



# Industrial Networking: **Leverage** **QorIQ Communications Processors** for PROFIBUS, PROFINET, EtherNet/IP, CAN, etc.

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# Agenda

- Protocols
- Serial Based Protocols
- Ethernet



















# Protocols and Physical Interfaces



	IEEE 802.11	IEEE 802.3	RS485	CAN
Interface	PCIe/USB/SPI/I <sup>2</sup> C	MII/RMII/RGMII/SGMII	UART/QE UCC	CAN
Topology	Multi Point	Point to Point	Multi Drop	Multi Drop
Distance	70 – 250m	100m	100 – 1,200m	40 – 1,000m
Protocol				
				<i>J1939</i>
	P-Series T-Series MPC8309 (PCI) LS-Series	P-Series T-Series MPC8306/9 LS-Series	P1025/16/21/16 T1040/42/20/22 MPC8306/9 LS102xA	P1010 MPC8306/9 LS102xA



# Industrial Support Software

Software		Vendor			
Programmable Logic Controller [PLC]			ISaGRAF		
Protocols	IEEE 1588		IXXAT		
	EtherCAT Master				
	EtherNet/IP				
	PROFINET				
	CANopen		IXXAT		
	Modbus TCP/IP		IXXAT		
	CAN	CANopen		IXXAT	
		DeviceNet		IXXAT	
		J1939		IXXAT	
	RS485	PROFIBUS		softing	
Modbus		IXXAT			
Operating Systems					
					



# Serial Based Protocols

UART

CAN

PROFIBUS

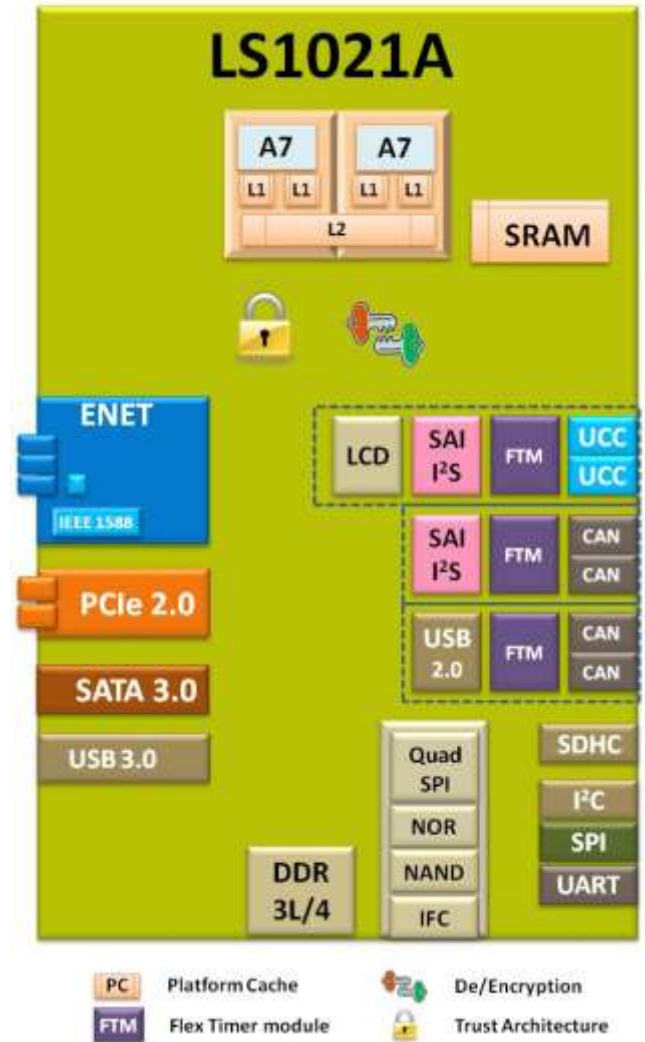


# Example Device that Covers Most of the Protocols

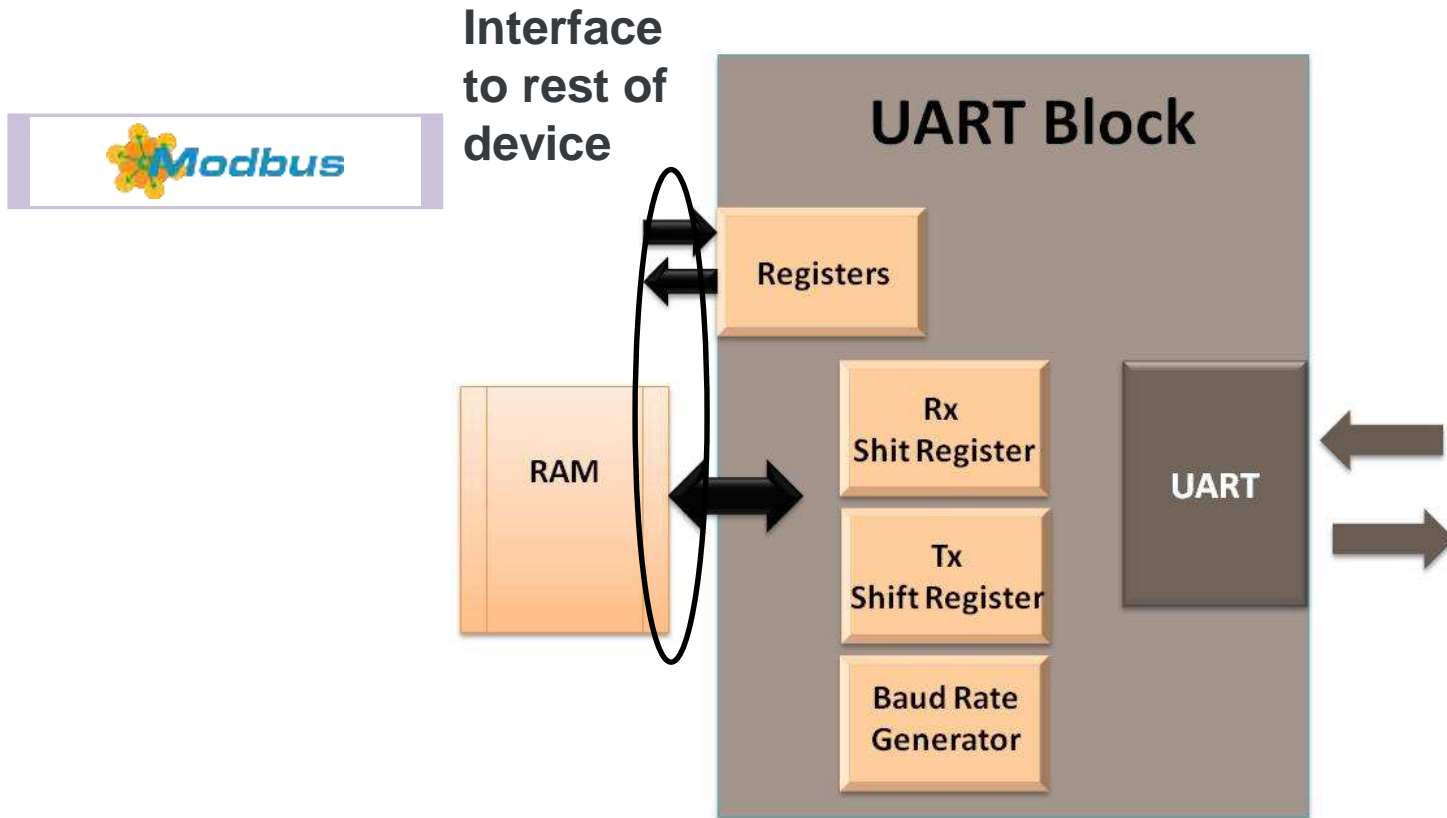


	LS1021A	LS1020A	LS1022A
Core Type	ARM Cortex™-A7 MPCore™ + NEON		
Cores/Threads	2 / 2		
Frequency	Up to 1GHz		Up to 600MHz
L1 I/D	32kB / 32kB with ECC		
L2 (Unified)	512kB Shared with ECC		
SRAM	128kB with ECC		
DDR	1x(16/32B it+ECC) DDR3L/4 up to 1.3GT/s		1x( 16bit+ECC) DDR3Lup to 1.0GT/s
SerDes	4 up to 6.0GHz		1 up to
Ethernet	3 x 1GE		2 x 1GE
PCIe	2 x Gen 2.0 (up to 5.0GT/s)		1 x Gen 2.0 (up to 5.0GT/s)
SATA 3.0	1 up to 6.0GHz		No
USB	1 x USB 3.0,1 x USB 2.0		1 x USB 2.0
CAN	Up to 4	0	Up to 4
TDM/HDLC	2		No
UART/I <sup>2</sup> C/SPI	Up to 8 / 3 / 2		
I <sup>2</sup> S	Up to 4		
LCD	1 x Controller		No
Acceleration	SEC,QE		No
	Trusted architecture		
	Pin Compatible 19x19mm, 0.8mm pitch		

