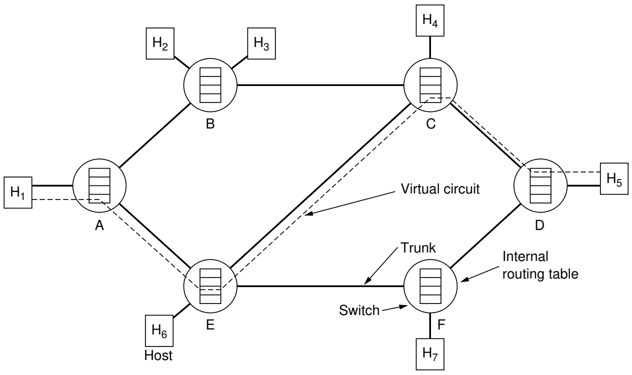
ATM: Virtual circuits

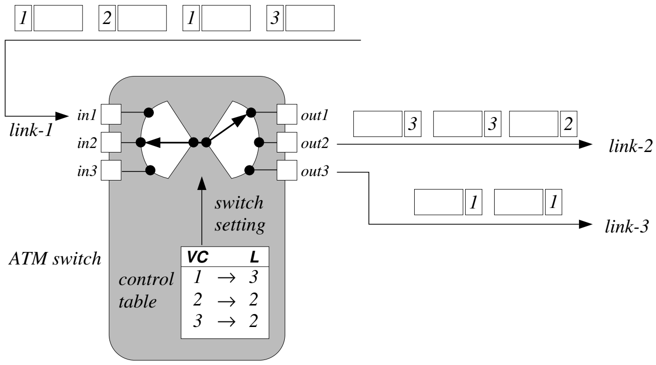
ATM services are built around the concept of **virtual circuit**: A full connection is set up between sender and receiver, but is implemented through packet switching.



ATM Technology

Basic idea: we transfer very small packets, called **cells** and maintain the order of their transmission.

An ATM switch keeps a table in which it records to which outgoing link an incoming cell should be routed. Setting up a connection implies setting the right table entries from the sender to the receiver.

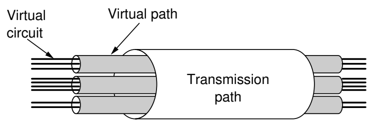


ATM Network

Controversy: ATM works at a relatively low level (i.e. it seems to be a datalink protocol), but includes a lot of routing aspects (i.e. functions as many network routers).

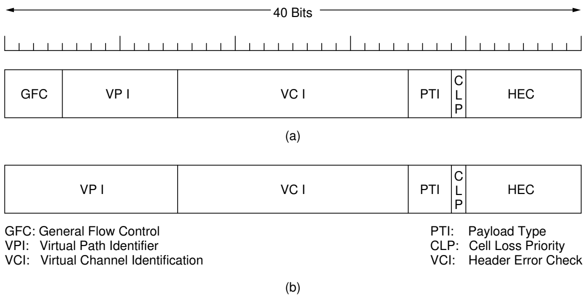
Reminder: ATM is essentially packet-switched network technology that offers virtual circuits (channels) to its users. Routing decisions are taken by the switches.

Note: ATM networks do not guarantee reliability (cells may be dropped), but do guarantee that cells in the same virtual channel are delivered in the order they were sent. Channels are grouped together into virtual paths.



ATM Cell Headers

Really useful(?): ATM makes a distinction between user–network interfaces and network–network interfaces: (*"The best way to think of [the GFC field] is as a bug in the standard."*)



VPI: virtual path identifier (is used for routing).

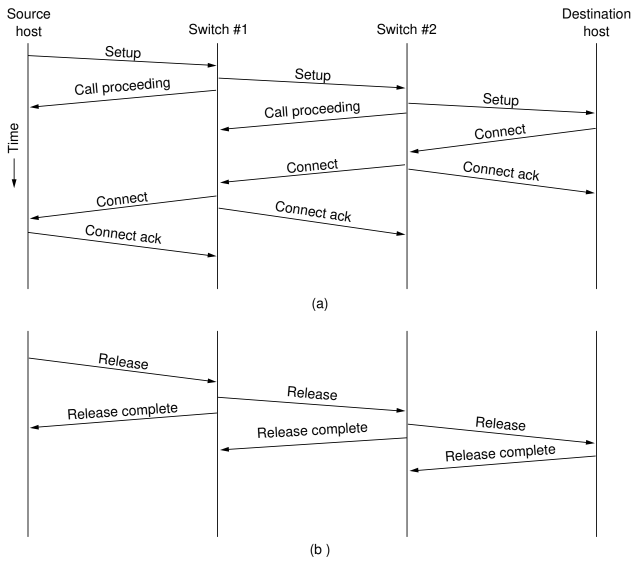
VCI: virtual channel identifier (channel within a path).

PTI: identifies the kind of data the cell carries.

CLP: discard CLP=1 cells first before the CLP=0 cells.

HEC: checksum over the header. There is no checksum over the data.

