Intent-based approach to detect Email Account Compromise

Presented by:
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Introduction

Fahim Abbasi, Ph.D.

Sr. Research Scientist @ Cisco
Talos Email Threat Research

Cybersecurity Researcher and Data Science enthusiast

- 10+ years of threat research experience working for Web and Email security product companies.
- Cisco Email Security technologies like ETD, ESA
- Novel detection algorithms: BEC, Phishing, Scams
- Based in Auckland, New Zealand

Cybersecurity Researcher

- Trustwave (MailMarshal): BEC, Phishing, Scams
- FireEye (NX): Malicious URL, Phishing

Published several patents, industry blogs, and academic journals and papers

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Abhishek Singh

Research and Engineering Leader

Led research and detection engineering at FireEye, Microsoft, Cisco's Security Business Group

Holds 35+ patents on detection algorithms and security technologies, authored books in information security.

2019 Reboot Leadership Award (Innovators Category): SC Media, Nominee for Prestigious Virus Bulletin’s 2018 Péter Szőr Award.

Double MS in Computer Science & Info Security from Georgia Tech, B.Tech. in EE from IIT-BHU, Master of Engineering Leadership program from UC Berkley, Post Graduation certification in AI from IIT Guwahati

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Email Account Compromise

Email Account Compromise (EAC)

- EAC is a highly sophisticated cyber threat, affecting businesses globally.
- Threat actors gain unauthorized access to legitimate email accounts via
  - Phishing, Malware, Password Cracking etc
- Targets: personal, corporate, partner and customer emails
- Goal
  - Become You – the account owner
  - Financial crime: steal money
  - Data crime: steal data or sensitive information

BEC vs EAC

BEC is a type of EAC, but not all EAC attacks are BEC attacks.

BEC

- A type of EAC that targets businesses
- Impersonate a trusted individual
- Conversational payload targeting businesses – e.g., fraud emails requesting payroll change, W-2 forms, aging reports or gift cards etc; impersonate a C-level executive requesting money transfers
- Goal: trick employees into sending money or sensitive information, redirect payments, change bank account information

EAC

- Any unauthorized access to any email account
- Becomes you – the account owner
- Leverage compromised corporate accounts to send phishing, scam, BEC and malware, both internally and externally, to personal, and corporate contacts including partners and customers
- Goal: steal money, personal information, send phishing, spam, malware, pivot and move laterally in an organization

EAC Detection Challenges from a SEG

Most SEGs don't scan internal emails

- Defense deployed at the perimeter for incoming emails only.
- Internal email scanning not enabled or audited by default in many SEGs

Emails from compromised accounts

- originate from authenticated employees of the organization
  - Headers are legit, difficult to detect
  - bypasses Authentication checks like SPF, DKIM and DMARC.
- sent to internal employees (move laterally) or outbound to partners and customers leveraging trust

Without Email Analysis:

- Anomalies in 0365 Login events
- features such as *UserId, UserAgent, ClientIP and Operation can be used* to detect EAC e.g., changes in geolocation and user agent of authenticated user.

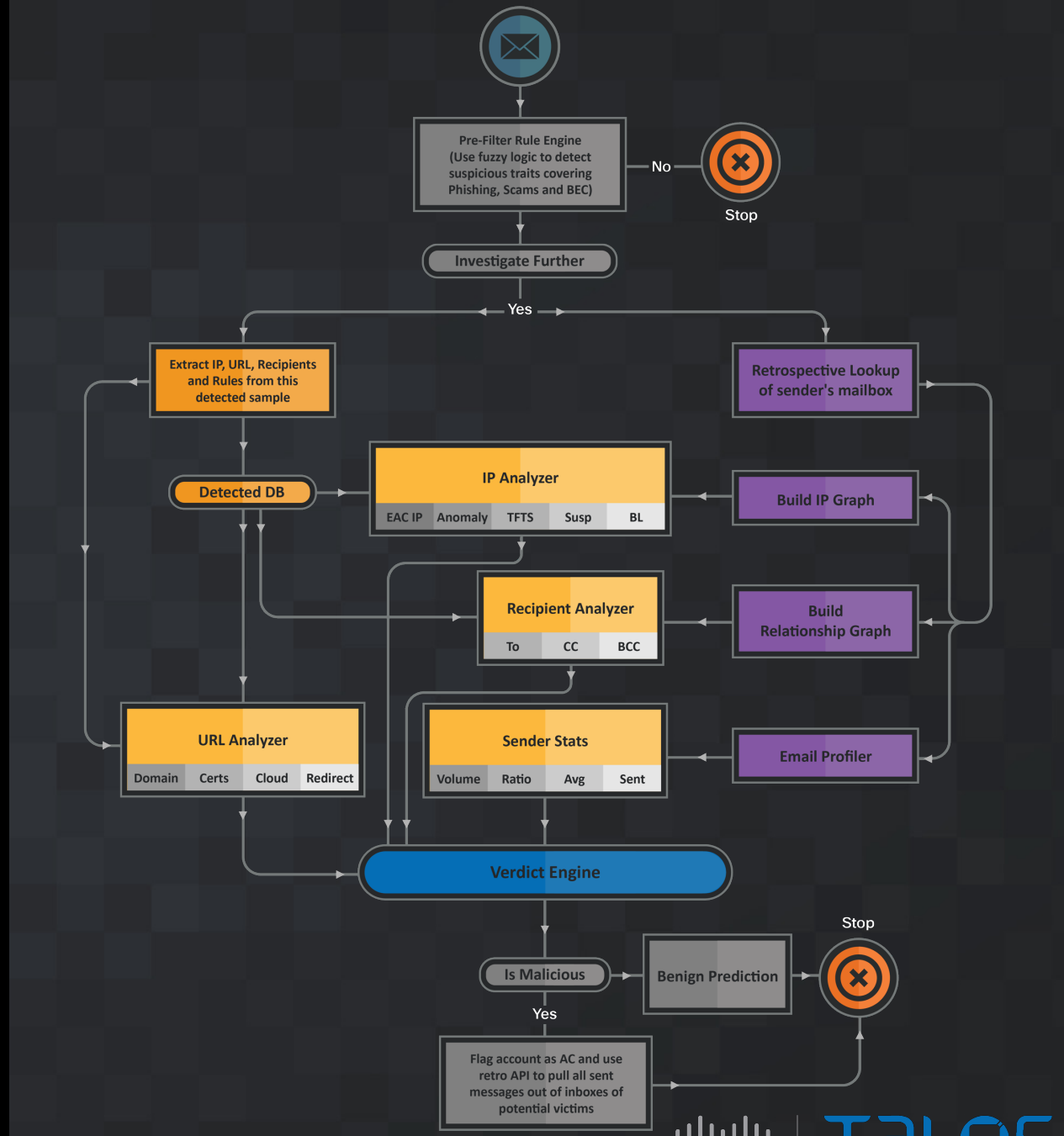
Solution to Detect EAC

With Email Analysis:

