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Open INTEL

Measuring the Impact of a Successful DDoS Attack on the Customer Behavior of Managed DNS Service Providers

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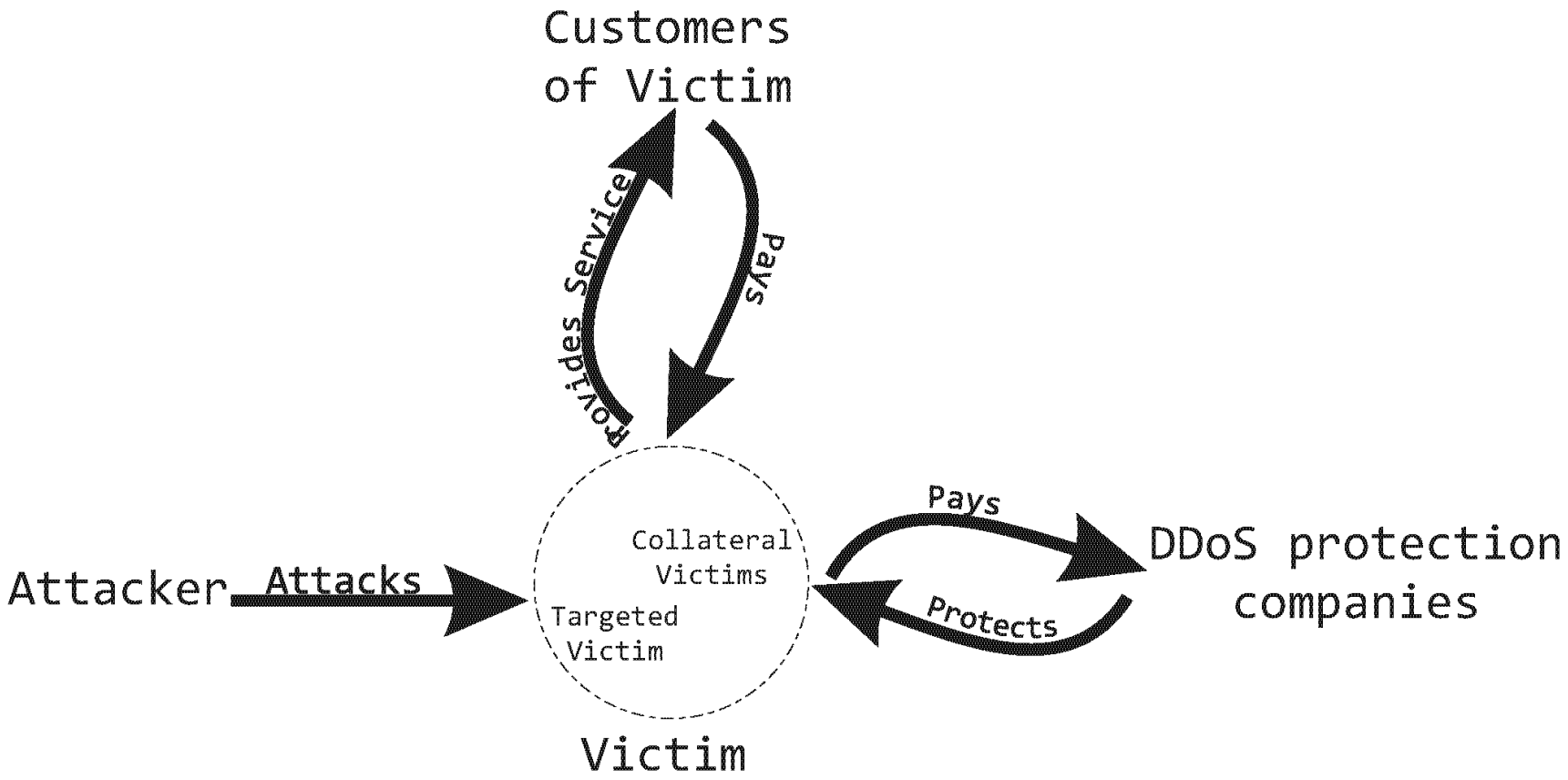
A human DDoS?

