

# Aplicativo web de auxílio à navegação aérea

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Departamento de Informática  
PUC-Rio

Dezembro 2024

# Outline

1 Introdução

2 Arquitetura

3 Projeto

4 Teste de carga

5 Conclusão

# Introdução



**Figure:** Electronic Flight Bag  
(David Guimarães)

# Introdução



**Figure:** Electronic Flight Bag  
(David Guimarães)



**Figure:** Electronic Flight Bag  
(MSFS2020 / FlyByWire  
Simulations)

# Introdução

## ■ Simulação de voo

**ROTAER**  
**Guarulhos - Governador André Franco Montoro (SBGR) / SÃO PAULO, SP**  
AD INTL PÁGINA INFRAER 24/NE UTC-3 VFR IFR L21 , L23 ,  
L25, L27  
**TOR** - [5, L9[1][8], L11A, L12A - I 3000x45 ASPH 77/F/B/W/T 5BBS (CREA-SE)  
L14A, L15, [4] L19A, L20] - L4, L9[1][8], L12A - **28L**  
**10R** - L5, L9[1][8], L11A, L12A - (3700)x45 ASPH 77/F/B/W/T  
L14A, L15, L19A, L20] - L4, L9[1][8], L12A - **28R**  
**10L** - L5, L9[1][8], L11A, L12A - (3700)x45 ASPH 77/F/B/W/T  
L14A, L15, L19A, L20] - L4, L9[1][8], L12A - **28R**  
**COM TORRE GUARULHOS** [5] [8] 118.400 121.500 [2] 132.750 135.200  
SOLO GUARULHOS [8] 121.700 126.900  
OPERAÇÕES GUARULHOS 122.500  
TRAFEGO GUARULHOS [8] 121.000  
ATIS [6] [8] 127.750  
**RDONAV** - ILS/DME 28L IBC 111.1 2326.385/04639.41W  
IM ILS 75 2326.385/04639.41W  
IM RVR 75 2326.385/04639.41W  
IM IGS 75 2326.415/04636.72W  
MM IGS 75 2326.375/04626.45W  
IM 10L IUC 75 2326.105/04629.17W  
MM IUC 75 2326.185/04629.47W



Figure: AISWEB

# Introdução

## ■ Simulação de voo

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**Guarulhos - Governador André Franco Montoro (SBGR) / SÃO PAULO, SP**  
AD INTL PÁGINA INFRAER 24/NE UTC-3 VFR IFR L21 , L23 ,  
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L14A, L15, L19A, L20] - L4, L9[1][8], L12A - **28R**  
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MM IUC 75 2326.185/04629.47W



Figure: AISWEB

# Introdução

## ■ Simulação de voo



Figure: AISWEB

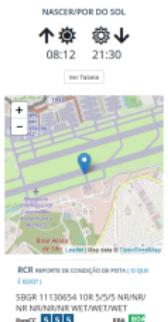


Figure: METAR-TAF

## UI

The screenshot shows a web browser window titled "AERO // A4". The URL is https://aero.albarros.com. The page has a dark header with the title "AERO // A4" and a search bar with a magnifying glass icon and the placeholder "Pesquisar...". Below the search bar is a button labeled "MAPA". The main content area is divided into a grid of 12 rectangular boxes, each containing a city name and its corresponding airport code. The boxes are arranged in four rows of three. The cities listed are: Belém (SBBE), Val de Cans - Júlio Cezar Ribeiro; Belo Horizonte (SBBH), Pampulha - Carlos Drummond de Andrade; Brasília (SBBR), Presidente Juscelino Kubitschek; Belo Horizonte (SBCF), Tancredo Neves; Goiânia (SBCT), Afonso Pena; Fortaleza (SBFZ), Pinto Martins; Rio de Janeiro (SBGL), Antônio Carlos Jobim; Goiânia (SBGO), Santa Genoveva; São Paulo (SBGR), Guarulhos; Campinas (SBKP), Viracopos; São Paulo (SBMT), Campo de Marte; Porto Alegre (SBPA), Salgado Filho; Recife (SBPE), Guararapes - Gilberto Freyre; Rio de Janeiro (SBPR), Santos Dumont; Natal (SBSG), São Gonçalo do Amarante.

## UI

The screenshot shows a desktop browser window displaying the "AERO // A4" application. The interface features a dark header with the title "AERO // A4". Below the header is a search bar with a magnifying glass icon and the placeholder "Pesquisar...". To the right of the search bar is a blue button labeled "MAPA". The main content area is divided into a grid of 12 rectangular cards, each containing a city name and a corresponding airport identifier. The cities listed are Belém, Belo Horizonte, Brasília, Cariáia, Fortaleza, Rio de Janeiro, São Paulo, and Natal. The identifiers include SBBE, SBBI, SBBR, SBCF, SBCT, SBFZ, SBGL, SBGO, SBGR, SBKP, SBMT, SBPA, SBRE, SBRL, and SBSG.

