

'Genshin Impact': Building a Scalable AI System

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Genshin Impact



- Anime-style
- Open-world adventure
- Expanding
- Multi-platforms



Road Map



Architecture design

- Concerns
- Pipeline and productivity

NavMesh for open world

- Size and complexity
- Dynamic scene objects

Performance optimization

- LOD
- Ticking Strategy
- Multithreading



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Expectation

- **Multiple types of AI**
 - Civilians
 - Wildlife
 - Combat NPCs
- **Entropies**
 - 200+ archetypes
 - Various positioning tactics
 - Various sensing strategies
 - ...
- **Diversity**
 - Customize specific AI behaviors



Architecture design

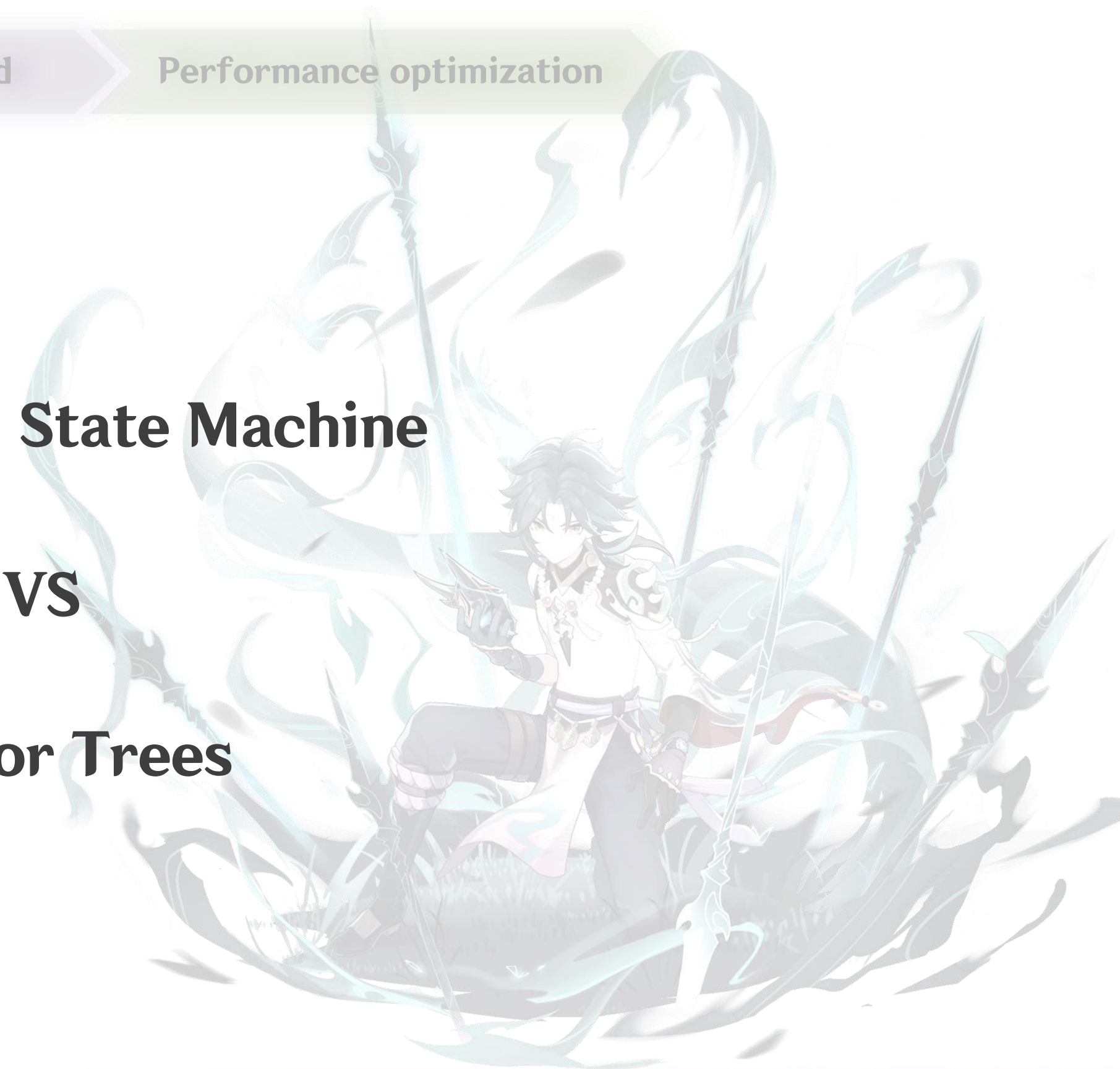
NavMesh for open world

Performance optimization

Pipeline and State Machine

VS

Behavior Trees



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Pipeline

a frame tick of AI

Reasoning

- Sensing, Threat
- Target Select
- Reactions
- Level scripted behavior
- Group behavior
- Positioning tactics