Stakeholders of a DDoS attack



Damages

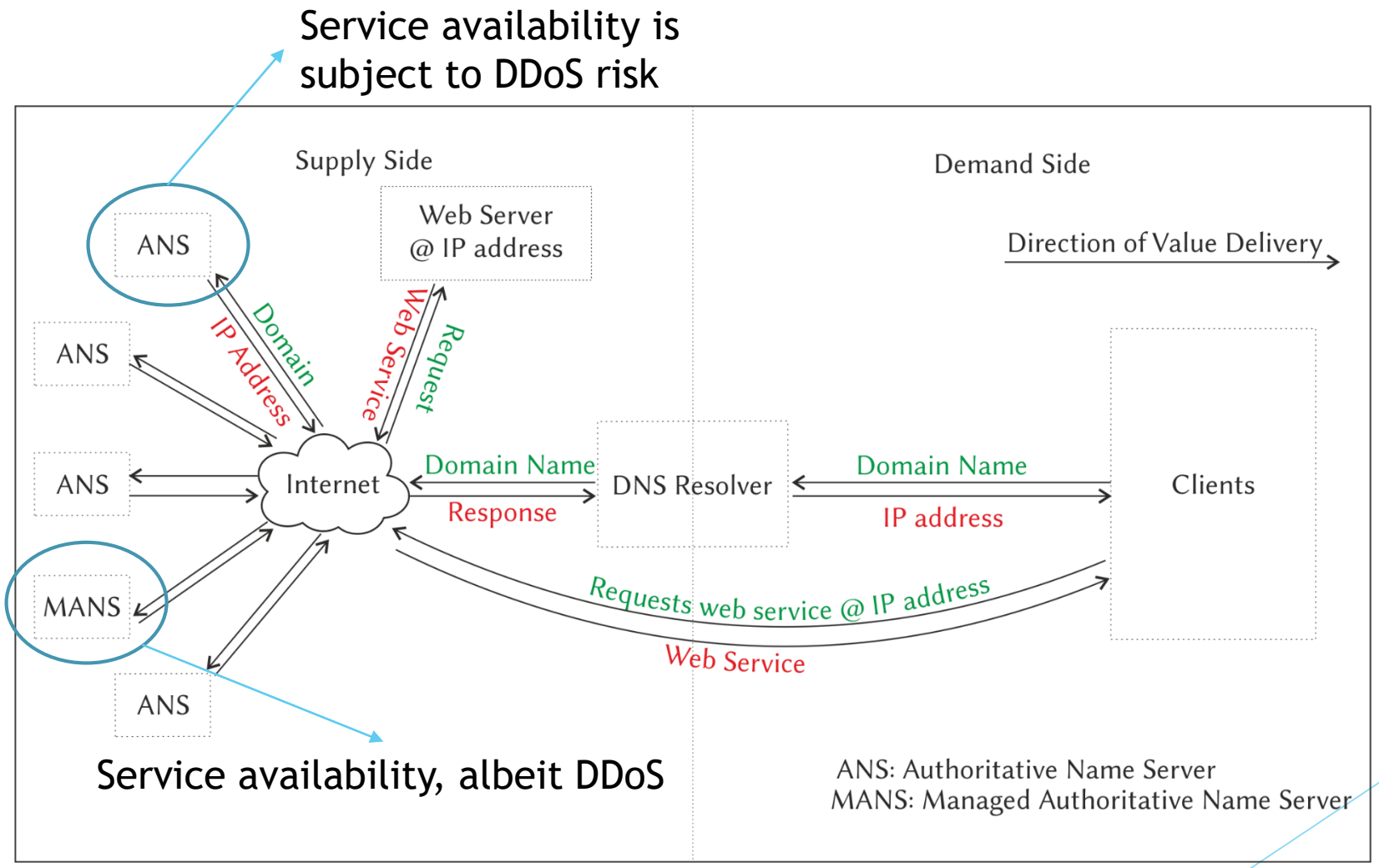
- Direct Damages
  - Loss due to infrastructure downtime.
  - Paid ransom.
  - Customer compensation etc.
- Indirect Damages
  - Reputational damage
  - Impact on stock price etc.

Questions

- Is there an impact of a successful DDoS attack on the customer behavior of a MDNS service provider? If yes-
  - How can we measure it?
  - Is the impact statistically significant?
  - What choices do the customers of the attacked MDNS providers make after the attack?

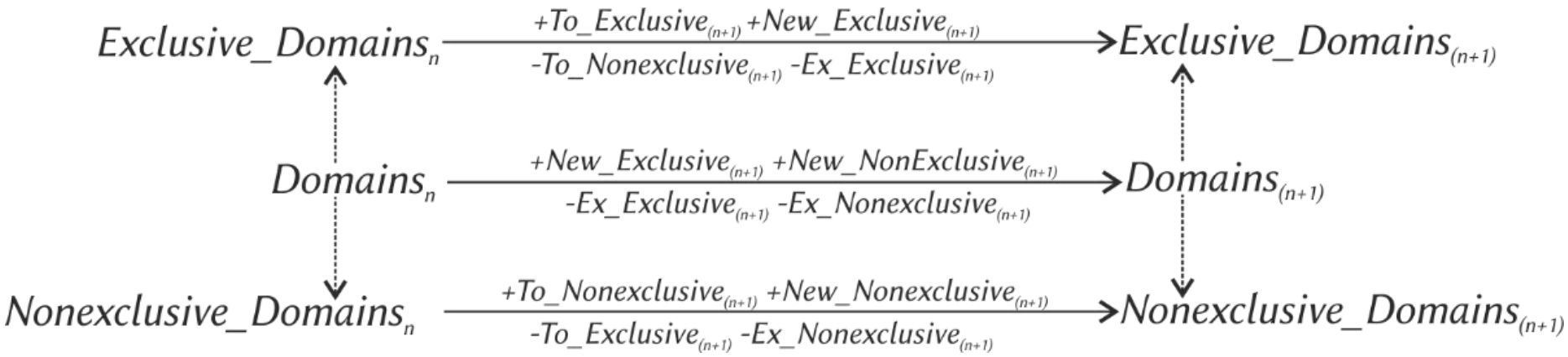
Is there an impact of a successful DDoS attack on the customer behavior of a MDNS service provider?

