Atlas for Urban Intelligence

Master Framework Document

Version: 1.0
Date: January 30, 2026
Author: Kyle MertensMeyer / MertensMeyer DnA
Project Type: Interactive 3D Knowledge Graph / Digital Exhibit
Associated Publication: "Parcel to Planet" (Book)

Part I: Project Narrative

What We Are Building

The **Atlas for Urban Intelligence** is an interactive 3D knowledge graph that visualizes the hidden epistemic architecture of cities. Unlike traditional digital twins that render static conditions, the Atlas reveals the *dependency structure* between urban concepts—showing how physical matter (bedrock, parcels) connects to regulatory constraints (zoning, entitlements), digital nervous systems (sensors, robots), socio-economic memory (historical trauma, market cycles), and governance regimes (contested vs. directed).

The visualization renders **55 nodes** and **72 edges** organized into a **seven-layer vertical stack**, where each layer acts as a logic gate for the layer above. Users can orbit, zoom, and fly through this structure, clicking nodes to reveal descriptions and toggling edge types to illuminate specific relationship patterns.

The Deliverable

A browser-based 3D experience accessible via:

- QR code (mobile/tablet)
- Direct URL (desktop/laptop)
- Museum exhibit display (large format touchscreen)

The Experience

1. **Landing Page:** Clean white screen with project title, description, and "Enter the Atlas" button
2. **3D Graph:** Force-directed knowledge graph floating in white void
3. **Interactions:**
    - Click node → Glass panel slides in with description, type, clusters, and connections
    - Hover edge → Pulse animation flows from source to target node
    - Click legend item → All edges of that type illuminate (black, thickened)

- Toggle layer → Show/hide entire epistemic layer

Why We Are Building It

1. Portfolio Exhibit for Wheelwright Prize Jury

The Atlas serves as a portfolio piece demonstrating the intersection of:

- Architectural research methodology
- Computational ontology design
- Interactive data visualization
- Systems thinking about urban complexity

The work must "stand up to the likes of someone like Alex Karp or Elon Musk"—meaning it must be intellectually rigorous, visually sophisticated, and technically bulletproof.

2. Digital Augmented Reality Component for "Parcel to Planet"

The Atlas is the interactive companion to the book, allowing readers to explore the conceptual framework in three dimensions. The QR code in the book links directly to this experience.

3. Proving the Ontology Before Simulation

Phase 01 is explicitly a **structural map of knowledge**, not a live simulator. By rendering the 11 clusters (7 structural + 4 thematic) in 3D space, we prove that the ontology is internally consistent before building the simulation engine in future phases.

4. Making the Invisible Visible

Cities are governed by hidden dependencies that planners, developers, and citizens rarely see:

- How a zoning code (L3) constrains a parcel (L1)
- How historical trauma (L5) brakes agent decisions (L4)
- How energy flows (L0) metabolically limit robot fleets (L2)

The Atlas makes these connections tangible and explorable.

Design Philosophy

Visual Hierarchy

Based on reference imagery from co-occurrence networks in physics research:

Element	Priority	Treatment
Nodes	Primary	Colorful, matte, dense, sized by connectivity
Edges	Secondary	Thin gray lines (40% black), visible but receding
Background	Tertiary	Pure white (#FFFFFF), creating void for graph to float

Nodes Are Primary Meaning

- Each layer has a distinct, sophisticated color
- Colors progress from geological darkness (L0) through analytical cool tones to warm human agency (L5-L6)
- Nodes are matte spheres with 95% opacity
- Size varies by connection count (more connected = larger)

Edges Are Secondary Meaning

- Default state: Thin gray lines (black at 40% opacity)
- On hover: Pulse animation from source → target using source node's color
- On type click: All edges of that type turn black and thicken; others fade to 15%
- Edges feel like "forces, traces, currents—not objects"

Color Palette

Layer	Name	Color	Hex	Description
L0	Bio-Physical	Deep Slate / Basalt	#2E2F2C	Geological, grounded, pre-instrumental
L1	Observable Reality	Blue-Gray / Atmospheric Steel	#4A5A63	Perception, measurement, sensing
L2	Cyber-Physical	Desaturated Teal	#4F7A74	Coupling of matter + data
L3	Logic / Knowledge	Muted Indigo	#5A5F8C	Abstraction, inference, reasoning
L4	Agentic Intelligence	Soft Amethyst	#7A6A9E	Intentionality, agency, deliberation
L5	Socio-Economic	Burnt Umber / Rose-Brown	#9B6A5F	Human exchange, value, friction

Layer	Name	Color	Hex	Description
L6	Governance	Warm Brass / Ochre-Gold	#B89A5A	Authority, legitimacy, power

Accent Color

- **Lime Gradient:** #C8E66E → #E8F5C8
- Used sparingly for pulse animations and highlights
- Creates energy and life without overwhelming the scholarly palette

---

Part II: Theoretical Framework

The Epistemic Stack

The Atlas is structured as a **Vertical Epistemic Ladder**. Each layer acts as a logic gate for the layer above, ensuring that abstract intelligence remains grounded in physical and historical reality.

