



Digital Twins of Digital Worlds: Agent-Based Modeling in Games and Beyond

Presenter: Jeff Wirtz



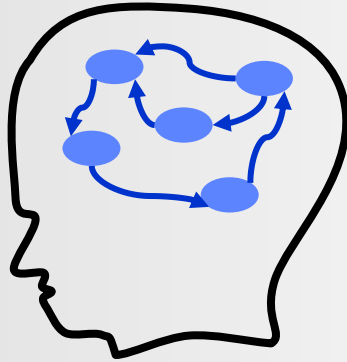
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Agenda

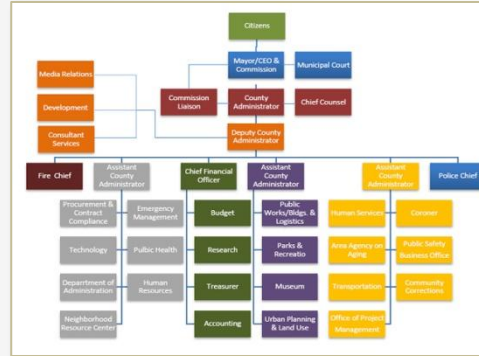
- **Welcome & Overview**
- **What Simulation Is & Why It Matters**
- **How AnyLogic Handles Complex Systems**
- **Case Study: Modeling the Corrupted Blood Pandemic**
- **Case Study: Modeling the Helldivers 2 Galactic War**
- **AnyLogic Ecosystem**
- **Questions & Discussion**

Types of Models

Mental models



Boxes connected with lines



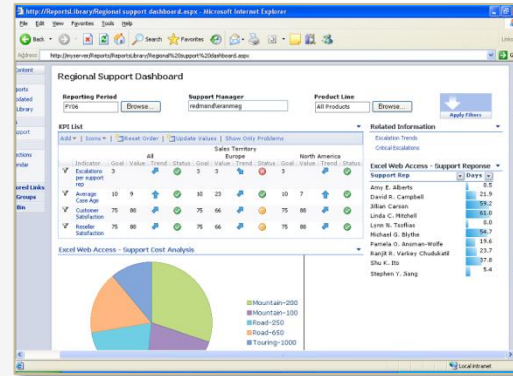
Physical models



Formulas on a sheet of paper

$$\begin{aligned} \vec{F} &= m \vec{a} \quad \vec{p} = m \vec{v} \quad KE = \frac{1}{2} m v^2 = \frac{p^2}{2m} \quad W_{\text{ext}} = \Delta(KE) = KE_f - KE_i \quad A_{\text{planar}} = 4\pi r^2 \\ \frac{R}{mv^2} &= k \frac{q_1 q_2}{r^2} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \quad \epsilon_0 = 8.85(10)^{-12} \frac{C^2}{Nm^2} \quad k = 8.99(10)^9 \frac{Nm^2}{C^2} \quad \epsilon_r = 8.85(10)^{-12} \frac{C^2}{Nm^2} \quad V_{\text{plate}} = \frac{4}{3}\pi r^3 \\ E &= \frac{F}{q} \quad E = k \frac{q}{r^2} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \quad V = k \frac{q}{r} = \frac{1}{4\pi\epsilon_0} \frac{q}{r} \quad V = \frac{U}{q} \quad \sim e^{-t/RC} \\ \sum E_{\perp} \Delta A &= \frac{q}{\epsilon_0} \quad Q = VC \quad C = \frac{A\epsilon_0}{d} \quad \alpha = \frac{Q}{A} \quad V = Ed \quad E = \frac{\sigma}{\epsilon_0} \quad \vec{U} = \frac{QV}{2} = \frac{CV^2}{2} = \frac{Q^2}{2C} \\ \sum I_j &= 0 \quad \sum V_j = 0 \quad V = IR \quad P = IV = I^2 R = \frac{V^2}{R} \quad R_{\text{eq}} = R_1 + R_2 \quad \frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} \\ F &= qvB_{\perp} = qv_{\perp} B = qvB \sin(\theta) \quad B = \frac{\mu_0 I}{2\pi r} \quad \mu_0 = 4\pi(10)^{-7} Tm/A \\ F &= ILB_{\perp} = I_{\perp} LB = ILB \sin(\theta) \quad \sum B_{\parallel} \Delta l = \mu_0 I_{\perp} \end{aligned}$$

Excel spreadsheets



Simulation models



What is Dynamic Simulation?

Dynamic Simulation is a **prospection** technique. It enables a business to see the impact of decisions before implementation while allowing for optimization of existing operations.

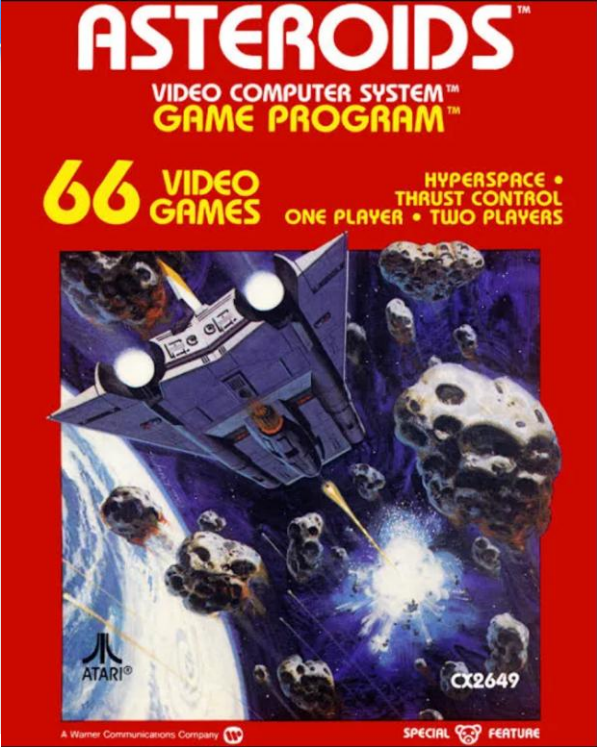


Real (or planned) System



Simulation Model

Another Type of Simulation



Two Game Worlds as Simulations

World of Warcraft: Virtual pandemic



Helldivers 2: Galactic War



World of Warcraft: the Corrupted Blood Plague Incident

- The 2005 *Corrupted Blood* incident unintentionally created a virtual disease outbreak that revealed realistic patterns of human behavior—panic movement, clustering, non-compliance, and voluntary risk-taking.
- Certain players learned they could summon a ‘disease’, that was designed for a specific boss fight, into highly populated areas



Simulating Stormwind City

- **City zones**

Stormwind is divided into key districts to reflect how players naturally move and gather. This structure creates realistic pathways and clustering points.

- **Pedestrian flow**

The Pedestrian Library models movement with pathfinding, collision avoidance, and density effects. This produces believable crowd patterns that influence how an infection spreads.

- **Agent behavior**

Agents follow individual goals and risk responses, such as exploring, gathering, or fleeing danger. Their combined actions create the emergent city-wide dynamics seen in the model.



