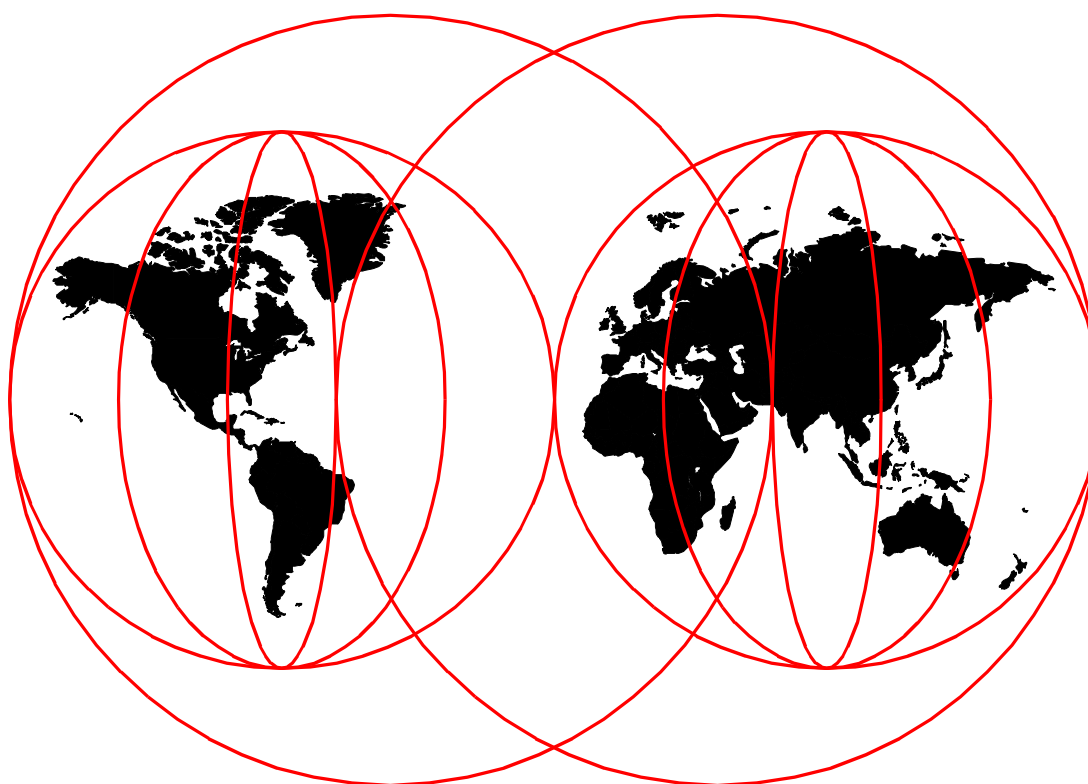


# FICON (FCV Mode) Planning Guide

*Ken Trowell, Franck Injey, John Stimson*



**International Technical Support Organization**

[www.redbooks.ibm.com](http://www.redbooks.ibm.com)





International Technical Support Organization

SG24-5445-00

## **FICON (FCV Mode) Planning Guide**

March 2000

**Take Note!**

Before using this information and the product it supports, be sure to read the general information in Appendix B, "Special notices" on page 127.

**First Edition (March 2000)**

This edition applies to the IBM 9672 Generation 5 and 6 at LIC driver level 22 and 26 (or higher) planning to install FICON channels in FCV mode, and the IBM 9032 Model 5 ESCON Director at an LIC level of 5.1 or higher to support the FICON Bridge adapter.

Comments may be addressed to:  
IBM Corporation, International Technical Support Organization  
Dept. HYJ Mail Station P099  
2455 South Road  
Poughkeepsie, NY 12601-5400

When you send information to IBM, you grant IBM a non-exclusive right to use or distribute the information in any way it believes appropriate without incurring any obligation to you.

---

# Contents

<b>Figures</b> .....	v
<b>Tables</b> .....	vii
<b>Preface</b> .....	ix
The team that wrote this redbook .....	ix
The people that helped make this a better redbook .....	ix
Comments welcome .....	ix
<b>Chapter 1. Introduction to designing a FICON configuration</b> .....	1
1.1 S/390 9672 Generation 5 and 6 I/O connectivity .....	1
1.2 S/390 ESCON and FICON Channel connectivity support .....	2
1.3 S/390 FICON Channel FCV mode configuration support .....	4
1.3.1 S/390 FICON design considerations .....	4
1.4 FICON (FCV) performance and ESCON to FICON aggregation .....	5
<b>Chapter 2. ESCON to FICON assessment</b> .....	7
2.1 ESCON to FICON does it apply .....	7
2.2 Quick assessment .....	9
2.3 Planning approach .....	9
<b>Chapter 3. FICON (FCV) Channel attachment and operation</b> .....	13
3.1 S/390 FICON channel topology and architecture .....	15
3.1.1 FICON channel FCV mode of operation .....	15
3.1.2 FICON channel FC mode of operation .....	16
3.2 I/O connectivity evolution, Parallel and ESCON .....	16
3.2.1 Parallel channels in a S/390 LPAR environment .....	16
3.2.2 ESCON (EMIF mode) channels in a S/390 LPAR environment .....	17
3.3 I/O connectivity evolution to FICON FCV mode .....	17
3.4 I/O connectivity evolution FICON FC (native) mode .....	18
3.5 Serial channel frame process .....	19
3.6 FICON Bridge adapter .....	21
3.6.1 FICON (FCV mode) channel I/O operation .....	22
3.7 Fibre Channel architecture .....	24
3.8 ESCON and FICON (FCV) implementation .....	25
<b>Chapter 4. 9672 FICON channel installation support</b> .....	27
4.1 9672 Resource requirements by channel type .....	47
<b>Chapter 5. 9032 Model 5 ESCON Director</b> .....	49
5.1 Port card plugging Considerations .....	50
5.2 FICON Bridge adapter channel topologies .....	56
5.3 OS/390, HCD, and HCM - 9032 Model 5 definition support .....	57
<b>Chapter 6. FICON cabling and connectivity</b> .....	59
6.1 Mode Conditioner Patch (MCP) cables .....	63
6.2 S/390 remote site connectivity .....	70
<b>Chapter 7. S/390 Channel performance paradigms</b> .....	75
7.1 Parallel - ESCON - FICON comparisons .....	75
7.1.1 S/390 ESCON and FICON operation .....	76
7.1.2 S/390 Parallel Channel .....	76

7.1.3 S/390 ESCON Channels . . . . .	77
7.1.4 S/390 FICON Channels in FCV mode . . . . .	77
7.1.5 S/390 FICON Channels in native mode . . . . .	78
7.1.6 S/390 FICON Channel benefits . . . . .	78
7.1.7 S/390 FICON Channel - CU intermixing . . . . .	79
<b>Chapter 8. FICON performance . . . . .</b>	<b>81</b>
<b>Chapter 9. S/390 FICON (FCV) configuration support . . . . .</b>	<b>83</b>
9.1 ESCON control unit configuration . . . . .	85
9.2 FICON (FCV mode) channel benefits . . . . .	86
9.3 FICON (FCV mode) connectivity recommendations . . . . .	87
9.3.1 FICON (FCV mode) channel architecture rules . . . . .	88
9.3.2 FICON (FCV mode) channel to CU characteristics . . . . .	89
9.4 Basic FICON configuration design . . . . .	89
9.4.1 FICON design awareness areas . . . . .	92
9.5 ESCON and FICON (FCV mode) channels connectivity differences . . . . .	93
9.5.1 ESCON (CNC) channel connectivity to LCUs . . . . .	94
9.5.2 FICON (FCV mode) channel connectivity to LCUs . . . . .	95
9.6 ESCON and FICON configurations with fewer channels . . . . .	98
9.7 Remote site ESCON and FICON (FCV mode) connections . . . . .	100
9.8 ESCON and FICON connectivity intermix . . . . .	101
9.9 Maximum I/O concurrency exploitation . . . . .	103
<b>Chapter 10. S/390 FICON (FCV) CTC support . . . . .</b>	<b>109</b>
<b>Chapter 11. FICON (FCV) configuration scenarios . . . . .</b>	<b>111</b>
<b>Chapter 12. ESCON to FICON aggregation . . . . .</b>	<b>117</b>
<b>Chapter 13. FICON (FCV) configuration design . . . . .</b>	<b>121</b>
13.1 ESCON (CNC) to FCON (FCV) workload factor . . . . .	122
13.2 ESCON to FICON aggregation for DASD only subsystems . . . . .	122
13.3 Configuration design and planning phase output . . . . .	123
<b>Appendix A. FICON Planning Worksheet . . . . .</b>	<b>125</b>
<b>Appendix B. Special notices . . . . .</b>	<b>127</b>
<b>Appendix C. Related publications . . . . .</b>	<b>131</b>
C.1 IBM Redbooks publications . . . . .	131
C.2 IBM Redbooks collections . . . . .	131
C.3 Other resources . . . . .	131
<b>How to get IBM Redbooks . . . . .</b>	<b>133</b>
IBM Redbooks fax order form . . . . .	134
<b>Glossary . . . . .</b>	<b>135</b>
<b>Index . . . . .</b>	<b>141</b>
<b>IBM Redbooks evaluation . . . . .</b>	<b>143</b>

---

## Figures

1. 9672 Generation 5 and 6 I/O connectivity . . . . .	1
2. 9672 G5 ESCON and FICON combined channel equivalence . . . . .	2
3. 9672 G6 ESCON and FICON combined channel equivalence . . . . .	3
4. S/390 FICON (FCV) configuration design activities . . . . .	4
5. ESCON to FICON enhancements . . . . .	7
6. Planning approach . . . . .	10
7. FICON channel to control unit attachment . . . . .	13
8. 9672 G5 and G6 supported I/O channels . . . . .	14
9. FICON channel to control unit connectivity . . . . .	15
10. Parallel and ESCON channel connection complexity . . . . .	16
11. FICON (FCV mode) channel connectivity . . . . .	17
12. FICON (FC mode) native, channel connectivity . . . . .	18
13. ESCON channel and links frame transfer . . . . .	19
14. FICON (FCV mode) channel and links frame transfer . . . . .	20
15. FICON Bridge adapter . . . . .	21
16. FICON (FCV mode) I/O operation and frame transfer . . . . .	22
17. FICON (FCV mode) and ESCON intermix access . . . . .	23
18. Fibre Channel standard . . . . .	24
19. S/390 ESCON and FICON (FCV) implementation . . . . .	25
20. 9672 G5 and G6 Processor - I/O cage and channel packaging . . . . .	27
21. 9672 G5 and G6 FICON channel installation . . . . .	28
22. FICON channel internal connections support . . . . .	29
23. IBM 9672 G6 internal system structure . . . . .	30
24. 9672 G5 and G6 channel capacity support . . . . .	32
25. I/O domains and STI assignment example . . . . .	34
26. STI assignments - ICB, FICON and I/O domains . . . . .	35
27. STI assignments - FICON/OSA-E/PCICC and I/O domain channels . . . . .	36
28. FICON, OSA-E, or PCICC, 1 to 18 channels install sequence . . . . .	38
29. 9672 G5 and G6 internal I/O communication structure . . . . .	39
30. FICON, OSA-E or PCICC, 19 to 24 channels install sequence . . . . .	40
31. 9672 G6 FICON, OSA-E, or PCICC, 25 to 36 channels install sequence . . . . .	41
32. 9672 G5 and G6 CHPID report (order process) . . . . .	42
33. FICON to ESCON channel equivalence and impact - 0 to 24 FICON . . . . .	43
34. FICON to ESCON channel equivalence and impact - 25 to 36 FICON . . . . .	44
35. 9672 G5 and G6 FICON, OSA-E or PCICC, 6 channels, single cage system . . . . .	45
36. 9672 G5 or G6 I/O Cage # 1, 0 to 6 FICON channels . . . . .	45
37. 9672 I/O Cages #1 and #2, 12 FICON, OSA-E, or PCICC channels . . . . .	46
38. 9672 I/O cages #1 and #2, 0 to 12 FICON channels . . . . .	47
39. 9672 resource requirements by channel type . . . . .	48
40. IBM 9032 Model 5 ESCON Director . . . . .	49
41. 9032-5 port card locations . . . . .	50
42. Recommended location for 4 FICON Bridge cards . . . . .	51
43. Recommended locations for 8 FICON Bridge cards . . . . .	52
44. Recommended location for 16 FICON Bridge cards . . . . .	53
45. FICON and ESCON Port Addresses when using recommended port slots . . . . .	54
46. 9032 Model 5 hardware changes to support FICON . . . . .	55
47. ESCON and FICON (FCV mode) valid and invalid channel topologies . . . . .	56
48. FICON (FCV mode) channel to FICON Bridge connection . . . . .	59
49. Patch panels and the FICON link connection . . . . .	60
50. FICON (FCV mode) channel connections to a multi-path CU . . . . .	61

51. FICON (FCV mode) and ESCON channels intermixed to a multi-path CU. . . .	62
52. FICON mode conditioning patch cables - requirement . . . . .	64
53. Use of FICON mode conditioner patch cables . . . . .	65
54. FICON Mode Conditioner Patch cables - construction . . . . .	66
55. FICON mode conditioner patch cables - patch panels . . . . .	67
56. FICON mode conditioner patch cables - fiber trunk cables and harness . . . .	68
57. FICON Mode Conditioner Patch cables - invalid use . . . . .	69
58. FICON fiber cabling requirements. . . . .	70
59. Local to remote site connections - two FICON (FCV mode) remote paths. . . .	71
60. Local to remote site connections - four FICON (FCV mode) local paths . . . .	72
61. Local to remote site connections - local site using intermixed paths . . . . .	73
62. FICON (FCV mode) extended distance support and IBM Filer Save . . . . .	74
63. FICON (FCV mode) design and implementation . . . . .	84
64. ESCON control unit configuration - 8 paths and 1 LCU . . . . .	85
65. IOCP definition for an ESCON connected 8 path CU . . . . .	86
66. Reduced part of a 9672 G5 or G6 CHPID report . . . . .	88
67. Invalid FICON configuration . . . . .	90
68. FICON (FCV mode) channel configuration - 8 paths and 1 LCU . . . . .	91
69. IOCP definition for an FICON (FCV mode) connected 8 path CU . . . . .	92
70. FICON (FCV mode) system design awareness areas . . . . .	93
71. ESCON (CNC) channel configuration - 8 channel paths 4 LCUs . . . . .	94
72. IOCP definition for an ESCON connected 8 path, 4 LCU control unit. . . . .	95
73. FICON (FCV mode) channel configuration - 8 channel paths 4 LCUs . . . . .	96
74. IOCP definition for FICON (FCV mode), 8 channel paths and 4 LCUs. . . . .	97
75. ESCON (CNC) channel configuration - 4 channel paths and 4 LCUs . . . . .	98
76. FICON (FCV mode) channel configuration - 4 channels to 4 LCUs . . . . .	99
77. ESCON (CNC) channel configuration - 2 channel paths to 4 LCUs . . . . .	100
78. FICON (FCV mode) channel configuration - 2 channels to 4 LCUs . . . . .	101
79. Intermixing ESCON (CNC) and FICON (FCV mode) channel paths . . . . .	102
80. ESCON (CNC) channel configuration - 16 channel paths, 8 LCUs . . . . .	104
81. IOCP definition for an ESCON connected 16 path, 8 LCU control unit. . . . .	105
82. FICON (FCV mode) channel configuration - 8 channels to 8 LCUs . . . . .	106
83. OCP definition FICON (FCV mode), 8 channel path, 8 LCU control unit . . . .	107
84. S/390 FICON (FCV) CTC support. . . . .	109
85. ESCON (CNC) to FICON (FCV) migration . . . . .	111
86. ESCON (CNC) to FICON (FCV) migration - invalid configuration. . . . .	112
87. ESCON to FICON (FCV mode) migration - rules . . . . .	113
88. ESCON and FICON (FCV mode) invalid configurations. . . . .	114
89. Invalid 9032-5 ESCON (CNC) to FICON FCV) - CUP path migration . . . . .	115
90. Valid ESCON to FICON configuration. . . . .	115
91. Valid ESCON to FICON (FCV mode) migration to LCUs . . . . .	116
92. ESCON channel to control unit configuration - aggregation candidates. . . .	118
93. IBM ESCON (CNC) to FICON (FCV) aggregation tool output . . . . .	119
94. Aggregated FICON (FCV) channel to control unit configuration. . . . .	120
95. Overall FICON (FCV mode) configuration planning sequence . . . . .	122
96. FICON (FCV mode) Impact Worksheet example . . . . .	124



---

## Tables

1. IBM single-mode FICON cabling .....	60
--	----



---

## Preface

This redbook covers the planning for S/390 FICON channels operating in FCV mode into an existing S/390 ESCON channel environment. It provides the information required for all stages of planning for the S/390 9672 G5 and G6 FICON channel in operating FCV mode. Also included is information required for planning for the installation and use of the FICON Bridge adapter in the 9032 Model 5 ESCON Director, and the OS/390 definition changes required to support the movement of control units from ESCON to FICON (FCV mode) channels.

---

### The team that wrote this redbook

This redbook was produced by a team of specialists from around the world working at the International Technical Support Organization Poughkeepsie Center.

**Ken Trowell** is a S/390 hardware processor and channel senior specialist at the International Technical Support Organization, Poughkeepsie Center. He writes extensively and teaches at IBM workshops worldwide on all areas of S/390 processors, channels and control unit architecture and connectivity. Before joining the ITSO 3 years ago, Ken worked in system support IBM Australia as a S/390 system specialist.

**Franck Injey** is a System Engineer in IBM France. He has over 20 years in supporting IBM France large S/390 customers. His areas of expertise include S/390 configuration design. He has written extensively on S/390 processors.

**John Stimson** is a Senior IT Consultant working for IBM in the United Kingdom. He has 15 years of experience in OS/390 and S/390 Server hardware. He has worked at IBM for 17 years. His areas of expertise include S/390 connectivity, Parallel Sysplex, and Server Consolidation. He has written extensively on OS/390, Geographically Dispersed Parallel Sysplex, GDPS and Peer-to-Peer Remote Copy (PPRC).

---

### The people that helped make this a better redbook

**Charlie Shapley** S/390 I/O development IBM Poughkeepsie

---

### Comments welcome

#### Your comments are important to us!

We want our Redbooks to be as helpful as possible. Please send us your comments about this or other Redbooks in one of the following ways:

- Fax the evaluation form found in "IBM Redbooks evaluation" on page 143 to the fax number shown on the form.
- Use the online evaluation form found at <http://www.redbooks.ibm.com/>
- Send your comments in an Internet note to [redbook@us.ibm.com](mailto:redbook@us.ibm.com)



## Chapter 1. Introduction to designing a FICON configuration

As with the introduction of any new technology, there are a number of new characteristics, topologies, and other functional items that need to be understood in designing an I/O configuration that will exploit the new technology. This chapter introduces the basics of these areas for the FICON channel. Later chapters cover these same areas in greater detail.

The S/390 9672 G5 and G6 support of the FICON channel allows the FICON channel to operate in one of two modes:

- FICON channel in *FCV* mode allows the accessing of S/390 ESCON interface control units with ESCON interfaces by a FICON channel in FCV mode via a 9032-5 ESCON Director FICON Bridge adapter.
- FICON channel in *FC* mode (FICON native mode) allows the accessing of FICON native interface control units either directly by a FICON channel in FC mode (FICON native point-to-point) or from a FICON channel in FC mode via a Fibre Channel switch (FC switch).

This redbook covers planning for FICON channels in an FCV mode of operation. This version of this redbook does not cover the operation of the FICON channel in FC mode (FICON native mode).

This chapter introduces basics of the support and requirements of the FICON channels in FCV mode. A FICON channel in FCV mode and a FICON channel in FC mode support different topologies and have different support requirements. Currently only the FICON channel in FCV mode is available.

### 1.1 S/390 9672 Generation 5 and 6 I/O connectivity

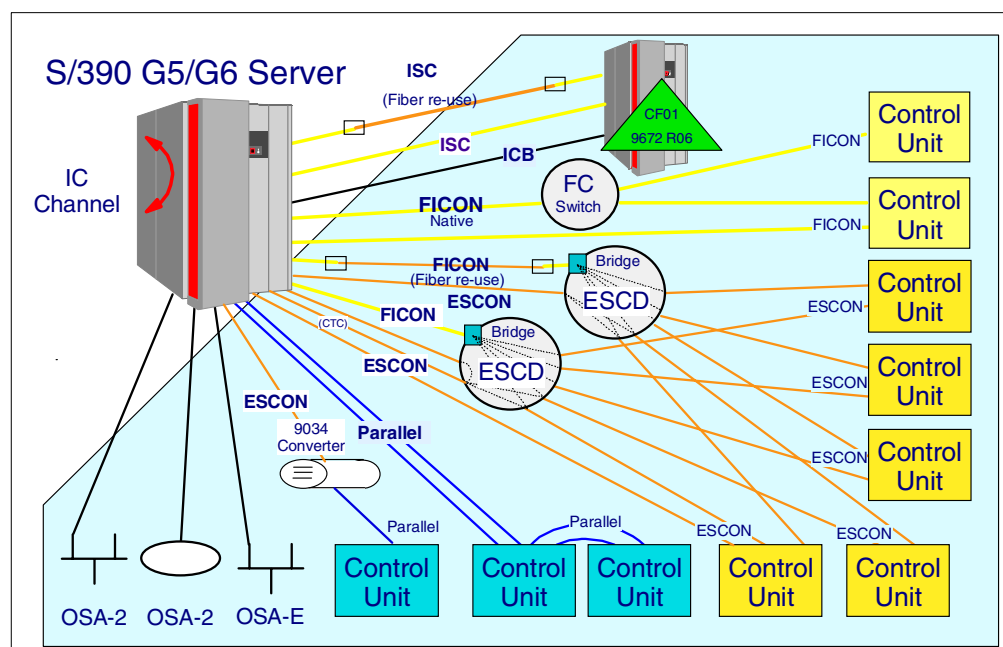


Figure 1. 9672 Generation 5 and 6 I/O connectivity

Figure 1 on page 1 shows the I/O connectivity support provided by the 9672 generation 5 and 6 family of processors. The prime serial channel to control unit support is provided by:

- ESCON channels in CNC mode - ESCON CNC mode channels support point-to-point and switched point-to-point topologies.
- FICON channels in FCV mode - FICON conversion connection to a 9032 model 5 ESCON director FICON Bridge card supports switch point-to-point connectivity.
- FICON channel in FC mode (FICON native) - the connection to a FICON native control unit is either FICON direct connect or via a FICON FCS switch connection.

## 1.2 S/390 ESCON and FICON Channel connectivity support

ESCON and FICON equivalence support, as explained below, is illustrated in Figure 2 on page 2 and Figure 3 on page 3.

### ***Equivalent channel support***

A S/390 9672 generation 5 processor supports up to 256 ESCON channels, or 168 ESCON channels and up to 24 FICON channels. A S/390 9672 generation 6 processor supports up to 256 ESCON channels, or 120 ESCON channels and up to 36 FICON channels. A FICON channel operating in FCV mode supports 8 concurrent I/O operations to S/390 ESCON control units. Therefore 24 FICON channels operating in FCV mode can support up to 192 concurrent I/O operation connections, and 36 FICON channels operating in FCV mode can support up to 288 concurrent I/O operation connections. This gives the 9672 generation 5 processor the equivalent concurrent I/O connectivity of up to 360 ESCON channels with 168 ESCON channels and 24 FICON channels installed.

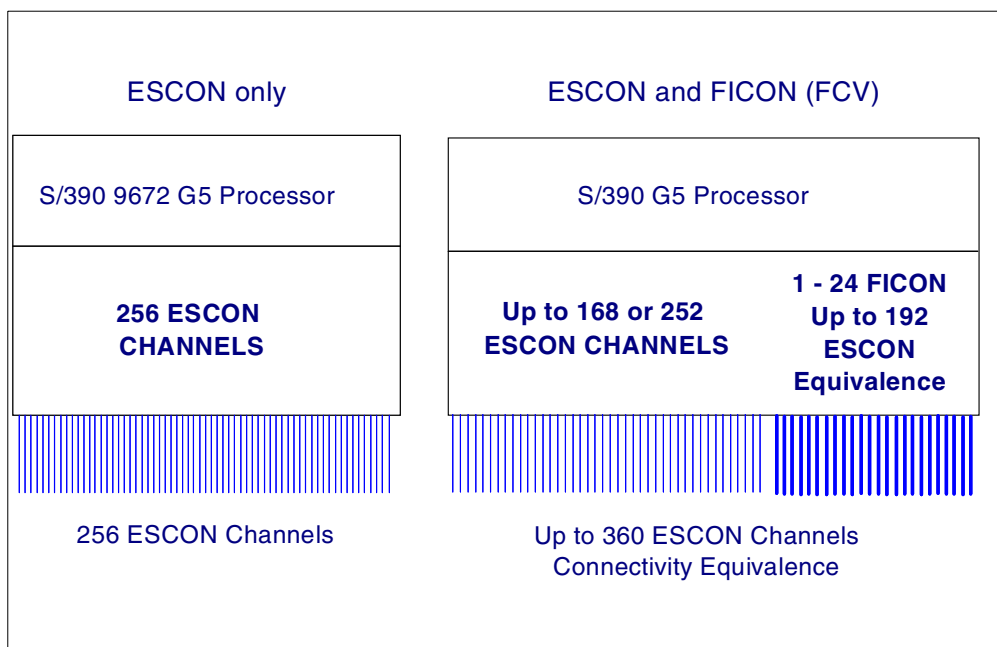


Figure 2. 9672 G5 ESCON and FICON combined channel equivalence

The 9672 generation 6 processor can have the equivalent concurrent I/O connectivity of up to 408 ESCON channels with 120 ESCON channels and 36 FICON channels installed.

Support for 36 FICON channels on the 9672 generation 6 processor will be made available in 6/00.

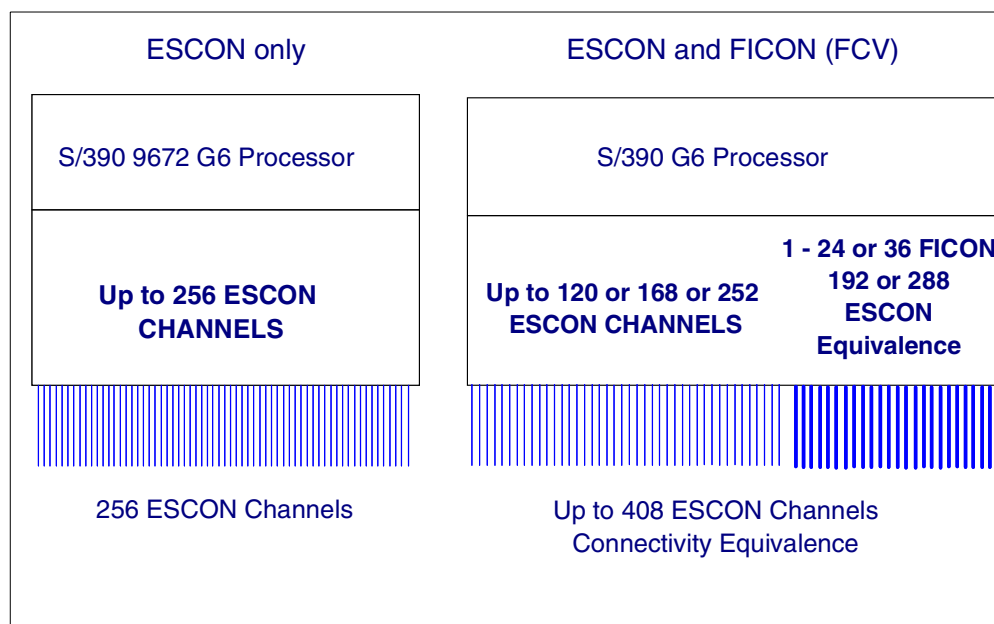


Figure 3. 9672 G6 ESCON and FICON combined channel equivalence

### **Channel device addressing support**

An ESCON channel operating in CNC mode supports 1024 device addresses. This support is increased to 16 K devices for a FICON channel operating in FCV mode.

### **Distance support**

The maximum un-repeated fiber connectivity distance for an ESCON CNC LED channel link using 62.5 micron multi-mode fiber is 3 km (if 50.0 micron fiber is used, the maximum distance for the same channel is 2 km). This same distance applies to ESCON Director to control unit links for ESCON director LED ports. For FICON channel long wavelength LASER links using 9 micron single-mode fiber, the supported distance is 10 km (20 km may be supported; you should submit an RPQ to IBM to determine this).

### **Data rate performance droop**

Data rate performance droop occurs at extended distances (over 9 km) for ESCON links. For FICON links the link distance can be increased up to 100 km before data rate performance droop starts to occur.

## 1.3 S/390 FICON Channel FCV mode configuration support

This section introduces the areas that need to be understood when designing for a successful FICON FCV mode configuration. Complete in-depth details of designing and planning a FICON FCV mode configuration are covered throughout the remainder of this redbook and they include the following areas.

1. S/390 FICON design considerations
2. ESCON to FICON channel path aggregation
3. ESCON to FICON Control Unit usage aggregation ratio guidelines
4. Other I/O configuration design changes (non-FICON)
5. Complete system I/O design, including both FICON channels and FICON Bridge adapters
6. S/390 9672 physical channel capacity review and 9032-5 port card placement review
7. FICON fiber channel requirements
8. Ordering S/390 9672 FICON channels
9. FICON software support

### 1.3.1 S/390 FICON design considerations

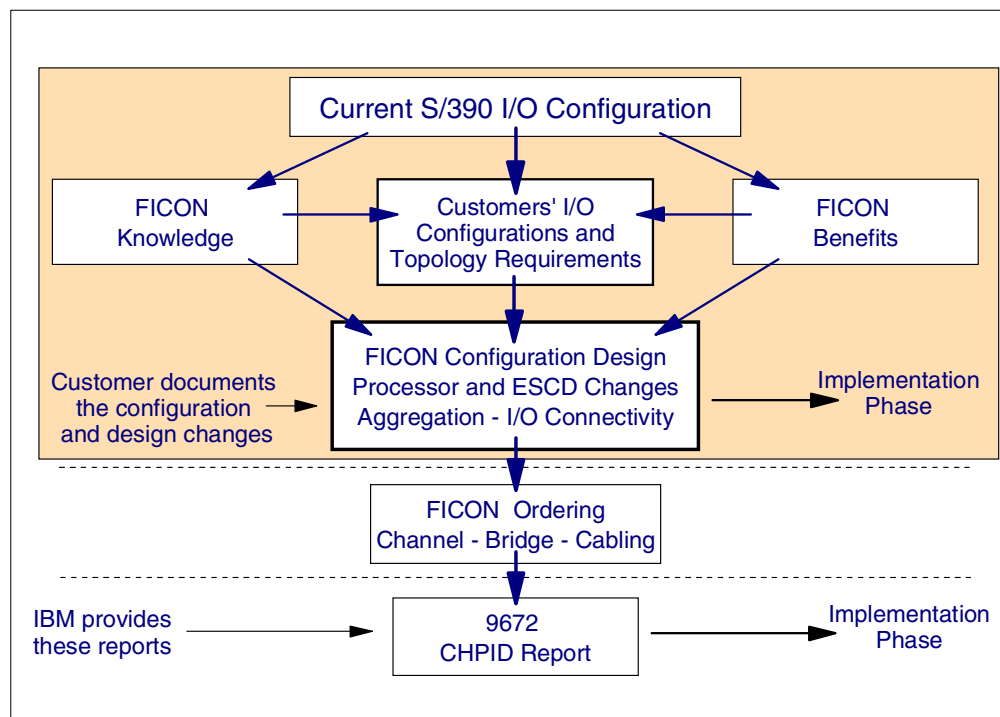


Figure 4. S/390 FICON (FCV) configuration design activities

When designing a S/390 FICON channel in FCV mode configuration you need to be aware of the following:

- FICON benefits

The needs and reasons for the customers wanting to use FICON



- Increase in the total S/390 concurrent I/O connectivity
- Un-repeated fiber distance increases
- Increase in the channel device addressing support
- Fiber consolidation
- FICON (FCV) topology rules
- FICON (FCV) channel sharing (dedicated, reconfigurable or shared)
- Remote site connectivity via FICON
- S/390 9672 channel infrastructure capacity
- Fiber cabling requirements

---

## **1.4 FICON (FCV) performance and ESCON to FICON aggregation**

To assist customers with FICON migration planning, IBM can analyze customer supplied SMF and configuration data to suggest ESCON channel candidates for aggregation onto FICON channels. Factors including current ESCON channel utilization and I/O rates, and projected FICON channel processor and FICON channel internal PCI bus utilization will be included in the analysis. Contact your IBM Sales Representative to request a FICON Channel Aggregation Analysis from the IBM Techline Organization.



---

## Chapter 2. ESCON to FICON assessment

The information provided in this chapter allows you to determine if S/390 9672 FICON channels when operating in FCV mode are applicable in helping overcome any S/390 9672 ESCON channel limitations that your systems may be currently experiencing.

---

### 2.1 ESCON to FICON does it apply

- **Today some IBM S/390 customers are experiencing limitations in their S/390 ESCON environment that S/390 FICON channels (in FCV mode) may help overcome.**
- **Enhancements to the customer's S/390 ESCON channel environment may be provided by S/390 FICON channels (in FCV mode) for system environments that are experiencing:**
  1. **S/390 256 ESCON channel constraint**
  2. **9672 ESCON channel 1024 device address limitation (per channel)**
  3. **Data rate performance droop at extended distances (over 9 km)**
  4. **High fiber cabling costs between local and remote sites**
  5. **Distance limitations for dark fiber**
- **FICON native channels (in FC mode) support different requirements and they are is not covered in detail in this version of the FICON Planning guide.**

*Figure 5. ESCON to FICON enhancements*

1. 9672 channel constraint occurs when a customer wants to install additional ESCON channels to support attachment of additional I/O, but the S/390 processor is already at or near the S/390 256 channel architecture limit (244 channels or greater are installed).

FICON channels (in FCV mode) provide additional I/O connectivity, while keeping within the S/390 256 channel architecture limit. The increase is from:

256 ESCON concurrent I/O connections are increased to 360 with a mix of 168 ESCON channels and 24 FICON (FCV mode) channels (G5 and G6).

256 ESCON concurrent I/O connections are increased to 408 with a mix of 120 ESCON channels and 36 FICON (FCV mode) channels (G6 with the 9672 LIC driver code release 26, available in 6/00).

Be aware that when moving workloads from ESCON (CNC) to FICON (FCV mode) channels (in this channel constraint case) for a 9672 you should aim to move the workloads of 5 to 8 ESCON channels to the FICON channel (in FCV mode). The recommendation of a minimum of 5, is because the installation one FICON channel card occupies an I/O slot that could have an ESCON channel card installed that supports 4 ESCON channels.

2. The 9672 ESCON channel implementation limits the device support to 1024 devices (subchannel/device numbers) per channel, whereas a 9672 FICON channel (in FCV mode) can be used to support up to 16 K devices.

The customers that are at or near the S/390 256 ESCON channel architecture limit and are experiencing the 1024 device number implementation limit on an ESCON channel (some DASD control units today require the support of 1024 device numbers or even as great as 4096 device numbers) can install a FICON (FCV mode) channel and then connect a second 1024 device CU on the same FICON (FCV mode) channel, as well as support the other ESCON control units that are aggregated onto the same FICON (FCV mode) channel.