The Seven Edge Types

Edges represent the "physics" of how information, energy, and authority flow through the urban system.

Type	Name	Currency	Direction	Function
E	Energy	Metabolic Load / Joules	L0 ↔ L2	Physical power required to run the city
M	Memory	Historical Weight / Trauma	L5 → L4	Systemic brake from past shocks
D	Data	Information / Telemetry	L2 → L3	Raw observations becoming "City Facts"
C	Constraint	Regulatory Limit / Geometry	L3 → L1	Rules that shape physical form
I	Intent	Goal / Bias / Will	L6 → L4	Motivation and optimization targets
V	Validation	Truth / Confidence	L0/L1 → L4	Reality checks against predictions
R	Reasoning	Intelligence-as-Infrastructure	L4 → L2	Brain-to-body connection for robots

The Eleven Clusters

Structural Clusters (7)

1. **Metabolic Cluster (L0):** Bedrock, Water Tables, Solar Potential, Material Reservoirs
2. **Identity Cluster (L1):** Parcels, Building Footprints, Stable IDs, Rights-of-Way
3. **Nervous System Cluster (L2):** IoT Sensors, Actuators, Robots, Drones, Edge Nodes
4. **Logic Cluster (L3):** Zoning Codes, Constraint Objects, Void Markers, Knowledge Graphs
5. **Agency Cluster (L4):** 5 Core Agents, Consensus Artifacts, Probability Cones
6. **Memory Cluster (L5):** Stakeholders, Social Friction Index, Historical Shocks
7. **Governance Cluster (L6):** Regimes, Jurisdictions, Policy-as-Code

Thematic Clusters (4)

8. **Risk & Resilience:** L0 Hydrography + L3 Zoning + L5 Fear + L4 Climate Agent
9. **Capital & Value:** L1 Parcels + L4 Market Agent + L5 Economic Memory + L3 Entitlements
10. **Synthetic Labor:** L2 Robots + L3 Voids + L4 Infra Agent + L5 Displacement Risk
11. **Metabolic Flow:** L0 Energy + L2 Actuators + L1 Infrastructure + L4 Infra Agent

---

Part III: Technical Architecture

Tech Stack

Layer	Technology	Purpose
Framework	React 18 + Vite	Fast builds, modern DX
3D Engine	Three.js via React Three Fiber	Industry-standard WebGL
3D Helpers	@react-three/drei	Camera controls, HTML overlays
State	Zustand	Lightweight reactive state
Animation	Framer Motion	UI transitions
Styling	Tailwind CSS	Glassmorphism, responsive
Deployment	Railway	One-click from GitHub

Project Structure

```
atlas-urban-intelligence/
├── public/
├── src/
│   ├── components/
│   │   ├── LandingPage.jsx      # Entry with "Enter the Atlas" button
│   │   ├── AtlasScene.jsx       # Main 3D container + UI overlays
│   │   ├── GraphCanvas.jsx      # Force-directed 3D graph rendering
│   │   ├── LegendPanel.jsx      # Layer + edge type toggles
│   │   └── NodeDetailPanel.jsx  # Glass panel for node info
│   ├── data/
│   │   ├── nodes.json           # 55 nodes with metadata
│   │   └── edges.json           # 72 edges with relationships
│   ├── stores/
│   │   └── graphStore.js        # Zustand state management
│   ├── styles/
│   │   └── globals.css          # Tailwind + custom styles
│   ├── App.jsx                  # View switching
│   └── main.jsx                 # Entry point
├── index.html
├── package.json
└── vite.config.js
```

```
├── tailwind.config.js
├── postcss.config.js
├── railway.json              # Deployment config
├── README.md
├── LICENSE
└── .gitignore
```

Data Schema

Node Schema

json

```
{
  "id": "l0-bedrock",
  "label": "Bedrock",
  "layer": 0,
  "layerName": "Bio-Physical Foundation",
  "color": "#2E2F2C",
  "nodeType": "Geological",
  "clusters": ["structural-L0", "metabolic-flow"],
  "description": "The lithospheric substrate upon which all urban form rests..."
}
```

