HARMAN

Automotive Networks

Dave Olsen

AKG harman/kardon Infinity JBL Lexicon Mark Levinson

We are proud of our 60 years of innovation, technical excellence and multiple GRAMMY® Awards.

Automotive Topology

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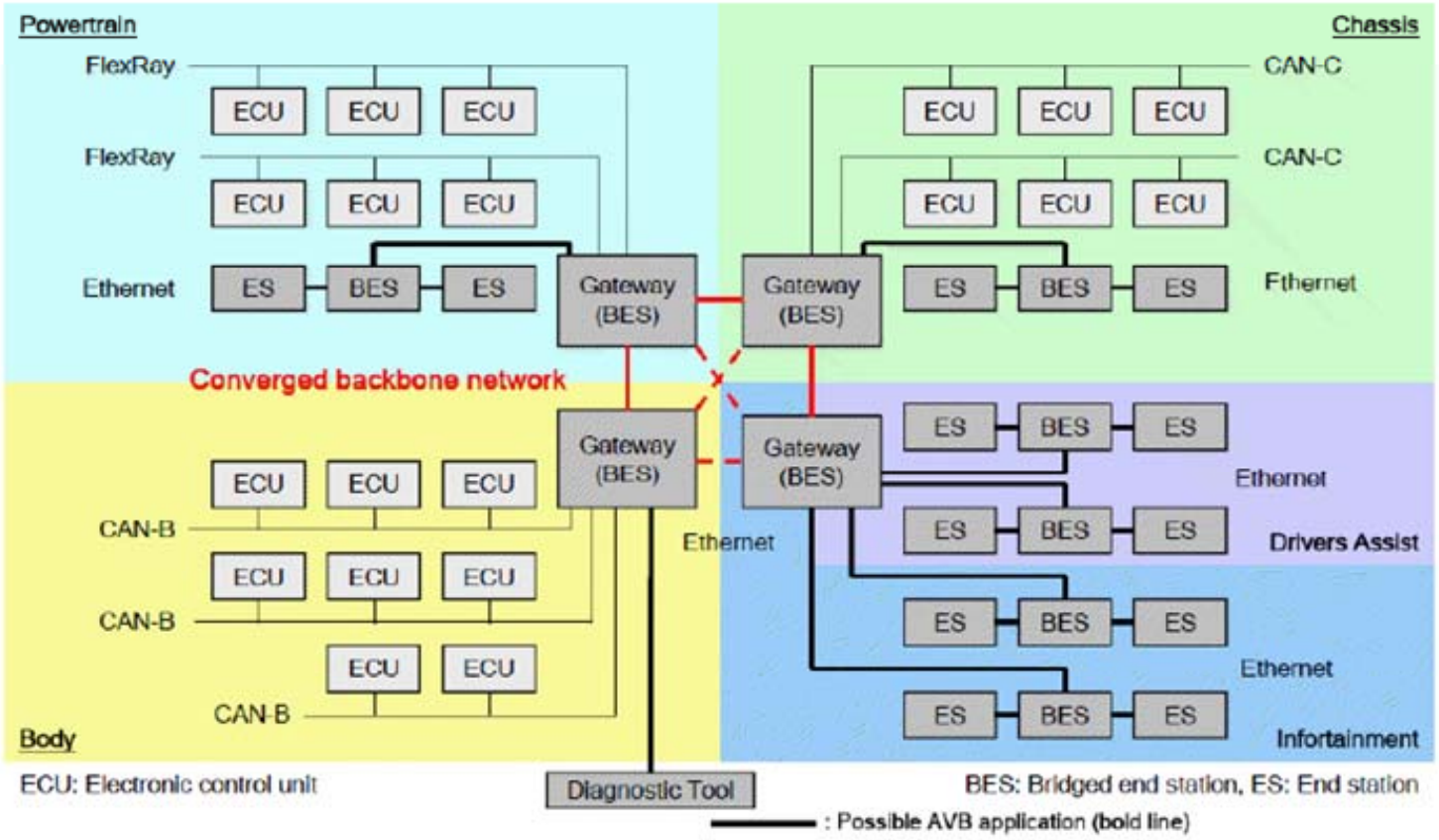