Again, the aim for a 9672 FICON channel (in FCV mode) must be to move a minimum of 5 ESCON connections/workloads onto the one FICON (FCV) channel (in this address constraint case).

The 9672 G5/G6 support for the number of subchannels that can be defined is increased from 80 K to 288 K with the 9672 G5/G6 driver code 26.

3. As an ESCON channel to an ESCON-attached CU distance is increased, the performance decreases (reduced data transfer rate) up to a point of 9 km, where the performance decreases more rapidly. This point of sudden rapid decrease in performance is called the *distance data rate droop point*.

For FICON channel links, the distance where this data rate droop point occurs is not until 100 km. This allows the customer to get the benefit of an extended distance from a FICON channel (in FCV mode) to a 9032 model 5 ESCON director FICON Bridge port, without having the same performance impact as seen on the ESCON channels after the 9 km distance (allowable device connectivity distances must still be considered on the ESCON links).

4. Multiple ESCON channel fibers between two extended distance sites can be very expensive.

With the use of FICON channels (in FCV mode) between two sites we would expect the customer to get up to an 8-to-1 reduction in the number of fibers required to connect the two extended distance sites. This in most cases will benefit the customer in a reduction (or prevention) of the overall cost of the fiber infrastructure. The fiber cabling requirements for FICON (FCV mode) channels is the same as required for FCS connections that use 9 micron single-mode fiber.

5. Some customers prefer the use of dark fiber with no retransmission of the fiber signal. Using ESCON LED channels, the dark fiber distance can only be 3 km, while using FICON long wavelength LASER channels (in FCV mode) and single-mode 9 micron fiber, the dark fiber distance can be extended up to 10 km, or even up to 20 km with an IBM approved RPQ.

The S/390 FICON channel (in FCV mode) provides some appreciable enhancements to the S/390 ESCON channel implementation. S/390 FICON channels (in FCV mode) supplement the S/390 ESCON channels, providing connectivity to additional ESCON interface control units. ESCON and FICON (FCV) connectivity coexists to ESCON control units, as well as being able to be intermixed from the same processor image to the same control unit.

Under some circumstances where the 9672 S/390 processor will support the installation of additional ESCON channels, the additional ESCON channels may

provide an adequate solution to the customer's ESCON environment requirements for the previously stated cases (1) and (2) above.

---

## 2.2 Quick assessment

This section provides details for a S/390 9672 FICON (FCV) and 9032-5 FICON Bridge quick assessment.

Any one of the following requirements may be addressed by the installation of FICON channels (in FCV mode):

1. The customer has 244 or more channels in total (ESCON and all other channels), or 61 I/O slots on the S/390 processor currently installed.
  - The customer needs more S/390 9672 ESCON channels to connect to more ESCON attached control units and is not able to discontinue the use of other channel types to allow for installation of more ESCON channels, or is not able to consolidate existing ESCON channel workloads among the existing ESCON channels to free up some ESCON channels.
  - The customer has run out of ESCON channel-to-CU addressability, and needs to support more than 1024 devices on some channels
2. The customer needs to connect S/390 processors in one site with S/390 control units in an off-campus site.
  - There is a need to consolidate the S/390 ESCON channel fiber cabling.
  - The ability to cable over extended distances (up to 10 km or 20 km, or 100 km) is required.

---

## 2.3 Planning approach

A FICON channel (in FCV mode) can successfully be used to concurrently access a number of control units that were previously accessed by ESCON channels.

ESCON channel performance information and channel path to CU connections need to be reviewed to determine which ESCON channels are good candidates to be aggregated to FICON.

The way the performance data needs to be reviewed and the selection of ESCON channels requires a certain amount of skill.

IBM ESCON-to-FICON aggregation tool can perform this function.

The customer can determine which ESCON channels to aggregate to FICON using information obtained from this book.

Installation and use of S/390 9672 FICON channels (in FCV mode) and 9032-5 FICON Bridge port cards may result in some increase in response times for certain I/O operations. Generally the increase will be acceptable to most customers. However, the customer may wish to determine this for his configuration and environment.

For most > 10 km fiber distance cases, the FICON channel (in FCV mode) performance should be better than ESCON at the same distance.

To assist customers with FICON migration planning, IBM can analyze customer-supplied SMF and configuration data to suggest ESCON channel candidates for aggregation onto FICON channels.

Factors including current ESCON channel utilization and I/O rate, and projected FICON channel processor and FICON channel internal PCI bus utilization, will be included in the analysis.

Contact your IBM Sales Representative to request a FICON Channel Aggregation Analysis from the IBM Techline Organization.

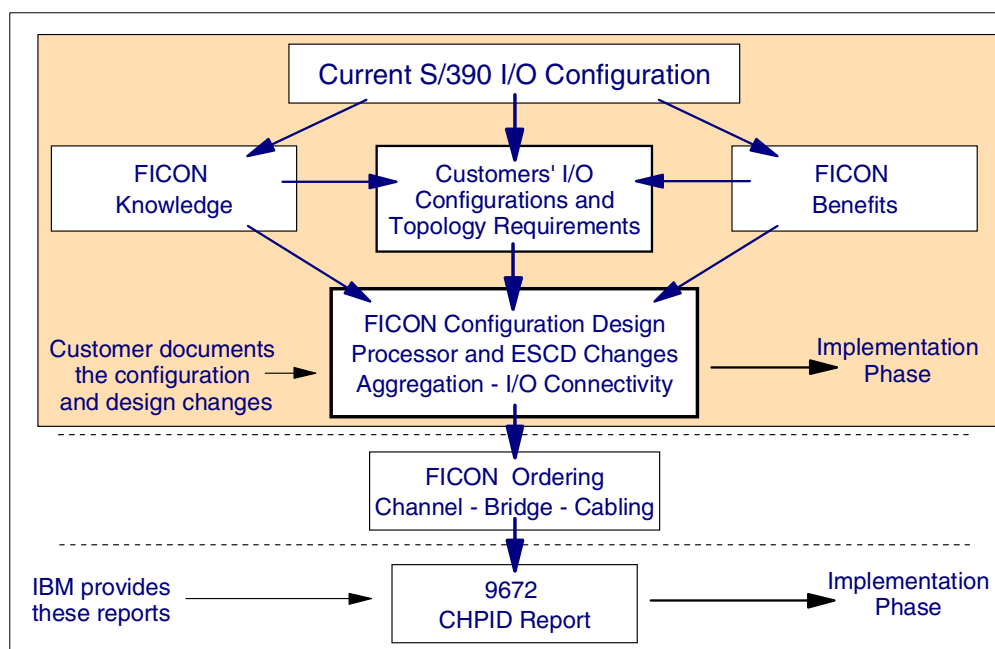


Figure 6. Planning approach

The S/390 FICON planning material provided in this document covers the following:

- ESCON (CNC) to FICON channel (in FCV mode) implementation enhancements
- An overview of the FICON channel (in FCV mode) operation and architecture
- The S/390 Processor support of the FICON channel:
  - I/O packaging, system structure, STI cabling and usage, I/O channel plugging, CHPID number assignment, ordering, and channel reassignment (movement)
- 9032 Model 5 ESCON Director support of the FICON Bridge adapter
- FICON channel (in FCV mode) connectivity and cabling
- S/390 channel performance paradigms
- S/390 FICON (FCV) mode performance

- FICON channels (in FCV mode) to CU, benefits and configurations, multiple examples
  - Benefits, connectivity recommendations, pathing rules, ESCON configurations, FICON (FCV) configurations, ESCON and FICON (FCV) mixed path configurations, maximum I/O concurrency
- FICON channel (in FCV mode) - CTC configurations
- FICON channel (in FCV mode) to ESCON control units configuration scenarios
- FICON channel (in FCV mode) OS/390 definition support
- ESCON (CNC) to FICON (FCV) aggregation
- Ordering the 9672 FICON channel and 9032-5 FICON Bridge adapter
- FICON channel (in FCV mode) configuration design





## Chapter 3. FICON (FCV) Channel attachment and operation

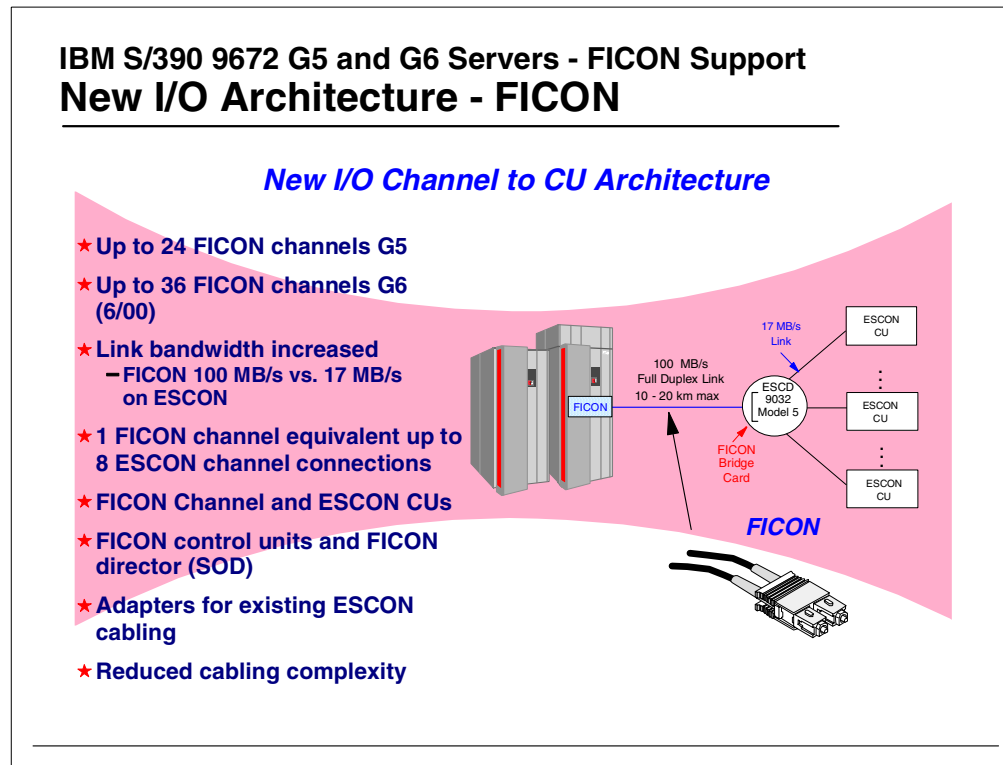


Figure 7. FICON channel to control unit attachment

The new FICON channel can be installed in the 9672 generation 5 (G5) and 9672 generation 6 (G6) processors. Up to 24 FICON channels can be installed in the G5, and up to 36 FICON channels can be installed in the G6 (36 FICON channels will be available in 6/00). The link bandwidth of the FICON link is 100 MB, whereas the link bandwidth of the ESCON link is 17 MBs. One FICON channel has the concurrent connectivity equivalence of 8 ESCON channels.

IBM announced a Statement of Direction (SOD) to support the FICON channel in native mode to operate over Fibre Channel Standard (FCS) links to a FICON control unit.

The preferred fiber cabling for a long wavelength (LX) FICON channel is 9 micron single mode fiber. However, 62.5 multi-mode or 50.0 multi-mode fiber cable may be used for a FICON (LX) channel, but the use of multi-mode cabling requires the use of mode conditioner patch (MCP) cables (one at each end of the link, or between optical ports in the link); see 6.1, "Mode Conditioner Patch (MCP) cables" on page 63 for more details.

## IBM S/390 9672 G5 and G6 Servers - FICON Support 9672 G5 and G6 - I/O Support

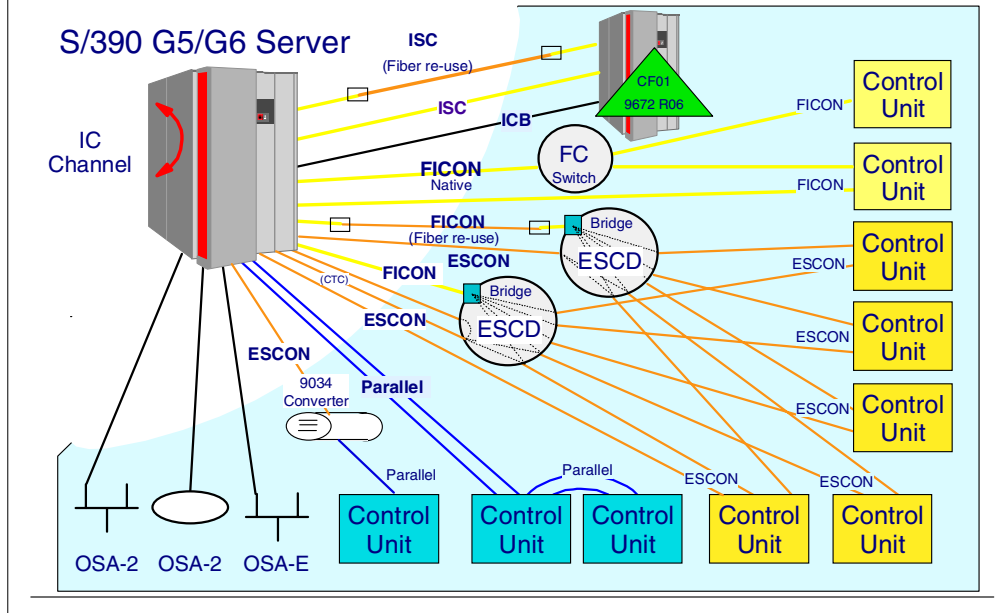


Figure 8. 9672 G5 and G6 supported I/O channels

There are advantages of using S/390 FICON channel (in FCV mode) over ESCON channels in both local site configurations (the S/390 processor and some of the channel accessible control units are in the same site) and in remote site configurations (the S/390 processor and some of the channel-accessible control units are in different sites).

Local sites (processor and control units in the same site) advantages:

- Greater channel and link bandwidth with FICON channels (in FCV mode)
- 8 concurrent I/O operations per FICON channel (in FCV mode)
- Larger number of device numbers (subchannels) supported per FICON channel (in FCV mode)
- Intermixing of CU types with different channel usage characteristics on the same channel

Remote sites (processor and control units in different sites) advantages:

- Fiber consolidation
- Greater fiber link un-repeated distances
- Performance droop moved from 9 km to 100 km
- 8 concurrent I/O operations per FICON channel (in FCV mode)
- Greater channel and link bandwidth per FICON channel (in FCV mode)
- Larger number of device numbers (subchannels) supported per FICON channel (in FCV mode)

- Intermixing of CU types with different channel usage characteristics on the same channel

The actual FICON channel (in FCV mode) benefits exploitation in a customer's installation is installation-dependent and will vary between different environments.

### 3.1 S/390 FICON channel topology and architecture

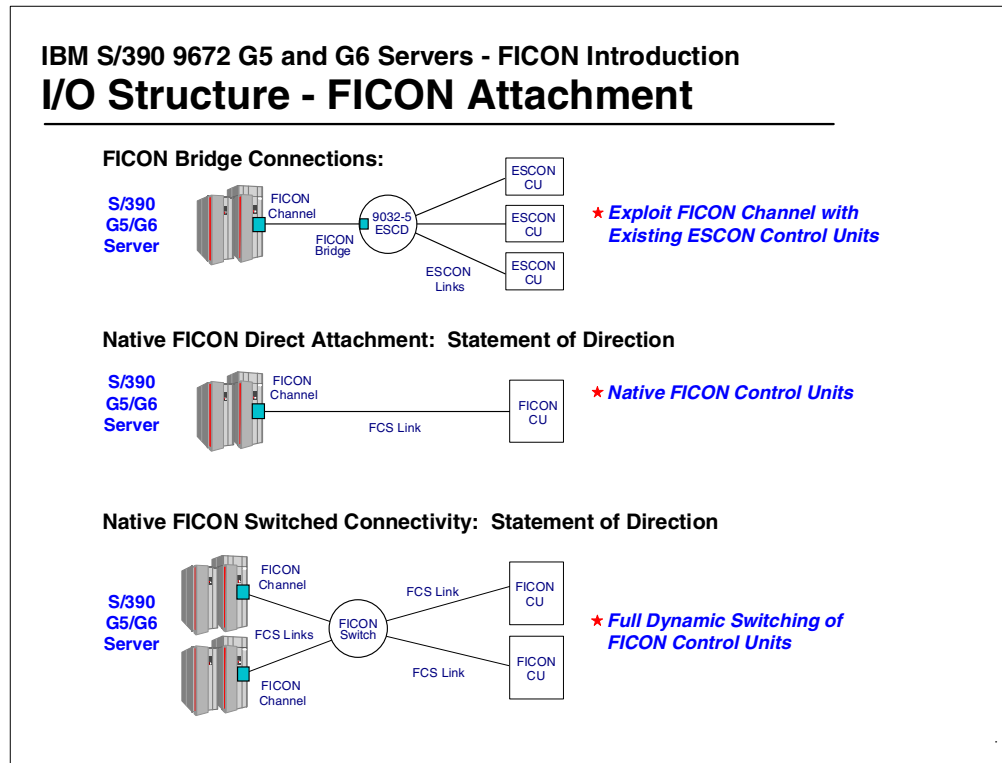


Figure 9. FICON channel to control unit connectivity

The 9672 FICON channel will be able to operate in one of two modes:

- FICON FCV mode to a 9032 model 5 ESCON Director, or
- FICON FC, FICON native mode in the FCS topology

#### 3.1.1 FICON channel FCV mode of operation

In FICON FCV mode, the connectivity from the 9672 G5/G6 processor FICON channel to an ESCON control unit is always from the FICON (FCV mode) channel to an ESCON Director that has a FICON Bridge card installed (like a 9032-5). The connection is then from the ESCON Director to an ESCON interface at the control unit. There can be up to eight concurrent connections (concurrent I/O operations) between the 9672 FICON (FCV mode) channel and ESCON control units. Each of the concurrent connections would be to different ESCON Director destination ports, and to different control units attached to the ports.

### 3.1.2 FICON channel FC mode of operation

In FICON FC mode, the connectivity from the 9672 G5/G6 processor FICON channel to a FICON capable Control Unit is from the FICON (FC mode) channel to either an FCS switch (Fiber Channel Standard switch) and then onto a FICON control unit, or directly to a FICON control unit with a FICON adapter installed. The number of concurrent I/O operations between the 9672 FICON (FC mode) channel and FICON control units is processor model dependent. Each of the concurrent I/O operations can be to the same FICON control unit (but to different devices) or to different FICON control units.

## 3.2 I/O connectivity evolution, Parallel and ESCON

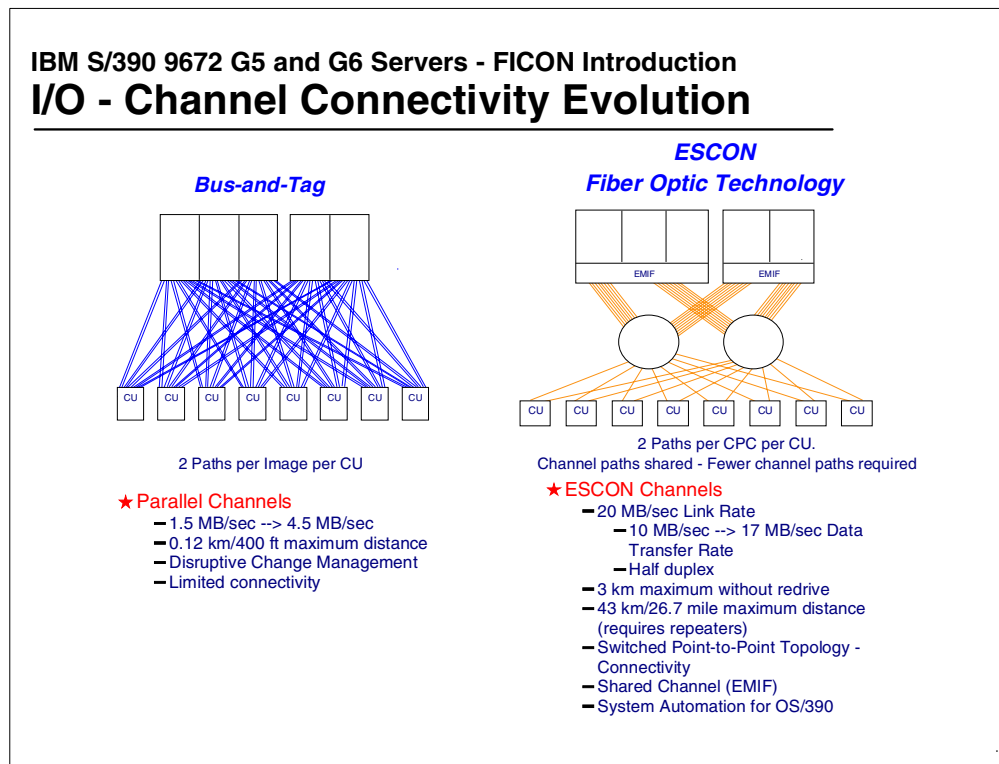


Figure 10. Parallel and ESCON channel connection complexity

As different channel types have evolved and the mode of operation of the channel has changed (such as EMIF) the complexity of the cable connections, has been reduced as follows:

### 3.2.1 Parallel channels in a S/390 LPAR environment

in order for every LPAR partition to have communication connectivity from the partition to a control unit, there must be channels dedicated to each partition. As can be seen in Figure 10 with three logical partitions in one processor, where each logical partition requires two parallel channel paths to each control unit, the number of dedicated parallel channel paths required (in this configuration) to connect to each control unit would be six, or for the eight control units shown in Figure 10 this would require a total of 48 parallel channels. In reality, many

customers would have required more than two paths in the case of channel connections to DASD control units.

### 3.2.2 ESCON (EMIF mode) channels in a S/390 LPAR environment

In this environment, and keeping the same processor to control unit connectivity as was shown Figure 10 on page 16 using parallel channels, the number of ESCON (EMIF) channel connections required to access one control unit from all three LPARS would be reduced from six to two. As can be seen in Figure 10 with three logical partitions in one processor, where each logical partition requiring access to control units will use two *shared* ESCON (EMIF) channel paths to each control unit, the number of shared ESCON channel paths required (in this configuration) to connect to each control unit would be two, or for the eight control units shown in Figure 10 this would require a total of 16 shared ESCON channels. However, even with ESCON, the maximum concurrent I/O connections is limited to the maximum of ESCON channels installed in the processor (the maximum of ESCON channels supported on the 9672 G5/G6 processor is 256). Some customers also experience the limitation in the number of devices supported by each ESCON channel (this limitation is 1024).

## 3.3 I/O connectivity evolution to FICON FCV mode

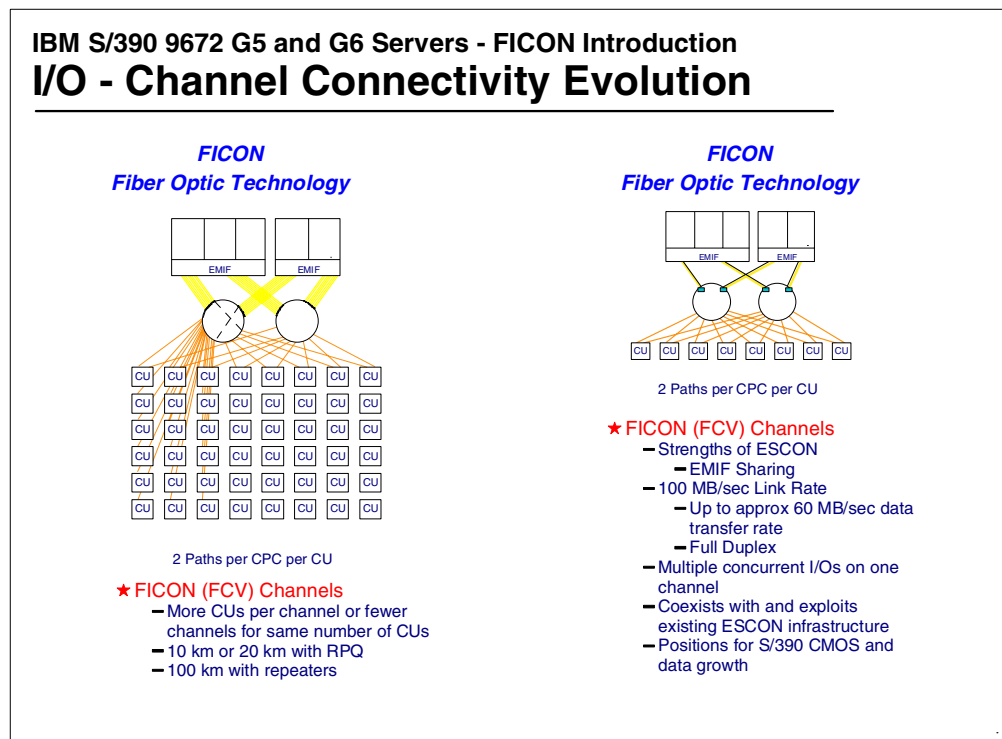


Figure 11. FICON (FCV mode) channel connectivity

With FICON channels in FCV mode, the concurrent I/O connectivity for a FICON channel is up to 8. This allows, either for same number of channels, more control units can be attached with the increase in concurrent connectivity, or fewer channels are required to support the same number of ESCON control unit concurrent I/O connections. This is supported both by the increase in the

concurrent I/O connectivity with FICON (FCV mode) channels (1 for ESCON and 8 for FICON FCV mode) and the increase in the number of devices supported by each FICON (FCV mode) channel, from 1024 devices for ESCON and up to 16K for FICON.

A customer may take advantage of connecting more control units to FICON channels when the channels and control units are in the same location, or take advantage of using fewer FICON (FCV mode) channels, to connect to the same number of control units as was connected to ESCON channels, when the FICON channels and ESCON control units are in different locations and long fiber connections are required. The FICON (FCV mode) channel can be exploited either way.

### 3.4 I/O connectivity evolution FICON FC (native) mode

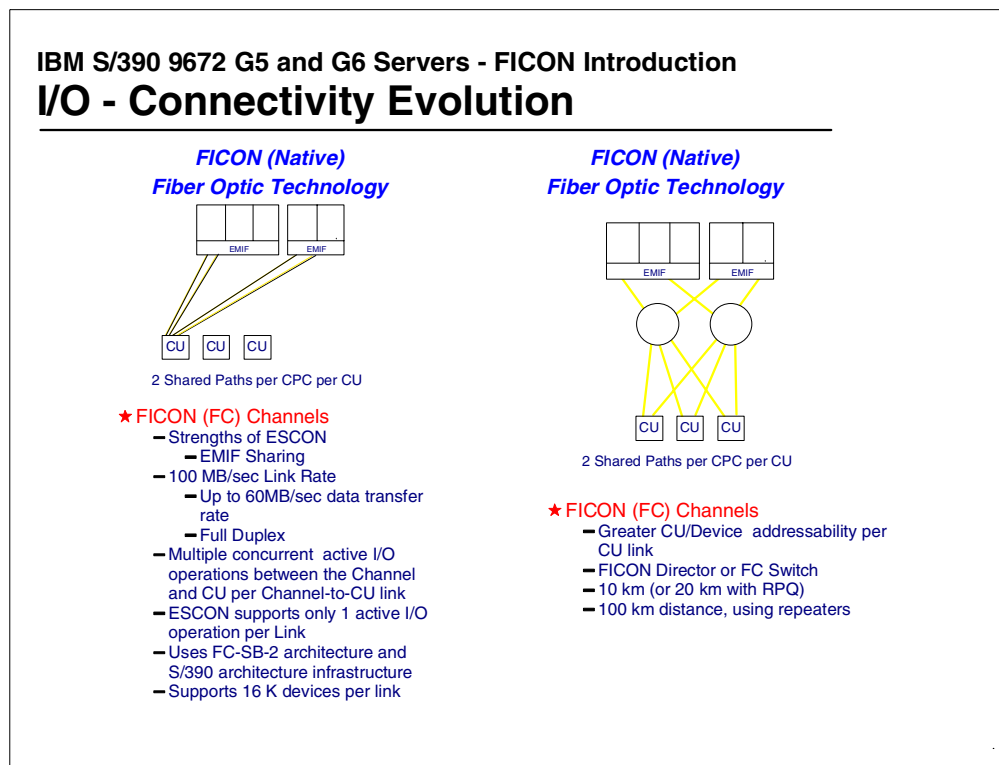


Figure 12. FICON (FC mode) native, channel connectivity

The introduction of FICON (FC mode) native channels will allow greater I/O concurrency, and also allow the transfer of data for an I/O operation to be at a higher data transfer rate. The FICON channel in FC mode will operate in the new Fibre Channel Standard (FCS) channel networks. These FCS networks are also sometimes being referred to Storage Area Networks (SANs). FICON native can operate over Storage Area Networks that match the current FICON support profile. The FICON FCS profile may be expanded in the future.

### 3.5 Serial channel frame process

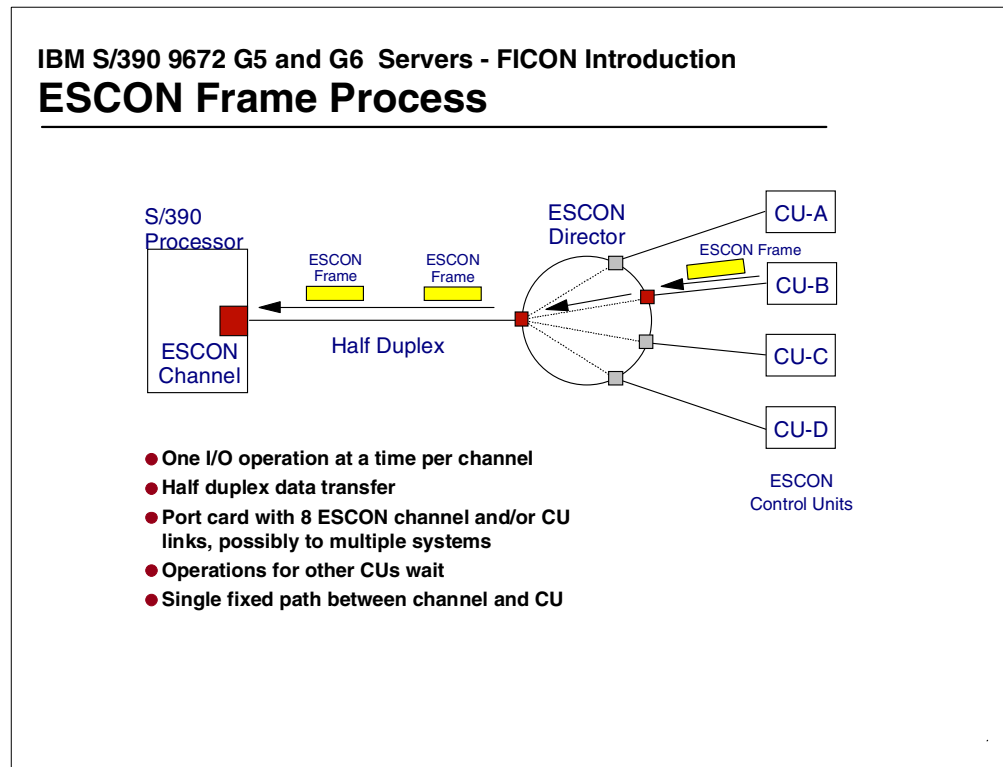


Figure 13. ESCON channel and links frame transfer

For an ESCON channel, data is transferred in the ESCON serial frames. All the data in the frame belongs to just one I/O device. The ESCON link connection (ESCON channel to ESCON director and ESCON director to ESCON CU) is dedicated to that device. If the CU/device data is transferred at a data transfer rate less than the capability of the link, then the aggregate rate is reduced as no device can transfer data at this time even though there may be large idle gaps between the frames. Operations for other control units cannot proceed on this ESCON channel. Also even though there are two fiber strands in the fiber cable data is transferred at half duplex mode.

## IBM S/390 9672 G5 and G6 Servers - FICON Introduction

### FICON (FCV) Frame Process via Bridge

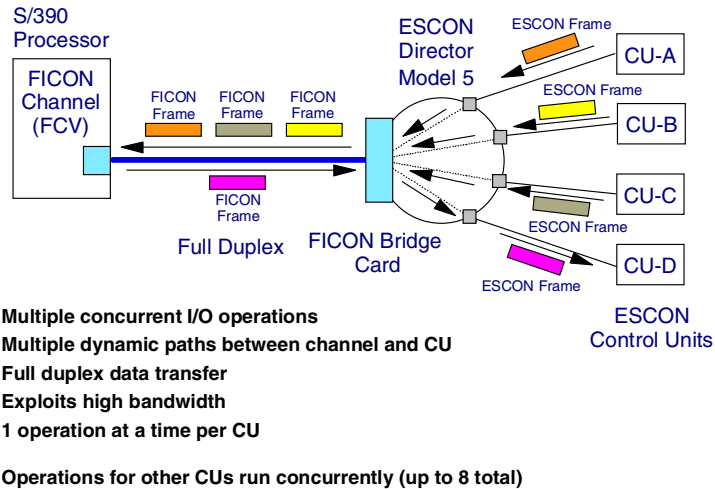


Figure 14. FICON (FCV mode) channel and links frame transfer

For a FICON (FCV mode) channel, there are always two links involved:

- The FICON (FCV) channel to ESCON Director FICON Bridge link
- The ESCON director port to ESCON control unit link

The FICON (FCV mode) channel and FICON Bridge adapter card will support up to 8 concurrent I/O operations, to 8 different control units, via 8 different ESCON links.

The FICON (FCV mode) channel link frame transfer between the FICON channel and the FICON Bridge adapter is both full duplex and demand-multiplexed between the (up to) 8 concurrent I/O operations.

For an understanding of the management of the I/O operations see the next figure description on the FICON Bridge adapter.

The frame transfer on the ESCON link in a FICON (FCV) channel to CU path, is the same as for a normal ESCON channel operation, it is half duplex at up to an peak aggregate data transfer rate of 17 MB.



### 3.6 FICON Bridge adapter

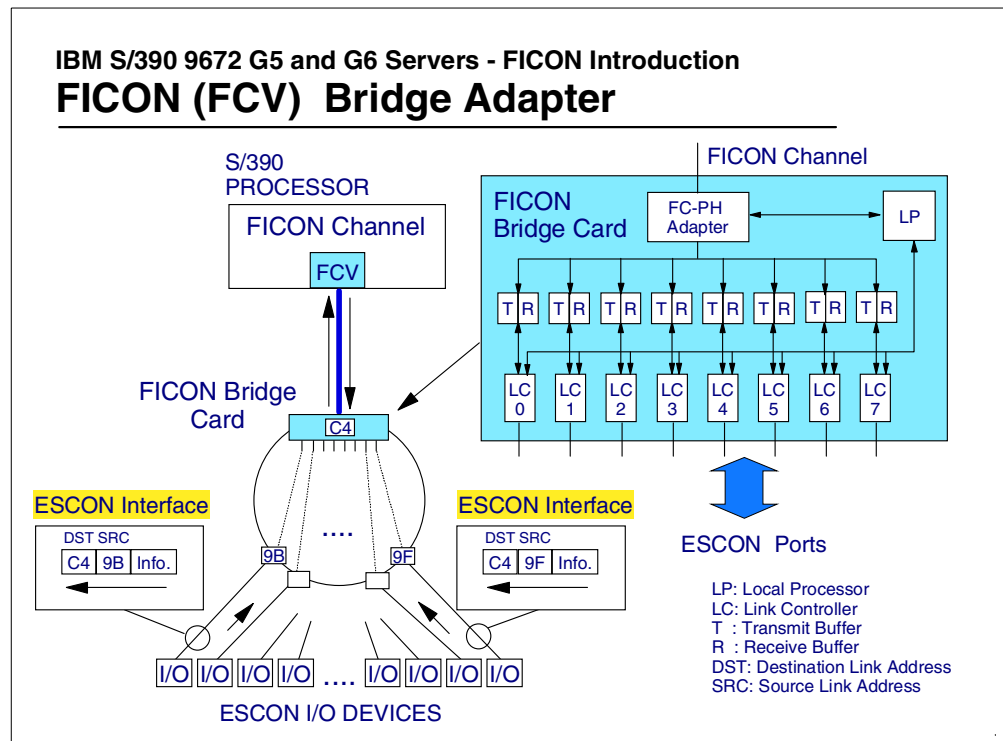


Figure 15. FICON Bridge adapter

The FICON Bridge adapter has 8 internal link controllers (LC). Each link controller manages one I/O operation between the FICON (FCV mode) channel and an ESCON director port to control unit link.

