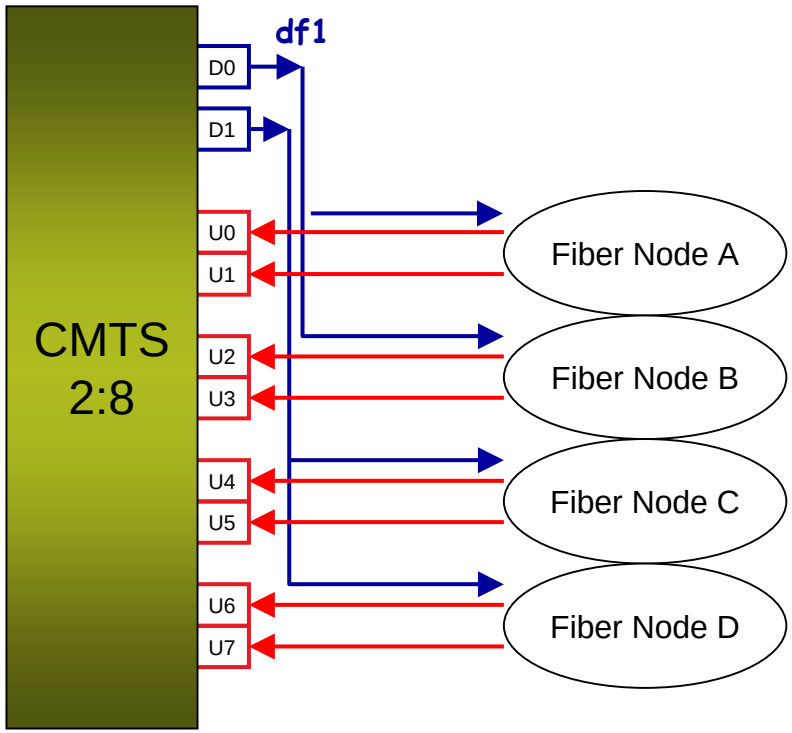
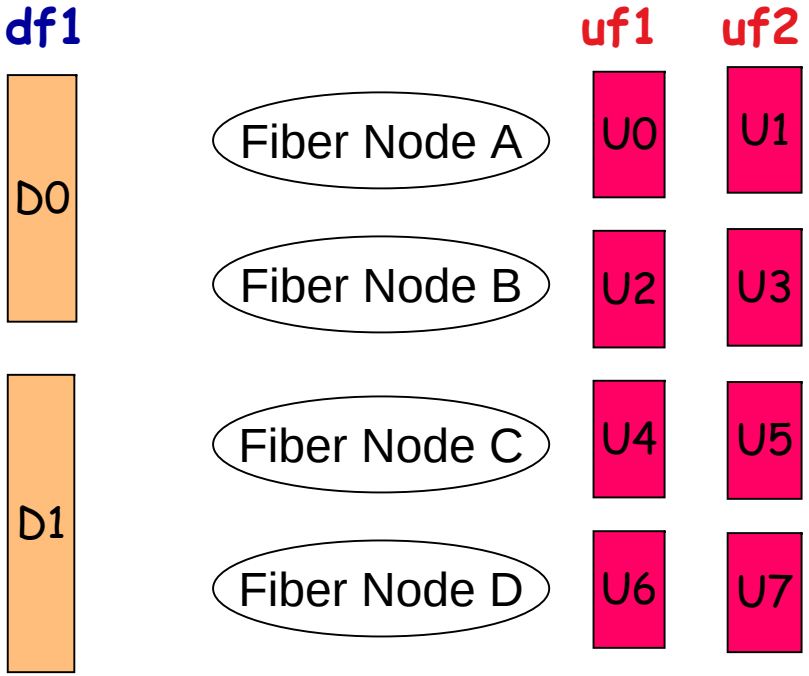
DOCSIS 3.0 Primer

