L27 - DQDB

DQDB

Distributed Queued Dual Bus
Metropolitan Area Networks
SMDS

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Agenda

- Introduction
- DQDB Topology
- DQDB Physical Layer
- DQDB Access Control
- DQDB Framing
- MAN
- SMDS/SIP

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MAN/DQDB

- metropolitan area network (MAN) provides
  - integrated services such as data, voice and video
  - high speed transmission of digital bitstreams over a large geographical area
- IEEE 802.6 defines base technology for MAN subnetworks
  - Distributed Queue Dual Bus (DQDB)
  - shared media like a LAN
  - fixed-length packets (cells) like ATM

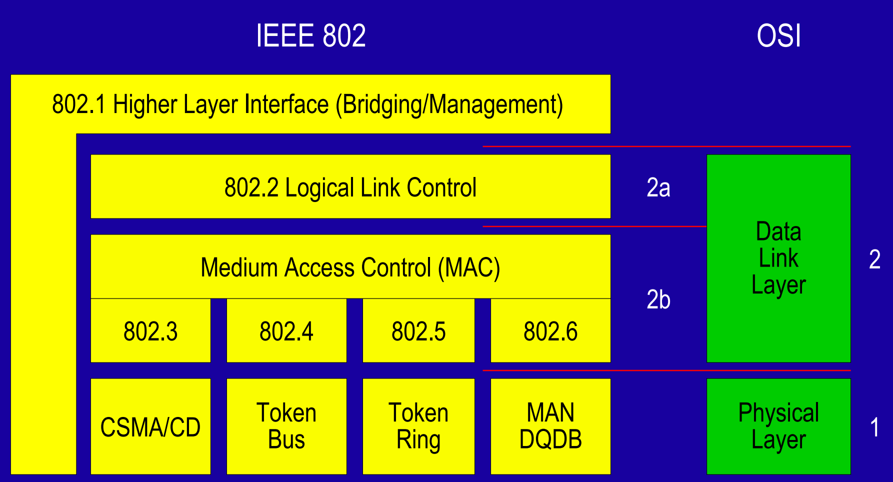
MAN/DQDB

- DQDB subnetwork
  - transmission rate between 1 Mbps and 155 Mbps
  - shared media communication between DQDB nodes located within an area typically up to 50 km in diameter
- usually a public or private MAN consists
  - of several DQDB subnetworks interconnected via bridges, routers or gateways
- therefore MAN service can cover large regions
  - infinite range

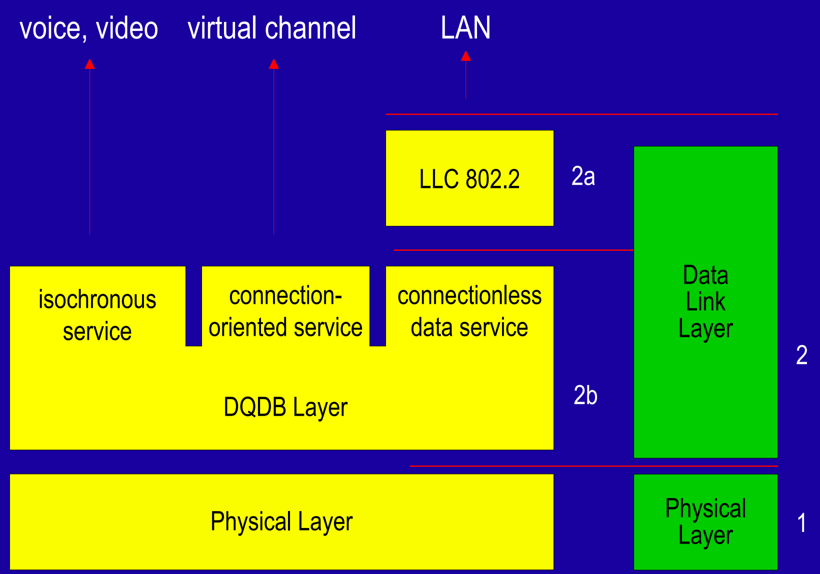
IEEE 802.6 DQDB

- IEEE 802.6 defines two layers
  - DQDB layer (MAC sublayer of OSI layer 2)
  - physical layer specification (OSI layer 1)
- IEEE 802.6 provides three functions
  - connectionless data service
    - MAC service to LLC (Logical Link Control) similar to LAN
    - DQDB plus LLC perform function of data link layer
  - connection-oriented data service
    - asynchronous transport of data over virtual channels
    - no guarantee of constant inter-arrival time for data units
  - isochronous service
    - transport of data with constant inter-arrival time over an isochronous connection (digitized voice or video)

