Case Study #2

Memi Lavi
www.memilavi.com

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The Real Autonomous Car

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- Manufactures autonomous systems for vehicles
- Has >10,000 vehicles on the roads right now
- Expects more than 200,000 vehicles by end of year
- Needs to reliably receive telemetry from cars and display data about them

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Requirements

Functional

What the system should do

1. Web Based
2. Receive telemetry from cars (location, speed, breakdowns, etc)
3. Store telemetry in a persistent store
4. Display dashboards summarizing the data
5. Perform analysis on the data

Non-Functional

What the system should deal with

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NFR - What We Know

1. Data intensive system
2. Not a lot of users
3. A lot of data
4. Performance is important

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NFR - What We Ask

1. *"How many expected concurrent users?"* 10
2. *"How many telemetry messages received per second?"* 7,000
3. *"What is the average size of message?"* 1KB
4. *"Is the message schema-less?"* Yes

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NFR - What We Ask

5. *"Can we tolerate some message loss?"* Sort of…

6. *"What is the desired SLA?"* Highest Possible

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Data Volume

- 1 Message = 1KB
- 7,000 messages / sec = 7MB / sec

=> ~25GB / hr

=> ~605GB / day

=> ~221TB / year ← That's a lot!

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Retention Period

Defines for how long records are kept in the database

What happens to them after the retention period?

- Deleted

- Moved to archive data store

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Retention Period

Motivation:

- Keep database from exploding
- Improve query performance

AWS Config adds the ability to specify a data retention policy for your configuration items

Posted On: Aug 7, 2018

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Retention Period

Muscar needs two types of data:

- Operational, near-real-time (location, speed, etc.)
- Aggregated and ready for analysis (BI – Business Intelligence)

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Retention Period

Data Type	Used for…	Retention Period
Operational	Monitor real time data from cars. Performance is critical	
Aggregated	Reports, BI. Not real time, can be slower.	

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Retention Period

Data Type	Used for…	Retention Period
Operational	Monitor real time data from cars. Performance is critical	1 week
Aggregated	Reports, BI. Not real time, can be slower.	Forever

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Data Volume

- 1 Message = 1KB
- 7,000 messages / sec = 7MB / sec

  => ~25GB / hr

  => ~605GB / day

  => ~221TB / year

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Data Volume

- 1 Message = 1KB
- 7,000 messages / sec = 7MB / sec

=> ~25GB / hr

=> ~605GB / day

=> ~4TB / week

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Requirements

Functional

What the system should do

1. Web Based
2. Receive telemetry from cars (location, speed, breakdowns, etc)
3. Store telemetry in a persistent store
4. Display dashboards summarizing the data
5. Perform analysis on the data

Non-Functional

What the system should deal with

1. 10 Concurrent users
2. 7,000 msgs/sec
3. Max data in the operational DB: 4TB
4. Mission critical
5. Performance is critical

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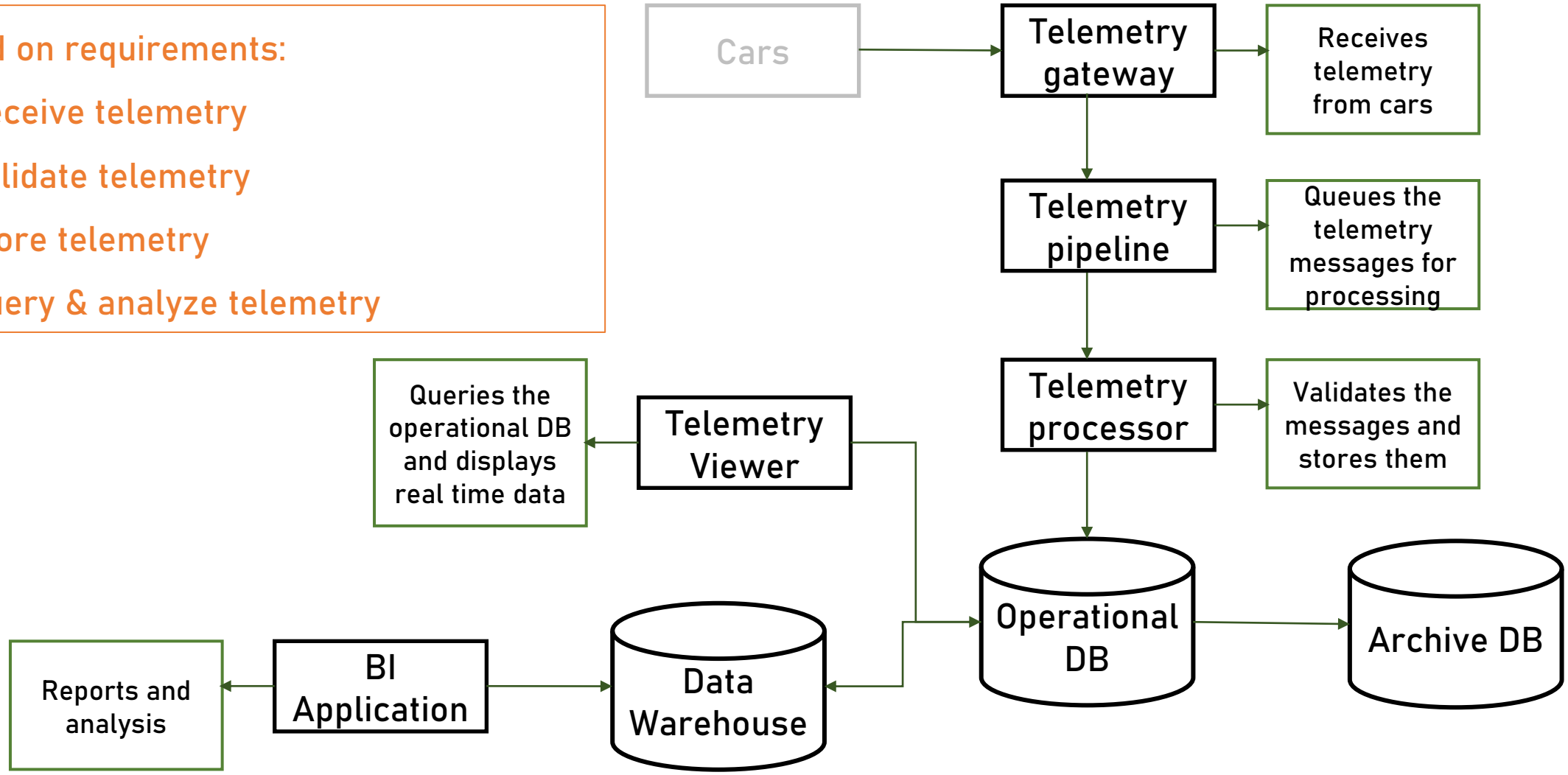
Components

Based on requirements:

