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“An Enhanced Cyber Attack Attribution Framework”

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Contents

- ☑Advanced Persistent Threats
- ☑Other Cyber Attacks
- ☑Cyber Attack Attribution
- ☑NEON Framework

Advanced Persistent Threats

- **Advanced**
  - Because the adversary is conversant with computer intrusion tools and techniques and is capable of developing custom exploits
- **Persistent:**
  - Because the adversary intends to accomplish a mission
  - They receive directives and work towards specific goals
- **Threats**
  - Because the adversary is organized, funded and motivated.

- **APTs:**
  - Rely on multi-step attacks designed to infiltrate a system and remain there undetected for a long period of time to obtain high-value information
  - May spend a significant interval of time between different attack stages
  - Combine different attacks types, e.g., zero-day attacks (exploitation of unpatched vulnerabilities) and advanced social engineering attacks

APT Incidents

- **2009 - Stuxnet:**
  - targets SCADA systems and is believed to be responsible for causing substantial damage to Iran's nuclear programs
- **2011 - Duqu:**
  - Is a collection of computer malware discovered on 1 September 2011, thought to be related to the Stuxnet worm
  - looks for information that could be useful in attacking industrial control system
- **2012 - Flame**
  - is a modular computer malware discovered in 2012 that attacks computers running the Microsoft Windows operating system
  - was being used for targeted cyber espionage in Middle Eastern countries
- **2012 – Red October**
  - was reportedly operating worldwide for up to five years prior to discovery, transmitting information ranging from diplomatic secrets to personal information, including from mobile devices
  - the primary vectors used to install the malware were emails containing attached documents that exploited vulnerabilities in Microsoft Word and Excel

Other Cyber Attacks

- **2011 - today :**
  - Cyber attacks have been populated over the past few years
    - April 2011, Sony PlayStation suffers massive data breach, theft of names, addresses and possibly credit card data belonging to 77 million user accounts
    - 2017, the Shadow Brokers hacking group came up with a Windows platform exploit named as EternalBlue→ part of the WannaCry ransomware that affected numerous countries around the world and their critical infrastructures such as the UK's National Health System (NHS)
    - 2017 Shipping giant Maersk suffers 300 million dollars loss from Petya malware
    - July 2018, COSCO (China Ocean Shipping Company) US branch was attacked by a ransomware that resulted in the breakdown of telephone network, email servers, even the US website of the company went offline
    - 20-22 August 2018, Air Canada Suffers Data Breach - 20,000 Mobile App Users Affected

Recent cyber attacks

- **Possible solutions:**
  - Conventional incident detection and classification mechanisms but…
    - a new threat that of adversaries who aim to harm defending mechanisms that use machine learning introducing a new field of research called adversarial machine learning
    - as malicious parties become aware of the machine learning techniques used in defensive strategies they become elusive, lowering the accuracy rate of all detection capabilities
    - attackers continue to develop their new attacks based on previous → they do not reinvent the wheel → they recycle methodologies and infrastructure→ malware families and APT campaigns
  - attribution
    - the need to identify who (i.e., cyber attacker) is responsible for the orchestration of a cyber attack
  - cybersecurity situational awareness must be promoted
    - social engineering attacks take advantage of the human factor, which is referred as the weakest link

Cyber Attack Attribution

- **Attribution problem:**
  - refers to the difficulty of identifying those initially responsible for a cyber attack and their motivating factors, is a key in solidifying the threat representation
  - attribution of cyber attacks is not a straight-forward task

- DARPA splits the attribution process in three distinct phases which run in parallel:
  - **Activity Tracking and Summarization**
    - collection of information from multiple sources
  - **Data Fusion and Activity Prediction**
    - data associations are being captured across diverse data sets
  - **Validation & Enrichment**
    - adversary mistakes are being identified
    - use of analytic techniques to expose known but hidden structures

Possible solution?