IEEE 802 compared to OSI



IEEE 802.6 Layers and Functions



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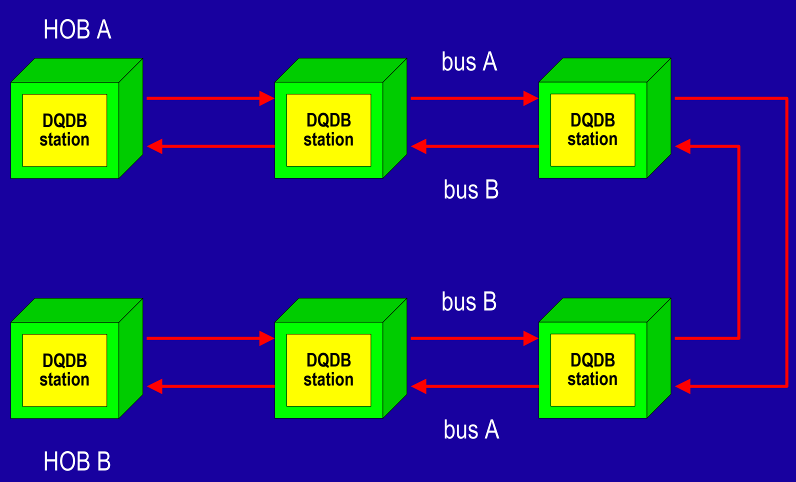
Dual-Bus Architecture

- end systems (DQDB stations) are connected to DQDB subnet
  - via two unidirectional serial buses
    - bus A
    - bus B
- bus A and B support
  - communication in opposite direction
  - full duplex transmission between any pair of stations
- station at the head of bus (HOB)
  - generates fixed-length slots of 53 octets which can carry data between stations
  - HOB A, HOB B