Low Power < 3W

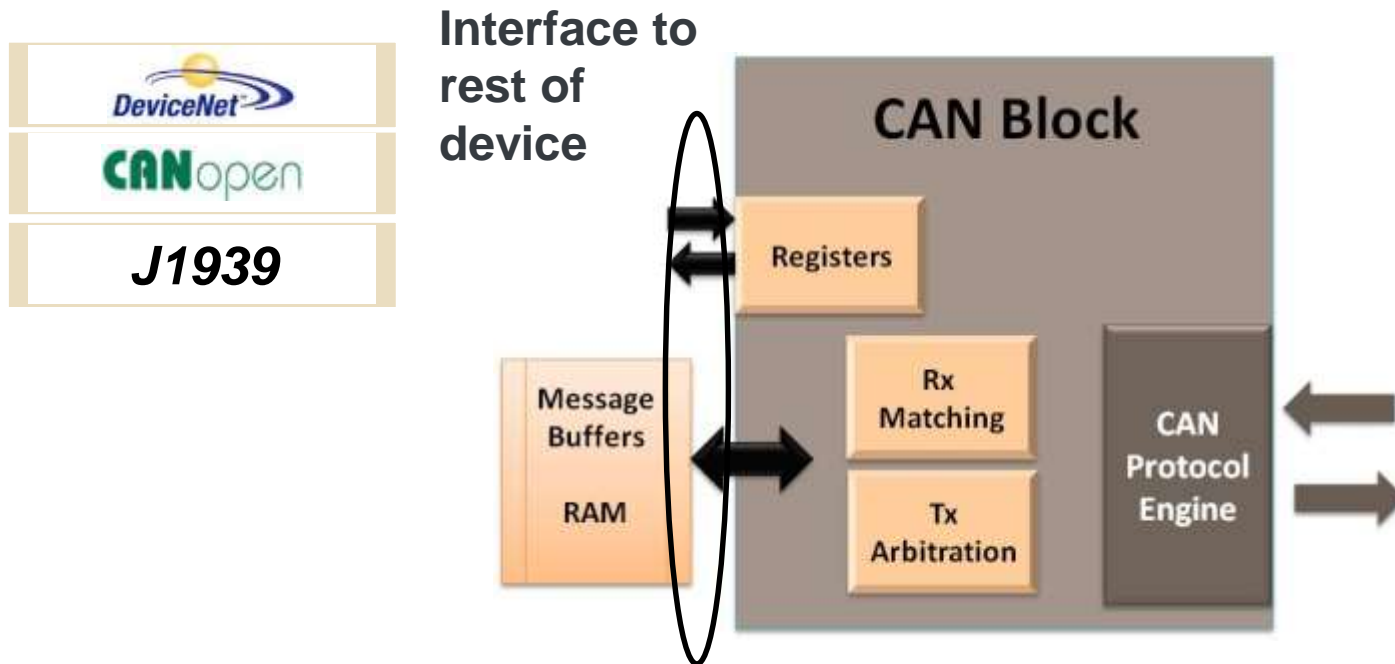


# Simplified UART Hardware Block



- Hardware block to perform the UART function

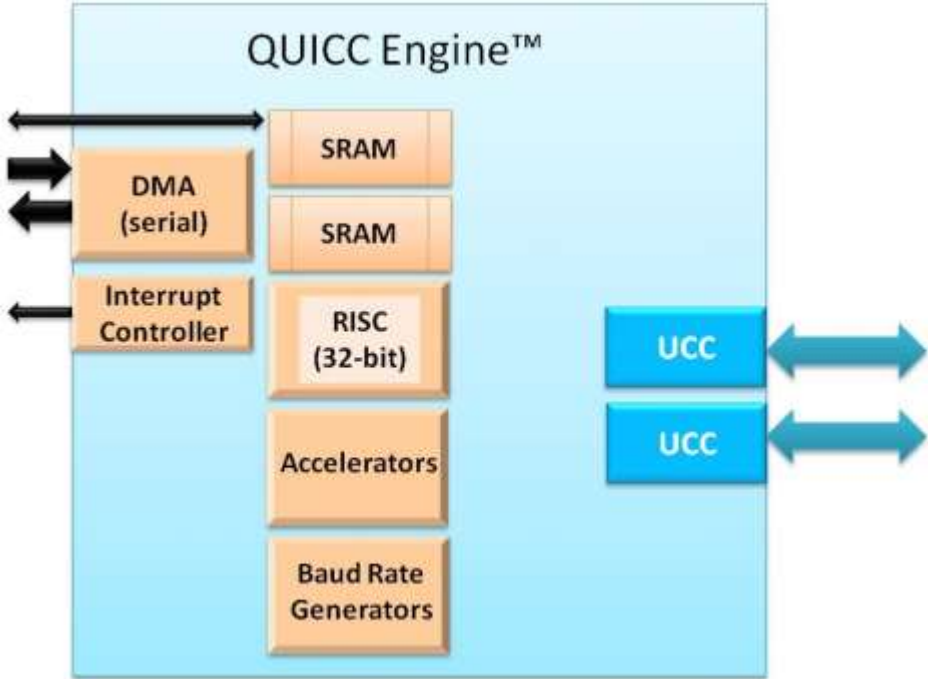
# Simplified CAN Hardware Block



- The CAN 2.0 B protocol specification is performed in a hardware block



# Simplified QUICC Engine Block Diagram



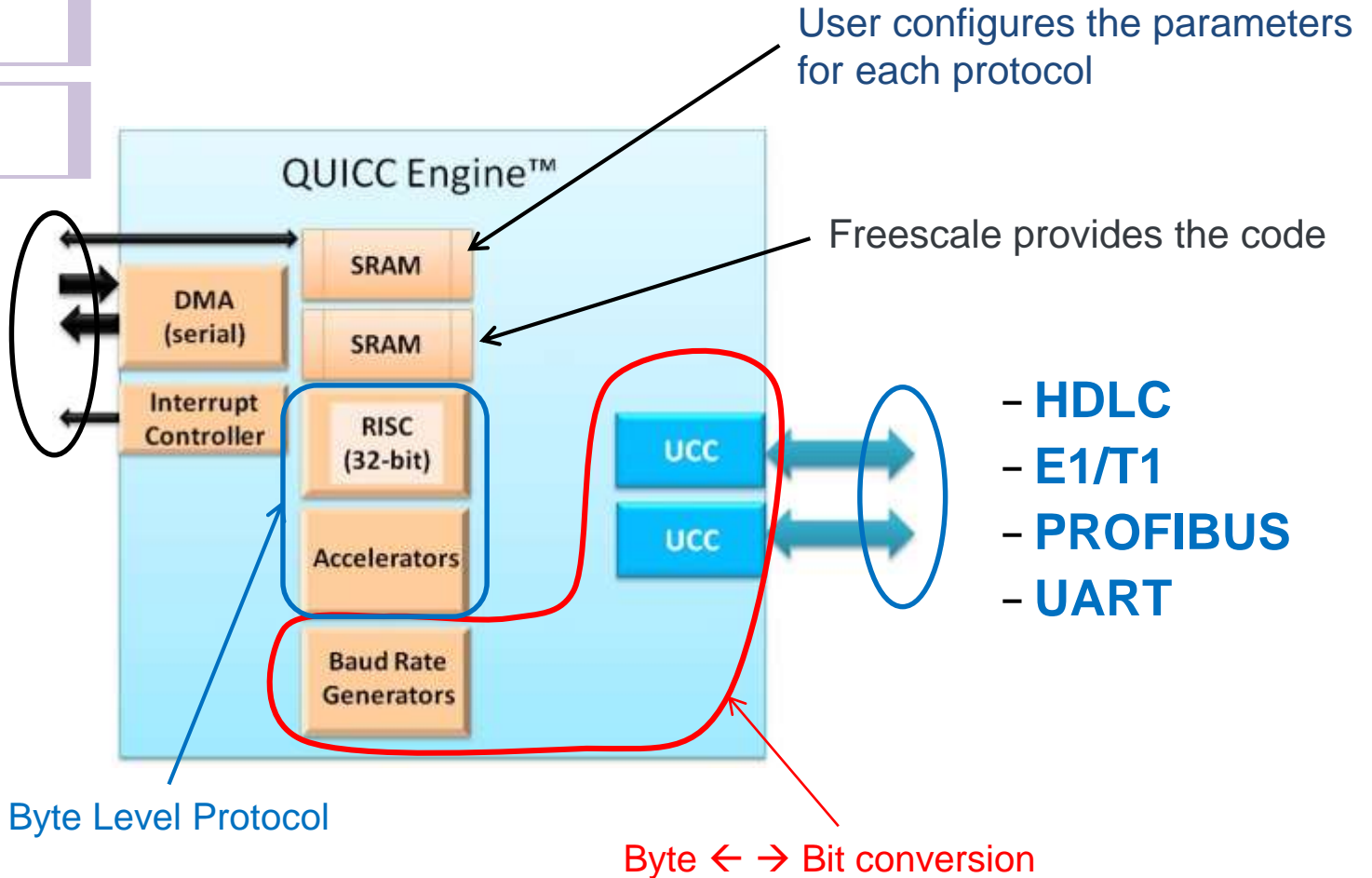
## Protocols

- Ethernet
- ATM
- HDLC
- E1/T1
- PROFIBUS
- UART

# Simplified QUICC Engine Block Diagram

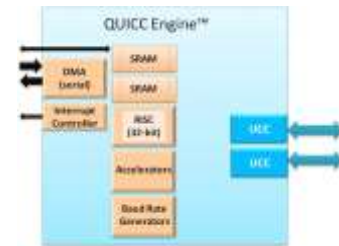


Interface to rest of device



# Example Protocol PROFIBUS

[www.freescale.com/profibusQorIQ](http://www.freescale.com/profibusQorIQ)



Single-chip PROFIBUS Reference Platform for QorIQ and PowerQUICC Processors

Overview | Documentation | Software & Tools | Buy / Parameters

**Buy**

With over 20 million installed nodes, PROFIBUS is the world's most successful fieldbus (communication) technology used in industrial automation systems. Ongoing growth of around 10 percent per year is forecasted and the expansion is aided by the addition of PROFIBUS functionality to Freescale's PowerQUICC and QorIQ communications processors. The integration of PROFIBUS Layer 2 creates a single-chip solution with a direct connection to a RS485 transceiver. This eliminates the most cost and board space associated with an external PROFIBUS ASIC, which is otherwise required.

Building on the versatility and long-term success of QUICC Engine technology, Freescale offers PROFIBUS Layer 2 firmware for PowerQUICC and QorIQ processors with a QUICC Engine controller. This solution not only removes the need for a costly PROFIBUS ASIC, it also leaves the processor core almost entirely free for application processing.

QorIQ processors can also provide simultaneous support for industrial Ethernet protocols like PROFINET, EtherCAT® and EtherNet/IP™.

**Features**

- PROFIBUS Reference Platform supports
  - PROFIBUS Slave certified by ComDoc, a PROFIBUS certification lab owned by Siemens AG
  - PROFIBUS Master
- Eliminates costly PROFIBUS FPGA or ASIC by routing PROFIBUS Layer 2 (FDL) on QUICC Engine controller hardware integrated inside the MPU
- Protocol and customer control application can run simultaneously on one chip
- Commercial PROFIBUS slave stack available from Technology Management Groups (TMG)
- Evaluate using Tower System modules (TWR-P1025-411F)
