Peering into the Darkness: The Use of UTRS in Combating DDoS Attacks

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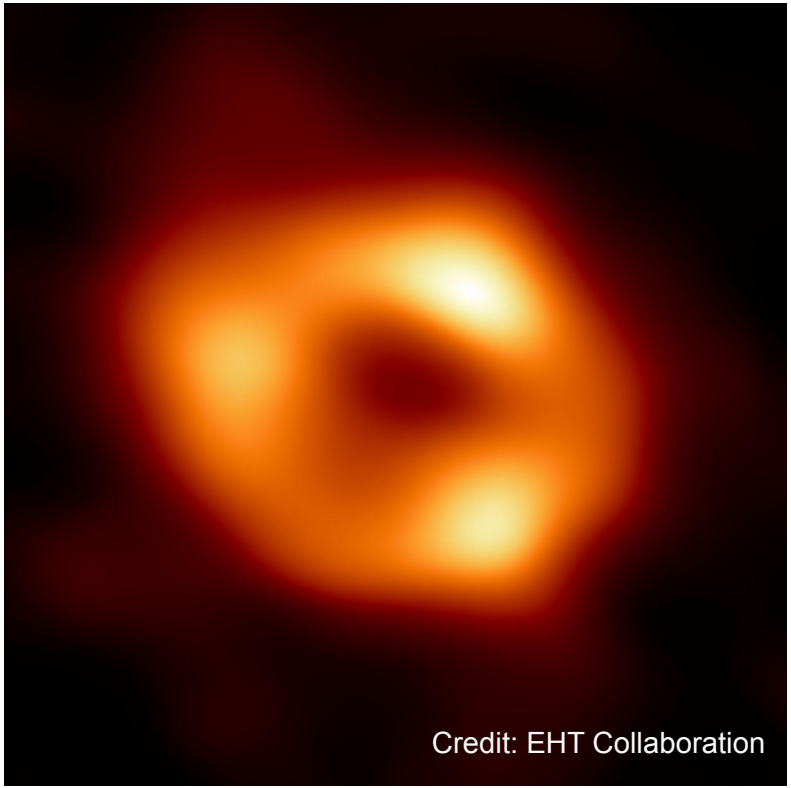
Background

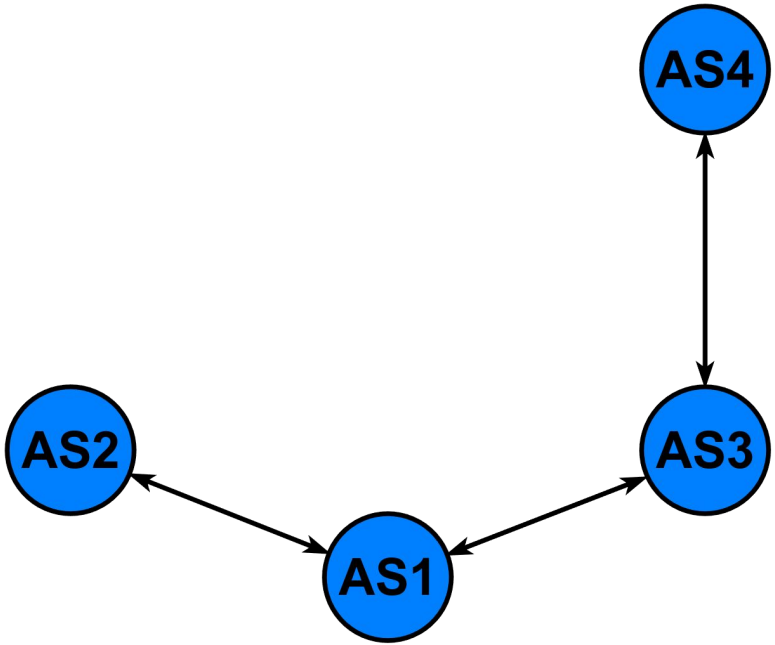
- **Border Gateway Protocol (BGP)** is a routing protocol responsible for ensuring the interconnectivity of **Autonomous Systems (ASes)**
- **BGP attributes** are used to provide additional value-added services, e.g., **Remotely Triggered Black Hole (RTBH)**:
- **RTBH** allows the victim AS to advertise an IP under attack using BGP [1]. Upon receiving this advertisement, the peers of the AS (or the community) start discarding the packets to that IP (null route, black hole)
- **Unwanted Traffic Removal Service (UTRS)** is a global free easy-to-join RTBH service operated by a trusted third-party (Team Cymru [2]).



1. Doughan Turk. 2004. Configuring BGP to Block Denial-of-Service Attacks. RFC3882. https://doi.org/10.17487/RFC3882

2. https://www.team-cymru.com/ddos-mitigation-services

Background: Unwanted Traffic Removal Service



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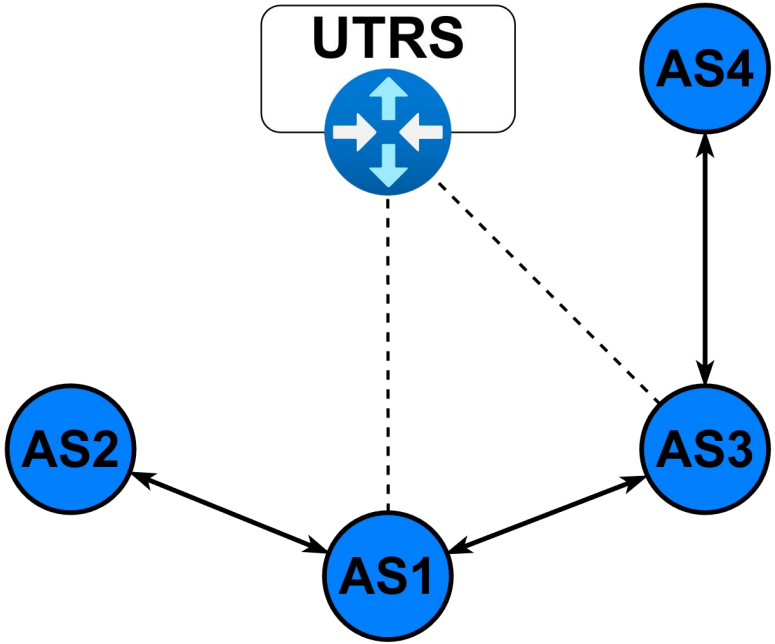

