Platform Architecture for OmniChannel Retail

O’Reilly Software Architecture Conference

London, October 16, 2017

Background

VP, Architecture and Chief Architect – Target

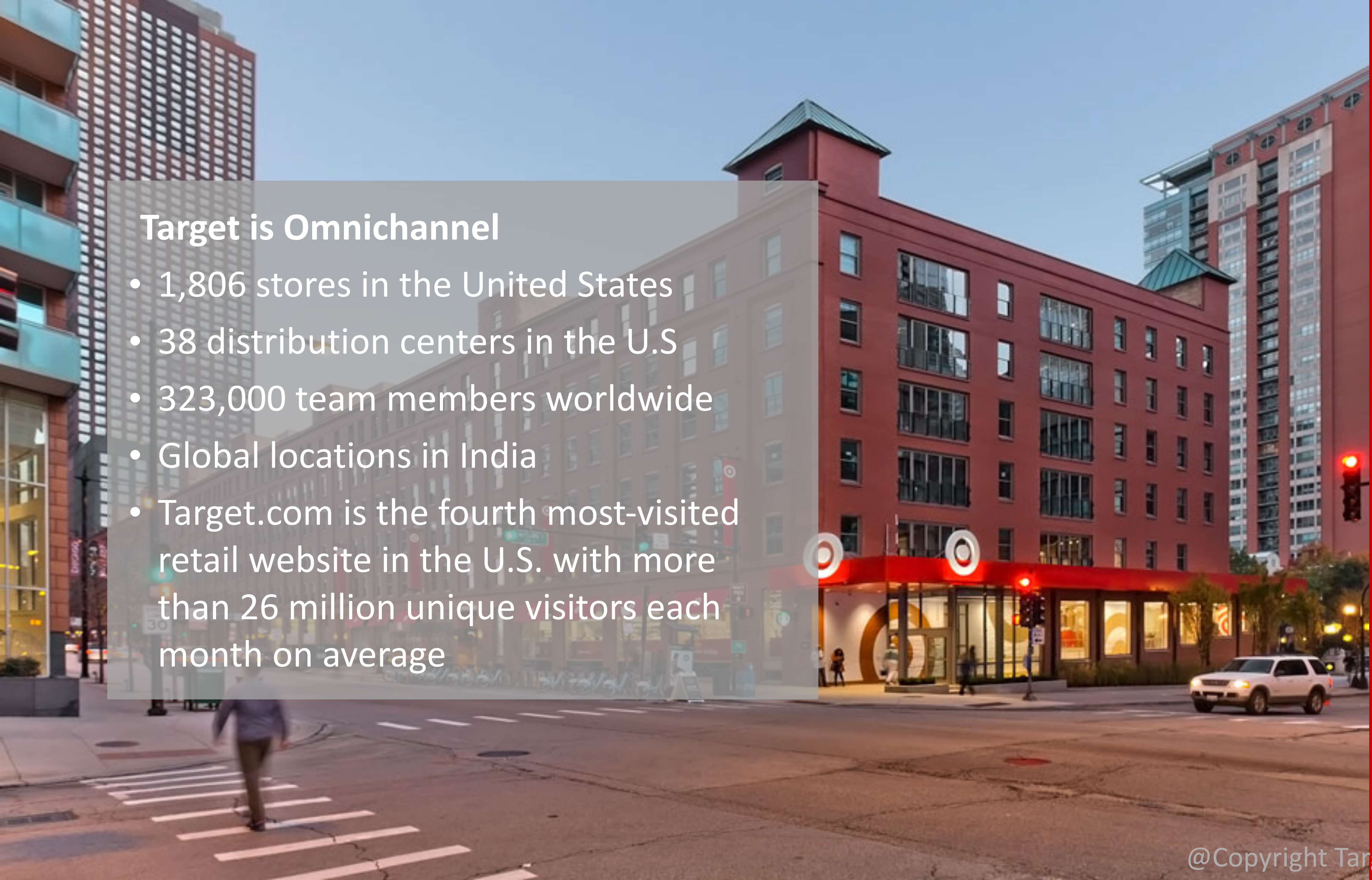
Former Chief Architect & Head of Digital Engineering - Best Buy

Plan for Today

- Context of the omnichannel retail environment
- Legacy architecture overview
- Platform architecture
- Platform examples
- Platform framework
- Platform learnings

Ask questions any time.

OmniChannel Retail



Target is Omnichannel

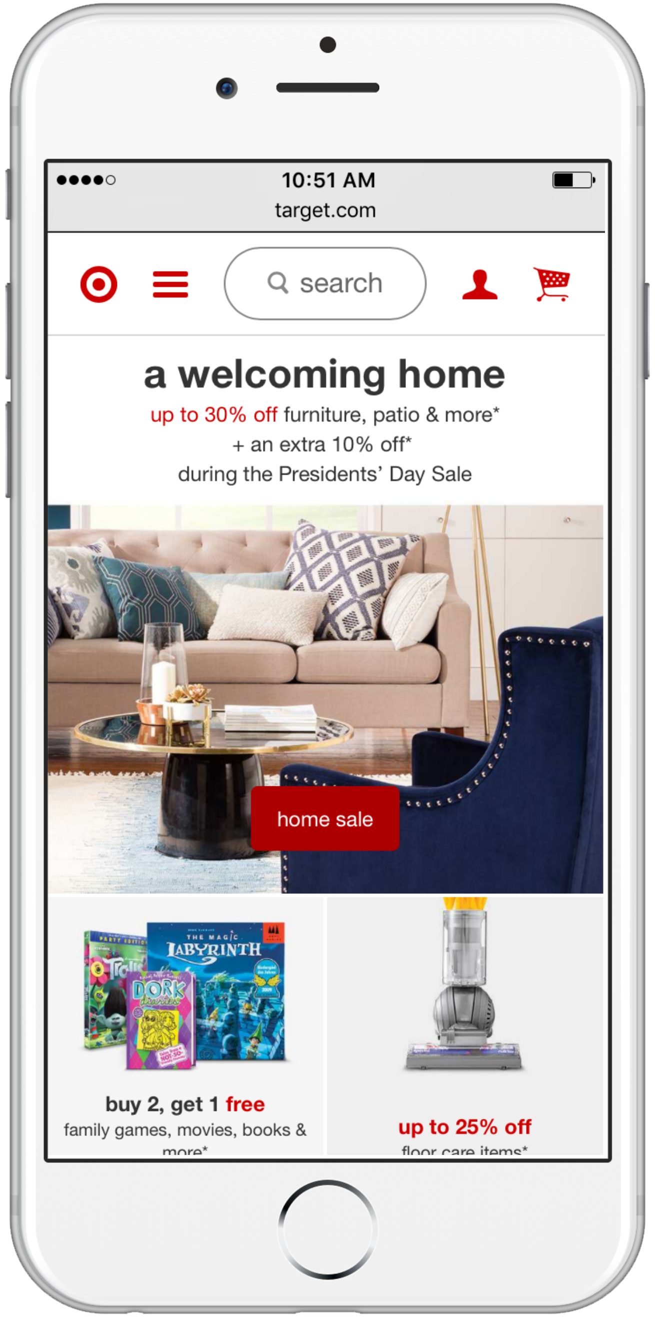
- 1,806 stores in the United States
- 38 distribution centers in the U.S
- 323,000 team members worldwide
- Global locations in India
- Target.com is the fourth most-visited retail website in the U.S. with more than 26 million unique visitors each month on average

85%

of Americans live within
10 miles of a Target store

55%

of all digital sales are fulfilled by a store



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target.com

search

a welcoming home

up to 30% off furniture, patio & more*

+ an extra 10% off*

during the Presidents' Day Sale

home sale

buy 2, get 1 free

family games, movies, books & more*

up to 25% off

floor care items*

Omnichannel Retail

Commerce

- Physical
- Online
- Mobile
- Partner
- Voice
- Text
- Social

Customer Interaction

- Store Associate
- Call Center
- Mobile App
- Online Chat
- Email
- Text
- Social
- Augmented Reality

Customer Fulfillment

- Shopping bags
- Ship to home
- Ship to store
- In-Store pickup
- Car park pickup
- Same day delivery
- Partner direct ship
- Digital goods

Omnichannel Retail Evolving Rapidly

Every step of the retail value chain is being disrupted

- Import and Logistics (Direct to Consumer, Crowdsourced Delivery)
- Selection & Curation (Online Search and Recommendations)
- Trips to Stores (Same Day Delivery, Personal Shoppers)
- Online Mega-Retailers (Everything Store)
- Online Micro-Retailers (Single Category Specialists)
- Checkout process (Self-checkout, Automated checkout)

Legacy Architecture

Legacy Footprint

70% of capabilities tied to mainframe

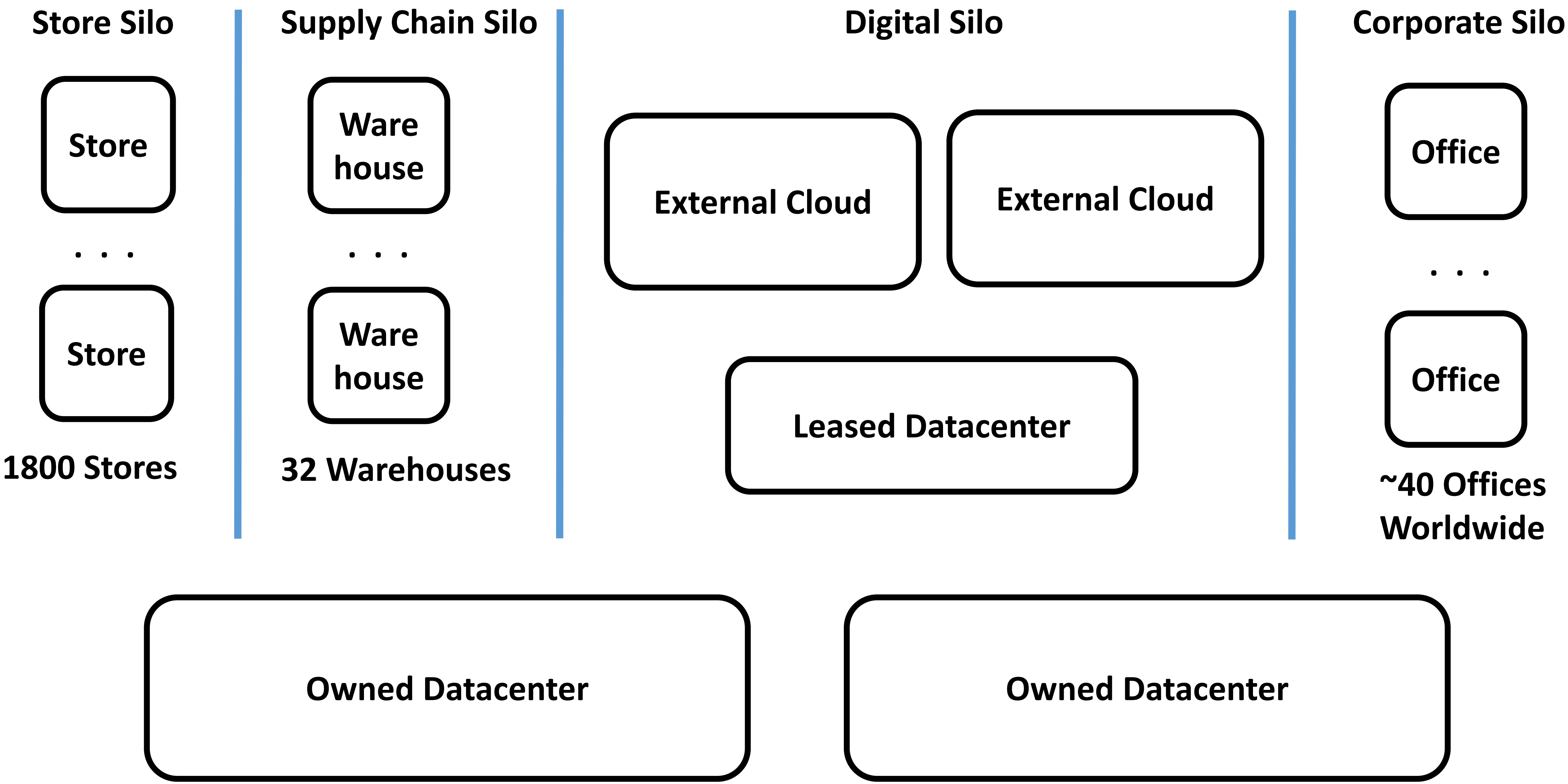
7000+ RDBMS

Operationally siloed

3000+ Applications

- Stores
- Digital
- Supply Chain
- Marketing
- Merchandising
- Product Development
- Corporate

Infrastructure



Store Silo

Store

. . .

Store

1800 Stores

Supply Chain Silo

Ware house

. . .

Ware house

32 Warehouses

Digital Silo

External Cloud

External Cloud

Leased Datacenter

Corporate Silo

Office

. . .