Belém SBBE • Val de Cans - Júlio Cezar Ribeiro	Belo Horizonte SBBH • Pampulha - Carlos Drummond de Andrade	Brasília SBBR • Presidente Juscelino Kubitschek
Belo Horizonte SBCF • Tancredo Neves	Cariáia SBCT • Afonso Pena	Fortaleza SBFZ • Pinto Martins
Rio de Janeiro SBGL • Antônio Carlos Jobim	Ceará SBGO • Santa Genoveva	São Paulo SBGR • Guarulhos
Campinas SBKP • Viracopos	São Paulo SBMT • Campo de Marte	Porto Alegre SBPA • Salgado Filho
Recife SBRE • Guararapes - Gilberto	Rio de Janeiro SBRL • Santos Dumont	Natal SBSG • São Gonçalo do



# Servidor

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**Compute**

Instances in a4server (root) compartment

An instance is a compute host. Choose between virtual instances (VMs) and bare metal instances. The image that you use to launch an instance determines its operating system and other software.

Name	Status	Public IP	Private IP	Shape	OCPUs count	Memory (GB)	Availability domain
a4server	Running	167.234.237.41	10.0.1.138	VM Standard.E2.1 Micro	1	1	AD-1
a4server	Running	164.152.43.215	10.0.0.94	VM Standard.E2.1 Micro	1	1	AD-1

0 selected Showing 2 items < 1 of 1 >

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# Servidor

The screenshot shows the Oracle Cloud Compute Instances page. The left sidebar has 'Compute' selected, with options like Overview, Instances (selected), Instance Maintenance, Dedicated Virtual Machine Hosts, Instance Configurations, Instances Pools, Cluster Networks, Compute Clusters, AutoScaling Configurations, Capacity Reservations, and Custom Images. The main area title is 'Instances in a4server (root) compartment'. It says 'An instance is a compute host. Choose between virtual instances (VMs) and bare metal instances. The image that you use to launch an instance determines its operating system and other software.' Below this is a table with columns: Name, State, Public IP, Private IP, Shape, OCPU count, Memory (GB), and Availability dom. Two rows are listed: 'a4server' (Running, 167.234.237.41, 10.0.1.138, VM Standard.E2.1 Micro, 1, 1, AD-1) and 'a4server1' (Running, 164.152.43.215, 10.0.0.94, VM Standard.E2.1 Micro, 1, 1, AD-1). At the bottom right of the table are icons for creating a new instance and deleting selected items.

- CPU: AMD EPYC 7551 (2 cores) @ 1.996GHz

# Servidor

The screenshot shows the Oracle Cloud Compute Instances page. The left sidebar has 'Compute' selected, with options like Overview, Instances (selected), Instance Maintenance, Dedicated Virtual Machine Hosts, Instance Configurations, Instance Pools, Cluster Networks, Compute Clusters, AutoScaling Configurations, Capacity Reservations, and Custom Images. The main area title is 'Instances in a4server (root) compartment'. It says 'An instance is a compute host. Choose between virtual instances (VMs) and bare metal instances. The image that you use to launch an instance determines its operating system and other software.' Below this is a table with columns: Name, State, Public IP, Private IP, Shape, OCPU count, Memory (GB), and Availability dom. Two rows are listed: 'a4server' (Running, 167.234.237.41, 10.0.1.138, VM Standard.E2.1 Micro, 1, 1, AD-1) and 'a4server' (Running, 164.152.43.215, 10.0.0.94, VM Standard.E2.1 Micro, 1, 1, AD-1). A message at the bottom says 'Showing 2 items < 1 of 1 >' with a refresh icon.

- CPU: AMD EPYC 7551 (2 cores) @ 1.996GHz
- RAM: 1GB

# Servidor



The screenshot shows the Oracle Cloud Compute Instances page. The left sidebar has 'Compute' selected, with options like Overview, Instances (selected), Instance Maintenance, Dedicated Virtual Machine Hosts, Instance Configurations, Instances Pools, Cluster Networks, Compute Clusters, AutoScaling Configurations, Capacity Reservations, and Custom Images. The main area title is 'Instances in a4server (root) compartment'. It says 'An instance is a compute host. Choose between virtual instances (VMs) and bare metal instances. The image that you use to launch an instance determines its operating system and other software.' Below this is a table with two rows:

Name	Status	Public IP	Private IP	Shape	OCPUs count	Memory (GB)	Availability dom
a4server	Running	167.234.237.41	10.0.1.138	VM Standard.E2.1 Micro	1	1	AD-1
a4server	Running	164.152.43.215	10.0.0.94	VM Standard.E2.1 Micro	1	1	AD-1

At the bottom right of the table are buttons for 'Create instance' and 'Actions'. The footer includes links for Terms of Use and Privacy, Cookies Preferences, and Copyright © 2024, Oracle and/or its affiliates. All rights reserved.

