

DOCSIS Quad-Cross-Cut Shared Reference

1,782 words · ~8 min read

*Cross-chapter shared reference for `vca-net-201` link-layer module + `vca-net-301` carrier / RF-front-end module + `vca-rf-301` Ch 5 cellular-and-cable-RF module + `vca-re-201` SB6141 burst-radio-signal RE (forward-pending until RE-201 prose ships).

Anchor: Kurose & Ross, *Computer Networking: A Top-Down Approach*, 9th ed., Pearson, 2021, §6.3.4 (DOCSIS, in Chapter 6, The Link Layer and LANs). Different artifact class. *

Purpose: one canonical reference that four different courses cite when they reach DOCSIS. Instead of four near-duplicate authorings with subtly different chip claims, citation forms, or pedagogical framings. **Pedagogical thesis:** *DOCSIS is the single industry case study where four curriculum lenses simultaneously look at the same hardware.* The link-layer protocol lens (NET-201) reads the same SB6141 the modulation-and-RF-front-end lens (NET-301) reads, which is the same SB6141 the advanced-waveform-RE lens (RF-301) reads, which is the same SB6141 the hands-on hardware-RE lens (RE-201) holds. When a student walks into RE-201 Lab 8 with the SB6141 board on the bench, the chip-by-chip map below is the bridge between the textbook spec they read in NET-201 and the silicon they are about to disassemble.

Print and pin during NET-201's link-layer module (DOCSIS as carrier-access link-layer protocol), NET-301's carrier / RF-front-end thread (DOCSIS as the canonical late-DOCSIS-3.x cable-modem case study), RF-301 Ch 5 (DOCSIS PHY/MAC analysis as a wired-RF complement to the cellular content), and RE-201 SB6141 lab (consulted live during chip-on-PCB inspection).

At a glance

Property	Value
Cross-chapter scope	Quad-cross-cut: NET-201 link-layer + NET-301 carrier/RF-front-end + RF-301 Ch 5 + RE-201 SB6141 lab-target
Lab target this references	Motorola SB6141 SURFboard cable modem (DOCSIS 3.0; ~2014 release)
Primary anchor	Kurose & Ross 9e, §6.3.4 (DOCSIS link-layer subsection of Ch 6, The Link Layer and LANs)
Voice family	Single canonical reference + per-track pickup pointers (companion to <code>cross-chapter-sb6141-cousin-mapping-card.md</code> ; NOT a comparison sidebar)
Companion handouts	<code>cross-chapter-sb6141-cousin-mapping-card.md</code> (CSA-101 cousin-map across all 6 SB6141 layers); <code>cross-chapter-control-plane-architectures.md</code> (5G Core / SDN / Mobile-IP comparison sidebar. Different artifact class, different scope)
Forward-pending pickup	RE-201 SB6141 burst-radio-signal RE. Pointer added when RE-201 prose ships; cross-team coordination with <code>cybersecurity/academy/vca-re-101-reverse-engineering</code> curriculum team

DOCSIS. Protocol overview at the cross-track register

DOCSIS (Data Over Cable Service Interface Specification) is the cable-modem-MAC standard that lets a cable-television operator deliver IP service over the same coaxial plant that historically carried analogue and digital television. Kurose-Ross's 9th-edition treatment in §6.3.4 frames DOCSIS as a link-layer protocol with three central architectural facts.

First, the access-network is asymmetric by design. Downstream (operator → subscriber) carries one or more high-bit-rate channels of QAM-modulated digital RF. Historically 256-QAM on a single 6 MHz carrier per DOCSIS 2.0 channel; multi-channel bonding from DOCSIS 3.0 onward; OFDM blocks of arbitrary aggregate bandwidth in DOCSIS 3.1. Upstream (subscriber → operator) carries a smaller burst-mode share of bandwidth, time-shared across all subscribers on the same physical segment via TDMA (or SC-FDMA in DOCSIS 3.1). The asymmetry is not a bandwidth-oversight; it is a deliberate architectural choice that mirrors residential-Internet usage patterns and that lets the operator concentrate the RF spectrum budget on the downstream where the demand is.

Second, the upstream is a multiple-access medium. Multiple cable modems on the same physical segment share one logical upstream channel, which means DOCSIS's link-layer has to solve the same arbitration problem Ethernet's CSMA/CD solved on the original shared-coax LAN (and that 802.11's DCF solves on the wireless LAN). DOCSIS's answer is centralised: the **CMTS** (Cable Modem Termination System, the operator-side endpoint) issues **MAP messages** that grant time-and-frequency slices to specific cable modems for upstream transmission. The cable-modem-side queueing-and-arbitration logic is in the DOCSIS MAC, which negotiates with the CMTS for the burst-grants the modem needs.

