The Conversion Technology Experts

Your Guide
To Making
Good Media
Conversion Decisions
And Avoiding
Expensive Pitfalls

# How To Avoid The 7 Most Costly Mistakes Of Upgrading Your Network To Fiber.

## Introduction

In the mad rush to increase network speed, it is important to stop, take a deep breath, and consider where you are going.

For good business reasons, most companies are committed to building a high-speed backbone and extending it to the desktop. However, the road to successful high-speed deployment is full of curves and hazards. This white paper is a roadmap that points out some of the potential rough spots. It highlights seven costly errors IS and IT people make when moving to fiber. Some are strategic errors. Others are tactical errors. Whether they arise from incorrect planning or installing correct technology, these errors cost a lot of money. It is simple to avoid stumbling as long as you are aware of where the pitfalls are located.

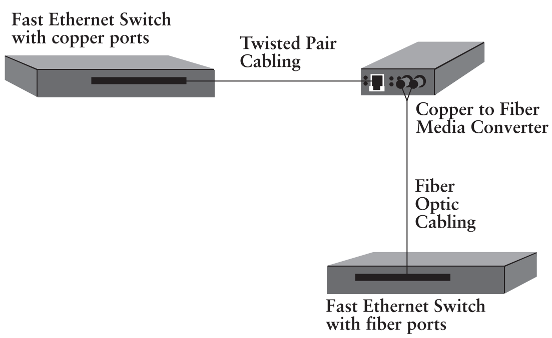
Rest assured that it is not vital that you do everything exactly as outlined below. While we are sure you can avoid making fiber flubs by following these proven strategies for success, in some cases, there may be sound business reasons for doing things a different way. Just be sure you have a good reason for deviating.

## Mistake #1

## Throwing the Baby out with the Bathwater

Even if they accept the argument that fiber is the way to future-proof their network, too many managers see migration to fiber as an all-or-nothing proposition. That is an expensive strategy. In fact, the cost of a massive upgrade is the main reason so many companies are going with the "nothing" strategy and are still installing Category 5E, Category 6 or looking at Category 7 cable. The common complaint is that, while they see the advantage of going to fiber, they simply cannot do a forklift upgrade or throw out so many miles of installed copper.

So what's the problem? Do the upgrade on the installment plan, a department at a time. There is no reason to toss the installed copper base along with all of its associated electronics. Keep it in place, let it do its job, and plan to keep downgrading the importance of the copper plant as technology advances.




Meantime, install optical fiber each and every time the network has to be upgraded. Simply link the copper cable with the fiber cable (using media conversion technology) and rest assured that those on the network are enjoying the best and fastest networking available without worrying about a call from the financial department about wasting money.

Before the advent of media conversion, this was a bigger deal. However, in the past couple of years many people who are upgrading to high speed backbones have discovered that media converters work, work well and work cheaply. Since humans began using machinery, they have been adapting one thing to another. Media converters can solve the problem by providing a transparent link between twisted pair horizontal cable and the fiber backbone without requiring new cable or replacement of expensive equipment.

For most applications, the economical answer to linking fiber, copper and/or coax is media conversion. Media conversion is the means by which one media type is converted to another media type. Changes in networking equipment driven by the ongoing quest for increased bandwidth, and structured cabling limitations, have helped define the need for media conversion technology. As routers, switches and other network devices evolve at a furiously fast pace, network administrators must develop ways to keep up. This constant migration places demands on both human and financial resources.

Put simply, media converters make one cable "look" like another cable—without changing the nature of your network. A media converter is a small device with two media dependent interfaces and a power supply. They can be installed almost anywhere in your network environment, expanding, rather than limiting your options. Your networking infrastructure, and thus, your investment is protected. Adapting new media types, such as fiber optics, does not require costly hardware upgrades.

The end user has an investment in fiber or twisted pair and is understandably reluctant to toss that investment out the window to achieve a faster network. Even going from copper to fiber or copper to copper presents a challenge. Most enterprises are not financially prepared to put in an entire new infrastructure to meet the needs of a new application. Media converters ease that transition by converting a variety of media to another: coax to twisted pair; coax to fiber; twisted pair to fiber and single mode to multimode fiber.

