ABSTRACTING INTER-PLATFORM COMMUNICATION IN AUTOMOTIVE

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SECURE CONNECTIONS
FOR A SMARTER WORLD

Agenda

- AMP Software Portfolio
- Motivation
- Solution
- Features
- Conclusions

NXP AMP Software

ADAS

(Advanced Driver Assistance Systems)

Radar, LIDAR
Vision
Sensor Fusion

- Linux BSP
- QNX SDK
- Vision, Radar and Fusion Software
- ADAS System Tools
- OpenCL compiler
- Autosar MCAL Drivers
- Autosar OS
- S32 SDK Drivers and Middleware
- **IPCF**

GPIS

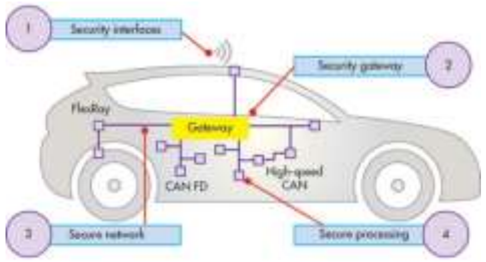
(General Purpose & Integrated Solutions)

Body Electronics
Edge Nodes

- S32 SDK Drivers and Middleware
- Software Stacks
- System Tools
- FreeRTOS
- Autosar MCAL Drivers
- Autosar OS
- Security

C&S

(Connectivity & Security)



Gateway

- Linux BSP
- FreeRTOS
- QNX SDK
- Autosar MCAL Drivers
- Autosar OS
- LLCE
- Software Stacks
- S32 SDK Drivers and Middleware
- **IPCF**

VDS

(Vehicle Dynamics & Safety)

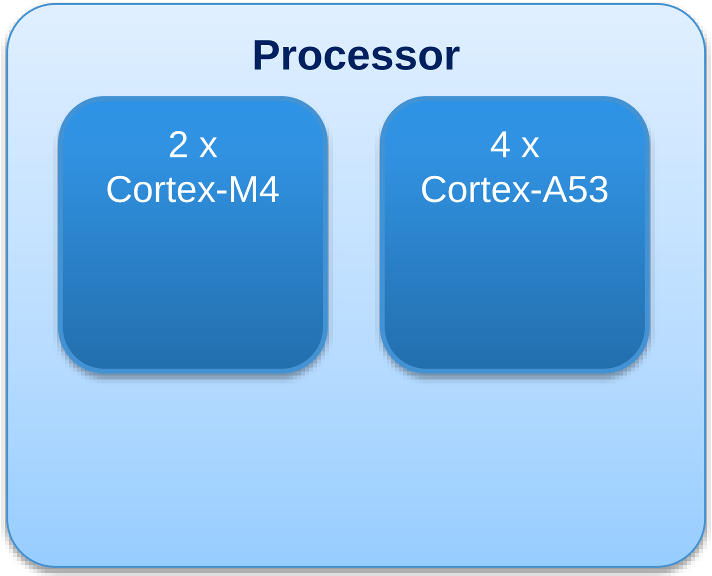
Chassis & Safety
Powertrain & Hybrid/EV

- Autosar MCAL Drivers
- Autosar OS
- Configuration and Initialization Tools

MOTIVATION

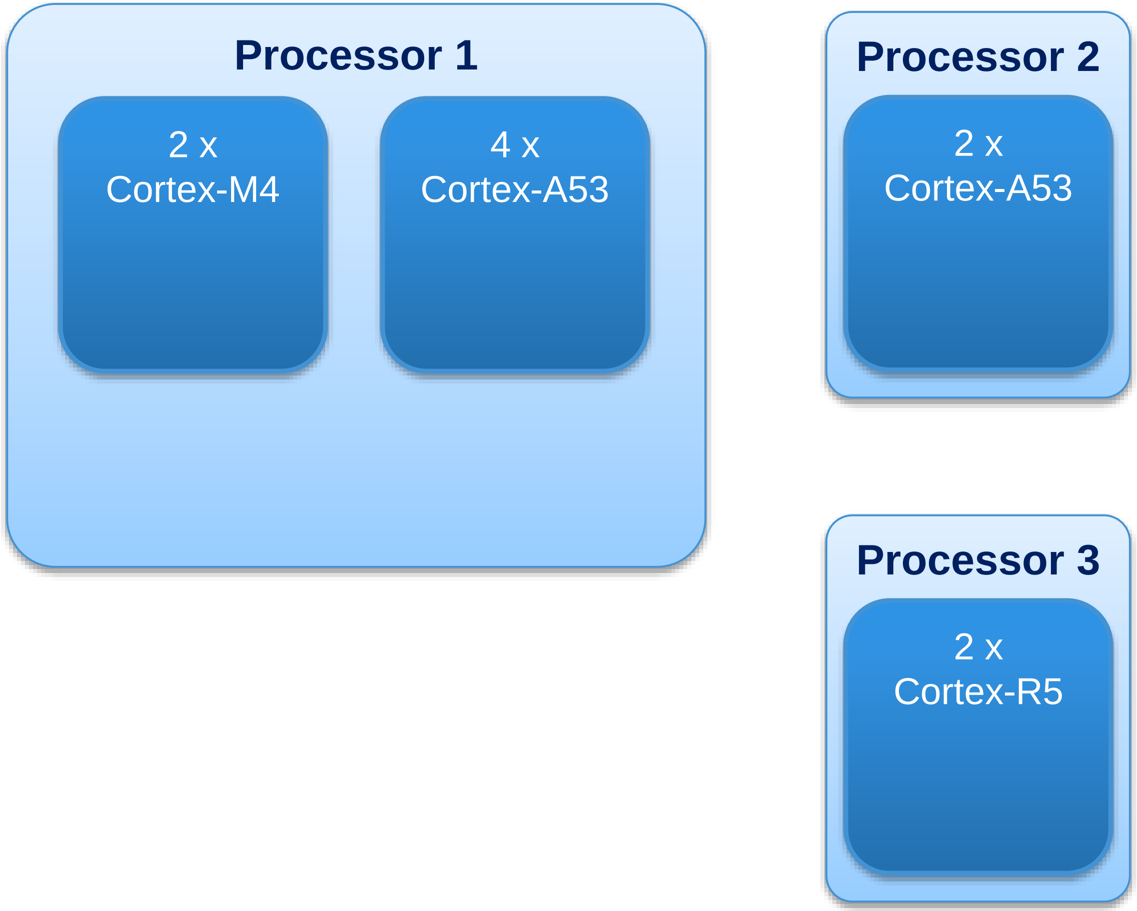
The need for inter-platform communication

- Multiple homogeneous or heterogeneous processing cores



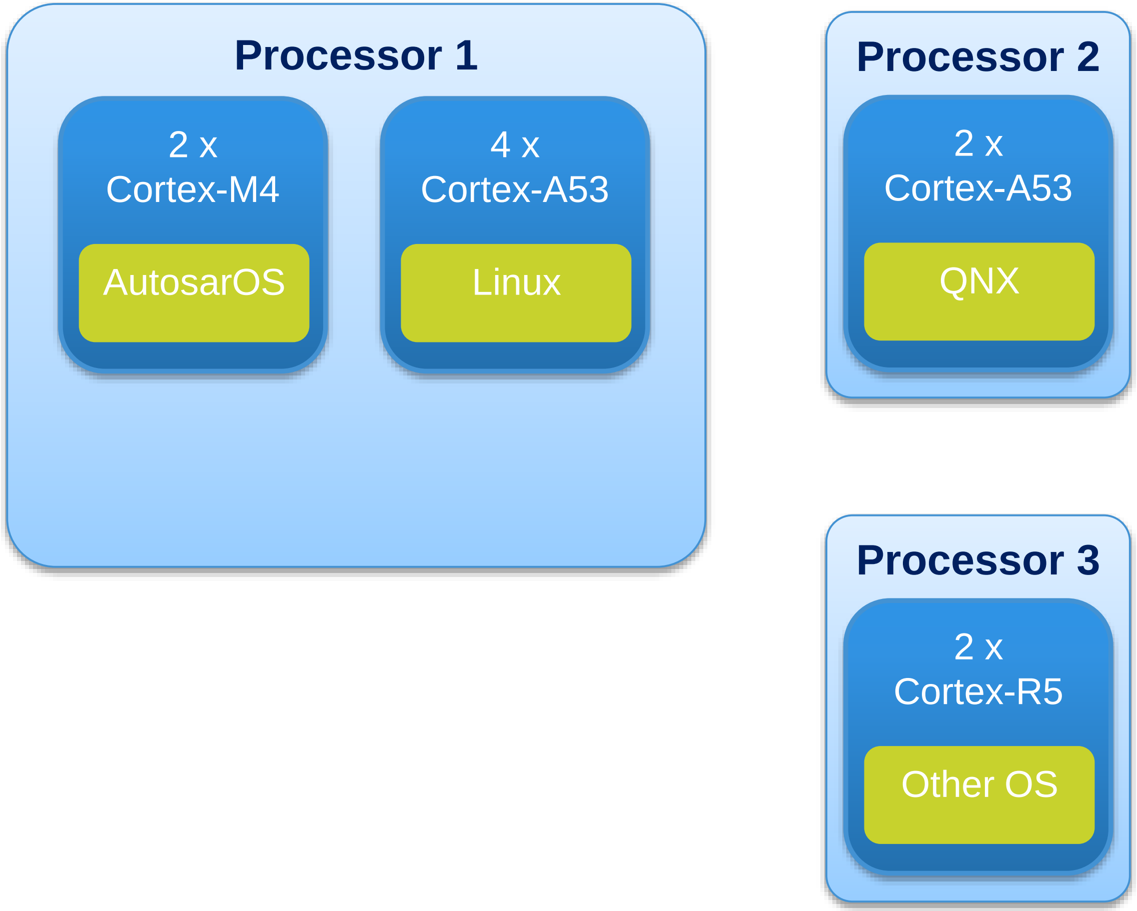
The need for inter-platform communication

- Multiple homogeneous or heterogeneous processing cores
- Located on a single chip or on multiple chips in a circuit board