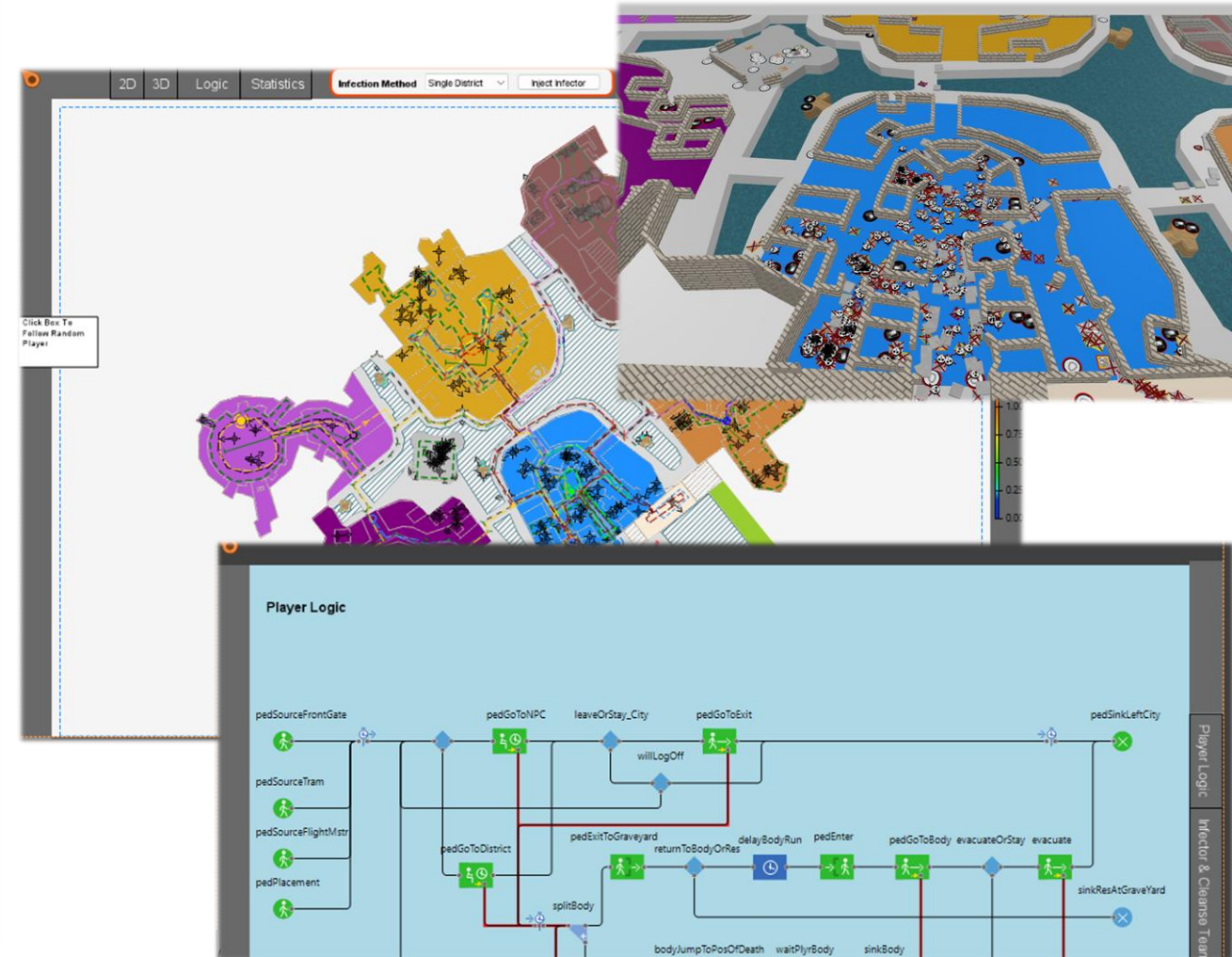
**Process
Modeling**



Pedestrian



**Agent
Modeling**



Simulating the Corrupted Blood Plague



Process
Modeling



Pedestrian



Agent
Modeling

- **SEIR states**

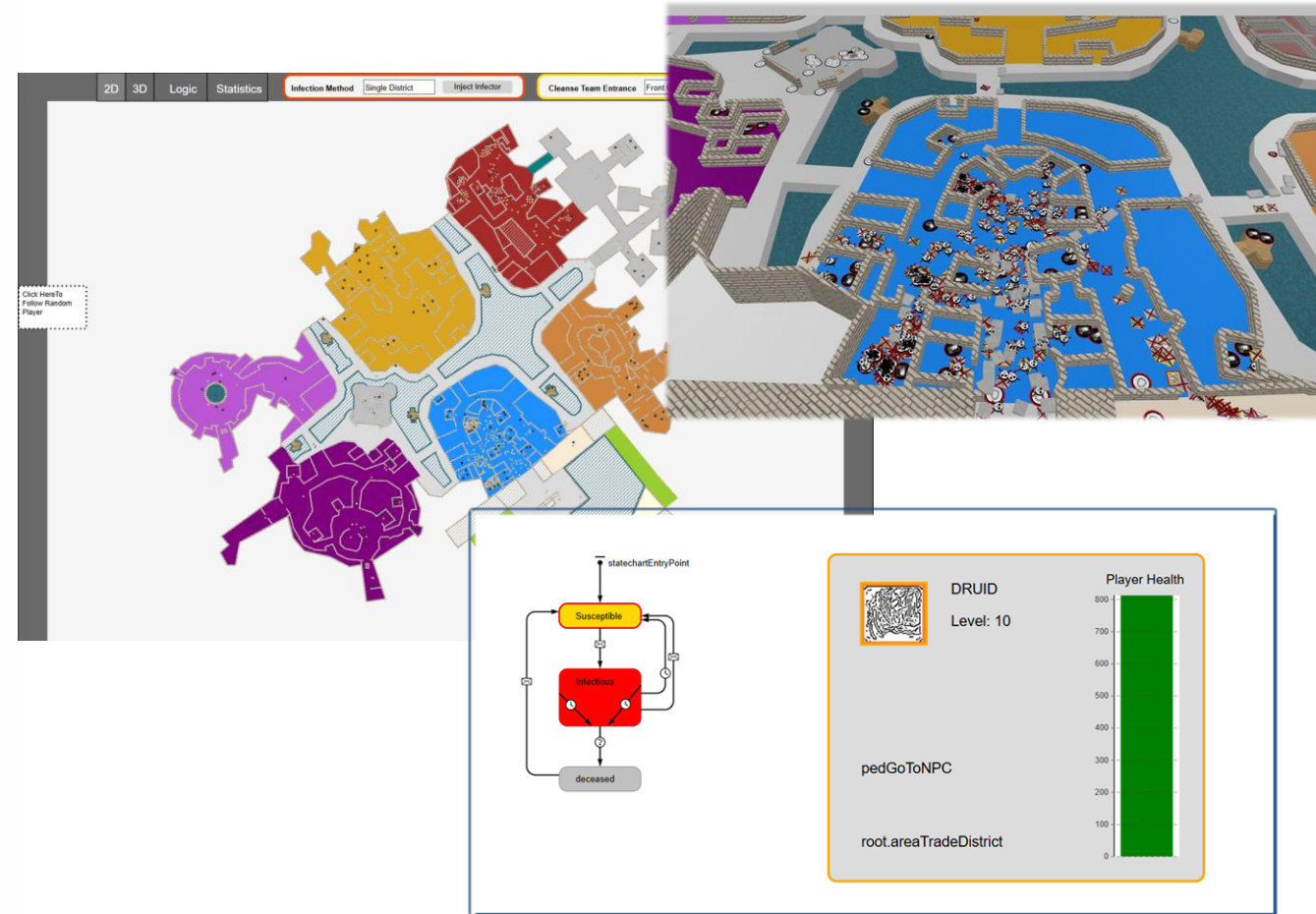
The model uses a standard SEIR structure to represent how agents progress from susceptible to exposed, infectious, and eventually recovered. This provides a clear and widely recognized framework for capturing the timing and dynamics of disease progression.

- **Contact-based spread**

Transmission occurs when agents come into close proximity within the pedestrian environment. This allows density, movement patterns, and crowd clustering to directly influence infection rates.

- **Asymptomatic carriers**

Some agents can transmit the infection without showing visible symptoms, similar to the original Corrupted Blood behavior. This adds uncertainty and supports more realistic early-stage spread.



Behavior Emergence

- **Fleeing from infected zones**

Agents dynamically reroute when infection becomes noticeable, avoiding high-risk areas. This behavior shifts crowd patterns and alters the overall shape of the outbreak.

- **Clustering and social grouping**

Players and NPCs naturally gather in key city hubs, creating high-density zones. These hotspots act as amplification points that accelerate transmission.

- **Intentional spread (griefing)**

Some agents intentionally move toward crowds while infected, modeling non-compliant or disruptive behavior. This adds variability and demonstrates how a small number of actors can significantly impact outbreak severity.



