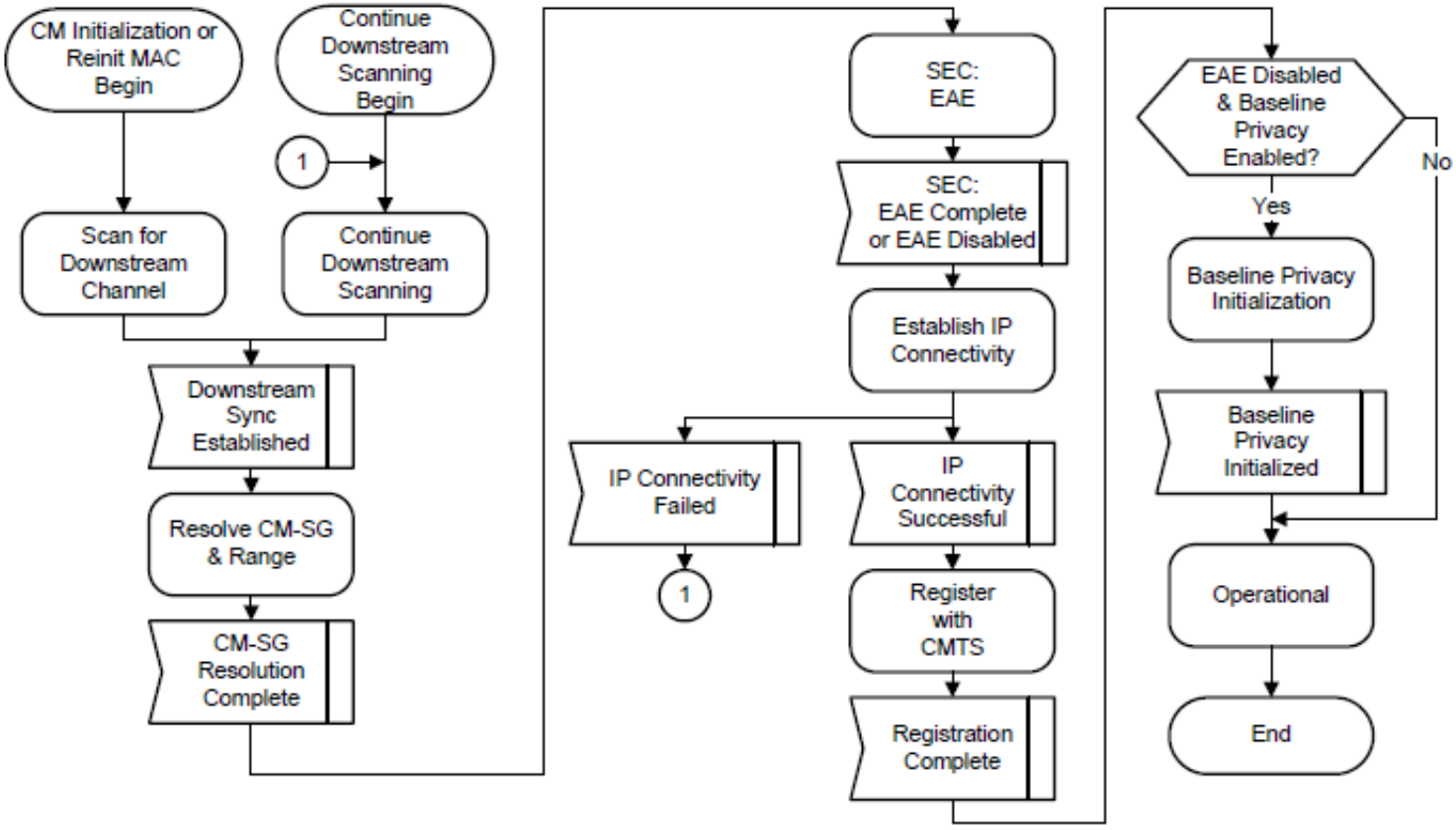
DOCSIS 3.0 DSCB

2010.5.14

CM initialization overview



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SG Discovery and Initial ranging