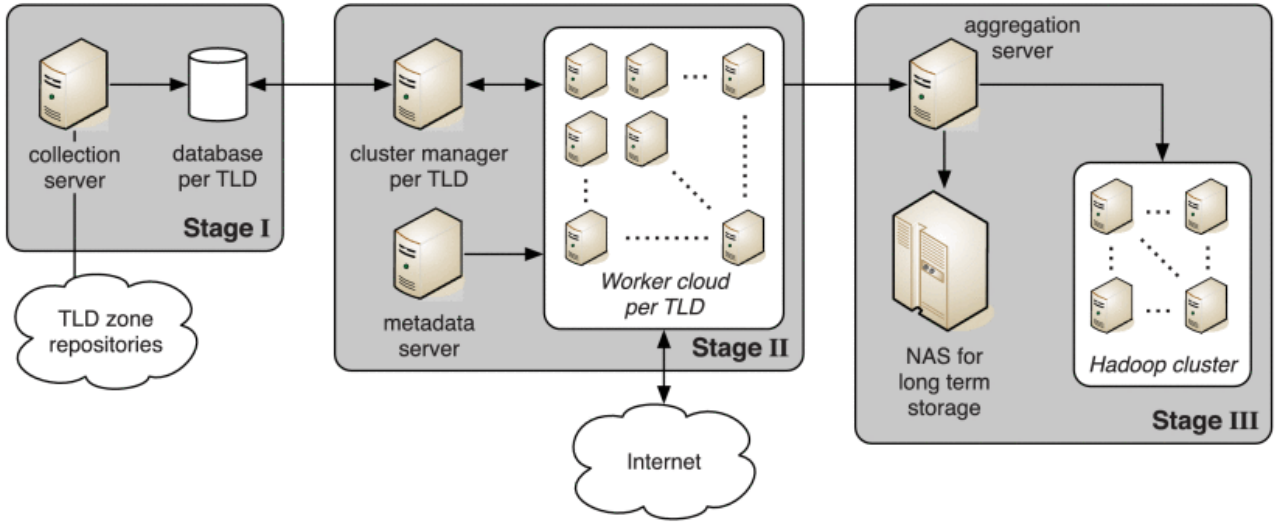
Value of a MDNS



How can we measure it?

Modelling Customer Behaviour



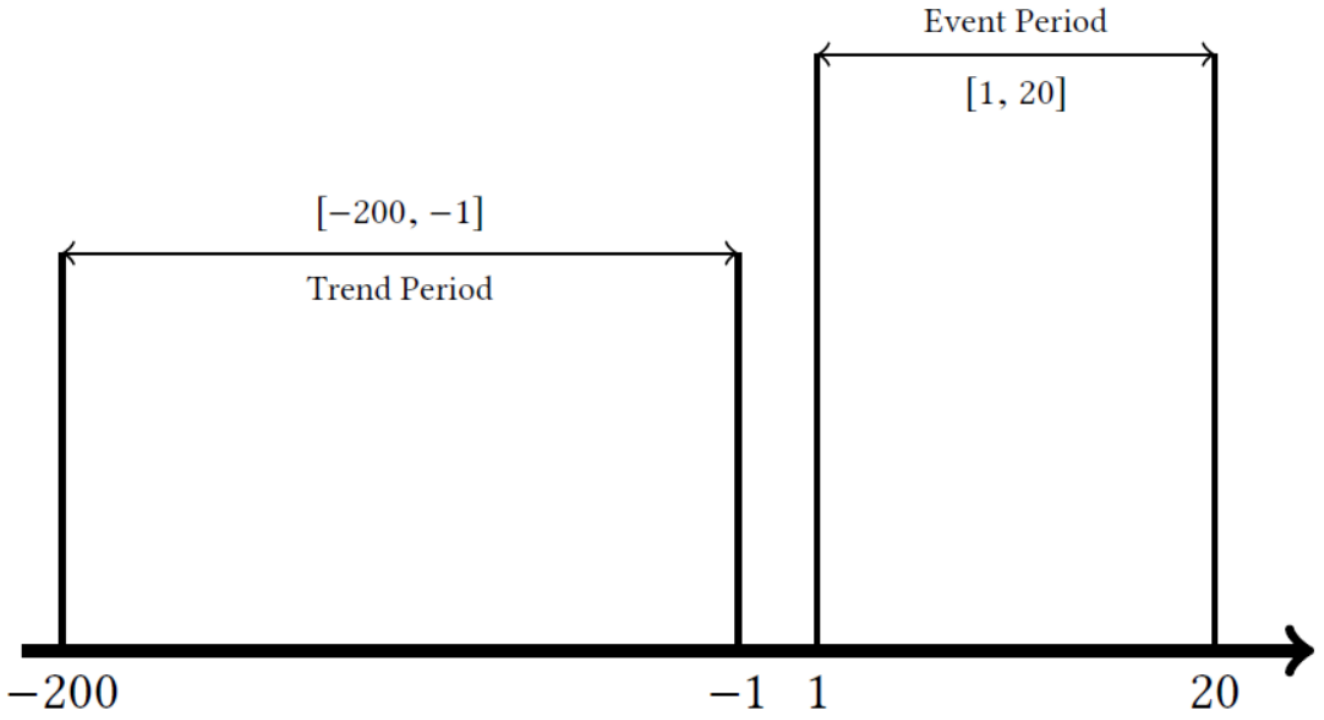


Active DNS Measurements

OpenINTEL Dataset[#]

[#] R. van Rijswijk-Deij, M. Jonker, A. Sperotto and A. Pras, "A High-Performance, Scalable Infrastructure for Large-Scale Active DNS Measurements," in *IEEE Journal on Selected Areas in Communications*, vol. 34, no. 6, pp. 1877-1888, June 2016.