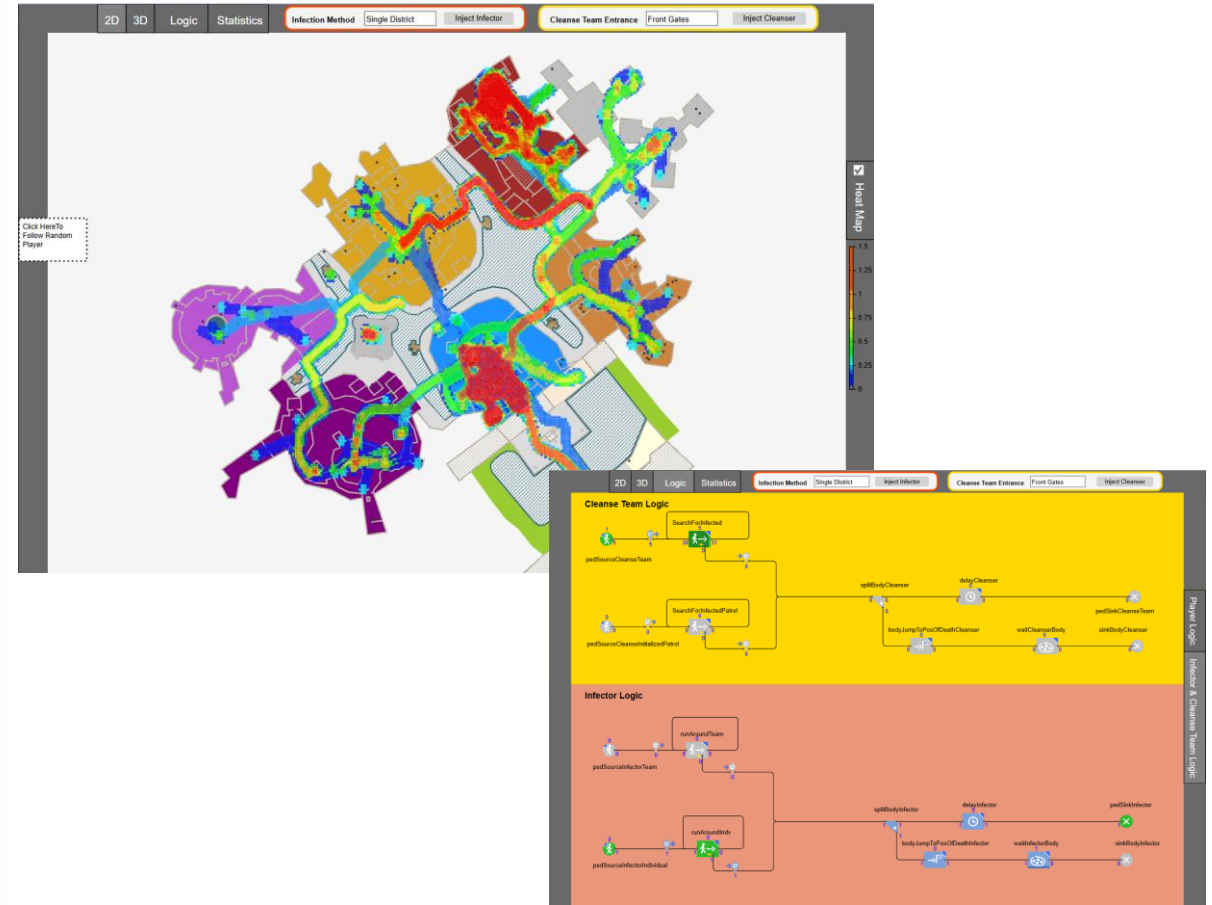
Process
Modeling



Pedestrian

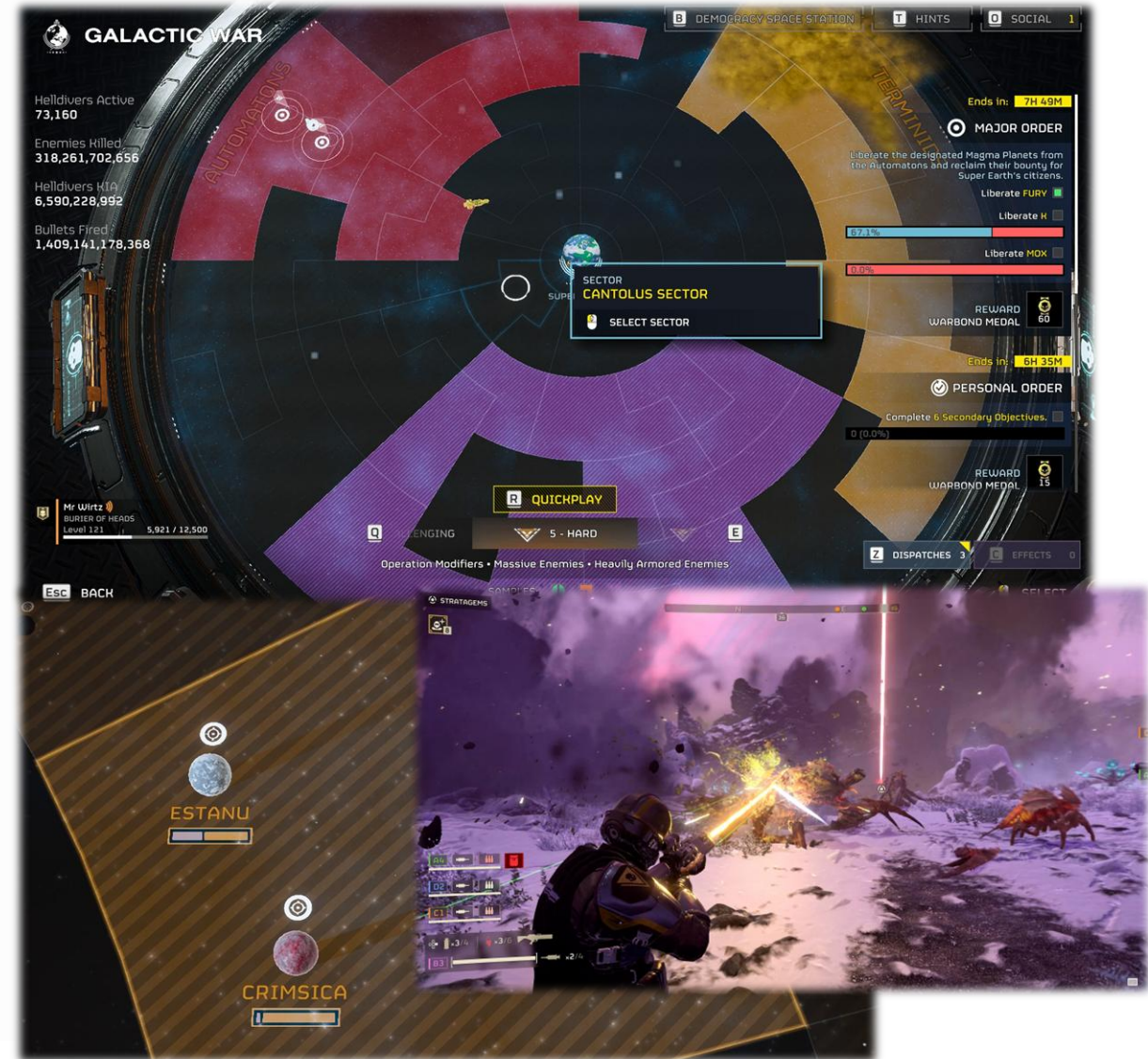


Agent
Modeling



Helldivers 2 – Fighting For Managed Democracy

- Helldivers 2 is a large-scale cooperative action game where millions of players contribute to a persistent, galaxy-wide war effort.
- Each mission completed by players influences the state of a dynamic strategic map, shifting the balance of power between factions across dozens of planets.
- The game's real-time, player-driven outcomes create a living system where frontlines evolve continuously, making it an ideal candidate for simulation and digital twin modeling.



