



“A Scalable Co-simulation Framework for AnyLogic”

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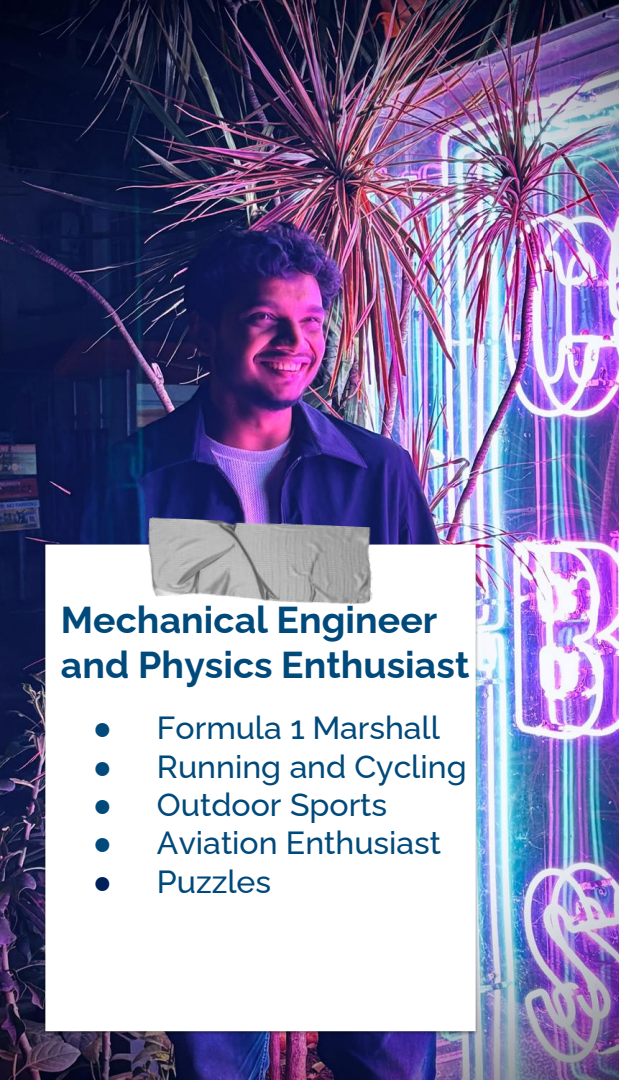


Mechanical Engineer who loves Aircrafts

- Fitness & Bodybuilding
- Badminton
- Tennis Enthusiast

Meet Junaid

Technical Specialist - Flow Simulation



**Mechanical Engineer
and Physics Enthusiast**

- Formula 1 Marshall
- Running and Cycling
- Outdoor Sports
- Aviation Enthusiast
- Puzzles

Meet Sathvik

Structural Design Engineer → Simulations



Software Engineer

- Open Source Enthusiast
- Basketball
- Music
- Trekking

Meet Ankush

Full Stack Developer

Agenda



Junaid

AIRBUS - Who we are

THE WHY?

THE WHAT?

THE HOW?

THE IMPACT?

THE FUTURE?

Who we are

Airbus is a global aerospace pioneer, operating in the commercial aircraft, helicopter, defence and space sectors.





Our purpose

We pioneer sustainable
aerospace for a safe
and united world

Leading the journey
towards clean aerospace

Helping
customers
defend their
values

Connecting and
uniting people across
the globe

Our Business

COMMERCIAL AIRCRAFT

HELICOPTERS

DEFENSE AND SPACE

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The WHY? — The Limits of Traditional Simulation

