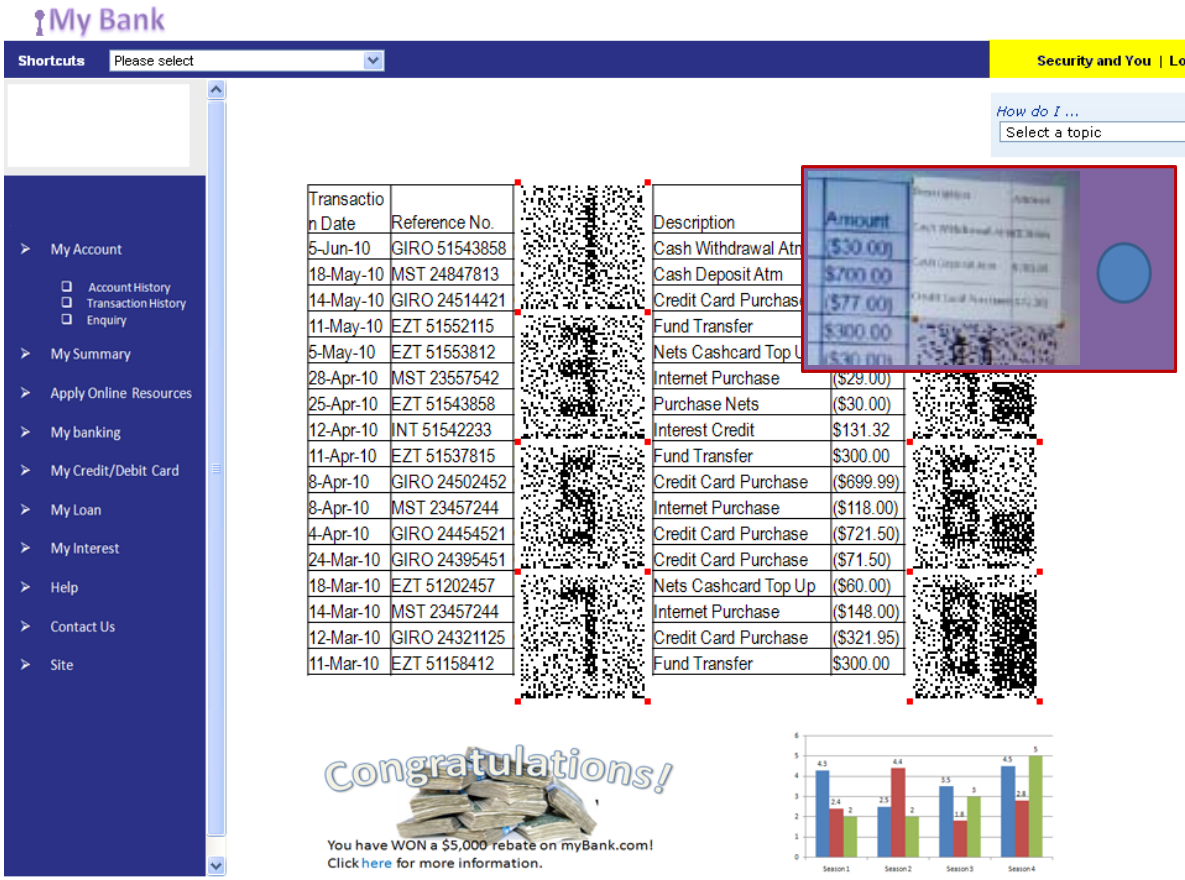
Model 2 Solution



Transaction Date	Reference No.	Description	Amount
5-Jun-10	GIRO 51543858	Cash Withdrawal Atm	($30.00)
18-May-10	MST 24847813	Cash Deposit Atm	$700.00
14-May-10	GIRO 24514421	Credit Card Purchase	($77.00)
11-May-10	EZT 51552115	Fund Transfer	$300.00
5-May-10	EZT 51553812	Nets Cashcard Top Up	($30.00)
28-Apr-10	MST 23557542	Internet Purchase	($29.00)
25-Apr-10	EZT 51543858	Purchase Nets	($30.00)
12-Apr-10	INT 51542233	Interest Credit	$131.32
11-Apr-10	EZT 51537815	Fund Transfer	$300.00
