Got it — I’ll treat the attached problem statement as the source of truth for scope and quality bars.

**Requirement elicitation (stakeholder interviews → condensed notes)**

**Customers (buyers & sellers)**

* Want fast search, safe payments, escrow/refunds, fair dispute handling, nearby deals, private chat, ratings.
* Trust signals (KYC/badges), clear fees, pickup/shipping options, fraud protection.

**Product Manager**

* Growth via discovery & re-engagement, strong mobile UX, experiment quickly, social proof, retention loops.
* Guardrails: fraud-loss cap, policy compliance, content safety.

**Business Owners**

* Monetization (listing boosts, ads, commissions), scalable to multiple countries, low operational burden.
* KPIs: GMV, take-rate, fraud loss rate, NPS/CSAT, time-to-first-transaction.

**Developers**

* Prefer microservices, cloud-native, IaC, trunk-based dev, CI/CD, canary, feature flags, clean DDD boundaries.
* Observability (traces/metrics/logs), testability, self-serve data platform.

**Testers/QA**

* Contract tests between services, deterministic test data, sandbox payments/shipping, synthetic user flows.
* Non-functional tests: perf, chaos, security, A/B guardrail monitoring.

**Trust & Safety**

* KYC/AML tiers, device intelligence, velocity/risk scoring, content moderation, chargeback handling.
* Audit trails, explainable decisions, appeals workflow.

**Marketing/CRM**

* Segmentation, triggered campaigns, retargeting pixels, discount/credits, attribution across devices.

**Analytics/Data Science**

* Near-real-time events, feature store, vector search for semantics, recommendations, fraud models, A/B platform.

**Use cases (brief list; ≤20 words each)**

1. **Browse & advanced search** — Filter, sort, semantic search, geo-radius, availability.
2. **Create/Manage listing** — Draft, images, price help, publish, pause, delete.
3. **Smart recommendations** — Personalized feeds, similar items, “price drops near you”.
4. **Buyer-seller messaging** — Secure chat, offers, attachments, safety filters.
5. **Offer/Counter/Accept** — Negotiation with expiry and auto-decline.
6. **Checkout & escrow** — Address, shipping/pickup, fees, tax, escrow.
7. **Fraud & risk control** — KYC, device checks, velocity, ML risk scores.
8. **Fulfillment** — Shipping labels, tracking, proof of delivery.
9. **Dispute & resolution** — Evidence upload, mediation, partial refunds.
10. **Ratings & reviews** — Two-way, after transaction, anti-abuse.
11. **Content moderation** — Image/text/metadata policy checks.
12. **Campaigns & ads** — Listing boosts, retargeting, coupons.
13. **Account & auth** — Sign-up, login, MFA, sessions (brief).
14. **Observability & audits** — Traces, BI, audit logs, PII access trails.
15. **Experiments & rollout** — A/B, feature flags, guardrails.

**Business driver (benchmark KPI)**

**Primary driver:** **Search-to-Purchase Conversion Rate (SPCR)** — % of search sessions that result in a completed transaction within **7 days**.  
**Guardrails:** p95 Search latency ≤ **300 ms**, Fraud loss ≤ **0.3% GMV**, Dispute resolution ≤ **72 h**.

*Rationale:* Optimizing SPCR aligns discovery, trust, payments, and fulfillment. It’s sensitive to architecture (search, recommendations, risk, availability) and directly ties to GMV.

**System boundary & actors**

**System boundary:** **C2C Marketplace Platform** (web, iOS, Android). Includes marketplace services, data/ML platform, admin console, and integrations.