Interconnected World, Isolated Models

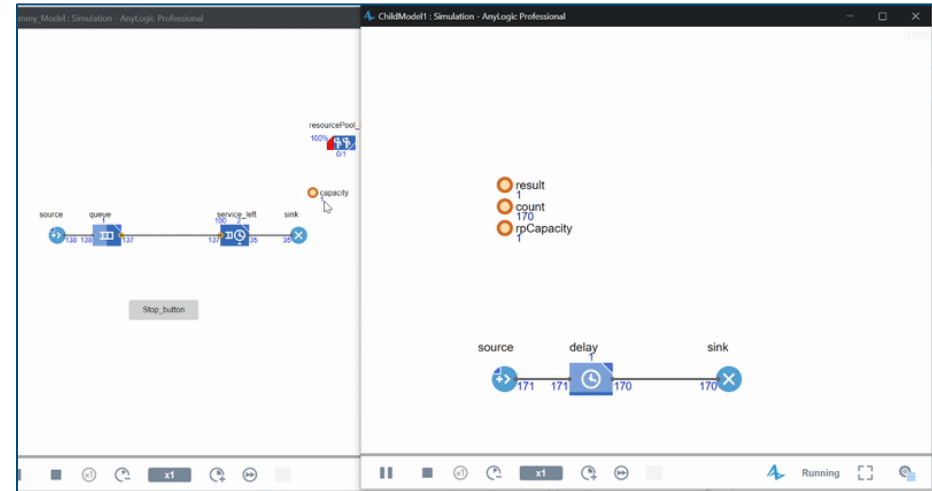
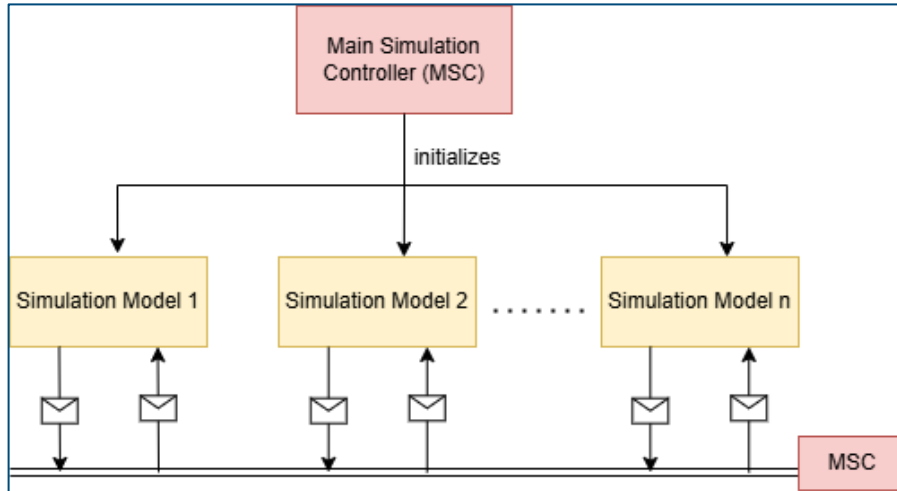
The Collaboration & IP Barrier



Complexity & Scalability Issues

The WHAT? — A "System of Systems" Approach

Master-Child Architecture: A methodology that enables multiple, independently developed simulation models to run concurrently, exchanging data in real-time to function as a single, cohesive system.

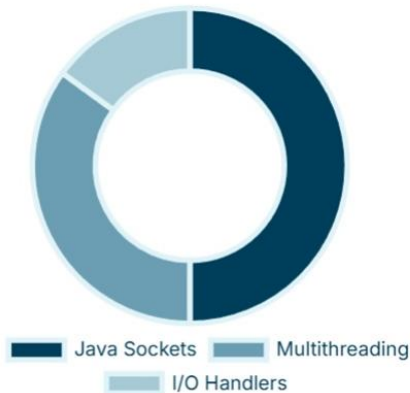


The HOW? — Our Implementation Journey in AnyLogic

Core Capabilities Developed

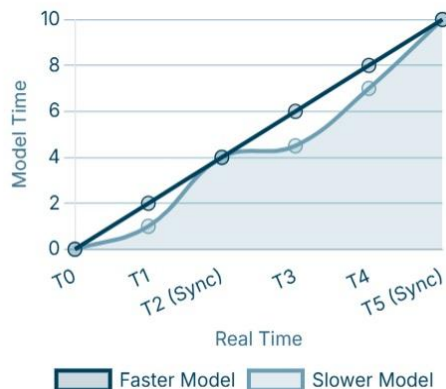
Real-Time Communication

A robust client-server architecture using Java sockets and multithreading enables seamless, two-way data flow between models, forming the backbone of the co-simulation architecture.



Adaptive Time Synchronization

Our Catch-up algorithm ensures all models stay synchronized. Slower models accelerate their step execution to catch up with faster ones, preventing time drift and maintaining simulation integrity.



Secure Black-Box Models

To protect intellectual property, models are encapsulated into runnable files. This "black-box" approach hides internal logic while allowing secure data exchange, fostering cross-organizational collaboration.



