The big data system for eBay Paid Social Ads

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Speaker Profile

- Senior engineering manager for eBay paid internet marketing products
- Lead a team of 8 to deliver two key products for marketing (Feeds; Paid Social)
- Also play a role as system architecture
- Before eBay, I'm a developer & performance engineer in IBM focus on Java EE
- Current interests
  - Big data (Hadoop/Spark/NoSQL) eco-system
  - Applied science and machine learning techniques
  - Philosophy and practices on building a high performance team

Agenda

- eBay paid internet marketing introduction
- eBay personalized Ads on Facebook (paid social)
- System architecture
- Business and data volume
- Technologies
- Case study: Feeds lambda architecture
- Case study: Merging two streams
- Case study: Real time model executions

eBay paid internet marketing (channels)

Paid Search	Paid Social	Display	ePN
Google PLA	Facebook Dynamic Ads	Google GDN	hundreds affiliates
Google Text Ads	Incubations (Pinterest, Snapchat)	Others	
Bing PLA			

eBay paid internet marketing (function layers)

Campaign Orchestration

- Channel campaign management
- Cross channel optimizations

Targeting and optimization

- Personalized targeting / recommendation
- Bidding algorithms
- Audience segmentation and ID linking

Contents, Creatives and Rendering

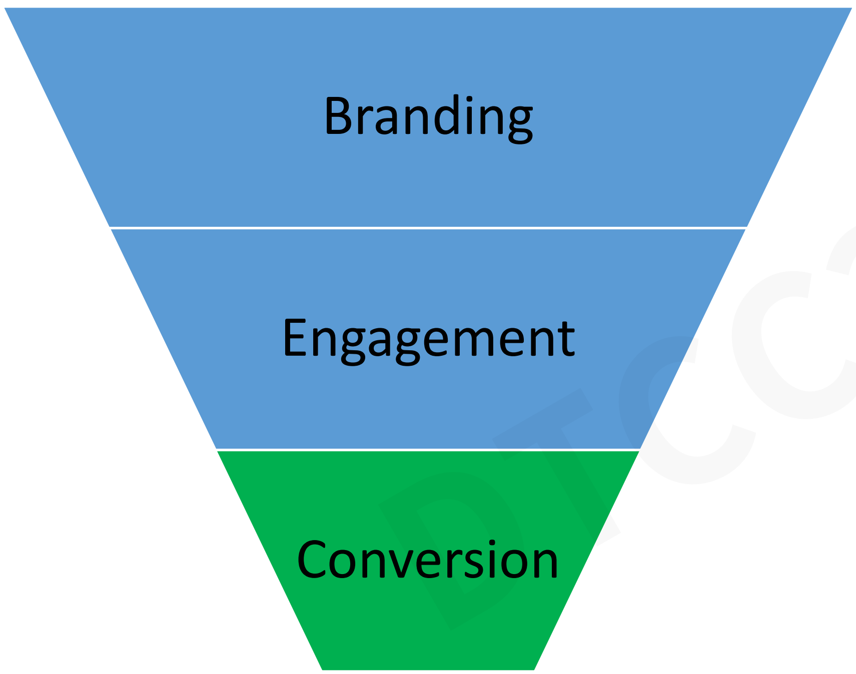
- Feeds listing platform
- Creative media studio
- Ads rendering server

Common data layers and foundations

- Marketing data marts
- Tracking & Attributions
- Experimentation platform

eBay paid social business

Facebook Funnels

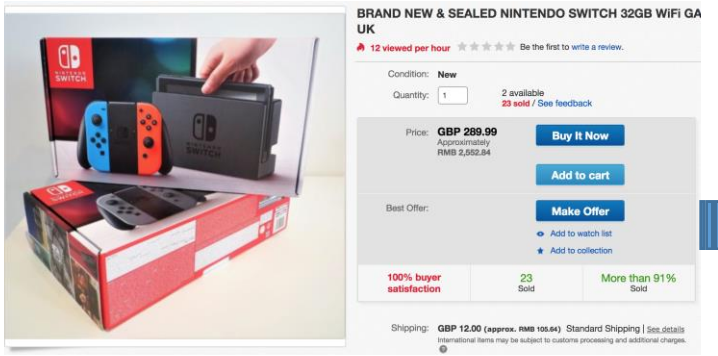


- Reach and convert existing or potential buyers
- Using attractive and personalized contents
- Run the business profitably at scale

