Reliable and secure communication library for critical autonomous systems

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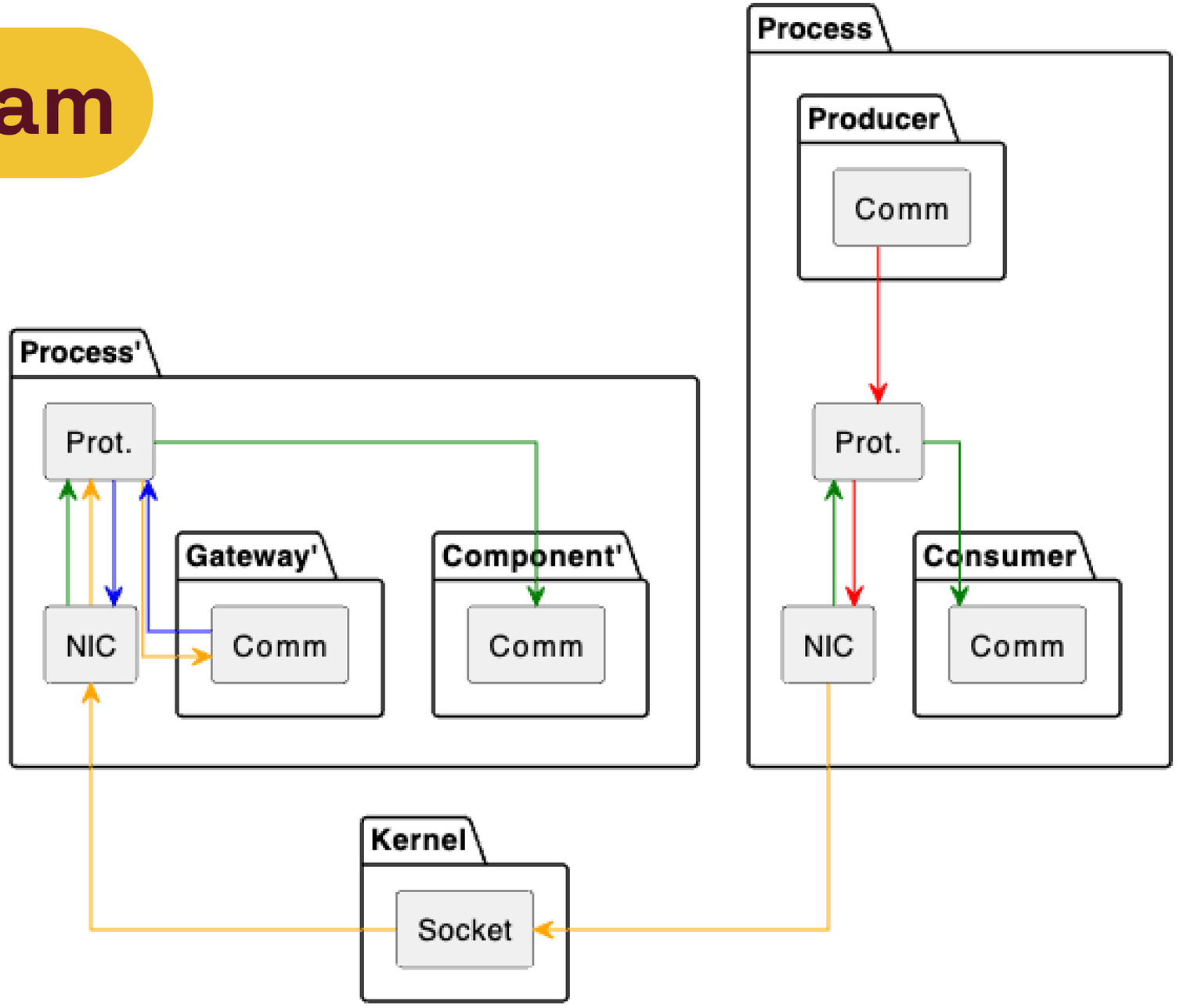
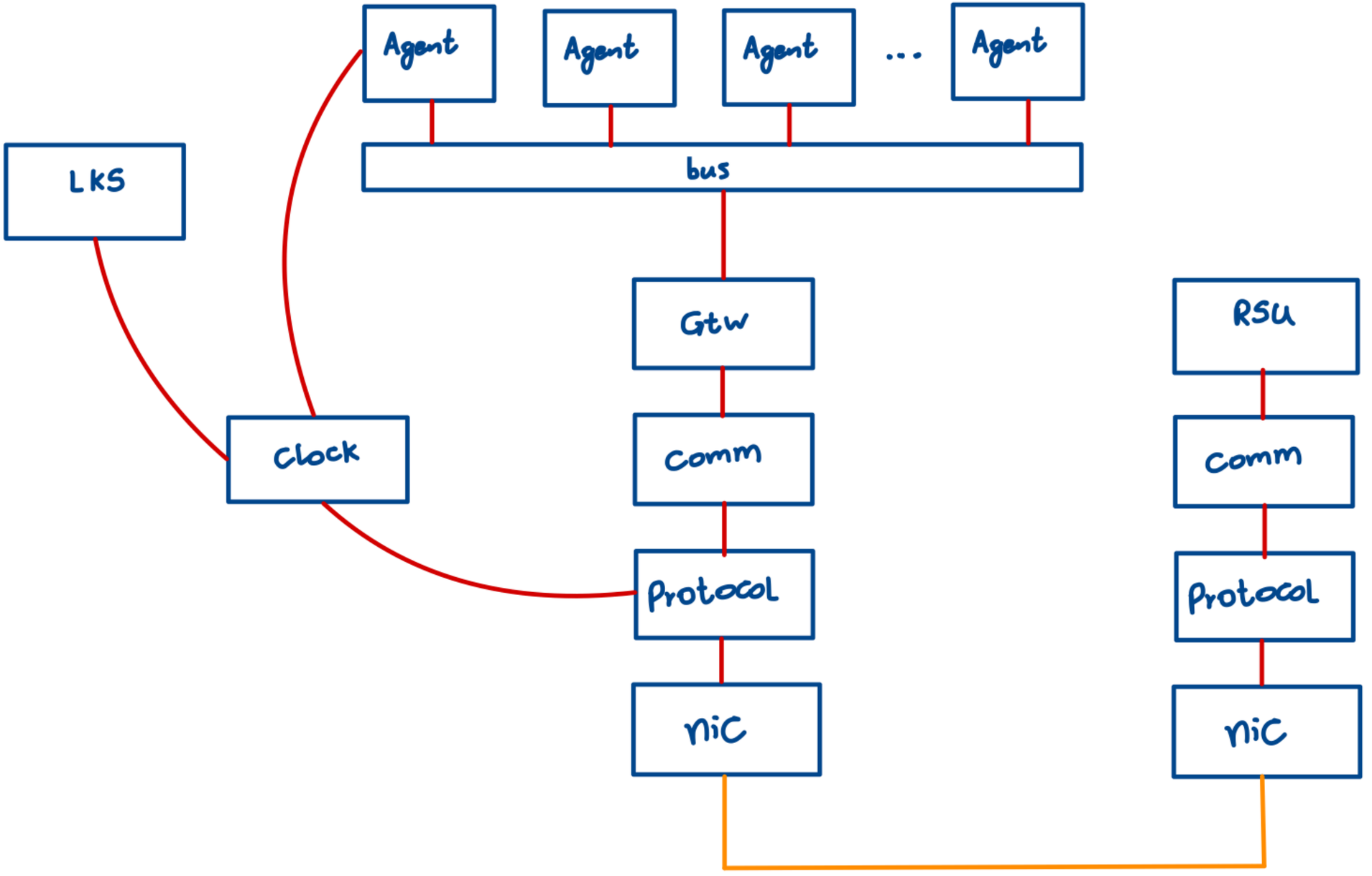
Process Diagram



