Team Binary Bros: PRD Version 2

Project: TackleBox

Developers

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Company

Novacoast

Introduction

Problem and Importance:

2020 has seen a sharp rise in the frequency of cybersecurity attacks and with it an increase in their sophistication. These improvements make the attacks harder to spot, thus allowing them to compromise higher-value targets. Often these attacks will target people as the weakest link in the security chain and as a result phishing scams—a tactic which uses fraudulent emails to trick receivers into revealing sensitive information—are becoming ever more apparent. Once sensitive information—like a sysadmin password— has been stolen, the hacker may be able to steal integral data from the company, encrypt it, and then demand money for the encryption key. Since currently there is no way to decrypt the data without the key, the organization is forced to pay the ransom. As a result, prevention is the only method to combat these attacks. Preventing employees from accessing these fake domains can be difficult though even with proper safety training. The process of registering a fake domain, pushing malicious code and emailing victims can take less than an hour total. This speed paired with high volumes of attacks allows some fake domains to exist for weeks or months without being spotted and thus it is only a matter of time before someone makes a mistake and falls for the trap. Furthermore, these attacks are not only tricky to combat, but are also extremely costly—The FBI issued a PSA that estimates that over $12 billion were lost due to email phishing between 2013 and 2018.

Team Goals and Objectives:

Our main goal is to create an automated anti domain-spoofing service, which will assist our users in identifying, tracking and dismantling malicious websites. We plan to do so by creating a frontend web application which allows its users to configure groups and within them domains to monitor. A user can then configure at—a specified cadence—a dns record scan which will locate all potentially malicious domains which have similar domain names to those within the user's group. Once the scan is complete our backend service will complete various automated checks on the phishing domains in order to rate their threat level and compose an analysis for each domain which can then be viewed on the web application. Furthermore, for high threat level domains a report will be emailed to a user's configured addresses so the user (or their legal team) can take action against the creators of the site. As a final measure, our backend service will work with Novacoast's firewall service to block navigation to these spoofing domains for all Novacoast firewall users.

Additionally, we all hope to gain various skills which will help us in our future careers. Foremost, we want to gain familiarity working with new pertinent technologies as these will not only be helpful in our future projects, but also provide good practice learning new concepts on the fly. We also hope to get experience working in remote environments and learn new methods of communication, which can help us in the future. Finally, we want to improve our ability to work together as a team and delineate tasks effectively and efficiently in order to maximize our speed to development.

Current Implementations:

To combat phishing, spam filter engines are typically the first line of defense. However, this solution cannot match the rampant speed at which attacks are being launched. Spam filter engines usually pull suspect domains from older data sources and therefore do not provide a real time solution. On the other hand, educational programs can provide real time solutions by bolstering security through teaching a company's workforce to detect and avoid phishing scams. Although effective, companies are still vulnerable to phishing due to human error. Finally, there are products which allow users to locate potential spoofing domains, but these are not automated and thus require a user to search for their domain in order to get real time results.

Core Technical Advancements:

Our product seeks to leverage open source intelligence software—like dns twist—to handle the discovery of malicious domains for phishing prevention. We will then improve upon these by making recurrent calls to their APIs at a cadence specified by our users through our React Frontend. Thus, a large advancement in our product is the automation of subsequent checks for spoofing domains which—once configured for a user—will provide real time updates. Additionally, our product will contain a domain analysis tool on top of the automation, which assesses the risk that a domain is malicious using regex matching. It will then send automated reports to the corresponding company's legal team or other specified points of contact with a breakdown of recent spoofing domains. Lastly, our software will expand its ability to prevent phishing attacks by integrating with Novacoast's firewall to block users who accidentally travelled to malicious sites.

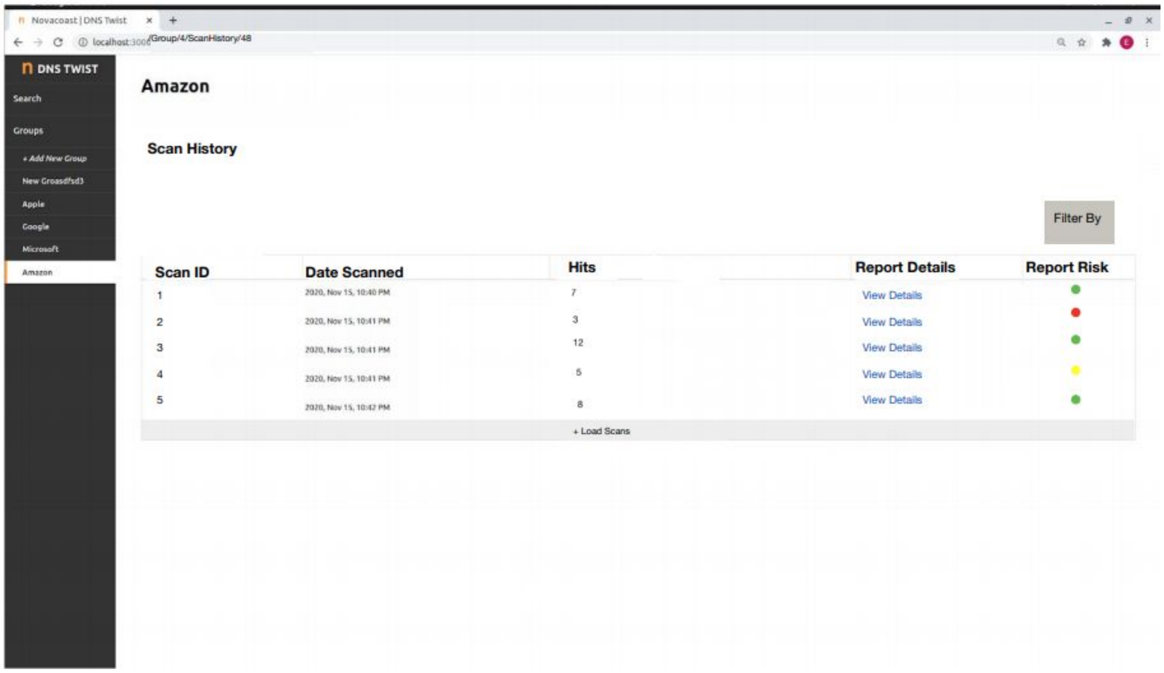
Assumptions:

- Users have their own domains to be monitored
- Users are subscribers of Novacoast's services.

UI Mockups and Screenshots

Mockups:

Scan History

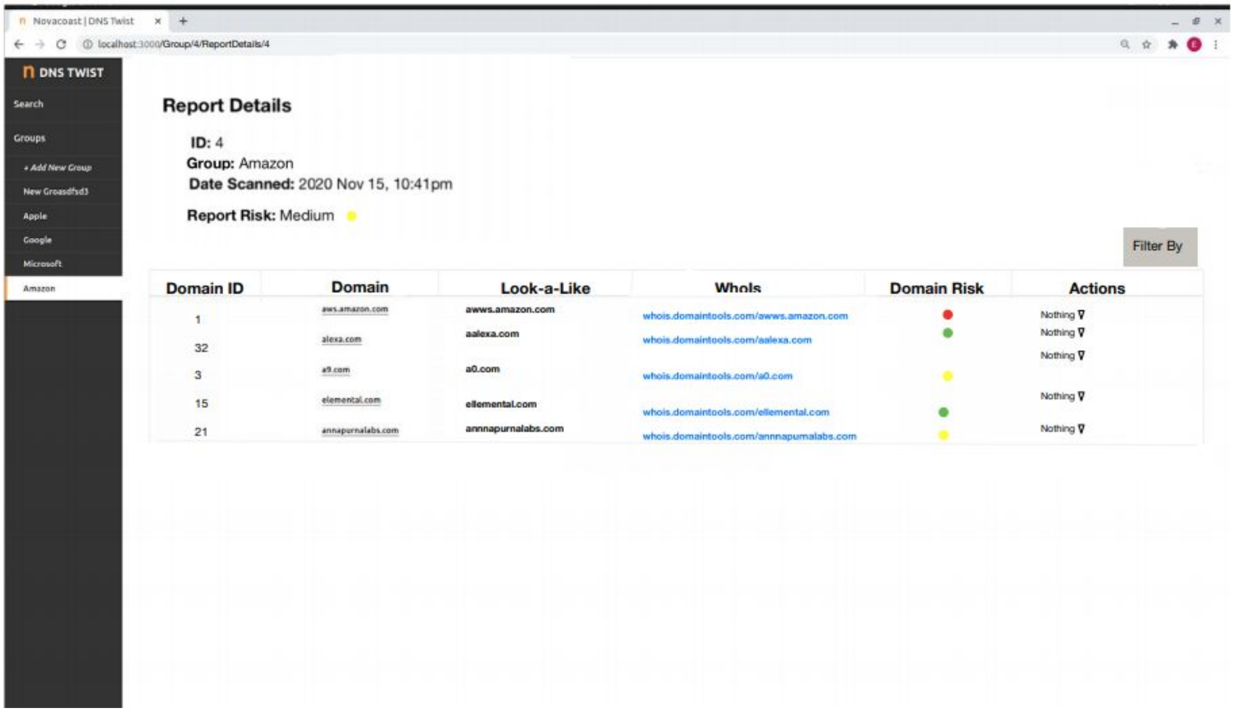


Amazon

Scan History

Scan ID	Date Scanned	Hits	Report Details	Report Risk
1	2020, Nov 15, 10:40 PM	7	View Details	🟢
2	2020, Nov 15, 10:41 PM	3	View Details	🔴
3	2020, Nov 15, 10:41 PM	12	View Details	🟢
4	2020, Nov 15, 10:41 PM	5	View Details	🟡
5	2020, Nov 15, 10:42 PM	8	View Details	🟢

Scan Details



Report Details

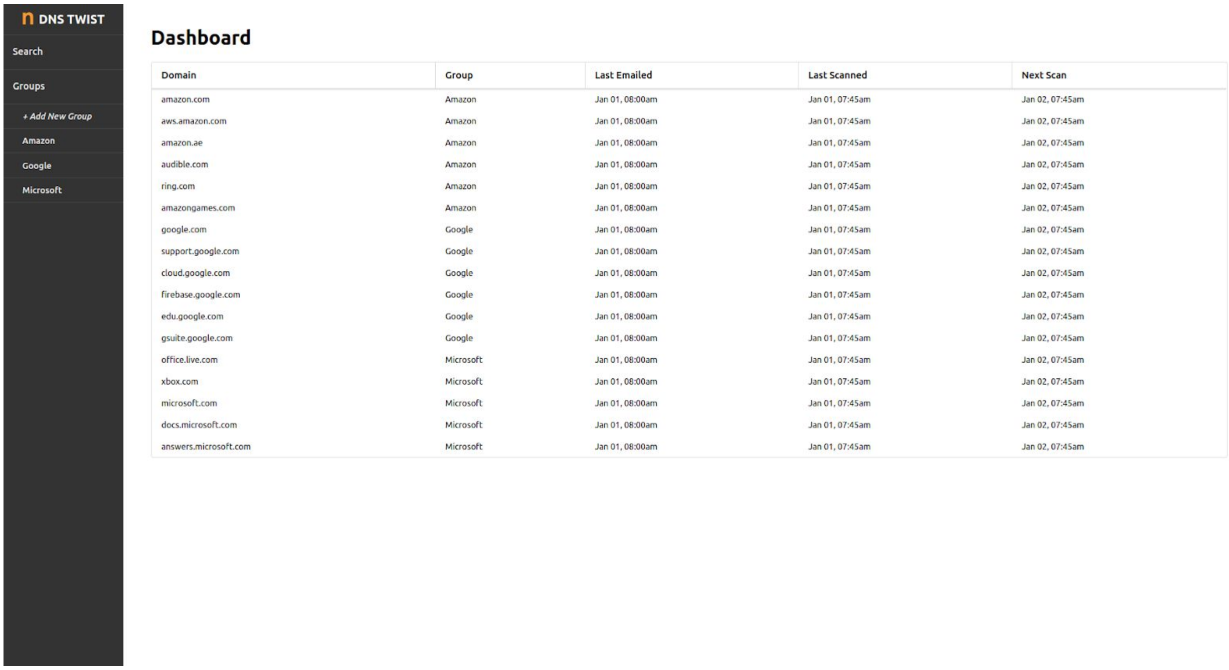
ID: 4
Group: Amazon
Date Scanned: 2020 Nov 15, 10:41pm

Report Risk: Medium 🟡

Domain ID	Domain	Look-a-Like	WhoIs	Domain Risk	Actions
1	aws.amazon.com	awws.amazon.com	whois.domaintools.com/awws.amazon.com	🔴	Nothing ▼
32	alexa.com	aalexa.com	whois.domaintools.com/aalexa.com	🟢	Nothing ▼
3	a9.com	a0.com	whois.domaintools.com/a0.com	🟡	Nothing ▼
15	elemental.com	ellemental.com	whois.domaintools.com/ellemental.com	🟢	Nothing ▼
21	annapurnalabs.com	annnapurnalabs.com	whois.domaintools.com/annnapurnalabs.com	🟡	Nothing ▼

Screenshots:

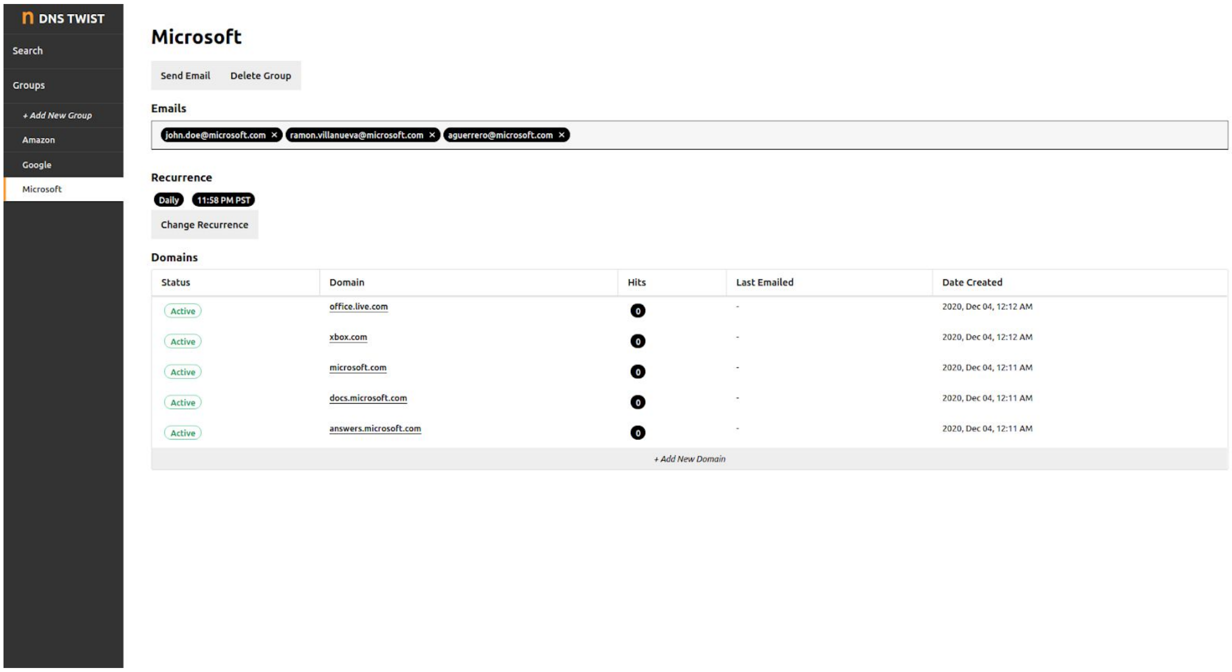
Homepage



Dashboard

Domain	Group	Last Emailed	Last Scanned	Next Scan
amazon.com	Amazon	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
aws.amazon.com	Amazon	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
amazon.ae	Amazon	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
audible.com	Amazon	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
ring.com	Amazon	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
amazongames.com	Amazon	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
google.com	Google	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
support.google.com	Google	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
cloud.google.com	Google	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
firebase.google.com	Google	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
edu.google.com	Google	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
gsuite.google.com	Google	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
office.live.com	Microsoft	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
xbox.com	Microsoft	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
microsoft.com	Microsoft	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
docs.microsoft.com	Microsoft	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am
answers.microsoft.com	Microsoft	Jan 01, 08:00am	Jan 01, 07:45am	Jan 02, 07:45am