- Intent-based approach: detect EAC by isolating suspicious intent (phishing, scam, BEC etc) from internal and outbound emails. Sender's past and present behavior is computed and correlated with features from emails to detect compromised account
- Leveraging XDR: Retrospective verdicts of Phishing URLs in emails can be compared with web gateway logs to check if a POST request was sent from the user/victim, to determine the account got compromised.

Intent-based Email Account Compromise

Architecture



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Prefilter

Intent	Examples of the High-Frequency Key Phrases
BEC	(Update change switch|need assist) my (direct deposit banking|paycheck) information, next (payroll salary), (text|send) me your (cell|mobile number), (need|purchase|surprise).*(employee|staff) with (gift|card), are you available, need (favor|assistance), (send|email). *(aging|W2|recievable), wire transfer
SCAM	Mutual benefit, good opportunity, invest. *(million|thousand hundred), reply with your (name|address|email|phone), (recieve|secure) (money|ATM|fund), (loan|finance) money, business (venture|partnership), compensation for (scam|victim), (late deceased) (husband wife father\mother), unclaimed (inheritance|fund|package), send payment to my (BTC bitcoin|wallet), hacked your (computerllaptop|webcam), suffer terminal (cancer|disease), donate (money|fund), won (jackpot|lottery|lotto), (United Nation|FBI) Fraud Claim, Covid.*(refund|settlement|fund), next of kin, invest fund, compensate scam victim, work from home, online job opportunity
Phishing	(Update|Change|keep) password here, your account will terminate, (outlook|0365|mailbox) (storage|reached|access|outlook|account).*(update|up grade), password.*(change|reset|reactivate|account), follow activation link, (update| payment | verify) account

- Objective: Filter suspicious emails from internal and outbound traffic for further investigation
- NLP Based Approach: n-gram analysis on scam, phishing, BEC datasets to extract the top keywords and phrases mapping to the intent of threat actor such as
  - Urgency, Call to Action etc.
  - Money transfer request
  - BEC scams - direct deposit, initial lure
  - Phishing lures with links
  - Scam lures
- Volume: Fine-tuned to minimize the volume of prefiltered emails.
  - Isolates around 4000 suspicious emails from 20 M

  (0.000005% of emails are getting isolated)

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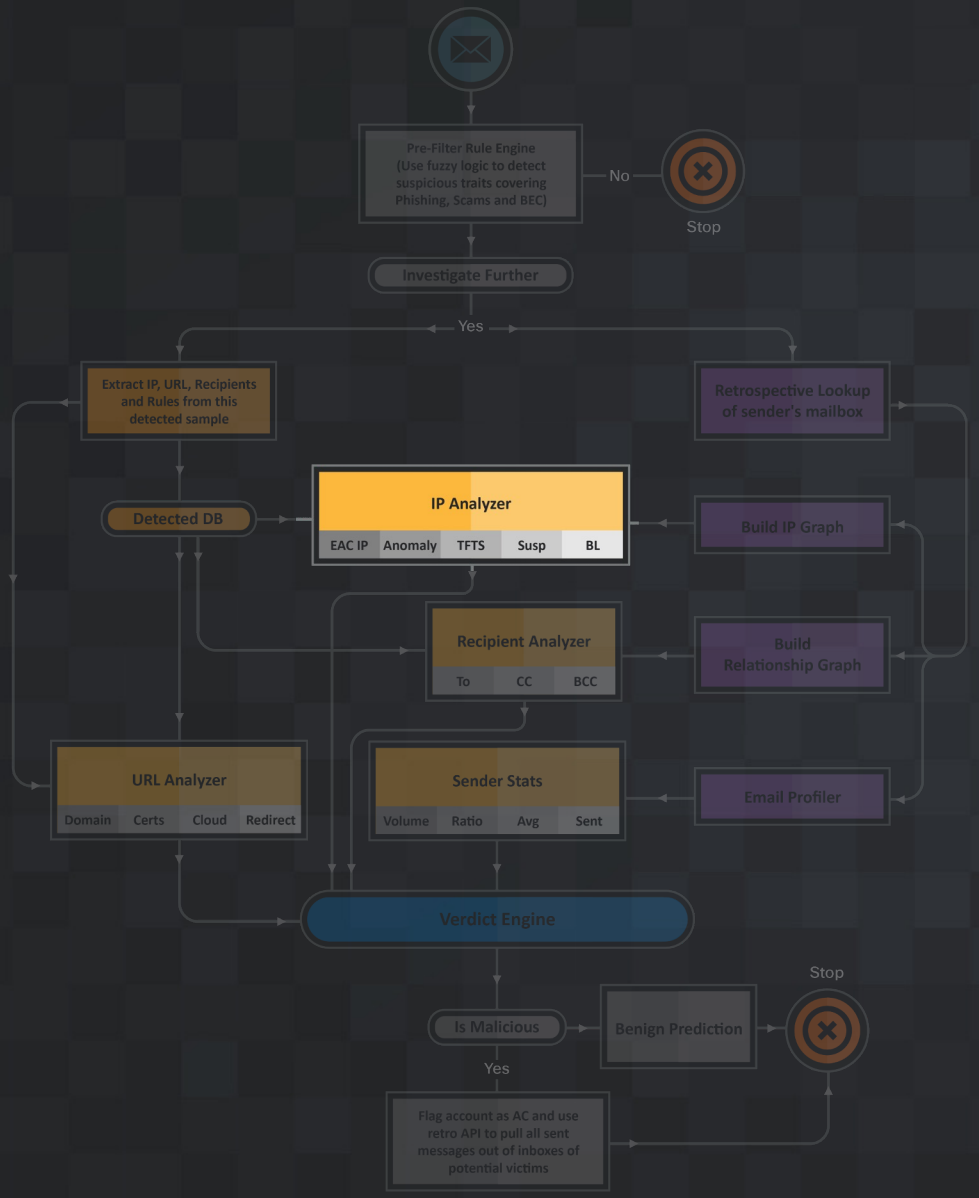
Retrospective Behavior Engine – IP Analyzer