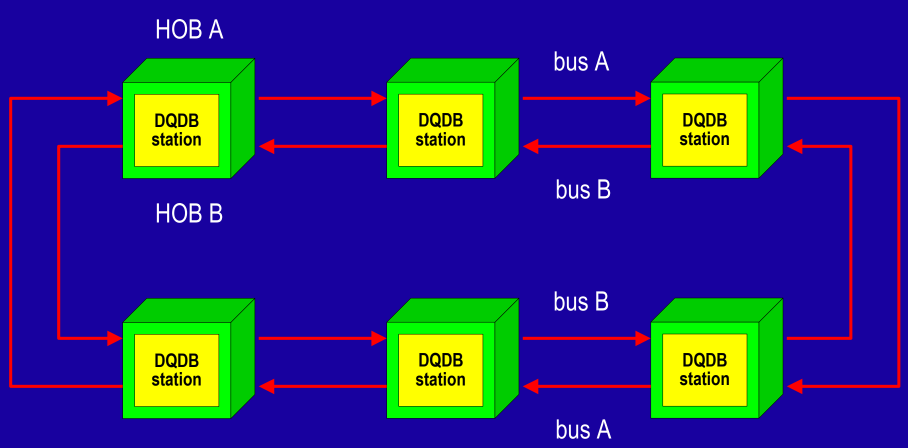
Open Dual-Bus Topology



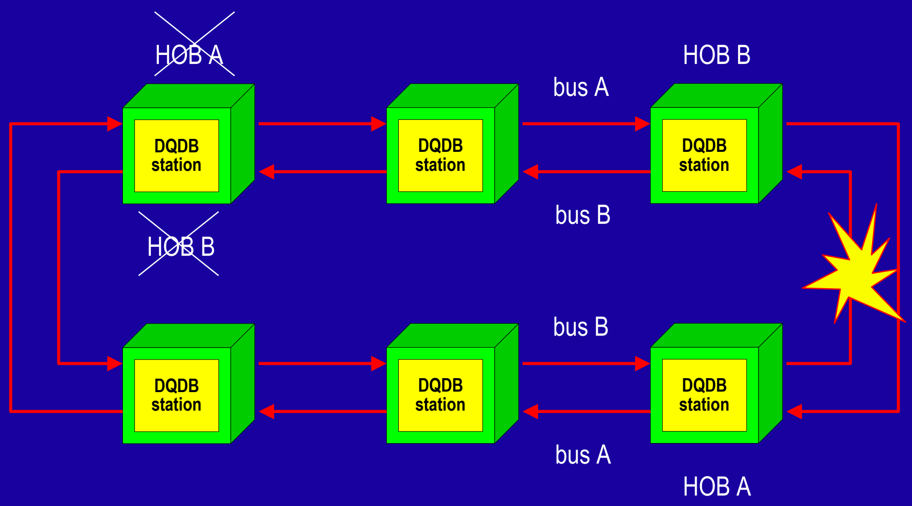
HOB

- HOB A is
  - start of data flow for bus A
  - end of data flow for bus B
- HOB B vice versa
- HOB A and HOB B
  - can be in different stations (open dual-bus topology)
  - can be in the same station (looped dual-bus topology)
- looped topology allows
  - automatic recovery from link failure
  - self-healing

Looped Dual-Bus Topology



Reconfiguration



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Physical Layer Options

- DQDB physical layer contains
  - Physical Layer Convergence Procedure (PLCP)
- PLCP is responsible
  - for adaptation of the capabilities of the transmission system in order to transport DQDB slots (53 octet cells)
- PLCP definitions for
  - DS1 (1.544 Mbps)
  - DS3 (45 Mbps)
  - G.703 E1 (2 Mbps)
  - G.703 E3 (34 Mbps)
  - G.703 E4 (140 Mbps)
  - G.707-9 (155 Mbps)

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Access Control

- DQDB allows two access methods
  - pre-arbitrated (PA)
    - used by isochronous service
  - queued-arbitrated (QA)
    - used by data services
- PA
  - for every isochronous connection a unique channel identifier is assigned by network management in advance
    - VCI (virtual channel identifier) field in cell header
  - HOB generates PA-cells with this VCI periodically
    - to satisfy timing constraints of isochronous connection
  - stations can use PA-cells with this VCI value
    - to transmit isochronous traffic across the network

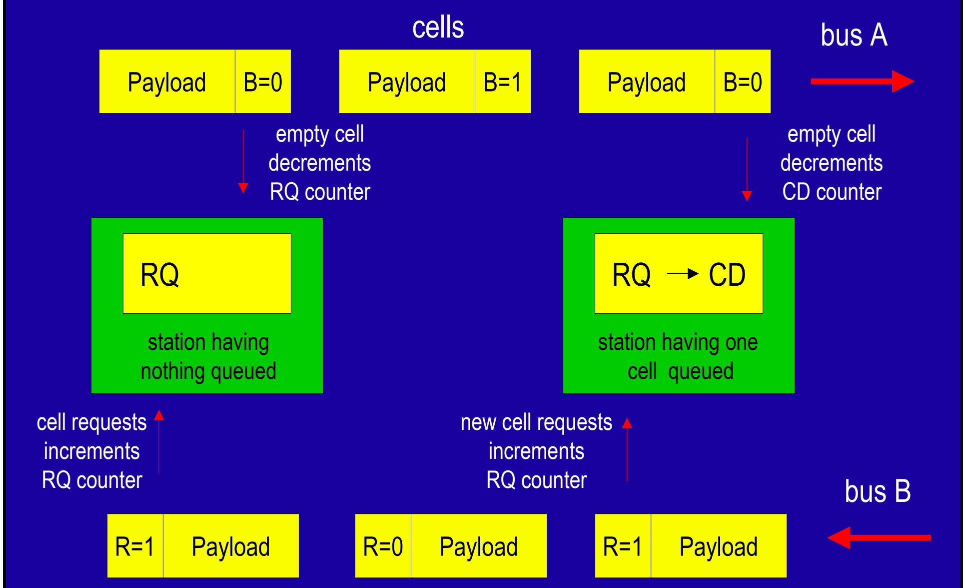
Access Control

- QA
  - controlled by distributed queuing protocol
- distributed queuing
  - each stations has explicit information about queuing state of the network
  - queuing state means, how many cells are waiting for transmission in all stations of the network
  - implemented by special bits in the cell header and counters within the station
    - busy-bit B, request bit R in access control field (ACF)
    - request counter RQ
    - countdown counter CD

