Beam data pipelines on microservice architectures

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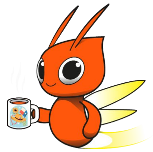
Wayfair

BEAM SUMMIT Austin, 2022

Agenda



- Wayfair & imagery
- Microservice essentials
- Digital Studio
- Domain event challenges
- Cloud Dataflow [Beam]
- Learnings
- QA

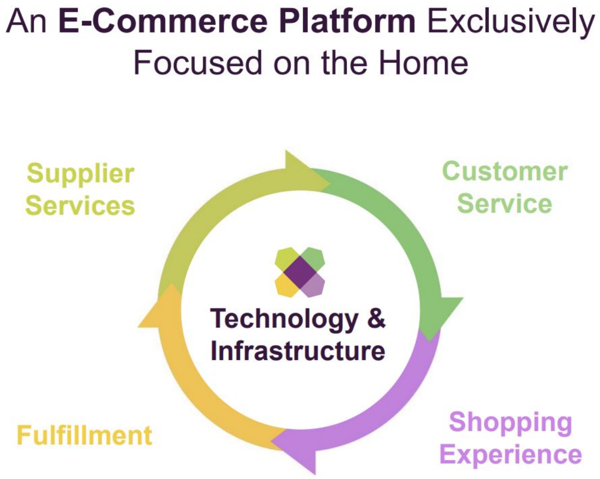
Explore building data pipelines for microservice architectures. Includes Wayfair Digital Studio domain event landscape and deriving key business metrics real-time in a decoupled scalable approach

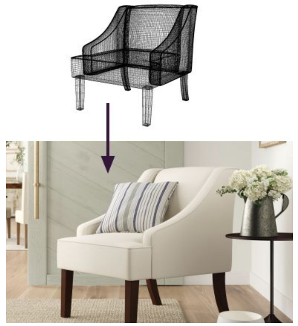
Wayfair & imagery

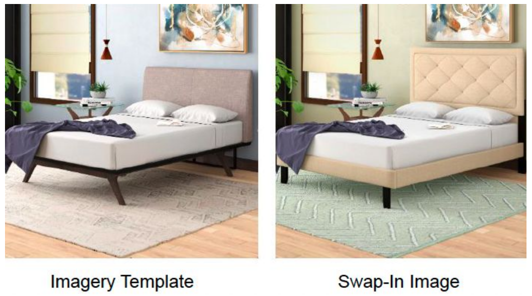
Wayfair is the **world's largest online destination** for all things home incl furniture, household items, appliances etc

Unparalleled selections and **high quality imagery** are keys to provide a rich & unique user experience
Photo studios are **expensive** to operate and require significant time to produce an image
3D modeling and **custom imagery** is one of the main focus areas of investment

We don't sell furnitures, we sell images

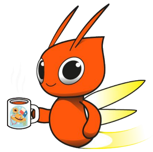

An E-Commerce Platform Exclusively Focused on the Home
Supplier Services
Customer Service
Technology & Infrastructure
Fulfillment
Shopping Experience

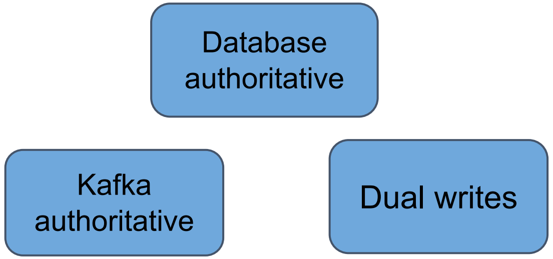

3D model to Image



Model swaps

Common streaming publications





DB authoritative	Kafka authoritative	Dual writes
Application writes to database	Application generate events	Application writes to database
Database generates events	Database is a consumer	Application also generate events
[Pros] Transactional consistency	[Pros] Multiple consumers	[Pros] Simplicity
[Cons] Database scalability	[Cons] Database latency	[Cons] Inconsistency

Database supports **transactions**, provide consistent view, durable and battle tested but have a weakness - **scalability**

The ones which scale doesn't provide above greatness

What if you need to build a data pipeline where you don't have guarantees of database but the system provides all elasticity in the most decoupled ways?

Let's talk about microservices!