Trend and Event Window



Large attacks on MDNS service providers

Attack on NS1 on 16th May 2016.

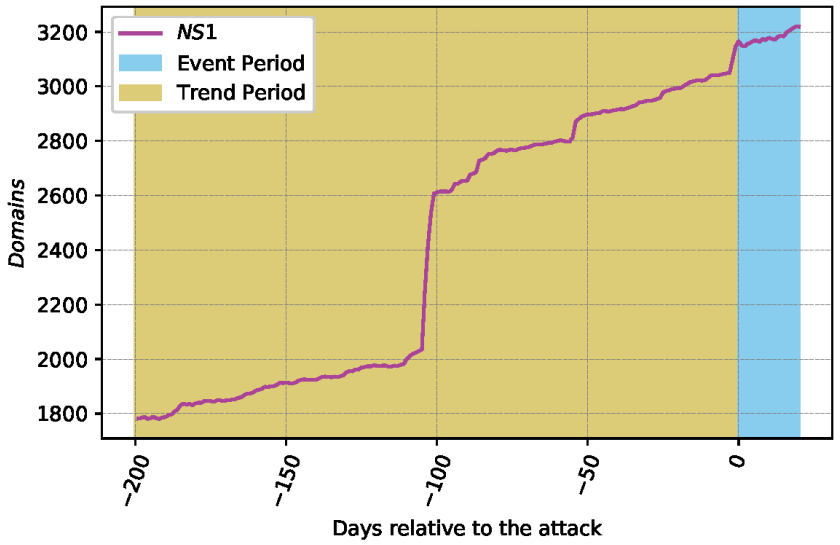
- Had ~3150 domains (.com/.org/.net) one day before the attack.
- ~98% domains were exclusive.

Attack on Dyn on 21st October 2016.

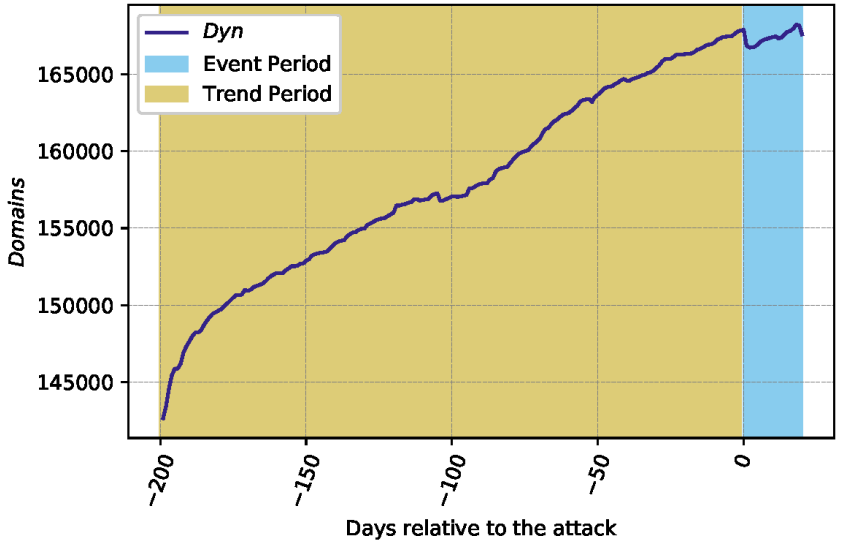
- Had ~167,000 domains (.com/.org/.net) one day before the attack.
- ~84% domains were exclusive.

