MAPPING THREAT ACTOR BEHAVIOR IN THE RANSOMWARE PAYMENT ECOSYSTEM: A MINI-PILOT

ZOË BRAMMER

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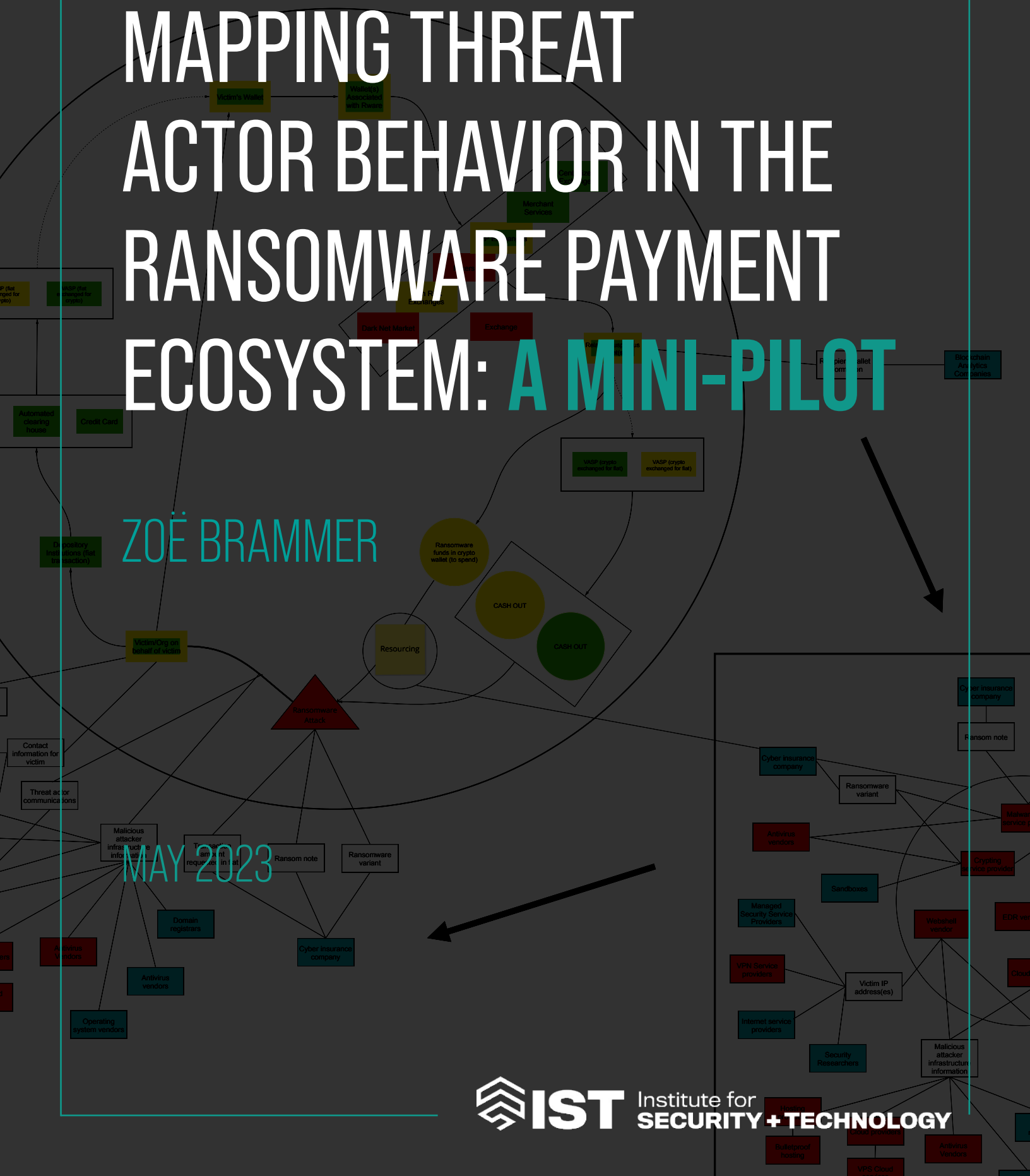