Microservice essentials

Object Oriented Programming (OOP) domination with reusability, flexibility & effective problem solving
Small independently deployable services that work together, modelled around a business domain
DDD, CQRS & Event Sourcing are talked a lot in microservice conversations

Domain-driven design (DDD) is the concept that the structure and language of software code (*class names, class methods, class variables*) should match the business domain. For example, if a software processes loan applications, it might have classes such as *LoanApplication* and Customer, and methods such as *AcceptOffer* and Withdraw.

Command Query Responsibility Segregation (CQRS) talks about separation of commands (*write requests)* and queries (*read requests*). Read stores are optimized for handling queries.

Event Sourcing (ES) is persisting changes that are happening in the application as a sequence of events

Any fool can write code that a computer can understand. Good programmers write code that humans understand.

— Refactoring: Improving the Design of Existing Code, 1999

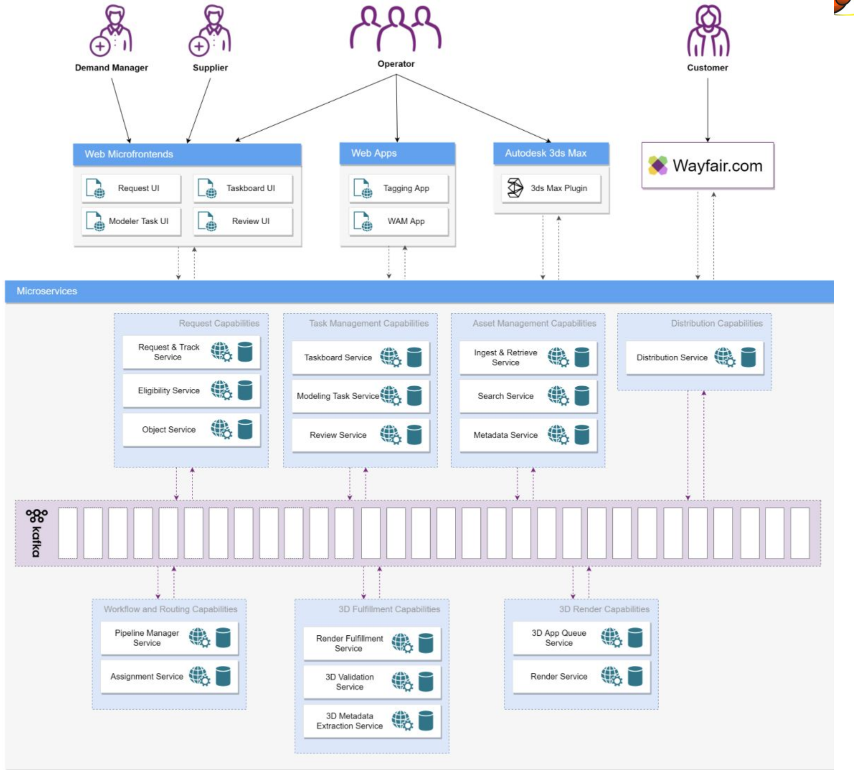
Wayfair Digital Studio

Platform made up of web applications, services and database to create 3D assets at Wayfair
Re-developed using domain driven design architecture patterns

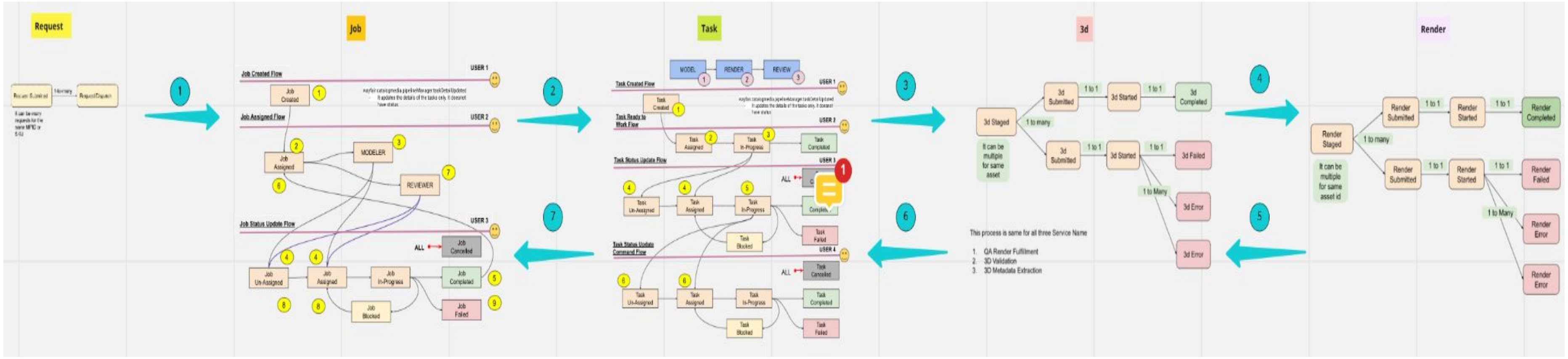
Domain: Business context on which a system is built.
Examples: Request, Job, Task