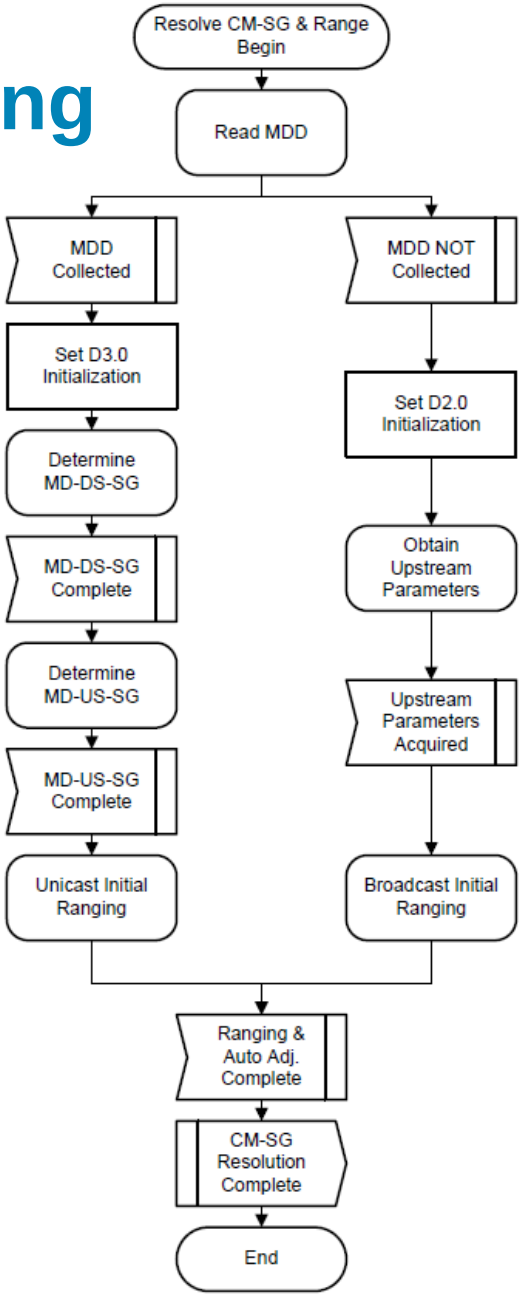
CM MUST attempt to determine its MAC Domain Downstream Service Group ID (MD-DS-SG-ID) if an MDD is present on the downstream.

If successful, the CM MUST provide the MD-DS-SG-ID it has selected to the CMTS in the Bonded Initial Ranging Request (B-INIT-RNG-REQ) message.

If the CM could not determine its MD-DS-SG-ID then it MUST send a B-INIT-RNG-REQ with the MD-DS-SG-ID set to zero.
The CMTS replies to the B-INIT-RNG-REQ with a RNG-RSP message.

In order to resolve the upstream service group (MD-US-SG) associated with this CM, the CMTS may include an Upstream Channel Adjustment in this RNG-RSP message.

If this occurs, the CM MUST tune to the new channel and sends an Initial Ranging Request (INIT-RNG-REQ) message. The CMTS responds with a RNG-RSP message, possibly including another Upstream Channel Adjustment.



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Service Group (SG)

- Cable Modem Service Group (CM-SG)

  Defined as the complete set of upstream and downstream channels that can provide service to a single cable modem

- Downstream Service Group (DS-SG)

  The complete set of downstream channels that may be received by a single CM

- Upstream Service Group (US-SG)

  The complete set of upstream channels that may receive the transmission of a single CM

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MAC Domain (MD)

Defined as CMTS subcomponent object responsible for all DOCSIS functions on a set of downstream channels and upstream channels

A MAC domain

- Contains at least one DS channel and US channel
- Provides layer 2 data forwarding between the CMTS forwarders and the set of CMs registered to that mac domain

Concept

- All upstream DOCSIS L2PDUs are delivered to CMTS forwarder subcomponent. The MAC Domain doesn't directly forward L2PDU from upstream to downstream
- A CM may be registered to a only one MAC Domain at a time
- Normally each DS channel and US channel is contained by a single MAC Domain

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Multiple DS Channels per MAC Domain

Primary Capable Downstream (usable by all CM)

- A Downstream channel which carries SYNC messages and carries the MAP and UCD messages for at least one associated upstream channel
- Pre 3.0 DOCSIS CMs can utilize only primary capable downstream channel
- Each CM must choose a primary capable downstream as its primary downstream channel upon which to receive timing information

Non-Primary Capable Downstream (usable by D3.0 or + only)

- Any Downstream channel which does not fit the definition of a primary capable downstream
- May be useful to CMs with multiple receivers when used in conjunction with at leaset one primary-capable downstream
- Can not be used by pre 3.0 DOCSIS CMs

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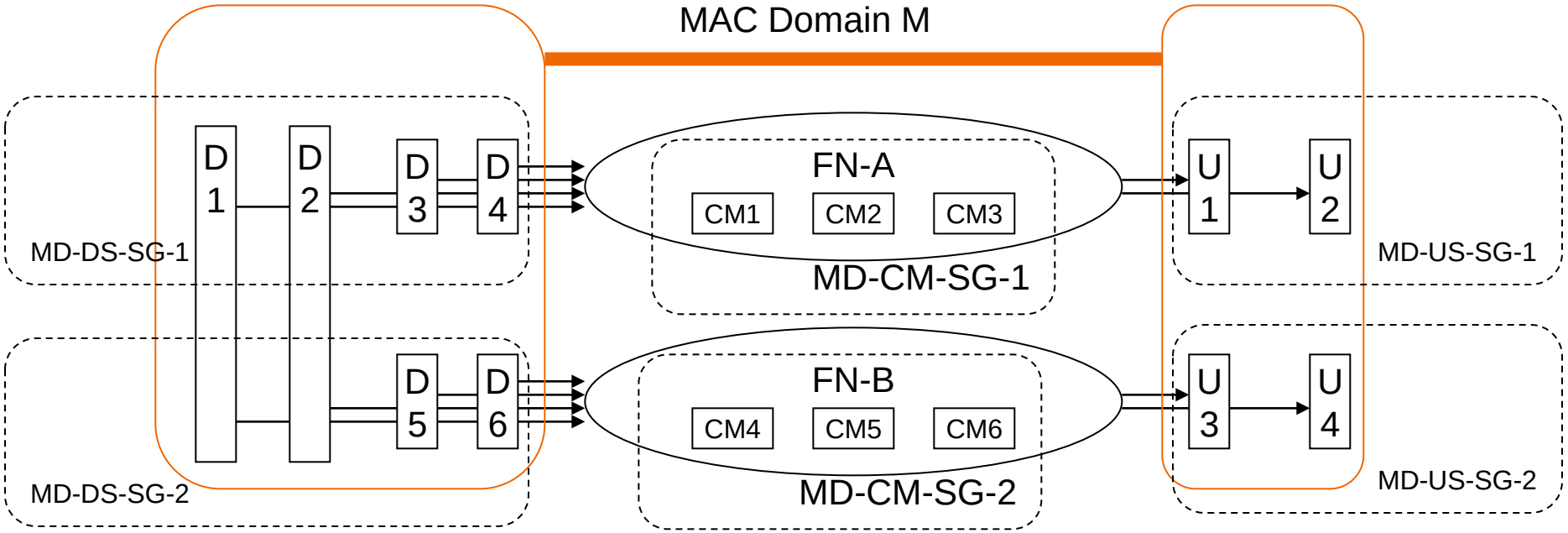
MAC Domain Service Groups