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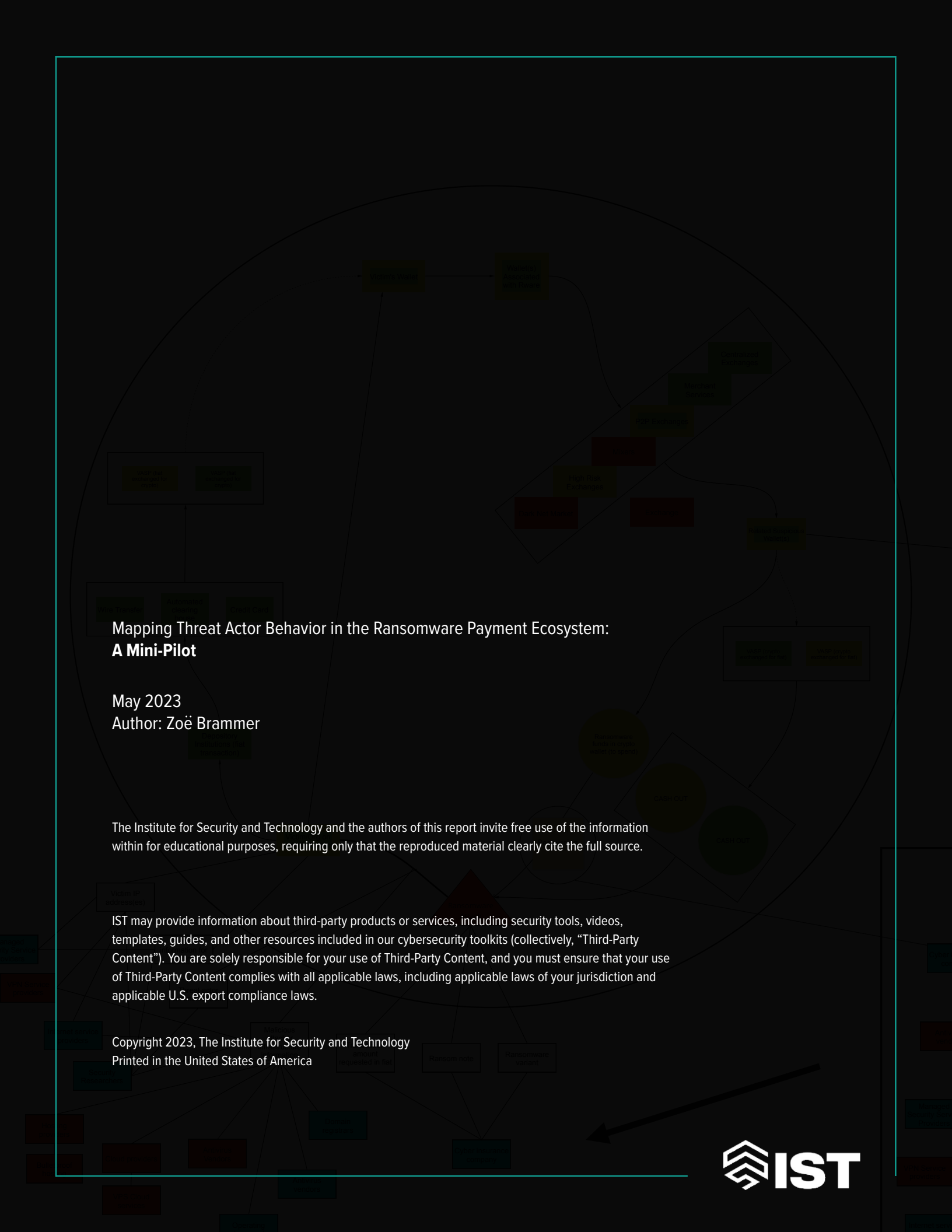

Mapping Threat Actor Behavior in the Ransomware Payment Ecosystem: **A Mini-Pilot**

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Background

The 2021 Ransomware Task Force Report called for the disruption of the ransomware business model to decrease criminal profits from ransomware attacks as a critical avenue to mitigate the ransomware threat. In the fall of 2022, IST published Mapping the Ransomware Payment Ecosystem, providing a comprehensive visualization of the process and participants involved in ransomware payments. The map was the first step in understanding the sources of available information to help disrupt the ransomware business model. The ultimate goal is for experts to use the map to take actions that disincentivize threat actors from carrying out attacks.

In late 2022, IST staff began work on a mini-pilot, an exercise that tests the map against four cases of ransomware attacks. The mini-pilot seeks to identify which kinds of disruption could be the most effective and where to apply them in the payment process. This briefing paper discusses the methodology employed in developing the mini-pilot and presents the mini-pilot results, key findings, and proposed next steps.

To conduct the mini-pilot, IST selected four case studies and overlaid ransomware threat actor behavior onto our payment ecosystem map. Although this exercise does not capture every ransomware actor or attack, it aggregates many of the entities threat actors commonly leverage to carry out ransomware attacks, including but not limited to antivirus vendors, cloud service providers, hosting providers, cryptocurrency exchanges, and tooling providers.

We present the cases in a series of maps. Each case map depicts the ransomware payment process from attack to cash out in the innermost circle. As described in the key, the entities involved in the ransomware payment process are generally either regulated (green) or unregulated/non-compliant (yellow). Some entities can be both unregulated and non-compliant, indicated by their yellow and green color coding. The circle of white boxes identifies types of information produced at each point of the ransomware payment process. The second concentric circle of blue boxes depicts entities with potential access to these pieces of information. The results of this mini-pilot indicate additional entities to include in the existing map, and reveal a "resourcing" phase where threat actors develop attacker infrastructure and perfect their tools before carrying out an attack.

Data and Methods

A number of Ransomware Task Force stakeholders made this mini-pilot possible by sharing data they routinely collect about threat actor behavior with the author of this report. Given the sensitivity of this data, references to specific organizations and other entities have been anonymized and generalized where needed. Most of the data we received was already anonymized; in instances without prior anonymization, IST staff removed all references to specific ransomware groups and other identified entities, for example by replacing entity names with the type of entity.

By overlaying threat actor behavior drawn from the anonymized data atop the original ransomware payment ecosystem map, IST staff were able to trace threat actor behavior as they prepared for and carried out attacks. Each type of entity that the actor came into contact with is highlighted in red on the map. IST staff produced five maps based on these case studies: four unique maps that trace specific ransomware threat actor behavior, and a fifth, composite map aggregating all four cases.