Decision Tree

- Light-weighted

Actions

- Skills
- Move tasks

Animation

- Params

↑
Archetype – combinations of various settings



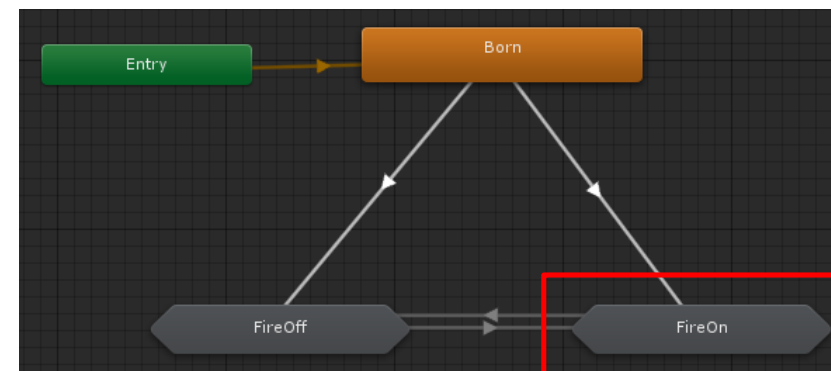
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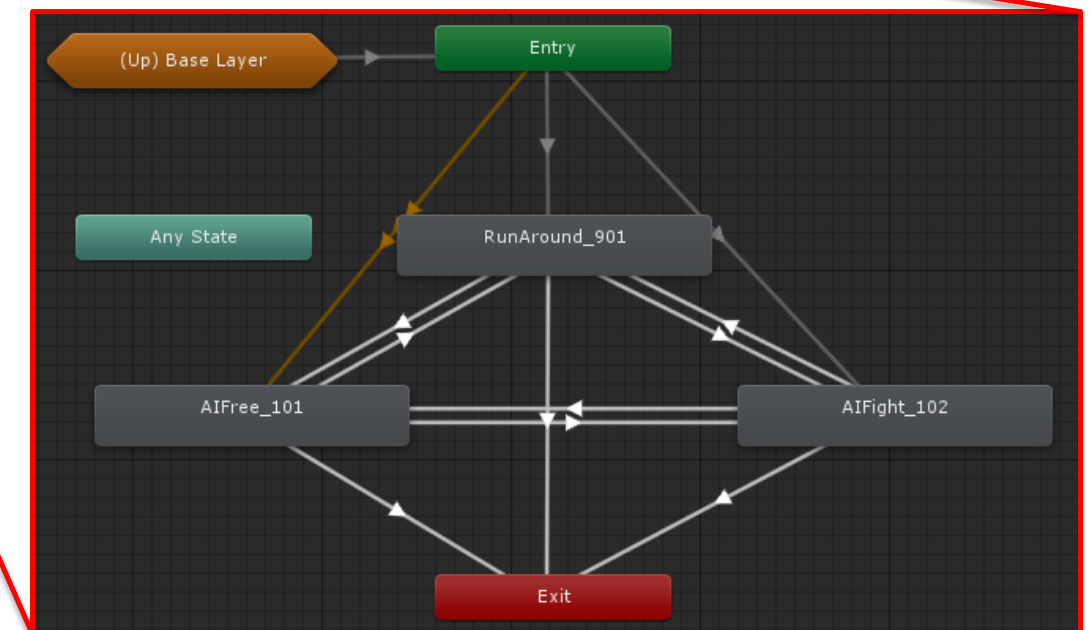


Key State Manager

- Finite state machine
- A key state could be
 - Combat phase
 - Buff status
 - Alertness
- Help decide skills and tactics
- Characteristics