Helldivers 2 – Forecasting Managed Democracy



Agent
Modeling



System
Dynamics



Planet Dynamics

- **Liberation progress**

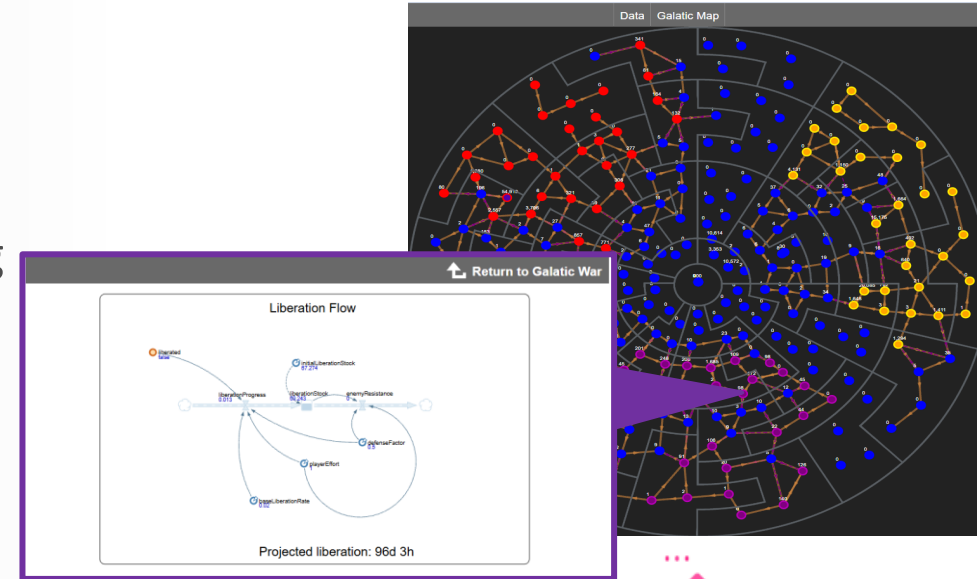
Each planet tracks its liberation as a continuous value that increases based on player activity. This provides a smooth, real-time view of how close a planet is to flipping factions.

- **Player impact**

The number of players on a planet directly influences how fast liberation advances. This captures the collective effect of player participation on strategic outcomes.

- **Ownership changes**

Once liberation reaches 100%, the planet automatically switches control. This event updates the galactic map and shifts players' attention to new targets.



Helldivers 2 – Forecasting Managed Democracy



Player Dynamics

- **Movement between planets**

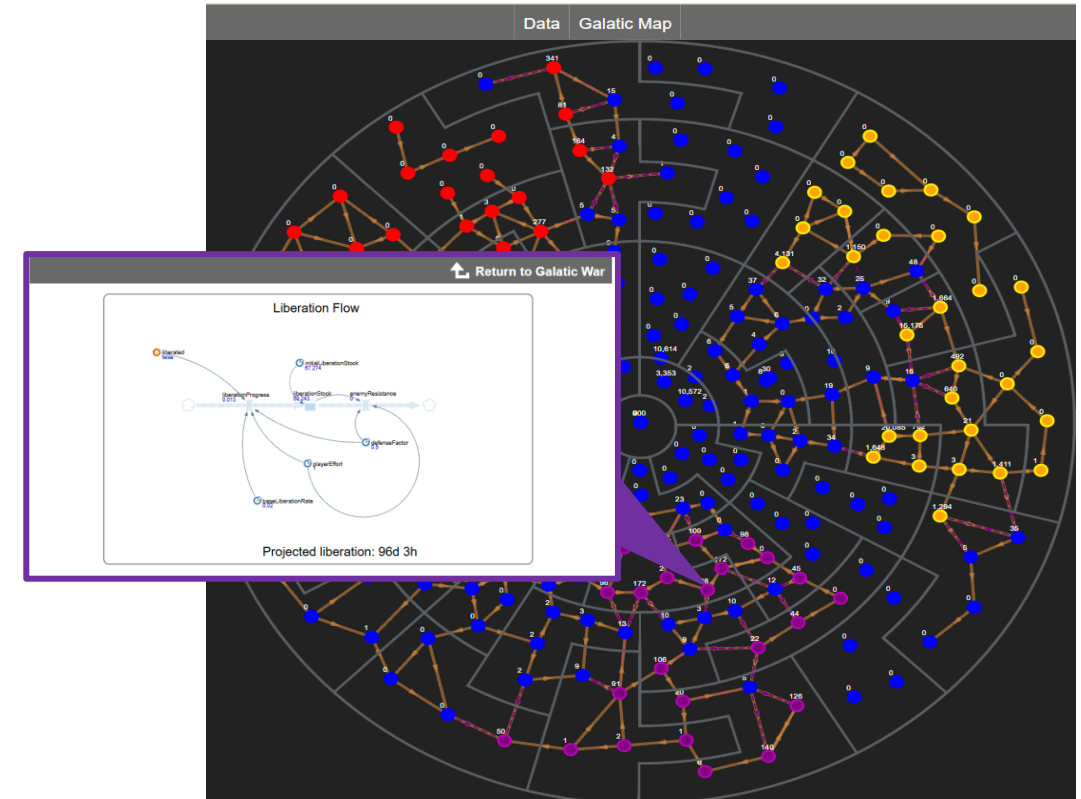
Players relocate based on war priorities, focusing on planets nearing liberation or under heavy pressure. This creates realistic surges in effort across the map.

- **Changing population levels**

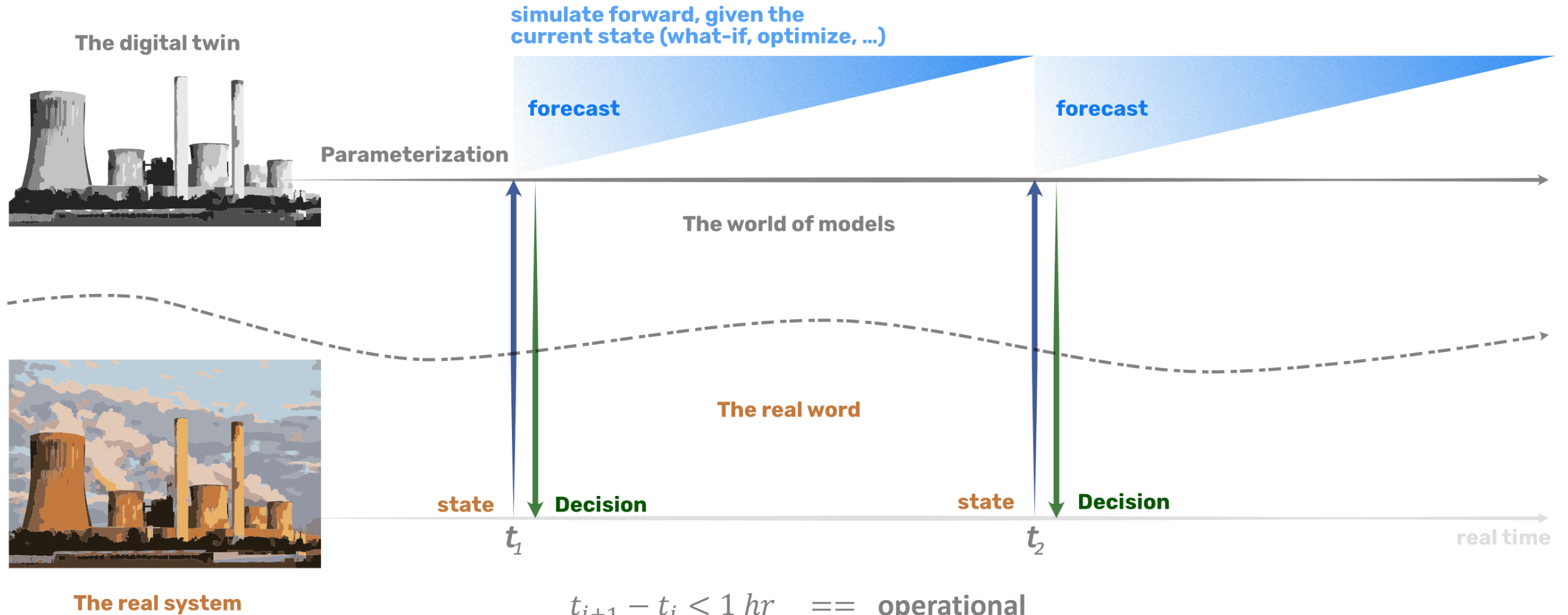
Player counts fluctuate throughout the day, and the model adjusts automatically using external data. This ensures the simulation reflects real-world player activity patterns.