The device itself has two media dependent interfaces and a power source. The style of connector depends on the selection of media to be converted by the unit. For example, in a Fast Ethernet environment a 100BASE-TX to 100BASE-FX Media Converter connects a 100BASE-TX twisted pair device to a 100BASE-FX compliant single or multimode fiber port that has either a ST or SC fiber optic connector. Converters are small enough to fit in a hand and can be stand-alone units on their own. Don't be one of those network managers who says, "I wish I'd known last month that it was possible to link TX and FX."

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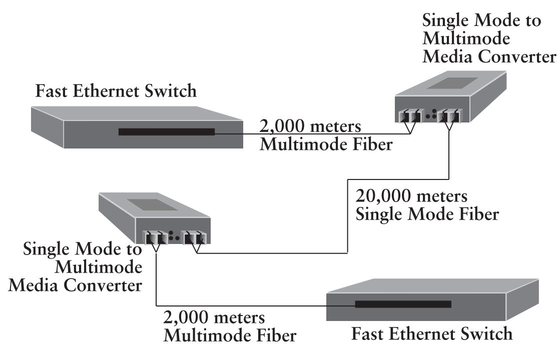
Check into media conversion. Prioritize the network links which will be upgraded. Use media conversion to bring the different technologies together, keeping the installed base while upgrading on a pay-as-you-go basis. Even if you don't save money on the actual fiber run, you will save a considerable amount by using the existing electronics.

The alternative to using media converters would be expensive; to put many more hubs out in the network, run new fiber plant, and make sure it would transition from one hub to the other while still maintaining the purity of the signal.




Fiber can be connected to almost any legacy environment. Equipment equipped with an AUI or MII port can also make use of fiber transceivers. Media converters can also be used to link single mode to multimode fiber.

Media converters are as simple to install as patch cables and connectors. Media converters function as physical layer devices. As such, they do not interfere with any upper level protocol information. This allows them to support both QoS (quality of service) and Layer 3 Switching.

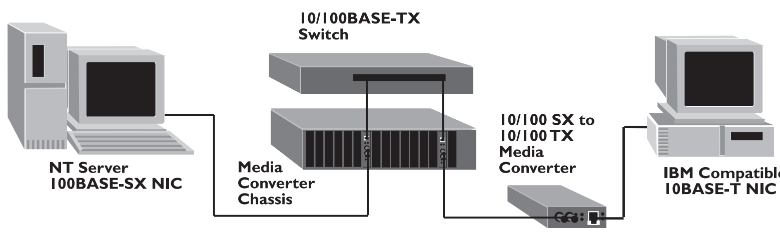
A fiber media converter can reliably and inexpensively extend the distance between two 10BASE2 devices or two 10BASE-T devices up to 2,000 meters. This function is done without the monetary expense of a repeater or the use of a portion of your network repeater budget.

Using media converters in a 100BASE-TX to 100BASE-FX back to back configuration, provides a single method of extending the distance between a full duplex switch and a fileserver up to 2,000 meters. The same strategy will work between two switches. In fact, media converters can function in either half-duplex or full-duplex mode. Full-duplex Ethernet over UTP runs at 20 or 200 Mbps, while half-duplex Ethernet over UTP runs at either 10 or 100 Mbps. Full-duplex Ethernet is especially valuable in linking two switches or connecting a switch to a file server. No adjustments are necessary when using either mode. A media converter will automatically sense which mode is in operation.

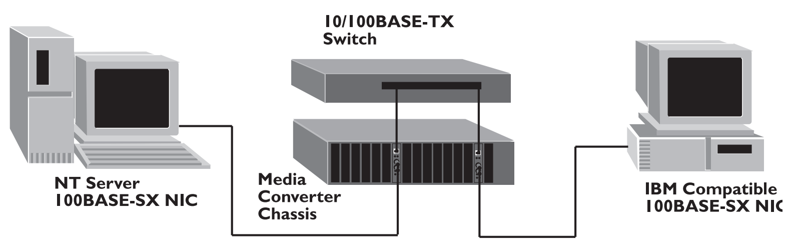
## Mistake #2

## Preventing Migration

Fast Ethernet offers two fiber options. 100BASE-FX is the most common. It supports distances of up to 2,000 meters over multimode fiber but offers no 10/100 negotiation. To address the need for 10/100 auto-negotiation and to lower the cost of fiber connectivity, the industry is developing the 100BASE-SX standard. 100BASE-SX is limited to deployments of 300 meters or less, but since it allows using both 10 and 100 Mbps, conversion technology can be used to run the link at whatever speed is required.




