MPAI Basics

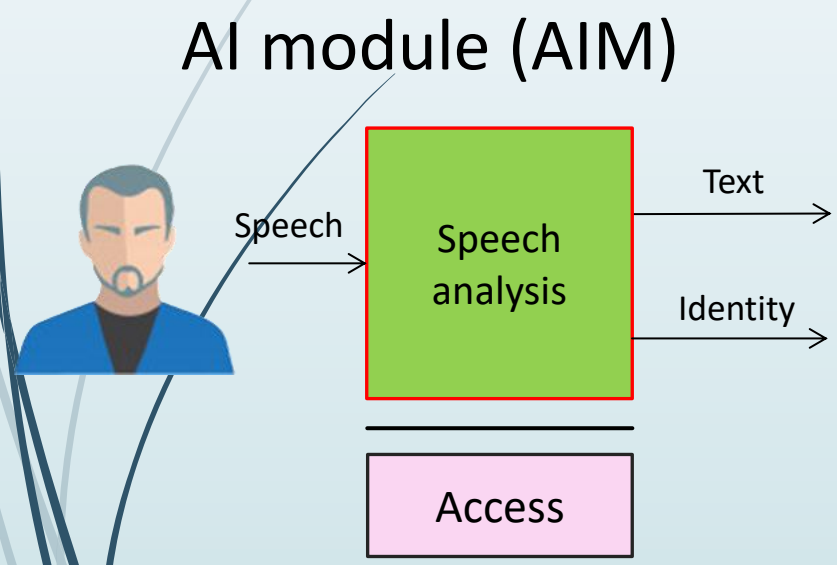
Leonardo Chiariglione

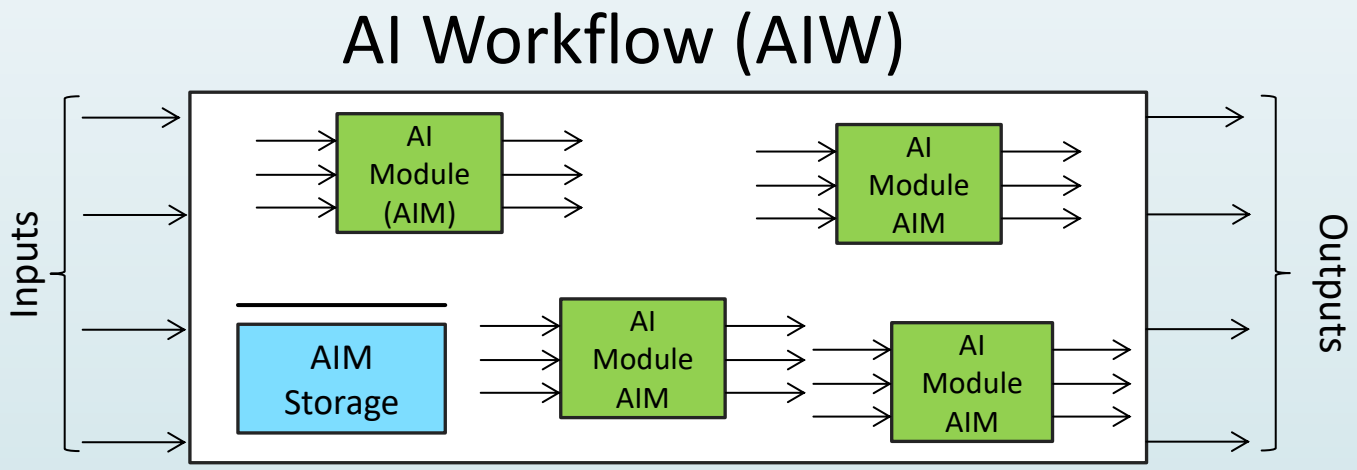
2025/02/12 T15:00 UTC

Who is MPAI

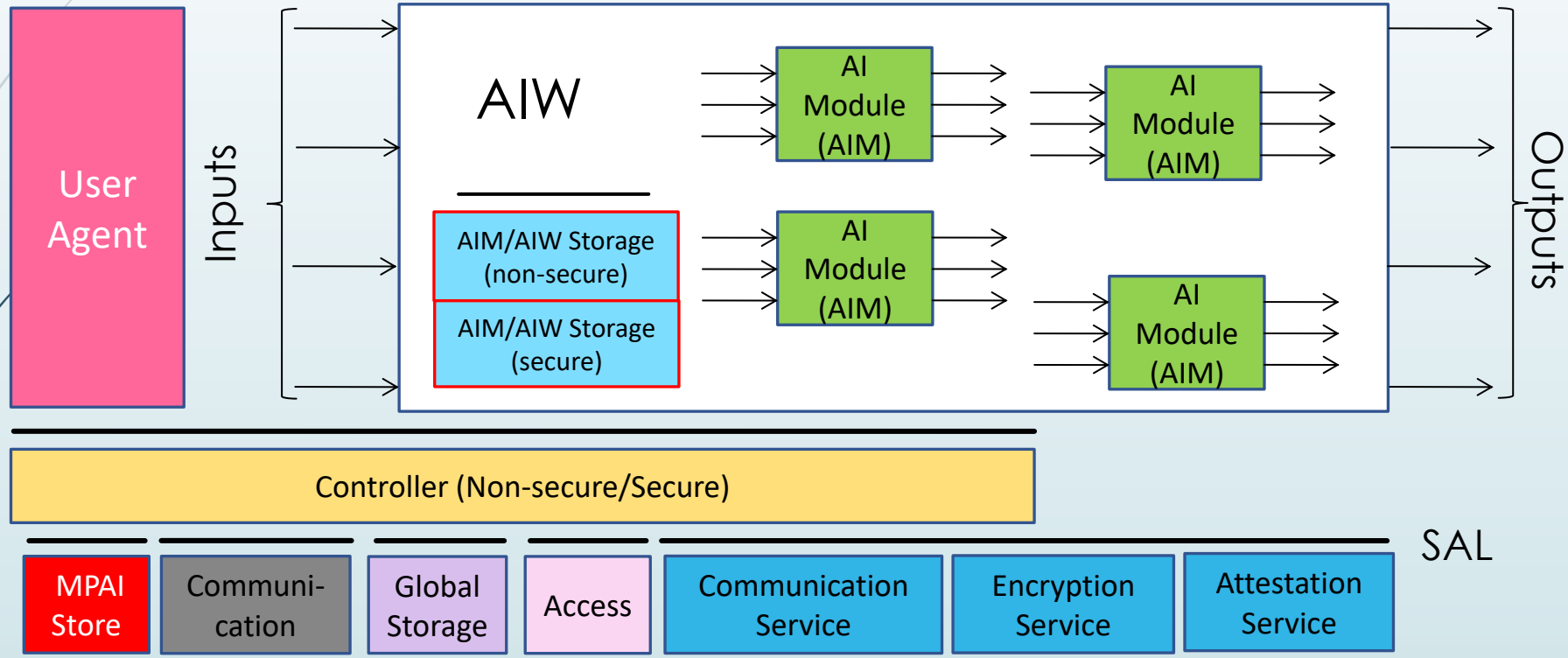
- MPAI – Moving Picture, Audio and Data Coding by Artificial Intelligence is an international, unaffiliated, non-profit association based in Geneva
- With the mission to promot the efficient use of Data by:
  - Developing Technical Specifications for
    - Coding of any type of Data, especially using new technologies such as AI, and
    - Technologies that integrate Data Coding components in ICT systems, and by
  - Bridging the gap between Technical Specifications and their practical use through the development of Intellectual Property Rights Guidelines (“IPR Guidelines”),.
- MPAI operates based on open international collaboration of interested parties supporting the MPAI mission and the means to accomplish it.