Group View



Microsoft

Emails

john.doe@microsoft.com × ramon.villanueva@microsoft.com × aguerrero@microsoft.com ×

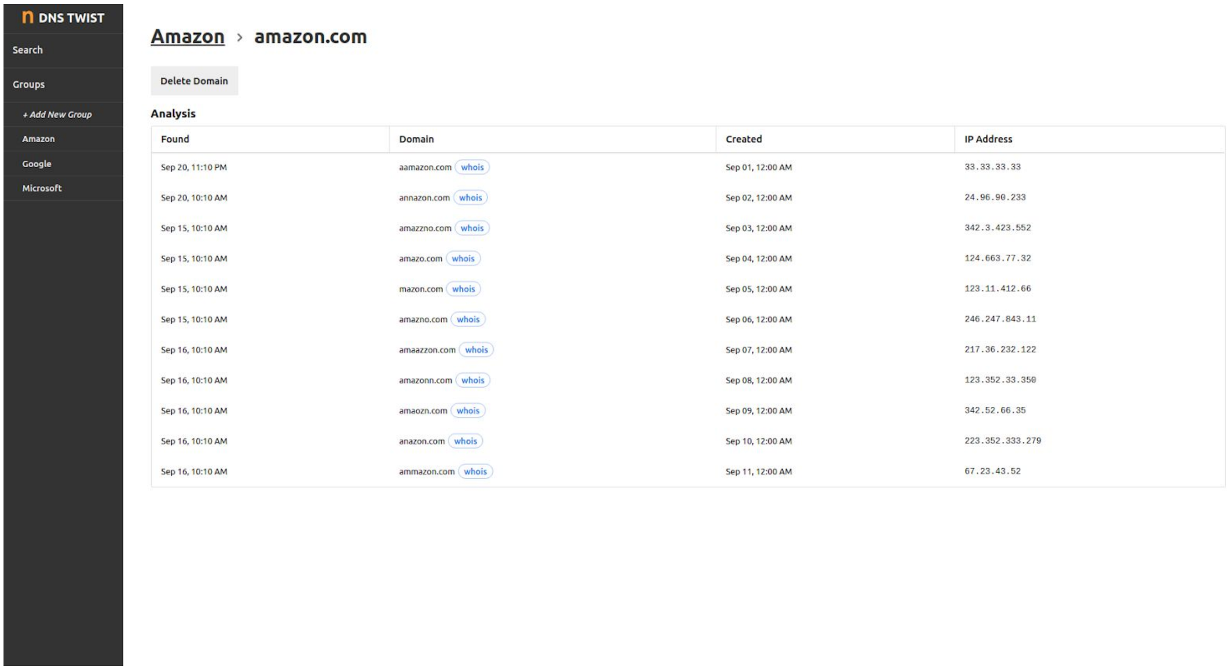
Recurrence

Daily 11:58 PM PST

Domains

Status	Domain	Hits	Last Emailed	Date Created
Active	office.live.com	0	-	2020, Dec 04, 12:12 AM
Active	xbox.com	0	-	2020, Dec 04, 12:12 AM
Active	microsoft.com	0	-	2020, Dec 04, 12:11 AM
Active	docs.microsoft.com	0	-	2020, Dec 04, 12:11 AM
Active	answers.microsoft.com	0	-	2020, Dec 04, 12:11 AM