example of fire slime



Open-world Constraint

- Large map
- 70+ km²

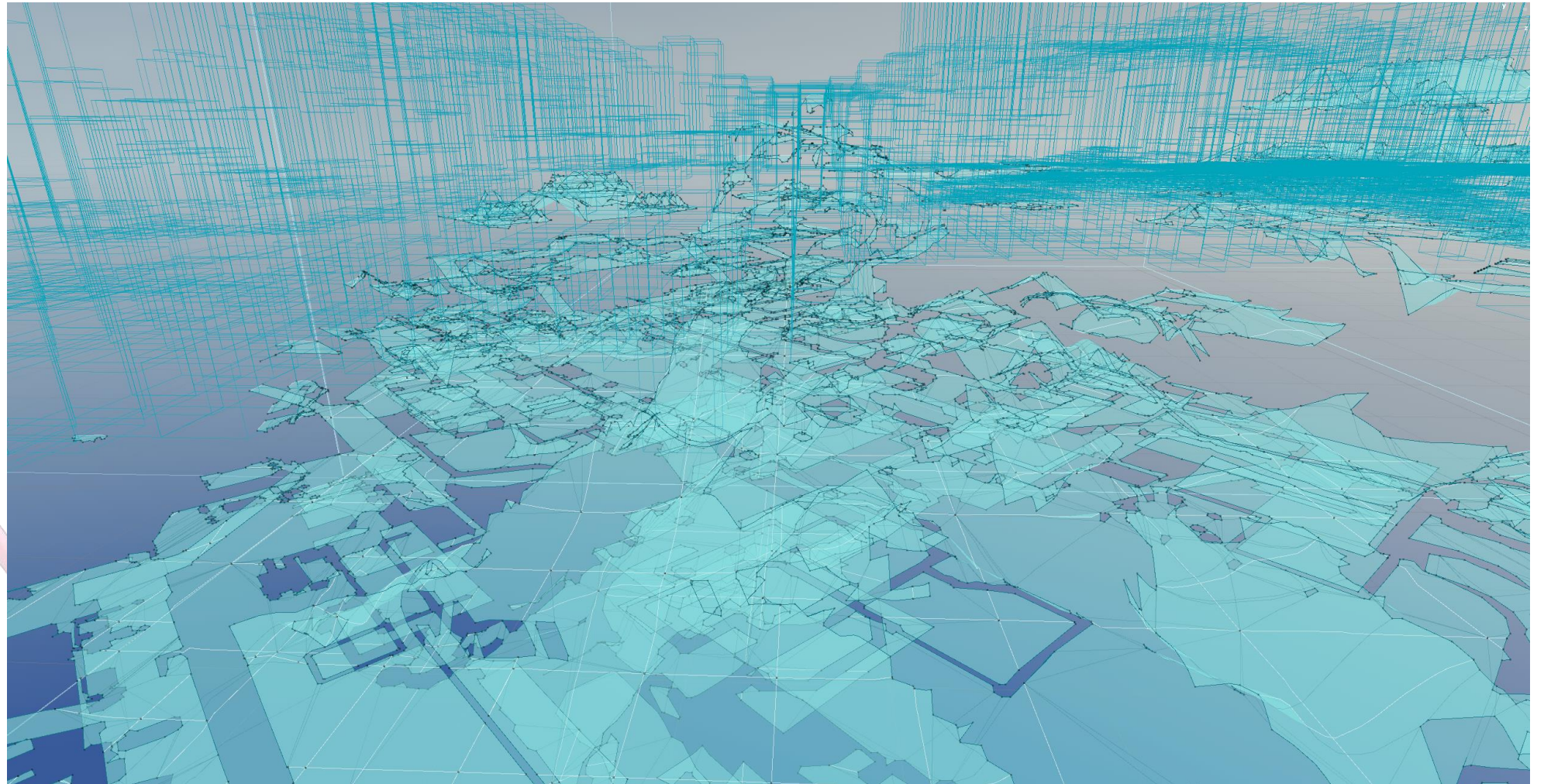


Architecture design

NavMesh for open world

Performance optimization

NavMesh

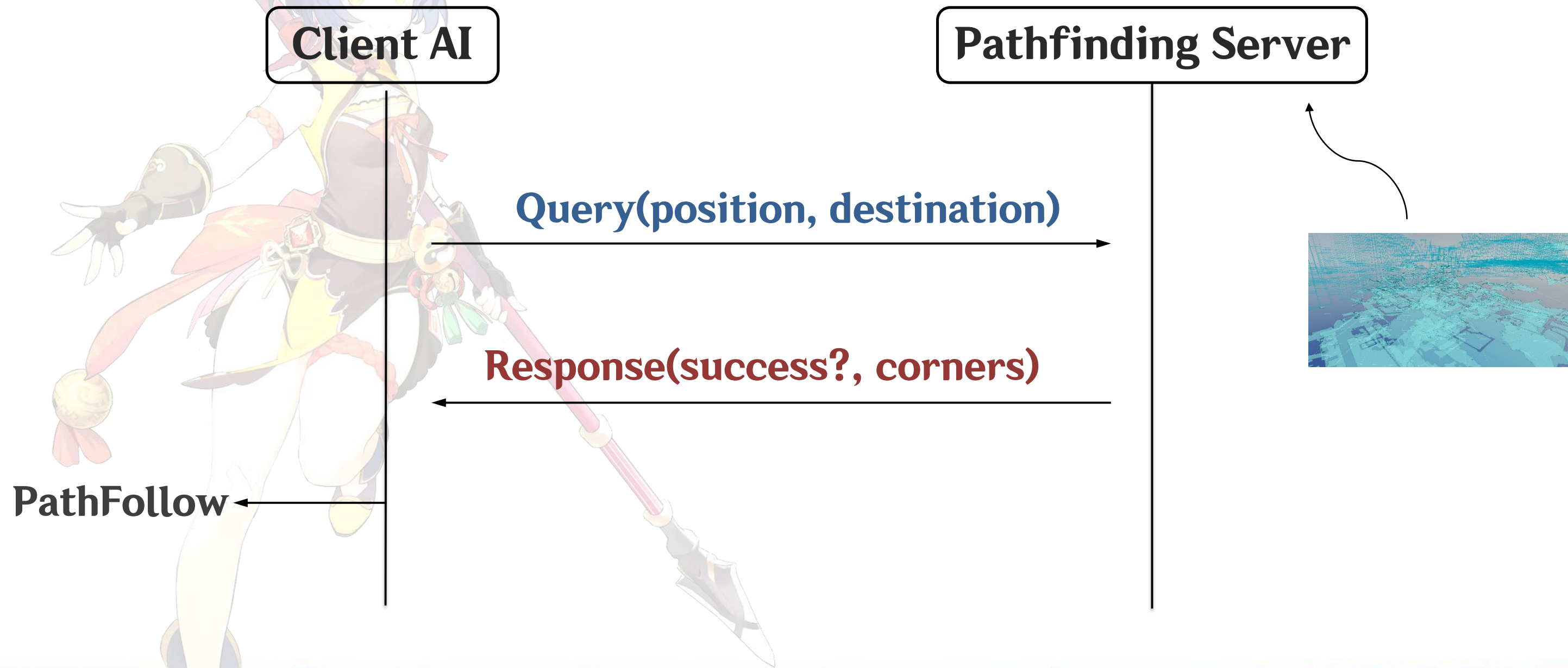


NavMesh

- Precision
- 128 tile size
- 0.125m voxel size
- ~6GB data



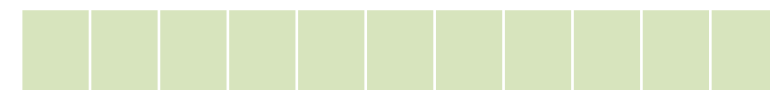
Remote Pathfinding



Dynamic Obstacles



Pathfinding Server



Player 1



Player 2



Player 3

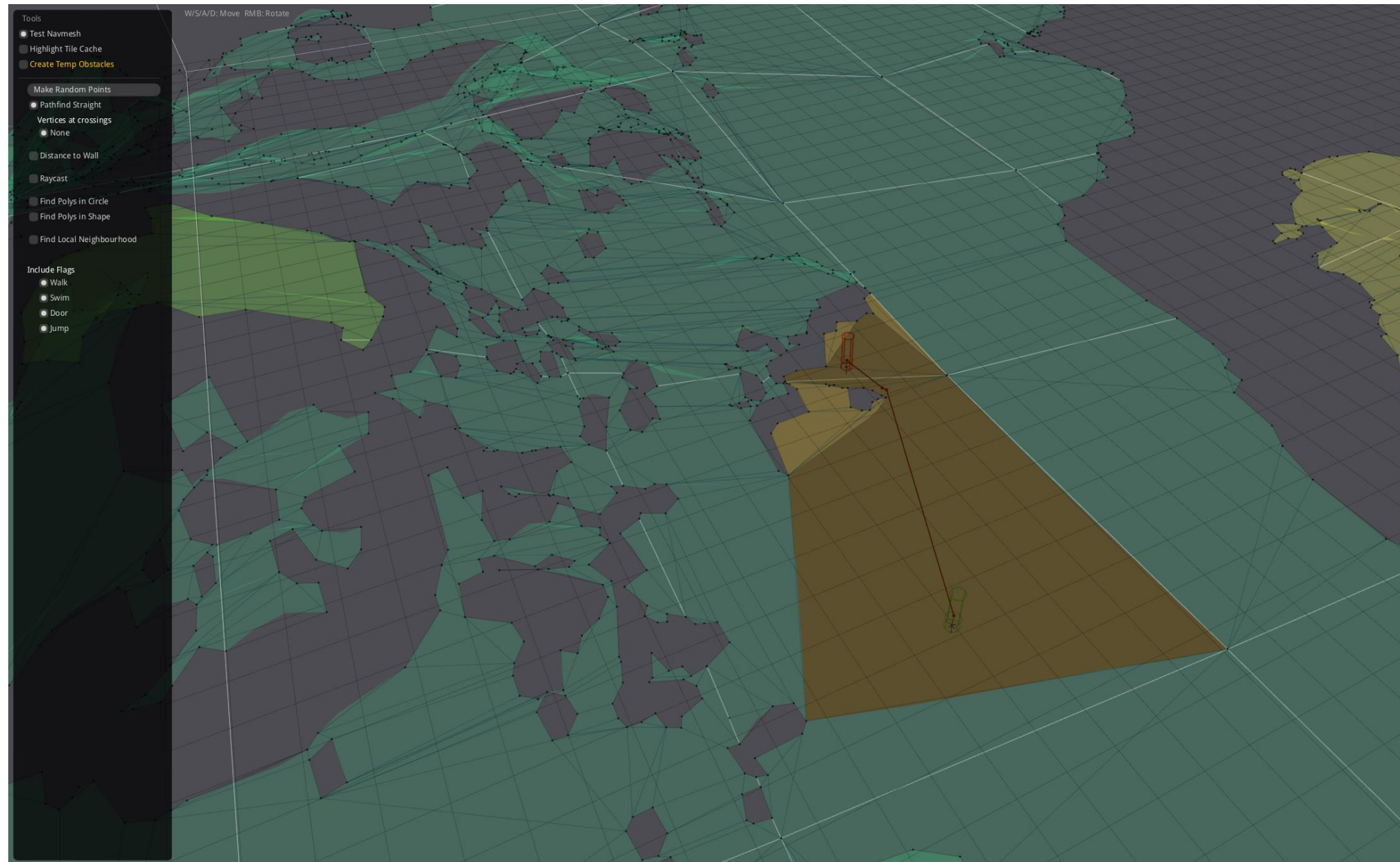
Obstacle object info (transform, bounds)