Frequency/Space Diagram

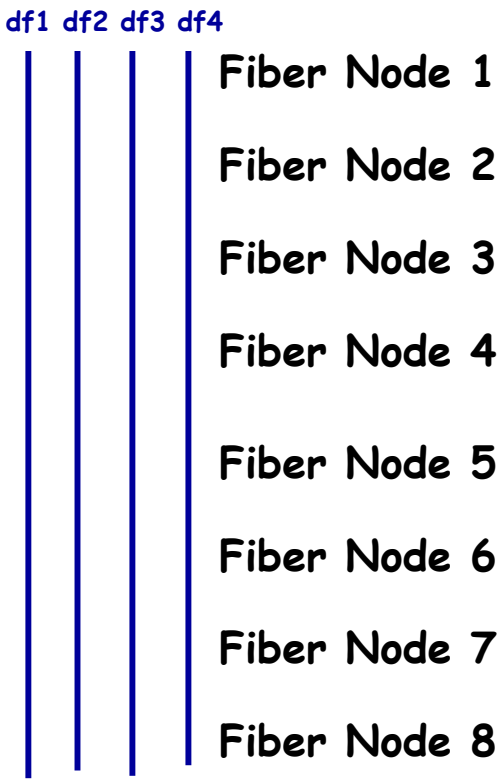
Frequency/Space Diagram



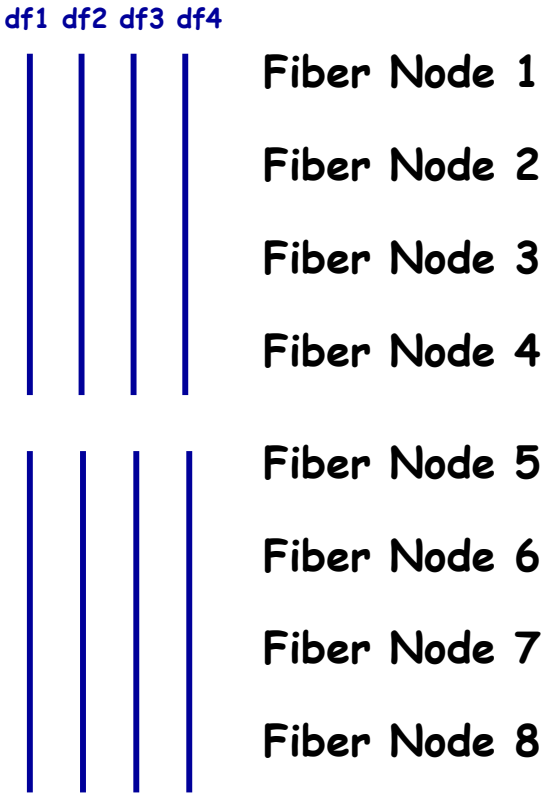


Columns indicate frequencies
Bars indicate channels

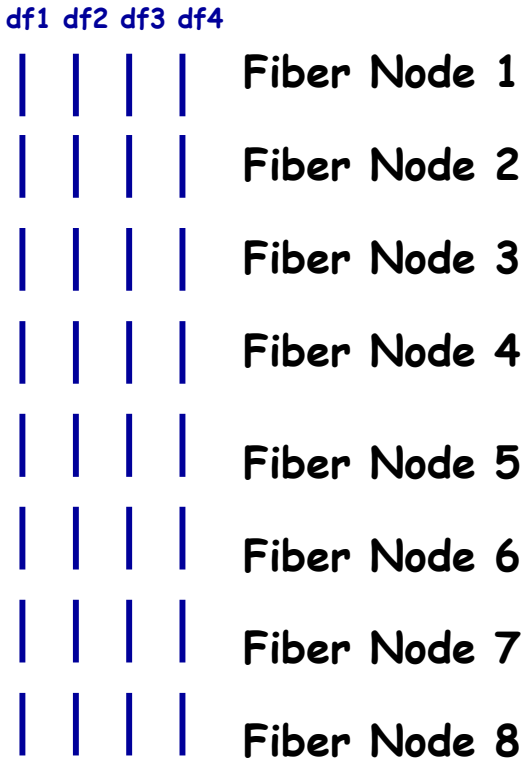
Peak vs. Average Bandwidth



Peak: 144 Mbps/FN
Avg: 18 Mbps/FN