- Software and hardware developed on TWR-P1025 can be re-targeted on a range of QorIQ P1 processors, including the P1021, P1023, P1019 and P1023, as well as the MPC8309 PowerQUICC processor
- QorIQ P1 processor family includes single- and dual-core options which integrate Power Architecture® cores (up to 800 MHz or 1820 DMIPS per core)
- QorIQ P1 processors can also provide simultaneous support for industrial Ethernet protocols like PROFINET, EtherCAT and EtherNet/IP™
- PowerQUICC MPC8309 processor delivers an impressive 535 DMIPS core performance for less than 1.8 watts

**Supported Devices**

- MPC8309 Low-Power PowerQUICC II Pro Processor with DCR2, eSDHC, 128-ch. HDLC/TDM, 10/100 Ethernet, USB, IEEE802.11b/g
- QorIQ Communications Processors Value-Performance Tier

**Featured Documentation**

PROFIBUS, PROFIBUS, PROFIBUS on QorIQ and PowerQUICC Processors - Fact Sheet

**Jump Start Your Design**

Getting Started With Freescale PROFIBUS for PowerQUICC & Freescale of late PROFIBUS Layer 2 firmware for PowerQUICC

**Kit Contents**

TWR-P1025-411F contains

- Tower System Evaporator Module
- QorIQ P1 MPU Tower System Module
- Industrial I/O Tower System Module
- An image of the complete PROFIBUS slave run-time software (including the layer 2 stack from TMG TE)

**Featured Partners**

TMG TE Group

**Featured Video**

PROFIBUS Solutions on QorIQ and PowerQUICC Processors (03:11 min)

**Read More**

Freescale and TMG TE Devices First PROFIBUS Interface Certified on Freescale Silicon

White Paper: Managing Machine Safety and Productivity with QorIQ Multicore Processors

**Contact with Us**

Sign up today to receive more information about industrial solutions

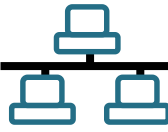
For more information contact

[iain.davidson@freescale.com](mailto:iain.davidson@freescale.com) or [profibus@freescale.com](mailto:profibus@freescale.com)



# Ethernet



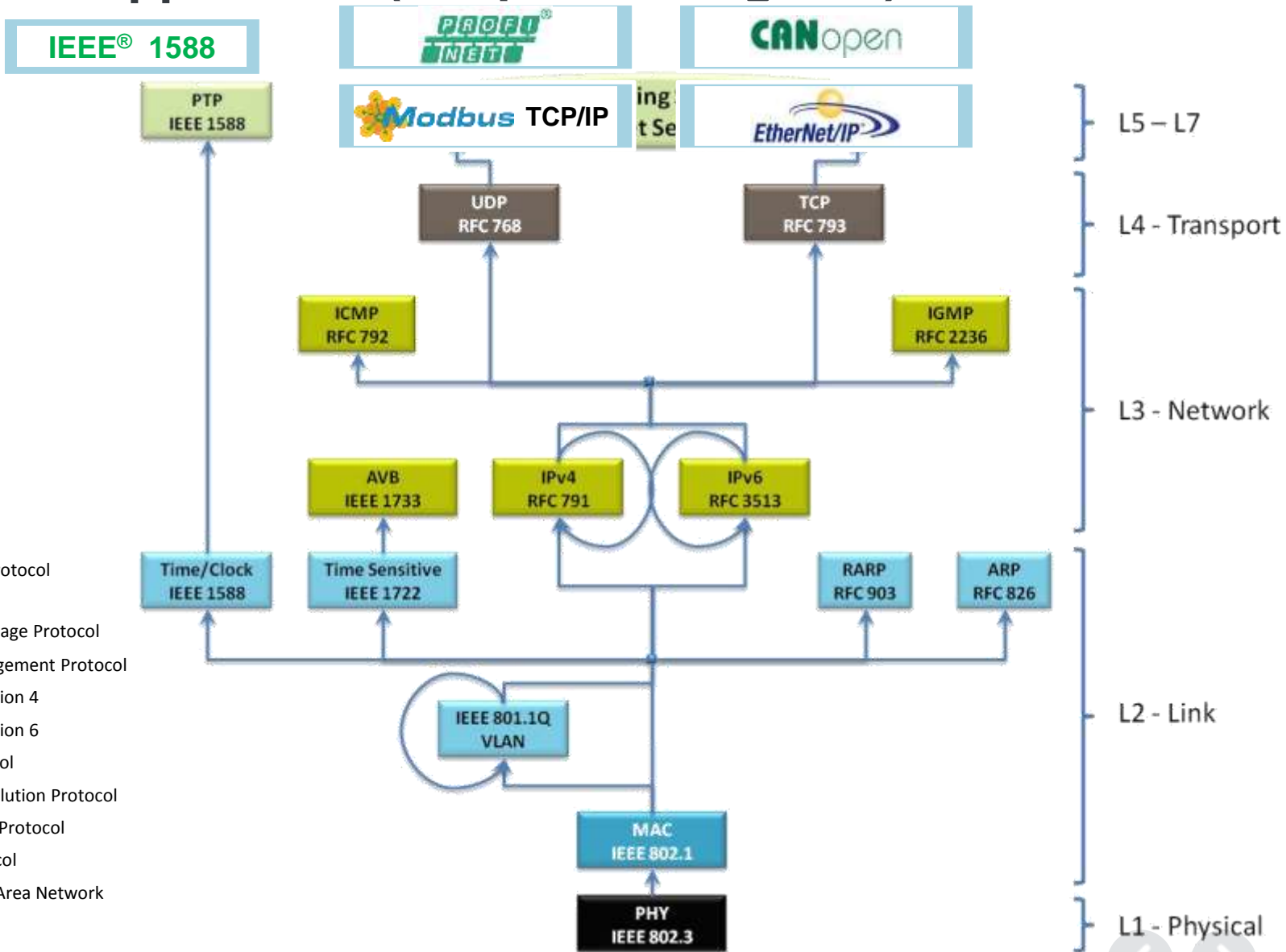


# Internet Protocol / Ethernet

- Machines (devices) are now using Internet Protocol (IP) over Ethernet more and more.
- To connect, you need an Ethernet controller with at least the capabilities of doing the low level media access control (MAC) linked to a physical interface (PHY).
- Applications do not generally directly “talk” IP. They normally use a software abstracted method, like sockets.
- So how do you get from the Ethernet to the application layer?



