FICON – WELL, ISN'T THAT SPECIAL?

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Since its introduction in 1994, Fibre Channel has become well recognized as the leading technology choice for storage attachment - it delivers superior scale, reliability, dependability and manageability. That much is pretty obvious. What's not so obvious is that in the late 1990s, when Fibre Channel was evolving, the S/390 mainframe architects realized that this technology would provide an excellent "next" underlying transport for mainframe I/O, replacing the technology being used at that time known as ESCON.

With Fibre Channel as the underlying transport, work began in the INCITS T11 standards body to define a protocol mapping that addressed the particular needs of the mainframe:

1. Predictable and superior performance even with increased distances between the server and storage devices, and
2. Enhanced reliability, availability, scalability and security, beyond what is provided by Fibre Channel natively to all ULPs.

Described as the Fibre Channel "Single-Byte Command Code Sets Mapping Protocol," this new protocol became known to the industry as FICON (Fiber Connection), and is the industry standard upper level protocol mapping of the mainframe S/390 architecture over Fibre Channel links.

Fibre Channel with Umpf!

Enterprise class I/O performance is more than just a measure of the data transfer rate on a single link. It also includes efficiencies built into the Upper Layer Protocol (ULP) for the exchange of commands and data. An example of this is how the S/390 (mainframe) I/O architecture works in conjunction with the FICON protocol to allow an application to pass a series of commands (possibly thousands) that include a mixture of read and write operations to the HBA with a single invocation from the host. In addition, FICON allows a host to access non-contiguous portions of a disk in a single I/O operation. These characteristics of FICON improve application work efficiency, which is the ultimate purpose.

When it comes to scale, FICON leverages and extends the value of the mainframe I/O subsystem to uniquely provide extreme levels of virtualization and sharing. Even in an I/O intensive workload environment, the host processors are able to focus their time and energy on the business logic of the workload, while the I/O subsystem and FICON HBAs handle the tasks of path selection and I/O operation initiation, execution and completion.

The most significant growth in both I/O rates and throughput for FICON has come from the definition of a new mode of operation, called Transport Mode. The architecture of the original mode, known as Command Mode, was more closely modeled after its predecessor ESCON, while Transport Mode encapsulates I/O operations in a way that allows it to take advantage of the same special hardware assists and firmware accelerators built into Host Bus Adapters (HBAs) for Fibre Channel Protocol (aka 'SCSI over Fibre Channel').

Traditional mainframe environments involve complex SANs that span multiple sites, configured for high availability and disaster recovery. As a result, optimizing performance at distance is a key concern for FICON. Fibre Channel has some built-in mechanisms for handling distance, including flow control mechanisms such as buffer-to-buffer credits between neighboring endpoints *(Ed: FCIA has a fantastic webinar on long-distance Fibre Channel that you can watch at fibrechannel.org).*

FICON goes even further. Since FICON allows you to *pipeline* multiple command and data frames between host and storage endpoints without having to wait for the status after each command, a feature called IU (Information Unit) Pacing is used to prevent over-running the endpoints. IU Pacing support includes a particularly unique feature that *dynamically* adjusts for distance.

A Reliable Source

Fibre Channel provides various means to ensure the integrity of both the physical link itself and the communications flowing over the link, yet built into FICON are additional measures to ensure an even higher level of integrity required for the most sensitive enterprise operations that run on mainframes.

Again, because FICON supports pipelining of commands and data, it provides mechanisms to help associate responses with the multiple commands sent. And because the integrity of data is of utmost concern in mainframe applications, FICON provides its own *end-to-end* Cyclic Redundancy Check (CRC) on top of the link CRC that is part of the Fibre Channel frame-signaling specification.

Fibre Channel provides an option that fabrics may deploy (known as High Integrity Fabrics) to provide security measures regarding switch membership in the fabric, notifying hosts when cables/routes are changed. FICON channels require these measures to be in place in any fabric to which they attach.

With the advent of Transport Mode some additional resiliency mechanisms were added. One such mechanism allows storage controllers to request a temporary “pause” of work requests in order to enable concurrent firmware updates, and a second mechanism allows a host to interrogate the state of an existing I/O operation to facilitate the reliable detection of “lost initiative” situations.

What’s So Special?

Mainframe environments require special characteristics to achieve the reliability, availability, scalability and security that customers demand. Fibre Channel captures these characteristics in the FC-SB architecture and the FICON transport defines a system with superior abilities to share IO across multiple systems, maintain application performance over distance, insure data integrity and security, and provide optimal protocol efficiency. It’s this combination of characteristics that makes FICON so special