An I/O operation is “FICON FCV mode transferred” from the FICON channel to one of the 8 link controllers. This can be any one of the 8 link controllers, as there is no affinity between the link controller and any of the ESCON link ports.

The channel side of the FICON Bridge adapter operates in a slightly modified FCS mode, and the ESCON side operates in normal ESCON mode.

Up to 16 FICON Bridge adapters can be installed in a 9032 model 5 ESCON Director.

### 3.6.1 FICON (FCV mode) channel I/O operation

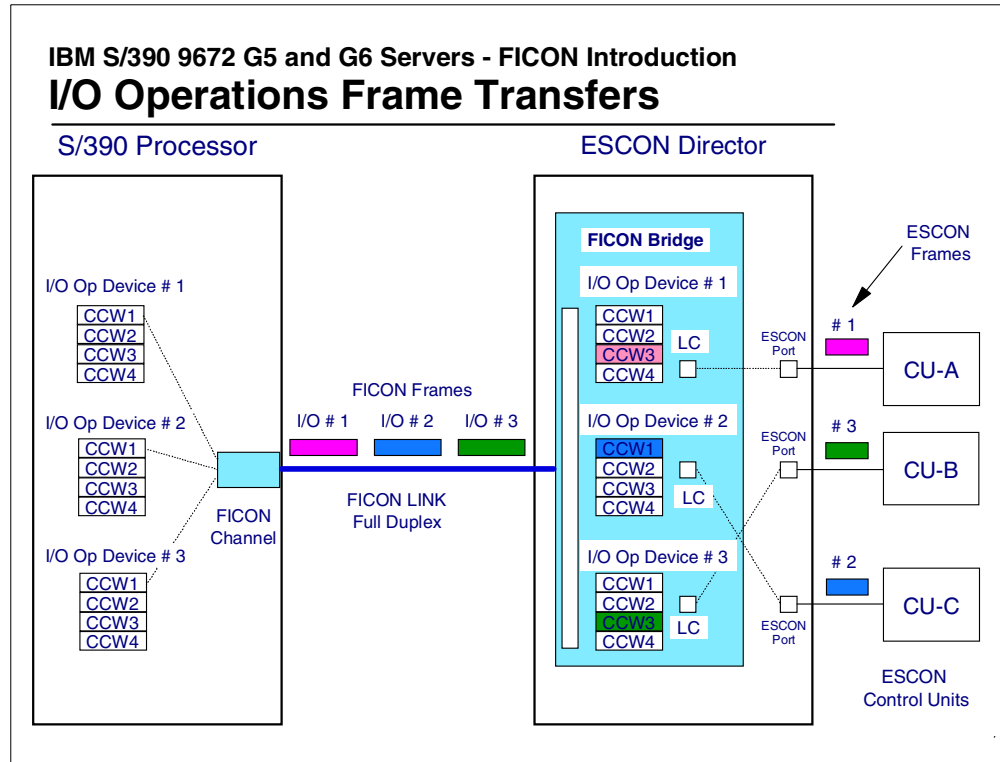


Figure 16. FICON (FCV mode) I/O operation and frame transfer

This figure shows the transfer of I/O operations (S/390 channel commands and data) from the channel to the FICON Bridge adapter. Each I/O operation is for a different device in a different control unit and therefore on a different ESCON link. Each I/O operation is transferred to a link controller, which will then manage the I/O operation out to the control unit via the addressed ESCON destination port. For most cases, as the individual commands are being successfully executed from the link controller and the ESCON control unit, there is no need to report this back to the FICON (FCV mode) channel. In general, successful completion conditions during the execution of the CCW chain are not reported back to the FICON (FCV mode) channel. Only when the operation does one of the following will there be communication back to the channel:

- A disconnect command chaining condition occurs
- The operation gets to the end of the CCW chain
- The operation terminates in an error
- A CU detected modifying condition occurs (CU reports status-modifier)

The method of not communicating back to the channel for successful completion of individual commands in the channel command chain, up to the last command, saves both channel turnaround times and frame bandwidth on the FICON link.

## IBM S/390 9672 G5 and G6 Servers - FICON Introduction

### FICON and ESCON - CU Intermix Access

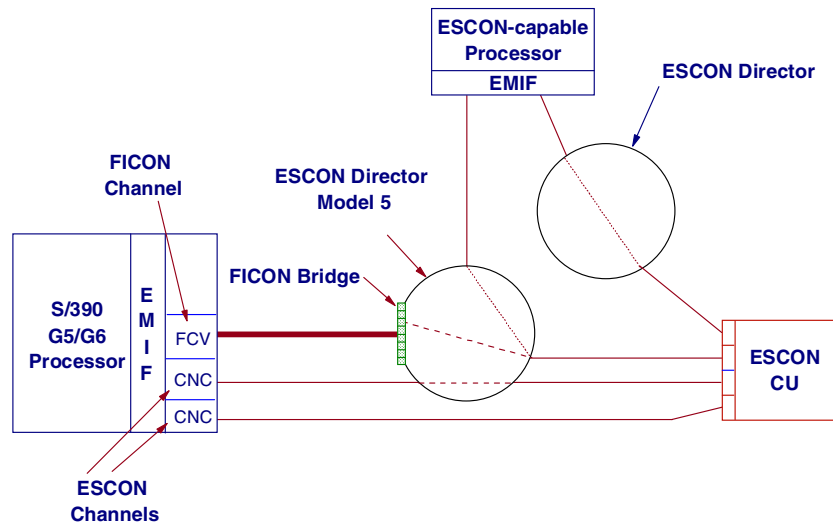


Figure 17. FICON (FCV mode) and ESCON intermix access

An ESCON control unit may be accessed by either an ESCON (CNC) channel or a FICON (FCV mode) channel, from the same 9672 image to the same control unit image. This ability of the 9672 processor of being able to use either an ESCON (CNC) channel or FICON (FCV mode) channel to access the ESCON control unit is referred to as ESCON (CNC) channel and FICON (FCV mode) intermixing.

The 9672 processor supports up to 8 channel paths to an ESCON connected control unit. These 8 paths can be all ESCON (CNC), all FICON (FCV mode), or any combination of channels (up to a maximum of a combined total of 8).

There is no impact by one S/390 processor using FICON (FCV) channels to communicate to an ESCON CU on any other S/390 processor that may only be using ESCON channel paths to the same control unit. The connectivity support to an ESCON control unit is very flexible as far as ESCON and FICON (FCV mode) channels are concerned.

### 3.7 Fibre Channel architecture

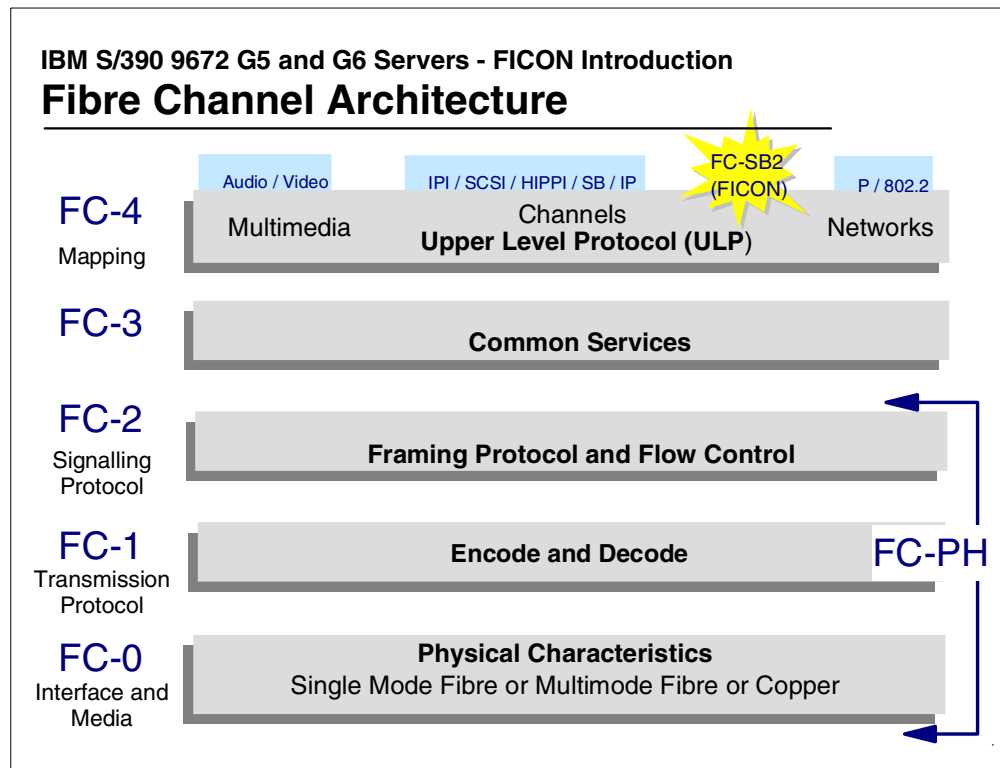


Figure 18. Fibre Channel standard

The Fibre Channel Standard (FCS) architecture was developed by the National Committee for Information Technology Standards (NCITS). The NCITS is a United States based standards body. The standards include:

- Fibre Channel Physical and Signaling Interface (FC-PH)  
Describes point-to-point physical interface, transmission protocol, and signaling protocol of high-performance serial link for support of higher level protocols associated with HIPPI, IPI, SCSI, FC-SB2 and others  
ANSI X3.230-1994
- The FC-SB2 (FICON) architecture can be obtained from the following website:  
[www.t11.org](http://www.t11.org) and FC-SB2
- Single-Byte Command Code Sets Connection Architecture (SBCON)  
ANSI X3.296-199x
- Fibre Channel Fabric Generic Requirements (FC-FG)  
Describes minimum requirements for a topology-independent interconnecting Fabric to support FC-PH  
ANSI X3.289-199x
- Fibre Channel Switch Fabric (FC-SW)  
Specifies tools and algorithms for interconnection and initialization of FC switches to create a multi-switch Fibre Channel Fabric

### 3.8 ESCON and FICON (FCV) implementation

	S/390 ESCON Architecture	S/390 ESCON Implementation	S/390 FICON(FCV) Implementation
# CHPIDs by type per CEC - G5	256	256	G5 - 24
# CHPIDs by type per CEC - G6			G6 - 36 (6/00)
ESCON & FICON (FCV) Channels Equivalence (8 Concurrent I/O)		42 ESCON Cards 4 Chans/card = 168	(24x8) = 192 (G5) (36x8) = 288 (G6)
Total ESCON + FICON (FCV) Equivalent channels		64 ESCON Cards 4 Chans/card=256	ESCON + FICON(FCV) (42x4)+(24x8)=360 (G5) (30x4)+(36x8)=408 (G6)
# CU Links per Channel	253	1-120	1-240
# Control Unit Images (CUADD) per Channel/Control Unit Link	16	16	16
# Control Units per Channel	4048	120	255
# Device Addresses per Control Unit Image (per CUADD)	256	256	256
# Device Addresses per Control Unit Link	4096	1024	4096
# Device Addresses per Channel	64 K	1024	16384
# S/390 Subchannels (G5/G6) Total for a CPC Maximum for an LPAR	64 K	80 K (288 K 6/00) 36 K	80 K (288 K 6/00) 36 K
Distances		2 km - 50um Fiber 3 km - 62.5 um Fiber 60 to 100 km Max (With Repeaters)	550m, 50/62.5um fiber 10 km - 9 um Fiber 20 km - 9 um (RPQ) 100 km tested Max (With Repeaters)
Maximum distances with repeaters are CU-dependent			
Date transfer droop distance		9KM	100KM

Figure 19. S/390 ESCON and FICON (FCV) implementation

This figure shows the architecture and implementation support characteristics that are provided with the S/390 9672 generation 5 and 9672 generation 6 processors. This information should be understood when designing a S/390 I/O configuration for attachment to a 9672 G5 or G6 processor, to ensure that during the design of an I/O configuration, you do not plan to exceed the implementation characteristics of the processor.



## Chapter 4. 9672 FICON channel installation support

This chapter covers the installation, physical locations, CHPID number assignments and other support of the FICON channel in the IBM S/390 9672 Generation 5 and 6 processors:

- Packaging of the I/O channels in the 9672 G5 and G6 processors
- The 9672 G6 processor system structure (the G5 is similar)
- The processor to channel internal Self Timed Interconnection cabling (STI cables)
- Installation plugging locations and sequence of install of the FICON channels (as well as the OSA-E and PCICC channels) in the 9672 G5 or G6 processor
- S/390 CHPID numbers assigned to the FICON channels
- Ordering of the FICON channels for the 9672 G5 and G6 processor
- Other 9672 G5 and G6 channel reassignment

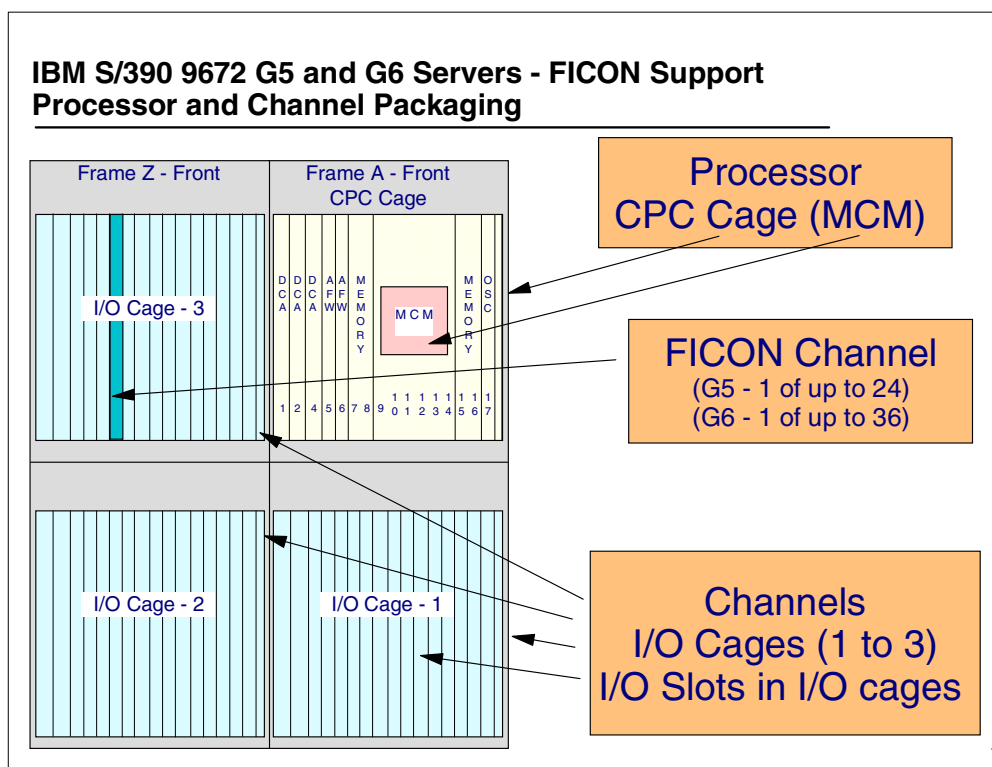


Figure 20. 9672 G5 and G6 Processor - I/O cage and channel packaging

The physical channels for the 9672 G5 and G6 processors are installed in I/O cages that are themselves installed in the G5 and G6 frames. There is always an "A" frame where the Central Processor Complex (CPC) and the first I/O cage (I/O cage number 1) is installed. This first I/O cage has 22 I/O slots where different channel types can be installed. Each I/O slot when used by I/O domain channels is assigned four CHPID numbers. The number of CHPID numbers actually used at each I/O slot is dependent on the channel type (card) installed in the I/O slot.

If the number of channels a customer requires exceeds the capacity of the first I/O cage, then a second I/O cage is required to be installed. However this would require that a second frame (the “Z” frame) also be installed and be attached to the “A” frame.

The second cage also has 22 I/O slots. Again, if the customer exceeds the capacity of the first and second I/O cages, then a third I/O cage can be installed. This third I/O cage also has 22 I/O slots, but for normal channels (non-FICON, OSA-E, and PCI cryptographic coprocessor (PCICC)), only 20 of the 22 I/O slots are used in this cage.

This means with three I/O cages, there will be 66 I/O slots of which 64 can be used for standard I/O domain channels (Parallel, ESCON, OSA-2, and ISC). If these channels were all ESCON, where each ESCON channel card supports four ESCON channels, there can be 64 x 4 (256) ESCON channels installed in one 9672 G5 or G6 processor.

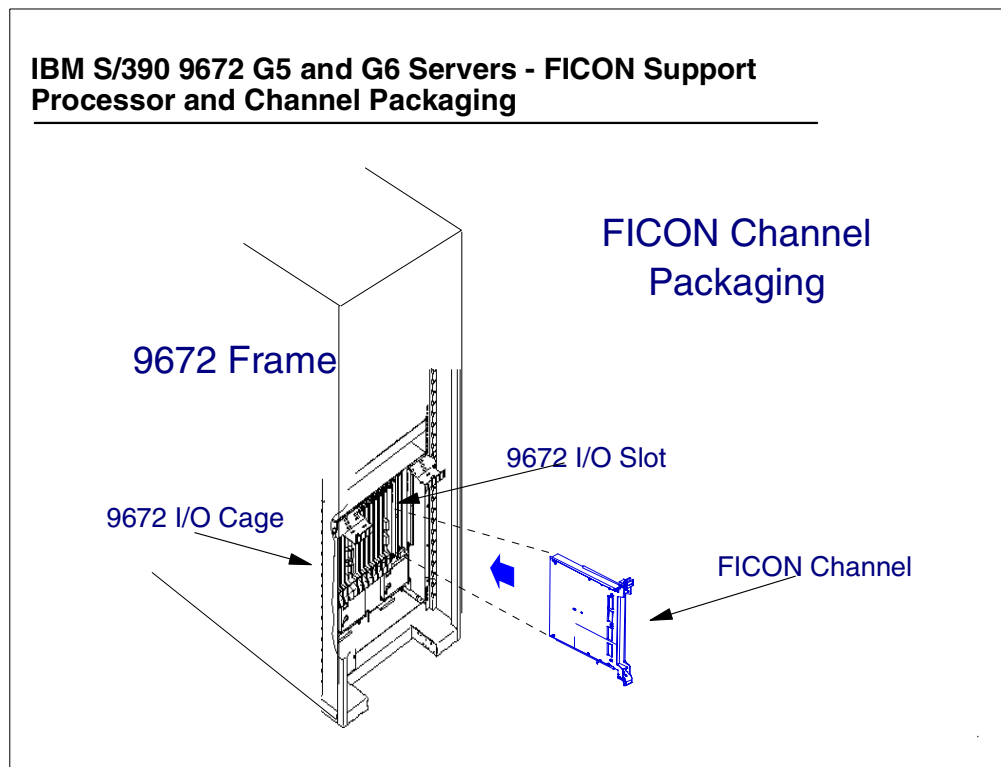


Figure 21. 9672 G5 and G6 FICON channel installation

The FICON channels (plus the OSA-E and PCICC channel types) are also installed in I/O slots in the I/O cages, but the rules as to which I/O slot in which I/O cage are different than for the normal channels. The assignment of CHPID numbers is also different. This is shown in the following figures.



## IBM S/390 9672 G6 Servers - FICON Support

### FICON Channel STI Chaining

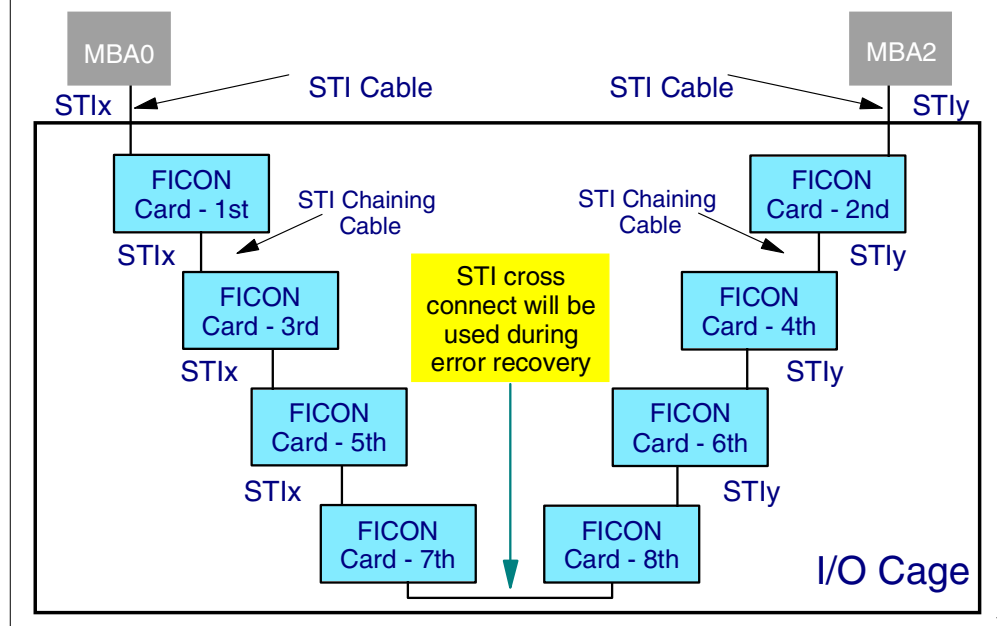


Figure 22. FICON channel internal connections support

The 9672 internal connections to FICON channels (and OSA-Express or PCICC cryptographic coprocessor (PCICC) channels) are via direct connect chaining STIs:

- A direct connect chaining STI can support up to four FICON or OSA-E or PCICC channels in an STI chain (STI chaining), or any mix of these channels (up to four).
- Each STI chain requires one STI connector.
- Each direct connect STI chain is assigned four channel numbers (CHPIDs), one for each channel that can be installed on the STI chain.
- STIs for FICON, OSA-E, or PCICC channels installed in an I/O cage are assigned in pairs. The FICON, OSA-E, or PCICC channels are installed across the pair of STIs. FICON, OSA-E, or PCICC channels 1, 3 and 5 are installed on the first STI of the pair and FICON, OSA-E, or PCICC channels 2, 4 and 6 are installed on the second of the pair of STIs. Later two more FICON, OSA-E, or PCICC channels can be installed, where the seventh channel (of this type in this I/O cage) is installed on the first STI, and the eighth channel is installed on the second of the pair of STIs.
- In all cases the last channel installed on the 1st STI is “chained” to the last channel installed on the second STI of the pair of STIs. This cross-chaining between STIs is for recovery or repair purposes. As an example, if the first FICON channel were to fail, then the second of the pair of STIs would automatically drive/control the FICON, OSA-E, and PCICC channels 2, 4, 6, 8, 7, 5 and 3.
- All this can be seen in Figure 22.

The 9672 internal connection paths to ESCON channels (and Parallel, ISC and OSA-2 channels) are via I/O domain STIs to the I/O cages' I/O domain structure:

- There can be from one to three I/O cages each with three I/O domains.
- Each I/O domain requires one STI connection.
- Each I/O domain STI supports 32, 24, or 16 I/O domain channels.

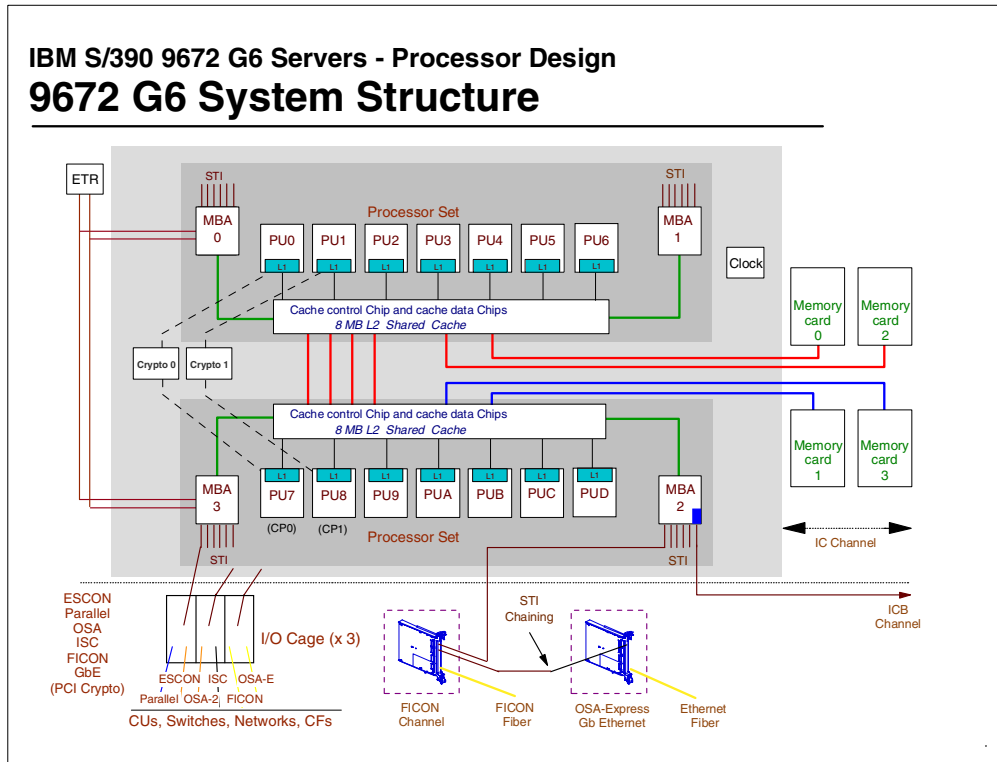


Figure 23. IBM 9672 G6 internal system structure

Figure 23 illustrates the IBM 9672 model G6 processor system structure, showing a logical representation of the dataflow from processing units (PUs), cache level 2 (L2), memory cards and memory bus adapters (MBAs), the MBAs provide the connections memory for the I/O channels through self timed interconnections (STIs).

Introduced on G5 Servers, this system “nest” structure (the central processors and SAPs split into two processor sets) uses separate connections for addresses and data, and controls memory fetches.

All G6 models have two processor sets, each one having seven PUs, two MBAs and 8 MB L2 Shared Cache. So, a complete system has 14 PUs, 4 MBAs and 16 MB L2 caches. Each PU has its own 256 KB level 1 cache (L1), designed as a store-through cache, meaning that altered data must also be stored to the next-level cache.

Each L2 cache, a store-in buffer design, has one storage control (SC) and four Storage Data (SD) chips. The SC chip controls the access and storing of data in the four SD chips. As shown in the Figure 23, the L2 cache is shared by all PUs within a processor set.

A PU can be assigned as a central processor (CP), a system assist processor (SAP) or an Internal Coupling Facility (ICF). If not assigned, it becomes a spare PU. A spare PU can be used for CP Sparing, SAP Sparing or ICF Sparing.

There are 24 STI buses that are used for the connections to I/O domains, or direct connect chaining to FICON, OSA-E, or PCICC channels, or direct connect non-chaining for ICBs. Each STI has a bidirectional bandwidth of 333 MB/sec (G6). An STI is an interconnection path to the memory bus adapter (MBA) and can be used to connect:

- ESCON channels, Parallel channels or OSA-2 cards (via a FIBB card and a channel adapter (CHA) card)
- FICON channels
- OSA-Express channels
- PCICC channels
- ISCs (coupling links) via an Intersystem Channel Adapter (ISC-M) card and an FIBB card
- Integrated Cluster Buses (ICBs) channels

Up to 4 FICON, OSA-Express or PCICC channels, which are High Bandwidth Channels, can be chained in the same STI (four-deep chaining).

An ICB must be connected to another ICB in another machine and the two systems must be within 7 meters of each other.

Internal Coupling (IC) channels are extremely fast coupling links, used to connect CPs to ICFs (or to CPs assigned as CF processors) inside the same machine. They are “virtual” links implemented via LIC code. The IC channel bandwidth is equivalent to the data transfers from one memory location to another.

I/O devices pass data to central storage through the memory bus adapter (MBA). The physical path from the channel includes the channel adapter (CHA) card, the Fast Internal Bus (FIB) card, the Self -Timed Interconnect (STI) bus, the storage control (SC) and the storage data (SD) chips.

G6s have up to 32 GB of memory, which can be assigned as a combination of central storage (Level 3) and expanded storage, supporting up to 15 Logical Partitions. Each Logical Partition can have up to 2 GB of central storage. In LPAR mode, central storage can be dynamically converted to expanded storage and back to central storage as needed, without a power-on reset (POR).

The storage control (SC) chip, which has the most signal paths of any chip in G6 MCM, efficiently controls the access and storing of data in four storage data (SD) chips. By using CMOS 7S technology, G6 has not only doubled the size of the L2 cache to 16 MB (as compared to G5, which is 8 MB), but also the L2 memory interleaving was doubled. The connection to processor storage is done by four high-speed Memory buses.

Storage access is interleaved between the storage cards and this tends to equalize storage activity across the cards. Also, by separating the address and command from the data bus, contention is reduced.

All G6 models have internal dual Cryptographic Coprocessors with dual paths to each processor set on a twin-tailed configuration (these are separate to the optional PCICC channels). This allows continued cryptographic operation even if a failed PU connected to a CP Cryptographic Coprocessor is spared. Single CP models only use one Cryptographic Coprocessor (while in single CP mode), and after the next power-on reset (POR) the spare Cryptographic Coprocessor will be used.

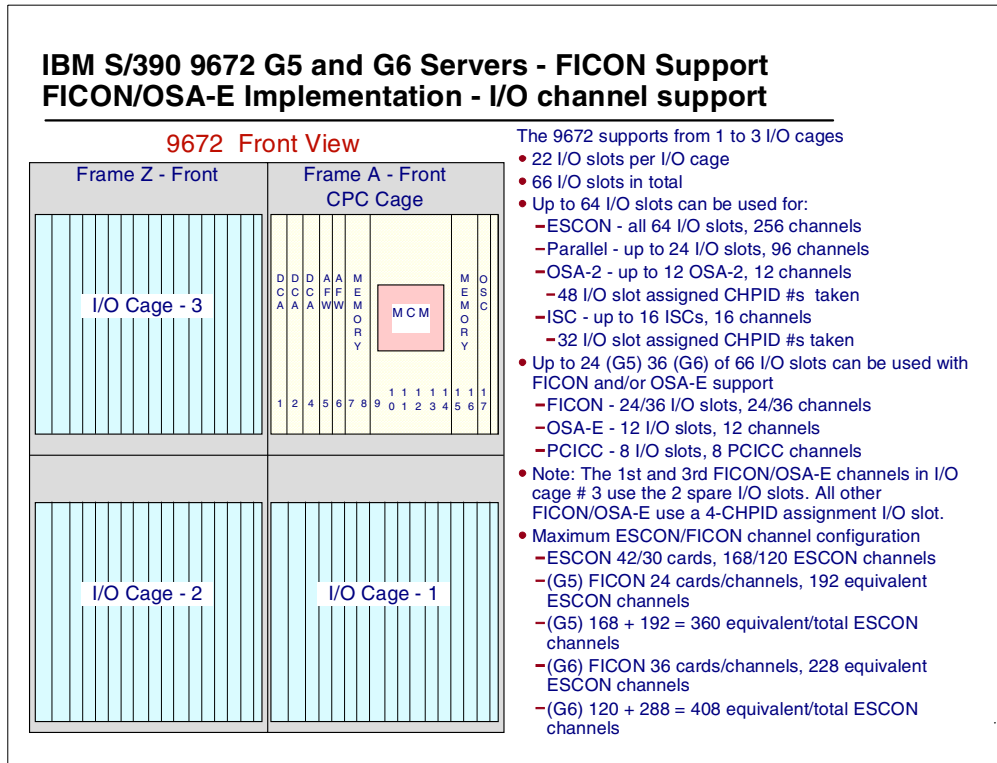


Figure 24. 9672 G5 and G6 channel capacity support

The IBM 9672 G5 and G6 supports from one to three I/O cages

- There are 22 I/O slots per I/O cage. When used by I/O domain channels, each I/O slot is assigned four CHPID numbers.
- There are 66 I/O slots in total
- Up to 64 I/O slots can be used for:
  - ESCON - up to 64 channel cards; this provides 256 ESCON channels.
  - Parallel - up to 24 channel cards; this provides 96 parallel channels.
  - OSA-2 - up to 12 OSA-2 channel cards; this provides 12 OSA-2 channels, but up to 48 CHPID numbers would be assigned to the I/O slots where the OSA-2 channels reside.
  - ISC - up to 32 ISCs channel cards, but these are installed two to an ISC adapter card that takes one I/O slot. This would provide 32 ISC channels, but up to 64 CHPID numbers would be assigned to the I/O slots where the ISC channels reside.
- 9672 G5 - up to 24 of 66 I/O slots can be used with FICON, OSA-E or PCICC support:

- FICON - 24 channel cards, requires 24 I/O slots, and provides 24 FICON channels
- OSA-E - 12 channel cards, requires 12 I/O slots, and provides 12 OSA-E channels
- PCICC - 8 channel cards, requires 8 I/O slots, and provides 8 PCICC channel functions
- 9672 G6 - up to 36 of 66 I/O slots can be used with FICON, OSA-E or PCICC support:
  - FICON - 36 channel cards, requires 36 I/O slots, and provides 36 FICON channels
  - OSA-E - 12 channel cards, requires 12 I/O slots, and provides 12 OSA-E channels
  - PCICC - 8 channel cards, requires 8 I/O slots, and provides 8 PCICC cryptographic coprocessor channel functions

**Note:** The first and third FICON, OSA-E or PCICC channels in I/O cage # 3 use the two spare I/O slots (I/O slot number 31 and 32). All other FICON, OSA-E, and PCICC channels use a 4-CHPID number assigned I/O slot (but the FICON, OSA-E or PCICC channels do not use the I/O domain CHPID number assigned to the slot).

For the 9672 G5, the maximum ESCON/FICON channel configuration is:

- 42 ESCON channel cards, supports 168 ESCON channels.
- 24 FICON channel cards, supports 24 FICON channels, with an 8 to 1 ESCON to FICON connectivity, which is the equivalent of 192 ESCON channels.
- In total, for the 9672 G5, this is 168 ESCON channels plus 192 ESCON equivalent channel concurrent I/O connectivity, making for a total of 360 ESCON equivalent channels.