**Primary actors**

* **Buyer** (authenticated or guest for browse)
* **Seller**
* **Payment Processor/Escrow** (external)
* **Fulfillment/Logistics** (external partners)

**Secondary actors**

* **Identity Provider/KYC** (external)
* **Trust & Safety Analyst** (internal)
* **Customer Support Agent** (internal)
* **Marketing Platform/DSP** (external)
* **Analytics/Data Platform** (internal)
* **Content Moderation Provider** (external)
* **Tax/Compliance Services** (external)
* **Admin** (policy, catalog, ops)

**Elaborated architecturally significant use cases**

**1) Browse & Advanced Search (core to SPCR)**

**Goal:** Fast, relevant discovery across text, images, and location.  
**Preconditions:** Catalog indexed; buyer location/locale known.  
**Main flow:**

1. User enters query or opens home feed.
2. **Query orchestrator** fans out to **Vector Search** (semantic), **Keyword/Faceted Search** (inverted index), and **Geo index**.
3. **Relevance service** blends lexical, semantic, popularity, and personalization signals; applies policy filters.
4. Return paged results with aggregations; cache results; log search events.  
   **Alternates:**

* Cold-start: fall back to trending near user.
* No results: relax filters; semantic expansion (“near-matches”).  
  **AI/ML:** Dual encoders for text/image embeddings; re-ranker (LTR); query intent classifier; spelling.  
  **Quality attributes:** p95 ≤300 ms, high cache hit rate, zero-downtime reindex.  
  **Key services/components:** API-Gateway → Search Orchestrator → (Vector DB + Search Engine) → Relevance/Ranking → Results Cache → Telemetry.

**2) Create/Manage Listing (with AI assist & moderation)**

**Goal:** Let sellers publish policy-compliant listings quickly.  
**Main flow:**

1. Seller uploads photos; **Vision model** auto-detects category, condition, brand, defects.
2. **LLM assist** drafts title/description and suggests price (comps from sales history).
3. Real-time **policy & risk checks** (text/image).
4. On publish, event **ItemCreated** emits; indexers update Search and Vector DB.  
   **Alternates:**

* Draft saved offline; later resume.
* Policy violation → explain reasons; allow appeal.  
  **Quality:** Create-to-search index ≤5 s; image CDN; idempotent uploads.

**3) Buyer-Seller Messaging & Offer/Counter**

**Goal:** Negotiation with safety.  
**Main flow:**

1. Secure chat (E2EE optional at rest; server-side scanning with privacy safeguards).
2. Structured **Offer** messages with price/expiry.
3. **Safety models** flag PII exchange, scams, off-platform payment attempts.
4. Accept → **Order Initiated**.  
   **Quality:** Delivery ≥99.99%, spam filtering, rate limits, auditability.

**4) Checkout & Escrow**

**Goal:** Complete payment safely; handle taxes/shipping.  
**Main flow:**

1. Address/identity checks; shipping or local pickup.
2. Risk gate: **Risk score** from fraud service (features: device, velocity, graph).
3. If pass, create **escrow charge** with processor; hold funds.
4. Emit **OrderPlaced**; notify seller; label generation if shipped.  
   **Alternates:**

* High risk → manual review; 3DS/MFA challenge.
* Pickup: escrow captured on buyer confirmation or POD code.  
  **Quality:** Payment SLO 99.95%; idempotent retries; PCI scope minimized (tokenization).

**5) Fraud & Risk Control (inline + async)**

**Goal:** Prevent fraud/abuse while keeping friction low.  
**Flows:**

* **Real-time checks** at account creation, listing publish, offer, checkout, withdrawal.
* **Async monitors** for velocity, mule accounts, collusion (graph features).
* **Models:** Gradient boosting/GBDT + GNN for account graphs; explainability for appeals.
* **Actions:** Soft/hard blocks, additional verification, delayed settlement, shadow bans.  
  **Quality:** Maintain fraud loss ≤0.3% GMV; <2% false-positive rate.

**6) Dispute & Resolution**

**Goal:** Resolve item-not-as-described, missing items, chargebacks.  
**Main flow:**

1. Case creation with evidence upload; SLA timers start.
2. **LLM triage** summarizes threads, classifies reason, proposes next steps.
3. Evidence review → mediation; partial refund or return shipping.
4. Auto-capture/auto-refund from escrow per outcome; update ratings.  
   **Quality:** Median resolution ≤72 h; auditable decisions.