Domain View



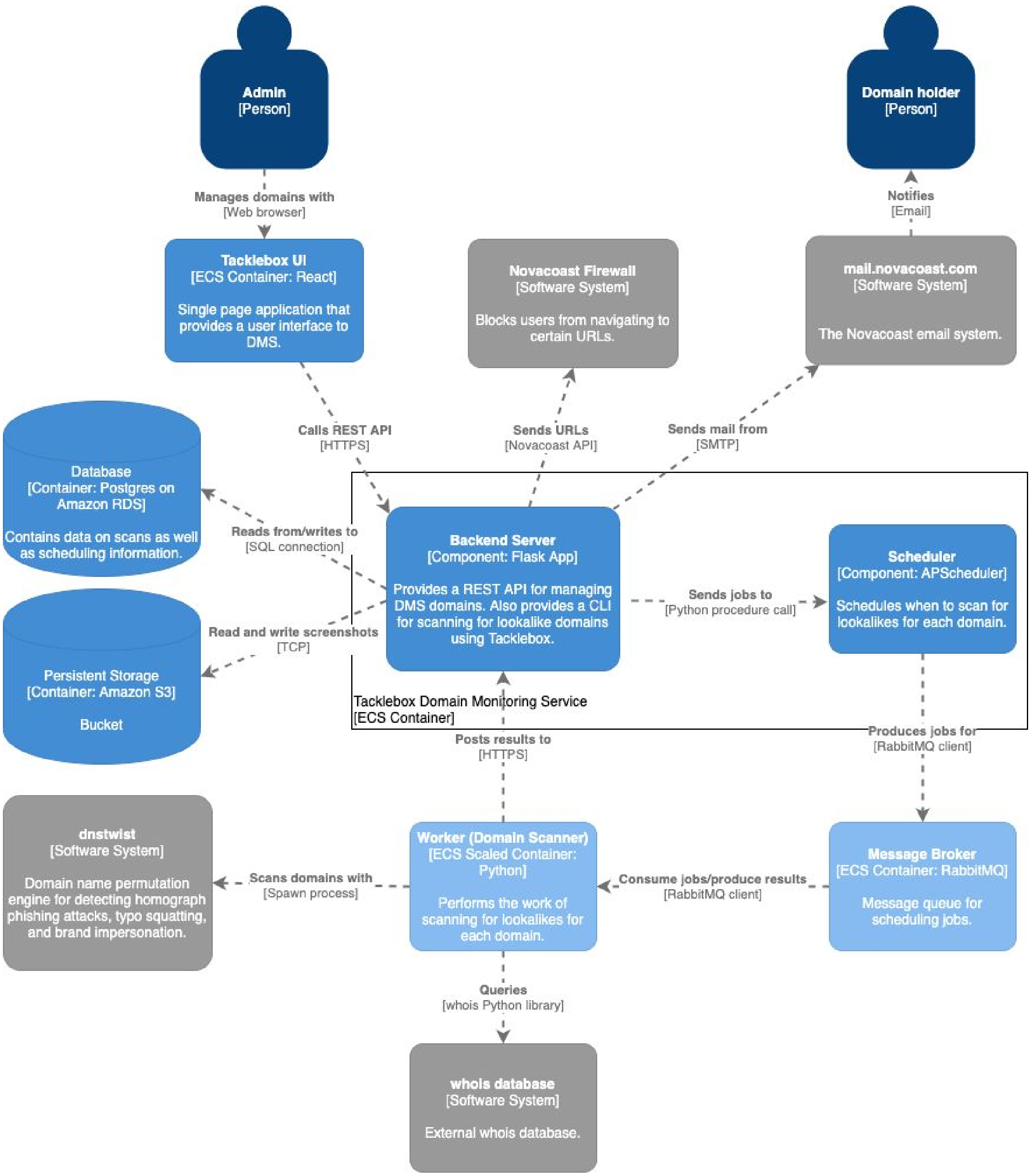
Amazon › amazon.com

Analysis

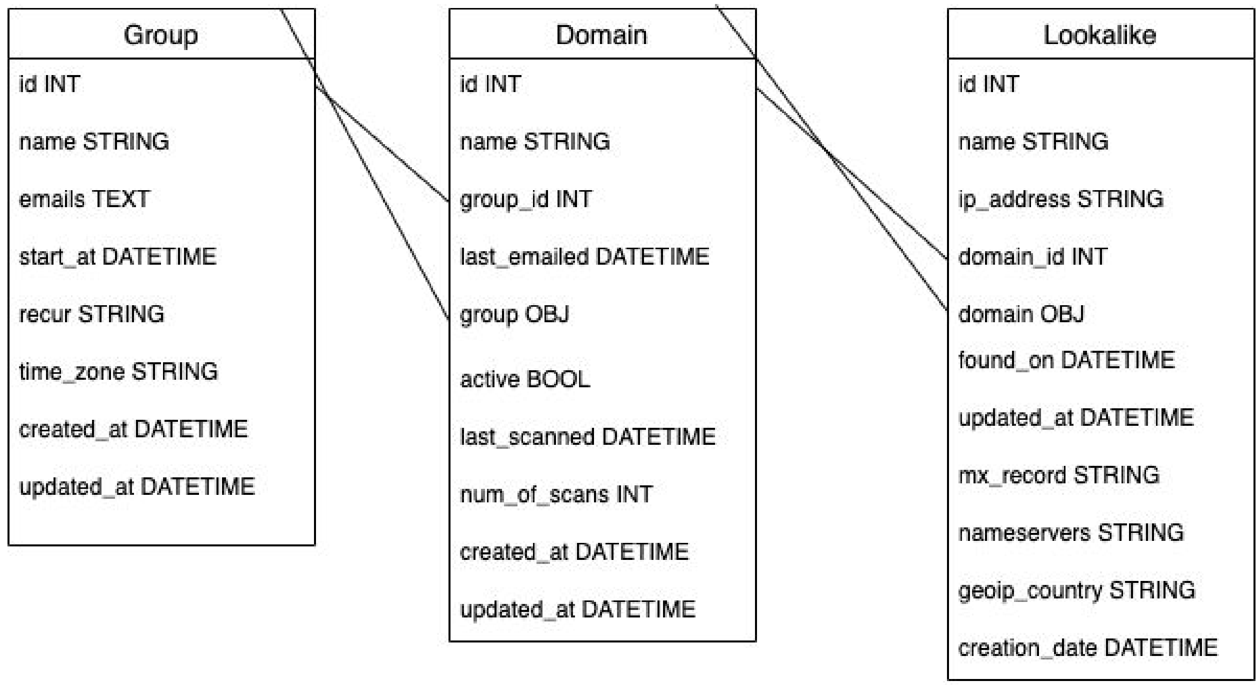
Found	Domain	Created	IP Address
Sep 20, 11:10 PM	aamazon.com whois	Sep 01, 12:00 AM	33.33.33.33
Sep 20, 10:10 AM	annazon.com whois	Sep 02, 12:00 AM	24.96.90.233
Sep 15, 10:10 AM	amazzno.com whois	Sep 03, 12:00 AM	342.3.423.552
Sep 15, 10:10 AM	amazo.com whois	Sep 04, 12:00 AM	124.663.77.32
Sep 15, 10:10 AM	mazon.com whois	Sep 05, 12:00 AM	123.11.412.66
Sep 15, 10:10 AM	amazno.com whois	Sep 06, 12:00 AM	246.247.843.11
Sep 16, 10:10 AM	amaazzon.com whois	Sep 07, 12:00 AM	217.36.232.122
Sep 16, 10:10 AM	amazonn.com whois	Sep 08, 12:00 AM	123.352.33.350
Sep 16, 10:10 AM	amaozn.com whois	Sep 09, 12:00 AM	342.52.66.35
Sep 16, 10:10 AM	anazon.com whois	Sep 10, 12:00 AM	223.352.333.279
Sep 16, 10:10 AM	ammazon.com whois	Sep 11, 12:00 AM	67.23.43.52

System Architecture Overview

High Level Diagram:


Admin
[Person]
Domain holder
[Person]
Manages domains with
[Web browser]
Notifies
[Email]
Tacklebox UI
[ECS Container: React]
Single page application that provides a user interface to DMS.
Novacoast Firewall
[Software System]
Blocks users from navigating to certain URLs.
mail.novacoast.com
[Software System]
The Novacoast email system.
Database
[Container: Postgres on Amazon RDS]
Contains data on scans as well as scheduling information.
Calls REST API
[HTTPS]
Sends URLs
[Novacoast API]
Sends mail from
[SMTP]
Reads from/writes to
[SQL connection]
Backend Server
[Component: Flask App]
Provides a REST API for managing DMS domains. Also provides a CLI for scanning for lookalike domains using Tacklebox.
Sends jobs to
[Python procedure call]
Scheduler
[Component: APScheduler]
Schedules when to scan for lookalikes for each domain.
Read and write screenshots
[TCP]
Persistent Storage
[Container: Amazon S3]
Bucket
Tacklebox Domain Monitoring Service
[ECS Container]
Posts results to
[HTTPS]
Produces jobs for
[RabbitMQ client]
dnstwist
[Software System]
Domain name permutation engine for detecting homograph phishing attacks, typo squatting, and brand impersonation.
Scans domains with
[Spawn process]
Worker (Domain Scanner)
[ECS Scaled Container: Python]
Performs the work of scanning for lookalikes for each domain.
Consume jobs/produce results
[RabbitMQ client]
Message Broker
[ECS Container: RabbitMQ]
Message queue for scheduling jobs.
Queries
[whois Python library]
whois database
[Software System]
External whois database.

Database Schema:



Group

id INT

name STRING

emails TEXT

start_at DATETIME

recur STRING

time_zone STRING

created_at DATETIME

updated_at DATETIME

Domain

id INT

name STRING

group_id INT

last_emailed DATETIME

group OBJ

active BOOL

last_scanned DATETIME

num_of_scans INT

created_at DATETIME

updated_at DATETIME

Lookalike

id INT

name STRING

ip_address STRING

domain_id INT

domain OBJ

found_on DATETIME

updated_at DATETIME

mx_record STRING

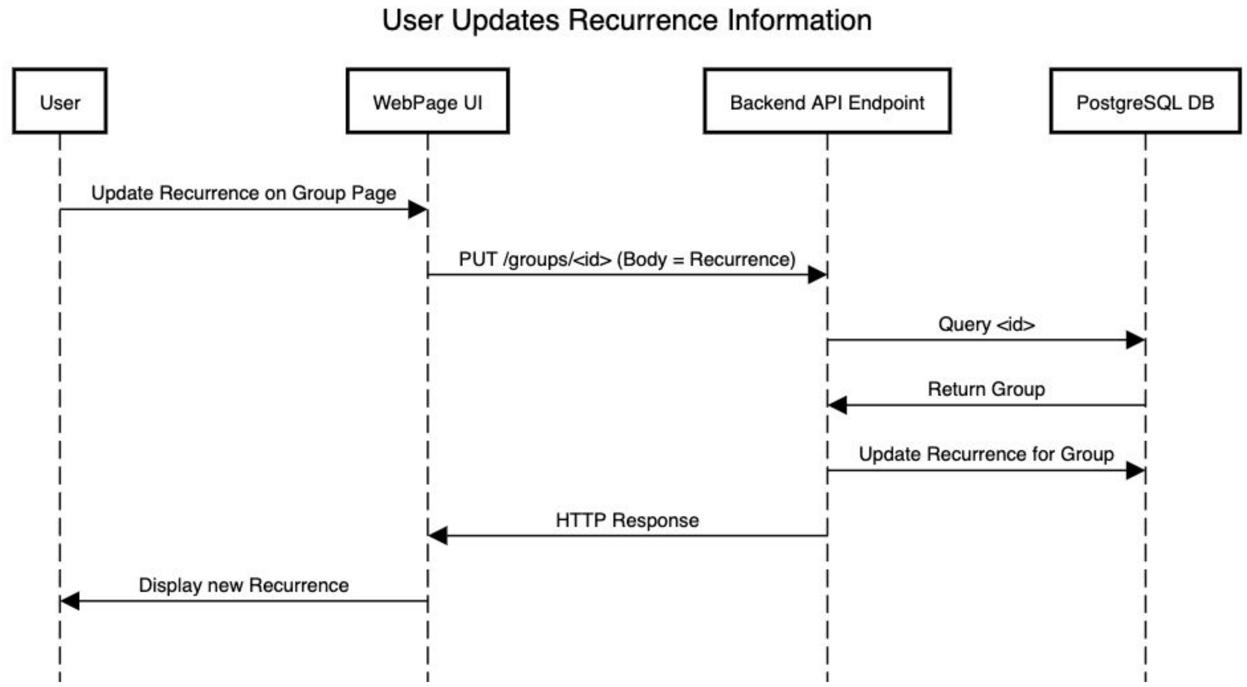
nameservers STRING

geoip_country STRING

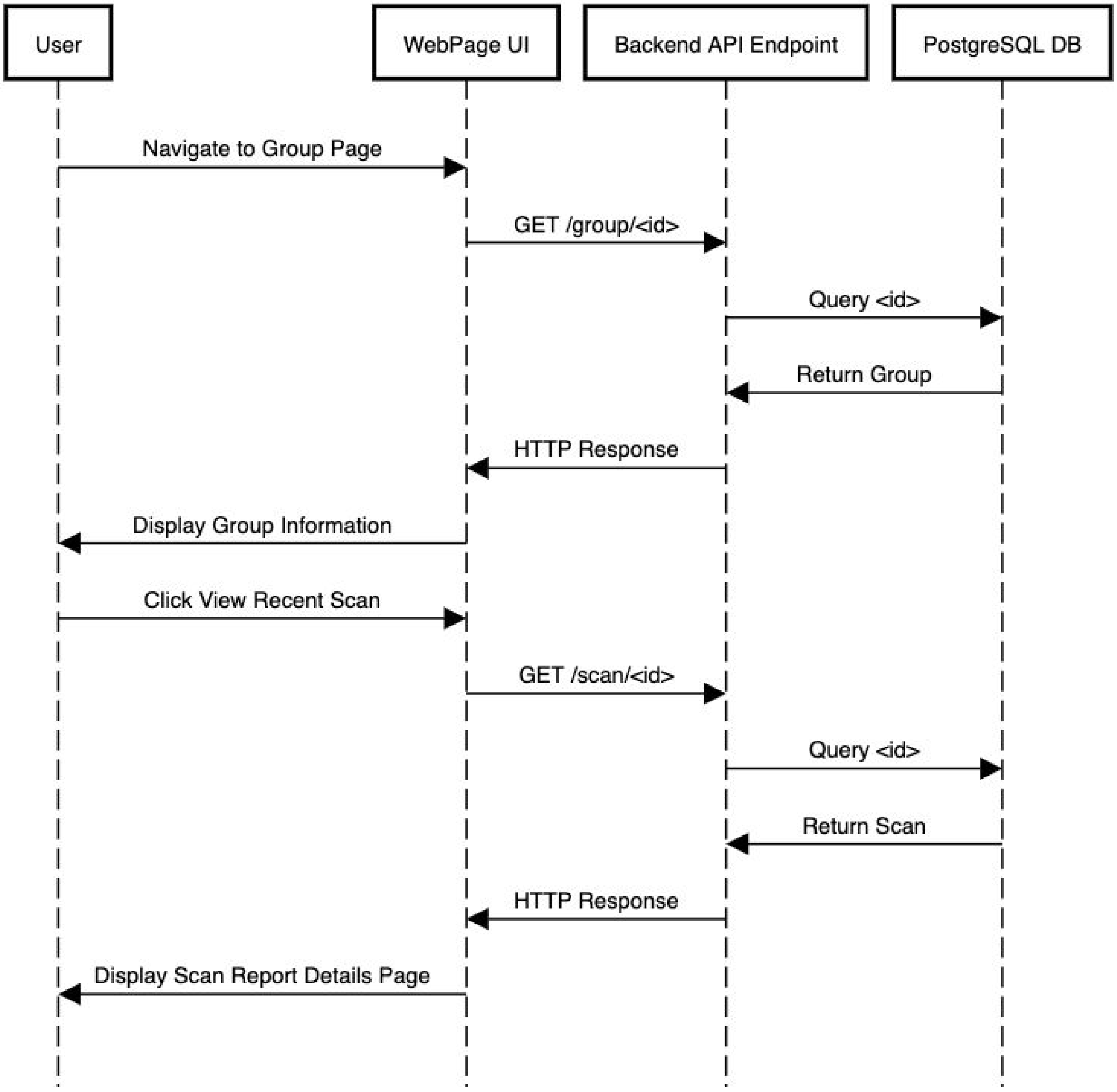
creation_date DATETIME

Sequence Diagrams

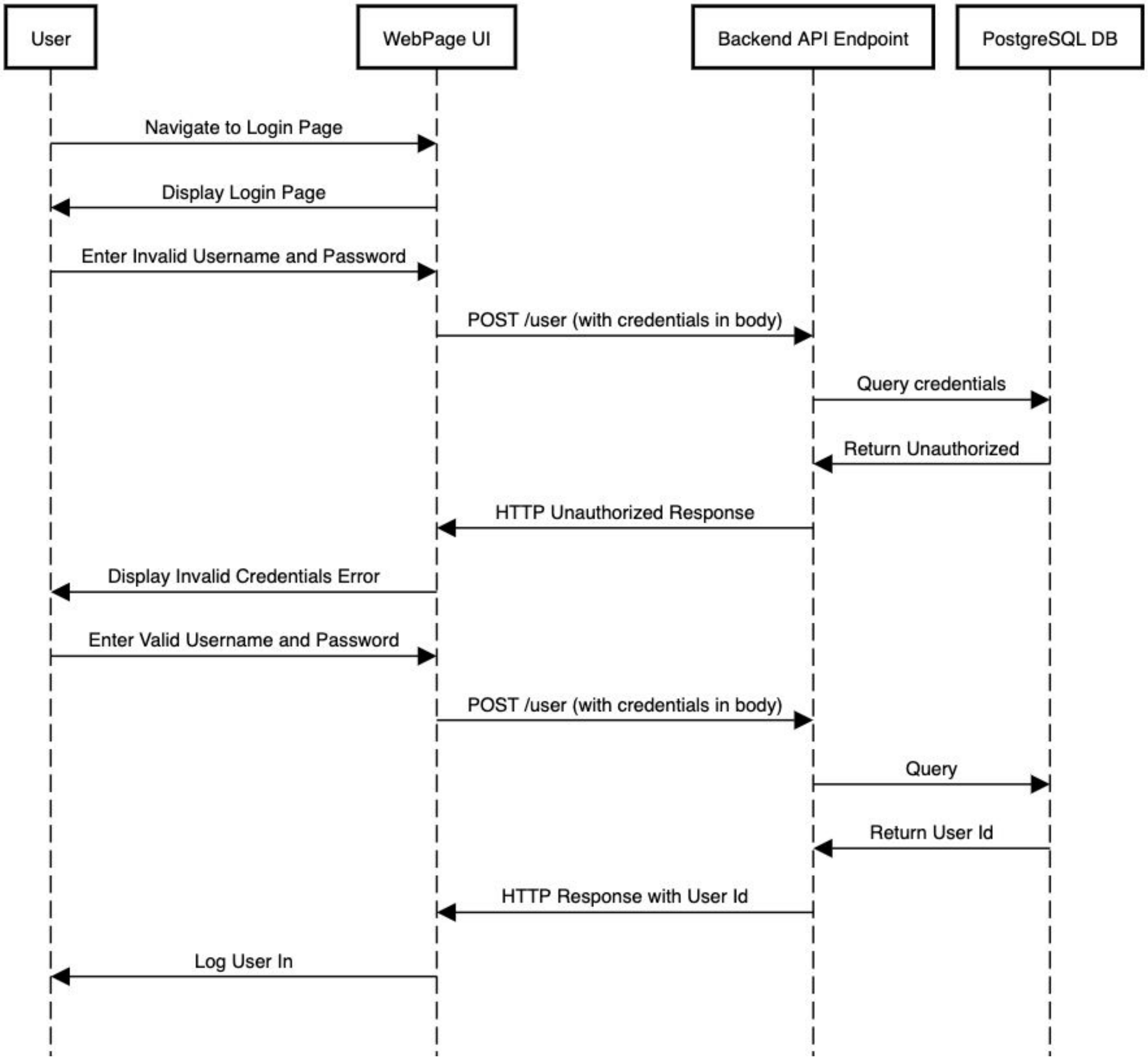
User Interactions:


User Updates Recurrence Information
User
WebPage UI
Backend API Endpoint
PostgreSQL DB
Update Recurrence on Group Page
PUT /groups/<id> (Body = Recurrence)
Query <id>
Return Group
Update Recurrence for Group
HTTP Response
Display new Recurrence

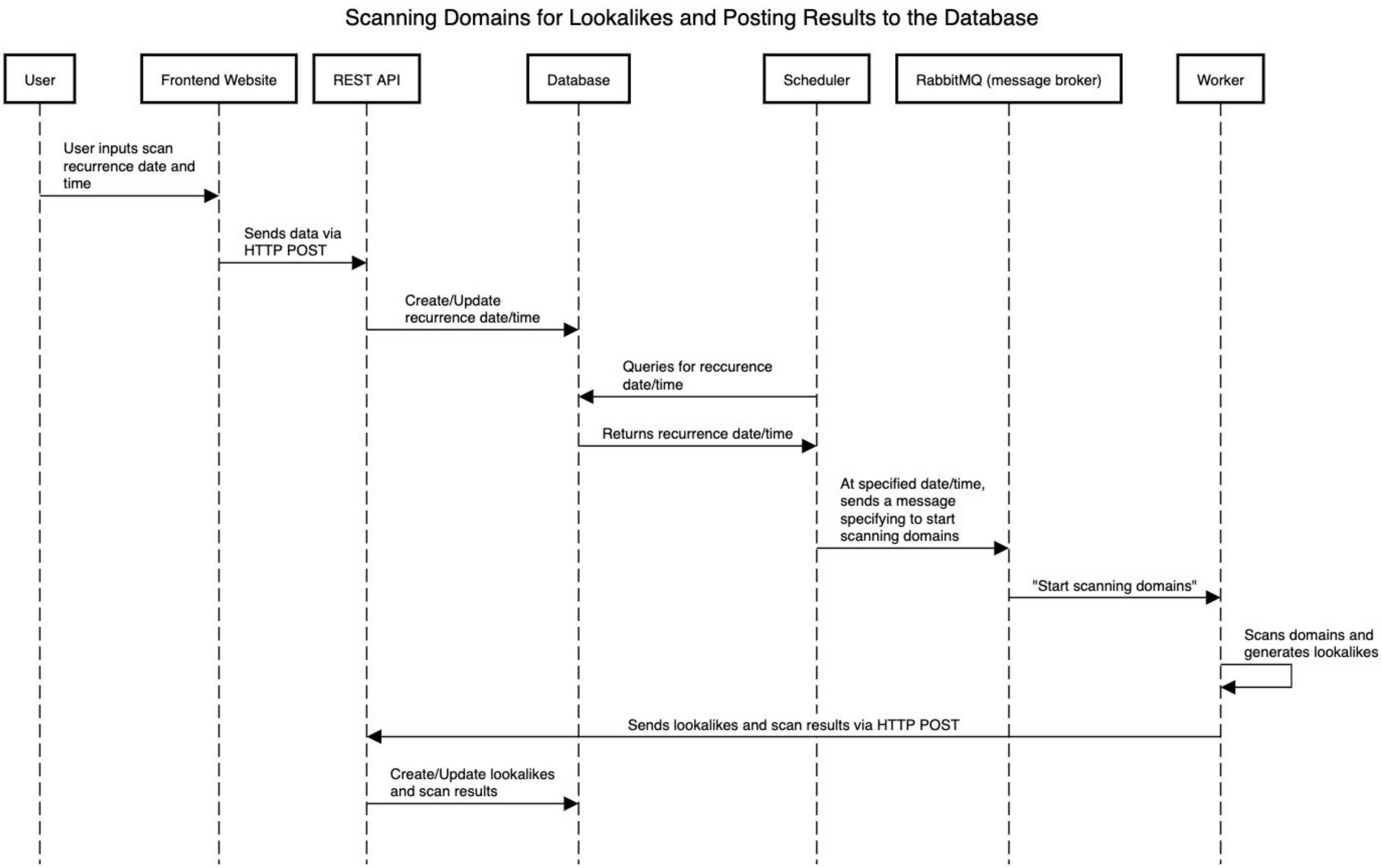
User views Scan Report Details



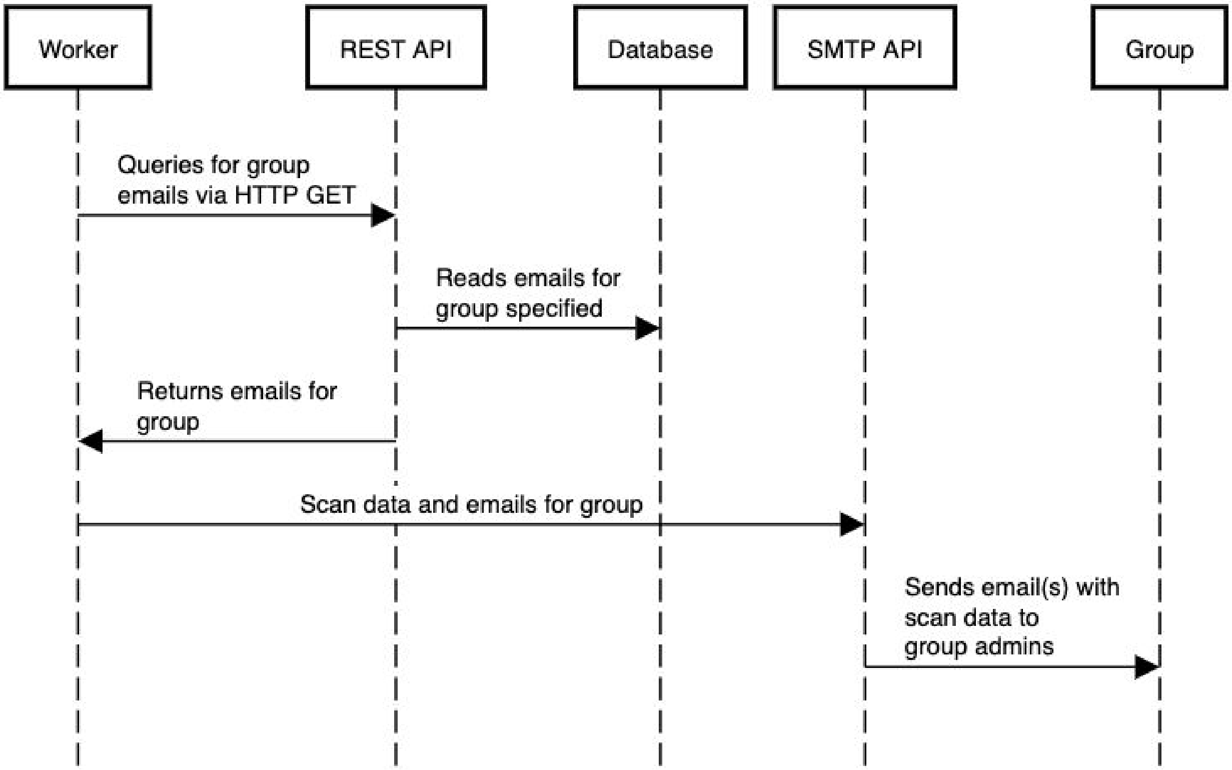
User views Scan Report Details


User
WebPage UI
Backend API Endpoint
PostgreSQL DB
Navigate to Login Page
Display Login Page
Enter Invalid Username and Password
POST /user (with credentials in body)
Query credentials
Return Unauthorized
HTTP Unauthorized Response
Display Invalid Credentials Error
Enter Valid Username and Password
POST /user (with credentials in body)
Query
Return User Id
HTTP Response with User Id
Log User In

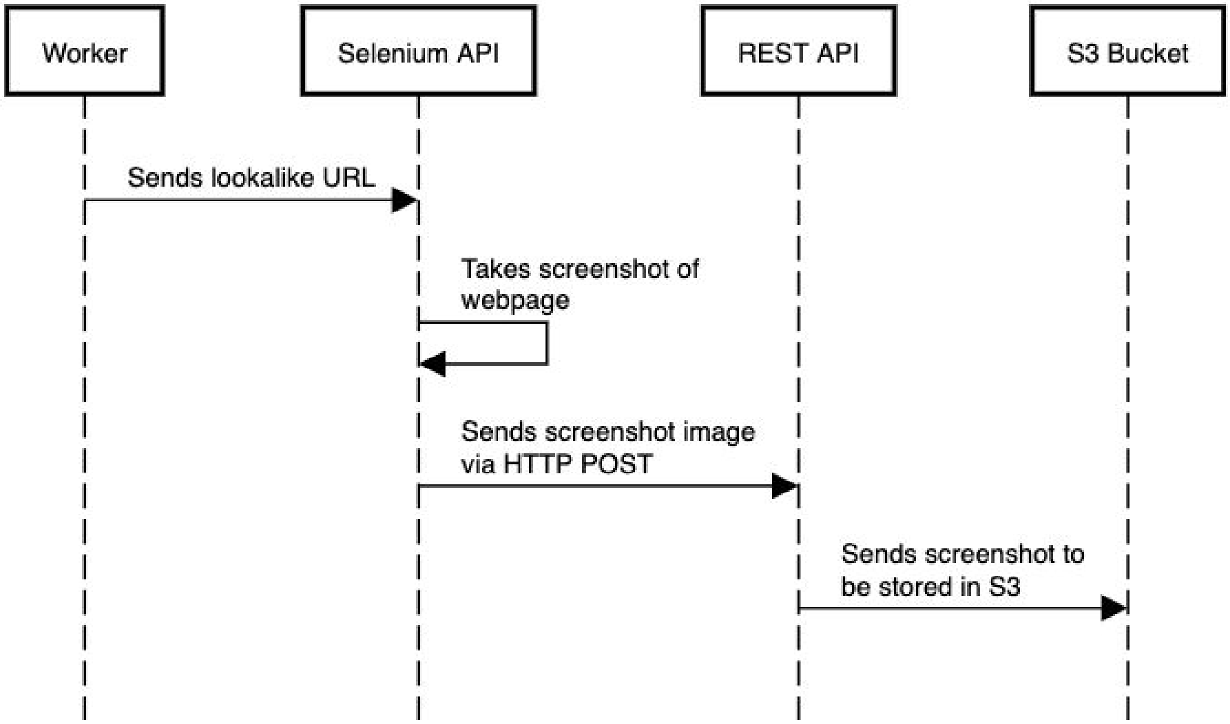
Class Interactions:


Scanning Domains for Lookalikes and Posting Results to the Database
User
Frontend Website
REST API
Database
Scheduler
RabbitMQ (message broker)
Worker
User inputs scan recurrence date and time
Sends data via HTTP POST
Create/Update recurrence date/time
Queries for reccurence date/time
Returns recurrence date/time
At specified date/time, sends a message specifying to start scanning domains
"Start scanning domains"
Scans domains and generates lookalikes
Sends lookalikes and scan results via HTTP POST
Create/Update lookalikes and scan results

Sending Emails of Scan Results to Group Admins


Worker
REST API
Database
SMTP API
Group
Queries for group emails via HTTP GET
Reads emails for group specified
Returns emails for group
Scan data and emails for group
Sends email(s) with scan data to group admins

Taking Screenshot of Lookalike and Storing Image in Amazon S3


Worker
Selenium API
REST API
S3 Bucket
Sends lookalike URL
Takes screenshot of webpage
Sends screenshot image via HTTP POST
Sends screenshot to be stored in S3

Prototyping Code, Tests, Metrics

GitHub: (frontend) https://github.com/bredmond5/dns-twist-react

(backend) https://github.com/bredmond5/dms-api-master

Sample Commits:

- Test case to check if query for lookalike can be filtered by domainId https://github.com/bredmond5/dms-api-master/commit/904577f705013b153087dff45b0a58004a686dff
- Test case to check if query for domain can be filtered by groupId https://github.com/bredmond5/dms-api-master/commit/904577f705013b153087dff45b0a58004a686dff