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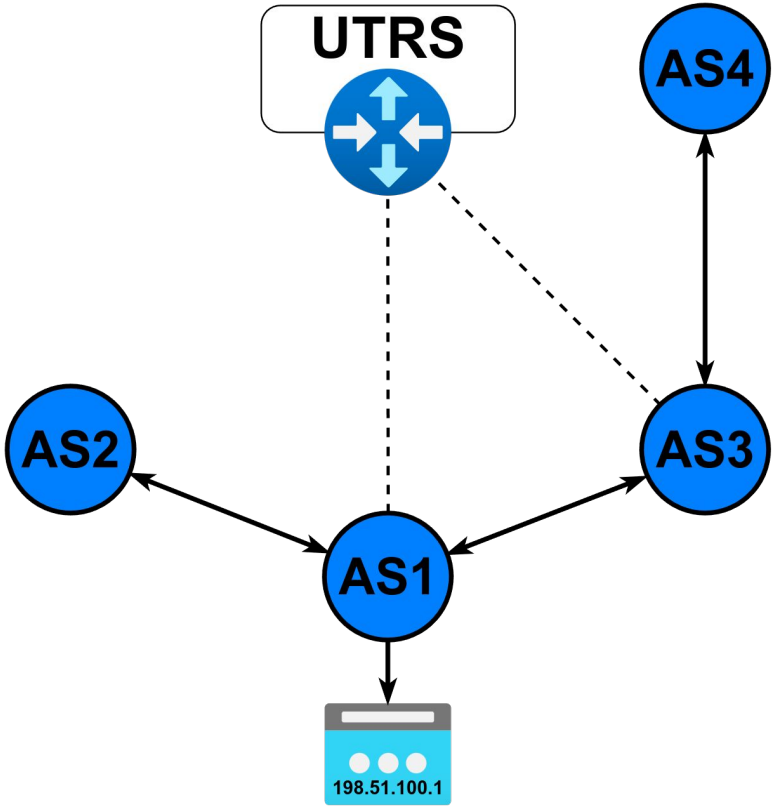
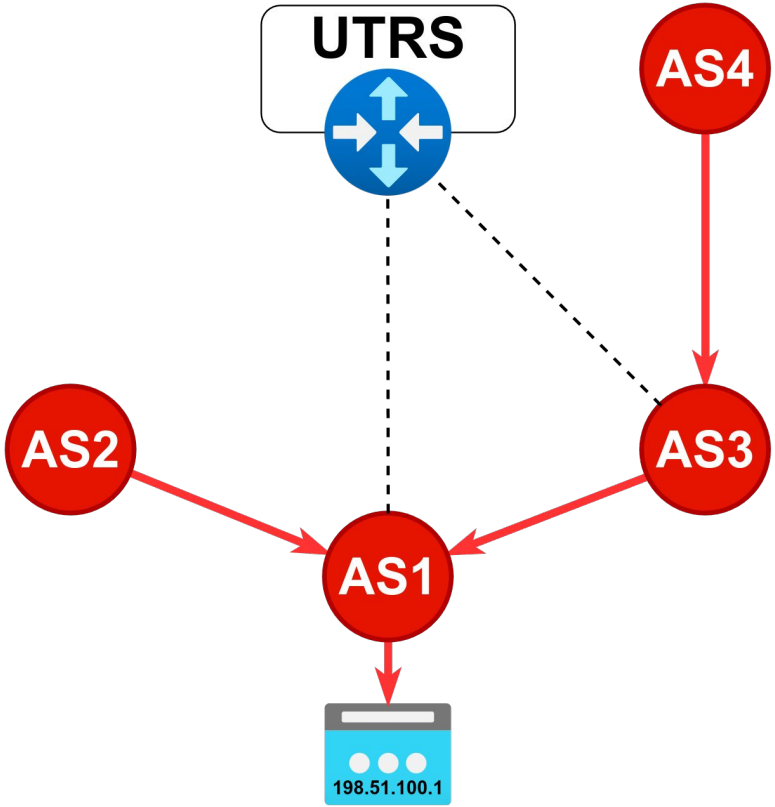


Unwanted Traffic Removal Service



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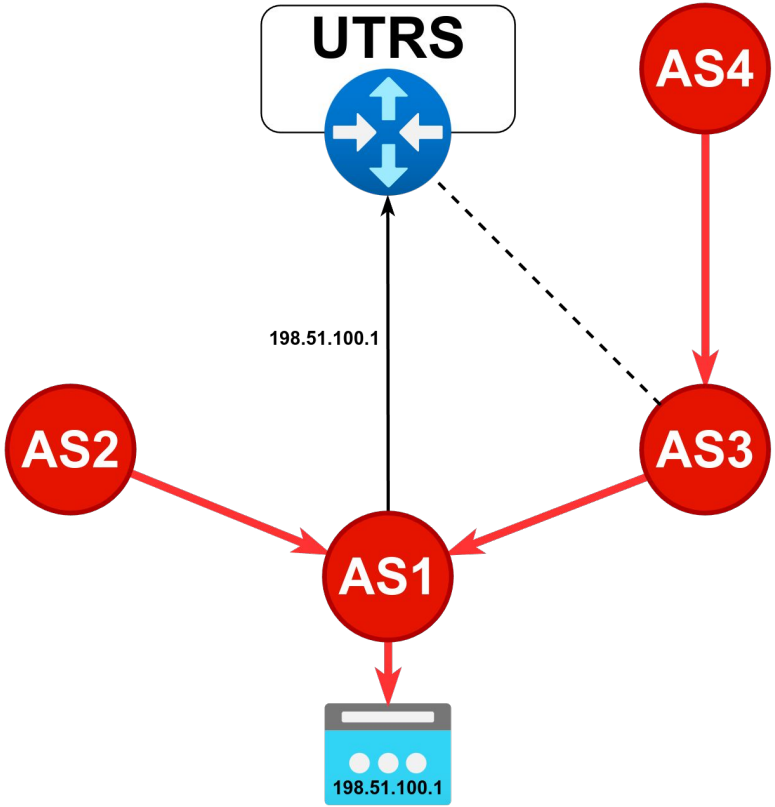