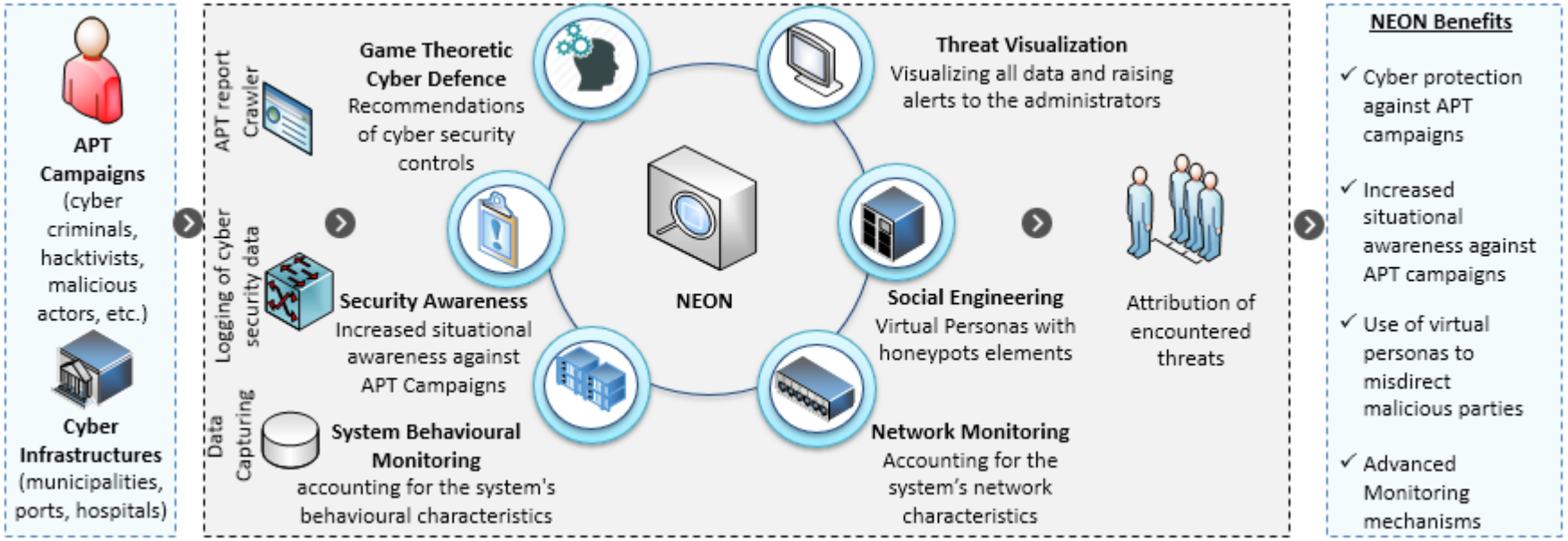
- there is no concrete methodology that attributes each attack to the malicious parties who launched it
- no methodology takes into consideration past knowledge of APT campaigns and both network and system behavioural data

NEON Framework

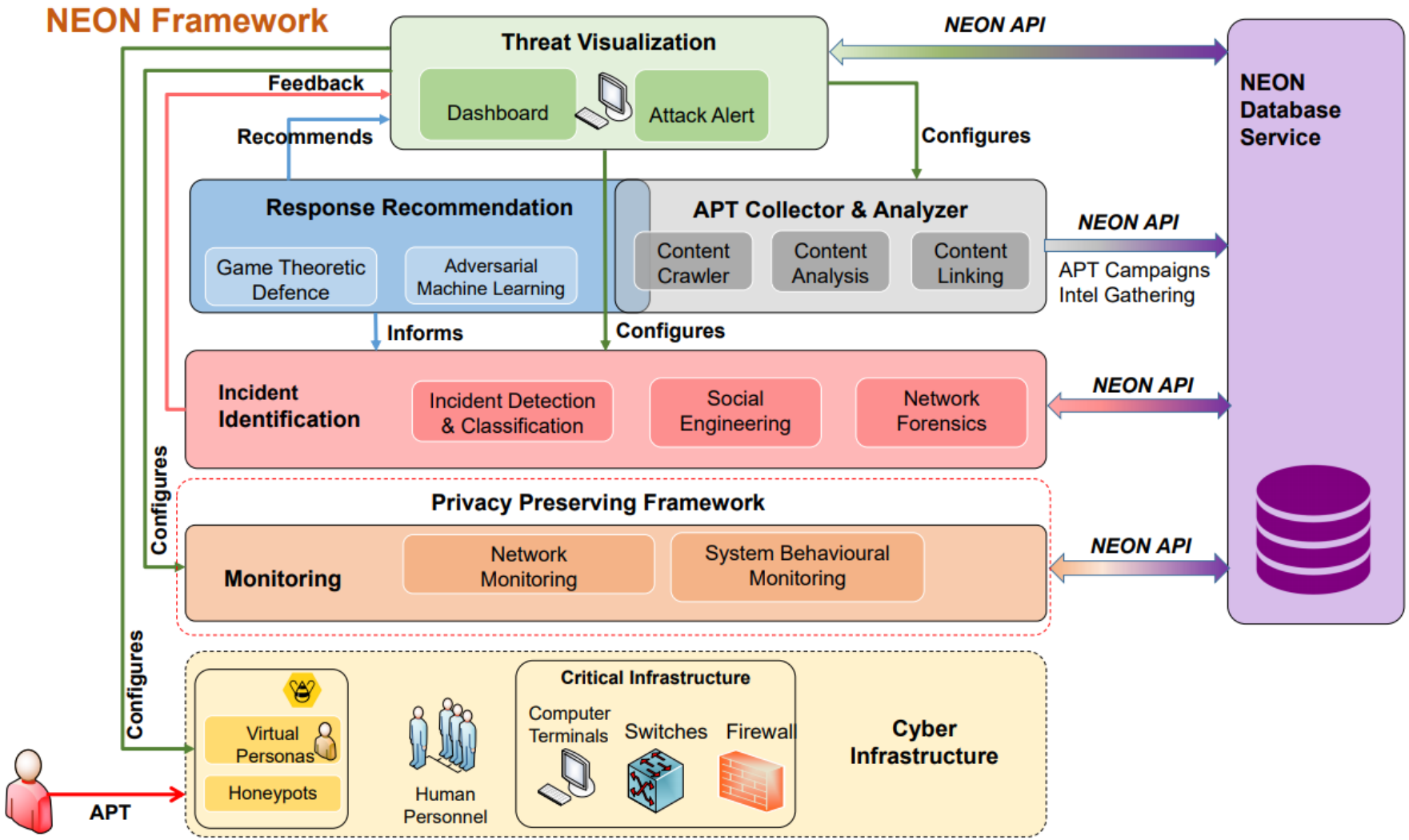
- E**n**hanced Cyb**e**r Attack Attributi**on** (**NEON**) Framework:
  - is designed to accommodate components that address the aforesaid challenges
  - leads to a user-centric automated cybersecurity platform that gathers heterogeneous data coming from APT reports and publicly available information from social media
  - using this material as ground truth, NEON correlates this with other data collected from network and system behavioural monitoring components
  - in order to increase defence against social engineering attacks, uses honeypots that attract the attention of potential attackers through the creation and management of virtual personas → accelerate the manifestation of the attacks in contained environments, drawing at the same time valuable information about the adversaries
  - uses a game theoretic approach to propose optimal cybersecurity actions against adversaries