*Step 1: Install new fiber utilizing existing copper-based workstations and switches.*




*Step 2: Upgrade workstation performance by simply replacing the 10Mbps copper NIC with a 100BASE-SX NIC.*

Using a 10/100 SX converter allows you to future-proof your install. Take, for example, a 10/100 NIC (network interface card) plugged into a 10BASE-T hub with SX converters at either end, and the link runs at 10 Mbps. Replacing the 10BASE-T should cause the whole link to come up at 100 Mbps if the 10/100 SX media converter is used. The alternative is to buy a 10 Mbps converter for the 10 Mbps link and replace it when the upgrade is made. Although a bit more expensive than a 10 Mbps converter, an SX converter costs less than a 100BASE-FX converter.

While Fast Ethernet is good for now, mixed network topology eventually will have to be scaled to Gigabit Ethernet. Using a

Gigabit Ethernet Media Converter enables converting one or more 1000BASE-SX ports on a Gigabit Ethernet switch or 1000BASE-LX for use in campus area networks or other applications requiring the distance advantages of single mode fiber. It is only necessary to convert those ports required for backbone connection.

Ironically, it is often less expensive to purchase a multimode switch and an external multimode to single mode media converter, than it is to buy a switch with single mode installed internally. Additionally, some Gigabit Ethernet electronics are only compatible with multimode fiber. In such an instance, a single mode to multimode media converter makes the connection.

With single mode fiber in the backbone, copper or another medium to the desktop and media conversion tools providing connectivity between disparate technologies, the network manager can confidently plan for a future network incorporating Gigabit Ethernet.

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## Mistake #3

## Getting Wrecked by Collision Domains

Understanding collision domains is key when designing an efficient, robust Fast Ethernet networking system. A collision domain is a group of Ethernet or Fast Ethernet devices that are directly connected by repeaters. Collision domains are separated by switches and routers that allow separate collision domains to communicate with each other. Only one device within a collision domain may transmit at any one time. When a device is transmitting, all other devices in the collision domain listen. Both Ethernet and Fast Ethernet use a collision sensing standard protocol that allows multiple devices to access a shared Ethernet or Fast Ethernet network. This is known as CSMA/CD (Carrier Sense Multiple Access/Collision Detection).

For each collision domain, the CSMA/CD determines which device has access to the network. The CSMA allows a node to transmit if there is no existing traffic on the network. The CD will detect simultaneous transmissions and stop all traffic. All devices will then re-send at random intervals, allowing each node to retransmit successfully unless another collision is detected. However, collision domain size is limited. Collision domain size is not measured in terms of distance, but in terms of bit time. This is because a signal on the network has a constant speed relating to the type of media it is traversing-fiber or twisted pair. Bit time is measured by the time it takes the smallest allowable packet to make the round trip from the transmitting node to the furthest node in the collision domain. The smallest allowable packet size in Ethernet and Fast Ethernet is 64 bytes or 512 bits.

If a node is too distant from other nodes in its collision domain, then packet transmissions may not be able to make the entire round trip distance needed to ensure that collisions are heard by all devices on the network. This is referred to as a late collision. Late collisions increase the possibility of lost packets and overall network problems.

The 512-Bit Rule says that the total bit times between any two devices in the same collision domain cannot be greater than 512 bit times in a round trip.

To eliminate the guesswork, here are three simple guidelines to follow:

1) Between two hubs: (2) Fast Ethernet *Bridging* Media Converters

2) Between a hub and a switch: (1) Fast Ethernet *Bridging* Media Converter on the hub side and (1) Fast Ethernet Media Converter on the switch side

3) Between two switches: (2) Fast Ethernet Media Converters

## Mistake #4

## We Can Work it Out: Make Automation Work for You

Look for a media conversion product which is auto-negotiation enabled. Believe us – it's a lot easier to let well-designed components negotiate speed and compatibility automatically than it is to do it by hand, on a piecemeal basis. This holds whether setting up speeds and resolving full/half-duplex issues, or sorting out which cable pair has the transmit and which the receive function.

