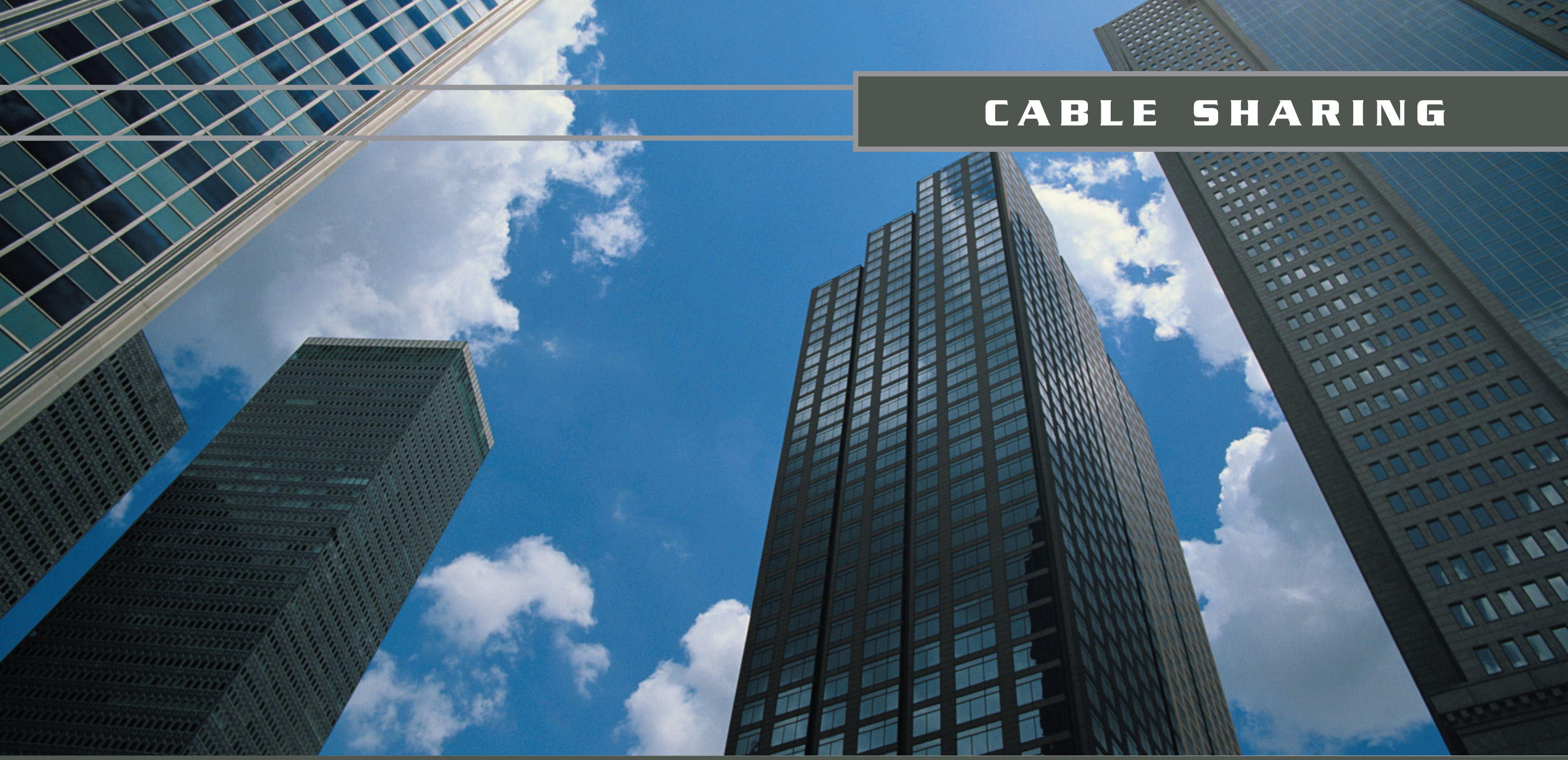

Cable Sharing in Commercial Building Environments

Reducing Cost, Simplifying Cable Management and Converging Applications Onto Twisted-Pair Media

Cable sharing describes the practice of running more than one application over different pairs of a twisted-pair copper telecommunications channel. Common examples of cable sharing include transmitting twelve 10BASE-T lines over one 25-pair cable and using y-adapters to break out separate voice and fax lines transmitting over one channel. Although the concept of cable sharing is clearly accepted by telecommunications professionals, it is only now starting to become a recognized practice for reducing costs, simplifying cable management, and converging applications onto one media type in commercial building environments. The growing market acceptance of fully-shielded (i.e. "category 7" or "class F") cabling systems has been identified as the primary reason why cable sharing techniques are appearing in the designs of the industry's top IT infrastructure designers and consultants.