- *To the best of our knowledge, NEON is the first framework that has been designed with the ultimate goal to perform enhanced attribution of APT campaigns*

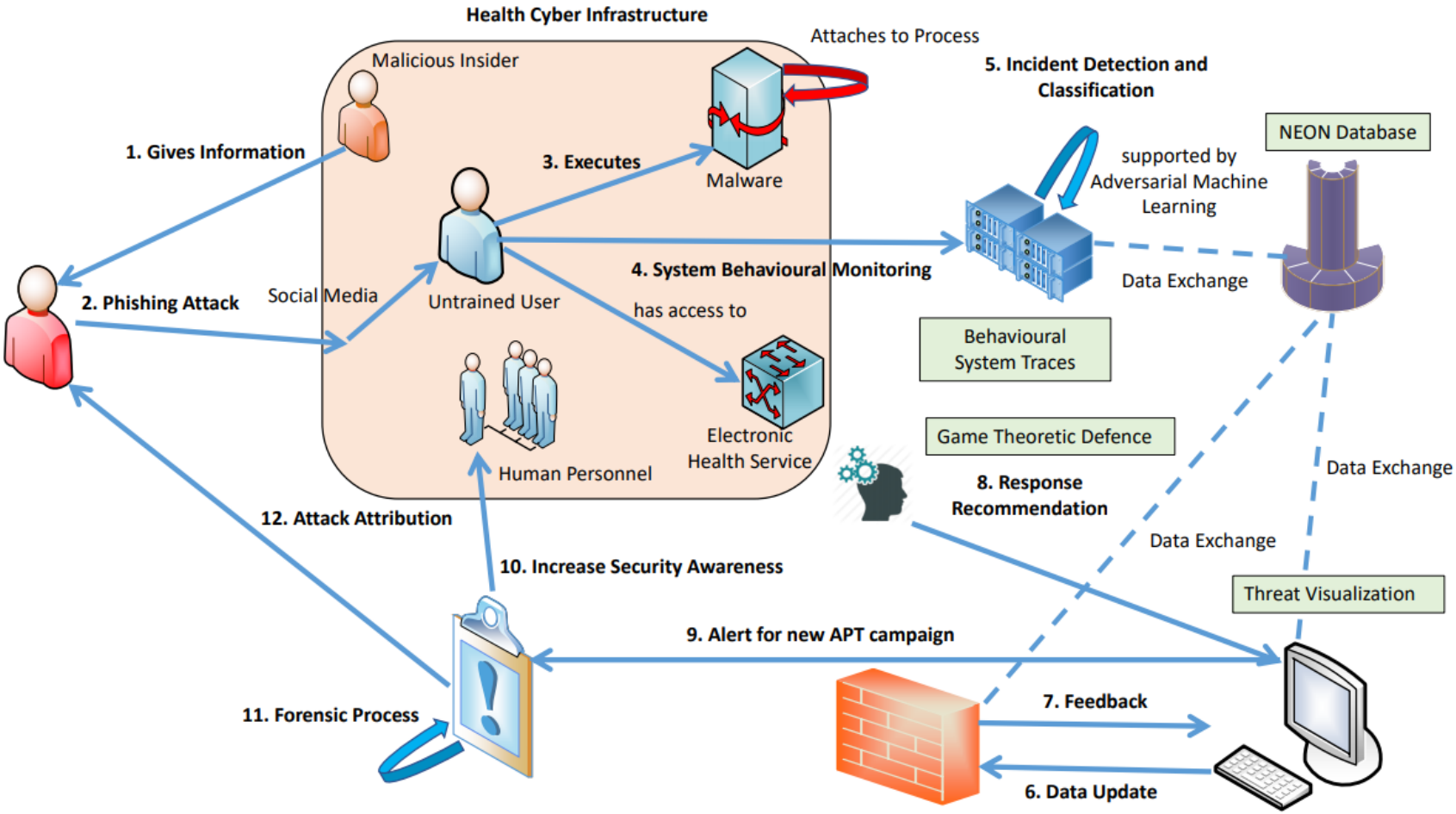
NEON Framework



NEON Architecture



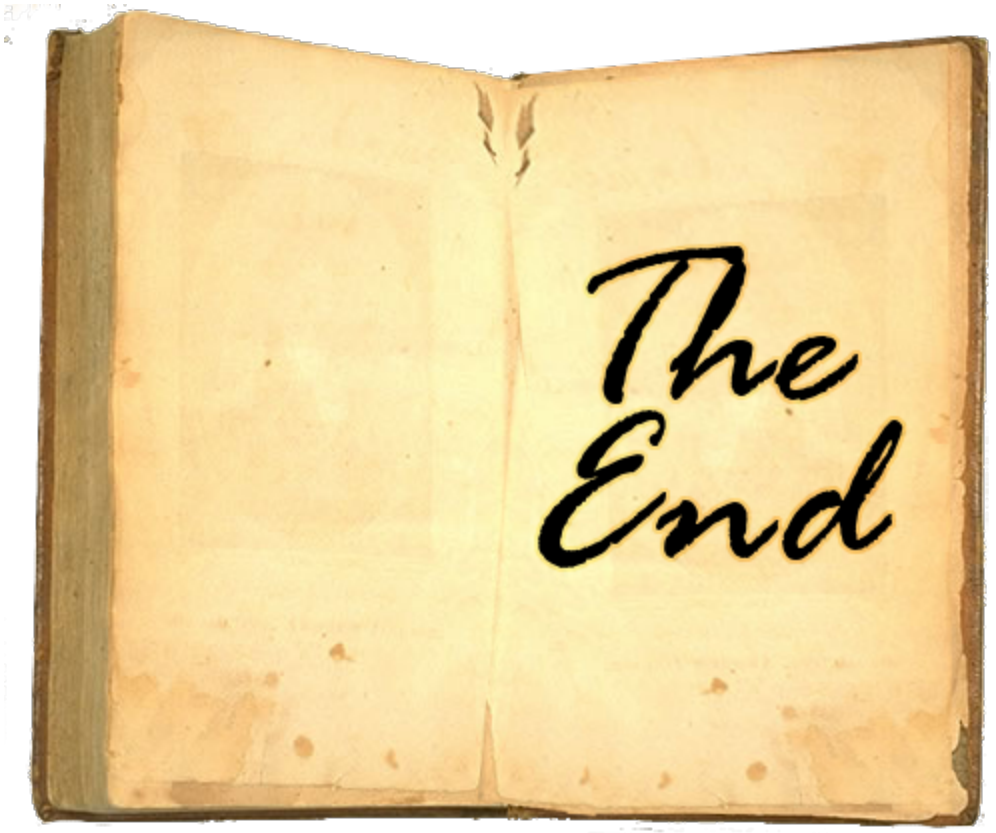
Healthcare Use case of NEON



Conclusions and future work

- Enhanced attack attribution frameworks are in their infancy
- APT becomes the most prominent threat paradigm
- To address challenges that emerge from the above, we propose the NEON framework:
  - Its primary target is the collection and representation of intelligence about APT campaigns and then the correlation with monitoring activities
  - Honeypots with the help of virtual personas improve the detection capabilities of zero-day exploits and social engineering attacks
  - Game theoretic defences are incorporated into NEON to mitigate the actions of sophisticated APT attackers
  - adversarial machine learning supports data trustworthiness thus facilitating accurate APT detection and attribution
  - threat management console visualizes and pronounces the situational awareness of people and critical infrastructures in NEON

- Our plan is to develop the individual NEON components in the following order: (i) APT Collector & Analyzer, (ii) Monitoring, (iii) Incident Identification, (iii) Response Recommendation, and (iv) Threat Visualization.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