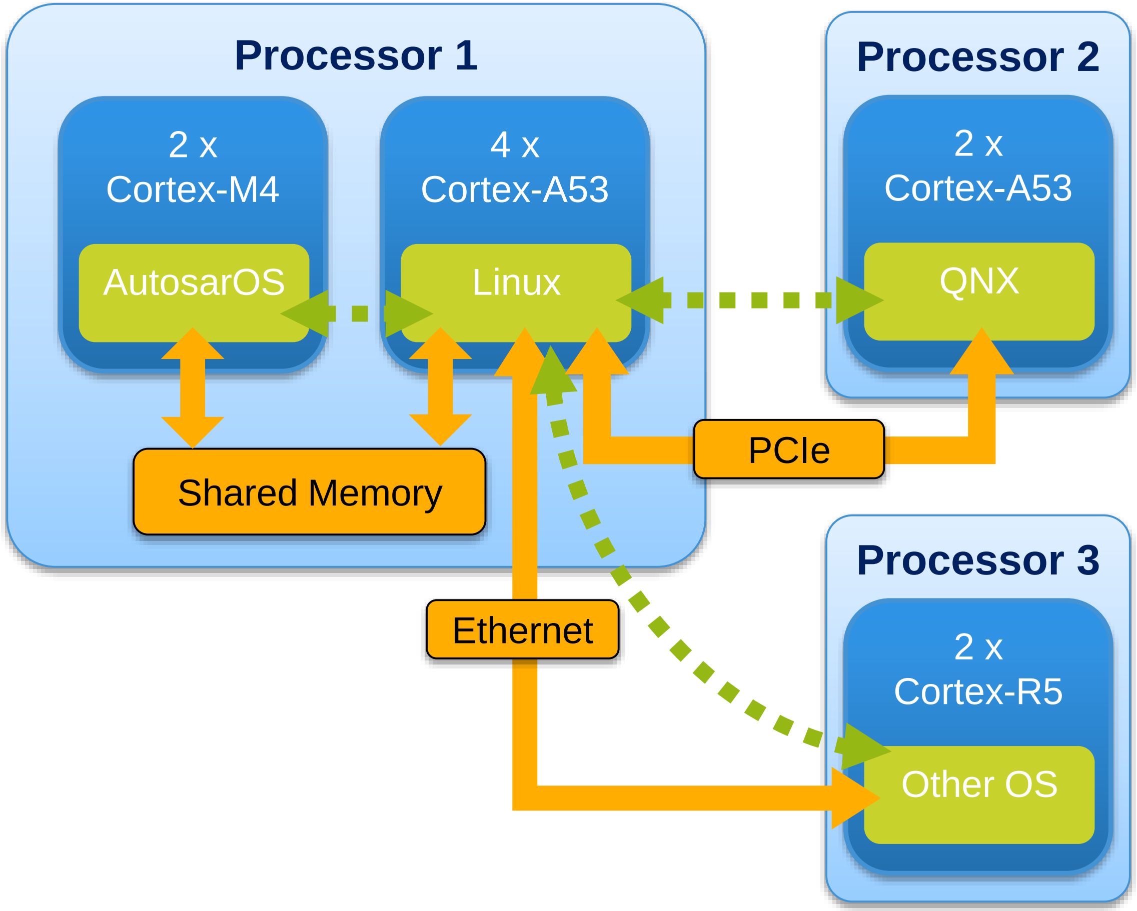
The need for inter-platform communication

- Multiple homogeneous or heterogeneous processing cores
- Located on a single chip or on multiple chips in a circuit board
- Running multiple OSes
  - AutosarOS, FreeRTOS, RTEMS
  - QNX, Integrity
  - Linux

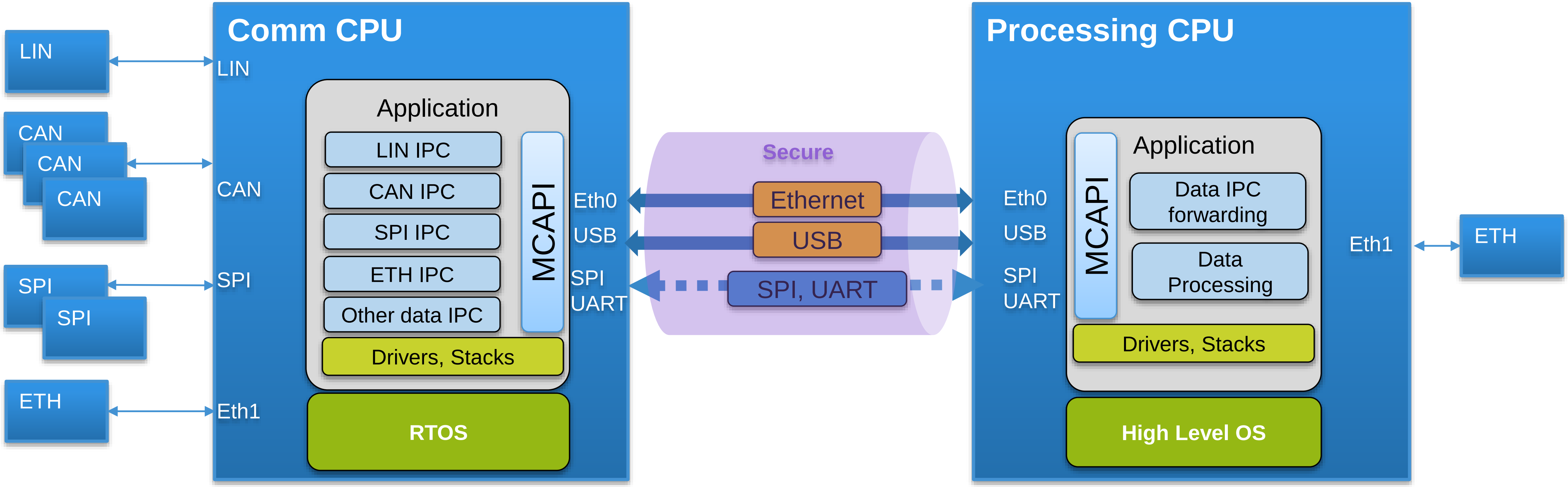


The need for inter-platform communication

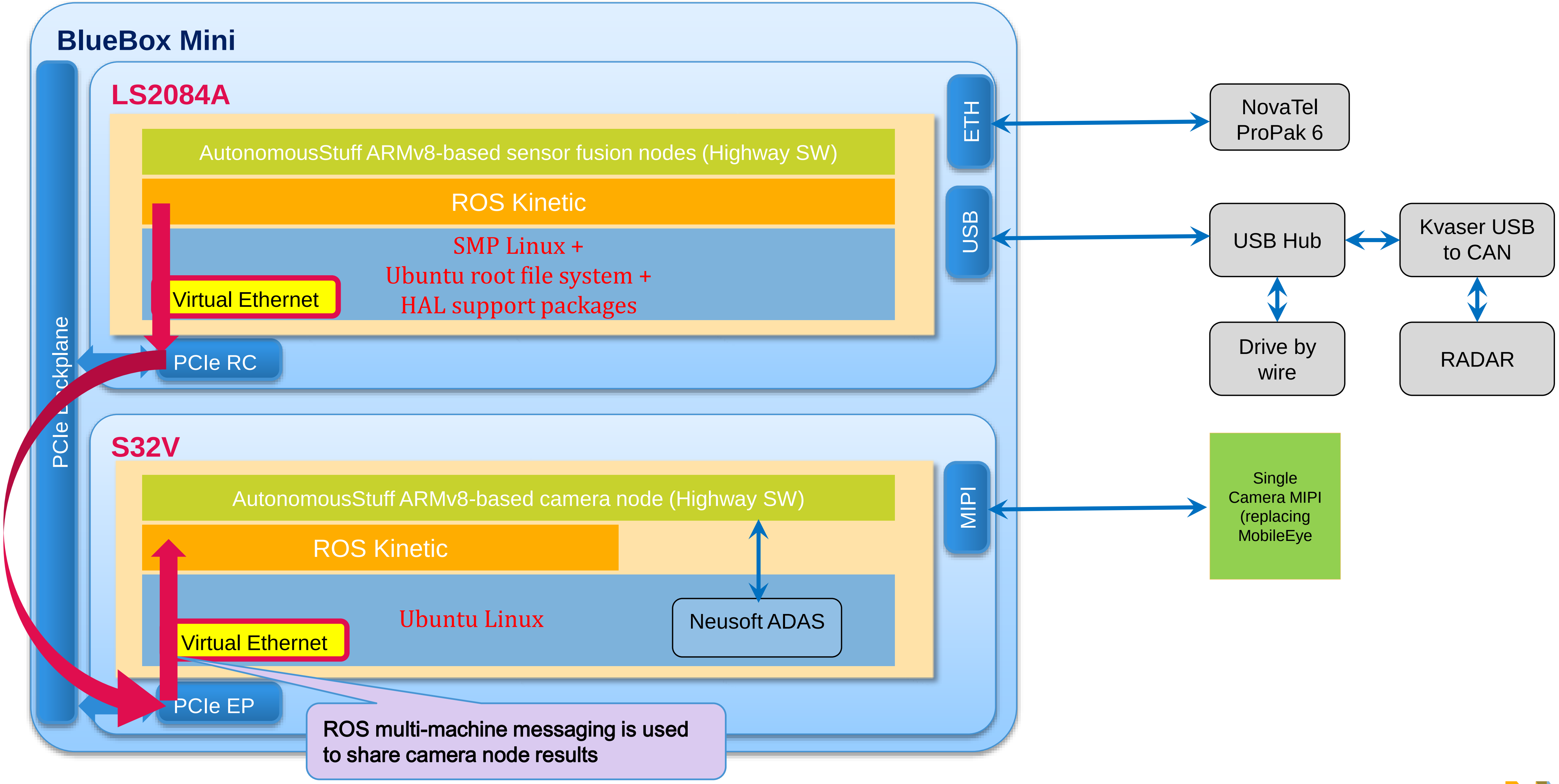
- Multiple homogeneous or heterogeneous processing cores
- Located on a single chip or on multiple chips in a circuit board
- Running multiple OSes
- Communicating over various interfaces:
  - Ethernet
  - PCIe
  - USB
  - UART, SPI
  - Shared memory



Concrete Example - Gateway



Concrete Example: Highway Autopilot on Blue Box Mini



ROS multi-machine messaging is used to share camera node results

Existing solutions

- MPI (Message Passing Interface)
  - communication protocol for programming parallel computers
  - dominant model in high performance computing
  - Implementations: openMPI, MPICH

