

# Token Hunt:

# Uncovering Post-Authentication Attacks in the Microsoft Cloud

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### Token Hunt | Agenda

- 1. Introduction to token theft and post-authentication attacks
- 2. Advanced insights of Microsoft Entra ID sign-in logs
- 3. Correlation of sign-in events to XDR alert or anomalies
- 4. Correlation of user sign-in, alert, and cloud app activity logs
- 5. Discover exposed token artifacts with exposure management





# Introduction to Token Theft and Post-Authentication Attacks



#### **Overview of Token Artifacts**



- Phishing-resistant authentication
- Device-Bounded or Cross-Device
- Device Identity proven by private key of certificate

#### Primary Refresh Token (PRT)

- Long-lived and Microsoft-specific artifact for SSO on a device
- Used to acquire token artifacts for any client/app
- Combines user and device identity, bounded to device

#### Refresh Tokens (RT)

- Long-lived artifacts to keep user logged-in
- Used on a scope of specific Client or "<u>Family</u> of <u>Client IDs</u>"
- Incl. authorization (groups, claims), device and user attributes

#### Access Tokens (AT)

- Shorter-lived artifacts for accessing resource
- Scope of Client ID and API permissions, restricted on client and resource (workload) combination

Token issuance (security and policy flow) including Conditional Access and Identity Risk Evaluation, User Assignment, User Consent Policy



# **Session cookies**

- Long-lived artifacts used for browser-based SSO after authentication
- Issued by IdP and service (resource owner)

#### Session Cookies

Learn / Microsoft Entra / Microsoft Entra ID / Authentication /







#### Web browser cookies used in Microsoft Entra authentication

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During authentication against Microsoft Entra ID through a web browser, multiple cookies are involved in the process. Some of the cookies are common on all requests. Other cookies are used for specific authentication flows or specific client-side conditions.

Persistent session tokens are stored as persistent cookies on the web browser's cookie jar. Nonpersistent session tokens are stored as session cookies on the web browser, and are destroyed when the browser session is closed.

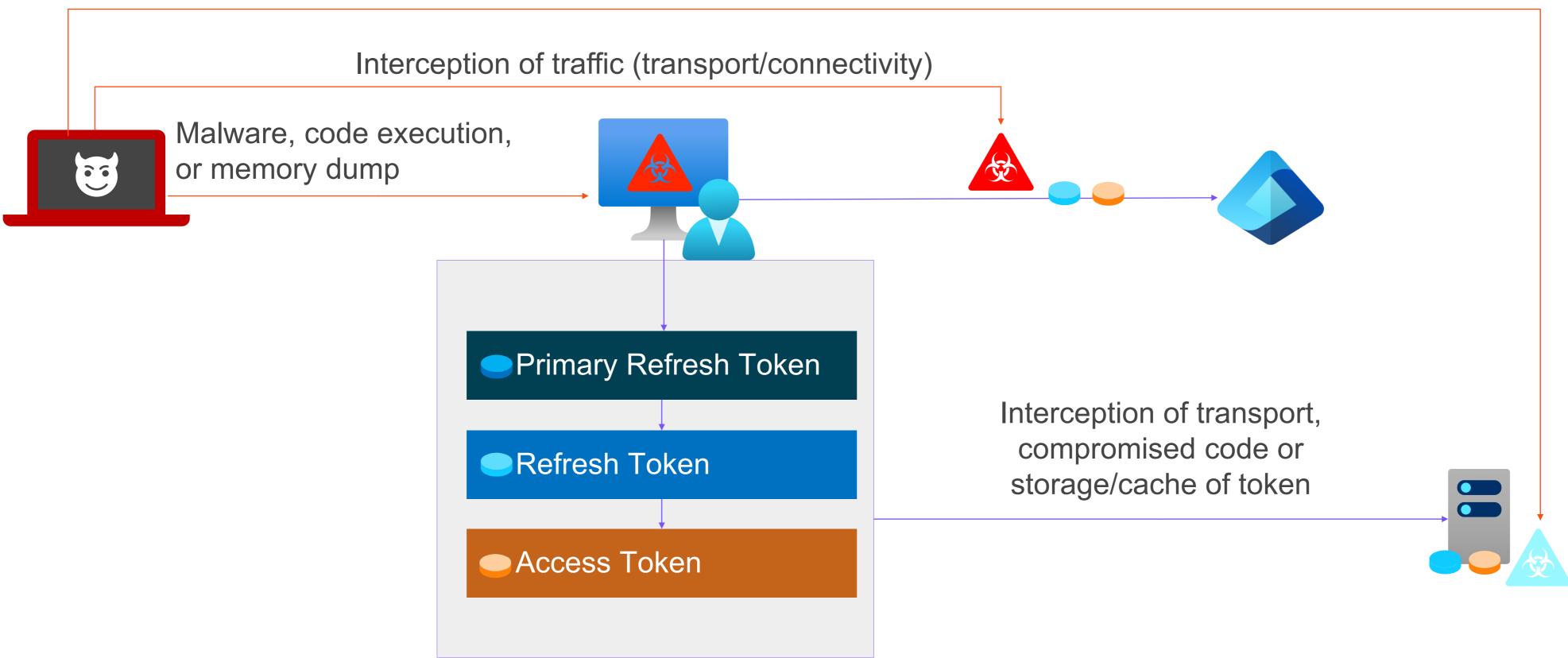
**Expand table** 

Cookie Name	Туре	Comments
ESTSAUTH	Common	Contains user's session information to facilitate SSO. Transient.