(Domain) Events: are described as something that happens in the domain and is very domain focused.
Example: *RequestSubmitted, RequestDispatched, JobAssigned*

Services: Gateway for external interactions
Example: Object Service, Eligibility Service

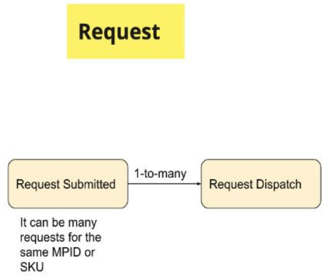


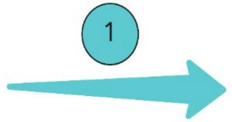
Domain landscape

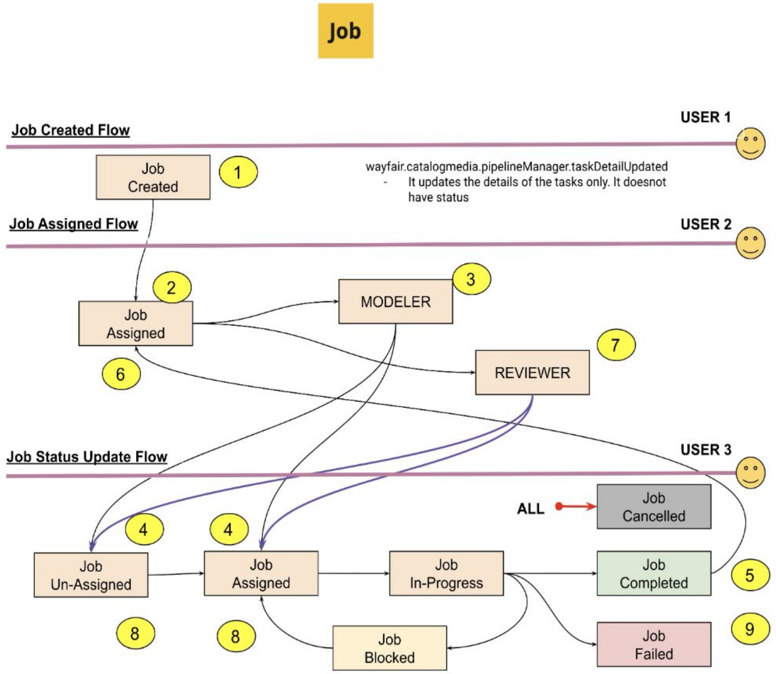


Applications are modelled on domains - Request, Job, Task, 3d, Renders etc
Supports multiple workflows - Model & Image rendering, Image modifications
Domain events triggered on state change, step completion etc

Request & Job domains





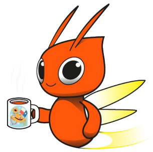


Request is a unit of human or an application desire for an asset creation.

