

Cable Modem

通訊網路簡介與實驗

Presenter:

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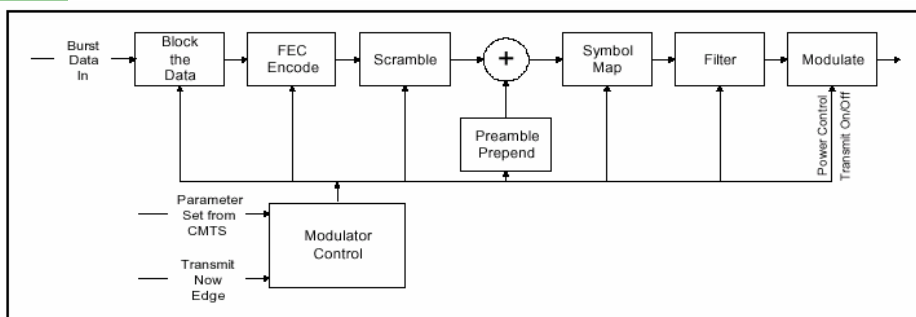
Introduction

- Spectrum allocation
 - Upstream : 5 – 42 MHz
 - Downstream : 54 – 750 MHz
 - 54 - 550MHz for Analog TV program signal.
 - 550 - 750 MHz for data traffic or digital TV program signal
- Modulation Scheme
 - Upstream : QPSK or 16 QAM, Bit Rate 0.32-10.24Mbit/sec (BW 200KHz - 3.2MHz)
 - Downstream : 64 QAM or 256 QAM, Bit Rate 30 or 43Mbit/sec (BW 6 MHz)

Data over Cable Architecture

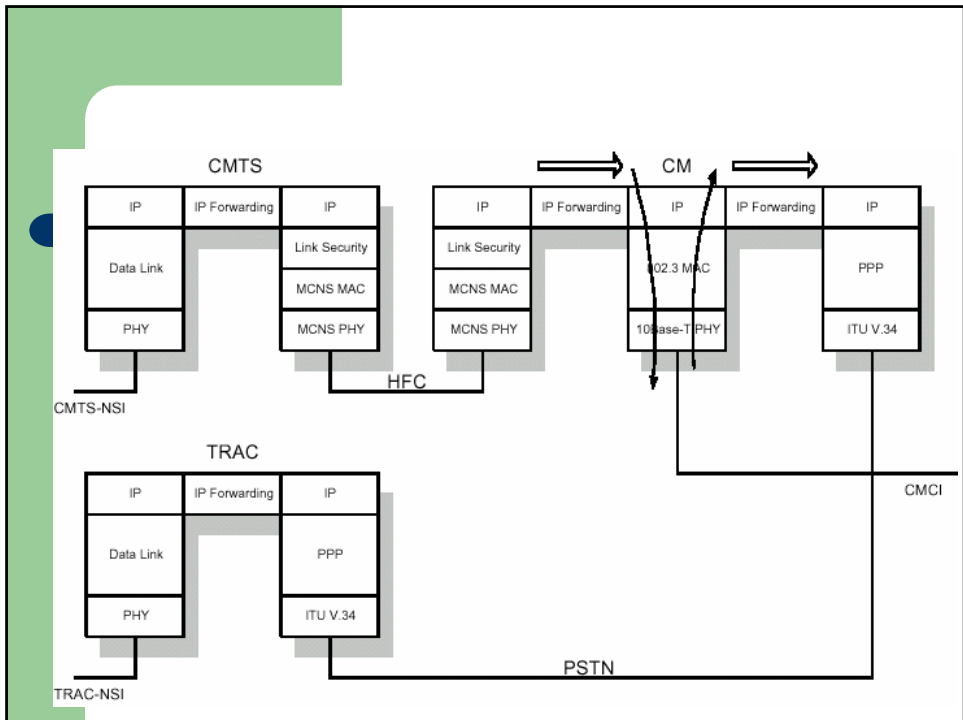
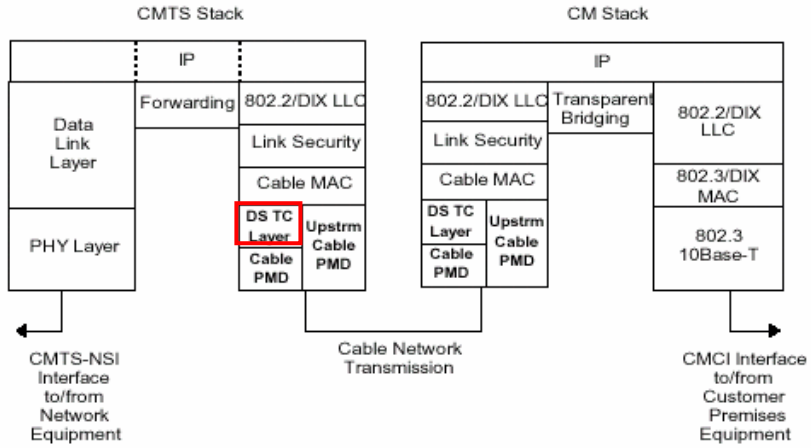
- Define some interfaces:
 - Cable Modem to CPE Interface (CMCI)
 - CMTS Network Side Interface (CMTS-NSI)
 - Baseline Privacy Interface (BPI)
 - ...