Automotive Network

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- **Automotive Network**
  - Increasing demand for bandwidth
  - Desire to reduce number of networking technologies
    - LIN, CAN, FlexRay, MOST
  - Distributed System need synchronization
  - Guaranteed QOS required
  - Guaranteed Latency required
  - 50-70 ECU’s in a modern car

Automotive Networks

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- **Current networks**
  - MOST
    - Synchronous TDMA Ring
    - 25, 50, 150 Mbps
    - Reserved bandwidth
  - CAN
    - CSMA/CR bus system
    - < 1Mbps
    - Prioritized by CAN identifier
  - FlexRay:
    - Time-triggered TDMA Bus and/or Star
    - < 10 Mbps
    - Guaranteed Latencies

CAN Messages

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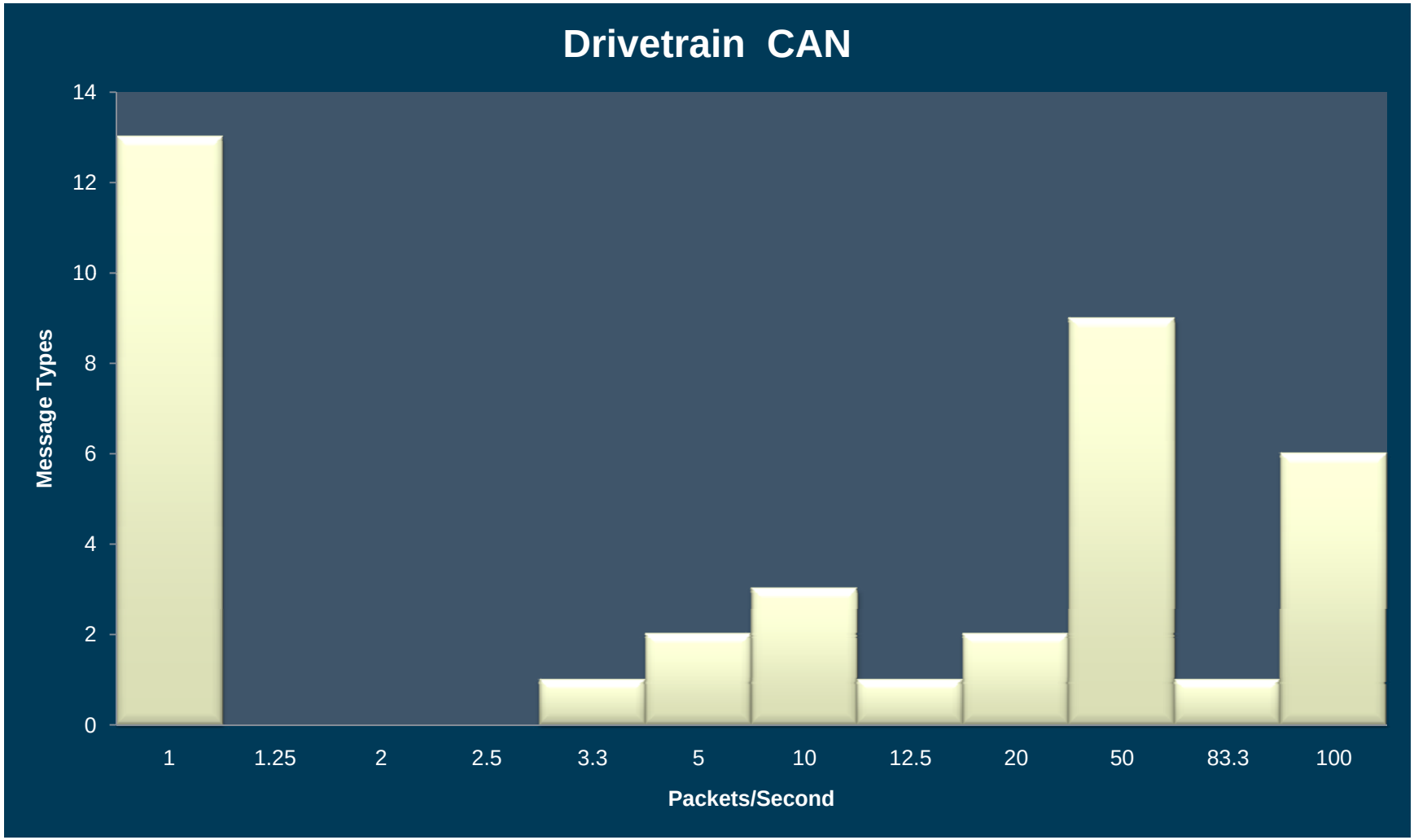
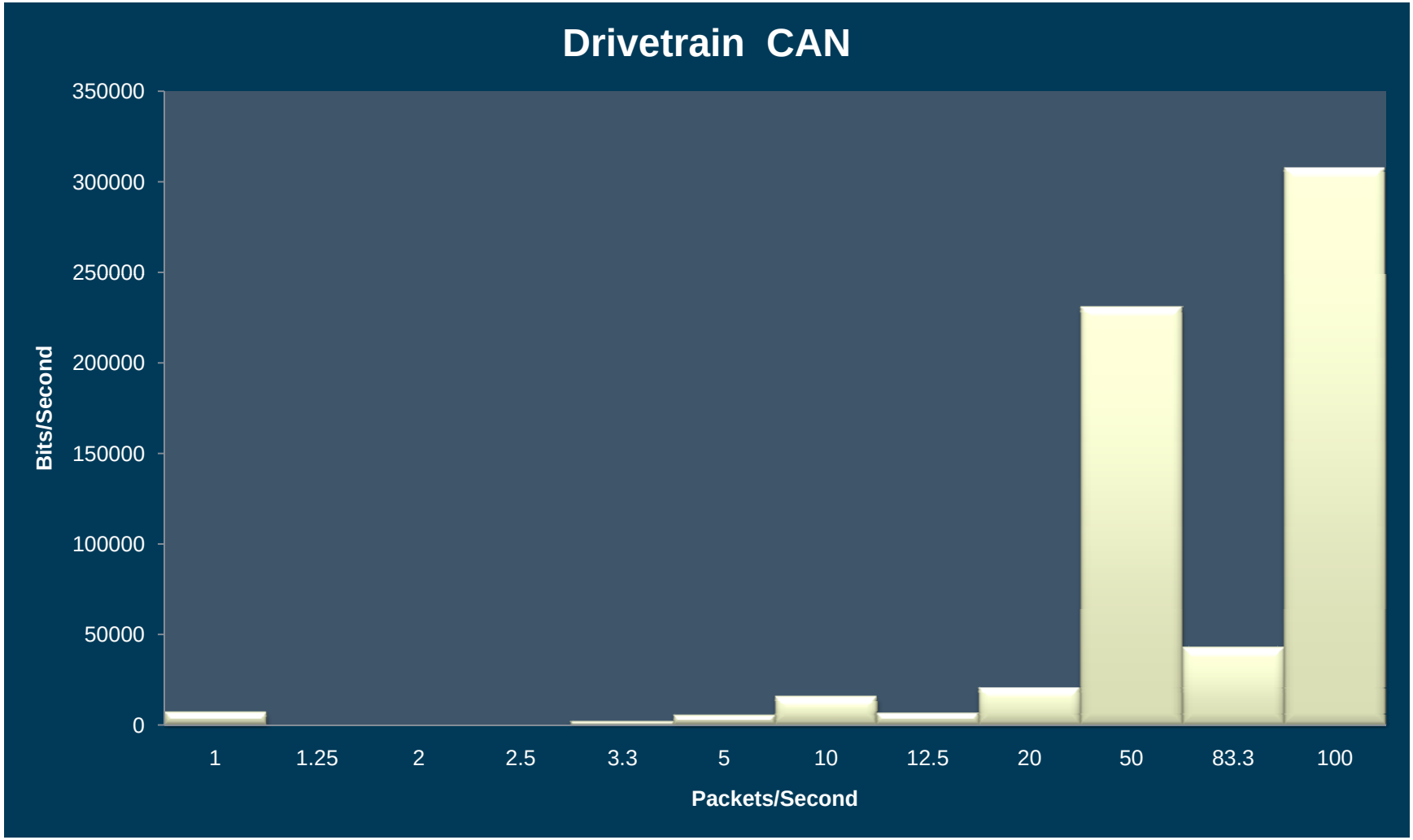
- **8 bytes of data per frame**
- **Base or Extended frame format**
  - Base: 11 identifier bits
  - Extended: 29 identifier bits
- **Messages prioritized by identifier**
- **Low latency for high priority frames**
- **Possible high latency for low priority frames**
- **Messages are unique per transmitter**
- **Two transmitters attempting to send the same message would cause a bus conflict**
- **Cyclical/Spontaneous messages**