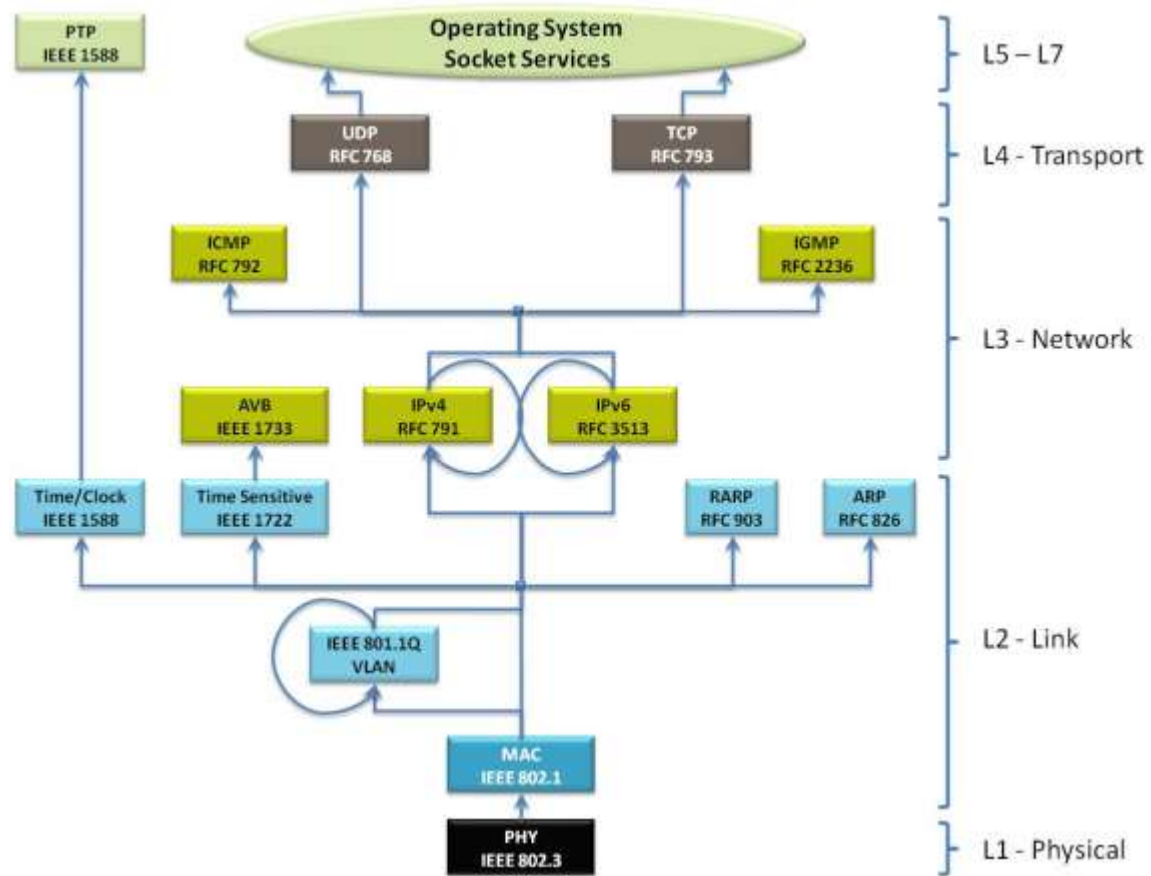
# Ethernet to Application (Simplified Diagram)



- ARP** Address Resolution Protocol
- AVB** Audio Video Bridging
- ICMP** Internet Control Message Protocol
- IGMP** Internet Group Management Protocol
- IPv4** Internet Protocol version 4
- IPv6** Internet Protocol version 6
- PTP** Precision Time Protocol
- RARP** Reverse Address Resolution Protocol
- TCP** Transmission Control Protocol
- UDP** User Datagram Protocol
- VLAN** Virtual Bridged Local Area Network



