

Designing 1000BASE-T1 Into Automotive Architectures

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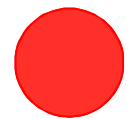


MARVELL

Ethernet IP & Automotive Tech Day

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Agenda



What Does 1000BASE-T1 Provide?

Advanced Driver Assist Systems (ADAS)

In-Vehicle Infotainment (IVI)

Next Steps and Conclusion

1000BASE-T1 Overview

- In Vehicle Gigabit Ethernet

- Single pair of wires reduces cable weight
- Meets automotive system EMC requirements
- Supports 15m over unshielded automotive cabling
- Standard gigabit Ethernet MAC interfaces (SGMII/RGMII/GMII)
- Defined through the IEEE standardization process

- Standard

- Progressing rapidly through IEEE 802.3bp
- Automotive limits consolidated by automotive manufacturers
- Active participation by multiple Ethernet PHY and cable vendors
- Marvell is a technology leader with presentations on many technical topics
- Marvell drove the Call For Interest for IEEE 802.3bp Standardization of RTPGE PHY in March 2012



- Timeline

- Targeting introduction in vehicles in 2018

1000 BASE-T1 Advantages

Higher Bandwidth

- Supports machine vision for ADAS
- Suitable for high speed video links
- Supports more video channels
- Can uplink 100 Mb/s domains

Low cost cables

- Can use cost effective unshielded cables
- Ethernet cables are light weight and flexible

Upgradeability

- Possibility to support 100BASE-T1 & 1000BASE-T1
- Can define systems with choice of resolution by replacing a single module
- Add video paths through software

100 Mbps Bandwidth = High Compression



- Uncompressed HD video needs $\gg 100$ Mb/s
- At 100 Mbps, strong compression is required
 - Can degrade image
 - Compression algorithm adds latency
- Limits the applications for Ethernet

1Gbps Reduces Compression Required



- At 1 Gb/s, little or no compression required
 - Unnoticeable image degradation from original source
 - Low latency from little / no compression algorithm
- Supports higher quality image transport
 - For machine vision, HD navigation & instrument cluster
 - High bandwidth compression algorithm being looked at by industry

Benefits of High Bandwidth connectivity

700Mb/s



70Mb/s



Example Compression Requirements

Application	Hres	Vres	Bit depth	FPS	Bandwidth (Mb/s)	100 Mbps	1000 Mbps
Camera	1280	720	12	30	331.78	Medium Compression	Uncompressed
Camera	1920	1080	12	30	746.50	Strong Compression	Uncompressed
Video	800	600	18	30	259.20	Strong Compression	Uncompressed
Video	1280	720	24	60	1,327.10	Strong Compression	Lite Compression
Video	1920	1080	24	60	2,985.98	Strong Compression	Lite Compression

Higher Bandwidth Brings Flexibility

More video streams allows faster response to market trends

- Display any video stream at any panel
- Upgrade to higher resolution LCD panels and cameras as needed
- Can add additional video sources or panels without changing the base architecture

Improves 100 Mb/s networks

- High speed links between domains
- Brings new applications into the network
- Will **not** replace 100 Mb/s in the vehicle

1000BASE-T1 for New Architectures

Gigabit Ethernet comparison to LVDS serial interconnects

Proprietary Serial	1000BASE-T1	Impact
High speed in one direction only, No network support	High speed in two directions, Network support	Serial requires a custom architecture and limits platform flexibility. Harder to respond to market requirements.
Different part for direction, resolution, color, video port	Same PHY for all components & designs	Serial device choice is complex and provides limited compatibility between modules
Does not require compression	Compression required for highest resolutions	Serial device end node can be simpler and lower power for certain applications
Limited to # of video input / output	Independent of # of video inputs / outputs	Serial device requires high end GPU to handle multiple video ports
Expensive STP or COAX	Low cost UTP	Lower harness cost

Gigabit Ethernet Application Trends

ADAS

- Basic visual systems will stay with 100 Mbps Ethernet
- Gigabit Ethernet needed for image processing & HD
- Image fidelity is critical for object recognition

IVI

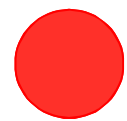
- Most bandwidth intensive in-vehicle application
- Gigabit Ethernet first used to connect infotainment modules
- Video panels link adoption will depend on total cost of solution

Body Electronics

- 100 Mb/s technology used to connect inside domains
- Gigabit Ethernet will connect the major control domains

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What Does 1000BASE-T1 Provide?

