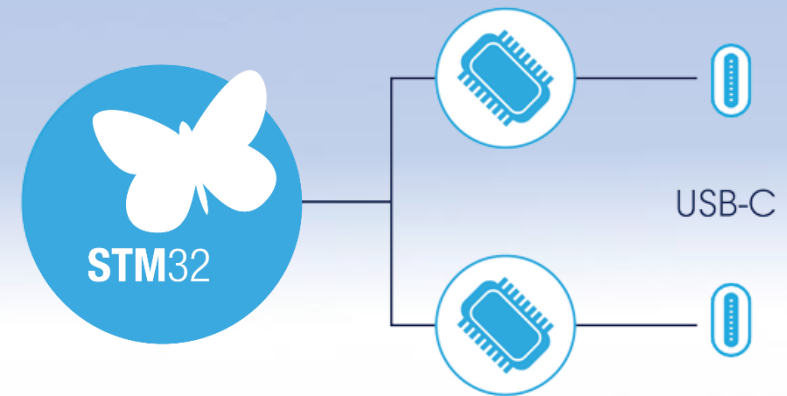# STM32 USB Type-C™ Port Manager

Certified Software Pack eases Migration to USB-PD 3.0 Power Delivery

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STM32 USB Type-C™ Port Manager

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STM32

USB-C

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Why to use USB-C and Power Delivery Technology ?

USB Type-C connector enhances user experience

- It's a 24-pin miniature and reversible connector . USB-C cable has same plug as both ends
- Some pins can be repurposed to support proprietary protocols (Alternate Modes)
- 15W of power can transit natively without USB PD protocol

To exchange more data faster with various protocols

- 2 separates USB data paths are available simultaneously : USB 2.0 + USB 3.1 (up to 10Gbit/s)
- Display Port, HDMI, MHL, Thunderbolt are supported to carry video/audio signals
- Conventional I²C/SPI/UART/Ethernet interfaces can be "bridge" to USB-C

To get more power with a comprehensive and robust protocol

- **USB Power Delivery** protocol enables power negotiation (up to 100W)
- It allows to discover power capabilities and needs between two USB-C connected devices
- .It enables advanced voltage and current negotiation to support fast charging
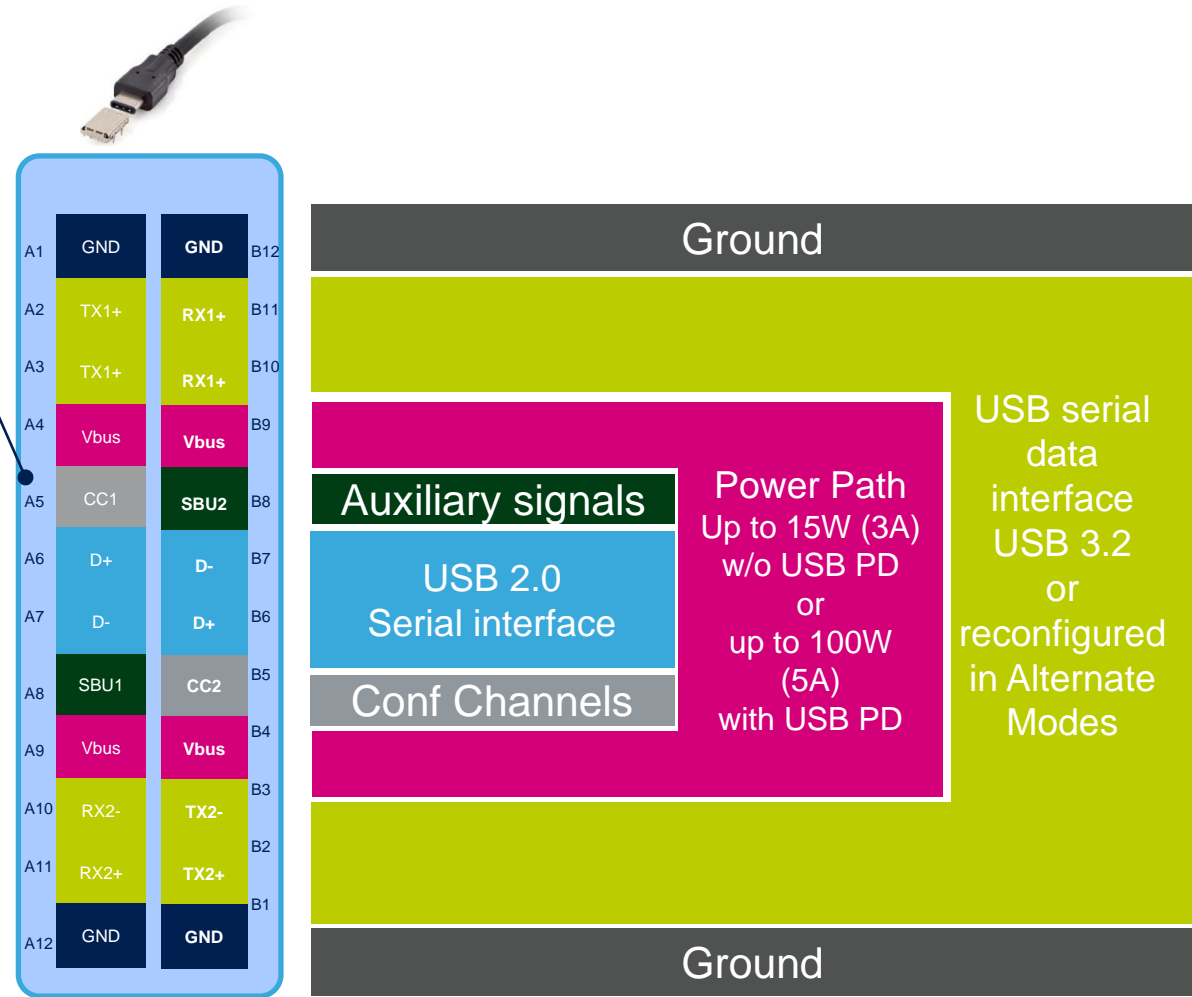- USB PD is used to activate Alternate Modes or to carry Authentication messages