Third, the framing distinction matters for RE work. DOCSIS frames at the cable-modem-side carry the IP packet payload up the stack (Ethernet at the customer-LAN side; DOCSIS-frame on the cable-RF side). The cable modem is therefore a **link-layer bridge** that translates between two distinct link-layer protocols, Ethernet on the LAN-facing port, DOCSIS on the cable-facing RF interface, with the IP layer transiting both sides unmodified. For NET-201 students, this is the canonical "two link-layers on one device" example. For RE-201 students, the framing translation logic is one of the central functions to identify in the SB6141 firmware dump.

Chip-by-chip mapping for the SB6141 lab target

The SB6141 is the curriculum's named lab target for `vca-re-101` and `vca-adv-101`. This section is the central payload of the handout: it maps the DOCSIS architectural roles above onto the actual silicon a student holds during the RE-201 hardware lab. The chip identifications are confirmed against the 2026-04-16 hardware dump and firmware analysis from the `arsenal/motorola-sb6141/` vuln-research lane.

DOCSIS architectural role	SB6141 chip	Track lens	What this chip's firmware does
RF demodulator + tuner front-end (cable-RF input → analog/digital boundary)	MaxLinear MxL261 tuner IC (with MxL261SF_FW_ES1.mbin / _ES2.mbin firmware blobs)	NET-301 RF lens; RF-301 Ch 5 PHY/MAC-analysis lens	Hard-real-time RF reception: tunes the downstream channel, performs analog-to-digital conversion, hands a digital baseband stream to the DOCSIS PHY
DOCSIS PHY framing (downstream demod + upstream burst modulation)	Broadcom DOCSIS RF front-end (tuner/PHY block in the SoC subsystem)	NET-301 modulation-and-PHY lens; RF-301 Ch 5 advanced-waveform-RE lens	DOCSIS-frame demodulation on the digital baseband; QAM constellation decode; FEC; symbol-to-bit recovery; upstream burst-mode modulator
DOCSIS MAC + packet acceleration (link-layer arbitration; framing; bridging)	TI PDSP coprocessors (×N, embedded in the Puma 5 SoC) running proprietary TI packet-processor firmware	NET-201 link-layer-protocol lens	Hard-real-time DOCSIS MAC: MAP-message processing, upstream burst scheduling, DOCSIS-to-Ethernet bridging at the link layer; packet acceleration for the LAN-side egress
Application processor (web UI, SSH, OAM, configuration, the "client side")	ARM1176JZ-S in the TI Puma 5 SoC (TNETC4830), running Linux 2.6.18 MontaVista Pro 5.0 in big-endian BE-32 mode	ARM-201 application-processor lens; NET-201 OS + Linux network-stack lens	Soft-real-time: subscriber-facing web UI, SSH config, OAM (Operations, Administration, Maintenance), DHCP-Client, TFTP-Client, the standard cable-modem provisioning protocol stack

This is the **archaeology-alignment layer**: it is what connects the textbook-DOCSIS protocol description in KR 9e §6.3.4 to the actual chip-on-PCB students hold during the RE-201 lab. Without this map, the protocol spec and the silicon are two separate things; with it, they are one industry case study read from four different curriculum angles.

For deeper component-level prose (disassembly findings, firmware reversal, exploit-research findings) see the [arsenal/motorola-sb6141/](#) vuln-research lane at [/media/laptop/data4t/laptop/jupyter/arsenal/motorola-sb6141/](#). **This handout deliberately**

does not duplicate exploit-research prose; it provides the spec-to-silicon map that lets RE-201 students work through the bridge between the protocol specification and the hardware implementation.

For the broader six-layer cousin map. Silicon / ISA / OS / boot / coprocessor / firmware. See the companion handout [handouts/cross-chapter-sb6141-cousin-mapping-card.md](#). The DOCSIS handout is the protocol-and-chip-mapping subset of that larger structural-cousin reference.

Per-track pickup pointers

Track	Course / chapter	What this handout supplies	Pickup form
NET (protocol)	vca-net-201 link-layer module	DOCSIS-as-link-layer-protocol overview + DOCSIS MAC + Ethernet-DOCSIS bridging story; TI PDSP = DOCSIS MAC chip-mapping	Citation in the link-layer Sample weave + Recommended Readings cross-reference; SB6141-thread cross-cut prose names this handout
NET (RF / modulation / carrier)	vca-net-301 carrier / RF-front-end thread	DOCSIS-as-late-DOCSIS-3.x case study + QAM/OFDM modulation framing; MaxLinear MxL261 + Broadcom DOCSIS PHY chip-mapping	Cross-chapter handouts paragraph naming this handout (voice: reference handout, not sidebar)
RF (advanced waveform RE)	vca-rf-301 Ch 5 cellular-and-cable-RF module	DOCSIS PHY/MAC analysis as a wired-RF complement to the cellular content; chip-mapping plus arsenal cross-link	Adjacent paragraph to existing 9e cellular weave naming this handout
RE (hands-on hardware RE)	vca-re-201 SB6141 lab. <i>forward-pending</i>	Chip-by-chip map consulted live at the bench during SB6141 PCB inspection and firmware analysis	RE-201 prose not yet drafted; pickup added when RE-201 prose ships (cross-team coordination required with cybersecurity/academy/vca-re-101-reverse-engineering)

Recommended reading anchor (citation row)

Citation	Use
Kurose, James and Keith Ross. <i>Computer Networking: A Top-Down Approach</i> , 9th ed. Pearson, 2021. ISBN 978-0-13-592861-5. Chapter 6, The Link Layer and LANs (esp. §6.3.4 DOCSIS) .	Primary anchor for the DOCSIS link-layer story across all four tracks.