A MAC Domain Downstream Service Group (**MD-DS-SG**) is the set of downstream channels from a single MAC Domain that reach a single CM.
MD-DS-SG-1= D1/D2/D3/D4 MD-DS-SG-2 = D1/D2/D5/D6

A MAC Domain Upstream Service Group (**MD-US-SG**) is the set of upstream channels in a single MAC Domain reached by a single CM..
MD-US-SG-1 = U1/U2 MD-US-SG-2 = U3/U4

A "MAC Domain CM Service Group" (**MD-CM-SG**) is the full set of channels from a single MAC Domain reaching a single CM.
MD-CM-SG-1 = D1/D2/D3/D4/U1/U2 MD-CM-SG-2 = D1/D2/D5/D6/U3/U4

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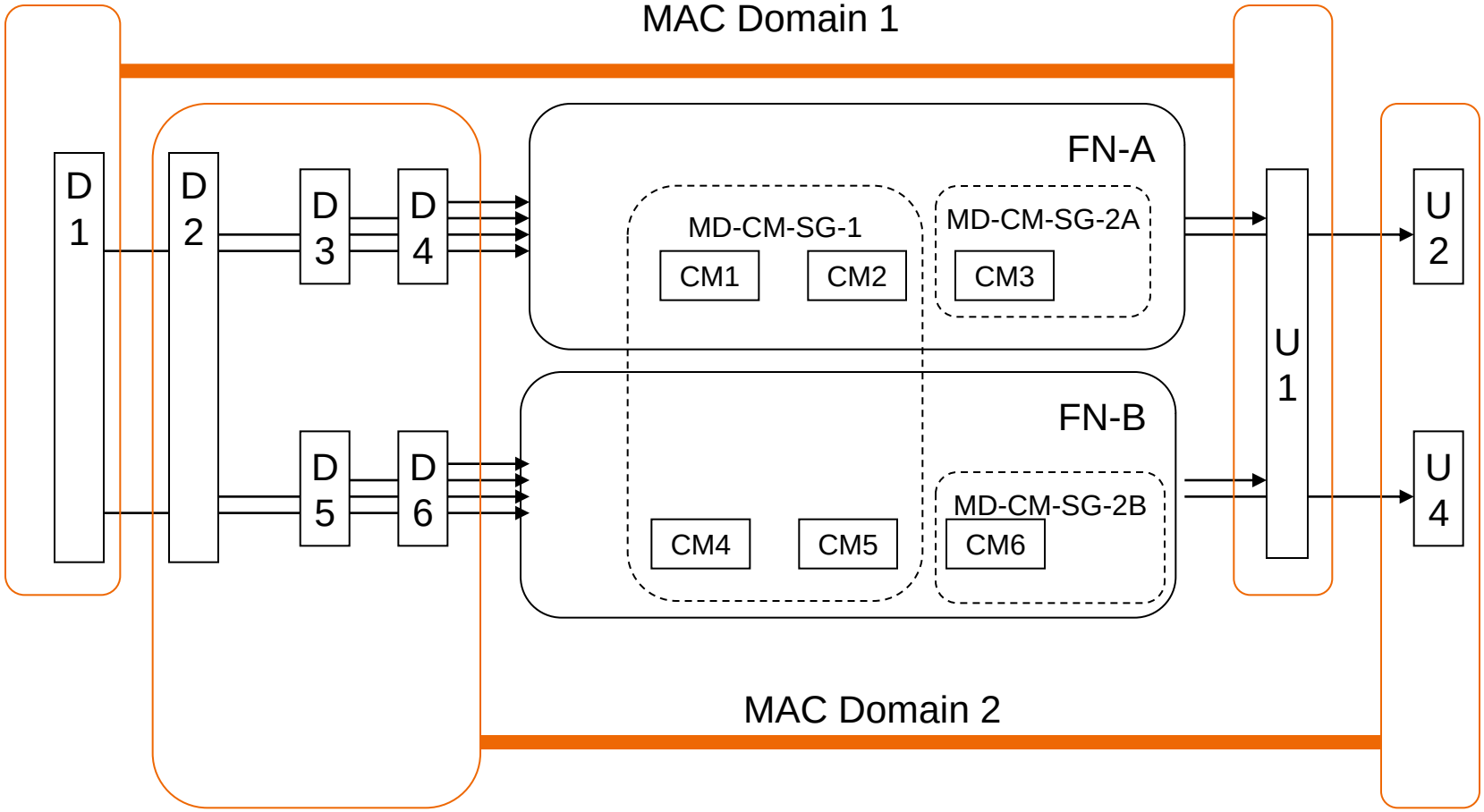
Multiple MAC Domains per Fiber Node