Here's how auto-negotiation works. Whenever two copper 10/100 ports talk to one another there is a negotiation process. Each port broadcasts its capabilities. It may say it can do 10 Mbps or 100 Mbps or both; or that it can handle full-duplex or only half-duplex, or both. A typical switch can do either 10 or 100, either full or half. If both have similar capabilities, they resolve to the highest performing common denominator (in this case 100 Mbps full-duplex). However, if a 10/100 switch is being connected to a dual-speed hub, the switch will come up and say it can do 10 or 100, full or half-duplex; the hub will say it can do 10 or 100, but can only do half-duplex. The result will be a 100 Mbps half-duplex link.

Lastly, consider a switch talking to an old, legacy NIC (network interface card). It may be a 100BASE-T NIC which does not have auto-negotiation. It is fixed at 100 Mbps. Again, the switch tries to establish a contact. But the NIC ignores the requests, since it has no idea what the switch is requesting. The NIC does not respond in auto-negotiation language. The answer to the conundrum is "parallel detection." When it does not get an auto-negotiation response, but rather discovers a legacy device, it has to respond in kind.

Parallel detection allows the intelligent device to detect the speed (in this case 100 Mbps), but has to take the safer road and set up a link based on the lowest common denominator: half-duplex.

The same scenario works for media conversion. Take the same intelligent server. Put an auto-negotiating 10/100 NIC card at the other end and both will be fully capable of auto-negotiation, with the result being a link running at the highest performing common denominator. A plain-jane media converter, without auto-negotiation, will have the same problem the dumb NIC had, and will give similar results—a link with the correct speed but the wrong duplex mode. The result is a three-aspirin headache for the network manager.

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If the media converter does not understand auto-negotiation, the switch will fall back on parallel detection and the network ends up with the right speed, but an unwanted half-duplex link. The media converter has to be intelligent enough to allow the link to be set up at the desired state (in most cases, full-duplex).

Transition Networks converters (on the copper port) will broadcast ability to do 100 Mbps. There is a DIP (dual in-line package) switch which can be set either to allow the converter to broadcast ability to run in full-duplex or ability to run at half-duplex.

The advantage of having this capability on media converters is that the converter will never give the other end a choice. It will either broadcast ability to do 100 Mbps full-duplex, or 100 Mbps half-duplex…nothing else. Think of this as ability to do just enough auto-negotiation to get by for the job at hand. The media converter can not negotiate to 10 Mbps and can not change on the fly—it is somewhat fixed. But the advantage is that, given this level of intelligence, the media converter can sit between the server and the NIC and the link will come up properly, never realizing there is a converter in between them.

## Mistake #5 Faking Out Your Own Network

Even with auto-negotiation and other sophisticated features, it is possible to create confusion on links running through media converters which are between router pairs. It is important to maintain link integrity. Transition Networks offers a feature called LinkAlert™ which does just that.

LinkAlert monitors 100% of physical uplink & downlink failures, ensuring that hubs, converters, repeaters, transceivers & NICs can detect Link status.

A common problem on trunked networks is that the network on each side of the media converter may begin to act independently of the other. Take a link where there is conversion from copper to fiber and back to copper. When the copper link goes down on one switch the fiber is not dropped.

### 4A: Don't Get Crossed Up

If the cable pair running through the media converter does not match what the system expects, the system will not operate properly. This is because the transmitter of the one interface should talk to the receiver at the other end. If the lines are not setup properly, this will not happen.

The solution is AutoCross—a feature which saves time and money during installation. Whenever a tech plugs in cables to any hub there should be an automatic transmission delineating which cable pair has the transmit and which pair has the receive capability. At this point, the system automatically re-configures itself on the fly and the link starts to work properly. This allows you to plug in a straight-through cable or a cross-over cable and it will sense the proper configuration for the link.

While this sounds simple (and, indeed, it really is), this AutoCross capability is a feature which can eliminate much of the backtracking through an installation. It is a huge time-saver for the technicians. All new Transition Networks media converters will have this ability; existing converters are being redesigned to include AutoCross.

Some switches may run a trunking algorithm, splitting traffic across multiple ports. If, at the physical layer, the switch does not see the that the port has gone down, the box becomes confused. It sees that it is not getting data through, yet it thinks the port is there.

Spanning tree also can be tricked the same way. If the spanning tree does not see the physical link go down, it will not be able to re-route it to another path, even though the primary path is bad. The physical layer appears intact.