- EAC-IP
  - Compare 3-tuple (IP, Country, Subdivision) of detected message with historical messages
  - Compute Jaccard_sim(susp_email(ip,c,s), hist(ip,c,s))
  - Similarity score between 0-mal and 1-benign
- Suspicious Country or BL
  - IP in BL or suspicious countries like RU and IR
- Anomaly Detection
  - Use anomaly detection technique to detect whether senders IP is anomalous
- Too Fast Too Soon
  - Sender IPs are changing too fast too soon.
  - Changing IPs are
    - not from the same ASN
    - from far away geographies

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IP Anomaly Detection -GMM

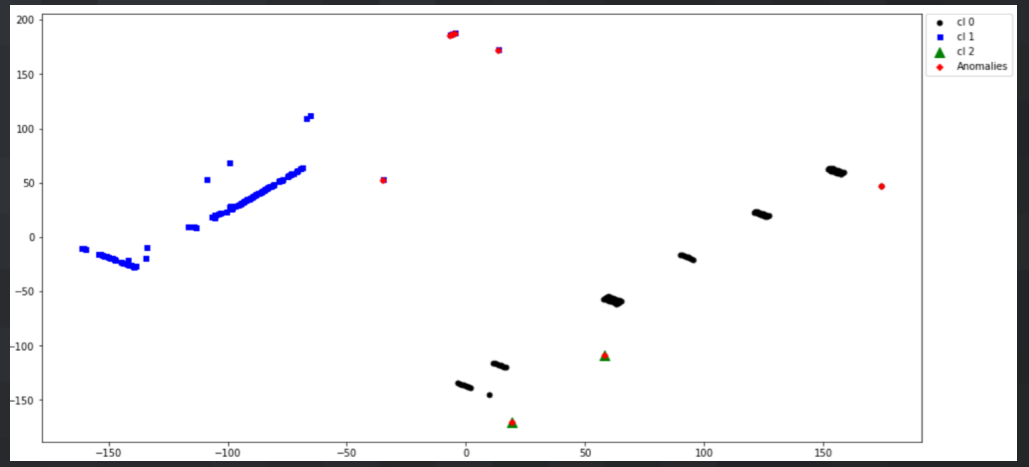
- Detect anomalies in sender's IP
- Build Clusters on retro sender IP's from last 90 days
- Suspicious IP not matching these clusters is considered an anomaly or outlier.
- Unique approach that uses IPs, Country code and ASN as features.
- Unsupervised learning algorithm called Gaussian Mixture Model (GMM) to create clusters and identify anomalies

Form clusters on IPs from last 90 days till yesterday

- Cluster 0: 89.212.157.101-118
- Cluster 1: 78.68.172.205-210
- Cluster 2: 5.158.217.169-175

Test sender's IPs seen today against known clusters, if unmatched then its an anomaly

Anomaly: 195.178.120.219



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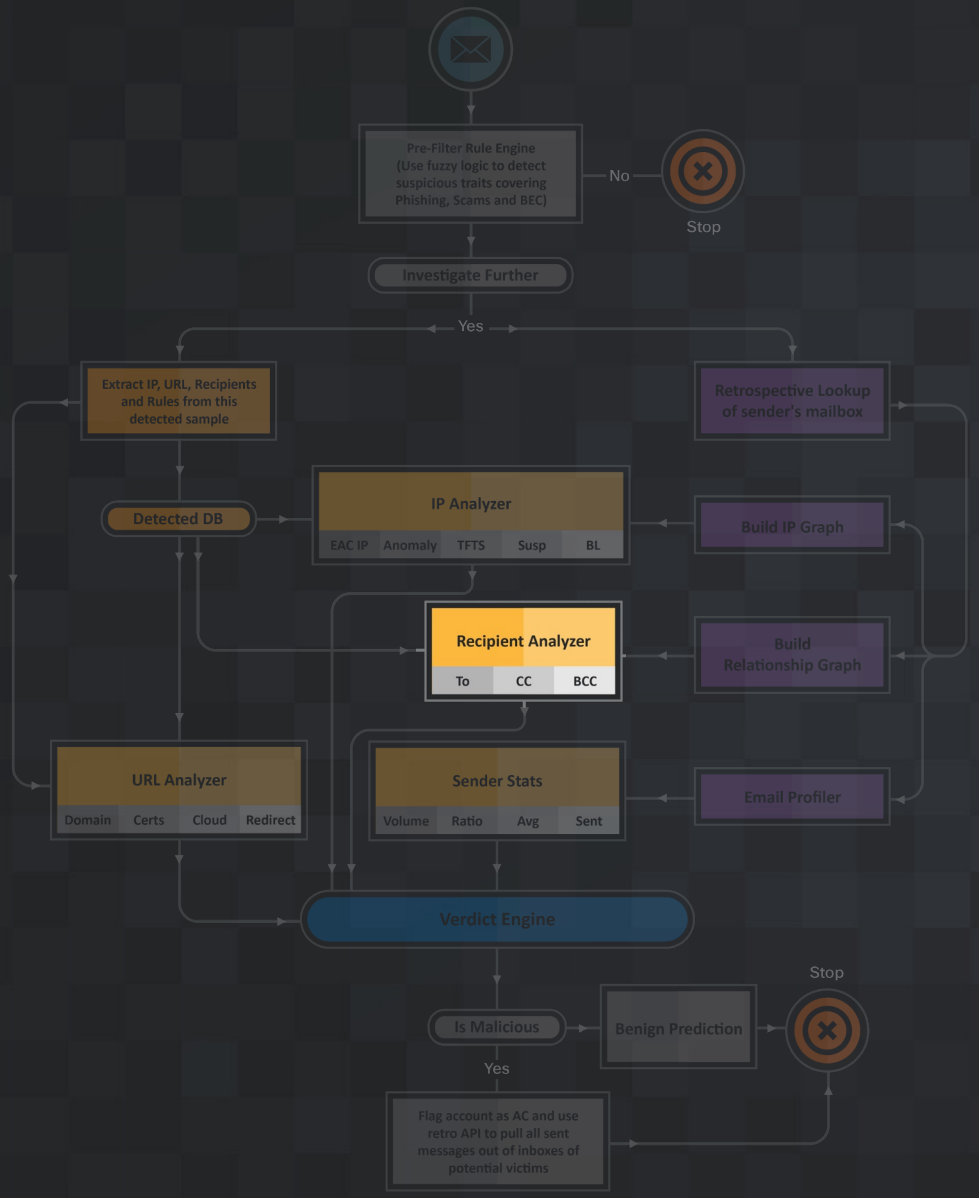
Too Fast Too Soon

