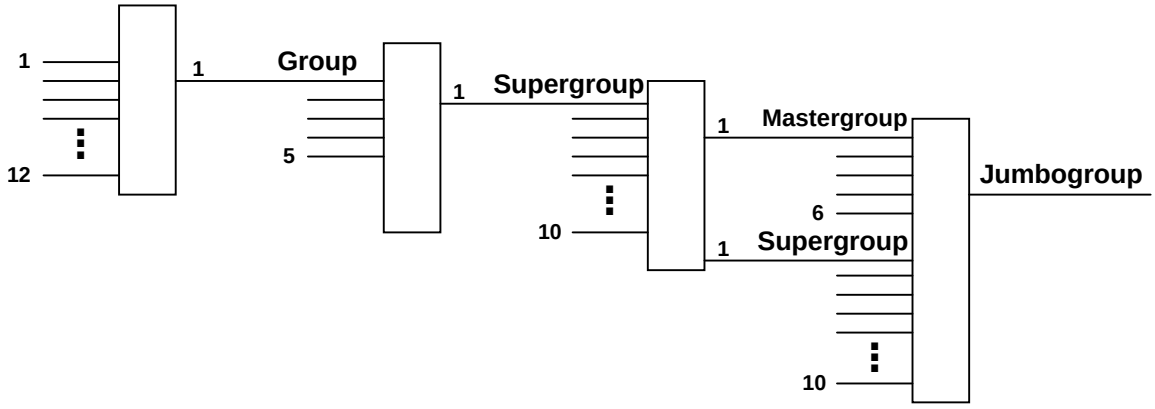
Multiplexing/Mapping of T1/E1 to Broadband Facilities

Historical Note

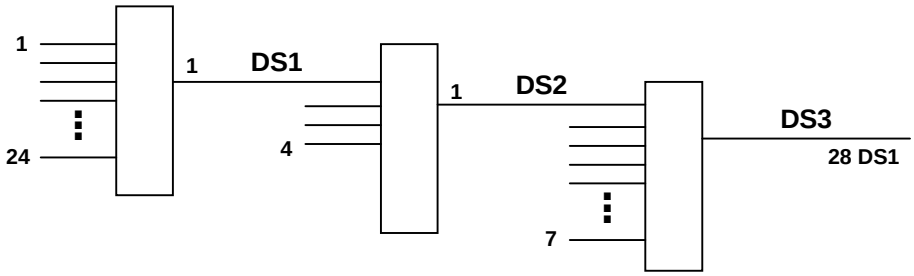
Multiplexing combines several signals into a single higher capacity signal for greater efficiency in transport. In the early days of telephony, the technique of frequency division multiplexing was widely employed. Because filters needed to separate the signals were imperfect, multiplexing took place in several stages, called a hierarchy. First, 12 voice channels were combined into a Group. Then 5 Groups were combined into a Supergroup of 60 channels. The next stage was to combine 10 Supergroups into a Mastergroup of 600 channels. Finally, 6 Mastergroups interspersed with 4 Supergroups made up a Jumbogroup of 3840 channels. Transmission facilities possible at the time influenced the multiples used at each level of the FDM hierarchy.



FDM Hierarchy

The North American Digital Hierarchy

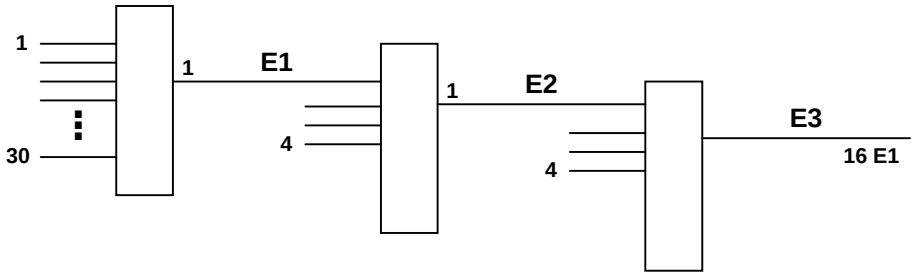
Switching machine architecture and transmission hierarchies are related. If the connectors on the switch were grouped in ranks of 12, but the incoming channels from transmission system were grouped, say in 16, then the 4 extra channels must be moved to the next rank of connectors. This disparity, called skewing, makes for difficult administration. To avoid skewing, the North American digital hierarchy adopted 24-channels, 2 Groups, for the first level digital hierarchy. The digital signal for level 1 is called DS1. The transmission facility for DS1 is T1. The upper levels of the hierarchy are influenced by available transmission technology. Four DS1 makes up DS2. Seven DS2 makes one DS3, resulting in a rate suitable for one video channel.



North American Digital Hierarchy

The European Digital Hierarchy

Avoiding the strange numbers of the North American Hierarchy, Europe, and eventually the rest of the world, adopted a different hierarchy. Here, multiples of 4 are favored, such as 4, 16, and 32. The first level has 32 time slots, of which 30 are assigned for voice channels, half of a Supergroup. European switches match the European Digital Hierarchy. Interconnection between North American and Europe is in 120-channel bundles, which match either 5 DS1 or 4 E1 signals. The second level, E2, is 4 E1 signals. The next level, E3, is four E2 signals.



