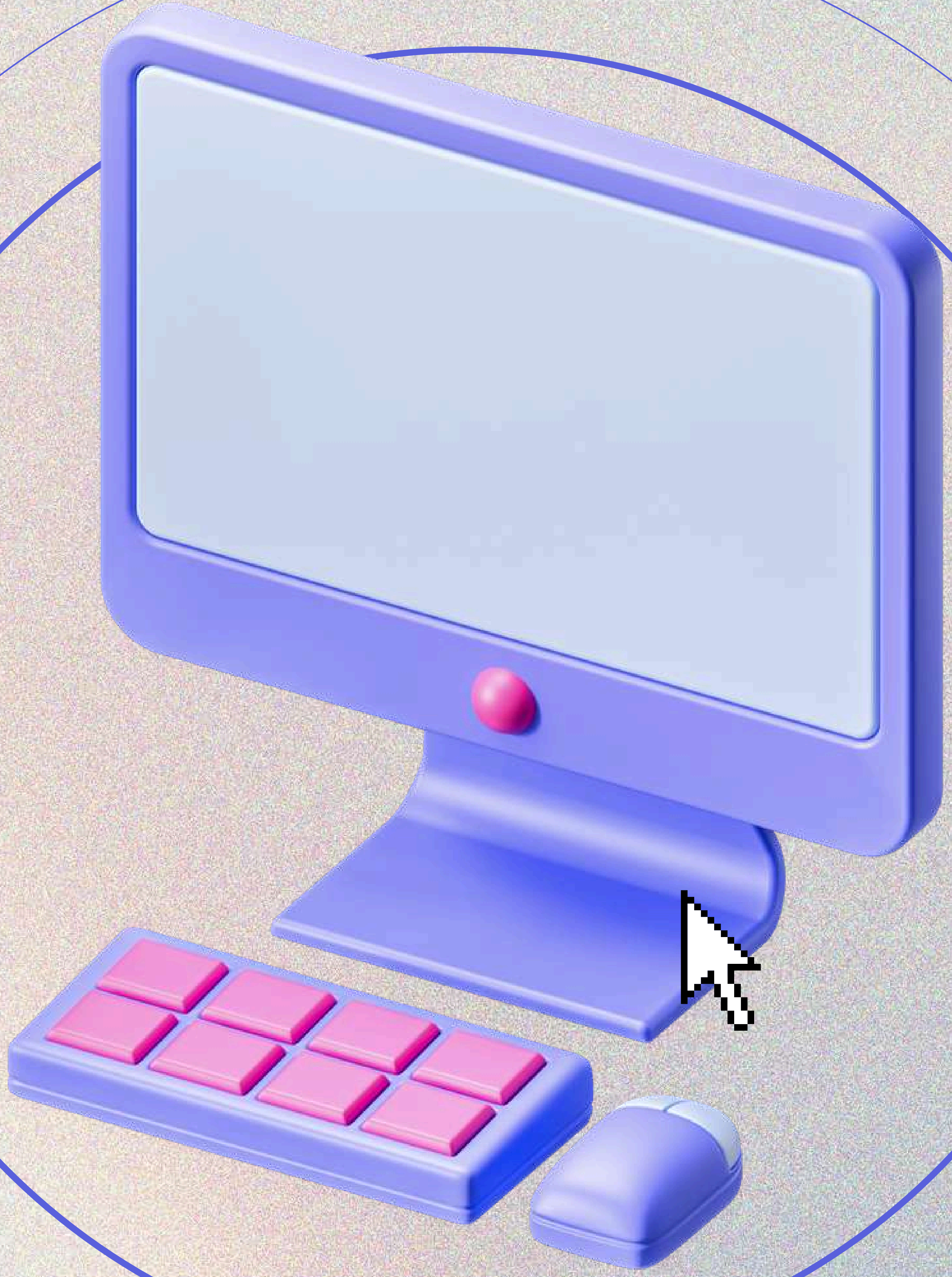
TIME WARP - OPTIMISTIC SYNCHRONIZATION ALGORITHM