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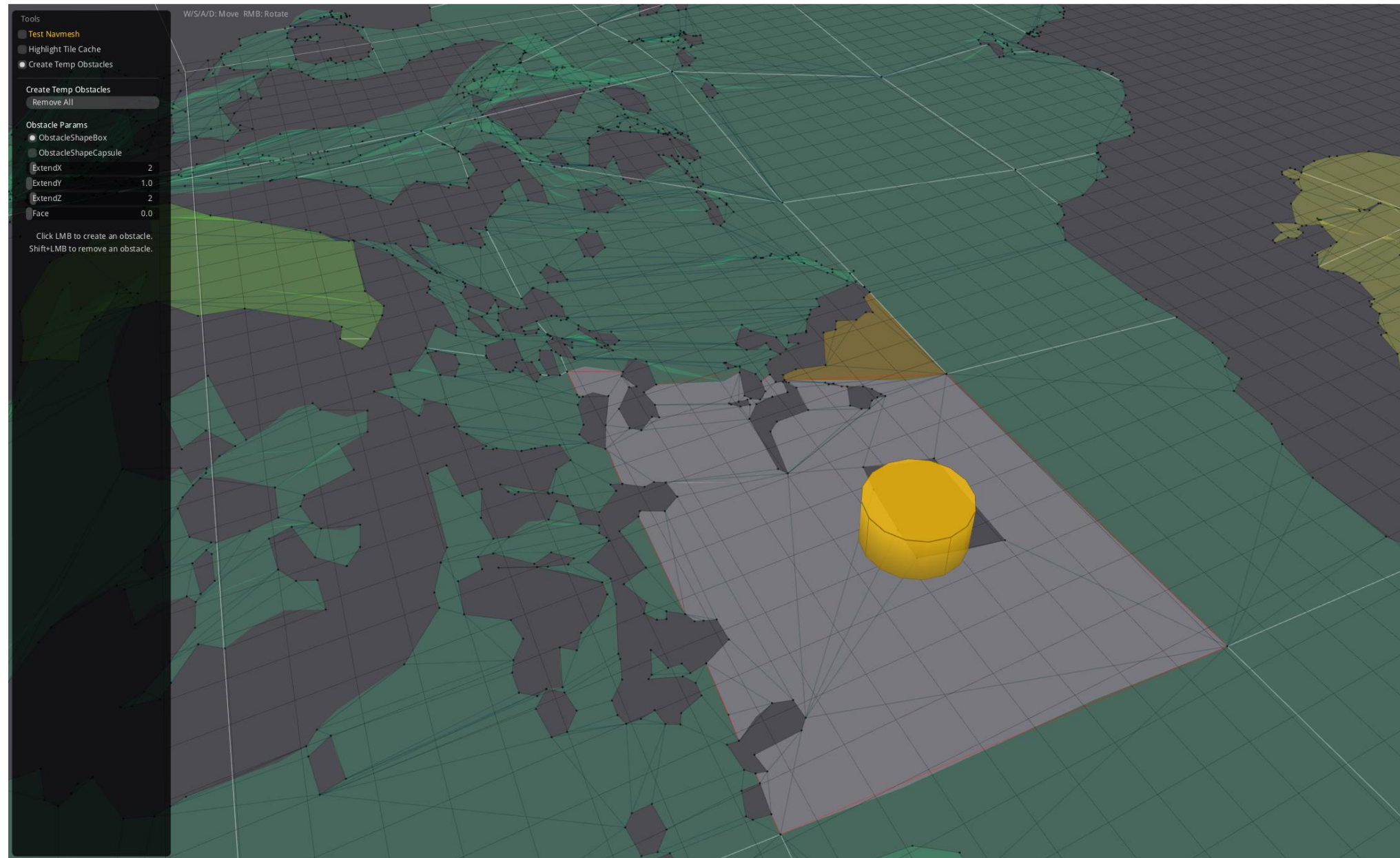
Dynamic Obstacles