An MSO may configure separate MDs with separate channels for separate services, e.g. business, residential, VOIP, STBs, IPTV, etc.



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MAC Domain Descriptor (MDD)

Periodic, possibly multi-segment message which is sent on every downstream channel (similar to a DCD message)

Intended primarily for use by the CM during initialization but also includes parameters related to CM-STATUS reporting which may be useful post-registration

Contents are unique per downstream channel
The header of the MDD contains the Downstream Channel ID (DCID) assigned by the MD.
Bonding CMs use the DCID of their MD's MDD to identify secondary channels

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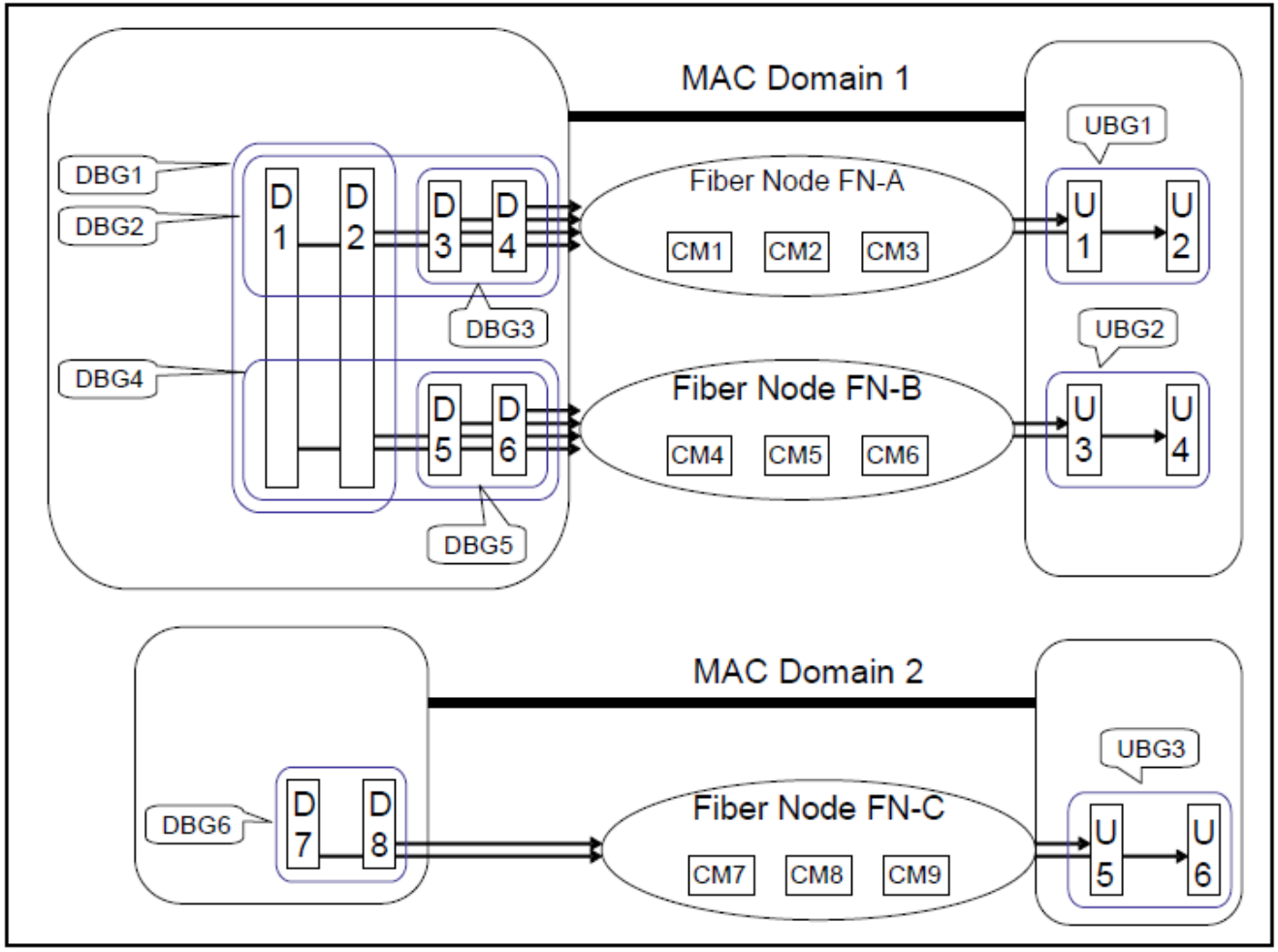
Bonding Group (BG)



