
IEEE 802.1ASbt for Industrial Networks

# Segment Protection

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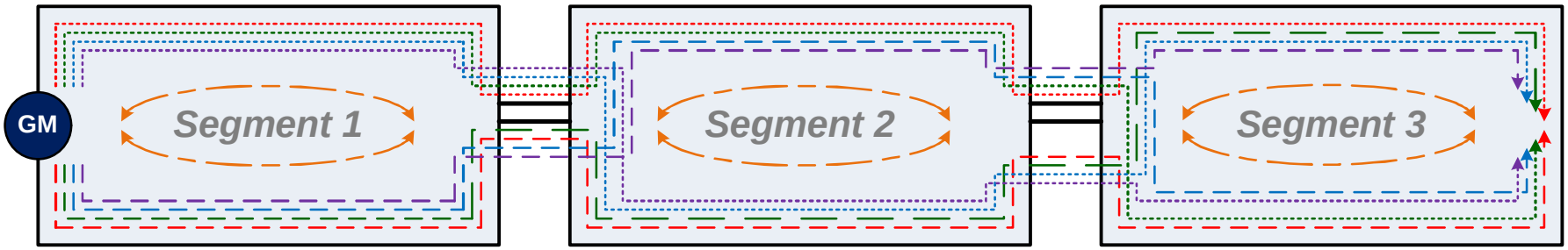
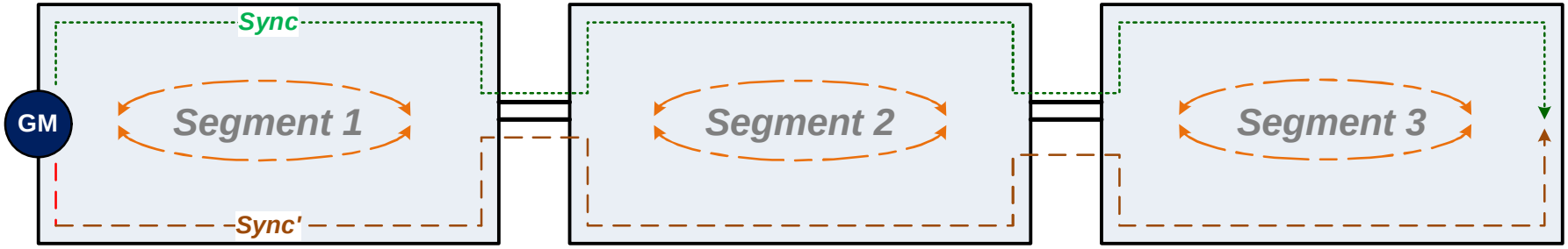
# High Available Synchronization for Redundant Coupled Rings w/o Special Sync Segment Protection Mechanism




✗ Option 1: $2^n$ redundant paths (n segments)




√ Option 2: 2 redundant paths (segment number independent)