- **CPU:** AMD EPYC 7551 (2 cores) @ 1.996GHz
- **RAM:** 1GB
- **Armazenamento:** 25GB

# Servidor

The screenshot shows the Oracle Cloud Compute Instances page. The left sidebar has 'Compute' selected, with 'Instances' highlighted. The main area displays 'Instances in a4server (root) compartment'. It shows two instances: 'a4server' and 'a4server1', both running. The table includes columns for Name, State, Public IP, Private IP, Shape, OCPU count, Memory (GB), and Availability domain.

Name	State	Public IP	Private IP	Shape	OCPUs	Memory (GB)	Availability Dom
a4server	Running	167.234.237.41	10.0.1.138	VM Standard.E2.1 Micro	1	1	AD-1
a4server1	Running	164.152.43.215	10.0.0.34	VM Standard.E2.1 Micro	1	1	AD-1

- **CPU:** AMD EPYC 7551 (2 cores) @ 1.996GHz
- **RAM:** 1GB
- **Armazenamento:** 25GB
- **SO:** Ubuntu 22.04.4 LTS

# Arquitetura

- Docker/Docker Compose

# Arquitetura

- Docker/Docker Compose
- Banco: MariaDB

# Arquitetura

- Docker/Docker Compose
- Banco: MariaDB
- Backend: Flask FastAPI

# Arquitetura

- Docker/Docker Compose
- Banco: MariaDB
- Backend: Flask FastAPI
- Frontend: Jinja2

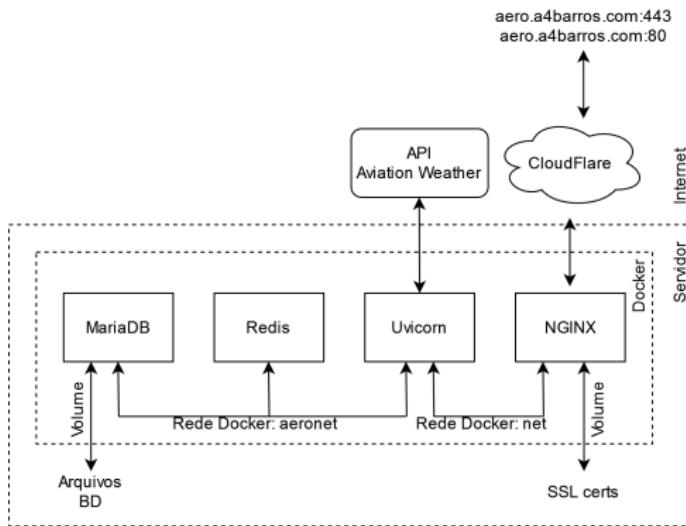
# Arquitetura

- Docker/Docker Compose
- Banco: MariaDB
- Backend: Flask FastAPI
- Frontend: Jinja2
- Observabilidade: GoAccess

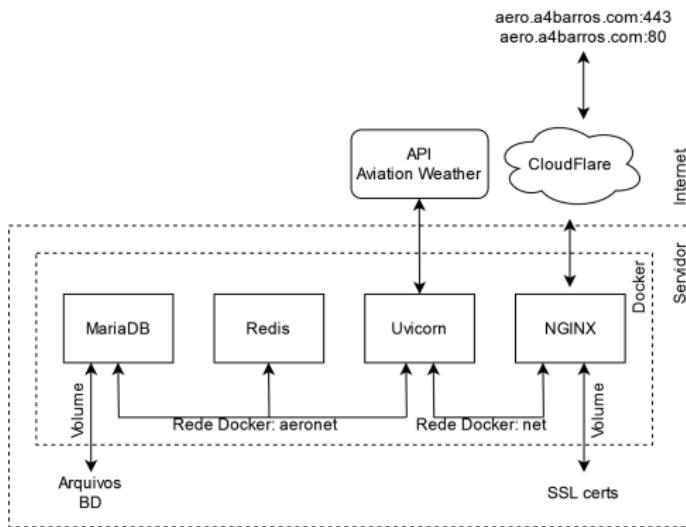
# Arquitetura

- Docker/Docker Compose
- Banco: MariaDB
- Backend: Flask FastAPI
- Frontend: Jinja2
- Observabilidade: GoAccess
- Outros subdomínios