For the 9672 G6, the maximum ESCON/FICON channel configuration is:

- 30 ESCON channel cards, supports 120 ESCON channels.
- 36 FICON channel cards, support 36 FICON channels, with an 8 to 1 ESCON to FICON connectivity, which is the equivalent of 288 ESCON channels.
- In total, for the 9672 G6, this is 120 ESCON channels plus 288 ESCON equivalent channel concurrent I/O connectivity, making for a total of 408 ESCON equivalent channels.

## IBM S/390 9672 G5 and G6 Servers - FICON Support I/O Domain and HB Channel CHPID assignment

I/O Domain STIs Parallel, ESCON, OSA-2, ISC		Direct Connect STIs ICBs, FICON, OSA-E and PCICC	
STI Number and CHPID Quantity	CHPID Number Range	STI Number and CHPID Quantity	CHPID Number Range
4 - 32	80 - 9F	9 - 1 (ICB)	FC
5 - 32	A0 - BF	10 - 1 (ICB)	FD
7 - 24	D8 - EF	11 - 1 (ICB)	FE
0 - 32	00 - 1F	12 - 1 (ICB)	FF
1 - 32	20 - 3F	13 - 4 (HB Chan)	F8 - FB
6 - 24	C0 - D7	14 - 4 (HB Chan)	F4 - F7
2 - 32	40 - 5F	15 - 4 (HB Chan)	F0 - F3
3 - 32	60 - 7F	16 - 4 (HB Chan)	EC - EF
8 - 16	F0 - FF	17 - 4 (HB Chan)	E8 - EB
		18 - 4 (HB Chan)	E4 - E7
		19	
		20	
		21	
		22	
		23	

STIs listed in sequence by STI number usage

Allocation of direct connect STIs is dependent on the installation sequence of ICBs and/or FICON/OSA-E/PCICC channels

HB Channel =  
High Bandwidth Channel  
(FICON, OSA-E and PCICC)

Figure 25. I/O domains and STI assignment example

There are 24 STI connections in the 9672 G5 and G6 processors. STI numbers 0 to 8 are usually assigned to I/O domains. STIs 9 to 23 are available as “direct connect” STIs using chaining for FICON, OSA-E, and PCICC channels. STIs 9 to 23 can also be used as direct connect STIs that do not use chaining, when being used to provide the ICB channel connections.

Figure 25 shows:

- STIs 0 to 8 being assigned to the I/O domains as well as showing which CHPID numbers would be assigned to each of these STIs.
- STIs 9 to 12 (in this example) have been assigned to ICB channels and each of these STIs is assigned one CHPID number as shown. There is an assignment of one CHPID number per STI when the STI is used by ICB channels.
- STIs 13 to 18 (in this example) have been assigned to high bandwidth channels (FICON, OSA-E, or PCICC channels), and each of these STIs is assigned four CHPID numbers as shown. There is an assignment of four CHPID numbers per STI when the STI is used by high bandwidth channels.

CHPID number assignment:

- I/O domain channel CHPID numbers (Parallel, ESCON, OSA-2, and ISC) are assigned in groups of 32, 24 or 16 by STI.
- ICB channel CHPID numbers are assigned in two groups of four for the first eight ICBs, and then one for each additional ICB (this applies to all the 9672 G5 and G6 models with the exception of the 9672 G5 RA6 to RD6 models; for these models, the ICB channel CHPID numbers are assigned one at a time).

- FICON, OSA-E, and PCICC channel CHPID numbers are assigned in groups of four, and they are used one at a time when one of these channel types are installed.
- IC channel CHPID numbers are assigned by the customer.

The FICON, OSA-E, and PCICC CHPID numbers are assigned from the highest group of four CHPID numbers not already assigned or reserved by any other direct connect STI (direct connect STIs are used by FICON, OSA-E, PCICC, and ICB channels).

When CHPID numbers are reassigned from I/O domain STIs to direct connect STIs, the I/O domain channels using those CHPID numbers are physically removed from their current locations. Depending on the installation requirements, they may be installed in other locations; this is all determine by the 9672 order process when the FICON channels are ordered, and is shown on the CHPID placement report (Figure 32 on page 42 shows a 9672 G5 or G6 CHPID report).

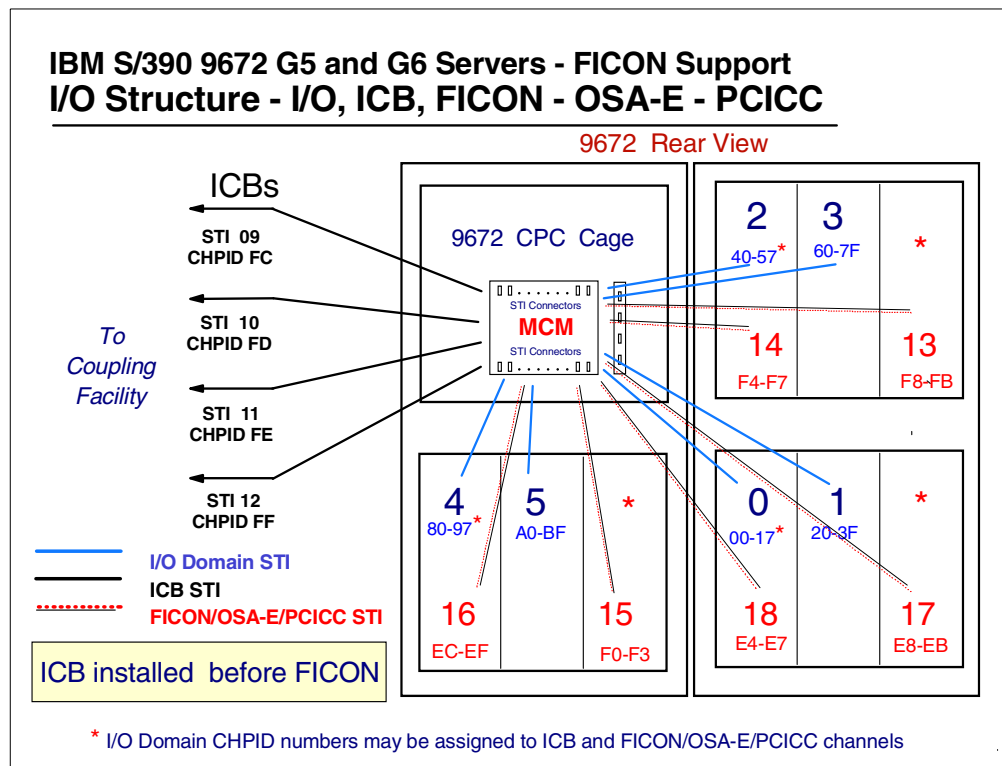


Figure 26. STI assignments - ICB, FICON and I/O domains

Figure 26 shows which STI and CHPID numbers are used by the channels in the example channel configuration shown:

- ICB channels use STIs 9 to 12 and CHPID number FC, FD, FE, and FF.
- FICON, OSA-E, or PCICC channels use:
  - STI 13 and 14, using CHPIDs F8-FB and F4-F7
  - STI 15 and 16, using CHPIDs F0-F3 and EC-EF

- STI 17 and 18, using CHPIDs E8-EB and E4-E7
- I/O domain channels - Parallel, ESCON, OSA-2, and ISC use:
  - STI 4 and 5 using CHPIDs 80-97 and A0-BF
  - STI 0 and 1, using CHPIDs 00-17 and 20-3F
  - STI 2 and 3, using CHPIDs 40-57 and 60-7F

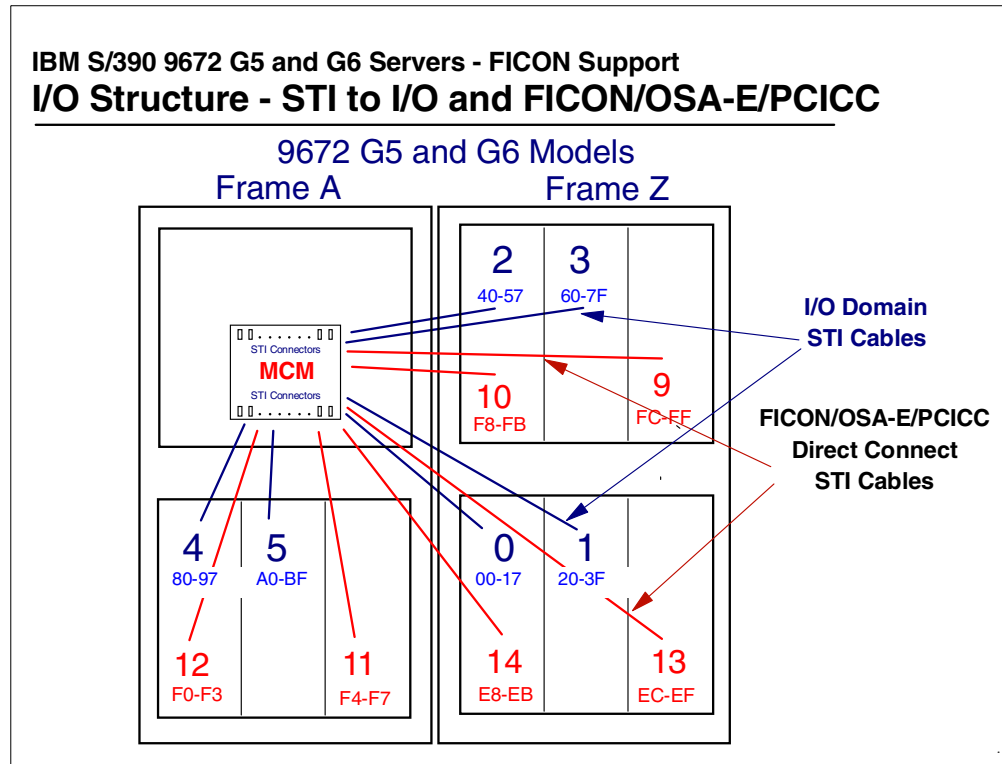


Figure 27. STI assignments - FICON/OSA-E/PCICC and I/O domain channels

#### FICON plugging rules:

- Up to 24 (G5) or 36 (G6) FICON channels in total, installed in three I/O cages
  - The maximum number of direct connect chaining channels (FICON, OSA-E or PCICC) that can be installed in the G5 is 24, in the G6, it is 36. This number (24 or 36) can be made up of any quantity of the following combination:
  - For the G5:
    - Up to 24 FICON channels, up to 12 OSA-E channels, and up to 8 PCICC channels, for a combined maximum of 24 of these channel types.
  - For the G6:
    - Up to 36 FICON channels, up to 12 OSA-E channels, and up to 8 PCICC channels, for a combined maximum of 36 of these channel types.
- For the 9672 G5, up to eight FICON, OSA-E, or PCICC channels can be plugged within one cage. The installation sequence requires the first 6 FICON, OSA-E, or PCICC channels will be installed in the same cage, and later two more can be installed in the cage (with a three I/O cage configuration).



- An I/O cage will have six of these channel types installed before stepping to the next I/O cage.
- When 18 FICON, OSA-E, or PCICC channels in total are installed, two more per cage can then be installed.
- The I/O cage plugging order for FICON, OSA-E, and PCICC channels in a three cage machine will be I/O cages 3, 1, then 2. For a two cage machine the order is cages 1 and 2. For a single cage machine, it is just cage 1.
- Cages will be filled with FICON, OSA-E or PCICC channels in the following I/O slot sequence: 31, 06, 32, 07, 33, and 34 for the first six, then I/O slot 8 and 25 for the last two.
- STIs direct attached to FICON, OSA-E, or PCICC channels starting with the first available direct connect STI (normally STI-9 without ICBs installed, if ICBs are installed, then the next available STI will be used) up to the highest STI number available (usually STI number 23), followed by STI-8, STI-7, then STI-6.
- For the 9672 G6, up to 14 FICON, OSA-E, or PCICC channels can be installed in I/O cages 3 and 1, and up to eight FICON, OSA-E, or PCICC channels in I/O cage 2. The installation sequence for 36 FICON, OSA-E, or PCICC channels requires that six of the FICON, OSA-E or PCICC channel types are installed in each of the three I/O cages (still keeping within the limit total for each of these channel types - 36 FICON, 12 OSA-E, and 8 PCICC), and later two more FICON, OSA-E, or PCICC channels can be installed in each of the three I/O cages. Finally six more FICON, OSA-E, or PCICC channels can be installed in I/O cages 3 and 1. The complete details are:
  - An I/O cage will have six of these channel types installed before stepping to the next I/O cage in the cage sequence of I/O cages 3, 1, and 2.
  - When 18 FICON, OSA-E, or PCICC channels in total are installed, then install two more channels of this channel type per I/O cage. At this time there would be a total of 24 FICON, OSA-E, or PCICC channels installed in the three I/O cages.
  - When there are 24 FICON, OSA-E, or PCICC channels in total installed, install six more of channel types FICON, OSA-E, or PCICC in I/O cage 3, and then six more in I/O cage 1 (still keeping within the limit total for each of these channel types - 36 FICON, 12 OSA-E and 8 PCICC).
  - The plugging order for I/O cages will be I/O cages 3, 1, then 2, for a three cage machine, with a limit of 36 channels of these three channel types. Cages 1 and 2 for a two cage machine, with a limit of 12 channels of these three channel types. Just cage 1 for a one cage machine, with a limit of six channels of these three channel types.
  - Cages will be filled with FICON, OSA-E and PCICC channels in the following I/O slot sequence: 31, 06, 32, 07, 33, and 34 for the first six. Then I/O slots 8 and 25 for the last two to take the total to 24. Then in I/O slots 26, 10, 27, 11, 28, and 29 for cages 3 and 1 only.
  - STI direct attached to FICON, starting with first available direct connect STI (normally STI-9 without ICBs installed) up to the highest STI number available (usually STI number 23), followed by STI-8, STI-7, then STI-6
- Within a system, more than six FICON, OSA-E, and PCICC channels require a second cage.

- Within a system, more than 12 FICON, OSA-E, and PCICC channels require a third cage.
- FICON, OSA-E, and PCICC STIs are assigned in pairs, and plugged when needed.
- Each STI used for FICON, OSA-E, or PCICC reserves four CHPID numbers (i.e. FC-FF).

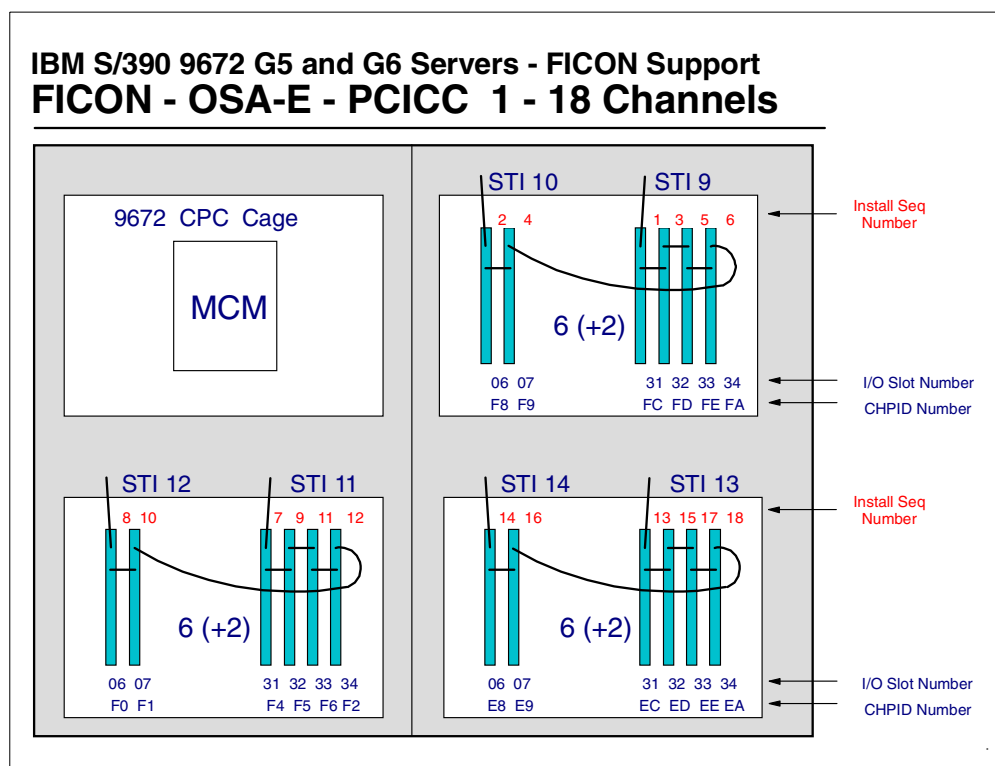


Figure 28. FICON, OSA-E, or PCICC, 1 to 18 channels install sequence

Figure 28 shows for FICON, OSA-E, or PCICC channels the installation sequence, the I/O slot number and assigned CHPID number, for the first 18 FICON, OSA-E, and PCICC channels. Also shown are the STI numbers assigned to the FICON, OSA-E, and PCICC channels in that I/O cage.

Both the CHPID number and STI assigned are dependent on whether ICB channels are also installed and when in the sequence they were installed relative to the FICON, OSA-E, and PCICC (before, after, or in between).

See Figure 30 on page 40 for the installation of 19 to 24 FICON, OSA-E, or PCICC channels in the 9672 G5 or G6 processors.

See Figure 31 on page 41 for the installation of 25 to 36 FICON, OSA-E, or PCICC channels in the 9672 G6 processor.

## IBM S/390 9672 G5 and G6 Servers - FICON Support

### FIB - CHA - I/O Structure 3rd Cage

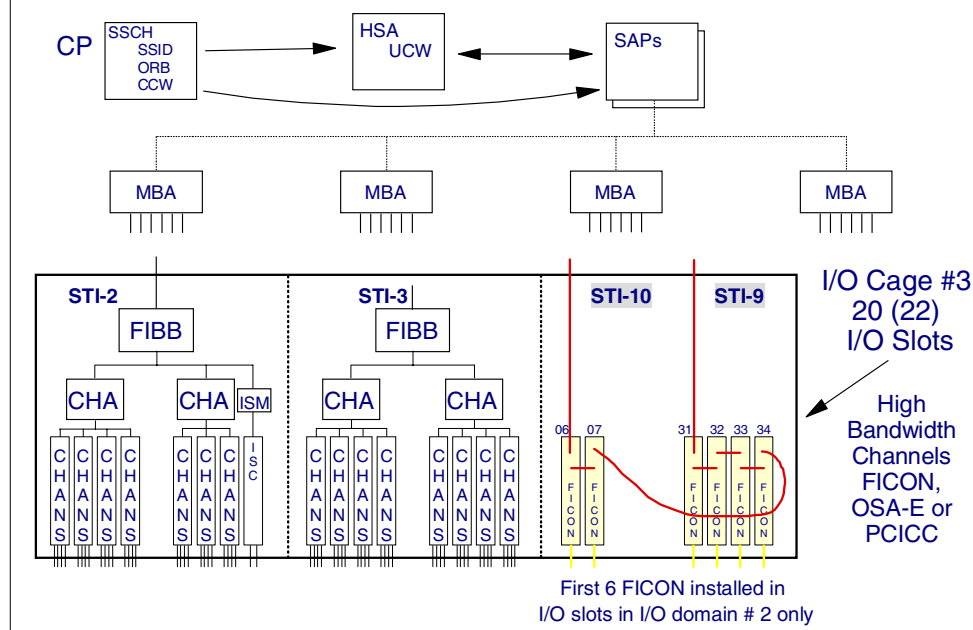


Figure 29. 9672 G5 and G6 internal I/O communication structure

Internal 9672 G5 or G6 communication for an I/O operation starts at a Central Processor (CP), and the I/O request is placed in the supporting I/O subchannel (shown as the UCW). One of the System Assist Processors (SAPs) is informed that there is an I/O request, and the SAP selects one of the defined channels that have an online path to the device.

The SAP passes the I/O request to the selected channel (via the MBA that the STI and channel is attached to). The selected channel determines if it is able to start the request and if so, proceeds to address the required device over the attached FCS link.

## IBM S/390 9672 G5 and G6 Servers - FICON Support FICON - OSA-E - PCICC 19 - 24 Channels

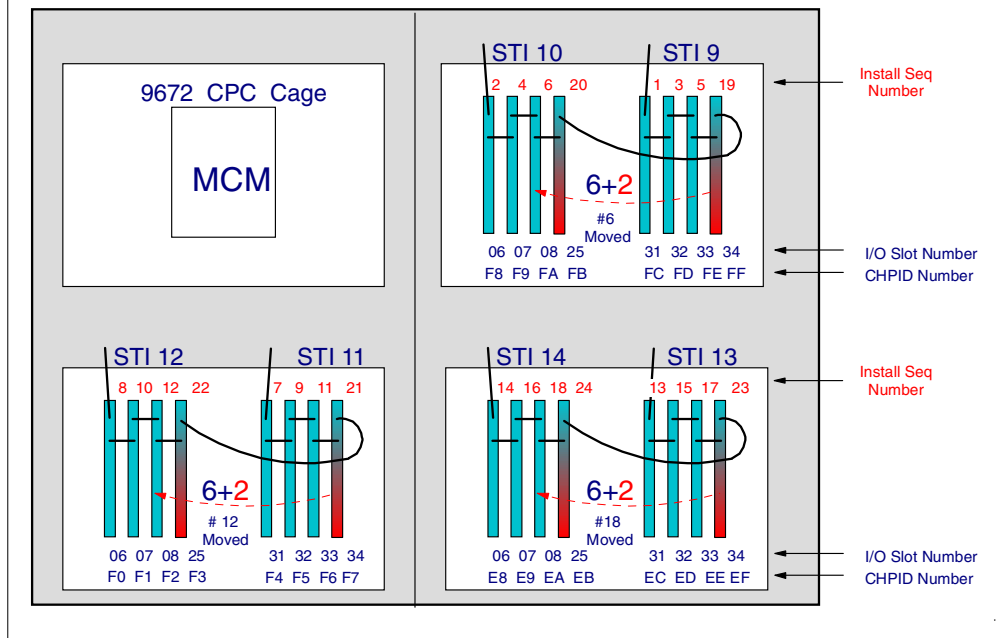


Figure 30. FICON, OSA-E or PCICC, 19 to 24 channels install sequence

When the seventh FICON, OSA-E, or PCICC channel is installed in each I/O cage, the sixth FICON, OSA-E, or PCICC channel is moved from I/O slot 34 to I/O slot 08.

For I/O cage # 3 this means that when the 19th(in total) FICON, OSA-E, or PCICC channel is installed, the original 6th FICON or OSA-E, or PCICC channel is moved from I/O slot location 34 to I/O slot location number 08. Then the 20th FICON, OSA-E, or PCICC channel is installed in I/O slot location 25. The installation instructions will include the movement of the currently installed chaining STI cables, as well as installation of an additional STI chaining cable.

For I/O cage # 1 this means that when the 21st (in total) FICON, OSA-E, or PCICC channel is installed, the original 12th FICON or OSA-E, or PCICC channel is moved from I/O slot location 34 to I/O slot location number 08. Then the 22nd FICON, OSA-E or PCICC channel is installed in I/O slot location 25. The installation instructions will include the movement of the currently installed chaining STI cables, as well as installation of an additional STI chaining cable.

For I/O cage # 2 this means that when the 23rd (in total) FICON, OSA-E, or PCICC channel is installed, the original 18th FICON or OSA-E, or PCICC channel is moved from I/O slot location 34 to I/O slot location number 08. Then the 24th FICON, OSA-E, or PCICC channel is installed in I/O slot location 25. The installation instructions will include the movement of the currently installed chaining STI cables, as well as installation of an additional STI chaining cable.

**Note:** Whenever a PCICC card is moved (removed and re-installed), it will require that the keys for this PCICC card be re-entered. The customer must be aware of this before any scheduled work on the PCICC channel card is performed.

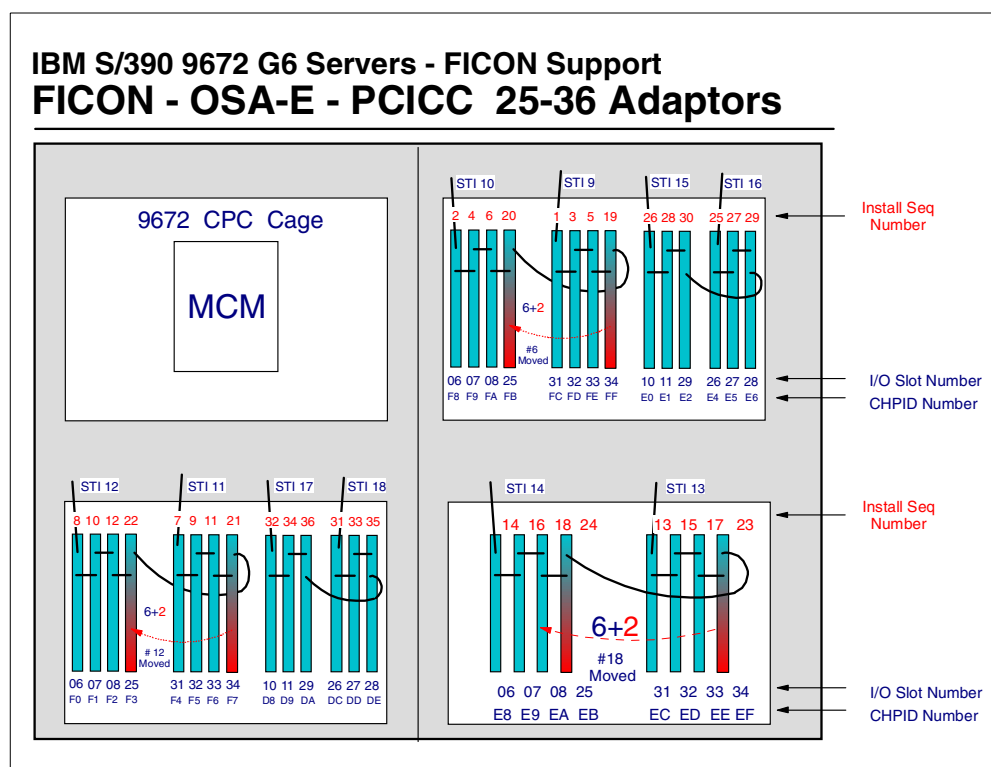


Figure 31. 9672 G6 FICON, OSA-E, or PCICC, 25 to 36 channels install sequence

The 9672 G6 processor supports the installation of 36 FICON channels. The installation of the FICON, OSA-E, or PCICC channels is as shown, with the limit for the total of the three types being 36, and the limit for each type of channel being as follows:

- FICON - 36 channels
- OSA-E - 12 channels
- PCICC - 8 channels

For I/O cage # 3 an additional six FICON (OSA-E or PCICC) channels are installed in order of the following I/O slot numbers, 26, 10, 27, 11, 28 and 29. I/O slots 26, 27, and 28 will be supported by an additional STI cable, and I/O slots 10, 11 and 29 will also be supported by (yet) another additional STI cable. The channel numbers and STIs assigned (if there are no ICB channels installed) will be as shown in Figure 31. The last two channels in each of the new STI chains will be chained (connected) together for recovery and repair actions.

For I/O cage # 1 an additional six FICON (OSA-E or PCICC) channels are installed in order of the following I/O slot numbers, 26, 10, 27, 11, 28 and 29. I/O slots 26, 27, and 28 will be supported by an additional STI cable, and I/O slots 10, 11 and 29 will also be supported by another STI cable. The channel numbers and STIs assigned (if there are no ICB channels installed) will be as shown in Figure

31. The last two channels in each of the new STI chains will be chained (connected) together for recovery and repair actions.

The IBM 9672 CHPID report shows the actual CHPID numbers and STI cables used. This is shown in Figure 32. This report can be obtained from IBM and should be handed to the customer for all new or upgraded machines or channel MESs.

**IBM S/390 G5 and G6 Servers - FICON Support**  
**FICON (FCV) - 9672 CHPID Report**

Even STI	Odd STI	CHA Support	CHPID # / Type
9672-R/6	CHPID REPORT		CHPID/TYPE
STI - CHA SLOT - CAGE LOCATION - I/O SLOT -			
0 - 24 - FRAME Z BOTTOM - 11 -	00/E	01/E	02/E
0 - 24 - FRAME Z BOTTOM - 10 -	04/E	05/E	06/E
0 - 9 - FRAME Z BOTTOM - 29 -	08/E	09/E	0A/E
0 - 9 - FRAME Z BOTTOM - 28 -	0C/P4	0D/P4	0E/P4
0 - 9 - FRAME Z BOTTOM - 27 -	10/P4	11/P4	12/P4
0 - 24 - FRAME Z BOTTOM - 26 -	14/P4	15/P4	16/P4
1 - 23 - FRAME Z BOTTOM - 21 -	24/E	25/E	26/E
1 - 16 - FRAME Z BOTTOM - 18 -	28/E	29/E	2A/E
1 - 16 - FRAME Z BOTTOM - 17 -	2C/P4	2D/P4	2E/P4
1 - 23 - FRAME Z BOTTOM - 15 -	30/E	31/E	32/E
...			
4 - 24 - FRAME A BOTTOM - 11 -	80/E	81/E	82/E
4 - 24 - FRAME A BOTTOM - 10 -	84/E	85/E	86/E
4 - 9 - FRAME A BOTTOM - 29 -	88/E	89/E	8A/E
4 - 9 - FRAME A BOTTOM - 28 -	8C/P4	8D/P4	8E/P4
5 - 23 - FRAME A BOTTOM - 21 -	A4/E	A5/E	A6/E
5 - 16 - FRAME A BOTTOM - 18 -	A8/E	A9/E	AA/E
5 - 16 - FRAME A BOTTOM - 17 -	AC/P4	AD/P4	AE/P4
5 - 23 - FRAME A BOTTOM - 15 -	B0/E	B1/E	B2/E
5 - 23 - FRAME A BOTTOM - 14 -	B4/E	B5/E	B6/E
...			
10 - - FRAME Z TOP - 6 -	F8/H1		
10 - - FRAME Z TOP - 7 -	F9/H1		
9 - - FRAME Z TOP - 31 -	FC/H1		
9 - - FRAME Z TOP - 32 -	FD/H1		

ESCON

FICON

Figure 32. 9672 G5 and G6 CHPID report (order process)

The IBM 9672 G5 or G6 CHPID report is provided to the customer for each of their 9672 G5 or G6 processors. From this report the customer can see:

- What channel types and quantity are installed
- The location of each channel and the assigned CHPID number
- The channel adapter (CHA) used to support the channel (not all channel types need to be supported by a CHA)
- The STI connection used to support the channel

The customer would use the report to:

- Define the actual channel type (and the customer's required channel mode for the channel) and CHPID number
- Which channels to select as a group of channels to connect to a multi-path control unit that provides the best availability, and define them as the channel group to a control unit.

## IBM S/390 9672 G5 and G6 Servers - FICON Support

### 0 - 24 FICON Channels Equivalence

Total FICON Channel Cards	FICON-ESCON Equivalent Channels	Total ESCON Channel Cards	Total ESCON CHPIDs	Total Equivalent Channels	FICON CHPID Number	FICON I/O Slot Required	CHPID # I/O Slot Impact	CHPID # Address Impact
0	0	64	256	256				
1	8	63	252	260	FC	Z - T - 31	Spare	Z - T - 33 (FC-FF)
2	16	61	244	260	F8	Z - T - 06	F4 - F7	Z - T - 34 (F8-FB)
3	24	61	244	268	FD	Z - T - 32	Spare	
4	32	60	240	272	F9	Z - T - 07	F0 - F3	
5	40	60	240	280	FE	Z - T - 33	Emptied	
6	48	60	240	288	FA	Z - T - 34	Emptied	
7	56	59	236	292	F4	A - B - 31	EC - EF	
8	64	58	232	296	F0	A - B - 06	DC - DF	
9	72	57	228	300	F5	A - B - 32	E8 - EB	
10	80	56	224	304	F1	A - B - 07	D8 - DB	
11	88	55	220	308	F6	A - B - 33	E4 - E7	
12	96	54	216	312	F2	A - B - 34	E0 - E3	
13	104	53	212	316	EC	Z - B - 31	D4 - D8	
14	112	52	208	320	E8	Z - B - 06	C4 - C8	
15	120	51	204	324	ED	Z - B - 32	D0 - D3	
16	128	50	200	328	E9	Z - B - 07	C0 - C3	
17	136	49	196	332	EE	Z - B - 33	CC - CF	
18	144	48	192	336	EA	Z - B - 34	C8 - CB	
19	152	47	188	340	FF	Z - T - 08	5C - 5F	
20	160	46	184	344	FB	Z - T - 25	58 - 5B	
21	168	45	180	348	F7	A - B - 08	9C - 9F	
22	176	44	176	352	F3	A - B - 25	98 - 9B	
23	184	43	172	356	EF	Z - B - 08	1C - 1F	
24	192	42	168	360	EB	Z - B - 25	18 - 1B	

Figure 33. FICON to ESCON channel equivalence and impact - 0 to 24 FICON

Figure 33 shows, for the number of ESCON and FICON channels (that will be installed on the 9672 G5 or G6 processor), what the equivalent number of ESCON channels that the combined ESCON and FICON channels will be equal to when the FICON channel quantity is from 0 to 24 FICON channels and the ESCON is from 64 to 42. (As the number of FICON channels installed is increased, there has to be a decrease in the number of ESCON channels installed).

The table also shows where the FICON channels will be installed and what the CHPID number assigned to each channel at each location will be. Also shown is the impact on other channels that the installation of the FICON channel will have.

To be able to install 24 FICON channels (and no OSA-E or PCICC channels) three I/O cages are required.

## IBM S/390 9672 G6 Servers - FICON Support

### 25 - 36 FICON Channels Equivalence

Total FICON Channel Cards	FICON-ESCON Equivalent Channels	Total ESCON Channel Cards	Total ESCON CHPIDs	Total Equivalent Channels	FICON CHPID Number	FICON I/O Slot Required	CHPID # I/O Slot Impact	CHPID # Address Impact
25	200	41	164	364	E4	Z - T - 26	54-57	
26	208	40	160	368	E0	Z - T - 10	44-47	
27	216	39	156	372	E5	Z - T - 27	50-53	
28	224	38	152	376	E1	Z - T - 11	40-43	
29	232	37	148	380	E6	Z - T - 28	4C-4F	
30	240	36	144	384	E2	Z - T - 29	48-4B	
31	248	35	140	388	DC	A - B - 26	94-97	
32	256	34	136	392	D8	A - B - 11	80-83	
33	264	33	132	396	DD	A - B - 27	90-93	
34	272	32	128	400	D9	A - B - 10	84-87	
35	280	31	124	404	DE	A - B - 28	8C-8F	
36	288	30	120	408	DA	A - B - 29	88-8B	

Figure 34. FICON to ESCON channel equivalence and impact - 25 to 36 FICON

Figure 34 shows, for the number of ESCON and FICON channels (that will be installed on a 9672 G6 processors), what the equivalent number of ESCON channels that the combined ESCON and FICON channels will be equal to when the FICON channel quantity is from 25 to 36 FICON channels and the ESCON is from 41 to 30. (As the number of FICON channels installed is increased, there has to be a decrease in the number of ESCON channels installed).