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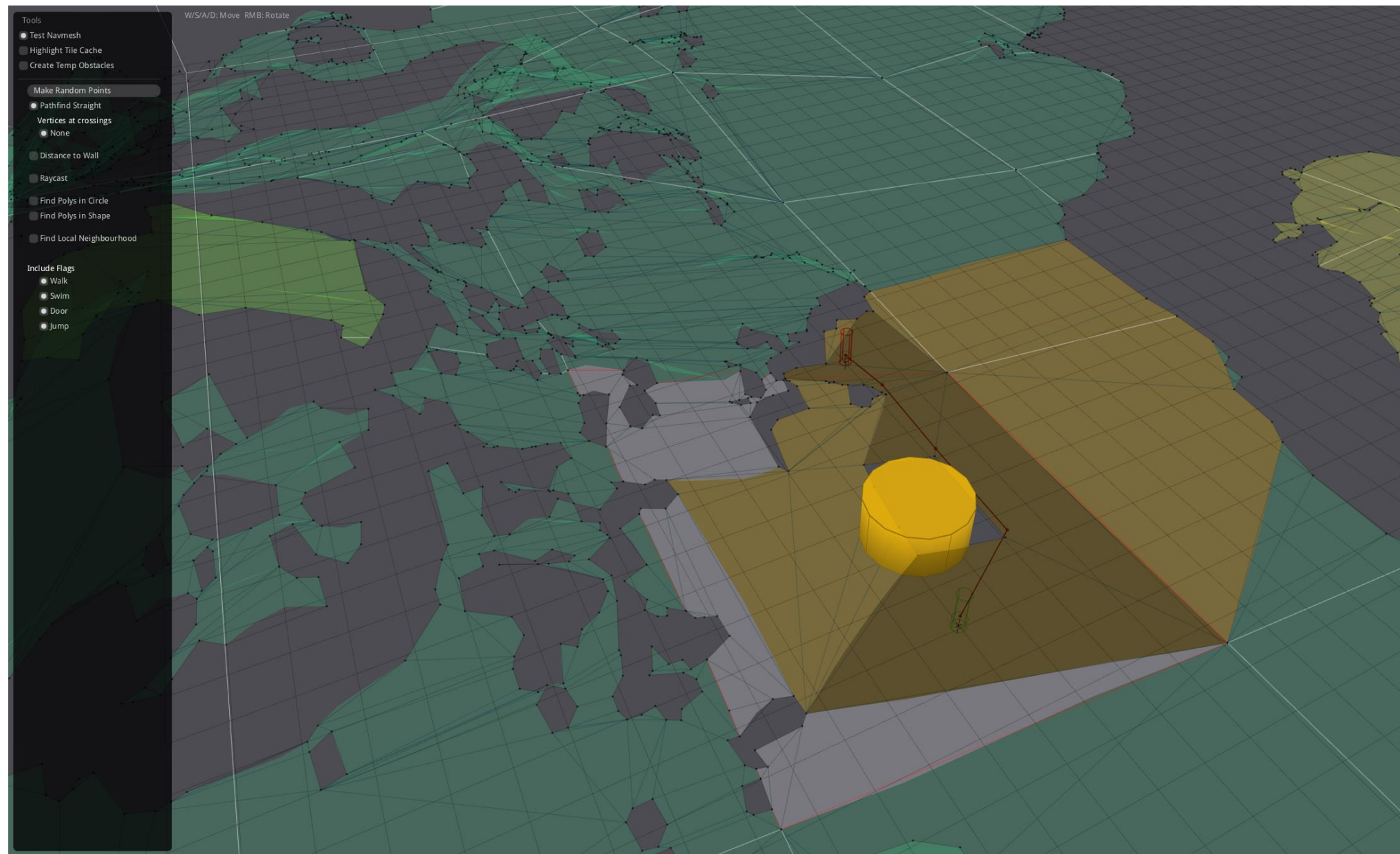
Dynamic Obstacles



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Dynamic Obstacles



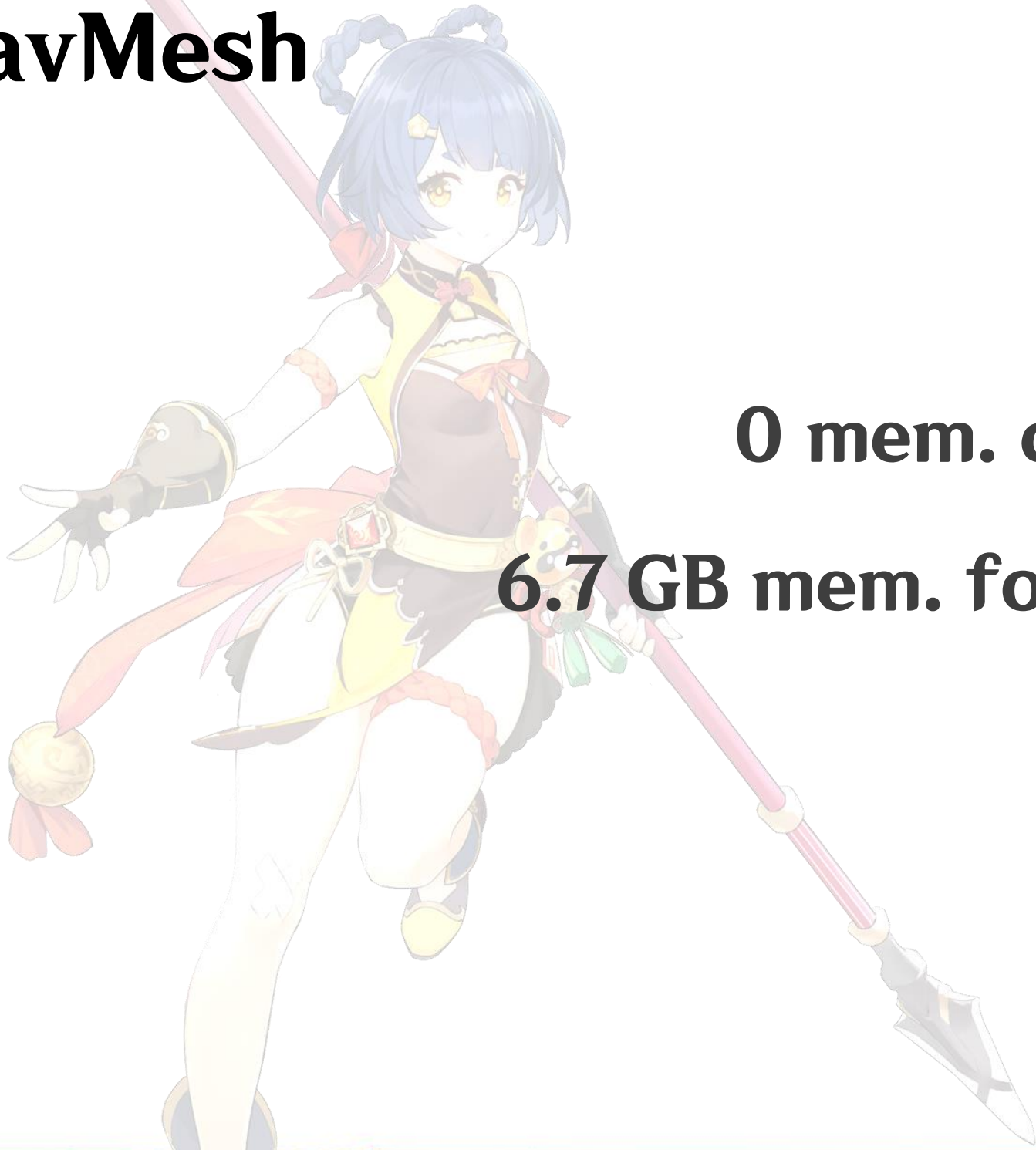
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NavMesh