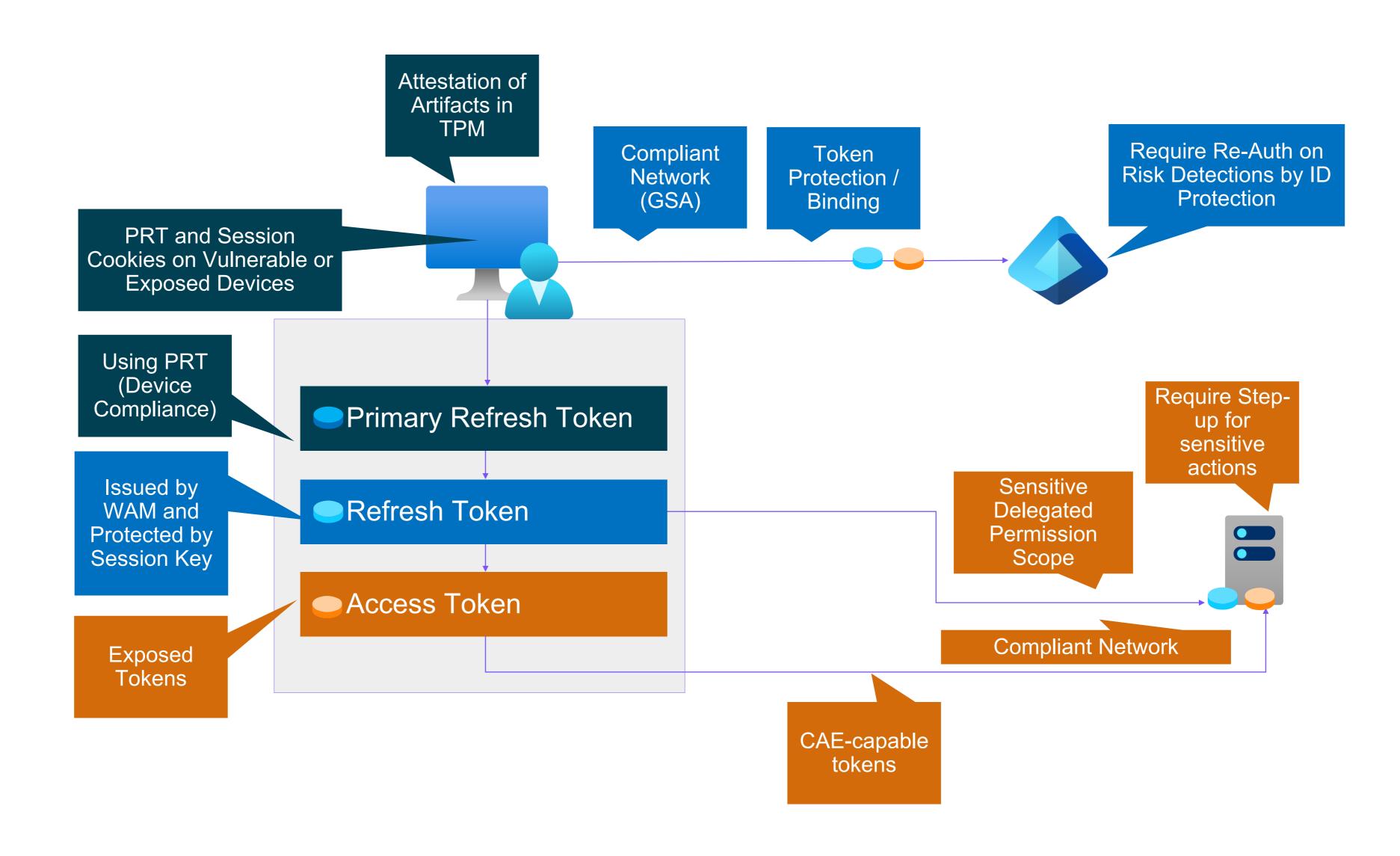
## Token-Related Attack Techniques

Compromised OAuth app with delegated permissions





## Token-Related Attack Techniques







# Advanced Insights of Microsoft Entra ID Sign-in Logs



# Types of Sign-in Identifiers

#### Correlation ID

Groups sign-ins from the same sign-in session, generated by client (not IdP)

#### (Original) Request ID

An identifier that corresponds to an issued token

The request identifier of the first request in the authentication sequence

☐ TimeGenerated [UTC] ↑↓	CorrelationId	OriginalRequestId	ResultType	AppDisplayName
) 1/9/2025, 4:36:34.812 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	da64a1df-a440-4f9e-9384-8e1e74cc1600	50057	ZTNA Network Access Client
) 1/9/2025, 4:38:50.378 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	99767c0a-a3e3-4bcb-911f-b435a02a2400	50057	ZTNA Network Access Client
) 1/9/2025, 4:41:36.923 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	4dcb705e-e855-4737-943c-40a281832300	0	ZTNA Network Access Client
) 1/9/2025, 4:41:39.250 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	535882bb-1efc-487f-9d3b-f3adf4d31c00	0	ZTNA Network Access Client
) 1/9/2025, 4:44:17.870 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	b693d7da-a90b-4c51-97c7-c67932d02400	0	ZTNA Network Access Client
) 1/9/2025, 5:20:40.974 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	7708cdc1-aeda-4669-a14c-66bb7aef4a00	0	ZTNA Network Access Client
) 1/9/2025, 5:25:36.516 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	53ebf0ce-19f7-4238-99ab-5efd7c7f1a00	0	ZTNA Network Access Client
) 1/9/2025, 5:27:46.532 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	bd6fe58a-12b5-4198-80be-0a4ef1ba2000	0	ZTNA Network Access Client
) 1/9/2025, 5:33:53.056 PM	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	227ddc64-37eb-448b-a618-7d7987bc4200	0	ZTNA Network Access Client



# Types of Sign-in Identifiers

#### Unique token identifier

Used to correlate the sign-in with the token request (passed during the sign-in)
Tracks tokens issued by Microsoft Entra ID as they're redeemed at resource providers