1. Receive telemetry
2. Validate telemetry
3. Store telemetry
4. Query & analyze telemetry



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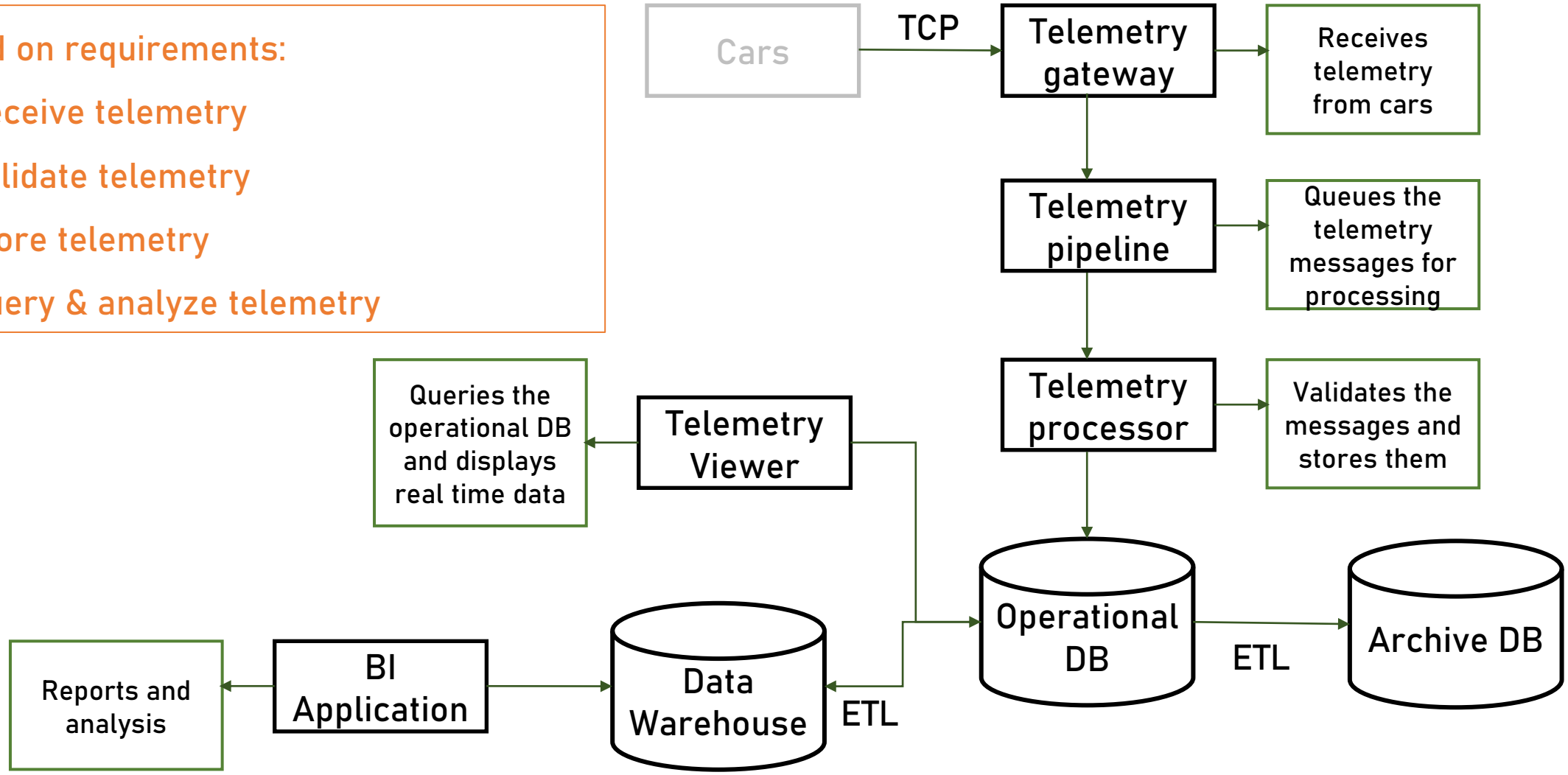
Messaging

Based on requirements:

1. Receive telemetry
2. Validate telemetry
3. Store telemetry
4. Query & analyze telemetry



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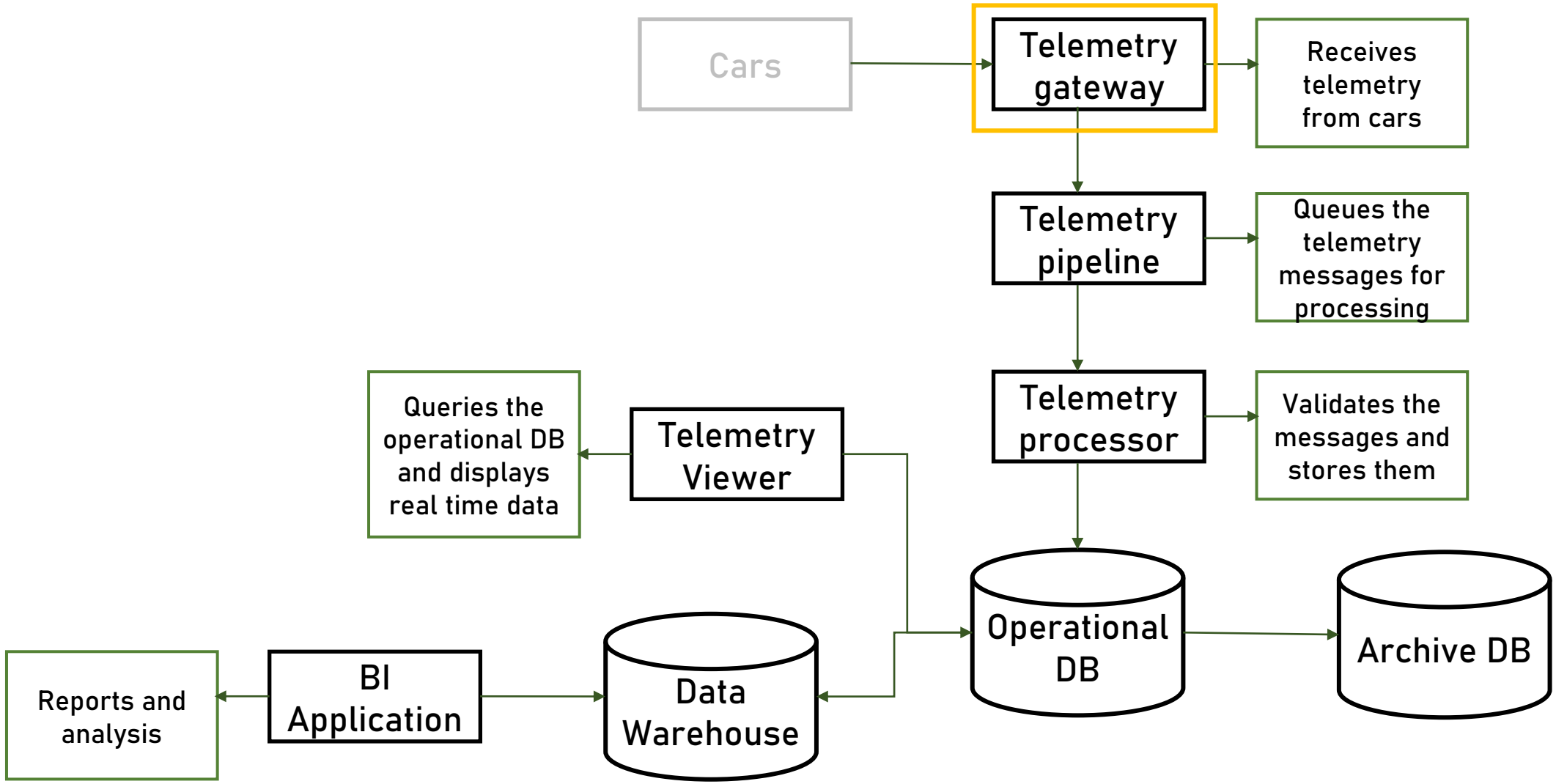
Components



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Telemetry Gateway

What it does:

- Receives telemetry data from cars using TCP

- Pushes the telemetry data to the pipeline

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Application Type

- Web App & Web API ✗
- Mobile App ✗
- Console ✓
- Service ✓
- Desktop App ✗

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Technology Stack

Considerations:

- Load (7,000 msgs/sec)
- Performance
- Team's current knowledge
- Environment (OS, etc)

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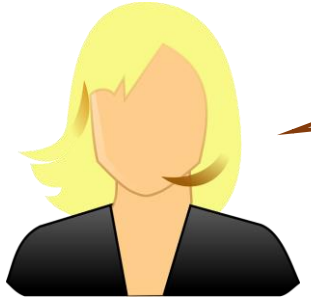
Technology Stack



Our developers are familiar with Python,
and are experts in JavaScript.
In addition, we use only Linux servers.