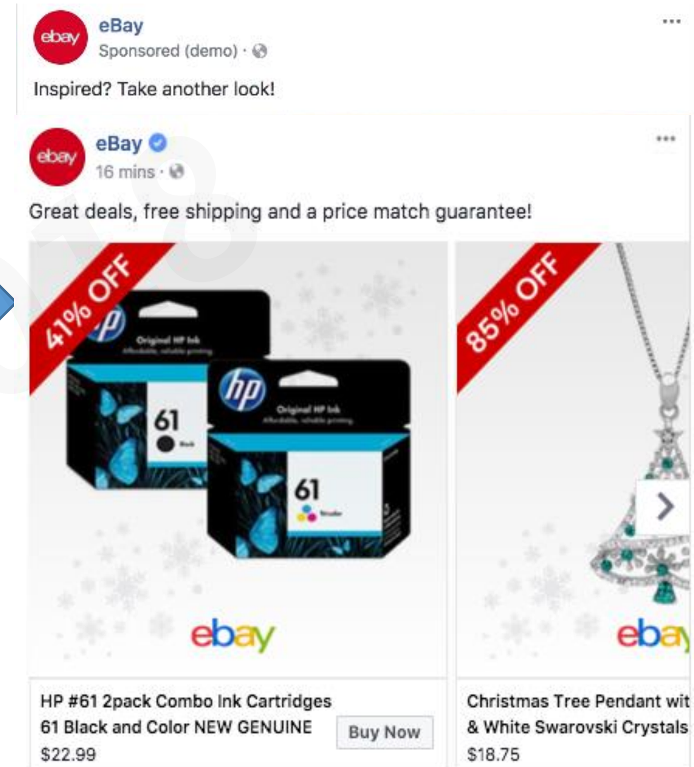
Facebook Dynamic Ads Experiences

See relevant Ads on Facebook

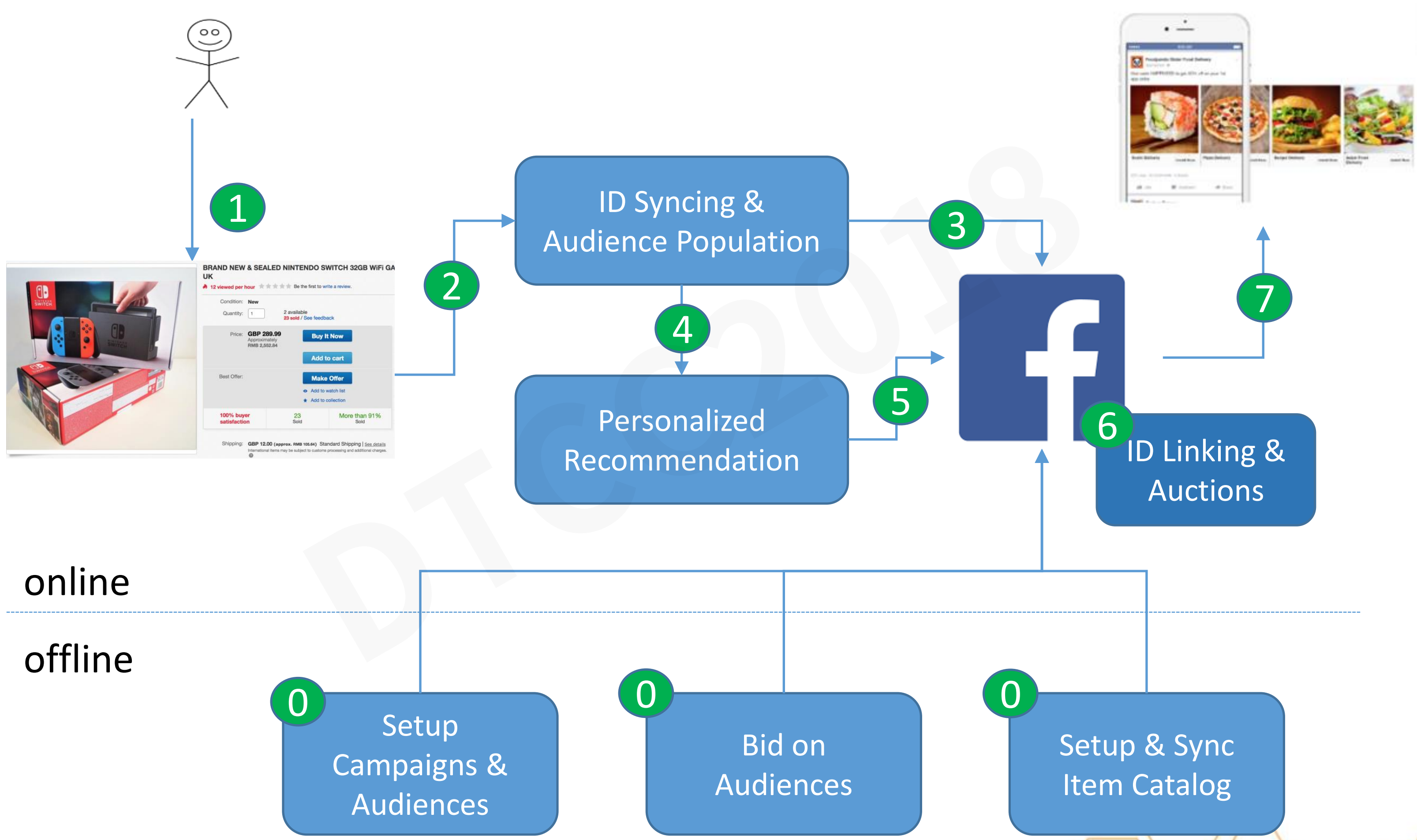
View an item on eBay



3m latency



Facebook Dynamic Ads Architecture



Business and system volume

Profitable Business (2017)

- Hundreds of millions $ business
- Double digit ROI
- Growing (double digit growth)

Scaled Big Data System

- ~40TB daily data processing for 1B Item listings
- ~3 min system latency for retargeting
- ~200M daily recommendations
- ~10K/s QPS for databases

Technologies

Monitor and Alert	• InfluxDB + Grafana • ELK stack
Online Stream Applications	• Kafka + Akka • Kafka + Spark Stream
Databases	• NoSQL: Cassandra + Redis • MySQL
ETL and offline data processing	• Spark RDD + Spark SQL • Teradata

Learnings on Architecture and Choosing proper Tech

No single point of failure

- We favor distributed and highly available components / middle-wares
- We have plans for single node services

Be Resilient

- Tolerate the dependent service failures
- Graceful downgrade for non critical modules
- Retries

Learnings on Architecture and Choosing proper Tech

Ground solid sub systems