☐ TimeGenerated [UTC] ↑↓	OriginalRequestId	UniqueTokenIdentifier	··· ResultType ···	AppDisplayName
) 1/9/2025, 4:36:34.812 PM	da64a1df-a440-4f9e-9384-8e1e74cc1600	36Fk2kCknk-Thl4edMwWAA	50057	ZTNA Network Access Client
) 1/9/2025, 4:38:50.378 PM	99767c0a-a3e3-4bcb-911f-b435a02a2400	Cnx2meOjy0uRH7Q1oCokAA	50057	ZTNA Network Access Client
) 1/9/2025, 4:41:36.923 PM	4dcb705e-e855-4737-943c-40a281832300	XnDLTVXoN0eUPECigYMjAA	0	ZTNA Network Access Client
) 1/9/2025, 4:41:39.250 PM	535882bb-1efc-487f-9d3b-f3adf4d31c00	u4JYU_wef0idO_Ot9NMcAA	0	ZTNA Network Access Client
) 1/9/2025, 4:42:02.908 PM	10bea83a-c782-453e-ad0c-c77a94bb1700	Oqi-EILHPkWtDMd6lLsXAA	0	ZTNA Network Access Client
) 1/9/2025, 4:43:36.855 PM	da64a1df-a440-4f9e-9384-8e1e9cf41600	36Fk2kCknk-Thl4enPQWAA	0	ZTNA Network Access Client
) 1/9/2025, 4:44:17.870 PM	b693d7da-a90b-4c51-97c7-c67932d02400	2teTtgupUUyXx8Z5MtAkAA	0	ZTNA Network Access Client
) 1/9/2025, 5:20:40.974 PM	7708cdc1-aeda-4669-a14c-66bb7aef4a00	wc0ld9quaUahTGa7eu9KAA	0	ZTNA Network Access Client
) 1/9/2025, 5:25:36.516 PM	53ebf0ce-19f7-4238-99ab-5efd7c7f1a00	zvDrU_cZOEKZq179fH8aAA	0	ZTNA Network Access Client
) 1/9/2025, 5:27:46.532 PM	bd6fe58a-12b5-4198-80be-0a4ef1ba2000	iuVvvbUSmEGAvgpO8bogAA	0	ZTNA Network Access Client
) 1/9/2025, 5:33:53.056 PM	227ddc64-37eb-448b-a618-7d7987bc4200	ZNx9lus3i0SmGH15h7xCAA	0	ZTNA Network Access Client



# Types of Sign-in Identifiers

#### SessionId

Identifies and matches the session (cookie) that was generated during the sign-in between the client and the IdP

Time	stamp ↑	CorrelationId	RequestId	SessionId	Application	ResourceDisplayName
>	Jan 9, 2025 4:34:43 PM	aa9e2340-e1ef-486b-8b	da64a1df-a440-4f9e-93	ac38ab1b-89f0-415c-a3	ZTNA Network Access C	ZTNA Network Access Tr
>	Jan 9, 2025 4:36:43 PM	aa9e2340-e1ef-486b-8b	99767c0a-a3e3-4bcb-91	ac38ab1b-89f0-415c-a3	ZTNA Network Access C	ZTNA Network Access Tr
>	Jan 9, 2025 4:38:54 PM	aa9e2340-e1ef-486b-8b	7708cdc1-aeda-4669-a1	ac38ab1b-89f0-415c-a3	ZTNA Network Access C	ZTNA Network Access Tr
>	Jan 9, 2025 4:39:27 PM	aa9e2340-e1ef-486b-8b	10bea83a-c782-453e-ad	ac38ab1b-89f0-415c-a3	ZTNA Network Access C	ZTNA Network Access Tr
>	Jan 9, 2025 4:39:59 PM	aa9e2340-e1ef-486b-8b	535882bb-1efc-487f-9d	ac38ab1b-89f0-415c-a3	ZTNA Network Access C	ZTNA Network Access Tr
>	Jan 9, 2025 4:40:32 PM	aa9e2340-e1ef-486b-8b	4dcb705e-e855-4737-9	ac38ab1b-89f0-415c-a3	ZTNA Network Access C	ZTNA Network Access Tr
>	Jan 9, 2025 4:41:06 PM	aa9e2340-e1ef-486b-8b	b693d7da-a90b-4c51-9	ac38ab1b-89f0-415c-a3	ZTNA Network Access C	ZTNA Network Access Tr



#### SessionId vs CorrelationId

TimeGenerated ↑	SessionId	CorrelationId	Application	ResourceDisplayName
> Jan 9, 2025 4:06:25 PM	ac38ab1b-89f0-415c-a3	b94145de-4a5f-4b52-97ce-076722d9d1e5	Microsoft Authentication	Windows Azure Active Directory
> Jan 9, 2025 4:06:25 PM	ac38ab1b-89f0-415c-a3	b94145de-4a5f-4b52-97ce-076722d9d1e5	Windows Sign In	Azure Windows VM Sign-In
> Jan 9, 2025 4:06:43 PM	ac38ab1b-89f0-415c-a3	6d3b97d2-82e6-45e9-9c12-08cd9fba31d5	Microsoft Application Co	Microsoft Device Directory Service
> Jan 9, 2025 4:06:43 PM	ac38ab1b-89f0-415c-a3	ee03da3d-af75-4f05-909f-653e011d5dba	Windows Shell	OfficeClientService
> Jan 9, 2025 4:06:44 PM	ac38ab1b-89f0-415c-a3	08e1f413-fc3c-4c93-be49-e9e867d7fb79	Microsoft Application Co	Microsoft Activity Feed Service
> Jan 9, 2025 4:06:47 PM	ac38ab1b-89f0-415c-a3	2a374f9b-a6ed-492c-8119-71feb4709a75	Windows Shell	Microsoft Graph
> Jan 9, 2025 4:08:03 PM	ac38ab1b-89f0-415c-a3	4f967753-39a1-4e25-8509-c611df4d89c5	OneDrive SyncEngine	Office 365 SharePoint Online
> Jan 9, 2025 4:34:43 PM	ac38ab1b-89f0-415c-a3	aa9e2340-e1ef-486b-8b4e-1b7b8caabbea	ZTNA Network Access Cli	ZTNA Network Access Traffic Profile
> Jan 9, 2025 4:34:50 PM	ac38ab1b-89f0-415c-a3	cc20815b-379d-1900-9b24-2e73d9ab13a8	Microsoft Outlook	Office 365 Exchange Online
> Jan 9, 2025 4:38:46 PM	ac38ab1b-89f0-415c-a3	961e37fb-991b-4540-98bd-9525b0edb39d	ZTNA Network Access Cli	ZTNA Network Access Traffic Profile
> Jan 9, 2025 4:38:47 PM	ac38ab1b-89f0-415c-a3	70ecebc1-0f10-490b-965e-ac59060091cf	ZTNA Network Access Cli	ZTNA Network Access Traffic Profile
> Jan 9, 2025 4:38:53 PM	ac38ab1b-89f0-415c-a3	c58b25f4-47db-1566-5a73-73d1b4ac30e1	Microsoft Outlook	Office 365 Exchange Online
> Jan 9, 2025 4:38:53 PM	ac38ab1b-89f0-415c-a3	fec81d90-c132-46cd-9be4-7eb960ac0900	ZTNA Network Access Cli	ZTNA Network Access Traffic Profile



