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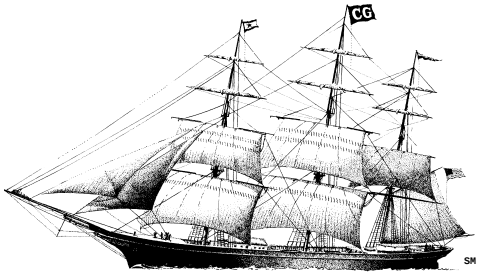

Navigating Information Technology Horizons℠

Published Since 1993 January 7, 2002

FICON – The Clearest Decision for 2002

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Management Summary

Bottlenecks. Life has them. Computer systems have them. Always have, always will. Systems architects and traffic engineers try to remove the most obvious bottlenecks. They also know that removing one creates another somewhere else. For years, the bottlenecks of computer systems were inside servers. As servers added functionality and technology, the bottlenecks moved to storage networks and storage. Recently, very large storage arrays have been redesigned to shift the bottleneck back to the network. Now, for mainframe systems, there tends to be plenty of horsepower. There tends to be plenty of storage. **The bottleneck *du jour* is in moving the data to the server and back – i.e., it's in the plumbing.** The increase in the amount of data, the increased data-centricity, and the bandwidth gluttony of new generation applications, will consume the available bandwidth – and then some.

We've had improved plumbing, in the form of FICON, for a couple of years, but the really critical plumbing fixtures, such as storage devices, have not been able to hook into the system until now. By the end of the first quarter of 2002, EMC and Hitachi Data Systems will join IBM in shipping large storage systems with FICON connectivity. **Now is the time to consider, from both a technical and a cost-benefit perspective, the reasons to move to FICON's high-speed plumbing.**

FICON's predecessor, ESCON, was a great improvement over ESCON's predecessor, bus and tag. Like the pneumatic tube messaging systems once common in bank drive-up windows and at cash registers in retail stores, it was a technical marvel. But like those pneumatic delivery systems, ESCON was constrained to a specific container and one-way-at-a-time operation. **FICON's ability to multiplex multiple channel programs is like being able to send many messages in different containers in both directions at the same time. It is an undeniably compelling technology, and there are many enterprises that have been waiting to install it and reap the rewards. For others, it is important to look beyond the technological justification and to determine how best to implement the FICON technology to maximize the return on investment.**

While the benefits are in performance, this is more than a performance decision. Enterprises must consider the applications on mainframe platform(s), their expected growth or diminution, and the degree to which they are critical to business operations. They must consider the age of the mainframe, for the benefits to be gained with an IBM S/390 G5 or G6 machine are more limited than those to be gained with the newer zSeries. They must consider the capabilities of their installed storage arrays, particularly those at the beginning of their lifecycle. They must consider their data center campus and whether, for robustness and business continuance, they wish to add a further degree of remoteness without sacrificing performance. And they must consider their fiscal constraints (budget) and data center technology time line. **The recession-caused lull in the dynamic growth of the past years may be a good time for a FICON migration.**

For a more detailed discussion of the factors and benefits involved in making this decision, read on.

IN THIS ISSUE

Situation Analysis – Assessing the Benefits of FICON

It all begins with your mainframe. FICON is a performance-enhancing, capacity-enhancing, and/or distance-enhancing play over the decade old ESCON technology. **You are probably not interested in FICON if your mainframe is not stressed:**

- To process increasing volumes of business transactions within the fixed limits of a 24-hour day,
- To move greater volumes of data between mainframe(s) and storage devices (disks and tape), or
- To interoperate with remotely-located storage or data centers that business-continuity plans now dictate should be even farther away.

This puts FICON into consideration at larger data centers, which likely have two or three of the requirements bulleted above. In addition, IBM offers FICON support only on its latest mainframes: zSeries/900 and S/390 G5 and G6, and only delivers its full potential on zSeries. But FICON in G5/G6 more than triples the ESCON I/O capability[1] and increases bandwidth significantly[2].

So if you have older/other mainframe technology[3], you are probably not pushing it to the wall in one of the three dimensions outlined above, and you may ask: why consider FICON? The answer lies in the business needs that drive enterprise information systems. By leveraging FICON's performance enhancements, an enterprise will get many benefits, including greater functionality and a simpler network. **FICON is dictated for mission-critical, high-performance, high-capacity needs.** These are not technology requirements but enterprise requirements, driven by the needs of business units and the applications that they deploy on mainframes.