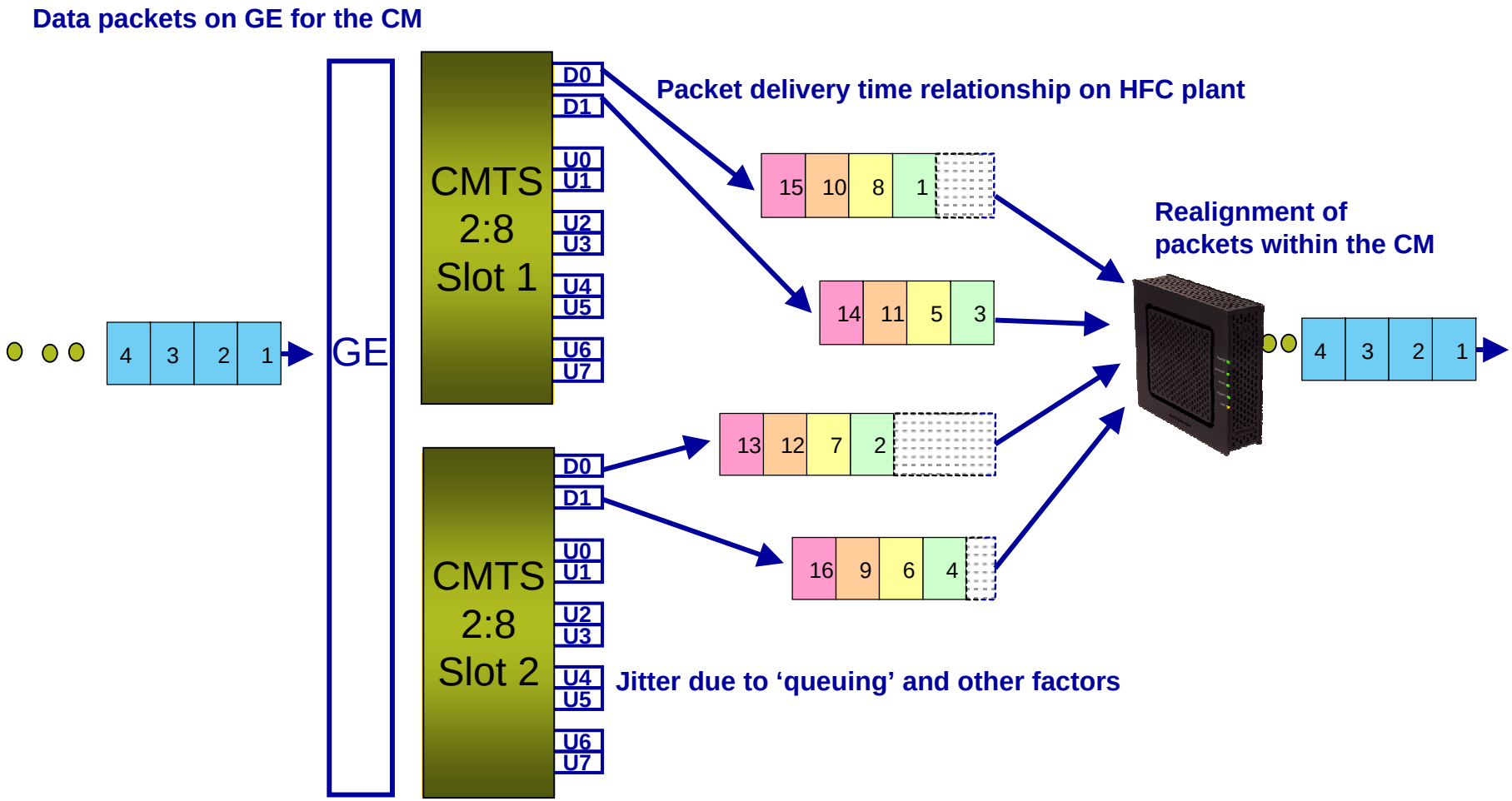
Peak: 144 Mbps/FN
Avg: 36 Mbps/FN



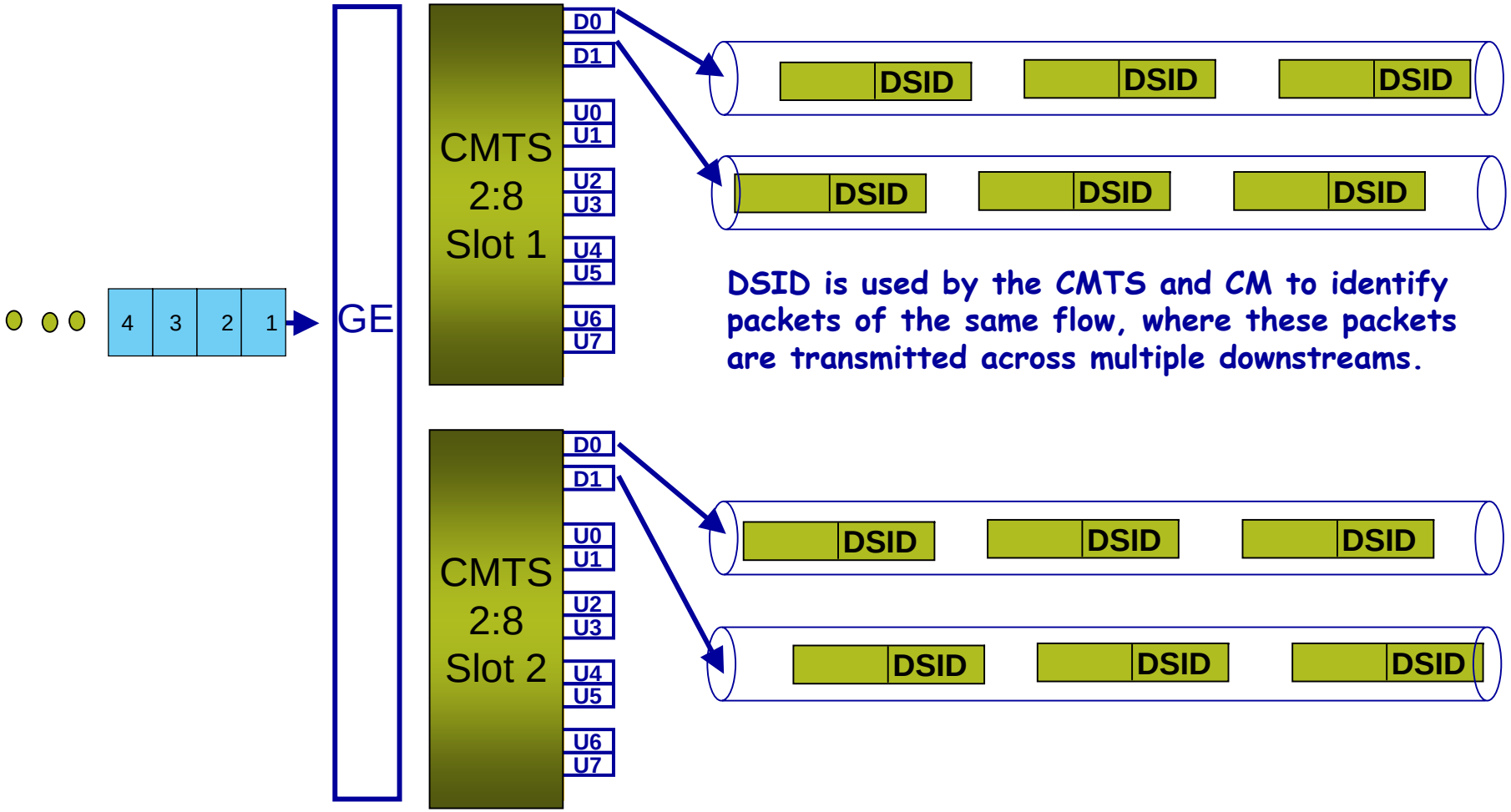
Peak: 144 Mbps/FN
Avg: 144 Mbps/FN

DS Channel Bonding Data Transmission

Channel Bonding Packet Transmission



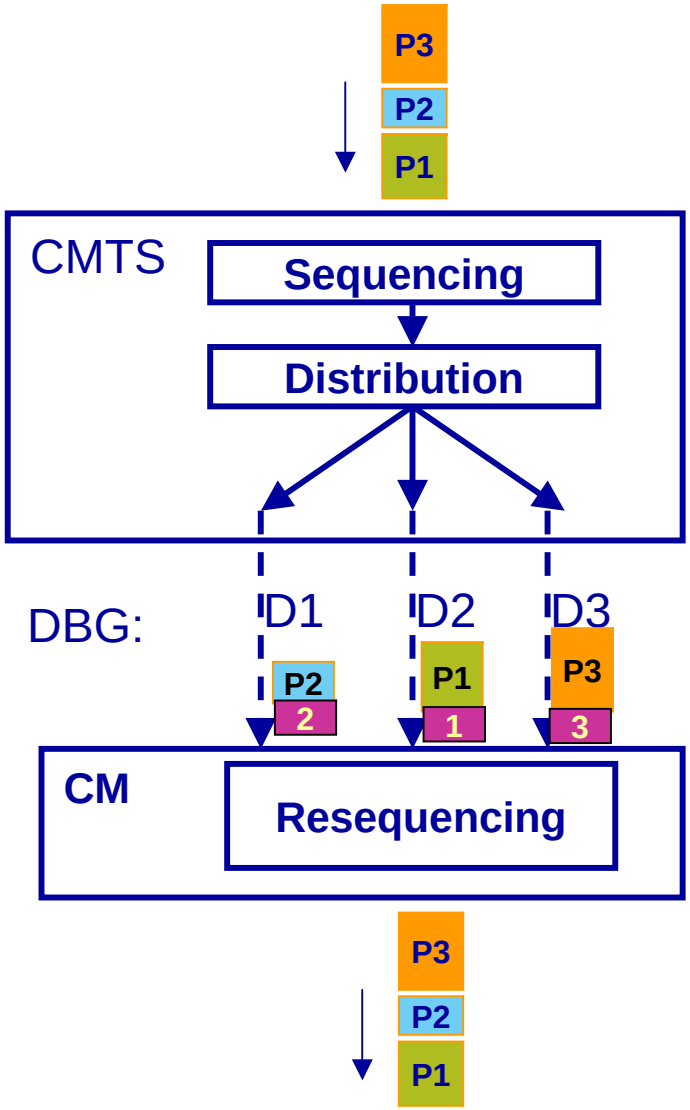
Downstream Service Identifier (DSID)