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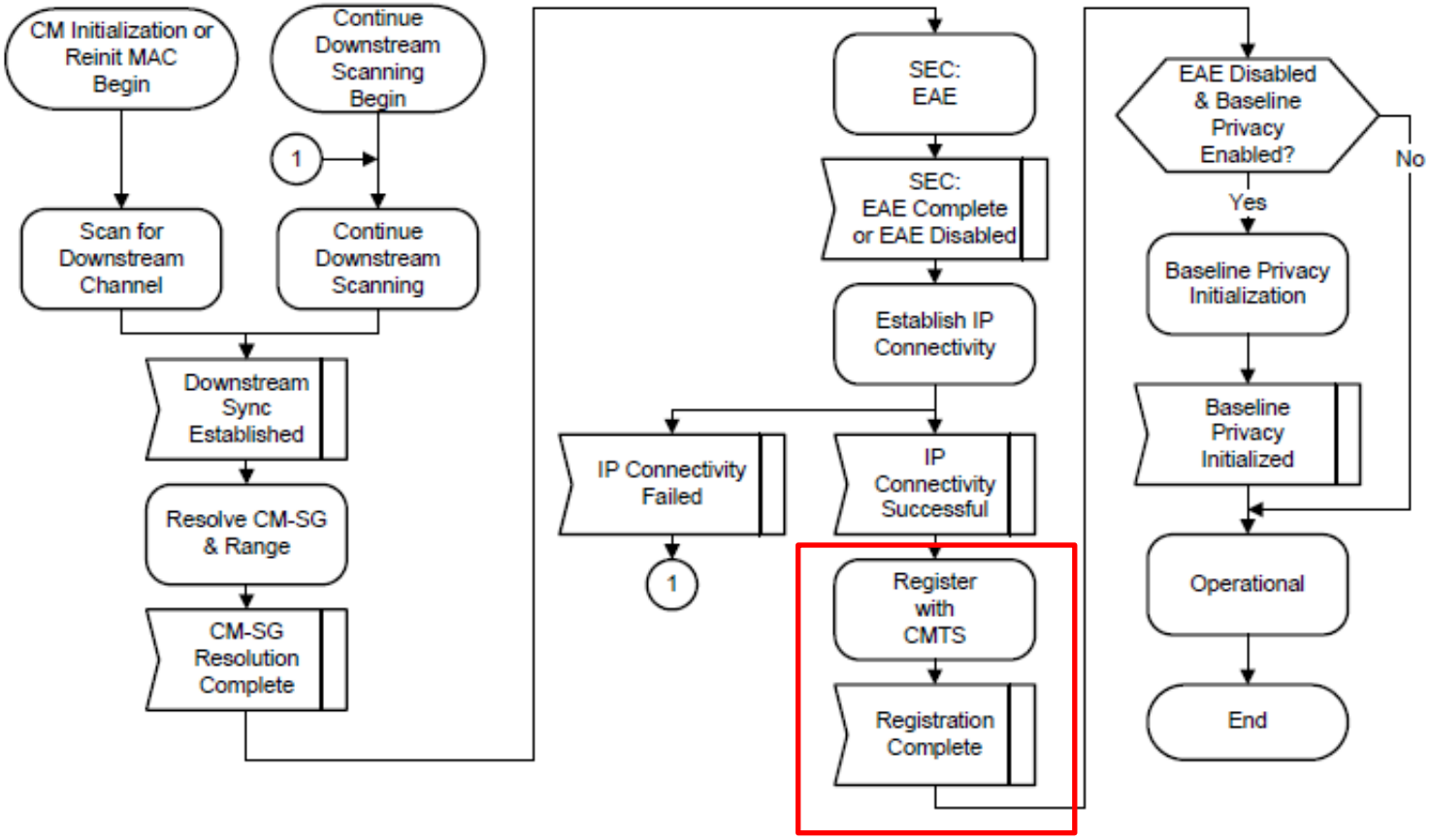
CM initialization overview



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REG-REQ TLVs

If found in the configuration file, the CM must include the following settings in the Registration Request

- All configuration setting included in the CMTS MIC calculation
- Enable 2.0 mode
- Downstream Channel List
- CMTS MIC configuration setting
- Channel Assignment Configuration Setting
  (US Channel ID – TCC / DS channel frequency - RCC)

The CM must include the following registration parameters in the Registration Request

- CM Capabilities Encodings
- Vendor ID configuration Setting (Vendor ID of CM)
- Receive Channel Profile (RCP) Encodings