Business Benefits of FICON

Enterprises are continually faced with the challenge of maintaining their IT infrastructure at a level adequate to meet their current and future needs. It must be done within the framework of functional improvements in the technology, business requirements, economic constraints and the cost-benefit relationship among them. Another factor is the necessity or desire to maintain a great deal of currency in the technology so that the IT

[1] Dependent on CPU speed, but up to 3500/second for FICON vs. 1200/second for ESCON.

[2] To 70MB/s throughput full duplex.

[3] Today, only IBM offers native FICON connectivity for its mainframes. HDS and Amdahl are expected to offer it for their installed mainframe customers early in 2002.

Historical Perspective of FICON

It sounds like biblical lineage. Parallel connections begat ESCON, which begat Fibre Channel and FICON, now first cousins, at least. This is important to understand, not so much as a progression of technology, for we have grown to expect that, but for the rate of adoption and the barriers along the way.

IBM's first general-purpose connection from mainframe to peripherals (like disk, printers and tape) deployed a parallel approach, not unlike the many wires and pins that have been used for years to connect desktop printers to personal computers. The many wires were used to move data simultaneously (in a parallel fashion). In mainframes, this was called "bus and tag." The physically huge connector and cable system was the only way to connect until ESCON came on the scene in 1990. ESCON was alien, the first to use optical fiber instead of copper and to use a serial approach instead of parallel. Everyone knew ESCON was superior and significantly faster, at least on paper, but adoption required a lot of testing and convincing before acceptance. It was launched during a recession, the devices to be connected were late in arriving and treated with equal suspicion, and four years passed before adoption became widespread.

With FICON, history has repeated itself in many ways. Launched by IBM on S/390 in 1997, it was clearly a technically superior product in the many ways described in this bulletin. For almost four years, the only devices that would connect via FICON were tape drives (an important improvement for backup and recovery) and printers. Only in 2001 did IBM finally add FICON connectivity to its Enterprise Storage Server (a.k.a. "Shark"). This again happened during a major economic downturn, when enterprises slowed their adoption of new technologies. But there are significant differences this time that portend an accelerated rate of FICON adoption in 2002. This time the concept of fiber is not new and SAN technology is widely accepted in and outside the mainframe world. Storage and mainframes continue to have strong growth. Today's directors, first developed to accommodate ESCON, are now based on standard Fibre Channel, and FICON is deployed on those same directors. Furthermore, FICON will evolve as Fibre Channel (FC) and those directors evolve, albeit a little behind the FC evolution, because FICON does so much more.

History indicates that the time is right for FICON.

system does not become outdated with the passage of time, increasing the effort of upgrading later. The truth is that technologies change, usually for the better. Our resistance to change has more to do with extending the return on in-place assets (including hardware, software and people). Moving forward almost always costs money. Deferring these costs is justifiable in many ways, but it may be detrimental when the financial delay means that the business benefits are also delayed.

The benefits are straightforward: faster data retrieval and storage, more capacity to do work, more efficiency in using the communications network between mainframes and storage subsystems, and greater distance in separation of data centers. Your determination of return on investment is based upon these benefits, which you must weigh against the costs.

Faster Data Retrieval and Storage

Everyone wants to go faster, but it is important to determine your mainframe system bottleneck. **Increasingly, it is not the horsepower (MIPS) of the mainframe that is slowing down processing, but the amount and rate of input and output (I/O) that is required by traditional transaction processing and rapidly-growing e-business.** More customers and employees want more access to more data, more frequently. This is mission-critical to most enterprises, so the alternative of not doing it does not exist. But all of this activity creates a huge amount of I/O between mainframes and attached storage devices (disk arrays and tapes). **The faster that you can move data and files to and from the storage devices, the faster that your mainframes can hum, the faster that real work can be done by customers and employees.**

FICON's ability to deliver significant I/O performance improvement over ESCON determines the nature of the benefit.[4] Because each FICON connection can deliver about six times the data flow, and about five-to-seven times more I/Os per second[5], FICON offers the ability to process significantly more work. Of course, as they say in the car commercials, "actual mileage may vary." It really depends on your applications, your workload, and your storage distribution. **But FICON'S bigger "pipes" will solve a lot of the current I/O bottlenecks.**

More Capacity to Do Work

Moving I/O faster will increase performance of systems, as previously discussed. But there is another parameter to consider – capacity. You probably want to work faster AND you want to do more work. They go hand-in-hand, but affect an enterprise differently. If you only do the current amount of work faster, you have only solved a tactical problem. **Doing more work is a strategic necessity for most enterprises.**[6]

FICON gives you both, a faster rate and increased capacity. And because that capacity is deployed much more efficiently[7], you get an even bigger benefit.