Cases 1, 2, and 3 are drawn from raw data provided to us by a blockchain analysis firm. Each case describes a unique threat group or actor and identifies the entities consistently leveraged by the group/actor to successfully carry out an attack. Case 4 is drawn from a combination of publications, outlining common ransomware actor tactics, techniques, and procedures (TTPs), specifically those required to make an attack possible.[1,2] These results were cross-referenced with a case study focused on a single threat group provided by an incident response organization. The caption associated with each figure includes additional details. The composite map aggregates the findings from all four cases to render overall conclusions about the map's counter-ransomware applications.

1 John Dwyer and Camille Singleton, "Understanding the Adversary: How Ransomware Attacks Happen," *SecurityIntelligence*, IBM, November 30, 2021, https://securityintelligence.com/posts/how-ransomware-attacks-happen/.

2 John Dwyer, "Detections That Can Help You Identify Ransomware," *SecurityIntelligence*, IBM, October 20, 2021, https://securityintelligence.com/posts/detections-help-identify-ransomware/.

Case 1

A ransomware group leverages a crypting service provider, malware-as-a-service provider, bulletproof hosting provider, VPN service provider, darknet market, cryptocurrency mixer, and cryptocurrency exchange to carry out a ransomware attack.

Entities with visibility:

Phase 1:

- Law enforcement
- DFIR firm
- Threat intelligence firm

Phase 2:

- Blockchain analytics companies
  Law enforcement

Phase 3:

- Cryptocurrency businesses
- Law enforcement

Key:

- Regulated avenue
- Unregulated or noncompliant avenue
- Entities with visibility
- Entities leveraged by threat actors to carry out a ransomware attack
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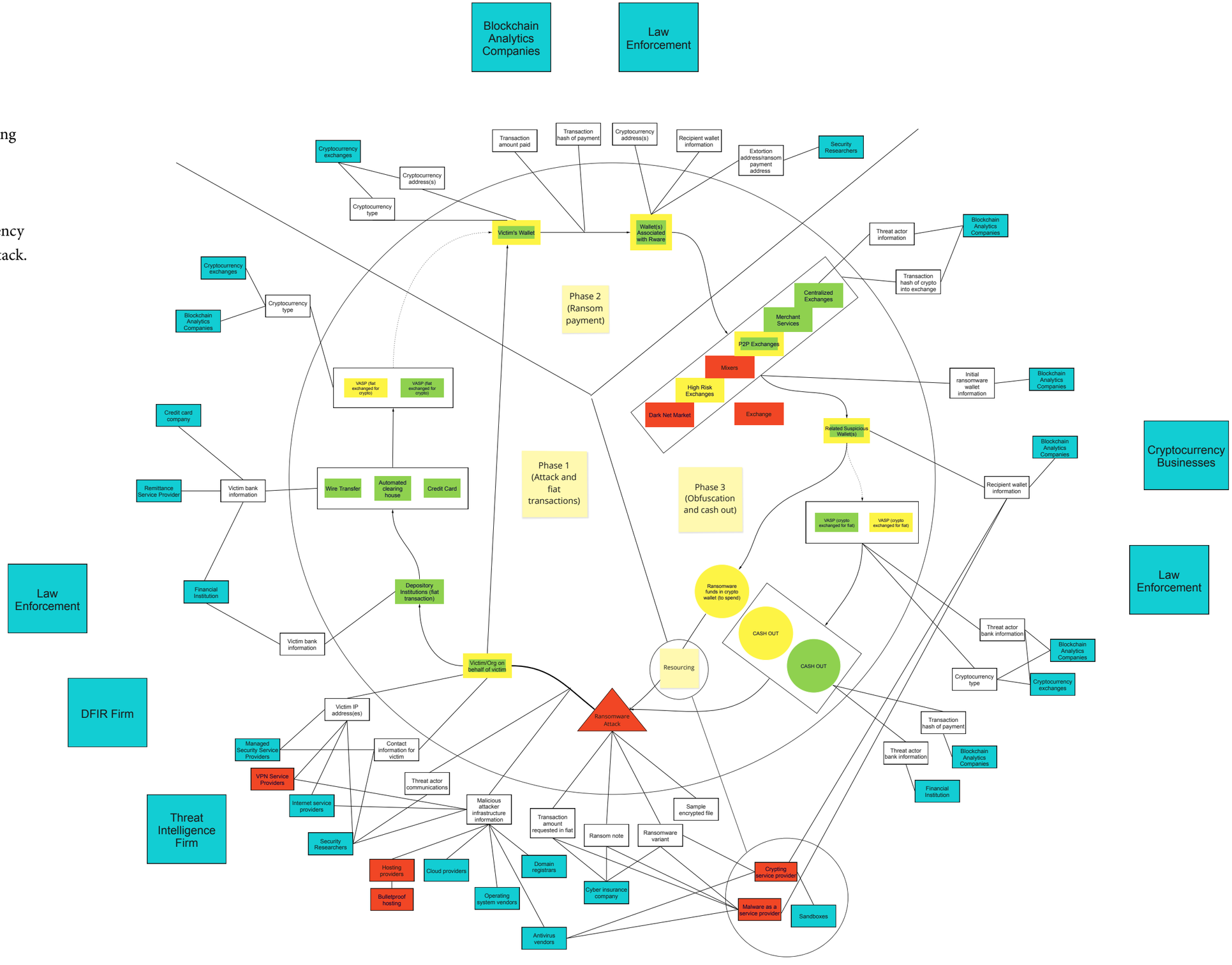

Case 2

A ransomware group leverages a hash decryption service, cloud provider, VPS cloud server, antivirus vendor, and VPN service provider to carry out a ransomware attack.