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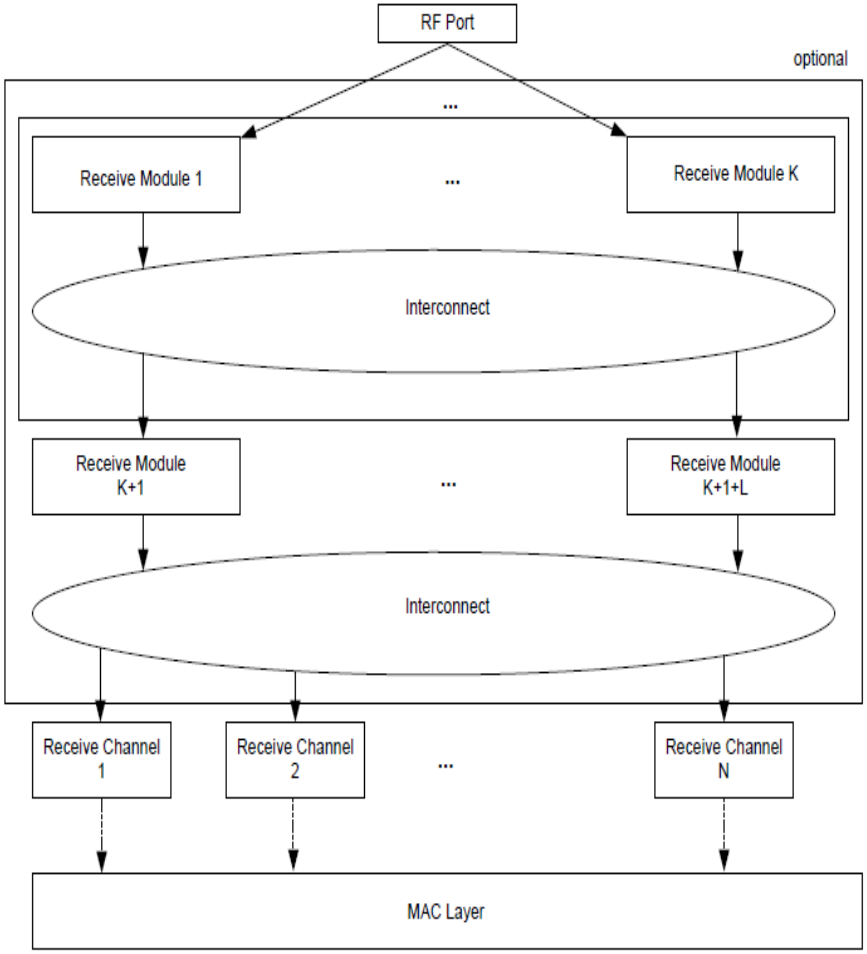
Receive Channel (RC) and Receive Module (RM)

Interconnection between RC and RM



Receive Channel (RC)

RC refers to the component of a CM that receives a single DS channel on a single center frequency

CMTS assigns one or more of its DS channels to the Receive Channels of a CM

Receive Module (RM)

RM refers to a component in the CM physical layer implementation shared by multiple RCs.

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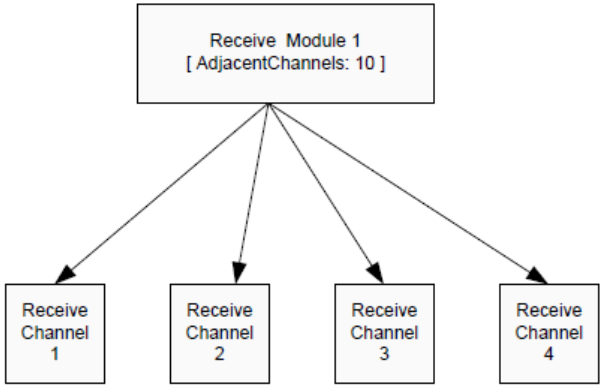
Receive Channel Profile (RCP)

- RCP is an encoding that represents RC and RM of the CM
- RCP is defined with either 6 MHz or 8 MHz CMTS advertises in its periodic MDD – Receive Channel Profile Reporting Control TLV
- RCP is identified with a globally unique RCP-ID that is consist of 5 byte

3 byte	2 byte
OUI	Assigned by manufacturer

Well-known RCP

0x 00 10 00 00 ‘02 – 04’ : CLAB-6M-002 (-004)
0x 00 10 00 10 ‘02 – 04’ : CLAB-8M-002 (-004)
0x 00 10 18 33 81 : BCM3381 3D/1U



Standard RCP CLAB-6M-004A

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RCP Definition

- RCP consists of:
  - RCP ID
  - RCP Name
  - Center Frequency Spacing (6 or 8 Mhz)
  - Receive Channels
  - Receive Modules

- Receive Channels are described with
  - RC ID (1, 2, …)
  - Primary Capable
  - RM Connectivity: set of RMs to which the RC can connect

- Receive Modules are described with
  - RM ID (1, 2, …)
  - Adjacent Channels
  - Block Range (min first center frequency, max last center frequency)
  - Resequencing Set (subset of RCs that may be resequenced by CM)
  - RM Connectivity: set of higher layer RMs to which the RM can connect
  - Common PHY parameter (e.g. interleave)

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Receive Channel Configuration (RCC)

The CMTS must select one of the RCPs in the Registration Request for configuring the CM. The CMTS returns, in a Registration Response to a CM, a RCC encodings that contains TLVs to configure RC and RM of the selected RCP