Job is the execution plan for completing request. Manage all tasks to fulfill request

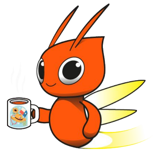
Task is an atomic unit of work needed to complete a job

Data pipeline challenges



- Need to stitch multiple events across domains to answer business KPIs (Ex: TAT of 3d model creation, % of requests blocked)
- Domain events represent an activity within a domain for domain experts
- Not suitable for external consumption
- Pure domain events must process in-memory & within the same transaction
- Fire & forget nature can cause inconsistencies if transaction fails
- Services endpoints (REST / GraphQL) designed for application interactions
    - High frequency, low data volume, low latency requests
    - Restricts payload size, rate of requests per hour, # of requests

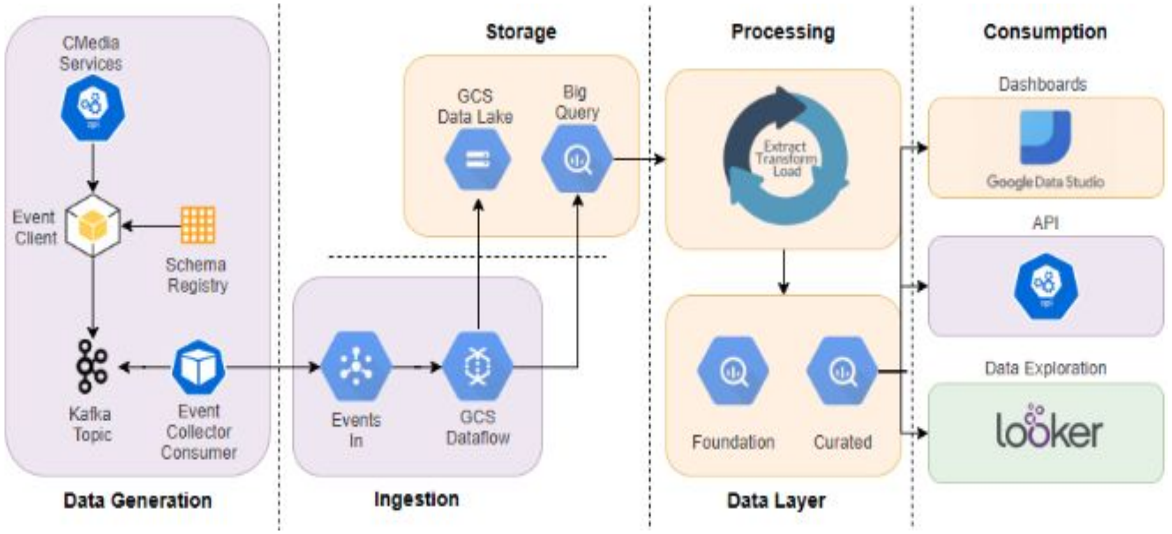
Potential options



- **Event Sourcing** is persisting changes that are happening in the application as a sequence of events
- This sequence can be used to reconstruct the current state
- Banking transactions example:
  - Credit and debits occuring in an account are events
  - All these events can be queried to derive a current balance
  - Alternatively utilizing event sourcing concepts current balance can be pre-calculated and stored

- **Event aggregation** are set of handler (continuous listener) to maintain an effective read model
- **Observer pattern** to avoid losing decoupling in domain architecture
- Example: Create an aggregate when a Job is assigned to a Modeler after the request is submitted
- Aggregate persistence options: SQL, NoSQL, Files, Kafka
- Aggregation of DDD is equivalent to projections of CQRS

Data architecture



Media Data Architecture & Pipeline

Event collector stream application

- Perform schema validation and envelop the Kafka message
- Publish Kafka messages to Cloud Pubsub