GLOBAL VIRTUAL TIME CALCULATION (GVT) & SAMADI'S ALGORITHM



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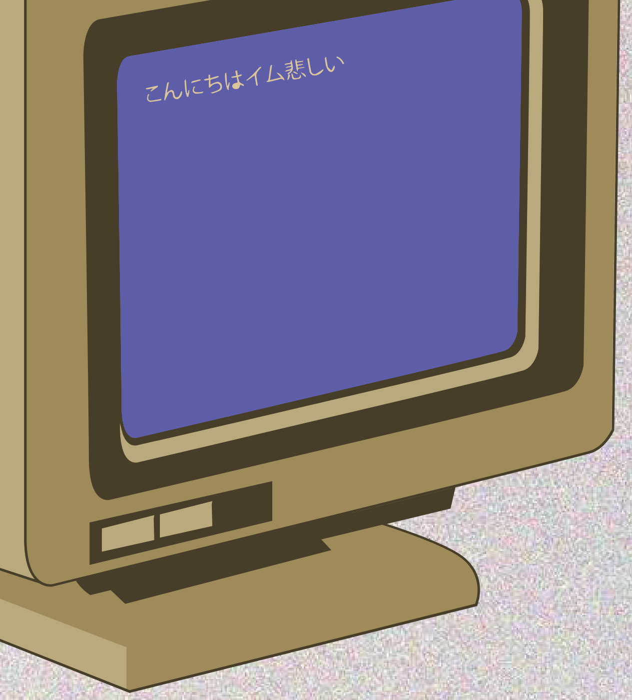
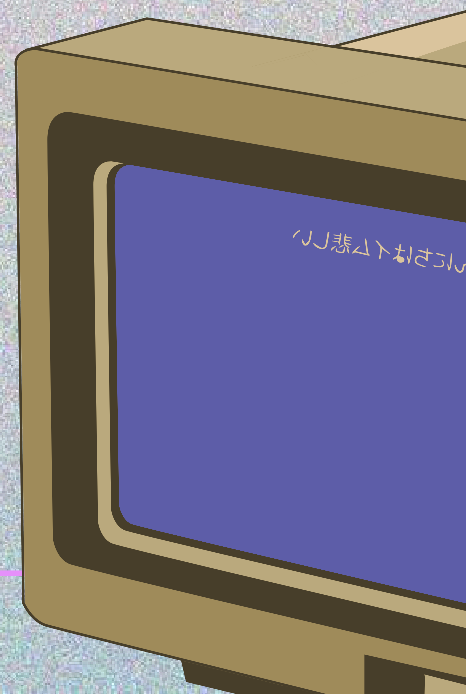
INTRODUCTION TO TIME WARP ALGORITHM

- What is Time Warp?
  - An optimistic synchronization algorithm used in parallel and distributed discrete-event simulation.
  - Allows out-of-order event execution and resolves inconsistencies via rollback mechanisms.
- Key Features:
  - Event execution optimism: Events are processed immediately without waiting for global time synchronization.
  - Rollback mechanism: Handles incorrect executions caused by events arriving in the past.



CORE COMPONENTS OF TIME WARP

1. Local Virtual Time (LVT):
   - Tracks simulation time at each logical process (LP).
2. Rollback Mechanism:
   - When a late event is received, the LP rolls back to the time of the event.
   - Cancels future events using anti-messages.
3. Global Virtual Time (GVT):
   - The minimum timestamp of all unprocessed and in-transit messages.
   - Ensures no event earlier than GVT can cause a rollback.



GLOBAL VIRTUAL TIME (GVT) CALCULATION

GVT is the minimum of:

- Local Virtual Times (LVT) of all LPs.
- Timestamps of in-transit messages.

Importance of GVT:

- Determines safe points for memory reclamation.
- Prevents further rollbacks beyond this point.

Challenges in GVT Calculation:

- Requires accurate detection of in-transit messages.
- Must account for delays in message propagation.

STEPS FOR GVT CALCULATION

<u>Snapshot Collection:</u>

- Collect LVTs from all LPs.

<u>Account for In-Transit Messages:</u>

- Consider messages in the communication network with timestamps.

<u>Global Minimum:</u>

- Compute the minimum value across LVTs and in-transit messages.

<u>Broadcast GVT:</u>

- Share the computed GVT with all LPs for consistency.

SAMADI'S ALGORITHM

Objective: Efficiently compute GVT in a distributed simulation environment.
Key Idea: Uses a token-passing mechanism to track the minimum LVT and in-transit messages.