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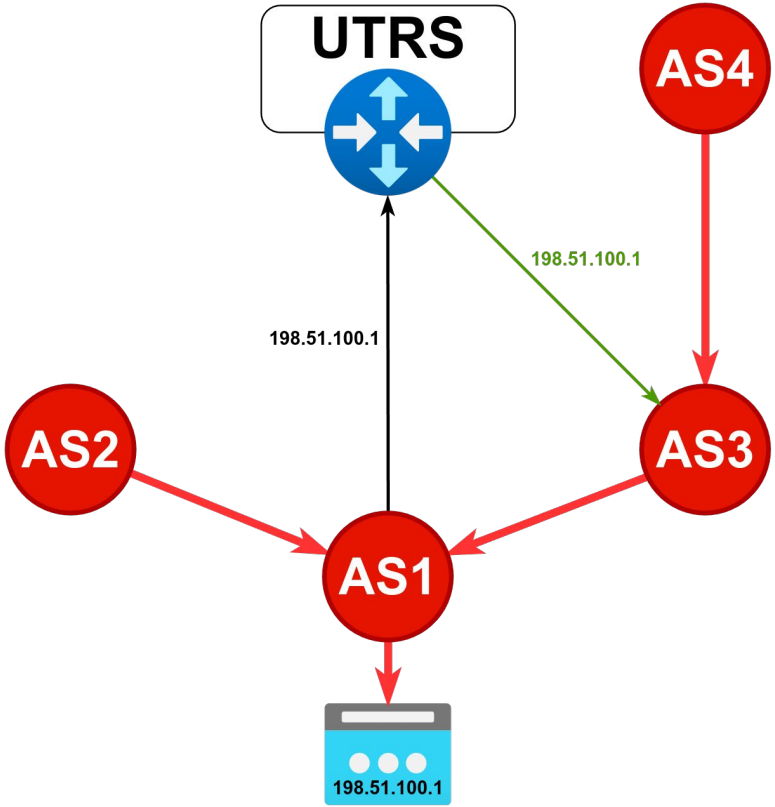

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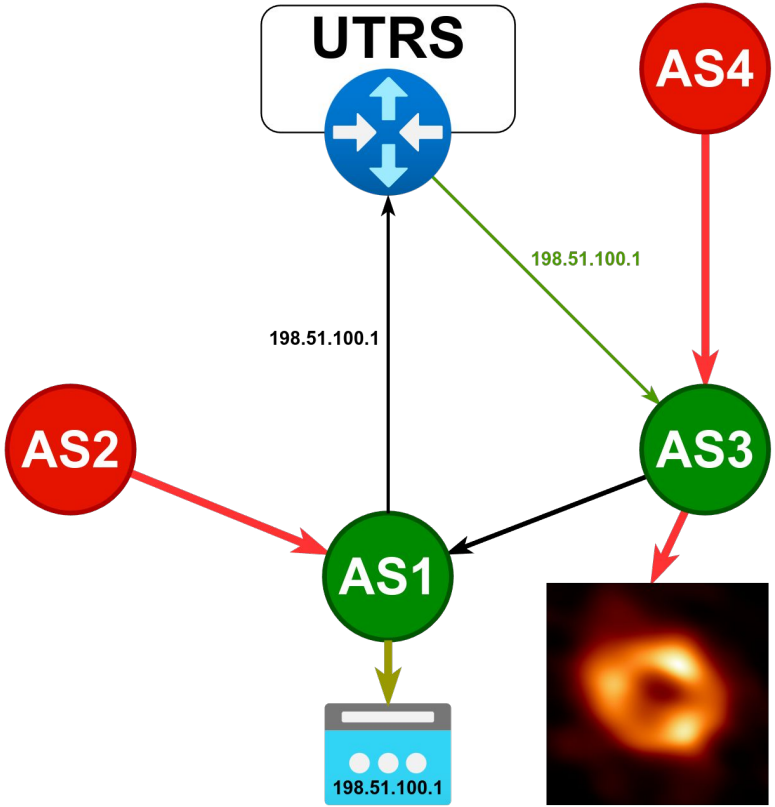
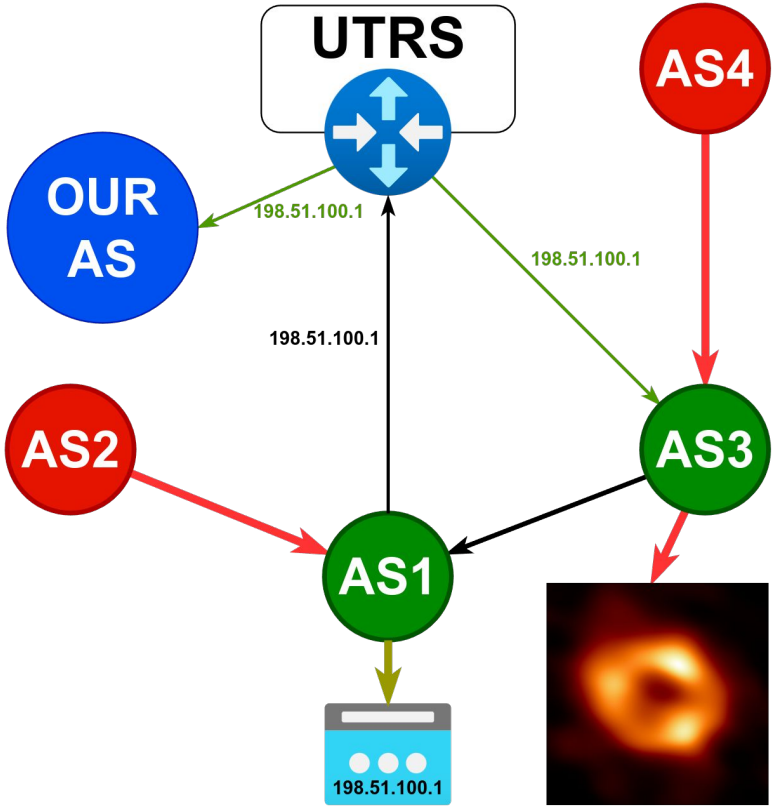