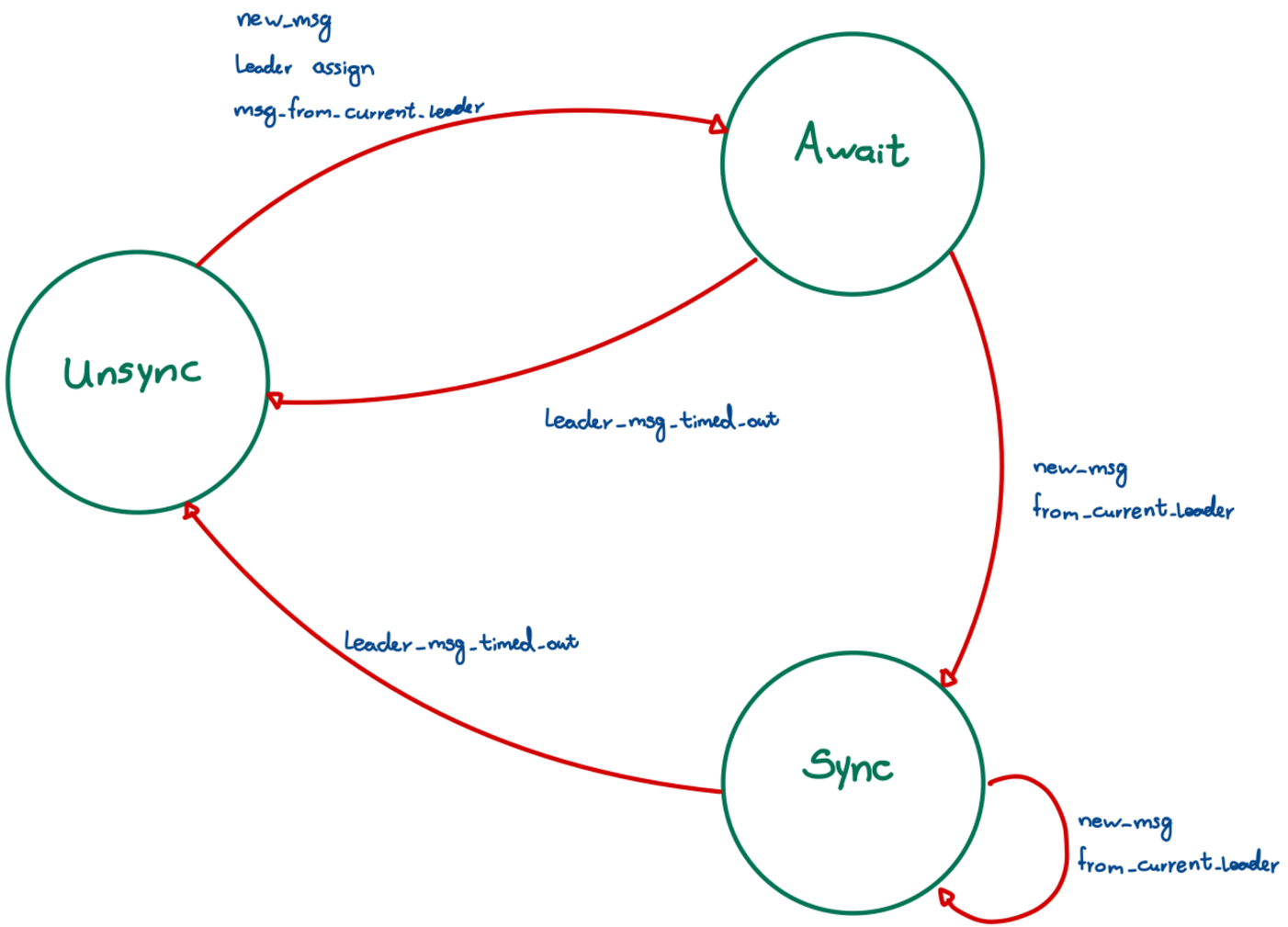

Agent
Agent
Agent
...
Agent
bus
LKS
Clock
Gtw
comm
Protocol
NIC
RSU
comm
Protocol
NIC

Clock

- **Message transmission time:** 2µs per message (tested)
- **Cumulative error limit:** 10ms (10× the 1ms precision for relaxed safety margin)
- **Assumed oscillator drift:** 20 parts per billion (ppb) Standard Crystal (HPET)
- **Message capacity:** ~250,000 messages possible during timeout period (500ms ÷ 2µs)