Entities with visibility into information in a given section:

Phase 1:

- Law enforcement
- DFIR firm
- Threat intelligence firm

Phase 2:

- Blockchain analytics companies
  Law enforcement

Phase 3:

- Cryptocurrency businesses
- Law enforcement

Key:

- Regulated avenue
- Unregulated or noncompliant avenue
- Entities with visibility
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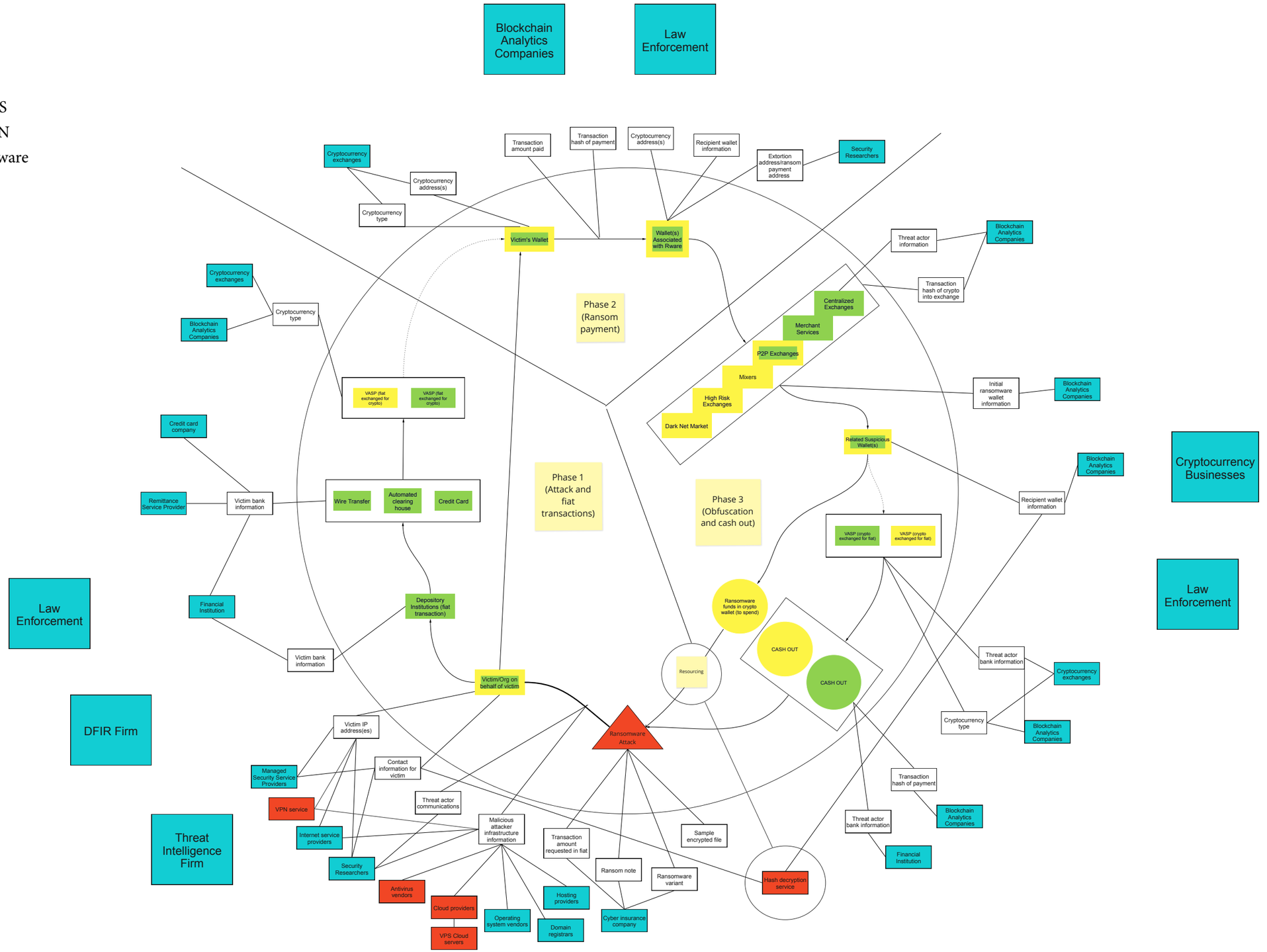

Case 3

A ransomware group leverages a crypting service provider, hash decryption service, webshell vendor, bulletproof hosting provider, VPN service provider, and dark net market to carry out a ransomware attack.