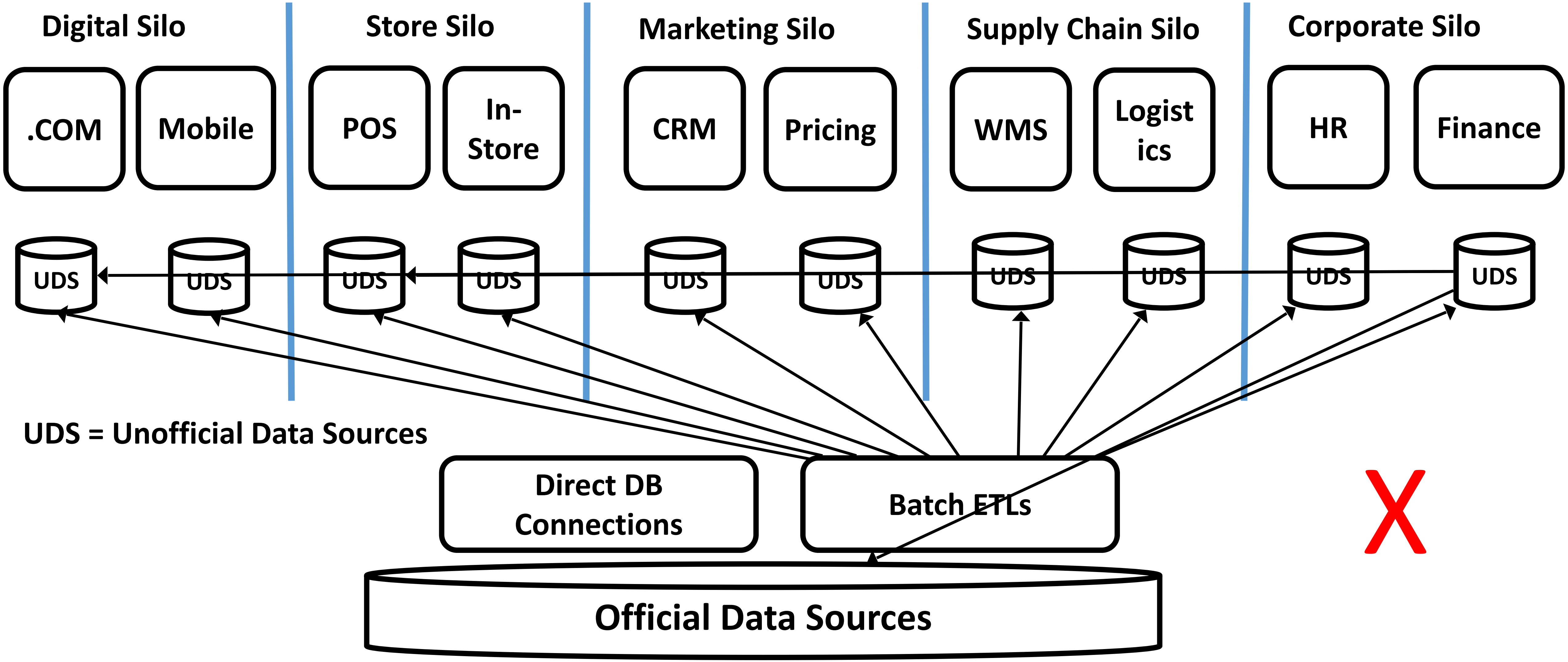
Office

~40 Offices Worldwide

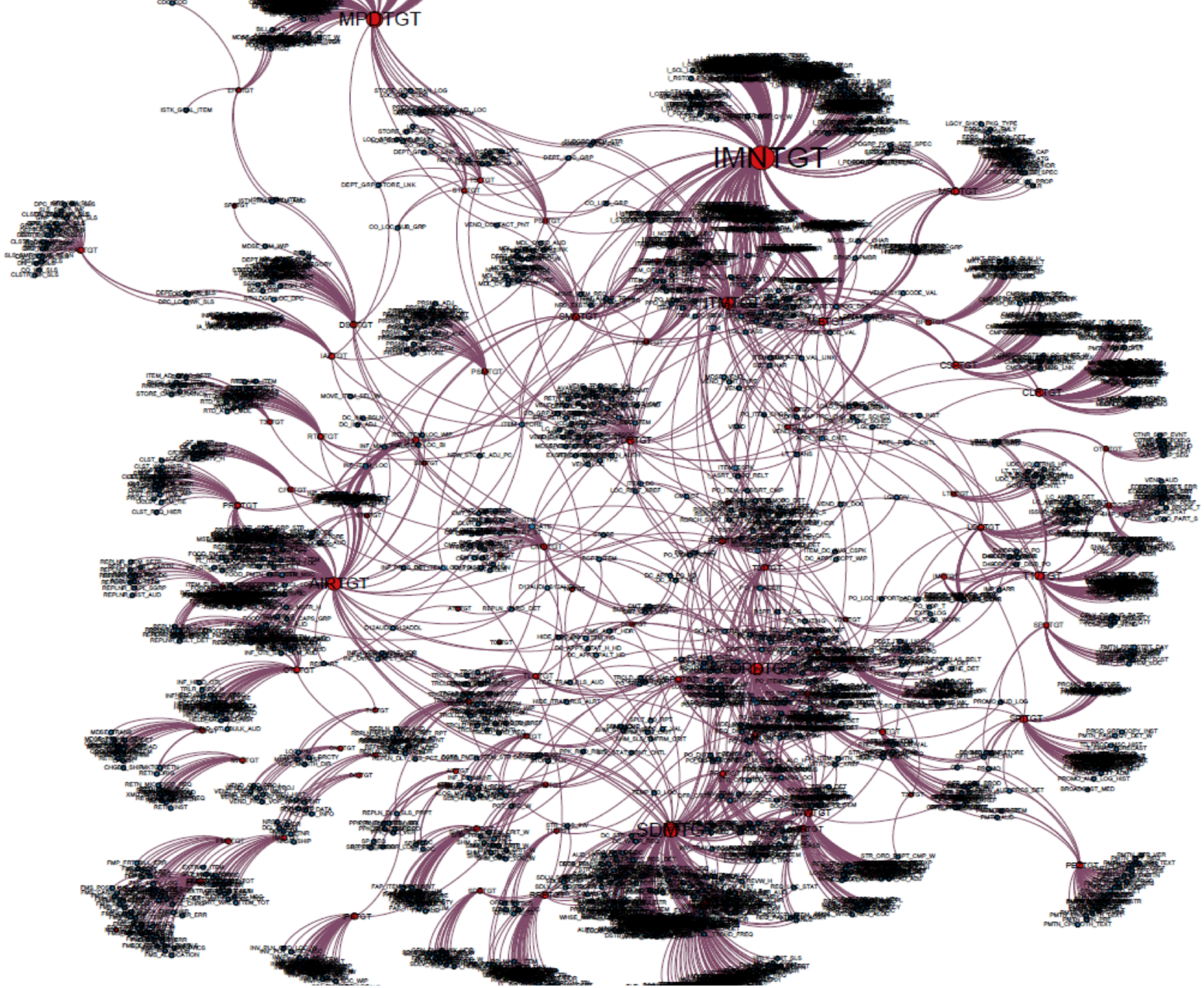
Owned Datacenter

Owned Datacenter

Each box contains infrastructure onsite



Legacy Architecture



Mainframe Dependency Graph

Each node is a table, each name is an application that writes to that table

Platform Architecture

What is a Platform?

A set of technologies that are the fundamental building blocks of custom applications

A Platform Has:

1. Primitive components
2. A defined surface
3. Extension points

What is a Retail Platform?

A set of primitive APIs and Services that represent the data, processes and business logic required to complete customer transactions

Retail Platform Primitives - Examples

Data

- Item API
- Price API
- Inventory API
- Location API
- Tax API
- Customer API
- Worker API

Process and Logic

- Checkout API
- Cart API
- Restrictions API
- Returns API
- Address Verification API
- Item Movement API
- Shift Management API

A Platform Has: Primitive components

Retail Defined Surface

The complete set of retail platform primitives that define the core components of a retailer

A Platform Has:

A defined surface

Retail Platform Extension Points

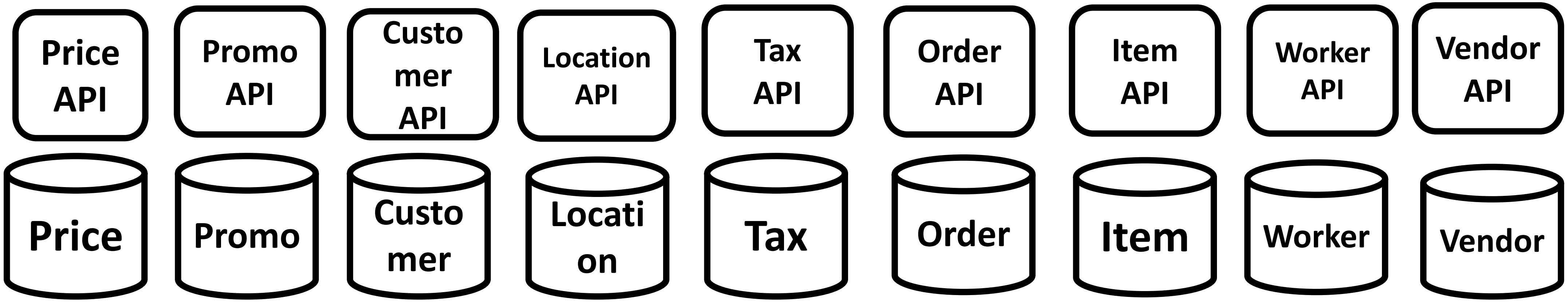
All retail platform primitives can be extended by users of the platform

A Platform Has:

Extension points

Fundamental Data

Data that cannot be derived from other data or is generated during common business processes of the company, divided into the logical domain entities of the business

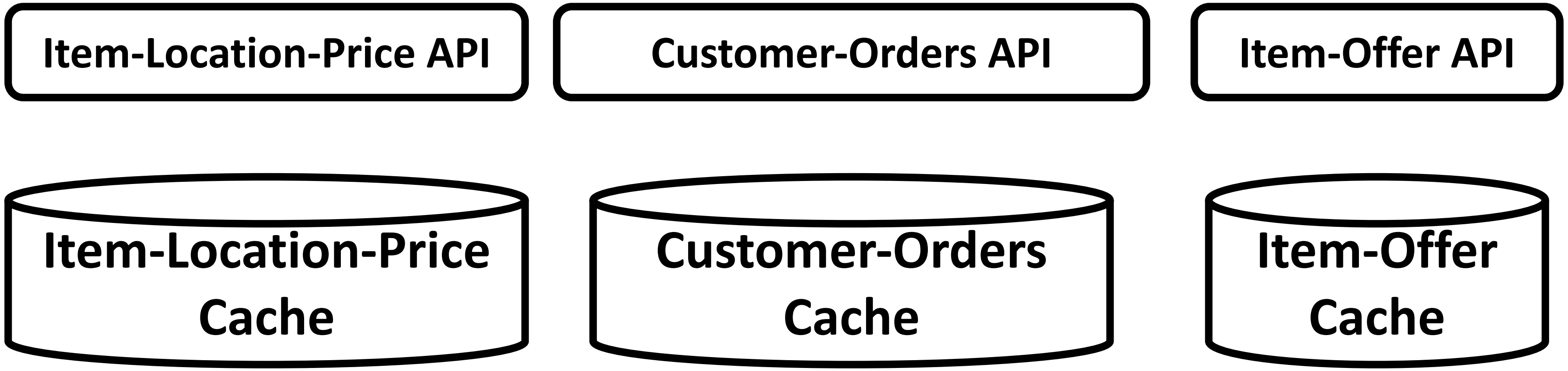


Retail Platform Architecture

Primitive component

Fundamental Data Aggregations

Pre-joined and cached fundamental data, used to pre-calculate commonly used data patterns and protect fundamental data services from excessive load



Retail Platform Architecture

Primitive component

Fundamental Business Process

The generic components of a business process, presented as an API, that can be used by all channels that execute the business process

- Checkout API
- Cart API
- Item Setup API
- Offer Setup API
- Payment API
- Fulfillment API
- Returns API

Retail Platform Architecture

Primitive component

Fundamental Business Logic

The proprietary logic of the business, presented as an API, that is used by all channels that require that business logic