Research Questions

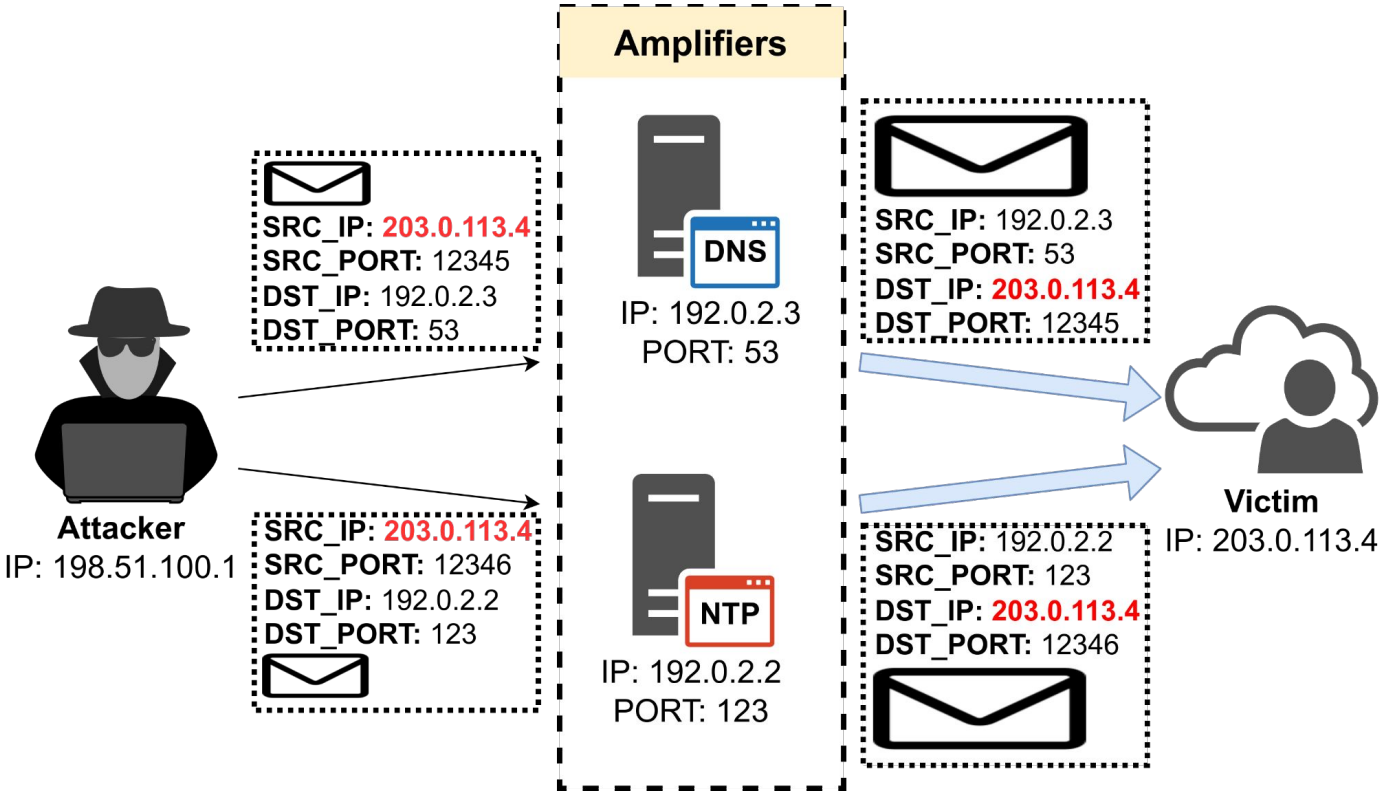
How extensively is UTRS used to counter DDoS attacks?

- RQ1: How many UTRS members use this service to mitigate attacks?
- RQ2: To what extent are DDoS attacks triggering mitigation attempts via UTRS?
- RQ3: To what extent can UTRS announcements be explained by amplification DDoS attacks?
- RQ4: To what extent can UTRS announcements be explained by IoT-botnet-driven DDoS attacks?

