FICON Express channels were a new generation of FICON channels that offered improved performance capability over previous generations of ESCON channels. IBM has made significant improvements to FICON channels since this product was initially shipped in 1999.

**FICON and zHPF protocol in System z**:
- High Performance FICON for System z (zHPF) was introduced in October 2008. Both FICON and zHPF are designed to support attachment to ECKD™ devices.
- The High Performance FICON for System z (zHPF) was introduced in October 2008.
- In February 2009, IBM announced the IBM Enterprise Storage Server (ESS) Express with zHPF capabilities.

**FICON Express32 channel**
- Maximum active 32 FICON 10Gbps.
- Single link limit for zHPF data transfers.
- In July 2009, FICON Express32 was introduced on System z10.
- Maximum support of 529 zHPF 10Gbps.
- 64k byte limit for zHPF data transfers.
- In July 2010, additional support on IBM zEnterprise 196 (z196) was introduced.
- Extension to multi-tracks of zHPF data transfers.

**FICON ExpressSS channel**
- Introduced a hardware data model for more efficient zHPF data transfers.
- FICON ExpressSS channel became the first channel with hardware specifically designed to support zHPF.
- zHPF performance: an extension to the FICON architecture designed to improve the execution of small block I/O requests.
- zHPF streamlines the FICON architecture and reduces the overhead on the channel processors, control units, switch ports, and links by improving the way channel programs are written and processed.
- To understand how the zHPF protocol improves upon the FICON protocol, one needs to review the relevant characteristics of FICON channel processing.

- A FICON channel program consists of a series of Channel Command Words (CCWs) which form a chain.
- The command code indicates whether the I/O operation is going to be a read or a write from disk and the field specifies the number of bytes to be transferred.
- When the channel finishes processing one CCW and either a command chaining or data chaining flag is turned on, it processes the next CCW, and the CCWs belonging to such a series are said to be chained.

**FICON ExpressSS**
- The CCW is the original I/O operation used for communications with the channel subsystem.
- To remove the CCW overhead, the new channel introduces a read-ahead mechanism, which allows the processor to prefetch data in the I/Os per second bar chart. Each of the recent generations of FICON Express channels, has two bars, one of which tracks the maximum capability using the FICON protocol exclusively and another that shows the maximum capability using the zHPF protocol exclusively.

For an additional perspective, an ESCONc performance benchmark measured in the late 1990s achieved bandwidth and response times.

**ExpressSS channel performance results**
- The maximum number of open exchanges or the number of I/Os that can be simultaneously active on FICON ExpressSS channels is designed to be significantly higher with the zHPF protocol compared to the FICON protocol.
- An open exchange is an I/O that is active between the channel and control unit and includes I/Os that are cache hits, which begin transferring data back to the channel immediately and those that are cache misses which might experience a delay of several milliseconds before the data can begin transferring back to the channel.
- Since higher I/O activity levels are both possible now and expected to increase in the future with zHPF, the maximum number of open exchanges or the number of I/Os that can be simultaneously active on small block I/Os per second (4k bytes per I/O that can be processed).

**FICON ExpressSS channel performance**
- The Mediation Manager component of DFSMS™ detects whether the device supports zHPF or not and builds the appropriate channel program.
- Media can achieve the 2GB prefecture Speed optimization with FICON ExpressSS channels.

**Linux on System z operating system**
- Several FICON ExpressSS channel performance measurements were also completed using the Linux on System z operating system.
- The results achieved with Linux on System z are similar to those achieved with z/OS.

For the FICON ExpressSS channel performance measurements, the following configuration was common across all tests:

- The hardware data router transfers data both to and from the channel to the System z Enterprise memory more efficiently than previous generation channels for I/O operations using the zHPF protocol.
- As a result improvements can be seen in both response times and maximum throughput for I/Os per second and MB/sec for workloads using the zHPF protocol on FICON ExpressSS channels.

**DB2 - One hundred percent of DB2 I/O is now convertible to zHPF for optimal I/O resource utilization, bandwidth and response time.**
- Format write throughput increases up to 52% (4K pages)
- Latency: two delays. Reorg writes to shadow / restores
- Preformatted throughput increases up to 100%
- Insert preformatting is asynchronous, except when allocating a new extent
- Set I/O case: cache hit response time increases by up to 30%
- Sequential prefetch throughput increases up to 19%
- Dynamic prefetch throughput increases up to 23% (40% with SSD)
- Disorganized index scans
- DB2 10 throughput increases up to 111% (more with 9K pages)
- Together, DB2 12 and zHPF is up to 11% faster
- Skip sequential index-to-data access
- Cache misses is 3 to 4 times faster

**FICON Scale, Efficiency and RAS**
- At the data density behind a CU and device increase, scale I/O rates and bandwidth to grow with the data
- Leverages HBA hardware optimizations done while preserving System z QoS
- Significant improvements in I/O rates (4-5x) for small block transfer
- Improved I/O bandwidth (ability to b-directionally fill the link at 8 Gbps)
- New ECKO commands for improved efficiency
- Improved first failure data capture
- Additional channel and CU diagnostics for debugging MIF conditions.