8-Apr-10	GIRO 24502452	Credit Card Purchase	($699.99)
8-Apr-10	MST 23457244	Internet Purchase	($118.00)
4-Apr-10	GIRO 24454521	Credit Card Purchase	($721.50)
24-Mar-10	GIRO 24395451	Credit Card Purchase	($71.50)
18-Mar-10	EZT 51202457	Nets Cashcard Top Up	($60.00)
14-Mar-10	MST 23457244	Internet Purchase	($148.00)
12-Mar-10	GIRO 24321125	Credit Card Purchase	($321.95)
11-Mar-10	EZT 51158412	Fund Transfer	$300.00

The transaction information is displayed together with their barcodes.

Model 2 Solution



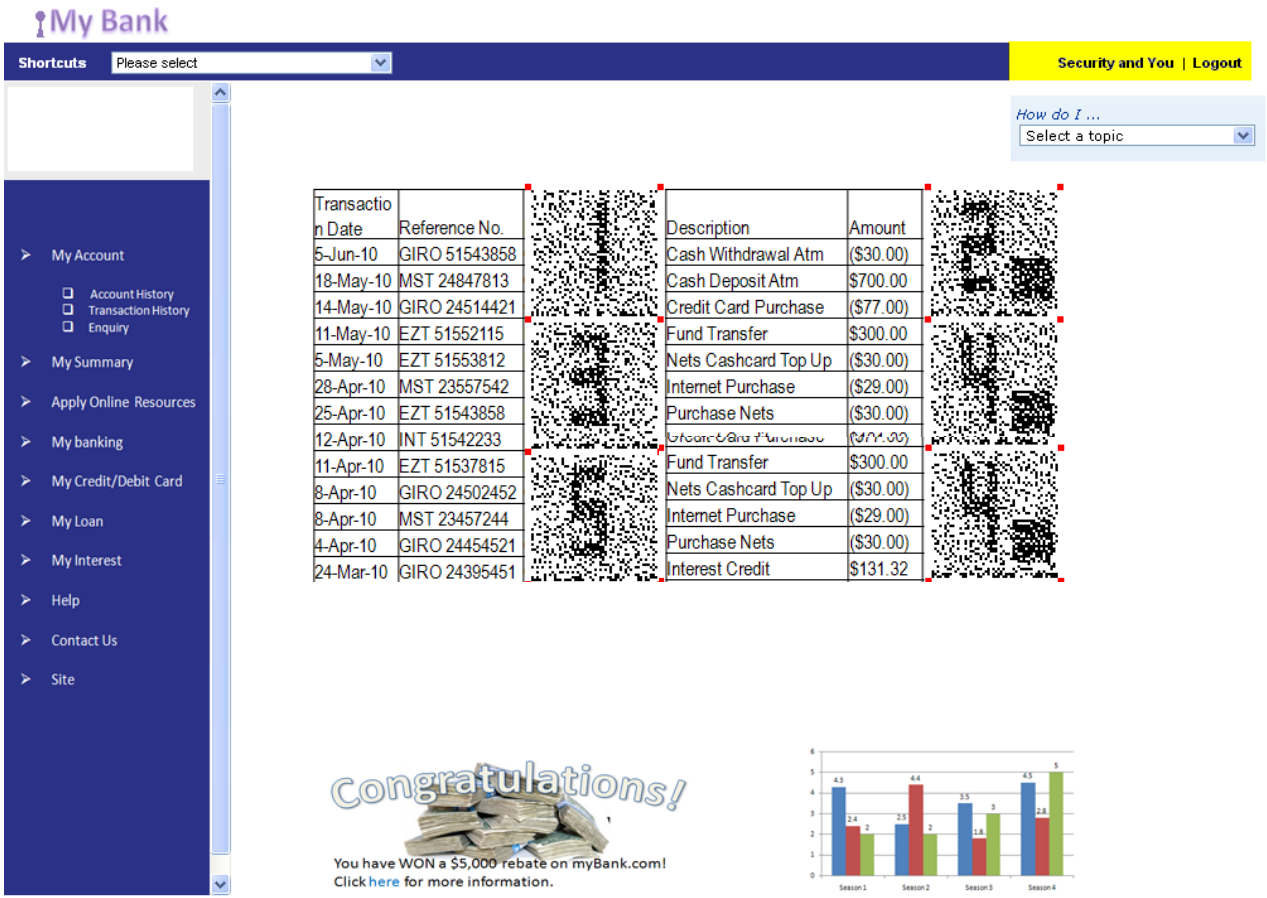
(1)User verifies the order of the barcodes.