Python can't be used for the gateway

Too slow

We look for a language with great performance,

runs on linux, and leverages current skills

(Python & JavaScript)

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Technology Stack

- Great performance
- Runs on Linux
- Leverages JS skills

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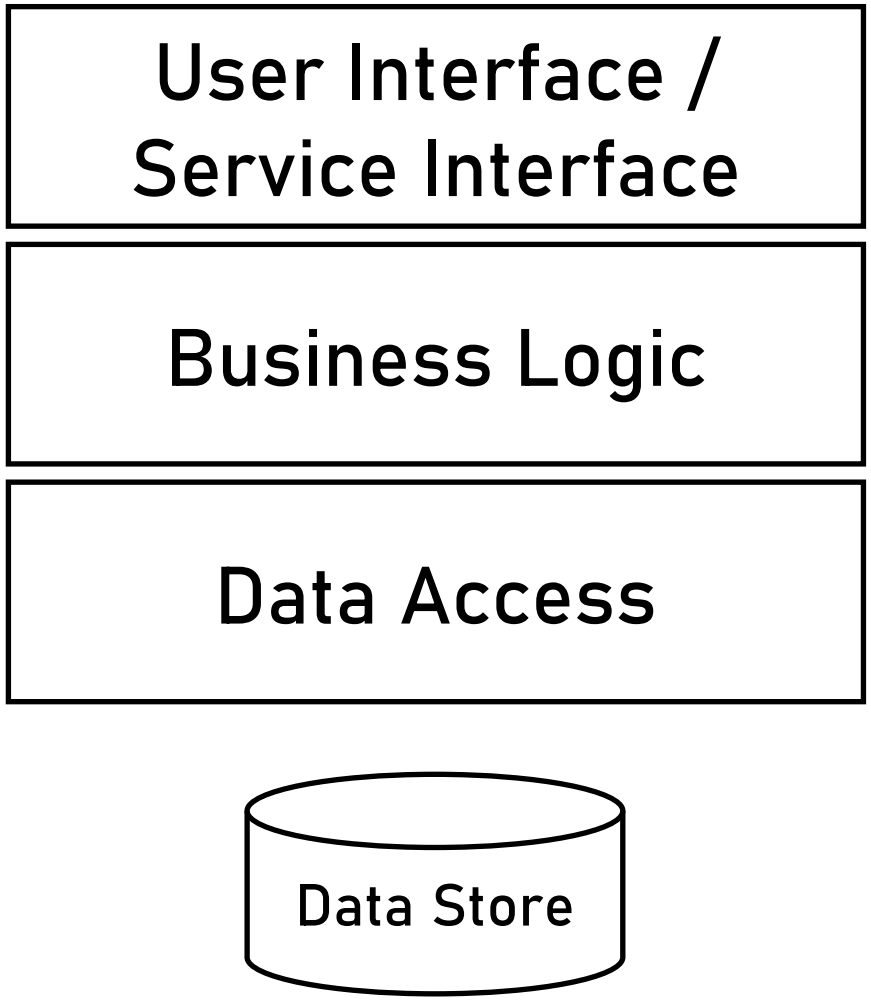
Architecture

Traditional:



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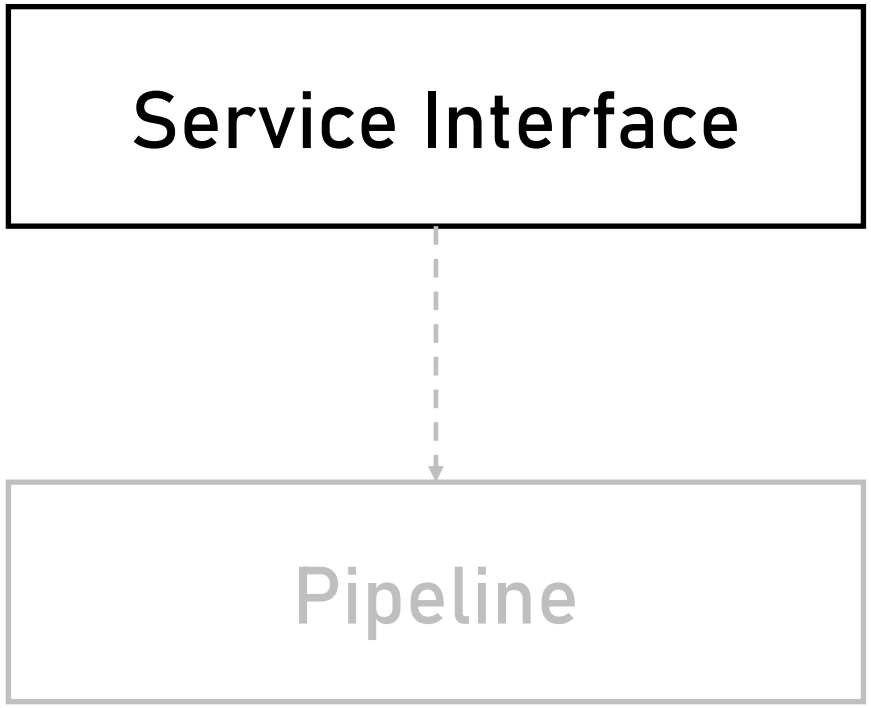
Architecture

In our case:



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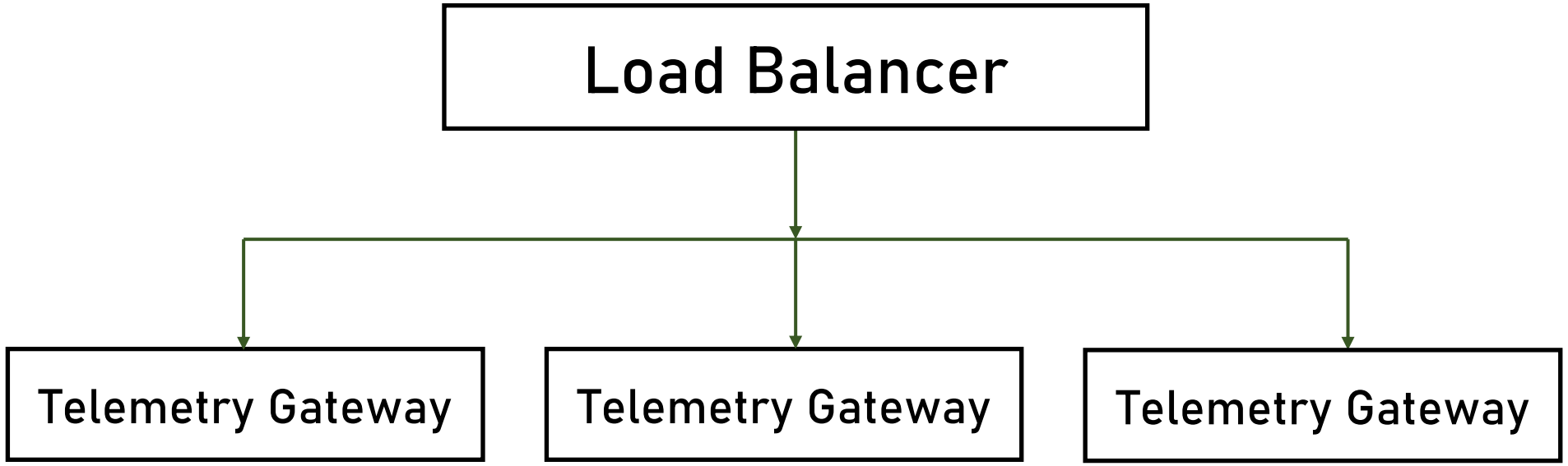
Telemetry Gateway Redundancy