The table also shows where the FICON channels will be installed and what the CHPID number assigned to each channel at each location will be. Also shown is the impact on other channels that the installation of the FICON channel will have.

To be able to install 36 FICON channels, three I/O cages are required.



## IBM S/390 9672 G5 and G6 Servers - FICON Support

### FICON - OSA-E - PCICC 1-6 Channels (1 I/O Cage)

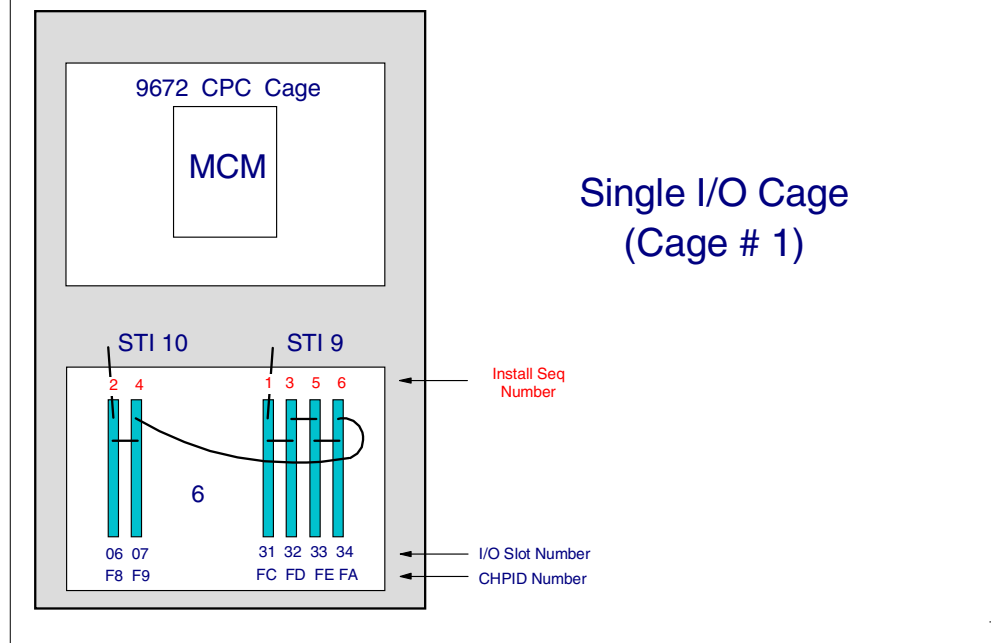


Figure 35. 9672 G5 and G6 FICON, OSA-E or PCICC, 6 channels, single cage system

Figure 35 shows, for FICON, OSA-E, or PCICC channels the installation sequence, the I/O slot number, and assigned CHPID numbers for a single I/O cage 9672 G5 or G6 processor. Also shown are the STI numbers assigned to the FICON, OSA-E, and PCICC channels in that I/O cage.

Both the CHPID number and STI assigned are dependent whether ICB channels are also installed and when in the sequence they were installed relative to the FICON, OSA-E and PCICC (before, after, or in between).

## IBM S/390 9672 G5 and G6 Servers - FICON Support

### 6 FICON Channels - Cage # 1 only

Total FICON Channel Cards	FICON-ESCON Equivalent Channels	Total ESCON Channel Cards	Total ESCON CHPIDs	Total Equivalent Channels	Assigned FICON CHPID Number	FICON I/O Slot Required	CHPID # I/O Slot Impact	CHPID # Address Impact
0	0	22	88	88				
1	8	21	84	92	FC	A - B - 31	EC - EF	
2	16	20	80	96	F8	A - B - 06	DC - DF	
3	24	19	76	100	FD	A - B - 32	E8 - EB	
4	32	18	72	104	F9	A - B - 07	D8 - DB	
5	40	17	68	108	FE	A - B - 33	E4 - E7	
6	48	16	64	112	FA	A - B - 34	E0 - E3	

Figure 36. 9672 G5 or G6 I/O Cage # 1, 0 to 6 FICON channels

Figure 36 shows, for the number of ESCON and FICON channels (that can be installed on a 9672 G5 or G6 processor), what the equivalent number of ESCON channels that the combined ESCON and FICON channels will be equal to when the FICON channel quantity is from 0 to 6 in a *single I/O cage* 9672 G5 or G6 channel configuration.

The table also shows where the FICON channels will be installed and what the CHPID number assigned to each channel at each location will be. Also shown is the impact on other channels that the installation of the FICON channel will have.

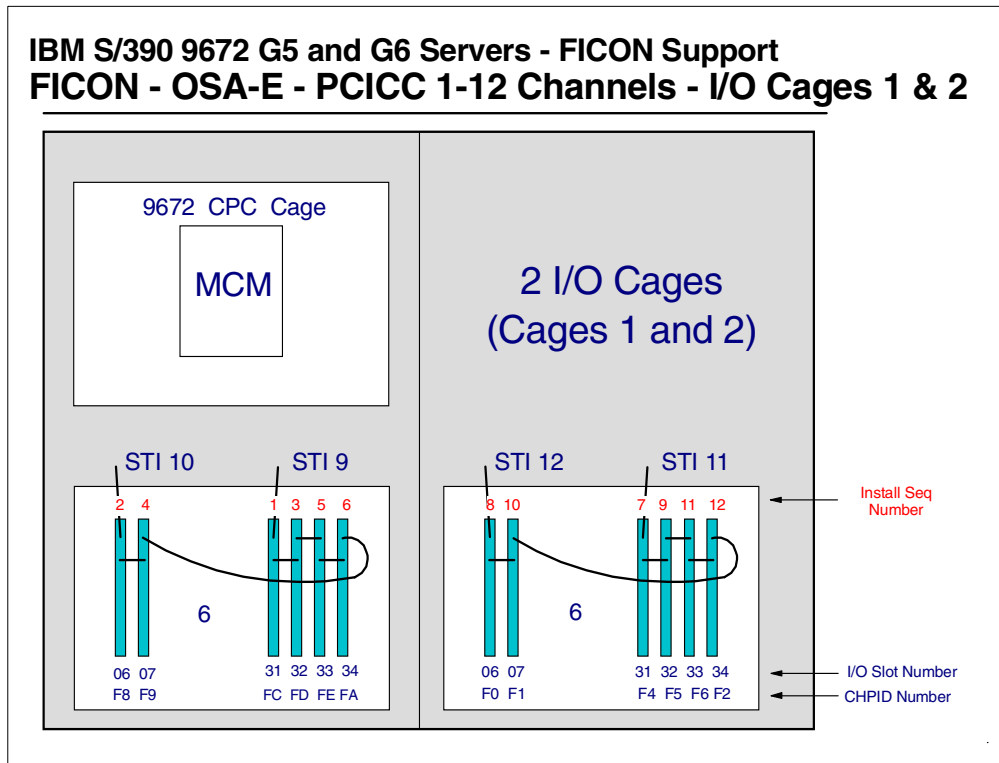


Figure 37. 9672 I/O Cages #1 and #2, 12 FICON, OSA-E, or PCICC channels

Figure 37 shows, for FICON, OSA-E, or PCICC channels, the installation sequence, the I/O slot number, and assigned CHPID number for a two I/O cage 9672 G5 or G6 processor. Also shown is the STI cable numbers assigned to the FICON, OSA-E, and PCICC channels in the I/O cages.

Both the CHPID number and STI assigned are dependent on whether ICB channels are also installed and when in sequence they were installed relative to the FICON, OSA-E, and PCICC installation (before, after, or in between).

## IBM S/390 9672 G5 and G6 Servers - FICON Support 12 FICON Channels - Cages # 1 and # 2

Total FICON Channel Cards	FICON-ESCON Equivalent Channels	Total ESCON Channel Cards	Total ESCON CHPIDs	Total Equivalent Channels	Assigned FICON CHPID Number	FICON I/O Slot Required	CHPID # I/O Slot Impact	CHPID # Address Impact
0	0	44	176	176				
1	8	43	172	180	FC	A - B - 31	EC - EF	
2	16	42	168	184	F8	A - B - 06	DC - DF	
3	24	41	164	188	FD	A - B - 32	E8 - EB	
4	32	40	160	192	F9	A - B - 07	D8 - DB	
5	40	39	156	196	FE	A - B - 33	E4 - E7	
6	48	38	152	200	FA	A - B - 34	E0 - E3	
7	56	37	148	204	F4	Z - B - 31	D4 - D8	
8	64	36	144	208	F0	Z - B - 06	C4 - C8	
9	72	35	140	212	F5	Z - B - 32	D0 - D3	
10	80	34	136	216	F1	Z - B - 07	C0 - C3	
11	88	33	132	220	F6	Z - B - 33	CC - CF	
12	96	32	128	224	F2	Z - B - 34	C9 - CB	

Figure 38. 9672 I/O cages #1 and #2, 0 to 12 FICON channels

Figure 38 shows, for the number of ESCON and FICON channels (that can be installed on a 9672 G5 or G6 processor), what the equivalent number of ESCON channels that the combined ESCON and FICON channels will be equal to when the FICON channel quantity is from 0 to 12 in a two I/O cage 9672 G5 or G6 channel configuration.

The figure also shows where the FICON channels will be installed and what the CHPID number assigned to each channel at each location will be. Also shown is the impact on other channels that the installation of the FICON channel will have.

### 4.1 9672 Resource requirements by channel type

Each S/390 9672 channel type group requires the use of 9672 processor resources:

- I/O or CP frame
- I/O cage
- I/O slots
- CHPID numbers
- STI connections
- Definition support

The channel type groups are:

- I/O domain channels - Parallel, ESCON, OSA-2, and ISC
- Direct connect STI chaining channels - FICON, OSA-E, and PCICC
- Direct connect STI non-chaining channels - ICB
- Internal channels - IC channel

Figure 39 shows which of the processor resources are required by each channel group and type.

IBM S/390 9672 G5 and G6 Servers - FICON Support									
Resource - Frame - Cage - STI - I/O Slot - CHPID #									
	I/O Domain CHPIDs STI CHPID assignments 32/24/16				Direct connect STI chain (CHPIDs 4)			Direct connect STI (x1)	Internal connect x2
	Parallel	ESCON	OSA-2	ISC	FICON	OSA-E	PCICC	ICB	IC Channel
Frame	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
I/O Cage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
I/O Slot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
I/O Domain STI	Yes	Yes	Yes	Yes	No	No	No	No	No
I/O CHA Required	Yes	Yes	Yes	No	No	No	No	No	No
I/O Domain STI CHPID #	Yes	Yes	Yes	Yes	No	No	No	No	No
Direct Connect STI STI Chaining	No	No	No	No	Yes	Yes	Yes	No	No
STI Chaining CHPID#	No	No	No	No	Yes	Yes	Yes	No	No
Direct Connect STI No STI Chaining	No	No	No	No	No	No	No	Yes	No
No STI Chaining CHPID #	No	No	No	No	No	No	No	Yes	No
Customer Assigned CHPID #	No	No	No	No	No	No	No	No	Yes
IOCP Definition Required	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

Figure 39. 9672 resource requirements by channel type

Figure 39 shows that the installation of FICON, OSA-E, and PCICC channels requires:

- An I/O cage and I/O slot.
- Direct connect chaining STI.
- CHPID numbers that are assigned to the STI (and not to the I/O slot).
- The FICON and OSA-E channel needs to be defined (HCD and/or IOCP).
- PCICC channels are not defined (using HCD or IOCP), but do take a channel number assigned to the STI and its position in the STI chain.

## Chapter 5. 9032 Model 5 ESCON Director

When a 9672 G5 or G6 FICON channel is used in FCV mode, it is required to be connected to a FICON Bridge adapter. FICON Bridge adapters are installed in 9032 model 5 ESCON Directors.

This chapter provides required information about the 9032 model 5 ESCON Director that you must be aware of when planning a FICON (FCV) mode environment.

### IBM S/390 9672 G5 and G6 Servers - FICON Support IBM 9032 Model 5 - ESCON Director

- Supports 31 port/link cards (ESCON and FICON Bridge)
- 248 ESCON Ports in 9032 Model 5 using all 31 card slots
- Supports the new FICON Bridge Feature
  - ▶ FICON Bridge Card 5260
  - ▶ FICON Enablement Feature 5700
- Can support up to 16 FICON Bridge cards
- With intermixed port cards, supports:
  - ▶ 15 ESCON cards x 8 ports = 120 ESCON ports
  - ▶ 16 FICON Bridge cards x 1 port = 16 FICON ports
- FICON channels in FCV mode always connect to the FICON bridge card
- One FICON Bridge card supports 8 concurrent I/O operations, to different ESCON links (to different LCUs)
  - ▶ 16 x 8 = 128 concurrent I/O via FICON links (limited to 120 because the 15 remaining ESCON port cards only support 120 ports (15 x 8 = 120))

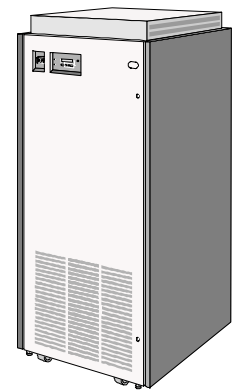


Figure 40. IBM 9032 Model 5 ESCON Director

The IBM 9032 Model 5 ESCON Director supports 31 port cards. There can be 31 ESCON port cards installed. Alternatively you can have up to 16 FICON Bridge port cards installed, with the remaining port cards all being ESCON port cards.

Each ESCON port card provides 8 ports and each port on the card will be assigned a unique port link address once the card is installed in the 9032 Model 5 ESCON Director.

Each FICON Bridge port card has just one port. This port will be assigned a unique port link address once the card is installed in the 9032 Model 5 ESCON Director, based on the port slot it is installed into.

Therefore, with all ESCON port cards installed, there will be 248 ESCON ports available. With 16 FICON Bridge adapter cards, there will be 16 FICON Bridge ports.

With the maximum FICON Bridge adapter cards installed and the remaining port slots having ESCON port cards installed, there will be:

- 16 FICON ports
- 120 ESCON ports

The only fiber connection that can be made to a FICON Bridge port is from a 9672 FICON channel in FCV mode.

One FICON Bridge card supports 8 concurrent I/O operations, each to a different ESCON port (destination link) in the same 9032 Model 5 Director. Each of the ESCON links will go to a different control unit (or it can go to a different control unit image in the same physical control unit).

With 16 FICON Bridge adapters installed, there could be a maximum of 128 concurrent I/O operations being performed through the 9032 Model 5 ESCON Director. However, with only 120 ESCON ports installed in the ESCON Director, this would be limited to 120 concurrent I/O operations (this also assumes that only ESCON control units or ESCON CTC channels are logically connected to the ESCON director ESCON ports). This is because with 16 FICON Bridge adapter cards installed, the remaining 15 port card locations can have all ESCON port cards installed and these would only support 120 ports (15 cards x 8 ports each = 120 ports in total).

## 5.1 Port card plugging Considerations

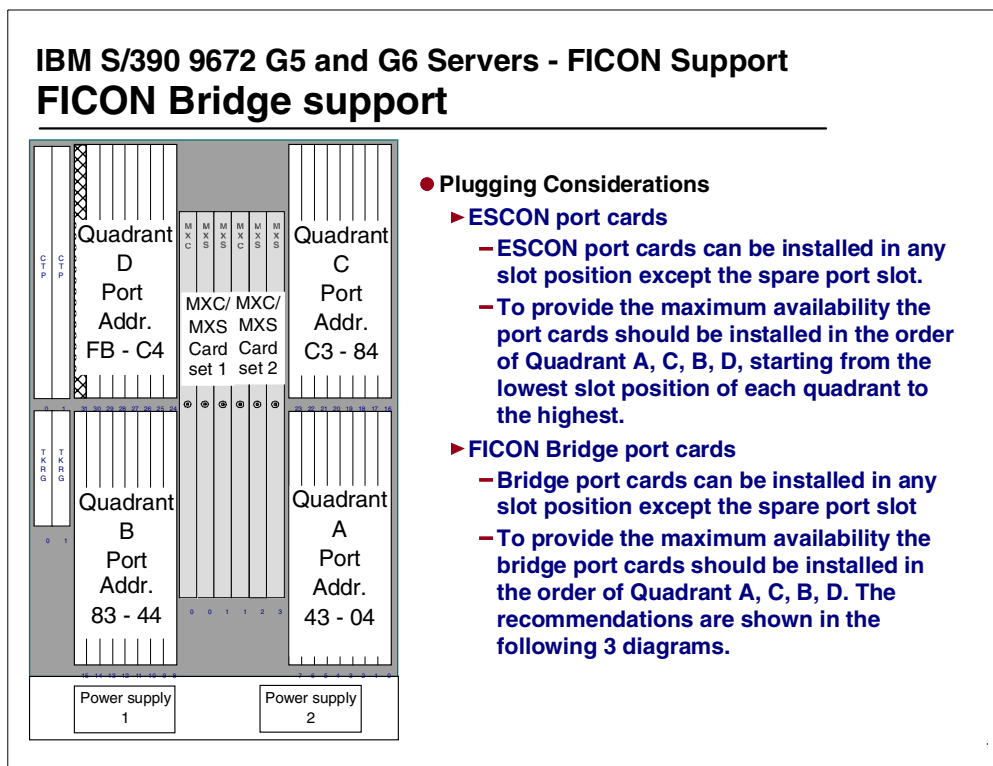


Figure 41. 9032-5 port card locations

- ESCON port cards

Standard ESCON port cards can be installed in any slot position except the spare port slot.

To provide the maximum availability, the port cards should be installed in the order of Quadrant A, C, B, D, starting from the lowest slot position of each quadrant to the highest.

- FICON Bridge port cards

The FICON Bridge port cards can be installed in any slot position except the spare port slot.

To provide maximum availability, the bridge port cards should be installed in the order of Quadrant A, C, B, D. The FICON Bridge port card recommendations are shown in the following three figures.

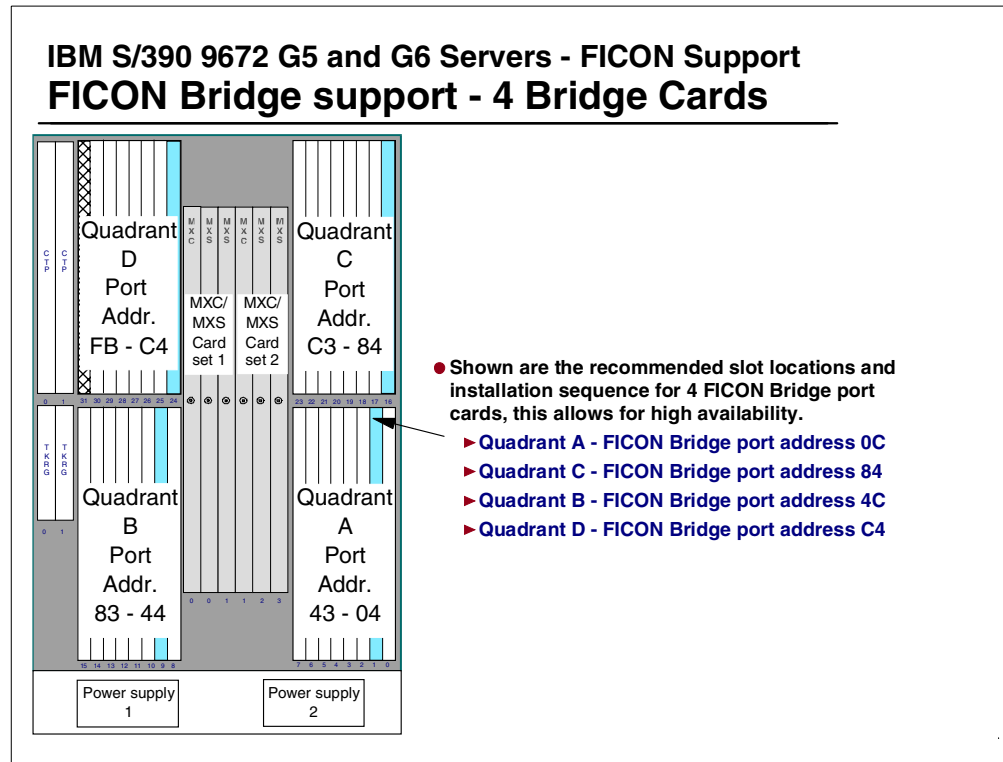


Figure 42. Recommended location for 4 FICON Bridge cards

Figure 42 shows both the recommended port slot locations for the installation of the first 4 FICON Bridge port cards and the sequence of installation (16 is the maximum number of FICON bridge cards that can be installed in one 9032 model 5 ESCON Director). The port addresses shown are for a 9032-5 ESCON Director using the standard default port address assignment.

As the FICON Bridge port card only has one port, only the first port address assigned to the port slot is used. The other 7 port addresses assigned to the port slot are unused.

## IBM S/390 9672 G5 and G6 Servers - FICON Support

### FICON Bridge support - 8 Bridge Cards

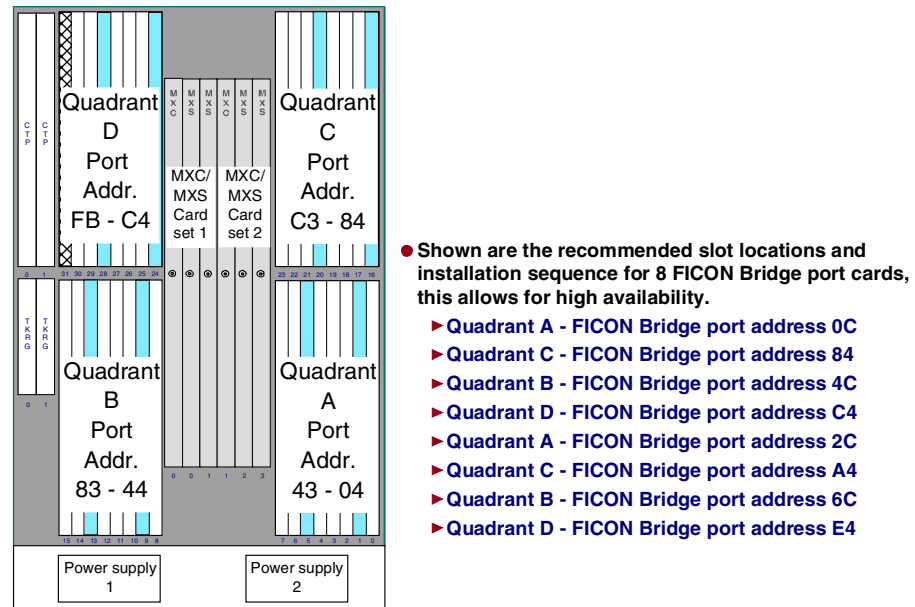


Figure 43. Recommended locations for 8 FICON Bridge cards

Figure 43 shows both the recommended port slot locations for the installation of the 8 FICON Bridge port cards and the sequence of installation (16 is the maximum number of FICON bridge cards that can be installed in one 9032 model 5 ESCON Director). The port addresses shown are for a 9032-5 ESCON Director using the standard default port address assignment.

As the FICON Bridge port card only has one port, only the first port address assigned to the port slot is used. The other 7 port addresses assigned to the port slot are unused.



## IBM S/390 9672 G5 and G6 Servers - FICON Support

### FICON Bridge support - 16 Bridge Cards

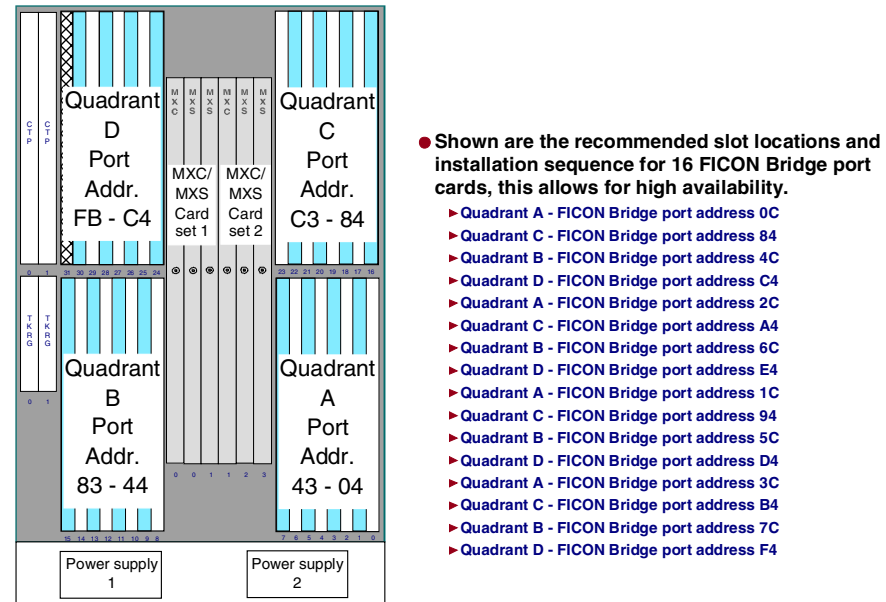


Figure 44. Recommended location for 16 FICON Bridge cards

Figure 44 shows both the recommended port slot locations for the installation of the 16 FICON Bridge port cards and the sequence of installation (16 is the maximum number of FICON bridge cards that can be installed in one 9032 model 5 ESCON Director). The port addresses shown are for a 9032-5 ESCON Director using the standard default port address assignment.

As the FICON Bridge port card only has one port, only the first port address assigned to the port slot is used. The other 7 port addresses assigned to the port slot are unused.

## IBM S/390 9672 G5 and G6 Servers - FICON Support

### FICON Bridge support - 16 Bridge Cards

16 - FICON Cards Port Address (per Bridge card)	FICON Port Addresses	15 - ESCON Cards Port Addresses (per port card)	ESCON Port/Addresses
0C	16 FICON Bridge card installation, shown by port address when installed in the recommended installation sequence order. These port addresses-locations allow for availability and good airflow over the FICON Bridge cards.	04 - 0B	15 ESCON Port cards 120 ESCON Ports (8 ports per card)
84		14 - 1B	
4C		24 - 2B	
C4		34 - 3B	
2C		44 - 4B	
A4		54 - 5B	
6C		64 - 6B	
E4		74 - 7B	
1C		8C - 93	
94		9C - A3	
5C		AC - B3	
D4		BC - C3	
3C		CC - D3	
B4		DC - E3	
7C		EC - F3	
F4		Spare Ports	

Figure 45. FICON and ESCON Port Addresses when using recommended port slots

When the FICON Bridge adapters (16) are installed in the recommended 9032 model 5 port slots, and ESCON port cards are installed in all the other port slots, the port addresses assigned for both the FICON Bridge ports and all the ESCON ports are as shown in Figure 45.

## IBM S/390 9672 G5 and G6 Servers - FICON Support FICON Bridge Support - FICON Capable

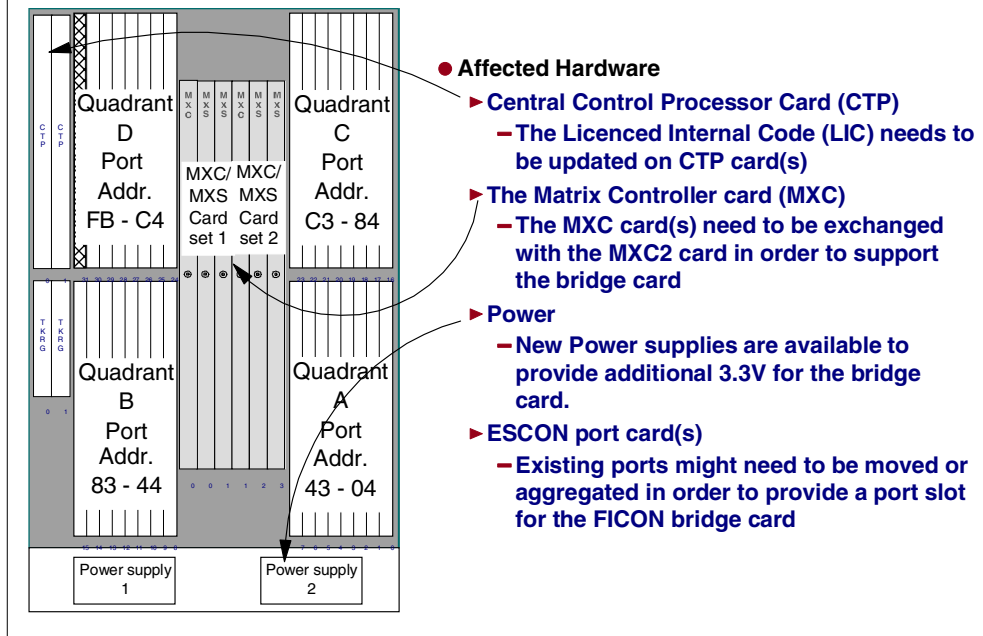


Figure 46. 9032 Model 5 hardware changes to support FICON

A concurrent upgrade to support the FICON Bridge cards in the 9032 Model 5 ESCON Director is only supported if the Director has a “High ESCON Director availability” configuration.

The FICON Bridge card installation sequence would then be:

1. Check director event log for any hardware failures.
2. Swap back any swapped ports to their original locations.
3. Install the 9032 Model 5 LIC 5.0 code or higher.
4. Both power supplies may need to be replaced, one at a time.
5. Install new MXC2 cards, if required.

Check the hardware configuration to determine the “active” and the “backup” MXC cards.

If MXC cards are installed, replace the “backup” MXC card with the MXC2 card.

Use the hardware configuration panel to verify that the new installed MXC2 card is flagged as “backup”.

From a “Terminal window” use the XPMDBG 7 3 command to force the “Backup” MXC2 card to become the “active” one.

Check the hardware configuration to verify that the new installed MXC2 card is flagged as “active”.

Replace the second MXC (which is now “backup”) card with the MXC2 card.

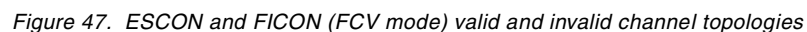
## e adapter channel topologies

The FICON Bridge adapter must be installed in the first ESCD when cascading of ESCON Directors is required. For FICON Bridge configurations, the first ESCD in the FICON (FCV mode) channel path must have a dynamic connection, and the second ESCD must have a dedicated connection.

- FICON (FCV)-to-FICON (FCV) connections are not allowed.
- You cannot create a dedicated connection from a FICON Bridge port to any other port (FICON bridge port or ESCON port).

The dedicated connection is between ESCON ports in the second (cascaded) ESCON Director.

- it only has one port number and source link address.
- All ESCD actions (block/unblock, allow/prohibit) to a FICON Bridge port, apply to the complete FICON Bridge adapter.



- ESCON can be point-to-point or switched point-to-point.

- For an ESCON switched point-to-point connection, there can only be one dynamic switch in the ESCON path.
- An ESCON CNC channel must connect to an ESCON port.
- FICON (FCV) can only be switched point-to-point.
- There can only be one dynamic switch in the channel to CU path.
- The FICON (FCV) channel must connect to a FICON Bridge port.

---

### 5.3 OS/390, HCD, and HCM - 9032 Model 5 definition support

OS/390, HCD, and HCM all provide definition support for the 9032-5

- CU and device support

Support for the CU and Device type of 9032-5

- Port status (installed or not installed)

Allows for port quantity from 0 to 248 ports being defined as installed

- Matrix support

Allows a port switch use to be defined (Block, Allow, Prohibit, etc.)

- Move port (new with FICON support)

Used when there is a need to move an ESCD port connection to free up the complete port card location to make room to install a FICON bridge card in the same location

- Convert port (new for FICON)

Used to change the definition of an ESCON port to a FICON Bridge port, and to then allow the HCD and HCM definition process to police the rule of port number (modulo (8-4)) and un-install the other port addresses on the FICON Bridge card so that they then cannot be used after that during the definition process



## Chapter 6. FICON cabling and connectivity

This chapter covers the 9672 G5 and G6 FICON (FCV mode) channel cabling requirements.

The preferred fiber cable connection between a 9672 long wavelength FICON channel (in FCV mode) and a 9032-5 FICON Bridge card is to use a 9-micron single-mode fiber cable. An IBM 9 micron single-mode fiber jumper cable is bi-directional and consists of two fiber strands in one jumper cable.

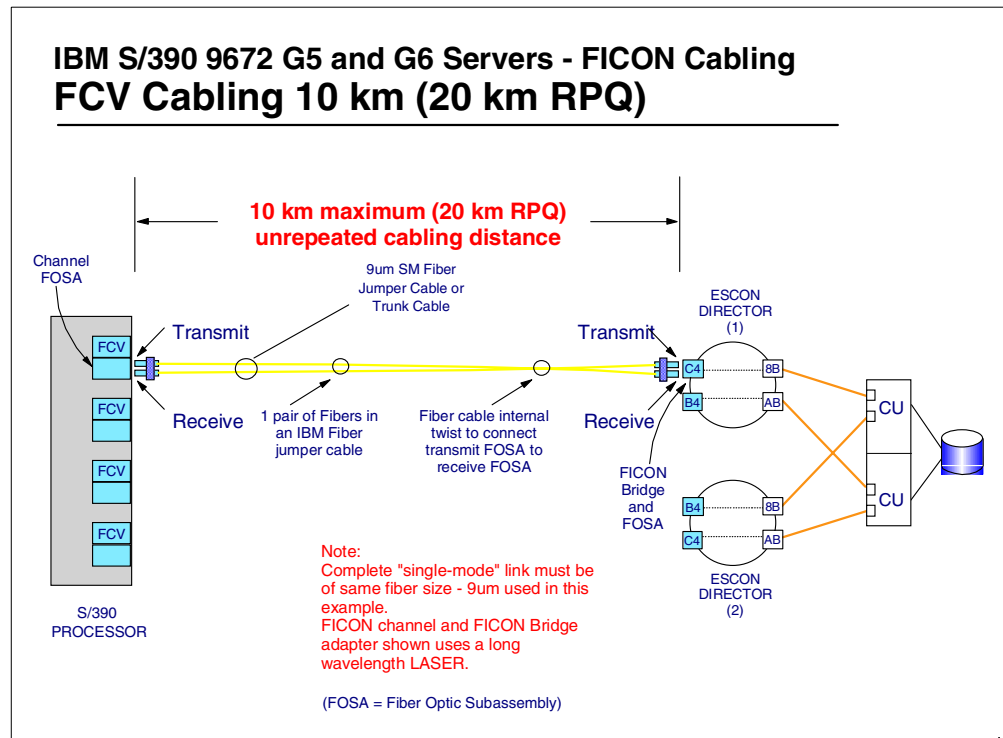


Figure 48. FICON (FCV mode) channel to FICON Bridge connection

The FICON channel and FICON Bridge card both have a fiber optic subassembly (FOSA) that consists of a transmitter and a receiver. The FICON channel and FICON bridge are connected together via a fiber cable that consists of two fiber strands. The fiber cable has one twist that, when the cable is installed, allows the transmit part of the FOSA at one end of the cable to be connected to the receive part of the FOSA at the other end of the cable.

The FICON (FCV mode) channel FOSA uses a long wavelength (LX) laser signal at 1300 nano-meters. The connection to the FOSA requires the use of a Fiber Channel Standard (FCS) duplex connector, which is equivalent to SC Duplex.

The maximum supported *link budget loss* of 7db is permitted.

When 9 micron single-mode fiber is used to connect the FICON channel in FCV mode to the 9032-5 FICON Bridge port, the maximum un-repeated distance that is supported is 10 km. An RPQ can be submitted to determine if the link environment (quality of signal) will support a distance of up to 20 km. This

requires that the attenuation of the signal does not exceed the allowable link budget loss.