Cyclical CAN Traffic



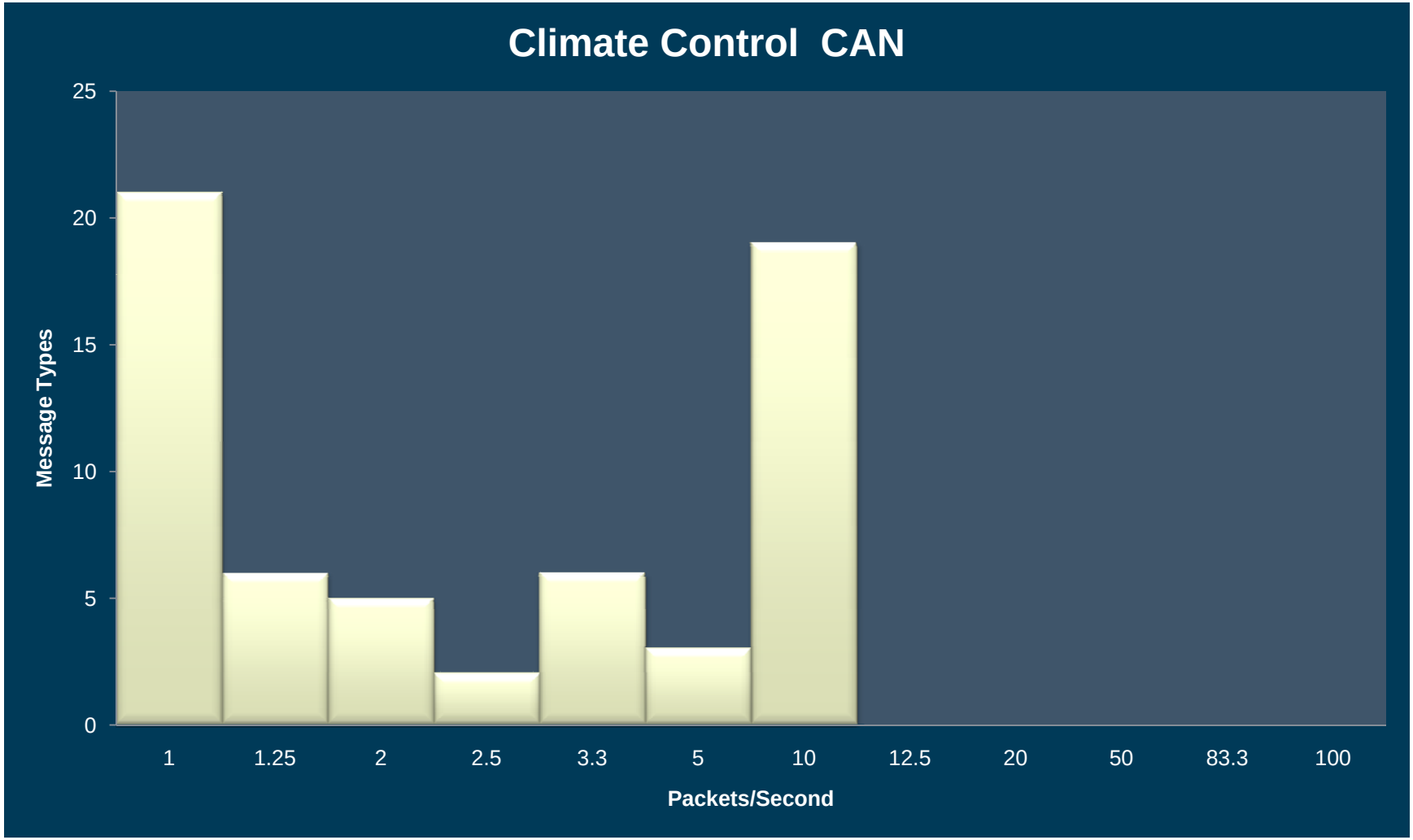
1243 Packets/Second

Cyclical CAN Traffic

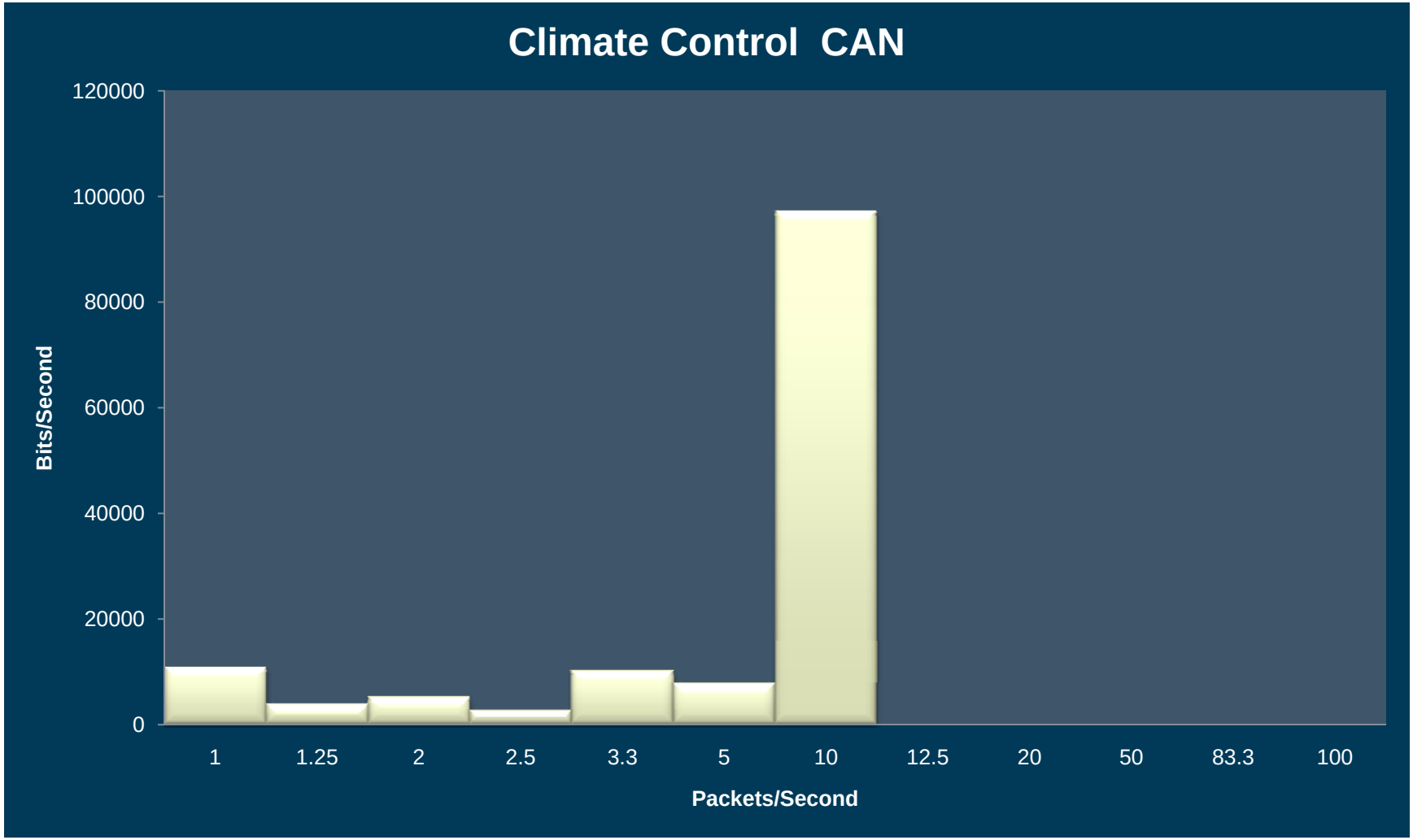


635955 Bits/Second

Cyclical CAN Traffic