Analog Voice	1-Pair
VoIP	2-Pair
Video over IP	2-Pair
CATV	1-Pair w/balun
CCTV	1-Pair w/balun
10/100BASE-T	2-Pair

Table 1: Typical Applications in High-Density Work Area Environments

TIA[1] and ISO[2] Telecommunications Standards specify generic topologies and minimum recommendations to ensure consistent cabling system design throughout the world. In many commercial environments, the minimum Standards' requirement[3] to provide two telecommunications outlets at each work area is adopted as the basic building infrastructure design. However, there are some end-user environments, such as call centers, fax centers, classrooms, training centers, and monitoring facilities that are supporting significantly more than two applications at each work area. In fact, some patient recovery room designs facilitate a minimum of 15 applications[4] at each work area! As shown in table 1, these high-density work areas are typically supporting multiple low-speed applications in addition to one high-speed data service. Cable sharing strategies benefit these types of work areas by simplifying cable management through decreased cable count and reducing waste and cost by eliminating the unused pairs that would be present if a 4-pair channel was dedicated to each application. Further cost and cable management benefits can be realized if services such as CATV and CCTV, that typically transmit over coaxial cable, and intercom, that transmits over 18 AWG copper wires, are converged onto the telecommunications network using low-cost devices such as video baluns.

Some designers and consultants are still concerned about specifying cable sharing because they are unsure of the Standards' acceptance of the practice. The good news is that both TIA and ISO recognize and provide guidance on cable sharing implementation. Annex B of ANSI/TIA/EIA-568-B.1 describes the transmission performance of various types of applications that do not interfere with each other in a shared environment based upon the internal crosstalk found in UTP (unshielded twisted-pair) cabling systems and provides examples of applications that can coexist in multipair cables. The Standard also indicates that knowledge of an application's transmission type (i.e. bursty, continuous, synchronized or random) and the internal noise of the cabling plant can be used to make a determination as to whether multiple applications or appearances of the same application can coexist in one channel. The ISO/IEC 11801: 2002, 2nd edition Standard expands on this information and provides crosstalk considerations for cable sharing and guidance for minimizing sheath-sharing incompatibilities. The ISO/IEC 15018 Standard goes one step further and recommends that cable sharing may be considered when pathway space is limited in residential environments. Industry groups such as BICSI[5] and building codes such as the NEC®[6] in the United States accept the practice of cable sharing. In summary, all telecommunications standards recognize cable sharing and provide implementation guidance based upon the potential for application interference due to the internal crosstalk levels of the cabling channel.

Cable sharing did not start gaining in popularity until the adoption of class F fully-shielded cabling systems by the ISO Standard. This is because the amount of internal crosstalk coupling (both near-end and far-end) in UTP and F/UTP (foil over twisted-pair) cabling systems made it difficult for users to predict whether multiple applications could coexist in one cable. As shown in figures 1 and 2, calculations demonstrate that 23.4% of an application's transmitted signal appears as either power sum near-end or far-end crosstalk noise at 100 MHz in category 5e/class D cabling systems. The situation improves for category 6A/class E_A systems, with 11.4% of an application's transmitted signal appearing as either power sum near-end or far-end crosstalk noise at 100 MHz, but this performance is not sufficient to ensure that all applications will perform properly in a shared sheath environment. With only 1.6% of an application's transmitted signal appearing as either power sum near-end or far-end crosstalk noise at 100 MHz in class F cabling systems, end-users are guaranteed that there is sufficient noise isolation between pairs to support multiple applications or the multiple appearance of any one application over a 4-pair class F channel.

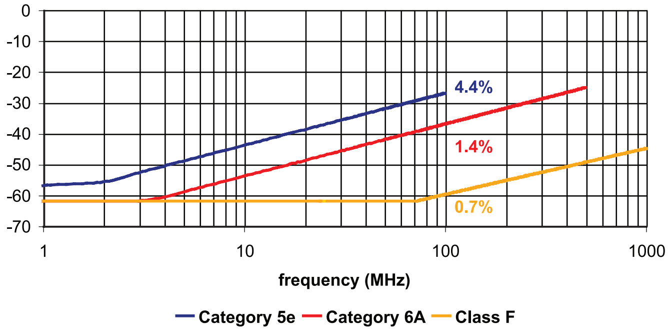

Figure 1: Comparative Channel PSNEXT Loss Coupling

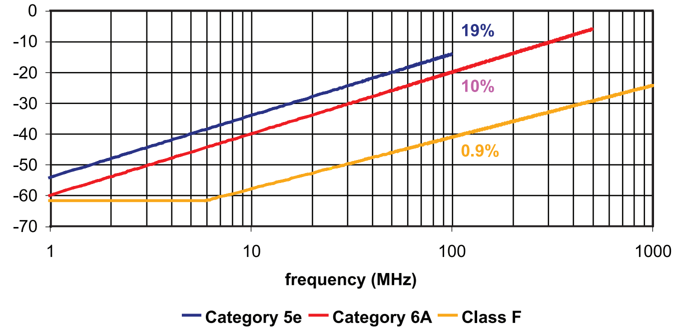

Figure 2: Comparative Channel PSELFEXT Coupling

Class F cabling requirements initially appeared in the first edition of the ISO/IEC 11801 Standard published in 1999. Class F cabling is constructed from fully-shielded category 7 components and is characterized over the bandwidth of 1 to 600 MHz. The preferred connecting hardware interface for cable sharing implementations is the non-RJ style interface described in IEC 61073-3-104 and shown in figure 3. This is because the isolated quadrant design of the non-RJ style interface allows easy access to one or two pairs of the channel using 1- and 2-pair non-RJ style plugs terminated to appropriately wired RJ-45 or RJ-11 Ethernet plugs as shown in figure 4. Class F_A cabling requirements are under development by ISO and, using the same non-RJ style connector mated to an enhanced category 7_A cable, are characterized over the bandwidth of 1 to 1,000 MHz. Class F_A is the appropriate grade of cabling to specify to support all channels of CATV (up to 862 MHz).