To protect your application and extend its functionalities

- Identification of genuine chargers or accessories using USB PD authentication messages
- USB PD Alternate Modes and Vendor Defined Messages enable product differentiation.
- Secure firmware upgrade capability

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Purpose of CC1/CC2 wires
(Configuration & Communication channels)

- Attach/detach and role management (SNK,SRC,DRP) between two USB-C devices
- Discover and configure V_{bus}
- Discover and configure V_{conn}
- Resolve cable orientation and twist connections to establish USB data bus routing
- Discover and configure optional Alternate and Accessory modes (USB PD)

A1	GND	GND	B12
A2	TX1+	RX1+	B11
A3	TX1+	RX1+	B10
A4	Vbus	Vbus	B9
A5	CC1	SBU2	B8
A6	D+	D-	B7
A7	D-	D+	B6
A8	SBU1	CC2	B5
A9	Vbus	Vbus	B4
A10	RX2-	TX2-	B3
A11	RX2+	TX2+	B2
A12	GND	GND	B1

Ground

Auxiliary signals

USB 2.0 Serial interface

Conf Channels

Power Path
Up to 15W (3A)
w/o USB PD
or
up to 100W
(5A)
with USB PD

USB serial data interface USB 3.2 or reconfigured in Alternate Modes

Ground

**24-pin
USB-C receptacle**

To enhance user experience safety thru innovation
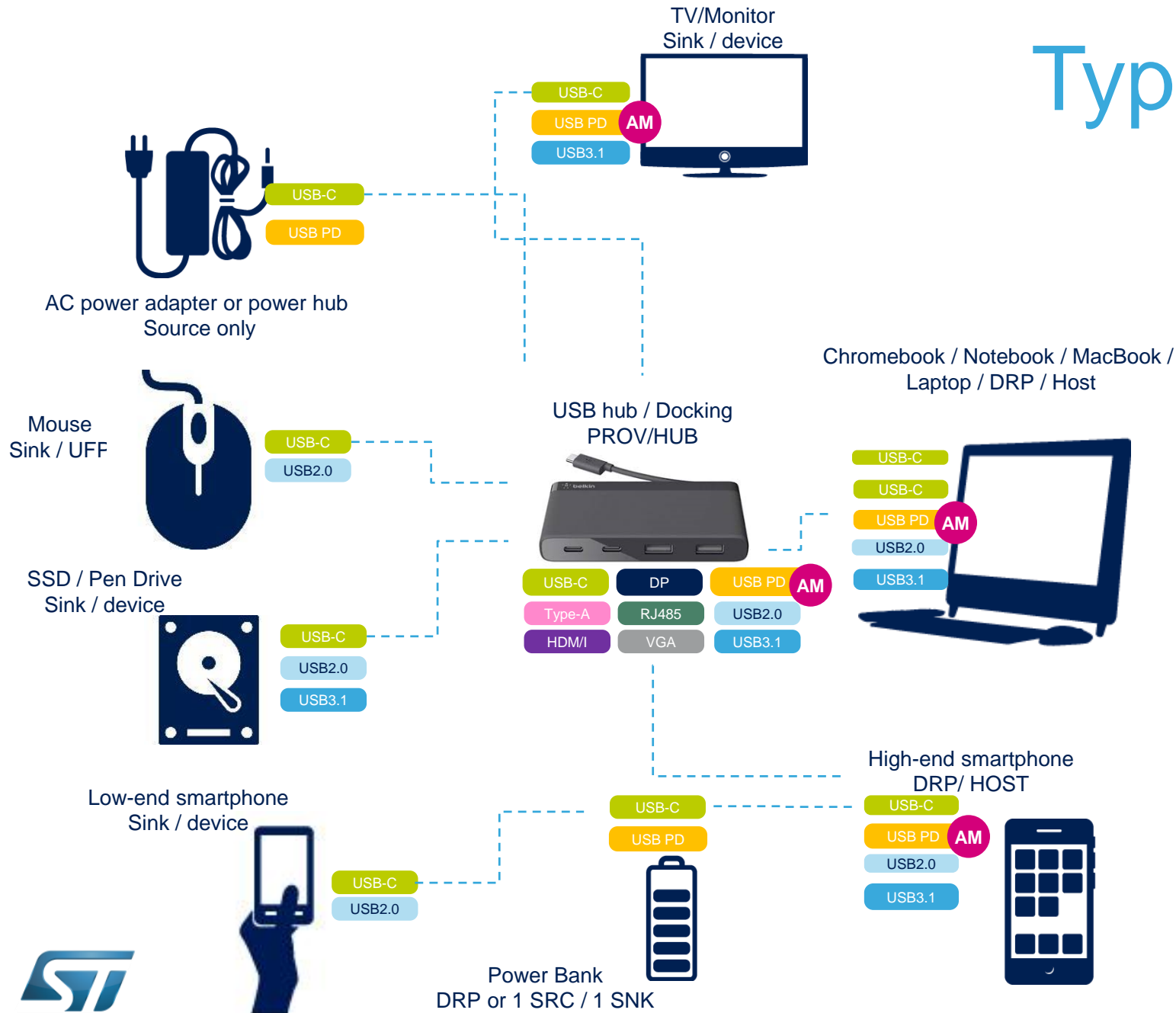
To get more power in a robust and safe way !

- Enables advanced and higher voltage and current negotiation (up to 100W)
- Source and Sink establish power contracts that match with their power capabilities and needs (ex : technology of battery used, power budget allocation, number of ports etc)
- Supply voltage (V_{bus}) is fixed (5V,9V,15V,20V) or configurable (Programming Power Supply)