DSID

- **DSID is a 20-bit value in a DOCSIS extended header that identifies a stream of packets**
- **DSID is unique per MAC Domain**
- **DSID can represent:**
  - **One or more Service Flows to a single CM**
  - **All Service Flows to a CM**
  - **A IP Multicast Session to multiple CMs**
- **Sequence Number may or may not be present**
  - **Bonded HSD – *present***
  - **Bonded or Non-Bonded Voice – *not present***
  - **Non-Bonded Multicast – *not present***

Sequence Number

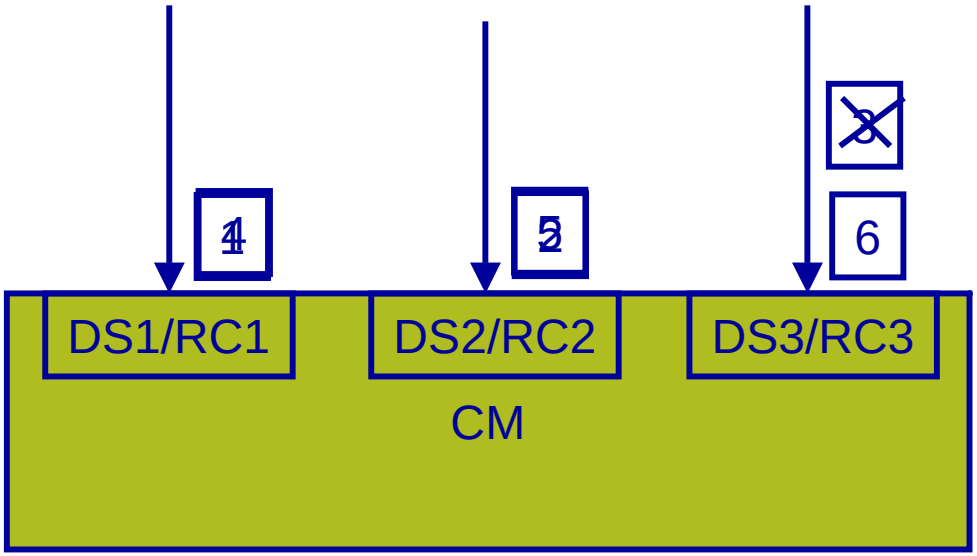


- **The CMTS marks HSD bonded packets with a packet *"sequence number"***
- **The CMTS distributes a stream of downstream packets to a set of channels; "Bonding Group" (BG)**
- **Bonded packets may arrive at the CM out of sequence order**
- **The CM "resequences" bonded packets and transmits them in packet sequence order.**

Sequence Number

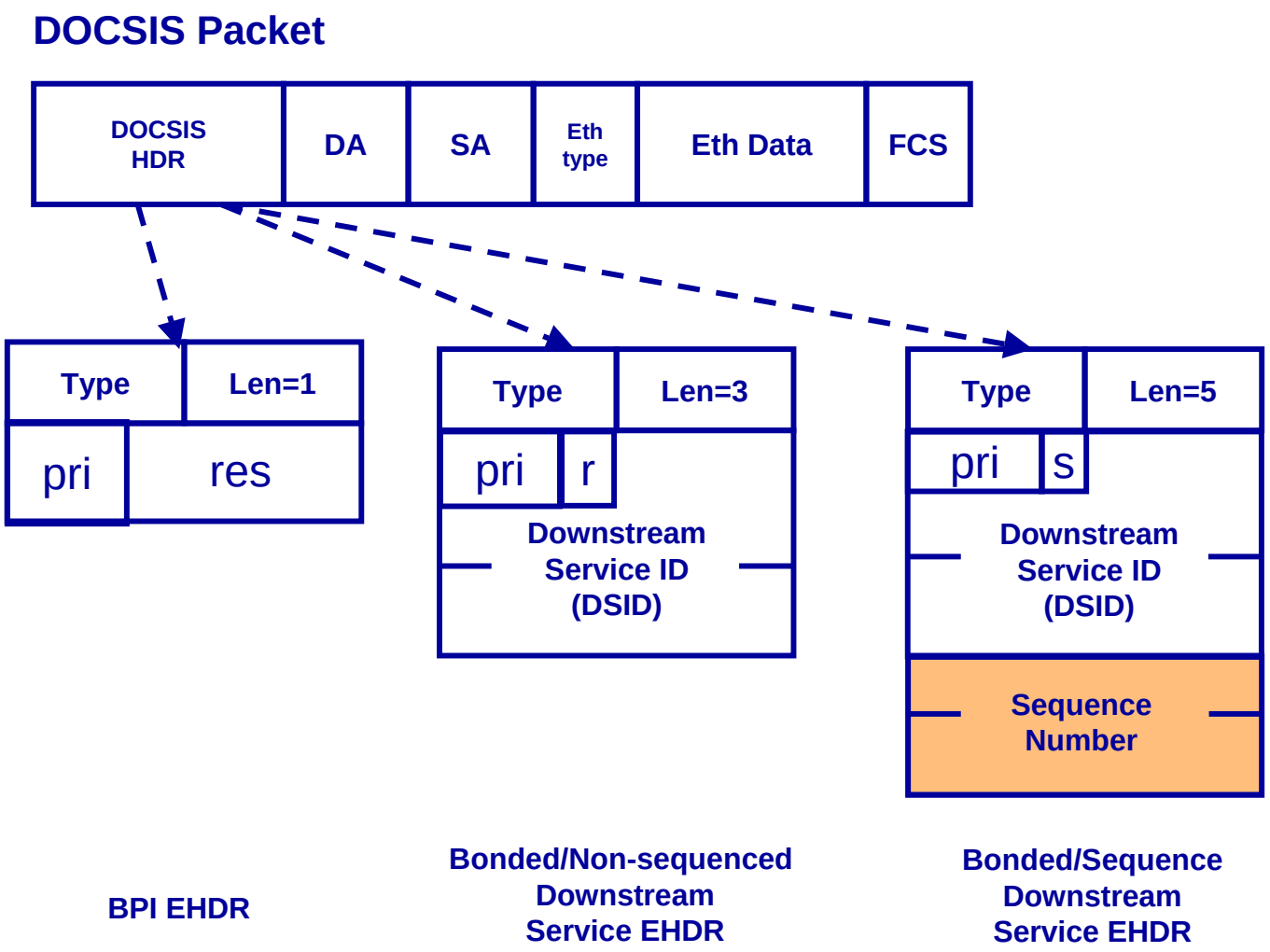
- **Bonded packets will be given a sequence number (in the extended header) by the scheduler**
- **Within any *single* downstream the packets must be transmitted in order**
- **Due to queuing delays for each DS channel, packets may arrive *out of order* at the CM**
- **CM must be able to collect and re-order packets**
- **Limit on how long a CM must buffer packets**
- **Packet sequence counter maintained by the CM and CMTS**