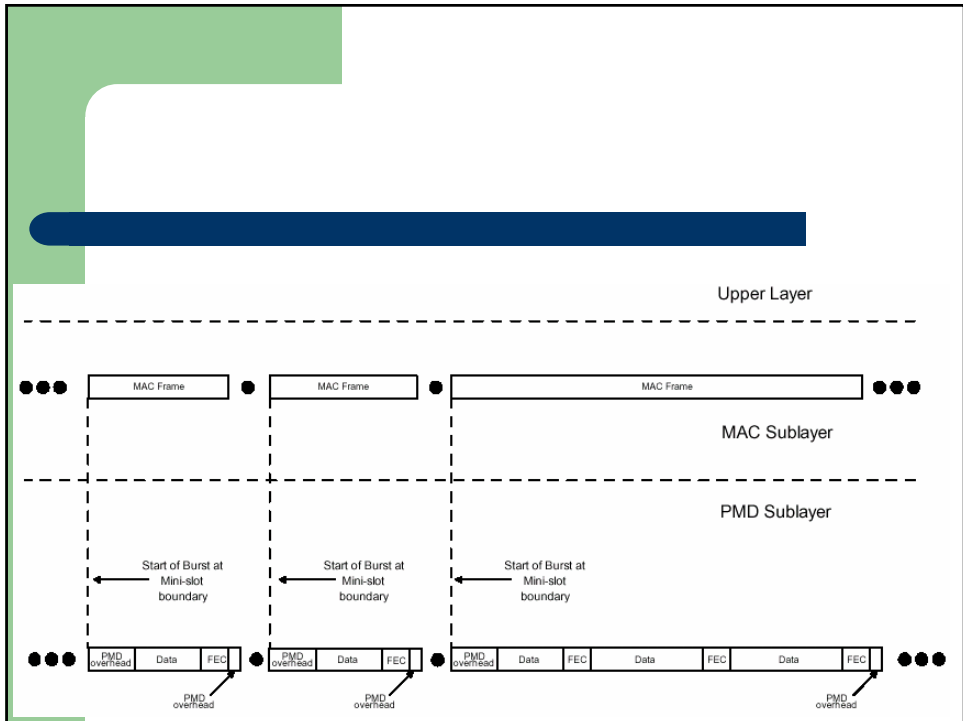
Transmitter



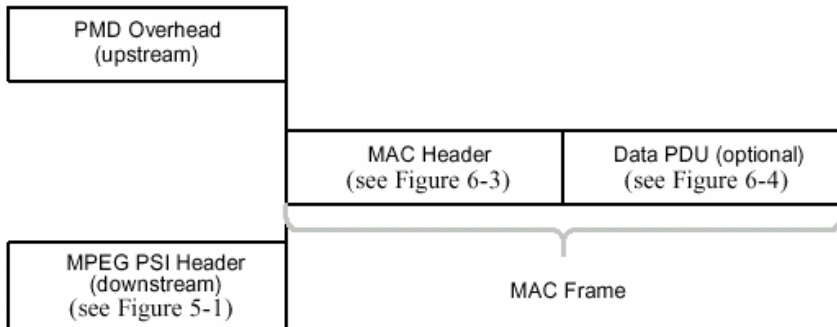
It is a Receiver will take reverse steps.

Protocol





Physical frame structure



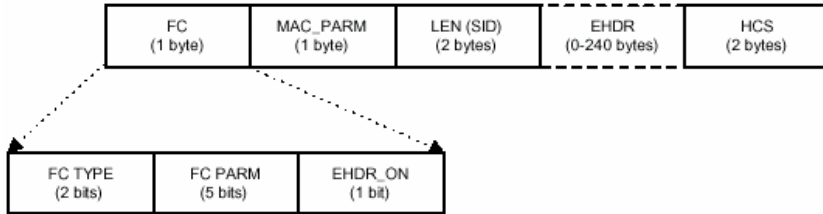
Down stream frame format

- In order to improve demodulation robustness, facilitate common receiving hardware for both video and data, and provide an opportunity for the possible future multiplexing of video and data over the PMD sub-layer bit-stream, a sub-layer is interposed between the downstream PMD sub-layer and the Data-Over-Cable MAC sub-layer.