Explainable standards





Technical Specification: AI Framework (MPAI-AIF) V2.1



AIF enables dynamic configuration, initialisation, execution, and control of an AIW

Accessible & timely available standards

Before initiating a standard, *Active Principal Members* **develop & adopt** its Framework Licence (FWL), a licence without *values: $, %, dates etc.* declaring that the eventual licence will be issued

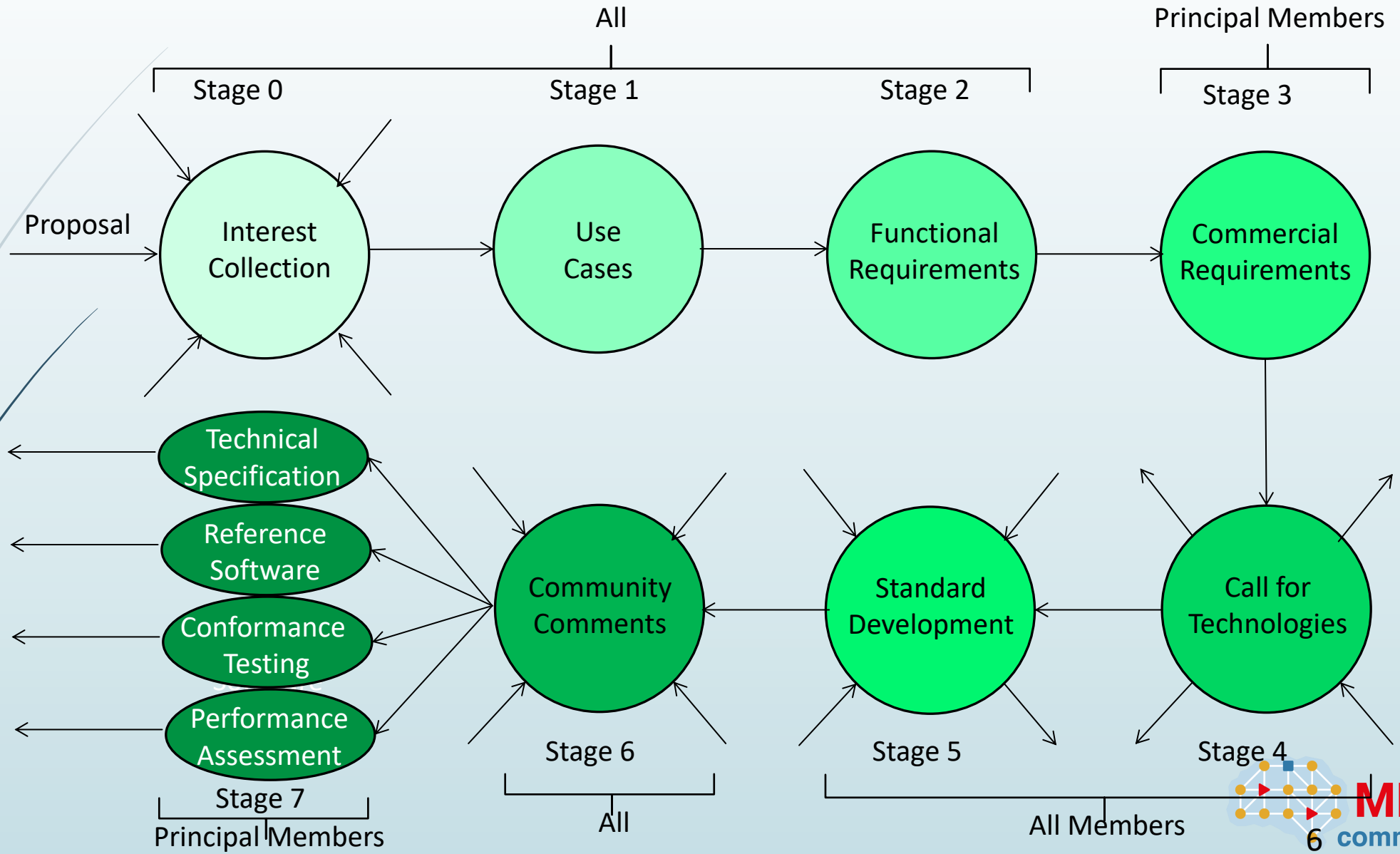
1. Not after products are on the market.
2. At a price comparable with similar standard technologies.

During the development, *any Member* making a contribution **declares** it will make its licence available according to the FWL.

After the development, *Members holding IP* in the standard **select** the preferred patent pool administrator.

Read the MPAI Patent Policy

Rigorous standards development process



The results, so far

Acronym	Name	TS	RS	CT	PA	IEEE
MPAI-AIF	AI Framework	x	x			3301-2024
MPAI-CAE	Context-based Audio Enhancement	x	x	x		(3302-2024)
MPAI-CAV	Connected Autonomous Vehicle					3307-2024
MPAI-CUI	Compression and Understanding of Financial Data	x	x	x	x	
MPAI-GME	Governance of the MPAI Ecosystem	x				
MPAI-HMC	Human and Machine Communication	x				
MPAI-MMC	Multimodal Conversation	x	x	x		3300-2024
MPAI-MMM	MPAI Metaverse Model	x				3305-2024
MPAI-NNW	Neural Network Watermarking	x	x			3304-2023
MPAI-OSD	Object and Scene Description	x				(3308-2024)
MPAI-PAF	Portable Avatar Format	x				3306-2024
MPAI-PRF	AI Module Profiles	x				
MPAI-SPG	Server-based Predictive Multiplayer Gaming	x	x			
MPAI-TFA	Data Types, Formats and Attributes	x				

Plans for new and extended standards

Acronym	Name
MPAI-AIH	AI for Health
MPAI-CAE	Context-based Audio Enhancement (6 Degrees of Freedom)
MPAI-CAV	Connected Autonomous Vehicle (Technologies)
MPAI-CUI	Compr. & Underst. of Financial Data (Company Perfom. Prediction)
MPAI-EEV	AI-Enhanced Video Coding
MPAI-EVC	End-to-End Video Coding
MPAI-MMC	Multimodal Conversation (Perceptive and Agentic AI)
MPAI-MMM	MPAI Metaverse Model (Integration of Architecture & Technologies)
MPAI-NNW	Neural Network Watermarking (new applications)
MPAI-TFA	Data Types, Formats and Attributes (new data types)
MPAI-XRV	XR Venues

We look forward to working
with you
in MPAI projects!

https://mpai.community/standards/

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Share the fun
Build the future

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MPAI-SPG MDL

Server-based Predictive Multiplayer Gaming (MPAI-SPG) – Mitigation of Data Loss

Francesco Strada – Politecnico di Torino

Online Multiplayer Gaming

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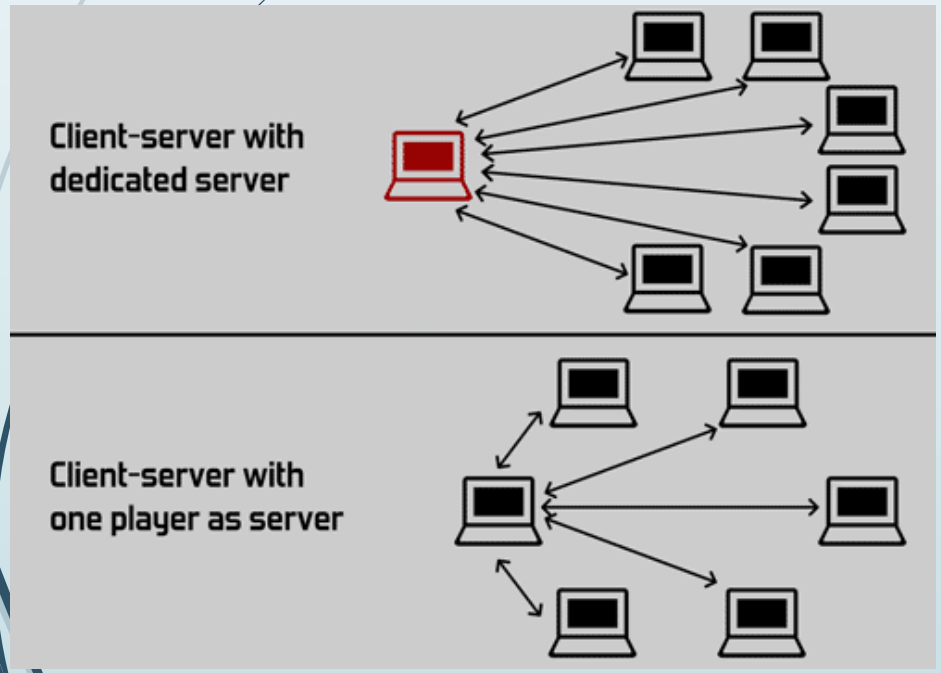
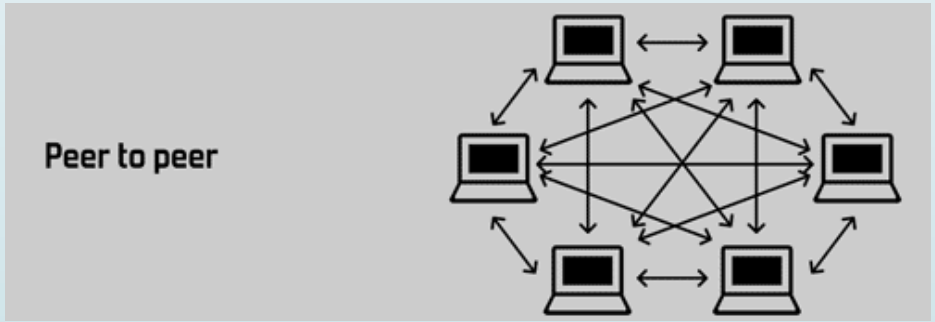
Online Multiplayer Gaming