# Ethernet Frame

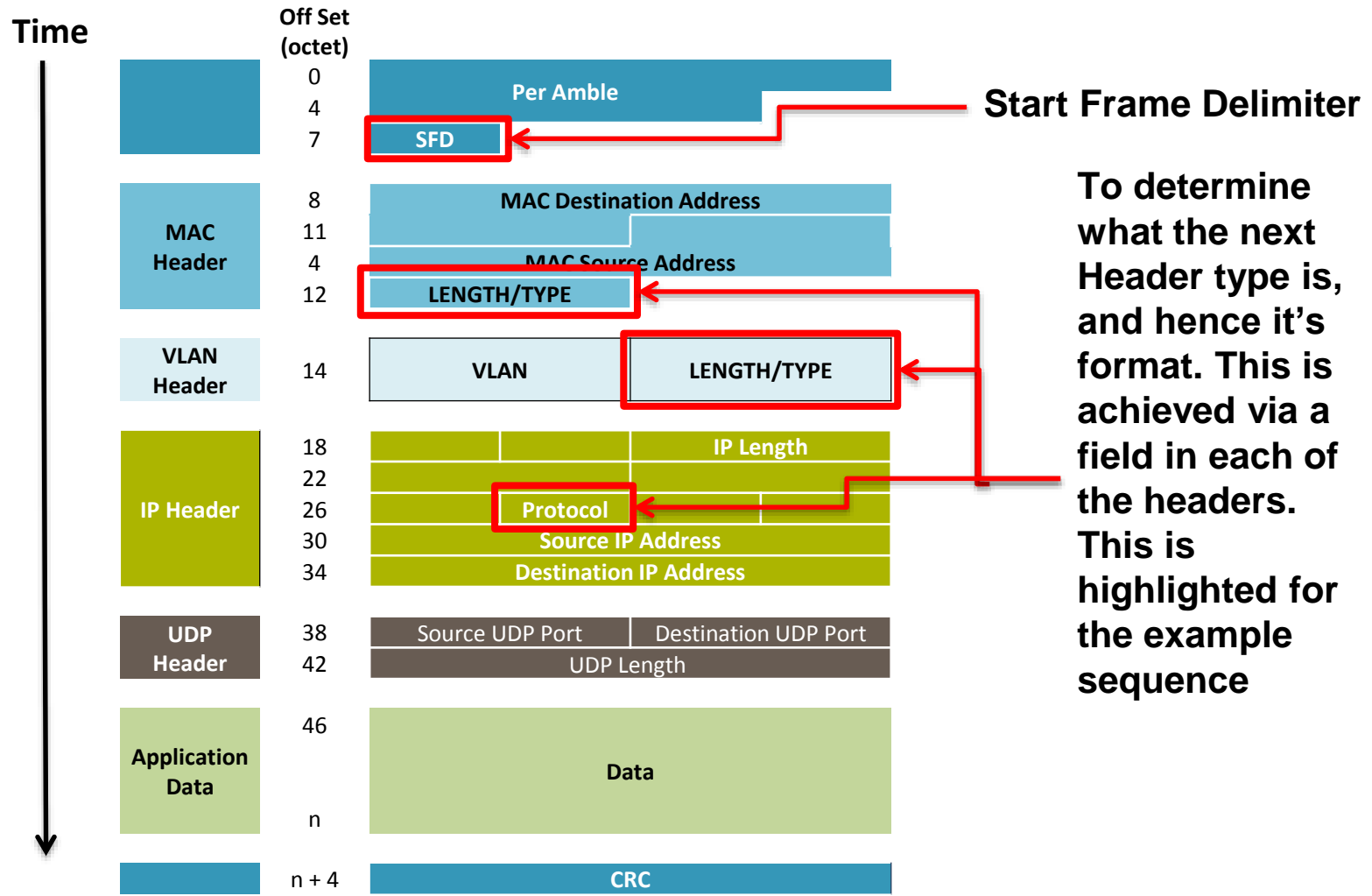


Implementation Specific





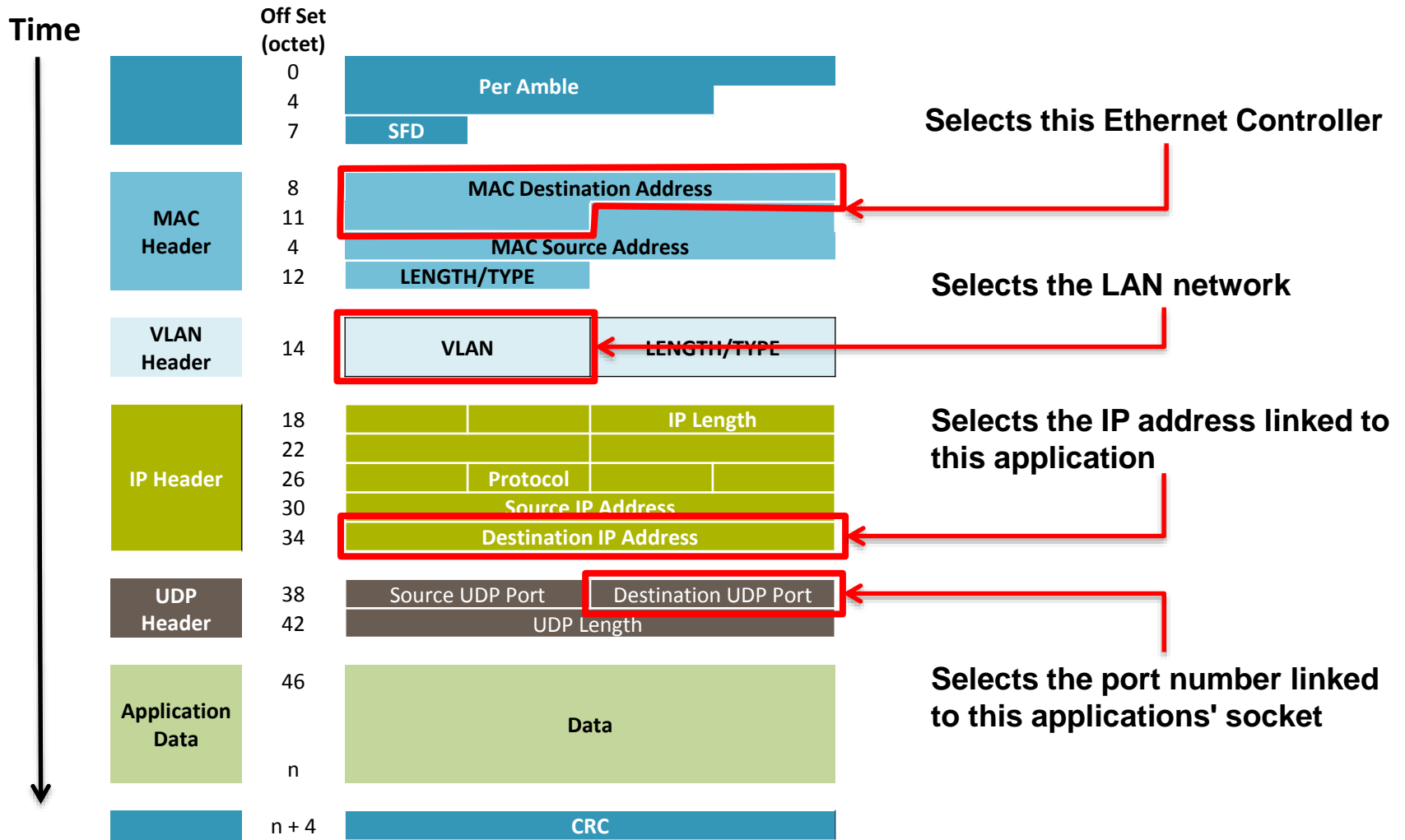
# Ethernet Frame [Protocols]



To determine what the next Header type is, and hence it's format. This is achieved via a field in each of the headers. This is highlighted for the example sequence



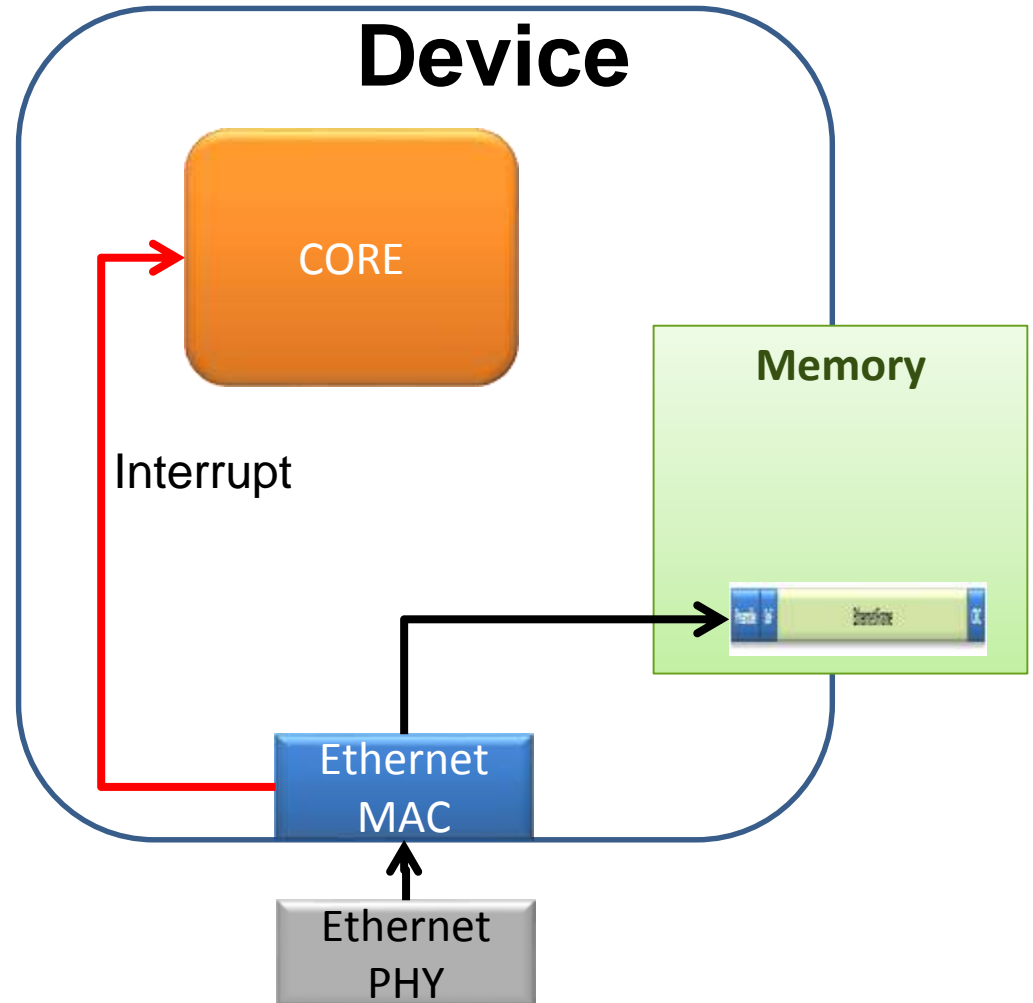
# Ethernet Frame [Addressing]



# Basic Ethernet Controller

## Ethernet **Media Access Control (MAC)** (Hardware)

1. On Receive detects Ethernet Frame and places it into memory
2. On Transmit takes the contents of memory and sends it to the PHY



# Different Types of Ethernet Controllers

## SIMPLE Controller

### Ingress

This takes each of the received frames from the PHY and places them into a buffer and informs the CORE/CPU  
Checks CRC to see if the frame is valid

### Egress

CORE passes a buffer containing the frame to be transmitted and the controller DMA's it to the PHY  
Generates the CRC for the frame being transmitted

## IEEE 1588 Assist

In addition to the functions performed by SIMPLE controller, it performs:

### Ingress

Copies the value of the IEEE 1588 clock when SFD is detected and the value is passed to the CORE/CPU  
referenced to this received frame

### Egress

If the frame is flagged to have the IEEE 1588 time stamp included, the controller copies the value of the IEEE  
1588 clock to the time stamp field

## QUEUE Assist

In addition to the functions performed by IEEE 1588 Assist controller, it performs:

### Ingress

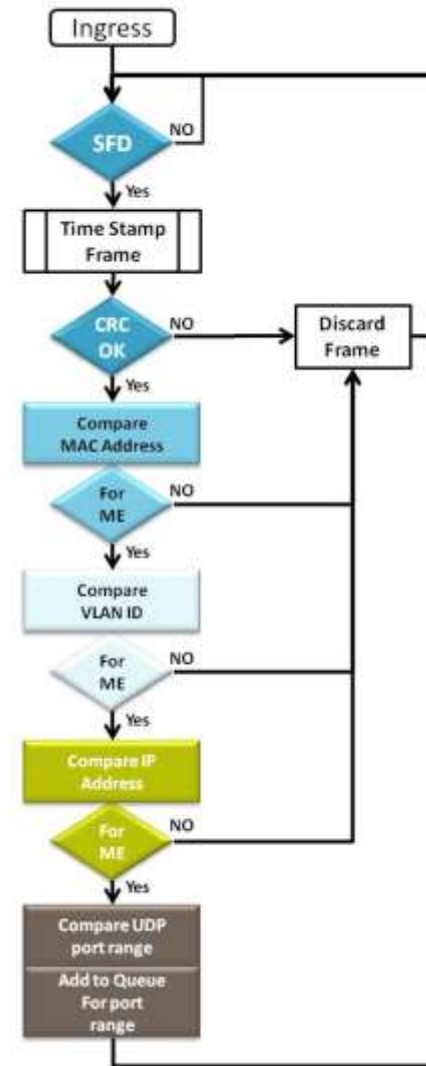
There is a comparison performed on fields in the frame being received, to determine which queue that the  
information about this frame is placed in for the CORE/CPU

### Egress

A round robin or some other selection method is used to check the transmit queues to obtain the next frame to  
be transmitted

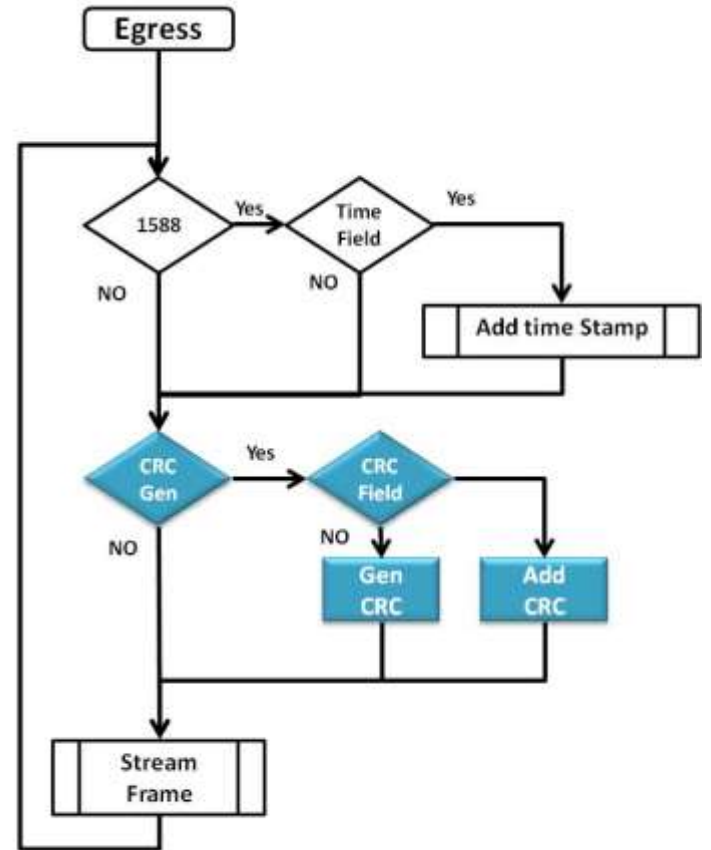
# Features of Ethernet Controllers (INGRESS)

Ethernet Controller Type		
Queue Assist	IEEE 1588 Assist	Simple
Hardware	Hardware	Hardware
Hardware	Hardware	n/a
Hardware	Hardware	Hardware
Hardware	Software	Software
Hardware	Software	Software
Hardware	Software	Software
Hardware	Software	Software



# Features of Ethernet Controllers (EGRESS)

Ethernet Controller Type		
Queue Assist	IEEE 1588 Assist	Simple
Hardware	Hardware <sup>2</sup>	Software <sup>1</sup>
Hardware	Hardware	Hardware
Hardware	Hardware	Hardware



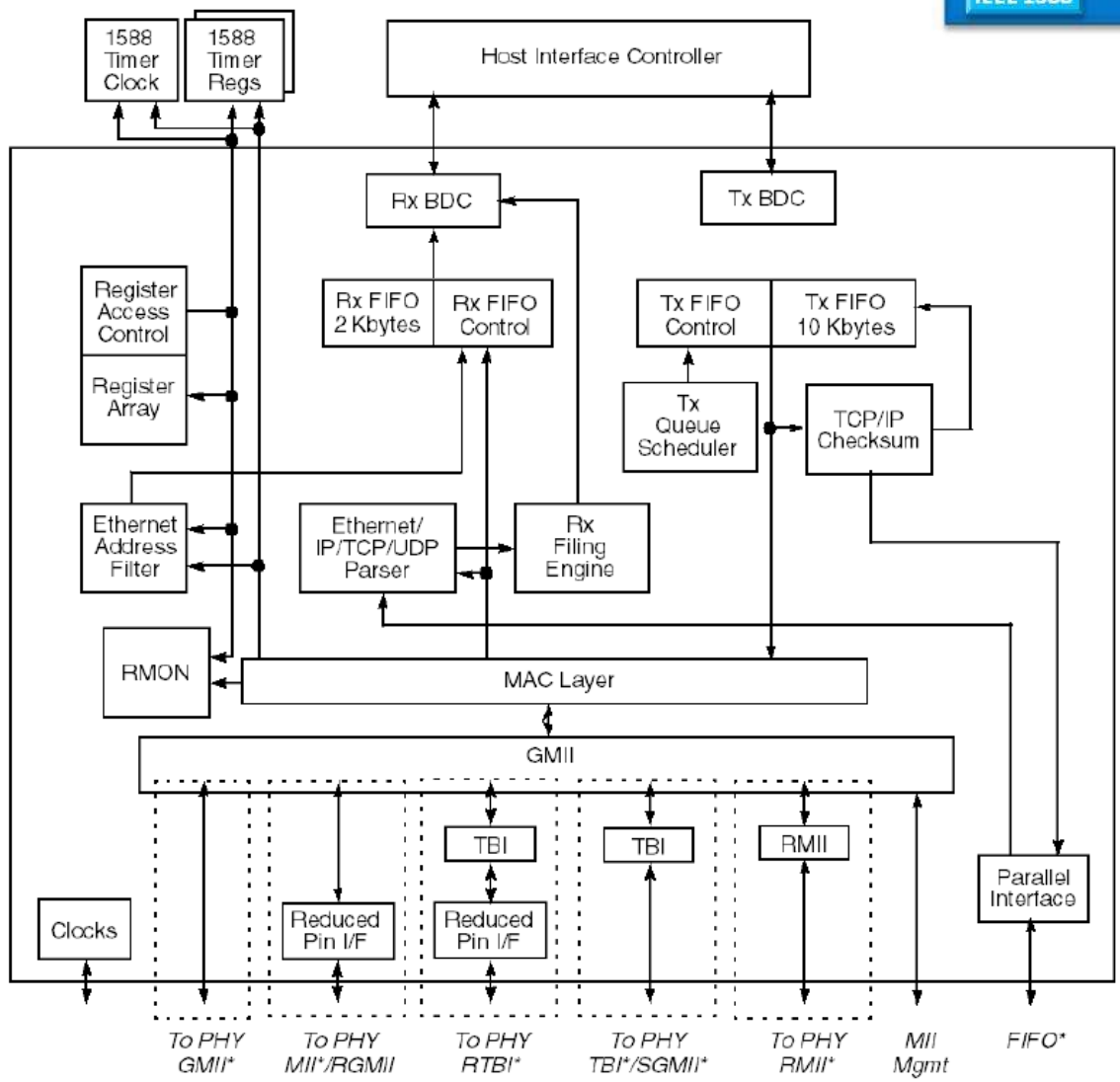
1. Software has to generate the frame, then pass it to the Ethernet Controller, hence for PTP the time stamp will have a larger jitter than a hardware implementation
2. Will be required to generate the checksums for UDP/TCP/IP if they are required by the system

# Ethernet Controller in Value-Performance QorIQ

This is called the Enhanced Three-Speed Ethernet Controller (eTSEC).

eTSEC falls into the Queue Assist category of Ethernet controllers.