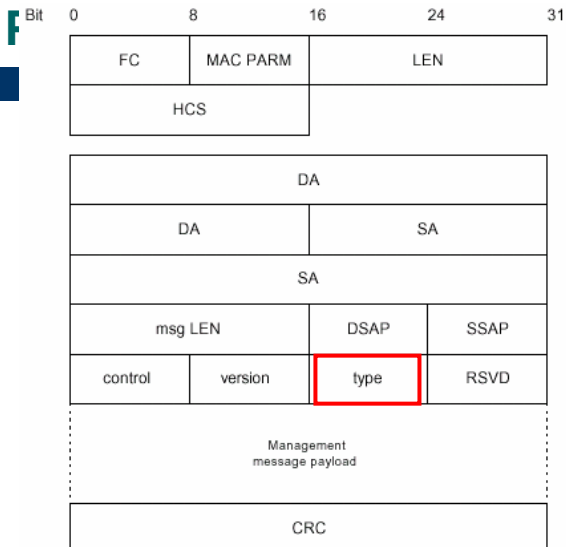
Down stream frame format

- The downstream bit-stream is defined as a continuous series of 188-byte MPEG [ITU-T H.222.0] packets. These packets consist of a 4-byte header followed by 184 bytes of payload. The header identifies the payload as belonging to the Data-Over-Cable MAC.

Mac header



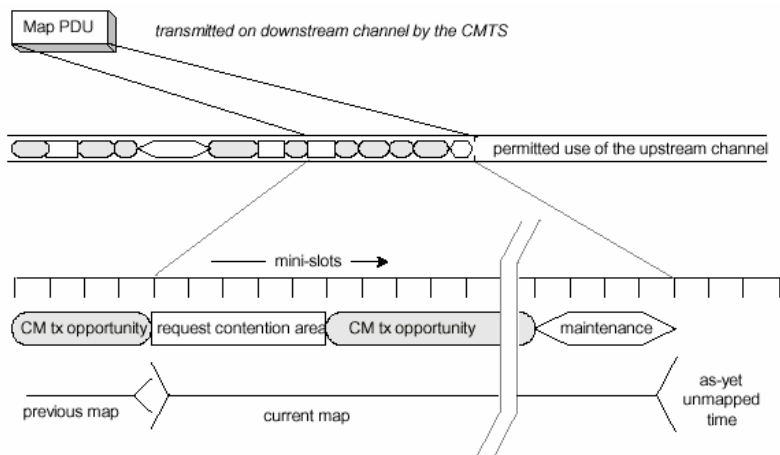
The Frame Control (FC) field is the first byte and uniquely identifies the rest of the contents within the MAC Header.