- **Adaptive targeting**

Players naturally cluster on high-priority planets, accelerating key pushes. This emergent behavior helps the model replicate the evolving frontline of the galactic war.



Simulation-Based Digital Twin



$t_{i+1} - t_i < 1 \text{ hr} \implies \text{operational}$

$t_{i+1} - t_i > 1 \text{ day} \implies \text{tactical}$

Helldivers 2 – Data Integration

- **Open-source war data**

The model connects directly to publicly available Helldivers war data, provided through openly accessible JSON files. This ensures the simulation remains aligned with the live state of the galactic conflict without requiring proprietary APIs.

- **JSON-based state updates**

Planet status—such as health, ownership, and active attacks—is continuously refreshed by reading updated JSON files. This lightweight integration method allows the model to stay synchronized with the actual evolving war.

- **Player population trends**

Real-world player activity data, sourced from open platforms like SteamDB, is incorporated through external datasets. These trends drive how many player agents are active in the digital twin at any given time.

- **Digital Twin Data Flow**

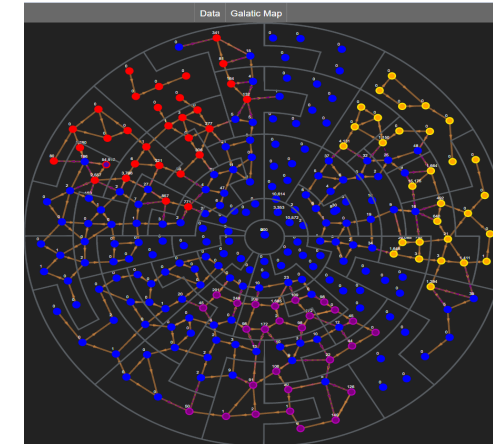
By combining static map data, live status updates, and real-world population signals, the model forms a complete digital twin pipeline. Each data stream feeds into the simulation engine, enabling accurate real-time behavior and forward projections of the galactic war.



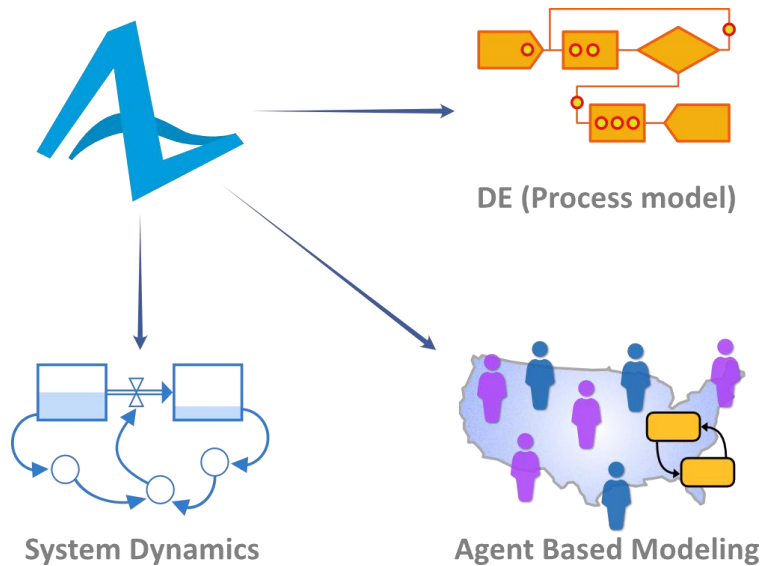
Agent
Modeling



System
Dynamics



AnyLogic Use Cases: Simulates Business and Practical Applications



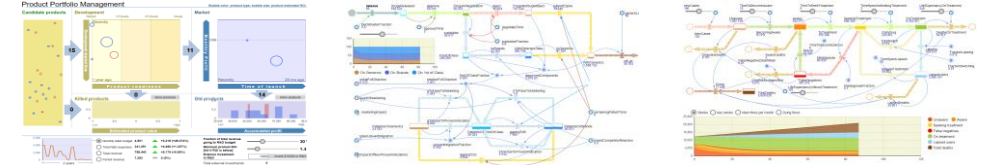
Supply Chains
Rail Logistics
Road Traffic
Asset Management
Manufacturing
Mining & Metals
Passenger Terminals
Marketing

Transportation
Oil & Gas
Healthcare
Social Processes
Warehouse Operations
Ports & Terminals
Business Processes
Defense



[Link to Case Studies](#)

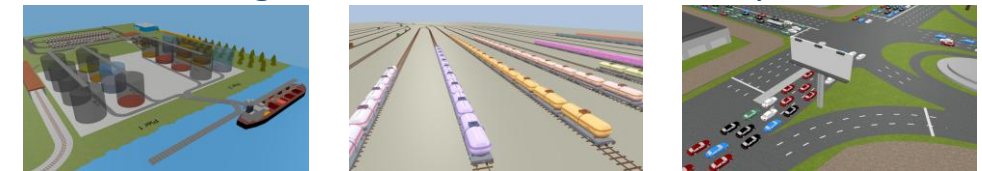
Strategic level: Market, Competition, Product portfolio, etc.



Larger scale: Supply Chains, GIS-based models...



Small scale logistics: Cars, Trucks, Trains, Pipelines, Tanks

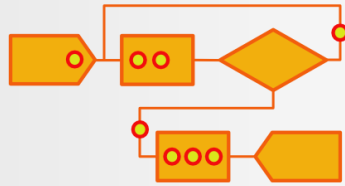


“Close to Physical” level: Material handling, Pedestrian

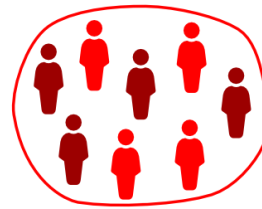


AnyLogic traditionally simulates “Business applications”

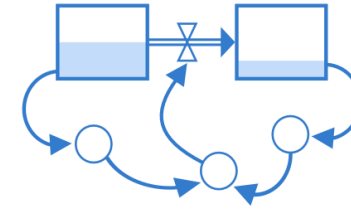
Multi-Method Modeling – Simulating Details & Complexities



DE (Process model)



Agents



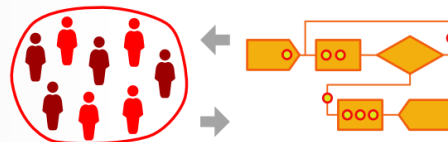
System Dynamics (SD)