Cyclical CAN Traffic



FlexRay

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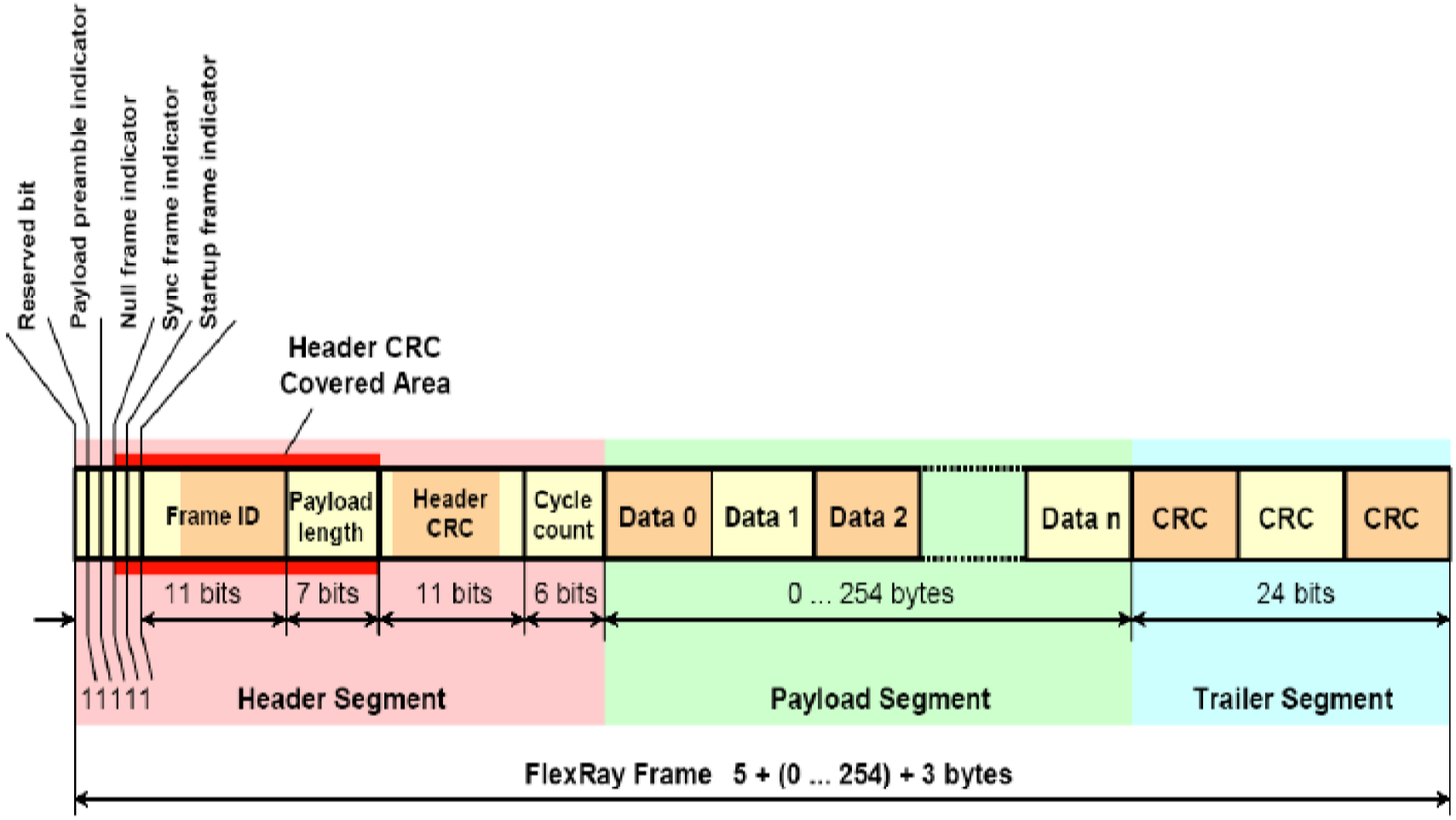
- **Flexible Topology**
  - Bus
  - Star
  - Combination Bus/Star
  - Redundant
- **0-254 Data bytes per frame**
- **Synchronized Network Clock**
- **Software TDM**
- **Communication Cycle**
  - Static segment, Dynamic segment, Symbol segment, Network Idle Time