Detect if email sender's IP changes too fast too soon between subsequent emails.

- FAST: Sender IPs are changing too fast too soon
  - Calculate time between changed sender source IP and distance in miles per hour
  - Calculate possibility to logon physically from new IP
    - determine if two logons are geoinfeasible based on distance and time
- ASN: Flag if ASN change detected
- DISTANCE: Changing IPs from far away geographies > 1000 miles
- Criteria: FAST + ASN + DISTANCE

Retrospective Behavior Engine – Recipient Analyzer



- Retrospective Relationship Graph
  - Build relationship graph of suspected user by harvesting historical recipient data mainly from To, CC, BCC fields from the last 90 days of email data.
- Relationship Graph from suspected email
  - Compute list of recipients from the suspicious email's To, CC, BCC fields
- Compare todays suspected email recipients with retrospective relationship graph recipients to flag any new relation/conversation
- Recent change in From Display Name

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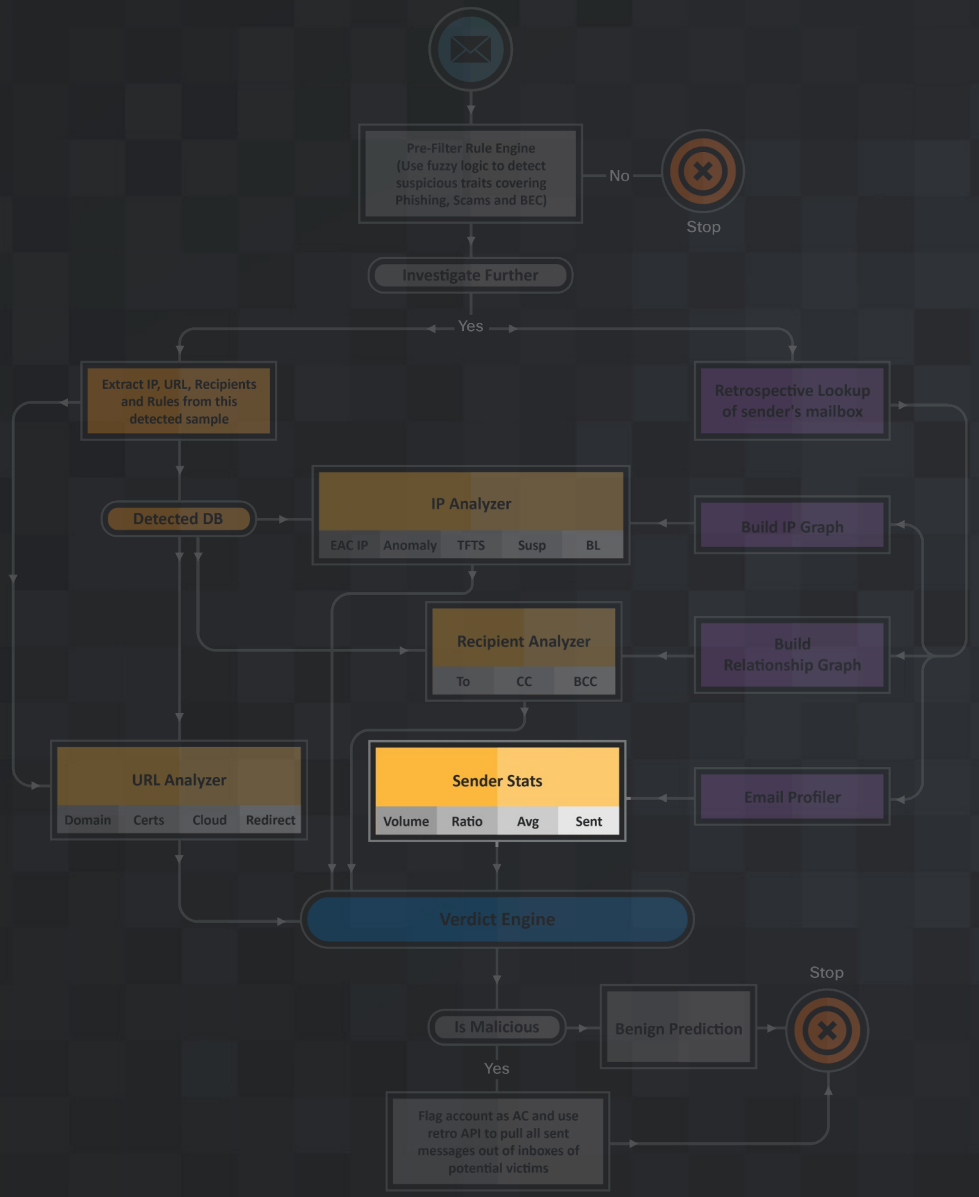
Retrospective Behavior Engine – Sender Stats



Volumetric Analysis

- Profile user's past email sending behavior and compare with today's behavior.
- Number of email sent today
- Avg number of email sent in the last 90 days
- Ratio of emails sent today compared to the past

$$\textit{Average number of emails sent} = \frac{\textit{Total number of emails sent in the past X days}}{X}$$

$$\textit{Vratio} = \frac{\textit{Total number of emails sent on the day suspicious email was detected}}{\textit{Average number of emails sent}}$$