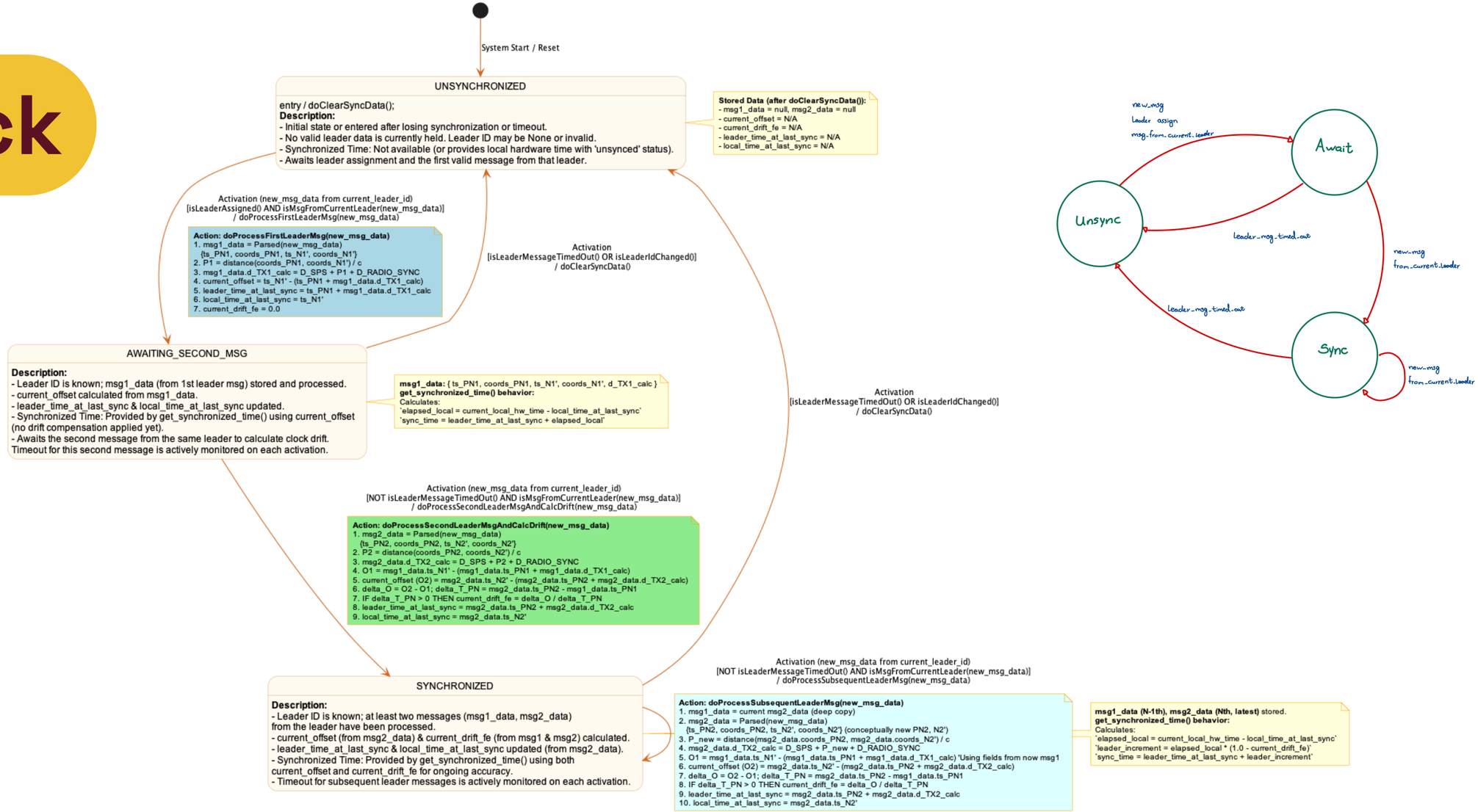
$$\text{Formula: } \text{MAX\_SILENCE} = \frac{\text{ERROR\_LIMIT}}{\text{DRIFT\_RATE}} = \frac{10\text{ms}}{20\text{ppb}} = 500\text{ms}$$

Clock


new_msg
Leader assign
msg_from_current_leader
Await
Unsync
Leader_msg_timed_out
new_msg
from_current_leader
Leader_msg_timed_out
Sync
new_msg
from_current_leader

Enhanced SPTP Clock Component State Machine

Clock



Clock Component State Machine (v2 with Activation-based Timeout)