Model Encapsulation

Proprietary Logic is Encapsulated and Secured

The Journey: A Milestone-Driven Approach

M1

One-Way Communication

Established initial client-server link via sockets.

M3

Time Synchronization

Implemented step-based sync and the adaptive "Catch-Up" algorithm.

M2

Bi-Directional Flow & Thread Fixes

Enabled two-way data exchange and resolved thread/socket management issues.

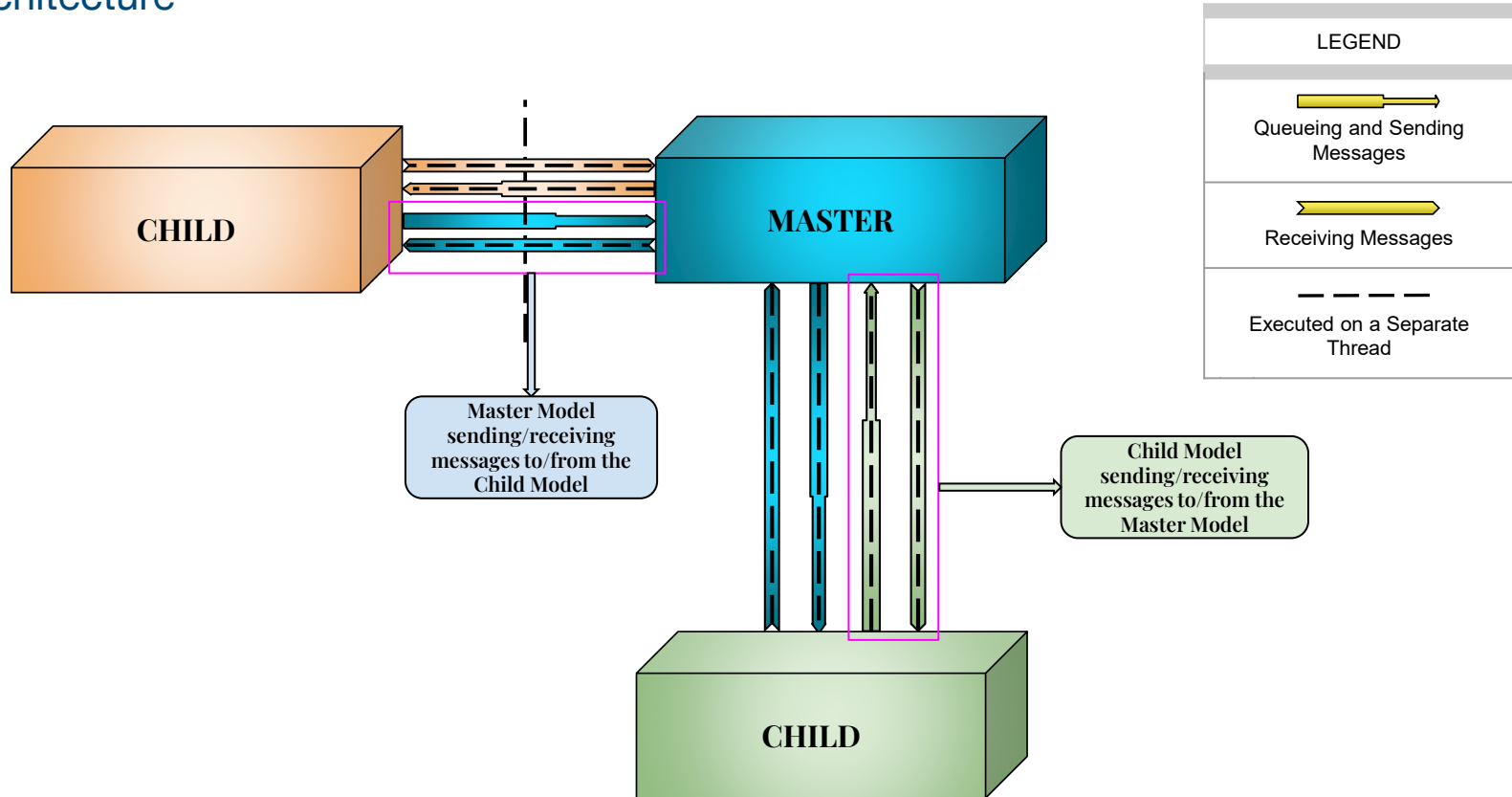
M4

Black-Box Implementation

Achieved model encapsulation using runnable JAR files.