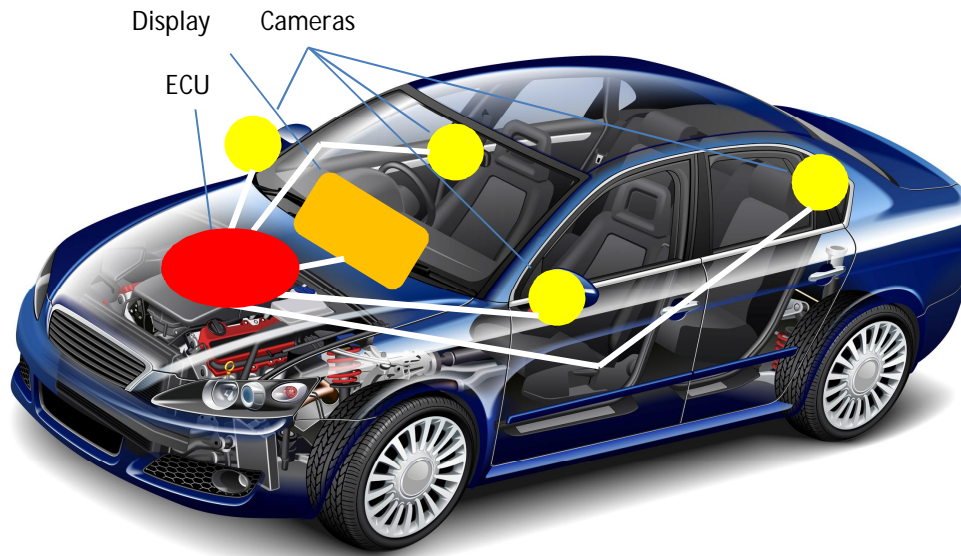


Advanced Driver Assist Systems (ADAS)

In-Vehicle Infotainment (IVI)

Next Steps and Conclusion

ADAS – Around View



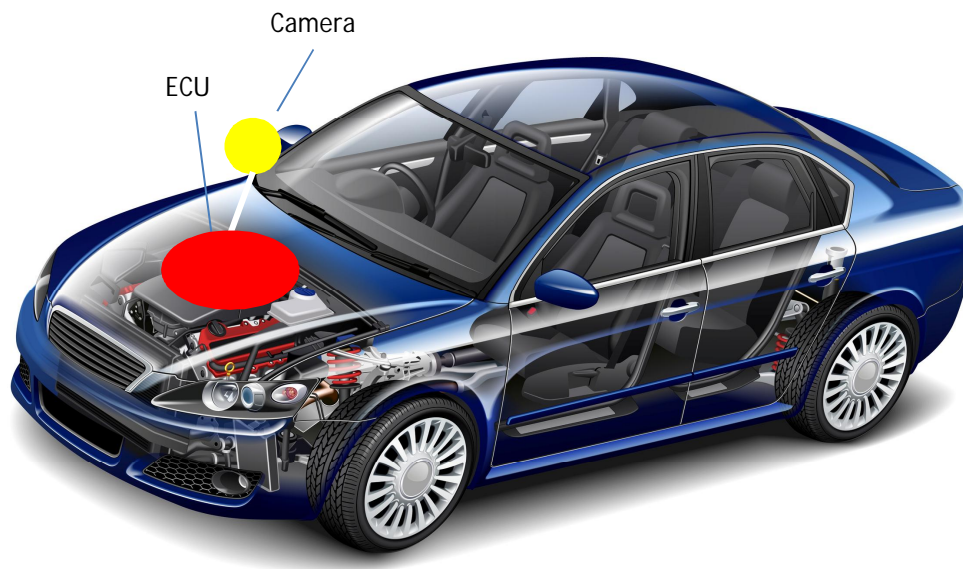
• Application

- Multi-camera system
- Separate ECU for processing
- Ties into infotainment display
- Analog & digital solutions now

• Trends

- Fast Ethernet (100Mb/s) now
- HD digital screens drive digital solutions
- Gigabit Ethernet provides higher resolution imager content