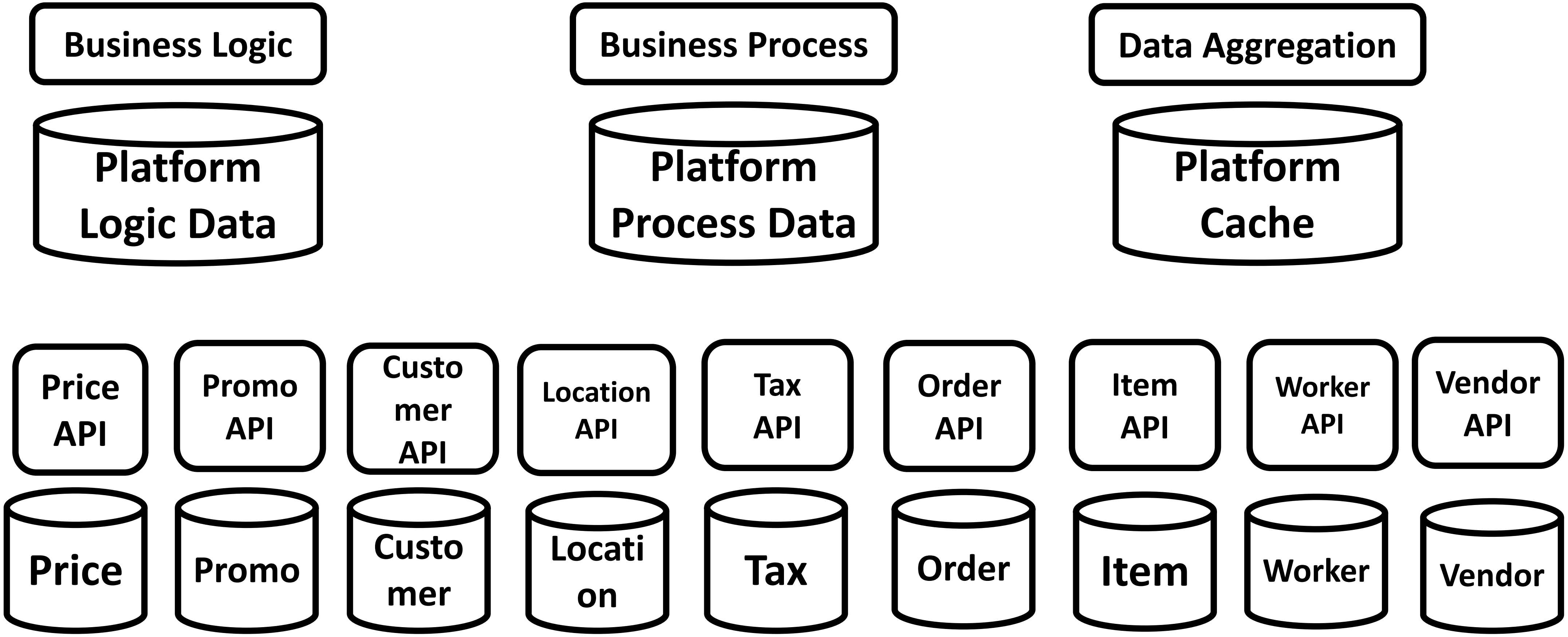
Restrictions API

Cart Price API

Worker Pay API

Address Verification API

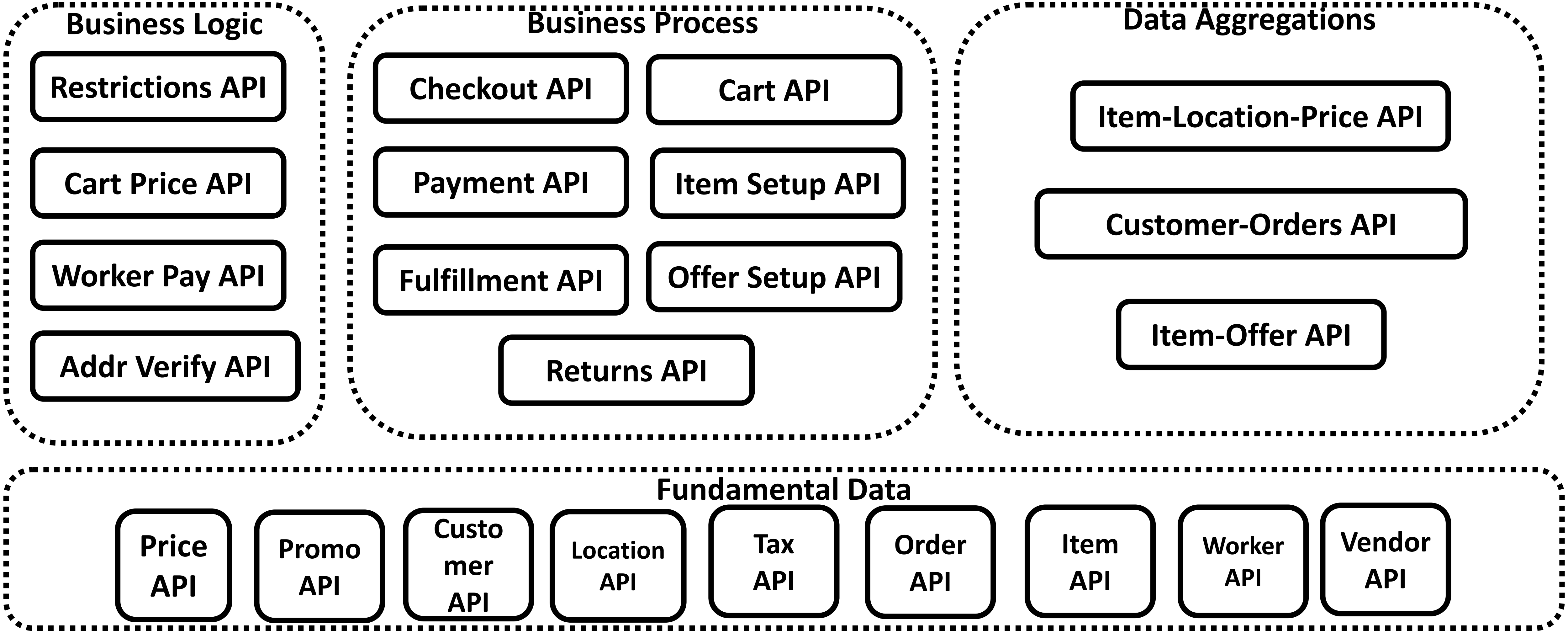
Fundamental Platform Components



Retail Platform Architecture

Primitive components

Retail Platform Surface



Business Logic

- Restrictions API
- Cart Price API
- Worker Pay API
- Addr Verify API

Business Process

- Checkout API
- Cart API
- Payment API
- Item Setup API
- Fulfillment API
- Offer Setup API
- Returns API

Data Aggregations

- Item-Location-Price API
- Customer-Orders API
- Item-Offer API

Fundamental Data

- Price API
- Promo API
- Customer API
- Location API
- Tax API
- Order API
- Item API
- Worker API
- Vendor API

Retail Platform Architecture

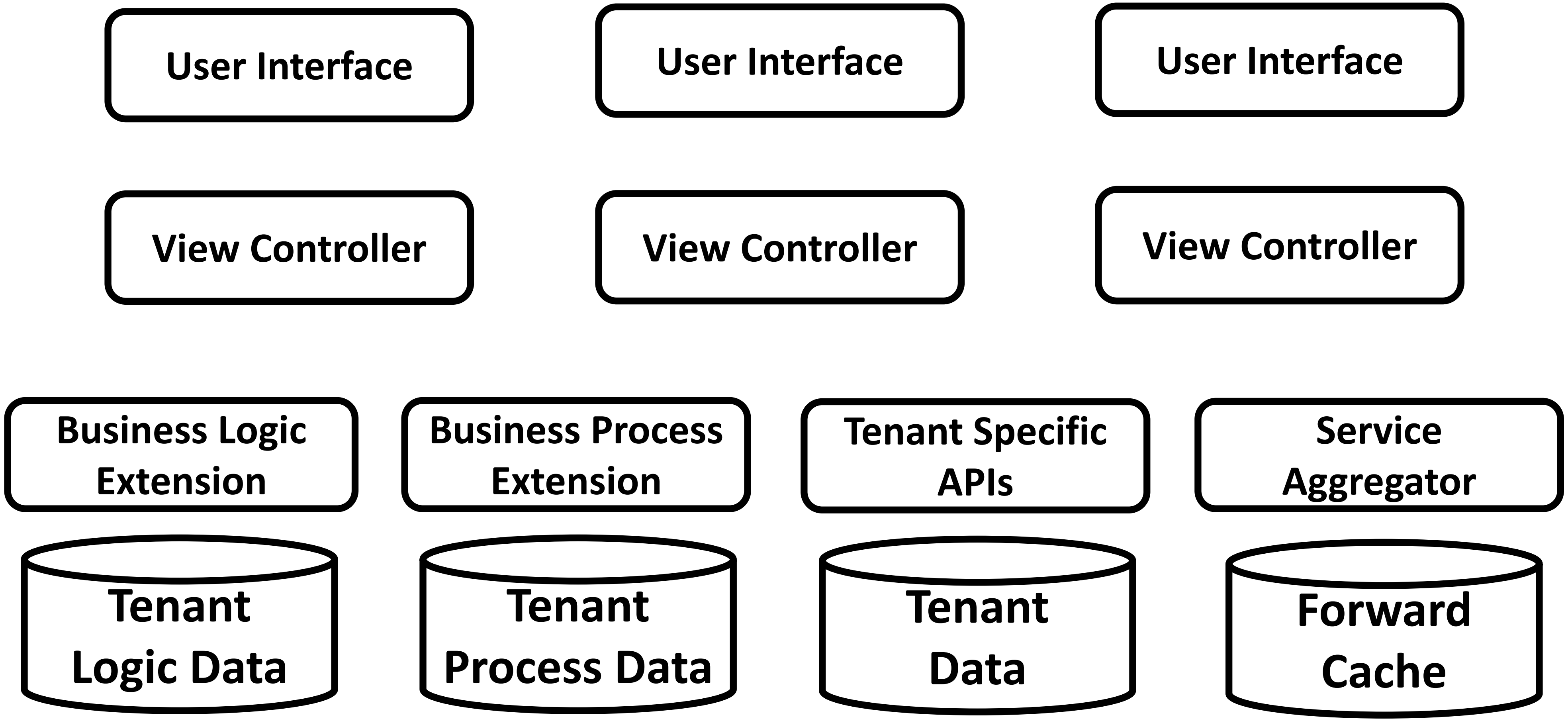
A defined surface

What is a Tenant?

A user of the platform that builds applications using and extending the platform primitives

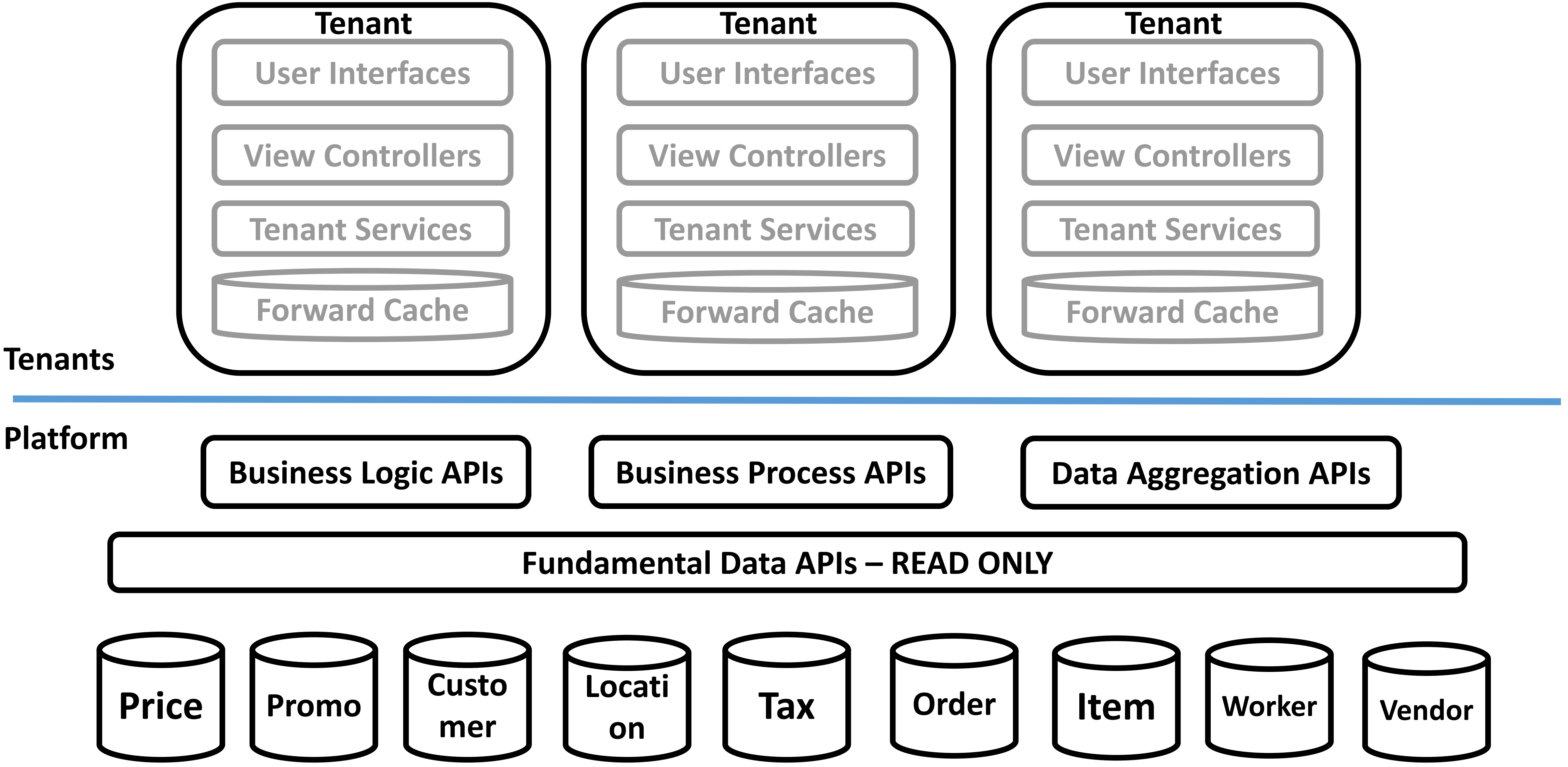
- Tenant drives an interaction with an actor
- Tenants are coarse grained around a channel (digital, store, supply chain, corporate)
- Isolation from other tenants
- Can only call services within the tenant, or provided by the platform

Single Tenant Components



Retail Platform Architecture

Extension points



Retail Platform Architecture

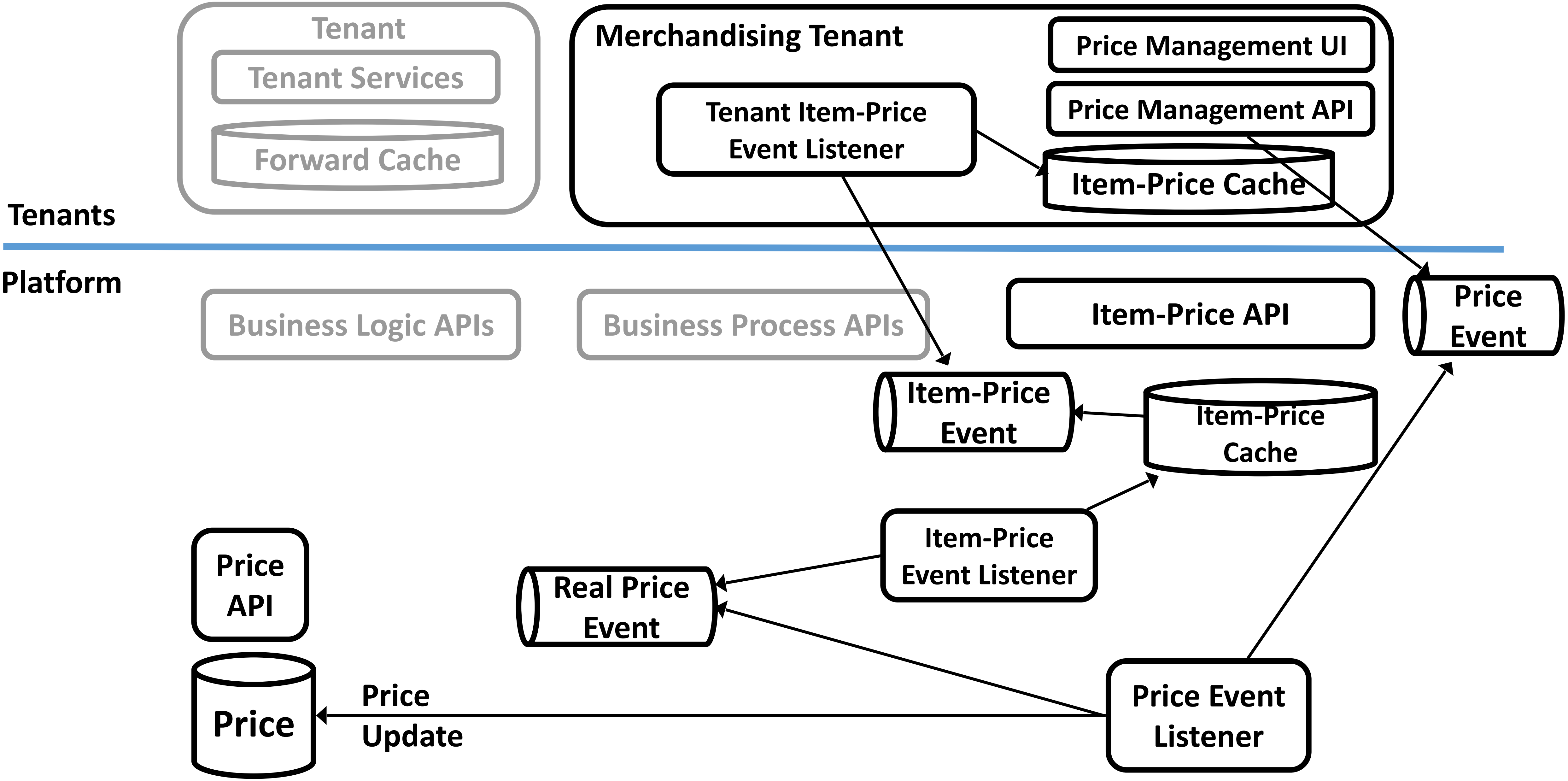
Tenant and Platform

Eventual Consistency

- The Fundamental Data layer contains the true real-time operational data – source of truth
- Fundamental Data is exposed to the Platform as READ ONLY
- All other layers are caches
- Tenants operate almost exclusively off caches
- Tenant applications must be designed for eventual consistency