Distributed Queuing Protocol

- handling of B-bit and R-bit
  - B and R bits in header of each cell
  - B = 0 ... empty cell, may be used by station for transmission downstream if access control does allow
  - if empty cell is used by a station, B is set to 1 on the fly and payload is filled
  - B = 1 ... busy cell, cannot be used by a downstream station
  - R = 1 ... cell contains a request of an upstream station, cannot be used by another station for signaling request
  - R = 0 ... cell does not contain a request of an upstream station, will be set on the fly by station signaling a request for a cell to downstream stations

Handling of RC and CC Counters



Access Control

- basic access principle
    - explained for access to bus A only (bus B vice versa)
  - if station wants to transmit a cell on bus A
    - 1.) R-bit set to 1 in a cell on bus B to indicate the request
      must wait for a cell with R-bit equal 0 in order to do this
    - 2.) count value of RQ is copied to CD
    - 3.) RQ is reset
    - actual state of distributed queue is frozen
  - station can use a empty cell on bus A
    - if CD counter has already reached zero and an empty cell arrives
  - this procedure guarantees
    - that every station will satisfy current station requests (cells waiting for transmission in station buffers) first before a cell can be sent
    - cell to be sent is queued in distributed queue

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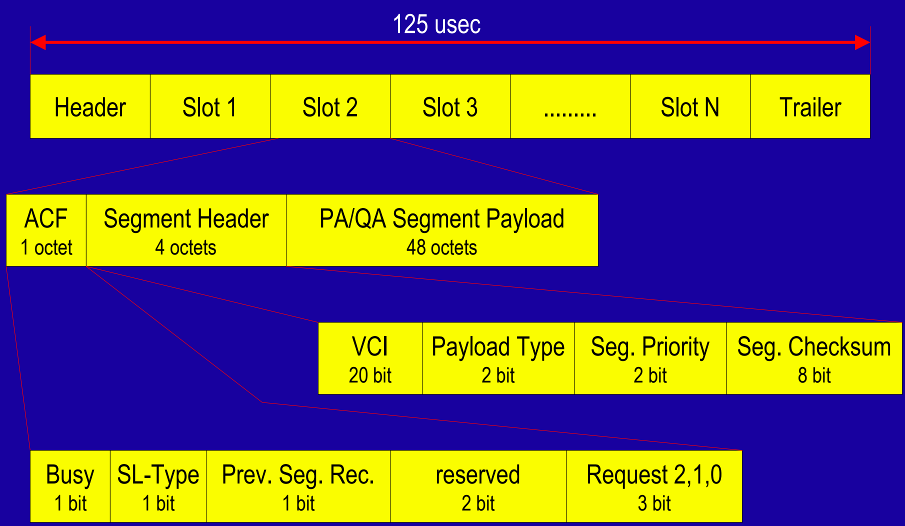
DQDB Framing



ACF, Segment Header

- ACF ... Access Control Field
  - Busy (0 ... slot empty, 1 ... slot contains information)
  - SL-Type ... Slot Type (0 ... QA, 1 ... PA)
  - Busy = 0 and SL-Type = 1 reserved
  - Previous Segment Cleared (1 ... clear)
  - Request 2, 1, 0 ... request (R) bits for three priority levels
- Segment Header Field
  - VCI ... Virtual Channel Identifier
    - set to all ones fur QA (connectionless service)
    - identifies isochronous channel for PA
  - Payload Type (00 ... user data, other values reserved for further study)
  - Segment Priority (set to 00, other values reserved for multiport bridging)
  - Segment Header Checksum (x8 + x2 + x +1)