- If the CM reports an RCP that is supported by the CMTS, CMTS must send an RCC encodings in the Registration Response
- If the CM does not send a Verbose RCP and the CMTS does not recognize any of the RCP-IDs advertised by the CM, CMTS must not send an RCC in the Registration Response
- If the CM does not receive an RCC in the Registration Response, it must set its Receive Channel Set to only contain its current Primary DS Channel

An RCC contains following

- RCP-ID
- Receive Module assignment
  - RM Index
  - RM First Channel Center Frequency
  - RM Connectivity
- Receive Channel assignment
  - RC Index
  - RC Connectivity
  - RC Center Frequency
  - RC Primary Downstream Channel Indicator

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RCC

Receive channel configuration (RCC) is generated during WB-CM registration and is created using the primary DS RC+ Wideband-cable RCs. RCC tlvs are sent to CM in the (MP)REG-RSP message. (Receive-Modules (RM) are note included)

```
uBR10K#show cable modem wideband
MAC Address     IP Address     I/F          MAC          Prim  RCC  MD-DS-SG/
                                            State        Sid   ID   MD-US-SG
001a.c3ff.e4ce  10.1.21.5      C6/0/0/U2    w-online     31    19   1 / N/A
001a.c3ff.e3d4  10.1.21.12     C6/0/0/U2    w-online     32    21   1 / N/A
0023.be83.1c94  10.1.21.16     C6/0/0/U3    w-online     33    19   1 / N/A
0022.ce9c.8398  10.1.21.8      C6/0/0/U2    w-online     34    21   1 / N/A
```

```
uBR10K#show cable mac-domain cable 6/0/0 rcc
RCC-ID  RCP            RCs  MD-DS-SG  CMs  WB/RCC-TMPL
19      00 00 00 00 00  4    0         4    WB (1)
20      00 00 00 00 00  3    0         0    WB (2)
21      00 00 00 00 00  4    0         3    WB (3)
```

```
uBR10K#show cable mac-domain cable 6/0/0 rcc 19
RCC ID                : 19
RCP                   : 00 00 00 00 00
Created Via           : Wideband - 1
Receive Channels      : 4
  Receive Channel     : 1
    Center Frequency  : 747000000
    Primary Capability : YES
  Receive Channel     : 2
    Center Frequency  : 753000000
    Primary Capability : YES
  Receive Channel     : 3
    Center Frequency  : 759000000
    Primary Capability : YES
  Receive Channel     : 4
    Center Frequency  : 765000000
    Primary Capability : NO
Receive Modules       : 1
  Receive Module      : 1
    First Frequency   : 747000000
```


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RCC-template Configuration

```
!
cable rcc-template 3
  rcp-id 00 10 00 00 04
  receive-module 1 first-center-frequency 747000000
  receive-channel 1 center-frequency 747000000 connected-receive-module 1
  receive-channel 2 center-frequency 753000000 connected-receive-module 1 primary
  receive-channel 3 center-frequency 759000000 connected-receive-module 1
  receive-channel 4 center-frequency 765000000 connected-receive-module 1
!
Interface Cable 5/0/0
  cable rcc-template 3
```

```
uBR10K#sh cable mac c6/0/1 rcc
RCC-ID   RCP             RCs  MD-DS-SG  CMs   WB/RCC-TMPL
19       00 00 00 00 00   4    0         2     WB (1)
20       00 00 00 00 00   3    0         0     WB (2)
21       00 00 00 00 00   4    0         2     WB (3)
22       00 10 00 00 04   4    1         1     RCC-TMPL (3)
```

```
uBR10K#sh cable mac c6/0/1 rcc 22
RCC ID                : 22
RCP                   : 00 10 00 00 04
Created Via           : rcc-template - 3
Receive Channels      : 4
  Receive Channel     : 1
    Center Frequency  : 747000000
    Primary Capability : NO
  Receive Channel     : 2
    Center Frequency  : 753000000
    Primary Capability : YES
  Receive Channel     : 3
    Center Frequency  : 759000000
    Primary Capability : NO
  Receive Channel     : 4
    Center Frequency  : 765000000
    Primary Capability : NO
Receive Modules       : 1
  Receive Module      : 1
    First Frequency   : 747000000
```

- RCCs are generated via Wideband-cable interface configuration as well as RCC-template configuration and association
- During registration a RCC is selected from the created RCC-list and sent to the CM via (MP-)REG-RSP
- WB CMs are associated with a RCC id instead of BG-ID

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RCC Selection

- Two methods of RCC selection is supported
  - Legacy functionality as per Rembrandt. RCCs created via Wideband-cable interfaces will be used for RCC selection for WB CMs. The primary DS RC + WB RCs can be used.
  - RCC-template based RCC assignment. In this case all Wideband-cable interface created RCCs will be ignored and only RCC-template based RCC will be used for RCC selection for WB CMs. In this scenario the primary DS RC must be included in the RCC-template.
- In case legacy functionality is desired, no rcc-template association should be created via the interface config command ‘cable rcc-template’
- RCC selection Criteria
  - Candidate RCCs that match CM’s primary DS
  - Total CM tuners and RCC RCs
  - CM count based selection if multiple RCCs available. (least total CM RCC picked)

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Partial Service

- Primary DS channel impairments result in a CM being forced offline (flap)
- Non-primary DS channel impairments need not result in a CM being forced offline.
- The CM-STATUS message allows a CM to inform the CMTS about QAM UP/DOWN.
- QAM UP events automatically inform the CMTS when the impairment has been removed.