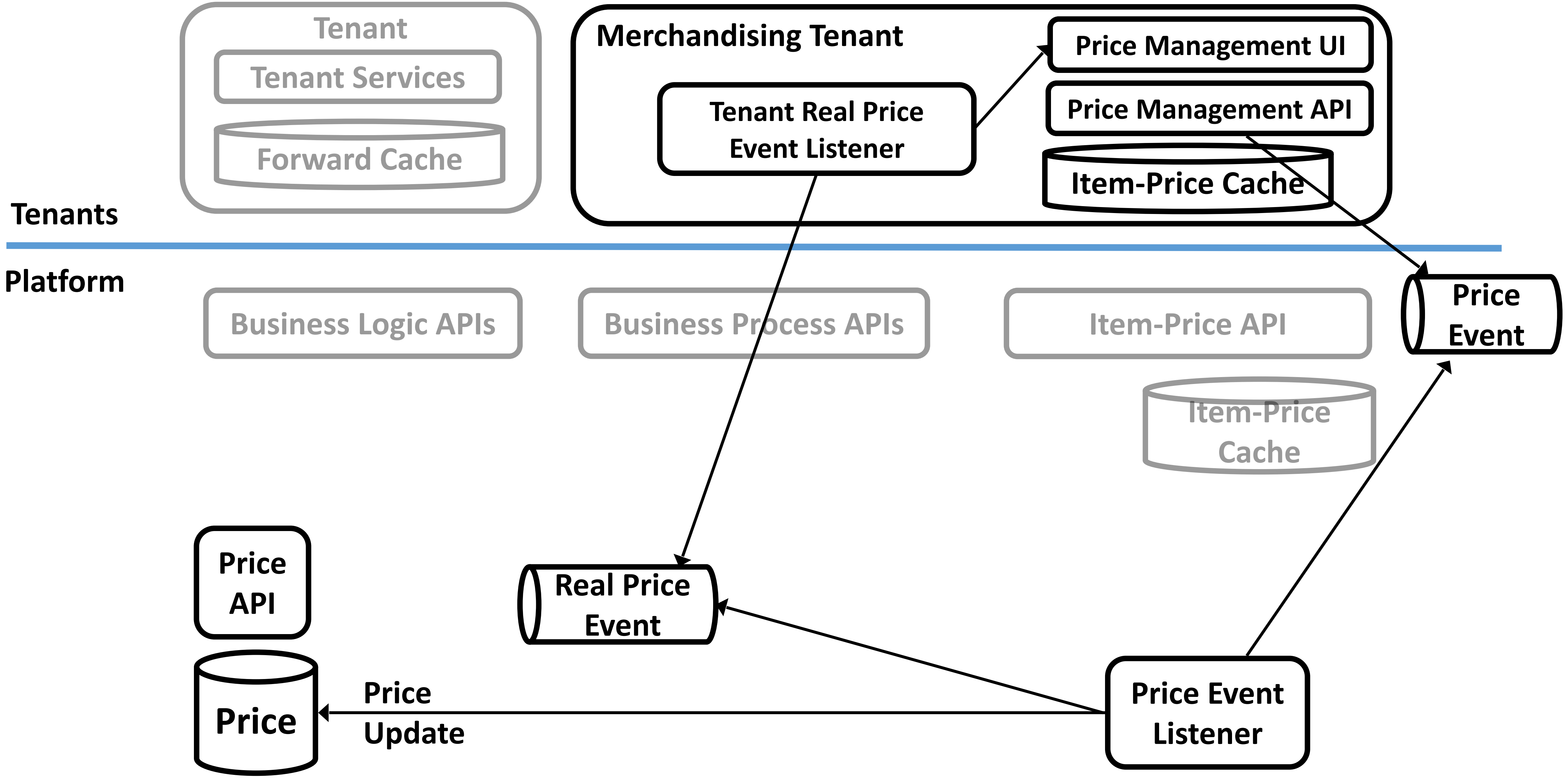
Events

- **All** data changes are events
- Tenants ***do not*** write to Fundamental Data
- Tenants **emit** events
- Fundamental Data **listeners** process events