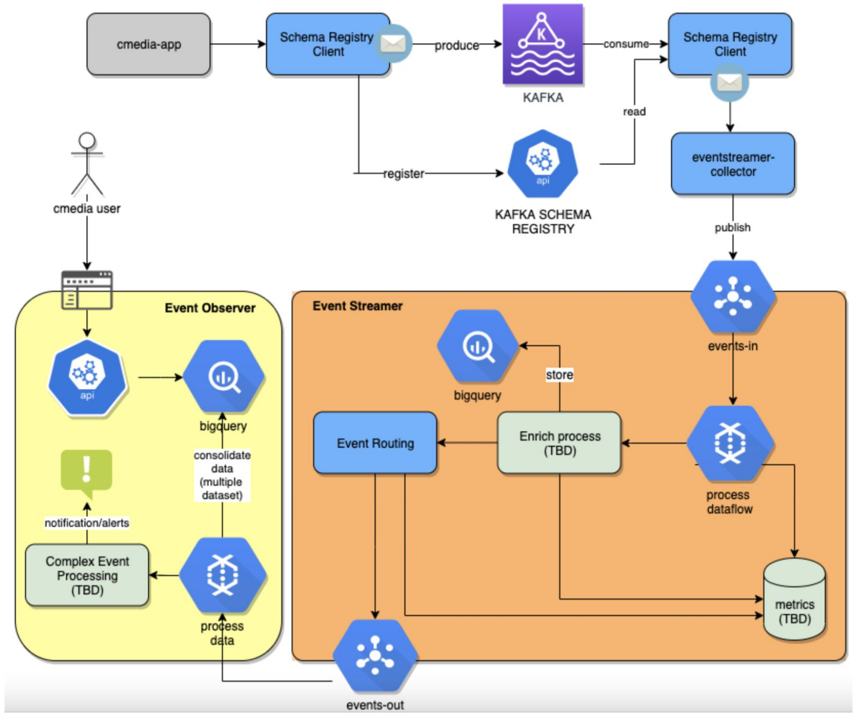
Apache Beam / Dataflow job

- Perform real-time enrichment
- Dynamic routing
- Event consolidation
- Implement observer pattern
- Outbound PubSub topic

Data Analytics

- Data processing in BigQuery
- Foundation & Curated data layers
- Data Studio dashboard

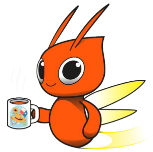
Event observer



Observer pattern using Cloud Dataflow

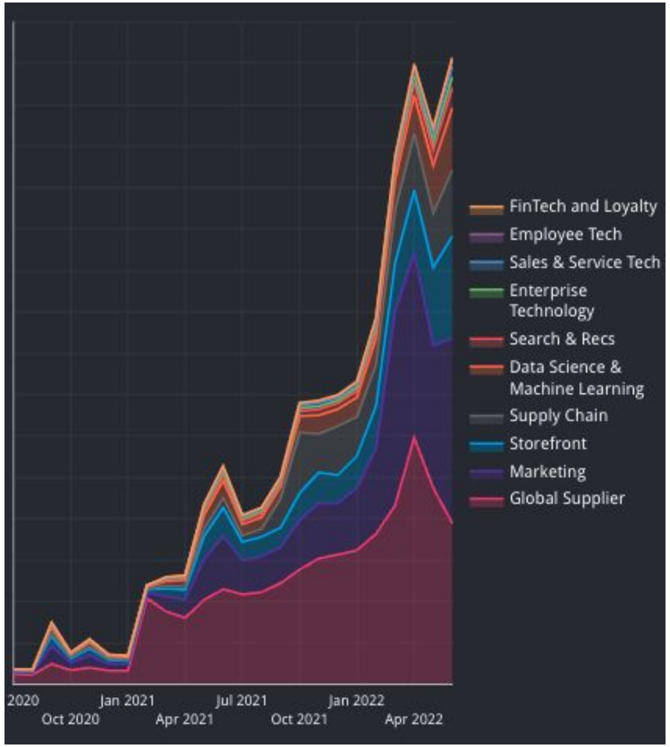
- One BigQuery table per domain event is not efficient
- Requires joining of multiple tables and apply business logic
- Needs to happen for all the data pipelines
- Introduced an event listener to Pubsub events
- Performs filtering, consolidation, routing in real time
- Utilize BigTable (NoSQL) for short term storage
- Outbound Pubsub event triggered once a milestone is achieved
- Example: Create an aggregate when a Job is assigned to a Modeler after the request is submitted