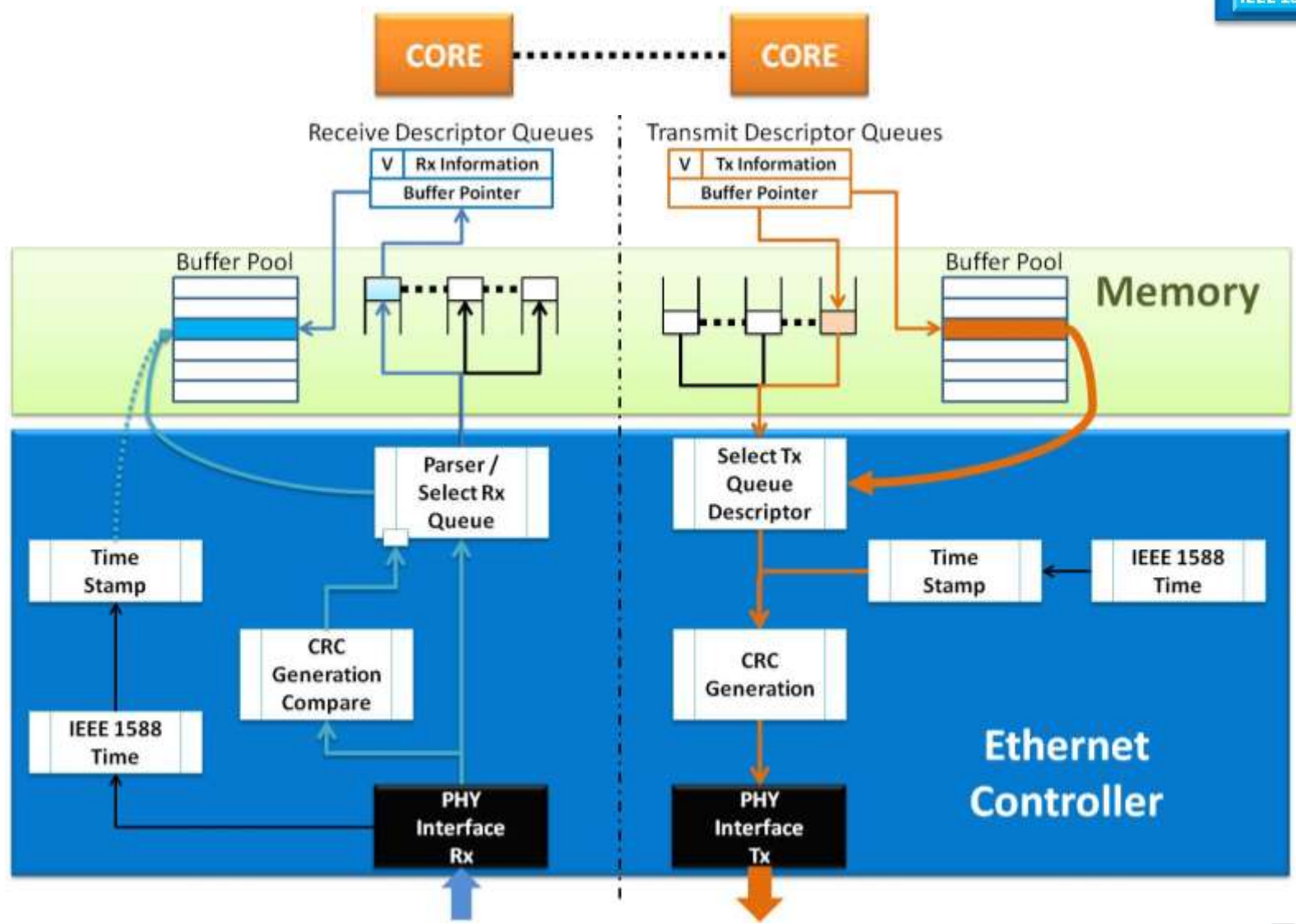
There is also virtualization support in the latest versions.



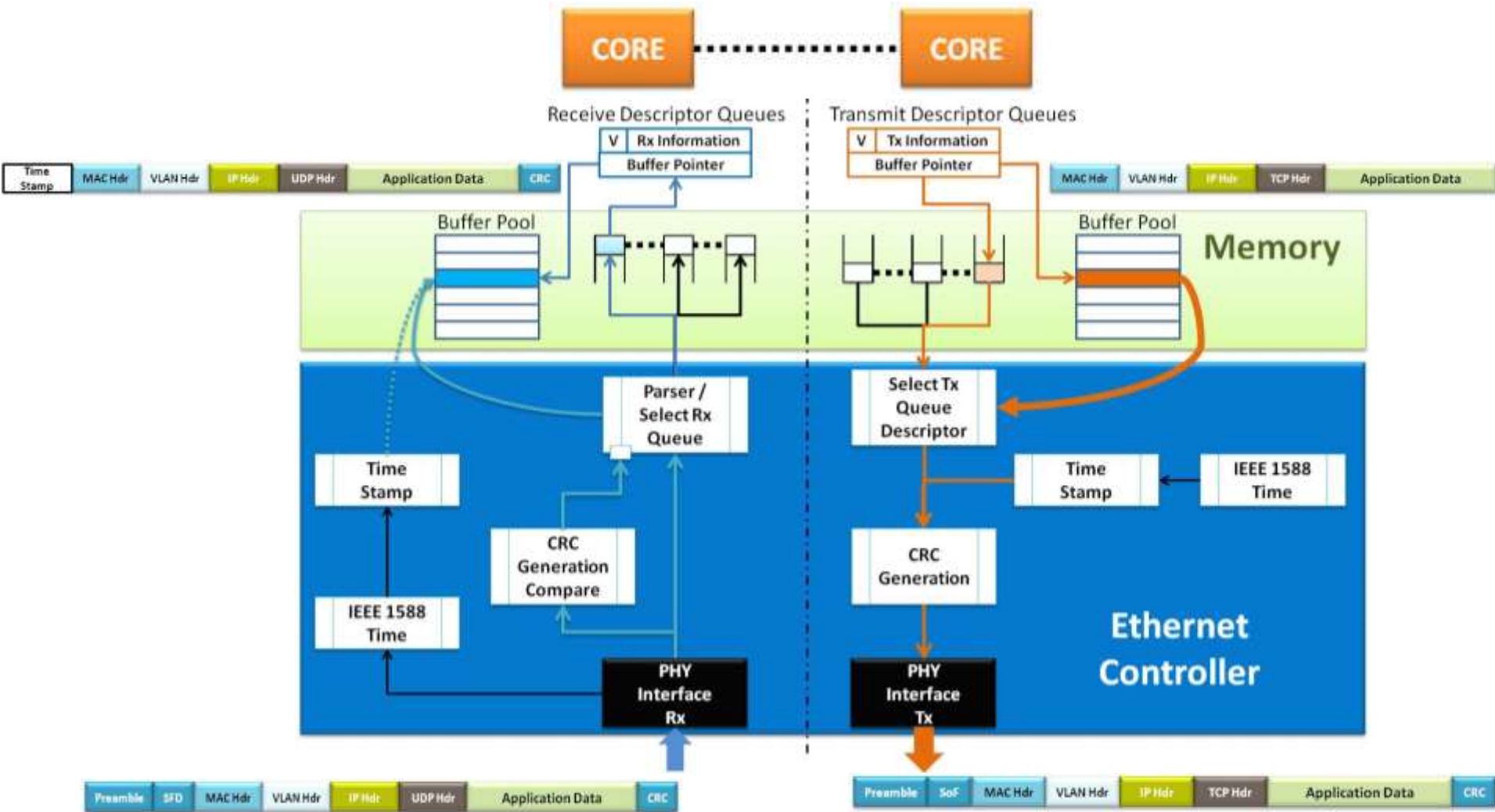
\* Note: Not all interfaces may be supported on this device



