Lecture 09-0: Web API Pipelines with Railway

DATA 503: Fundamentals of Data Engineering

Lucas P. Cordova, Ph.D.

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This lecture introduces cloud-based data pipelines using Railway. We set up a shared PostgreSQL database, explore public web APIs, and deploy automated services that collect weather and flight data over Portland on a schedule. This is the infrastructure that powers your group project and sets up the data we will analyze in the next lecture.

Table of contents

1 Why Web API Pipelines?

1.1 The Group Project Problem

Your group project requires two things that are hard to do on a laptop:

- A **shared database** that every team member can access
- **Automated data collection** that runs on a schedule, even when your laptop is closed

Today we solve both of those problems.

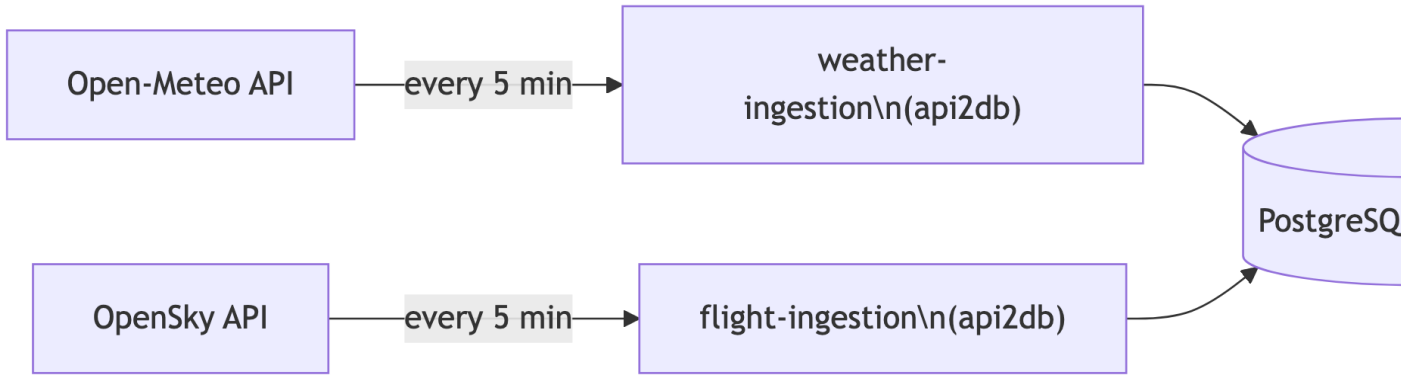
1.2 When Do You Need a Polling Service?

A web API polling service is for **continuous, periodic data collection**. Think:

- Weather readings every 5 minutes
- Flight positions updated in real time
- Sensor data from IoT devices
- Stock prices throughout the trading day

You do **not** need a polling service for downloading a static CSV or a one-time data dump. Just download the file. The exception is when an API has strict rate limits and you need to spread requests over time.

1.3 What We Are Building Today



By the end of today, you will have two services running in the cloud, collecting weather and flight data over Portland every five minutes, storing it all in a shared Postgres database.

2 Introducing Railway

2.1 What is Railway?

Railway is a Platform-as-a-Service (PaaS). Think of it as a friendly version of AWS. You tell it what to run, and it handles servers, networking, deployment, and scaling.

You sign up with your **GitHub account** (recommended) at railway.app.

2.2 Free Trial vs Hobby Plan

This matters, so pay attention:

	Free Trial	Hobby Plan
Cost	Free ($5 credit)	$5/month (with $5 credit)
Net cost	Free until credit runs out	Effectively free for small projects
Cron jobs	Not available	Available
Always-on services	Limited execution time	Yes
Expiration	Credit expires	Ongoing

The Hobby plan is **required** for cron jobs. Since it gives you a $5 credit against the $5 charge, small projects like ours cost nothing. Sign up for Hobby.

2.3 Sharing a Workspace with Your Team

Railway uses **Teams** for collaboration:

1. Go to **Settings > Teams > Create Team**
2. Add members by their Railway username or email
3. Team members can see all projects and services in the team workspace

Each team member needs their own Railway account (Hobby plan recommended). One person creates the team, everyone else joins. This is how your project groups will collaborate on a shared database and shared services.