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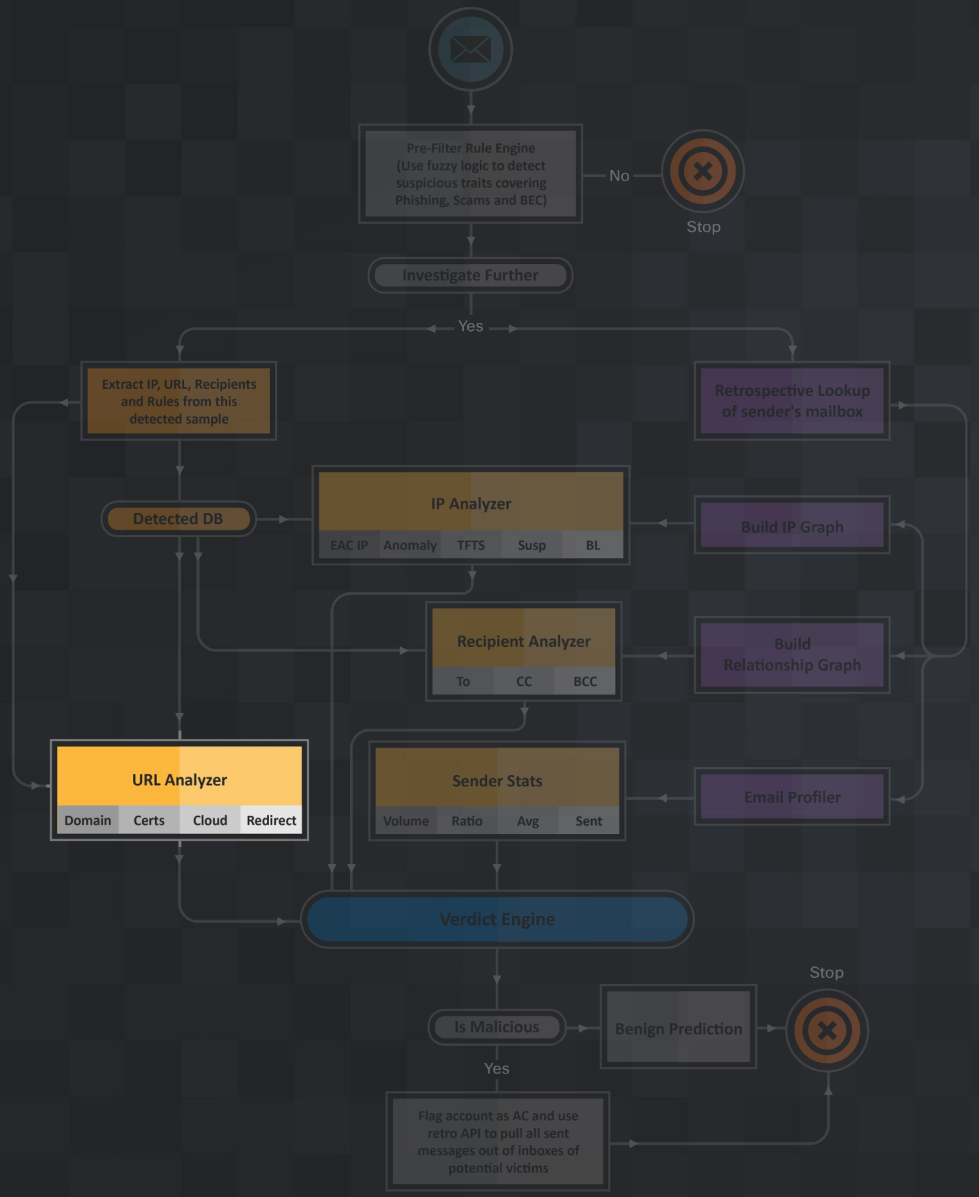
URL Analyzer



- Extract all URLs from suspicious emails
- Detects Suspicious URLs using domain and URL algorithms
- Suspicious Domain detection
  - Exclude domains matching top 1 Million Umbrella list
  - *Domain Whois information checks*
    - *recently created < 6 months*
    - *expiring soon < 6 months*
    - *valid registrant org*
  - *SSL Certificate* checks
    - Stolen or Expired Certificate
    - Certificate issuing authority (cPanel,Let's Encrypt etc)
    - Expiry time of certificate < 6 months
- Suspicious URL Detection
  - URL contains an email as plain or base64 encoded
  - File-sharing or data collection services like google forms, draw, drive, DocuSign, JotForm etc., or on cloud hosting
  - URL shorteners like Bitly, TinyURL, goo. Gl
  - Evasive feature in URL, such as google redirect

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EAC : Verdict Consolidation

- Consolidate output/signals from multiple components like volumetric analysis, recipient analysis, IP analysis, and URL analysis and correlate to convict a compromised account
- Combination of conditions to give verdicts after statistical analysis and manual fine-tuning
  - Can be implemented as an expert system (human) or an AI/ML system
- 3 Verdicts: Benign, Suspicious and Malicious

Compromised Account rule example

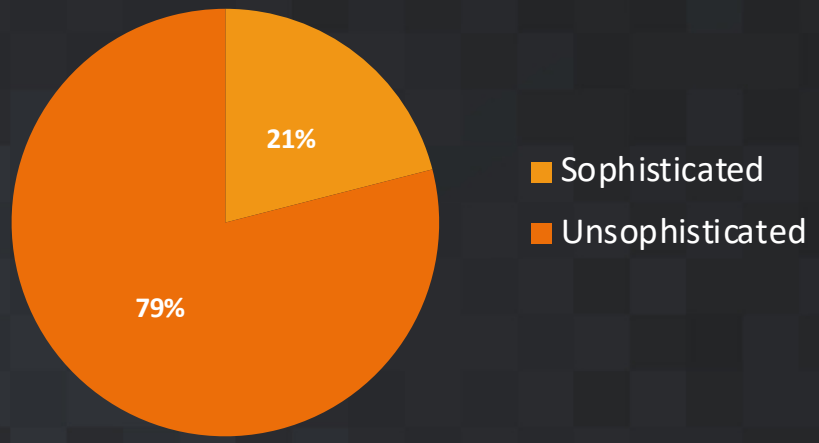
- ratio > 2 and eacip < 0.5 and (anom > 0 or tfts == 'Suspicious') and (phish == 1 or cloud ==1 or redirect ==1) and (ip_rep == 1 or susp ==1)
- Ratio > 2: user has sent twice as many emails as in the past.
- eac < 0.5: sender's geo-location and IP address changed
- Anom: IP is anomalous not seen before
- TFTS: Too fast too soon triggered
- phish == 1: phishing URL present
- IP belongs to suspicious country with bad reputation

