ATM Logical Connections

ATM is a packet-oriented transfer mode. It allows multiple logical connections to be multiplexed over a single physical interface. The information flow on each logical connection is organized into fixed-size packets called cells. Logical connections in ATM are referred to as virtual channel connections (VCCs). A VCC is analogous to a virtual circuit; it is the basic unit of switching in an ATM network. A VCC is set up between two end users through the network, and a variable-rate, full-duplex flow of fixed-size cells is exchanged over the connection. VCCs are also used for user–network exchange (control signaling) and network–network exchange (network management and routing).

For ATM, a second sublayer of processing has been introduced that deals with the concept of virtual path. A virtual path connection (VPC) is a bundle of VCCs that have the same endpoints. Thus, all of the cells flowing over all of the VCCs in a single VPC are switched together. The virtual path concept was developed in response to a trend in high-speed networking in which the control cost of the network is becoming an increasingly higher proportion of the overall network cost. The virtual path technique helps contain the control cost by grouping connections sharing common paths through the network into a single unit. Network management actions can then be applied to a small number of groups of connections instead of a large number of individual connections.

Several advantages can be listed for the use of virtual paths:

• **Simplified network architecture:** Network transport functions can be separated into those related to an individual logical connection (virtual channel) and those related to a group of logical connections (virtual path).

• **Increased network performance and reliability:** The network deals with fewer, aggregated entities.

• **Reduced processing and short connection setup time:** Much of the work is done when the virtual path is set up. By reserving capacity on a virtual path connection in anticipation of later call arrivals, new virtual channel connections can be established by executing simple control functions at the endpoints

of the virtual path connection; no call processing is required at transit nodes. Thus, the addition of new virtual channels to an existing virtual path involves minimal processing.

• **Enhanced network services:** The virtual path is used internal to the network but is also visible to the end user. Thus, the user may define closed user groups or closed networks of virtual channel bundles.

Virtual Path/Virtual Channel Characteristics ITU-T Recommendation I.150 lists the following as characteristics of virtual channel connections:

• **Quality of service (QoS):** A user of a VCC is provided with a QoS specified by parameters such as cell loss ratio (ratio of cells lost to cells transmitted) and cell delay variation.

• **Switched and semipermanent virtual channel connections:** A switched VCC is an on-demand connection, which requires a call control signaling for setup and tearing down. A semipermanent VCC is one that is of long duration and is set up by configuration or network management action.

• **Cell sequence integrity:** The sequence of transmitted cells within a VCC is preserved.

• **Traffic parameter negotiation and usage monitoring:** Traffic parameters can be negotiated between a user and the network for each VCC. The network monitors the input of cells to the VCC to ensure that the negotiated parameters are not violated.

The types of traffic parameters that can be negotiated include average rate, peak rate, burstiness, and peak duration. The network may need a number of strategies to deal with congestion and to manage existing and requested VCCs. At the crudest level, the network may simply deny new requests for VCCs to prevent congestion. Additionally, cells may be discarded if negotiated parameters are violated or if congestion becomes severe. In an extreme situation, existing connections might be terminated.

I.150 also lists characteristics of VPCs. The first four characteristics listed are identical to those for VCCs. That is, QoS; switched and semi permanent VPCs; cell sequence integrity; and traffic parameter negotiation and usage monitoring are all also characteristics of a VPC. There are a number of reasons for this duplication. First, this provides some flexibility in how the network service manages the requirements placed upon it. Second, the network must be concerned with the overall requirements for a VPC, and within a VPC may negotiate the establishment of virtual channels with given characteristics. Finally, once a VPC is set up, it is possible for the end users to negotiate the creation of new VCCs. The VPC characteristics impose a discipline on the choices that the end users may make. In addition, a fifth characteristic is listed for VPCs:

Virtual channel identifier restriction within a VPC: One or more virtual channel identifiers, or numbers, may not be available to the user of the VPC but may be reserved for network use. Examples include VCCs used for network management.

Control Signaling In ATM, a mechanism is needed for the establishment and release of VPCs and VCCs. The exchange of information involved in this process is referred to as control signaling and takes place on separate connections from those that are being managed. For VCCs, I.150 specifies four methods for providing an establishment/release facility. One or a combination of these methods will be used in any particular network:

1. Semipermanent VCCs may be used for user-to-user exchange. In this case, no control signaling is required.

2. If there is no preestablished call control signaling channel, then one must be set up. For that purpose, a control signaling exchange must take place between the user and the network on some channel. Hence we need a permanent channel, probably of low data rate, that can be used to set up VCCs that can be used for call control. Such a channel is called a meta-signaling channel, as the channel is used to set up signaling channels.

3. The meta-signaling channel can be used to set up a VCC between the user and the network for call control signaling. This user-to-network signaling virtual channel can then be used to set up VCCs to carry user data.

4. The meta-signaling channel can also be used to set up a user-to-user signaling virtual channel. Such a channel must be set up within a preestablished VPC. It can then be used to allow the two end users, without network intervention, to establish and release user-to-user VCCs to carry user data.