ADAS – Forward Camera



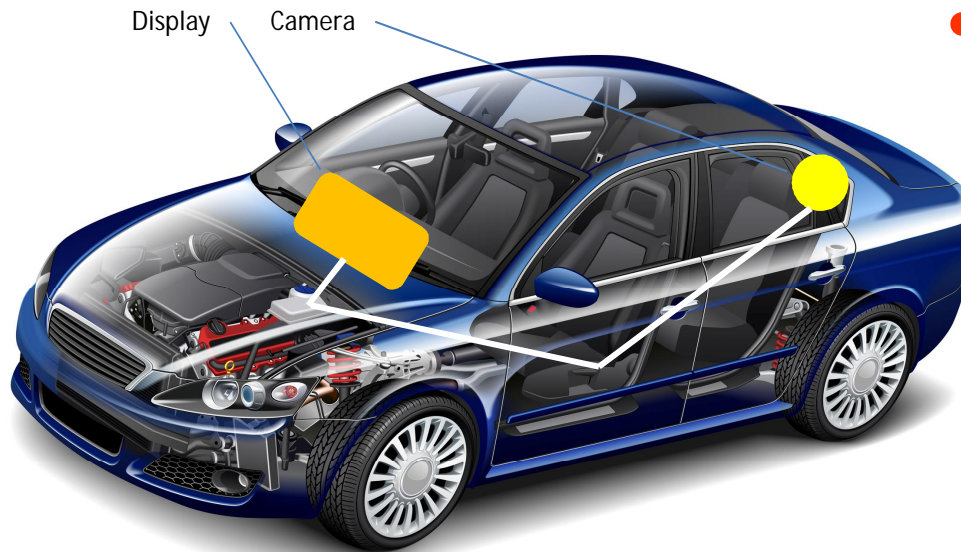
- Application

- Machine vision applications
- Lane departure
- Adaptive cruise control
- Deployed first on high end vehicles
- ECU often delivers ADAS data only, not video

- Trends

- Currently smart camera or LVDS
- Gigabit Ethernet needed to support machine vision features

ADAS – Rear View



- Application

- Highest Volumes
- US legislation will drive growth
 - Required by 2018
- Mainly analog NTSC
- HD digital screens will drive digital solutions

- Trends

- Digital adoption depends on delivering a cost effective solution
- HD digital screens drive digital solutions
- Likely to use Fast Ethernet (100Mb/s) for cost reasons

ADAS Technology Needs

Around View	Forward View	Rear View	Parameter
HD	HD	STD	Video
No	Yes	No	Low compression required
Yes	Yes	Yes	Low power for improved low light performance
Yes	No	No	AVB Sync
Yes	Yes	Yes	Small size
Yes	Yes	Yes	Fast response times
No	No	Yes	Cost driven
Yes	Yes	Yes	Power over Data Line (PoDL)
Gigabit & 100M	Gigabit	100M	Ethernet

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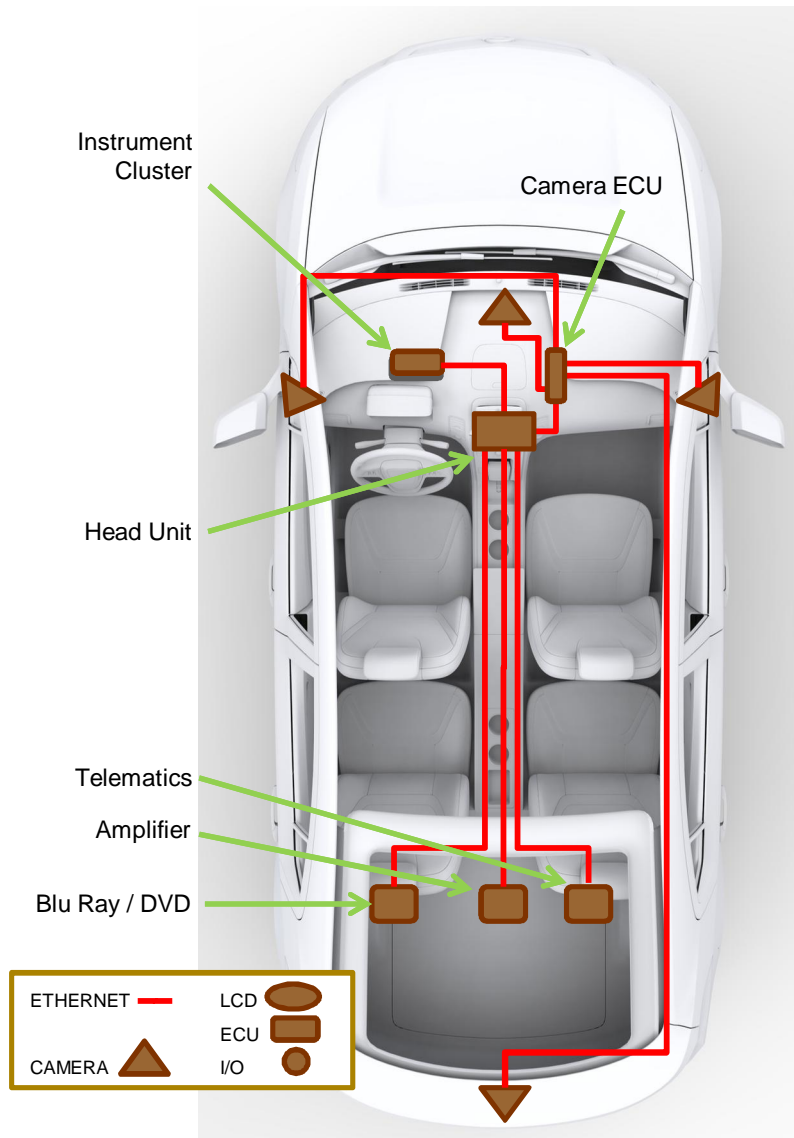
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IVI – Connecting Modules