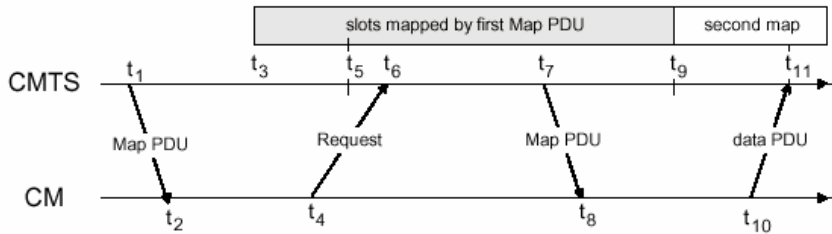
MAC header – message types

Type Value	Version	Message Name	Message Description
1	1	SYNC	Timing Synchronization
2	1	UCD	Upstream Channel Descriptor
3	1	MAP	Upstream Bandwidth Allocation
4	1	RNG-REQ	Ranging Request
5	1	RNG-RSP	Ranging Response

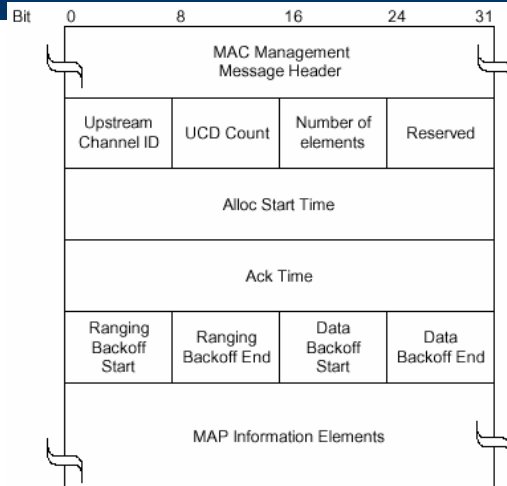
MAP Intro.



MAP example



MAP format



Mini-slot

- A “mini-slot” is the unit of granularity for upstream transmission opportunities.
- 16 bytes/mini-slot (QPSK)
- 25 msec/mini-slot
- 40,000 mini-slots/second
- 2,560,000 symbols/second
- 640,000 bytes/second

Service Identify (SID)

- Each CM has one or more short (14-bit) service identifiers (SIDs) as well as a 48-bit address.
- Four types of SID:
 - 0x0000 – null address, addressed to no station.
 - 0x0001 – 0x1FFF – unicast.
 - 0x2000 – 0x3FFE – multicast.
 - 0x3FFF – broadcast.

MAP IE

IE Name ^a	Interval Usage Code (IUC) (4 bits)	SID (14 bits)	Mini-slot Offset (14 bits)
Request	1	any	Starting offset of REQ region
REQ/Data (refer to Appendix A for multicast definition)	2	multicast	Starting offset of IMMEDIATE Data region (well-known multicasts define start intervals)
Initial Maintenance	3	broadcast ^b	Starting offset of MAINT region (used in Initial Ranging)
Station Maintenance ^c	4	unicast ^d	Starting offset of MAINT region (used in Periodic Ranging)
Short Data Grant ^e	5	unicast	Starting offset of Data Grant assignment; If inferred length = 0, then it is a Data Grant pending.
Long Data Grant	6	unicast	Starting offset of Data Grant assignment; If inferred length = 0, then it is a Data Grant Pending
Null IE	7	zero	Ending offset of the previous grant. Used to bound the length of the last actual interval allocation.
Data Ack	8	unicast	CMTS sets to map length
Reserved	9-14	any	Reserved
Expansion	15	expanded IUC	# of additional 32-bit words in this IE

Rookie

- The Initial Maintenance IE provides an interval in which new stations may join the network. A long interval, equivalent to the maximum round trip time plus the transmission time of the Ranging Request (RNG-REQ) message, must be provided to allow new station to perform initial ranging.