### Other Token-Related Properties

#### Incoming token types

Token type that were presented to Microsoft Entra ID to authenticate the actor in the sign in

#### For example:

PrimaryRefreshToken, RefreshToken, SAML or

None (= Browser SSO / Direct Auth. via Creds)

#### Token Protection - Sign In Session

Indicator if sign-in token (PRT/RT) was cryptographically bound to the device (or not)

#### AuthenticationProcessingDetails

- Is CAE Token
- OAuth Scope Info



# Graph, Diagnostic, & XDR Logs (2025-01)

Entra Portal (Sign-in events)	Microsoft Graph Beta	Diagnostic Logs	AADSignInEventsBeta
Date	createdDateTime	CreatedDateTime	Timestamp
Correlation ID	correlationId	CorrelationId	CorrelationId ( = ReportId)
Request ID	id (beta-Endpoint with empty OriginalRequestId)	id, OriginalRequestId	RequestId
Unique token identifier	uniqueTokenIdentifier	UniqueTokenIdentifier	N/A
Session ID	sessionId	N/A	SessionId
Token Protection Status	signInTokenProtectionStatus	N/A	N/A
Incoming token type	incomingTokenType	N/A	N/A
GlobalSecureAccessIpAddress	GlobalSecureAccessIpAddress	N/A	N/A
Through Global Secure Access	isThroughGlobalSecureAccess	N/A	N/A
Is CAE Token	Is CAE Token	Is CAE Token	N/A
Oauth Scope Info	Oauth Scope Info	Oauth Scope Info	N/A



# Graph, Diagnostic, & XDR Logs (>2025-03)

Entra Portal (Sign-in events)	Microsoft Graph Beta	Diagnostic Logs	AADSignInEventsBeta
Date	createdDateTime	CreatedDateTime	Timestamp
Correlation ID	correlationId	CorrelationId	CorrelationId ( = ReportId)
Request ID	id (beta-Endpoint with empty OriginalRequestId)	id, OriginalRequestId	RequestId
Unique token identifier	uniqueTokenIdentifier	UniqueTokenIdentifier	N/A
Session ID	sessionId	SessionId	SessionId
Token Protection Status	signInTokenProtectionStatus	signInTokenProtectionStatus	N/A
Incoming token type	incomingTokenType	incomingTokenType	N/A
GlobalSecureAccesslpAddress	GlobalSecureAccessIpAddress	GlobalSecureAccesslpAddress	N/A
Through Global Secure Access	isThroughGlobalSecureAccess	isThroughGlobalSecureAccess	N/A
Is CAE Token	Is CAE Token	Is CAE Token	N/A
Oauth Scope Info	Oauth Scope Info	Oauth Scope Info	N/A



# Advanced Insights of Microsoft Entra ID Sign-in Logs

Enrichment of sign-in data with mitigation capabilities for token theft and detection of unusual token issuance

# Demo





# Correlation of Sign-in Events to XDR Alert or Anomalies



#### Risk Detection in Entra ID Protection

Risk Detection Details		
user's risk repor	t 🧿 User's sign-ins 🗿 User's risky sign-ins 🧕 Linked risky sign-in	
Detection type A	Anomalous token ①	
Risk state A	At risk	
Risk level N	Medium	
Risk detail -		
Attack type(s) A	Access using a valid account (Detected Offline), Steal Web Session Cookie/Token Theft	
Source I	dentity Protection	
Detection timing (	Offline	
Activity	User	
Detection time	8/14/2024, 5:36 PM	
Detection last updat	ted 8/14/2024, 5:36 PM	
Token issuer type	Microsoft Entra ID	
Sign-in time	8/14/2024, 9:16 AM	
IP address	2607:f0d0:3602:69::4	
Sign-in location	Montreal, Quebec, CA	
Sign-in client	Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Geck Safari/537.36 Edg/127.0.0.0 OS/10.0.19045	
Sign-in request id	9a227f17-eec8-407c-b2a5-28e8db17af00	
Sign-in correlation i	d 92c40244-9b01-498e-88d5-e8bffc30d196	

#### Risk Detections in relation to sign-in/token:

- Anomalous token (offline detection)
- Attempted access of PRT (by MDE)
- Unfamiliar sign-in properties
- Unfamiliar sign-in

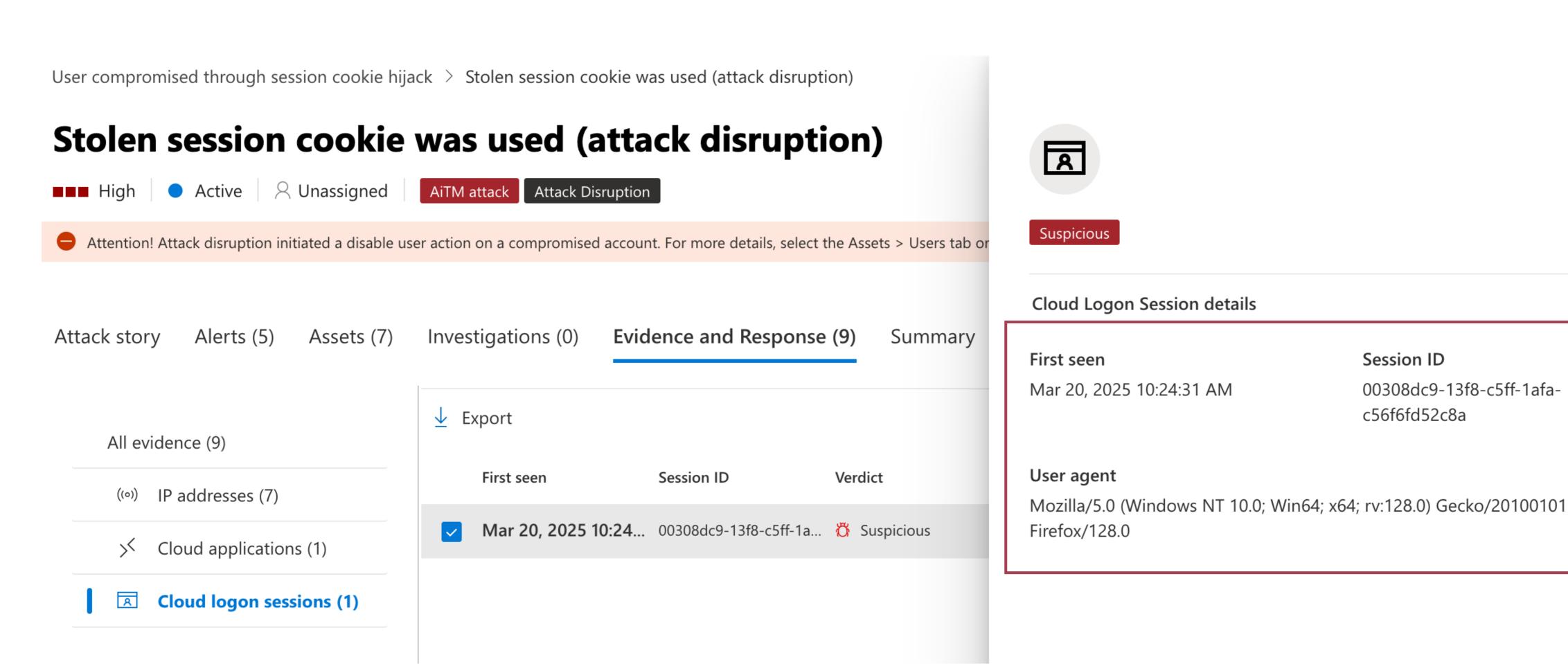
#### Risk Detections by post-auth. activity:

- Mass Access to Sensitive Files
- Suspicious API traffic

- ...

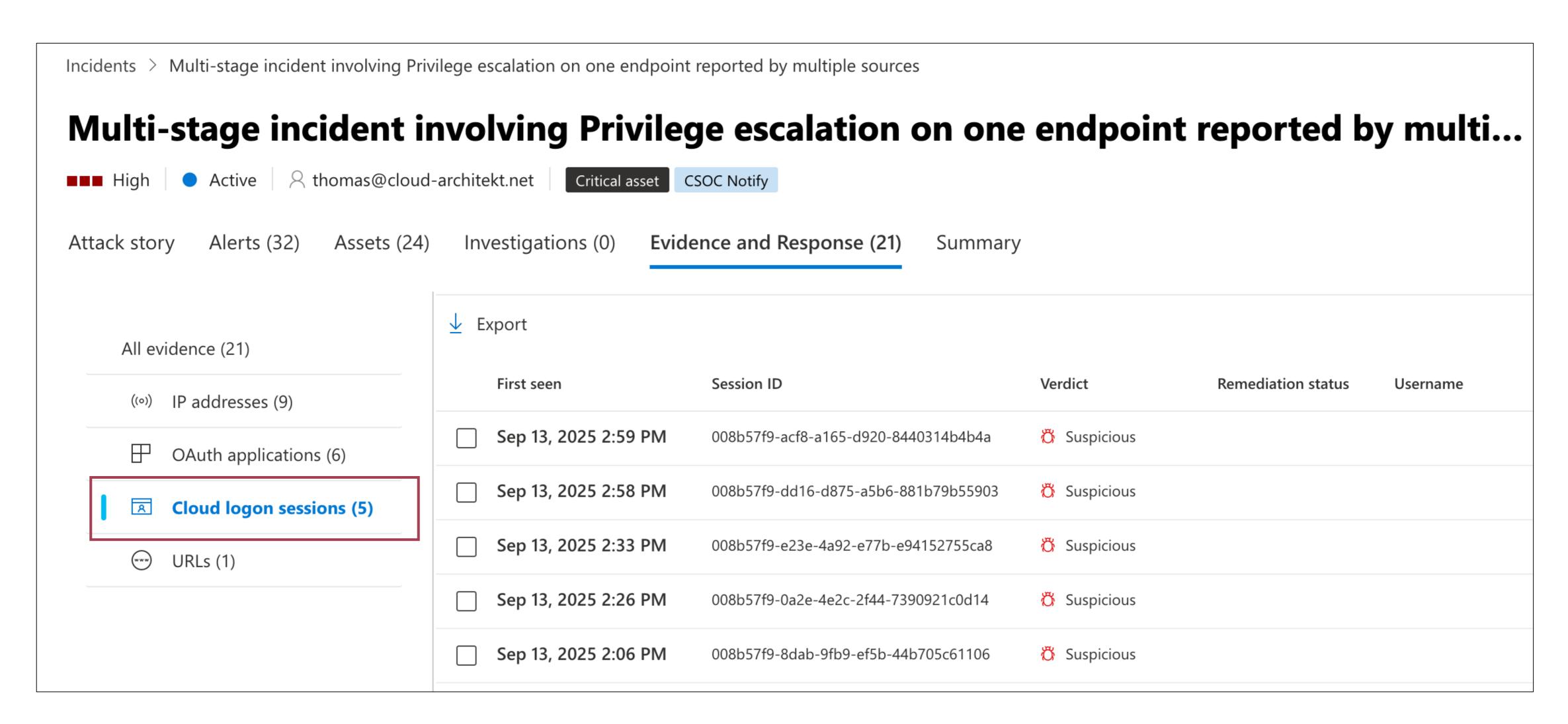


### Suspicious Session Cookie





#### Defender XDR Incident Evidence





#### Samples of Behavior-Based Detections

- Behaviors in Microsoft Defender XDR
   Mass download (OneDrive), Unusual addition of credentials to an OAuth app,...
- User Entity Behavior Analytics (UEBA) in Microsoft Sentinel
   ML-based anomalies on activities but also sign-ins
   Suspicious number of protected documents accessed
- Alerts in Microsoft Defender for Cloud (e.g., Resource Manager)
   Suspicious management session using Azure Portal/PowerShell detected,...