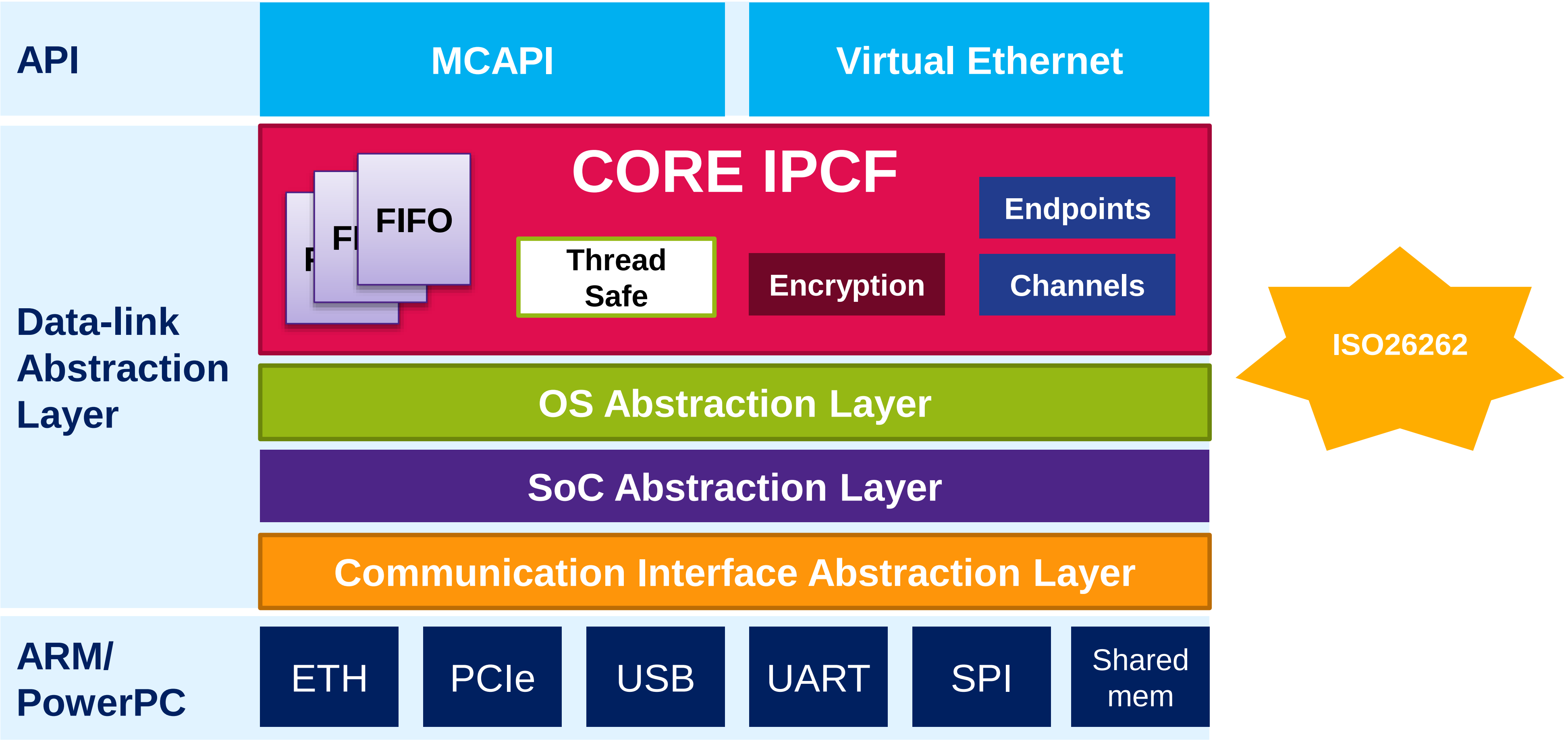
- RemoteDMA
  - useful in massively parallel computer clusters
  - need to install a different networking infrastructure
  - implementations: InfiniBand, iWARP, RoCE

- RPC/RMI (Remote Procedure/Method Call)
  - used in distributed computing programming
  - multilanguage support: C/C++, Java, Python, Ruby
  - implementations: D-Bus, CORBA, Java-RMI, DCOM, Protocol Buffers

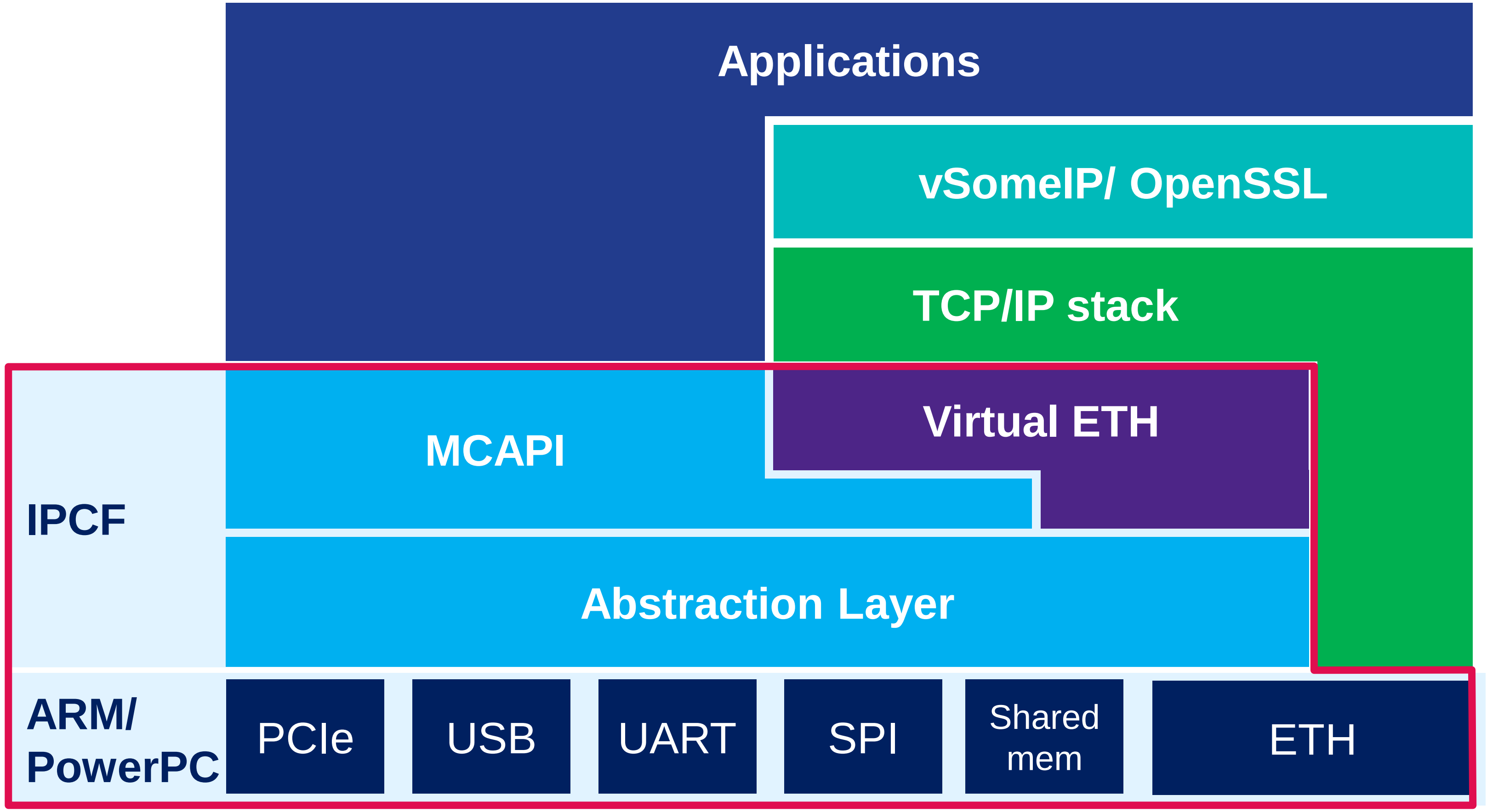
- DDS (Data Distribution Service)
  - publish-subscribe middleware
  - simplifies complex network programming for distributed applications
  - implementations: OpenDDS, Connext DDS, Vortex OpenSplice

Inter Platform Communication Framework

Architecture



System Software Overview



Features

API: MCAPI

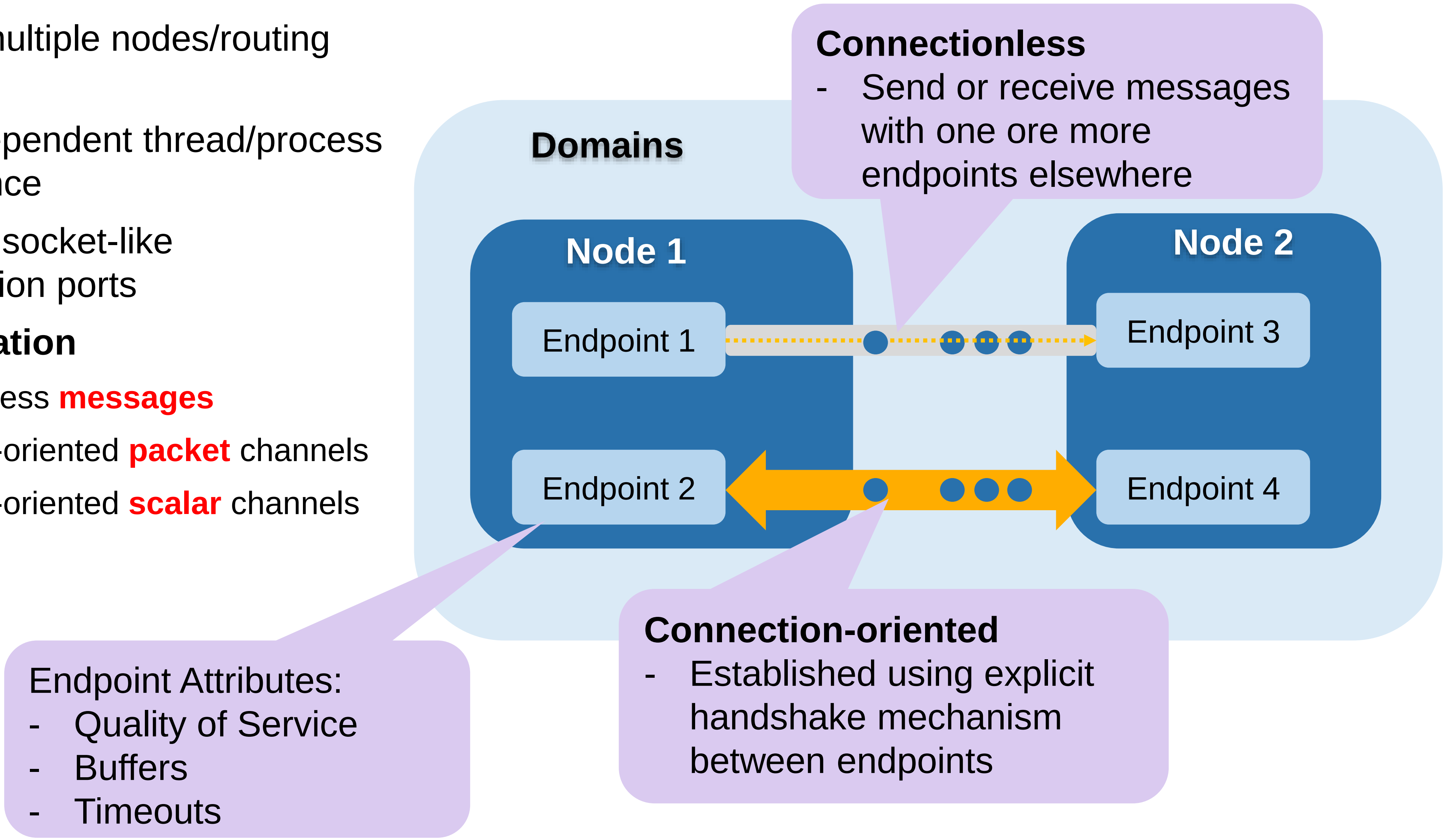
- What is MCAPI?
  - Standardized API for communication between closely distributed embedded systems