**7) Recommendations & Personalization**

**Goal:** Improve SPCR through relevance beyond explicit search.  
**Flows:**

* Home feed, similar items, complementary items, “recently viewed”, email push.
* Models: user/item embeddings (two-tower), re-rank with session context, diversity constraints.  
  **Quality:** Real-time features (≤500 ms staleness) via feature store; explainable cards (“Because you liked X”).

**8) Content Moderation & Policy Compliance**

* Multi-stage (hash-match → heuristics → ML vision/NLP → human review).
* Region-aware policies; child safety; dangerous goods.
* Appeals queue; immutable evidence logs.

**9) Campaigns, Boosts & Ads**

* Seller boosts (paid ranking slots) with budget pacing and fairness caps.
* CRM triggers (price drops, saved searches) and retargeting pixels (consent-aware).
* Attribution: MTA with impression/click stream; guardrails against cannibalization.

**10) Observability, Audits, Experiments**

* **A/B platform** with guardrail metrics (SPCR, latency, fraud).
* Full-fidelity event stream (Kafka) → lakehouse; PII governance.
* Traces (OpenTelemetry), SLOs with error budgets, chaos testing.

*(Auth/signup/login, profile, notifications, and settings are implemented but intentionally treated briefly.)*

**Use-case diagram (PlantUML)**

@startuml

left to right direction

skinparam usecase {

BackgroundColor White

BorderColor Black

}

actor Buyer

actor Seller

actor "Payment Processor" as Pay

actor "KYC/ID Provider" as KYC

actor "Logistics Partner" as Ship

actor "Content Moderation Provider" as Mod

actor "Trust & Safety Analyst" as TSA

actor "Customer Support Agent" as CSA

actor Admin

rectangle "C2C Marketplace Platform" {

(Browse & Advanced Search) as UC\_Search

(Recommendations & Personalization) as UC\_Recs

(Create/Manage Listing) as UC\_List

(Messaging & Offers) as UC\_Chat

(Checkout & Escrow) as UC\_Checkout

(Fraud & Risk Control) as UC\_Fraud

(Fulfillment & Tracking) as UC\_Ship

(Dispute & Resolution) as UC\_Dispute

(Ratings & Reviews) as UC\_Reviews

(Content Moderation) as UC\_Moderation

(Campaigns/Boosts & CRM) as UC\_CRM

(Experiments & Observability) as UC\_Obs

(Auth & Account) as UC\_Auth

UC\_Checkout .> UC\_Fraud : <<include>>

UC\_List .> UC\_Moderation : <<include>>

UC\_Chat .> UC\_Fraud : <<include>>

UC\_Dispute .> UC\_Fraud : <<include>>

UC\_Recs .> UC\_Search : <<extend>>

UC\_Dispute .> UC\_Reviews : <<extend>>

}

Buyer --> UC\_Search

Buyer --> UC\_Recs

Buyer --> UC\_Chat

Buyer --> UC\_Checkout

Buyer --> UC\_Dispute

Buyer --> UC\_Reviews

Seller --> UC\_List

Seller --> UC\_Chat

Seller --> UC\_Dispute

Seller --> UC\_Reviews

Seller --> UC\_CRM

Pay --> UC\_Checkout

KYC --> UC\_Auth

Ship --> UC\_Ship

Mod --> UC\_Moderation

TSA --> UC\_Fraud

CSA --> UC\_Dispute

Admin --> UC\_CRM

Admin --> UC\_Obs

@enduml

**Notes tying architecture to the KPI (SPCR)**

* **Fast, relevant discovery** (vector+keyword+geo, re-ranking) → higher add-to-cart, lower bounce.
* **Trust gates inline** (risk before escrow) → fewer abandoned checkouts/chargebacks.
* **AI-assisted listing quality** → cleaner catalog, higher conversion.
* **Observability & A/B** → safe, rapid iteration on relevance and UX.
* **SLOs as guardrails** (p95 search, fraud loss, dispute SLA) → protect SPCR while scaling.

If you want, I can expand the **service decomposition** (per-service APIs, data stores, event topics, and SLOs) next, or generate sequence diagrams for any of the elaborated use cases.