- Network architectures: **Authoritative Servers** vs **Peer to Peer**
- Authoritative servers is among the **most widespread**





Online Multiplayer Gaming - Problems

- The server's game state shared version can be corrupted
  - Data loss
  - Latency
  - Data corruption

Online Multiplayer Gaming - Solutions

- Several techniques to mitigate/compensate network issues [1]
  - Time Delay - (Server)
  - Time Warp - (Server)
  - Client Prediction - (Client)

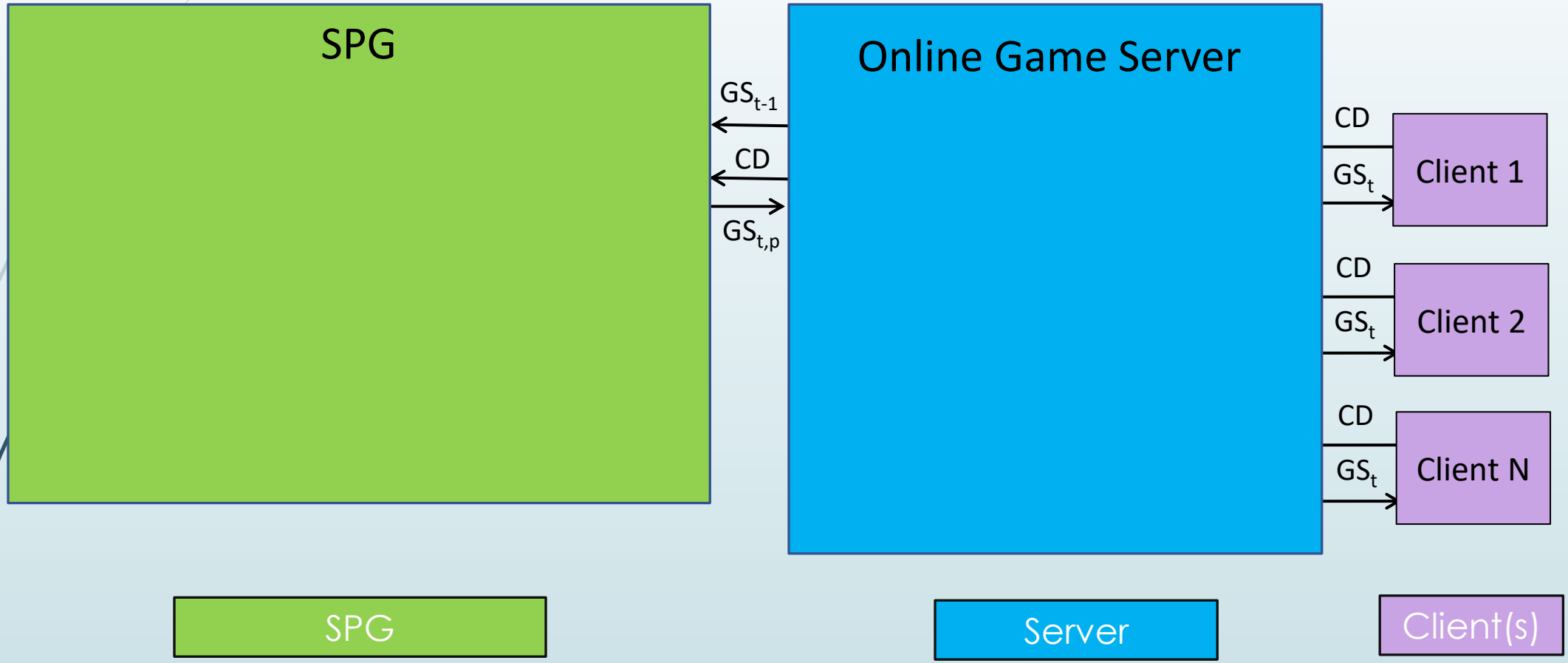
[1] L. Shengmei, X. Xiaokun e M. Claypool, «A survey and taxonomy of latency compensation techniques for network computer games,» ACM Computing Surveys (CSUR), pp. 1-34, 2022

SPG MDL

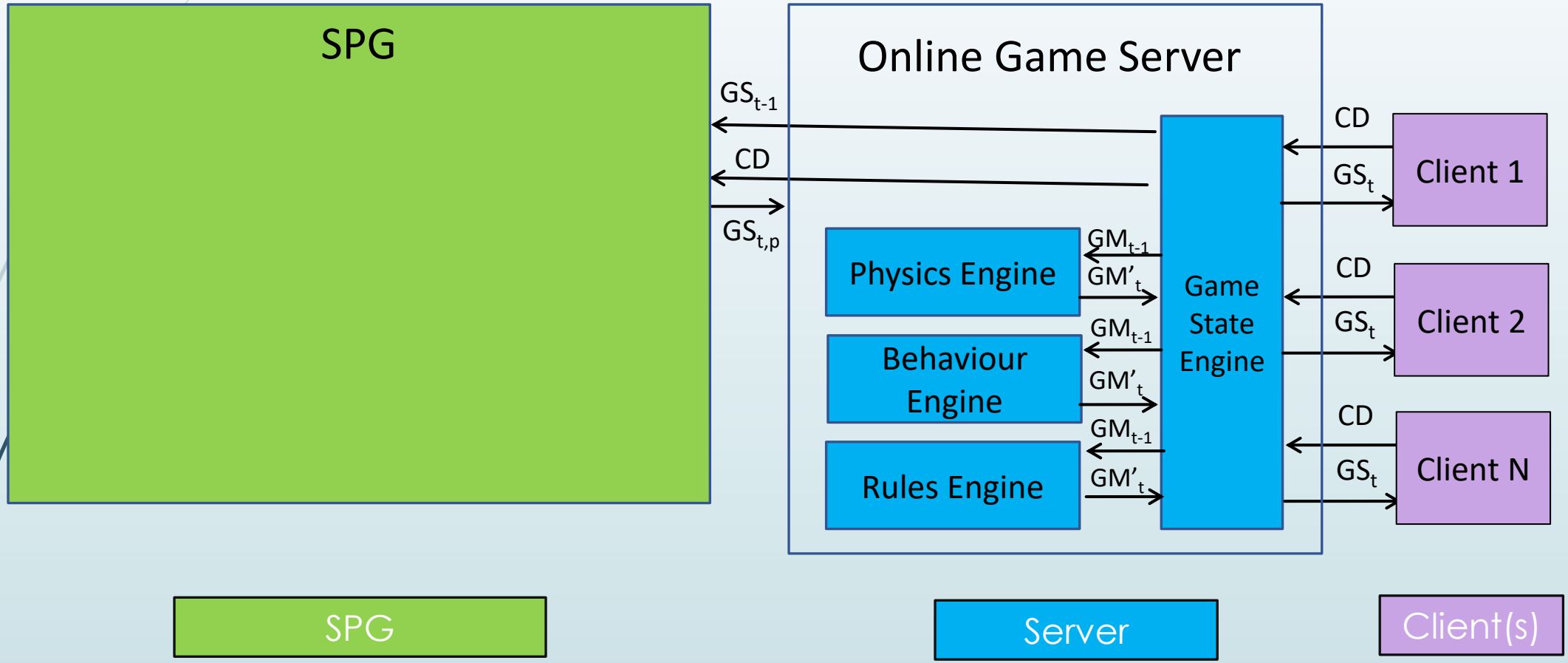
- Server-Side Prediction (SPG) – Mitigation Data Loss (MDL)
  - Server Side -> guarantees consistency and QoE for all clients
  - Prediction -> AI-based
  - Data Loss -> missing data or delayed data