- Dual Role Power devices can swapped power direction (ex : tablet charging a Notebook !)

To extend devices functionalities and create an unique differentiation !

- Use of USB PD Structured Vendor Defined Messages (VDMs) to extend the functionality a device exposes

Mode of operation		Nominal voltage	Maximum current	Maximum power
USB PD		Configurable	5 A	100 W
USB Type-C Current @ 3.0 A		5 V	3.0 A	15 W
USB Type-C Current @ 1.5 A		5 V	1.5 A	7.5 W
USB BC 1.2		5 V	Up to 1.5 A	7.5 W
Default USB Power	USB 3.2	5 V	900 mA (x1) 1,500 mA (x2)	4.5 W 7.5 W
	USB 2.0	5 V	500mA	2.5 W

TV/Monitor
Sink / device

USB-C
USB PD **AM**
USB3.1

USB-C
USB PD

AC power adapter or power hub
Source only

Mouse
Sink / UFF

USB-C
USB2.0

SSD / Pen Drive
Sink / device

USB-C
USB2.0
USB3.1

USB hub / Docking
PROV/HUB

USB-C	DP	USB PD **AM**
Type-A	RJ485	USB2.0
HDM/I	VGA	USB3.1

Chromebook / Notebook / MacBook /
Laptop / DRP / Host

USB-C
USB-C
USB PD **AM**
USB2.0
USB3.1

Low-end smartphone
Sink / device

USB-C
USB2.0

Power Bank
DRP or 1 SRC / 1 SNK

USB-C
USB PD

High-end smartphone
DRP/ HOST

USB-C
USB PD **AM**
USB2.0
USB3.1

Terminology

Power roles
- Source/Provider: Provide Power
- Sink/Consumer: Consume power
- DRP**: Dual Role Power** (can be either Sink or Source)

Data roles
- DFP: Downstream Facing Port (usually a Host / HUB ports)
- UFP: Upstream Facing Port (usually a device)
- DRD : **Dual-Role Data** - typical of "on-the-go" ports

Power role and Data role can swap !
Roles can be dynamically swapped using USB PD

