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Identification of Low-Latency Obfuscated Traffic Using Multi-Attribute Analysis

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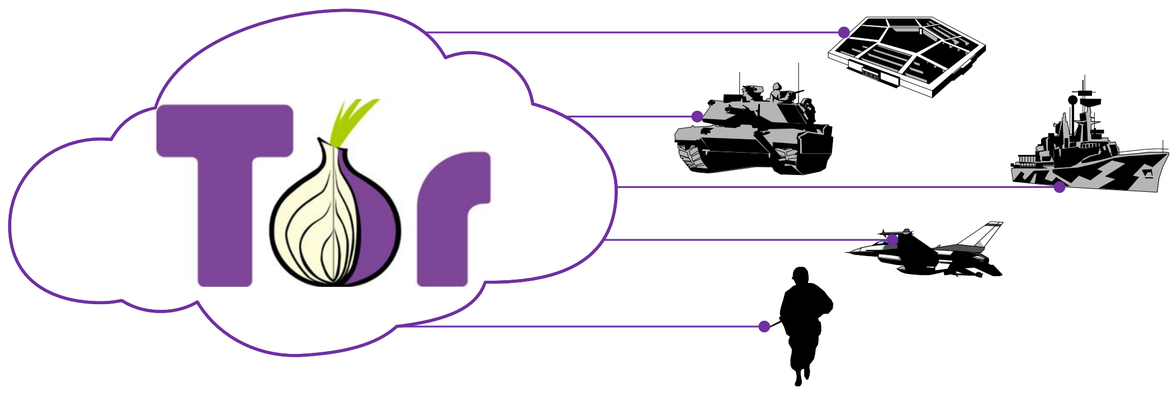
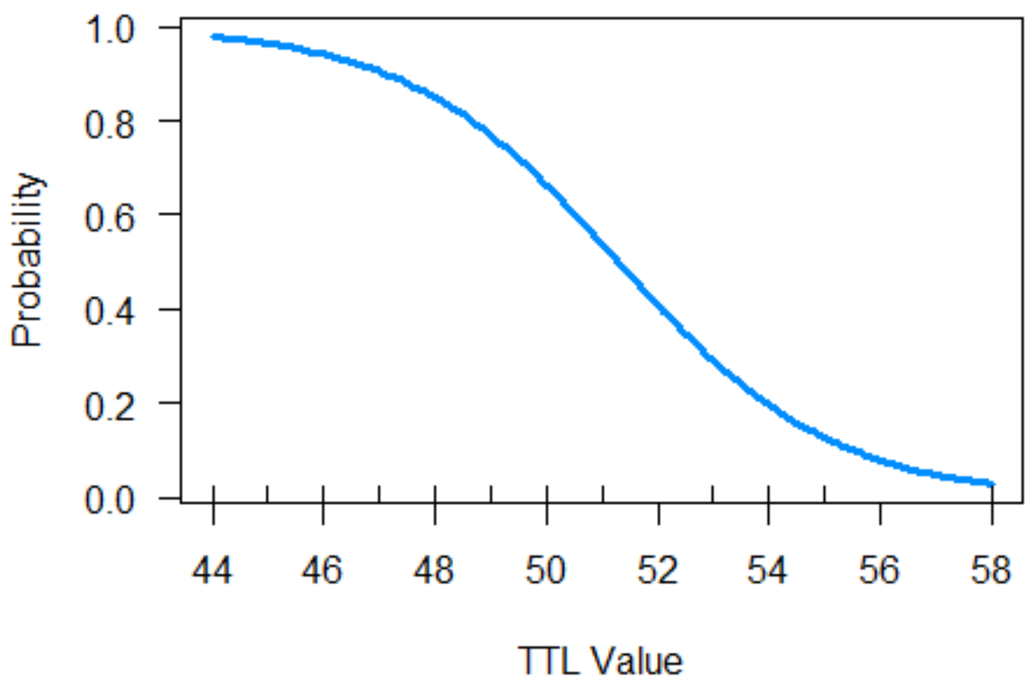
Real World Threat

- No process or system capable of detecting Tor network traffic on DOD networks.
- The level of unauthorized Tor traffic on DOD networks is unknown. This creates significant risk from both insider-threat and network-defense perspectives.
- Only14.6 percent of all Tor source IP addresses observed were published on the hourly Tor exit node list — blacklisting is NOT an effective solution.