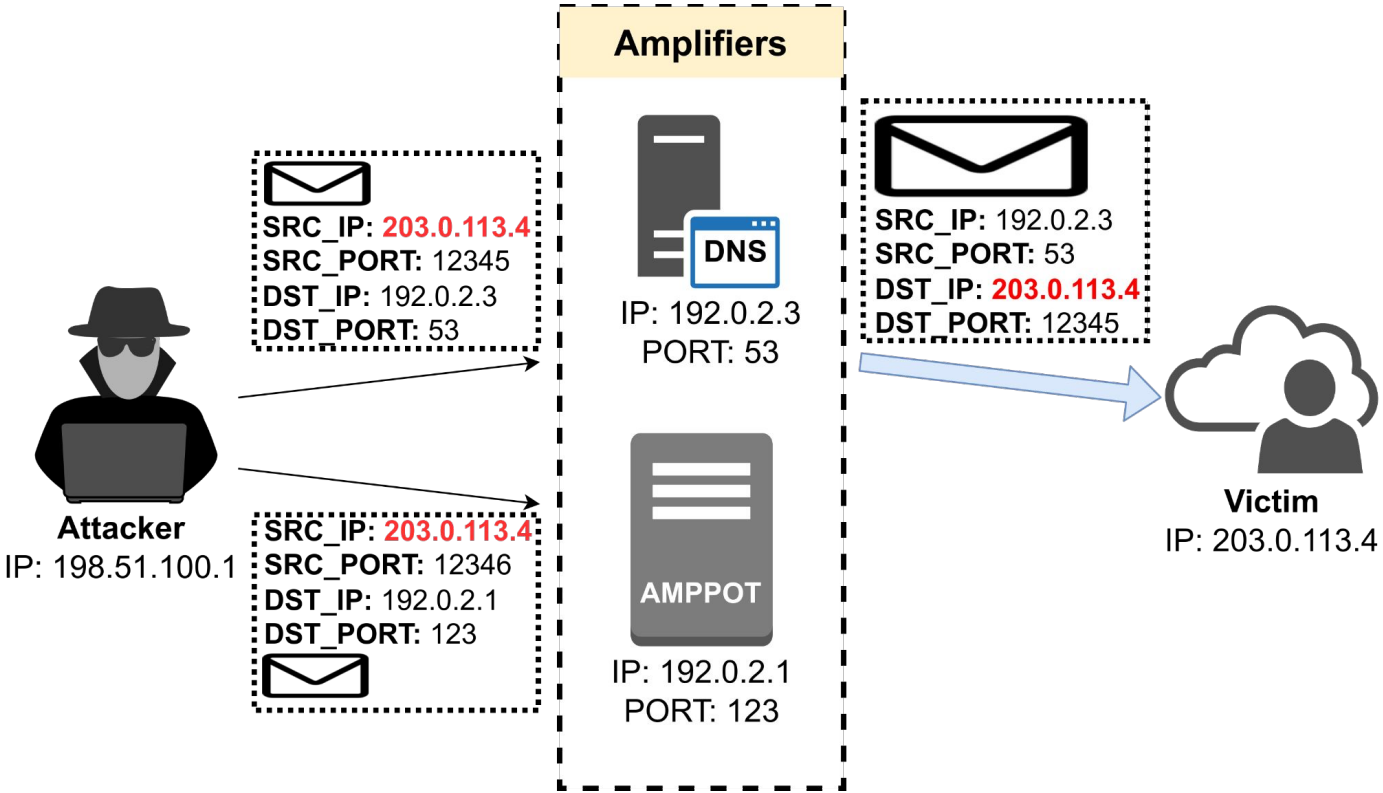
UTRS Dataset Collection



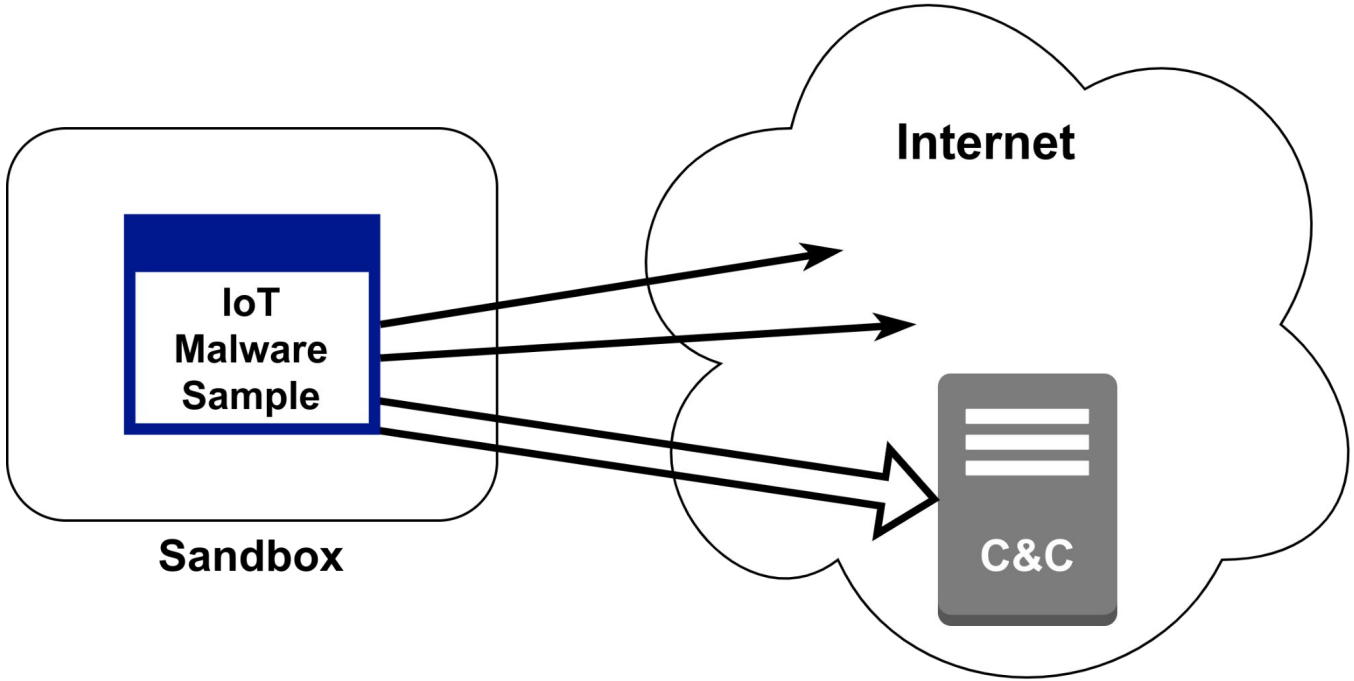
Amplification DDoS Attacks



Amplification DDoS Attacks Dataset Collection



IoT DDoS Attacks Dataset Collection



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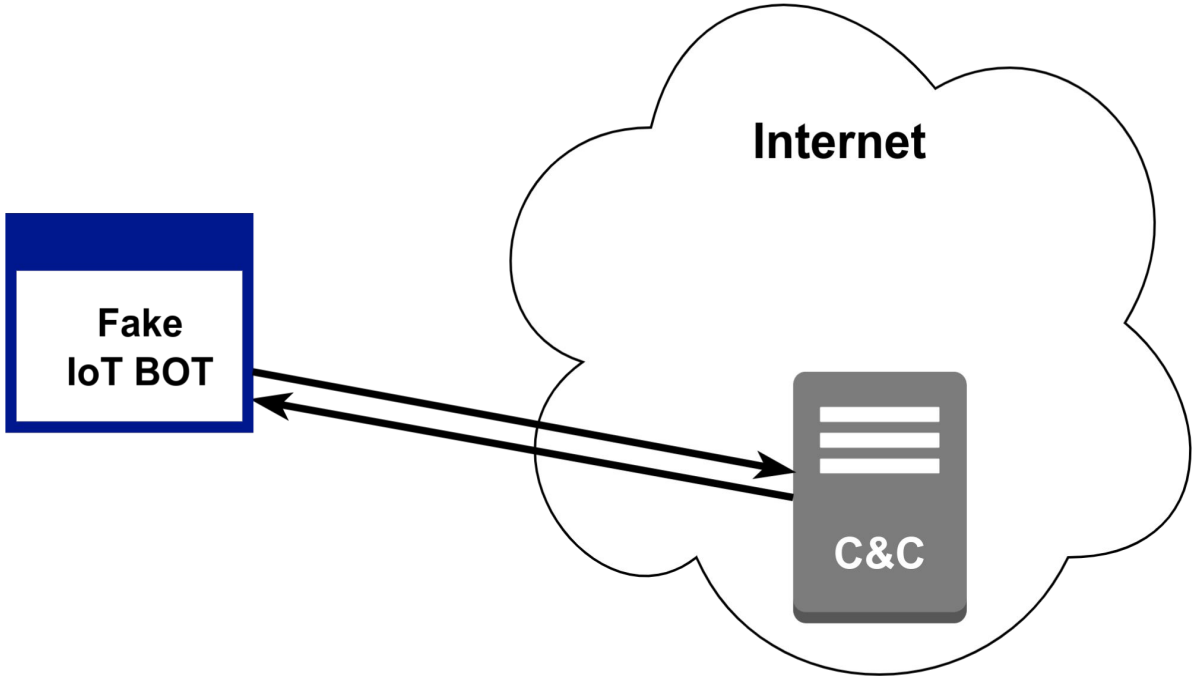
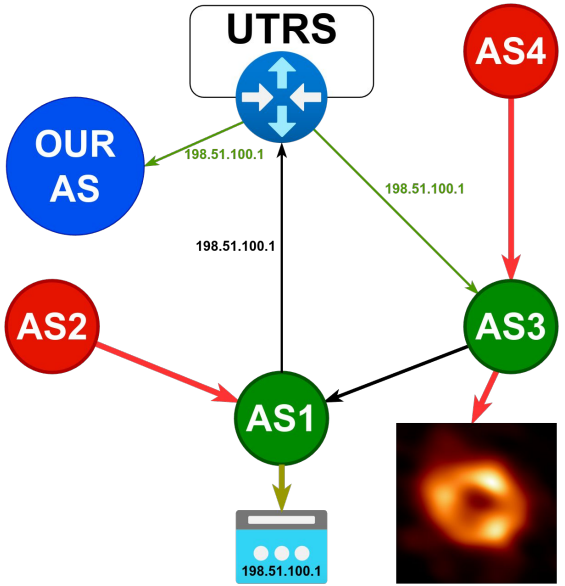