**—** ...



# Correlation of Sign-in Events to XDR Alert or Anomalies

Enrichment of sign-in data with related alerts from Microsoft Defender XDR

## Demo

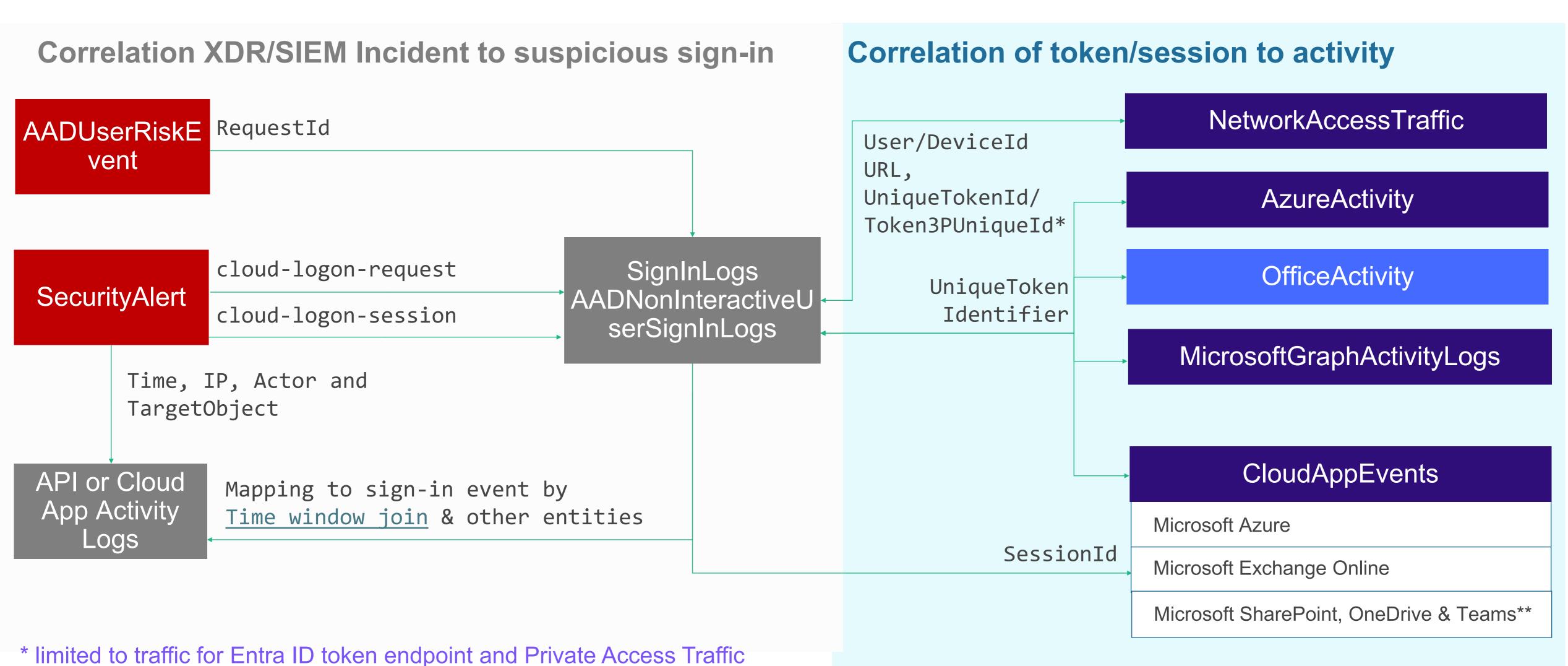




# Correlation of User Sign-in, Alert, and Cloud App Activity Logs



# Sign-in, Alert, and Activity Log Mapping



<sup>\*\*</sup> limited to specific ActionTypes of M365 workloads



#### Linkable Token Identifier

- GA "feature" since July 2025, identifier "SessionId" across log sources
  - Microsoft Entra sign-in logs
  - Microsoft Exchange Online audit logs
  - Microsoft Graph activity logs
  - Microsoft Teams audit logs
  - Microsoft SharePoint Online audit logs

"Limitation": Device Code Flow shares same session ID



#### Linkable Token Identifier in Claims

Claim	Description
oid	Immutable identifier identity of the user or service principal
tid	Tenant ID that the user is signing in to
sid	Identifier for entire session which has been generated when a user does interactive authentication. ID links all authentication artifacts
deviceid	Unique identifier for the device
uti	Token identifier
iat	Timestamp when the authentication for this token occurred.



# Azure Activity Log

× (	Claims	("aud":"https://management.core.windows.net/","iss":"https://sts.windows.net/36955
	aud	https://management.core.windows.net/
	iss	https://sts.windows.net/36955ea9-c98e-4749-b603-ffefe652dd90/
	iat	1754121792
	nbf	1754121792
	ехр	1754126556
	acrs	p1,urn:user:registersecurityinfo,c1,c3,c10,c11
	groups	0304e423-1ccc-4d3f-8188-093ed0da94cd,19496686-1ffb-4d8d-bf39-1a2e4d1a3e
	idtyp	user
	ipaddr	87.163.31.194
	name	Thomas Naunheim
	http://schemas.microsof	. 0e1e6c34-9d5c-4b24-bba6-aafb0995a6e0
	puid	10032000E0AADE98
	rh	1.AYEAqV6VNo7JSUe2A_v5lLdkEZIf3kAutdPukPawfj2MBNEAYqBAA.
	http://schemas.microsof	. user_impersonation
	sid	004f8779-e8c7-66e0-41d3-20371da64a80