Impact on total number of customers

NS1

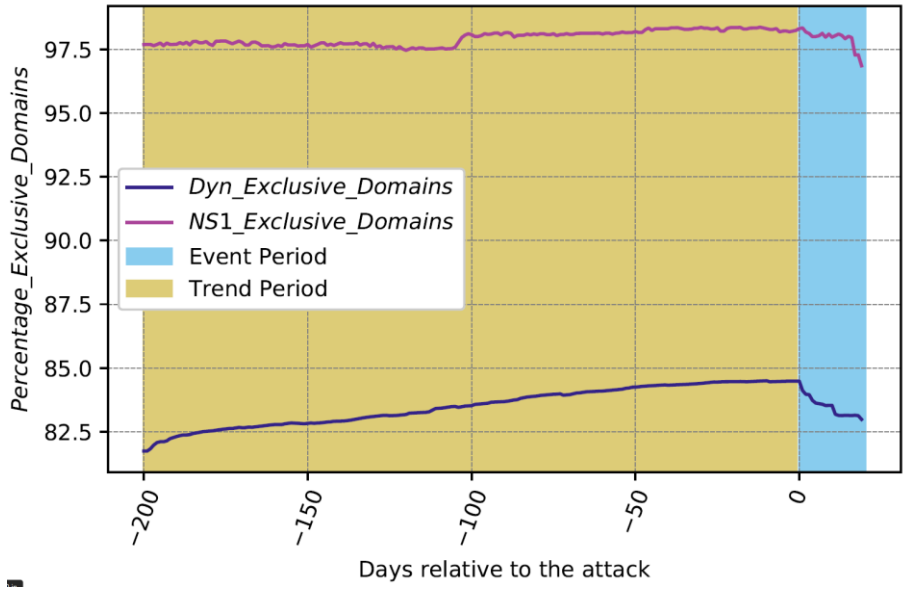


Dyn

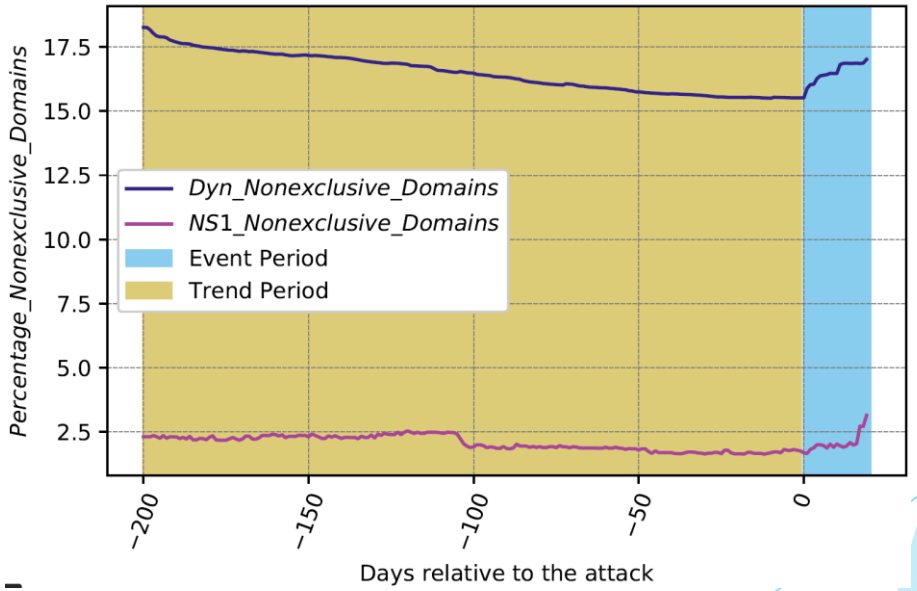


Change in behaviour!