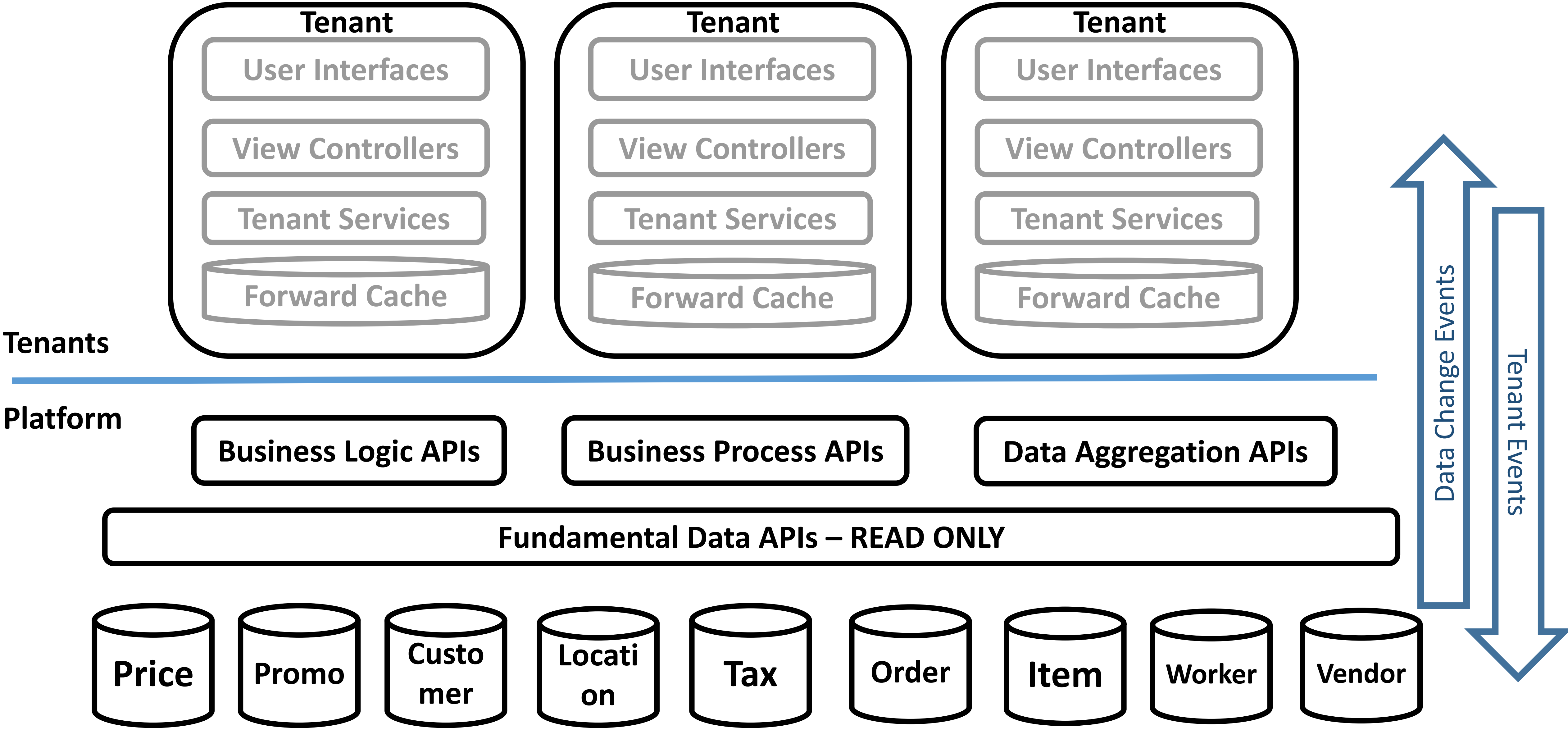
Retail Platform Architecture

Data Change Event



Retail Platform Architecture

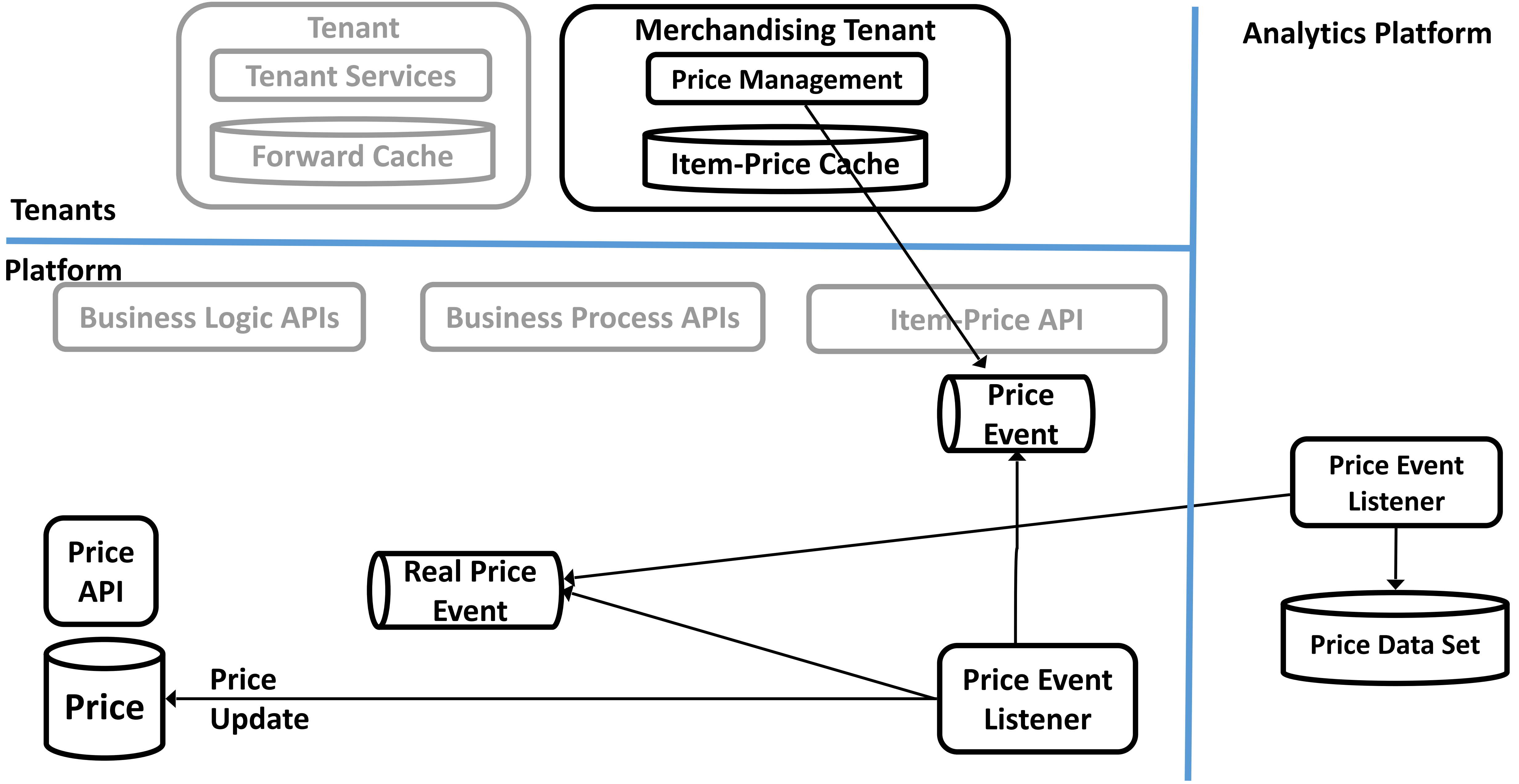
Tenant Verification



Retail Platform Architecture

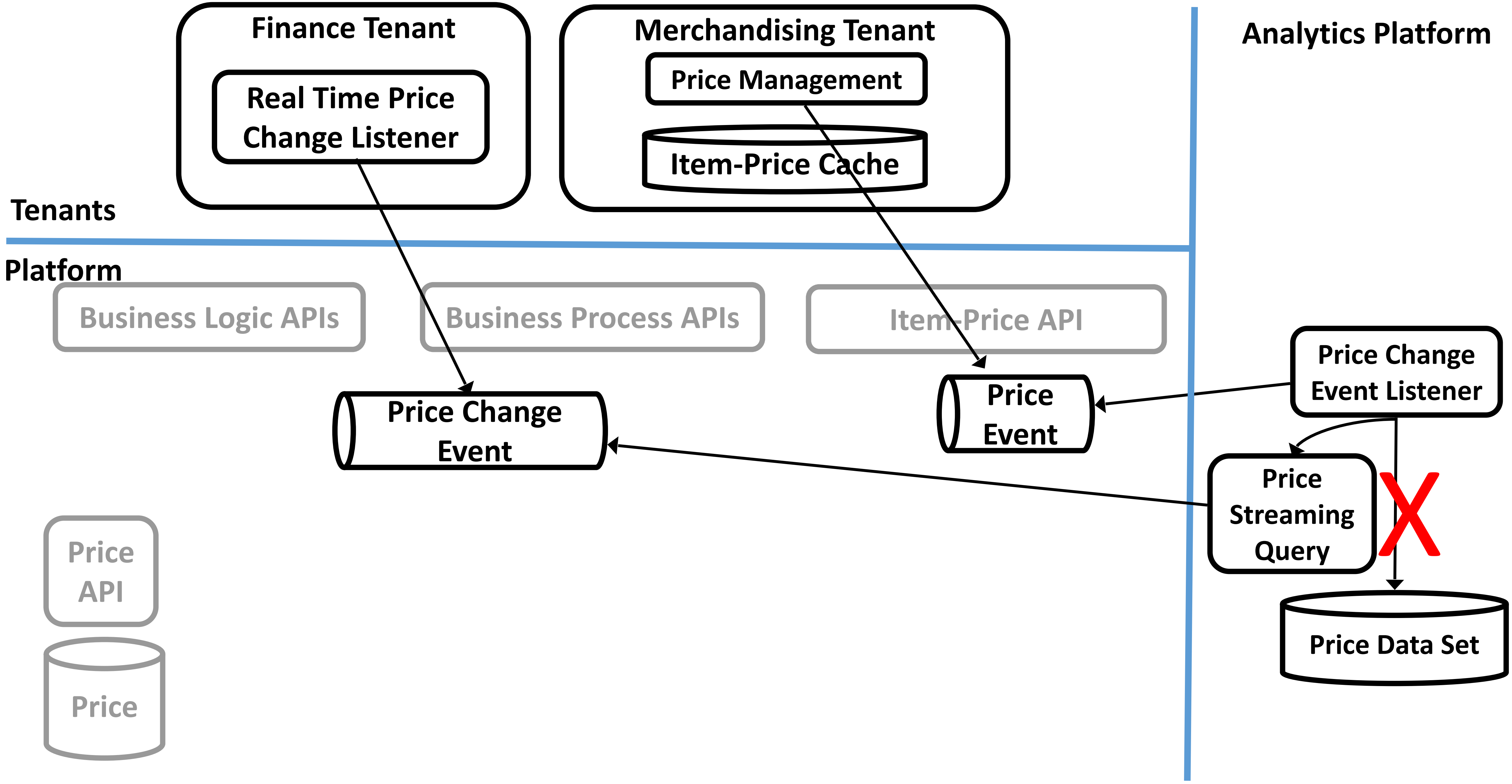
Complete Platform

Analytics Extension



Retail Platform Architecture

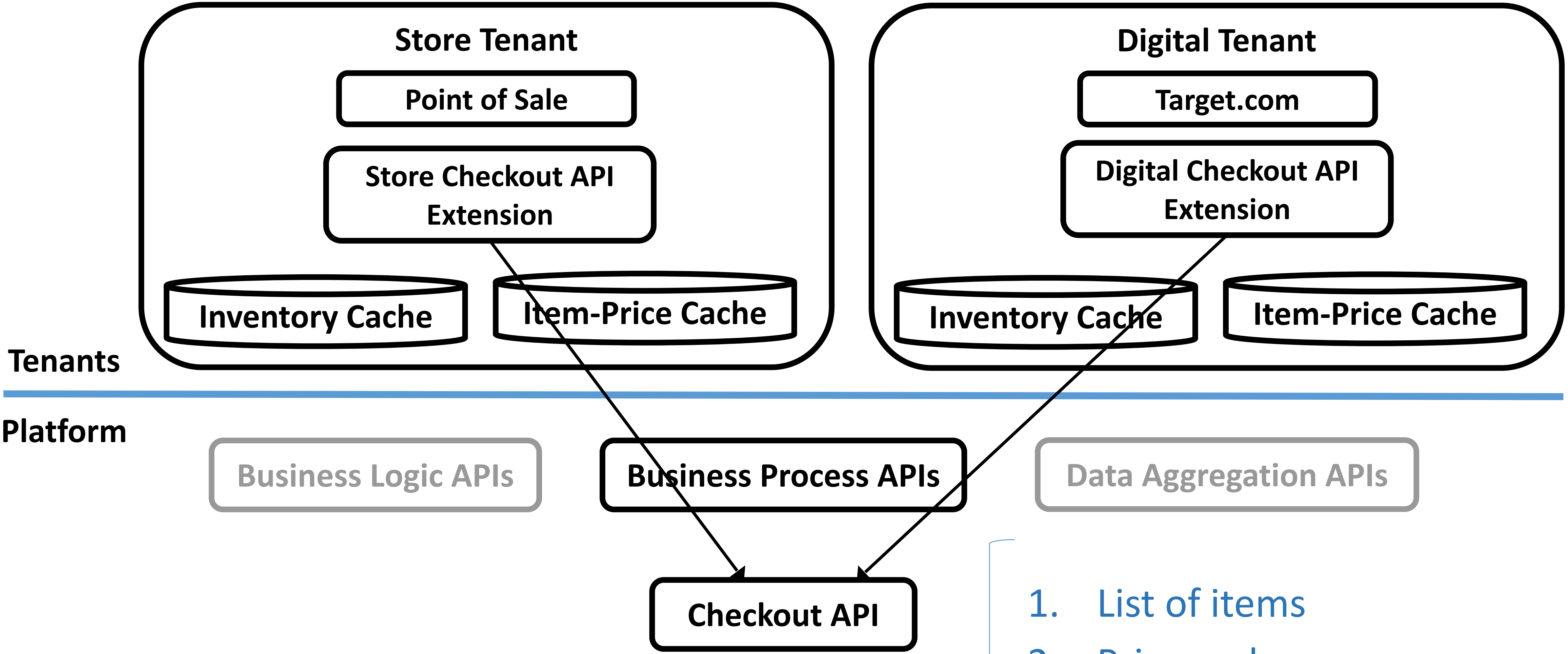
Data Analytics



Retail Platform Architecture

Stream Processing

Process or Logic Extension



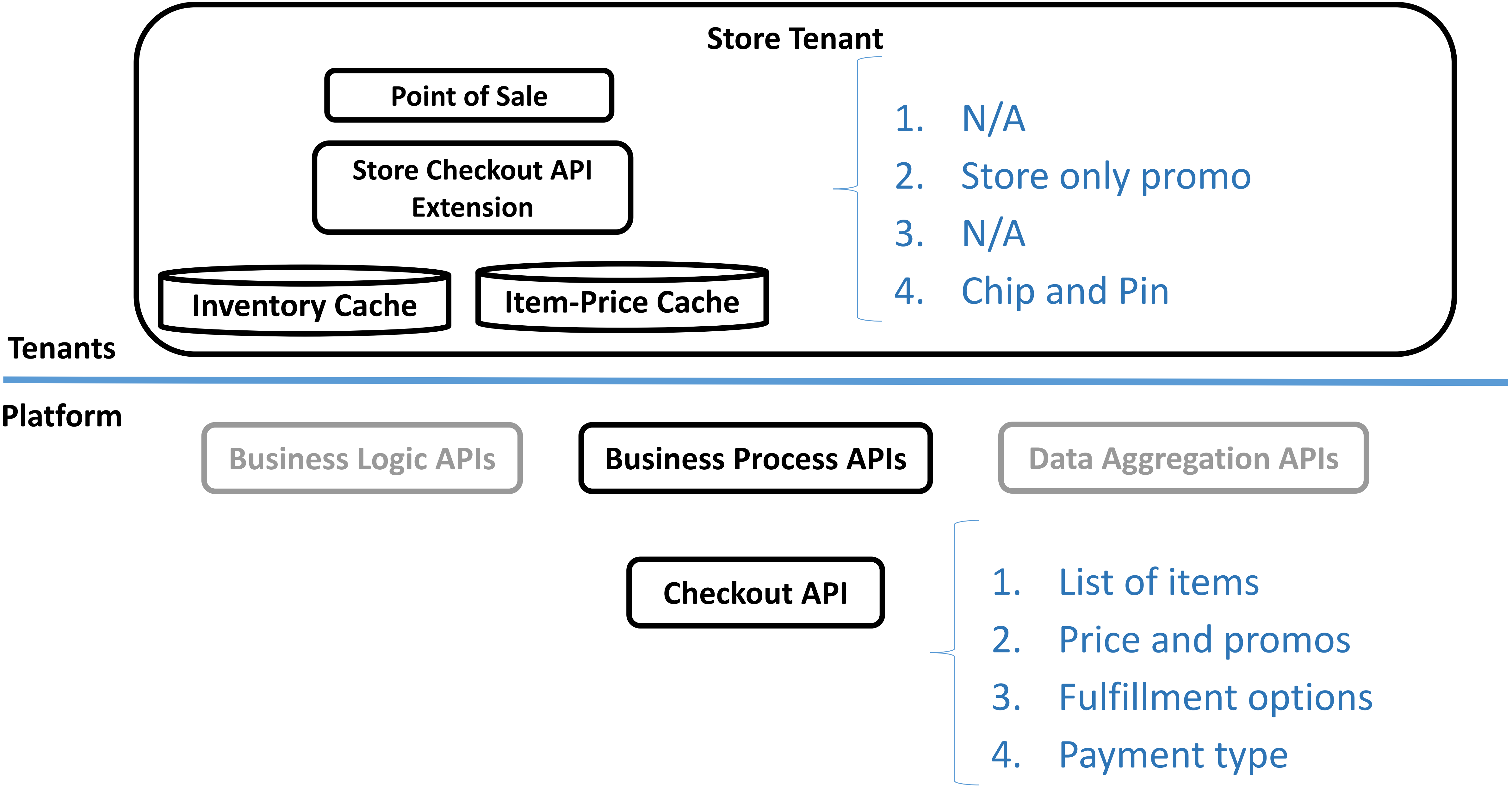
1. List of items
2. Price and promos
3. Fulfillment options
4. Payment type