Entities with visibility into information in a given section:

Phase 1:

- Law enforcement
- DFIR firm
- Threat intelligence firm

Phase 2:

- Blockchain analytics companies
  Law enforcement

Phase 3:

- Cryptocurrency businesses
- Law enforcement

Key:

- Regulated avenue
- Unregulated or noncompliant avenue
- Entities with visibility
- Entities leveraged by threat actors to carry out a ransomware attack
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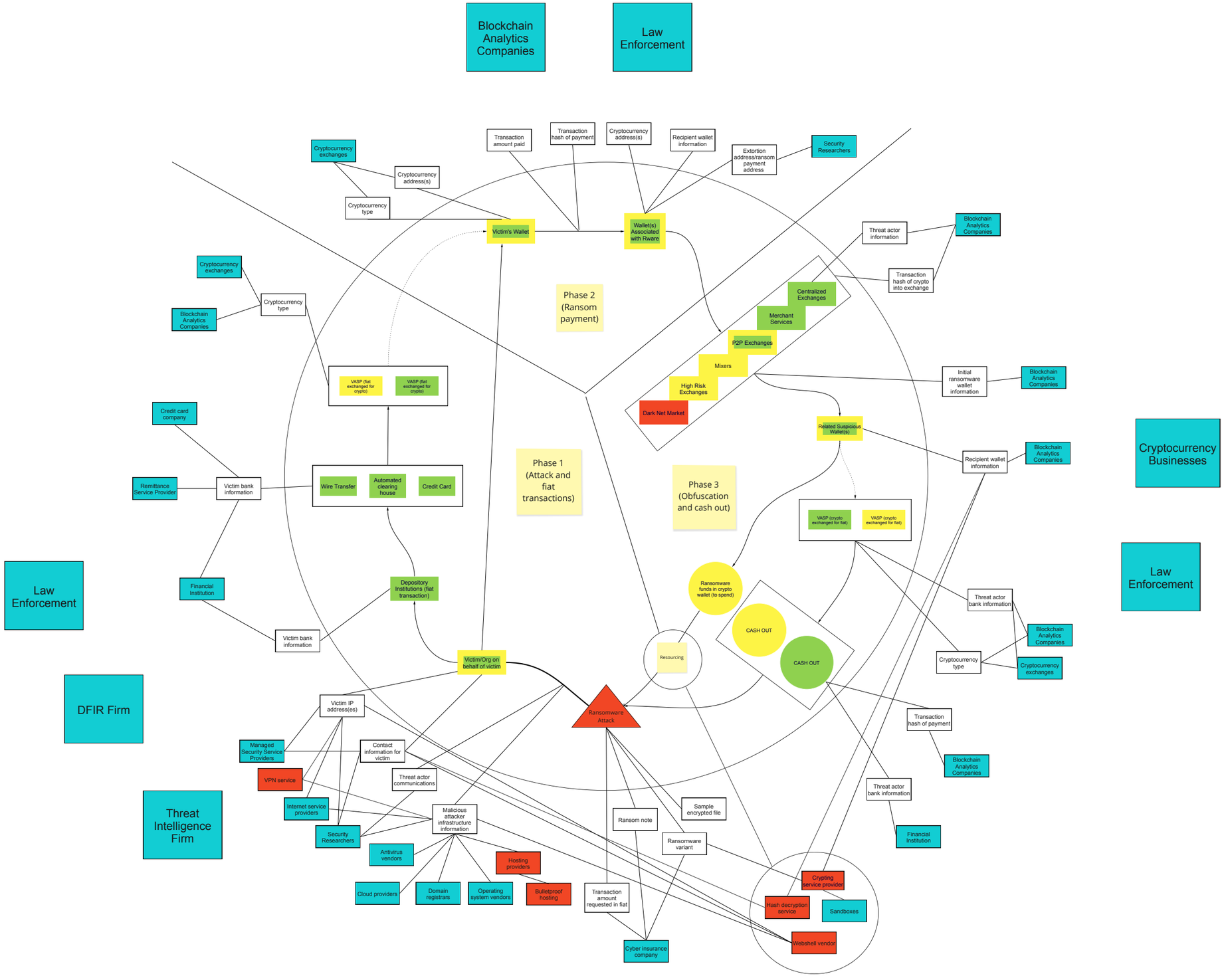


Case 4

Ransomware groups leverage tooling providers, cloud providers, EDR vendors, domain registrars, and antivirus vendors to prepare for a ransomware attack.

Entities with visibility into information in a given section:

Phase 1:

- Law enforcement
- DFIR firm
- Threat intelligence firm

Phase 2:

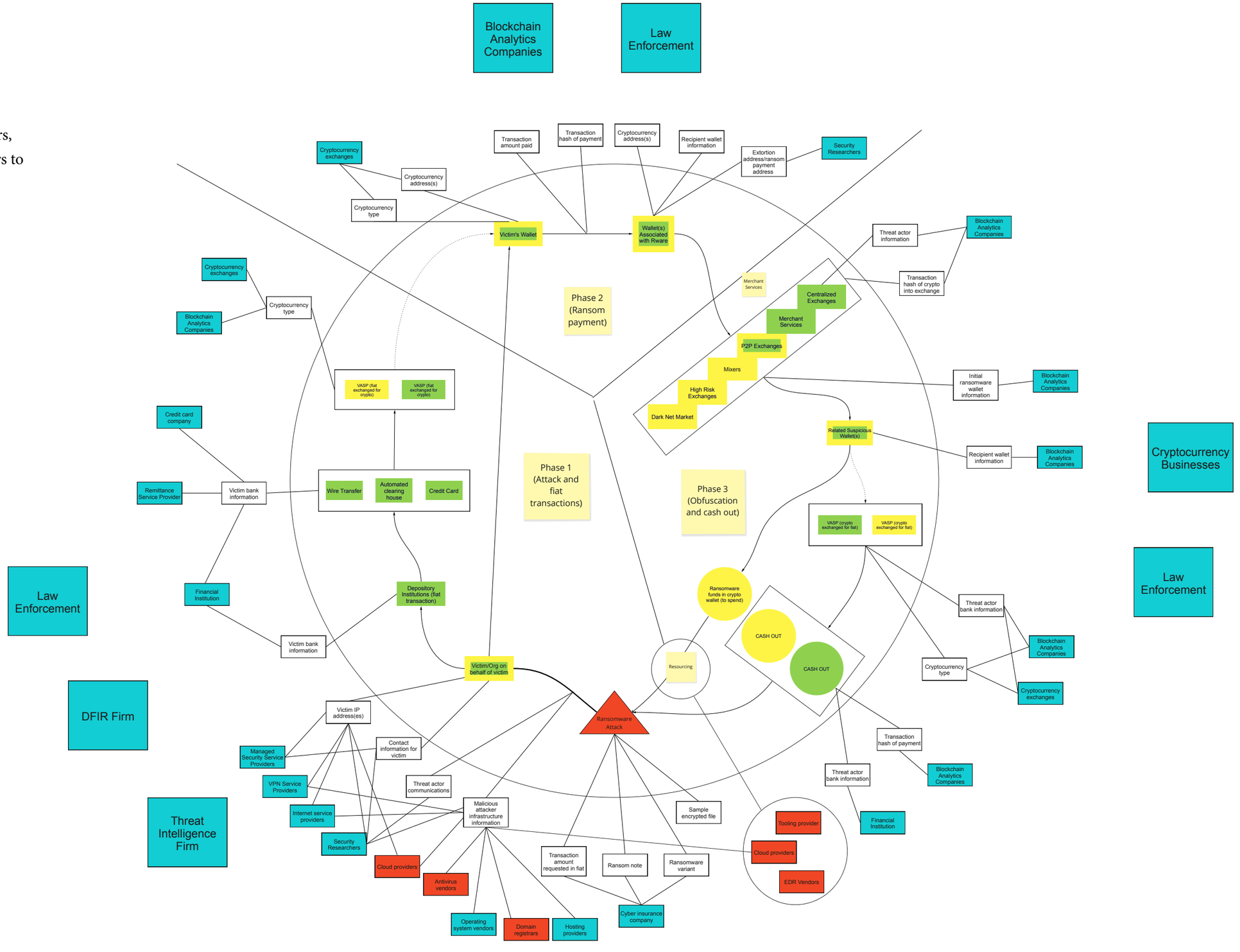
- Blockchain analytics companies
  Law enforcement

Phase 3:

- Cryptocurrency businesses
- Law enforcement

Key:

- Regulated avenue
- Unregulated or noncompliant avenue
- Entities with visibility
- Entities leveraged by threat actors to carry out a ransomware attack
- ----- Escrow



Composite Map

Aggregates the data from cases 1-4.

Entities with visibility into information in a given section:

Phase 1:

- Law enforcement
- DFIR firm
- Threat intelligence firm

Phase 2:

- Blockchain analytics companies
  Law enforcement

Phase 3:

- Cryptocurrency businesses
- Law enforcement

Key:

- Regulated avenue
- Unregulated or noncompliant avenue
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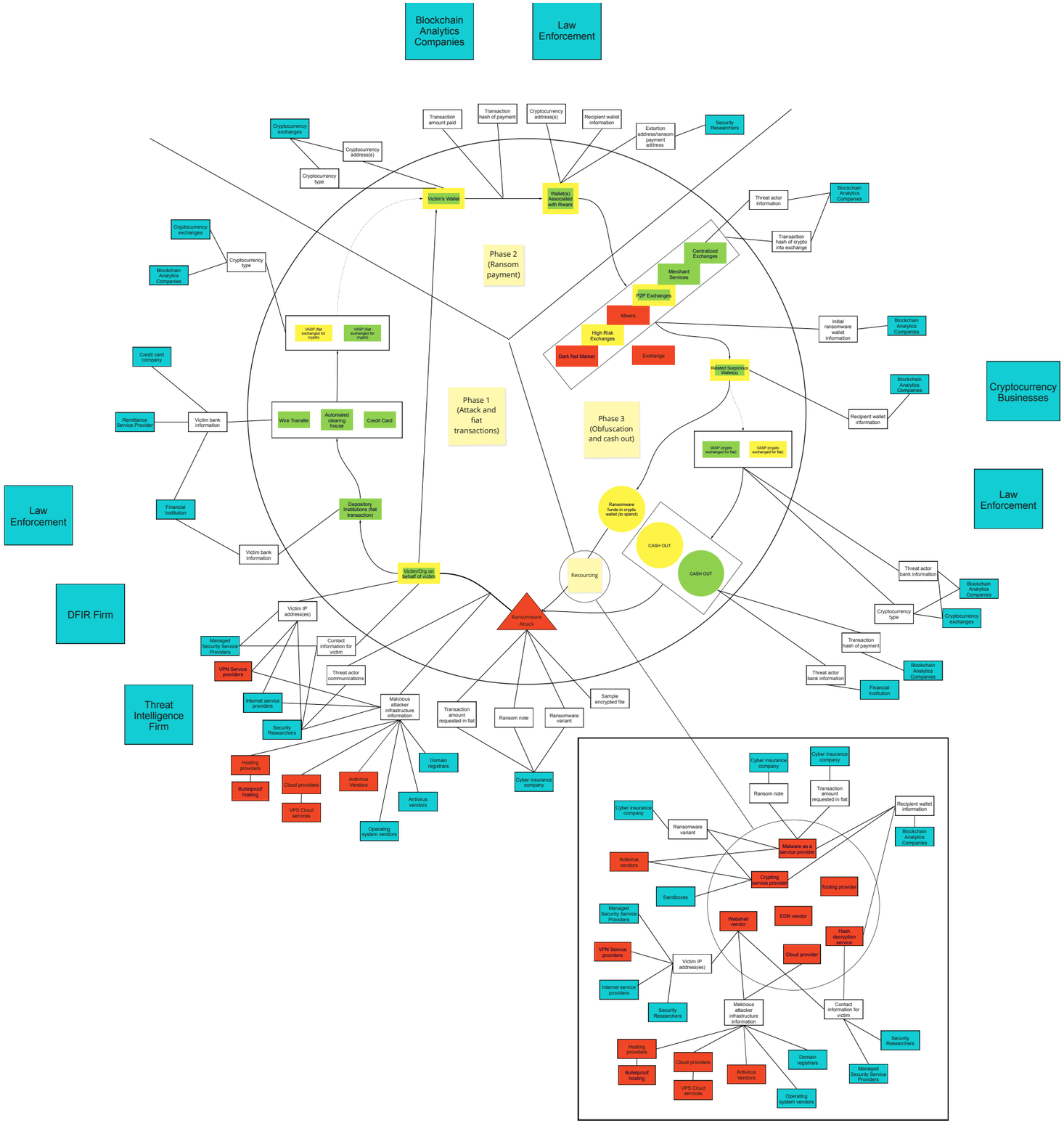


Results

The results of this mini-pilot indicate several additional entities (blue tiles) to include in the map, as well as a new "resourcing" phase (in the "magnified" circle in the bottom right quadrant of each map), where threat actors develop attacker infrastructure and perfect their tools before carrying out an attack.

The mini-pilot identifies entities previously left off the map that are directly and tangentially related to ransomware payments. In the innermost circle, the data indicates that cryptocurrency mixers, cryptocurrency exchanges, and dark net markets are commonly used to launder payments. The majority of the entities identified by this mini-pilot, however, are only tangentially related to ransomware payments. In other words, while they are not directly involved in paying ransoms, obfuscating cryptocurrency, or the cash out process, threat actors use the tools and services they provide to carry out attacks. This distinction could present the opportunity for a number of avenues to disrupt the payment ecosystem and thereby meaningfully impact the ongoing use of ransomware for financial gain.

As a result of this mini-pilot, IST staff highlight two distinct types of entities that ransomware threat actors leverage to carry out attacks. Some entities that threat actors use exist for precisely this type of malicious activity and are not generally used by the public. This group includes:

- Crypting service providers
- Cryptocurrency mixers
- Darknet markets
- Hash decryption services
- Malware-as-a-service providers
- Webshell vendors

Threat actors also consistently leverage legitimate entities:

- Antivirus vendors
- Cloud service providers and VPS Cloud services
- Cryptocurrency exchanges
- EDR vendors
- Hosting providers, especially bulletproof hosting
- Tooling providers
- VPN service providers

The results of this mini-pilot suggest that each entity illustrated in the original ransomware payment ecosystem map may have an opportunity to help add friction to the ecosystem, regardless of their direct involvement in ransom payments.

A Note on Changes to the Original Ransomware Payment Ecosystem Map

In developing this mini-pilot, IST staff, in collaboration with RTF members, identified two inaccuracies in the original ransomware payment ecosystem map. First, upon noting that threat actors frequently use VPN service providers to leverage their attacks we elected to add this entity to the original ransomware payment ecosystem map. Second, members of the RTF identified that merchant services, which enable customers to send and receive currency and are included in the obfuscation section of the map, are usually regulated. To reflect this characteristic, this tile is now green.