Connection Setup

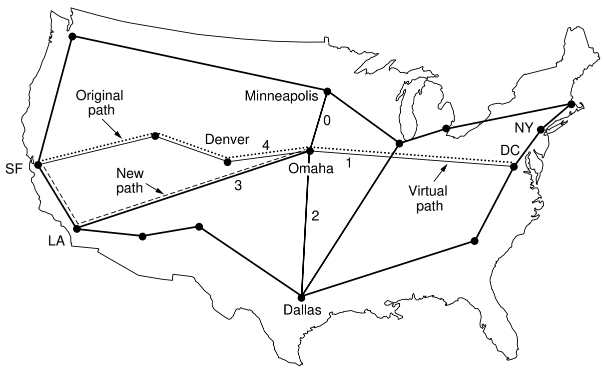


Note: Normally, we first acquire a special virtual circuit for setting up a connection (called a signaling channel). That circuit is then used for the full setup and release.

Routing and Switching

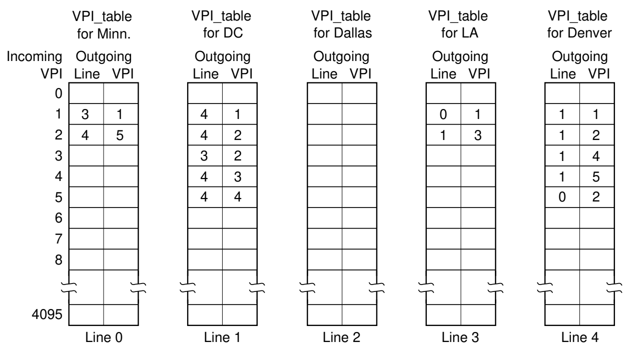
Basic idea: Don't route on channels, but only on paths. Channels are used only for routing at the user–network interface. Because a VPI is 12 bits, routing tables can be kept small ($2^{12} = 4096$ entries at the most).

Note: ATM networks have been primarily designed as WAN backbones. Presumably, we don't have that many paths anyway. Big advantage: rerouting channels can be done in chunks.



Routing and Switching II

Src	Line in	VPI in	Dst	Line out	VPI out	Path
NY	1	1	SF	4	1	New
NY	1	2	Denver	4	2	New
LA	3	1	Minn.	0	1	New
DC	1	3	LA	3	2	New
NY	1	1	SF	4	1	Old



Service Categories

Basic idea: If you know the kind of traffic that is going through your network, it is possible to optimize switching technology for specific classes. ATM distinguishes five categories:

- Constant Bit Rate (CBR): emulate copper wire (i.e. no switching, flow control, etc.)
- Real Time Variable Bit Rate (RT-VBR): real-time videoconferencing. Goal is to keep jitter to a minimum.
- Non-Real Time Variable Bit Rate (NRT-VBR): multimedia email, and other applications that can be buffered first before delivery (thus reducing jitter).
- Available Bit Rate (ABR): designed for bursty, predictable traffic, such as browsing the Web, or office network traffic (having rush hours). The idea is you get a guaranteed average capacity, and some more when needed.
- Unspecified Bit Rate (UBR): no guarantees whatsoever, and not even feedback when things go wrong (cells are just discarded). Good for file transfers: lost datagrams can easily be handled at the application level.

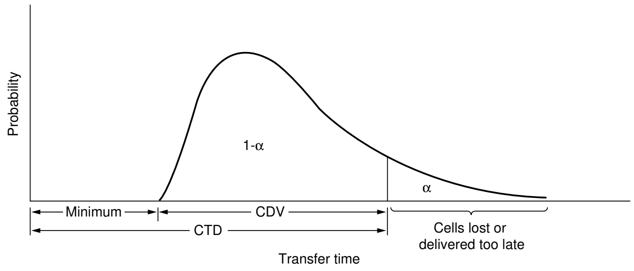
Quality of Service

Basic idea: ATM is supposed to support a wide range of applications. This requires that an application (user) and the network (carrier) should be able to *negotiate* a quality of service:

- **Peak cell rate** (PCR): Maximum rate at which cells will be sent.
- **Sustained cell rate** (SCR): Long-term average cell rate. Note that PCR/SCR is a measure for burstiness.
- **Minimum cell rate** (MCR): Minimum number of cells/sec. that user finds acceptable. Note that with ABR, the actual bandwidth must always lie between MCR and PCR.
- **Cell variation delay tolerance** (CVDT): Maximum acceptable cell jitter. Can be controlled using a leaky bucket algorithm.
- **Cell loss ratio** (CLR): Fraction of lost cells, or cells delivered too late.

Quality of Service – cnt'd

- **Cell transfer delay** (CTD): How long does delivery take, measured in mean and maximum.
- **Cell delay variation** (CDV): The variance in cell delivery times.



ATM Traffic Shaping and Policing

Problem: We need a way to enforce the QoS parameters. One general way of doing this is to check whether PCR and CVDT are within the negotiated limits $\Rightarrow$ **generic cell rate algorithm**.

Basic idea: We introduce an expected next time for a successive cell, based on periodic behavior with period $T = 1/PCR$. Also, we introduce a border time $L < T$ in which the next transmission may start, but never before $T - L$.

A nonconforming cell may be discarded, or its CLP bit may be set to 1 so that it may be discarded when congestion starts.

ATM Traffic Shaping and Policing II