Rapid Packet Loss Detection



- **The CMTS MUST transmit packets for the same DSID in increasing order on a downstream channel.**
- **As soon as the CM receives sequence number 6 on RC3, it knows that 3 has been lost.**
- **The CM doesn't wait for a "resequencing wait" time.**

D3.0 Downstream Service EHDRs



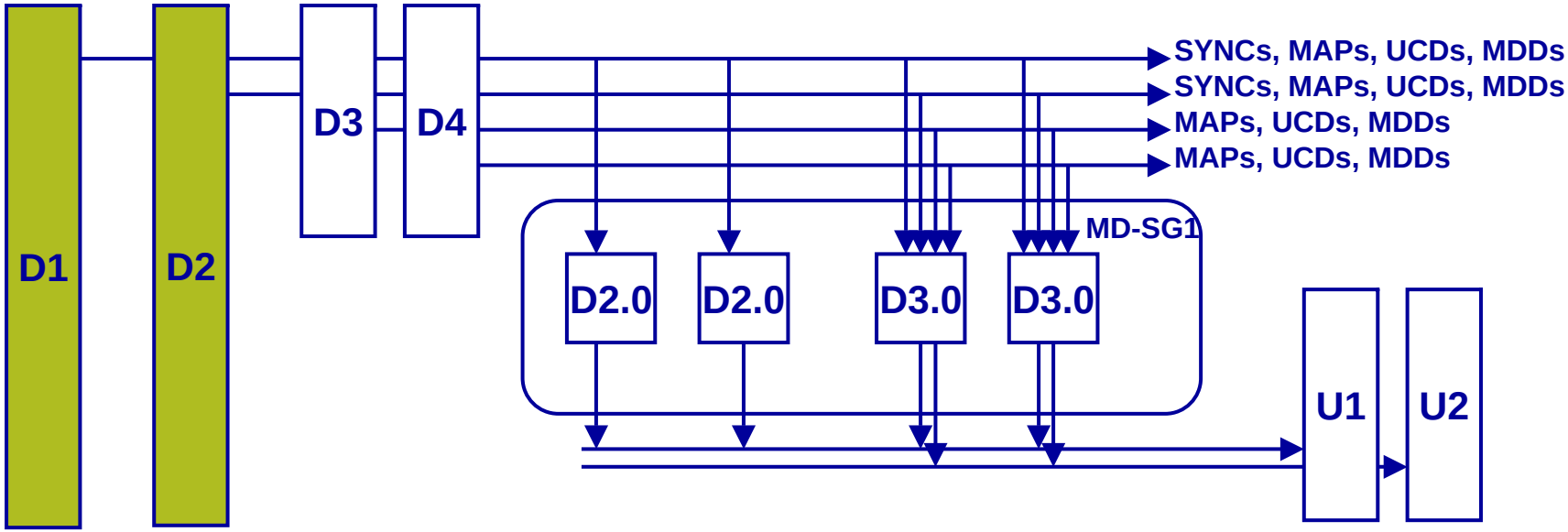
DS Channel Types

- **Primary-Capable Downstream (CMTS perspective)**
  - **Any downstream channel on which SYNC messages are periodically transmitted**
  - **A downstream channel that is configured as part of a bonding group and has upstreams bound to it**
    - **Upstreams are not shutdown**
- **Primary Downstream Channel (CM perspective)**
  - **Channel on which the CM receives all DOCSIS management messages**
  - **Channel on which the CM registers**
  - **Bonding modem may have only one primary downstream channel**
  - **A bonding modem's upstream channel and its primary downstream channel must be within the same MAC domain**

DS Channel Types

- **Non-primary Capable Downstream Channel**
  - **Also called a ‘secondary’ channel**
  - **Sync messages are not transmitted on ‘non-primary’ DS channels**
  - **CMs can not register on Non-primary channels**
  - **A downstream channel that is a member of a bonding group that does not have upstreams bound to it**
    - **For example, a 2x8 card configured as a 1x8 would have one downstream (the second downstream) without any upstreams bound to it.**

Primary Downstream Channels



- **Primary Capable Channel is a DS configured to send SYNCs.**
  - **D1 & D2**
- **Primary Channel of a CM is the DS on which it receives SYNCs.**
- **Non-Primary DS Channel is a DS which does not send SYNCs**
  - **D3 & D4**