The answer is simple: a media converter that says, in effect, if the copper side goes down then the fiber side goes down as well; or, vice versa. LinkAlert accomplishes this simply and elegantly, allowing either trunked or spanning tree-based networks to "see" that the physical layer has been broken. The result is an alert sent to the network manager who can proceed to make whatever correction is needed.

## Mistake #6

## Not Knowing What Network Management Buys You

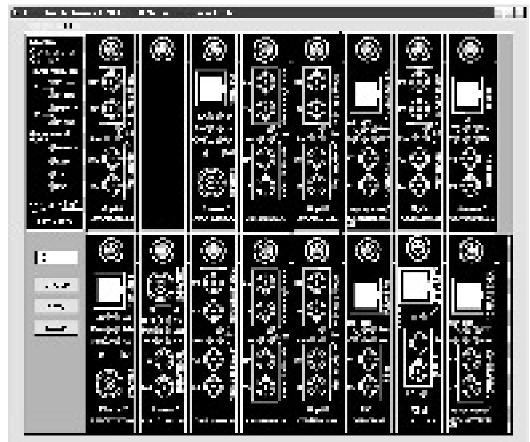
A well-designed network management system allows network managers to respond to problems quickly – often before the people using the network know there has been a degradation of service. Proactive management means catching problems before they become service-disrupting.

Network management has been standardized around SNMP and is used by virtually every network management system as a means to communicate information. Network management requires information to be passed from the SNMP agent to the management station and vice versa. Because each managed item is unique, there needs to be a standard way to define it so that any SNMP management system can "talk" to it. This is accomplished by using a Management Information Base, (MIB) which defines status and control items that are available in a particular piece of equipment and does it in a very structured method. As an example, a MIB might define a media converter as having a status item called "FiberLink" or "CopperLink." With these links, any SNMP software would know that this status information is available, and understands how to obtain it from the media converter.

This exchange of information can happen in one of two ways, in-band and out-of-band. Most managed items support both in-band and out-of-band connections. The in-band method can be done using SNMP, telnet or recently with HTTP (Web browser based management). Out-of-band management typically utilizes an RS-232 port and a dumb terminal type interface.

While SNMP management has been around in high-end LAN equipment for several years, the physical plant has been largely neglected, primarily due to cost issues. Previously, it was expensive to install equipment that manages the cable plant. When fiber started being deployed, people often used media converters to connect it to legacy copper equipment. These devices were typically not managed and further complicated the issue of managing the physical plant.

Now several manufacturers of media conversion products offer managed conversion solutions. These are typically in the form of a chassis that can manage up to sixteen media converters, allowing them to be placed in critical locations within the network.



In managed media conversion systems the primary piece of information that is gathered is a port link status. Simply put, it is the link up or down. This information is available upon request (like when looking at a graphical representation of the product) or as a trap. Traps are sent to the management system as soon as the SNMP agent detects that the link is down. When the link is restored, another trap can be sent which notifies the administrator that the problem has been solved.

For example, if there is a physical loss of a patch cord going to a managed media converter, the media converter senses that the link has been lost and sends a trap to the network management system. Even though the problem could not be prevented, the network manager is able to fix the problem before anyone realizes that the network is down. Without management, there is no indication of a problem until someone calls the help desk complaining that he/she can not log onto the server.

Once the network has been installed, operability testing is always a challenge. If the network is not performing correctly it could due to any one of a variety of problems: it could be the media converter slowing the packet down, the cable itself, a problem with the patch cord or the NIC card. There may be a difficulty with the application itself. Or, the server might simply be too slow. Troubleshooting follows standard Ethernet procedures.

The keys are being proactive in management or, alternatively, responding rapidly when a problem does strike. In the media conversion sense, this usually means the latter – a trap will show when a link goes down. It may warn of the loss of a fiber link on a given port. Management can work around the problem, thus preserving productivity.

