Tandem Attack: DDoS Attack on Microservices Auto-scaling Mechanisms

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Abstract

In this work we demonstrate how an attacker can exploit the tandem behavior of microservices with different auto-scaling mechanisms to create an attack we denote as the Tandem Attack. We demonstrate the attack on a typical Serverless architecture and show that using managed infrastructure does not liberate from strict planning of scaling definitions.

Introduction

Auto-scaling

- A primary ability of cloud computing which allows systems to adapt to fluctuating traffic loads.
- Dynamically increasing (scale-up) and decreasing (scale-down) the number of resources used.

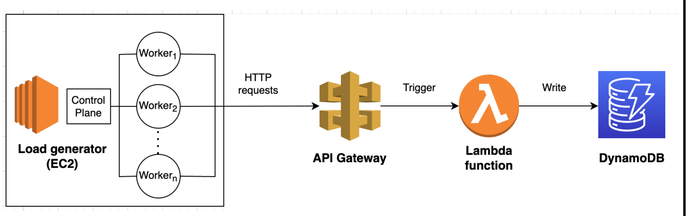
Microservices Architecture

- Software systems are implemented by loosely-coupled services
- Each service is responsible for specific task and defined with separate scaling properties.

Attack Methodology

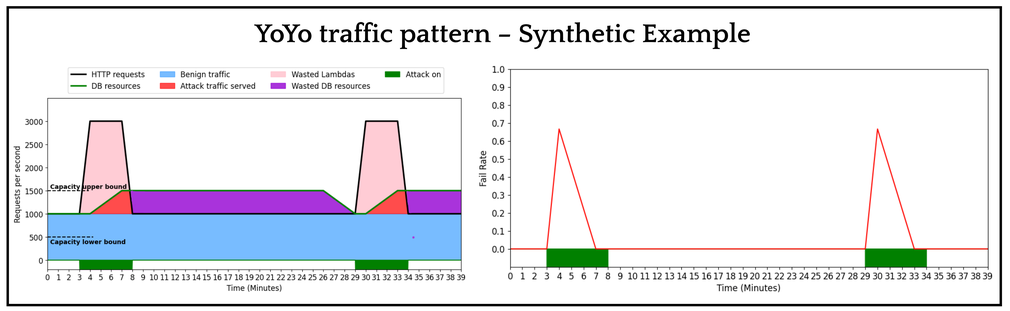
- Microservices with separate auto-scaling mechanisms work in tandem to process traffic, they can overload each other.
- Overload results:
- Throttling (Denial of service - DoS)
- Over-provisioning of resources (Economic Denial of Sustainability - EDoS).