# Diagrama da arquitetura

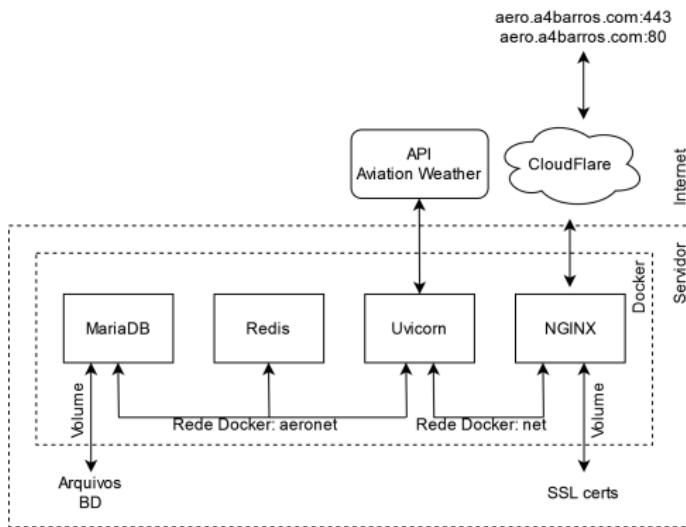


# Diagrama da arquitetura



## ■ Uso de Docker network

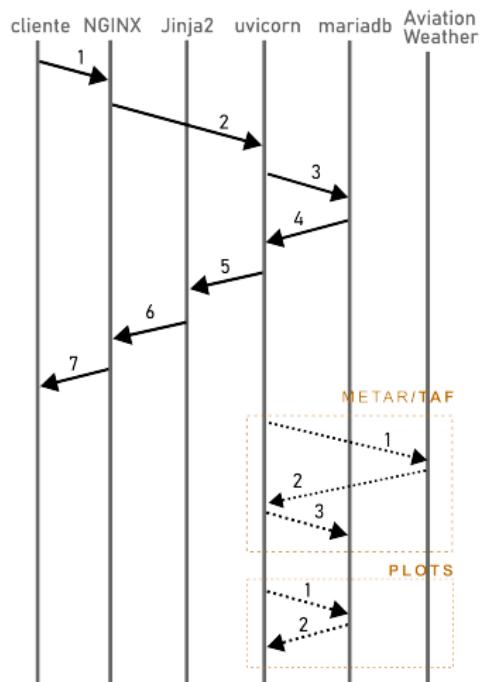
# Diagrama da arquitetura



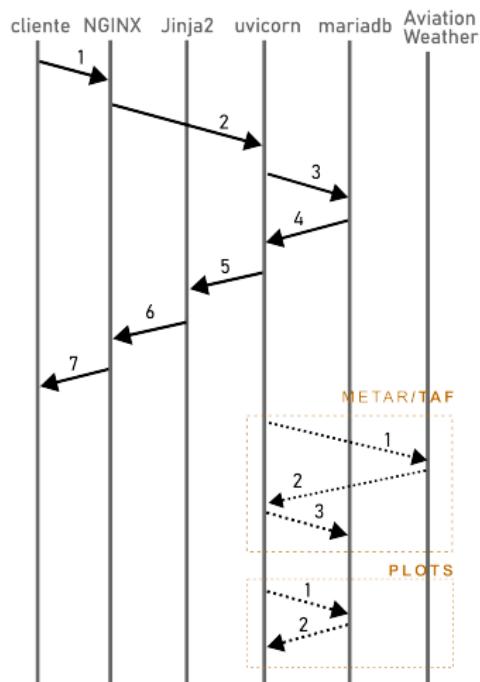
- Uso de Docker network
- Uso de volumes