Edge Schema

json

```
{
  "id": "e-001",
  "source": "l0-energy-grid",
  "target": "l2-iot-sensors",
  "edgeType": "E",
  "edgeTypeName": "Energy",
  "isPrimary": true,
  "direction": "L0 → L2",
  "description": "Electrical power flows from the grid to distributed sensors..."
}
```

State Management

javascript

```
// graphStore.js
{
  currentView: 'landing' | 'atlas',
  selectedNode: null | NodeObject,
  hoveredNode: null | NodeObject,
  hoveredEdge: null | EdgeObject,
  activeEdgeType: null | 'E' | 'M' | 'D' | 'C' | 'I' | 'V' | 'R',
  visibleLayers: { 0: true, 1: true, 2: true, 3: true, 4: true, 5: true, 6: true }
}
```

Part IV: Claude Code Reference

Skills Required

When working on this project, Claude should read these skill files:

```
/mnt/skills/public/frontend-design/SKILL.md    # For UI/UX work
/mnt/skills/examples/web-artifacts-builder/SKILL.md  # For React artifacts
```

Key Commands

Development

bash

```
# Install dependencies
npm install

# Start development server
npm run dev

# Build for production
npm run build

# Preview production build
npm run preview
```

Deployment

bash

```
# Initialize git
git init
git add .
git commit -m "Initial commit"

# Push to GitHub
git remote add origin https://github.com/USERNAME/atlas-urban-intelligence.git
git branch -M main
git push -u origin main

# Railway auto-deploys from main branch
```

Levers and Triggers

Adding New Nodes

1. Edit `src/data/nodes.json`
2. Add node object with required fields: id, label, layer, layerName, color, nodeType, clusters, description
3. Rebuild/redeploy

Adding New Edges

1. Edit `src/data/edges.json`
2. Add edge object with required fields: id, source, target, edgeType, edgeTypeName, isPrimary, direction, description
3. Ensure source and target IDs exist in nodes.json
4. Rebuild/redeploy

Adjusting Visual Parameters

Parameter	File	Location
Layer colors	`tailwind.config.js`	`theme.extend.colors`
Node size	`GraphCanvas.jsx`	`size` calculation in node map
Edge opacity	`GraphCanvas.jsx`	`opacity` variable in Edge component
Force layout	`GraphCanvas.jsx`	`calculatePositions()` function
Glass panel styling	`globals.css`	`.glass-panel` class

Changing Layout Algorithm

The force-directed layout is in `GraphCanvas.jsx` → `calculatePositions()`. Key parameters:

```javascript
const layerHeight = 20      // Vertical spacing between layers
const radius = 25           // Base radius for circular arrangement
const iterations = 50       // Force simulation iterations
const repulsionThreshold = 15  // Minimum distance between nodes
const attractionThreshold = 30 // Ideal edge length
```

Common Modifications

Add a new edge type

1. Add to `edges.json` → `edgeTypes` object
2. Add to `LegendPanel.jsx` → `EDGE_TYPES` array
3. Add color to edge type if needed

Change node sizing logic

```javascript
// In GraphCanvas.jsx
const size = 1.5 + Math.min(connections * 0.3, 3)
// Adjust 1.5 (base size), 0.3 (growth rate), 3 (max bonus)
```

Adjust pulse animation speed

```javascript
// In GraphCanvas.jsx → Edge component → useFrame
setPulseProgress(prev => Math.min(prev + delta * 0.5, 1))
// Adjust 0.5 to change speed (higher = faster)
```

Part V: Original Source Document

The Atlas for Urban Intelligence: Comprehensive Layers

From Parcel to Planet: Atlas for Urban Intelligence

Abstract

"The Atlas for Urban Intelligence" is a new representational medium designed to describe the city not merely as a collection of assets, but as a vertical ecology of matter, data, and intelligence. Unlike traditional digital twins that visualize static conditions, the Atlas is a recursive, seven-layer epistemic stack that transforms real urban data into explainable feasibility intelligence.

At its foundation lies the "Identity Spine" (Layer 1), a "System of Record" that anchors every unique parcel and building to the "Planetary Metabolism" (Layer 0) of bedrock and energy limits. This physical reality supports a "Technical Nervous System" (Layer 2) and a computable "Logic Layer" (Layer 3) that translates raw zoning text into binding constraint objects.