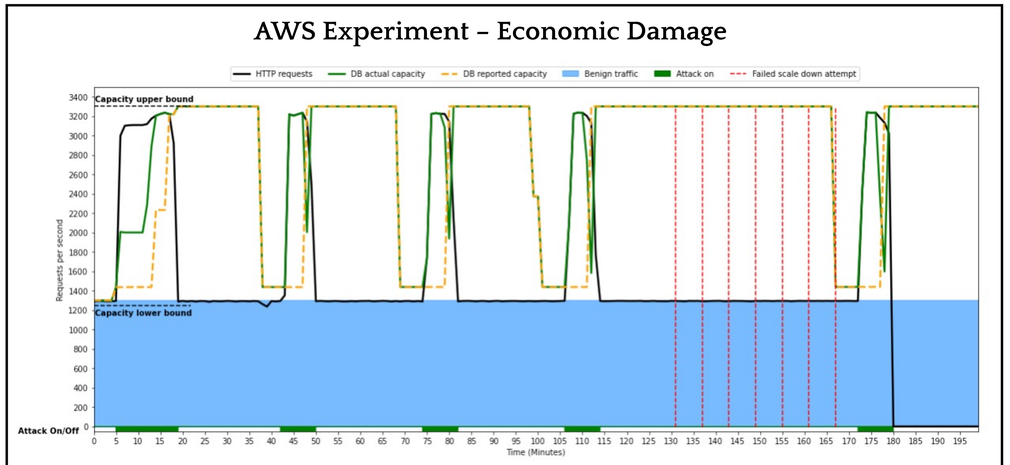
Experiment Architecture

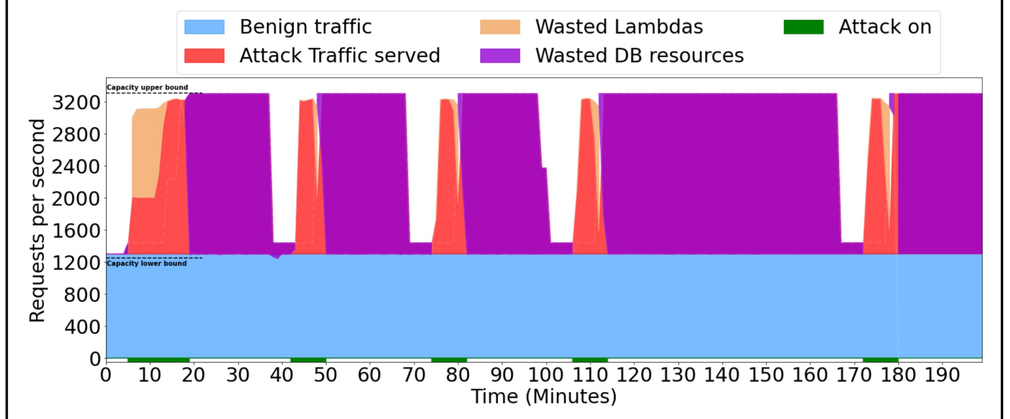


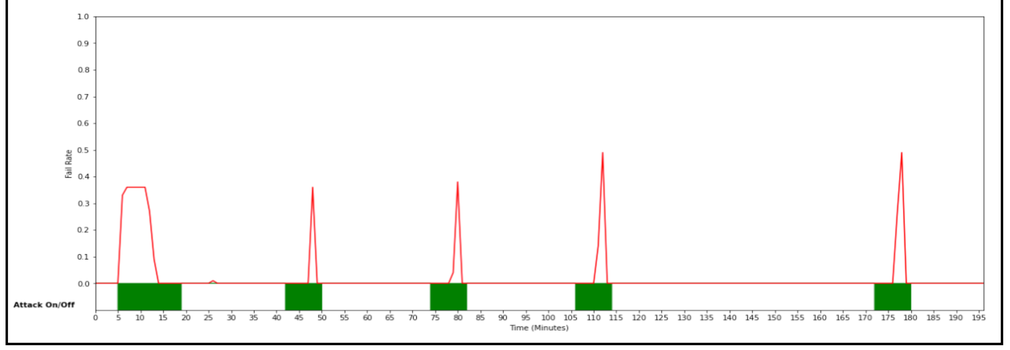
	AWS Lambda (Fast Scaling)	DynamoDB (Slow Scaling)	
		On-demand	Provisioned
Cost	• Request → function → cost • Execution time • HW, network and others.	Per successful completion (Pay-per-use)	Allocated resources
Scale Up	No upper bound; 3K for burst followed by 500 per minute	~15min	~7min
Scale Down	→ 0	Never	~22min/60min

Experiment Results









Evaluation

	Tandem: DDoS DB provisioned Model	Tandem: Yo-Yo DB Provisioned Model	Tandem: Yo-Yo DB Provisioned Experiment	Tandem: DDoS DB on-demand Model/Experiment	Tandem: YoYo Yo-Yo on-demand Model
Attack Cost	2	0.38	0.55/0.27	2	0.83
Relative Economic Damage lambda	2	0.38	0.55/0.27	2	0.83
Relative Economic Damage DB	0.5	1.81	2.79/3.08	2	0.83
Relative Performance Damage	0.5	0.27	0/0	0	0
Economic damage lambda Potency	1	1	1	1	1
Economic damage DB Potency	0.25	4.73	5.06/11.36	1	1
Performance Potency	0.25	0.25	0/0	0	0

The Attacker's Perspective

- Very easy to overload web components that do not require auth/login
- Automated solutions for handling captcha and login exist
- Real time systems are more prone (financial, security, medical)
  - In async. systems likely to see performance degradation
- Can create Tandem attack only by following 2 metrics:
  - Success/Fail ratio of requests
  - RTT
- Prior knowledge on the system can assist in optimizing the attack

Mitigations

- Rate limiting - limit traffic as close as possible to the origin:
  - Easy & Effective
  - In our use case: limit the Lambda to match the DB scaling capabilities
- Decoy by inserting noise to response time (when under attack)
  - Randomizing the RTT reduces the attacker's ability to evaluate the system's state
  - Attacker using same resources to attack multiple targets might be exausted
- Retry comes with costs
  - Can compensate when services are not synced
  - Significant increase in latency (sometimes not acceptable) & costs
  - If attack is realitvely strong might prolong the effect of the attack
- Developing better service control planes that can backpressure – relevant especially for cloud services
- Validate incoming traffic when possible (considering the time penalty)

Conclusions

- Trade-off between cost & performance – No complete solution !
  - Over provisioning/reserve pools can compensate for DDOS up to a certain extent but with extra costs
- In large systems the micro-service connectivity and dependency can become complex and hard to analyze
- Serverless is not a solution for Tandem attack

Future Work

- Detection - collect real-time data from systems with complex micro-services dependency and implement Algorithm that identifies issues
- Mitigation - Algorithm that identifies tandem issues and resolves

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Complete Research