# Diagrama de tempo

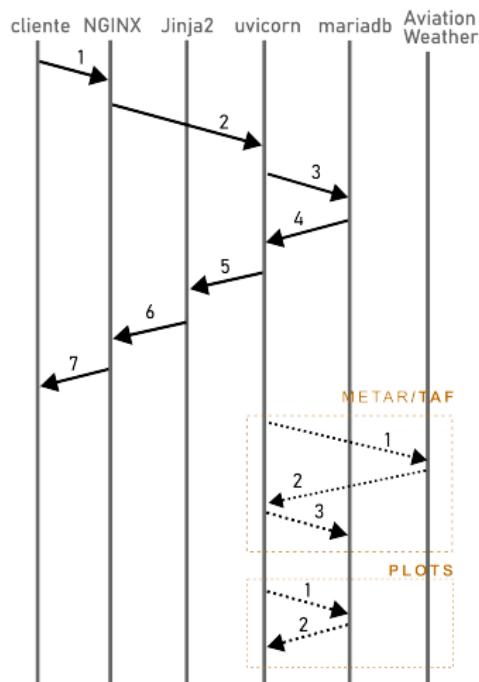
# Diagrama de tempo



# Diagrama de tempo

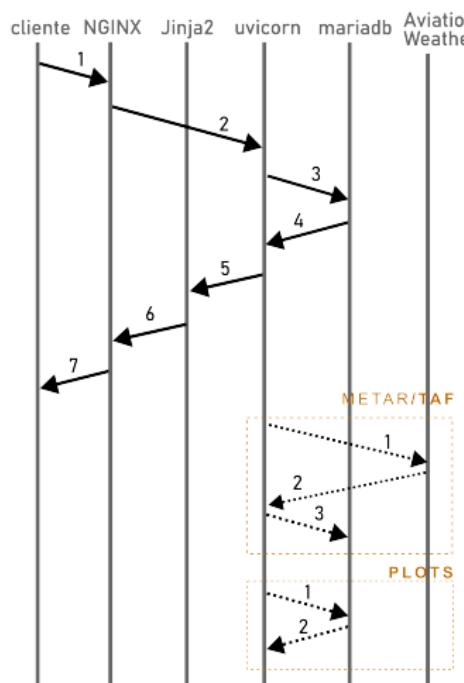


# Diagrama de tempo



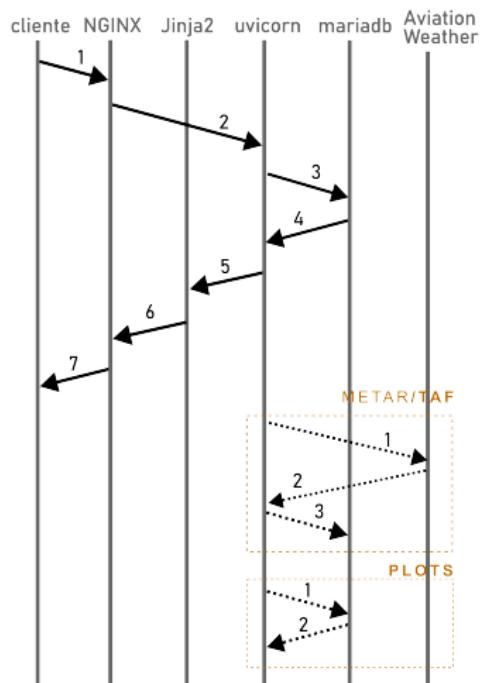
■ Tarefas síncronas

# Diagrama de tempo



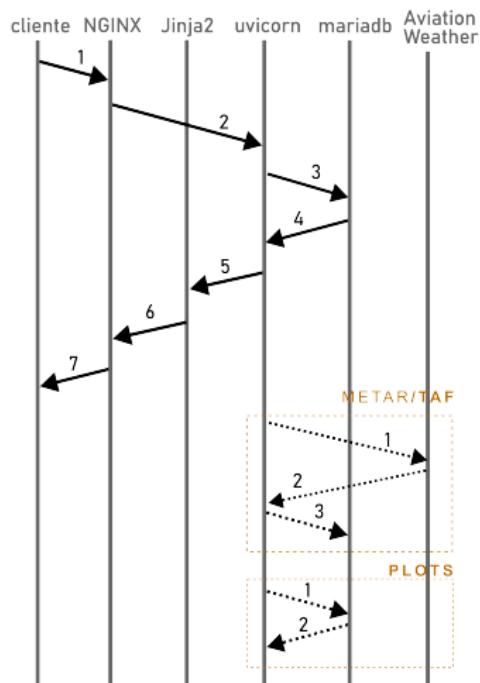
- Tarefas síncronas
- Rotas

# Diagrama de tempo



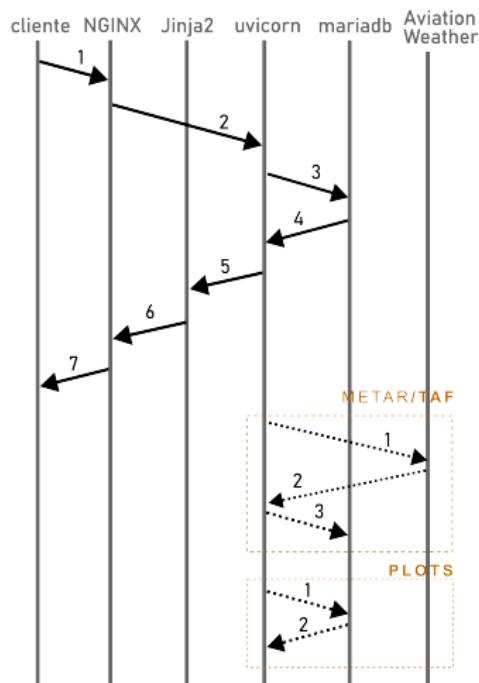
- Tarefas síncronas
  - Rotas
- Tarefas assíncronas