More Efficiency in the Communications Network

Think again about the pneumatic tube system described on page 1. Only one carrier can travel through the tube at a time and in only one direction. That is why there often were multiple tubes at cash registers. Singular and unidirectional: that describes how ESCON works. FICON can work in multiple streams and in both directions simultaneously. **Not only can you carry more work with FICON to more destinations, 16 times greater than ESCON, you can do it with far greater efficiency. So you have two very significant benefits from which to choose: increased channel capacity for storage and processing growth or channel consolidation.**

Birdseye View of ESCON and FICON

There is a range of deployment possibilities between the extremes of being all ESCON and all FICON connected. There are many issues that we have omitted from the exhibits that follow, including remote tape and printers and standalone Coupling Facilities for Parallel Sysplex. On the next page you will find three exhibits, starting with ESCON only (Exhibit 1A), moving to FICON by adding FICON connectivity between the mainframe and an ESCON director (1B) and ending with mixed but segregated ESCON and FICON networks (1C). And the storage vendors may have FICON upgrade options for their existing arrays as well, adding to your issues to consider.

[4] Also important, but a little more technical, is FICON's ability to simultaneously address significantly more storage device addresses. As business analysis grows in importance, there are more data sources, and as databases grow, increased addressability becomes significant.

[5] FICON does this by multiplexing and also by Channel Command Word (CCW) pipelining, which batches session level commands to streamline I/O.

[6] Don't forget that workloads tend to rise to eventually consume the available capacity.

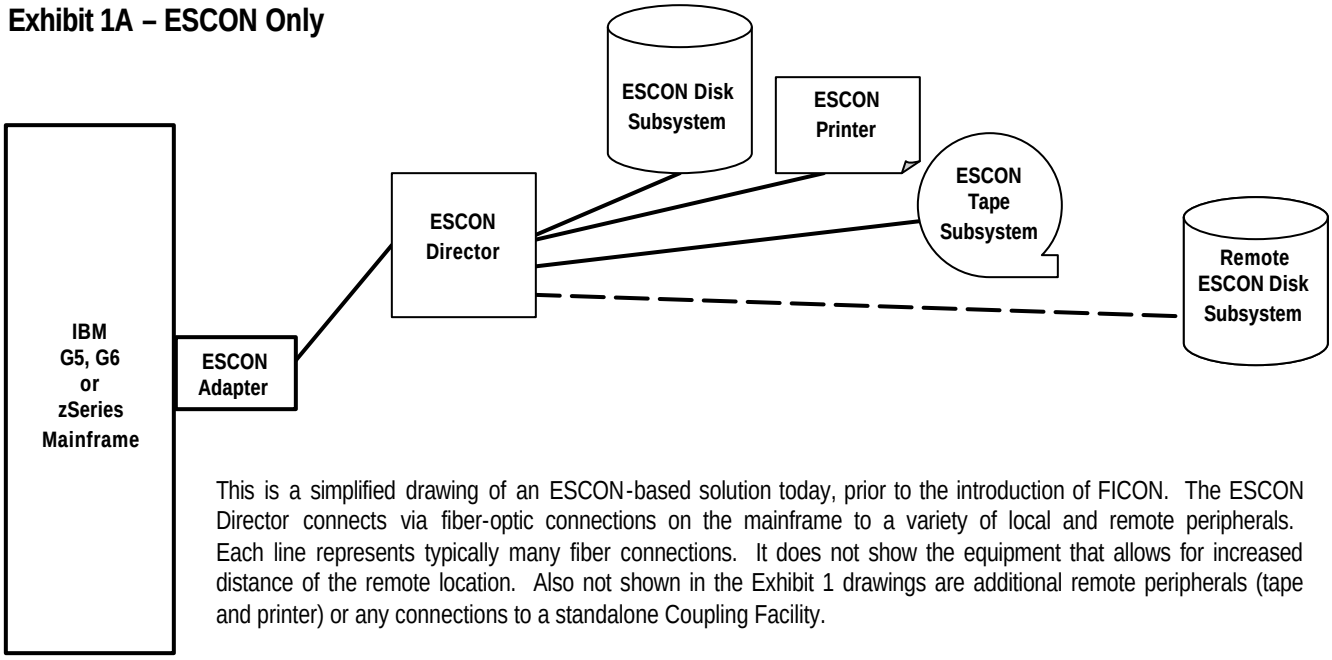
[7] IBM's second generation FICON adapter, FICON EXPRESS (launched in October 2001 for the zSeries only) can support both normal I/O traffic and intrasystem connectivity (CTC) traffic concurrently within the same channel. ESCON requires separate dedicated channels. This further enhances FICON's efficiency.