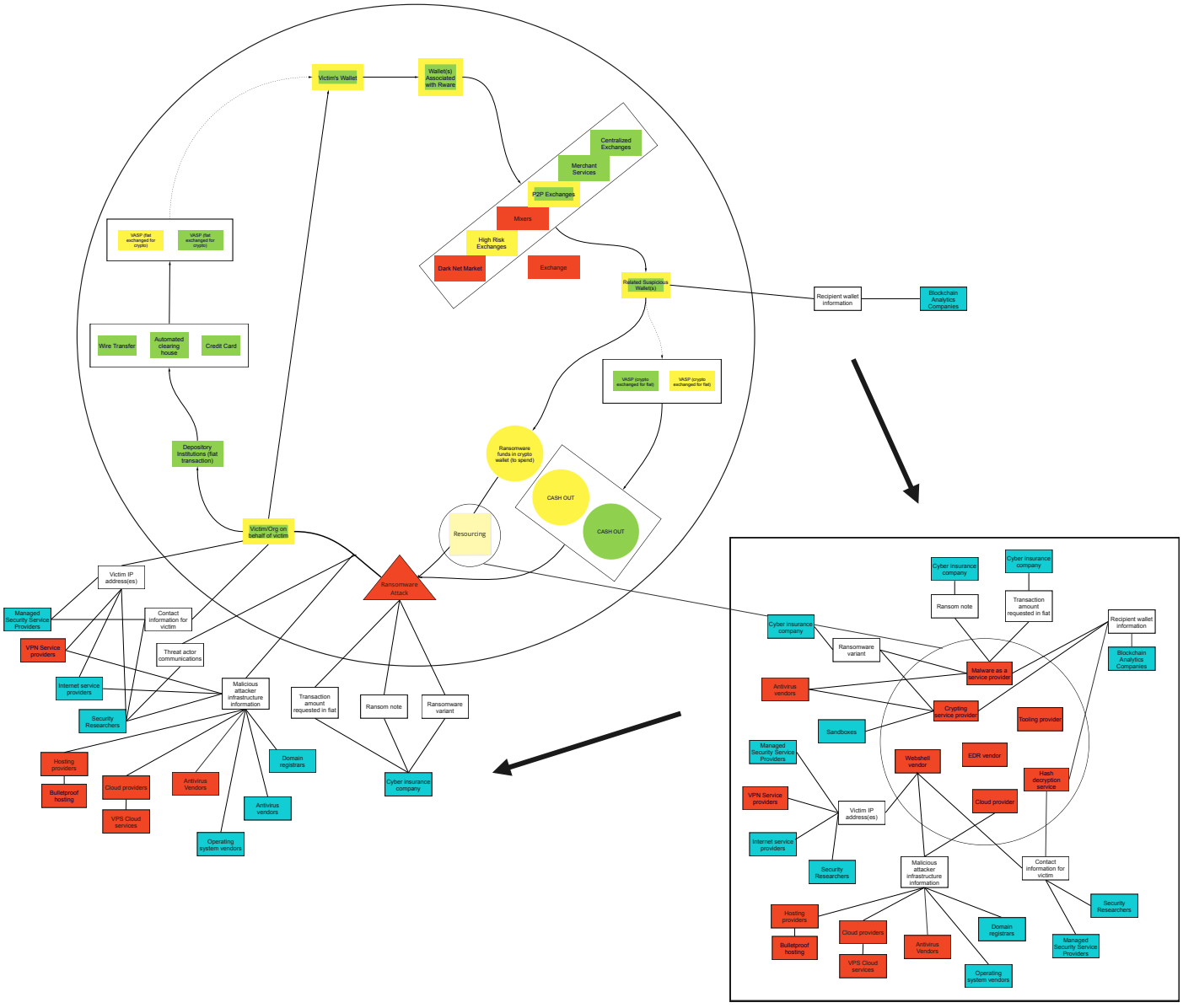
Next Steps

The results of this mini-pilot suggest at least three potentially impactful opportunities to disrupt ransomware attacks.

First, some entities employed by threat actors, like malware-as-a-service providers, crypting service providers, and webshell vendors, among others, exist precisely for malicious activity. In future work, IST staff and the Ransomware Task Force will explore opportunities to curb the proliferation of these types of entities. Among other opportunities, enhanced information sharing about these entities among stakeholders included in the map could be impactful. Encouraging information sharing could require additional incentives, such as regulation or other governmental action.

Second, threat actors at times use legitimate entities, like cloud service providers, VPN providers, and antivirus vendors, for purposes that are not benign. The use of these entities occurs primarily in the resourcing phase and phase one of the ransomware payment ecosystem map–after a ransomware attack occurs but before the ransom is paid. This suggests the possibility of information sharing opportunities that could, if structured appropriately, provide vital indicators to law enforcement and others with the ability to intervene in the attacks, thereby adding friction for threat actors.

Finally, the inclusion of the resourcing phase illustrates the cyclical nature of the ransomware ecosystem. As shown in the graphic below, this mini-pilot suggests that, in some cases, threat actors pay for tools and services to develop attacker infrastructure using cryptocurrency wallets associated with prior attacks. This points to the possibility that, with enough contextual information, entities like blockchain analytics companies and cryptocurrency businesses, among others, might be able to share cryptocurrency wallet information with law enforcement and other relevant stakeholders. This could help identify illicit proceeds as they move through the payment process and prevent future attacks by those same threat actors.



The arrows indicate that threat actors often reuse cryptocurrency wallets, and pay for tools and services required to carry out ransomware attacks using wallets associated with prior attacks. This highlights the cyclical nature of the ransomware cycle.

Conclusion

In the coming months, using this mini-pilot as a launching point, IST staff and RTF working groups will identify potential opportunities to disrupt the ransomware payment ecosystem and subvert the profitability of this crime. In particular, the group will focus on testing how key barriers and enablers could prompt change in the ecosystem and identifying hot spots in the payment ecosystem where disruption might have an outsized effect on threat actors, as some tools and services are easier to replace or replicate than others. This mini-pilot indicates that there may be a range of opportunities to add friction for all entities depicted in the ransomware payment ecosystem map, and that disrupting this ecosystem requires not just a multistakeholder approach but a strategic one. By centering threat actor behavior, it may be possible not only to disrupt the ecosystem, but to predict where these actors will move as the ecosystem tightens its grip on illicit activity.

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