The core engine of the Atlas is the "Agentic Inference Council" (Layer 4), where synthetic agents, representing Market, Policy, and Community interests, debate plural urban futures rather than optimizing for a single output. These debates are informed by "Socio-Economic Memory" (Layer 5), which weighs "Social Friction" and historical shocks against future density acceptance.

By toggling between "Directed" and "Contested" governance models (Layer 6), the Atlas operates as a "Geopolitical Operating System". It explicitly exposes the spatial friction of the "Three Cs": Contest, Coexist, and Converge—allowing policymakers to stress-test how systemic shocks propagate through divergent regime types. It is a medium for negotiating the metabolic and political survival of the built environment.

In this phase, the **Atlas for Urban Intelligence** acts as a **structural map of knowledge** rather than a live simulator. It visualizes the *ontology*, the complex web of relationships between urban concepts—so users can understand the hidden connections between a "Bedrock" node and a "Zoning Policy" node.

Phase 01: The Epistemic Atlas (Interactive 3D Knowledge Graph)

Description:

Phase 01 is a strictly visual, interactive 3D web interface representing the **Atlas for Urban Intelligence** as a **Co-occurrence Network**. It displays the seven-layer epistemic stack as a force-directed graph where nodes are concepts (e.g., "Parcel," "Social Friction," "Market Agent") and edges are the semantic relationships between them (E, M, D, C, I, V, R).

Goal: To render the "skeleton" of the urban system. It allows users to fly through the layers of the city to see how physical matter (L0) is structurally bound to legal constraints (L3) and social memory (L5). The system does not calculate live data; instead, it reveals the **dependency architecture** of the city.

User Experience:

- **Visual Structure:** A vertical "spine" of nodes where color indicates the Layer (0–6).
- **Interactivity:** Clicking a node (e.g., "Constraint Object") highlights its specific "Ecosystem of Influence"—lighting up every node it governs (e.g., "Parcel") and every node that informs it (e.g., "Policy Agent").

- **Edge Visualization:** Edges are rendered as static, colored lines representing the *type* of relationship (Energy, Memory, Constraint, etc.), allowing users to filter the graph (e.g., "Show me only 'Memory' connections").

Layer Definitions

Layer 6: Governance, Rights, and Policy (The "Who")

- **Functional Scope:** This layer defines enforceable authority, jurisdictions, and the operating rulebook for the city.
- **Regime Type Attribute:** Distinguishes between **Contested** (prioritizing litigation and pluralist friction) and **Directed** (prioritizing state-led scaling and metabolic efficiency) governance models.
- **Historical Integration:** Models "Legacy Governance" to track how firewalled societies create divergent urban equilibria over time.
- **Core Systems:** Neo-Governance, International Organizations, Jurisdictions, and Tort Law.
- **Function:** Enforces **Policy-as-Code**, managing permissions for both humans and agents.

Layer 5: Socio-Economic and Human Memory (The "People")

- **Functional Scope:** Maps demand, equity, labor, and market feasibility drivers.
- **Stakes & Distribution:** Foregrounding "Who Benefits / Who Bears Costs" through explicit stakeholder nodes (e.g., community caregivers vs. logistics corporations).
- **Psychographic Logic:** Houses the **Fear/Preparation Index** (Social Friction Index), which uses historical shocks like market crashes or displacement events to modulate present density acceptance.
- **Core Systems:** Demography, Market Potential, Income Distribution, and Sociological Memory.
- **Function:** Houses the **Fear/Preparation Index**, modeling how historical shocks (bubbles, layoffs) create current social friction.

Layer 4: Agentic Intelligence Overlay (The "Inference Council")

- **Functional Scope:** A multi-agent council (Market, Policy, Climate, Infra, Community) that debates plural urban futures rather than seeking a single "optimized" answer.
- **Reasoning Bridge (R):** Provides the cognitive infrastructure for Layer 2 actors, enabling physical systems to navigate complex social and legal environments.
- **Spatial Logic:** Disagreements between agents are visualized spatially to reveal "Scenario Fields" and probability cones.
- **Core Systems:** Multi-Agent Coordination, LLMs, and Task Executors.
- **Function:** Five core agents (Market, Policy, Climate, Infra, Community) debate competing urban futures.