Greater Distance Between Data Centers

There is one further big driver in the FICON decision. FICON can connect devices that are 10km apart, more than three times the available standard distance with ESCON. And with FICON there is no performance droop (inability to go at full speed) as the distance increases, a serious ESCON limitation. This distance can be increased up to 100km for FICON (with repeaters), surpassing about 30km for ESCON, although the ESCON will begin to exhibit significant droop at that distance.

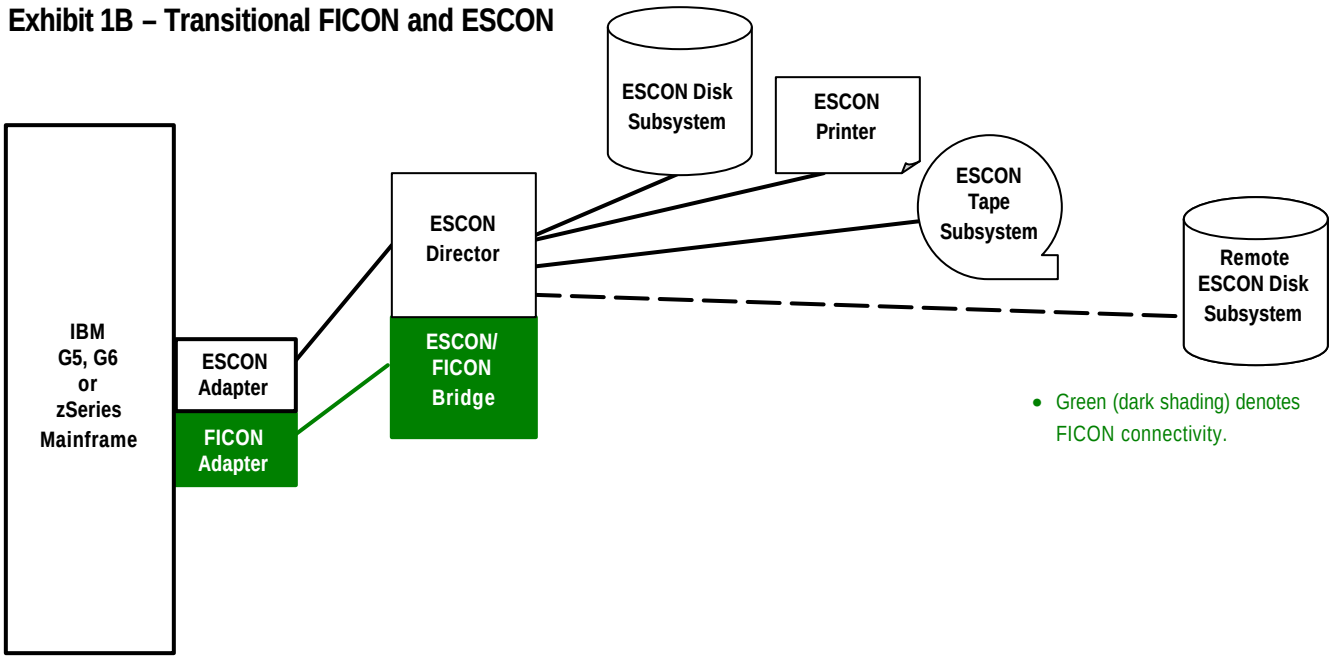
More and more enterprises are deciding that the contingency plans that they made for recovery from a disaster (of any sort) were jeopardized by having their remote data center too close to their primary site. FICON gives them much more distance at which to place devices.