- Why MCAPI?
  - Multicore and Multichip
  - Connection-oriented and Connectionless
  - Simple and efficient
  - Designed for low-latency, high performance and tiny footprint
  - Portability
  - Standardized programming model

http://www.multicore-association.org/member/memberlist.php

MCAPI™ Overview

- **Domains**: multiple nodes/routing purposes
- **Nodes**: independent thread/process or OS instance
- **Endpoints:** socket-like communication ports
- **Communication**
  - Connectionless **messages**
  - Connection-oriented **packet** channels
  - Connection-oriented **scalar** channels



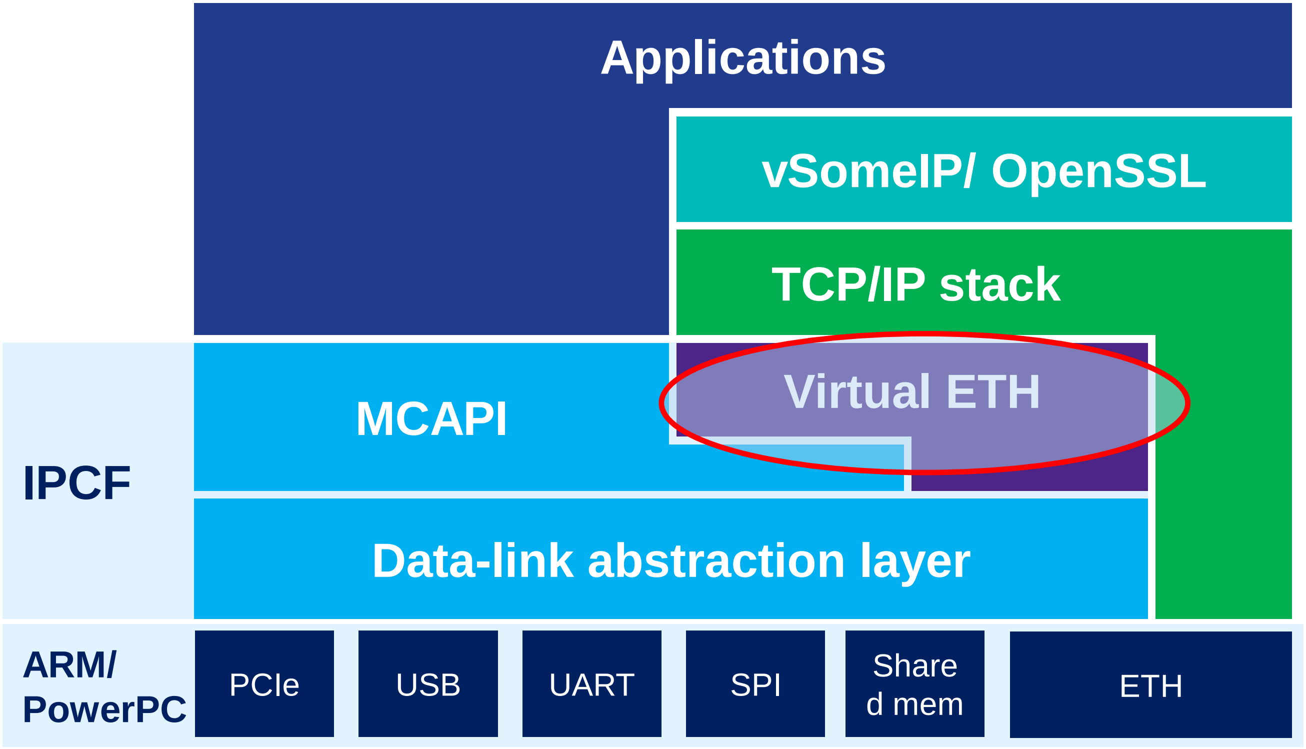
Connectionless
- Send or receive messages with one ore more endpoints elsewhere

Connection-oriented
- Established using explicit handshake mechanism between endpoints

Endpoint Attributes:
- Quality of Service
- Buffers
- Timeouts

Virtual Ethernet

- Standard API: **Virtual Ethernet**
- Simplify the inter-communication specification
- Ease of use using standard network socket
- No difference than standard ETH interface