Retail Platform Architecture

Process Extension

Retail Platform Architecture

Process Extension



Store Tenant

Point of Sale

Store Checkout API Extension

Inventory Cache

Item-Price Cache

1. N/A
2. Store only promo
3. N/A
4. Chip and Pin

Tenants

Platform

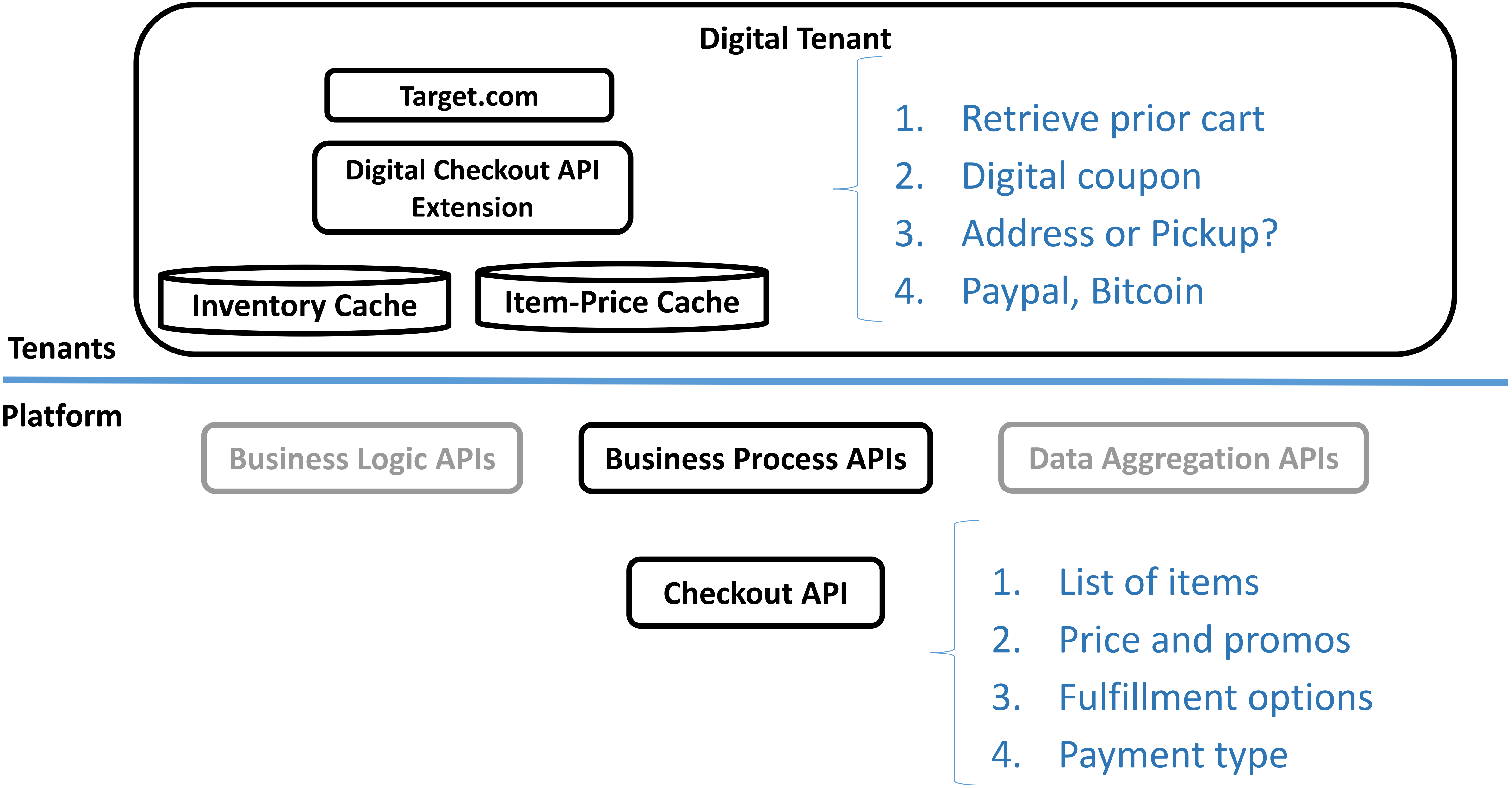
Business Logic APIs

Business Process APIs

Data Aggregation APIs

Checkout API

1. List of items
2. Price and promos
3. Fulfillment options
4. Payment type



Digital Tenant

Target.com

Digital Checkout API Extension

Inventory Cache

Item-Price Cache

1. Retrieve prior cart
2. Digital coupon
3. Address or Pickup?
4. Paypal, Bitcoin

Tenants

Platform

Business Logic APIs

Business Process APIs

Data Aggregation APIs

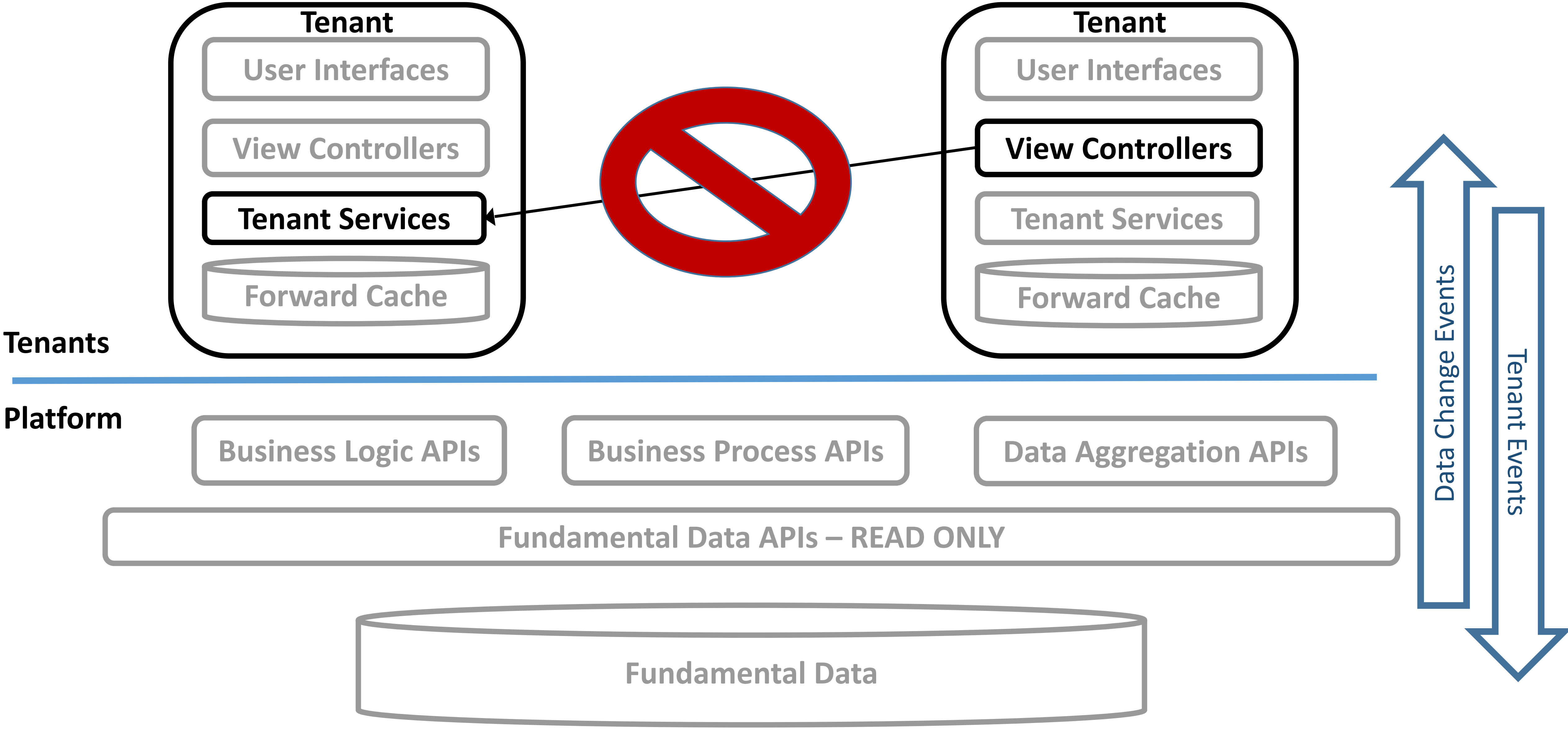
Checkout API

1. List of items
2. Price and promos
3. Fulfillment options
4. Payment type

Retail Platform Architecture

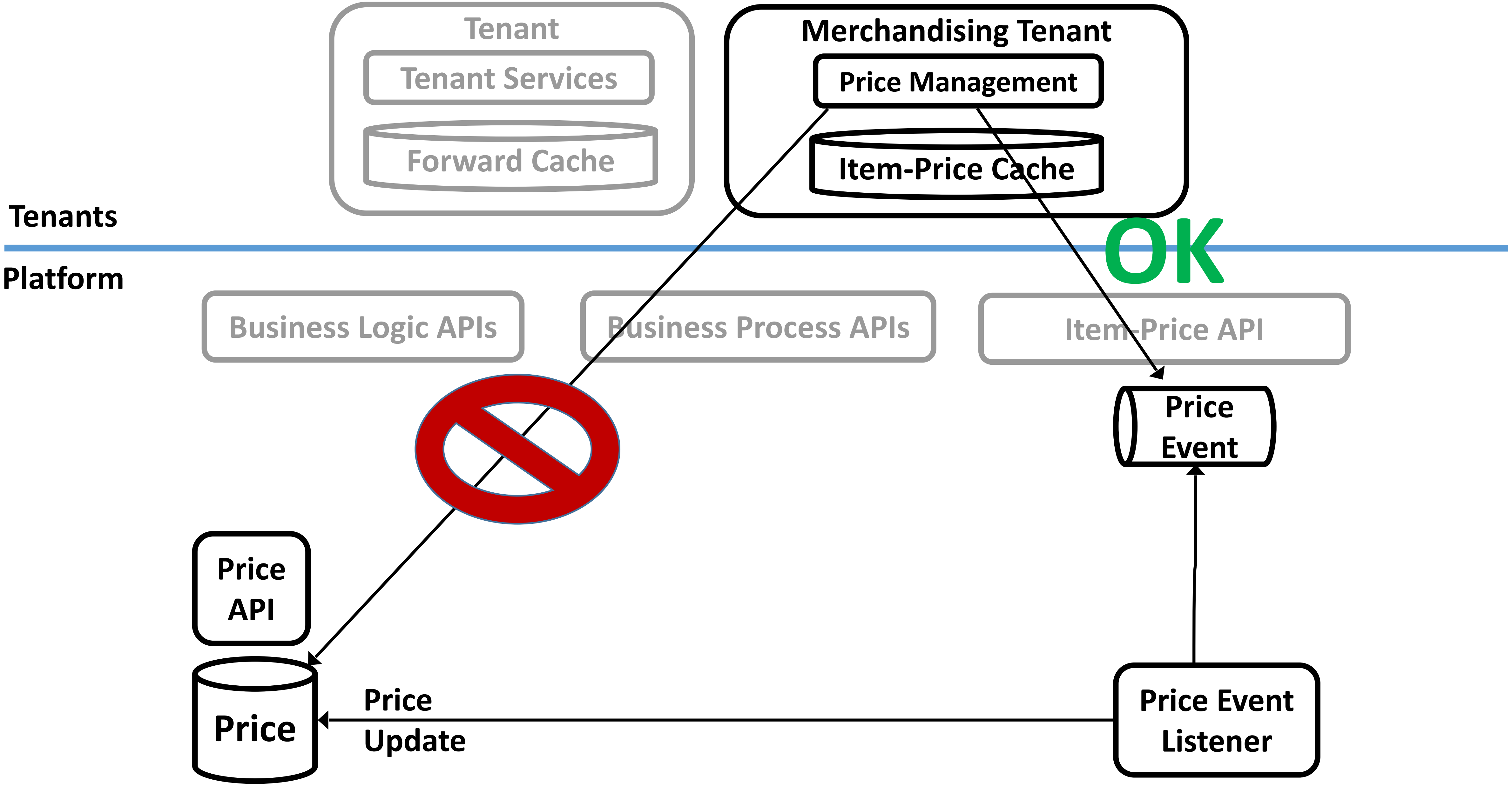
Process Extension

Platform Operating Principles



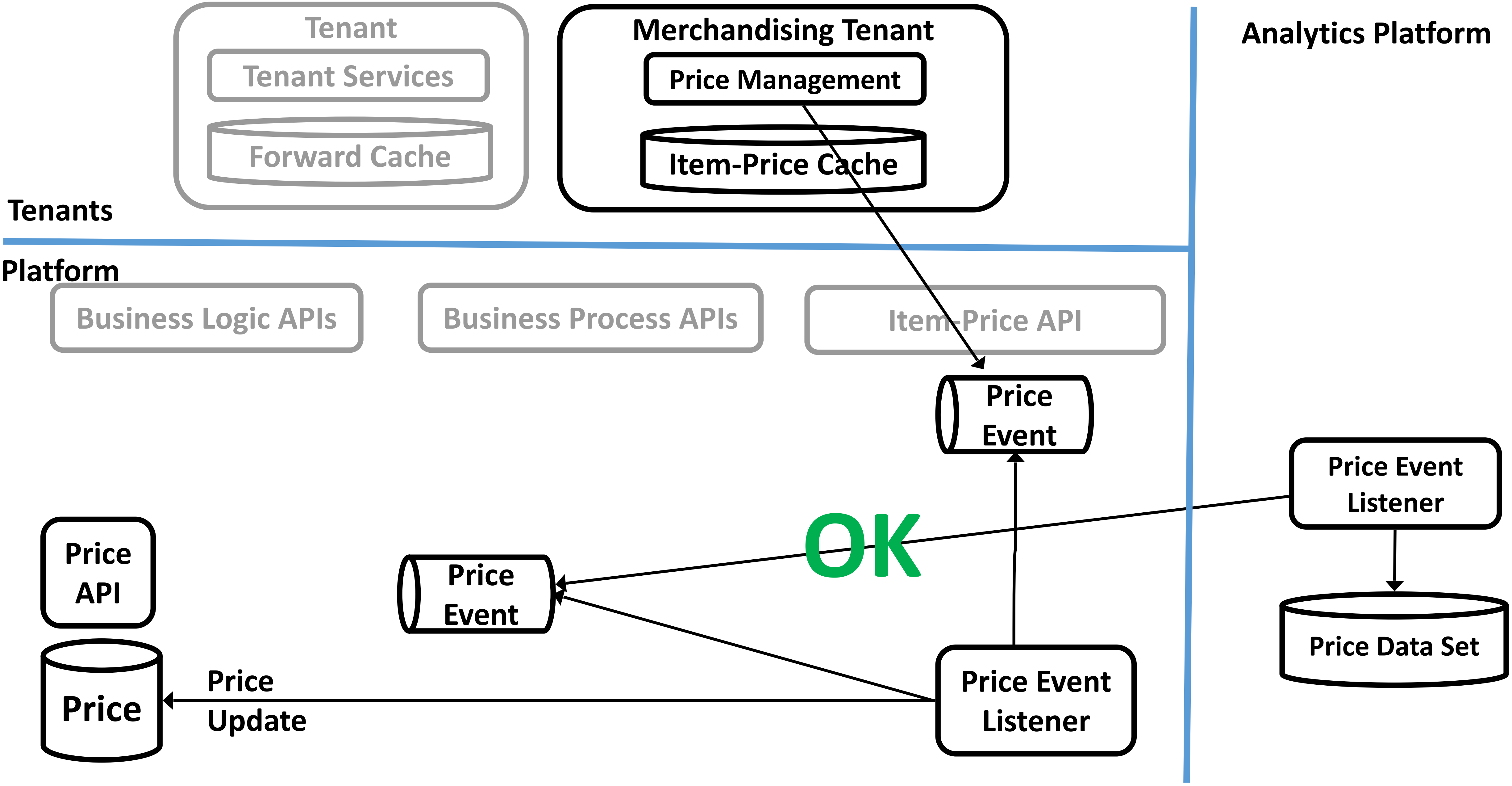
Generic Platform Architecture

No Tenant to Tenant Calls



Retail Platform Architecture

All Transactions are Events



Tenant

Tenant Services

Forward Cache

Merchandising Tenant

Price Management

Item-Price Cache

Analytics Platform

Tenants

Platform

Business Logic APIs

Business Process APIs

Item-Price API

Price Event

Price Event Listener

OK

Price API

Price Event

Price Data Set

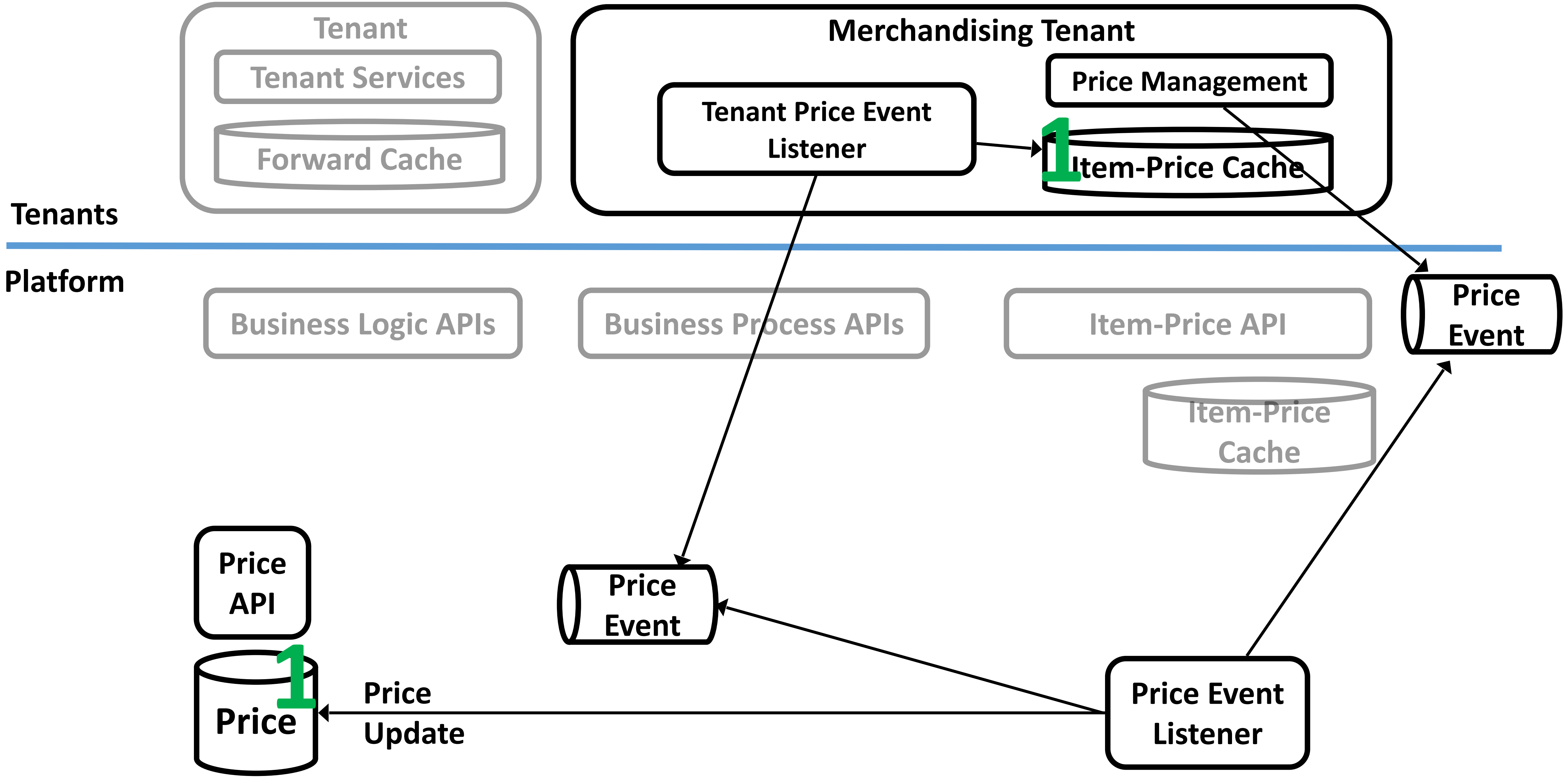
Price

Price Update

Price Event Listener

Retail Platform Architecture

Events are Open to All



Retail Platform Architecture

Eventually Consistent

Platform Operating Principles

- No Tenant to Tenant calls
- All transactions are Events
- Events are (almost) completely open to all
- All caching layers are eventually consistent