AM Alternate Mode capabilities enabled via USB PD

Value Proposition

Adding USB-C to your design has never been so easy !
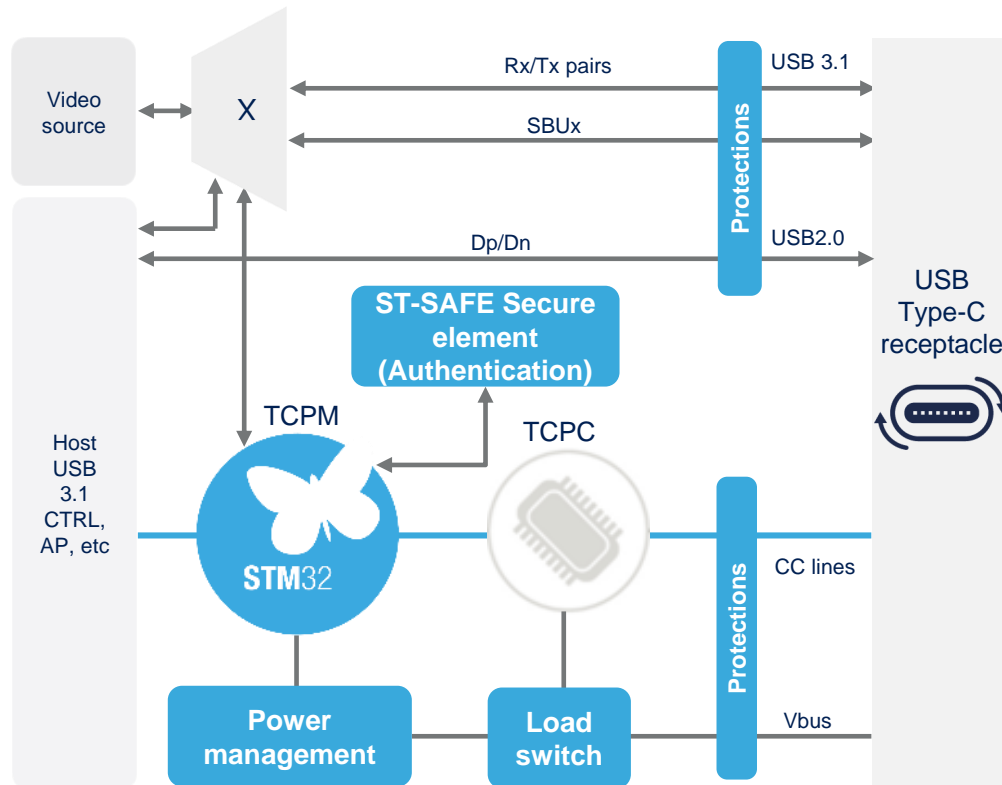
- Add-on USB IF certified software pack **X-CUBE-USB-PD** for implementing a Type-C Port Manager (TCPM) on any Arm® Cortex®-based **STM32 Microcontroller**
- Optimized hardware/software partitioning involving standard Type-C port Controller (TCPC) or **STUSB1602**
- Lowest design and validation effort