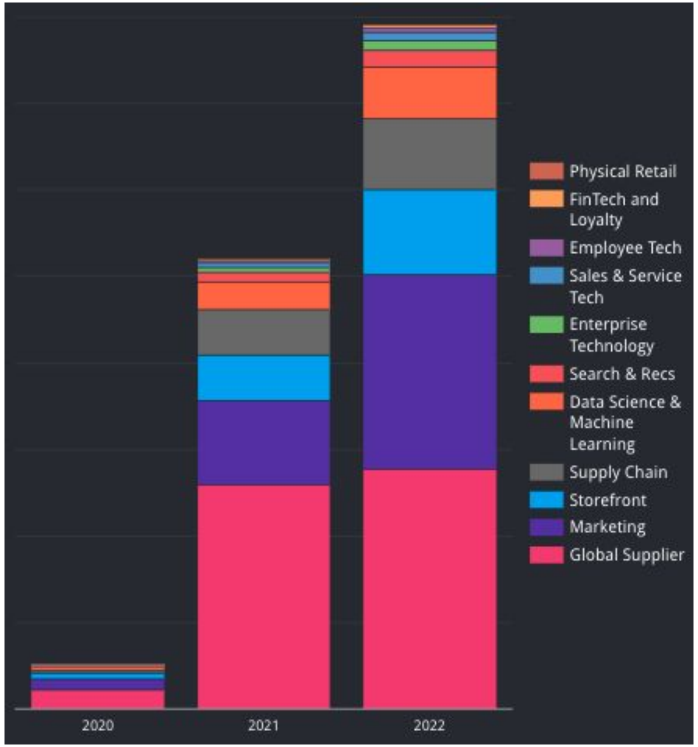
Apache Beam: Cloud Dataflow



- **Fully managed service** for batch & stream
- Apache Beam framework
  - Unified programming model
  - Runner independent
  - Functionally biased MapReduce
- **Serverless**, auto provision of resources
- No infrastructure woes
- **Dynamic scaling**
  - Key for unbounded source
  - Predicting future data not needed
- Google provided **templates** for common use-case
- Not ideal for SQL data pipelines
  - More lines of code and complexities