European Digital Hierarchy

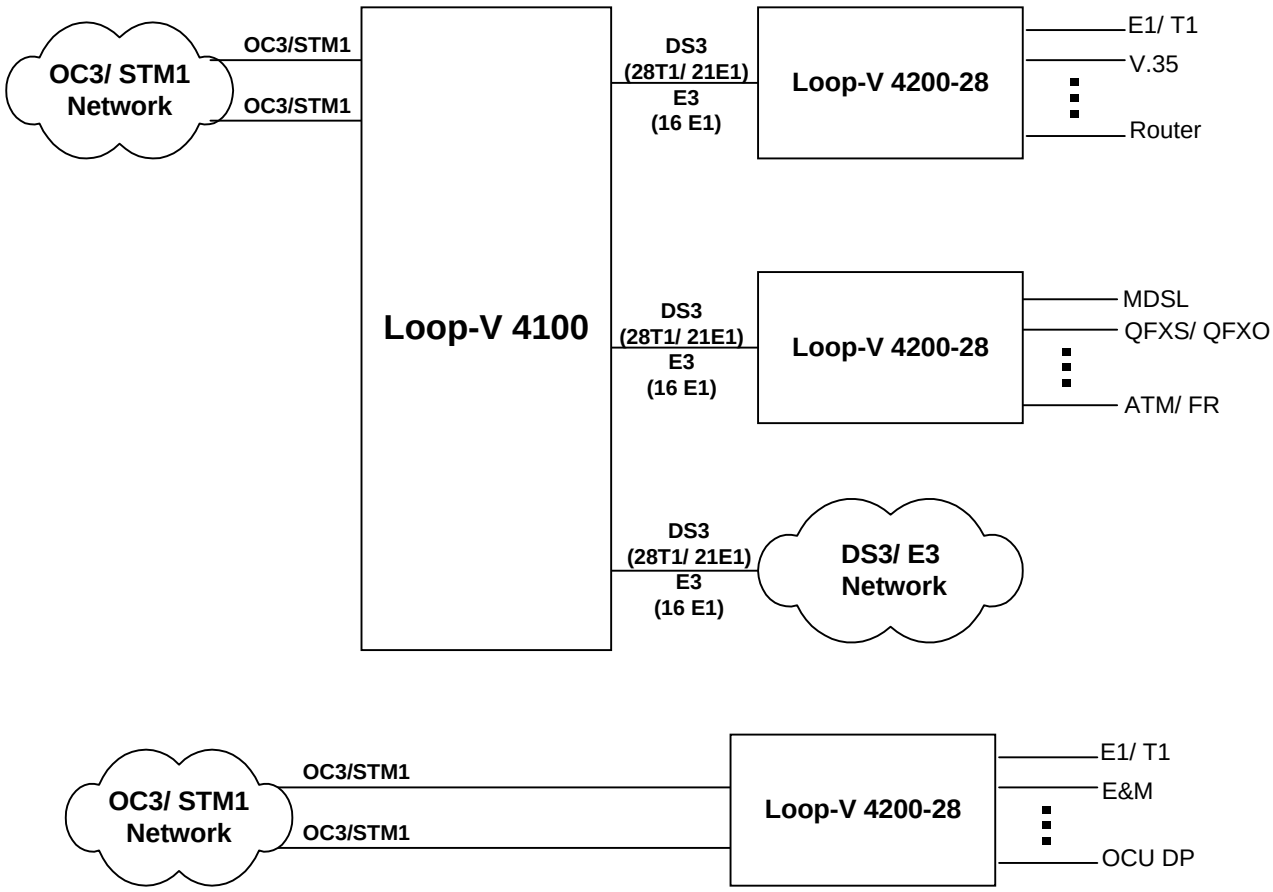
The Synchronous Hierarchy

Beginning in 1970, both transmission and switching migrated to digital technology. The emergence of optical fiber technology further accelerated the digital revolution. With these changes, all digital systems, out of necessity, became synchronous to a national master clock. This change allowed the elimination of intermediate multiplexers, for example from DS1 to DS2, then from DS2 to DS3. In fact, a whole new hierarchy emerged designed for the optical technology. The North American standard is SONET (synchronous optical network). The equivalent standard for Europe is SDH (synchronous digital hierarchy). Within a synchronous system, each time slot of the tributaries now occupy a fixed location in the final format, thus the term “mapping” is used for this more precise multiplexing technique.

Universal and Integrated Multiple Access Platforms

While the SONET and SDH architecture allows for efficient multiplexing and add-drop functions, compatibility with the legacy digital hierarchy requires access platforms that are inclusive of all formats. The Loop-V 4200-B310 UMAP and the Loop-V 4200-28 IMAP provide this versatility. Using these two platforms, singly or in combination, any input, low speed to broadband, can be interconnected with any other. All incoming signals are first reduced to the lowest digital level of DS0, 64 Kbps. Each DS0 signal can then be cross-connected to any outgoing DS0 signal.

Finally, all outgoing DS0 signals can be mapped to any of the broad-band formats, STM1, OC3, any of the wide band formats, DS3, E3, or any variety of low speed ports. Internal to the STM1, VC11 for DS1 and VC12 for E1 are supported. Internal to the OC3, VT1 for DS1 and VT2 for E1 are supported.



Loop-V 4100 & Loop-V 4200-28 Application