SPG – Reference Model

SPG MDL - Reference Model



SPG MDL - Reference Model



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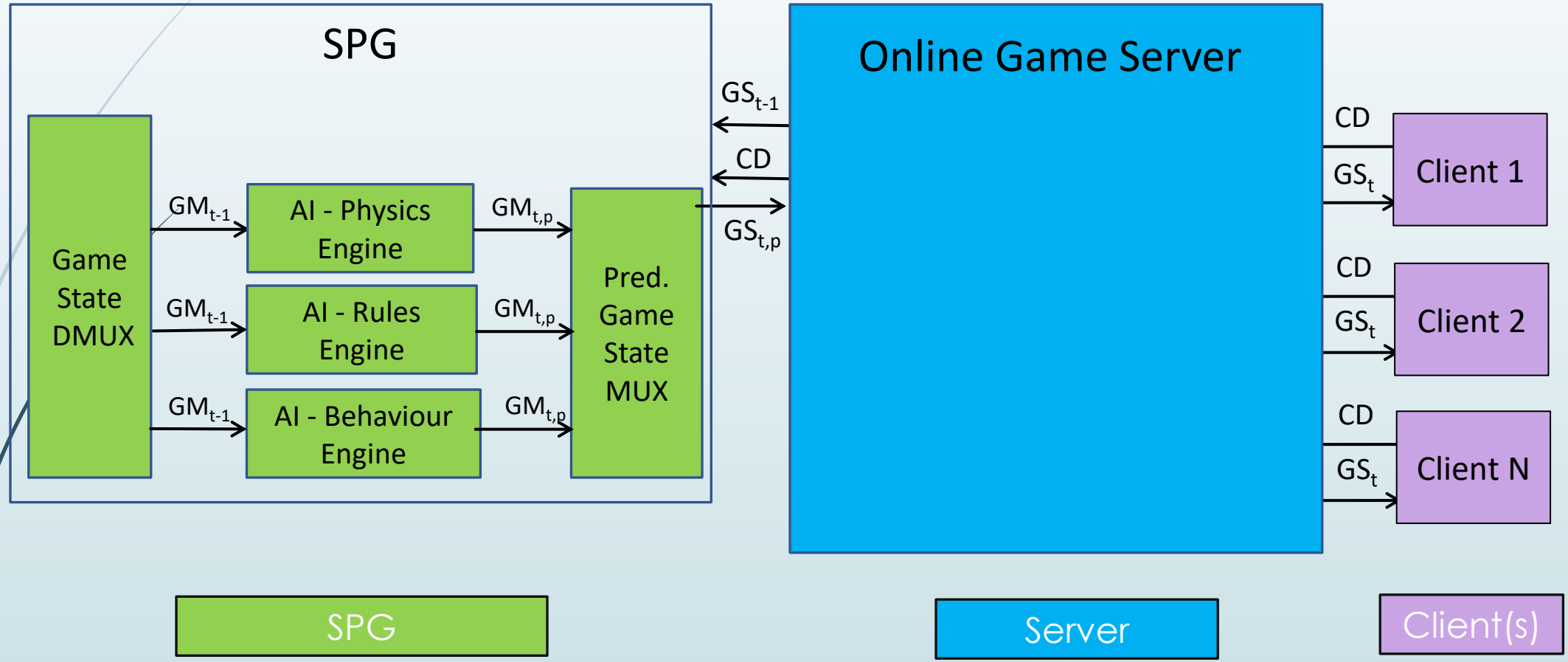

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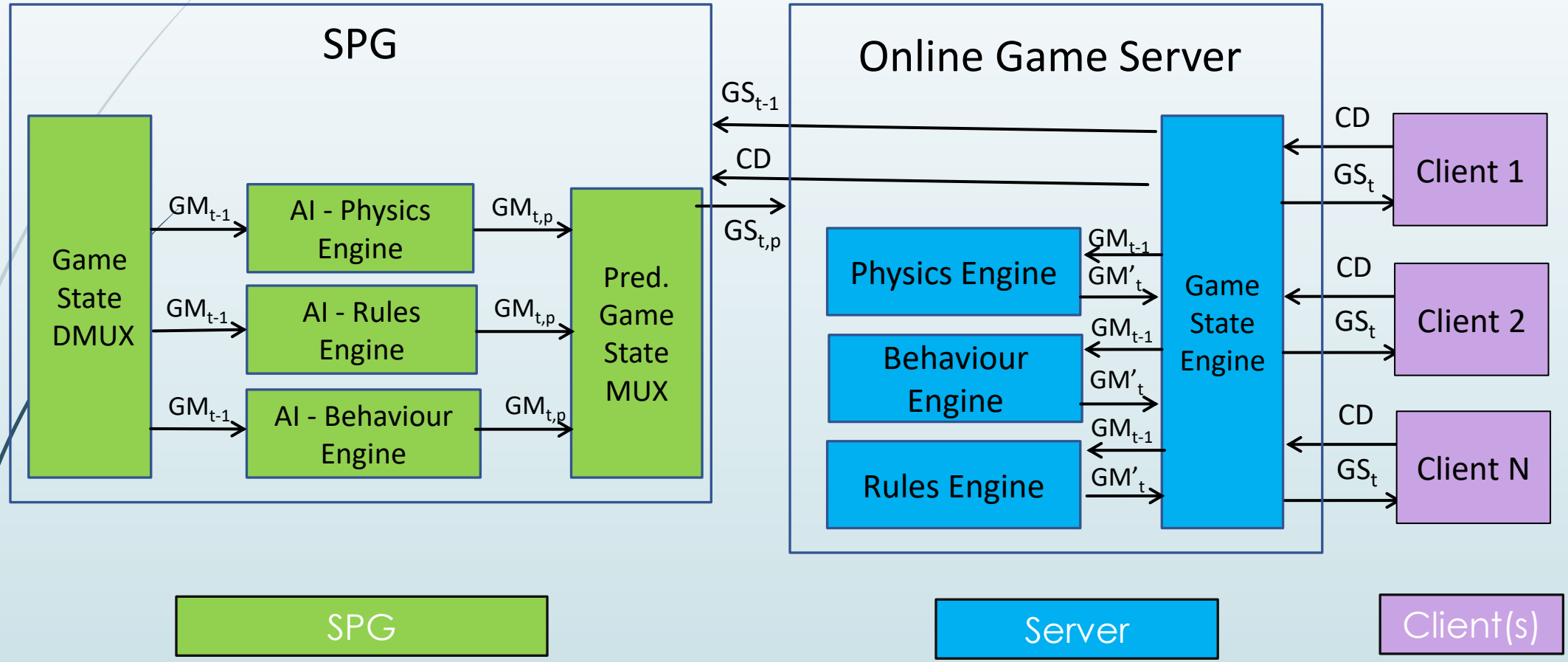
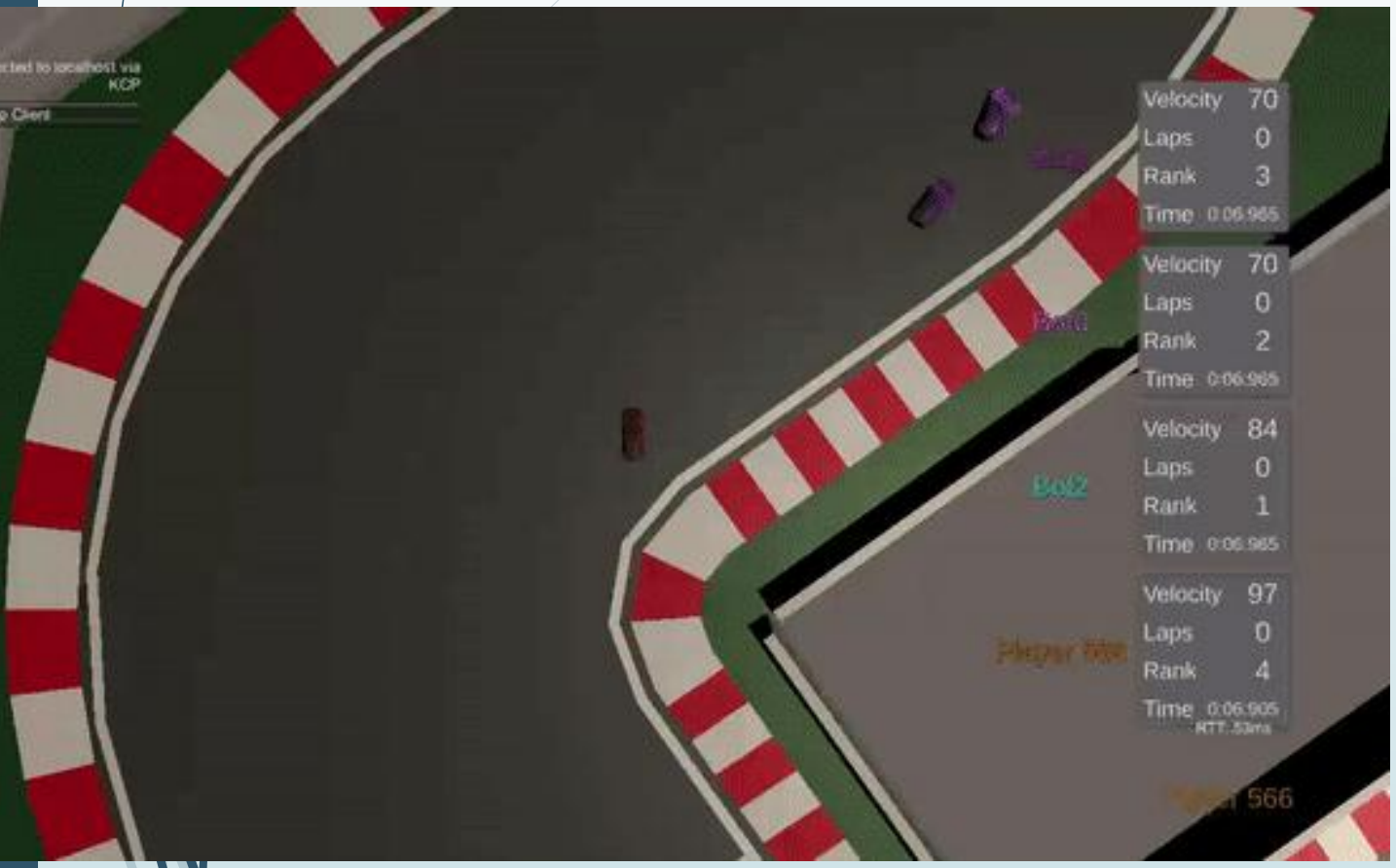