Enables any STM32 to handle USB-C and Power Delivery

Standardized TCPC

or

USB-C

STM32

Type-C Port Manager (TCPM)
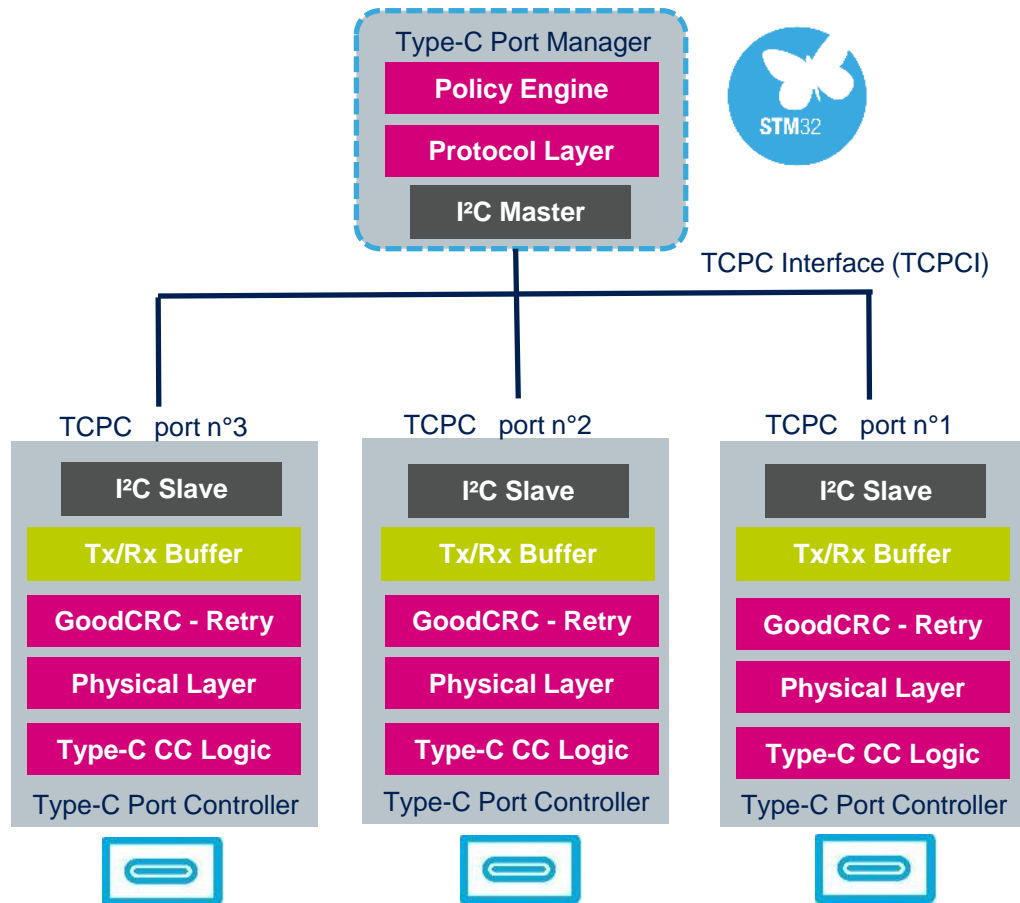
STUSB1602
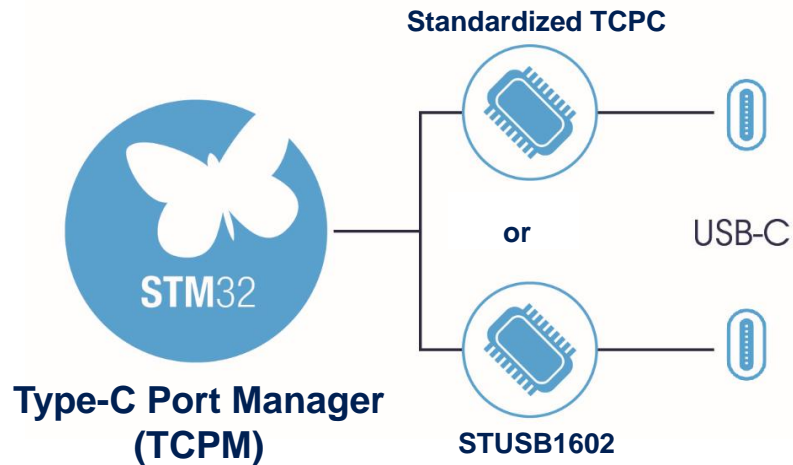
TCPM stands for Type-C Port Manager
TCPC stands for Type-C Port Controller

- X-CUBE-USB-PD complies with :
  - USB-C 1.3 and **USB PD 3.0** specifications
  - Type-C Port Controller Interface specification (TCPCi)

- Hardware architecture supported
  - Any STM32 as **TCPM** with standardized **TCPC** from 3rd parties (Our stack has been tested with ON Semiconductor® FUSB307B, a USB-PD 3.0 v1.1-certified TCPC)
  - Or STM32F0 with STUSB1602 Type-C interface

- Single-or multi-port supported (Sink, Source, Dual Role Power)