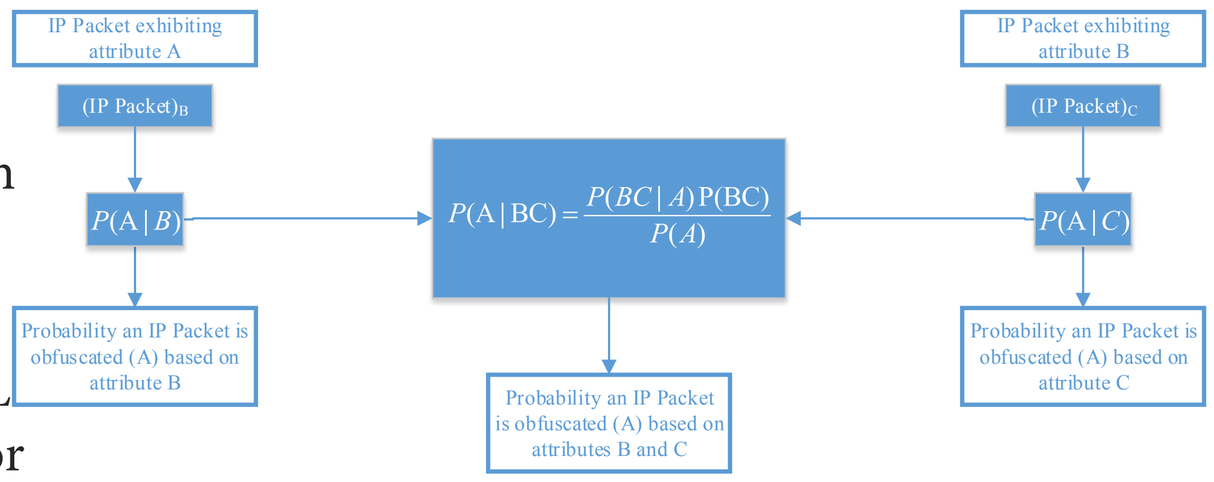
Probability of classification for Tor traffic based on IP TTL

Single Attribute Analysis

- 351,188 unique Tor packets exhibited common characteristics in their IP time-to-live (TTL), TCP offset, and IP packet length fields.
- Each trait was tested to determine its ability to detect Tor traffic in a mixed dataset; this resulted in a 53 to 62.1 percent probability of correctly classifying Tor traffic.
- IP TTL was the best single discriminator to detect Tor traffic which is likely due to the preponderance of Tor exit nodes running Linux; as of January 2017, Linux-based operating systems accounted for 91.3 percent of all Tor exit nodes.

Multi-Attribute Prediction

- Using three pre-filter variations, the observed FPR for non-Tor ranged from 94.4 percent to 7.2 percent, and the observed FNR for Tor ranged from 61.3 percent to 1.6 percent. Interestingly, the tests that used more pre-filters performed the worst.
- Filtering the data set based on common Tor IP TTL values only resulted in a TPR of 91.3 percent for Tor traffic and a FPR of 7.2 percent for non-Tor traffic.



Multi-attribute decision model using Naïve Bayes analysis

- Naïve Bayes multi-attribute prediction model allows maximum flexibility when applying to real-world networks and applications.

Key Takeaways

- Real-time detection of Tor traffic is possible using network traffic analysis.
- Tor traffic has identifiable TPC/IP packet and routing characteristics — more are are likely to exist.
- Probability of detection can be increased by evaluating groups of packets from a single source IP all at once — this will examine the behavior from an IP address vice that of each TCP/IP packet.

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