- Test case to check if query for lookalike can be filtered by scanId https://github.com/bredmond5/dms-api-master/commit/8419f4a7834b6b96e9ffe23c9c243299e2b4b5f2
- Test case to check routes for Scan model https://github.com/bredmond5/dms-api-master/commit/8419f4a7834b6b96e9ffe23c9c243299e2b4b5f2
- Worker now properly updates scan database after launching a dnsTwist https://github.com/bredmond5/dms-api-master/commit/90fe53cdadda190c260bbbcce1666dad58654a60
- Frontend validates domain input https://github.com/bredmond5/dns-twist-react/commit/471ce5186ac3822e99ca2f69d01b545aee5e6f57
- Recurrence information added at group level https://github.com/bredmond5/dns-twist-react/commit/0010039a8b4a79b0598b660fb867cff7e5a3afc3
- Groups fetch domains from database https://github.com/bredmond5/dns-twist-react/commit/477d0325ca38288fcda14d9494ddf55ee246ee89
- Sidebar fetches groups from database https://github.com/bredmond5/dns-twist-react/commit/3138410d9a6e15b415da20a205e5eff6de2cc0b4

User Stories & Use Cases

#1: Receive Scheduled Reports

User Story: As a user I will receive reports on potential phishing domains with addresses similar to those I am registered for, so I can seek action to protect my company from phishing attacks.

Acceptance Criteria:

- Report emailed to addresses specified at correct frequency
- Report shows a table of each lookalike domain
- Email returns a table of similar domains for each domain managed by our group

Card: https://trello.com/c/MBV8VyY8/36-user-story-receive-reports-of-similar-domains

Time Estimate: 10 person hours

#2: Create a Domain

User Story: As a user I can create a domain in the frontend so that all of its information is persisted in the database as well as the frontend.

Acceptance Criteria:

- Ability to create domains in the frontend, with emails, groups and recurrence information
- Persistence of data despite clearing of cache, refreshing, etc...

Card: https://trello.com/c/w0OPGUHb/35-user-story-create-update-delete-a-domain

Time Estimate: 10 person hours

#3: Create a Group

User Story: As a Tacklebox Admin I want to be able to create a group in the user interface, which stores a list of email addresses, domains, and recurrence information such that the data is saved in the database, and properly shows up in the UI.