Multi-Method Modeling



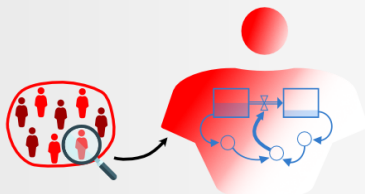
Agents + SD environment



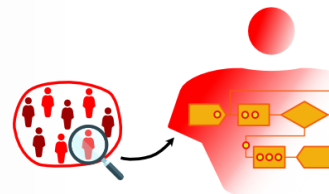
Agents + process model



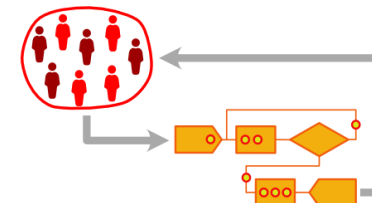
SD + process model



SD inside agent



Process model inside agent

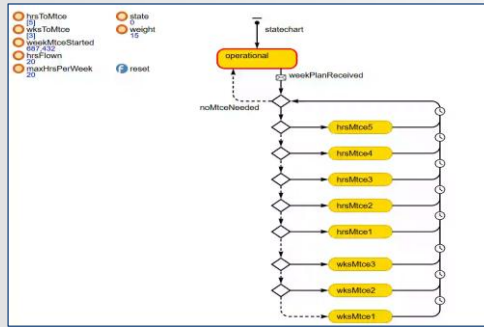


Agents become entities

AnyLogic – Industry Specific Libraries



**Agent
Modeling**



**Road
Traffic**