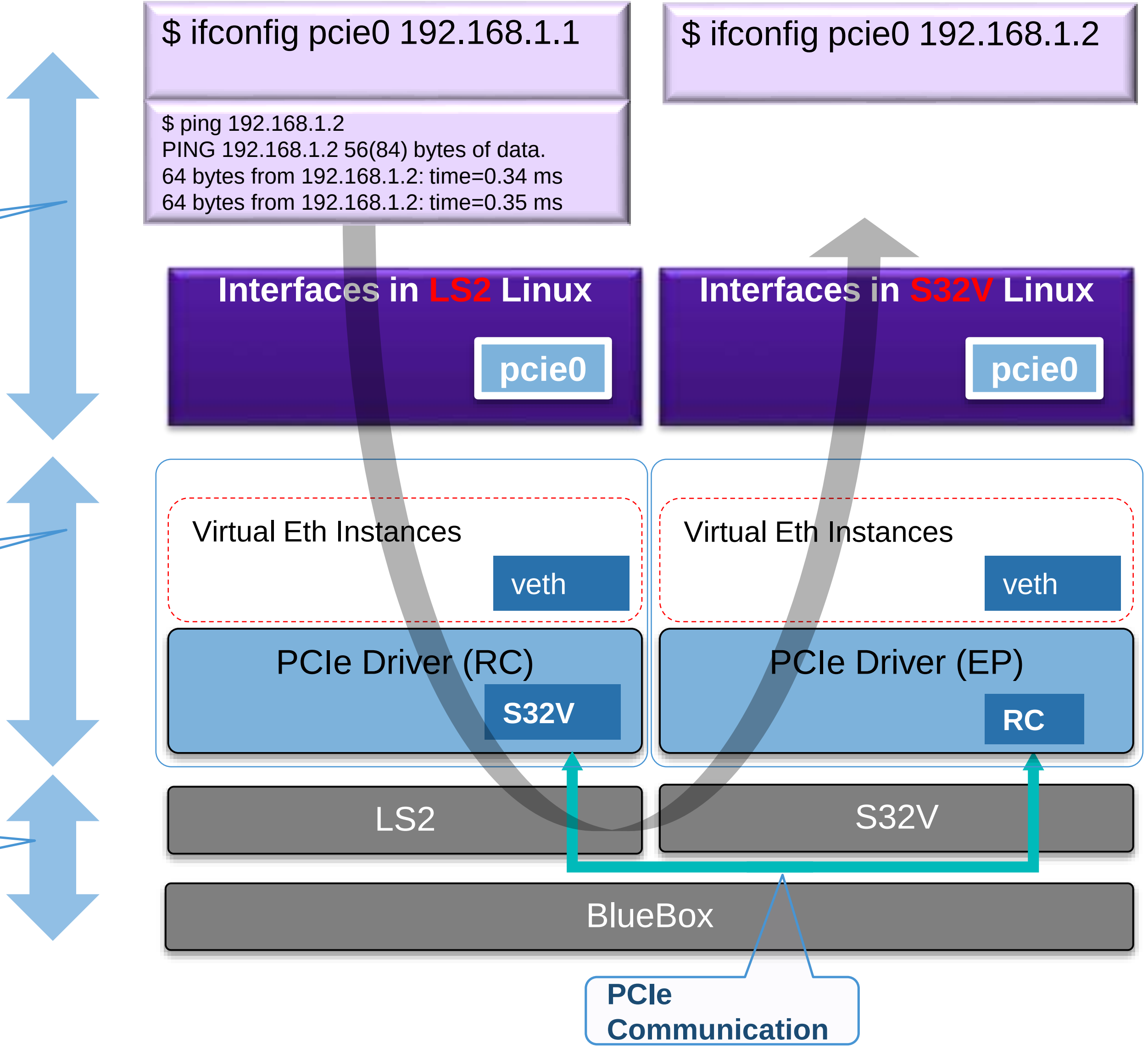


Virtual Ethernet - Deep Dive

Standard Ethernet Linux interface

Implementation:
- **Virtual Ethernet Network Device**
- **PCIe driver**

BlueBox

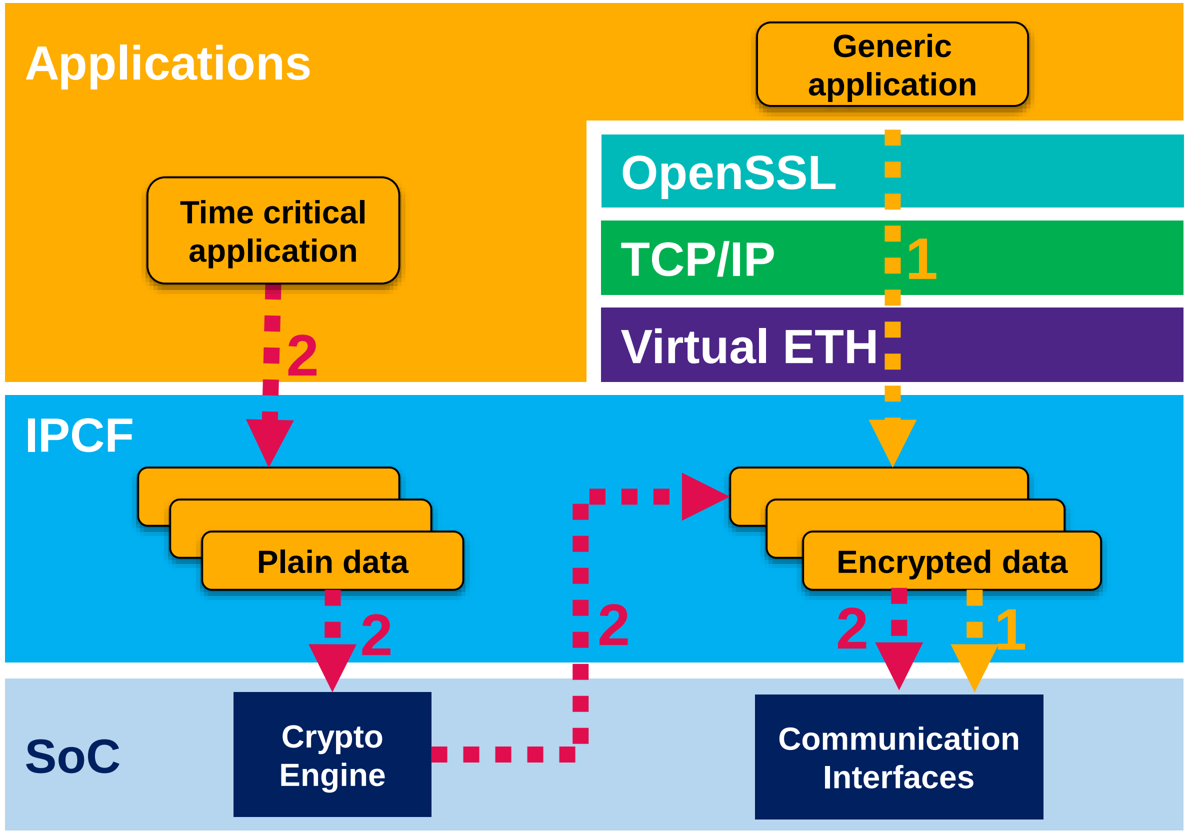


```
$ ifconfig pcie0 192.168.1.1
```

```
$ ping 192.168.1.2
PING 192.168.1.2 56(84) bytes of data.
64 bytes from 192.168.1.2: time=0.34 ms
64 bytes from 192.168.1.2: time=0.35 ms
```

```
$ ifconfig pcie0 192.168.1.2
```

Security



1. SW encryption & authentication
   - OpenSSL over **Virtual ETH**
   - Reuse existing user applications

2. HW accelerated encryption & authentication
   - for time critical applications

Defaults vs Flexibility

Default Platforms

- Cortex A
- Cortex M
- PowerPC Cortex e200

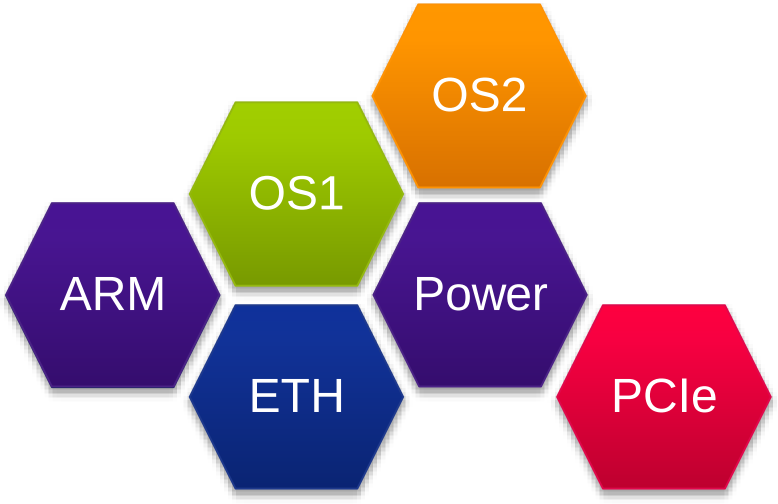
Default OSes

- Linux
- QNX
- NXP AutosarOS
- freeRTOS
- Integrity

Default Communication

- PCIe
- Ethernet
- SharedMem
- USB
- SPI

+



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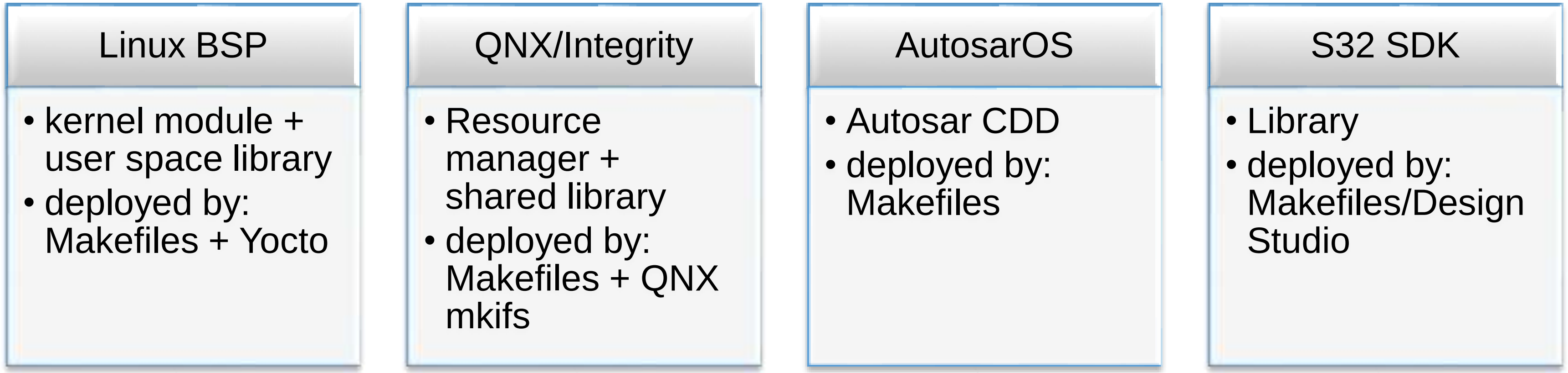
IPCF