- Optional features such as Programming Power Supply (PPS), Authentication messages and Fast Role Swap (FRS) are supported
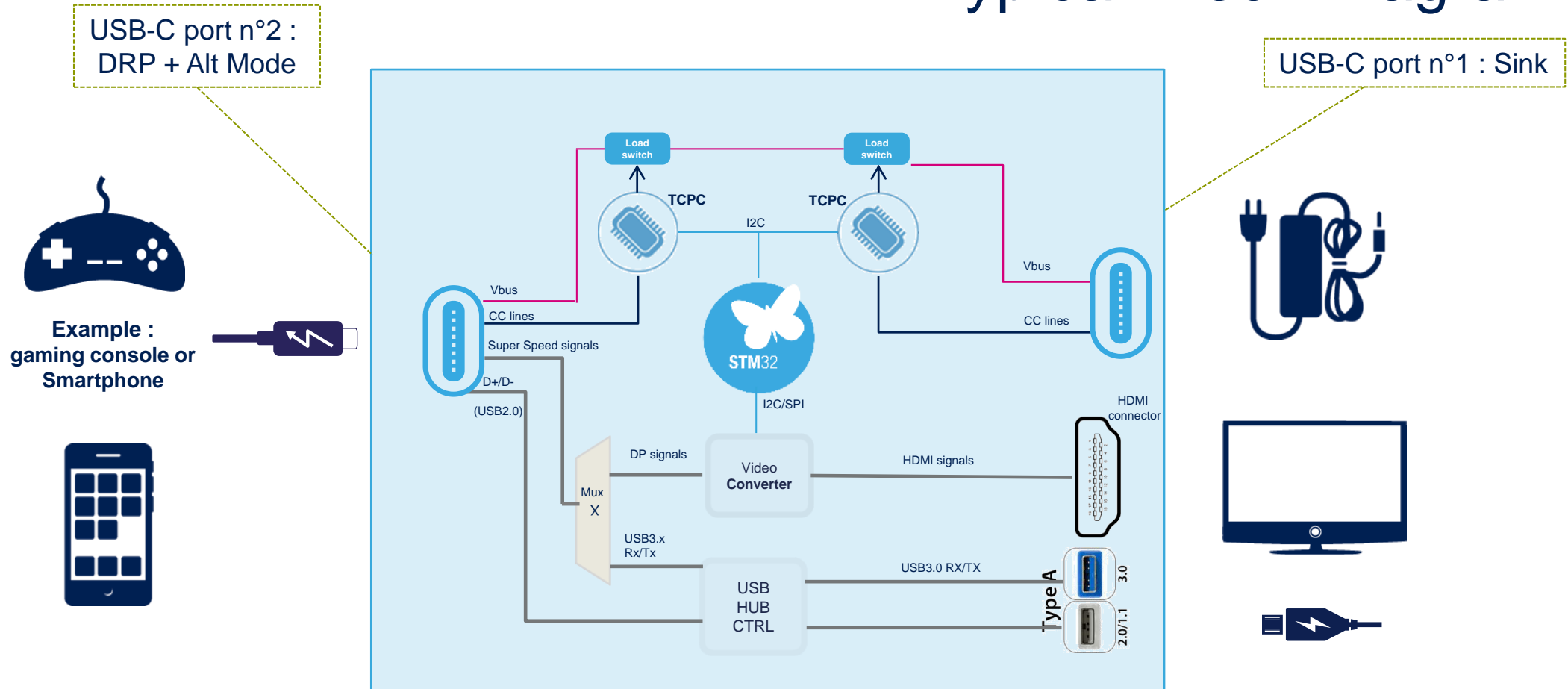
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Optimized HW/SW partitioning for single- or multi-port

Type-C Port Manager
- Policy Engine
- Protocol Layer
- I²C Master

STM32

TCPC Interface (TCPCI)

TCPC port n°3
- I²C Slave
- Tx/Rx Buffer
- GoodCRC - Retry
- Physical Layer
- Type-C CC Logic

Type-C Port Controller

TCPC port n°2
- I²C Slave
- Tx/Rx Buffer
- GoodCRC - Retry
- Physical Layer
- Type-C CC Logic

Type-C Port Controller

TCPC port n°1
- I²C Slave
- Tx/Rx Buffer
- GoodCRC - Retry
- Physical Layer
- Type-C CC Logic

Type-C Port Controller

- The STM32 provides a high customization and flexibility to manage power policy, application layers, and to support evolution of the standard faster.

- TCPCI interface provides a low pin count interconnect using Fast-Mode Plus I²C (1 MHz) bus, plus one alert line, and a comprehensive set of TCPC registers making stack porting across STM32 platform easier.

- TCPC provides the "Power Path" and integrate components with fast latency requirements as well as USB-C/PD PHY, V_{conn}, dead battery and protection.

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Docking Station
Typical Block Diagram

USB-C port n°2 :
DRP + Alt Mode

USB-C port n°1 : Sink

Example :
gaming console or
Smartphone

Load switch

Load switch

TCPC

TCPC

I2C

Vbus

Vbus

CC lines

CC lines

Super Speed signals

D+/D-

(USB2.0)