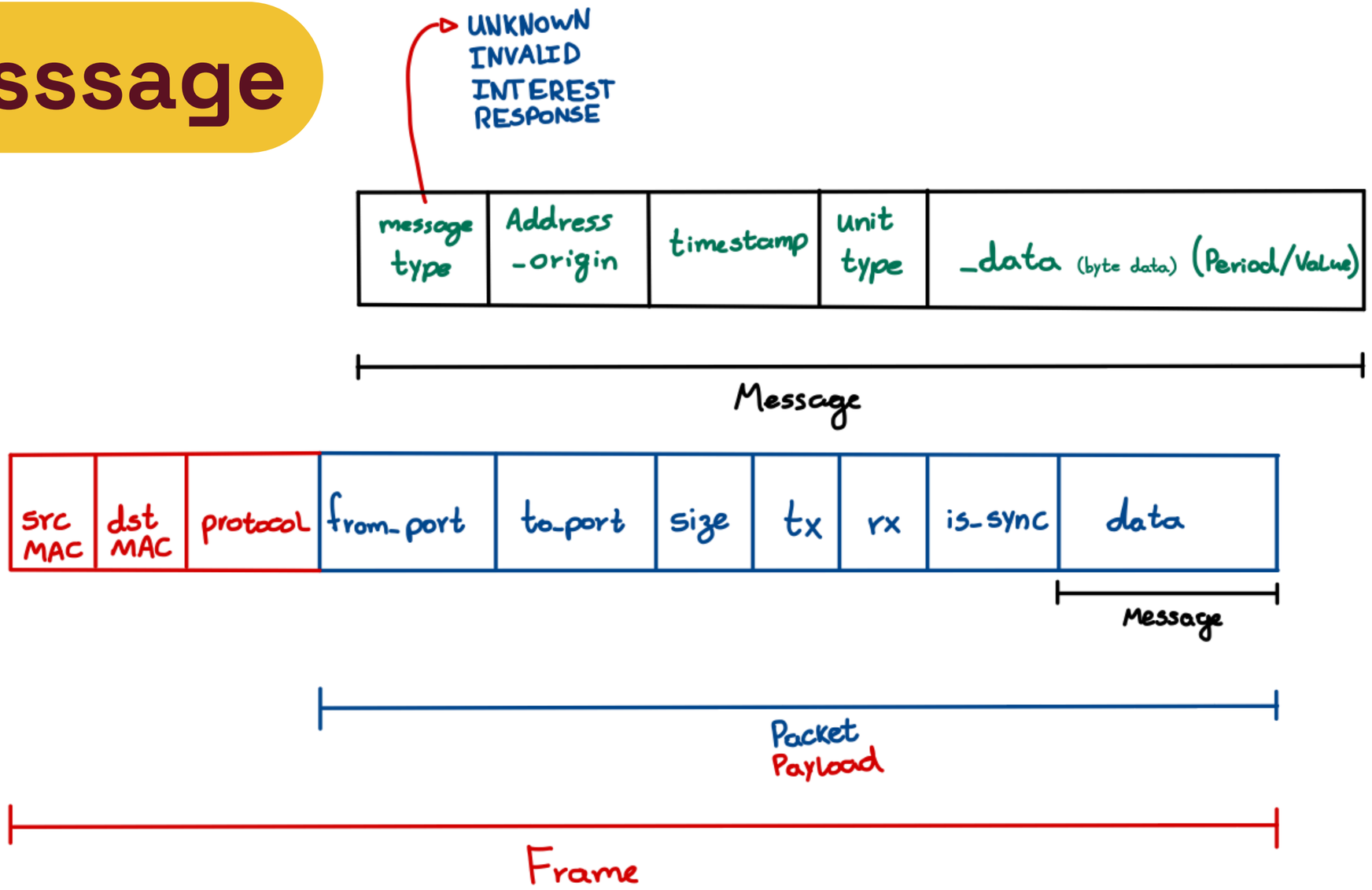
Activation Model:
- The component is activated (e.g., by any NIC message arrival, or a periodic internal check).
- During any activation, if in AWAITING_SECOND_MSG or SYNCHRONIZED state, it first checks `isLeaderMessageTimedOut()` and `isLeaderIdChanged()`. If true, it transitions to UNSYNCHRONIZED.
- Otherwise, if the activation was due to a message from the current leader, the relevant `doProcess...Msg()` action is performed.

Guard Conditions (in brackets []):
- `isLeaderMessageTimedOut()`: (hw_now - local_time_at_last_sync) > MAX_LEADER_SILENCE_INTERVAL
- `isLeaderIdChanged()`: current_leader_id differs from externally managed leader ID.
- `isMsgFromCurrentLeader(msg)`: msg.sender_id == current_leader_id.
- `isLeaderAssigned()`: current_leader_id is valid.

Constants & Functions: As defined in previous discussions.
(D_SPS, D_RADIO_SYNC, c, Parsed(msg), distance(), get_synchronized_time(), etc.)

(v2: Activation-based Timeout Check)

Messsage


UNKNOWN
INVALID
INTEREST
RESPONSE
message type
Address -origin
timestamp
unit type
_data (byte data) (Period/Value)
Message
src MAC
dst MAC
protocol
from_port
to_port
size
tx
rx
is_sync
data
Message
Packet Payload
Frame

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