SPG – Process Guidelines

SPG MDL - Process Guidelines

- Games are intrinsically **very different from one another** as they have different:
  - Mechanics
  - Entities
  - Rules
- Defining a standard **that fits all** of them is **almost impossible**
- We decided to define a **Process** which should serve as **Guidelines**, documenting it in a **Technical Report**

SPG MDL - Process Guidelines Technical Report



- The process is composed of **10 steps**, where we provide:
  - High Level Guidelines (**WHAT** you should do)
  - Implementation Example (**HOW** we did it)
- The example is provided in the form of a multiplayer **car racing game**

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SPG MDL - Process Guidelines

- 1.**Select** the game
- 2.Define the **Entities** (to enable parameters identification)
- 3. Define the **Game State** and relevant **Entities**
- 4. **Design training** dataset
- 5. **Collect training** dataset
- 6. **Train** prediction models
- 7. **Implement SPG**
- 8. **Evaluate SPG** to select the model yielding the best predictions
- 9. Implement modules which **simulate** the **disturbances**
- 10. Evaluate the SPG enabled **game experience** with human players

SPG MDL - (1) Select the Game

Guideline

- SPG can be **applied to any** multiplayer online game (authoritative server).
- SPG must be **embedded** in the game -> having access to the source code is a requirement

Car Racing Game

- An example game was **developed from scratch**

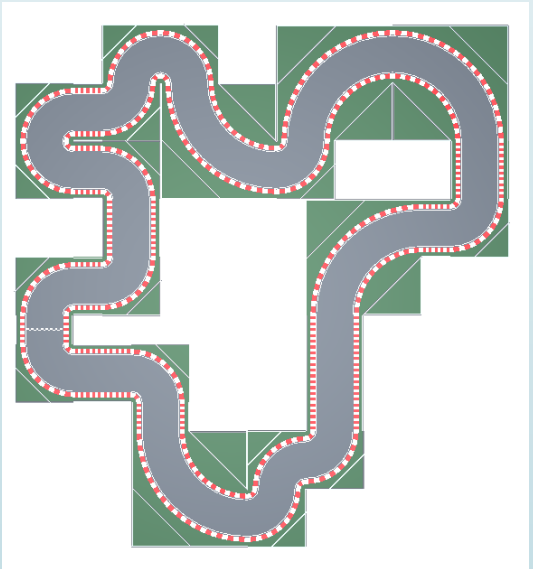
SPG MDL - (2) Define Entities

Guideline

- Identify how Entities affect the Game State to single out which of them will benefit from predictions.

Car Racing Game

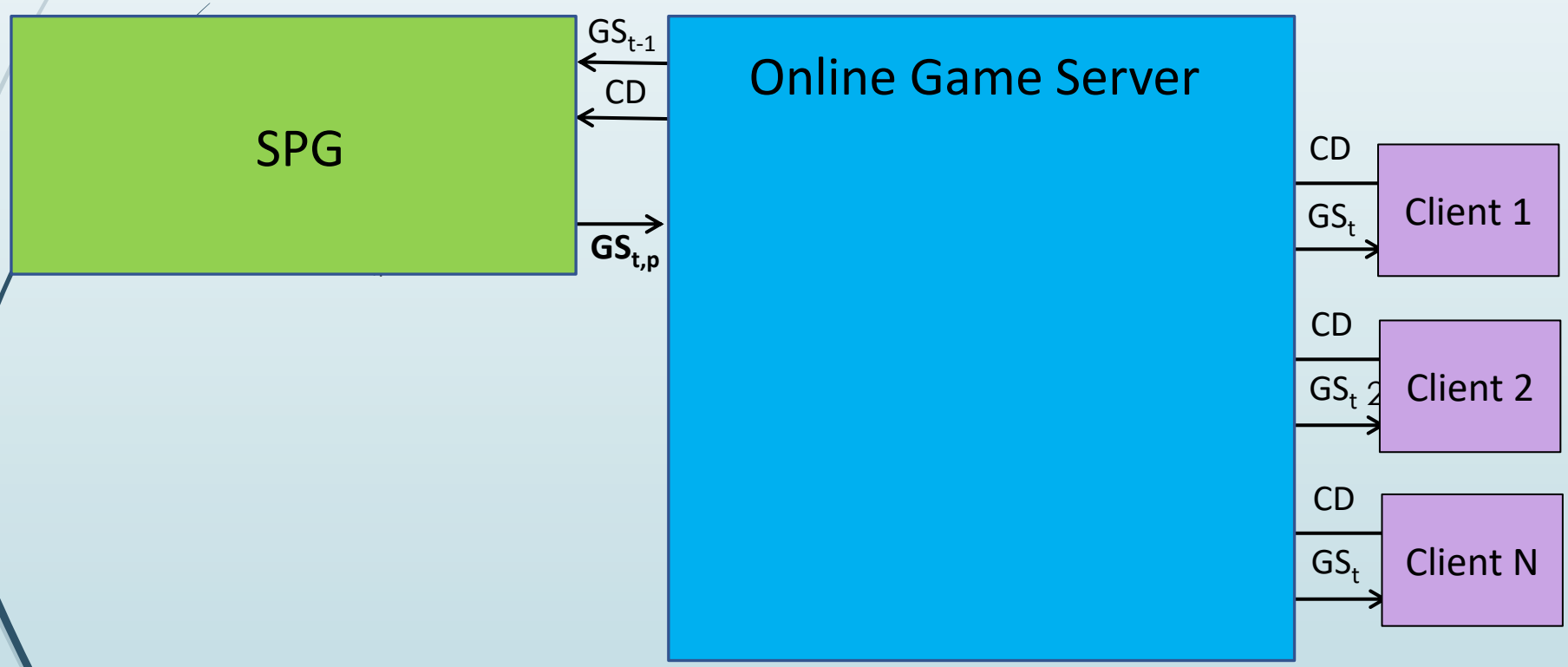
- **Cars** controlled by players racing along the **track**