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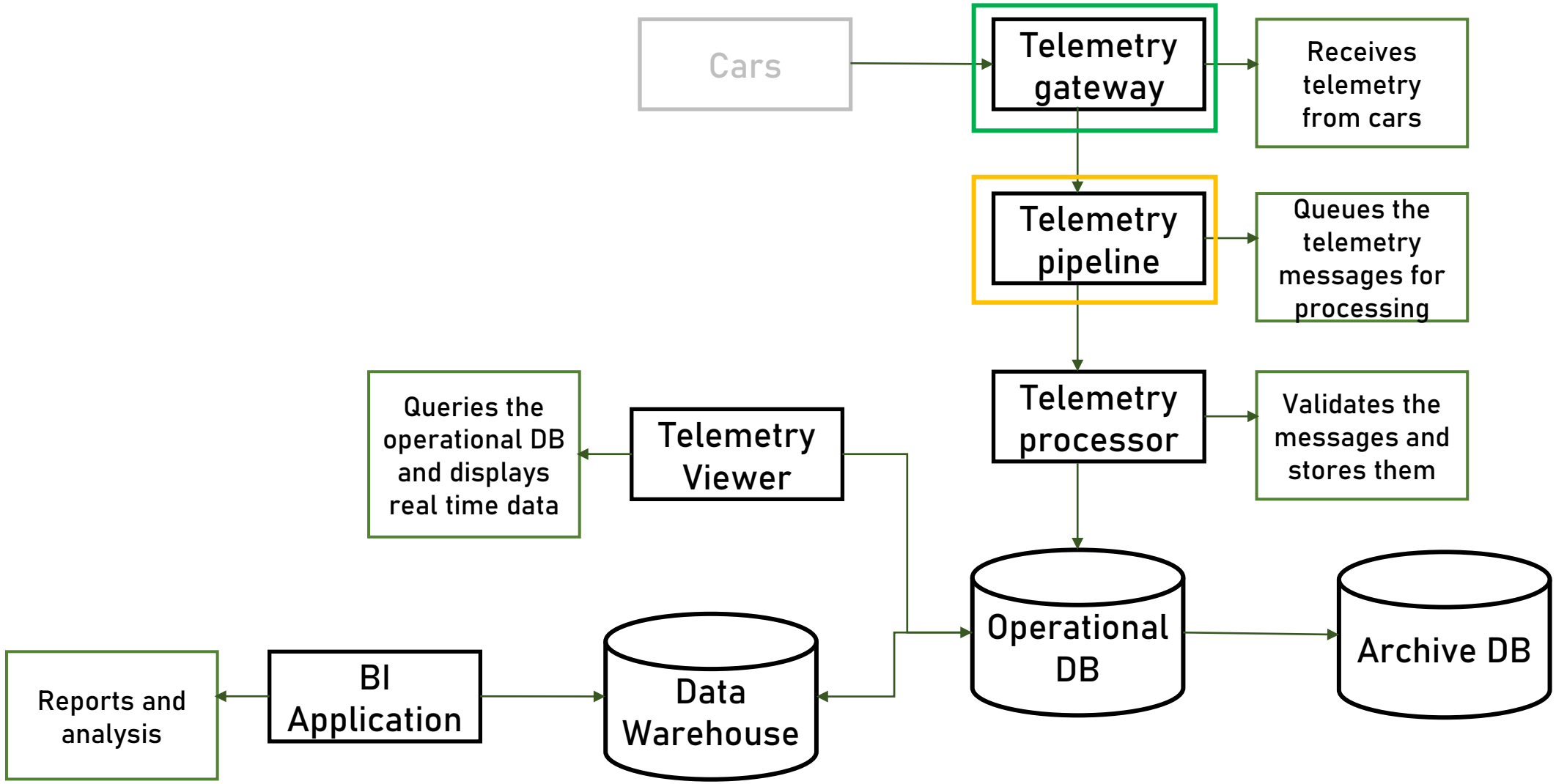
Components



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Telemetry Pipeline

What it does:

- Gets the telemetry messages from the gateway

- Queues the telemetry for further processing

- Basically – a queue for streaming high volume data

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Telemetry Pipeline - Questions

1. Is there an existing queue mechanism in the company?

   No

2. Develop our own or use 3rd party?

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Telemetry Pipeline - Questions

Let's look around...

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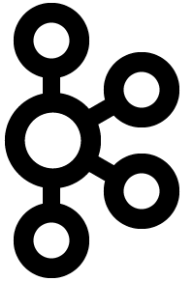
Telemetry Pipeline - Kafka



Pros:

- Very popular
- Can handle massive amount of data
- High availability support

Cons:

- Complex set-up
- Complex configuration

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Telemetry Pipeline - Decision

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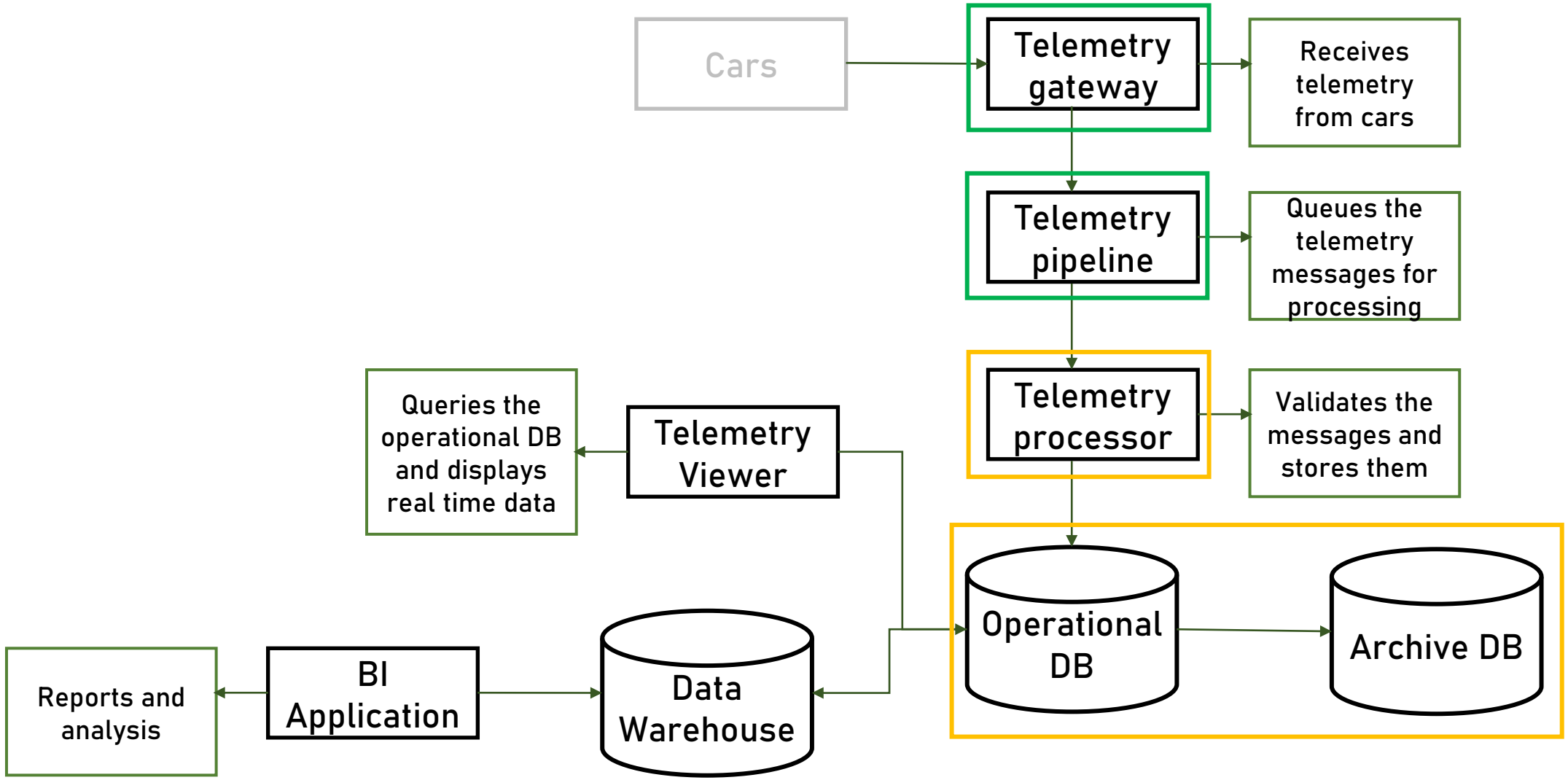
Components



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Telemetry Processor

What it does:

- Receives the messages from the pipeline

- Processes the messages (mainly validation)

- Stores the messages in a data store

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Application Type

- Web App & Web API ✗
- Mobile App ✗
- Console ✓
- Service ✓
- Desktop App ✗

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Technology Stack

For:

- The processor
- The datastore

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Technology Stack

The Processor:

- Already used in the system
- Fast
- Great Kafka support

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Technology Stack

The Datastore – what we're looking for:

- Schema-less message support
- Quick retrieval
- No complex queries

mongoDB®

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Technology Stack

mongoDB®

- Schema-less message support ✓
- Quick retrieval ✓
- No complex queries ✓

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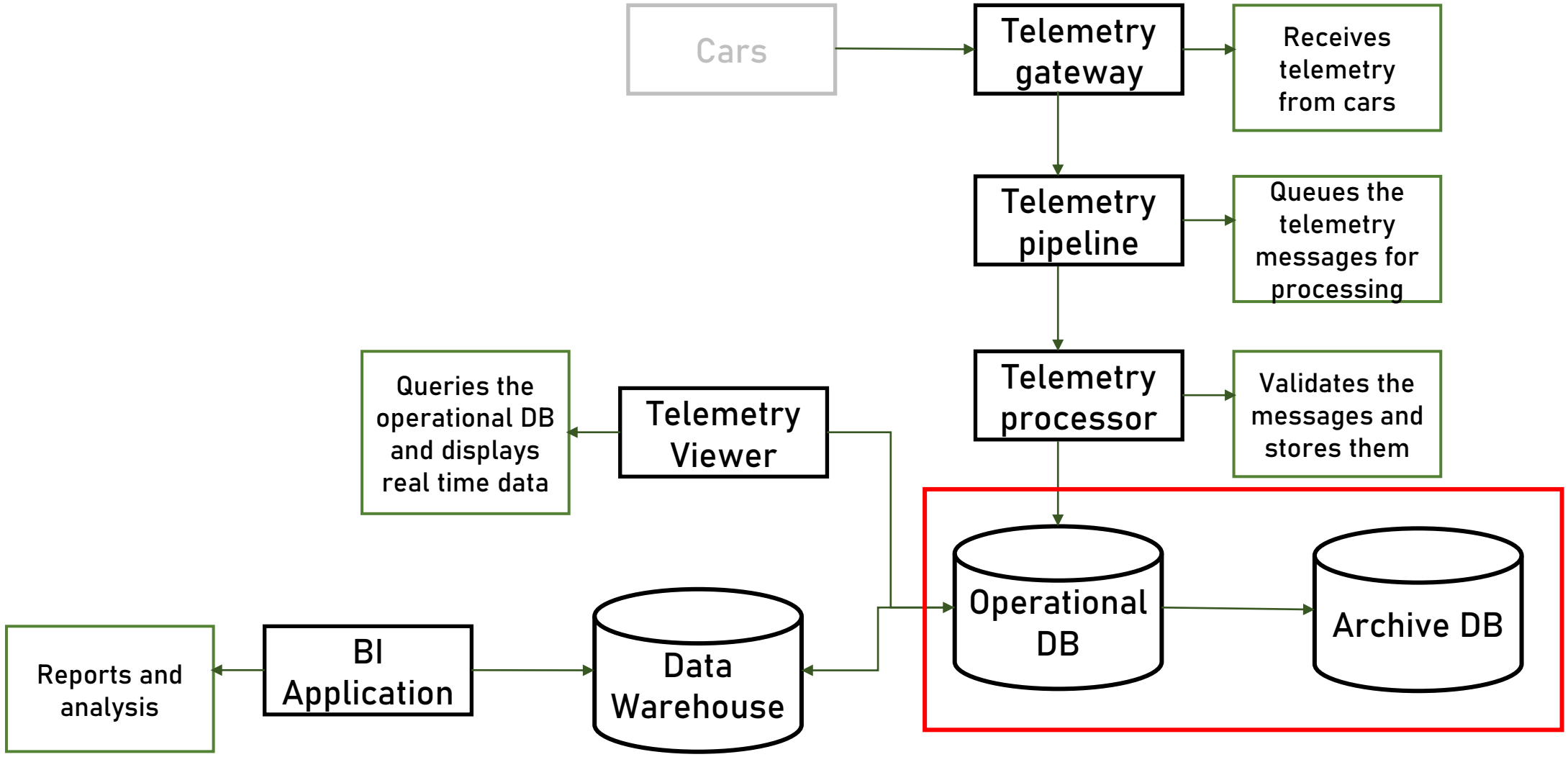
Components



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Technology Stack

Archive– what we're looking for:

- Support for a huge amount of data (221TB / Year)
- Not accessed frequently
- No need for fast retrieval
- Save costs

Going To The Cloud

Cloud Storage:

- Huge amounts of data (221TB / Year) ✓
- Not accessed frequently ✓
- No need for fast retrieval ✓
- Save costs ✓

Cloud Storage

Microsoft Azure

	PREMIUM	HOT	COOL	ARCHIVE
First 50 terabyte (TB) / month	$0.195 per GB	$0.0196 per GB	$0.01 per GB	$0.0018 per GB
Next 450 TB / Month	$0.195 per GB	$0.0189 per GB	$0.01 per GB	$0.0018 per GB
Over 500 TB / Month	$0.195 per GB	$0.0181 per GB	$0.01 per GB	$0.0018 per GB

After 1 year: 221TB => 398$

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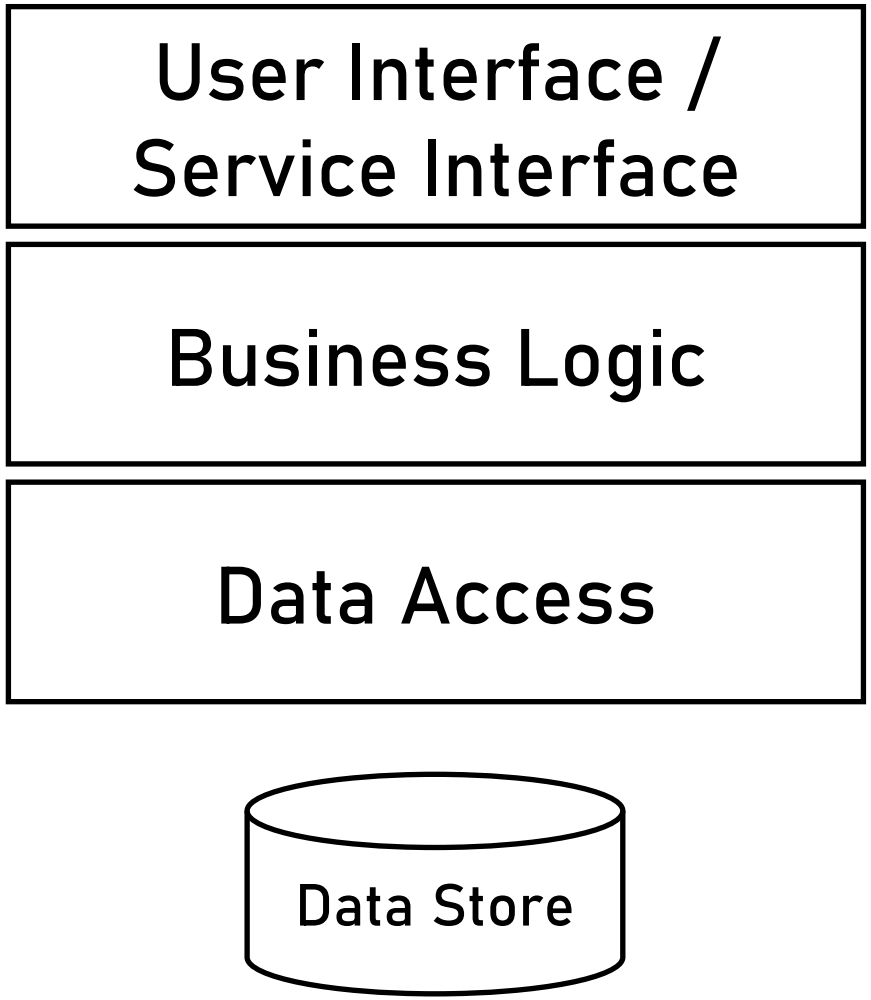
Architecture