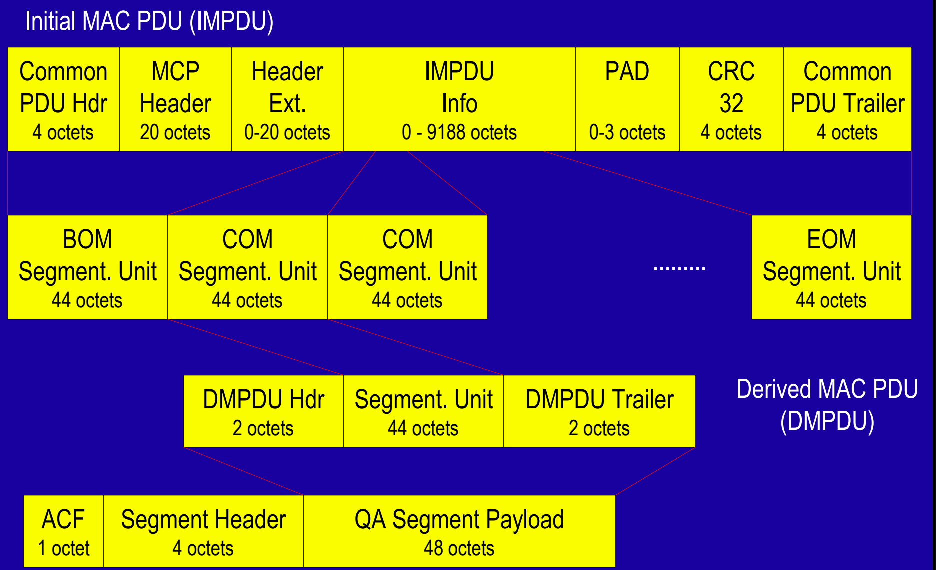
MAC Convergence Function

- basic DQDB framing is not sufficient for connectionless service
  - cell or slot contains no address information about source or destination (VCI = all ones !!!)
- MAC convergence function is necessary
  - to offer to the LLC layer normal MAC datagram functionality
  - to allow transport of variable length LLC packets over DQDB
    - segmenting of LLC PDU into cells
    - reassembling of cells to original LLC PDU

MAC Convergence Function

- MAC convergence function
  - takes MAC service data unit of LLC layer (0 - 9188 octets)
  - builds a so called Initial MAC Protocol Data Unit (IMPDU)
    - header contains information about source and destination, length of PDU, protocol type, QoS, Begin TAG; trailer contains End TAG, CRC, padding
  - splits IMPDU in segmentation units (44 octets), adds header to form a Derived MAC PDU (DMPDU)
    - header contains sequence number, type (BOM, COM, EOM) and message ID of segmentation unit; trailer contains checksum of segmentation unit
  - finally DMPDU (48 octets) fits in the QA Segment Payload of a slot

Mapping IMPDU/DMPDU/QA Segment



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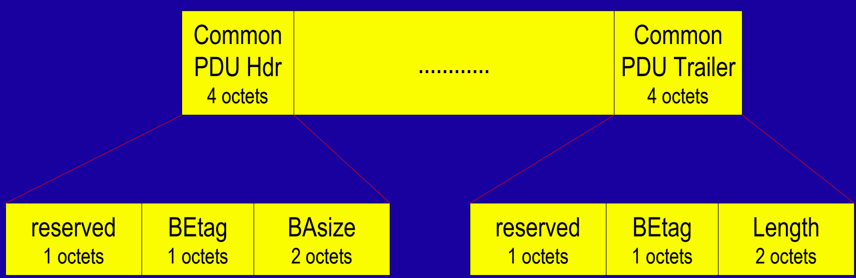
IMPDU Fields



reserved ... set to zero for transfer of IMPDU

BE (Beginning-End) tag ... value selected by MAC convergence function to allows association of the BOM DMPDU with EOM DMPDU

BA (Buffer Allocation) size = Length ... number of octets MCP Header -> CRC32

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IMPDU Fields

Common PDU Hdr 4 octets	MCP Header 20 octets	....	Common PDU Trailer 4 octets

Destination Address 8 octets	Source Address 8 octets	Protocol Identifier 6 bits	Pad Length 2 bits	QoS Delay 3 bits	QoS Loss 1 bits	CRC32 Indic. 1 bits	Hdr. Ext. Length 3 bits	Bridging reserved 2 octets

Address Type 4 bits	Address 60 bits

0100 = 16 bit address
1000 = 48 bit address (IEEE 802 MAC)
1100 = 60 bit address, individual, public (E.164)
1110 = 60 bit address, group, public (E.164)
1101 = 60 bit address, individual, private
1111 = 60 bit address, group, private

source addresses can be individual only, mapping of 16 or 48 bit addressing in 56 bit done by padding remaining bits (left to right), assignment of E.164 addresses (country code) is administered by CCITT according to Numbering Plan for the ISDN Era
E.164 uses decimal numbers encoded using BCD starting with 0xC (individual) or 0XE (group)