Deployment



Linux BSP

- kernel module + user space library
- deployed by: Makefiles + Yocto

QNX/Integrity

- Resource manager + shared library
- deployed by: Makefiles + QNX mkifs

AutosarOS

- Autosar CDD
- deployed by: Makefiles

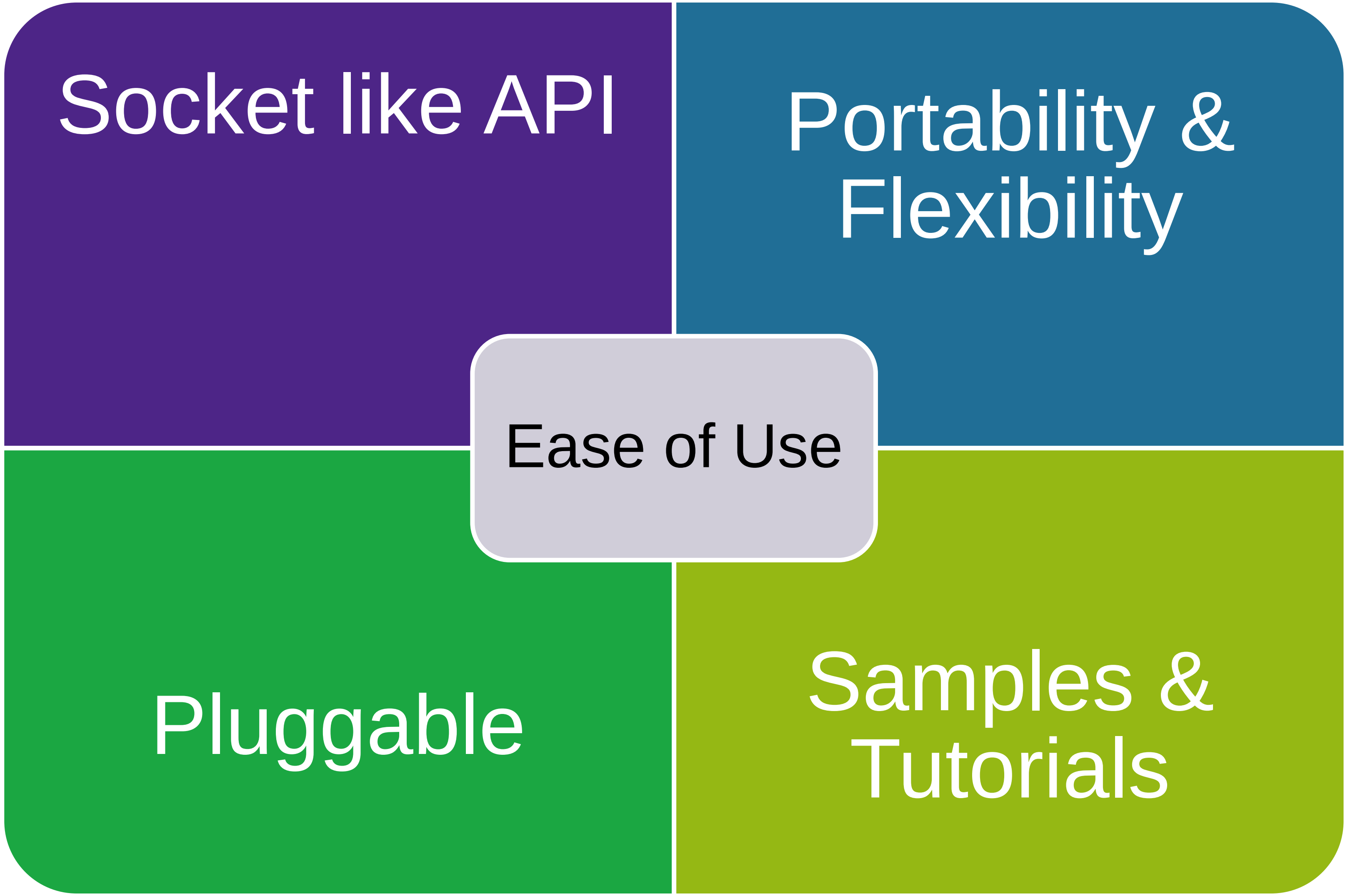
S32 SDK

- Library
- deployed by: Makefiles/Design Studio

Default installation through already existing products

If required, can be delivered as a separate installation package

Ease of Use



Socket like API

Portability & Flexibility

Ease of Use

Pluggable

Samples & Tutorials

space
Scrn
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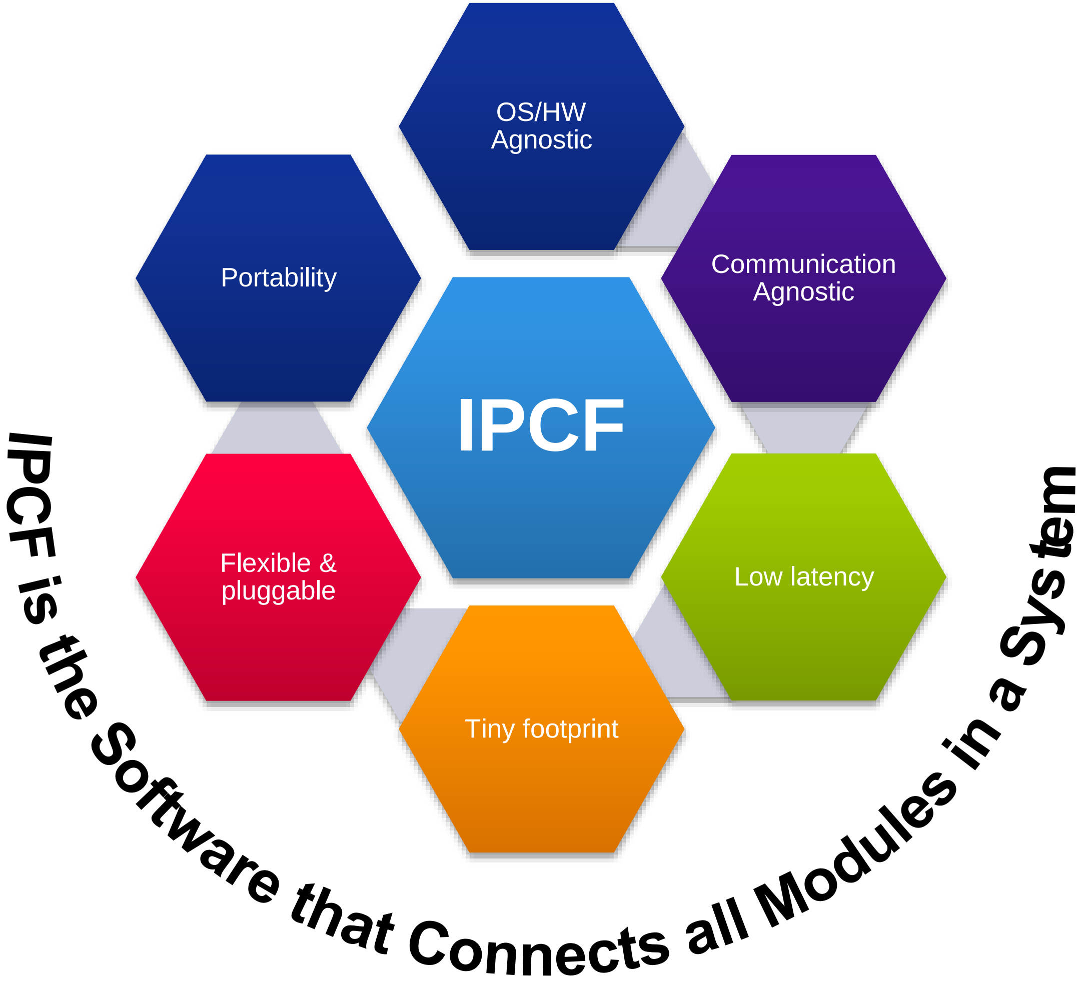
Pause
conclusions
Insert
Home
Page

Conclusions



IPCF is the Software that Connects all Modules in a System

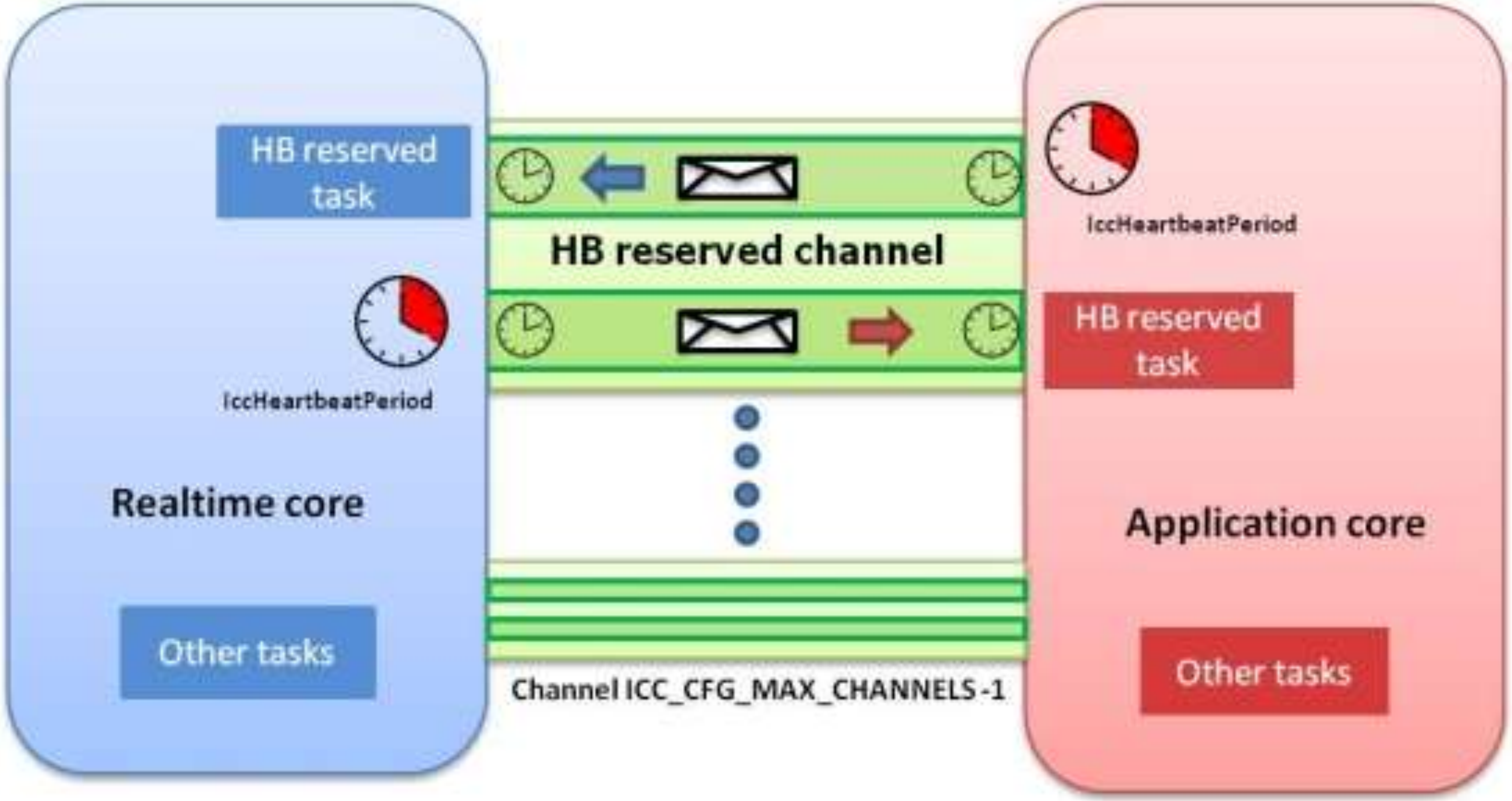
Availability

	Q3 2017	Q4 2017	Q1 2018	Q2 2018	Q3 2018	Q4 2018	2019
NG Vision		preEAR	preEAR	preEAR	EAR	BETA	RTM
NG Radar			preEAR	preEAR	preEAR	EAR	RTM BETA
NG Gateway	EAR	EAR	EAR	EAR	EAR	BETA	RTM
BlueBox		preEAR	preEAR	preEAR	EAR	BETA	RTM

SECURE CONNECTIONS
FOR A SMARTER WORLD

BACKUP SLIDES

HeartBeat

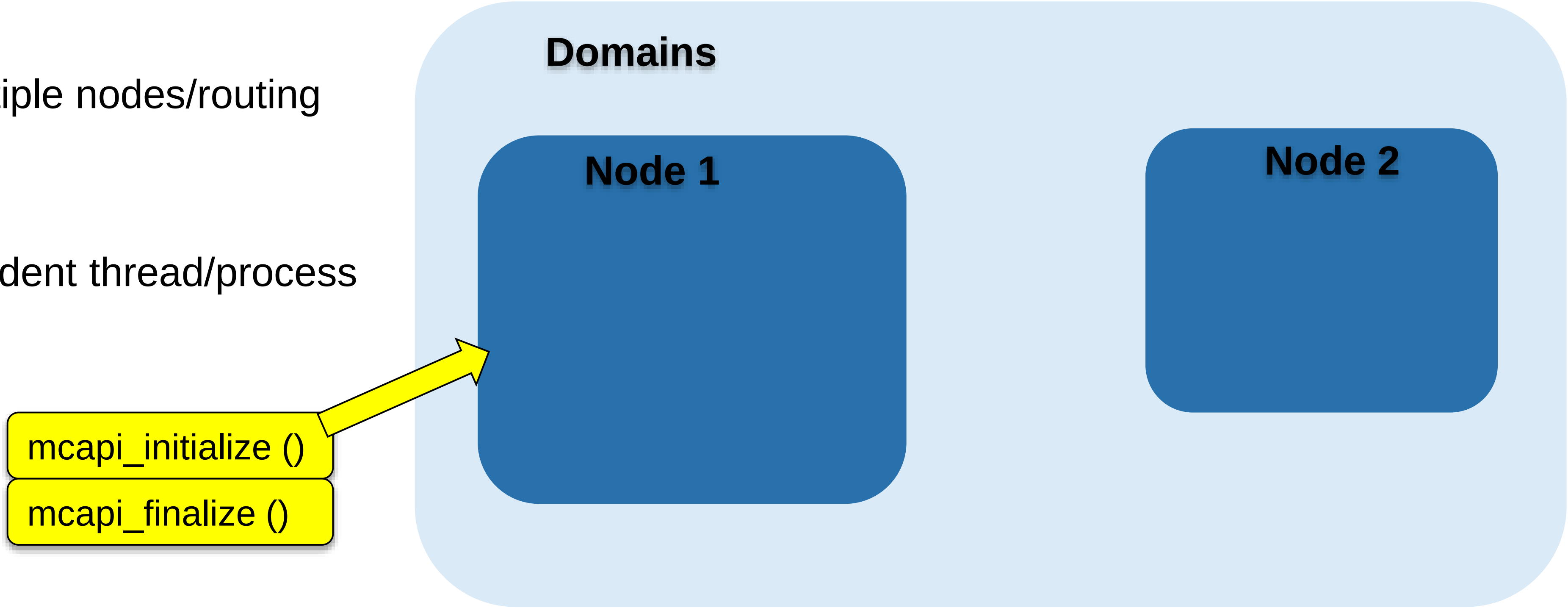

HB reserved task
IccHeartbeatPeriod
HB reserved channel
IccHeartbeatPeriod
HB reserved task
Realtime core
Application core
Other tasks
Channel ICC_CFG_MAX_CHANNELS -1
Other tasks