Exhibit 1A – ESCON Only



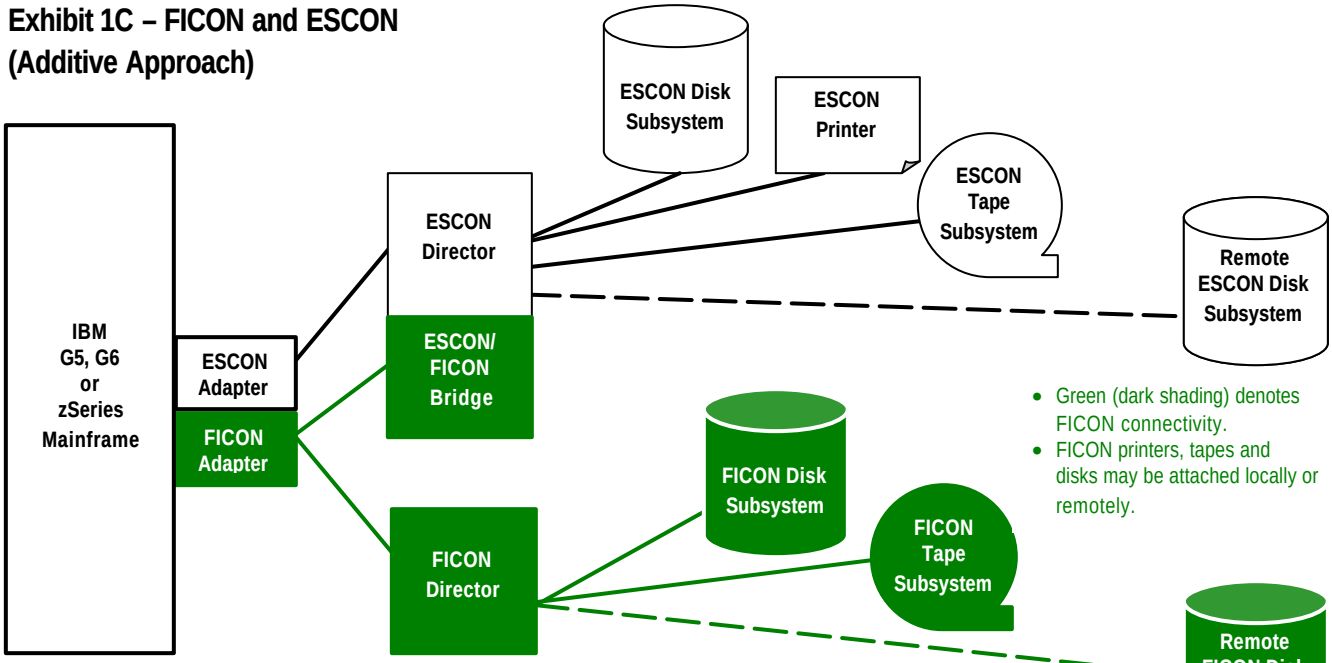
This is a simplified drawing of an ESCON-based solution today, prior to the introduction of FICON. The ESCON Director connects via fiber-optic connections on the mainframe to a variety of local and remote peripherals. Each line represents typically many fiber connections. It does not show the equipment that allows for increased distance of the remote location. Also not shown in the Exhibit 1 drawings are additional remote peripherals (tape and printer) or any connections to a standalone Coupling Facility.

Exhibit 1B – Transitional FICON and ESCON



A transitional approach is the addition of an ESCON/FICON bridge to the ESCON director, permitting existing ESCON peripherals to take advantage of FICON capabilities, but only from the mainframe to the director. This protects the investment in ESCON peripherals.

Exhibit 1C – FICON and ESCON (Additive Approach)



Most likely, enterprises will want to commit to FICON by adding a new FICON Director (or piggybacking FICON onto an existing Fibre Channel Director) plus FICON adapters on the mainframe, plus FICON-capable peripherals, resulting in separate ESCON and FICON networks (unless there is a transitional ESCON/FICON bridge), each capable of achieving its rated potential. Applications in need of a performance, capacity, or distance boost would be deployed on the FICON network. The older ESCON equipment and network eventually can be decommissioned.