SPG MDL - (3) Define Game State

Guideline

- Identify minimal set of Entities and their properties affecting the Game State
- Achieve a balance between Prediction accuracy and Model complexity



SPG MDL - (3) Define Game State

Car Racing Game

- The car's **Spatial Attitude (SA)**: Position, Orientation, Velocity and Accelleration
- Composing each car's SA the entire Game Sate can be reconstructed

SPG MDL - (4-5) Training Dataset

Guideline

- (?) Data available –> exploit **existing** dataset
- (?) No available dataset -> **create** one
  - **Human** Player -> real game sessions (- convenient + accurate)
  - **AI Agent** Player -> simulated game (+ convenient - accurate)

SPG MDL - (4-5) Training Dataset

Car Racing Game

- Exploited autonomous Agent Players to simulate numerous game sessions and collected 2 million records (50% train, 25% test, 25% validation)
- Each record is a sample containing:
  - Car's SA (entity data)
  - Car's relative position on the tile (environment data)

SPG MDL - (6) Train Prediction Models

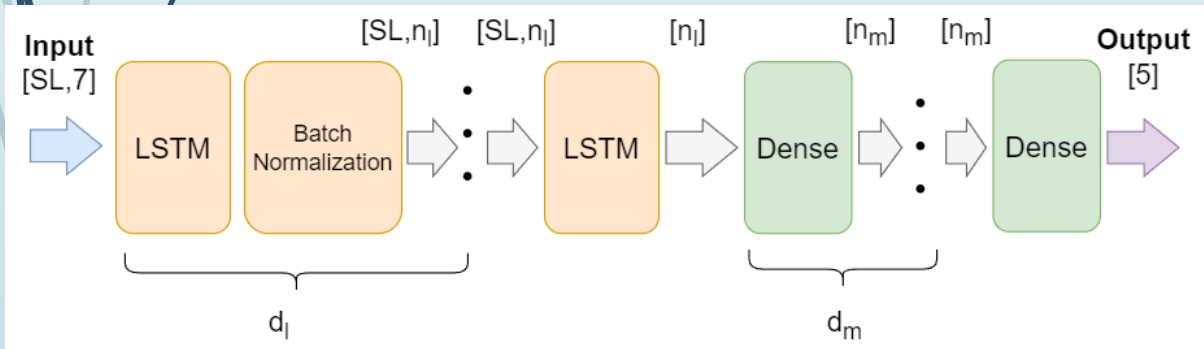
Guideline

- Time series prediction -> select a Neural Network model suitable for the task
- Train several networks exploiting:
  - Different input vectors
  - Different hyperparameter
- Select a subset of the n (e.g., 4) best networks -> lower mean absolute error

SPG MDL - (6) Train Prediction Models

Car Racing Game

- Used a deep LSTM as NN
- Input: vector of N containing car's SA + environment data from present and past
- Output: car's SA
- Selected a subset of the 4 best



ID	d_l	n_l	d_m	n_m	SL	Val MAE
1	3	64	3	64	20	**0.579**
2	3	256	3	64	20	**0.544**
3	1	256	0	0	40	**0.569**
4	3	256	3	64	40	**0.453**

SPG MDL - (7-8) Implement and Evaluate SPG

Guideline

- Implement the SPG predictions in the game
- Two possible issues:
  - Prediction **accuracy** (MAE) different between **training** and **game**
  - **Error Accumulation ->** when the input vector contains predicted data

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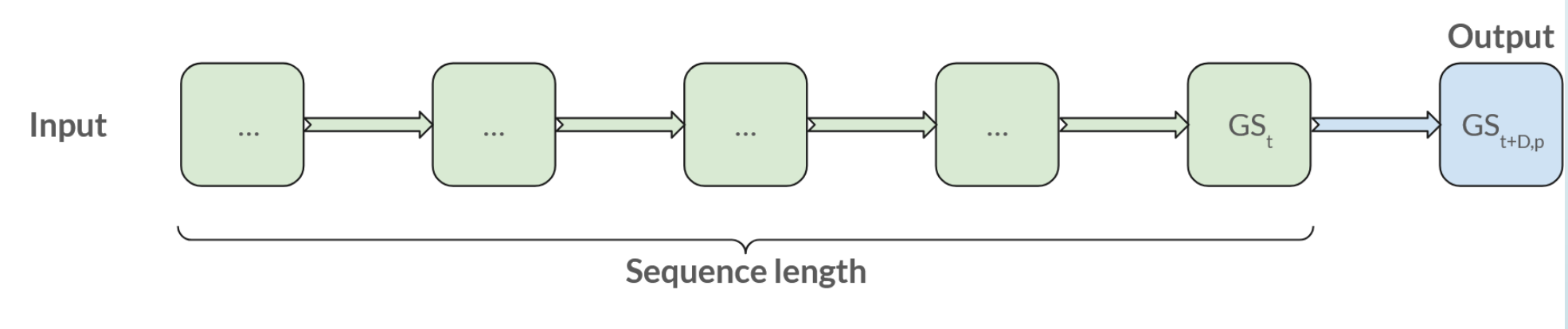

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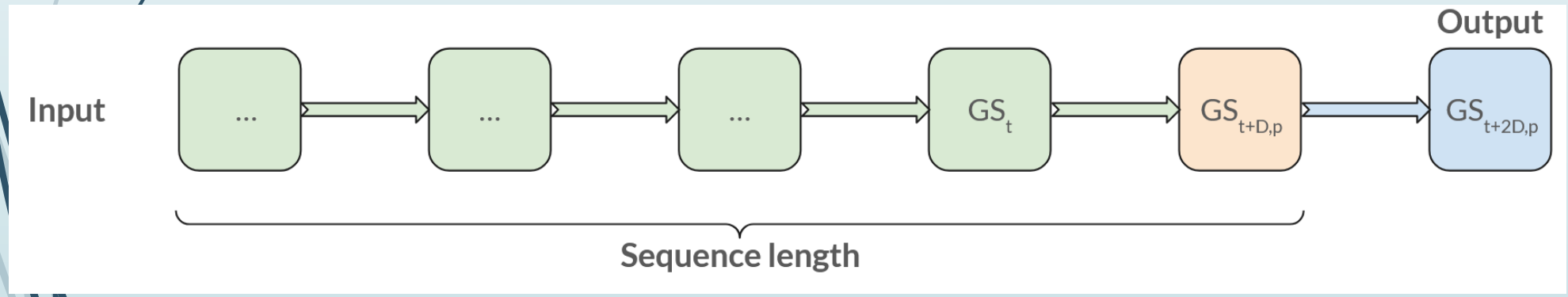