EAC Cases and Trends

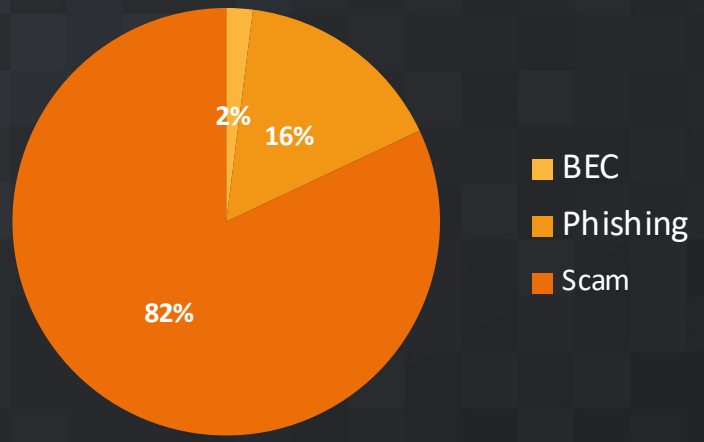
Threat Actors Intent

- Sophisticated vs Unsophisticated
  - Targeted vs spray-and-pray
  - 79% unsophisticated/spray-and-pray
  - 21% Sophisticated attacks
- Intent by Attack Type
  - Scam email: 82%
  - Phishing: 16%
  - BEC: 2%
  - TA leveraged compromised accounts to maximize credential and personal data harvesting

Complexity of EAC Email



Types of EAC Emails Detected



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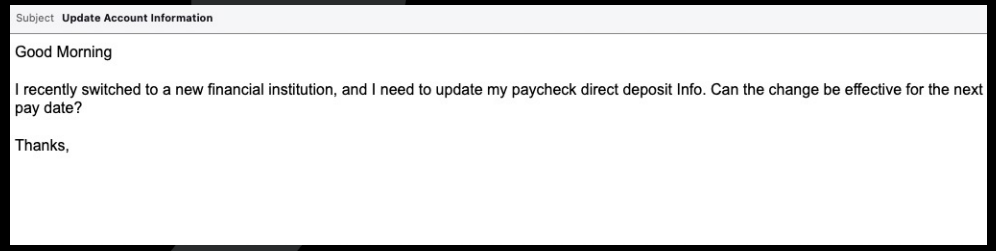
Sophisticated EAC Attack - BEC Example


Subject **Update Account Information**

Good Morning

I recently switched to a new financial institution, and I need to update my paycheck direct deposit Info. Can the change be effective for the next pay date?

Thanks,

- Client: ABC SCHOOL DISTRICT
- Compromised account: john.doe@schooldistrict.org
- Prefilter: EAC_Prefilter_BEC
- Volumetric Analysis:
  - Emails Sent Today: 10
  - Avg. Emails sent per day by this user in last 90 days: 0.7emails/day
  - Email Sent Ratio: 14 (email_count/avg_email)
- IP Analyzer:
  - Sending IP belongs to suspicious country
  - IP Reputation: Suspicious
  - Sending IP Anomalies: Yes
  - Too Fast Too Soon: False, only 1 IP used to send out all these emails

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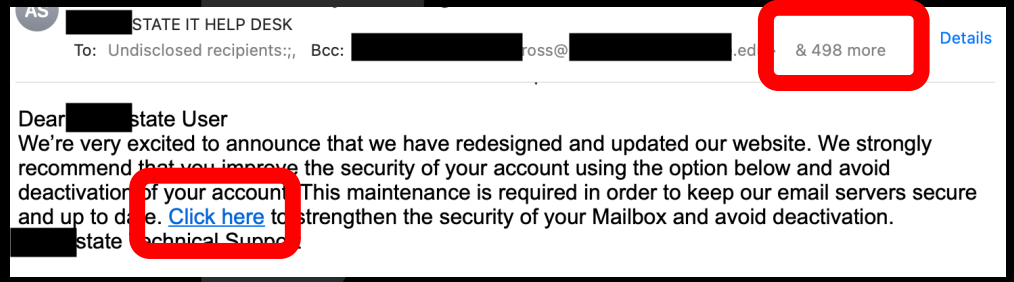
EAC Phishing ITHelpdesk Example



- Client: ABC STATE UNIVERSITY
- Compromised account: john.doe@stateuni.edu
- Prefilter: EAC_Prefilter_Phishing
- Volumetric Analysis:
  - Emails Sent Today: 18
  - Avg. Emails sent/day by this user in last 90 days: 0.2emails/day
  - Email Sent Ratio: 90
- IP Analysis
  - Sending IP belongs to suspicious country
  - Sending IP Anomalies detected: Yes, 78 IPs changing Too Fast Too Soon: True
  - IP Reputation: Suspicious
- New Relations/conversations: True, 480
- Phishing URL detected: True