Layer 3: Logic, Processing, and Knowledge (The "Meaning")

- **Functional Scope:** Translates unreadable text and laws into computable "Constraint Objects" (e.g., FAR, setbacks, and height limits).
- **Constraint Resolution:** Operates as a "Zoning Graph" where metrics are clickable, auditable, and bound to physical parcels.
- **Regulatory Voids:** Identifies "Structural Gaps" where emerging synthetic occupancy (e.g., high-density battery storage or autonomous flows) currently lacks established code protocols.
- **Core Systems:** Knowledge Graphs, Computable Constraints, and Entity Resolution.
- **Function:** Translates raw data and PDF codes into a **Golden Record** of "City Facts".

Layer 2: Technical and Cyber-Physical (The "Nervous System")

- **Functional Scope:** The city's sensory network, including IoT actuators, telecommunications, and robotic channels for Embodied AI.
- **Embodied Action:** Enables urban service robots and actuators to move through and respond to the physical environment in real-time.
- **Latency & Lineage:** Tracks every technical shift and sensor event with a timestamp and audit trail for historical verification.
- **Core Systems:** IoT Sensors, Urban Actuators, and Telecommunications.
- **Function:** Enables **Embodied AI** (robots, drones) to sense and move through the city.

Layer 1: Observable Reality and Built Environment (The "Hardware")

- **Functional Scope:** The "Place Graph" backbone consisting of parcels, building footprints, and infrastructure.
- **Identity Spine:** Enforces stable IDs across every asset, ensuring all other layers "snap" to the same physical world coordinate.
- **The 3Cs Spatial Mode:** Classifies nodes based on their human-synthetic interaction typology: **Contest** (friction), **Coexist** (negotiation), or **Converge** (integration).
- **Core Systems:** Parcels, Building Footprints, Infrastructure, and Transit Networks.
- **Function:** Provides the **Identity Spine** (Place Graph) where every asset has a Stable ID.

Layer 0: Bio-Physical Foundation and Metabolism (The "Earth")

- **Functional Scope:** Models the planetary conditions making urbanization possible: bedrock, hydrography, and material reservoirs (sand, steel, timber).
- **Geospatial Substrate:** Integrates soil chemistry and energy circulation into a shared coordinate truth.

- **Evolutionary Logic:** Uses historical flood depths and climate cycles to establish the "Baseline City" constraints before any form is proposed.
- **Core Systems:** Geology, Hydrography, Energy Potentials, and Material Reservoirs.
- **Function:** Tracks the **Planetary Boundaries** and "Material Metabolism" (carbon, soil, water).

Edge Type Definitions

1. Energy (E)

- **Currency:** Metabolic Load / Joules
- **Direction:** L0 (Grid/Earth) ↔ L2 (Embodied AI)
- **Function:** Represents the physical power required to run the city. It flows from the grid to the robot/sensor. If a robot fleet (L2) scales up, the Energy edge thickens, potentially overloading the L0 node.

2. Memory (M)

- **Currency:** Historical Weight / Trauma
- **Direction:** L5 (Past Events) → L4 (Agentic Logic)
- **Function:** This is the "Systemic Brake." It carries the weight of past shocks (e.g., "2008 Crash"). If the Memory edge is heavy (High Fear), it forces the Agents to reject risky growth scenarios.

3. Data (D)

- **Currency:** Information / Telemetry
- **Direction:** L2 (Sensing) → L3 (Logic)
- **Function:** Raw observations (e.g., "lidar point cloud") flowing up to be translated into "City Facts" (e.g., "There is a wall here").

4. Constraint (C)

- **Currency:** Regulatory Limit / Geometry
- **Direction:** L3 (Law) → L1 (Physical Form)
- **Function:** The "Shape Maker." This edge transmits the rules (FAR, Setbacks) that physically mold the massing of buildings and parcels.

5. Intent (I)

- **Currency:** Goal / Bias / Will

- **Direction:** L6 (Policy) → L4 (Agentic Council)
- **Function:** Represents the "Motivation." It tells the agents what to optimize for (e.g., "Maximize Profit" or "Maximize Equity"). It is the driver of action.

6. Validation (V)

- **Currency:** Truth / Confidence
- **Direction:** L0/L1 (Reality) → L4 (Agent Prediction)
- **Function:** The "Reality Check." It compares the Agent's prediction against the actual sensor readings. If they don't match, the agent's confidence score drops.

7. Reasoning (R)

- **Currency:** Intelligence-as-Infrastructure
- **Direction:** L4 (Agentic Council) → L2 (Embodied AI)
- **Function:** The "Brain-to-Body" connection. Physical robots (L2) subscribe to this edge to access the high-level ethical and navigational logic of the Council (L4). Without this edge, robots are just dumb hardware.