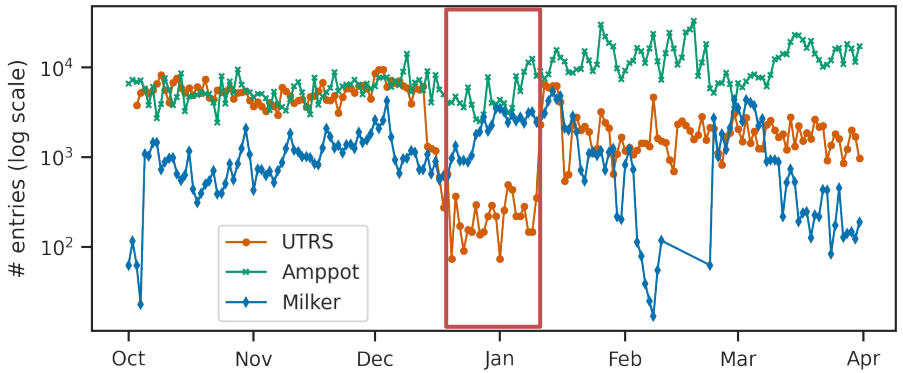
Datasets (6 months)

- UTRS
  - OUR AS collects snapshots of active UTRS-related BGP routes every 5 minutes
  - Stitch entries if the same target is in the two consecutive snapshots
- AmpPot [1]
  - Honeypot that pretends to be an amplifier
  - Collects the start and end time, target IP address, source port and volume of a DRDoS attack
- IoT Milker
  - Imitates IoT bot behavior, receiving attack commands from C&C servers
  - Collects the start time, target network and port, and duration of an IoT DDoS attack

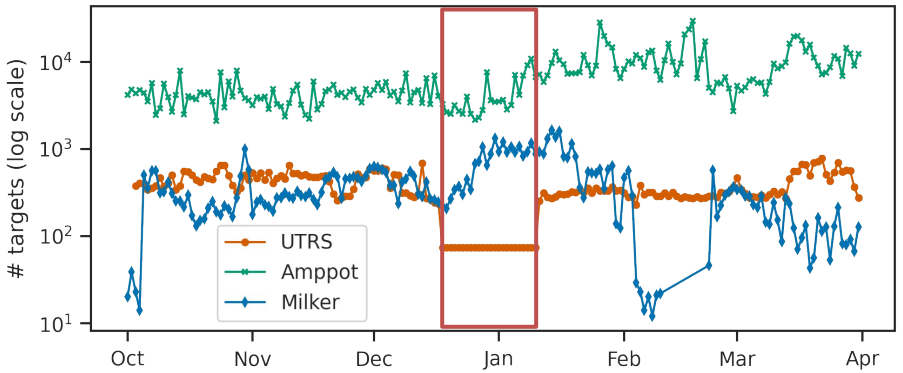


1. Krämer, L., Krupp, J., Makita, D., Nishizoe, T., Koide, T., Yoshioka, K., Rossow, C.: “AmpPot: Monitoring and Defending Against Amplification DDoS Attacks.” RAID, 2015

Datasets Description



a) Number of entries per day



b) Number of targets per day

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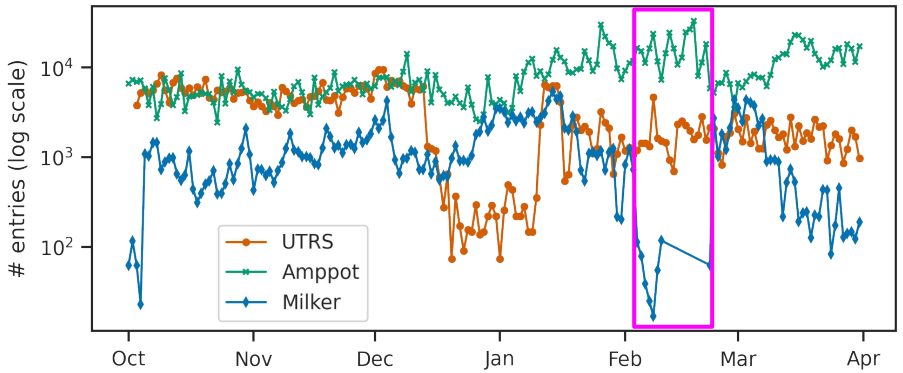

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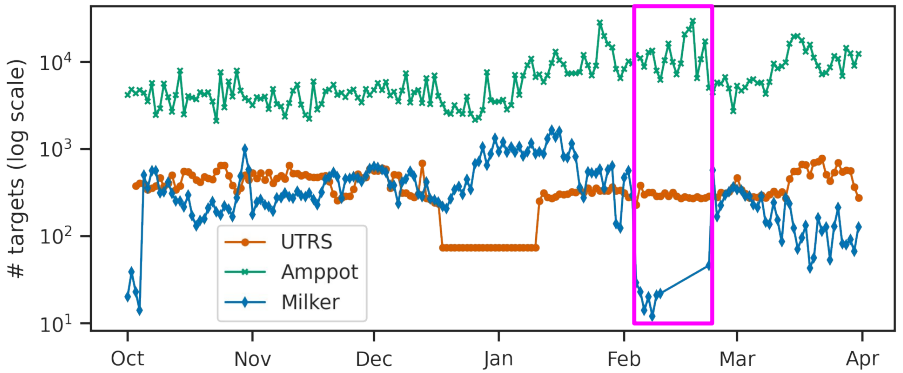