FlexRay Frame



FlexRay Clock

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- **Microtick**
  - Node's own internal time base
  - Derived from a local oscillator
  - Free running, not synchronized with system
- **Macrotick**
  - Derived from system wide clock sync algorigthm
  - Always an integral number of microticks
    - Number of microticks per macrotick varies from node to node
    - Number of microticks per macrotick can vary from macrotick to macrotick
- **Transmission cycles start/end on Macrotick boundries**

FlexRay Communication Cycles

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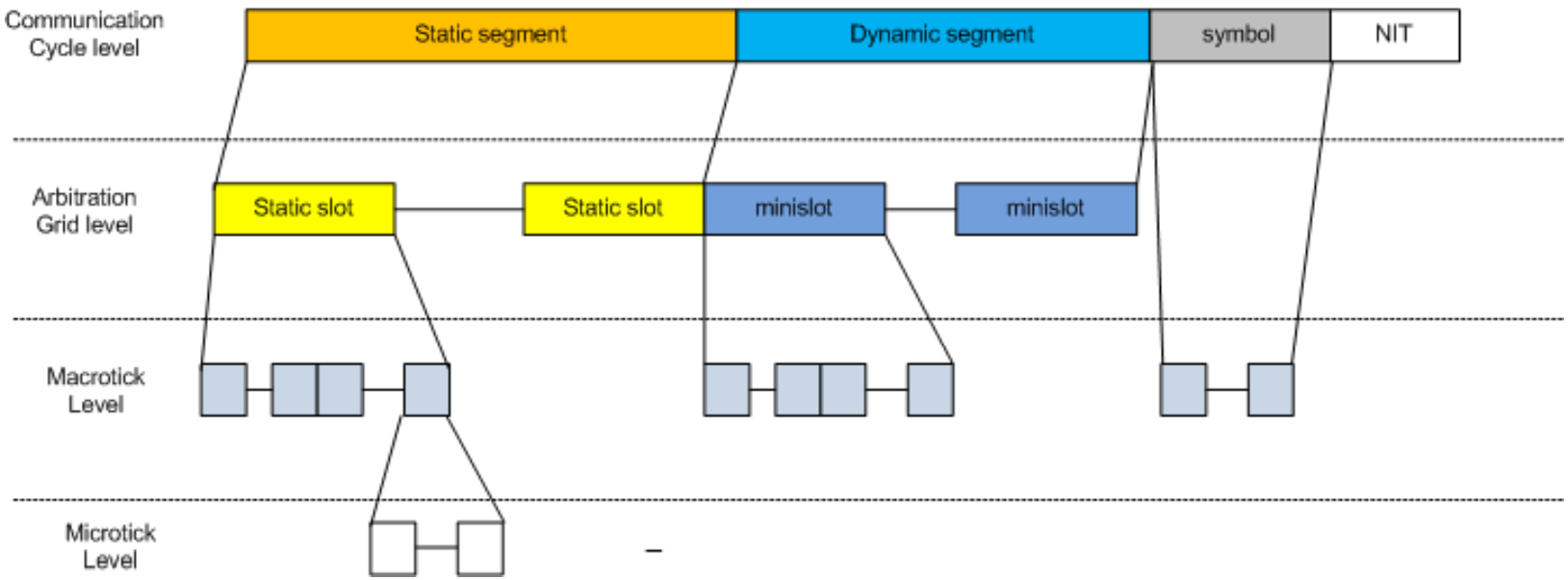
- **Communications based on a recurring sequence of 64 communication cycles numbered 0-63**
- **Static Segment**
  - Present in every cycle, used for time-triggered communications
- **Dynamic Segment**
  - Optionally present in the communication cycle and is used for ad-hoc, event-driven communication
- **Symbol Window**
  - Optionally present in the communication cycle and is used to transmit FlexRay defined symbols
- **Network Idle Time (NIT)**
  - NIT is used by each node to calculate and apply clock correction

Communication cycle



Sources

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- http://www.ip-extreme.com/downloads/flexray_mb_wp.pdf
- http://www.ece.cmu.edu/~ece649/lectures/21_flexray.pdf
- http://www.flexray.com/products/protocol%20overview.pdf

WHERE SOUND MATTERS