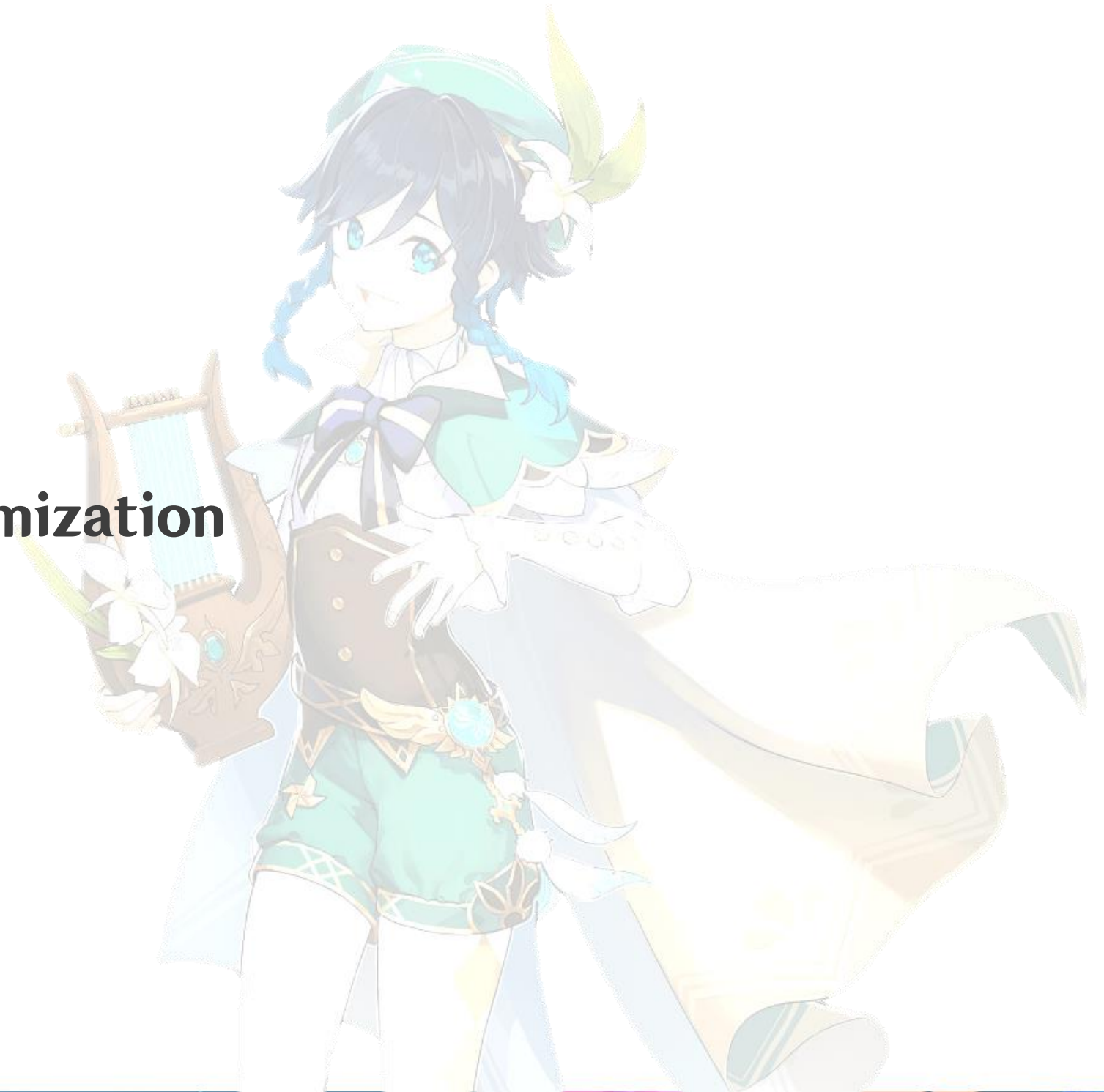
0 mem. cost for client

6.7 GB mem. for pathfinding server



Performance

- **Mobiles**
 - Targeting 60 FPS
 - 30+ simultaneously running NPCs
 - AI takes 2~3ms budget before optimization
 - Overall bottleneck on CPU
 - Thermal management



LOD for AI

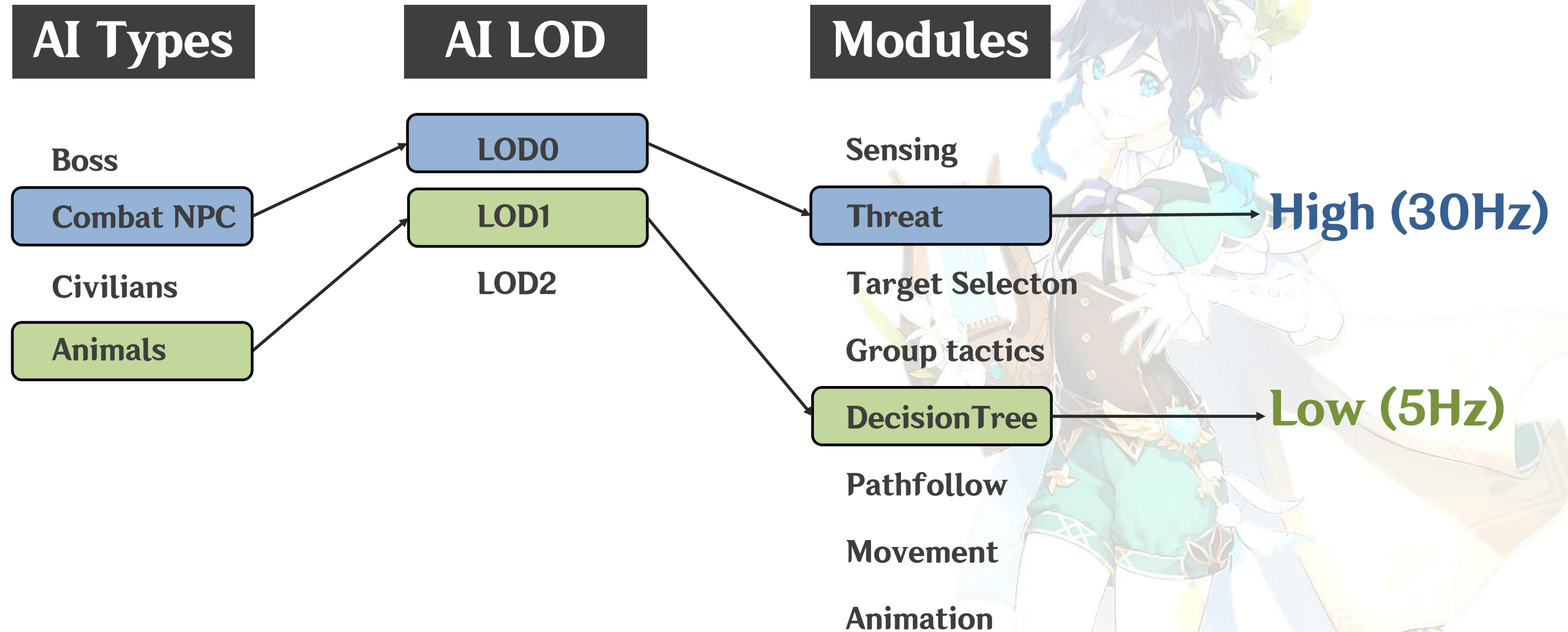
- Importance of ticking
- 3 tiers
- Decide on
 - Player distance
 - Combat status
 - ...



