CS-1: Single-Connector Infotainment Interface (Draft v0.9)

Purpose: eliminate bespoke harnesses and CAN decoder boxes by standardizing a single physical/data interface between vehicle and head unit (HU). CS-1 specifies power, data transports, APIs, and security so aftermarket or OEM HUs plug-and-swap with OEM-level reliability.

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# Goals

* One physical connector (Automotive-C) between vehicle and HU.
* Zero external decoder boxes; cameras, SWC, chimes, CAN data, and amps are native.
* Plug-and-swap aftermarket with OEM reliability.
* Security and safety by design (HU never touches vehicle buses directly).

# Physical & Electrical

Connector: USB-C in an automotive locking shell (Automotive-C). IP5X+, −40 °C to +85 °C, ≥10k mating cycles, fully shielded.

Power: USB-PD 3.1 EPR as the only power rail. Required profiles: 5V@3A, 12V@5A, 20V@5A, 48V@5A (240W). Classes: A ≤60W, B ≤100W, C ≤240W. Ignition is logical (vds.power) rather than a discrete 12V ACC pin; Sleep/Wake via API.

# Data Transport

Link: USB 3.2 Gen 2×1 (10 Gb/s) minimum; USB4 (20–40 Gb/s) recommended. HU is USB Host; vehicle side exposes a composite USB device: the Vehicle Bridge Module (VBM).

Composite interfaces exposed by VBM:

* CDC-ECM/RNDIS (Ethernet-over-USB): 1–5 Gb/s logical link (IP)
* USB-CAN-FD: GS-USB compatible endpoints; up to 5 logical CAN buses
* UAC2 (USB Audio Class 2): up to 8ch 24/96 playback, 8ch 24/48 capture
* UVC (USB Video Class): reverse/360/ADAS cameras (H.264 or raw)
* HID: steering wheel controls & hard keys
* MSC (optional): read-only docs partition
* Vendor DFU: signed firmware updates to VBM only

# Vehicle Data & Control (VDS over IP)

* Higher-level data rides on gRPC over HTTP/2 over the USB-Ethernet link. Namespace: vds.\*. TLS is mandatory with mTLS certificates.  
  Core topics (pub/sub + RPC):
* vds.power: IgnitionState {OFF, ACC, RUN}; RPC: Sleep(), Wake()
* vds.vehicle: read-mostly snapshot (VIN, odometer, speed, gear, fuel, SOC, TPMS, doors/hood/trunk, ambient)
* vds.swc: ButtonEvent {VOL\_UP, VOL\_DOWN, NEXT, PREV, VOICE, OK, BACK, CUSTOM1…}
* vds.chime: PlayChime(id, priority, volume, duration)
* vds.camera: enumerate UVC endpoints, capabilities
* vds.climate: read setpoints/fan; write setpoints only (policy-gated)
* vds.lighting: read-only lighting state (for UI dimming)

Example messages (JSON-shaped):  
// ignition  
{"topic":"vds.power","event":"IgnitionState","value":"RUN","ts":1693612345123}  
  
// SWC button  
{"topic":"vds.swc","event":"ButtonEvent", "value":{"code":"NEXT","longPress":false,"repeat":0},"ts":1693612346123}  
  
// Reverse trigger  
{"topic":"vds.vehicle","event":"Gear","value":"R","ts":1693612347123}  
  
// Climate write (policy-gated RPC)  
{"service":"vds.climate","method":"SetSetpoint","args":{"zone":"driver","c":20.0}}

# Audio / Video Paths

Audio: UAC2 PCM playback to vehicle amps; UAC2 capture from OEM mic array. DSP metadata (ducking/ASL) via vds.audio.  
Video: Cameras as UVC devices. Legacy analog cameras digitized in VBM. Reverse camera stream available ≤300 ms after Gear=R.

# Cameras, Sensors, Accessories

Up to four 1080p30 UVC cameras. Parking sensor distances via vds.vehicle. Rear displays via USB hub or DP/HDMI alt-mode.

# Security & Safety

mTLS with factory-provisioned certs; HU and VBM mutually authenticate. VBM is the only node on vehicle buses; HU never directly touches CAN. Writable endpoints are whitelisted and rate-limited. If HU crashes, VBM maintains cameras/chimes. Signed audit logs in VBM NVRAM.

# Backwards Compatibility

VBM-Legacy harness adapts OEM buses and I/O to CS-1: Ford/LIN/CAN-FD ↔ USB-CAN; analog camera ↔ UVC; OEM amp ↔ UAC2; SWC resistive/lin ↔ HID; PD source from 12–14.4V. HU only needs Automotive-C.

# Mechanical & UX

Panel USB ports are wired as a standard upstream hub—no USB retention adapters. Illumination/dimming is read-only via vds.lighting. HU updates itself; VBM DFU is signed via vendor DFU interface.

# Compliance Levels

CS-1 Bronze: USB 3.2 10 Gb/s, PD ≤100 W, 2 cams, 4ch audio  
CS-1 Silver: USB4 20 Gb/s, PD ≤140 W, 3 cams, 6ch audio  
CS-1 Gold: USB4 40 Gb/s, PD ≤240 W, 4 cams, 8ch audio, ADAS-grade latency

# Migration Example (2015 Focus)

Install VBM-Legacy-Ford-C1 behind the dash. Battery 12 V → PD3.1 to HU. Ford CAN ↔ USB-CAN; factory reverse cam ↔ UVC; SWC ↔ HID. One cable (Automotive-C) from VBM to HU. No Maestro/Metra/PAC required.