In the whole system, we need some components that "never" fail

Monitor and Alerts

- Early detection + facilitate debugging
- Four layers of monitors in the system

Case #1: Learnings on Feeds Lambda architecture

Time	3/1 0	3/1 6	3/1 12	3/1 18	3/2 0	3/2 6	3/2 12	3/2 18	3/3 0
Batch	3/1				3/2				
Speed									
Merge				Query			Query		

Lambda Architecture 101

- Daily batch processing to come out summary view with latency
- Speed (NRT) layer to provide small amount of NRT data w/o latency
- Merge layer to combine the two sources and provide a single, merged view
- Benefits
  - Near real time data accuracy
  - Daily remediation for speed layer data

Case #1: Learnings on Feeds Lambda architecture

Feeds platform

- Create or update item listings in a daily basic
- NRT updates on item prices
- NRT listing for new items
- NRT delete for expired / sold out items
- Hourly updates for item tags (deals, trending, etc…)

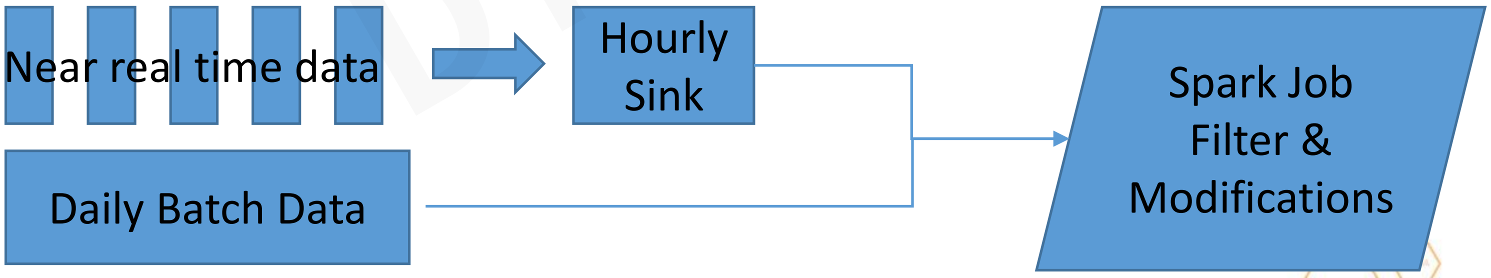
Challenges

- Need to apply item filtering and modification logic in two processes
- Well handling on batch data latency (eg. old price from batch; expired items in batch; etc…)