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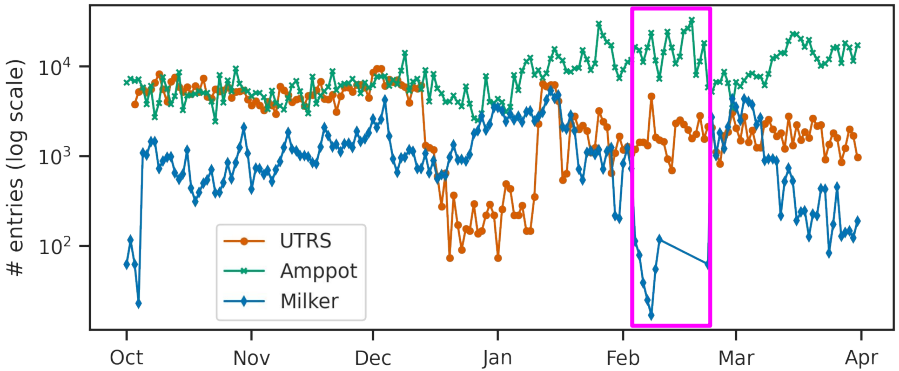

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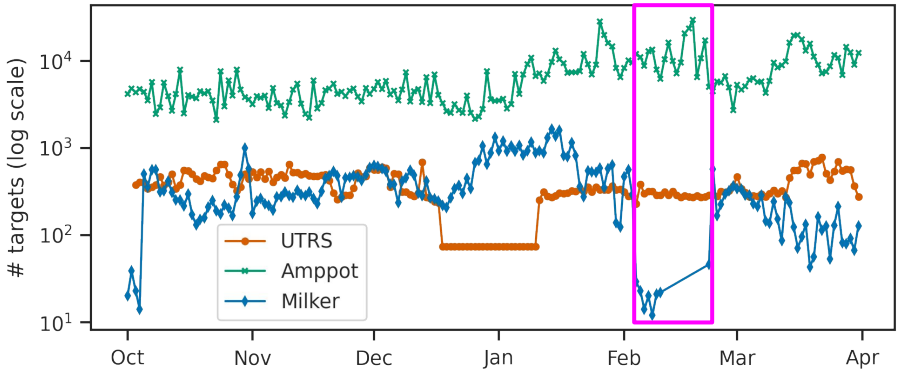


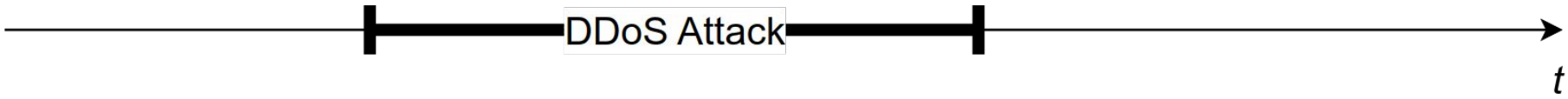
b) Number of targets per day

Dataset	# entries	# targets	# unique target IPs	Duration (sec)		
				min	mean	max
UTRS	533,257	7,820	7,830	300.0	4,682.7	413,700.0
AmpPot	1,616,184	1,080,770	1,080,770	0.5	891.5	1,949,571.0
Milker	223,267	46,764	2,787,522	1.0	93.0	3,600.0

Findings: UTRS Dataset

- **Highlights:**
  - **Low usage:** minimum 74, mean 3,122, and maximum 9,427 announcements to minimum 74, mean 357, maximum 776 targets per day
  - **Sparse coverage:** the majority of UTRS announcements (533,255) target individual IP addresses (/32 prefix length), only 2 entries targeted the same /27 subnetwork within the same day
  - **Low conversion:** only 124 ASes out of 1,300+ UTRS members (around 10%) use this service to advertise IPs
  - **Short duration:** 21% of all announcements is less than 5 minutes, longest - 4 days, 18 hours and 55 minutes

Datasets Intersection



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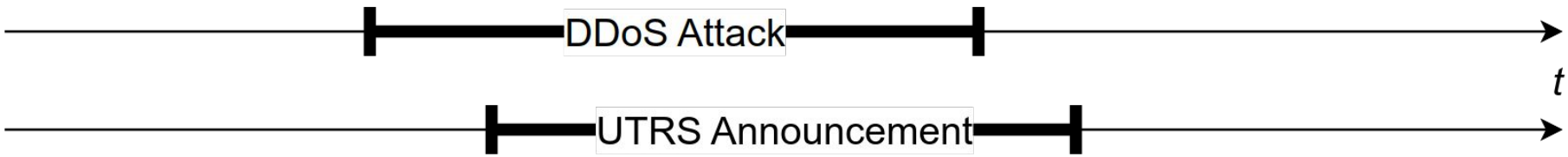
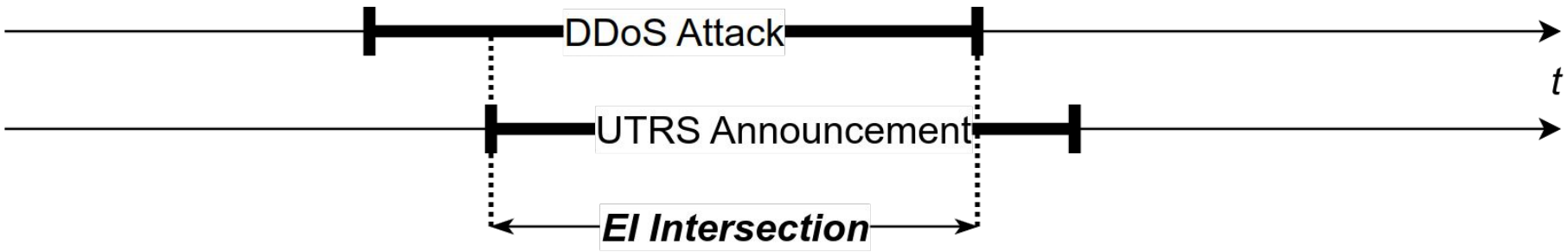
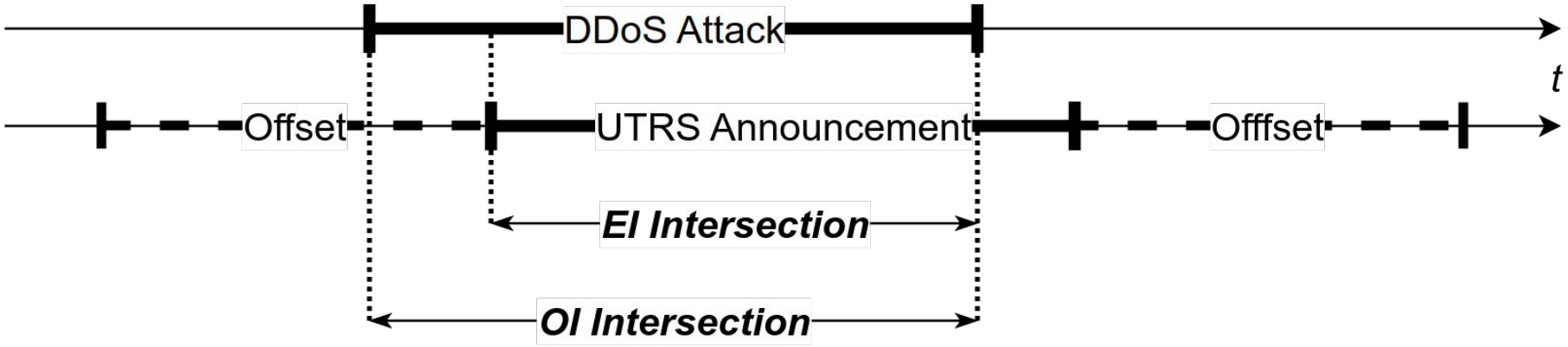


