ASA MotionLink – Tutorial

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Kamal Dalmia

Chair, Marketing Committee

COO – Aviva Links Inc.

ASA – New Standard for in-vehicle Connectivity

- **A**utomotive **S**erDes **A**lliance
- Founded in May 2019
- Optimized for in-vehicle connectivity
- Rev 1.01 Spec released in Dec 2020
- Complete eco-system including…
  - OEMs
  - Tier 1s
  - Semiconductor vendors
  - Cable & connector vendors
  - Test companies

https://auto-serdes.org/

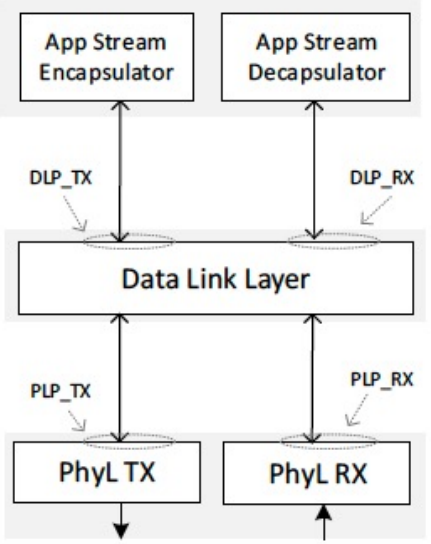
75+

Member companies
& growing fast…..

ASA MotionLink Overview

- ASA is built grounds up for Automotive environment
- Highly optimized for Sensor & Display use cases
- These use cases require multi-gigabit speeds in the forward direction
- Control traffic at much lower speed is required in the reverse direction
- ASA specifies “asymmetric SerDes” for such applications
- In addition, ASA provides a deterministic delivery framework with upper layers

- ASA specifies a full connectivity framework for next gen vehicles
  - **Physical layer**
  - **Link layer**
  - **Adaptation layer (encapsulation)**
  - **Security**

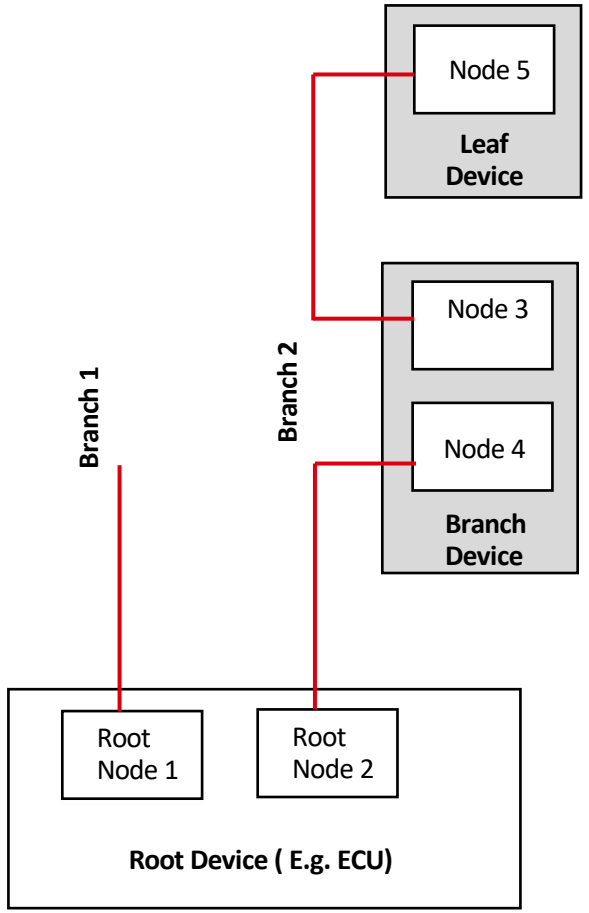


Network Architecture: Root, Branch & Leaf

Topologies are optimized specifically for vehicle needs

- ✓ **Point-to-point**
- ✓ **daisy-chain**

- **Root Node (port)**
  - The Root node/device is the device containing the ASA node, which is in control by running OAM sessions with all other ASA nodes in the SerDes Branch. There is only one root node in each SerDes Branch.
- **Branch Device**
  - The Branch device is a device in the SerDes Branch containing two or more ASA ports (non-root)
- **Leaf Node (port)**
  - The Leaf node/device is a device in the SerDes Branch containing a single ASA node (non-root)