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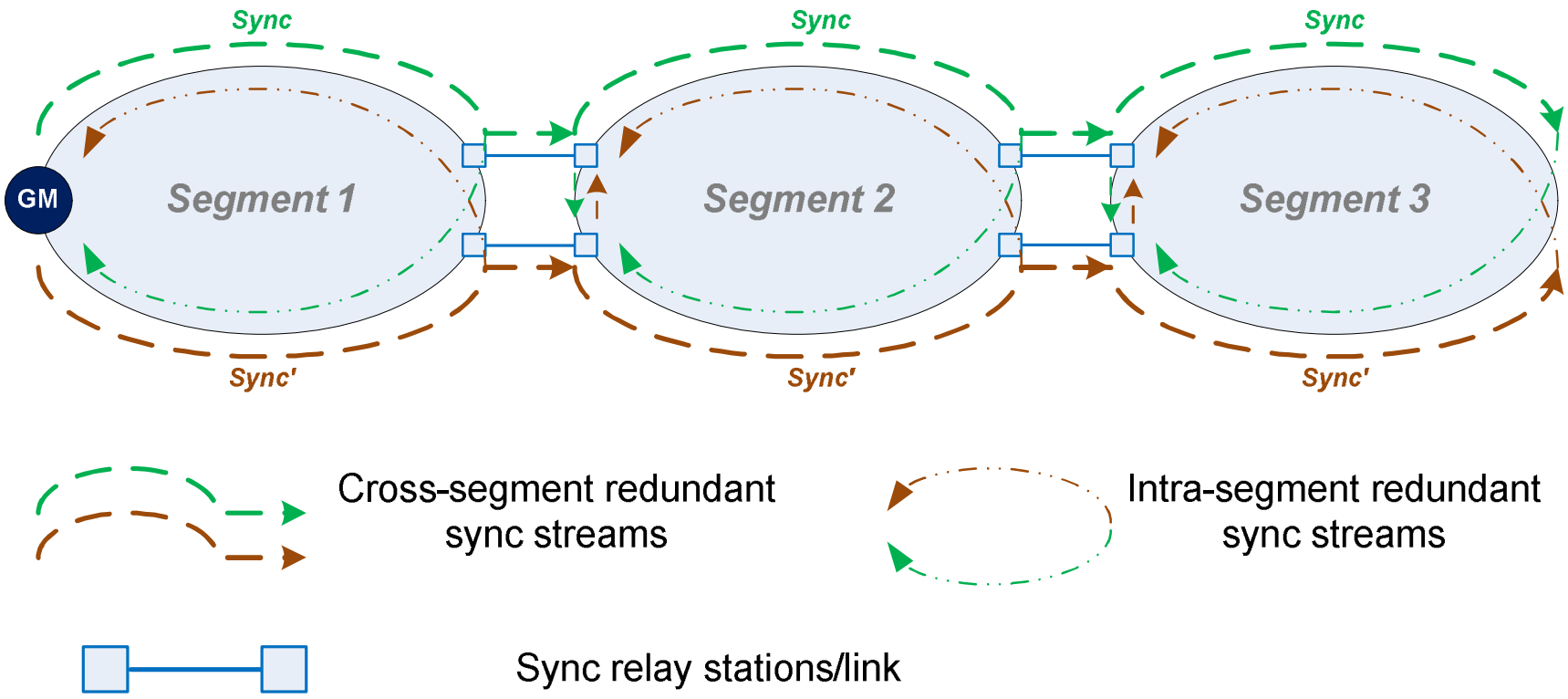
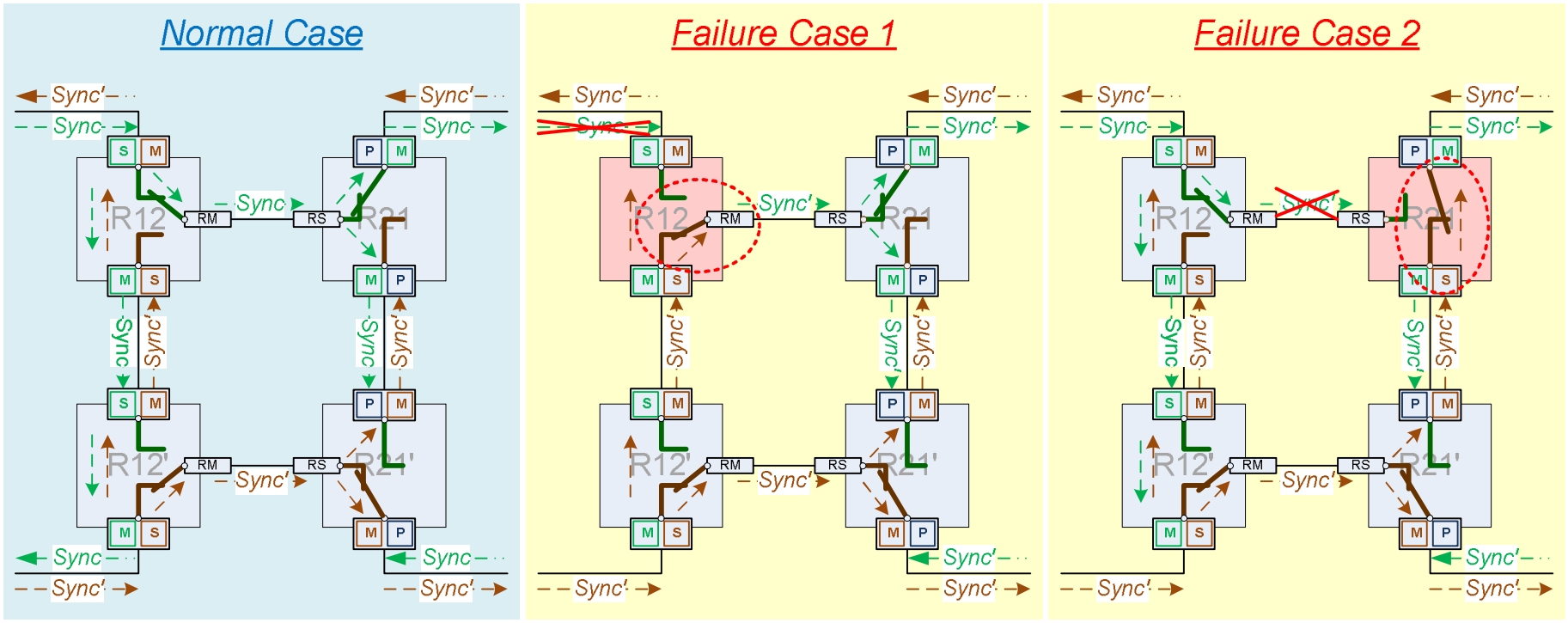
# Requirements for Sync Segment Protection in .1ASbt