Service Group

- **Service Group (SG) the complete set of upstream and downstream channels that can provide service to a single subscriber device. This includes channels from different DOCSIS MAC Domains and even different CMTSs**
- **Cable Modem Service Group (CM-SG) The complete set of downstream and upstream channels within a single CMTS that a single cable modem can receive or transmit on**
- **Downstream Service Group (DS-SG) The complete set of CMTS downstream channels that may be received by a single CM**
  - **Used for tier service separation, channel bonding and load balancing**
- **Upstream Service Group (UP-SG) The complete set of upstream channels in a CMTS that may receive the transmissions of a single CM**

MAC Domain Service Group

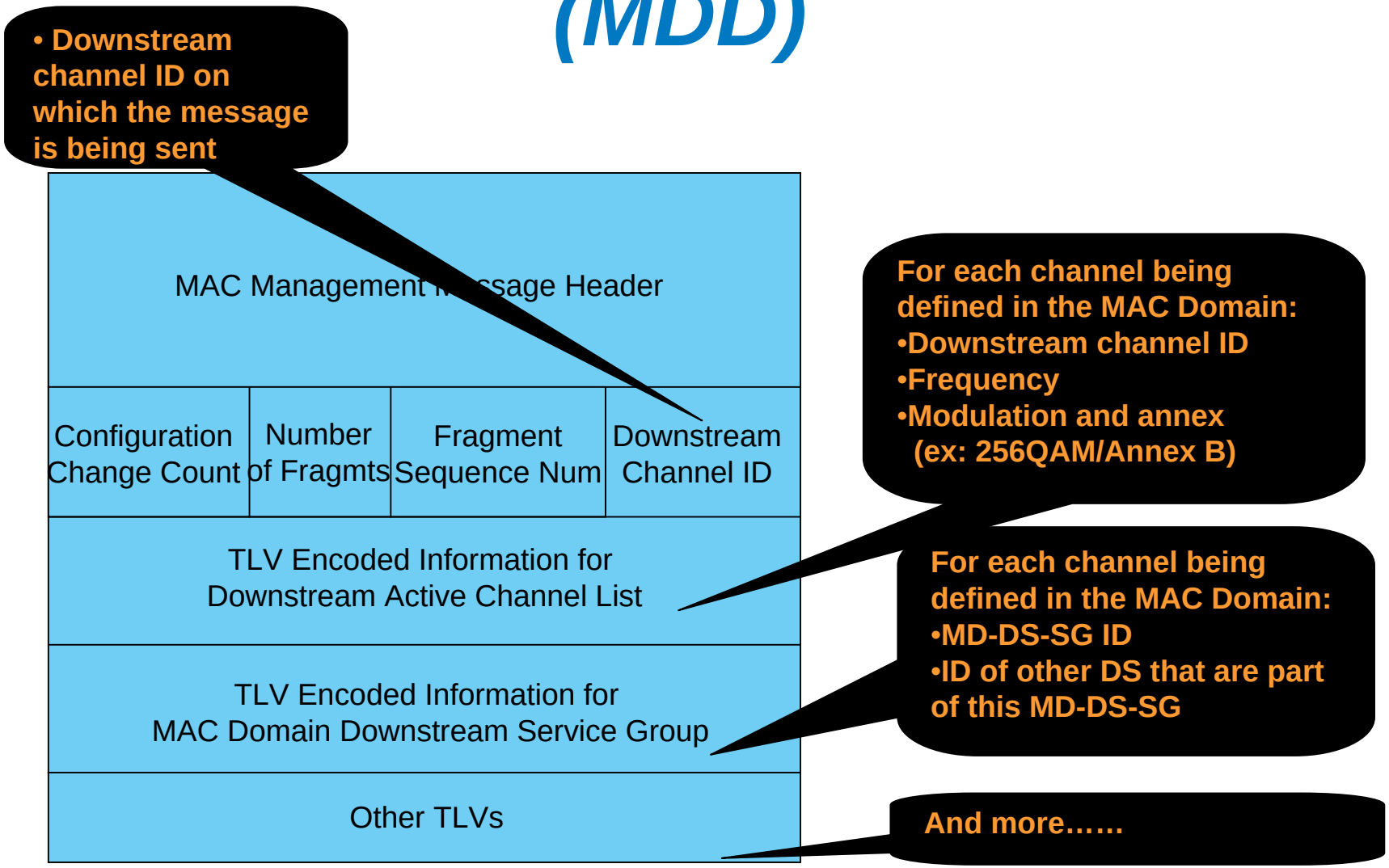
- ***MD-CM-SG (MAC Domain Cable Modem Service Group)***
  - The set of channels in a MAC Domain that reach a particular cable modem
- ***MD-DS-SG (MAC Domain Downstream Service Group)***
  - Refers to the set of downstream channels from the same MAC Domain that reaches a CM/fiber node
- ***MD-DS-SG-ID (MAC Domain Downstream Service Group Identifier)***
  - This is an 8-bit field
  - Identifier of the MAC Domain Downstream Service Group
- ***MD-US-SG (MAC Domain Upstream Service Group)***
  - Refers to the set of upstream channels from the same MAC Domain that is reached by a single CM

How D3.0 Bonded Modem Registers

MAC Domain Descriptor Message (MDD)

- **Message advertises topology initialization parameters**
- **Sent periodically on every downstream channel in the MAC domain**
- **mdd-interval ranges from 0 to 2000 msec**
  - **‘0’ value disable sending MDD message on the DS**
  - **Default -> 2000**

MAC Domain Descriptor Message (MDD)