IMPDU Fields

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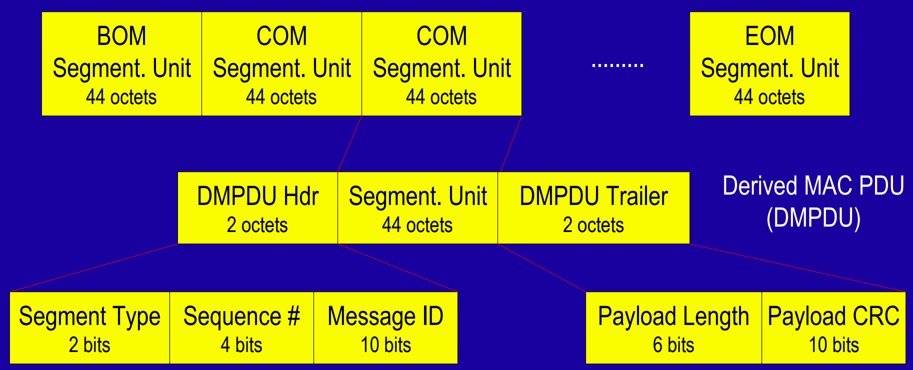
Protocol Identifier ... set to 1 for LLC, 48-63 available for use of local administration, other values reserved for future standardization by IEE 802.6
Pad Length ... (0-3) number of Pad octets after INFO; INFO plus PAD must be an integral multiple of four octets
QoS Delay ... contains priority bits (7 ... shortest, 0 ... longest delay)
QoS Loss ... reserved (set to zero)
CRC32 Indication ... indicates presence or absence of CRC32 checksum field
Header Extension Length ... length of Header Extension field (multiple of four octets)
Bridging ... reserved for future use with MAC Sublayer bridging (set to zero)

DMPDU Fields



Segment Type ... 00 Continuation of Message (COM), 01 End of Message (EOM)
10 Begin of Message (BOM), 11 Single Segment Message (SSM)

Sequence # .... sequence number of DMPDU, used for reassembling IMPDU

Message ID .... identifies all DMPDUs of original IMPDU using the same value;
(every station is assigned a unique identifier by DQDB layer management, which is used as message ID; like TEI in ISDN)

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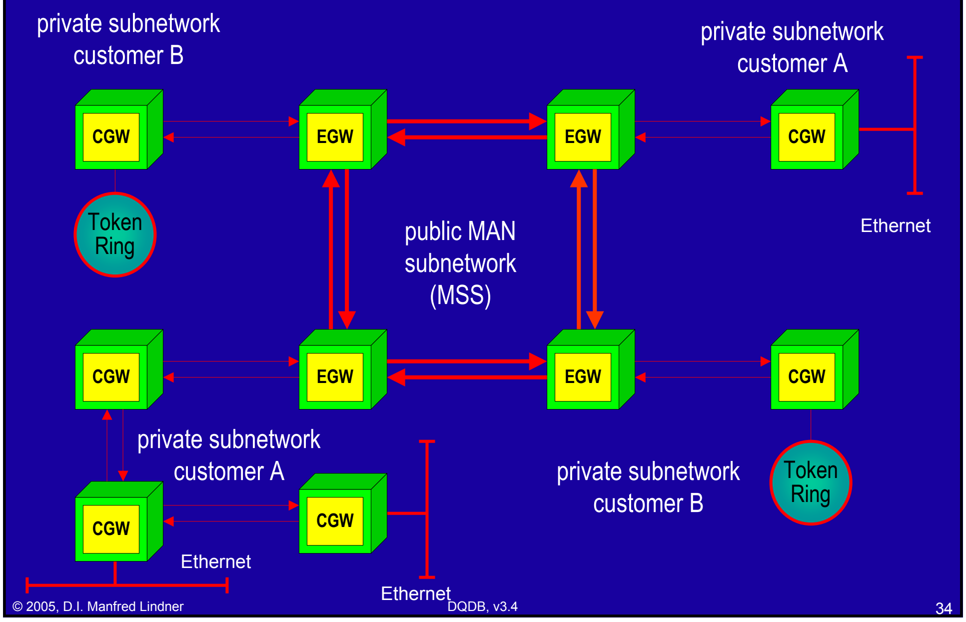
MAN Hierarchy