Comparing ESCON to FICON

Exhibit 2 on the next page summarizes many of the important characteristics. Only the characteristics of single mode FICON implementation are listed. Multi-mode (short wavelength) has a maximum distance of 550 m. The FICON advantage is noted, but with each row there is a technical discussion that is beyond the scope of this bulletin. All of the vendors (mainframe, director, storage and other peripherals) stand ready to help enterprise IT departments make the appropriate decisions. From Exhibit 2, **FICON's advantages are obvious, if you have the need.**

The Costs Associated with Moving to FICON

Moving to FICON is a cost-of-the-benefit decision. Many of the benefits have been described. It is difficult to assign a financial value to the enterprise of faster transactions, faster update, and faster backup. But you already know whether these are enterprise issues. If they are a problem, or are soon to become one, and FICON will alleviate one or more of these problems, then the issue is more of whether the cost is in line with the benefits. **Costs will be different for new environments (e.g., expansion) than for modification of existing environments.**

Expanding with FICON

Let's begin with the conclusion. **For new installations, FICON is about a third of the cost of ESCON for the same amount of network capacity.** If you are adding capacity or installing a new system and storage, it is a "no-brainer" decision. The key to this is understanding that the potential of a six-fold improvement in capacity (and significant improvement in overall performance) comes at no increase in cost. Let's dissect this.

Adapters[8]

If we assume an IBM zSeries/z900, the cost of an ESCON adapter with 8 ESCON ports is about the same as a 2-port FICON adapter. **If you look at capacity, there is much more usable bandwidth with the FICON adapter. And as we know well, demand is likely to rise to consume the available capacity.**

Directors[9]

There is cabling from the mainframe to a high-performance switch called a director. (Let's leave the

[8] An adapter sits inside the mainframe and connects the mainframe to its communication channel and ultimately to an ESCON or FICON director.

[9] A director is a high port count switch with internal redundancy and the ability to hot-swap degraded components.

Exhibit 2 – Comparing ESCON to FICON

Cabling	ESCON	FICON (long wave)	FICON advantage
Laser type	Short wave laser, multi-mode	Long wave laser, single mode	Greater distance
Bidirectional	Half duplex	Full duplex	Better bandwidth utilization
Maximum distance	3 km; 6 km with RPQ	10 km; 20 km with RPQ	Fewer distance limitations
(Further distances might be achieved with additional technology)	9 km without data droop; approximately 30 km with repeaters	100km without data droop, with repeaters	More "remote" for mirroring
Connectivity	**ESCON**	**FICON (long wave)**	**FICON advantage**
Unit address per channel	1000	16,000	FICON allows networks greater granularity of communication
Device attachments per port	4000	64,000	FICON allows networks to scale more
Frame Size	1K; Cannot mix small and large blocks.	2K; Can mix.	More data per frame FICON gives more flexibility
Channel Bandwidth	17MB/sec	100 MB/sec with FICON EXPRESS	FICON gives more throughput
I/Os Per Second	1200	7500 with FICON EXPRESS	FICON handles more I/O

Note: FICON can also be delivered over short wave laser/multimode fiber, but the distance limitations shrink to 550 m.

specifics of cabling until later.) The first directors were for ESCON, which paved the way for fiber optics as a connectivity vehicle.[10]

ESCON adapters require connection to a director that speaks ESCON protocols. In the past, that was a single-purpose device. ESCON directors were and are expensive, on a per-port cost basis. (Remember that ESCON is a 10-year old technology.) While some ESCON directors can be equipped with FICON connectivity to the mainframe, it should be viewed as a transitional option.

Today there are general-purpose directors that do open Fibre Channel protocols and also do FICON protocols. These are very competitively priced on a per-port cost basis. Remember that each FICON port can handle roughly four-to-eight times the traffic as a special-purpose ESCON director port. So FICON going through a Fibre Channel director is cheaper per port and each port is faster. Not free, but a bigger ROI. You may want an equal number of ports (for capacity expansion) or may want to consolidate onto fewer ports. **Either way, a new FICON director will cost less than a new ESCON director.**

Storage connectivity

There is additional cabling from the director to the storage array or tape drive (see cabling below). Each array and drive must be able to handle ESCON and/or FICON protocols. Within a specific storage device, it typically costs no more per port for one than the other, but this is something that you will have to discuss with your storage vendor. Assuming that the cost per port is similar, FICON has the same performance/capacity advantage over ESCON. Because only the top-of-the-line storage devices can be FICON-equipped, performance and capacity are usually critical determinants; the vendors want you to use FICON to get the most out of their storage.

Cabling

Cabling is a big issue. ESCON uses what is now considered an older fiber cable.[11] FICON optimally uses a more modern fiber, less than 20% of the earlier diameters.[12] This new fiber gives FICON the superior performance and capacity and distance described. **While FICON protocols can be transported over older cabling, the basic**

[10] Mainframes have been doing Storage Area Networks (SANs) since 1990.