MCAPI™ overview

- **MCAPI™ components**

- **Domains**: multiple nodes/routing purposes

- **Node**: independent thread/process or OS instance

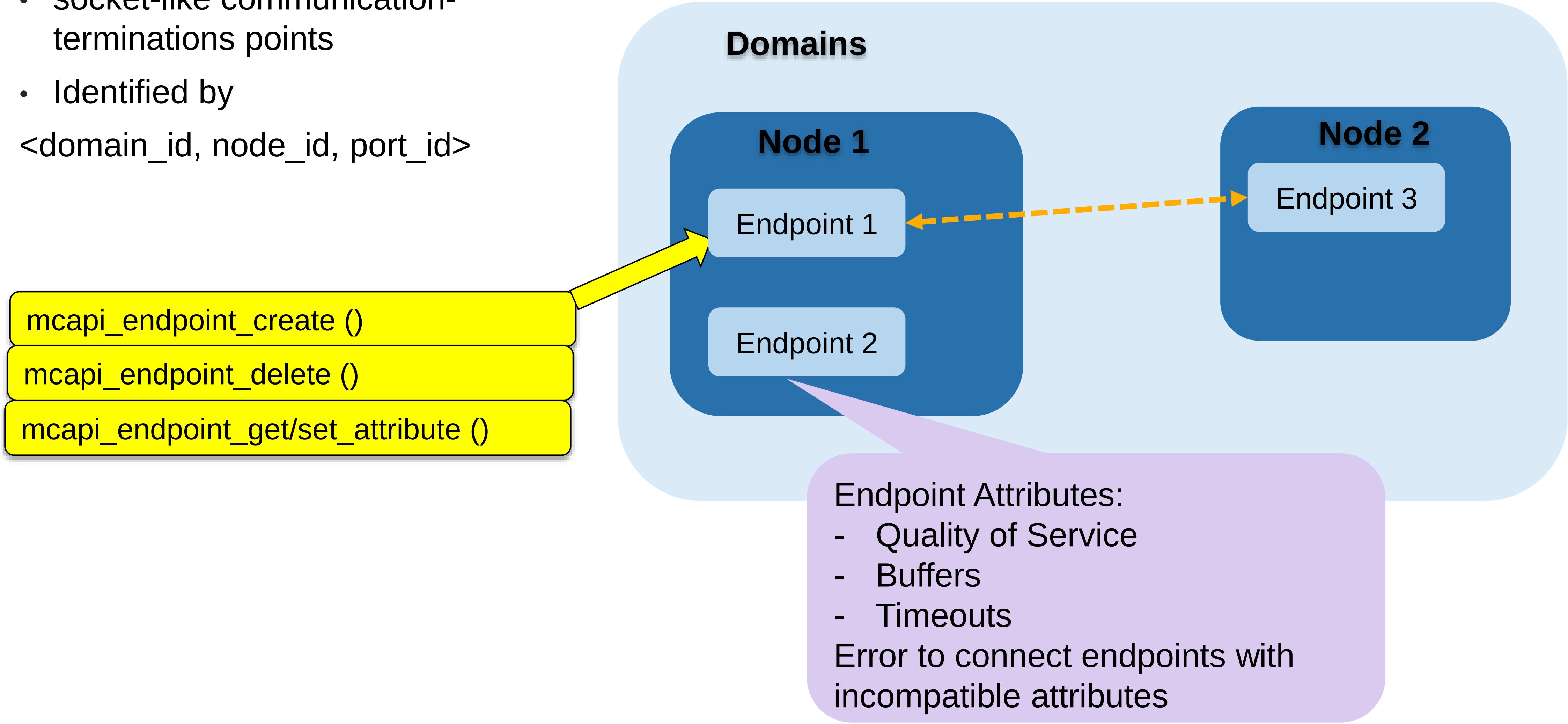


MCAPI™ overview

Endpoints

- socket-like communication-terminations points
- Identified by

<domain_id, node_id, port_id>



Domains

Node 1

Endpoint 1

Endpoint 2

Node 2

Endpoint 3

mcapi_endpoint_create ()

mcapi_endpoint_delete ()

mcapi_endpoint_get/set_attribute ()

Endpoint Attributes:

- Quality of Service
- Buffers
- Timeouts

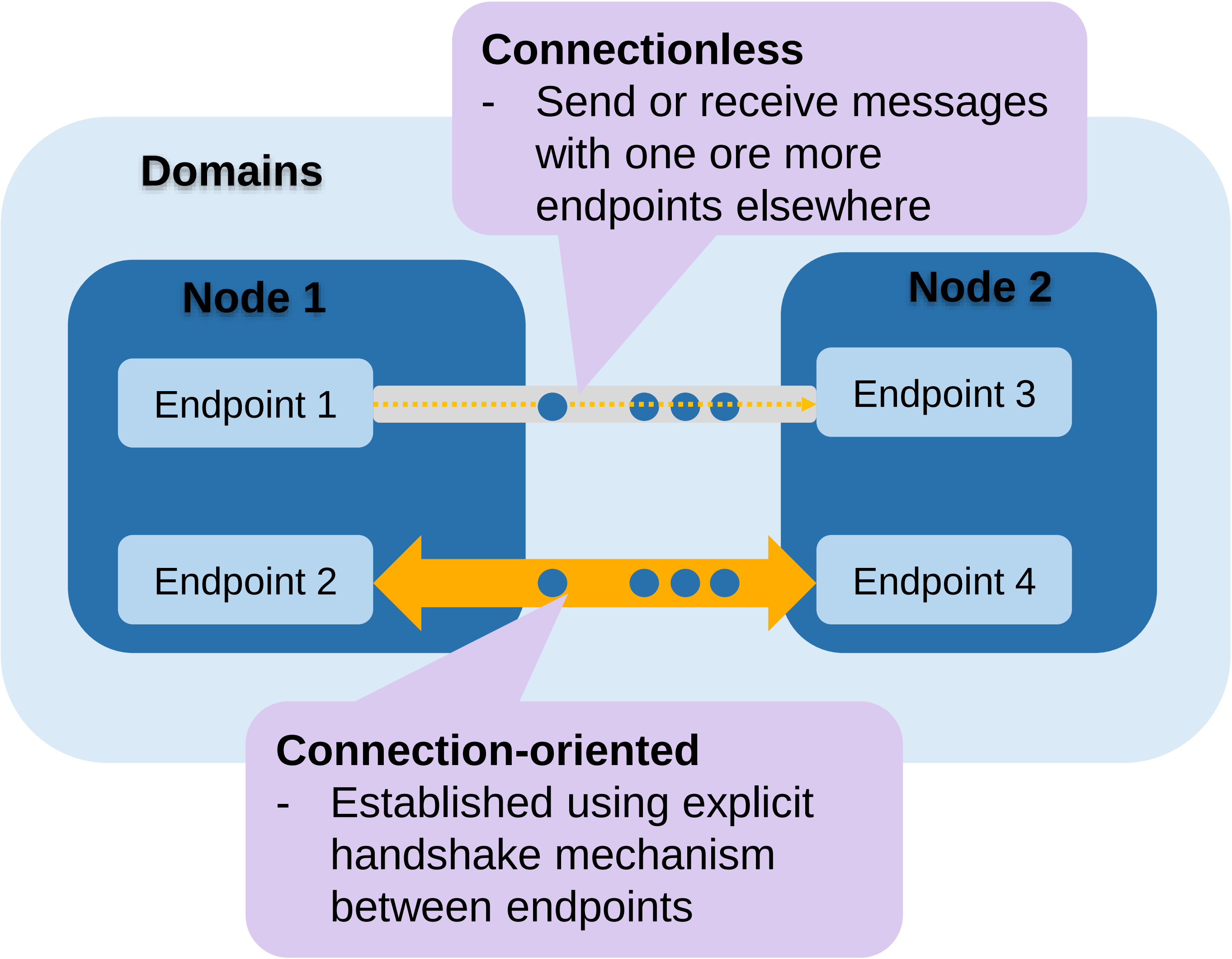
Error to connect endpoints with incompatible attributes

MCAPI™ overview

Communication

- Connectionless **messages**
- Connection-oriented **packet** channels
- Connection-oriented **scalar** channels

Point-to-Point between send and receive endpoints



Connectionless

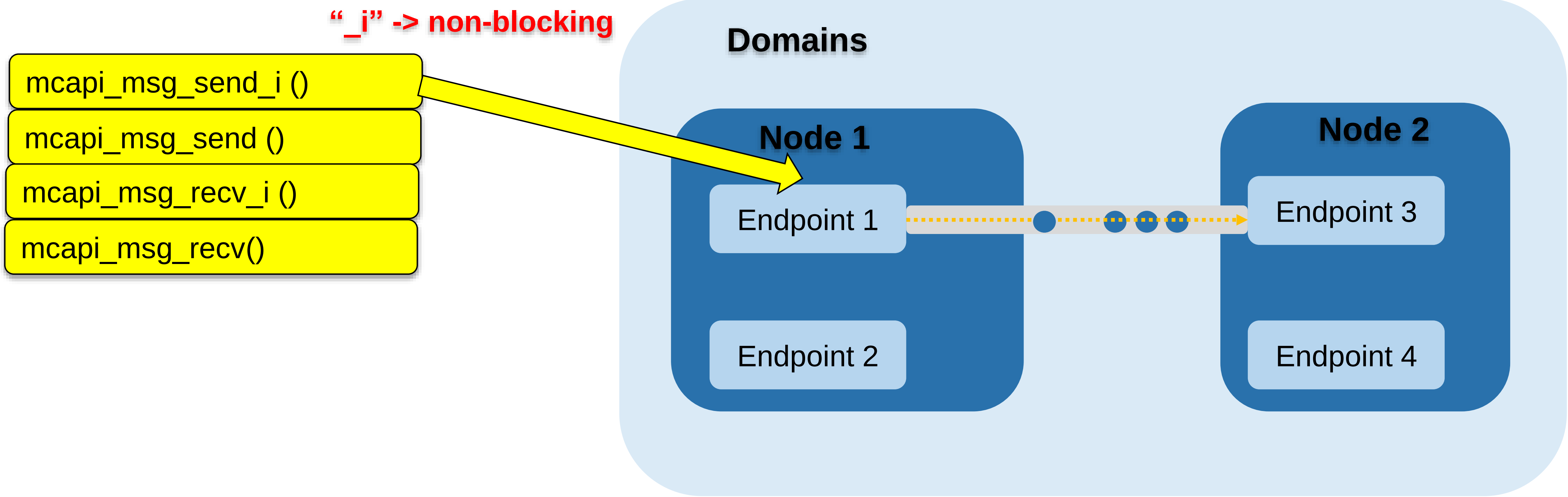
- Send or receive messages with one ore more endpoints elsewhere