- MAN is based on DQDB subnetworks
- DQDB subnetworks are shared media
- privacy problem if DQDB subnetworks should offer a public transport service to different customer
- therefore public MAN services
  - are built on hierarchical network topology
  - central public DQDB subnetwork to interconnect edge gateways (EGW)
  - several independent private DQDB subnetworks with customer gateways (CGW) as access stations
  - private DQDB subnetworks are used by one customer only and are connected to EGW

MAN Hierarchy (EGW/CGW)



MAN Hierarchy (EGW/CGW)

- CGW
  - customer networks such as LAN´s, Frame Relay are connected to CGW which provides normal bridging or routing functionality over MAN
  - several CGWs can form a private DQDB subnetwork in order to connect different locations (e.g. campus)
  - private DQDB subnetwork is controlled by customer
  - small customer locations can be connected EGW directly to avoid high cost of CGW
    - point-to-point link between router and EGW
      - SMDS interface protocol (SIP)
      - DXI Data Exchange Interface (DXI)
      - SMDS DSU ("DQDB modem")

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MAN Hierarchy (EGW/CGW)

- EGW
  - is responsible to provide security and privacy to customer using MAN transport services
  - is controlled by service provider only
  - works as transparent bridge between private and public DQDB subnetworks
    - store and forward device (IMPDU packet switch with connectionless service)
    - transparent bridging based on E.164 addresses
  - privacy guaranteed by EGWs
    - filtering functions of transparent bridge
    - mapping of customers broadcasts to customer specific E.164 group/multicast addresses

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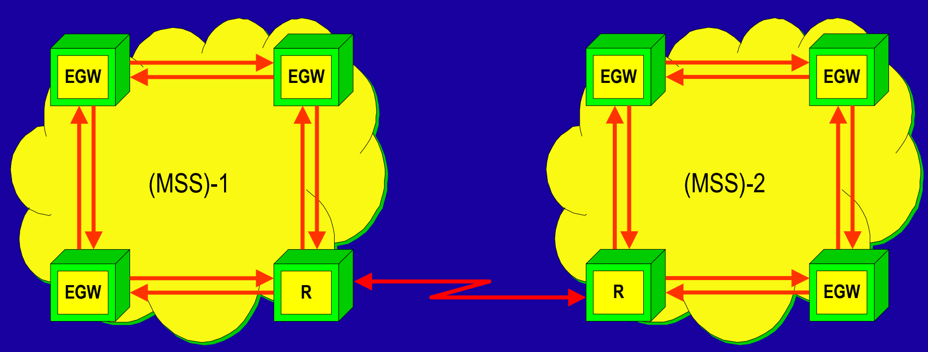
MSS

- public DQDB network
  - consists of EGWs and DQDB trunk lines
  - MSS (MAN Switching System)
- countrywide public MAN service
  - can be built by interconnection of MSSs
  - done by DQDB routing functionality

Interconnection of MSS



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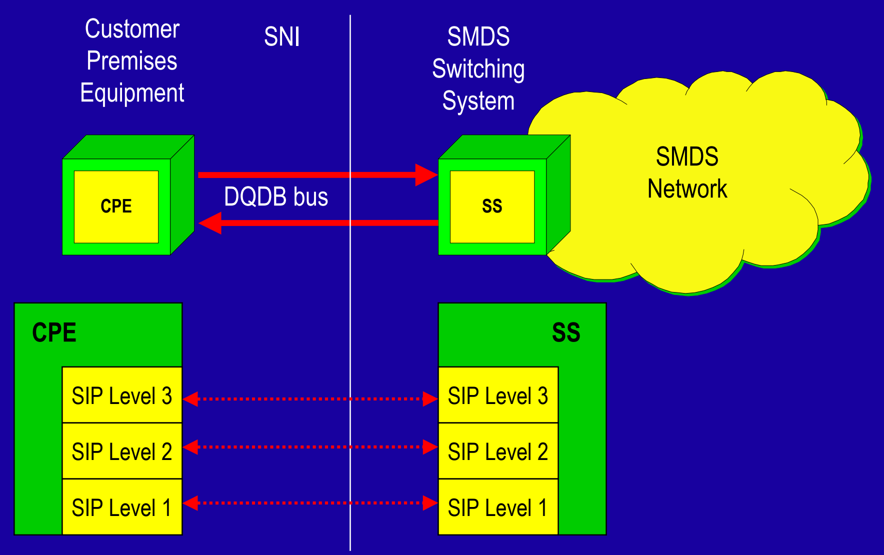
SMDS