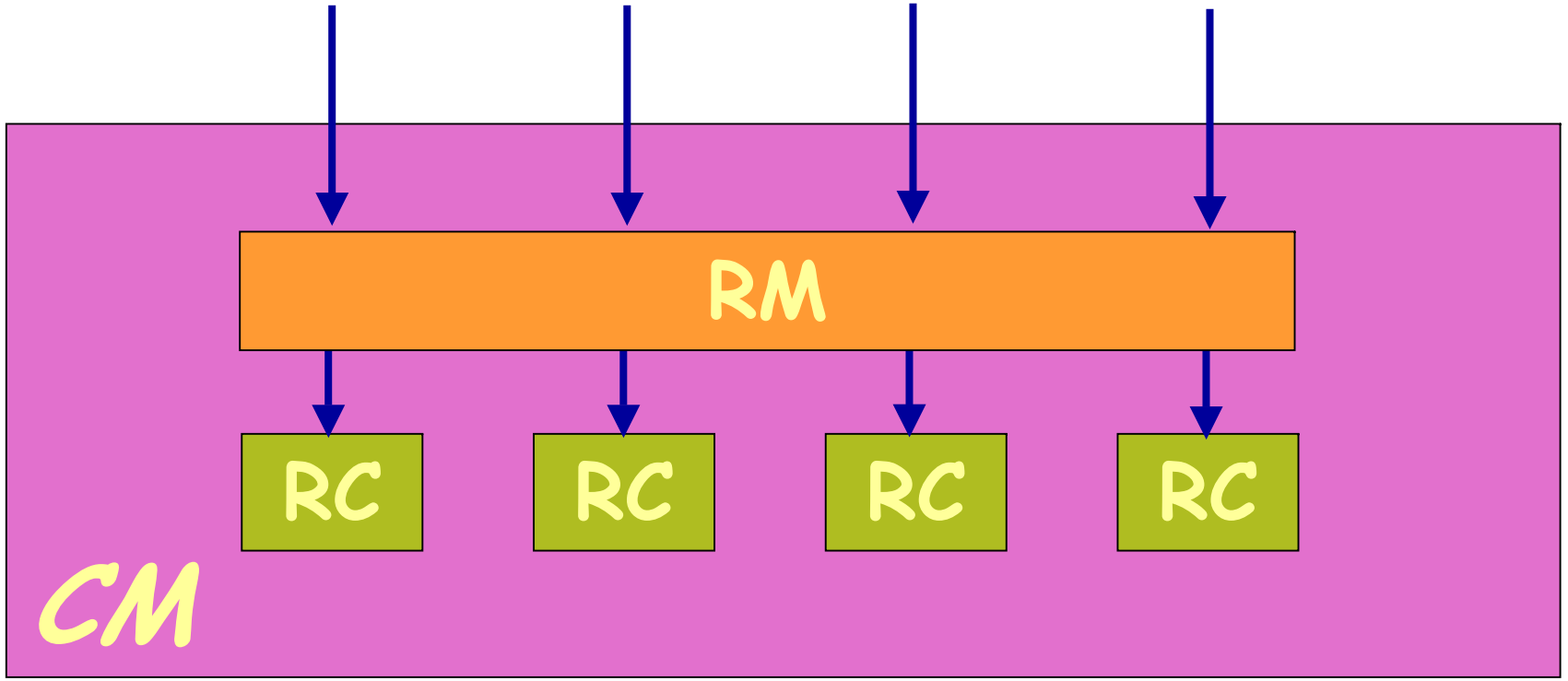


RCP and RCC

- **Receive Channel Profile (RCP)**
  - **TLV encodings that represent the CM receive channels and receive modules**
  - **CL defines 6 standard profiles**
    - Three 6 MHz
    - Three 8 MHz
  - **Non standard profiles**
- **Receive Channel Configuration (RCC)**
  - **Profile selected by the CMTS (center frequency)**
  - **May be a subset of the advertised profile**
  - **Returned by the CMTS in the registration response**

RC & RM

- **RC – Receive Channel:** Refers to the component of a Cable Modem that receives a single Downstream Channel on a single center frequency.
- **RM – Receive Module:** Refers to the component of a Cable Modem physical layer implementation shared by multiple Receive Channels.



Bonded CM Registration

- **Finding the Downstream**
  - **The bonding CM will activate only one of its receivers to scan the downstream**
  - **The bonding CM will lock on the primary downstream and use the MAC Domain Descriptor (MDD) message to discover the bonding groups that are available**

Ranging with a Bonded Modem

- **B-INIT-RNG-REQ: used by a downstream channel bonded cable modem to range**
  - **Includes the MD-DS-SG-ID from the downstream serving group resolution**
  - **Only sent if the DS contains MDD messages**

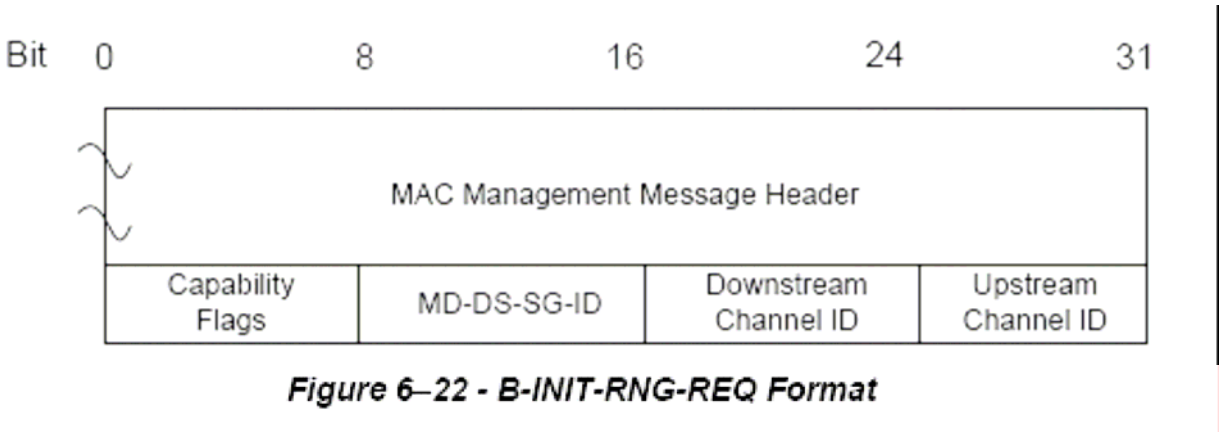


Figure 6–22 - B-INIT-RNG-REQ Format

Registration Request/Response

- **CM sends a REG-REQ-MP if the DS contains MDD messages**
- **REG-REQ-MP: advertise the CM downstream bonding capabilities:**
  - RCP encodings
- **If the CM sent a REG-REQ-MP message, the CMTS responds with a REG-RSP-MP message**
- **REG-RSP-MP: the CMTS** configures the CM's physical layer components to specific downstream frequencies
  - RCC encodings
- **If there are no BGs that matches the CMs RCPs, the CMTS will not include a RCC into the REG-RSP-MP**