This citation matches the canonical 9e citation voice already in use across the NET / RF tracks per the 2026-05-02 9e edition uplift. NET-301 and NET-201 already carry the 9e in their Recommended Readings; RF-301 already carries the 9e for the cellular cross-cut. Adding this handout's anchor row to a course's Recommended Readings is therefore a citation-form match, not a new edition introduction.

Cross-references

- [vca-net-201.html](#) . Link-layer module + SB6141 thread
- [vca-net-301.html](#) . Carrier / RF-front-end thread (DOCSIS as late-DOCSIS-3.x case study)
- [vca-rf-301.html](#) Ch 5. Cellular protocols (DOCSIS adjacent as wired-RF case study)
- [vca-re-201](#) (forward-pending), SB6141 burst-radio-signal RE
- [handouts/cross-chapter-sb6141-cousin-mapping-card.md](#) . Six-layer structural-cousin reference; DOCSIS handout is the protocol-and-chip-mapping subset
- [handouts/cross-chapter-control-plane-architectures.md](#) . Voice-class precedent for cross-chapter shared references (different artifact class (comparison sidebar) but same publish-once-cite-many pattern)
- [arsenal/motorola-sb6141/](#) . Vuln-research / exploit-dev lane that feeds chip-level depth back into curriculum

Pedagogical note. Why DOCSIS is the quad-cross-cut

The SB6141 lab target was chosen for the curriculum because four different courses can use the *same* hardware to teach four different lenses on one industry case study. DOCSIS is the protocol that makes the four-way reading coherent.

- **NET-201 reads DOCSIS as a link-layer protocol**, the canonical "two link-layers on one device" example, where Ethernet on the LAN-side and DOCSIS on the RF-side are bridged by a soft-real-time MAC running on dedicated coprocessors. This is the abstract-protocol lens.
- **NET-301 reads DOCSIS as a modulation-and-RF-front-end case study**, the canonical late-DOCSIS-3.x cable-modem case, where the QAM-on-coaxial-RF physics and the OFDM-block bandwidth aggregation in 3.1 illustrate why bits-on-RF is fundamentally the same problem as bits-on-fibre or bits-on-air. This is the bits-and-modulation lens.
- **RF-301 reads DOCSIS as a wired-RF protocol** that complements the cellular wireless-RF content of the same chapter, DOCSIS's burst-mode upstream + TDMA/SC-FDMA + symbol-decode pipeline reads as a structural cousin to the cellular RACH + uplink-grant + symbol-decode pipeline, but on coaxial cable rather than air. This is the advanced-RF lens.
- **RE-201 reads DOCSIS as the protocol on the silicon**, the chip-by-chip map turns the textbook spec into navigation guidance for hardware-RE work on the actual SB6141 PCB the student holds at the bench. This is the hands-on hardware lens.

One handout, four reads. The pedagogical economy is that students who study the SB6141 across multiple courses see the same device from progressively deeper architectural angles, and the handout is the canonical reference each course cites rather than each re-deriving the same mapping.

Decisions / Pedagogy / Supplements (tri-section)

Decisions captured authoring this handout

- **Voice class chosen: reference-content, not comparison-sidebar.** Per D7 audit §4.4 distinction, this handout follows the SB6141 cousin-mapping-card voice family (single canonical reference + per-track pickup pointers), not the CT-B / Petzold-style comparison-sidebar voice. The artifact class drives the section structure: at-a-glance table + protocol overview + chip-mapping + per-track pickup pointers + citation, *not* N-implementations-compared-on-M-axes.

- **Chip-mapping derived from arsenal/motorola-sb6141 hardware-dump confirmation.** The SB6141's online community identification as Broadcom-BCM3384 is wrong; the 2026-04-15 hardware dump confirmed TI Puma 5 (TNETC4830) + ARM1176JZ-S BE-32 + MaxLinear MxL261 tuner + TI PDSP coprocessors. Findings §22.2 carries the corrected identification; this handout cites that confirmed mapping.
 - **RE-201 pickup deferred (forward-pending).** RE-201 source-of-truth lives at [cybersecurity/academy/vca-re-101-reverse-engineering](#) under a separate operator team. RE-201 prose not yet drafted. Pickup added when RE-201 prose ships; cross-team coordination required.
-

© Virtus Cyber Academy. Generated 2026-05-08.