- Switched Megabit Digital Service
  - high-speed, connectionless, public packet switching service to extend LAN-like performance beyond the subscribers premises across a MAN or WAN
- SMDS is broadband networking technology developed by Bellcore
  - subset of IEEE 802.6; access to SMDS via DQDB
  - specifies interfaces and protocols to be used between user and SMDS provider
    - SNI (Subscriber Network Interface)
    - SIP (SMDS Interface Protocol) based on DQDB
  - internal implementation of SMDS different to 802.6

SMDS SNI/SIP



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SIP

- SIP Level 3
  - format the same as for IMPDU of DQDB
  - variable frame length 0 - 8199 octets
- SIP Level 2
  - consists of DMPDU plus segment header and trailer
  - 53 octets cells
- SIP Level 1
  - defines PLCP for DS1 (1.544 Mbps), DS3 (45 Mbps)

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DXI

- to allow easy upgrade of existing equipment such as bridges or routers to DQDB/SMDS
  - DXI (Data Exchange Interface) protocol was defined
- DXI allows
  - communication between CPE (router) and DSU using normal serial interface technology and HDLC like framing
    - use of HDLC address field, UI and Test frames only
  - router is responsible for creating SIP Level 3 IMPDU
  - router will carry IMPDU´s in HDLC frames to DSU
  - DSU will provide splitting of IMPDU into DMPDUs and generating of DQDB cells in order to transmit DMPDUs

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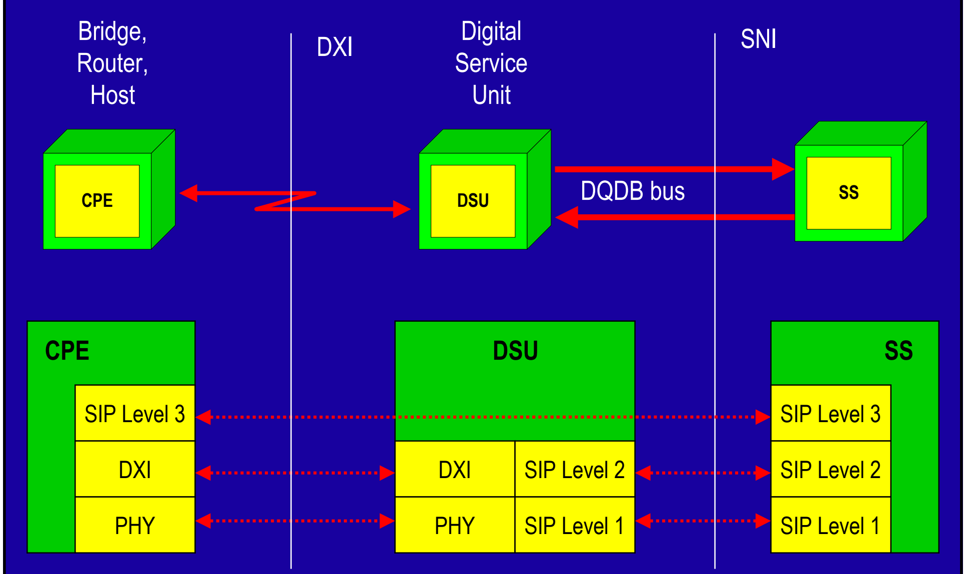
DXI



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Summary

- DQDB (IEEE 802.6) is base technology for MAN
- three services
  - connectionless data (LAN-LAN)
  - connection oriented data (virtual channel)
  - isochronous (voice, video)
- dual-bus shared media
- access control by distributed queuing protocol
- data services need convergence functions
  - to assemble and reassemble packets into DQDB cells
- SMDS service description
  - based on IEEE 802.6, connectionless only, SIP, DXI