# Diagrama de tempo



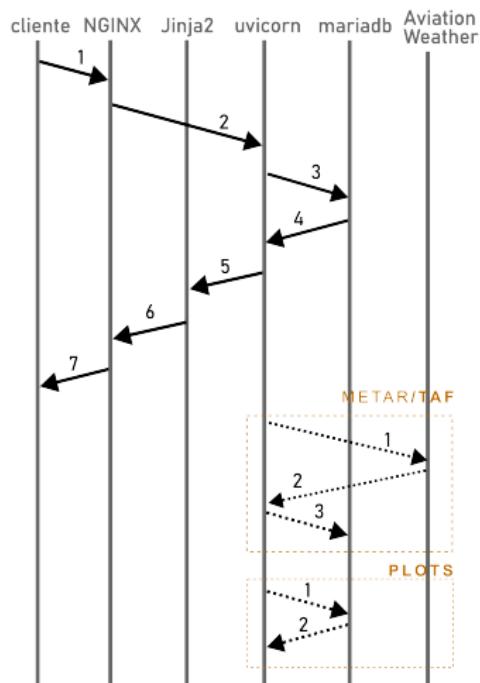
- Tarefas síncronas
  - Rotas
- Tarefas assíncronas
  - METAR

# Diagrama de tempo



- Tarefas síncronas
  - Rotas
- Tarefas assíncronas
  - METAR
  - TAF

# Diagrama de tempo



- Tarefas síncronas
  - Rotas
- Tarefas assíncronas
  - METAR
  - TAF
  - Plots

# Uso de recursos

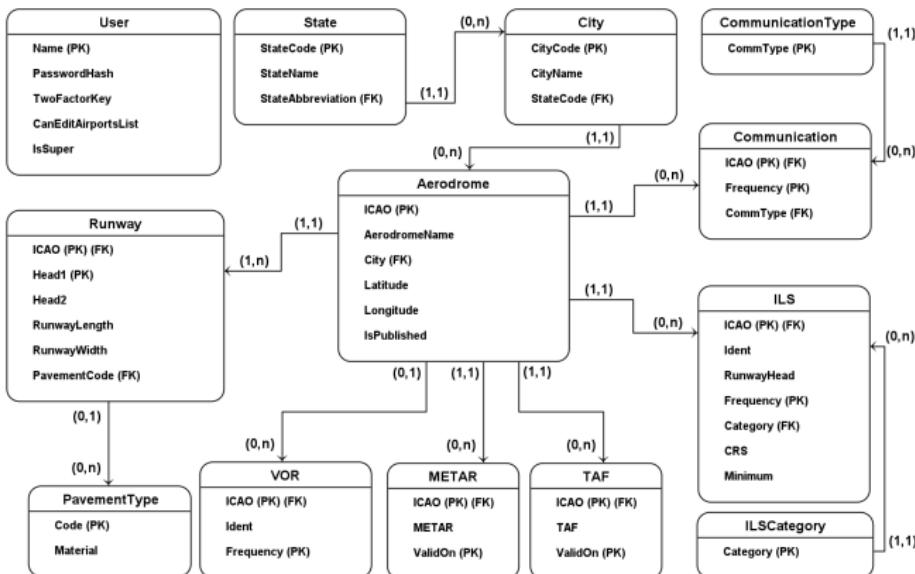
- 500 acessos simultâneos (usando Locust)

```
0[|||||] 41.5% Tasks: 60, 220 thr, 79 kthr; 2 running
1[|||||] 100.0% Load average: 0.17 0.09 0.16
Mem[|||||] 566M/957M Uptime: 4 days, 00:49:36
Swp[0K/0K]

PID USER      PRI  NI    VIRT   RES   SHR S CPU% MEM% TIME+ Command
151468 root      20   0  295M 130M 14464 S  0.0 13.7  0:15.41 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151647 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.16 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151651 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.00 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151652 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.00 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151653 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.00 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151654 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.00 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151655 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.00 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151735 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.00 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151910 root      20   0  295M 130M 14464 S  0.0 13.7  0:00.18 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151911 root      20   0  295M 130M 14464 R  81.9 13.7  0:39.84 /opt/venv/bin/python3 -u -m fastapi run server.py --h
151194 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.73 mariadb
151548 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.18 mariadb
151549 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.00 mariadb
151550 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.00 mariadb
151551 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.04 mariadb
151556 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.00 mariadb
151557 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.00 mariadb
151623 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.01 mariadb
151650 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:01.49 mariadb
151912 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.00 mariadb
151913 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.00 mariadb
151916 lxd      20   0 1375M 90456 10112 S  0.0  9.2  0:00.00 mariadb

F1?help F2Setup F3Search F4Filter F5Tree F6SortBy F7Nice -F8Nice -F9Kill F10quit
```

# Tabelas



# METAR

- Separação nos espaços

# METAR

- Separação nos espaços
- Regex

# METAR

- Separação nos espaços
- Regex
- Lista de tuplas

# METAR

- Separação nos espaços
- Regex
- Lista de tuplas
- Ferramenta de templating

# METAR

- Separação nos espaços
- Regex
- Lista de tuplas
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# METAR