2.4 Creating a Project

1. Click **New Project** from the Railway dashboard
2. Give it a meaningful name (e.g., "DATA 503 - Team Weather")
3. Railway creates a default environment called `production`; you can rename it if you want

This project is the container for everything we build today: the database and the ingestion services.

3 Setting Up PostgreSQL on Railway

3.1 Adding a Postgres Service

Inside your project:

1. Click **New** (the purple button)
2. Select **Database > PostgreSQL**
3. Railway provisions a Postgres instance in about 10 seconds

That is it. You now have a cloud database.

3.2 Understanding the Connection Variables

Click on your Postgres service and open the **Variables** tab. You will see a wall of variables. Here are the ones that matter:

Variable	What It Is	Where You Use It
`DATABASE_URL`	Internal connection URL	Used by other Railway services in the same project (fast, no internet routing)
`DATABASE_PUBLIC_URL`	Public connection URL	Used by external tools like Beekeeper Studio and pgAdmin (goes over the internet)
`PGHOST`, `PGPORT`, `PGUSER`, `PGPASSWORD`, `PGDATABASE`	Individual connection components	Alternative to the URL, useful when a tool needs separate fields

3.3 Internal vs Public URLs

The **internal** `DATABASE_URL` is only accessible from within Railway's network. Other services in the same project reference it as `${{Postgres.DATABASE_URL}}` and it resolves automatically. This is fast because traffic never leaves Railway's infrastructure.

The `DATABASE_PUBLIC_URL` is accessible from anywhere on the internet. This is what you paste into Beekeeper or pgAdmin on your laptop. It routes through Railway's proxy, so it is slightly slower, but it works from anywhere.

4 Connecting with Beekeeper Studio and pgAdmin

4.1 Beekeeper Studio

1. Open **Beekeeper Studio**
2. Click **New Connection > PostgreSQL**
3. Click **"Import from URL"**
4. Paste the `DATABASE_PUBLIC_URL` from Railway
5. Click **Connect**

That is genuinely all there is to it. Beekeeper parses the URL and fills in everything for you.

4.2 pgAdmin

pgAdmin requires you to fill in the fields manually:

1. Open **pgAdmin**
2. Right-click **Servers > Register > Server**
3. **General** tab: give it a name like "Railway - Project Name"
4. **Connection** tab: fill in the individual fields from Railway's variables:
    - **Host**: the `PGHOST` value (e.g., `roundhouse.proxy.rlwy.net`)
    - **Port**: the `PGPORT` value (e.g., `20848`)
    - **Maintenance database**: `railway`
    - **Username**: `postgres`
    - **Password**: the `PGPASSWORD` value
5. Click **Save**

4.3 Verify Your Connection

Run a simple query to confirm everything works:

```sql
SELECT 1;
```

If you get a result, you are connected.

> ⚠ Warning
>
> **Pay attention to which database you are connected to.** If you have multiple databases (local, Railway, class server), it is easy to run queries against the wrong one. Check the connection indicator in your tool before executing anything destructive.

5 Understanding Web APIs

5.1 What is a Web API?

A web API is a structured way to request data from a server using URLs.

- The **URL** is the request
- The **JSON** is the response

That is the mental model. You construct a URL with the right parameters, send it to a server, and get back structured data.

5.2 The Golden Rule

To use any API, you need to **read its documentation**.

Understand three things:

- The **base URL** (where the API lives)
- The available **endpoints** (what data you can request)
- The **query parameters** (how you customize the request)

Let us look at two APIs we will use today.

5.3 Open-Meteo Weather API

Docs: open-meteo.com/en/docs

No API key required. Free and open.

Base URL: `https://api.open-meteo.com/v1/forecast`

Parameters for Portland weather:

Parameter	Value	Purpose
`latitude`	`45.52`	Portland, OR
`longitude`	`-122.68`	Portland, OR
`current`	`temperature_2m,wind_speed_10m,weathercode`	Current conditions we want

5.4 The Weather API URL

The full URL:

```
https://api.open-meteo.com/v1/forecast?latitude=45.52&longitude=-122.68&current=temperature_
```

You can paste this directly into your browser to see the response. Try it.