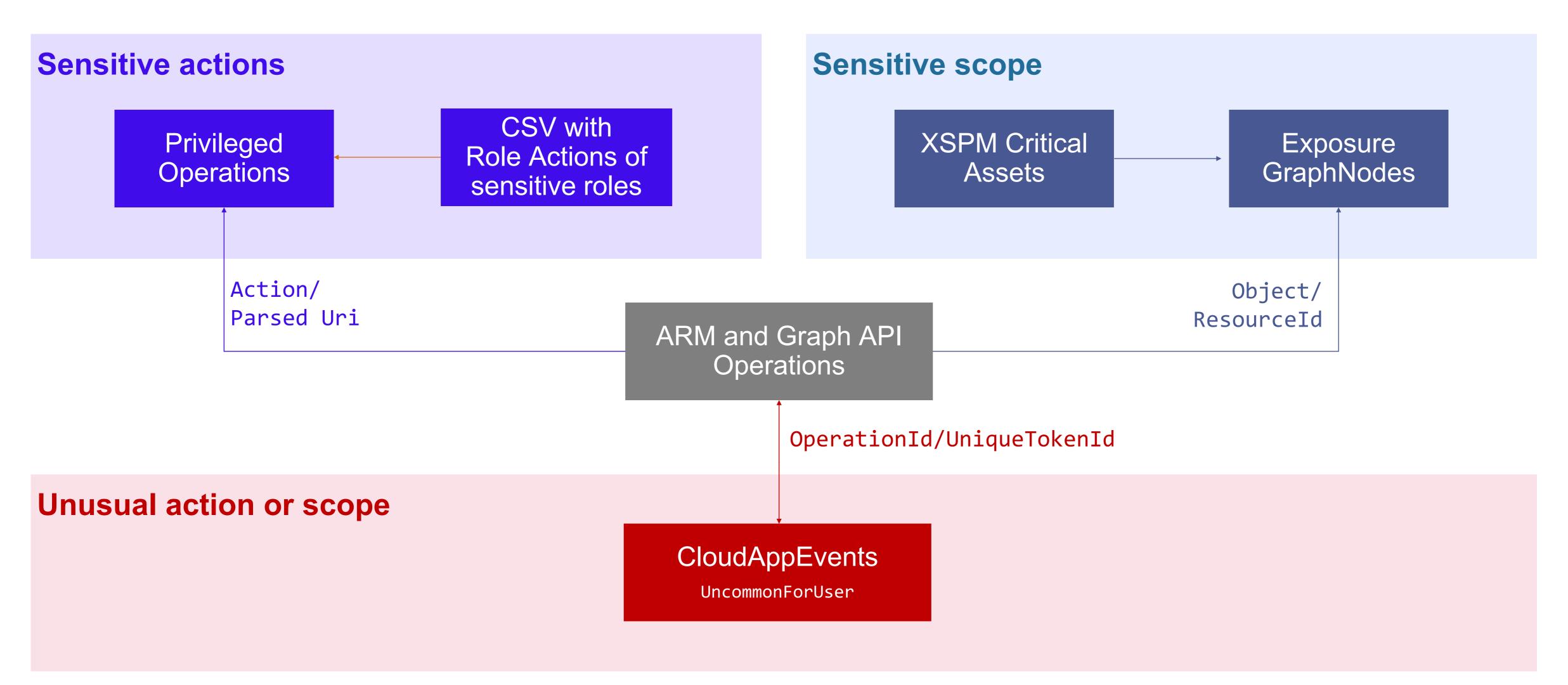


# Azure Activity Log

Αι	ıthorization	{"scope":"/subscriptions/4d3e5b65-8a52-4b2f-b5cd-1670c700136b/resourceGroups/lab-mgmt/provide
	scope	/subscriptions/4d3e5b65-8a52-4b2f-b5cd-1670c700136b/resourceGroups/lab-mgmt/providers/Mi
action Microsoft.SecurityInsights/incidents/comments/write		Microsoft.SecurityInsights/incidents/comments/write
~	evidence	{"role":"Microsoft Sentinel Responder","roleAssignmentScope":"/subscriptions/4d3e5b65-8a52-4b2t
	role	Microsoft Sentinel Responder
	roleAssignmentScope	/subscriptions/4d3e5b65-8a52-4b2f-b5cd-1670c700136b/resourceGroups/lab-mgmt/providers/
	role Assignment Id	ecfdf36568a44b18a018363f3c05333f
	roleDefinitionId	3e150937b8fe4cfb80690eaf05ecd056
	principalld	d3ec39e013ed411cb3488b32719350da
	principalType	Group



### **Enrichment of Sensitive Actions/Scope**





# Correlation of User Sign-in, Alert, and Cloud App Activity Logs

Tracking sign-in events and issued tokens, correlated to cloud app access (post-authentication events)