LOD for AI



Asynchronous Module Ticks



Even more

- **Pause animations**
- **Hide skinned meshes**

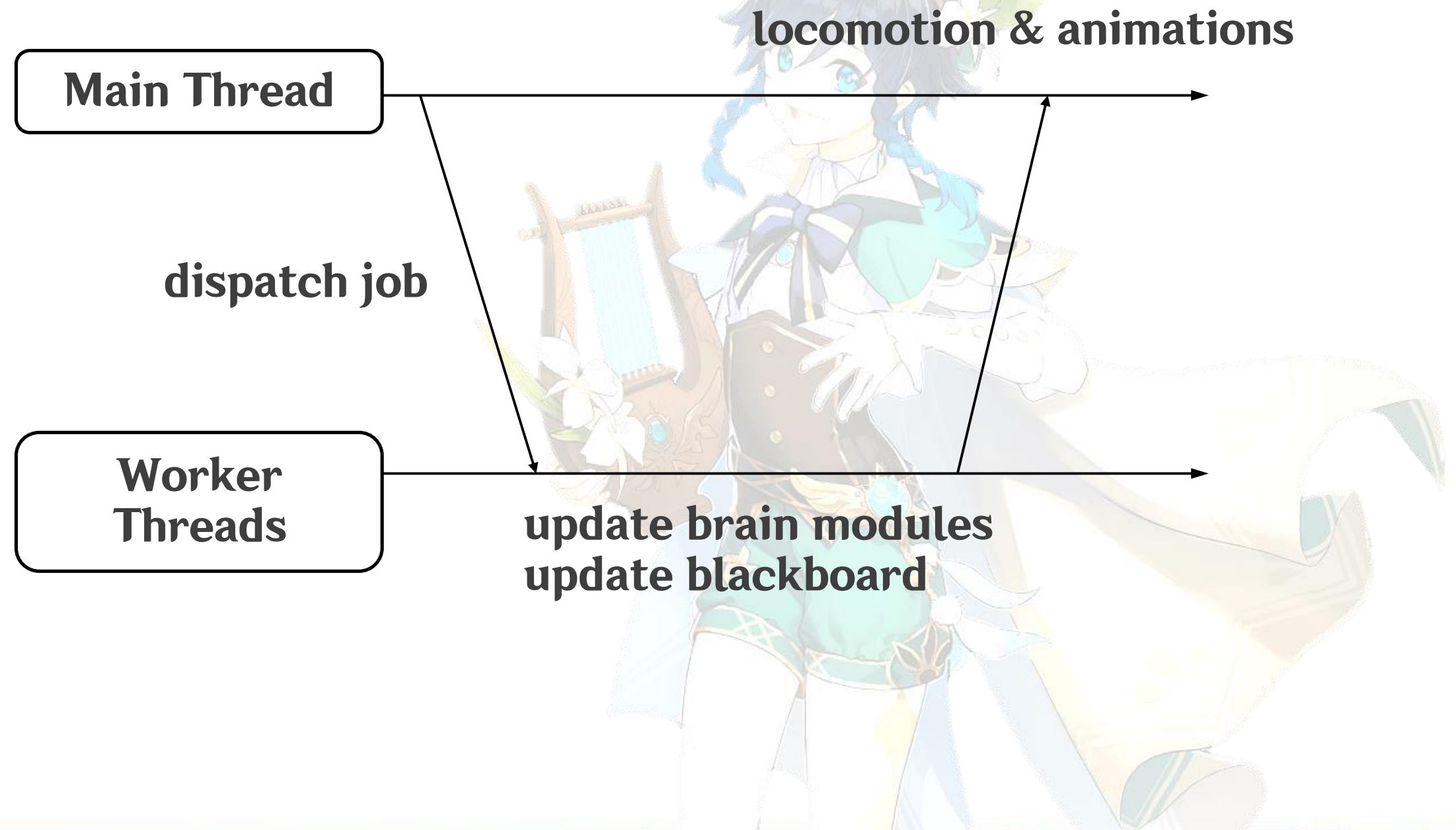


Combined



Multithreading

- **Best practice**
- **Modules**
 - Sensing
 - Threat
 - Ability scoring
 - Decision Tree
 - Positioning Tactics