- In normal cases (no link or node failure)
  - sync jitter needs to be kept as low as possible
    - Each station should be synchronized with the sync frames forwarded via a (predefined) constant path
    - This requires a timeout at sync relay stations to handle the case when expected default sync arrives later than redundant sync (due to jitter in sync propagation)
      - Buffer the redundant sync for a while until the default sync comes
- In failure cases (assume only one link or node failure in a single ring at a time)
  - Detected by previous timeout at sync relay stations
  - Switch to forwarding redundant sync only on the occurrence of three (or more) consecutive timeouts
  - Switch back to default sync only when receiving default sync within timeout for a consecutive number of cycles (e.g. 4)

# Proposal for Sync Segment Protection



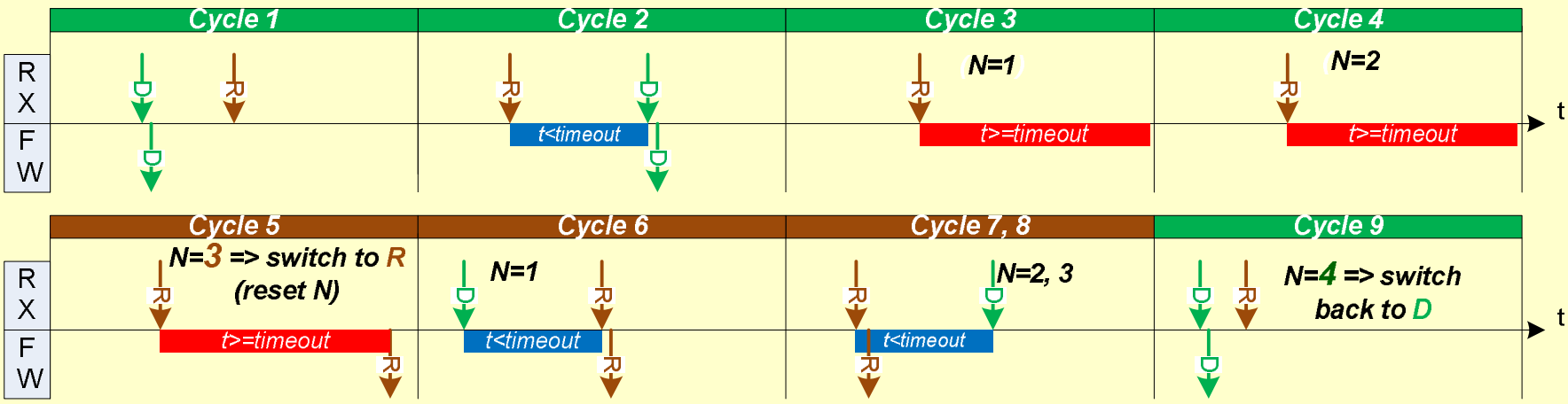
# Sync Forwarding at Relay Stations




M Master Port  S Slave Port  P Passive Port  RM Relay Master Port  RS Relay Slave Port

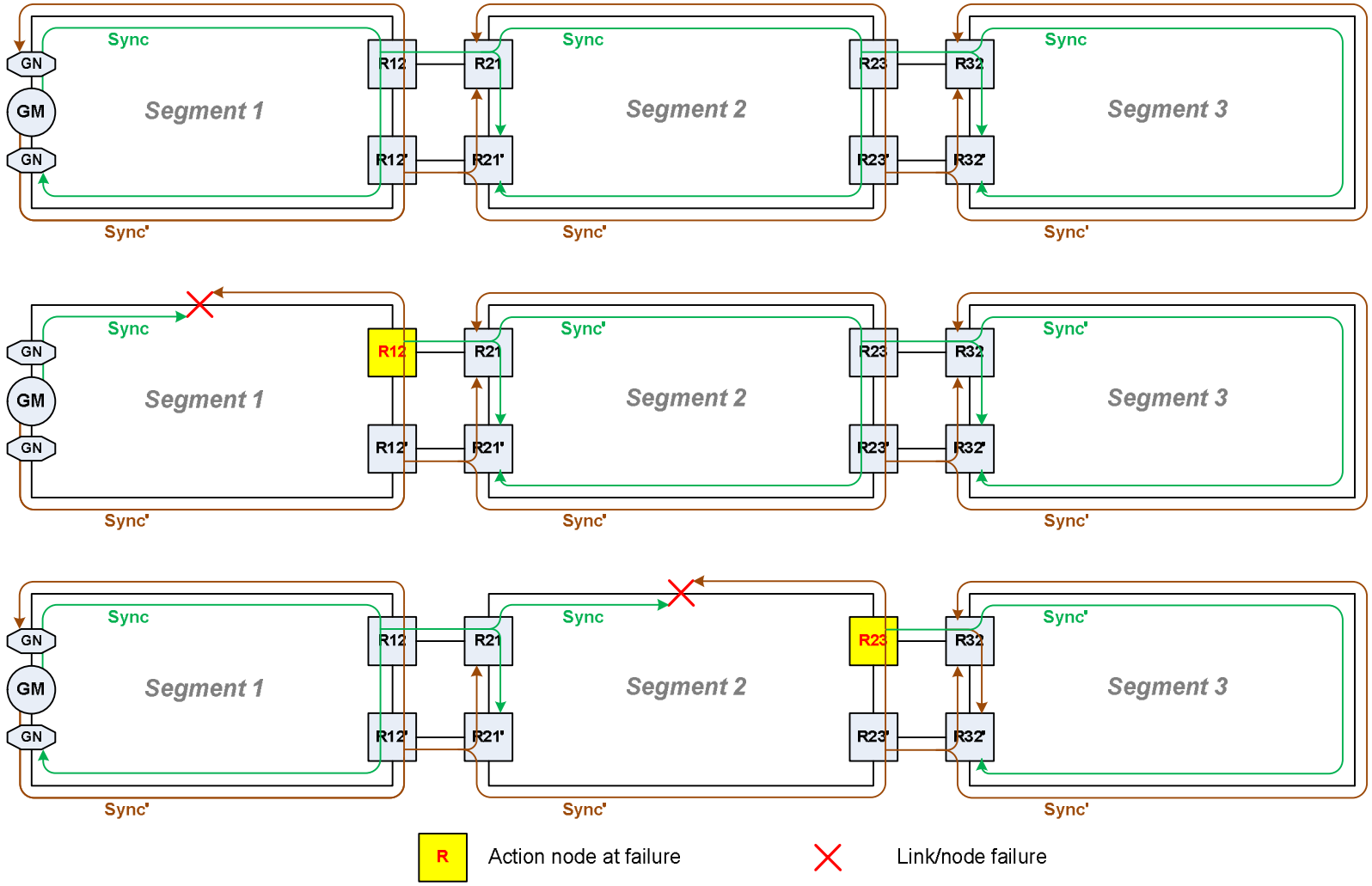
* Stations w/ RM or RS ports are **Relay Stations**