Case #1: Learnings on Feeds Lambda architecture

Solution to filters/modifications

- Original design
  - Storm for NRT processing
  - Spark for Batch processing
  - Shared filter/modification logic by code pieces (lib)
  - Duplicate efforts on formatting data schema
- New design
  - Retire storm and use hourly Spark job (acceptable latency)
  - From re-using code pieces to re-using components (spark job)



Case #1: Learnings on Feeds Lambda architecture

Solution to “merge” data from different sources

- Merge layer before item synchronization
- Row updates by PK+CK
- Row merge by PK

PK	CK	CF1 (fields)	CF2 (price)	CF3 (del)	Timestamp
123	batch	xxx	3		12:00:00
123	update		4		13:00:00
123	delete			true	13:05:00

Item 123

merge

Item 123 should be removed

Batch Start
@12:30:00

Batch End
@20:30:00

Case #2: A solution to merge two streams

Problem statement

- Two streams of events with the same key, but different value fields
- Need to join/merge the two streams for the events on the same key and fill in all the required fields coming from two streams to create a new stream
- No guarantee of which event will come first, and could have duplicate events

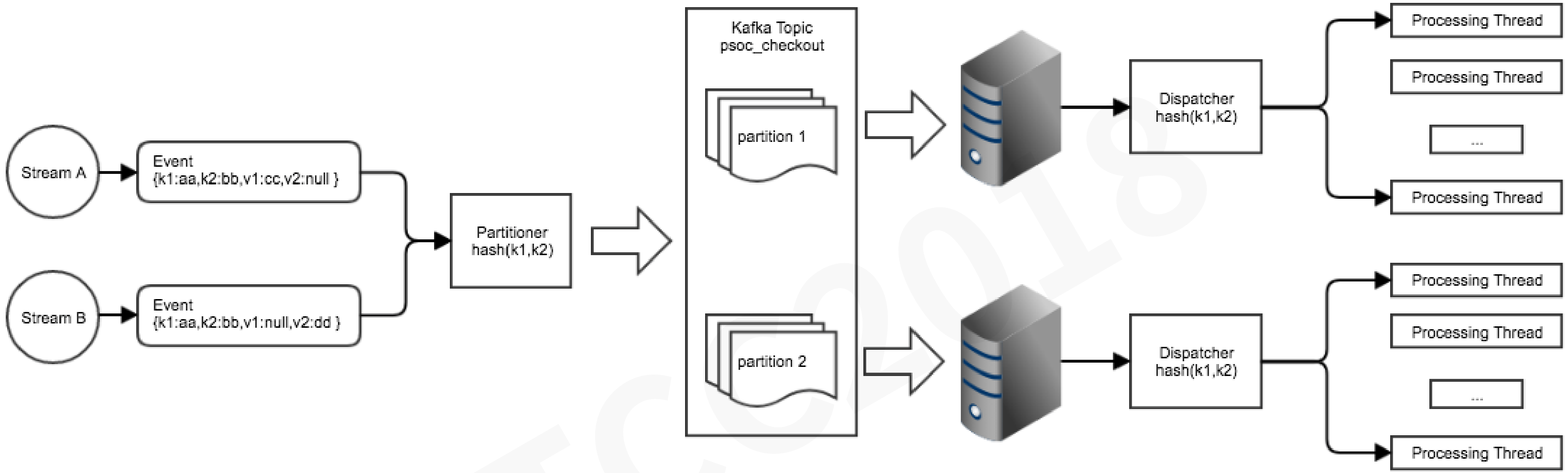
A naïve solution

- Processing the two streams and sink them to a message queue (Kafka)
- Maintain a database (kv store) and upsert the event based on key
- Grab events that have all the required fields and send them out