Exclusive Customers

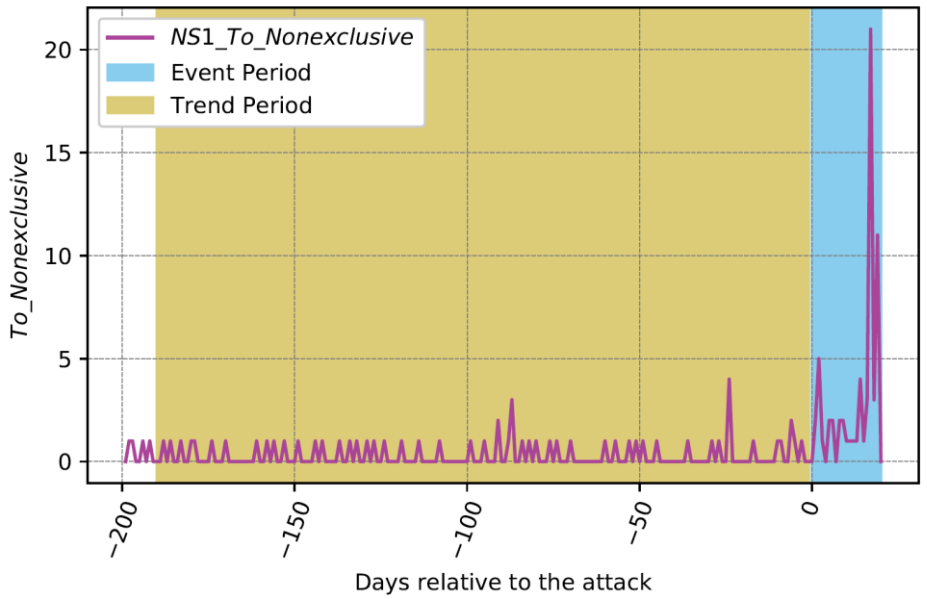


Non-Exclusive Customers

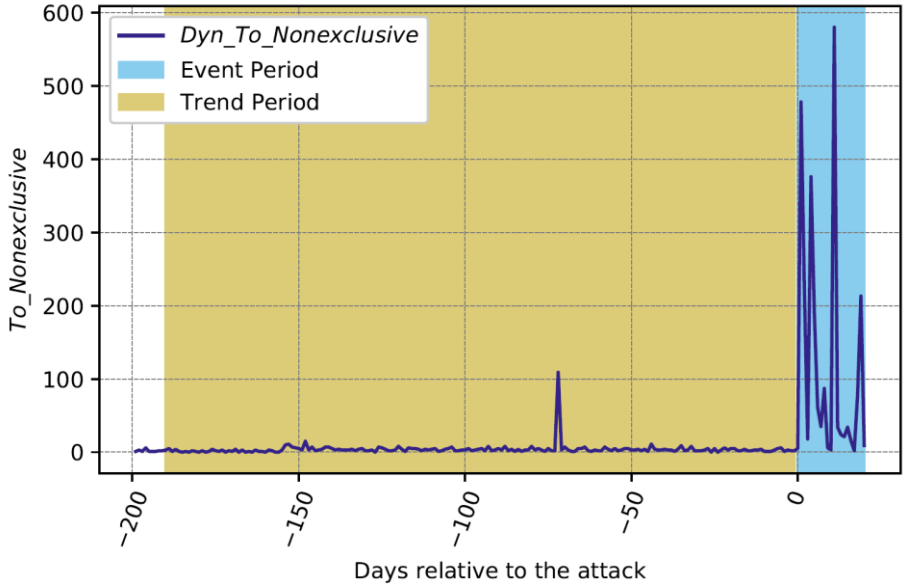


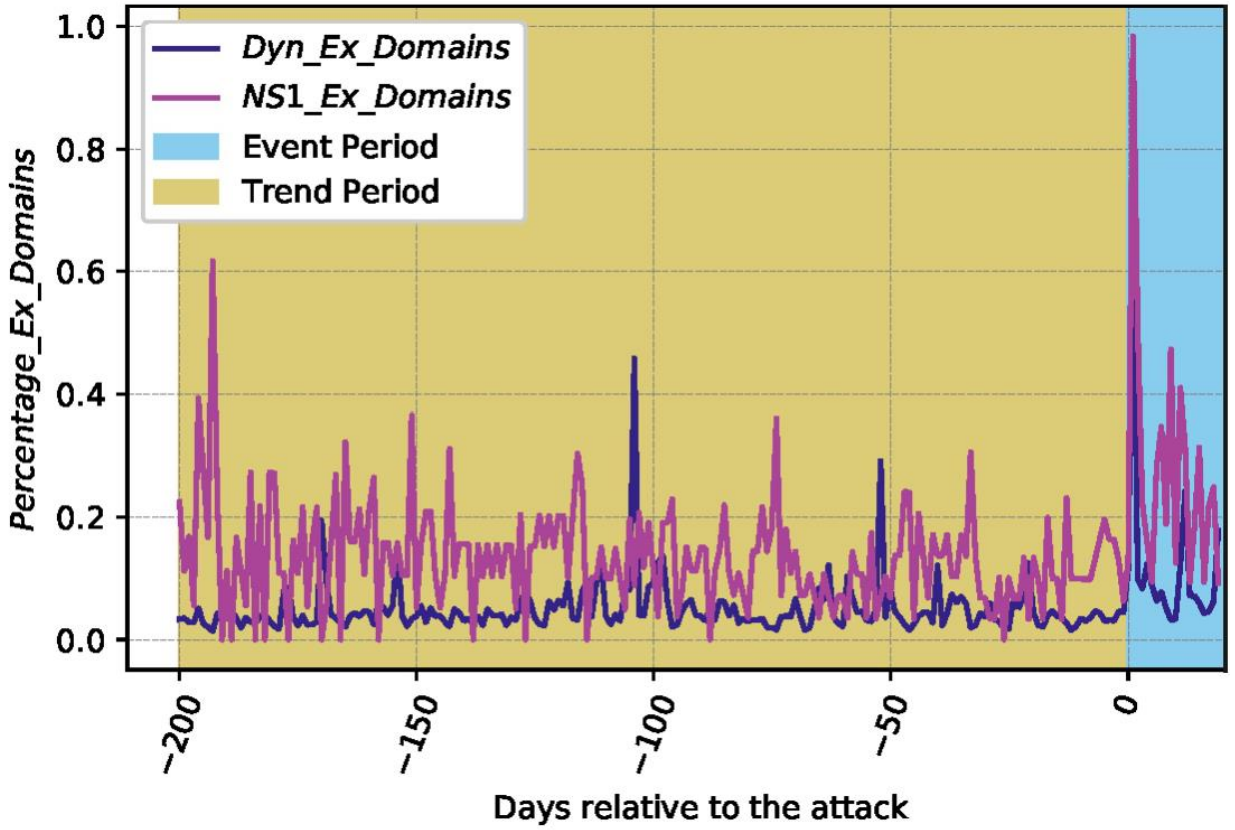
Being Non-exclusive…

NS1



Dyn





Domains that stopped using the services of the MDNS provider.

Is the impact statistically significant?

Statistical significance of the change in behavior variables.

- H_{a1}: There is no change in the behavior of domains that use an MDNS provider after a DDoS attack.
- H_{a2}: There is no change in the mean of behavior variables in the trend and the event period.

Table: Results of T-test on behavioral variables

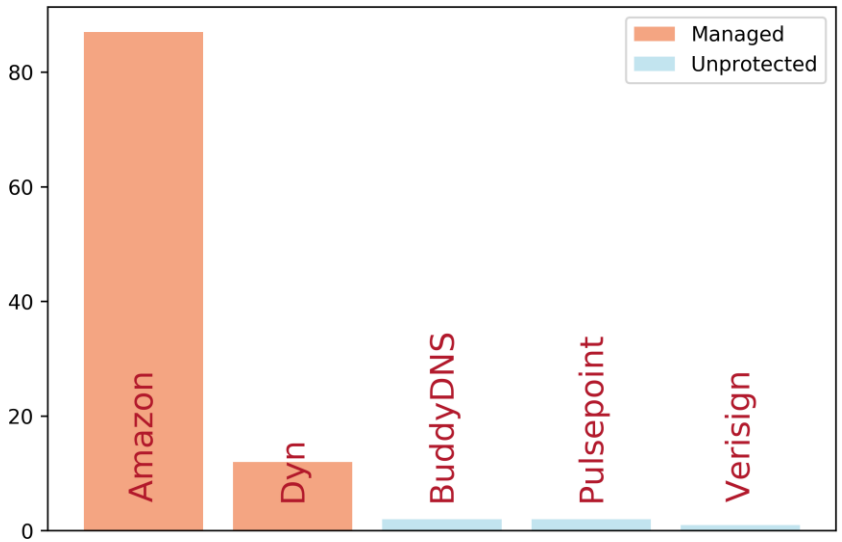
Variable	Trend Period Mean		Event Period Mean		t-statistic	
	Dyn	NS1	Dyn	NS1	Dyn	NS1
Δ *Domains*	127.05	6.87	-9.545	3.42	2.229*	1.45
Δ *Exclusive_Domains*	126.985	6.80	-127.82	1.42	3.16*	2.18*
Δ *Nonexclusive_Domains*	0.065	0.07	118.27	2	−3.341*	−1.42
Ex_Exclusive	66.63	2.85	212.59	5.47	−2.595*	−2.02*
Ex_Nonexclusive	10.68	0.24	7.682	3.19	1.93	−7.32*
New_Exclusive	194.29	9.68	195.4	8.90	-0.057	0.40
New_Nonexclusive	10.07	0.29	15.32	3.19	−2.49*	−8.1*
To_Nonexclusive	3.8	0.3	114	3	−3.12*	−2.57*
To_Exclusive	3.1	0.27	3.36	1	-0.44	-5.1