Datasets Intersection: Exact Interval (EI)



Datasets Intersection: Offset Interval (OI)



1. Jonker, M., Pras, A., Dainotti, A., Sperotto, A.: “A First Joint Look at DoS Attacks and BGP Blackholing in the Wild.” IMC, 2018

Findings: Datasets Intersections

- Low number of intersections with DDoS datasets

Parameter	UTRS-AmpPot		UTRS-Milker	
	EI	OI	EI	OI
# of entries	468	6,774	9	791
# of unique DDoS attack targets	249	1,268	2	143
# of unique UTRS targets	249	1,268	8	163
# of unique UTRS ASNs	25	43	2	6
Mean entries # per UTRS announcement	1.55	1.76	1.12	1.88

Findings: Datasets Intersections

- Low number of intersections with DDoS datasets
- Low number (43 total) of ASNs for which an intersection is found
  - 11 ASNs are from Brasil, 9 from the USA, 7 from Argentina

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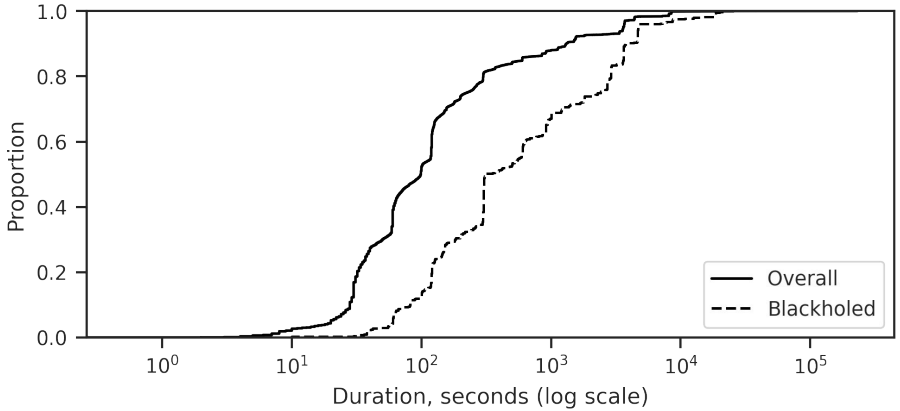
Findings: Datasets Intersections

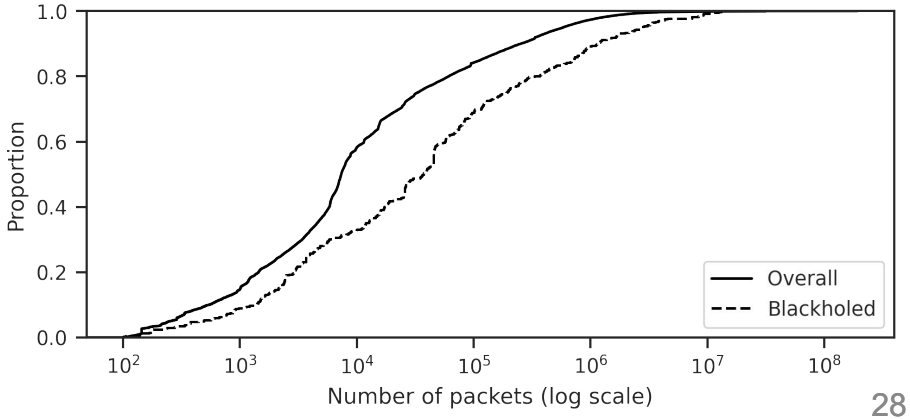
- Low number of intersections with DDoS datasets
- Low number (43 total) of ASNs for which an intersection is found:
  - 11 ASNs are from Brasil, 9 from the USA, 7 from Argentina
- Low percent of DDoS attacks **on the UTRS members** trigger mitigation:
  - 1.03% of AmpPot and 0.06% of Milker for EI
  - 8.86% of AmpPot and 6.88% of Milker for OI
- **Globally**, the percentage even lower:
  - 0.025% of AmpPot and 0.001% of Milker for EI
  - 0.212% of AmpPot and 0.147% of Milker for OI

Findings: Blackholed Attacks Characterisation

Overall - all AmpPot-recorder attacks on all ASNs triggering at least one mitigation attempt

Blackholed - all AmpPot-recorded attacks for which exact intersection with the UTRS data is found





Conclusions

- UTRS is a free, global, and low-effort-to-join alternative to RTBH
- **Takeaways:**
  - Around 1% of all ASNs are UTRS members
  - Only 124 ASes out of 1300+ UTRS members (around 10%) use this service to advertise IPs
  - UTRS announced maximum 776 targets per day
  - Only 0.025% of amplification and 0.001% of IoT-botnet-driven attacks are highly likely attempted to be mitigated using UTRS
- **Acknowledgements:**

  - RAPID project (Grant No. CS.007) supported by Dutch Research Council (NWO), the Netherlands
  - MITIGATE project (JPJ000254) supported by MIC, Japan
  - Commissioned research (No.05201) supported by NICT, Japan
  - JSPS KAKENHI Grants (Numbers 21H03444 and 21KK0178)