- Separação nos espaços
- Regex
- Lista de tuplas
- Ferramenta de templating

251600Z 22011KT 9999 BKN023 OVC035  
21/16 Q1012

# METAR

- Separação nos espaços
- Regex
- Lista de tuplas
- Ferramenta de templating

251600Z 22011KT 9999 BKN023 OVC035  
21/16 Q1012

```
[ ('251600Z', 'METAR válido para dia 25 as 16:00 (UTC)'),  
  ('22011KT', 'Vento proa <b>220</b>° com velocidade <b>11</b>  
nós (kt).'),  
  ('9999', 'Visibilidade ilimitada'),  
  ('SCT017', 'Nuvens espalhadas (3/8 a 4/8 do céu com nuvens) em  
<b>>1700</b> pés de altitude.'),  
  ('BKN023', 'Nuvens broken (5/8 a 7/8 do céu com nuvens) em  
<b>>2300</b> pés de altitude.'),  
  ('OVC035', 'Totalmente encoberto em <b>>3500</b> pés de altitude.'),  
  ('21/16', 'Temperatura <b>21</b>°C e ponto de orvalho <b>>16</b>°C.'),  
  ('Q1022', 'O altímetro deve ser ajustado para <b>1022</b> hPa  
(30.18 inHg)').  
]
```

# TAF

220859Z 2212/2312 06006KT 9999 SCT040 TX34/2217Z TN24/2309Z  
BECMG 2215/2217 34013KT SCT040 FEW045TCU  
TEMPO 2220/2222 TS SCT030 FEW035CB  
BECMG 2222/2224 04008KT CAVOK  
BECMG 2310/2312 SCT020 RMK PGX

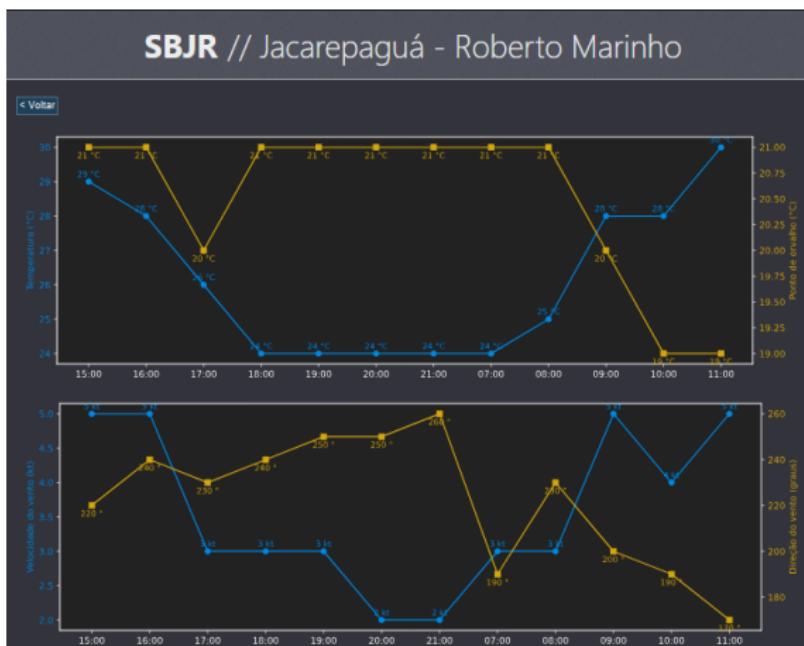
220859Z	Disponibilizado em 08:59Z no dia 22
2212/2312	Válido do dia 22 as 12:00Z até dia 23 as 12:00Z
06006KT	Vento proa 060° com velocidade 06 nós (kt).
9999	Visibilidade 9999 metros
SCT040	Nuvens espalhadas (3/8 a 4/8 do céu com nuvens) em 4000 pés de altitude.
TX34/2217Z	A temperatura máxima é de 34°C prevista de ocorrer dia 22 as 17:00 (UTC)
TN24/2309Z	A temperatura mínima é de 24°C prevista de ocorrer dia 23 as 09:00 (UTC)
BECMG 2215/2217 ▲	Condições previstas do dia 22 as 15:00 (UTC) até dia 22 as 17:00 (UTC)
34013KT	Vento proa 340° com velocidade 13 nós (kt).
SCT040	Nuvens espalhadas (3/8 a 4/8 do céu com nuvens) em 4000 pés de altitude.
FEW045TCU	Poucas nuvens (1/8 a 2/8 do céu com nuvens) em 4500 pés de altitude. <b>Atenção:</b> nuvens de grande extensão vertical.
TEMPO 2220/2222 ▼	Condições temporárias previstas do dia 22 as 20:00 (UTC) até dia 22 as 22:00 (UTC)