Figure 3: Category $7/7_A$ Non-RJ Plug and Jack Interface

Although cable sharing implementation practices are extremely flexible and support a wide range of configurations, two basic configurations can satisfy the needs of most end-users. In call and fax centers, agents are typically arranged in work groups and are supported by both an analog phone and Internet connection. In this example, the recommended cable-sharing practice would be to provide each work group of 4 agents with a MuTOA[7] containing one class F outlet and four category 6A outlets. The one class F channel would provide 4 analog phone lines to the group as shown in figure 5. By utilizing cable sharing practices in call and fax centers, end-users typically realize a cost savings in excess of 10% for materials, a 38% reduction in the total number of outlets, and reduced cable management complexity. In many multi-application environments, such as classrooms, healthcare, and monitoring facilities, work area outlets support a plethora of services including VoIP (voice over IP), CATV, CCTV, Internet, security cameras, intercom, and high-speed data. In this example, providing a dedicated cable for each application would require 9 outlets at the work area! A more efficient

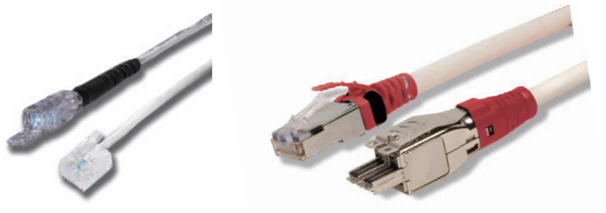

Figure 4: Hybrid Cords (1-Pair Non-RJ Style Plug-to-RJ11 and 2-Pair Non-RJ Style Plug-to-RJ45 Plug)

solution for multi-application environments such as this is to implement cable sharing whereby each work area would support the 9 services over two class F channels and one category 6A channel. The two class F outlets would support the services depicted in figure 6. Using this implementation, end-users typically realize a cost savings in excess of 20% for materials, a 57% reduction in the number of outlets, and reduced cable management complexity. In addition, these end-users benefit from converging their coaxial (CATV and CCTV) and copper wiring (intercom) onto the telecommunications network for the added benefit of simplified infrastructure management and reduced complexity.

When designing cable sharing solutions, it is critical to plan for the types of applications to be supported and understand their equipment lifecycles. Fortunately, the lifecycle of call center and most video applications is greater than the 10-year life cycle specified by the TIA and ISO Standards for data applications. Although there are many benefits to be realized from implementing cable sharing design strategies, it is important to remember that these techniques can reduce the ability of the cabling infrastructure to support future applications and upgrades.

Figure 5: Typical Call/Fax Center Cable Sharing Implementation

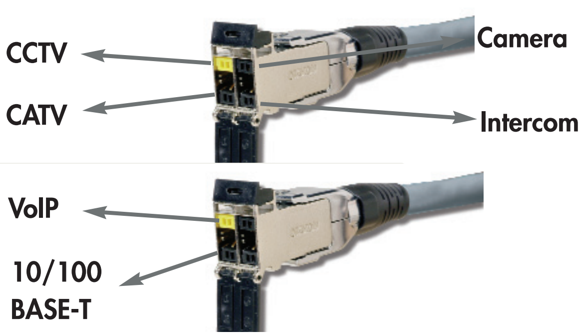

Figure 6: Typical Multi-Application Cable Sharing Implementation

As a result, the recommended practice for all cable sharing solutions is to provide a minimum of one dedicated 4-pair category 6A or higher rated outlet in addition to the shared class F outlets to ensure a migration path for high-speed data upgrades. End-user demand for high-density, low-speed application support is increasing as more and more equipment devices support IP protocol, Ethernet communication, and operation over twisted-pair cabling. Fortunately, class F and F_A cabling provides the necessary internal noise isolation to support Standards-approved cable sharing methods that reduce cost, simplify cable management, and support convergence of applications on twisted-pair media.

[1] TIA is the acronym for the Telecommunications Industry Association
[2] ISO is the acronym for the Internal Standards Organization
[3] Minimum telecommunications outlet requirements are specified in ANSI/TIA/EIA-568-B.2 and ISO/IEC 11801: 2002, 2nd edition
[4] Typical applications supported include: 2 voice, 4 clinical Ethernet data, 2 ICU remote patient monitoring Ethernet data, 1 nurse-call Ethernet, 1 auxiliary Ethernet data for non-clinical applications, 2 patient entertainment, and additional outlets for "family zone" activity
[5] See www.bicsi.org for more information
[6] NEC is the acronym for the National Electrical Code®
[7] MuTOA is the acronym for Multi-user Telecommunications Outlet Assembly

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