# Simplified View of Ethernet Controller (eTSEC)

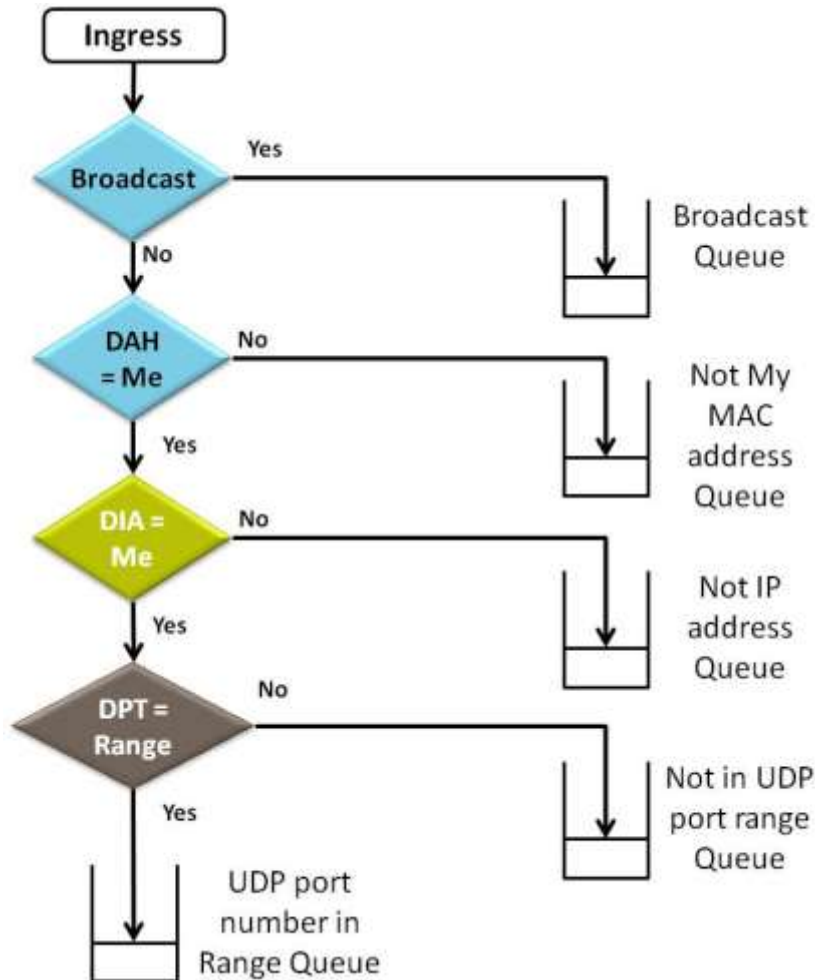


# Frame Flow through the eTSEC





# Simple Parsing Flow

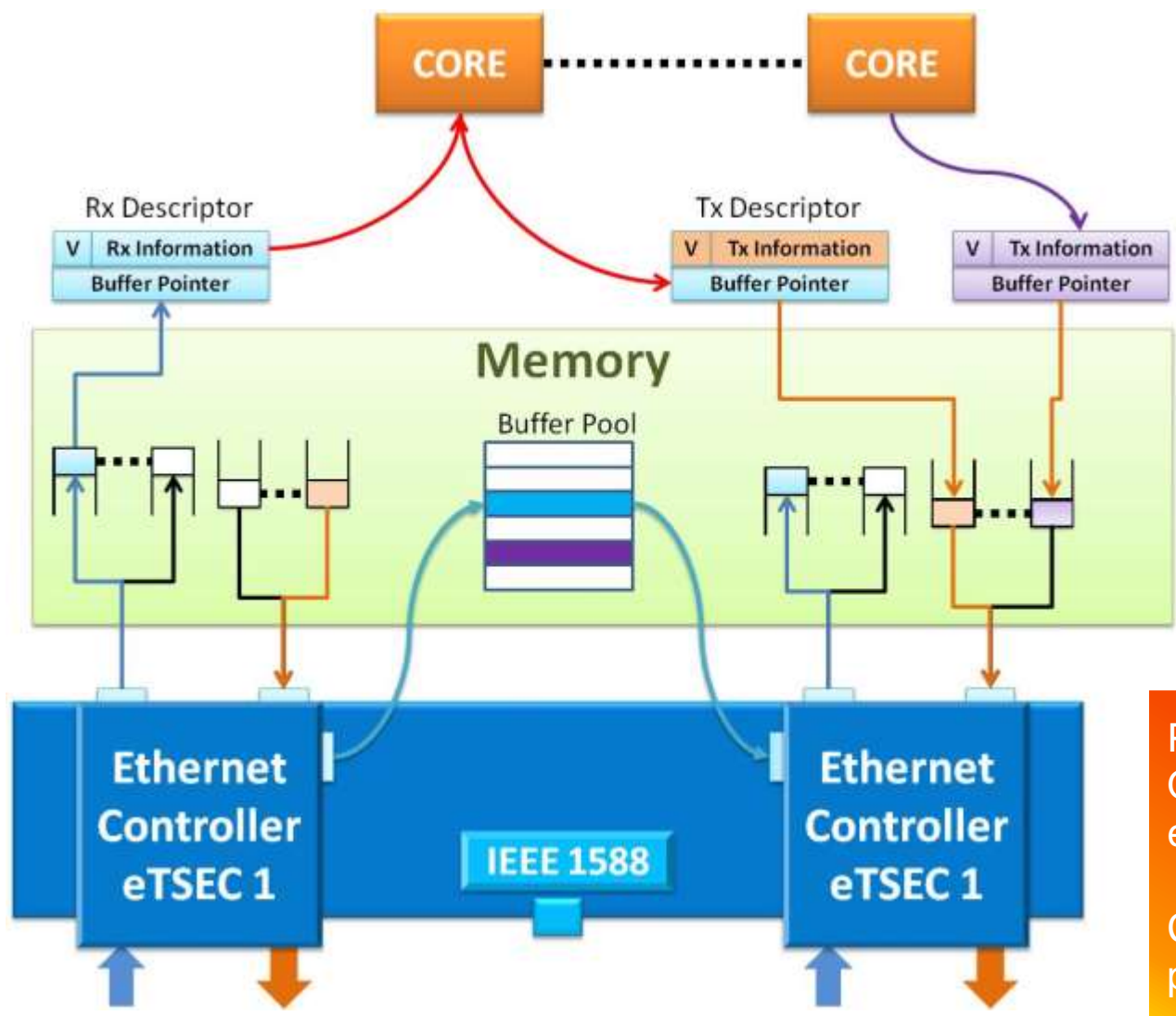


Field	Description
MASK	Generic MASK
DAH	Destination MAC address most significant 24 bits
SAH	Source MAC address, most significant 24 bits
SAL	Source MAC address, least significant 24 bits
ETY	Ethertype of next layer protocol
VID	VLAN network identifier (as per IEEE Std 802.1Q)
PRI	VLAN user priority (as per IEEE Std 802.1p)
TOS	IPv4 header Type Of Service field or IPv6 Traffic Class field
L4P	Layer 4 protocol identifier as per published IANA specification
DIA	Destination IP address ( IPv4 or IPv6 header) 32 most significant bits
SIA	Source IP address ( IPv4 or IPv6 header) 32 most significant bits
DPT	Destination port number for TCP or UDP headers
SPT	Source port number for TCP or UDP headers

Parser also knows protocol header definitions and the user can instruct a decision tree



# Simple Switch Application



Parser places in Switch Queue if not for this device, excluding broadcast frames

Core only needs to move pointer to Tx queue



This shows some of the capabilities of the eTSEC used in the QorIQ family of communications processors from Freescale.

Note the eTSEC Ethernet controller is just the junior member of the Ethernet controllers used in the QorIQ family, in both hardware acceleration and line rate performance.

For more information go to  
<http://www.freescale.com/QorIQ>

# Introducing The QorIQ LS2 Family

**Breakthrough, software-defined approach to advance the world's new virtualized networks**

## **New, high-performance architecture built with ease-of-use in mind**

Groundbreaking, flexible architecture that abstracts hardware complexity and enables customers to focus their resources on innovation at the application level

## **Optimized for software-defined networking applications**

Balanced integration of CPU performance with network I/O and C-programmable datapath acceleration that is right-sized (power/performance/cost) to deliver advanced SoC technology for the SDN era

## **Extending the industry's broadest portfolio of 64-bit multicore SoCs**

Built on the ARM® Cortex®-A57 architecture with integrated L2 switch enabling interconnect and peripherals to provide a complete system-on-chip solution

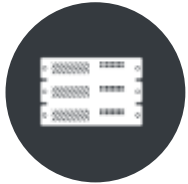


# QorIQ LS2 Family

## Key Features



**SDN/NFV  
Switching**



**Data  
Center**



**Wireless  
Access**

Unprecedented performance and ease of use for smarter, more capable networks

### High performance cores with leading interconnect and memory bandwidth

- 8x ARM Cortex-A57 cores, 2.0GHz, 4MB L2 cache, w Neon SIMD
- 1MB L3 platform cache w/ECC
- 2x 64b DDR4 up to 2.4GT/s

### A high performance datapath designed with software developers in mind

- New datapath hardware and abstracted acceleration that is called via standard Linux objects
- 40 Gbps Packet processing performance with 20Gbps acceleration (crypto, Pattern Match/RegEx, Data Compression)
- Management complex provides all init/setup/teardown tasks

### Leading network I/O integration

- 8x1/10GbE + 8x1G, MACSec on up to 4x 1/10GbE
- Integrated L2 switching capability for cost savings
- 4 PCIe Gen3 controllers, 1 with SR-IOV support
- 2 x SATA 3.0, 2 x USB 3.0 with PHY



# See the LS2 Family First in the Tech Lab!



## 4 new demos built on QorIQ LS2 processors:



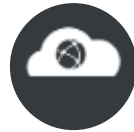
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