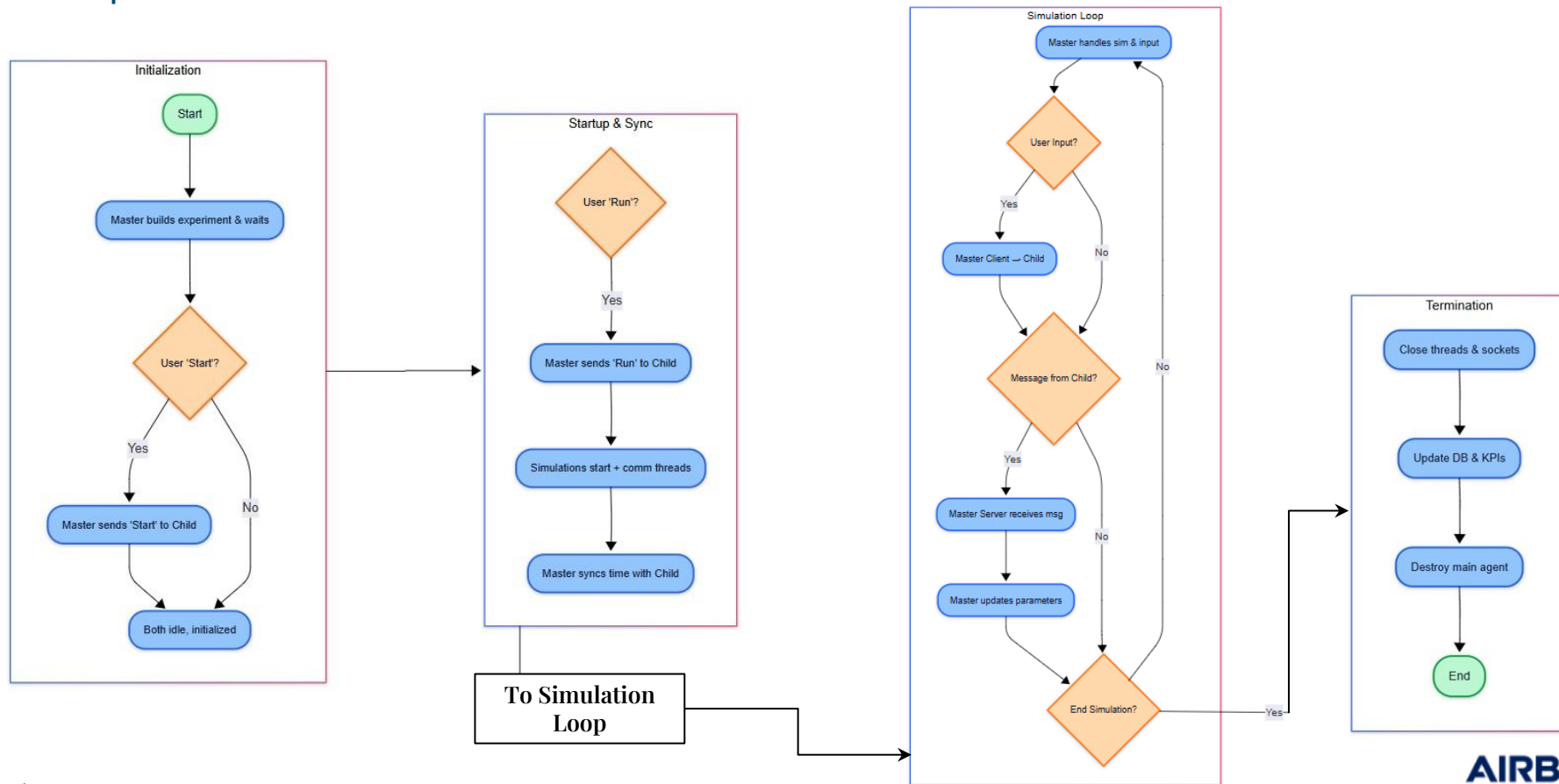
The HOW? — Our Implementation Journey in AnyLogic