Scalability Principles

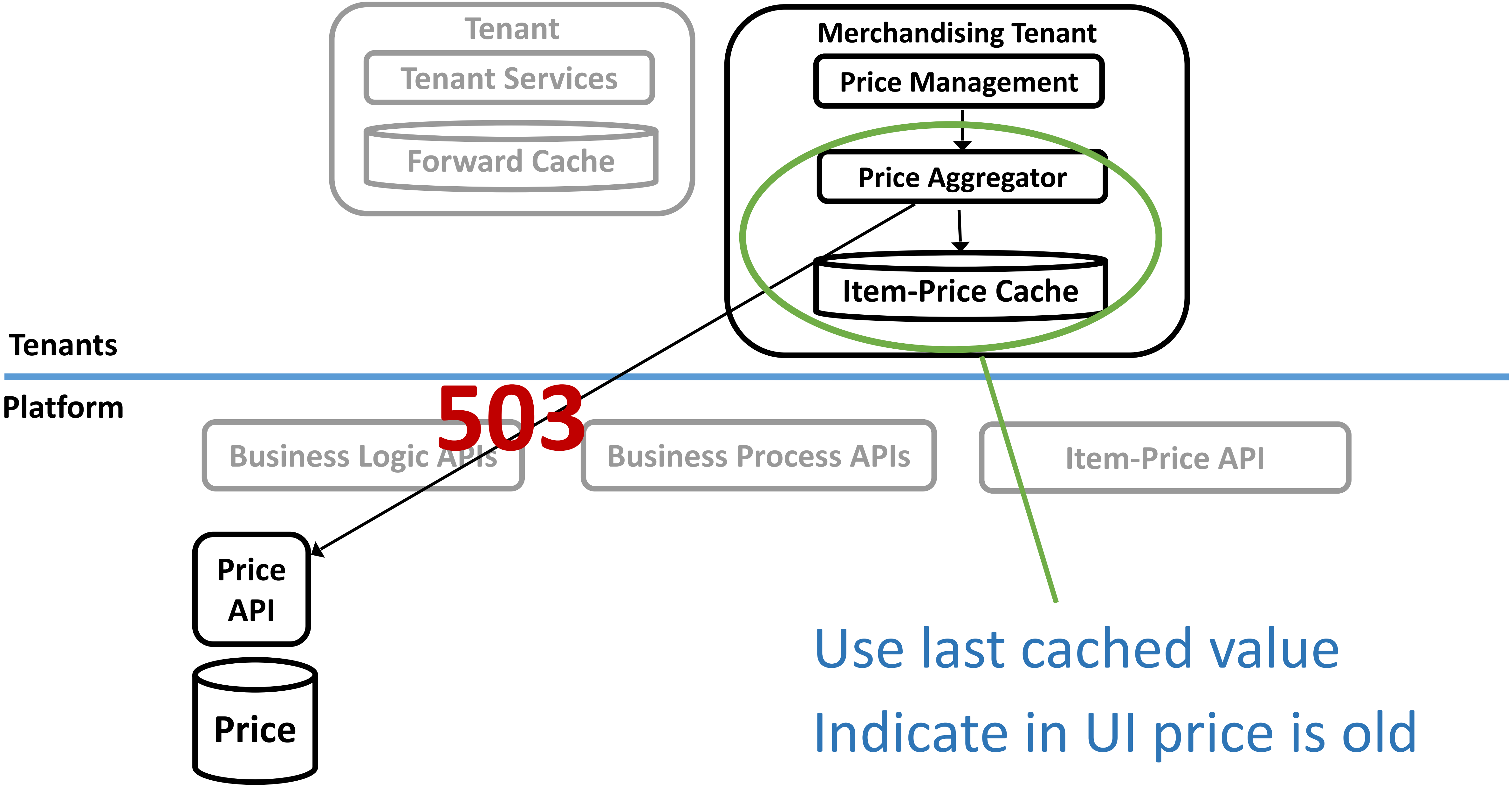
- Protect Fundamental Data services
  - Platform Aggregations and Tenant caches
  - Throttle events to Fundamental Data layer
  - Asynchronous writes
- Serve majority of traffic from tenant layer
  - Distribute data to edge
  - All caching layers are eventually consistent

Handling Failure

Platform Micro-Failures

- Individual platform service failure
- Tenant to Platform network failure

Tenant decides how to handle failure



Use last cached value

Indicate in UI price is old

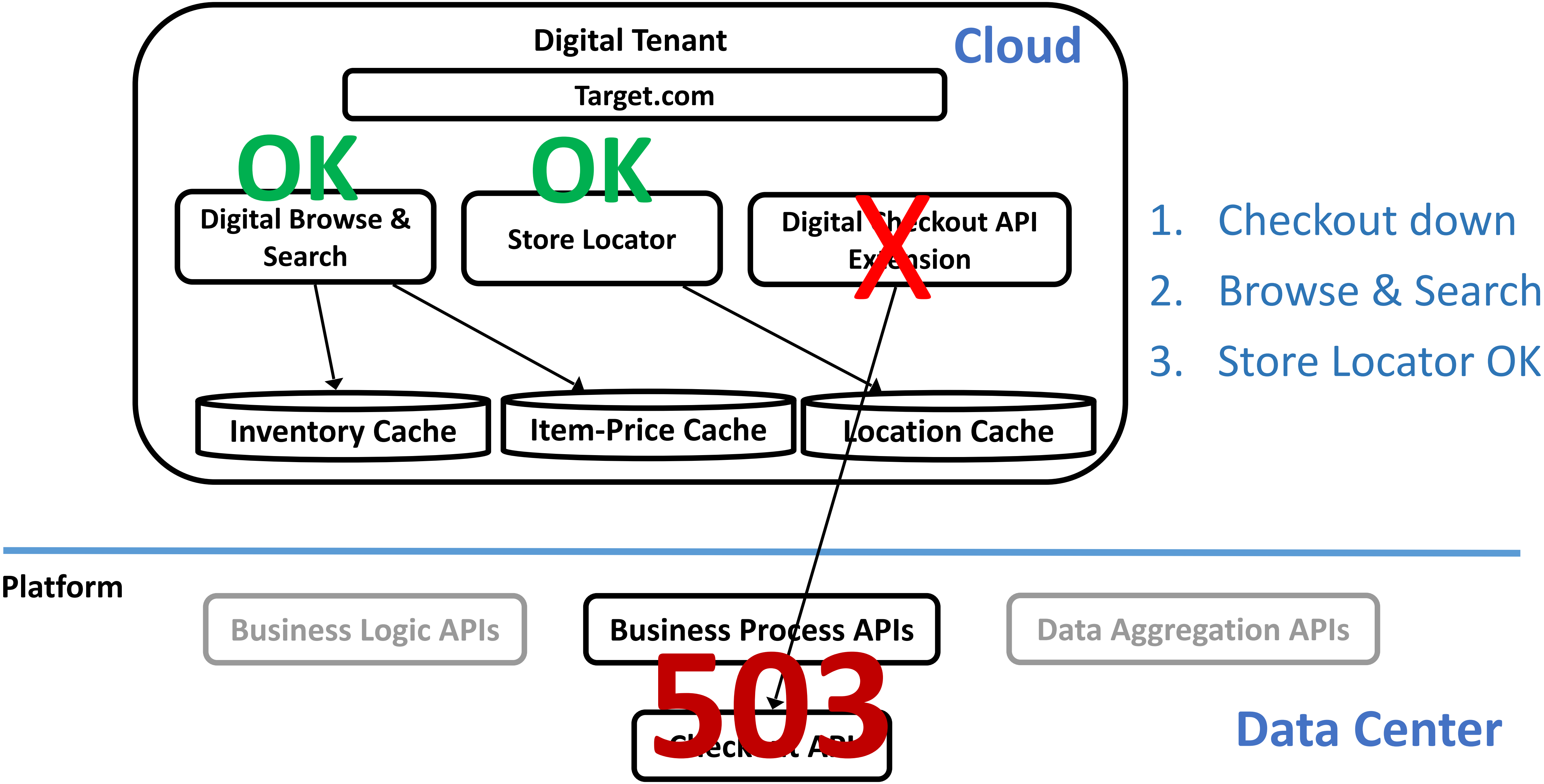
Retail Platform

Micro-failure - Read

Platform Macro-Failures

- Platform down
  - Network failures
  - DDOS
  - Exceeded capacity
  - Excessive latency

Tenant decides how to handle failure



1. Checkout down
2. Browse & Search OK
3. Store Locator OK

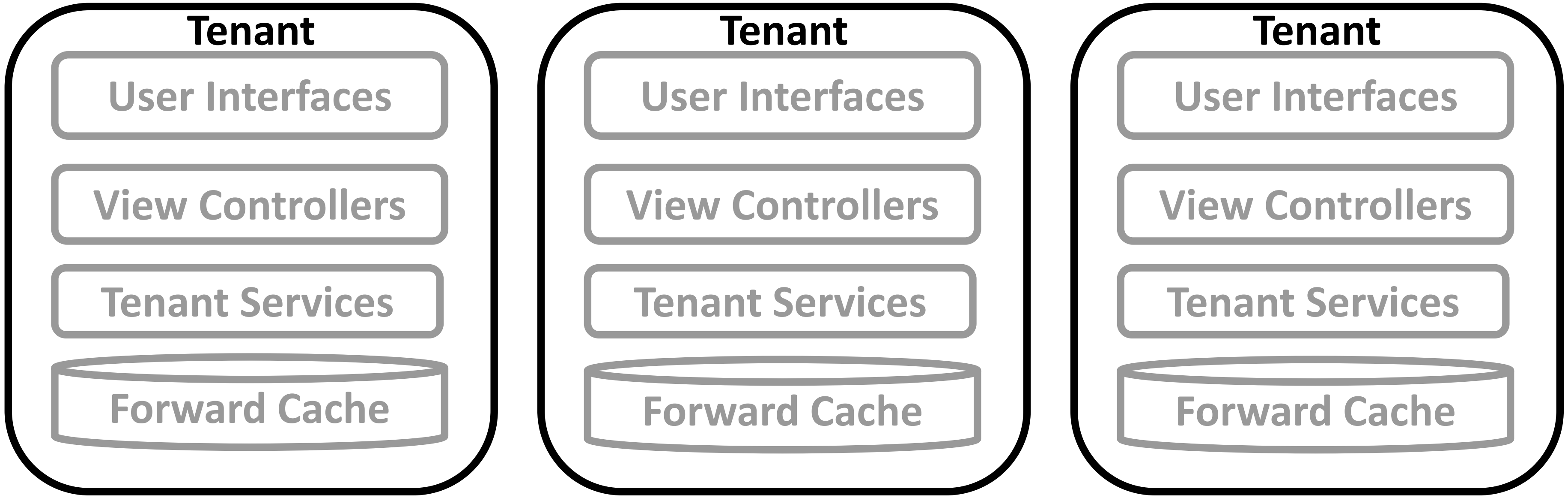
Retail Platform

Macro-failure – Platform Network

Architecture Governance

Architecture Governance Considerations

- Every system has a context: Platform or Tenant
- Every system has a defined scope: Data, Process, Logic, Aggregation, UI
- Tenants are decoupled from other tenants & the platform
- Context decides amount of enterprise governance