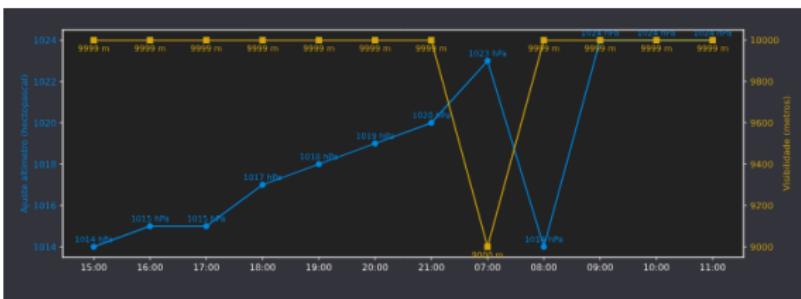
# Histórico

wind_direction	wind_speed	temperature	dew_point	qnh	visibility	clouds_few	clouds_scattered	clouds_broken	clouds_overcast	timestamp
150	6	21	19	1012	9999					2024-10-17 03:00:00
160	4	21	19	1012	9999					2024-10-17 04:00:00
100	5	20	19	1012	9999 4000	10000				2024-10-17 05:00:00
		21	20	1011	9999 4000	8000				2024-10-17 06:00:00
140	3	20	19	1011	9999					2024-10-17 07:00:00
140	4	20	19	1012	9999 500	10000				2024-10-17 08:00:00
0	0	21	19	1013	9999 2000	10000				2024-10-17 09:00:00
80	2	22	20	1014	9999 2000	10000				2024-10-17 10:00:00
30	5	23	20	1014	9999					2024-10-17 11:00:00
60	4	25	20	1014	9999 3000					2024-10-17 12:00:00
140	6	26	20	1014	9999 3000					2024-10-17 13:00:00
160	11	26	19	1014	9999 3000					2024-10-17 14:00:00

# Histórico

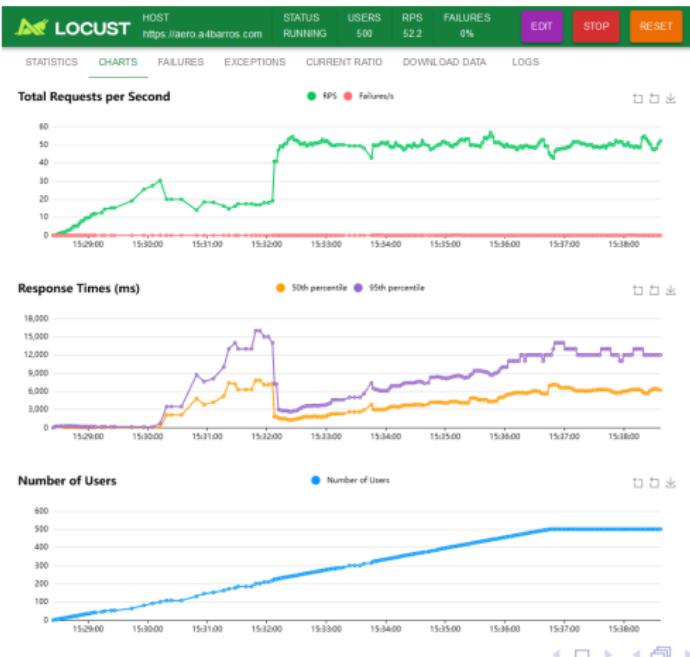


# Histórico



# Sem cache

## ■ Modo desenvolvedor CloudFlare

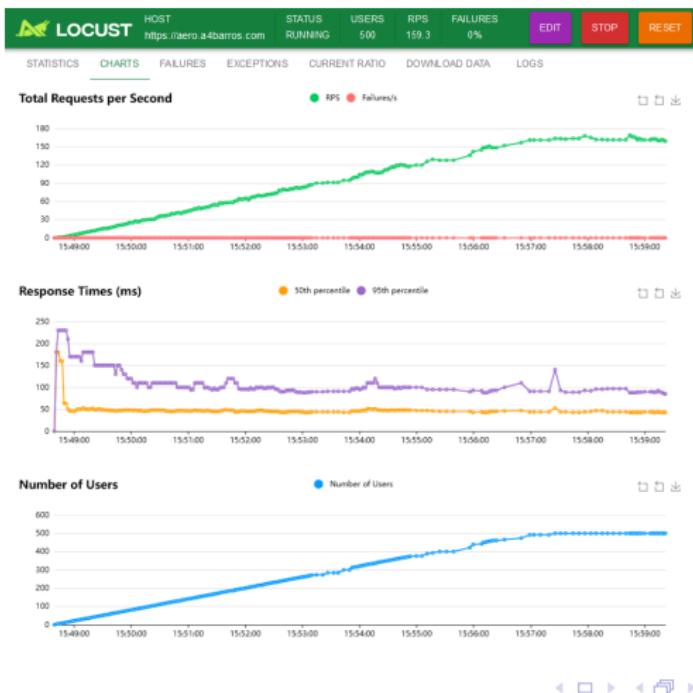


# Cache Redis

- Decorator implementado: cache\_it



# Cache NGINX



# Demonstração

<https://aero.a4barros.com>

Obrigado

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Perguntas?