<u>Steps in Samadi's Algorithm:</u>

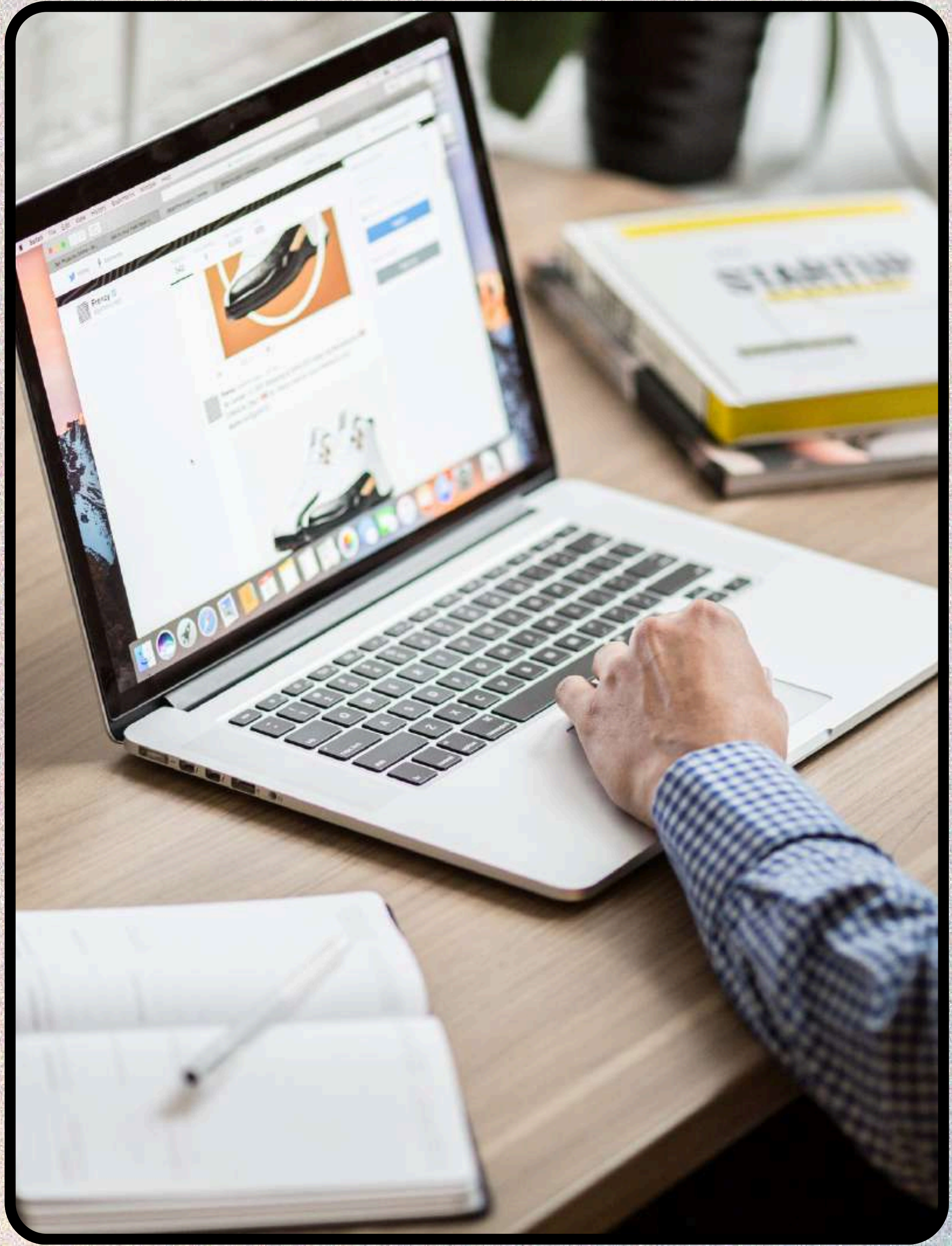
1. Token Initialization:
   - A control token is initialized with the maximum time value.
2. Token Passing:
   - Each LP updates the token with its LVT and any in-transit message timestamp.
3. Completion:
   - Once the token completes a cycle, the GVT is determined.
4. Broadcast:
   - The GVT is shared with all LPs.