(2) User moves the mobile device over the barcode.

(3) Mobile device captures and verifies the barcodes, and displays the content.

(4) User verifies the transactions are consistent in device and work station.

Rearrangement Attacks



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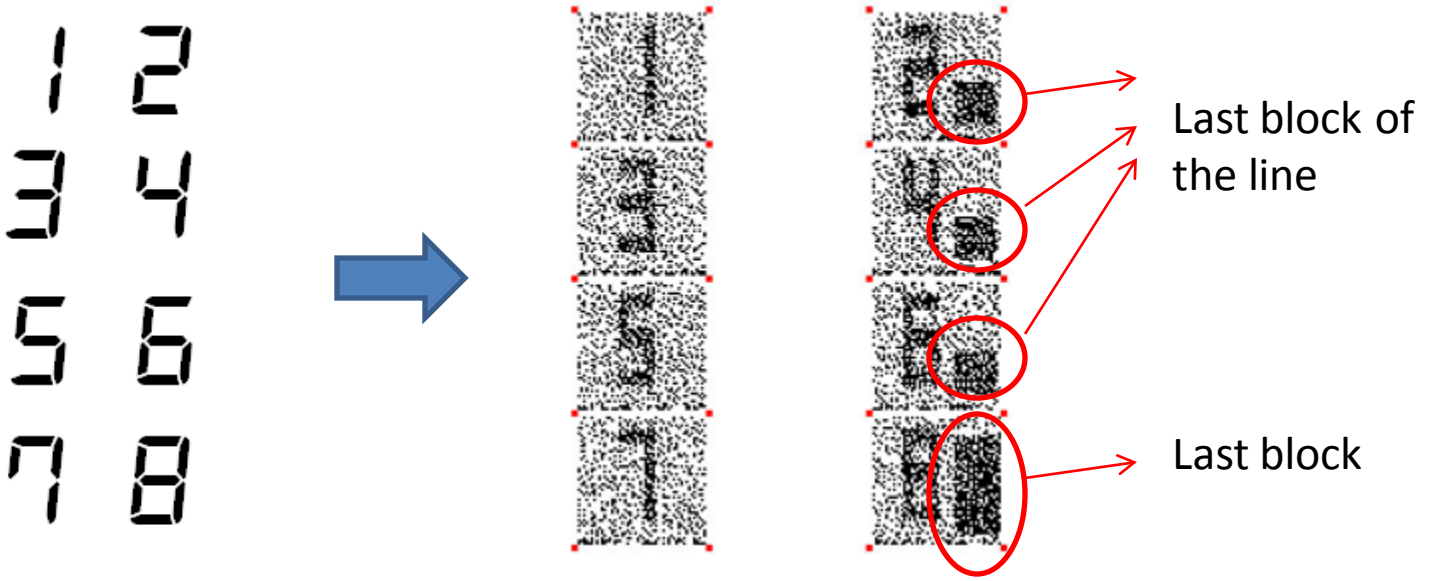
Sub-Region Authentication

- Capture and decode one small region at a time.
  - It is subjected to rearrange/delete/duplicate attack
- Hardware limitation of mobile's camera
  - It cannot capture a whole screen with sufficient precision.
- Sub-region authentication problem:
  - how to authenticate the whole message using a device that can only verify one small region at a time.