5.5 Weather API Response

The response looks something like this:

```
{
  "latitude": 45.52,
  "longitude": -122.68,
  "current_units": {
    "time": "iso8601",
    "interval": "seconds",
    "temperature_2m": "°C",
    "wind_speed_10m": "km/h",
    "weathercode": "wmo code"
  },
  "current": {
    "time": "2026-03-09T14:30",
    "interval": 900,
    "temperature_2m": 8.2,
    "wind_speed_10m": 12.5,
```

```
    "weathercode": 3
  }
}
```

The `current` object has everything we care about: temperature in Celsius, wind speed in km/h, and a WMO weather code (0 = clear, 3 = overcast, 61 = rain, etc.).

5.6 OpenSky Network Flight API

Docs: openskynetwork.github.io/opensky-api

No API key required for anonymous access (but rate limited to ~10 requests per minute).

Base URL: `https://opensky-network.org/api/states/all`

Parameters for the Portland metro bounding box:

Parameter	Value	Purpose
`lamin`	`45.2`	Southern boundary latitude
`lomin`	`-123.2`	Western boundary longitude
`lamax`	`45.8`	Northern boundary latitude
`lomax`	`-122.2`	Eastern boundary longitude

5.7 The Flight API URL

The full URL:

```
https://opensky-network.org/api/states/all?lamin=45.2&lomin=-123.2&lamax=45.8&lomax=-122.2
```

5.8 Flight API Response

The response has a `time` field and a `states` array:

```
{
  "time": 1741542600,
  "states": [
    ["a1b2c3", "UAL1234 ", "United States", 1741542598,
     1741542598, -122.56, 45.59, 10972.8, false,
     230.5, 142.3, 0, null, 11277.6, "2461", false, 0],
    ...
```

```
  ]
}
```

Each inner array is one aircraft. The key indices:

- `[0]` = ICAO24 transponder address
- `[1]` = callsign
- `[2]` = origin country
- `[5]` = longitude
- `[6]` = latitude
- `[7]` = altitude (meters)

Note: `states` can be `null` when no aircraft are in the bounding box. That is normal, especially late at night.

6 The api2db Template

6.1 What is api2db?

lucascordova/api2db is a Docker container that does one simple thing:

1. Fetches a URL
2. Stores the JSON response in a Postgres table

It runs once per execution and exits. Combined with Railway's cron scheduling, it becomes an automated data collection pipeline.

The table it creates has this structure:

```
id serial PRIMARY KEY,
raw_json jsonb,
created_at TIMESTAMPTZ DEFAULT NOW()
```

Every row is one API response: the raw JSON and when it was collected.

6.2 Deploying via Template

Use this template link to deploy:

railway.com/deploy/api2db-template

Steps:

1. Click the template link

2. Click **"Deploy Now"**
3. Select your project and environment
4. Configure the environment variables (next slide)

6.3 Environment Variables

Variable	Required?	Default	Purpose
`SITE_URL`	Yes	(none)	The API URL to fetch
`TABLE_NAME`	Yes	(none)	The Postgres table name to store data in (created automatically if it does not exist)
`DATABASE_URL`	Preconfigured	`${{Postgres.DATABASE_URL}}`	The connection to your Railway Postgres. Uses Railway's variable referencing so it auto-connects.
`DEBUG`	Preconfigured	`false`	Set to `true` for verbose logging
`HEADER_KEYS`	Preconfigured	`{}`	HTTP headers to send with the request (JSON object)

6.4 What Are Header Keys?

Some APIs require authentication or special headers with each request. `HEADER_KEYS` is a JSON object of key-value pairs that get sent as HTTP headers.

Examples:

- Bearer token: `{"Authorization": "Bearer abc123xyz"}`
- API key header: `{"X-API-Key": "your-key-here"}`

Our APIs (Open-Meteo and OpenSky) do not require any headers, so `{}` is fine. But if your group project API requires authentication, this is where those credentials go.

7 What is Cron?

7.1 Cron Expressions

Cron is a time-based job scheduler. Railway uses cron expressions to determine when a service runs.

The format is five fields:

```
        minute (0-59)
          hour (0-23)
            day of month (1-31)
              month (1-12)
                day of week (0-6, Sunday=0)

* * * * *
```

7.2 Common Cron Examples

Expression	Meaning
`*/5 * * * *`	Every 5 minutes
`0 * * * *`	Every hour on the hour
`0 9 * * 1`	Every Monday at 9 AM
`0 0 * * *`	Midnight every day

Use crontab.guru to test and visualize cron expressions. It is a lifesaver.