Seeker

- Propagation delays are an order of magnitude larger than the transmission burst time in the upstream.
- Two pieces of information are needed by each cable modem:
 - A global timing reference sent downstream from the CMTS to all cable modem.
 - A timing offset, calculated during a ranging process, for each cable modem

Seeker

- Ranging is the process of acquiring the correct timing offset such that the cable modem's transmission are aligned to the correct mini-slot boundary.
- Once successfully ranged, the cable modem must join normal data traffic in the upstream.

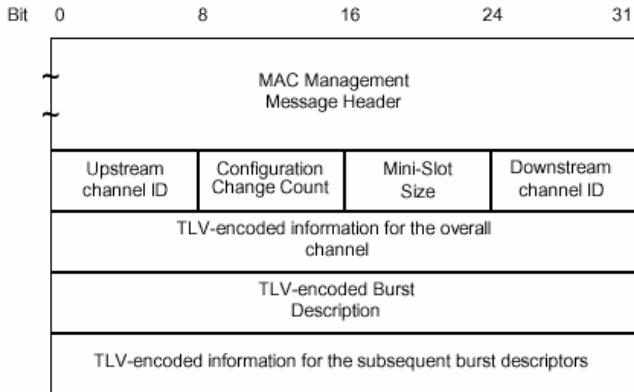
Veteran

- The Station Maintenance IE provides an interval in which stations are expected to perform some aspect of routine network maintenance, such as ranging or power adjustment.

Data Transfer

- The mandatory method of contention resolution which must be supported is based on a truncated binary exponential back-off, with the initial back-off window and the maximum back-off window controlled by the CMTS.
- The value are specified as part of the MAP MAC message.

UCD



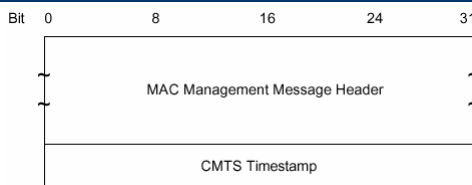
UCD

- An Upstream Channel Descriptor is transmitted by the CMTS at a periodic interval to define the characteristics of an upstream channel.
- **Configuration Change Count:** Incremented by one (modulo the field size) by the CMTS whenever any of the values of this channel descriptor change. If the value of this count in a subsequent UCD remains the same, the CM can quickly decide that the remaining fields have not changed, and may be able to disregard the remainder of the message. This value is also referenced from the MAP.

UCD

- **Mini-Slot Size:** The size T of the Mini-Slot for this upstream channel in units of the Timebase Tick of 6.25 ms. Allowable values are $T = 2^M$, $M = 1, \dots, 7$. That is, $T = 2, 4, 8, 16, 32, 64$ or 128.
- **Upstream Channel ID:** The identifier of the upstream channel to which this message refers. This identifier is arbitrarily chosen by the CMTS and is only unique within the MAC-Sublayer domain.
- **Downstream Channel ID:** The identifier of the downstream channel on which this message has been transmitted. This identifier is arbitrarily chosen by the CMTS and is only unique within the MAC-Sublayer domain.

SYNC



- Time Synchronization (SYNC) is transmitted by CMTS at a periodic interval to establish MAC sub-layer timing.
- The count state of an incrementing 32 bit binary counter clocked with the CMTS 10.24 MHz master clock.

When power on

- Physical Layer Link
 - Scanning and Synchronization to Downstream
 - Obtain Upstream Parameters
 - Ranging and Automatic Adjustments
- Network and above Layer Link
 - Establish IP Connectivity (DHCP)
 - Establish Time of Day
 - Transfer Operational Parameters (TFTP)
 - Registration

Reference

- Data-Over-Cable Service Interface Specifications (DOCSIS), SP-RF1v1.1-I03-991105.