Visual Inspection of Visual Cues

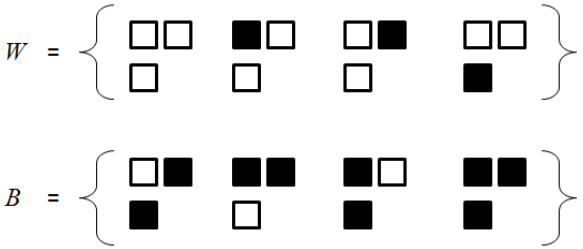
- Idea: bind the location information to the appearance of the barcodes.
- Example:



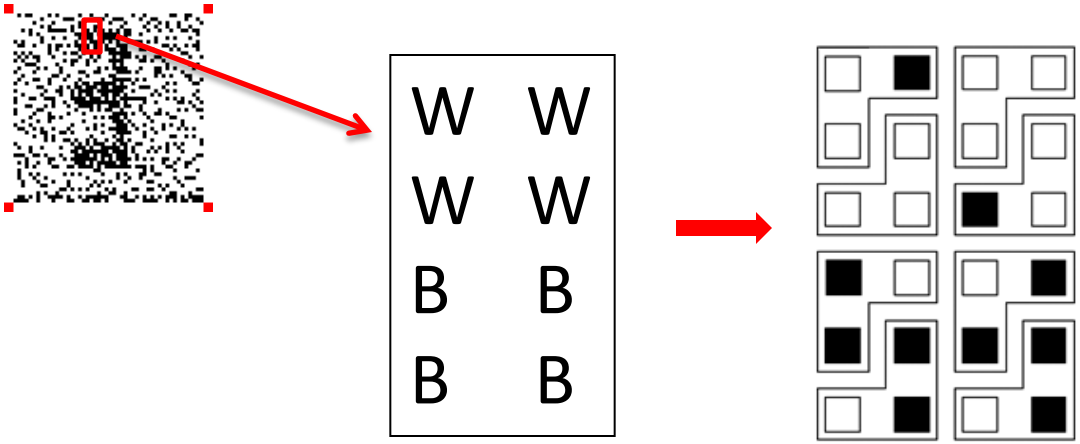
Our Design

2 bit message + 1 bit visual appearance + key -> 3 pixels

{00, 01, 10, 11} {W, B} [1 … 576]



L-blocks



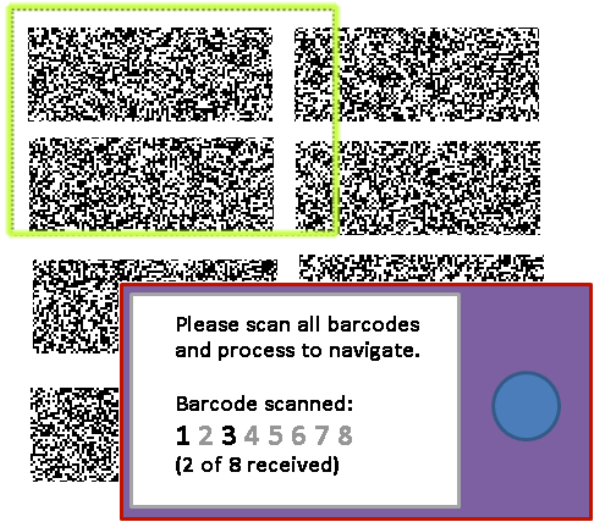
Our Design

- The arrangement is derived from session key. Hence, a malicious terminal who change a Black L-block to White L-block has 3/4 chance of introducing error.
- To change the visual appearance, the adversary will need to change many L-blocks. This will destroy the barcode with high probability.

Alternative 1

- Use camera as a channel to send everything, then start browsing in mobile device.