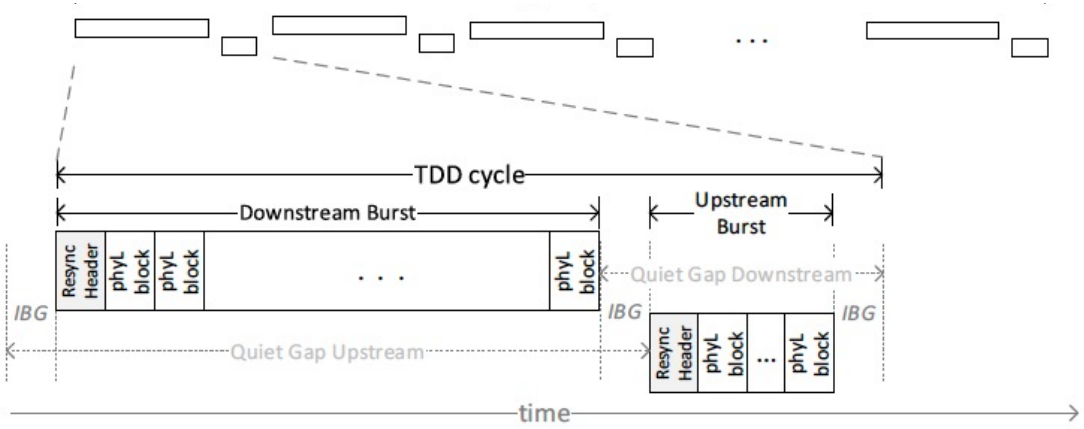
Physical Layer

Physical Layer is based on Time Division Duplexing (TDD)

- **TDD**
  - Downstream and Upstream traffic does not overlap on the wire
  - This results in significant benefits in terms of power, performance and implementation complexity

- **Physical Coding Sublayer (PCS)**
  - Reed Solomon FEC
  - Precision Time Base (PTB) messaging

- **Physical Medium Attachment (PMA)**
  - Based on PAM4 and PAM2 transmission
  - PAM2 is used for lower speeds
  - PAM4 is used for higher speeds



ASA - Speed Chart

Speed Grades spanning 2Gbps to 16Gbps to cover a wide variety of applications

DOWNSTREAM TRAFFIC					UPSTREAM TRAFFIC			
Speed	**Line Rate**	**Modulation**	**Baud Rate**	**Data rate**	**Line Rate**	**Modulation**	**Baud Rate**	**Payload Data rate**
SG- 1	**2 Gbps**	PAM2	2G	>1.8 Gbps	2 Gbps	PAM2	2G	**50 Mbps**
SG- 2	**4 Gbps**	PAM2	4G	>3.6 Gbps	2 or 4 Gbps	PAM2	2G or 4G	**50 or 100 Mbps**
SG- 3	**8 Gbps**	PAM2	8G	>6.4 Gbps	2 or 4 Gbps	PAM2	2G or 4G	**50 or 100 Mbps**
SG- 4	**12 Gbps**	PAM4	6G	>9.7 Gbps	2 or 4 Gbps	PAM2	2G or 4G	**50 or 100 Mbps**
SG- 5	**16 Gbps**	PAM4	8G	>13 Gbps	2 or 4 Gbps	PAM2	2G or 4G	**50 or 100 Mbps**

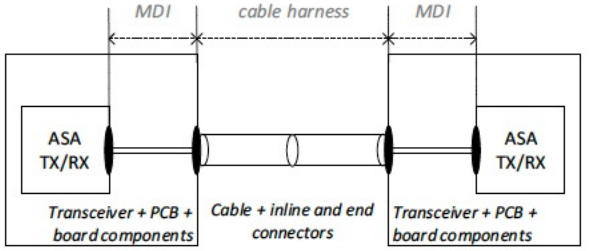
Line rate includes physical layer and upper layer coding overhead

Payload data rate above is the net rate **with** security, OAM and DLL overhead **already subtracted.** i.e. Payload rate will be higher if security is not turned on.