[11] ESCON uses multimode cabling, either 62.5 or 50-micron in size, which has also been used for ATM (Asynchronous Transfer Mode), FDDI and Ethernet.

[12] Single mode 9-micron cabling is unaffected by modal dispersion. The signal carries farther than with 62.5 or 50.

technology limits of this older cabling means that the costs go up[13] **and the performance, capacity, and/or distance goes down.**[14]

Adaptations to an existing Environment

Remember that the discussion began by presuming "new system and storage". **It is a "no brainer" decision, when comparing new ESCON versus new FICON, including the cabling.** When you compare new FICON to in-place ESCON, it will cost more (when compared to a sunk and long-since-depreciated cost). New fiber, new adapter cards, new directors (or at least new port capacity on existing directors), and new storage devices (or new capabilities added to your existing storage device(s)) all cost hard dollars. Plus you have to add the cost of the transition, which might include services from a director or storage device vendor[15]. **So FICON is far from free, but is most likely well worth the investment, if you value performance, capacity, efficiency, and/or distance.**

There is another complication. If the mainframe is not a z900, as we just assumed, but an IBM G5 or G6, then the FICON capabilities[16] on the mainframe side are reduced and the cost-benefit analysis yields a less clear alternative to ESCON. It is still better in each dimension, but not the same ROI as with zSeries.[17]

Whether zSeries or G5/6, there is another possibility to protect in-place assets. You can install FICON in the mainframe and use a bridge conversion to connect it to legacy ESCON storage devices. This gets you moving in the right direction, but only takes you part of the way toward the full FICON potential, which requires native FICON on storage disk arrays and tape systems.

So you have a lot of possibilities:

1. **Stick with ESCON** (the cheapest thing to do) and live with your current performance, etc. (Best for those systems/applications that do not indicate stress or those with no growth requirements.)
2. **Stick with ESCON, but use a FICON bridge to access ESCON peripherals**, beginning the transition to FICON assets. (Best if you want to preserve investment in an existing ESCON director and existing ESCON peripherals and just improve mainframe-to-director I/O performance and/or increase distances.)
3. **Add a FICON network with a FICON director, to take advantage of new FICON-based storage/peripherals.** (Best to for high-demand, high-growth applications.)
4. **Do a combination of (2) and (3), moving the highest-priority, most-demanding applications to FICON and using ESCON for less-demanding applications.** (Best way to optimize old and new assets.)

Consolidated Storage Bonus

Soon there may be an opportunity to combine your FICON and open Fibre Channel environments on the same directors, using zoning to segregate the traffic.[18] While consolidating physical resources, there is a management trade-off here. Mainframe use of single-byte addressing for I/O devices precludes the use of interswitch links (ISLs) used by open FC systems (which use a three-byte port address) to cascade switches. In FICON mode, some switch management systems will not configure FC E_ports for ISL. If your mainframe or storage system is of a size to utilize a large director, this may not matter.

Conclusion

If you have FICON-ready mainframes and storage devices and your system or applications are stressed, you need to consider FICON. If you have some mileage left on legacy devices, it still may be worthwhile to move your constrained apps to FICON, and plan on moving more over as additional mainframe or storage capacity is purchased. **A FICON decision probably makes sense in 2002.**

[13] To use multimode for FICON, mode-conditioning patch cables must be used at each end. These complex and expensive devices may cost about the same as installing new single mode fiber.

[14] Using ESCON/FICON bridges with multi-mode fiber, FICON's maximum distance drops to 550 m without repeaters. This is a limitation of Fibre Channel technology, not FICON.

[15] Non-disruptive migration from ESCON or ESCON/FICON Bridge to native FICON is relatively straightforward, because channel path groups can function in a mixed ESCON/FICON mode. FICON paths are added to the existing channel path group designation. After installing the new hardware (FICON directors or bridges, FICON adapters on legacy storage, and new cabling, if desired), the mainframe will start using the new paths. Redefining the channel path groups will non-disruptively remove the obsolete connection. This method presumes sufficient ports to support old and new configurations.

[16] Measured in performance, capacity, efficiency and/or distance.

[17] The ROI has different variables, but the overall evaluation is very similar. Since the costs associated with a G5/6 are much lower than the zSeries, the ROI has a reduced hurdle rate, in terms of performance required to be advantageous.

[18] Storage vendors should certify these mixed FICON/FC director capabilities by mid-2002, for use in selected environments.

About The Clipper Group, Inc.

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