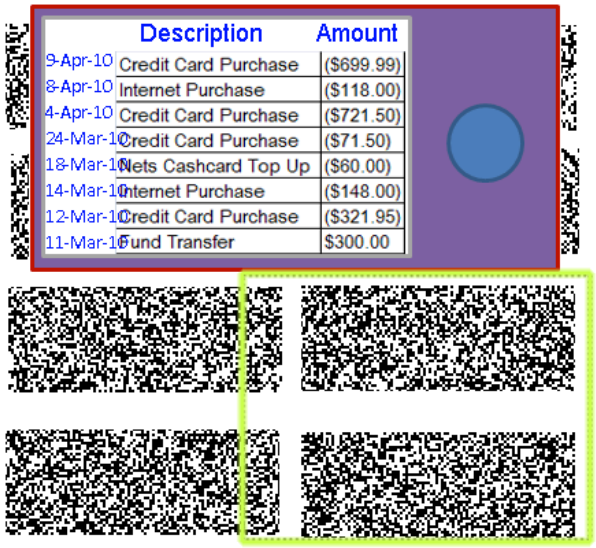
(1) Less user-friendly to browse with small display.
(2) Not easy to extend to cater dishonest mobile device.



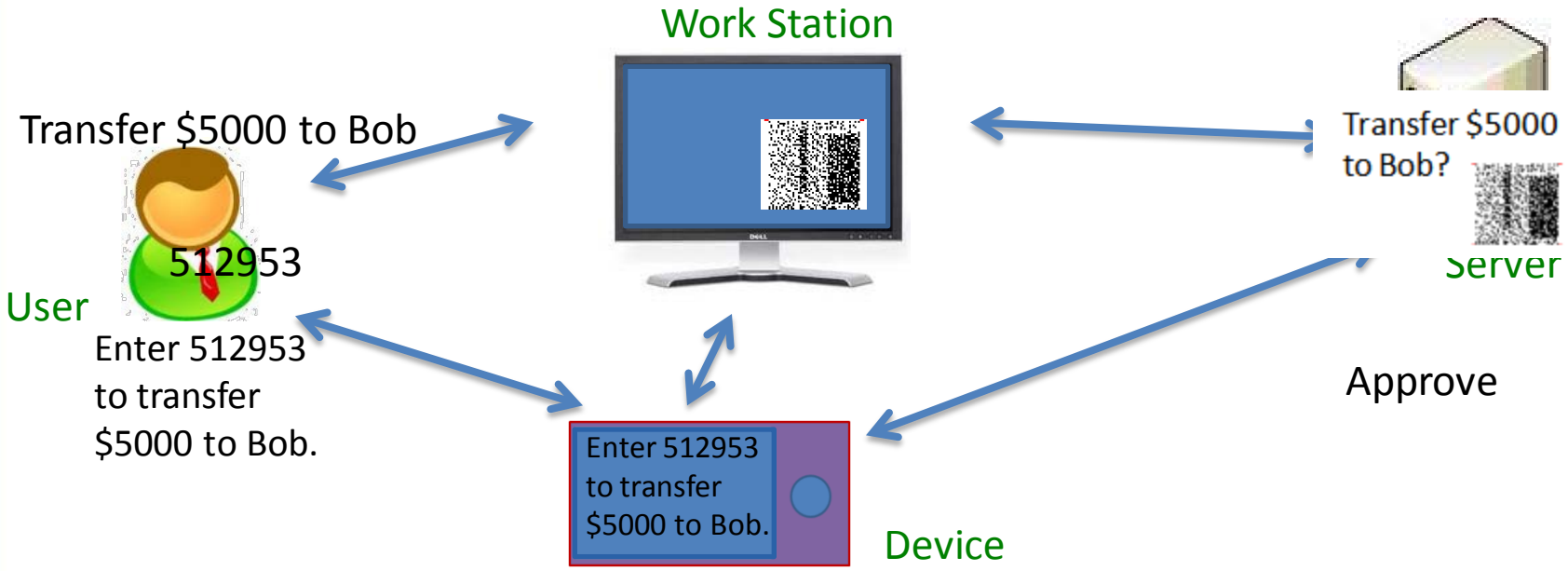
Alternative 2

- Store location information (e.g. row names, column names) in the payload.