Acceptance Criteria:

- I can add a group to the frontend, with emails/domains and recurrence information.
- I can refresh the page and the data persists.

Card: https://trello.com/c/olkjyJ2U/44-user-story-create-delete-a-group

Time Estimate: 10 person hours

#4: View Group Details

User Story: As a user I can navigate to a group and see its domains, with relevant lookalike counts from previous scan results.

Acceptance Criteria:

- Frontend renders count of lookalike domains within group
- Frontend renders most recent lookalike found
- Frontend renders the date of the most recent lookalike found

Card: https://trello.com/c/NFtddJxy/37-user-story-view-group-details

Time Estimate: 12 person hours

#5: View Lookalike details

User Story: As a user I can view details including date registered, IP Address, and similarity for each domain so that I can track malicious activity

Acceptance Criteria:

- Renders date registered in frontend
- Renders IP Address
- Renders similarity analysis to associated domain

Card: https://trello.com/c/peXWoZVc/66-user-story-view-lookalike-details

Time Estimate: 12 person hours

#6: View Scan Details

User Story: As a Tacklebox Admin I want to view a list of scans that took place on a group, click into a specific scan to see the exact lookalikes found, and click into a lookalike to drill into details.

Card: https://trello.com/c/ii7GziIb/46-user-story-scan-details

Acceptance Criteria:

- Renders time when scan started
- Renders time when scan ended
- Reports number of lookalikes found for that scan

Time Estimate: 12 person hours

#7: Continuous Front-end Deployment

Use Case: Whenever developers push code to the master branch of our frontend github repository, the updates are automatically deployed to the ECS service for the frontend.

Card: https://trello.com/c/87oYRM8Y/40-use-case-continuous-front-end-deployment

Acceptance Criteria:

- Continuously deploys front-end to AWS whenever the master front-end codebase updates
- Developers and individuals may access the continual deployed front-end via a URL

Time Estimate: 20 person hours

#8: Continuous Back-end Deployment

Use Case: Whenever developers push code to the master branch of our backend github repository, the updates are automatically deployed to the ECS service for the backend.

Card: https://trello.com/c/WgSf1TMn/63-use-case-continuous-back-end-deployment

Acceptance Criteria:

- Continuously deploys back-end to AWS whenever the master back-end codebase updates
- Developers can make requests to the continual deployed back-end via a URL

Time Estimate: 30 person hours

#9: Change recurrence information on a Group level

User Story: As a user I can update the recurrence information at the group level so that I can change the lookalike scan frequency by day, week, and month.

Acceptance Criteria:

- Ability to customize recurrence date, time zone and frequency
- Updating Recurrence information is reflected in both frontend and backend
- Lookalike scan updates frequency based off the new recurrence

Card:
https://trello.com/c/by02yZXX/67-user-story-change-recurrence-information-on-a-group-level

Time Estimate: 5 person hours

#10: Scheduled Database Update

Use Case: After a scheduled dns twist scan completes, it should update the database with the new lookalikes found.

Acceptance Criteria:

- New lookalikes are present in the database after each scan
- The new lookalikes can be pulled from the database

Card: https://trello.com/c/mhB4T5Im/65-use-case-scheduled-database-update

Time Estimate: 5 person hours

#11: Ping Legal Team

User Story: As a user I want my legal team to be automatically contacted if there is a high enough similarity between my domain and a look alike so that they can reach out to the phishing domain directly and pursue legal action against them.

Acceptance Criteria:

- Report is sent to legal team if a certain similarity analysis is reached
- Report contains all necessary information for team to seek legal action

Card: https://trello.com/c/FYX6WBlt/64-user-story-ping-legal-team

Time Estimate: 5 person hours

#12: View Screenshots of a Lookalike Domain Over Time

User Story: As a user I want to view a screenshot of spoofed domains in order to access legal viability as well as document the state of each possible spoof domain.

Card:

https://trello.com/c/9VuDW2Th/68-user-story-view-screenshots-of-a-lookalike-domain-over-time

Acceptance Criteria:

- After a scan, screenshots of lookalikes are stored in the backend
- User can see screenshots over time that were gathered from the scanner

Time Estimate: 40 person hours

#13: Return data back to open source intelligence

User Story: As a Tacklebox Admin I want the information that is uncovered by my scans to be returned to open source intelligence so that clients of my website can be better protected.

Card: https://trello.com/c/9uc6TvOi/75-user-story-return-data-back-to-open-source-intelligence

Acceptance Criteria:

- Scans produce digestible data for open source intelligence systems
- Open source intelligence systems provide additional security to users

Time Estimate: 30 person hours

#14: Domain name validation

User Story: As a Tacklebox Admin I want to add domains to a group and get real time validation so I can't add invalid domains to my groups.

Card: https://trello.com/c/GV3F5Q2b/42-add-client-side-validation-on-domains-using-regular-expressions

Acceptance Criteria:

- Valid domain is accepted as input
- Valid domain displays acceptance feedback to user
- Invalid domain is rejected as input
- Invalid domain displays rejection feedback to user

Time Estimate: 30 person hours

#15: Authentication

User Story: As a Tacklebox Admin I want to be able to login so that I can only see the information relevant to my company.

Acceptance Criteria:

- A secure login with a email and password
- I can change my password using my email

Card: https://trello.com/c/XmyQThhB/76-user-story-authentication

Time Estimate: 35 person hours

#16: Delete a Domain

User Story: As a user I can remove a domain from its associated group so that I no longer track unnecessary domains.

Acceptance Criteria:

- Delete persists in the frontend despite clearing of cache, refreshing, etc...
- Deletion also removes entry from all rows in database where it occurs

Card: https://trello.com/c/w0OPGUHb/35-user-story-create-update-delete-a-domain

Time Estimate: 2 person hours

#17: Delete a Group

User Story: As a user I can remove a group and its associated domains so that I no longer track unnecessary groups.

Acceptance Criteria:

- Delete persists in the frontend despite clearing of cache, refreshing, etc...
- Deletion also removes entry from all rows in database where it occurs for both groups and domains connected to that group

Card: https://trello.com/c/olkjyJ2U/44-user-story-create-delete-a-group

Time Estimate: 2 person hours

#18: Block on Novacoast Firewall

User Story: As a person that runs Novacoast software, I want phishing domains to be blocked on my firewall if they are deemed to be malicious by Tacklebox.

Card: https://trello.com/c/1L4Eylws/77-user-story-block-on-novacoast-firewall

Acceptance Criteria:

- Malicious domains are automatically updated to a blocked URL list within Novacoast's firewall
- User can no longer access sites marked malicious by Tacklebox

Time Estimate: 10 person hours

#19: Autoscaling worker containers

User Story: As a developer, I want to scale up and down worker containers to address the scheduled scans.

Acceptance Criteria:

- This uses less resources than constantly keeping the worker online

- This executes scans quicker since multiple scans could occur at the same time

Card: https://trello.com/c/gxjSQIJc/78-use-case-autoscaling-worker-containers

Time Estimate: 40 person hours

#20: Regex comparisons

User Story: As a Tacklebox Admin, I want similar domains that DNS Twist finds to be scanned for regex comparisons with my monitored website.

Acceptance Criteria:

- If the website is constructed in a way to look like the monitored website, it should be marked with a risk

Card: https://trello.com/c/BWJd4BHR/79-user-story-regex-comparisons

Time Estimate: 50 person hours

Appendix

Technologies:

Frontend - React, Javascript, CSS

Backend - Flask (Python), SQLalchemy

Storage - Amazon RDS, PostgreSQL, AWS S3

Hosting - AWS ECS, AWS ECR

Internal Messaging - RabbitMQ

Domain Identification - DNSTwist

Containerization - Docker