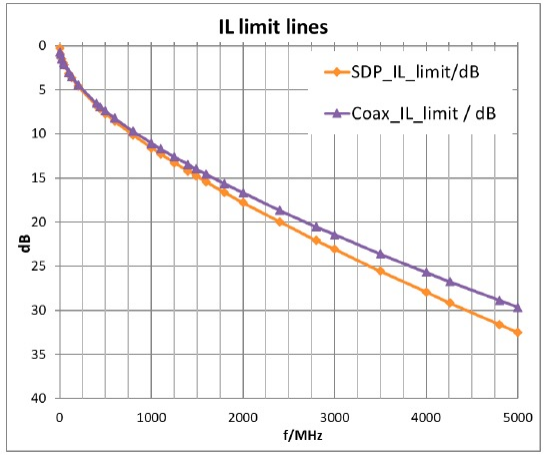
Specification for downlink rate of 64 Gbps is under development.

Cabling and Connectors

- ASA specs are well suited for practical and reasonable cable harnesses



- Up to 10 meters of SDP & 15 meters of Coax cabling
  - SDP = Shielded Differential Pair
  - STP cable is a type of SDP
  - In-line connectors are included in the harness limit lines



Cable Harness IL limits

- Insertion loss and EMI are primary considerations

- Due to TDD nature of transmission, Return loss is more relaxed compared to traditional SerDes
  - specified for both cable harness & MDI

- Cross talk limit includes cable, near-end MDI and far-end MDI

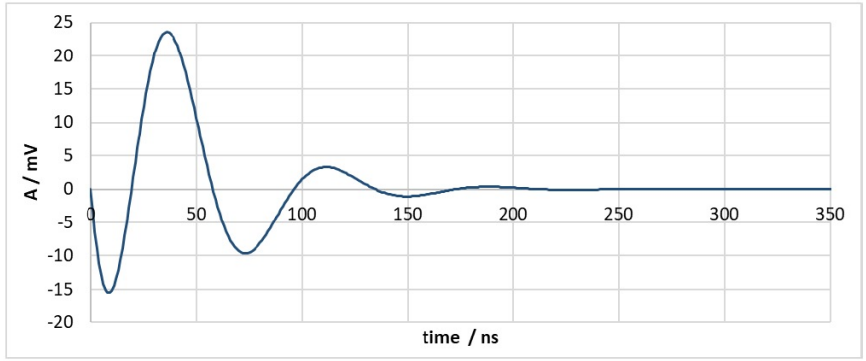
EMC Immunity and BER

Appropriate PAM levels and FEC coding result in adequate SNR for robust operation in presence of environmental noise for all speed grades

Specification includes provision for

- **Narrow Band Interference over full frequency range to include 5G & LTE bands**
- **Fast transients**
- **Power over Cable ripple**

No need for re-transmission!

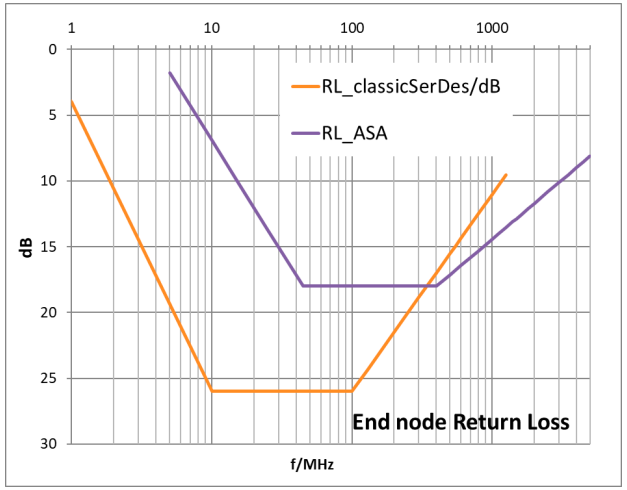


Fast transient for Coax Cable

Power Consumption and Power Delivery

- **Power consumption**
  - TDD based SerDes enable the lowest power consumption for multi-gigabit speeds
  - Light-sleep mechanism to further optimize power consumption of the link depending on utilization