## Demo

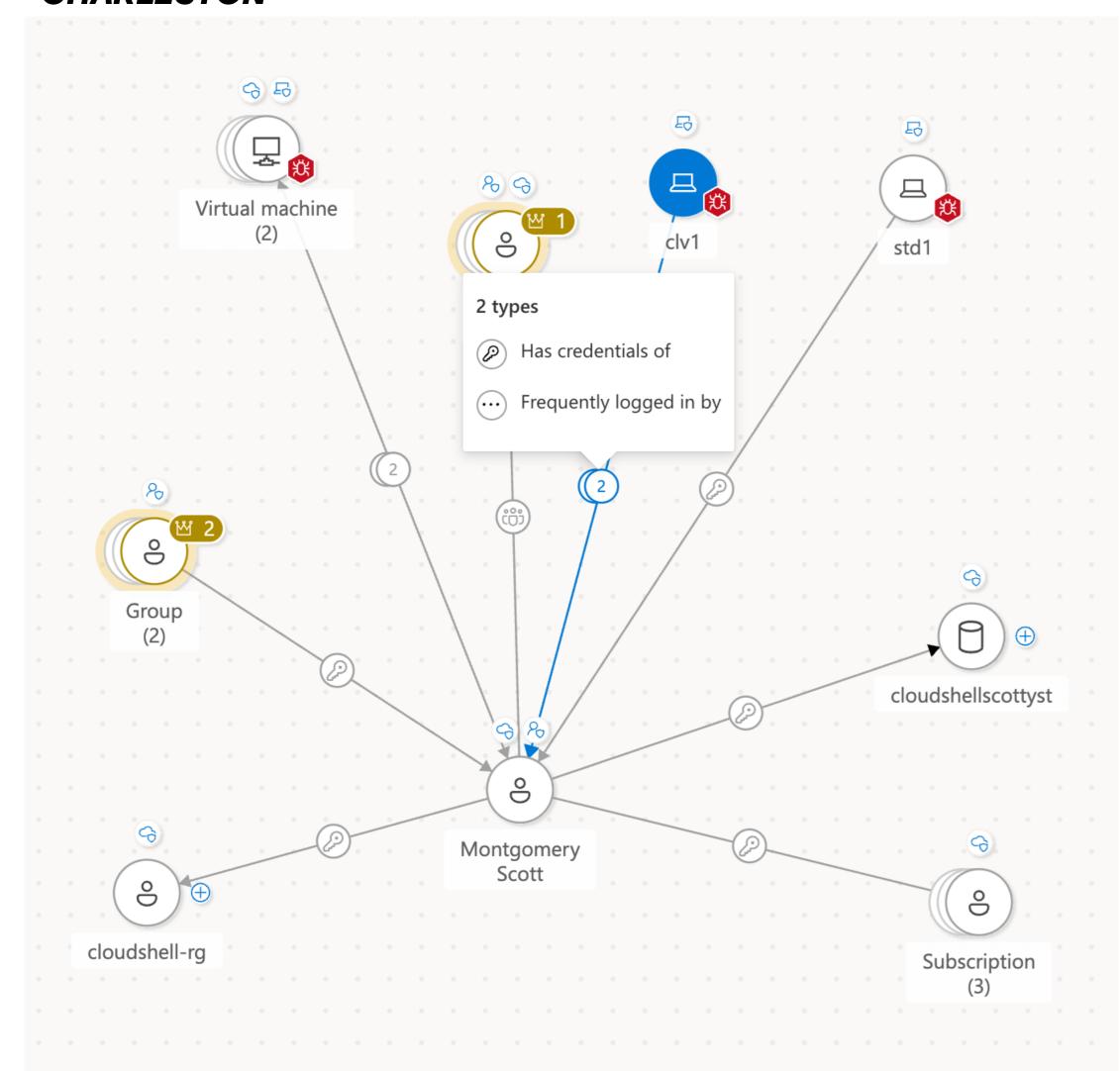




# Discover Exposed Token Artifacts with Exposure Management



#### Vulnerable Device and MDE Alerts



User	Montgomery Scott
Device	clv1
DeviceId	□ 9f49baa52d787c1458d0d4d601fb7b188
PublicIP	((o)) 91.16.
ExposureScore	Medium
RiskScore	Medium
HighRiskOrCriticalVulner	true
MaxCvssScore	8.8
AllowedRDP	false
CredentialGuard	false
TpmActivated	true
TokenArtifacts	["PrimaryRefreshToken"]
Alerts	'Tokebrokesz' malware was prevented

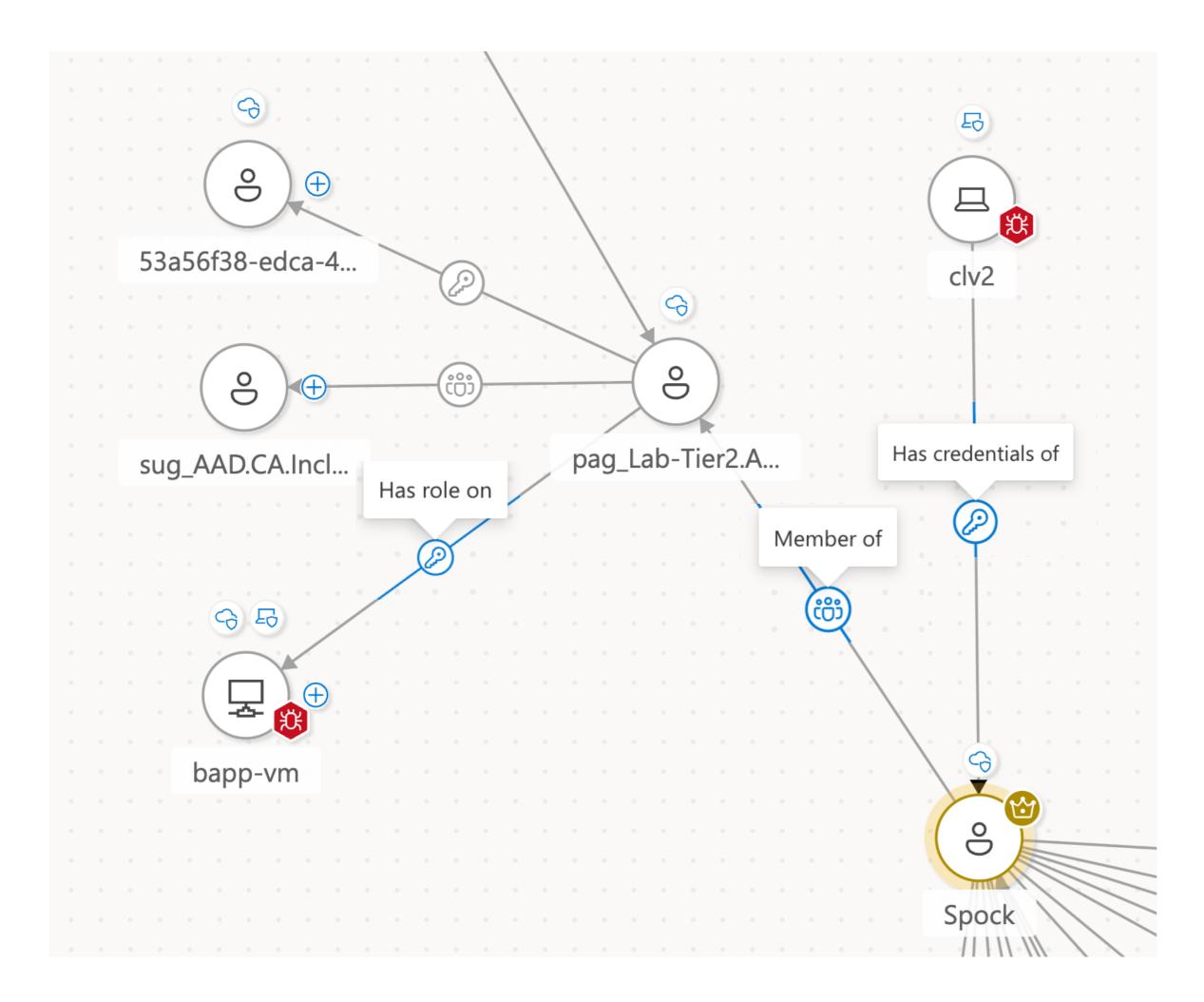


#### But What About Session...?





## **Smart Analysis of Browser Artifacts**



EdgeLabel		has credentials of		
>	browserCookies	{"type":"BrowserCookies","browserCookies":true}		
>	primaryRefreshToken	{"type":"PrimaryRefreshToken","primaryRefreshToken":true}		
>	cloudCliTool	{"type":"CloudCliTool","cloudCliTool":true}		



#### Maester Check





MT.1080: Credentials, tokens, or cookies from highly privileged users should not be exposed on vulnerable endpoints.



Learn more @ maester.dev



At least one authentication artifact seems to be exposed on a vulnerable endpoint.

AccountName	Device	Classification	Criticality Level	Artifacts	ExposureScore	RiskScore
Thomas  Naunheim	<u>vsaw-</u> <u>0</u>	ControlPlane	0	Primary Refresh Token	Medium	High
Thomas  Naunheim	<u>vsaw-</u> <u>0</u>	ControlPlane	0	User Cookie	Medium	High



# Get hunting queries from my demos



This is not a phishing link

# Questions?