STM32

I2C/SPI

HDMI connector

Mux X

DP signals

Video Converter

HDMI signals

USB3.x Rx/Tx

USB HUB CTRL

USB3.0 RX/TX

Type A

3.0

2.0/1.1

- Port 1 negotiates power contracts with external USB-C power adapter.
- Port 2 supplies plugged accessory and handle HDMI signals request when TV detected, or USB devices inserted into legacy USB connectors.
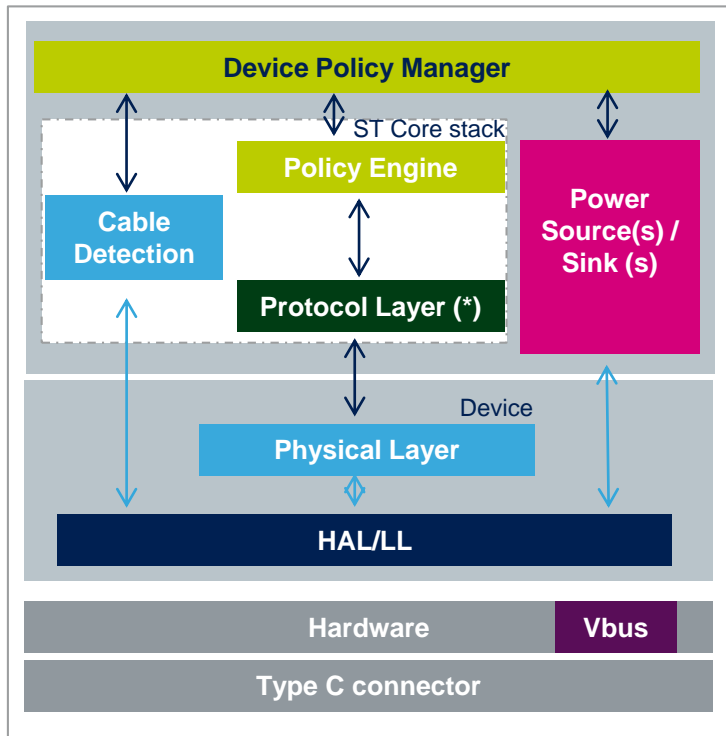
Typical Block Diagram
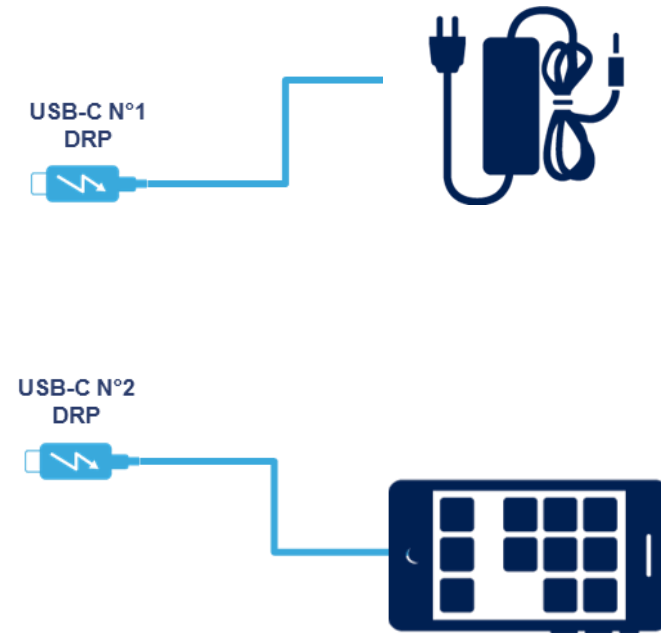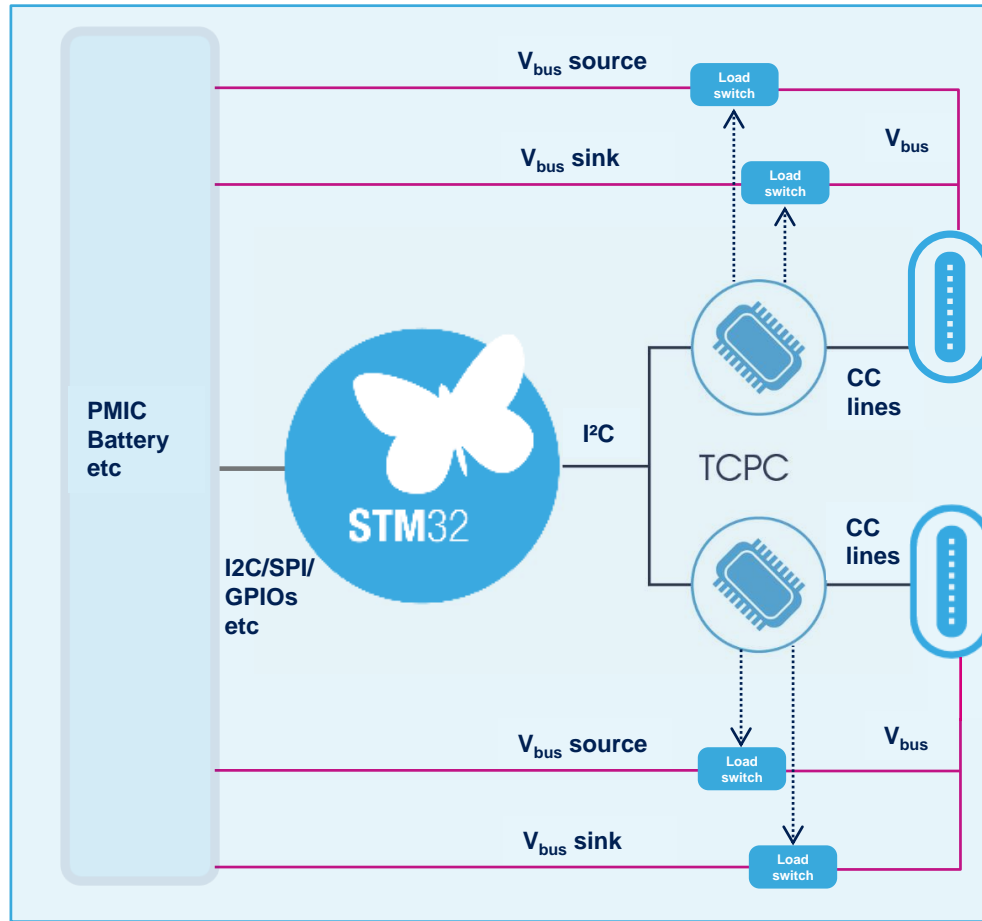
Features and Memory Footprint