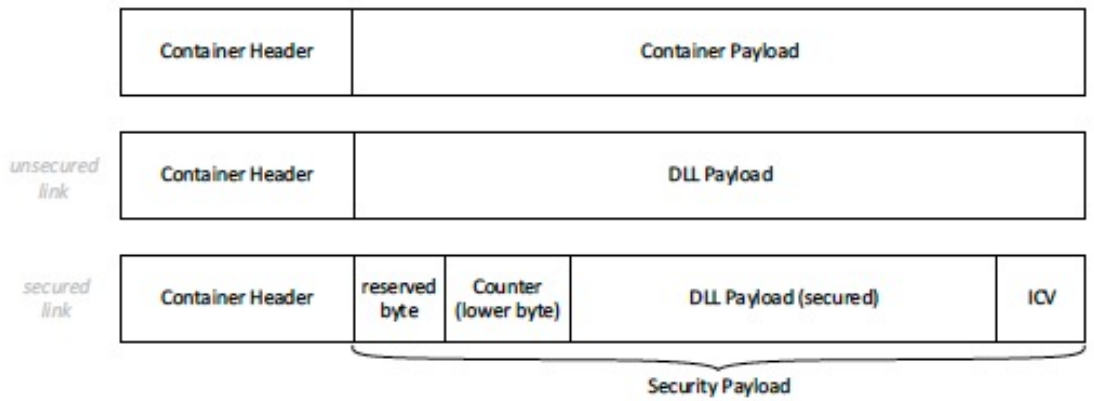
- **Power-over-cable**
  - Both STP and coax PoC are supported
  - 100mV peak-peak amplitude ripple is tolerated by the PHY
  - Relaxed RL limit relative to existing SerDes
  - Results in ability to deliver **more power** with **smaller inductors**



Return Loss – compared with analog SerDes

Data Link Layer (DLL)

- Data Link Layer provides the means to transport fixed size "**Containers**" from one node to one or more nodes in the SerDes Branch
- Containers are transported based on **dedicated time slots**
- Allocations are deterministic, guaranteed latency in data delivery with very low jitter
  - No over-signing of bandwidth, no issues with congestion, no scheduling priority
- Container Payload is filled with data provided by an Application Stream Encapsulator or OAM and the Security Entity (if present)



OAM

- **O**peration, **A**dministration, **M**anagement (OAM) functionality is available via an internal communication channel between the root node and the non-root nodes in Branch and Leaf Devices

- OAM is used to configure and control ASA nodes and to obtain status and diagnostics/debug information of the nodes
  - OAM CAD (Command-Address-Data) for access of the ASA register map
  - Ability to carry special instructions

- Root node runs multiple OAM sessions (one with each non-root node)

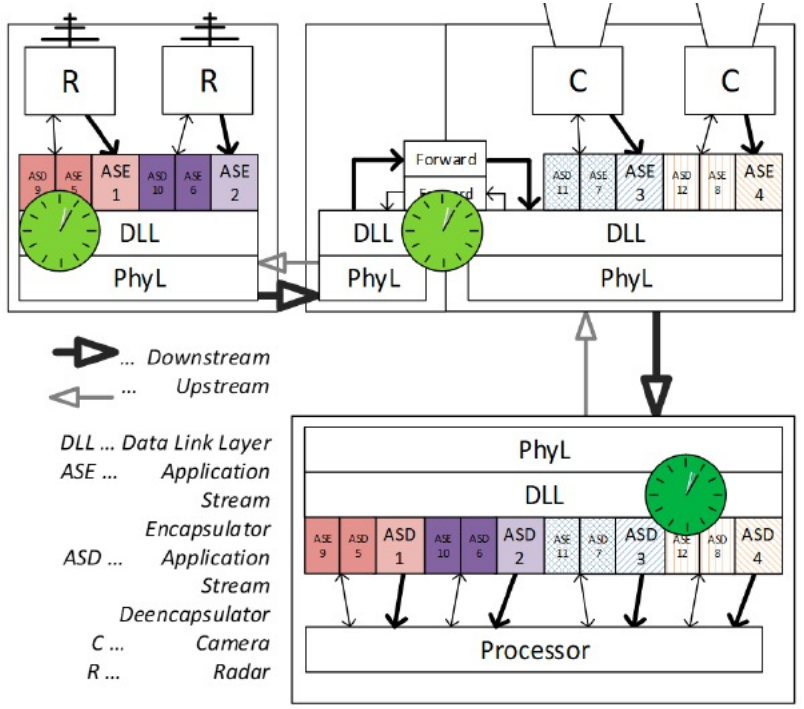
- Non-root node runs a single OAM session with the root node.