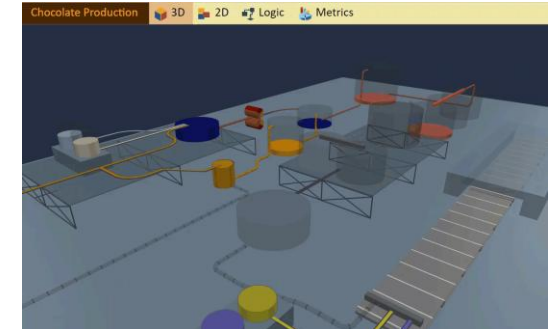
Pedestrian



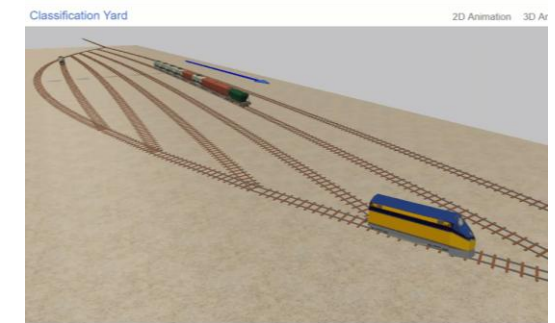
**Material
Handling**



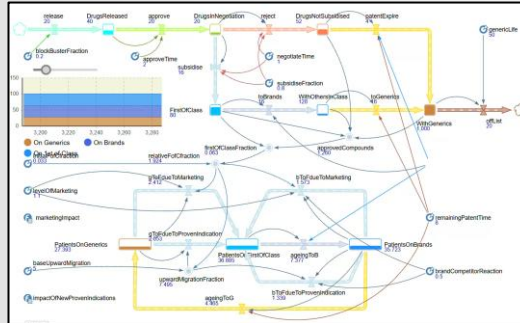
Fluid



Rail



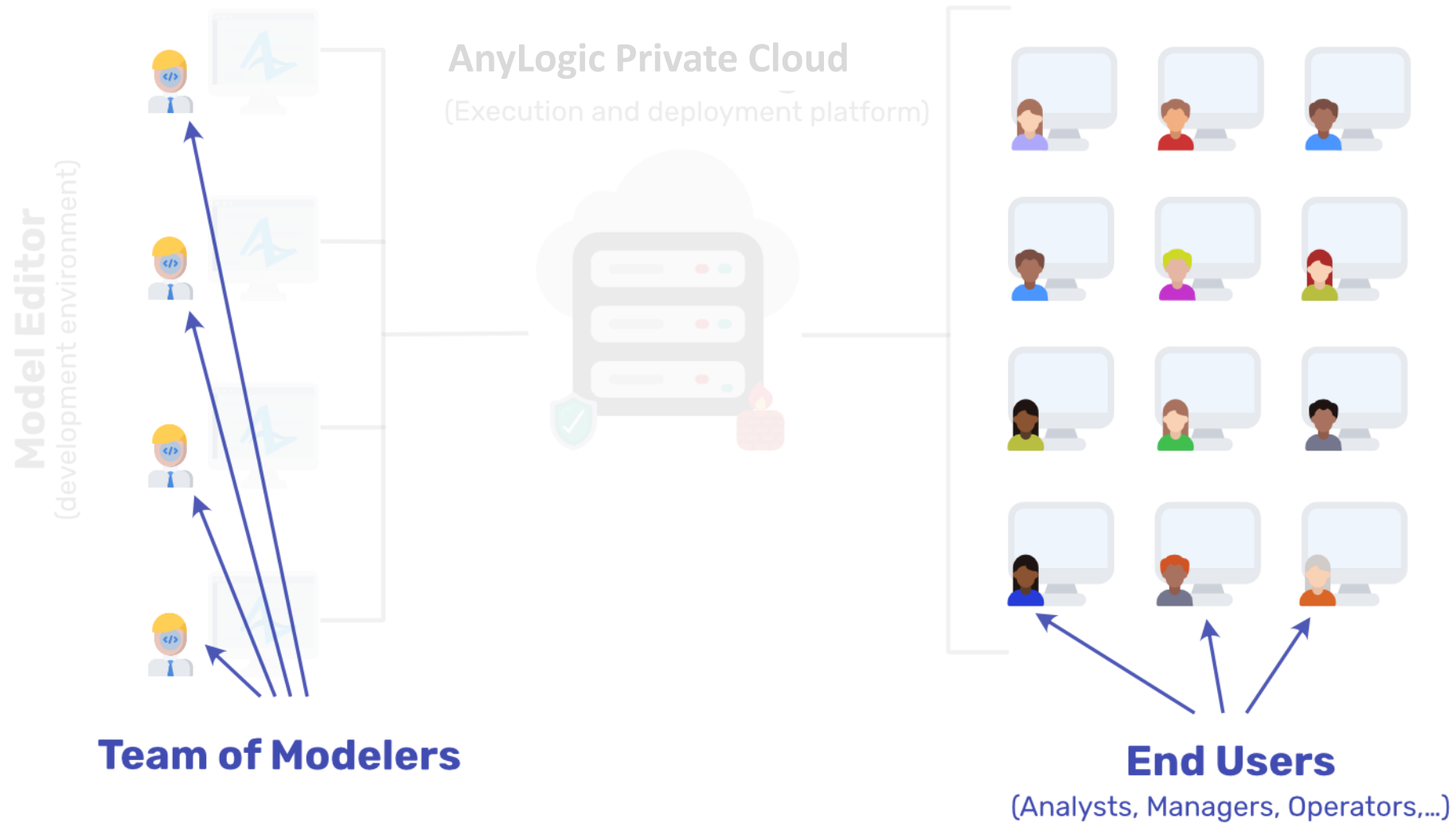
**System
Dynamics**



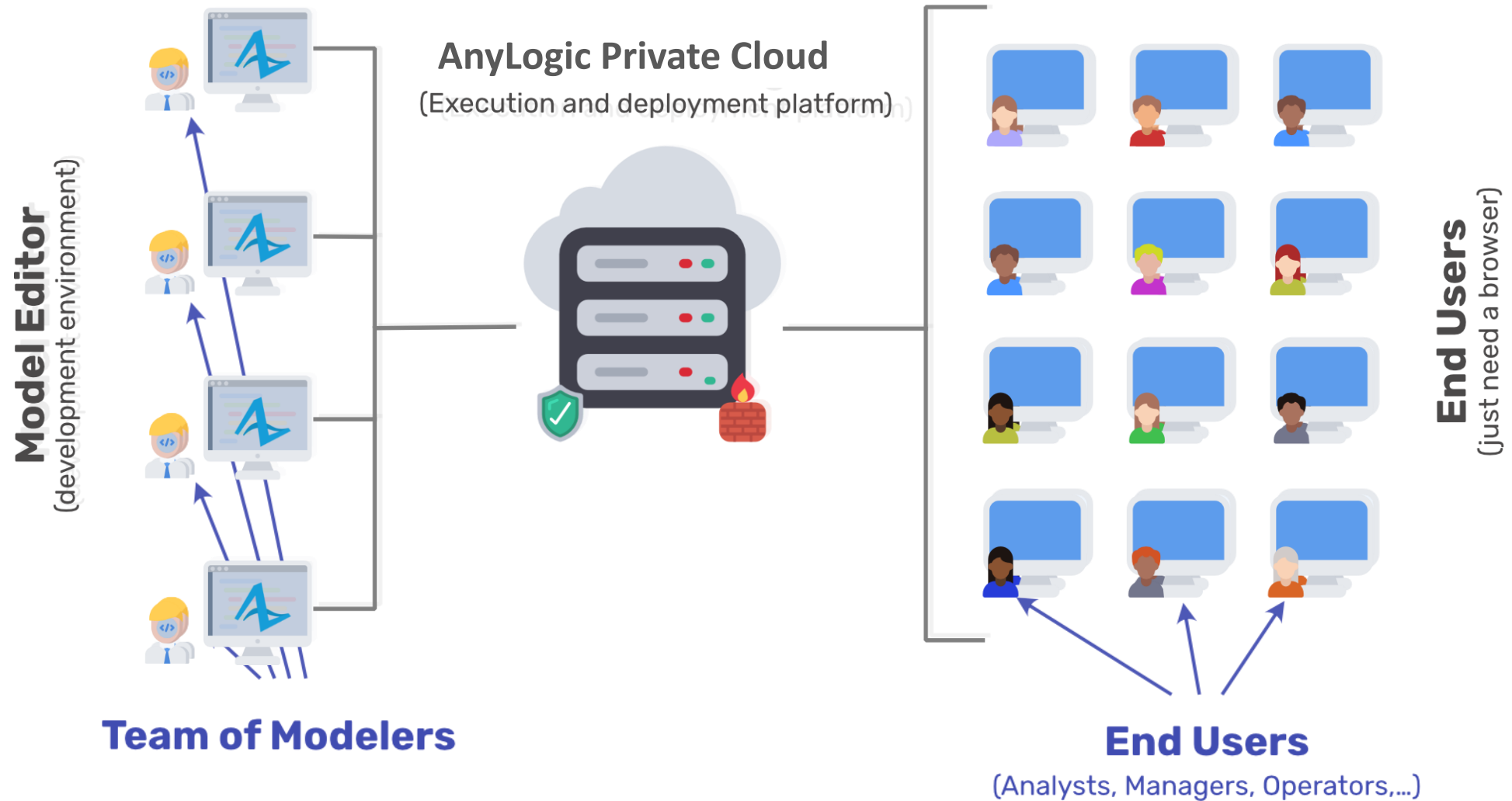
**Process
Modeling**



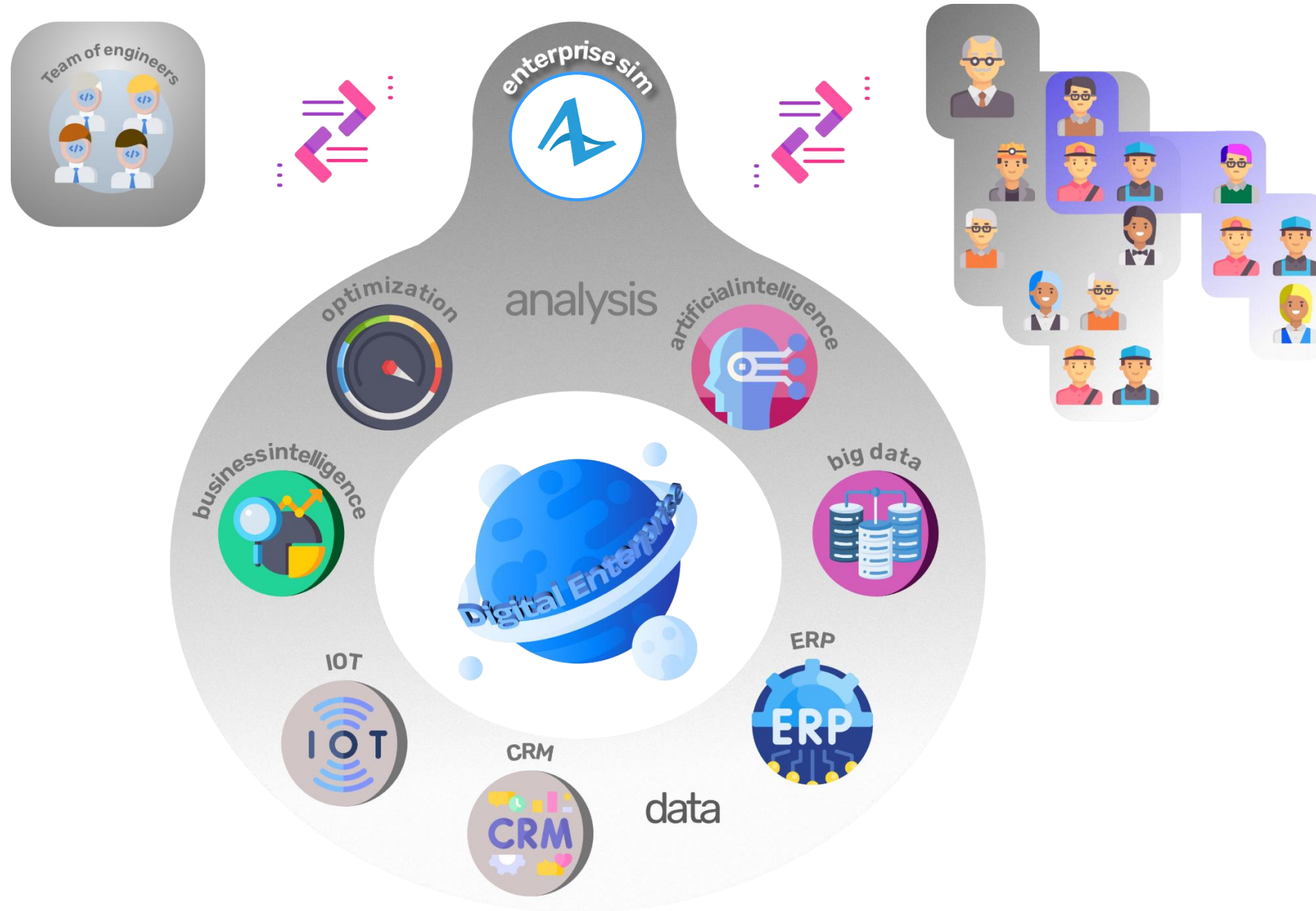
AnyLogic Ecosystem Overview



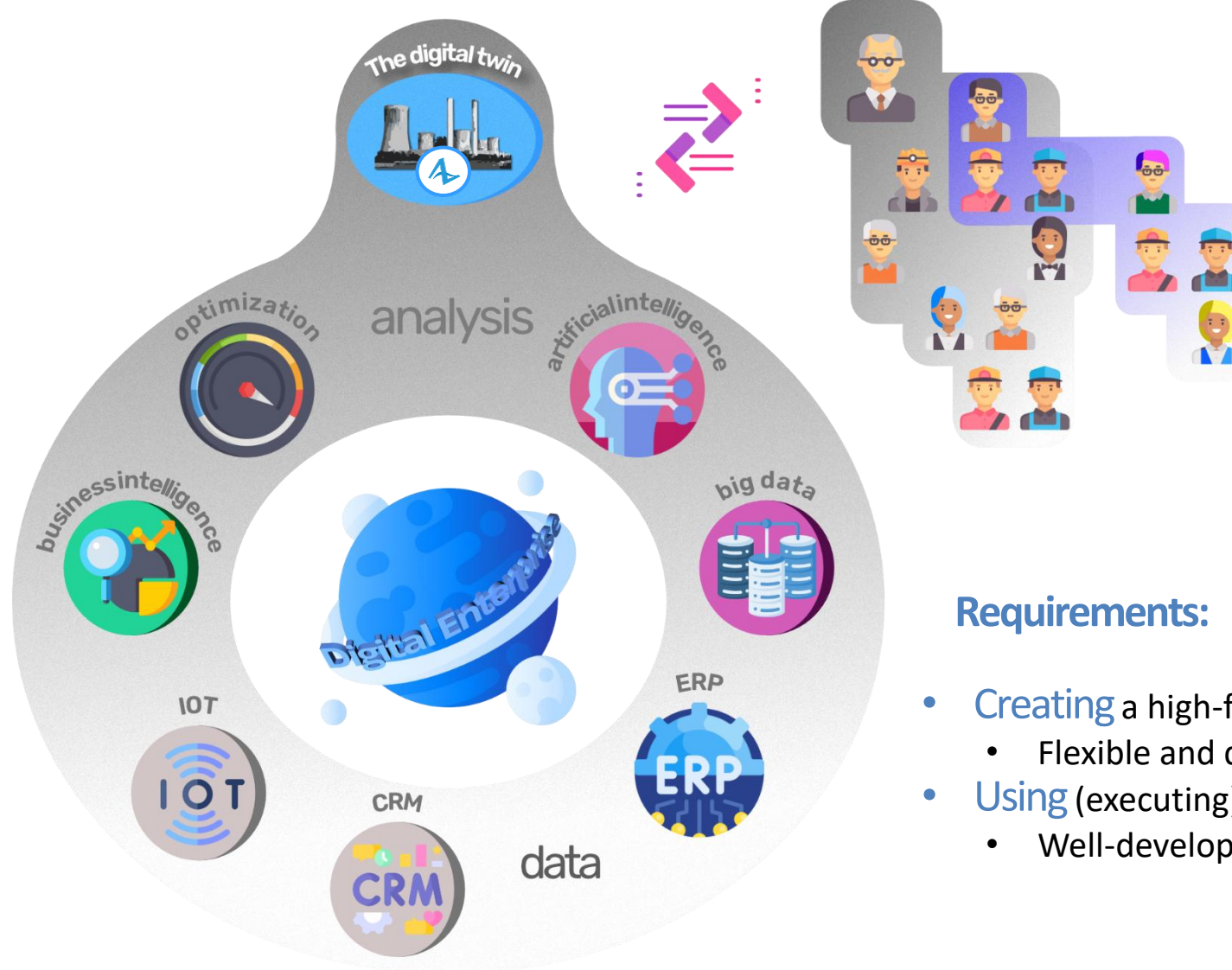
AnyLogic Ecosystem Overview