**Mistake #7**

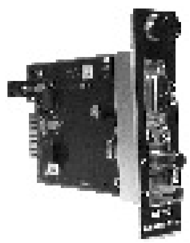
## Not Building on a Solid Platform

Once the decision to do media conversion is reached, it is important to know what kind of media converter platform will be used for the application. There are three types of platforms to consider:

1) chassis mount

2) fixed-port unit

3) stand-alone

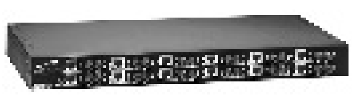


*Slide-In-Module for Conversion Center*

For management, a chassis is the best way to go. Fixed-port units have six or twelve of the same type of media converter in one enclosure. They are not modules which can be slid in or out. The structure is more like a hub. In an application that requires redundant power, the chassis also is the platform of choice. In many networks, an hour of downtime costs the organization hundreds of thousands of dollars. A redundant power system costs about $300, making this the classic example of a "no-brainer" for companies involved in fail-safe networking, such as those requiring meeting service level guarantees, electronic commerce, EDI (electronic data interchange), banking and similar pursuits.

*Conversion Center*

A company which does not need redundant power or is not concerned about continuous management on every link, but which will do a lot of conversion, should look at a fixed-port unit. Fixed port units have six or twelve of the same type of media converter in one enclosure. They are not modules which can be slid in or out. The mechanical structure is more like a hub. This is especially indicated when a lot of the same type of conversion is going to be done in the same spot. Take, for example, a network converting twelve 10BASE-T's to fiber or six 100BASE-TX to fiber, the fixed port unit will provide the required number of media converters in a single enclosure. These fixed-port units are smaller, so they save rack space. Typically you can fit twelve converters in a space one rack unit high. If racking economy is important, this is probably the way to go. The old "cheaper by the dozen" rule applies, too – racks are cheaper than buying stand-alones.

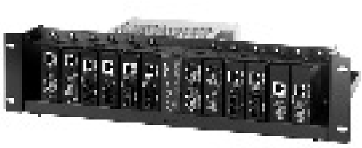


*Fixed-Port Unit*

For single end node conversion, the stand-alone product is the answer. The right media converter will allow linking one type of media to another. Page 12 shows a number of common conversions and which converter will do the job. This is not an exhaustive list, but does show the versatility of media converters.

*Stand-Alone Unit*

No matter who you chose to deal with, there are several basic questions you should ask any media conversion provider. First, look at their demonstrated commitment to quality. This includes not only the reliability of their existing products, but also their commitment to upgrading those products and to introducing new, useful features on future devices.



*Stand-Alone Rack*

Second, look at the company's range of product line. It is rare that a network will have only one kind of fiber or only a single type of connectivity need. As you upgrade different segments of the network to increase network speed or versatility, you'll encounter the need for different types of converters. There is copper-to-fiber, copper-to-coax, coax-to-fiber and many other permutations. It is much easier to find a full-line media conversion vendor at the outset than it is to hunt for a new supplier every time you encounter a new conversion in the project.

Lastly, be sure your vendor is committed to media conversion. This may sound like a given, but it is not. Do business with a company which is focused on media conversion, which has a primary engineering and technical background in media conversion, and where the sales staff speaks conversion as a first language, not something picked up on the fly.

## Conclusion

Economics, more than electronics, often determines the way a network ends up being designed.

By continuing to use as much of the installed copper as possible, designing around 100BASE-SX to gain 10/100 based functionality over fiber, being aware of collision domains, letting the components transparently do as much of the work as possible, and staying on top of network management issues you will be able to keep the economics under control.

Lastly, deal with forward-looking, reliable vendors who design with the future of your network in mind. With these elements in choice, you're ready to pick the correct converters for the job, install them on the platform of your choice, and proceed to enjoy the benefits of an easy, economical, evolutionary upgrade to high-bandwidth networking.

Transition Networks offers a complete line of media converters that give you the highest price-performance available in the industry. We are continually expanding our product offering. Check our web site for the most current product information. Transition Networks offers copper to fiber (multimode & single mode) media converters as well as single mode to multimode media converters for the following environments:

- **Ethernet**
- **Fast Ethernet**
- **ARCNet™**
- **ATM**
- **FDDI**
- **Gigabit Ethernet**
- **IBM®3270**
- **IBM®5250**
- **OC-12**
- **RS232**
- **Token Ring**
- **High Speed Token Ring**
- **T1/E1**

TRANSITION networks

The Conversion Technology Experts

**USA Headquarters**
612.941.7600
800.526.9267
Fax 612.941.2322
info@transition.com
http://www.transition.com
6475 City West Parkway
Minneapolis, MN 55344 USA

**European Headquarters**
tel +44 (0) 118 981 9696
fax +44 (0) 118 981 9218

P/N 900560 10.99