(1) Not easy to prevent deletion and duplication attacks.
(2) Only applicable for some table data.



Send Message to Server



Comparison with Existing Work

- It can:
  - authenticate transaction content,
  - provide confidentiality when mobile is trusted.
- It requires:
  - mobile device has camera and display.
- It does NOT require:
  - installation in work station;
  - out-of-band channel;
  - mobile device to be trusted when confidentiality is not required.

Proof-of-Concept Implementation

Programmed using Android API 1.6.

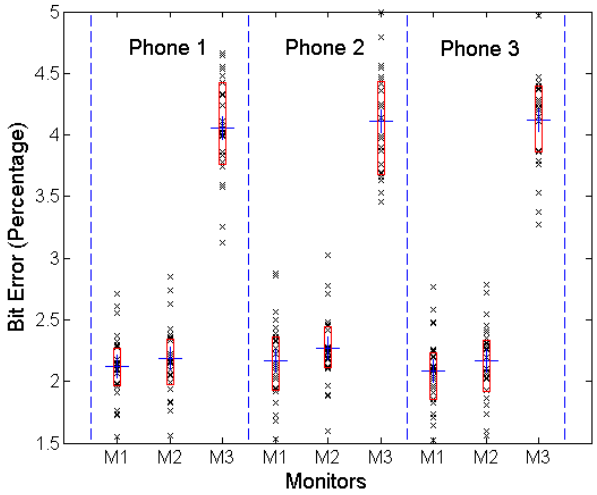
Tested on 3 phones: Acer Liquid, Motorola Milestone XT, HTC Legend;

Tested on 3 monitors:

- An 19 inch at TFT monitor in Dell model Optiplex 755;
- A 13.3 inches display of a Toshiba portege M900 laptop;
- A 15 inch Dell CRT monitor.

Performance

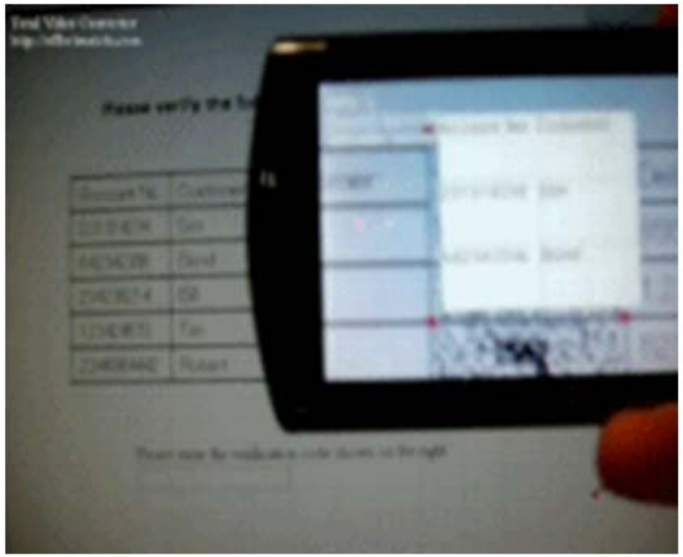
- Decoding rate: around 5 frames per second.
- Bit error rate:



- A barcode of 50 by 50 can carry around 952 bits message, and is able to correct 8% errors.

Proof-of-Concept Demo

- Proof-of-concept program running on Acer Liquid model,
- the webpage is render in a Dell model “Optiplex 755”, 19 inch TFT monitor.
- To improve user experience, we employ augmented reality framework, instead of requiring the user to manually take pictures.



Conclusions and Future works

- We designed a visual cue technique and show that this technique can help securing interactions.
- Our proof-of-concept implementation shows that such system is feasible to run in mobile devices.
- Our solution serves as an interesting example where authentication is carried out by coupling computer processing power and human perceptual system.
- The visual cue technique could potentially have other applications.

Thank you!