AnyLogic Ecosystem Overview



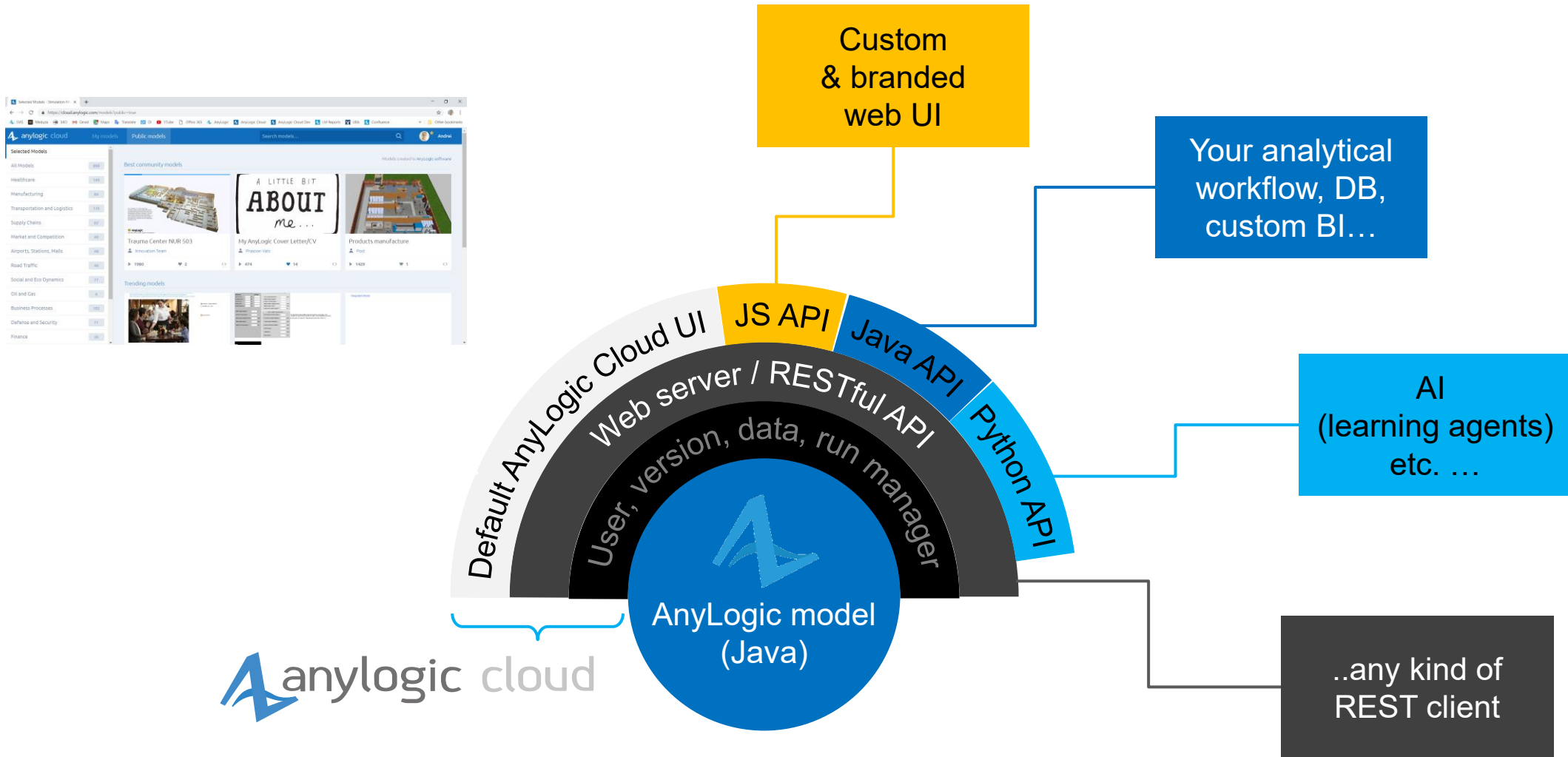
AnyLogic Ecosystem for Digital Twin



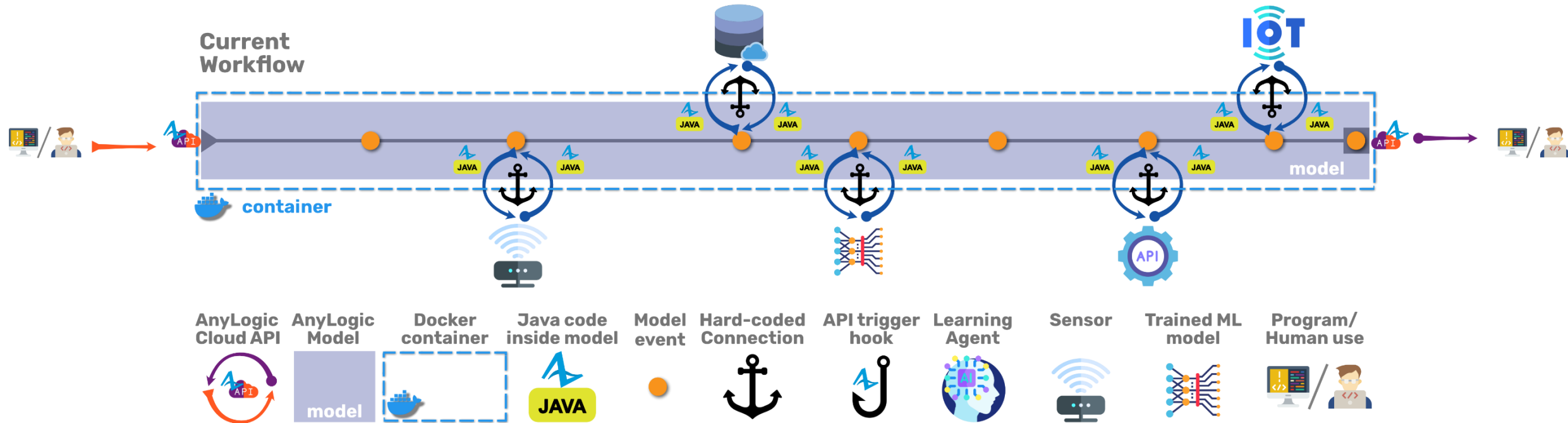
Requirements:

- **Creating** a high-fidelity simulation model
 - Flexible and deep parametrization
- **Using** (executing) the model on powerful servers
 - Well-developed data connectivity

AnyLogic Cloud is a Wrapper Around the Model Providing Multiple APIs



Model Manager API



Thank you!