Isolated impact

Open to new technologies

Build and deploy quickly

Tenants

Tenants make many technology decisions

Retail Platform Architecture

Tenant Governance

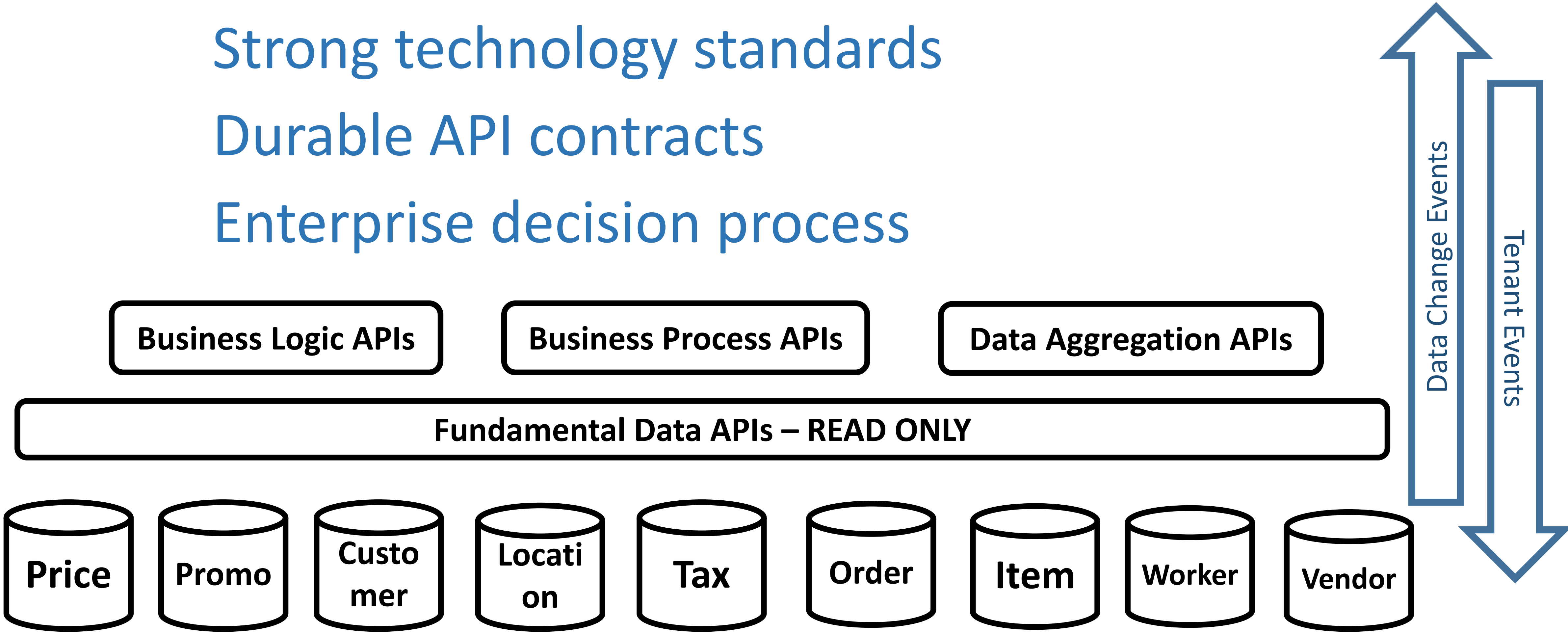
Platform

Wide impact

Strong technology standards

Durable API contracts

Enterprise decision process



Business Logic APIs

Business Process APIs

Data Aggregation APIs

Fundamental Data APIs – READ ONLY

Price

Promo

Customer

Location

Tax

Order

Item

Worker

Vendor

Data Change Events

Tenant Events

Retail Platform Architecture

Platform Governance

Architecture Considerations

- Adopt new technologies in Tenants
- Innovate and experiment in Tenants

- Learn and evaluate for graduation to Platform

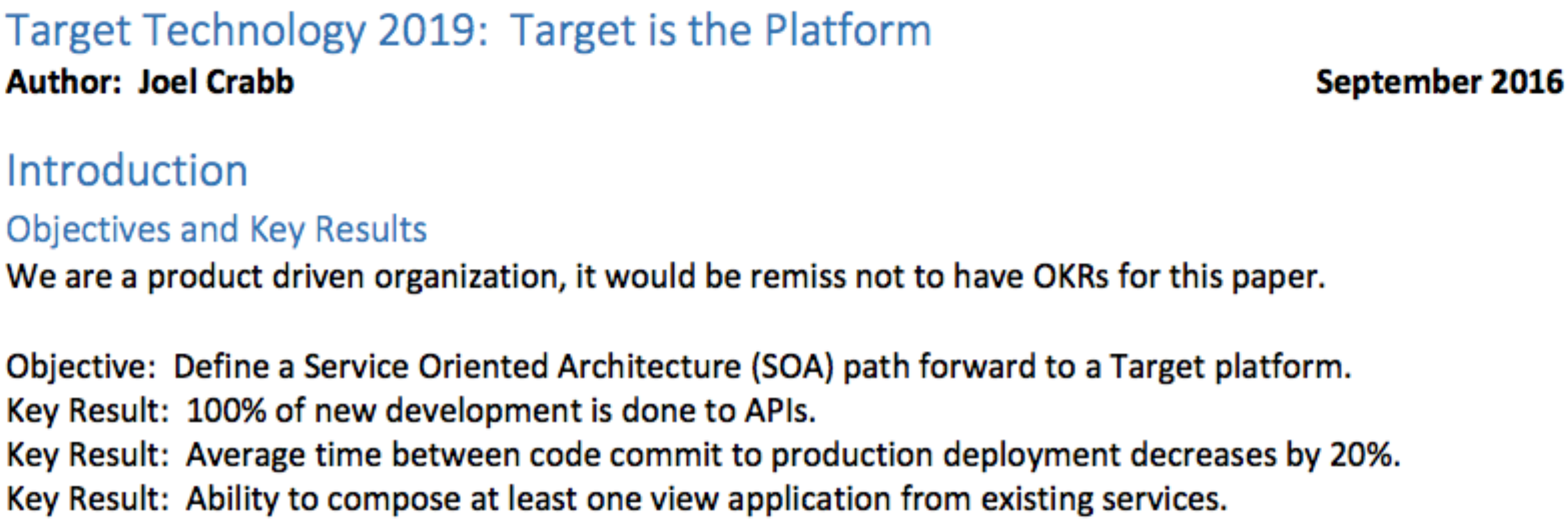
Architecture Framework

Platform Architecture Framework

1. Architecture vision definition
2. Platform diagram – one page!
3. Top down agreement to build a platform
4. Communicate the strategy!
5. Define fundamental data
6. Define platform surface
7. Create Portfolio/Domain level diagrams
8. Create automated measurement of progress

#1 Architecture Vision

- Document it!
- Write a 10 page whitepaper



Target Technology 2019: Target is the Platform

Author: Joel Crabb **September 2016**

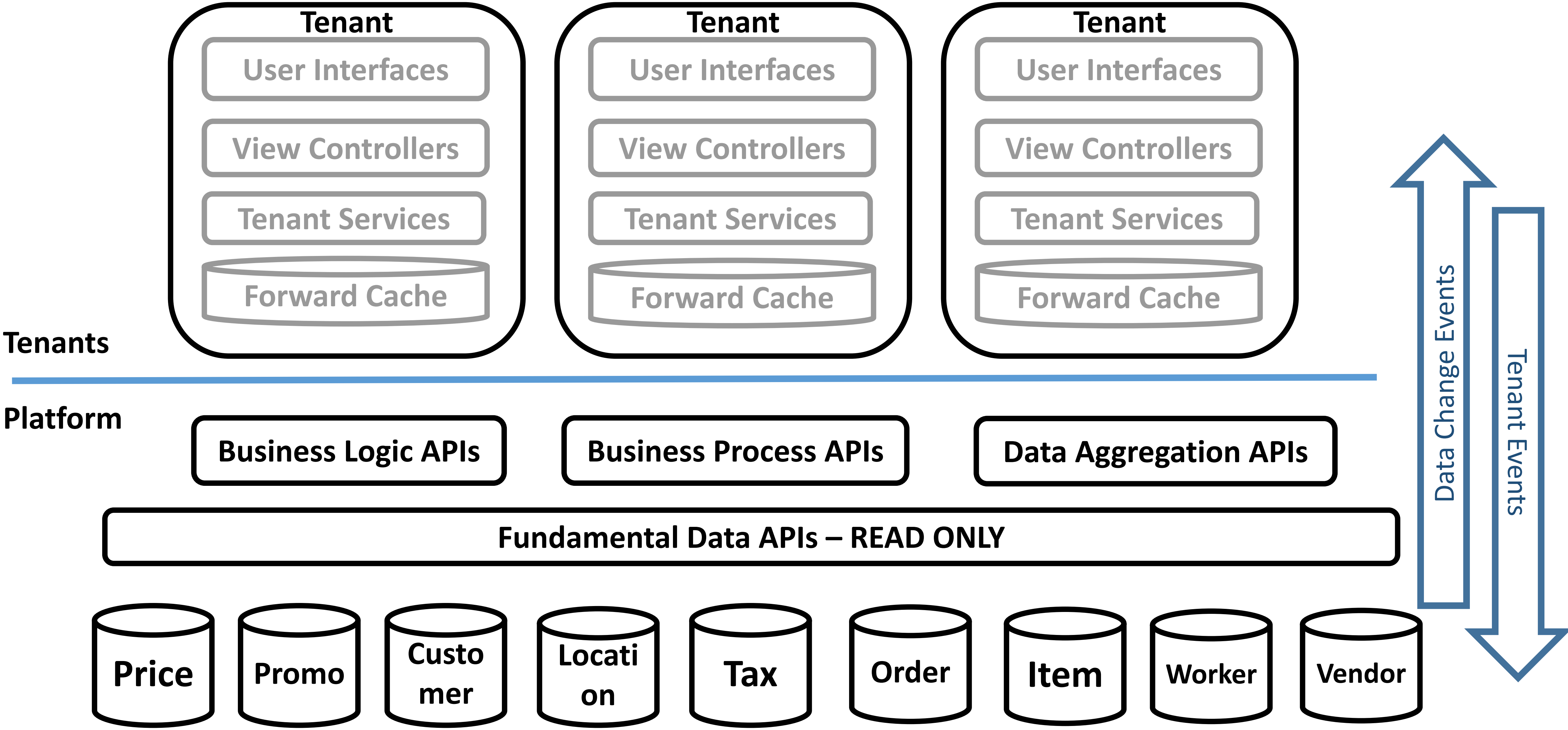
Introduction

Objectives and Key Results

We are a product driven organization, it would be remiss not to have OKRs for this paper.

Objective: Define a Service Oriented Architecture (SOA) path forward to a Target platform.
Key Result: 100% of new development is done to APIs.
Key Result: Average time between code commit to production deployment decreases by 20%.
Key Result: Ability to compose at least one view application from existing services.

#2 Platform Diagram – One Pager



Retail Platform Architecture

Complete Platform

#3 Top Down Agreement

- Reviewed with CIO and all VPs in IT
- Enterprise agreement on the platform direction
- Acknowledge it will require organizational restructuring

- Architecture team to evangelize and measure progress

#4 Communicate the Strategy

To reach 3000+ Engineers:

1. Have a 30 minute presentation on the platform
2. Take a lot of questions
3. Do it over and over and over
4. Teach the architects and the evangelists
5. Make a video
6. Continuous communication throughout the life of the platform

#5 Define Fundamental Data

- Identified 41 fundamental data topics
- Assigned ownership to technology teams
- Stand up the 10 most important APIs first

#6 Define Platform Surface

Survey

- Find existing APIs
- Define Needs

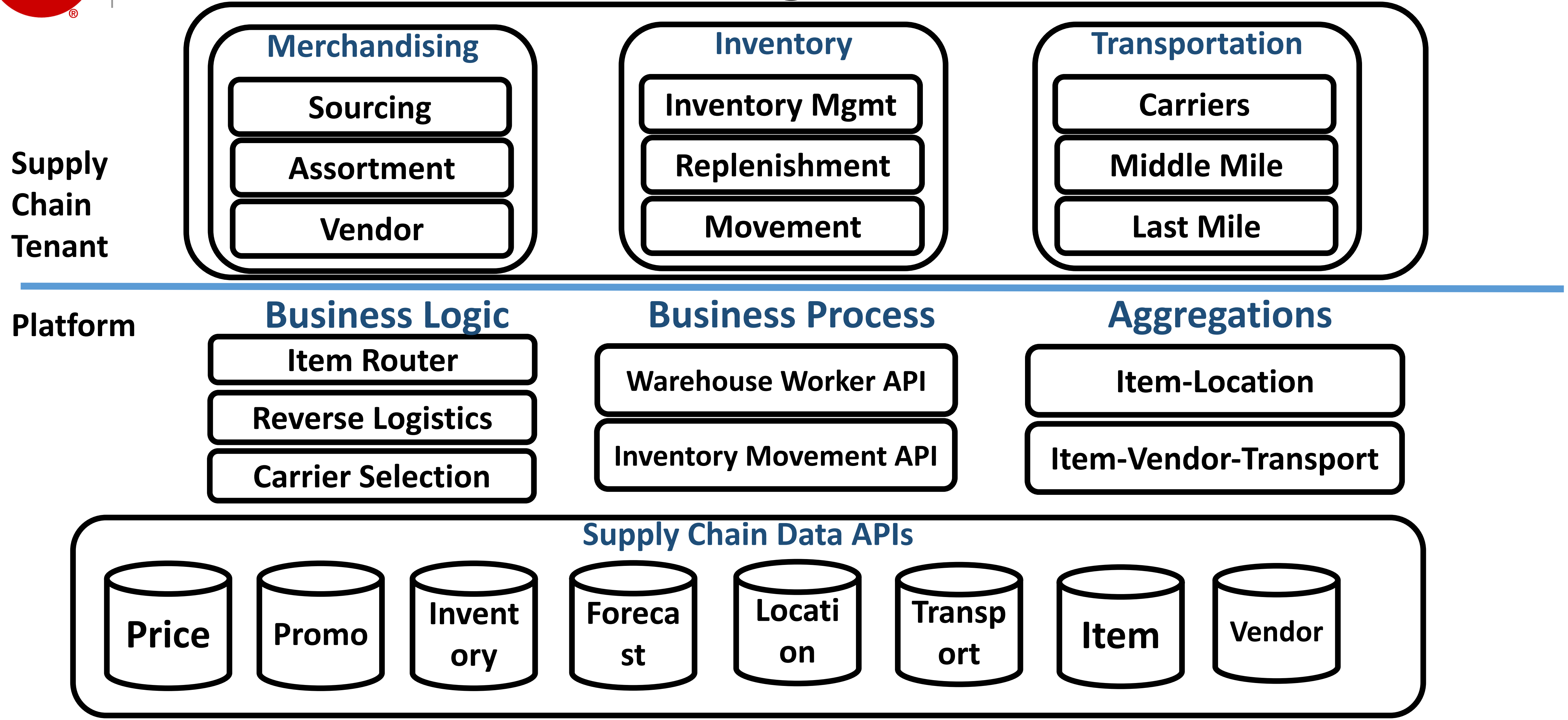
Identify

- Catalogue APIs
- Apply Metadata
  - Platform
  - Tenant

Standardize

- Event Metadata
- API Specification
- API Templates

#7 Portfolio Level Diagram



Supply Chain Tenant

Merchandising
- Sourcing
- Assortment
- Vendor

Inventory
- Inventory Mgmt
- Replenishment
- Movement

Transportation
- Carriers
- Middle Mile
- Last Mile

Platform

Business Logic
- Item Router
- Reverse Logistics
- Carrier Selection

Business Process
- Warehouse Worker API
- Inventory Movement API

Aggregations
- Item-Location
- Item-Vendor-Transport

Supply Chain Data APIs
- Price
- Promo
- Invent ory
- Foreca st
- Locati on
- Transp ort
- Item
- Vendor

Retail Platform Architecture

Portfolio Diagram

#8 Measure Progress - Automatically

- Fundamental Data API count
- # of Tenants
- # of Platform Logic and Process APIs
- # of Events defined
- # of API calls
- # of Events generated

Platform Learnings

Learnings

- Fundamental Data systems need an event listener with business logic to decide what to Insert/Update/Delete
- Platform components need separate funding
- Once you establish a Platform model, everything becomes a platform
  - Infrastructure platform, pricing platform, guest data platform, identity platform, etc

Security Considerations

- Event security and provenance
- Event traceability
- Event data access authorization
- Event data encryption for PII
- API security and authorization

Issues to Work Through

- No Tenant to Tenant traffic
- South -> North traffic for large payloads
- Tenant granularity
- Tenants can become miniature monoliths
- Graduating tenant functions to the platform
- Aggregation proliferation at Tenant level
- Event definition
- Metadata definition

Use Conway’s Law

Any organization that designs a system (defined broadly) will produce a design whose structure is a copy of the organization’s communication structure.

~ M. Conway

http://www.melconway.com/Home/Conways_Law.html

This is exactly what we want!

Questions