Wayfair's Dataflow usage growth





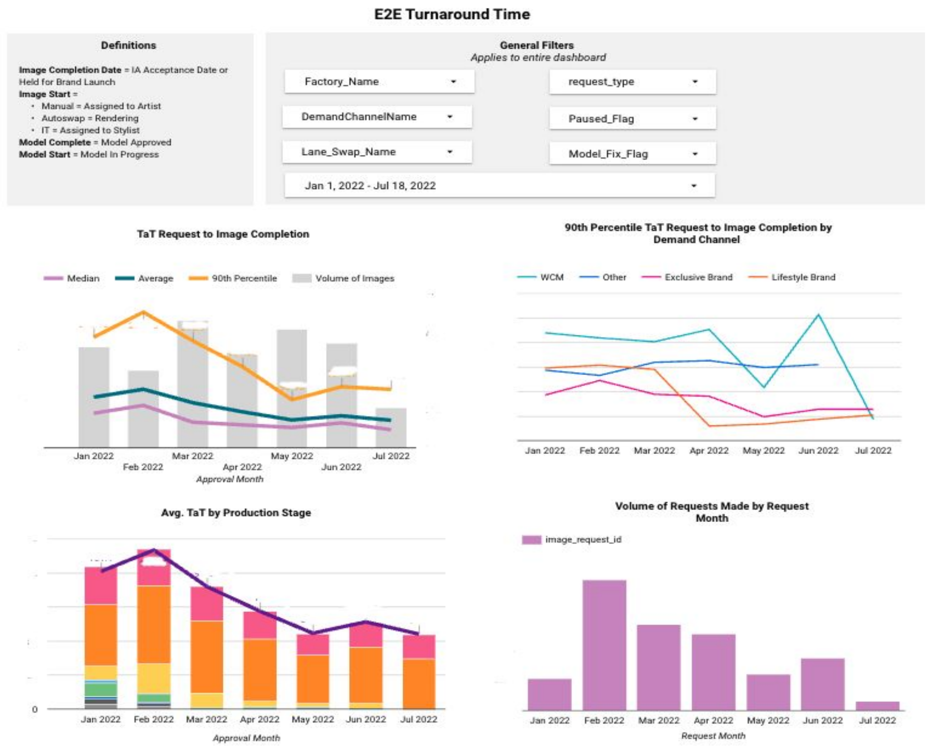
GCP cloud migration started in 2020

Exponential growth in the last 2 years

Usage across multiple teams and orgs

Cost metrics, can't be shared publicly

Imagery Ops Dashboards



E2E Turnaround Time

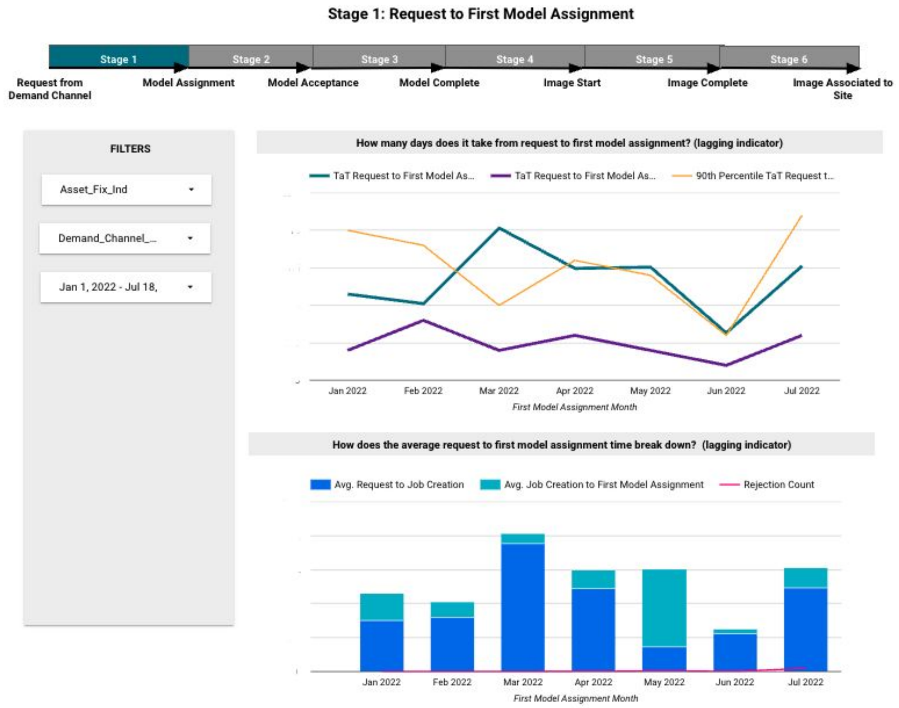
Definitions

Image Completion Date = IA Acceptance Date or Held for Brand Launch
Image Start =
- Manual = Assigned to Artist
- Autoswap = Rendering
- IT = Assigned to Stylist

Model Complete = Model Approved
Model Start = Model In Progress

General Filters
Applies to entire dashboard

Factory_Name
request_type
DemandChannelName
Paused_Flag
Lane_Swap_Name
Model_Fix_Flag
Jan 1, 2022 - Jul 18, 2022



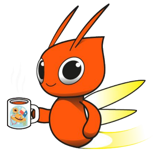
Stage 1: Request to First Model Assignment

FILTERS

Asset_Fix_Ind
Demand_Channel_...
Jan 1, 2022 - Jul 18,

How many days does it take from request to first model assignment? (lagging indicator)
TaT Request to First Model As...
TaT Request to First Model As...
90th Percentile TaT Request t...
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
Jul 2022
First Model Assignment Month
How does the average request to first model assignment time break down? (lagging indicator)
Avg. Request to Job Creation
Avg. Job Creation to First Model Assignment
Rejection Count
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
Jul 2022
First Model Assignment Month

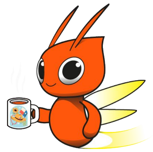
Learning & Recommendations



- Focussed more on technical solutions like stream ingestion and processing
- Lack of understanding of Microservice architecture (DDD, CQRS, ES) in the beginning
- Treated domain events as another Kafka / Pubsub topics
- Deep dive on architecture patterns only when data stopped making sense
- Observer pattern reduced the noise, simplified the data pipeline
- Apache Beam event windows - multiple options, complex, dropped records

Don't jump onto technical solution with just business knowledge, try to understand the underlying design constructs

Helpful resources



The Blue book - Domain driven design by Eric Evans. Introduced DDD as an established concept to the world in 2004
https://www.domainlanguage.com/ddd/blue-book/

Martin Fowler
https://martinfowler.com/tags/domain%20driven%20design.html

Implementing domain driven design
https://medium.com/design-and-tech-co/implementing-domain-driven-design-for-microservice-architecture-26eb0333d72e

Aggregates in domain driven design
https://khalilstemmler.com/articles/typescript-domain-driven-design/aggregate-design-persistence/

Dataflow docs (Google official)
https://cloud.google.com/dataflow/docs

Apache beam framework (Apache official)
https://beam.apache.org/documentation/

Questions?