FCS repeaters can be used to extend the distance on a point-to-point link up to 100 km (or sometimes more).

FICON links can also be extended via the IBM 2029 Fiber Saver, a dense wavelength division multiplexer which can run up to 32 protocol-independent data channels over one pair of optical fibers to distances of 50 km point-to-point, 35 km in a hubbed ring, and longer distances upon RPQ request. This is described in the *IBM Fiber Saver (2029) Implementation Guide*, SG24-5608.

Table 1. IBM single-mode FICON cabling

Part number	Length meters/feet
54G3409	7/20
54G3410	13/40
54G3411	22/70
54G3412	31/100
54G3413	46/150
54G3414	61/200
54G3415	Custom

IBM provides a number of standard 9 micron single-mode fiber cables. Table 1 shows the part number and length (in meters and feet) for the standard sizes.

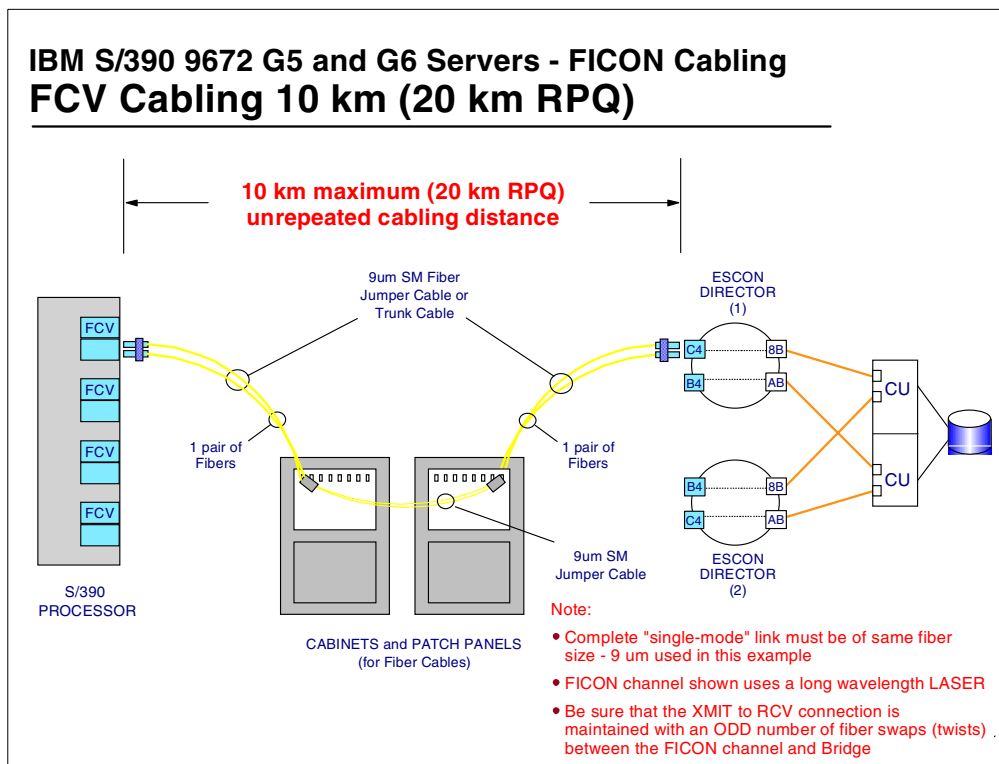


Figure 49. Patch panels and the FICON link connection



Patch panels may be used in the link path between the FICON (FCV mode) channel and the FICON bridge adapter. When patch panels are used, the following conditions must be observed:

- Maximum un-repeated distance is 10 km (an RPQ may be submitted to extend the distance to 20 km).
- 9 micron single-mode fiber should be used for the complete link connection.
- The transit function in one FOSA must connect to the receive function in the other. This can be accomplished by maintaining an odd number of twists in the fiber cables. Normally each fiber jumper cable should have a twist.
- The connections at the 9672 FICON channel and the 9032-5 FICON bridge are Fiber Channel Standard (FCS) duplex connector, which is equivalent to SC Duplex.

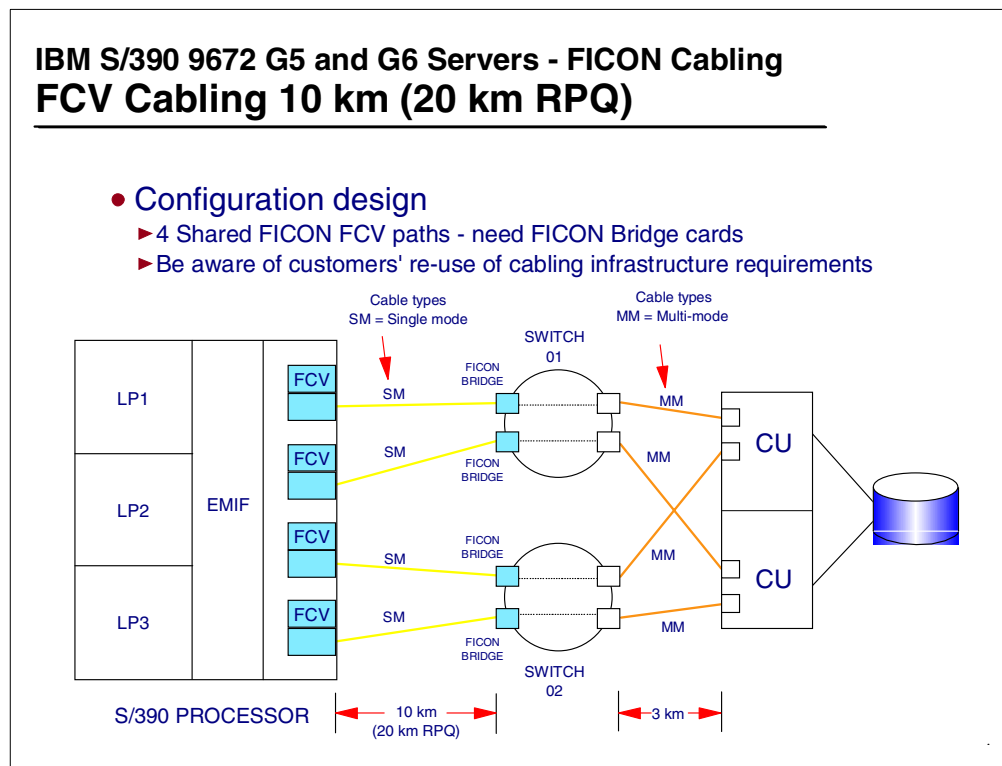


Figure 50. FICON (FCV mode) channel connections to a multi-path CU

A multi-path ESCON interfaced CU may be connected to FICON (FCV mode) channels. One FICON (FCV mode) channel is required for each CU path when going to the same multi-path CU. There may be up to 8 paths from a 9672 G5 or G6 processor image to the same CU image. If all these paths were to use FICON FCV mode channels, this would require 8 FICON channels.

Each FICON (FCV mode) channel will support up to 8 concurrent I/O operations (8 concurrent connections), but to 8 different control units. The number of control unit connections (paths) defined from a FICON (FCV mode) channel is installation dependent (determined by the control unit characteristics, and the customer's configuration and performance requirements).

A FICON (FCV mode) channel path can only be defined once to a CU. All other CU paths defined to use this same channel must be to different control units. See Chapter 11., “FICON (FCV) configuration scenarios” on page 111 for details on valid and invalid control unit path connections.

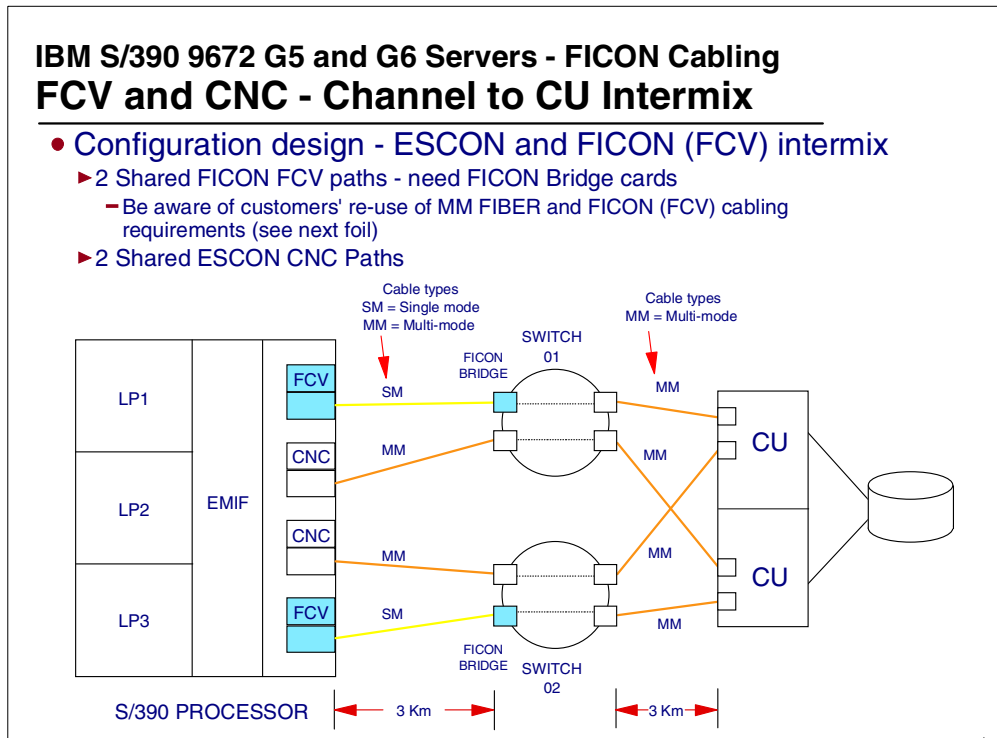


Figure 51. FICON (FCV mode) and ESCON channels intermixed to a multi-path CU

Both ESCON (CNC) channel paths and FICON (FCV mode) channels paths may be defined from a 9672 G5 or G6 processor image to the same CU image. The number of paths that may be intermixed is 8 (a S/390 rule).

The fiber cabling requirements for the FICON and ESCON paths are as follows:

- 9 micron single-mode optical fiber is supported for up to 10 km FICON channel links (20 km with RPQ). These are non-repeated distances, i.e. there is no signal re-drive.
- 62.5 or 50 micron multi-mode optical fiber is supported for up to 3 km or 2 km for ESCON channel links. These are non-repeated distances, i.e. there is no signal re-drive.
- When 62.5 and 50 micron multi-mode optical fiber is used with FICON (FCV mode) channels, the supported distance drops to 550 meters.
- The use of 62.5 or 50 micron multi-mode fiber requires the installation of IBM FICON Mode Conditioner Patch (MCP) cables - FC 0106 or FC 0103.
- There is a FCS SC duplex receptacle on the FICON Channel and the FICON Bridge cards.
- The Mode Conditioning Patch cables provide a FCS SC duplex-to-ESCON multi-mode connection.

---

## 6.1 Mode Conditioner Patch (MCP) cables

FICON long wavelength channels use a single-mode 9 micron fiber cable infrastructure.

A 9 micron single-mode fiber is supported for up to 10 km link distances (no need for repeaters) with maximum permitted link budget loss of 7db. A 20 km link distance may be supported, but an IBM RPQ should be submitted to determine this.

FCS single-mode SC duplex receptacles are used on the FICON channel cards and the FICON Bridge cards.

S/390 FICON channel configurations can also re-use an existing multi-mode fiber infrastructure, by the use of FICON Mode Conditioner Patch (MCP) cables.

62.5 and 50 micron multi-mode fiber is supported for up to 550 meters; this requires the use of the FICON mode conditioner patch cables, one at each end of the link. The mode conditioner patch cables are available for the reuse of existing ESCON multi-mode fiber optic cables that have IBM ESCON type connectors on the end of the cables.

When the FICON Mode Conditioner Patch cables are used, there is a reduced link loss budget, 5 dB versus 7 dB for normal use of single-mode fiber.

Two mode conditioning patch cables are required per multi-mode optic link, (a link as stated here is the connection between fiber optical ports). For most cases the two optical ports will be the FICON channel FOSA and the FICON Bridge FOSA. However, some installations may be using an IBM 2029 Fiber Saver product to either extend the link distance or consolidate the use of fiber; in this case, the optical ports would be the FICON channel and the IBM 2029 Fiber Saver OCI port that the FICON channel fiber cables plugs into.

The FICON mode conditioning patch cables enable a single-mode laser signal to transfer to a multi-mode fiber with minimal impact to the transmission signal due to the modal noise problem caused by light dispersion of the 1300 nano-meter laser signal being transmitted through a multi-mode fiber cable.

There is a Fiber Channel Standard (FCS) duplex connector, which is equivalent to SC Duplex, at one end of the FICON mode conditioner patch cable that plugs into the FICON FOSA (FICON channel or FICON Bridge), and a IBM Duplex ESCON MM receptacle at the other end that the ESCON MM cable plugs into.

The FICON mode conditioner patch cables are all 2 meters in length.

## IBM S/390 9672 G5 and G6 Servers - FICON Cabling Mode Conditioning Cables (Fiber Re-use)

- Be aware of customers' re-use of cabling infrastructure requirements

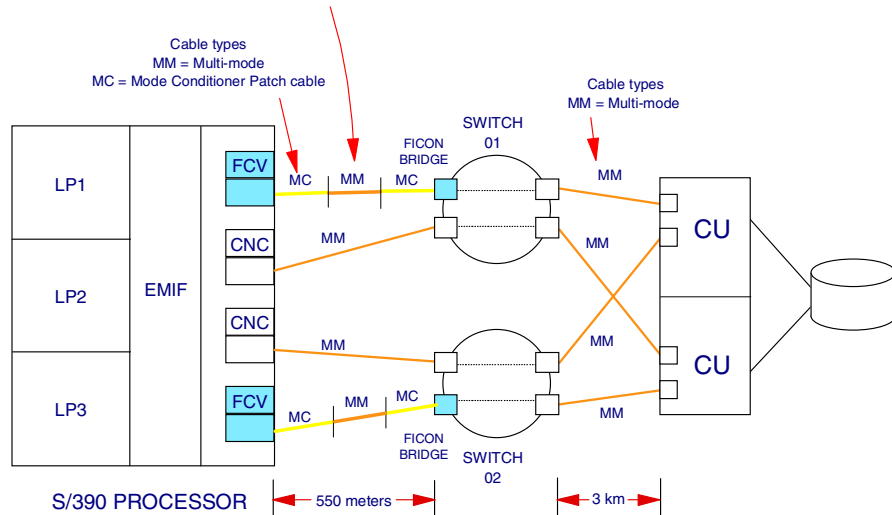


Figure 52. FICON mode conditioning patch cables - requirement

Figure 52 shows four paths from the 9672 G5 or G6 processor to the same CU. Two of the paths are ESCON (CNC) and use standard 62.5 micron multi-mode fiber. The other two paths are FICON (FCV mode) and are also using the customer's 62.5 micron multi-mode fiber, but because of this, there has to be a fiber mode condition path (MCP) cable to connect the customer's fiber to the 9672 FICON channel and the 9032-5 FICON Bridge card. This requires that there be an MCP cable at each end of the FICON (FCV mode) optical link.

There is a MCP cable feature code (FC 0106) for connecting LX laser FOSA to 62.5 multi-mode fiber, and a different feature code (FC 0103) for connecting to 50 multi-mode fiber.

## IBM S/390 9672 G5 and G6 Servers - FICON Cabling Mode Conditioning Cables (Fiber Re-use)

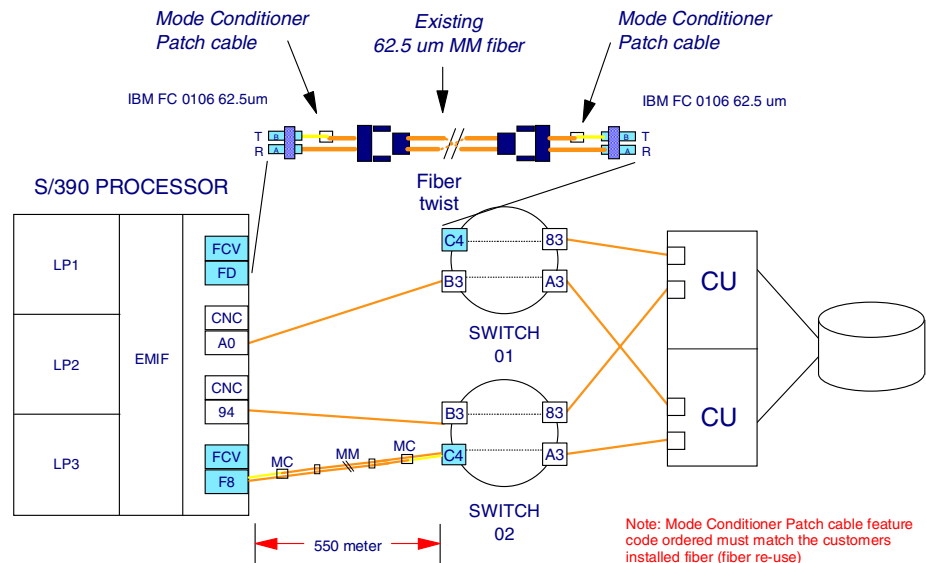


Figure 53. Use of FICON mode conditioner patch cables

Figure 53 shows the two MCP cables in one of the FICON (FCV mode) channel links.

## IBM S/390 G5 and G6 Servers - FICON Cabling Mode Conditioning Cables (FICON)

Mode Conditioning Patch cables for re-using ESCON Multi-mode fiber

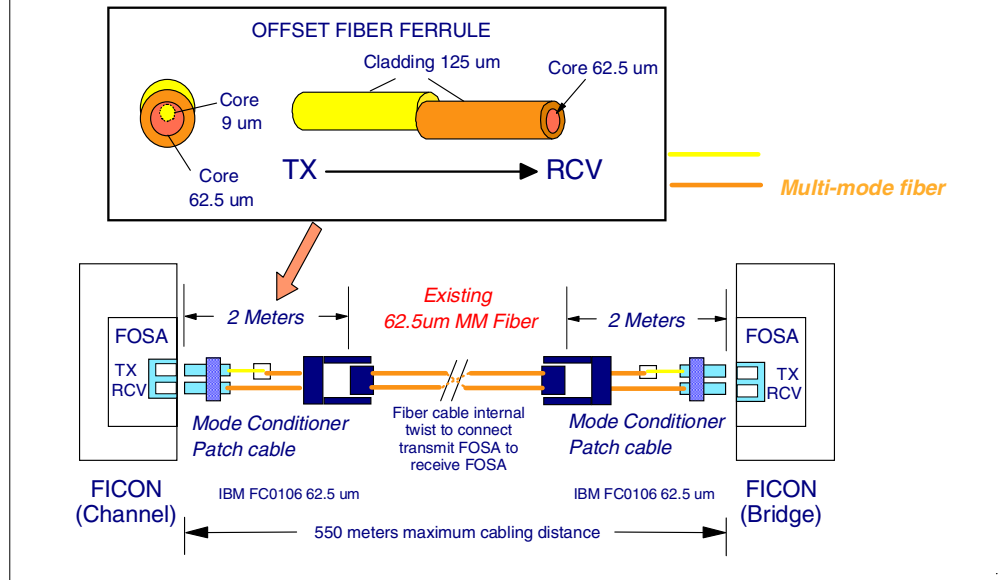


Figure 54. FICON Mode Conditioner Patch cables - construction

The construction of the MCP cable is as shown in Figure 54. The MCP cable consists of three main parts, and three pieces of fiber cabling (fiber stands):

- A Fiber Channel Standard (FCS) duplex connector, which is equivalent to an SC duplex connector, is at one end of the MCP cable.
- An IBM ESCON duplex connector is at the other end of the MCP cable. There is a single-mode to multi-mode fiber offset ferrule.

These are all connected as follows:

- The Fiber Channel Standard (FCS) duplex connector, which is equivalent to SC Duplex connector is connected to two fiber strands:
  - A 9 micron single-mode fiber that is connected to the MCP offset ferrule.
  - A multi-mode fiber that connects straight through to the IBM ESCON duplex connector.
- The IBM ESCON duplex connector is connected to two fiber stands:
  - A multi-mode fiber that is also connected to the MCP offset ferrule.
  - A multi-mode fiber that connects straight through to the Fiber Channel Standard (FCS) duplex connector, which is equivalent to an SC duplex connector.

The purpose of the single-mode to multi-mode fiber offset ferrule is to allow the transit of a laser signal from a single-mode fiber to a multi-mode fiber. To allow this to happen, the two fibers are offset to one another where they join inside the encapsulated ferrule.

As the laser signal travels through the multi-mode fiber, there is a dispersion of the signal and therefore effectively an attenuation of the signal. Because of this attenuation, the supported distance between the FICON channel FOSA and the FICON Bridge FOSA is reduced to 550 meters.

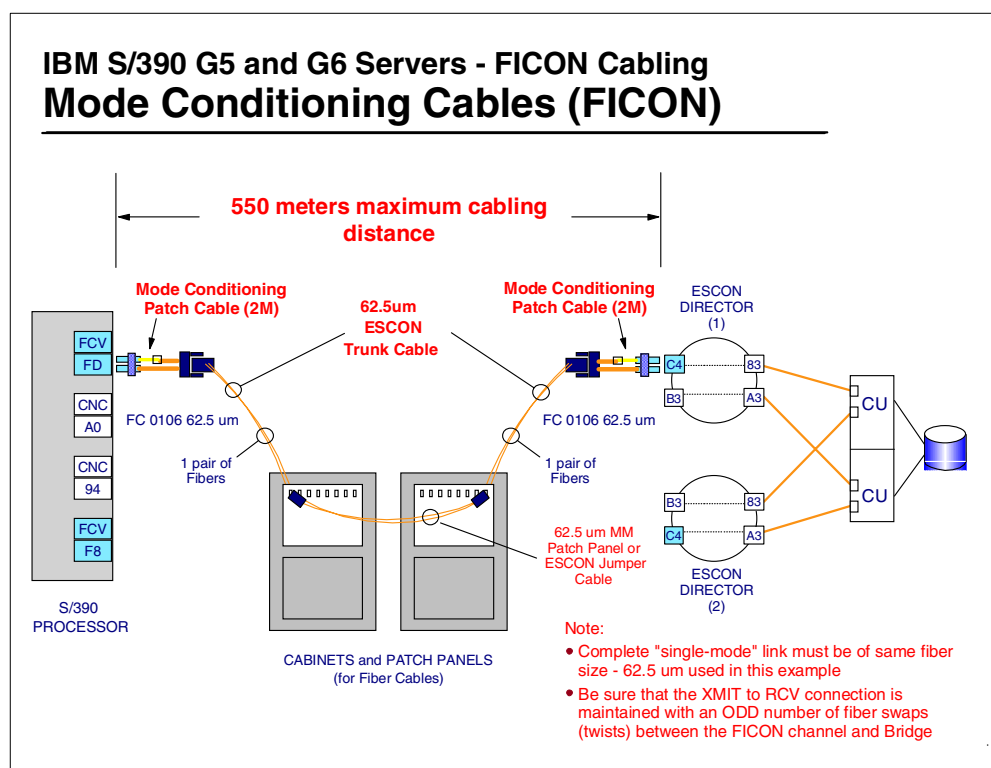


Figure 55. FICON mode conditioner patch cables - patch panels

Note that the customer's patch panels may still be used in a multi-mode fiber cabling infrastructure, when MCP cables are used in the FICON (FCV mode) channel link that uses the multi-mode fiber cabling infrastructure. The conditions that must be observed are:

- The correct MCP cable must be used to connect to the customers multi-mode fiber infrastructure (FC 0106 or FC 0103).
- Only two MCP cables are ever required in the FICON (FCV mode) channel link, one at the FICON channel FOSA and the other at the FICON Bridge FOSA.
- The same fiber size (62.5 micron or 50 micron) must be used all the way between the two MCP cables.
- There must still be an odd number of cable twists between the two FOSAs.

## IBM S/390 G5 and G6 Servers - FICON Cabling Mode Conditioning Cables (FICON)

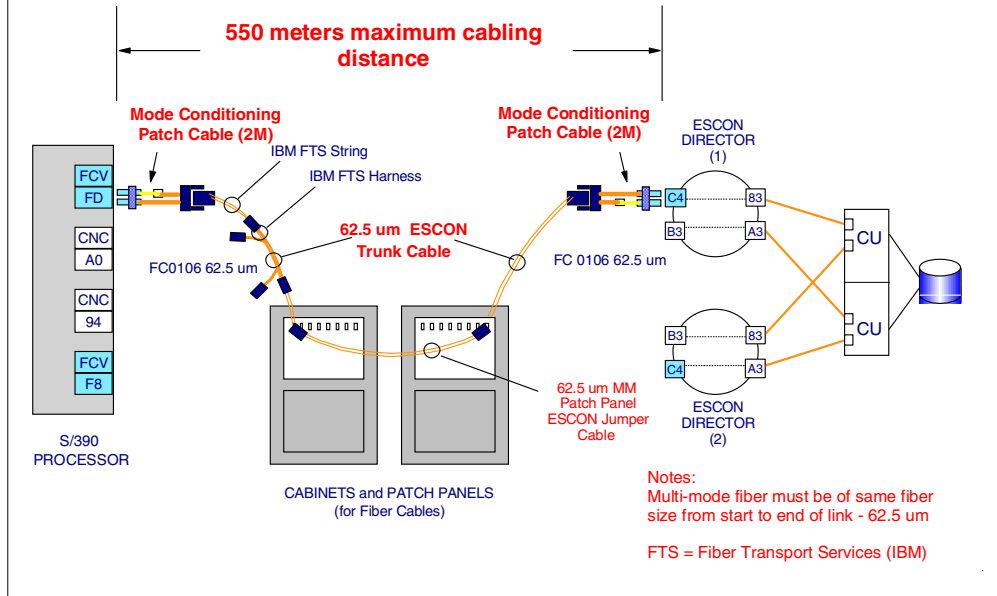


Figure 56. FICON mode conditioner patch cables - fiber trunk cables and harness

In addition to the patch panels being in the FICON channel link path, the actual fiber provided may either be fiber jumper cables or a fiber trunk. All of these are supported, provided that they meet the conditions of:

- Correct MCP cable (FC 0106 or FC 0103) for the fiber size being used (62.5 or 50 micron multi-mode fiber).
- Correct connectors at the MCP cable ESCON end (IBM ESCON duplex connector).
- An odd number of cable twists.
- Same size of fiber all the way through the FICON (FCV mode) channel link (62.5 or 50 micron) between the two MCP cables.



## IBM S/390 G5 and G6 Servers - FICON Cabling Mode Conditioning Patch Cables (FICON)

- The Mode Conditioner Patch cables must plug directly into the Channel and Bridge FOSA
- SM or MM jumper cables must not be installed between the Mode Conditioner Patch cables and the FICON channel FOSA or the FICON Bridge FOSA

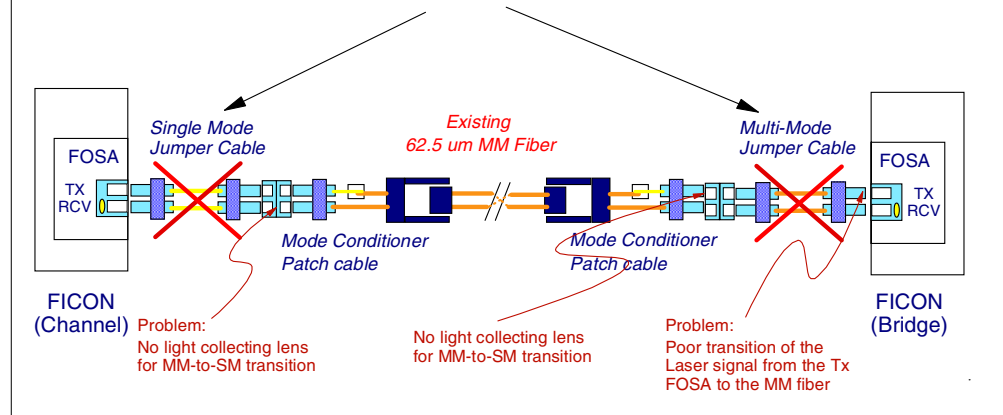


Figure 57. FICON Mode Conditioner Patch cables - invalid use

When mode conditioner patch (MCP) cables are used, they must be plugged directly in the FICON channel and the FICON Bridge card. No other fiber cable must be placed between the MCP and the FOSA.

If a 9 micron single-mode fiber cable is incorrectly placed between the MCP and the FOSA, then the incoming receive signal will not pass successfully between the end of the MCP and the 9 micron single-mode fiber. Normally the MCP is plugged into the FOSA which has a receive signal lens, and it can collect most of the incoming signal, whereas most of the signal is lost when passing between the MCP and a single-mode fiber cable.

If a 62.5 multi-mode fiber cable is incorrectly placed between the MCP and the FOSA, then the outgoing transmit signal will not pass successfully between the FOSA and the end of the incorrectly placed multi-mode fiber cable. This is because a laser signal is trying to transit from a single-mode fiber cable to a multi-mode fiber cable without there being an offset between the two fibers.

## IBM S/390 G5 and G6 Servers - FICON Support

### FICON Fiber Cabling Requirements

Channel/Use	FOSA	Trunk Fiber Specification	Plug Type	Distance (Unrepeated)	Loss Budget	Notes
FICON Channel (FC 2314)	Laser LX-1300nm	Single mode: 9 um	FCS-Duplex (sm)	10 km 20 km (RPQ)	7db	100 km via repeaters
FICON Channel (FC 2314) Mode Conditioner Cable (FC 0106)	Laser LX-1300nm	Multi-mode: 62.5 um Mode Conditioner Patch cable (Trunk Fiber re-use)	FCS-Duplex (sm)  ESCON	550 meters	5db	All Fiber between mode conditioners must be 62.5 um
FICON Channel (FC 2314) Mode Conditioner Cable (FC 0103)	Laser LX-1300nm	Multi-mode: 50 um Mode Conditioner Patch cable (Trunk Fiber re-use)	FCS-Duplex (sm)  ESCON	550 meters	5db	All Fiber between mode conditioners must be 50 um

Figure 58. FICON fiber cabling requirements

Figure 58 shows the three fiber cable connection sizes that are supported for long wavelength FICON (FCV mode) channel links and the connection conditions that must be observed.

## 6.2 S/390 remote site connectivity

For FICON connection between remote sites (site A and site B), where one site has a S/390 processor and wants to connect to the other site's S/390 channel connected control units, you must observe the following:

- We recommend that you install the FICON Bridge card in the ESCON Director in the same site as the attaching control units.
- Connect the site A S/390 processor (CPC) FICON channels (in FCV mode) to the 9032 Model 5 ESCON Director FICON Bridge card in site B using single-mode 9 micron fiber for the FICON (FCV) inter-site links.
- Connect the site B S/390 processor (CPC) FICON channels (in FCV mode) to the 9032 Model 5 ESCON Director FICON Bridge card in site A using single-mode 9 micron fiber for the FICON (FCV) inter-site links.

The benefits of connecting the two sites this way are:

- There are fewer fiber cable connections between sites.  
Up to 8 times more fiber cabling required when using ESCON links.
- The unrepeated distance between the two sites can be up to 10 km (20 km with and RPQ).  
The maximum supported ESCON unrepeated distance is 3 km.  
Greater distances are possible before the data transfer droop effect occurs.  
The ESCON droop is about 9 km, whereas the FICON droop is about 100 km.

## IBM S/390 9672 G5 and G6 Servers - FICON Cabling FICON (FCV) Local and Remote Sites

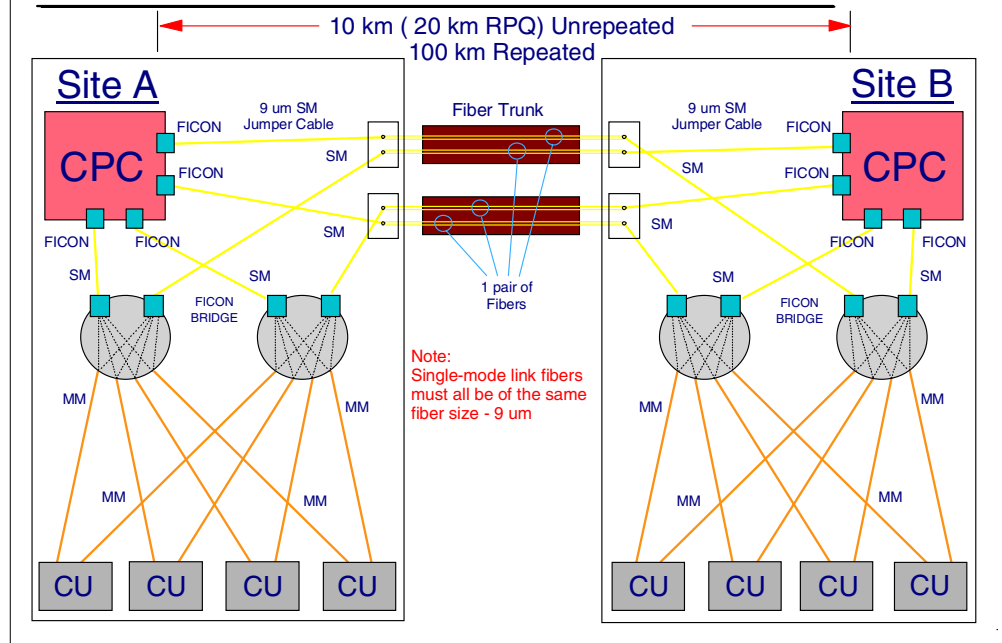


Figure 59. Local to remote site connections - two FICON (FCV mode) remote paths

Local to remote site connection:

- There are the same number of channel paths from the local processor to the remote control units as there are from the local processor to the local control units.
- Local Processor to local site DASD control units (disk control units), two FICON (FCV) paths.
- Local Processor to remote site DASD control units (disk control units), two FICON (FCV) paths.