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CM-STATUS message

```
uBR10K(config)#cable cm-status ?
  <1-10>  CM-STATUS Event
  1       Secondary Channel MDD timeout
  2       QAM/FEC lock failure
  3       Sequence out of range
  4       MDD recovery
  5       QAM/FEC lock recovery
  6       T4 timeout
  7       T3 re-tries exceeded
  8       Successful ranging after T3 re-tries exceeded
  9       CM operating on battery backup
  10       CM returned to A/C power
  all     ALL CM-STATUS events
```

```
uBR10K(config)#cable rf-change-?
rf-change-dampen-time  rf-change-trigger
```

- Default configuration will reset CM after expiration of dampening time.
- Configuration of ‘trigger’ ‘count’ and/or ‘percent’ will enable wideband resiliency

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Show command

```
uBR10K#sh int c5/0/0 service-flow
Sfid  Sid   Mac Address     QoS Param Index Type  Dir   Curr    Active  DS-ForwIf/
                           Prov  Adm   Act                 State   Time    US-BG/CH
61    29    001a.c3ff.e3d4  3     3     3     P     US    act     14:34   BG 500
62    N/A   001a.c3ff.e3d4  4     4     4     P     DS    act     14:34   Wi5/0/0:0
63    30    0023.be83.1c8a  3     3     3     P     US    act     14:37   BG 500
64    N/A   0023.be83.1c8a  4     4     4     P     DS    act     14:37   Wi5/0/0:0
65    31    0023.be83.1c94  3     3     3     P     US    act     35:35   BG 500
66    N/A   0023.be83.1c94  4     4     4     P     DS    act     35:35   Wi5/0/0:0
```

```
uBR10K#sh int wide 5/0/0:0 rf-status
                Logical
Resource        RF  Status
----------------------
5/0/0           0   UP
                1   UP
                2   UP
                3   UP
```


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Show commands for partial service

- show interface <wideband-interface> rf-status
- show cable rf-status
- show cable modem summary wb-rfs
- show cable modem cm-status
- show cable modem <addr> wideband rcs-status
- show cable flap-list wb-rf

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Examples

```
uBR10K#show cable modem cm-status
I/F    MAC Address    Event          TID   Count Error Dups  Time
C5/0/0 001a.c3ff.e3d4 MDD timeout     1     1     0     0     May 4  18:03:35
                      QAM failure     1     1     0     0     May 4  18:03:29
C5/0/0 0023.be83.1c94 MDD timeout     2     1     0     0     May 4  18:03:37
                      QAM failure     2     1     0     0     May 4  18:03:32
                      QAM recovery    2     1     0     0     May 4  18:03:58
C5/0/0 0022.ce9c.8398 MDD timeout     2     1     0     0     May 4  18:03:35
                      QAM failure     0     0     1     0     May 4  18:03:29
                      QAM recovery    0     0     1     0     May 4  18:03:29
```

```
uBR10K#sh int wide 5/0/0:0 rf-status
              Logical
Resource    RF  Status
-----------------------
5/0/0       0   UP
            1   UP
            2   UP
            3   DOWN
```

```
uBR10K#sh cable flap-list wb-rf
                  MDD              QAM/FEC
RF        Timeout Recover Failure Recover Flaps CM      Percent
--------  ------- ------- ------- ------- ----- ------- -------
5/0/0 2   0       0       1       0       1     7       14
      3   6       0       5       2       7     7       85
```

```
uBR10K#show cable modem 10.1.21.5 wideband rcs-status
CM  : 001a.c3ff.e4ce
RF  : 5/0/0 1
  Status                : UP
  FEC/QAM Failure       : 0
  Dup FEC/QAM Failure   : 0
  FEC/QAM Recovery      : 0
  Dup FEC/QAM Recovery  : 0
  MDD Failure           : 0
  Dup MDD Failure       : 0
  MDD Recovery          : 0
  Dup MDD Recovery      : 0
  Flaps                 : 0
  Flap Duration         : 00:00
RF  : 5/0/0 2
  Status                : UP
  FEC/QAM Failure       : 0
  Dup FEC/QAM Failure   : 0
  FEC/QAM Recovery      : 0
  Dup FEC/QAM Recovery  : 0
  MDD Failure           : 0
  Dup MDD Failure       : 0
  MDD Recovery          : 0
  Dup MDD Recovery      : 0
  Flaps                 : 0
  Flap Duration         : 00:00
RF  : 5/0/0 3
  Status                : DOWN
  FEC/QAM Failure       : 1       May 4  18:03:29
  Dup FEC/QAM Failure   : 0
  FEC/QAM Recovery      : 0
  Dup FEC/QAM Recovery  : 0
  MDD Failure           : 1       May 4  18:03:35
  Dup MDD Failure       : 0
  MDD Recovery          : 0
  Dup MDD Recovery      : 0
  Flaps                 : 1
  Flap Duration         : 04:39
```


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