Connection-oriented

- Established using explicit handshake mechanism between endpoints

MCAPI™ overview

Messages



MCAPI™ overview

Packet channels

- mcapi_pktchan_connect_i ()
- mcapi_pktchan_recv_open_i ()
- mcapi_pktchan_send_open_i ()

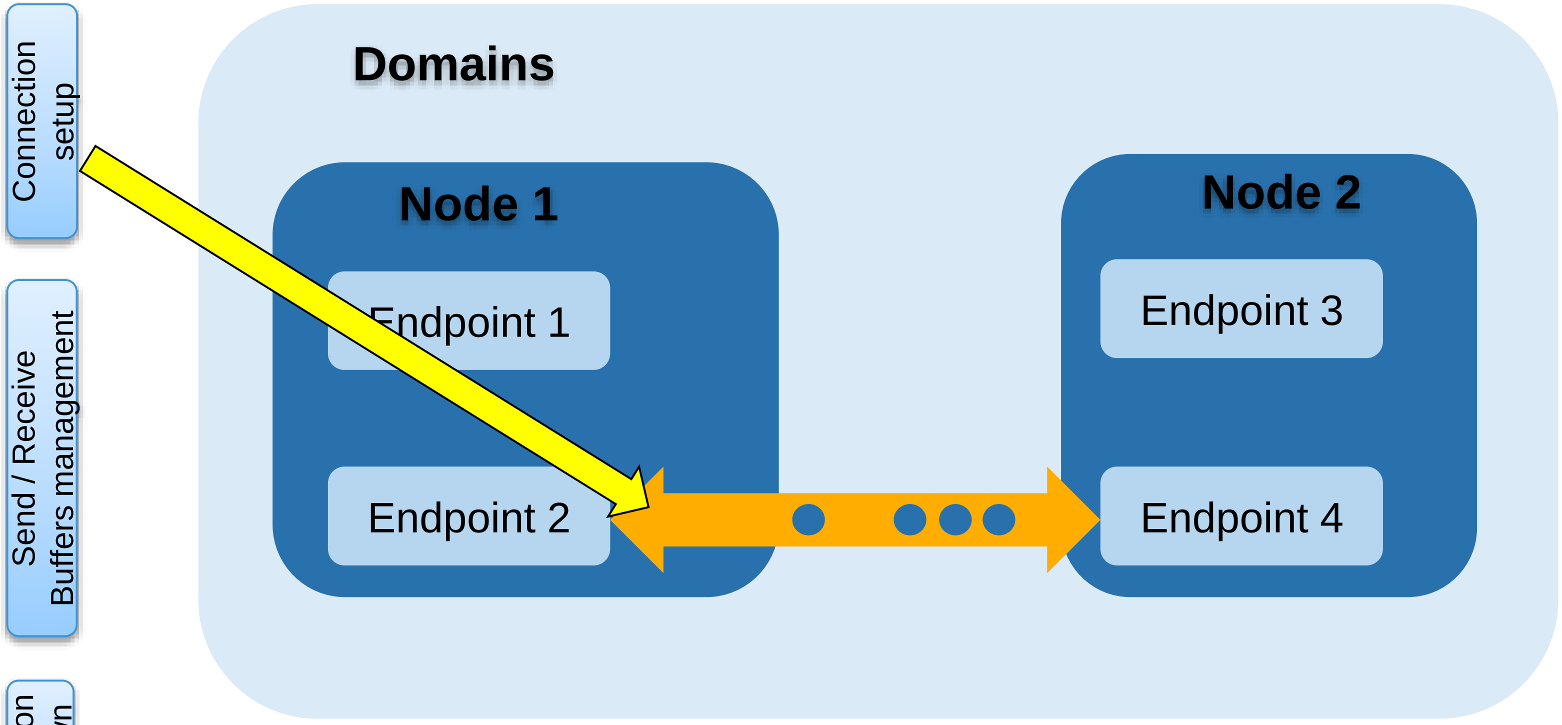
Connection setup

- mcapi_pktchan_send () send_i ()
- mcapi_pktchan_recv () recv_i ()
- mcapi_pktchan_available ()
- mcapi_pktchan_release ()

Send / Receive Buffers management

- mcapi_pktchan_recv_close_i ()
- mcapi_pktchan_send_close_i ()

Connection tear-down

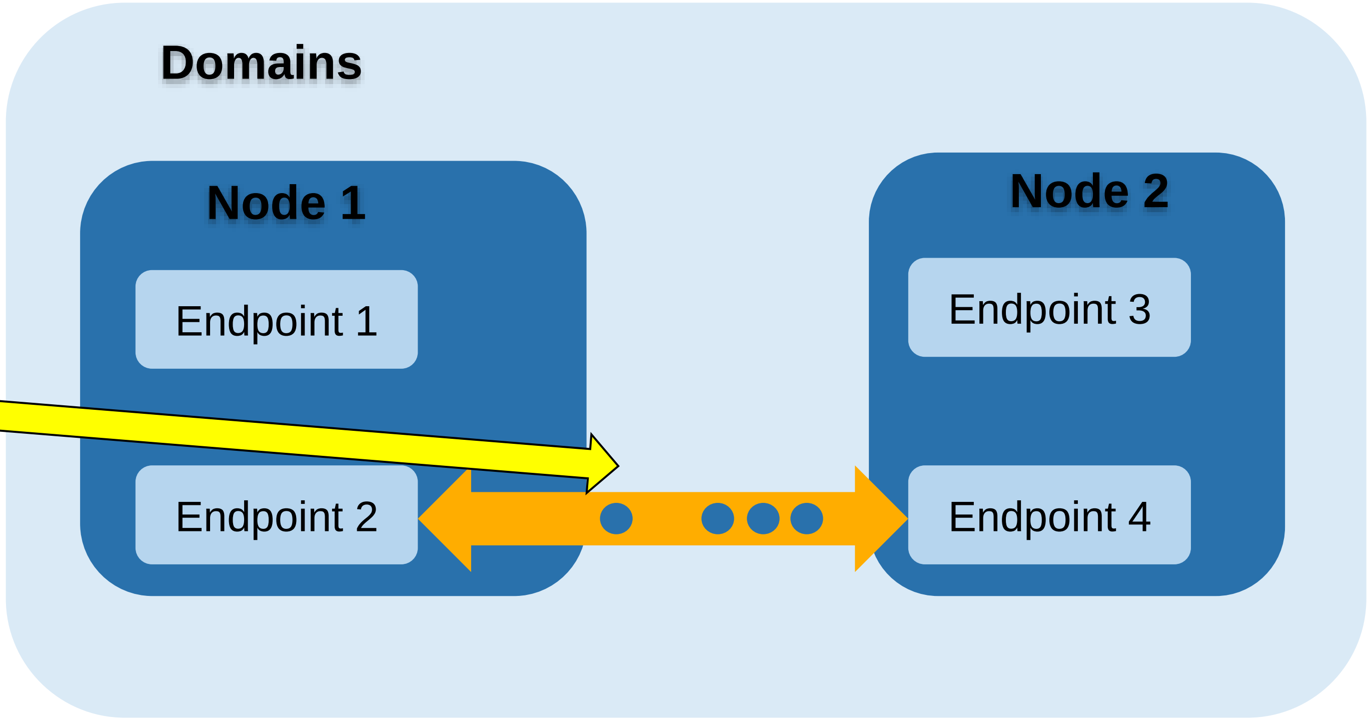


MCAPI^{TM} overview

Scalar channels

- Same as packet channels, use two-phase setup mechanism
- Used to transfer 8-, 16-, 32-, 64-bit scalars
- Provides only blocking send and receive metods

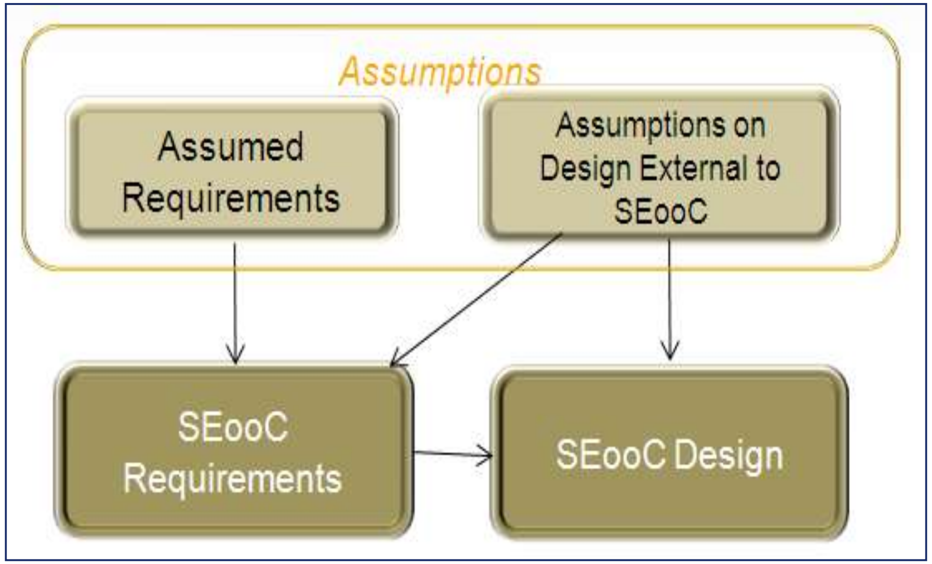
```
mcapi_sclchan_send_uint8 () … uint64 ()
mcapi_sclchan_recv_uint8 () … uint64 ()
```



IPCF Safety

- Automotive SPICE development process
- + Functional Safety ISO26262

- IPFC provided as Safety Element out of Context (ISO 26262 – 10 Clause 8)
  - developed for different applications and different customers
  - Hazard analysis and risk assessment
    - FMEA - Failure Modes and Effects Analysis
    - Assume safety requirements for ASIL-D
  - Testing
    - Fault injection
    - Error guessing



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