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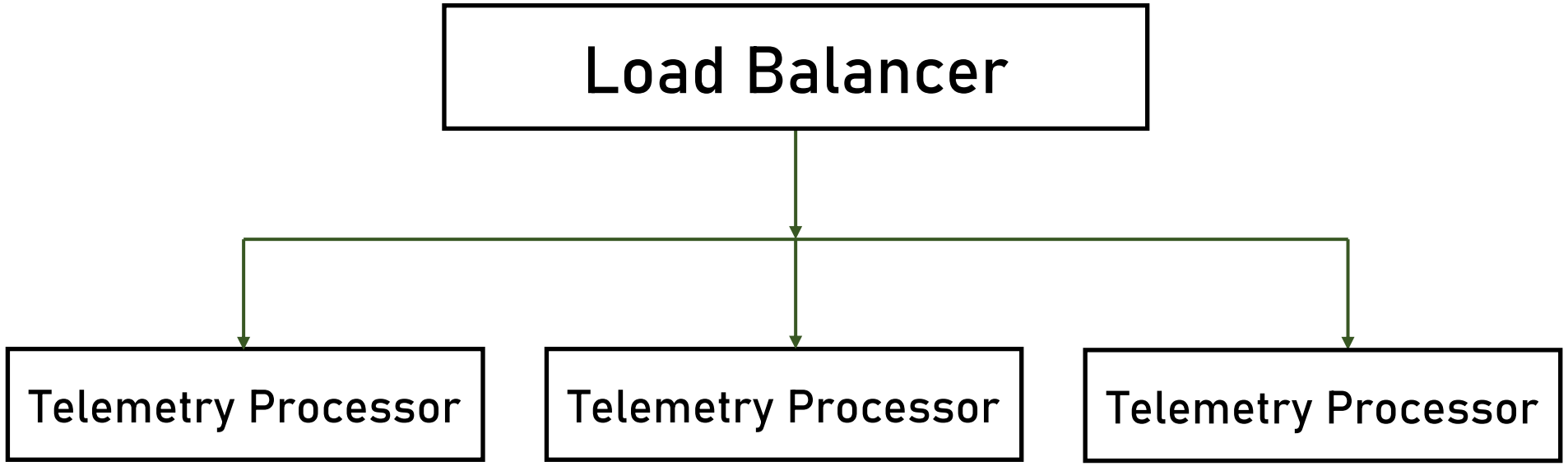
Telemetry Processor Redundancy



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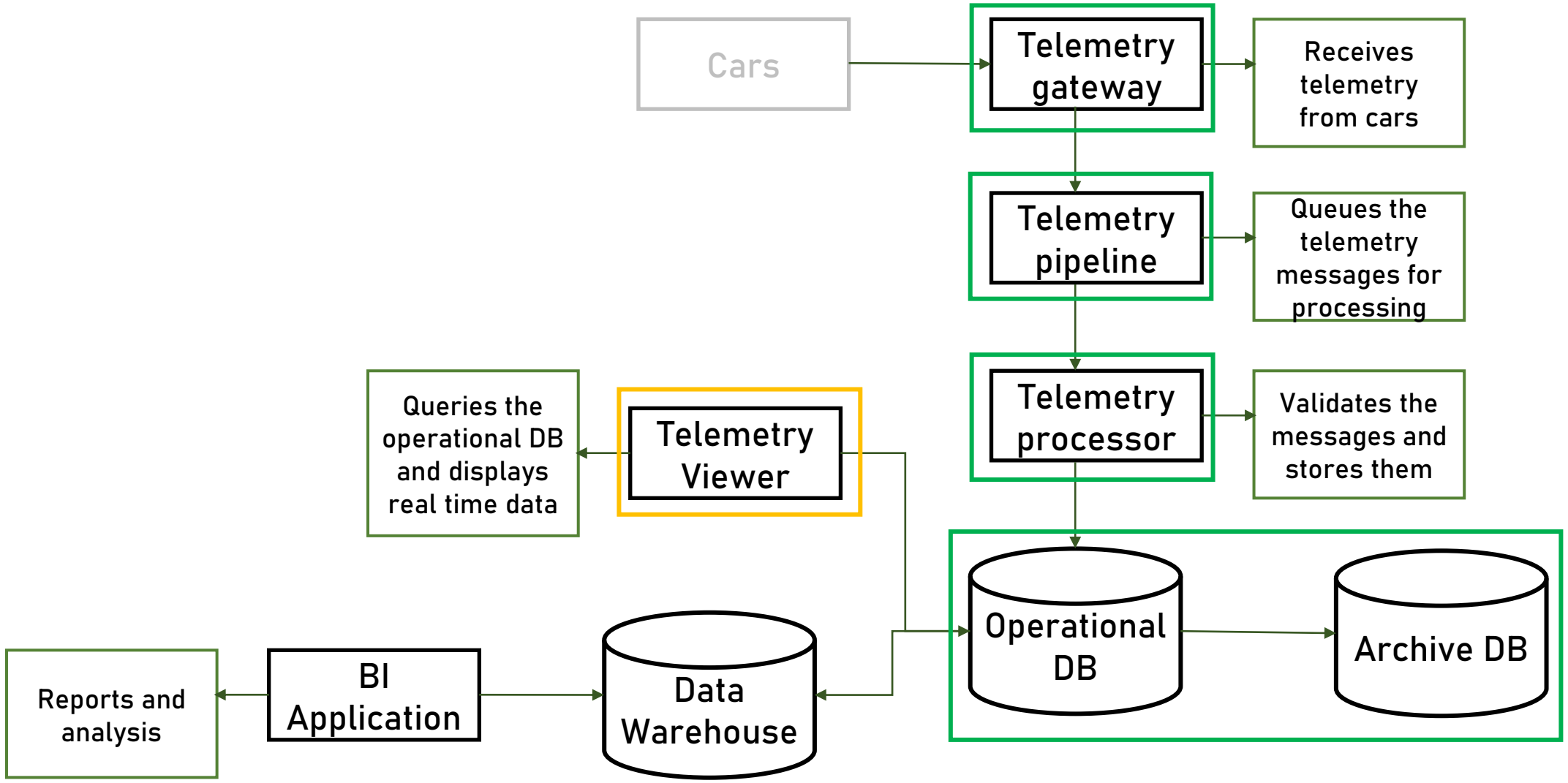
Components



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Telemetry Viewer

What it does:

- Allows end users to query telemetry data

- Displays real time data

What it doesn't:

- Analyzes the data

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Application Type

- Web App & Web API ✓
- Mobile App ✗
- Console ✗
- Service ✗
- Desktop App ✗

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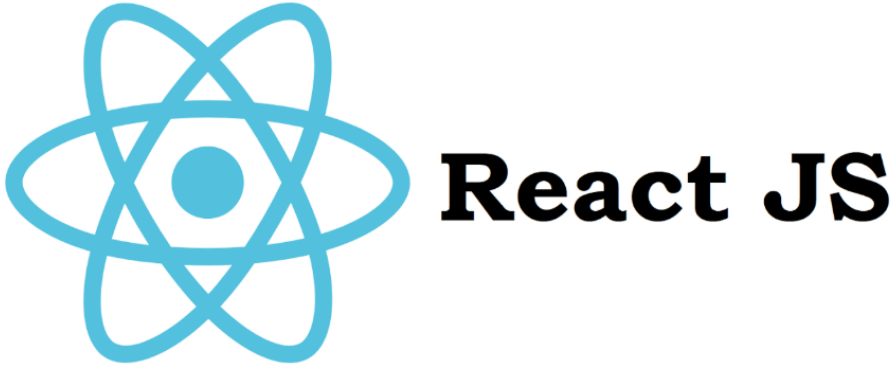
Technology Stack

Back End

Front End



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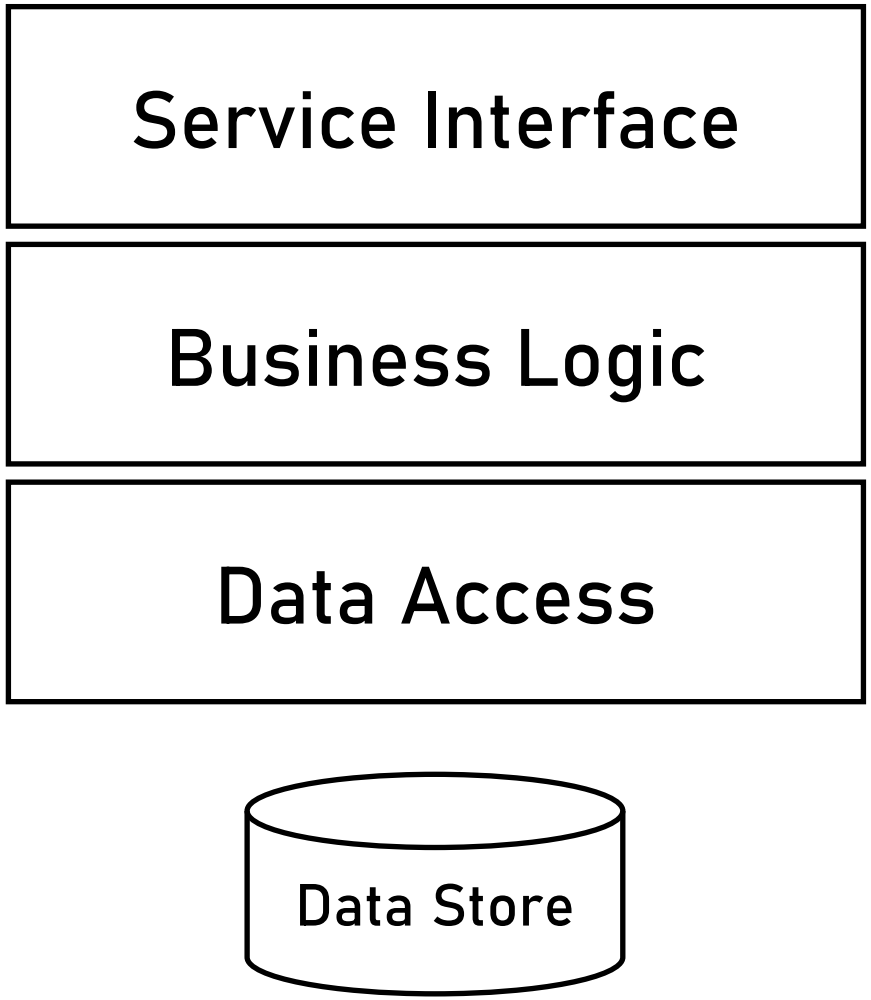
Architecture