Registration Completed

- **CM will use the RCC information in the REG-RSP message to tune the remaining receivers to achieve sync/lock on the other bonded downstreams**
  - **If no RCC is present in the "REG-RSP" the CM will complete registration as a non-bonding CM**
- **Once the CM has achieved sync/lock on all secondary receivers it will send the reg-ack to the CMTS**
  - If the CM fails to achieve "sync/lock" on all receivers the CM enters into "partial service" mode

MD-DS-SG & DBG Selection

Fiber Node Config → MD-DS-SG

CMTS will send the MD-DS-SG(s) in the MDD → CM uses the MDD to select the MD-DS-SG-ID

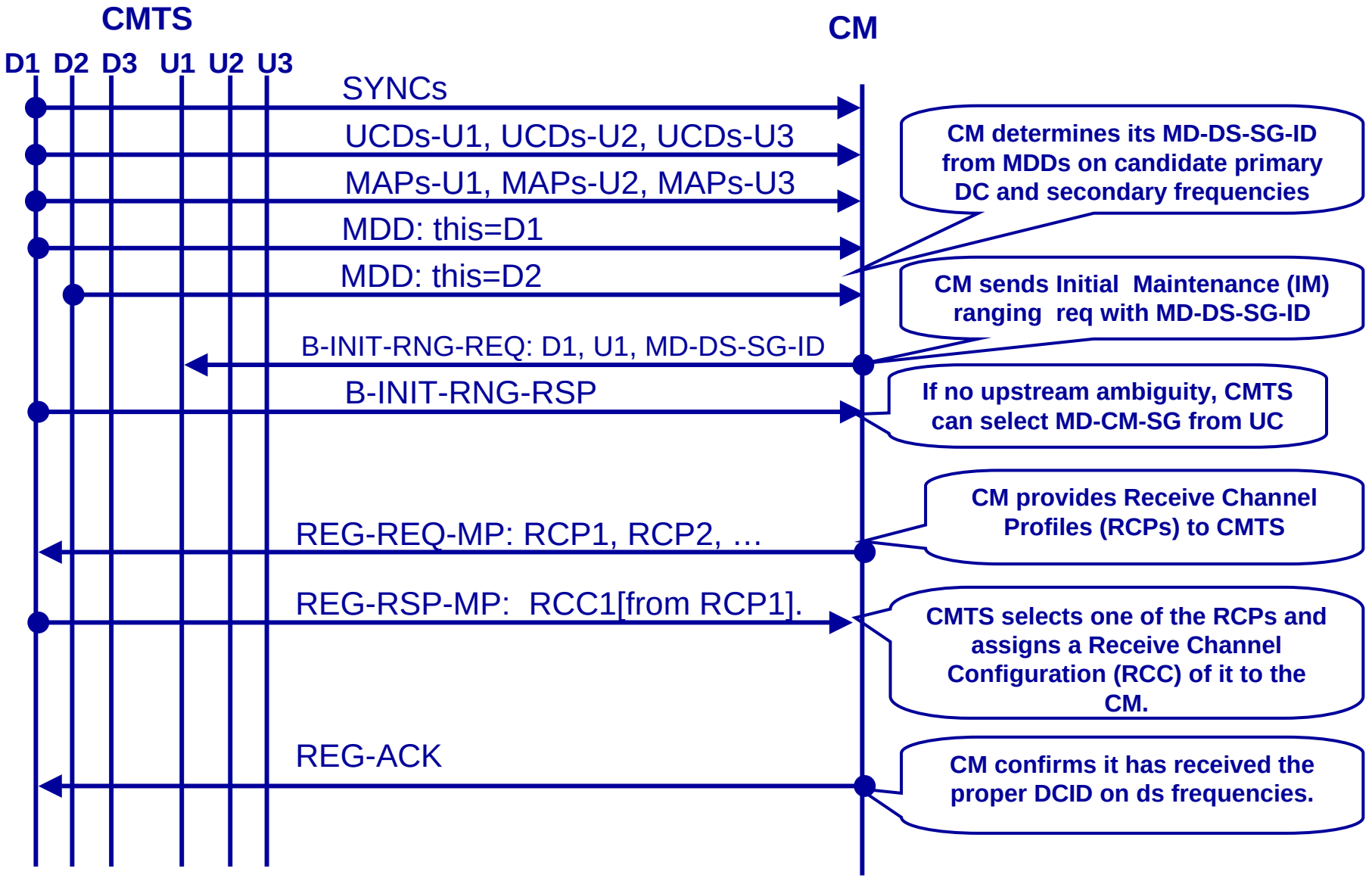
CM sends MD-DS-SG-ID in the B-INIT-RNG-REQ →

CM sends RCPs in the REG-REQ-MP: RCP1, RCP2 → CMTS uses the RCPs to select RCC and the DBG
*CMTS will select the largest possible DBG

CMTS will send the selected RCC in the REG-RSP-MP → CM uses the RCC to config the RC & RM

Also, the CMTS will send the DSID for the DS SF in the REG-RSP-MP → CM assigns the DSID to the SF

DOCSIS 3.0 CM Initialization Overview



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