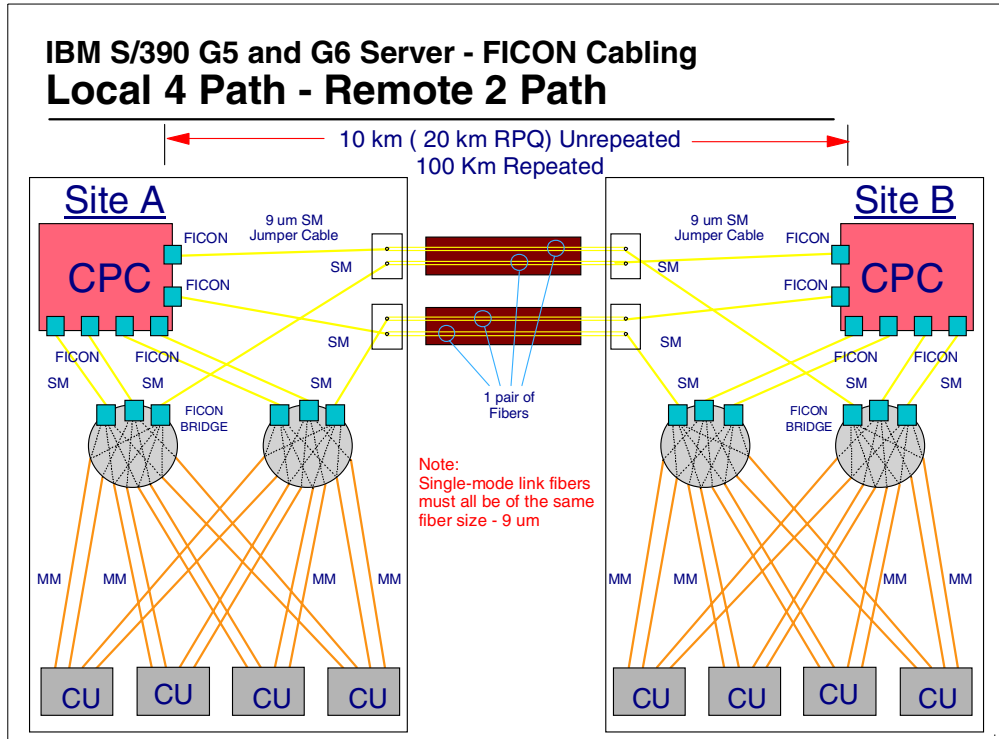


Figure 60. Local to remote site connections - four FICON (FCV mode) local paths

Local to Remote site connection:

- There are a different number channel paths from the local processor to the remote control units than from the same local processor to the local control units.

There are four channel paths to the local control units and two channel paths to the remote control units.

- Local processor to local site DASD control units, four FICON (FCV) channel paths.
- Local processor to remote site DASD control units, two FICON (FCV) channel paths.

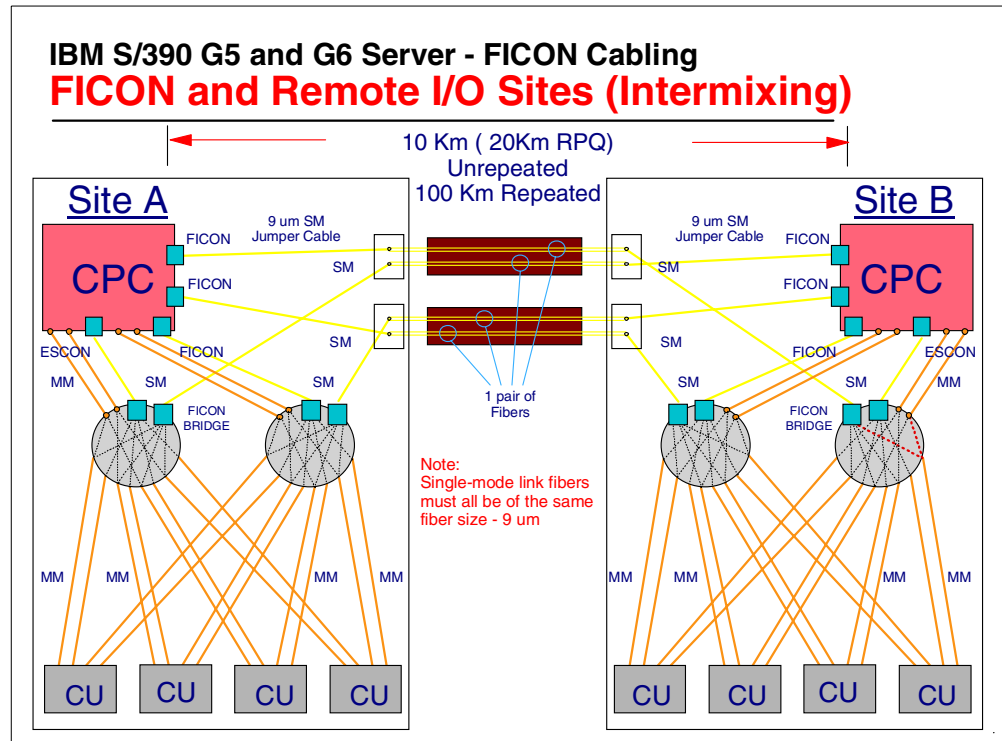


Figure 61. Local to remote site connections - local site using intermixed paths

Local to Remote site connection:

- There is intermixing of ESCON and FICON channel paths (in FCV mode) to the local processor site DASD control units, but only FICON channel paths (in FCV mode) to the remote site DASD control units.
- The FICON channel path to remote control unit connection “destination port” is the same as used by the ESCON channel path from the local processor in getting to the same control unit.
- The local processor to local site DASD control unit uses four ESCON channel paths and two FICON channel paths (in FCV mode).
- The local processor to remote site DASD control unit uses two FICON channel paths (in FCV mode).

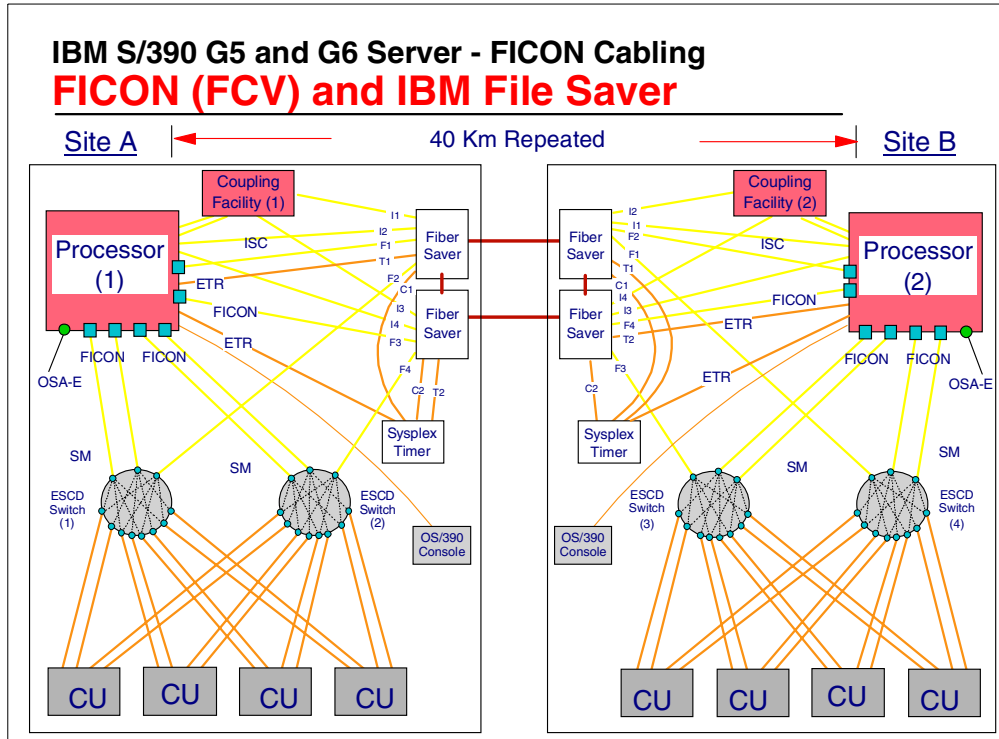


Figure 62. FICON (FCV mode) extended distance support and IBM Filer Save

The distance between two processor-to-control unit sites may be extended beyond the 10 k (or 20 km distance) that the FICON (FCV mode) channel permits by the use of “extender” products. Figure 62 shows the connection between two processor-to-control unit sites being extended to 40 km, with the use of the IBM File Saver 2029.

The IBM File Saver supports a number of fiber path connections, each one operating at the same or different protocols.

Extending of the fiber path connections between sites allows a customer to install a Geographically Dispersed Parallel Sysplex (GDPS). FICON (FCV mode) channels can be used for the channel paths connections between the processor in one site and the FICON Bridge adapter/ESCON Director in the control unit site in a GDPS configuration.

---

## Chapter 7. S/390 Channel performance paradigms

Each S/390 channel type has its own performance paradigm, and each S/390 channel type has its own topology requirements and advantages.

Different S/390 channel types accessing the same CU can perform differently for the same operation with the same topology or distance for the new channel environment due to the operating characteristics of the channel type:

- Topology (point-to-point versus switched point-to-point)
- Distances - characteristic impacts
  - Frame multiplexing
  - Number of outstanding frame requests allowed

Whenever a new S/390 host processor or new I/O channel type is introduced, there will always be performance comparisons made between the current channels and the new channels when they provide connectivity to the same type of CU and device.

This was the case going from:

- One type of parallel channel to another (Selector to Block)
- All the changes in parallel channels (DCI to Streaming)
- Parallel to ESCON (3 MB - 4.5 MB to 17 MB data rate) and topology
- ESCON to EMIF support
- ESCON to FICON (FCV) Bridge (FICON entry)
- As there will be going from FICON (FCV) to FICON native

New S/390 channel types that provide connectivity to the same type of CU/device are always introduced to provide connectivity, addressing, topology, or performance benefits over the previous channels.

Not every characteristic of the older channel will automatically be improved. But the net of all the new channel benefits provides significant improvements over the previous channel.

This was the case for all previous channels and is still the case for FICON channels when operating in FCV mode.

In each case the new channel type provides for a connectivity and performance enhancement in a more complex, intermixed environment.

---

### 7.1 Parallel - ESCON - FICON comparisons

Parallel - Interlocked tag protocol selection sequences:

- Supports one I/O operation at a time
- Requires careful selection of intermixed CU types

ESCON - Interlocked frame protocol sequences:

- Supports one I/O operation at a time

- Requires careful selection of intermixed CU types

FICON (FCV mode) - Command/Data - multiplexed and less interlocked protocols:

- Reduced command sequence requirement
- Supports multiple concurrent I/O operations
- Greater selection of intermixed CU types

FICON (FCV) and ESCON (CNC) will coexist to the same CU; FICON (FCV) supplements ESCON, it does not replace ESCON.

S/390 FICON channel in native mode provides the S/390 tie-in to the evolving Storage Area Networks (SAN) environment.

### 7.1.1 S/390 ESCON and FICON operation

Today's ESCON ties up the channel for every I/O operation on the interface:

- Link utilization = Channel utilization

FICON multiplexing allows a number of I/O operations to proceed concurrently, on the same channel.

Therefore you need to understand the FICON performance paradigm in order to design an I/O configuration using the new paradigm rules in regards to the following:

- There is improved response time (pending and connect times for extended distances).
- You have the freedom to intermix different CU types with different data transfer and channel usage characteristics.
- Distances can be extended before a performance droop occurs.

FICON channel utilization is separate from FICON channel link utilization:

- New Channel Path Measurement data

Channel utilization = number of sequences/maximum number of sequences.

Link utilization = Number of bytes transferred per partition, both reads and writes.

### 7.1.2 S/390 Parallel Channel

With Parallel Byte Multiplexor channels, there is:

- Slow data transfer to and from devices
- High channel management overhead

With Parallel Selector channels, there is:

- A channel is dedicated to one operation, so there is no “disconnect command chaining” support, i.e. no block multiplexing support.
- Low channel efficiency for separate disconnect CE to DE devices

With Parallel Block Multiplexor channels support:



- A control unit can request to disconnect in the middle of an I/O. This frees up the channel to perform another I/O to the same or a different control unit on the same channel path.
- The data transfer will be either:
  - DCI
  - DCI Offset Interlock
  - 3 MB Data Streaming
  - 4.5 MB Data Streaming
- DASD RPS miss reduction (disconnect command chaining provides a “reconnection window”)
- DPS and DPR (DASD RPS miss-avoidance)

### 7.1.3 S/390 ESCON Channels

With ESCON CNC channels:

- The operating distance between the channel and configured control units is increased from the parallel channel operating distance of 122 meters to 3 km for the ESCON channel (using 62.5 micron multi-mode fiber optic cabling).
- There is greater shared-system CU connectivity with the introduction of the ESCON director.
- There are shorter response times on longer records (as compared to Parallel channels).
- There is a slight response time elongation on short records.
- EMIF was introduced with ESCON channel to allow for sharing of a channel between S/390 images on the same S/390 processor.
- A Port busy condition occurs when a S/390 channel attempts to access a CU/device via an ESCON director destination port address (destination link) at the time that it is already in use by another S/390 channel. This condition is managed by the S/390 channel that sees the Port Busy condition.
- ESCON channels support a control unit request to disconnect in the middle of an I/O operation. This frees up the channel to perform another I/O operation to the same or a different control unit on the same channel path.
- ESCON channel multi-path mode supports:
  - Dynamic Path Selection
  - Dynamic Path Reconnect (DASD RPS miss-avoidance)

### 7.1.4 S/390 FICON Channels in FCV mode

The FICON channel (in FCV mode) provides:

- Increased I/O operation concurrency.
- Frame multiplexing to up to 8 different control units.
- The FICON channel (in FCV mode) fiber link operating distance between the channel and the FICON Bridge adapter (when using 9 micron single mode fiber) is increased from an ESCON channel operating distance of 3 km (for the ESCON channel using 62.5 micron multi-mode fiber optic cabling) to a

non-repeated supported distance of up to 10 km (FICON) (up to 20 km with an RPQ).

### 7.1.5 S/390 FICON Channels in native mode

FICON (FC) in native mode:

- It provides frame multiplexing to the same or different control units.
- Distance (un-repeated) of up to 10 km is support (20 km with an RPQ).
- The FICON channel (in FC mode) fiber link operating distance between the channel and its connected node (when using 9 micron single mode fiber) is increased from an ESCON channel operating distance of 3 km (for the ESCON channel using 62.5 micron multi-mode fiber optic cabling) to a non-repeated supported distance of up to 10 km (FICON) (up to 20 km with an RPQ).
- It uses the Fibre Channel standard.

### 7.1.6 S/390 FICON Channel benefits

FICON channel (in FCV mode) exploitation benefit is customer installation-dependent.

For local sites, when the processor and the control units are in the same site, it allows:

- Greater channel and link bandwidth per FICON channel (in FCV mode), which allows for more ESCON control unit to be connected via the same channel.
- 8 concurrent I/O operations per FICON channel (in FCV mode). These 8 concurrent I/O operations are to 8 different control units all accessed from this same FICON (FCV mode) channel on different ESCON director port links.
- A larger number of device numbers (subchannels) are supported per FICON (FCV) channel. The maximum that was supported (implementation) on an IBM 9672 G5 or G6 processor using ESCON channels was up to 1024 subchannels per channel; for a FICON channel (in FCV mode) this is increased up to 16 k. This allows for more of today's CU (with the larger number of devices per CU) to be accessed from the same channel.
- Greater channel and link bandwidth per FICON channel (in FCV mode).
- Intermixing of CU types with different channel usage characteristics on the same channel.

For remote sites, when the processor and control units are in different sites, it allows:

- Fiber consolidation, since more concurrent operations can use the same fiber (up to 8 for a FICON channel in FCV mode). In ESCON, only one I/O operation at a time can use the fiber link.
- Greater fiber link un-repeated distances: 10 km (20 km with an RPQ) for FICON (FCV mode) channels versus 3 km for ESCON channels.
- Performance droop is moved from 9 km for ESCON channels to 100 km for FICON channels (in FCV mode).
- 8 concurrent I/O operations per FICON channel (in FCV mode), versus 1 operation a time for an ESCON channel.

- Greater channel and link bandwidth per FICON channel (in FCV mode)
- A larger number of device numbers (subchannels) are supported per FICON channel (in FCV mode). There was up to 1024 devices being supported on an ESCON channel, and it is up to 16 k devices for a FICON channel (in FCV mode).
- Intermixing of CU types with different channel usage characteristics on the same channel is possible.

### 7.1.7 S/390 FICON Channel - CU intermixing

Determining whether you can intermix the same CU type and different CU types on the same S/390 channel requires knowledge of the control unit's operational characteristics and the channel characteristics.

Historically, it has been recommended not to intermix control units that you do not want to be locked out for periods of time with other control units (and their operations) that can cause lockout for certain types of channel operations.

Do not lock out the following system items:

- OS/390 Master Consoles
- CTCs (GRS and XCF)
- System DASD (paging devices)

Control units and device types that could cause lockouts:

- Tape
- Certain old DASD access channel programs (RYO)

The FICON channel operational characteristics allows for freer intermixing:

- You can now intermix high channel activity control units with other control units on the same channel. This assumes that no single control unit operation exceeds the bandwidth of the FICON channel (in FCV mode). This is the case today, that no control unit operation exceeds that bandwidth of the FICON channel when operating in FCV mode.

This means, for example, that other CU/devices can now be intermixed on the same FICON channels (in FCV mode) with tape CU/devices.



---

## Chapter 8. FICON performance

I/O operations to ESCON-interfaced control units on ESCON (CNC) channels and FICON (FCV) channels perform the same way at the CU. The control unit at its ESCON interface does not know if it is being addressed by an ESCON channel or by a FICON (FCV mode) channel.

The I/O performance to the CU/device over a FICON (FCV mode) channel is very similar to that over a ESCON channel.

The I/O operation from a FICON (FCV mode) channel is always via a FICON bridge card in the 9032 model 5 ESCON director.

The FICON (FCV) Bridge adaptor introduces a very small management overhead during the I/O operation.

For a customer's normal application I/O operation this overhead has not shown to be significant to the application performance.

During some FICON (FCV) tests to a dedicated CU with short I/O operations (and short distances), a difference between ESCON and FICON (FCV) can be seen in a laboratory environment. For tests with long records over long distances (greater than 10 km), the ESCON (CNC) channel takes a longer time to complete the same I/O operation as compared with the FICON (FCV) channel using the same I/O operation tests.

The actual I/O response times (Pending, Connect and Disconnect times) are reported the same way for both the ESCON (CNC) and FICON (FCV mode) channels.

Therefore, actual ESCON (CNC) and FICON (FCV) performance is dependent on the customer's channel and I/O configuration, and use.



---

## Chapter 9. S/390 FICON (FCV) configuration support

When designing a S/390 I/O configuration, you must be aware of the architecture rules, the S/390 processor implementation, the connectivity topology supported, the cabling requirements, the connectivity recommendations, and the performance requirements.

S/390 and ESCON architecture:

- S/390 pathing rules
- Maximum specified architected resources

9672 resource rules:

- Maximum resources that are implemented (CHPID, links, subchannels)
- Hardware plugging sequence and hardware-assigned CHPID numbers

Topology:

- ESCON - point-to-point or switched point-to-point
- FICON (FCV) switched point-to-point only

Path availability (Multi-path CUs):

- Spread the CU paths between 9672 channels on even and odd STIs
- Spread CU paths between ESCDs and ESCD quadrants

Performance considerations and expectations:

- Number of paths to a control unit (device)
- Intermix of control unit types on a channel path (old rules and new rules)
- Number of control units defined to use the same channel path

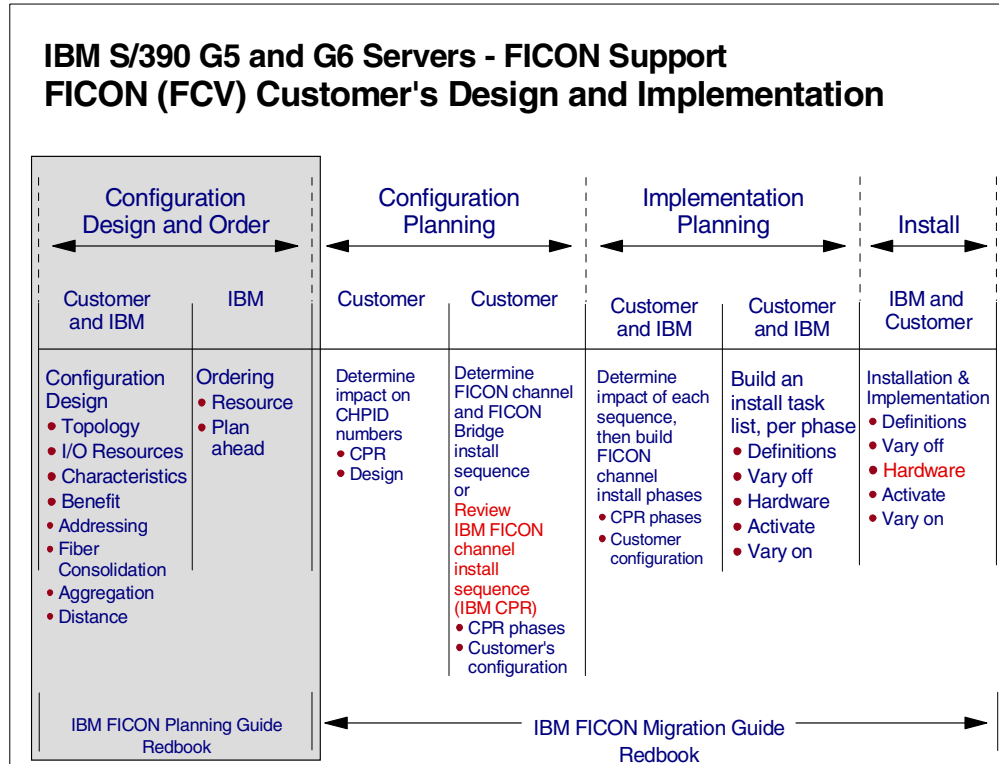


Figure 63. FICON (FCV mode) design and implementation

Figure 63 shows the sequence and steps that need to be planned when designing and implementing a FICON (FCV mode) channel to an ESCON control unit configuration. These are:

1. Configuration design and ordering
  - Understand the 9672 G5 and G6 channel resources that are supported.
  - Understand the S/390 channel to control unit topology that is supported.
  - The addressing and connectivity characteristics of the control unit to be attached.
2. The benefits of a FICON (FCV mode) channel connection over an ESCON channel connection
  - Addressing
  - Fiber consolidation
  - ESCON to FICON aggregation
  - Distance
3. Configuration planning
  - S/390 9672 CHPID impact
  - 9032 model 5 port impact
  - Install sequence
  - Install phases
4. Implementation planning



- Task list for each customer install phase

#### Installation tasks

- Installation of the IBM S/390 9672 G5 or G6 FICON channels and the 9032 model 5 Bridge cards, both of which are required to follow the IBM install sequence and the customer install phases.

## 9.1 ESCON control unit configuration

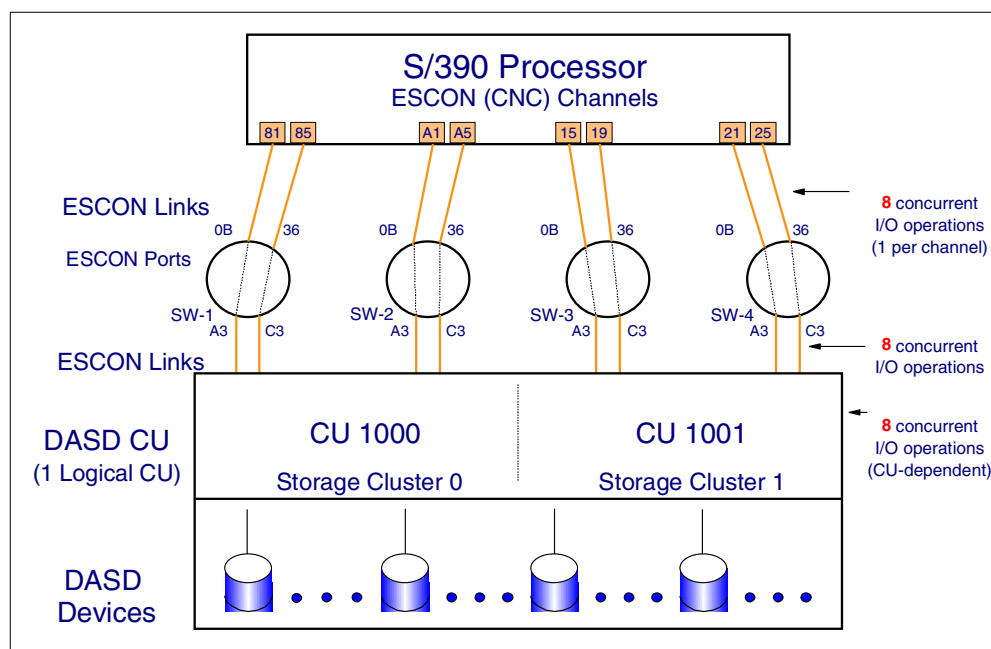


Figure 64. ESCON control unit configuration - 8 paths and 1 LCU

For maximum I/O concurrency to a multi-path control unit, we recommend that the number of paths from a S/390 processor image that are defined to access (and be configured) to a control unit/device be equal to the maximum number of concurrent I/O operations that the CU can sustain. The S/390 architecture maximum that is supported from a processor image to a CU image is eight.

Figure 64 shows:

- The need to determine from the control unit vendor the maximum number of concurrent I/O operations that are supported by the physical CU. Also determine if the physical control unit supports one or more logical control units (CUADD - CU addressing). The control unit vendor should be asked to provide all the control unit addressing and connectivity characteristics, as these affect how the control unit can be configured into a S/390 environment.
- The number of ESCON interfaces that the control unit supports.
- The connection of S/390 channel paths (from a single processor image - these can be EMIFed if the control unit supports EMIFed channel paths) to up to eight interfaces on a multi-interface control unit.

All ESCON interfaced control units should support EMIF connected channels, but there may still be a few control unit types that do not.

- The use of 8 ESCON channels.

The ESCON configuration shown in Figure 64 has the following I/O concurrency.

- Eight concurrent I/O operation are supported by the control unit.
- Eight control unit ESCON interfaces are used and these in total will support eight concurrent I/O operations.
- Eight S/390 ESCON channels are used and these in total will support eight concurrent I/O operations.

```

ID MSG1='9672-Z77',                                     x
    MSG2='ESCON CHANNEL CU DEFINITIONS',                 x
    SYSTEM=(9672,6)
RESOURCE PARTITION=((LP1,1),(LP2,2),(LP3,3))
CHPID PATH=(81,85),TYPE=CNC,SHARED,SWITCH=01,           x
    PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(A1,A5),TYPE=CNC,SHARED,SWITCH=02,           x
    PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(15,19),TYPE=CNC,SHARED,SWITCH=03,           x
    PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(21,25),TYPE=CNC,SHARED,SWITCH=04,           x
    PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
*****
**
** DASD CU 1000 and 1001, plus DEVICES 1000 to 103F
**
*****
    CNTLUNIT CUNUMBR=1000,PATH=(81,85,A1,A5),UNITADD=((00,64)), x
        LINK=(A3,C3,A3,C3),UNIT=3990-6
    CNTLUNIT CUNUMBR=1001,PATH=(15,19,21,25),UNITADD=((00,64)), x
        LINK=(A3,C3,A3,C3),UNIT=3990-6
    IODEVICE ADDRESS=(1000,064),UNITADD=00,CUNUMBR=(1000,1001), x
        STADET=Y,UNIT=3390

```

Figure 65. IOCP definition for an ESCON connected 8 path CU

Figure 65 shows the I/O definition support (IOCP statements) to support the I/O configuration shown in Figure 64 on page 85. There are eight ESCON channel paths defined to access each of the attached devices as the I/O device statement connects to both control unit statements and each control unit statement has four paths defined.

## 9.2 FICON (FCV mode) channel benefits

FICON channels (in FCV mode) provide the following benefits over ESCON (CNC) channels:

- Greater channel and link bandwidth
- Eight concurrent I/O operations per FICON channel (in FCV mode)
- Greater fiber links un-repeated distances: 3 km to 10 km (or 20 km with an RPQ)
- Performance droop distance extended (9 km to 100 km)
- Fiber consolidation (eight multi-mode fiber ESCON operations into one single mode fiber FICON operation performing eight concurrent I/O operations)
- That a larger number of device numbers (subchannels) are supported

- The intermixing of CU types with different channel usage characteristics on the same channel (DASD and Tape)

---

### 9.3 FICON (FCV mode) connectivity recommendations

In an all ESCON (CNC) channel CU connectivity environment (when all paths from a processor to a CU use ESCON (CNC) channels), the minimum number of recommended ESCON (CNC) channel paths required to support an ESCON interface “physical CU” should be equal to the maximum number of concurrent I/O transfers that the ESCON physical CU can perform on the ESCON interfaces (up to the S/390 architecture maximum of eight for any LCU). This will allow the maximum exploitation of concurrent I/O operations to the physical CU and any logical CU in the physical CU.

In an all FICON (FCV) channel CU connectivity environment (when all paths from a processor to a CU are via FICON (FCV) channels), the minimum number of recommended FICON (FCV) channel paths required to support an ESCON interface “logical CU” should be equal to the maximum number of concurrent I/O transfers that the ESCON connected logical control unit can perform on the ESCON interfaces (up to the S/390 architecture maximum of eight). This will allow the maximum exploitation of concurrent I/O operations to any logical CU.

When an ESCON CU channel path access is changed from ESCON (CNC) to FICON (FCV) (this is ESCON to FICON aggregation), then:

- Generally never use fewer FICON (FCV) paths to any one logical CU than the ESCON CU channel configuration used (up to eight). This recommendation is applicable when the processor and control units are in the same site (local connections).
- In general you should only go above eight FICON (FCV) paths to any one physical CU if the CU supports greater than eight concurrent I/O operations and the physical CU does not support logical control units. This assumes that the physical CU does not have logical path restrictions or internal connectivity restrictions. A physical CU that has no internal connectivity restrictions, means that any ESCON interface could be used to get to any device in any logical CU (in the physical CU).
- Use the same number of FICON (FCV) channels to a logical control unit that the ESCON control unit configuration used, but use the FICON channels (in FCV mode) to access a greater number of control units (both logical control units and physical control units).

Recommendations for connecting a S/390 multi-path control unit to S/390 channels on a S/390 9672 G5 or G6 processor are:

- For redundancy reasons, spread the channel path (CHPID) selection (for the multi-path CU) between CHPIDs that are on different 9672 G5 or G6 Even and Odd STIs. If you have to choose a CHPID that is connected to an STI that you have already selected (for connection to the same logical CU), then choose a CHPID that is supported by a different channel adapter card (CHA) on that same STI.
- To determine the CHPID numbers, STI numbers, and the CHA locations for your S/390 9672 processor, review the IBM CFSYSTEM CHPID placement

report that should have been made available to the customer by IBM after the S/390 processor or additional CHPIDs were ordered.

- Part of a CHPID report is shown in Figure 68.

STI	CHA SLOT	CAGE LOCATION	I/O SLOT	CHPID/TYPE
0	24	FRAME Z BOTTOM	11	00/E 01/E 02/E 03/E
0	24	FRAME Z BOTTOM	10	04/E 05/E 06/E 07/E
0	9	FRAME Z BOTTOM	29	08/E 09/E 0A/E 0B/E
0	9	FRAME Z BOTTOM	28	0C/P4 0D/P4 0E/P4 0F/P4
0	9	FRAME Z BOTTOM	27	10/P4 11/P4 12/P4 13/P4
0	24	FRAME Z BOTTOM	26	14/P4 15/P4 16/P4 17/P4
1	23	FRAME Z BOTTOM	21	24/E 25/E 26/E 27/E
1	16	FRAME Z BOTTOM	18	28/E 29/E 2A/E 2B/E
1	16	FRAME Z BOTTOM	17	2C/P4 2D/P4 2E/P4 2F/P4
1	23	FRAME Z BOTTOM	15	30/E 31/E 32/E 33/E
...				
4	24	FRAME A BOTTOM	11	80/E 81/E 82/E 83/E
4	24	FRAME A BOTTOM	10	84/E 85/E 86/E 87/E
4	9	FRAME A BOTTOM	29	88/E 89/E 8A/E 8B/E
4	9	FRAME A BOTTOM	28	8C/P4 8D/P4 8E/P4 8F/P4
5	23	FRAME A BOTTOM	21	A4/E A5/E A6/E A7/E
5	16	FRAME A BOTTOM	18	A8/E A9/E AA/E AB/E
5	16	FRAME A BOTTOM	17	AC/P4 AD/P4 AE/P4 AF/P4
5	23	FRAME A BOTTOM	15	B0/E B1/E B2/E B3/E
5	23	FRAME A BOTTOM	14	B4/E B5/E B6/E B7/E
...				
10	-	FRAME Z TOP	6	F8/H1
10	-	FRAME Z TOP	7	F9/H1
9	-	FRAME Z TOP	31	FC/H1
9	-	FRAME Z TOP	32	FD/H1

Figure 66. Reduced part of a 9672 G5 or G6 CHPID report

Customer FICON (FCV mode) channel to control unit configuration design considerations are:

- Local or remote - processor to CU connectivity:
  - Number of processor channels available for CU connectivity
  - Number of local CU interfaces available
  - Number of remote CU interfaces available
  - Cost of the fiber between the processor and remote location
- Connectivity between 9672 G5 or G6 processors and control units in different sites:
  - Connect the sites via FICON channels (in FCV mode) and 9 micron single-mode fiber
  - Install FICON (FCV) Bridge cards in the 9032 model 5 ESCON Directors in the control unit site.

### 9.3.1 FICON (FCV mode) channel architecture rules

You must follow the S/390 Processor channel path to control unit (CU) configuration architecture rules:

- A logical CU and device cannot be accessed more than once from the same S/390 channel path (CHPID). This applies to both ESCON (CNC) channels and FICON (FCV mode) channels.

- A physical control unit that has multiple logical control units (uses CUADD addressing) may be accessed more than once from the same FICON (FCV mode) channel path, but to different logical control units (different CUADDs) within the physical control unit subsystem.

### 9.3.2 FICON (FCV mode) channel to CU characteristics

The following items are dependent on the CU characteristics:

- Number of installed S/390 ESCON interfaces at the control unit.
- Number of S/390 logical paths supported by the control unit at each ESCON interface.
- Number of logical paths supported by the control unit, when there is only one control unit function within the physical control unit.
- Number of logical paths supported by each logical control unit within a physical control unit.
- Number of logical control units supported and the LCU address for each LCU.
- Number of S/390 concurrent I/O transfers per physical CU.
- Number of S/390 concurrent I/O transfers per LCU.
- Number of devices and device unit addresses (UAs) supported per LCU (logical CU).

Some devices may be supported by more than one unit address (UA), each device unit address being supported by a different S/390 device number (this is the case for the IBM ESS control unit that supports Base and Aliases device addresses). This function is known as Parallel Access Volumes (PAV).

- For each LCU, the base device unit address (UA) and address range per LCU.

---

## 9.4 Basic FICON configuration design

When designing a FICON (FCV) configuration, you must be aware of both the S/390 architecture and S/390 9672 G5 and G6 processor rules and recommendations:

- Do not design a system that cannot be ordered.  
Be aware of 9672 G5 and G6 resource rules, 24 or 36 FICON channels (included in the 24 or 36 install limit are also any OSA-Express channels and PCICC channels).
- Do not design a system that cannot be defined because of S/390 pathing rules.  
You can only define a channel to be used once to a CU or logical control unit.
- Do not design a system that does not meet the customer's performance expectations. Ensure that there are enough channel paths to the CU, and that the channel usage will be within the customer's expectation.
- The system should have enough paths to a CU to exploit the control units' concurrent I/O operations capability.
- Ensure the system has the right number of control units and control unit mix per path: do not put more control units on a channel path than the

performance of the channel and control unit will support (within the customer's expectations).

- Ensure the system meets the customer-quantified requirements.

Figure 67 shows that even through a FICON channel supports eight concurrent I/O operations, the 8 I/O operations must be to different control units or logical control units. You just cannot take an ESCON connected control unit with eight paths (see Figure 64 on page 85) and design a FICON (FCV mode) configuration (Figure 67 shows an invalid configuration) without understanding the S/390 rules.