We will use `*/5 * * * *` (every 5 minutes) for both of our services.

8 Creating the Staging Tables

8.1 The Staging Tables

Both staging tables have the same dead-simple structure:

```sql
CREATE TABLE flight_json_data (
    id serial PRIMARY KEY,
    raw_json jsonb,
    created_at TIMESTAMPTZ DEFAULT NOW()
);

CREATE TABLE weather_json_data (
    id serial PRIMARY KEY,
    raw_json jsonb,
    created_at TIMESTAMPTZ DEFAULT NOW()
);
```

One column for the ID, one for the entire JSON blob, one for when we grabbed it.

This is the database equivalent of throwing everything in a cardboard box during a move. It works, but you would not want to live like that.

9 Deploying the Weather Service

9.1 Step by Step

1. Open the api2db template link
2. Select your project and environment
3. Set the environment variables:
    - **SITE_URL** = `https://api.open-meteo.com/v1/forecast?latitude=45.52&longitude=-122.68&current=temperature_2m,wind_speed_10m,weathercode`
    - **TABLE_NAME** = `weather_json_data`
4. Click **Deploy**
5. Once deployed, go to **Settings**
6. Under **Cron Schedule**, enter: `*/5 * * * *`
7. Rename the service to **`weather-ingestion`**

The service will now run every 5 minutes, fetch the current Portland weather, and store it in the `weather_json_data` table.

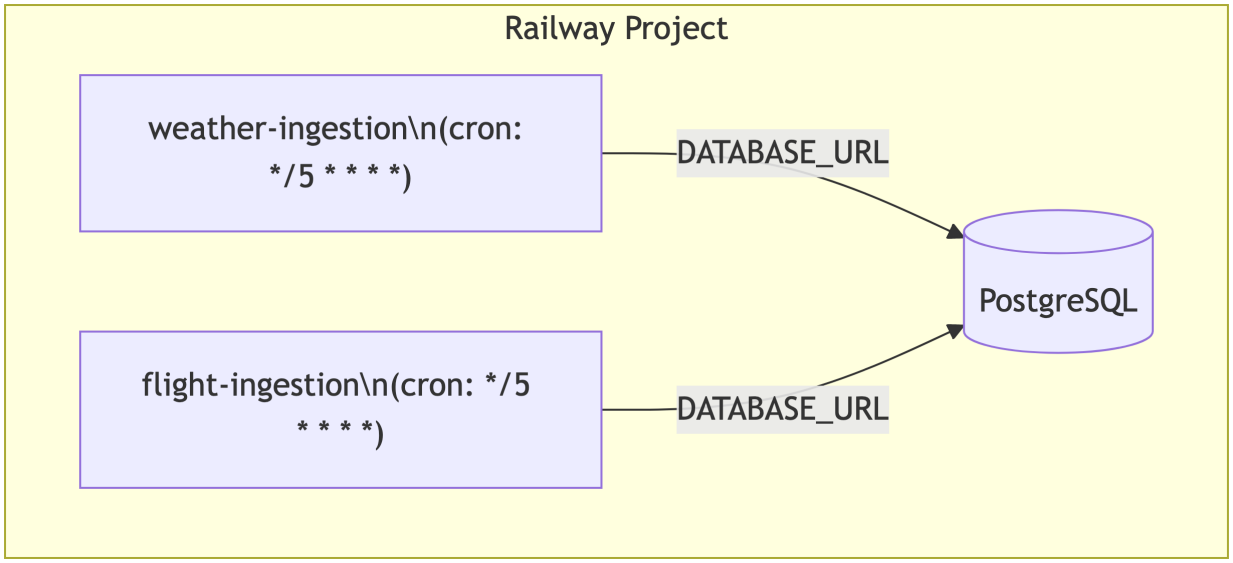
10 Deploying the Flight Service

10.1 Same Process, Different Data

1. Open the api2db template link again
2. Select your project and environment
3. Set the environment variables:
   - **`SITE_URL`** = `https://opensky-network.org/api/states/all?lamin=45.2&lomin=-123.2&lamax=45.8&lomax=-122.2`
   - **`TABLE_NAME`** = `flight_json_data`
4. Click **Deploy**
5. Set **Cron Schedule** to: `*/5 * * * *`
6. Rename the service to **`flight-ingestion`**

10.2 Your Railway Project

Your project should now look something like this:



Three services: one database, two ingestion workers. Clean and simple.