Time Synchronization

Precise timing synchronization via Frequency Lock + Time stamping

- **Time stamping**
  - ASA incorporates PTB “Precision Time Base” mechanism
  - A PTB stamp is sent every 27.376 microseconds
  - 4 ns granularity
  - Root node is clock leader
  - Leaf nodes adjust their counters to match root node via time stamp message exchange

- **Frequency locking**
  - Performed via loop timing
  - Device transmits using the recovered clock from receiver side



Application Specific Encapsulation Protocols

- ASA provides the means to seamlessly interface with various complementary interface technologies

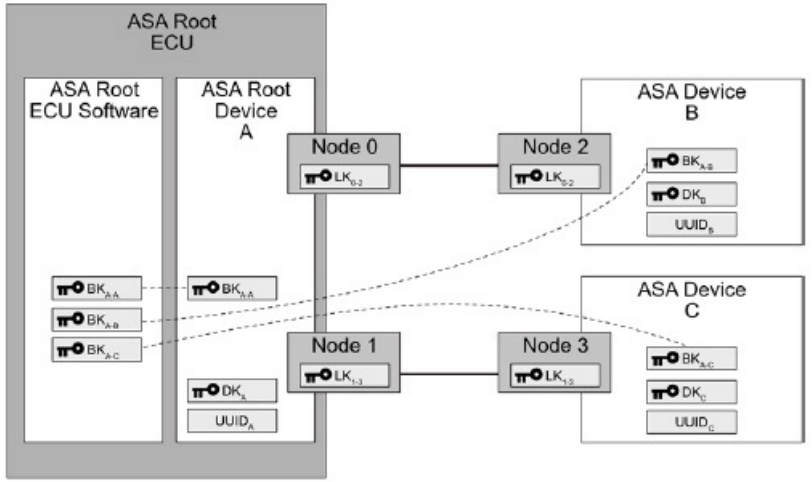
- Rev 1.01 specification includes the following ASEPs
  - **Video Data**
    - This ASEP allows for a variety of system level video interfaces to be bridged to ASA SerDes
  - **I2C**
    - Byte Mode (legacy)
    - Bulk Mode (throughput optimized)
  - **Ethernet**
    - All Layer 2 headers and payload are transported

- Other ASEPs such as eDP, GPIO and I2S are being developed

Security

A complete security framework is available as an option. The Security functionality has two high level components:

- Key Exchange Entity – Responsible for handling and exchanging keys. Also, responsible for storing the keys securely. Key Exchange messages are transported by the OAM channel.
- Link Layer Security – Responsible for protecting messages using keys provided by the Key Exchange Entity.
  - Authentication and integrity protection
  - Encryption of containers is an optional feature.



ASA supports security along the supply-chain structure of Automotive as well as for the end-user

- Device Keys (DK) – top-level key of an ASA Device.
- Binding Keys (BK) – key binding an ASA Device to a vehicle.
- Link Keys (LK) – session keys for Link Layer Security - shared by adjacent devices
- UUID – 128 bit ID of an ASA device

Safety & Diagnostics

Comprehensive Safety and Diagnostics offerings

- Video CRC checker
  - Link is protected from end to end. CRC is Preserved from leaf device to root device via branch devices.
- Link quality monitor
  - Reporting of number of bursts lost or link training results
- Signal quality indicator
  - SNR reporting
- FEC stats for corrected errors
- OAM messages for system wide visibility and control
- Harness Diagnostics

Summary

- ASA continues its rapid momentum as the new standard for Asymmetrical Automotive SerDes
- Complete eco-system of members
- Rev 1.01 is in place
- Complete framework includes Physical, Link, Security and Adaptation Layers

THANK YOU!

kamal@avivalinks.com

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