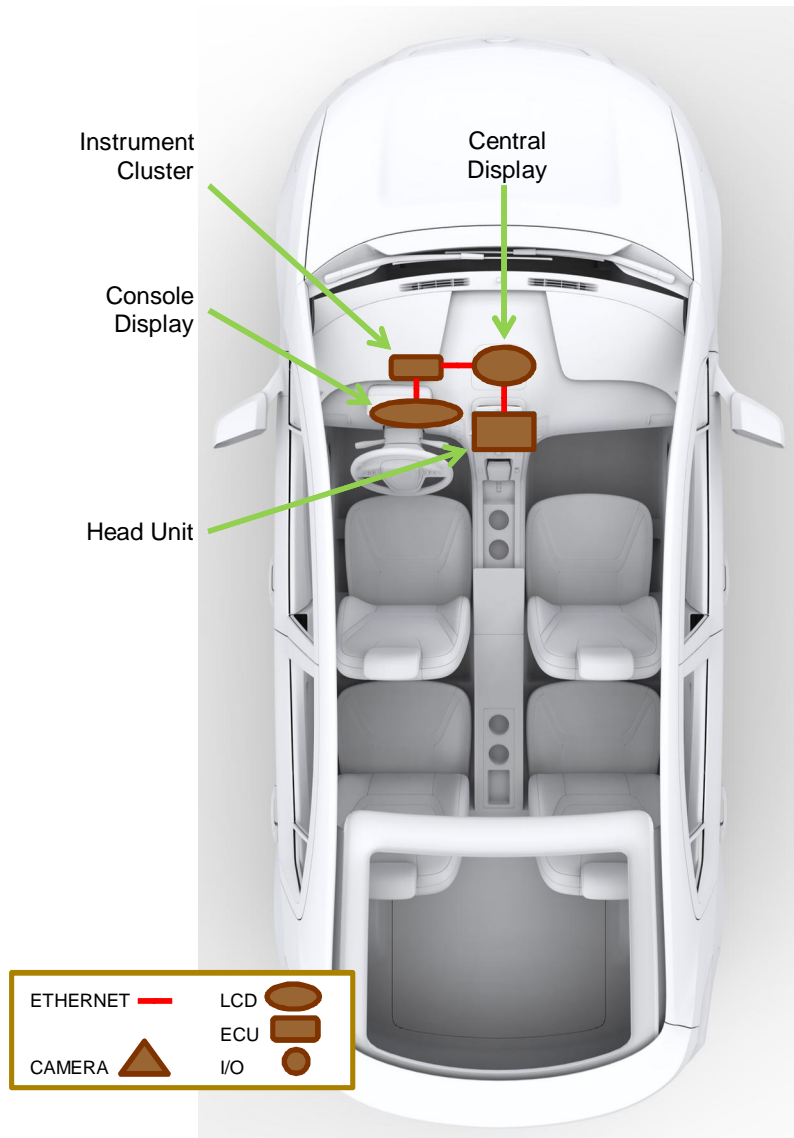
• Application

- Connect IVI modules and video sources
- Connect camera ECU to IVI
- Connect head unit to audio amplifier

• Trends

- Switched networks replace serial links
- Multiple data sources and HD video drive Gigabit Ethernet adoption
- Possibility of a single cable for 1000BASE-T1 & 100 BASE-T1 simplifies deployment