Compliant with USB Type-C™ 1.3 and USB PD 3.0 specifications

Diagram (left):

- Device Policy Manager
- ST Core stack
  - Policy Engine
  - Cable Detection
  - Protocol Layer (*)
  - Power Source(s) / Sink (s)
- Device
  - Physical Layer
- HAL/LL
- Hardware — Vbus
- Type C connector

Right text:

- X-CUBE-USB-PD Expansion Software package includes :
  - USB PD "core" library for Cortex™-M0/M4 based devices (STM32F0/F4/L4/F3)
  - Open-source drivers to support TCPC devices and STUSB1602
  - Firmware examples (Provider, Consumer, Dual Role Power) for MDK-ARM, IAR-EWARM and SW4STM32 IDEs

- Key features :
  - Device Policy Manager, Policy Engine and Protocol Layer
  - Cable detection and orientation
  - Supports Vendor-Defined Messages (Alternate Modes)
  - Billboard driver
  - SOP' and SOP'' for communication with cables

Typical TCPM Memory Footprint (no VDM, no Vconn)	Source or Sink only	Dual Role Power
1 port (w/o RTOS)	32 Kbytes in Flash 3.6 Kbytes in RAM	40 Kbytes in Flash 3.6 Kbytes in RAM
2 port (w/RTOS)	32 Kbytes in Flash 7.8 Kbytes in RAM	43 Kbytes in Flash 8.1 Kbytes in RAM

TCPM/TCPC evaluation board
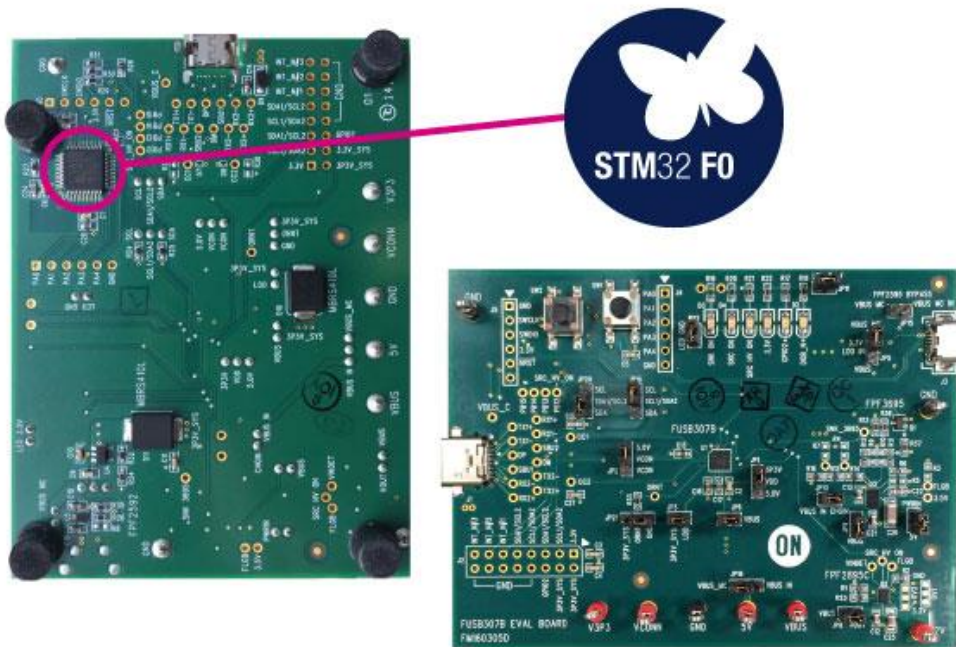
Main features

- 1 USB Type-C port
- SINK,SOURCE, DRP capability
- STM32F072CBT6, 32-bit Arm® Cortex®-M0 MCU as TCPM
- ON Semiconductor® FUSB307B Type-C port controller
- On board power management and dedicated power connector to interface with an external power supply
- Link to order one kit (149$ range)

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www.st.com/x-cube-usb-pd

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