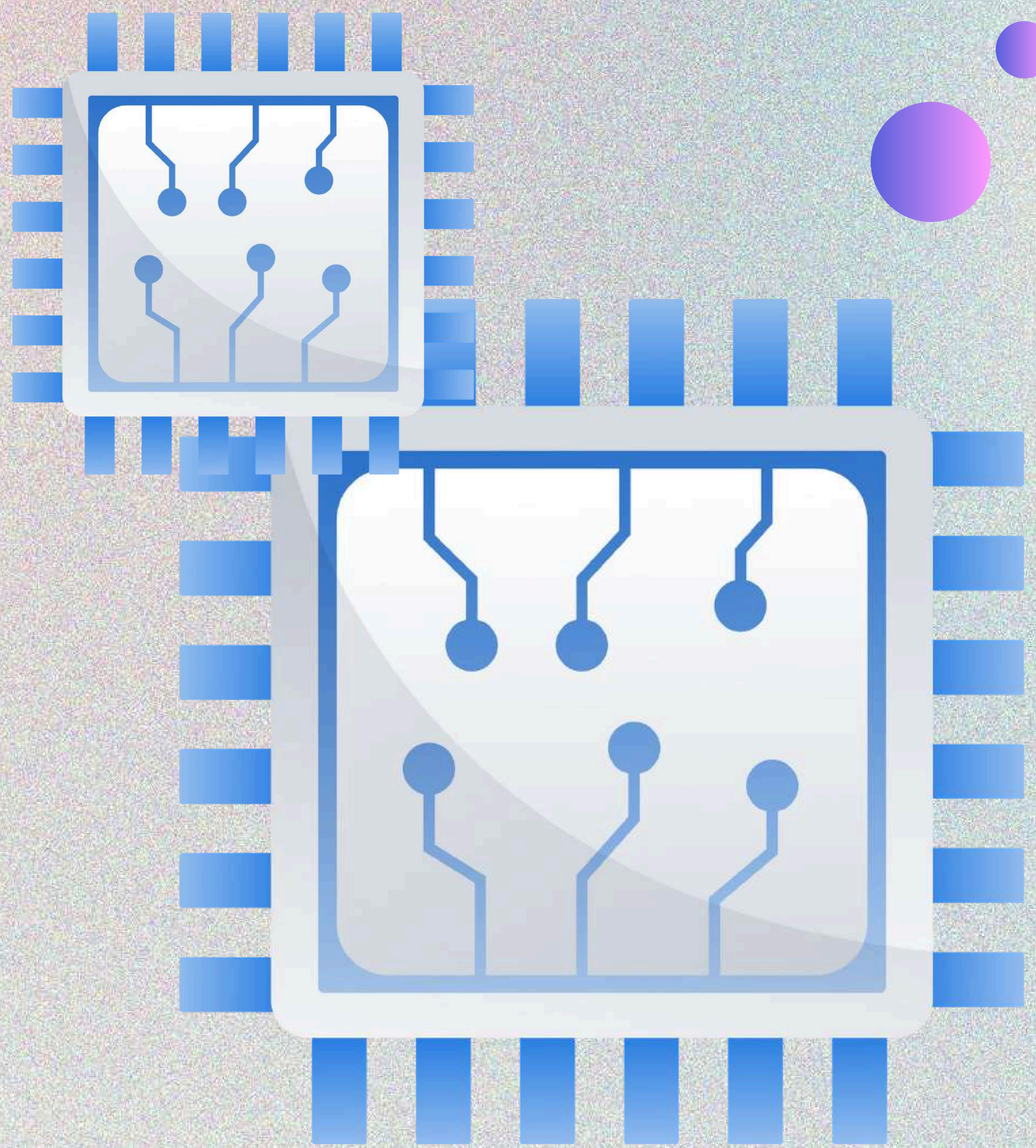
ADVANTAGES OF SAMADI’S ALGORITHM

- REDUCES OVERHEAD BY USING A SINGLE TOKEN.
- ENSURES ACCURATE GVT COMPUTATION IN DISTRIBUTED ENVIRONMENTS.
- HANDLES MESSAGE DELAYS AND NETWORK ASYNCHRONY EFFECTIVELY.

LIMITATIONS AND TRADE-OFFS

- Potential delays in GVT calculation due to token circulation.
- Requires reliable communication for token passing.





APPLICATIONS OF TIME WARP AND GVT

Parallel Discrete Event Simulation (PDES):

- Simulating large-scale systems like traffic networks, communication systems, etc.

Distributed Simulations:

- Synchronizing state updates across geographically distributed nodes.

Memory Management:

- Safe garbage collection and state restoration.

SUMMARY

- Time Warp allows optimistic event execution with rollback mechanisms.
- GVT ensures consistent state across LPs and is critical for memory management.
- Samadi's Algorithm is an efficient technique for GVT computation in distributed systems.

THANK
YOU!