Multithreading



Architecture design

NavMesh for open world

Performance optimization

Result

0.5ms frame budget for AI

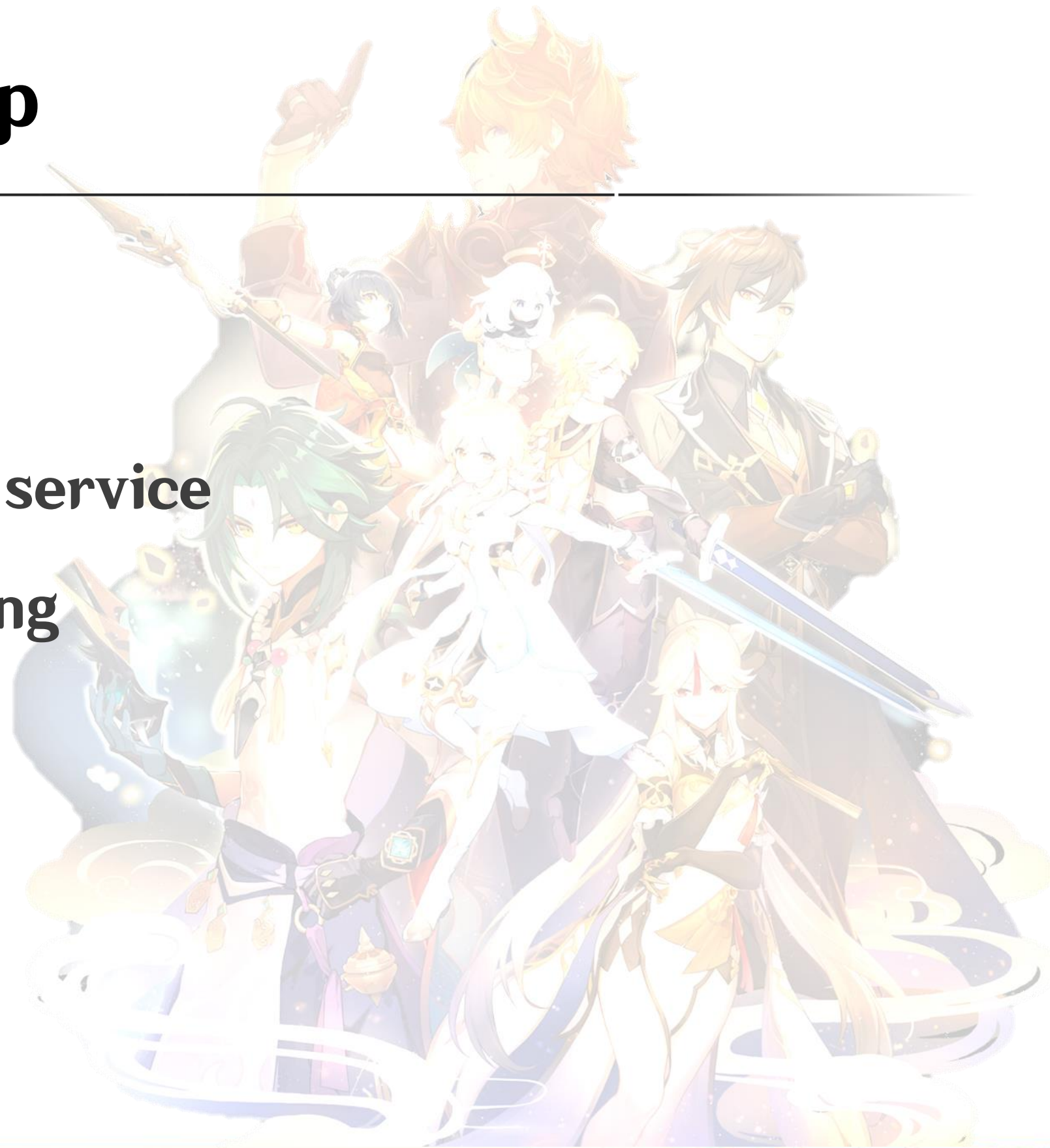
Tested on Apple A12 chip



Recap



- **An AI pipeline**
- **Remote NavMesh and pathfinding service**
- **Ticking strategy and multithreading**



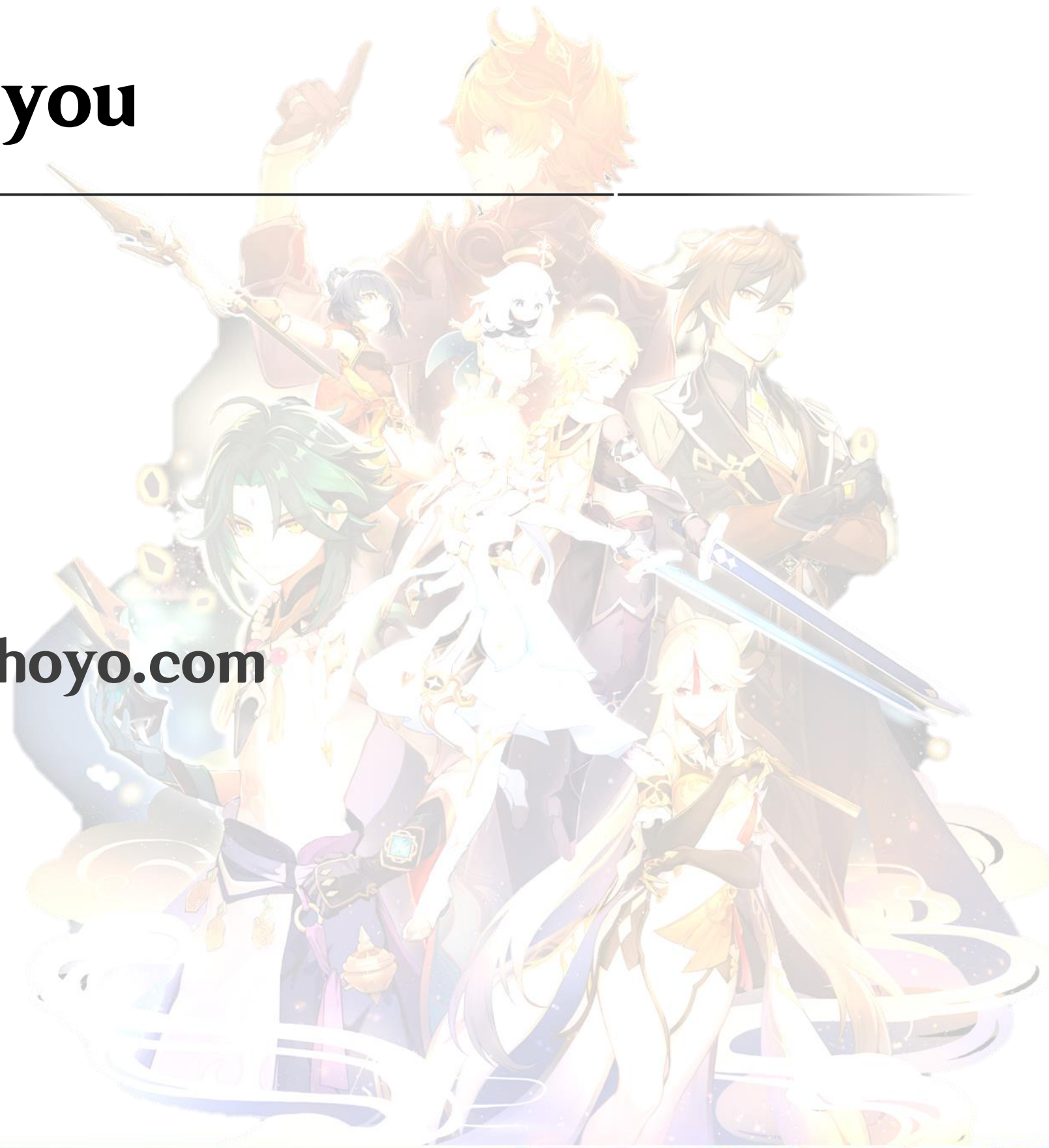
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Thank you



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