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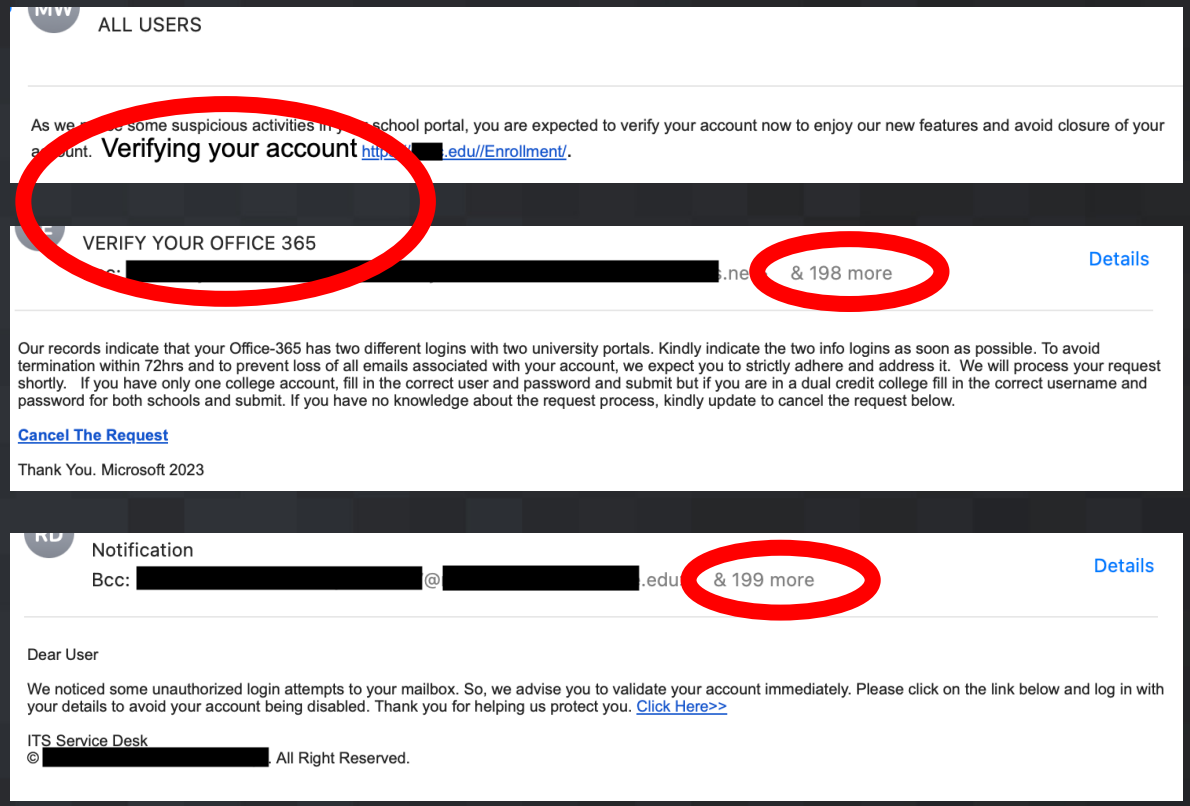
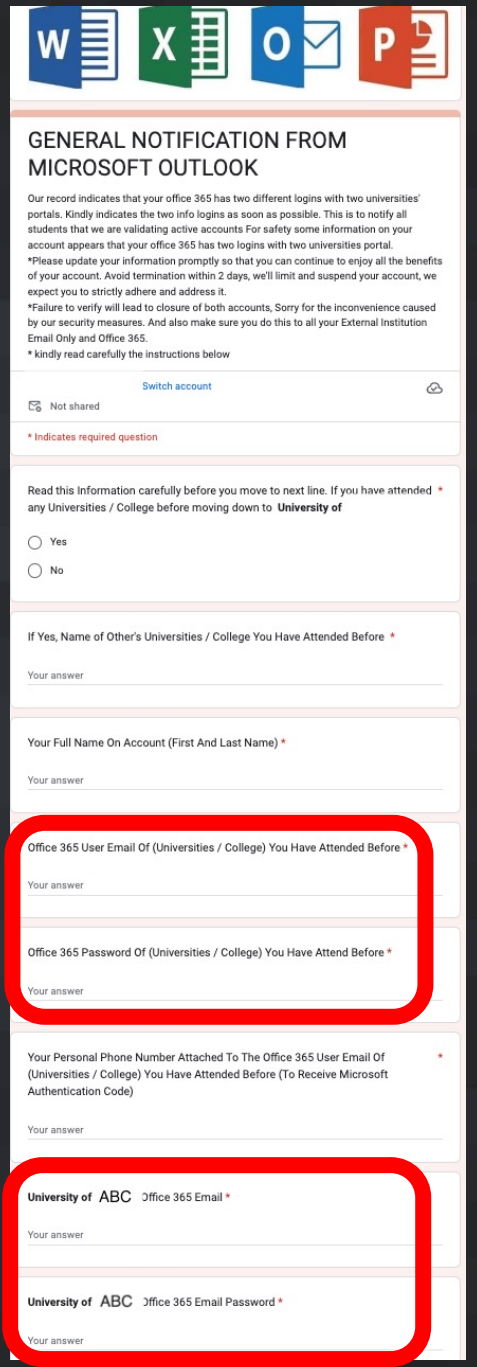
EAC Attack Trends - Phishing

- Majority phishing lures were sent out to large org groups in a spray-and-pray strategy.
- Most lures were Office 365 account termination/verification/upgrade/renewal lures.
- Other lures include Fake Docusign, fake Sharepoint etc
- Phishing URLs mostly pointed to data collection services like Google Forms, Jotform, Office forms etc
- Some campaigns targeting academia asked the victims to supply credentials of their current and prior school/university



EAC Attack Trends - Phishing

Some campaigns targeting academia asked the victims to supply credentials of their current and prior school/university



GENERAL NOTIFICATION FROM MICROSOFT OUTLOOK

Our record indicates that your office 365 has two different logins with two universities' portals. Kindly indicates the two info logins as soon as possible. This is to notify all students that we are validating active accounts For safety some information on your account appears that your office 365 has two logins with two universities portal.
*Please update your information promptly so that you can continue to enjoy all the benefits of your account. Avoid termination within 2 days, we'll limit and suspend your account, we expect you to strictly adhere and address it.
*Failure to verify will lead to closure of both accounts, Sorry for the inconvenience caused by our security measures. And also make sure you do this to all your External Institution Email Only and Office 365.
* kindly read carefully the instructions below

Switch account

Not shared

* Indicates required question

Read this Information carefully before you move to next line. If you have attended any Universities / College before moving down to **University of** *