Concept Architecture

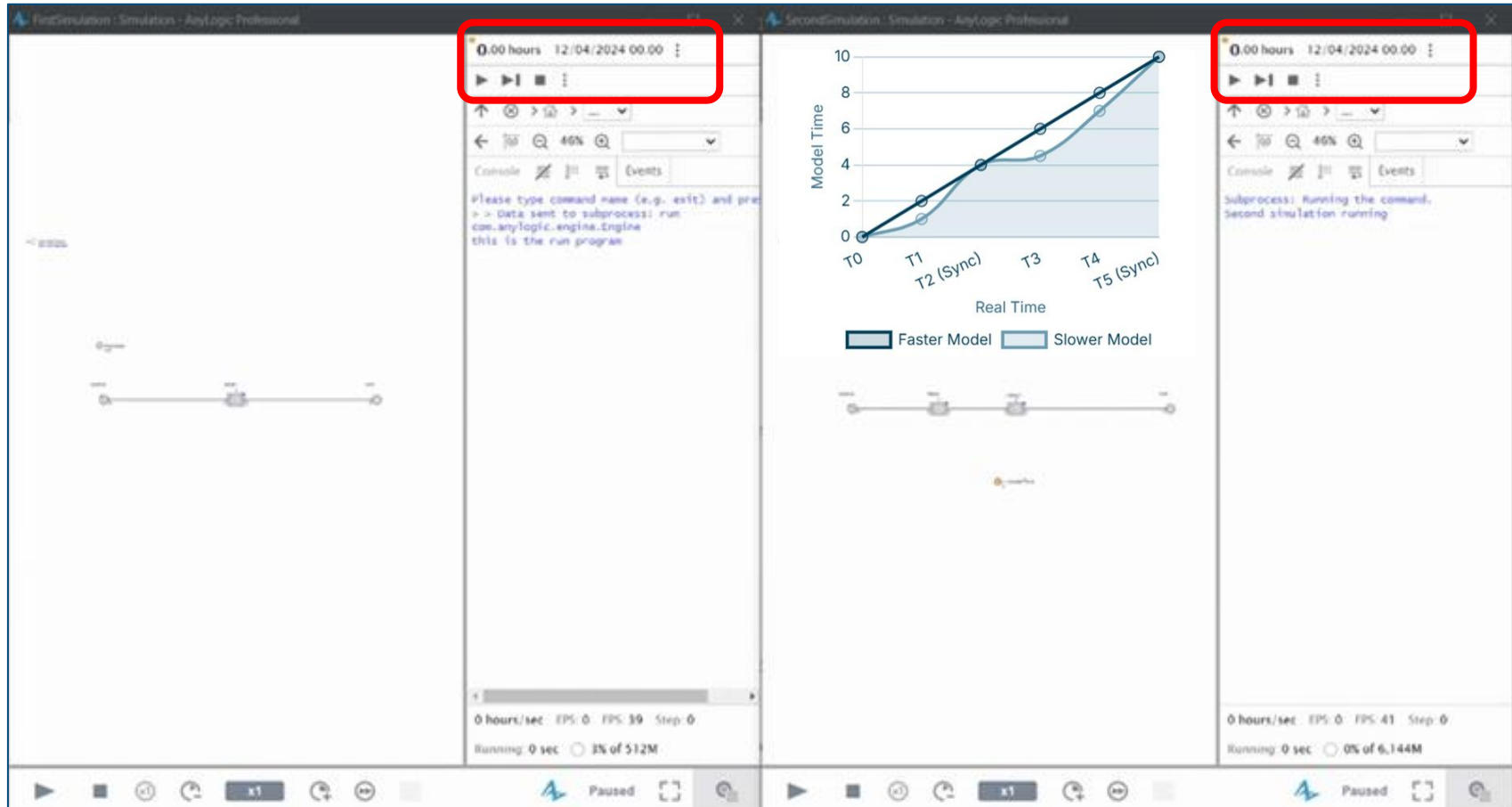


The HOW? — Our Implementation Journey in AnyLogic

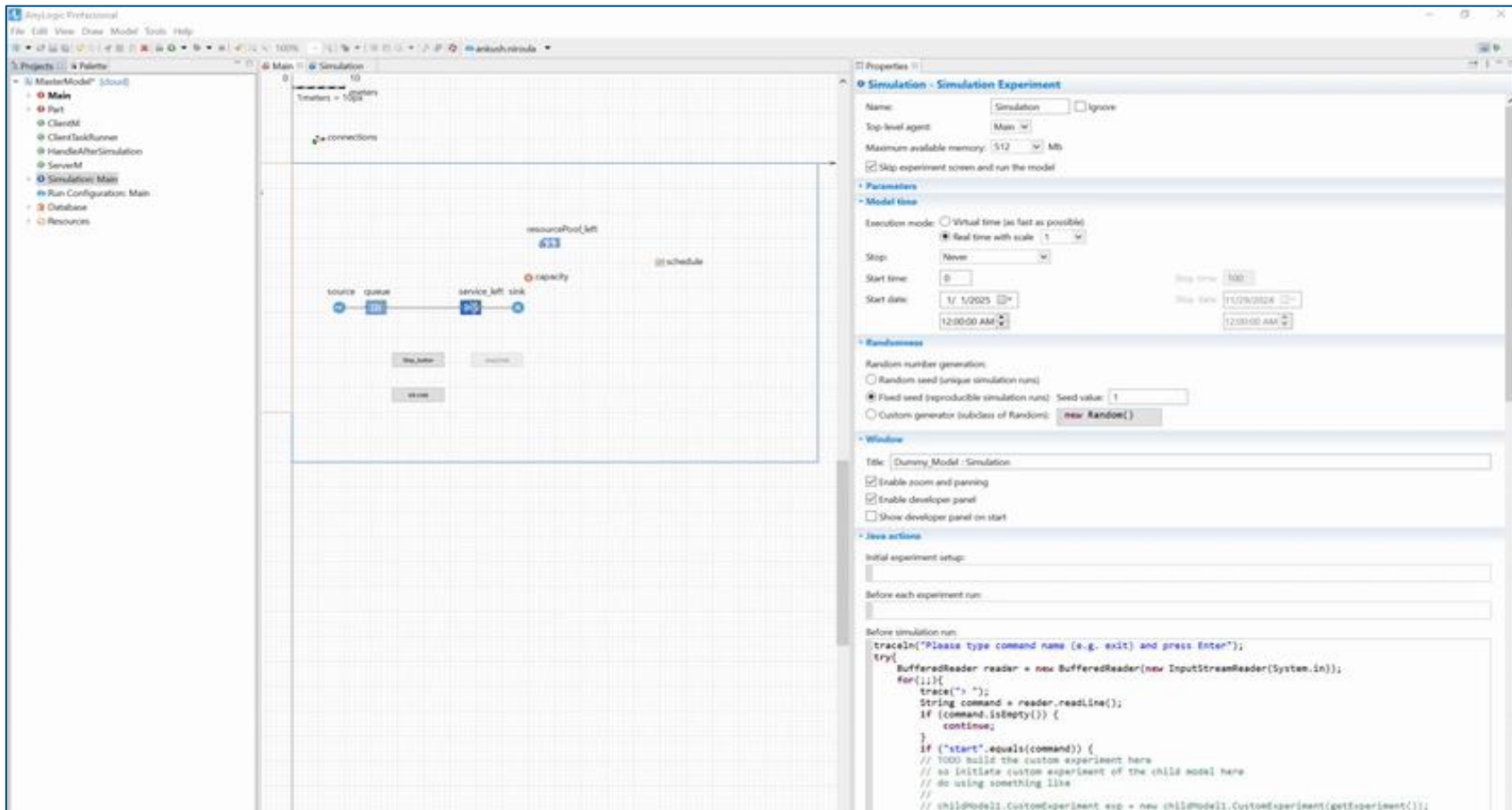
Concept Architecture



The HOW? — Our Implementation Journey in AnyLogic



The HOW? — Our Implementation Journey in AnyLogic



The screenshot displays the AnyLogic Professional interface. On the left, a project tree shows the hierarchy: MasterModel (Source), Main, Part, ClientM, ClientTaskRunner, HandleAfterSimulation, ServerM, Simulation: Main, Run Configuration: Main, Database, and Resources. The central workspace shows a simulation model with a flow from 'source' to 'queue' to 'service_left' to 'sink'. A 'resourcePool_left' is connected to 'service_left' with a capacity of 6.5. A 'schedule' block is also present. The right panel shows the 'Simulation - Simulation Experiment' properties. The 'Name' is 'Simulation', and the 'Top-level agent' is 'Main'. The 'Maximum available memory' is set to 512 Mb. The 'Execution mode' is 'Real time with scale 1'. The 'Stop' button is 'Never'. The 'Start time' is '0' and the 'Start date' is '1/1/2025 12:00:00 AM'. The 'Stop time' is '100' and the 'Stop date' is '11/29/2024 12:00:00 AM'. The 'Randomness' section shows 'Random number generation' set to 'Fixed seed (reproducible simulation runs)' with a 'Seed value' of '1'. The 'Window' section shows the 'Title' as 'Dummy Model : Simulation'. The 'Java actions' section shows the 'Initial experiment setup' and 'Before each experiment run' fields. The 'Before simulation run' field contains the following code:

```
traceIn("Please type command name (e.g. exit) and press Enter");
try{
    BufferedReader reader = new BufferedReader(new InputStreamReader(System.in));
    for(;;){
        traceIn("");
        String command = reader.readLine();
        if (command.isEmpty()) {
            continue;
        }
        if ("start".equals(command)) {
            // TODO build the custom experiment here
            // or initiate custom experiment of the child model here
            // do using something like
            // childModel1.CustomExperiment exp = new childModel1.CustomExperiment(getExperiment());
```