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API

- Get latest errors for all cars
- Get latest telemetry for specific car
- Get latest errors for specific car

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API

Functionality	Path	Return Codes
Get latest errors for all cars	`GET /api/v1/telemetry/errors`	`200 OK`
Get latest telemetry for specific car	`GET /api/v1/telemetry/{carId}`	`200 OK` `404 Not Found`
Get latest errors for specific car	`GET /api/v1/telemetry/errors/{carId}`	`200 Ok` `404 Not Found`

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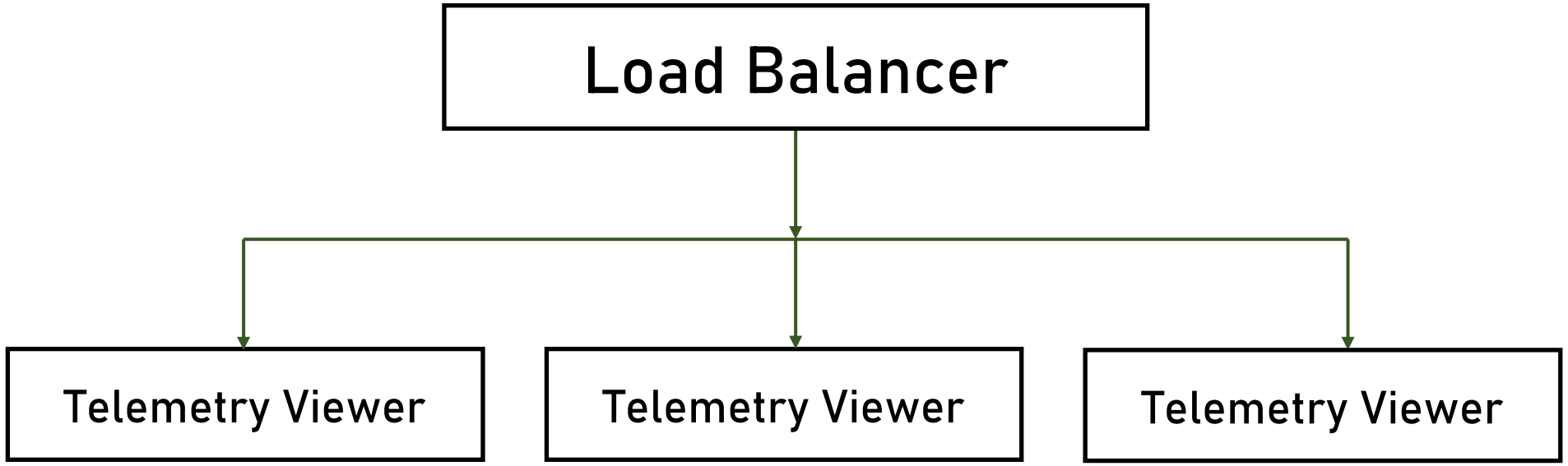
Telemetry Viewer Redundancy



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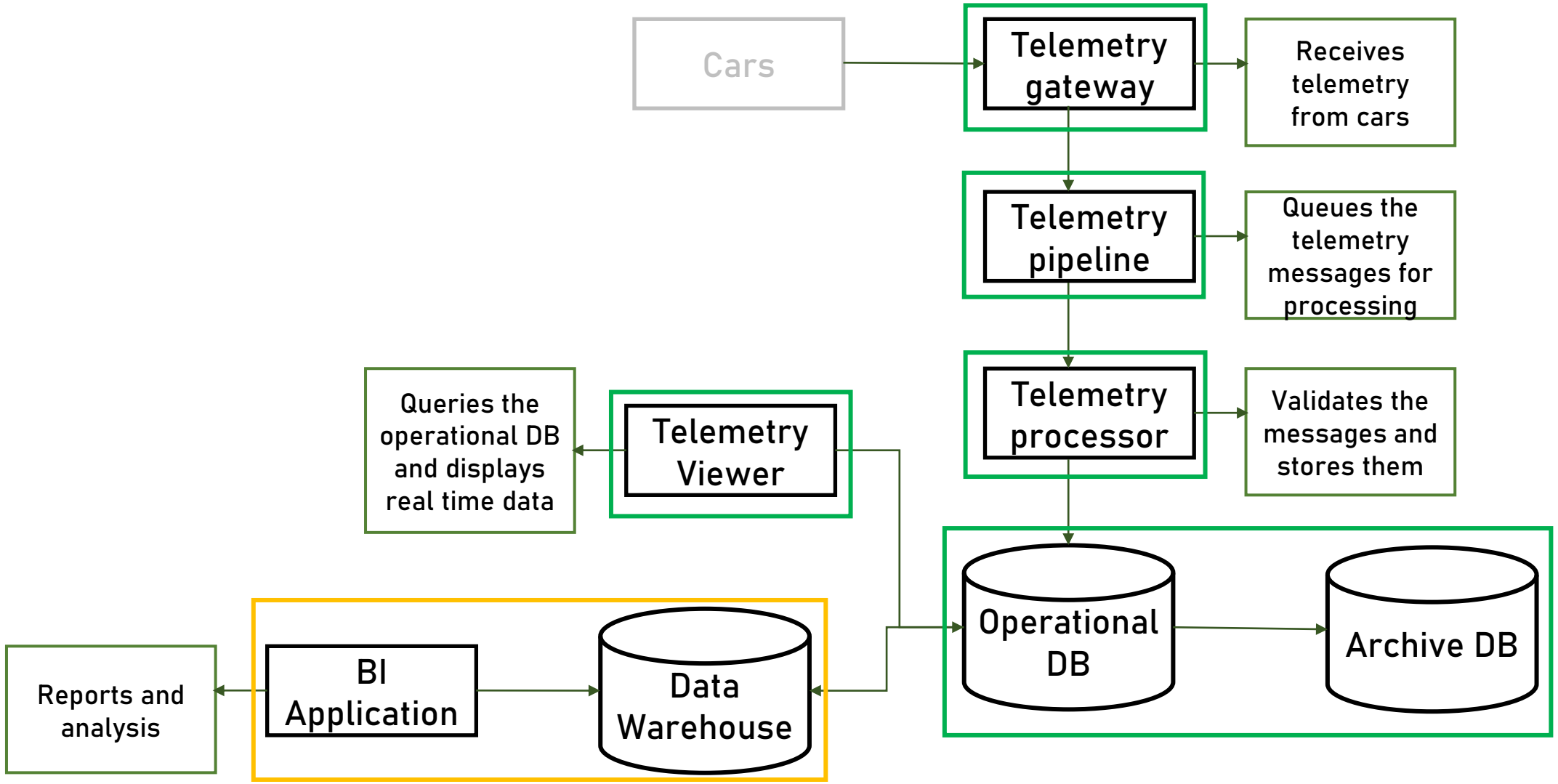
Components



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BI Application

Business Intelligence

What it does:

- Analyzes telemetry data

- Displays custom reports about the data, trends, forecasts etc.