Yes

No

If Yes, Name of Other's Universities / College You Have Attended Before *

Your answer

Your Full Name On Account (First And Last Name) *

Your answer

Office 365 User Email Of (Universities / College) You Have Attended Before *

Your answer

Office 365 Password Of (Universities / College) You Have Attend Before *

Your answer

Your Personal Phone Number Attached To The Office 365 User Email Of (Universities / College) You Have Attended Before (To Receive Microsoft Authentication Code) *

Your answer

University of ABC Office 365 Email *

Your answer

University of ABC Office 365 Email Password *

Your answer

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Complexity of Phishing Links

Form Builders

- hxxps[:]//docs.google[.]com/forms/d/e/1FAIpQLSeVJ38UInmc7lX6_sSSIlVyahq2b0k2jkRNKUgkIv-LMNWMWQ/viewform?usp=pp_url
- hxxps[:]//forms[.]gle/73KLav2zFGX9r4kS7
- hxxps[:]//docs.google[.]com/drawings/d/1gqRAYNczzxrmn9rN5-0e3xLNeUyXJFDoloocuZihgFQ/preview
- hxxps[:]//forms.office[.]com/r/kVXQU27PLV

Redirects

- hxxps[:]//www.google[.]com/url?q=https%3A%2F%2Fnaughtymilfl5vj.com%2F%3Futm_source%3DRgVunY3DTnByC7%26utm_campaign%3Dren&sa=D&sntz=1&usg=AOvVaw0Tty-URzTvXXWirDtwHI3o
- https[:]//www.bing.com/ck/a?!&&p=6e9a1f3929ba4ff2JmltdHM9MTY4NTkyMzIwMCZpZ3VpZD0xNGQyOGJiMS0wNDI5LTYzZTEtMTQ1Yy05ODk3MDU5YTYyZWUmaW5zaWQ9NTE3Nw&ptn=3&hsh=3&fclid=14d28bb1-0429-63e1-145c-9897059a62ee&u=a1aHR0cHM6Ly93d3cuZm9yZXN0YmF0aGluZ3N1ZmZvbGsuY29tL21vdmluZ3NwYWNlLW1vdmVtZW50LWNsYXNzZXM#amphbmRyYWluQGJ1dHRlcmJhbGwuY29t

Free hosting providers

- hxxps[:]//outlookfacepage.weebly[.]com

URL Shorteners

- hxxp[:]//bit[.]ly/SOMEUNI_EDU
- hxxps[:]//forms[.]gle/73KLav2zFGX9r4kS7

EAC Attack Trends -Scam

Majority scams were Job scams luring students and financially vulnerable victims to provide their personal data and use them as money mules.

Romance Scams make up the other big category, followed by smaller advance fee scams

Job, Romance and advance fee scams are sent with a spray-and-pray strategy with the goal to maximize reach.

BEC Payroll Scam attacks were targeted.

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EAC - Scams

Hello!
I understand that we do not know each other, but I decided to take a chance and write you a letter.
I hope my letter reached you and you don't mind receiving the message.
I am writing to you with the hope of meeting an interesting person or finding a new friend.
I noticed that we have a lot in common in our interests, and I would like to get to know you better.
Let me share with you a few words about myself:
My name is Simona, I am 30 years old, I work as a photographer and love to travel.
I like to spend time in nature and cook delicious meals
In addition, I really appreciate smart and
polite people, and I think that you can be one of them.I
I hope that my letter will not cause you any unpleasant feelings.
I'm not used to making the first move,
but I couldn't pass up the opportunity to write to you.
I have been living here for about four months.
All my friends are related to work, and when we meet, we talk only about it.
And I need to find not just a friend, but a person with whom we can spend our free time
That is why I decided to try to find new friends on the Internet,
where I think you can find people with similar interests and hobbies.
And I believe that you are a decent and kind man who I liked :)
If you don't mind, I suggest starting an acquaintance
on the site in order to avoid unpleasant situations.
For me, and for you, safety is very important, I think you will agree with me
It's very easy to find me. Here is all the information about me Snowflake_lady
I am waiting for your response on the site
and I hope we will have more than just friendship

NL

UNICEF Part-time Job opportunity

To: [redacted]@unicef-jobs.org> Bcc: & 91 more Details

Good morning and Happy New Year.

I am sharing a winter job opportunity with anyone who might be interested in a paid temporary job over the break and in the new year with a weekly pay of $500.00 (USD).

Attached is further information about the employment details. Kindly follow the steps in the attached document and send a message with your alternate/non-school email address (i.e., Gmail, Yahoo, Hotmail, etc.). For more details on the job,

Take note: this is strictly a work-from-home position.

Hello!

This is to notify you about an available part-time vacancy. Mr. Mike Kem needs a part-time Personal Assistant Position in your area.

He offers to pay five hundred dollars ($500) weekly. Please send your Full Name and Phone Number to (mikekemfortross@hotmail.com) for more information. Remember to email Him with your private email or your school email when applying.

Thanks

AD

THIS EXTRA OFFER IS FOR YOU!!

[redacted].edu> [redacted].edu>

Good Day !!!

During this time that we are in, working from home would be great. Therefore, you have been offered a campus employment office Job Opportunity which serves as a gateway to pay all expenses incurred on campus.

This opportunity should be done at leisure taking at most 7 Hours Weekly and earn $500 Weekly. It is a Flexible Opportunity where you will determine your working time.

All the tasks are work from home/on campus job, you do not need to travel, you do not need to have a car to get started. You can be in any location and work from your home/school.

If you are interested in working with her Kindly email her (olsonmary899@gmail.com).

Kindly include your private email and cellphone number when applying for direct contact.

Please Note: This position is available on a first come, first served basis.

Sincerely,

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Take Aways

- Intent based approach identifies both set of victims
  - employee whose account has been compromised and
  - employees who receive malicious emails from compromised accounts.

- With each detected attempt of exploitation, intent of the threat actor (Phishing, SPAM, BEC etc.) also gets captured which aids in additional remediation
  - Such as blocking Phishing Links
  - Correlating Phishing links with Web gateway logs to detect additional compromised accounts.
  - Retrospectively removing emails sent to internal employee mailboxes

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