Node Connectivity Map

Layer 0: Bio-Physical Foundation (The Earth)

1. Geological & Hydrographic Nodes

- → Connects To: L1 Parcels (via C Constraint), L4 Agents (via V Validation)
- ← Connects From: L0 Evolutionary Logic (via M Memory)

2. Atmospheric/Energy Nodes

- → Connects To: L2 Compute/Robots (via E Energy), L4 Climate Agent (via V Validation)
- ← Connects From: Planetary Systems (via E Energy)

Layer 1: Observable Reality (The Identity Spine)

3. Land Assets (Parcels)

- → Connects To: L4 Agents (via V Validation), L5 Stakeholders (via D Data)
- ← Connects From: L3 Zoning (via C Constraint)

4. Mobility Assets & Spatial Modes

- → Connects To: L2 Embodied AI (via C Constraint), L4 Infrastructure Agent (via V Validation)
- ← Connects From: L1 Parcels (via D Data)

Layer 2: Technical & Cyber-Physical (The Nervous System)

5. Embodied AI Nodes (Robots/Drones)

- → Connects To: L1 Physical Space (via I Intent), L5 Stakeholders (via M Memory)
- ← Connects From: L4 Agentic Council (via R Reasoning), L0 Grid (via E Energy)

6. Sensing Nodes

- → Connects To: L3 Logic (via D Data), L4 Agents (via V Validation)
- ← Connects From: L1 Built Environment (via C Host)

Layer 3: Logic & Informational (The Meaning)

7. Constraint Nodes (Zoning/Code)

- → Connects To: L1 Parcels (via C Constraint)
- ← Connects From: L6 Policy (via I Intent), L2 Sensors (via D Data)

8. Structural Gap Nodes (Voids)

- → Connects To: L4 Agents (via M Memory), L6 Governance (via V Validation)
- ← Connects From: L3 Constraints (via C Absence/Failure)

Layer 4: Agentic Intelligence (The Council)

9. The 5 Core Agents

- → Connects To: L2 Embodied AI (via R Reasoning), L3 Logic (via I Intent), L6 Governance (via D Data)
- ← Connects From: L5 Memory (via M Memory), L0/L1 (via V Validation)

Layer 5: Socio-Economic (Memory)

10. Psychographic & Stakeholder Nodes

- → Connects To: L4 Agents (via M Memory), L6 Governance (via I Intent)
- ← Connects From: L1 Assets (via D Data), L2 Embodied AI (via I Intent)

Layer 6: Governance (The Who)

11. Regime & Policy Nodes

- → Connects To: L4 Agents (via I Intent), L3 Constraints (via I Intent)
- ← Connects From: L5 Stakeholders (via I Intent), L4 Agents (via V Validation)

Part VI: Future Phases

Phase 02: Simulation Engine

- Real urban data integration (parcel databases, zoning APIs)
- Agent deliberation with actual LLM reasoning
- Time-series simulation of shock propagation
- Scenario comparison tools

Phase 03: Collaborative Platform

- Multi-user exploration
- Annotation and commenting
- Export to planning documents
- Integration with GIS tools

Part VII: Deployment Reference

Railway Configuration

File: railway.json

```
json
```

```
{
  "$schema": "https://railway.app/railway.schema.json",
  "build": {
    "builder": "NIXPACKS",
    "buildCommand": "npm install && npm run build"
  },
  "deploy": {
    "startCommand": "npx serve dist -s -l ${PORT:-3000}",
    "restartPolicyType": "ON_FAILURE",
    "restartPolicyMaxRetries": 10
  }
}
```

Environment

- **Node.js:** 18+
- **Build Output:** `dist/` directory
- **Server:** `serve` (static file server)
- **Port:** Dynamically assigned by Railway via `$PORT`

URLs

- **Production:** `atlas-for-urban-intelligence-production.up.railway.app`
- **QR Code Target:** Same as production URL

Part VIII: Ontology Statistics

Node Count by Layer

Layer	Count
L0: Bio-Physical	8
L1: Observable Reality	10
L2: Cyber-Physical	7
L3: Logic/Knowledge	9

Layer	Count
L4: Agentic Intelligence	7
L5: Socio-Economic	9
L6: Governance	8
Total	**55**

Edge Count by Type

Type	Count
E (Energy)	7
M (Memory)	12
D (Data)	13
C (Constraint)	12
I (Intent)	11
V (Validation)	10
R (Reasoning)	8
Total	**72**

Document generated: January 30, 2026
Atlas for Urban Intelligence v1.0