# Sync Forwarding Algorithm at Relay Stations



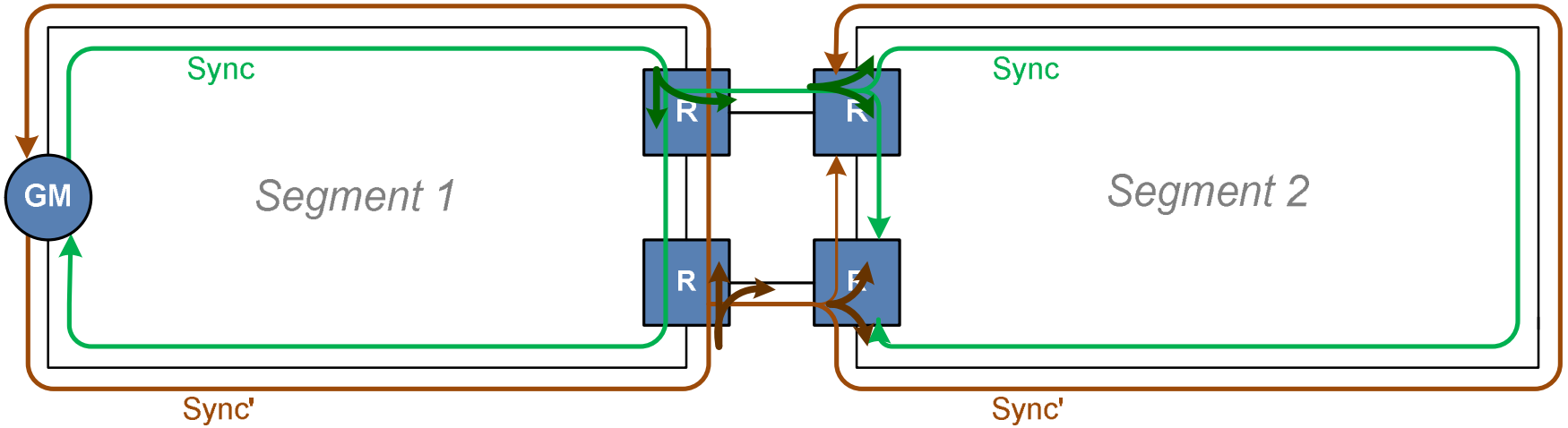

*(Note: this example assumes —D→ is default sync, e.g. at R12 and R21 in the previous slide)*

# Example: Behaviors in Normal- / Failure-Cases



# Sync Replication

## Sync Replication at GM and Relay Stations



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# Duplicate Detection/Elimination

- At each link in each direction, transmit only one Sync generated by the same GM (*GM_ID*) in the same *Sync domain* per *Sync Interval*, which must be implemented at all stations, for purposes of Sync loop prevention and robustness
- Information related to Sync duplicate detection
  - *domainNumber* (needed to support multiple Sync domains)
    - present in each 802.1AS message (in header)
    - currently support only one Sync domain (w/ default value 0)
  - *GM ID* (needed to identify GM)
    - currently NOT present in 802.1AS Sync or Follow-up messages
  - *sequenceId*
    - present in each 802.1AS message (in header)
    - but will be rewritten by each sender
  - *preciseOriginTimestamp*
    - present in each 802.1AS Follow-up message
    - assigned by GM and remain unchanged along the whole sync path
    - unique for each *Sync Interval*