11 Verifying Data Collection

11.1 Wait for the First Run

Cron services run on schedule, not immediately on deploy. Wait about 5 minutes for the first trigger, or check the **Deployments** tab to see if a run has completed.

11.2 Check Row Counts

Connect to your database via Beekeeper Studio and run:

```
SELECT count(*) FROM weather_json_data;
SELECT count(*) FROM flight_json_data;
```

If you see numbers greater than zero, your pipeline is working.

11.3 Peek at Weather Data

```
SELECT id,
       raw_json->'current'->>'temperature_2m' AS temp_c,
       created_at AS collected_at
FROM weather_json_data
ORDER BY created_at DESC
LIMIT 5;
```

11.4 Peek at Flight Data

```
SELECT id,
       jsonb_array_length(raw_json->'states') AS num_aircraft,
       created_at AS collected_at
FROM flight_json_data
WHERE raw_json->'states' IS NOT NULL
  AND raw_json->>'states' != 'null'
ORDER BY created_at DESC
LIMIT 5;
```

The `WHERE` clause filters out rows where no aircraft were in the bounding box (the `states` field is `null`).

11.5 Troubleshooting

If you are not seeing data:

- **Check the Deployments tab**: is the service actually running? Look for successful completions.
- **Check the Logs tab**: error messages will tell you what went wrong.
- **Verify `SITE_URL`**: a single typo in the URL will cause failures. Copy-paste, do not retype.
- **Check `DATABASE_URL`**: it should be `${{Postgres.DATABASE_URL}}` (with the double curly braces). If you typed a raw connection string, it will not resolve inside Railway.

12 What Comes Next

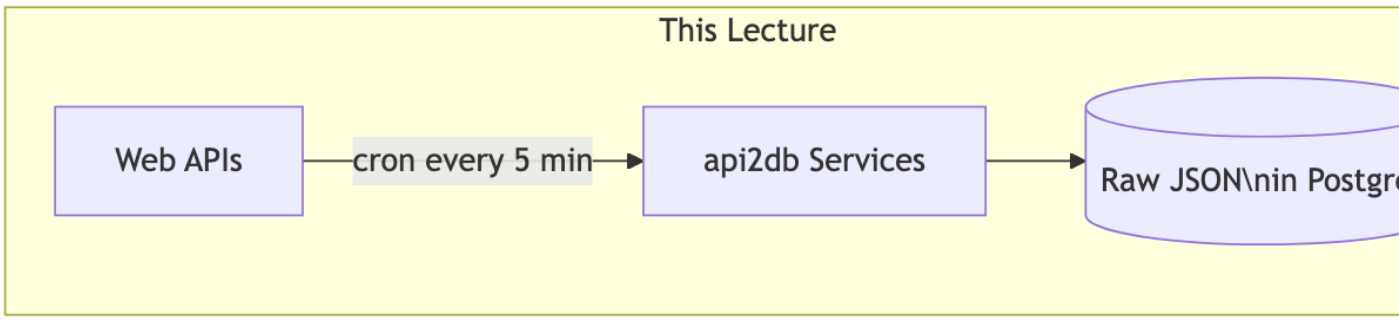
12.1 Let the Data Accumulate

Your services are now collecting data every 5 minutes. **Let them run.**

For meaningful analysis, you want at least a week of data, ideally two weeks. That gives us:

- ~2,000 weather readings
- ~2,000 flight snapshots
- Enough variation to see patterns across weekdays, weekends, day, and night

12.2 The Full Pipeline



12.3 Next Lecture: Advanced Statistics

In the next lecture, we will:

- Transform the raw JSON into clean, normalized tables
- Run statistical analysis: correlation, ranking, window functions
- Answer a real question: **does weather affect air traffic over Portland?**

The data you are collecting right now is what makes that analysis possible. Do not turn off your services.

13 References

13.1 Resources

- Railway Documentation
- Open-Meteo API
- OpenSky Network API
- Crontab Guru
- Beekeeper Studio
- pgAdmin