Key considerations to the solution

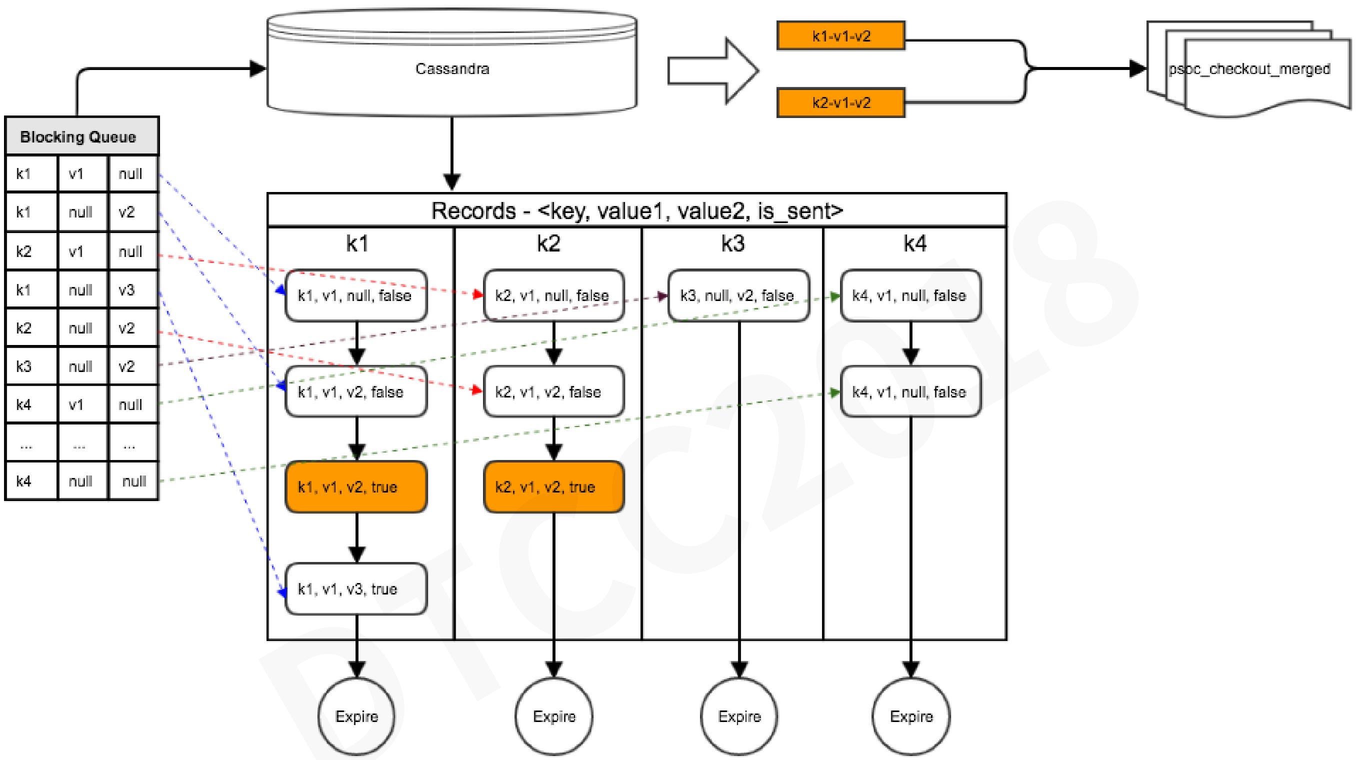
- Need to be a multi-threading App due to the high concurrency requirements
- Update + Query are two actions that could cause “dirty read” in multi-threading environment

Case #2: A solution to merge two streams



- Keep the events that have the same keys to the same partition
- Keep the events that have the same keys to the same thread
- No coupling / restriction for the # of consumers and Kafka partition number

Case #2: A solution to merge two streams



Things happened in a specific thread

- Upsert + Query for each event in a transaction (batch in Cassandra)
- Mark “sent” flag once data fields are complete
- Use Cassandra TTL to implement “caching window”

Case #3: Real time model executions

Recommendation / Personalized Ads backgrounds

- Recommend items that an user is most likely to purchase
- Recommend similar but more appealing items
- Try to capture user recent interests and promoted items (deals)
- Key algorithms
    - Ranked Recently Viewed Items (RRVI)
    - Similar items
    - Rule based massage on Last View Items (LVI), Deals and model results

Problem statement

- The online recommendation process is a NRT pipeline, which needs all communications between components to be service (real time) based
- Need real time resolution for the recommendation list for a given user
- Need real time bid adjustment for a given user

Case #3: Real time model executions

Solution #1 (use case: bid adjustment)

- Daily offline model predictions
- Synchronize & maintain a bidding cache keyed by user
- Real time look up in the App for user level bid adjustment
- Trade-offs: acceptable latency as user monetization powers won’t change frequently

Solution #2 (use case: RRVI model prediction)

- Real time updated feature cache
    - 7 day’s key user behavior events
- Batch updated feature cache
    - Statistic metrics based on items or users
- Real time fetch for features + distributed model predictions
- Limitations
    - Only cache the dominant features
    - Simple models
    - 10K level calls per second with decent amount of machines

Beyond CAP theory, building commercial big data system is all trade-offs between latency, consistency, accuracy, tolerable failures and the resources you have.

THANKS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