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**ECE 535 Satellite Communications**

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Module # 11-1: Asynchronous Transfer Mode Satellite Services

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## Asynchronous Transfer Mode Satellite Services

Networks link devices in various form factors for intercommunications using voice, data, video, and images. The Internet is a mixture of signals that can be connected by a method known as asynchronous transfer mode (ATM). Multiple factors underline the rigidity and quality of an ATM network protocol when used with a satellite service. The use of networks with satellites in low earth orbit (LEO), medium earth orbit (MEO), and geostationary earth orbits (GEO) can utilize ATM protocol for interconnectivity. Using satellite ATM networks provides networking to areas where existing terrestrial networks are infeasible or impractical.

In ATM networks, user information, described as packets or cells, does not need to be transmitted periodically. This is the asynchronous aspect of the ATM network and typically uses small cells within the protocol. Cells have a 48-byte payload and a 5-byte header through a virtual circuit (J. Ivanova). The physical layer, or the lowest layer, deals with the bit timing. Due to the asynchronous nature of the protocol, the physical medium layer, controls the bit timing for receiving the signals. The upper layer, or the transmission convergence sublayer, frames the bit stream with packed cells. The receiver of the bit stream can unpack the frame and identify the boundaries of the cells. Table I defines the ATM network layers and their designations in the stack.

**TABLE I**  
ATM Network Layers

Level	Layer	Usage(s)	Sublayer	Designation
Upper	ATM Adaption Layer	<ul style="list-style-type: none"><li>• Convergence</li><li>• Segmentation and Reassembly</li></ul>	AAI-1	Constant Bit Rate (CBR) Applications.
				Voice/Data sent over circuit facilities, with 48 octets (47 used for payload, one used for overhead)
			AAI-2	Variable Bit Rate (VBR) Applications
				Video/voice with compression, with 48 octets used (45-47 payload, 1-3 overhead)
			AAI-3/4	Connectionless VBR data Application
				Data can be sensitive to loss but not delay
			AAI-5	Connection-oriented VBR data Applications
				There is no overhead, so the payload makes use of available 48 octets.
			AAI-0	Null Adaption Layer for information already assembled in cell format.
Mid	ATM Layer	<ul style="list-style-type: none"><li>• Flow Control</li></ul>	Cell Header Control	Cell path/channel Identifiers (VPI/VCI) Cell multiplex/demultiplex

Lower	Physical Layer	• Transmission Convergence Sublayer	Cell rate decoupling	Bit Timing, header error control, cell delineation, framing
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ATM networks can generally use public and private connections for subscribers. Subscribing to a public or private network typically consists of choosing an interface best suited for the individual or organization. User network interfaces (UNI) can be public or private and exist at the subscriber's entry point. Network Node Interface (NNI) interfaces between public or private nodes. Network network interfaces (NNI) utilize a network-node or network-network interface to join two private networks, as PNNI indicates.

In addition to the various types of connectivity to the ATM network, a virtual path can be set up permanently. Switching identifiers on the path do not change and are available for use as required. These are permanent virtual circuits (PVC). Switched virtual circuits (SVC) are connections where the users disconnect when the transfer is finished and need a new connection if required.

For the radio frequency bandwidth, ATM can provide bandwidth on demand. This flexible bandwidth allocation is directly related to the bit rate needed and the capability to maximize the digital bits supported over the speed of the link. Cells can be distributed over multiple channels, which are multiplexed into the ATM transmission. This allows the cells to be packed into frames and sent synchronously to users. A quality of service (QoS) is defined within the flexible bandwidth, which can assess a user's tolerance to delay versus sensitivity to data loss. The QoS determines the bit rate and the performance available.

When ATM networks are utilized in satellite services instead of terrestrial ground stations, delay, and jitter are added factors for transmission and data reception. Voice and video may suffer from these transient effects, and buffering is needed to minimize the delay jitter. LEO and MEO satellites reduce the propagation delay. Still, according to a paper published for NASA by Ohio State University, the handover delays related to orbital dynamics hinder both real-time and non-real-time applications (R. Goyal et al.). However, the distance of the LEO satellites has the advantage of less power required for signal propagation. Beam-switching is necessary to employ seamless transfers between the LEO downlinks, and a constellation of space vehicles is required for availability.

ATM networks are one of many satellite services used to bridge networks. GEO, LEO, and MEO satellites are responsible for processing the subscriber's ability to stay connected regardless of geolocation constraints.

## References

- J. Ivanova and M. Jurczyk, "Computer Networks," *Encyclopedia of Physical Science and Technology*, pp. 561–576, 2003. doi:10.1016/b0-12-227410-5/00133-2
- R. Goyal, R. Jain, M. Goyal, S. Fahmy, and B. Vandalore, "Traffic Management in ATM Networks Over Satellite Links." NASA, Cleveland, OH, Oct. 1999