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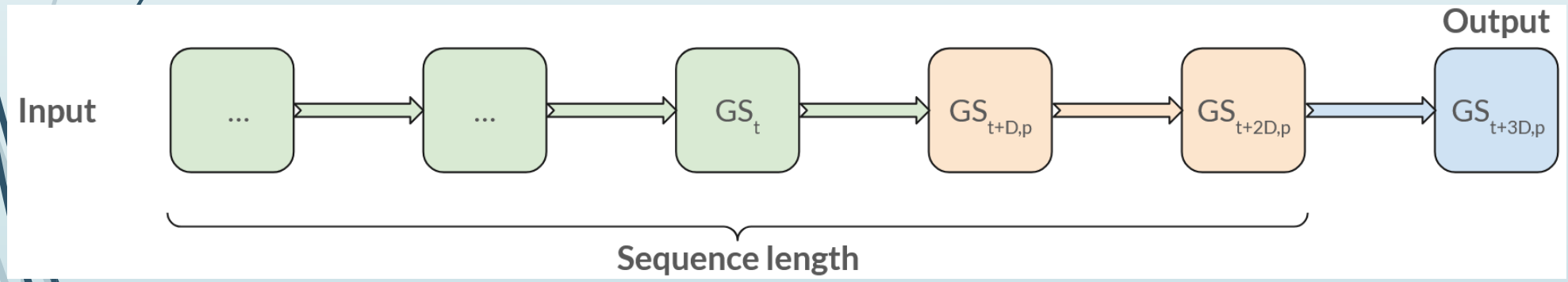

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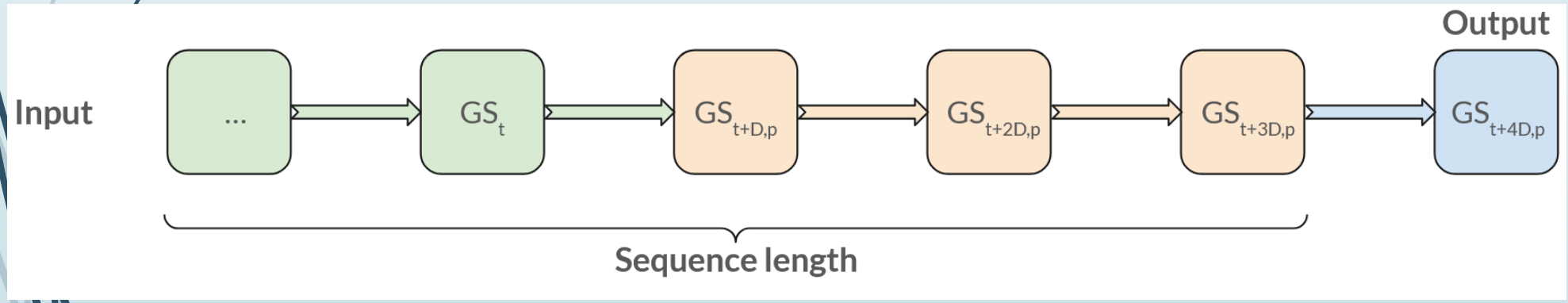
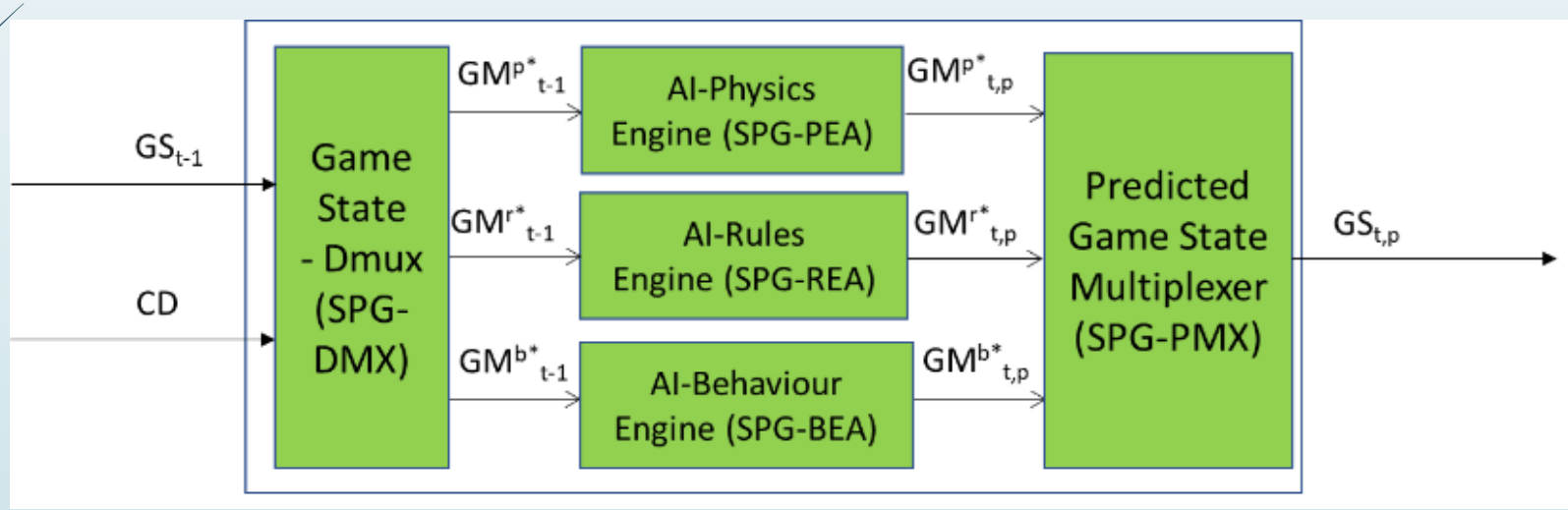


SPG MDL - (7-8) Implement and Evaluate SPG

Car Racing Game

- Implemented the Behaviour Engine AI



SPG MDL - (7-8) Implement and Evaluate SPG

Car Racing Game

- Implemented the Behaviour Engine AI
- Computed MAE for all 4 model from the pool
- Assessed the degree of Error Accumulation

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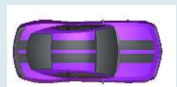
SPG predictions



AI-Driver

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SPG MDL - (7-8) Implement and Evaluate SPG

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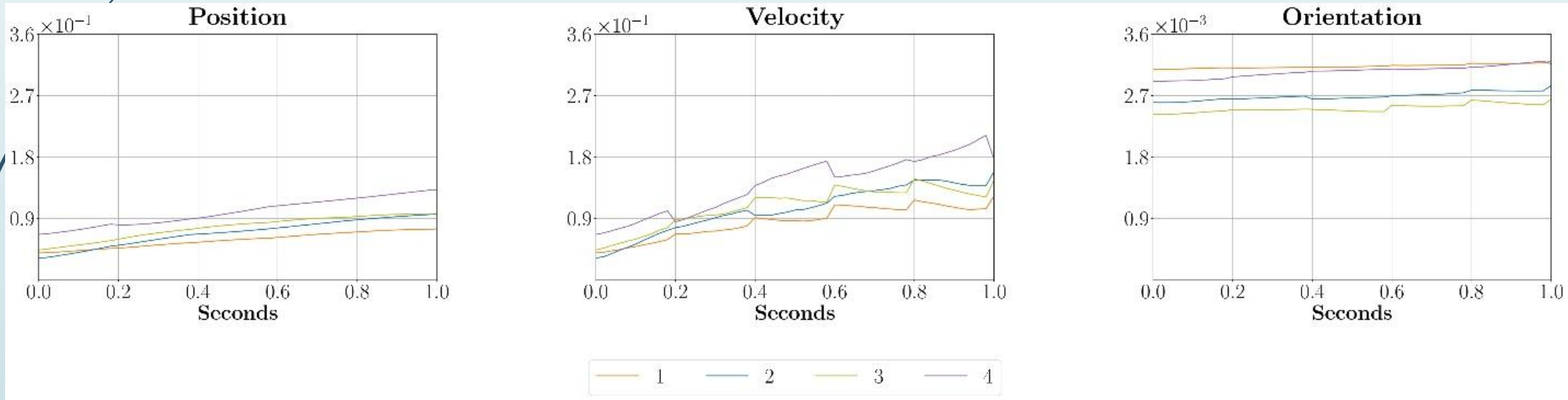