  - How many cars did break during the last month?

  - What is the total distance the cars drove?

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Application Type

- Doesn't matter
- BI Application is ALWAYS based on an existing tool

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BI Tools

Power BI

QlikView

tableau

SISENSE

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BI Tools

Figure 1. Magic Quadrant for Analytics and Business Intelligence Platforms

Source: Gartner (February 2019)

BI Tools

- An important lesson:
  - Designing BI solution is NOT part of the architect's job
  - ALWAYS use BI expert for this task

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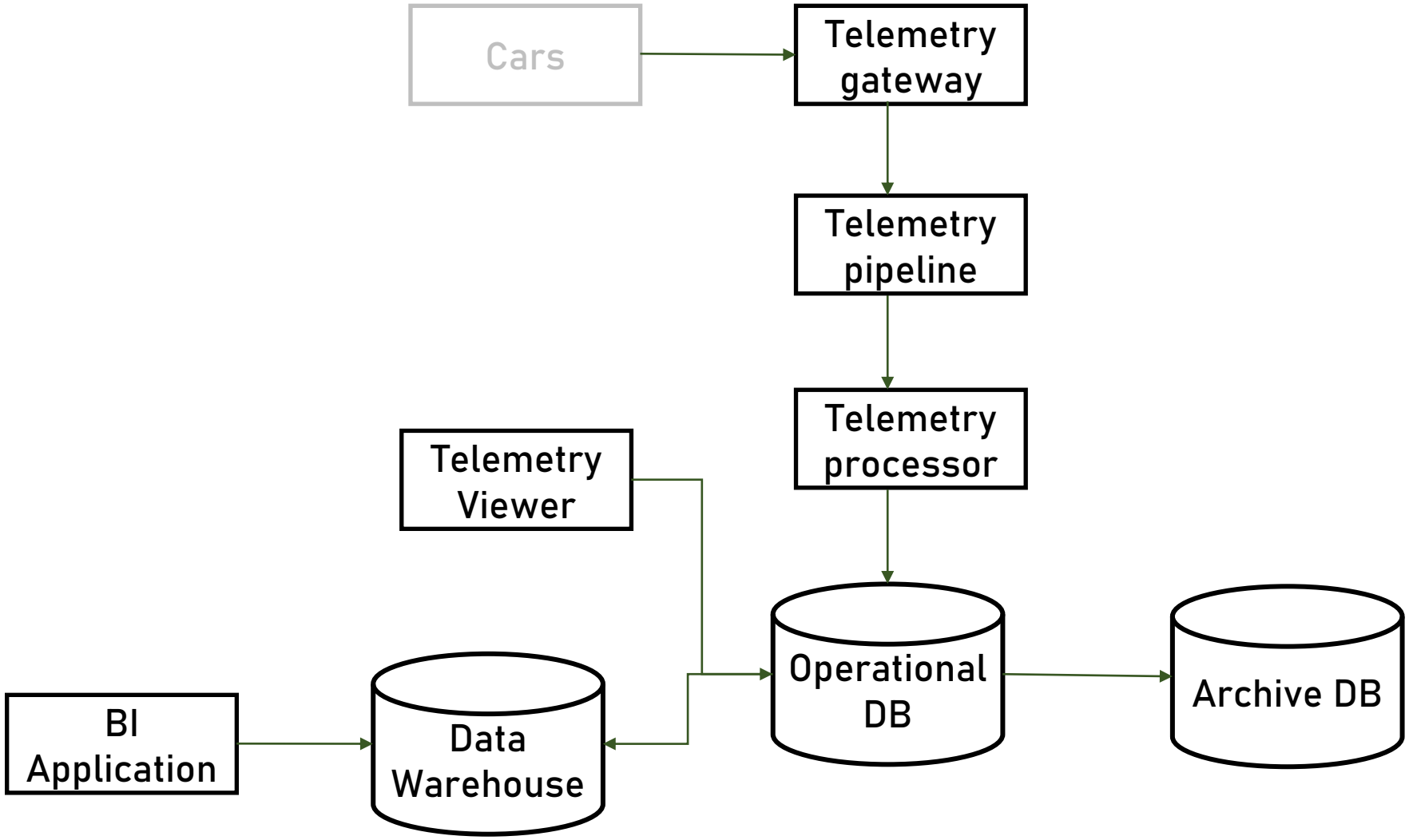
Logic Diagram



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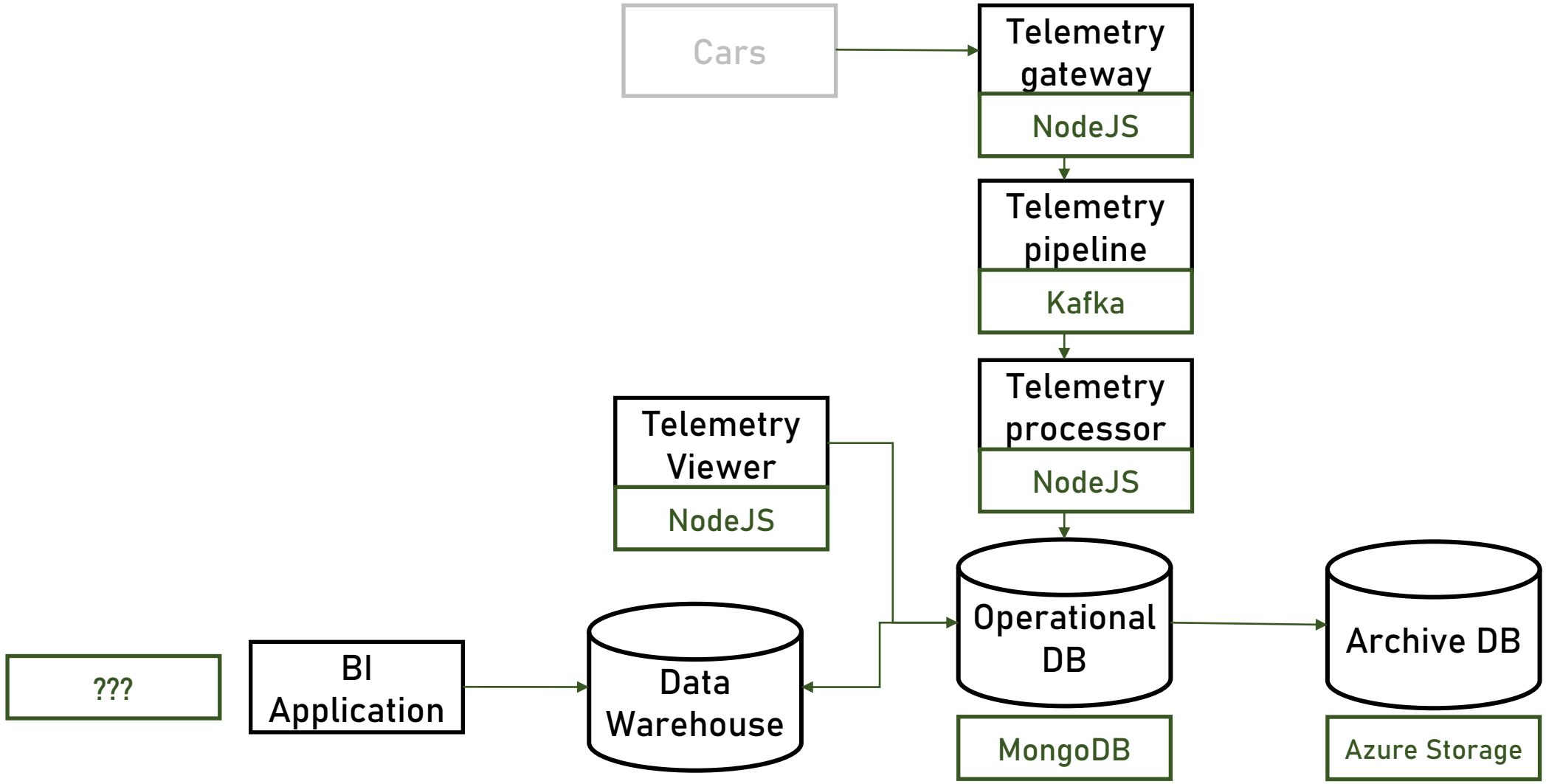
Technical Diagram



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Physical Diagram