*p -value ≤ 0.05

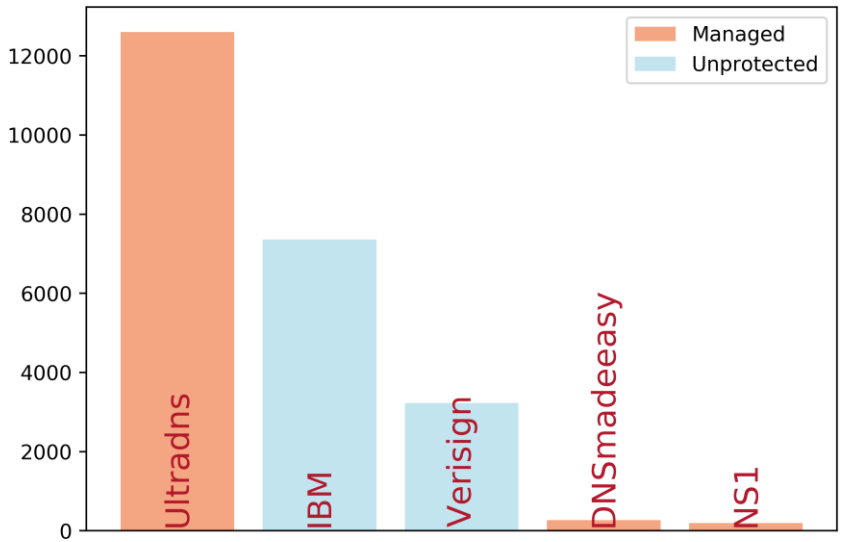
Choice of Secondary DNS provider

Top Secondary DNS choices before the attack.

NS1

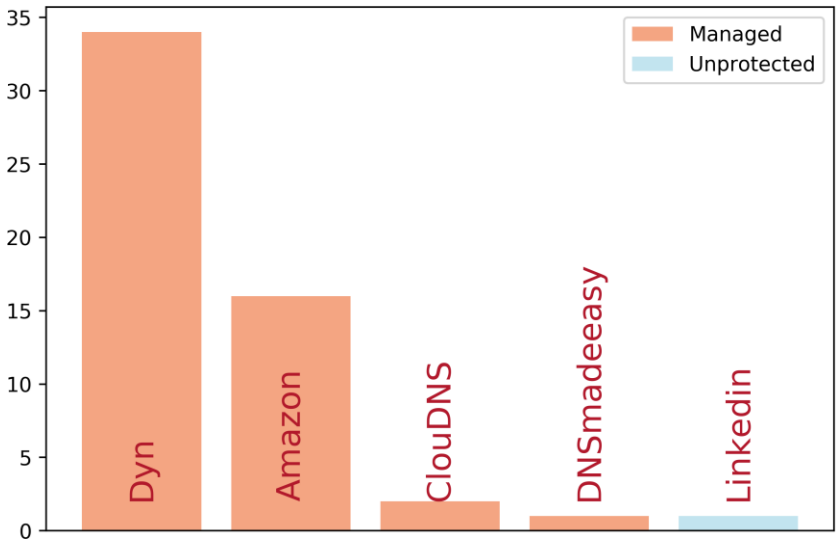


Dyn



Top Secondary DNS choices after the attack.