The IMPACT — Unlocking Transformative Business Value



Junaid

This capability unlocks critical insights across numerous sectors

Supply Chain

Build resilient, end-to-end digital twins by connecting secure models from suppliers, logistics partners, and distributors to proactively manage and mitigate disruptions across the entire value chain.

Aerospace & Defense

Validate the mission readiness and interoperability of complex, multi-contractor systems in a secure environment.

Energy & Utilities

Analyze grid stability by integrating realistic, proprietary models from independent power producers.

Financial Services

Test the entire financial system's response to a crisis, allowing competing banks to contribute to the simulation securely without sharing their private information.

Healthcare

Co-simulation connects hospitals into a regional digital twin, simulating real-time capacity to route critical patients to the optimal facility, preventing fatalities from life-threatening delays.

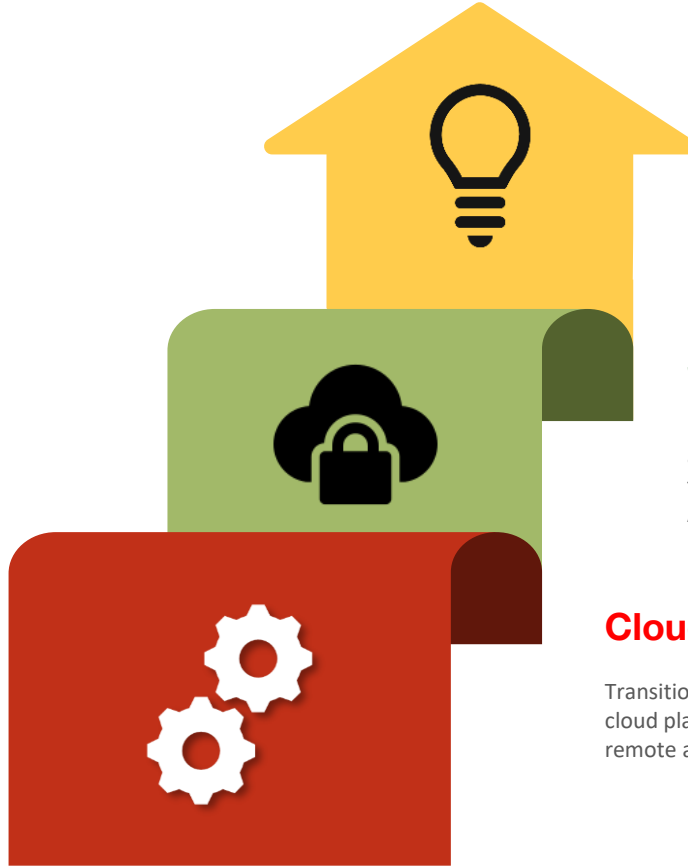
Manufacturing

Virtually commission multi-vendor smart factories by integrating protected models of robots, machinery, and control systems, eliminating integration risks and optimizing production flow before physical setup.



The FUTURE — From a Capability to an Ecosystem

The Vision for Scalable Co-Simulation



Full Digital Twin Integration

Evolve the framework into a real-time Digital Twin, creating a live, virtual replica of the production line for continuous monitoring and predictive maintenance.

Security on the Cloud

Implement a system where the models can be run and perform communications on the cloud without the requirement of local runs of the models. Achieved with secure communication protocols.

Cloud Adaptation

Transition the co-simulation framework to cloud platform for enhanced flexibility on remote access to global teams.

Thank you

Q & A