IVI – Direct LCD Panels Connect



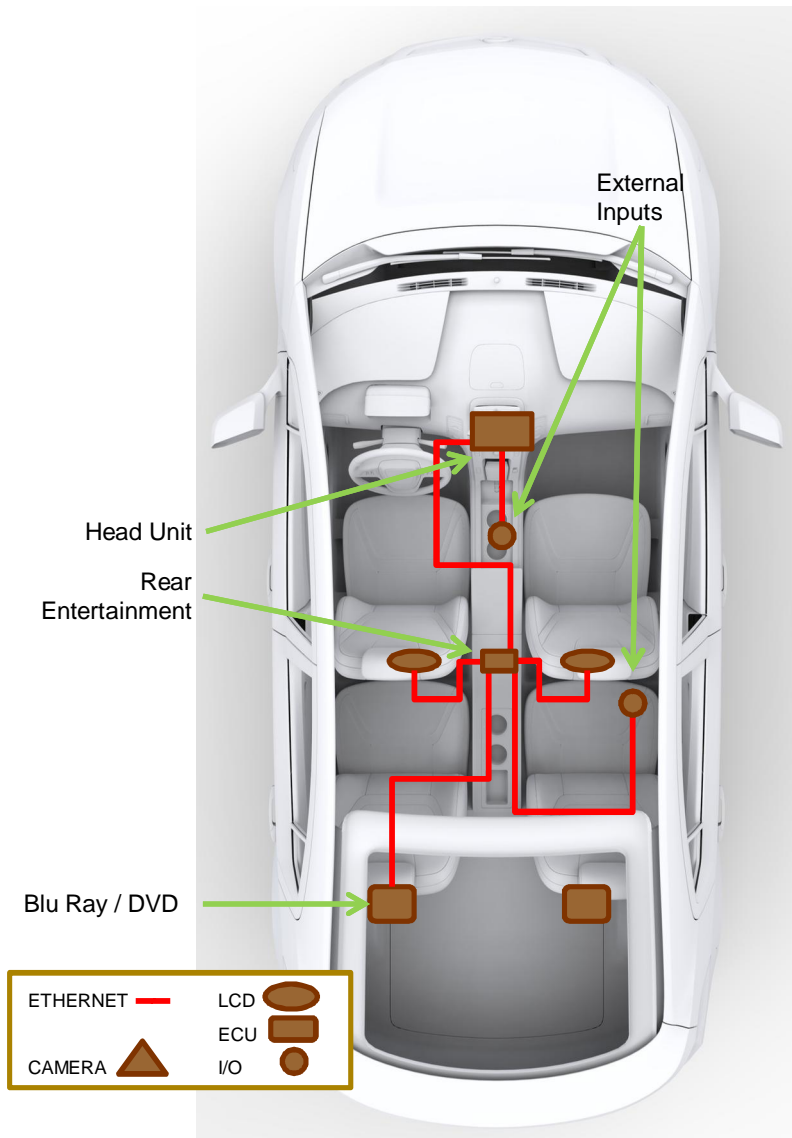
• Application

- Connect head unit to central display
- Connect instrument cluster to console display

• Trends

- Central displays and full size console screens becoming standard equipment
- Adoption will require Gigabit Ethernet
- Allows the most flexible network deployment
- Requires new cost effective solutions at panel

IVI – Rear Entertainment & External Inputs



• Application

- Connected optional entertainment unit to base systems
- Connect entertainment unit to displays
- Enable external video inputs

• Trends

- Lot of innovation and different architectures
- Alternative systems may use WIFI, tablet dock, etc...
- Gigabit Ethernet needed to drive panels and connect to the base system

IVI Technology Needs

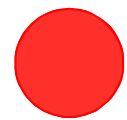
Module Connect	Panel Connect	Entertain System	Parameter
Multiple HD	HD	Multiple HD	Video
Yes	No	Yes	Audio
No	Yes	No	Low compression (if HD)
Yes	Yes	Yes	Content protection (if HD)
Yes	Yes	Yes	AVB Sync
Yes	Yes	No	Fast response times
Some	No	No	Power over Display Line (PoDL)
Gigabit & 100M	Gigabit	100M	Ethernet

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Next Steps and Conclusion

Making it work

- Challenges to adopting 1000BASE-T1 architectures
 - Processor required at each node
 - Software required to support packet based networks
 - Need to meet difficult power, size, and cost requirements
 - Higher bandwidth images require higher speed uplink
 - Separate network needed for low compression video
 - Needs cost effective unshielded twisted pair cable

Conclusion

- Ethernet will add new applications with 1000BASE-T1
- High bandwidth, low compression video enables Ethernet based machine vision, HD for navigation and for instrument clusters
- Key applications are for next gen ADAS and IVI Systems
- Gigabit Ethernet offers several advantages over serial link technologies like LVDS
- Gigabit Ethernet will play an important role in next generation architectural design