NS1



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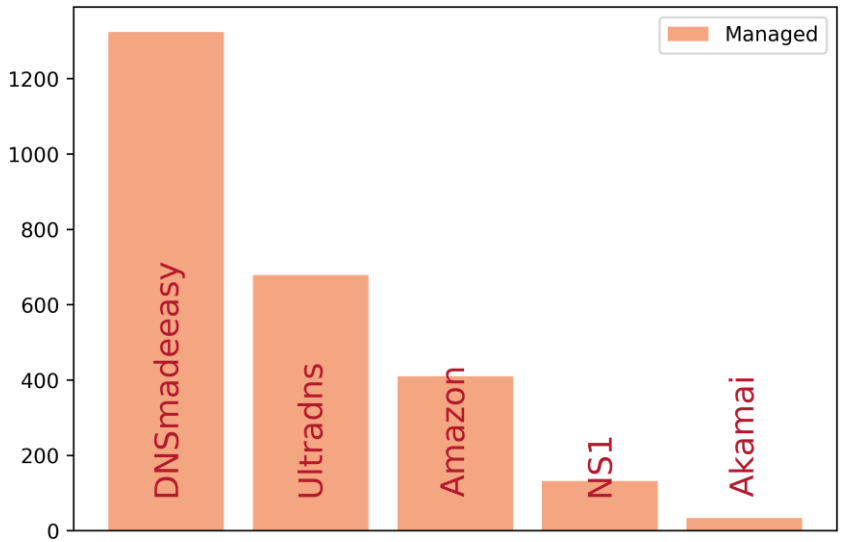
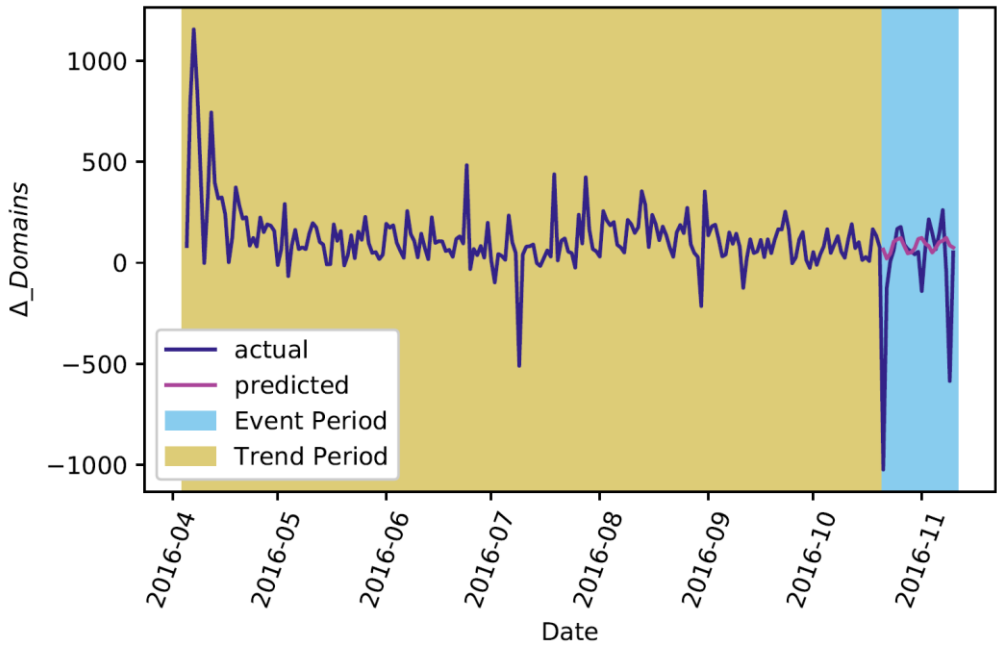
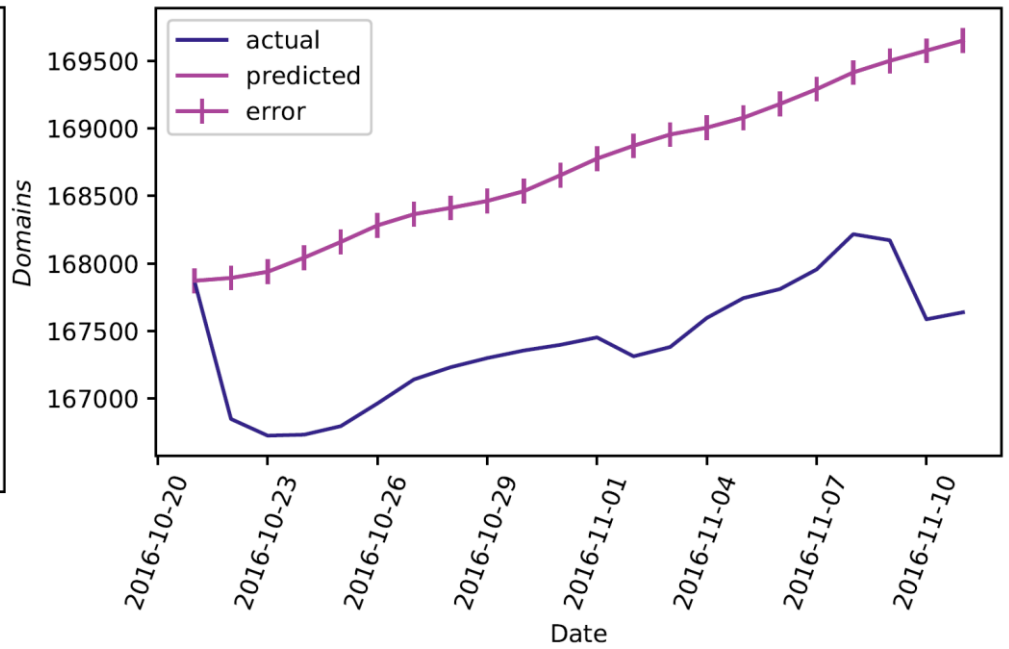


Applications

Loss of Customers for Dyn





By the most conservative of estimates Dyn lost ~2000 domains due to single successful attack event!

Take Away

If we then focus on the aftermath of the attack, we observe a number of statistically significant changes:

- A significant number of MDNS customers that were using Dyn's or NS1's service exclusively switch to non-exclusive use in the aftermath of the attack. (Lasting change)
- No significant changes in the behaviour of Dyn customers that were already non-exclusive users.
- In terms of risk management, using multiple providers is a good strategy.
- Most of the customers that became non-exclusive after the attack on NS1 and Dyn chose an MDNS service provider as a secondary DNS to further reduce the risk of downtime.

Thank You

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