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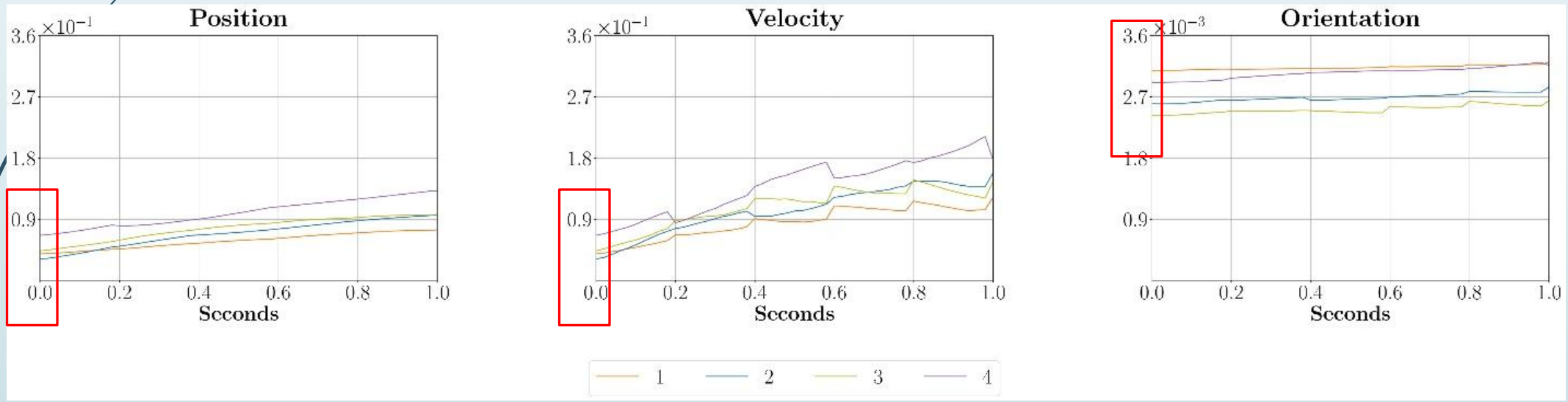

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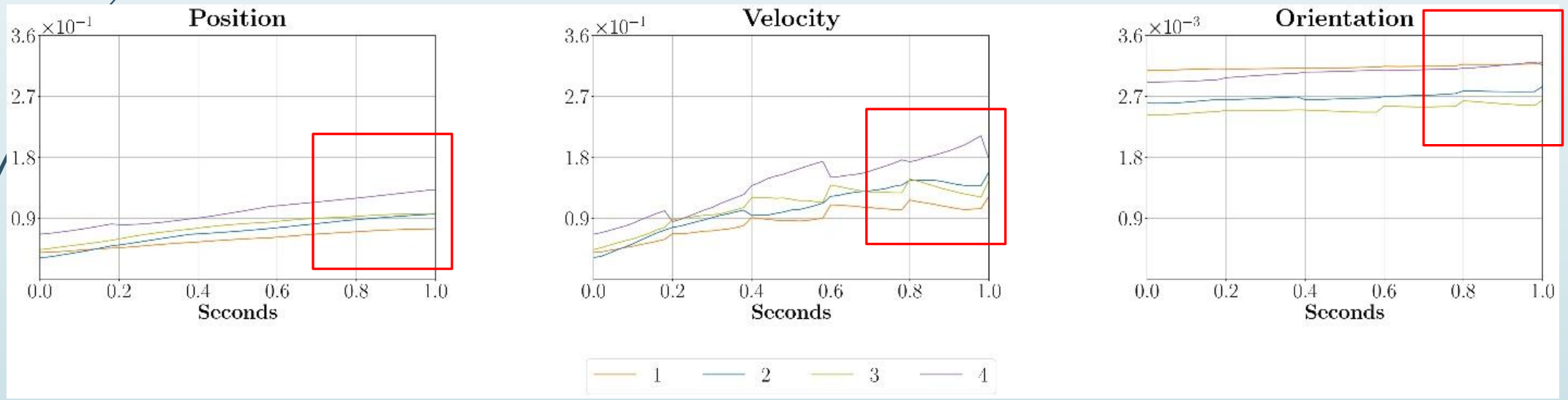


SPG MDL - (9) Simulate Disturbance

Guideline

- Simulate SPG working environment: missing/delayed data due to network issues
- Disturbance simulation:
  - Application Level
  - Network Level

SPG MDL - (9) Simulate Disturbance

Car Racing Game

- Disturbance simulated at the **Application Level**
- Implementation of a **Discard Module**
  - **Length**
  - **Interval**

DL	Length (s)	Interval (s)
DL1	0	0
DL2	0.3	10 +/- 2
DL3	0.6	8 +/- 2

SPG MDL - (10) Evaluate Game Experience

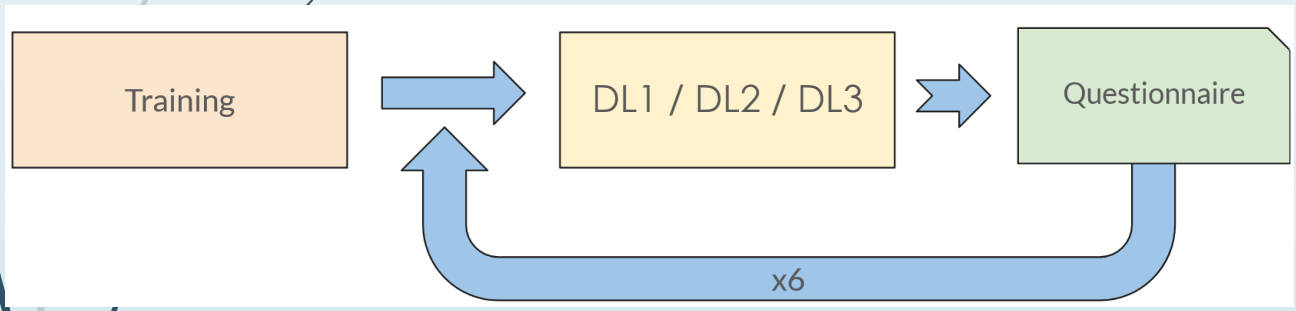
Guideline

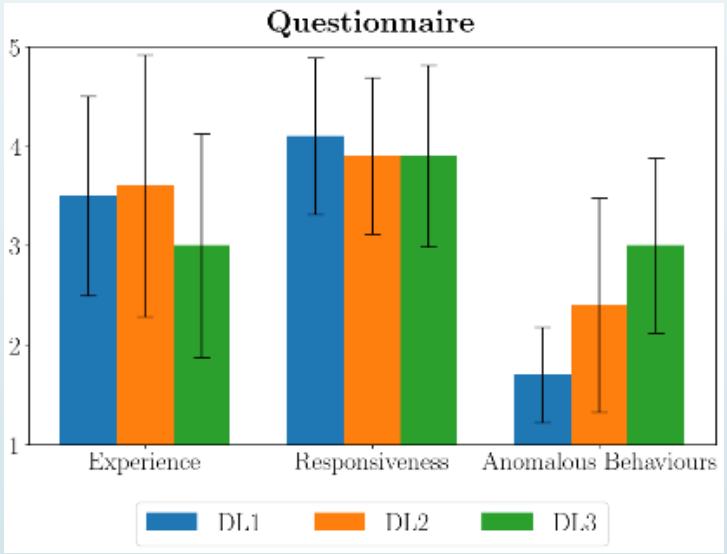
- Perform a user study (with Human Players) under 2 conditions:
  - (1) **no network disturbance**
  - (2) **simulated disturbance** with SPG active to **compensate**
- **Collect Qualitative Data addressing:**
  - Perception of anomalous behaviors
  - Game responsiveness
  - Overall gaming experience

SPG MDL - (10) Evaluate Game Experience

Car Racing Game

- Conducted a user study involving 12 participants





SPG MDL – Future Works

- Test different models -> for example diffusion models instead of LSTM
- Extensive testing with real players
- Real player data collection -> for a refined dataset
- Instead of game state prediction, use AI agents as forecasters to take over when data is missing

SPG MDL - Thanks to

- Leonardo Chiariglione
- Marco Mazzaglia (Tiny Bull Studio)
- Davide Cavagnino & Maurizio Lucenteforte (University of Turin)
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- Antonio Guarino & Giorgio Gamba (University of Turin)
- Daniele Spina (Politecnico di Torino)