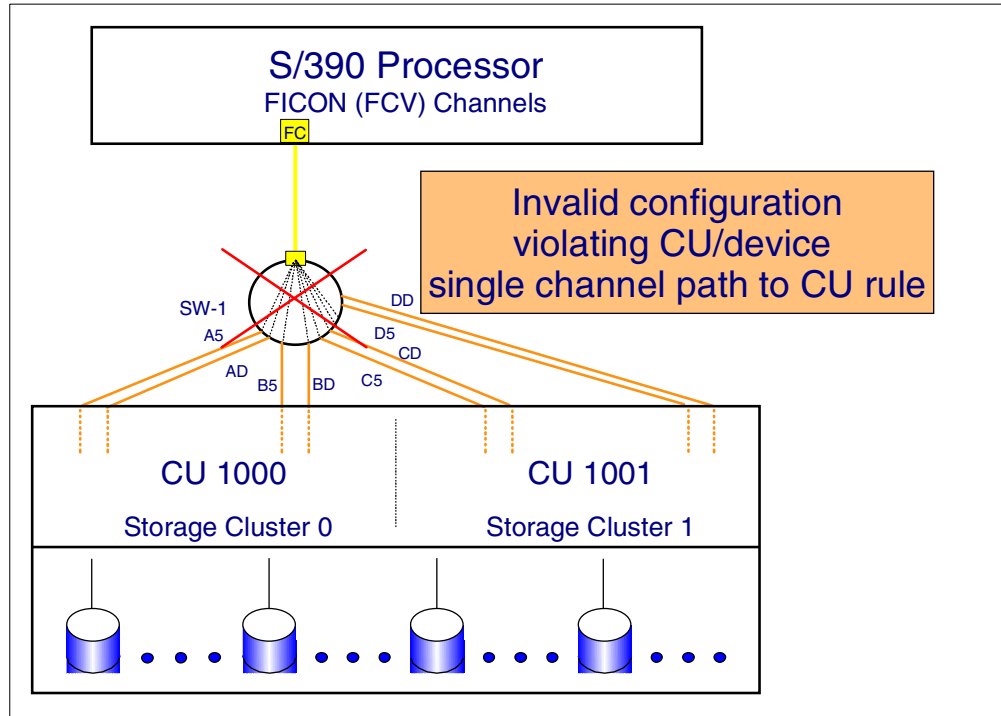


Figure 67. Invalid FICON configuration

When connecting the ESCON configuration shown in Figure 64 on page 85 to FICON (FCV mode) channels (requiring the same I/O concurrency) it should look like that shown in Figure 68 on page 91.

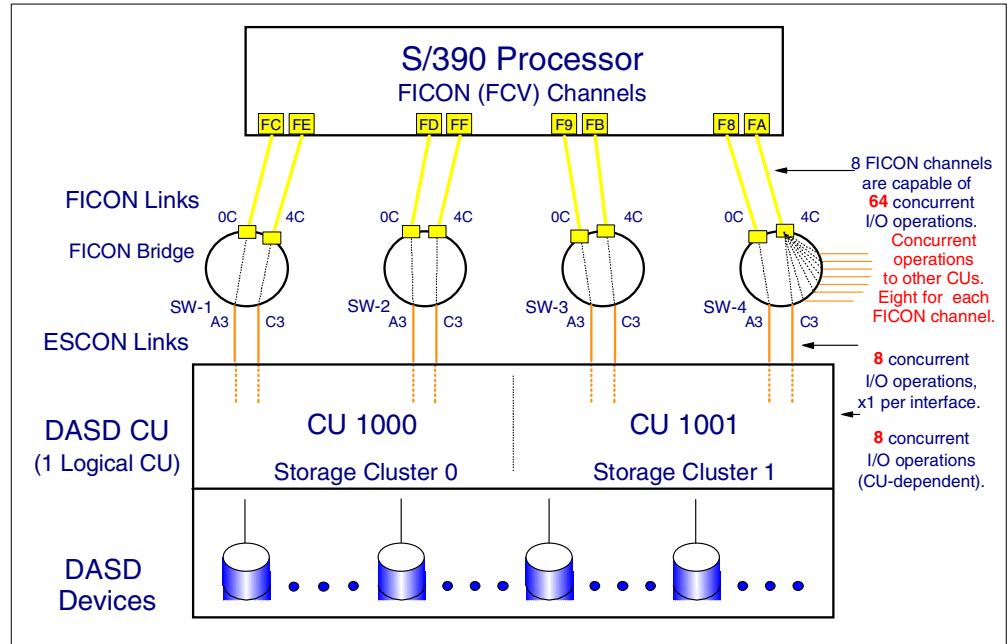


Figure 68. FICON (FCV mode) channel configuration - 8 paths and 1 LCU

The FICON (FCV mode) configuration shown in Figure 68 has the following I/O concurrency:

- Eight concurrent I/O operations are supported by the control unit.
- Eight control unit ESCON interfaces are used and these in total will support eight concurrent I/O operations.
- Eight S/390 FICON (FCV mode) channels are used and these will support 64 concurrent I/O operations in total. Eight of these concurrent I/O operations will be to the two control units numbered 1000 and 1001 (which make up one IOCP logical control unit), and 56 of the 64 possible concurrent I/O operations will be to other control units.

```

ID MSG1='9672-Z77',
MSG2='FICON (FCV) CHANNEL TO ESCON CU DEFINITIONS',
SYSTEM=(9672,6)
RESOURCE PARTITION=((LP1,1),(LP2,2),(LP3,3))
CHPID PATH=(FC,FE),TYPE=FCV,SHARED,SWITCH=01,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(FD,FF),TYPE=FCV,SHARED,SWITCH=02,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(F9,FB),TYPE=FCV,SHARED,SWITCH=03,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(F8,FA),TYPE=FCV,SHARED,SWITCH=04,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
*****
**
** DASD CU 1000 and 1001, plus DEVICES 1000 to 103F
**
*****
CNTLUNIT CUNUMBR=1000,PATH=(FC,FE,FD,FF),UNITADD=((00,64)),
LINK=(A3,C3,A3,C3),UNIT=3990-6
CNTLUNIT CUNUMBR=1001,PATH=(F9,FB,F8,FA),UNITADD=((00,64)),
LINK=(A3,C3,A3,C3),UNIT=3990-6
IODEVICE ADDRESS=(1000,064),UNITADD=00,CUNUMBR=(1000,1001),
STADET=Y,UNIT=3390

```

Figure 69. IOCP definition for an FICON (FCV mode) connected 8 path CU

Figure 69 shows the I/O definition support (IOCP statements) to support the I/O configuration shown in Figure 68 on page 91. There are eight FICON (FCV mode) channel paths defined to access each of the attached devices, as the I/O device statement connects to both control unit statements and each control unit statement has 4 paths defined.

#### 9.4.1 FICON design awareness areas

When designing a FICON (FCV mode) channel to control unit configuration, you need to be aware of:

- 9672G5 and G6 resources and packaging.
- 9032 model 5 ESCON director resources and packaging.
- Connection recommendations:

Number of paths to support the required number of concurrent I/O operations from a processor to a CU.

- Fiber cabling requirement (single-mode or multi-mode, and distance)

Processor to switch:

Generally single-mode 9 micron fiber is required for long wave-length laser FICON channels.

FICON (FCV mode) optical links using single-mode 9 micron fiber cables will support up to 10 km (20 km with an RPQ).

Switch to CU:

Generally multi-mode fiber is required (either 62.5 or 50 micron multi-mode fiber), for long wave-length LED ESCON interfaced control units.

ESCON (CNC) optical links using multi-mode 62.5 micron fiber cables will support up to 3 km.



Control units may have shorter distance limitations.

- Pathing rules:

You can only define the access to a LCU *once* on any given channel (this is a S/390 architecture rule).

- Control unit characteristics:

Addressing - LCUs (CUADD) and Devices

Logical Paths

Concurrent I/O

Figure 70 shows the system's "awareness areas" required when designing connectivity from a S/390 processor to a S/390 interfaced CU.

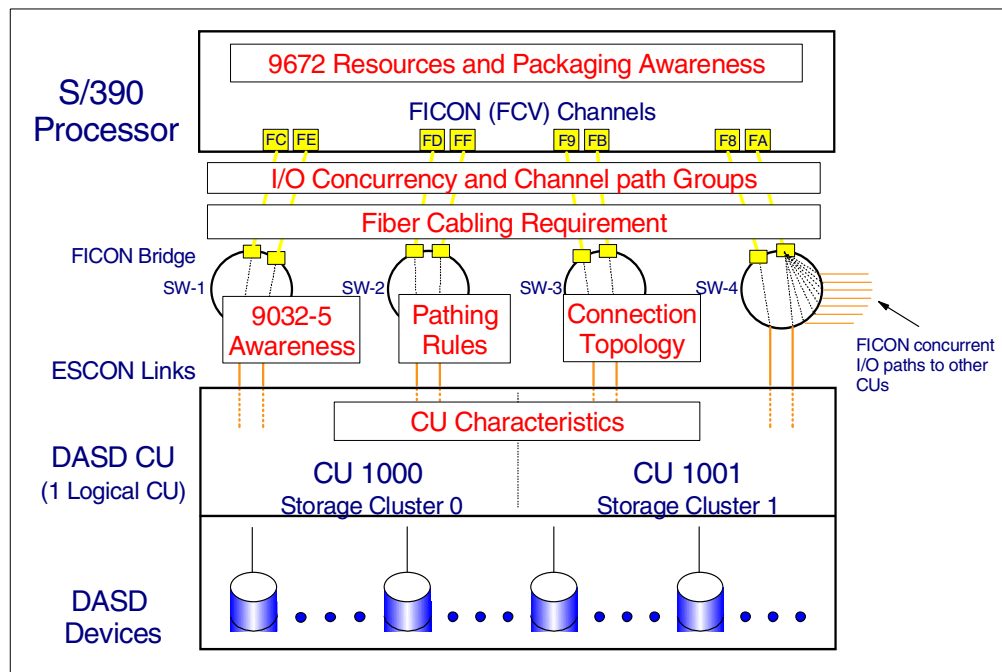


Figure 70. FICON (FCV mode) system design awareness areas

## 9.5 ESCON and FICON (FCV mode) channels connectivity differences

Channel to CU connectivity is different for FICON channels (in FCV mode) than it is for ESCON (CNC) channels to the same control unit, when a physical CU has two or more logical control units:

- One FICON channel (in FCV mode) can be used for up to eight concurrent I/O transfers from the same physical control unit, where each transfer is from a device in a different logical control unit.
- One ESCON (CNC) channel path can be used for only one I/O transfer at a time.

The net effect of these differences is shown in the following configuration diagrams, where the physical control unit has two or more logical control units. Shown in the diagrams for each configuration is the total number of:

- Concurrent I/O transfers for all the channel paths shown in the diagram.
- Concurrent I/O transfers for the physical control unit.
- Concurrent I/O transfers for a logical control unit (LCU).

An even greater advantage of this characteristic occurs when there are few FICON channels (in FCV mode) to remote sites, or for local sites when a CU can handle greater than eight concurrent I/O operations (i.e., an IBM 2105 ESS).

### 9.5.1 ESCON (CNC) channel connectivity to LCUs

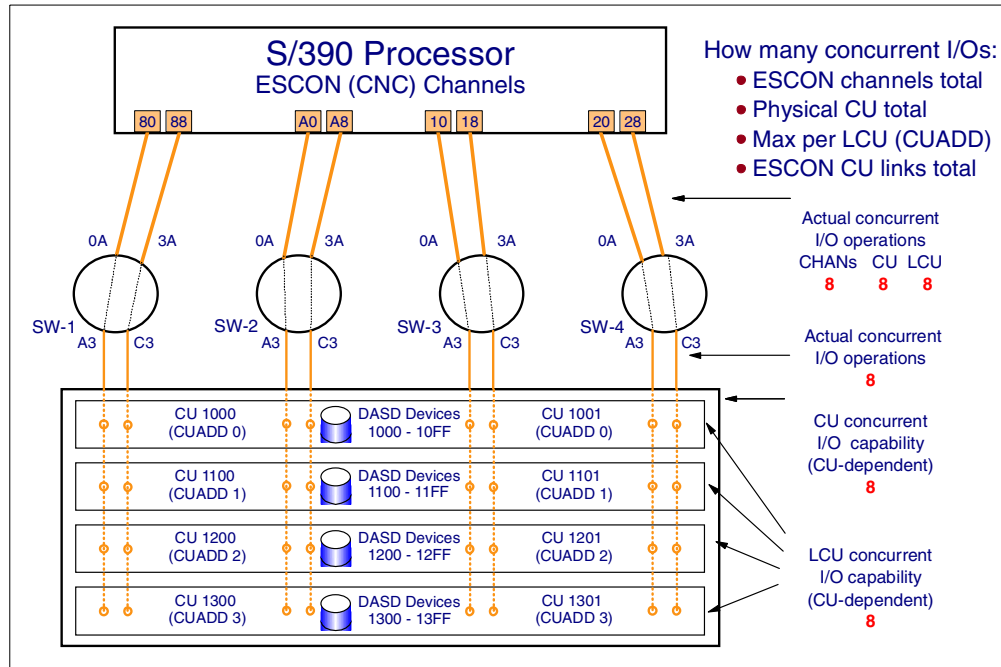


Figure 71. ESCON (CNC) channel configuration - 8 channel paths 4 LCUs

The ESCON configuration shown in Figure 71 has the following I/O concurrency:

- Each of the eight ESCON paths can address all four of the logical control units shown in the configuration.
- Eight concurrent I/O operations are supported by any one of the 4 logical control units.

But only eight concurrent I/O operations in total are supported by the physical control unit (this is the I/O concurrency characteristic of the CU shown in this example).

- Eight control unit ESCON interfaces are used and these in total will support eight concurrent I/O operations.
- Eight S/390 ESCON channels are used and these in total will support eight concurrent I/O operations.

```

ID MSG1='9672-277',
MSG2='ESCON CHANNEL CU DEFINITIONS',
SYSTEM=(9672,6)
RESOURCE PARTITION=((LP1,1),(LP2,2),(LP3,3))
CHPID PATH=(80,88),TYPE=CNC,SHARED,SWITCH=01,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(A0,A8),TYPE=CNC,SHARED,SWITCH=02,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(10,18),TYPE=CNC,SHARED,SWITCH=03,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(20,28),TYPE=CNC,SHARED,SWITCH=04,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
*****
** DASD CUs 1000 and 1001 and Devices 1000 to 10FF
*****
CNTLUNIT CUNUMBR=1000,PATH=(80,88,A0,A8),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=0,UNIT=3990-6
CNTLUNIT CUNUMBR=1001,PATH=(10,18,20,28),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=0,UNIT=3990-6
IODEVICE ADDRESS=(1000,256),UNITADD=00,CUNUMBR=(1000,1001),
STADET=Y,UNIT=3390
*****
** DASD CUs 1100 and 1101 and Devices 1100 to 11FF
*****
CNTLUNIT CUNUMBR=1100,PATH=(80,88,A0,A8),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=1,UNIT=3990-6
CNTLUNIT CUNUMBR=1101,PATH=(10,18,20,28),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=1,UNIT=3990-6
IODEVICE ADDRESS=(1100,256),UNITADD=00,CUNUMBR=(1100,1101),
STADET=Y,UNIT=3390
*****
** DASD CUs 1200 and 1201 and Devices 1200 to 12FF
*****
CNTLUNIT CUNUMBR=1200,PATH=(80,88,A0,A8),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=2,UNIT=3990-6
CNTLUNIT CUNUMBR=1201,PATH=(10,18,20,28),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=2,UNIT=3990-6
IODEVICE ADDRESS=(1200,256),UNITADD=00,CUNUMBR=(1200,1201),
STADET=Y,UNIT=3390
*****
** DASD CUs 1300 and 1301 and Devices 1300 to 13FF
*****
CNTLUNIT CUNUMBR=1300,PATH=(80,88,A0,A8),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=3,UNIT=3990-6
CNTLUNIT CUNUMBR=1301,PATH=(10,18,20,28),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=3,UNIT=3990-6
IODEVICE ADDRESS=(1300,256),UNITADD=00,CUNUMBR=(1300,1301),
STADET=Y,UNIT=3390

```

Figure 72. IOCP definition for an ESCON connected 8 path, 4 LCU control unit

Figure 72 shows the I/O definition support (IOCP statements) to support the I/O configuration shown in Figure 71 on page 94. There are eight ESCON channel paths defined to access the attached devices in each of the four logical control units as the I/O device statement connects to both control unit statements that are used to define a logical control unit, and each control unit statement has four paths defined.

### 9.5.2 FICON (FCV mode) channel connectivity to LCUs

The following recommendation is a repeat of what was stated earlier, as you must become familiar with this to understand the best method of how to configure a physical control unit that supports multiple logical control units.

In a FICON (FCV) environment, the minimum number of recommended FICON channels (in FCV mode) required to support an ESCON interface “logical control unit” should be equal to the maximum number of current I/O transfers that the ESCON logical control unit can perform on its ESCON interfaces. This will allow the maximum exploitation of concurrent I/O operations to any logical CU.

You may install and define more than eight paths to any physical CU (from the same S/390 processor image) when the physical control unit has 2 or more logical control units. But still a maximum of only eight channel paths may be defined to any one logical control unit. You can use this approach for physical control units that support greater than eight concurrent I/O transfers and that have a customer requirement for a high I/O rate when using ESCON channels. An example of this is the IBM ESS (the IBM 2105 Enterprise Storage Server) and is covered in “Maximum I/O concurrency exploitation” on page 103.

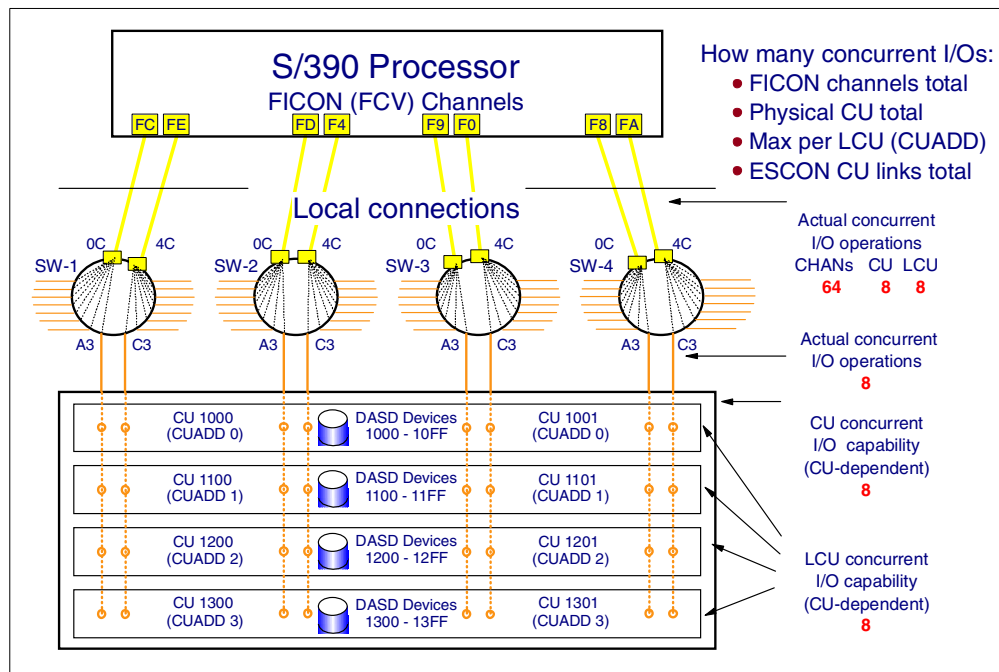


Figure 73. FICON (FCV mode) channel configuration - 8 channel paths 4 LCUs

The FICON (FCV mode) configuration shown in Figure 73 has the following I/O concurrency:

- The exploitation of the possible I/O concurrency is dependent on the control unit characteristics. When a control unit supports more than eight concurrent I/O operations and the physical control unit has multiple logical control units, it would take more than eight ESCON channels to take advantage of this, but it would take only eight FICON (FCV mode) channels to exploit this greater I/O concurrency (up to a limit of 64 concurrent I/O operations to the one physical control unit by the eight FICON (FCV mode) channels). A later example shows the exploitation by using fewer FICON (FCV mode) channels.

- Each of the eight FICON (FCV mode) paths are used to address all four logical control units.
- Eight concurrent I/O operations are supported by any one of the four logical control units.

But only eight concurrent I/O operations in total are supported by the physical control unit (this is an I/O concurrency characteristic of the CU shown in this example).

- Eight control unit ESCON interfaces are used and these in total will support eight concurrent I/O operations.

- Eight S/390 FICON (FCV mode) channels are used and these in will support 64 concurrent I/O operations in total. 8 of these concurrent I/O operations will be to the any of the defined (and configured) logical control units shown in Figure 73, and 56 of the 64 possible concurrent I/O operations will be to other control units.

```

ID MSG1='9672-277',
MSG2='FICON (FCV) CHANNEL TO ESCON CU DEFINITIONS',
SYSTEM=(9672,6)
RESOURCE PARTITION=((LP1,1),(LP2,2),(LP3,3))
CHPID PATH=(FC,FE),TYPE=FCV,SHARED,SWITCH=01,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(FD,F4),TYPE=FCV,SHARED,SWITCH=02,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(F9,F0),TYPE=FCV,SHARED,SWITCH=03,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(F8,FA),TYPE=FCV,SHARED,SWITCH=04,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
*****
** DASD CUs 1000 and 1001 and Devices 1000 to 10FF
*****
CNTLUNIT CUNUMBR=1000,PATH=(FC,FE,FD,F4),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=0,UNIT=3990-6
CNTLUNIT CUNUMBR=1001,PATH=(F9,F0,F8,FA),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=0,UNIT=3990-6
IODEVICE ADDRESS=(1000,256),UNITADD=00,CUNUMBR=(1000,1001),
STADET=Y,UNIT=3390
*****
** DASD CUs 1100 and 1101 and Devices 1100 to 11FF
*****
CNTLUNIT CUNUMBR=1100,PATH=(FC,FE,FD,F4),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=1,UNIT=3990-6
CNTLUNIT CUNUMBR=1101,PATH=(F9,F0,F8,FA),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=1,UNIT=3990-6
IODEVICE ADDRESS=(1100,256),UNITADD=00,CUNUMBR=(1100,1101),
STADET=Y,UNIT=3390
*****
** DASD CUs 1200 and 1201 and Devices 1200 to 12FF
*****
CNTLUNIT CUNUMBR=1200,PATH=(FC,FE,FD,F4),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=2,UNIT=3990-6
CNTLUNIT CUNUMBR=1201,PATH=(F9,F0,F8,FA),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=2,UNIT=3990-6
IODEVICE ADDRESS=(1200,256),UNITADD=00,CUNUMBR=(1200,1201),
STADET=Y,UNIT=3390
*****
** DASD CUs 1300 and 1301 and Devices 1300 to 13FF
*****
CNTLUNIT CUNUMBR=1300,PATH=(FC,FE,FD,F4),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=3,UNIT=3990-6
CNTLUNIT CUNUMBR=1301,PATH=(F9,F0,F8,FA),UNITADD=((00,256)),
LINK=(A3,C3,A3,C3),CUADD=3,UNIT=3990-6
IODEVICE ADDRESS=(1300,256),UNITADD=00,CUNUMBR=(1300,1301),
STADET=Y,UNIT=3390

```

Figure 74. IOCP definition for FICON (FCV mode), 8 channel paths and 4 LCUs

Figure 74 shows the I/O definition support (IOCP statements) to support the I/O configuration shown in Figure 73 on page 96. There are eight FICON (FCV mode) channel paths defined to access each of the attached devices in each of the four logical control units, as the I/O device statement connects to both control unit statements that are used to define a logical control unit, and each control unit statement has four paths defined.

## 9.6 ESCON and FICON configurations with fewer channels

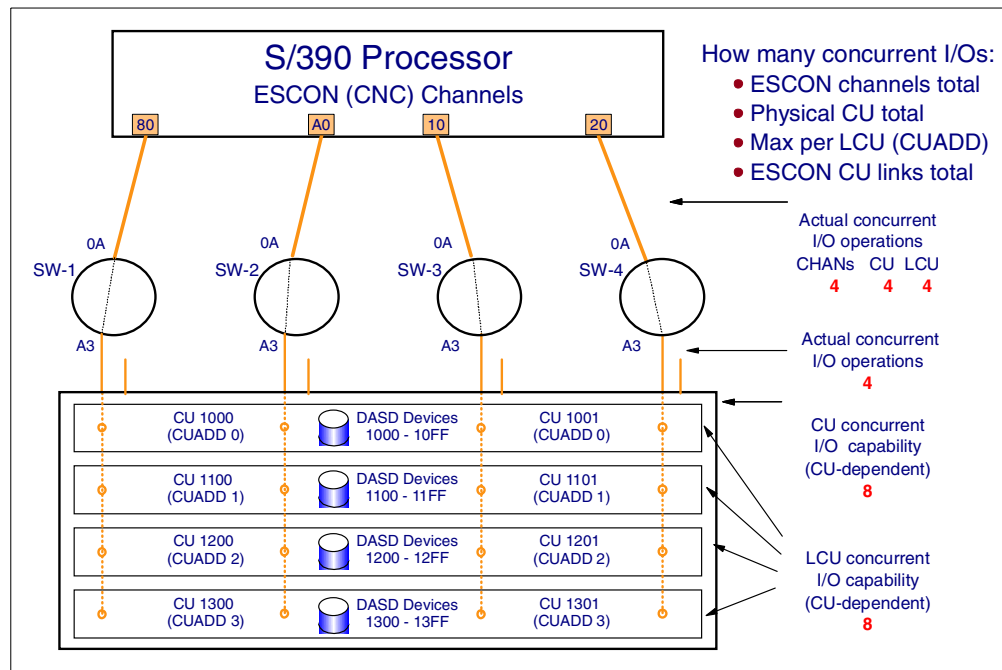


Figure 75. ESCON (CNC) channel configuration - 4 channel paths and 4 LCUs

The number of concurrent I/O operations that can be performed between a processor and a control unit is also dependent on both the number of channel paths between the processor and the control unit, as well as on the I/O concurrency capabilities of the CU. In Figure 75, even though the control unit supports eight concurrent I/O operations, there are only four channel paths defined to the control unit from the processor, therefore only four concurrent I/O operations can be performed for this configuration (it uses ESCON paths). When FICON (FCV mode) channel paths are used, this can be different; see the configuration shown in Figure 76 on page 99.

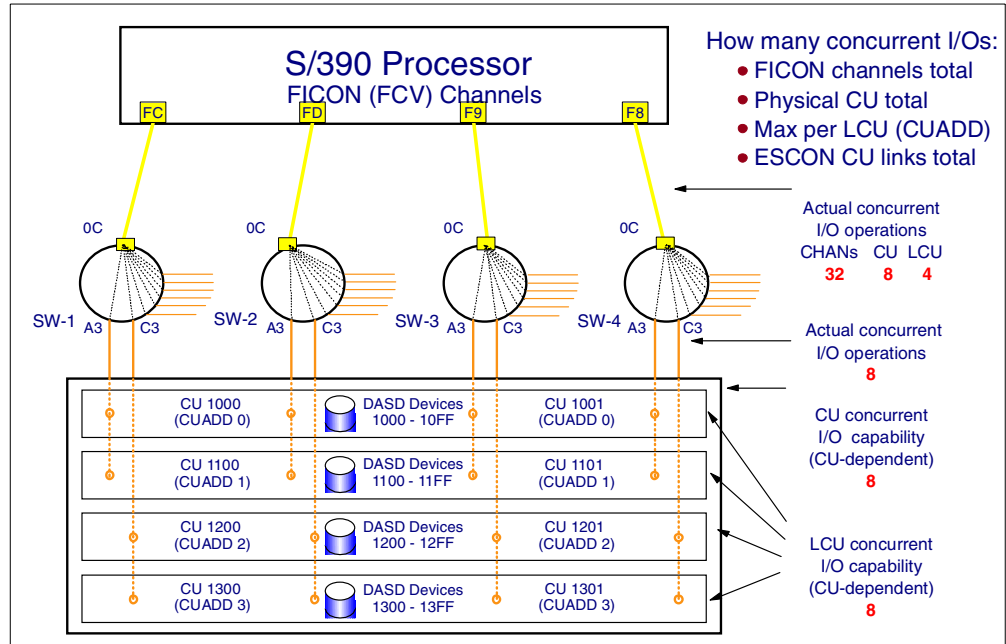


Figure 76. FICON (FCV mode) channel configuration - 4 channels to 4 LCUs

When FICON (FCV mode) channels are used to a control unit that both supports I/O concurrency and multiple LCUs, the I/O concurrency that can be achieved is not just dependent on the number of FICON (FCV mode) channels, but also on how the channels paths are defined and configured between the 9032-5 ESCON Director and the control unit.

Figure 76 shows that there are four FICON (FCV mode) channels to the 9032-5 ESCON Director, but there are eight links between the ESCON Director and the control unit. The figure also shows that logical control unit address (CUADD) 0 and 1 are defined as being accessed by each of the four ESCON Director port links x'A3', and that logical control unit address (CUADD) 2 and 3 are defined as being accessed by each of the four ESCON Director port links x'C3'.

This means that a total of eight concurrent I/O operations can be supported between the processor and the control unit: four of the concurrent I/O operations from LCUs 0 and 1 and four of the concurrent I/O operations from LCUs 2 and 3.

Therefore, you can use fewer FICON (FCV mode) channels to exploit the I/O concurrency of an ESCON interface control unit.

## 9.7 Remote site ESCON and FICON (FCV mode) connections

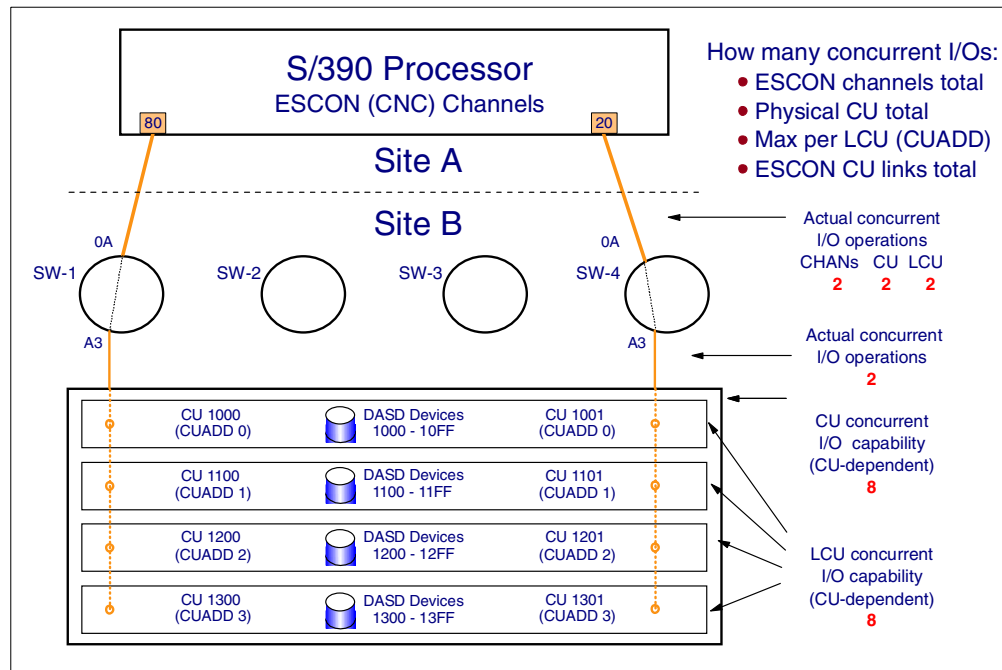


Figure 77. ESCON (CNC) channel configuration - 2 channel paths to 4 LCUs

Connecting a processor in one site to control units in another site can be expensive due to the cost of the fiber cables that connect the two sites. This may be a factor in the customer deciding to use fewer fiber connections (fewer channels) between the two sites (between the processor and control units).

Using fewer ESCON (CNC) channels connections than the supported I/O concurrency of the control unit means that the actual I/O concurrency achieved between the processor and the control unit will drop. It would be equal to up to the number of channel path connections.

In the configuration shown Figure 77, the control unit is capable of 8 concurrent I/O operations, but there are only two ESCON channels path connections, therefore, the actual maximum concurrent I/O operations that could be achieved is only two.



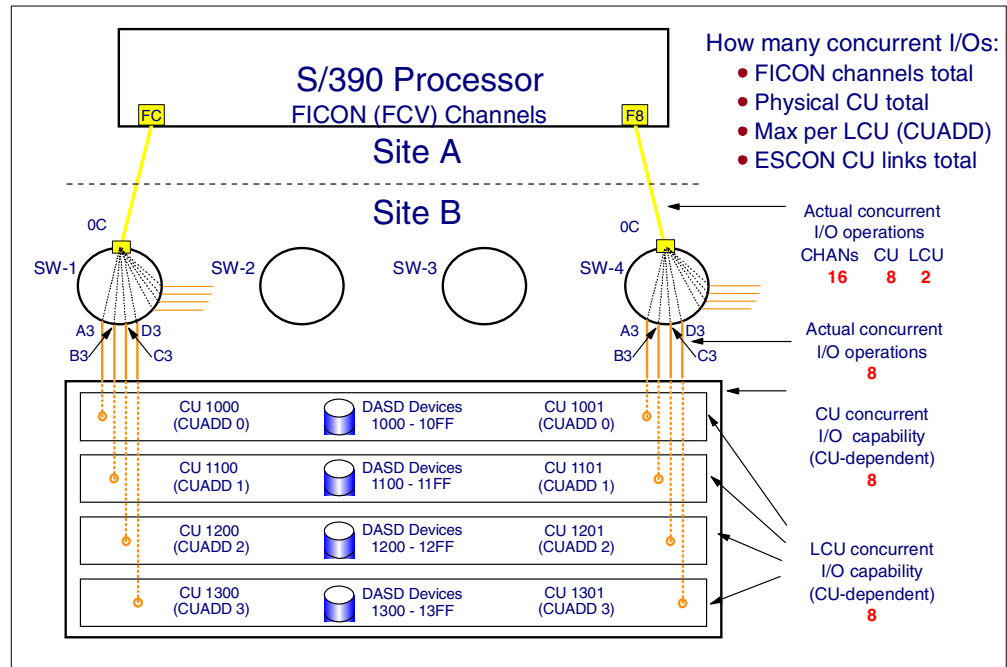


Figure 78. FICON (FCV mode) channel configuration - 2 channels to 4 LCUs

It may still be expensive when connecting a processor in one site to control units in another site due to the cost of the fiber cables that connect the two sites even when using FICON (FCV mode) channels. This may be a factor in the customer deciding to use fewer fiber connections (fewer channels) between the two sites (between the processor and control units).

Using fewer FICON (FCV mode) channels connections than the supported I/O concurrency of the control unit does not cause the actual I/O concurrency achieved between the processor and the control unit to drop in the same way. The I/O concurrency will be dependent on how the link connections are configured between the remote site ESCON Directors and the control units, and how the access to the logical control units are defined when using the FICON (FCV mode) channels.

In the configuration shown in Figure 78, the control unit is capable of eight concurrent I/O operations, but there are only two FICON (FCV mode) channels path connections. But there are a total of eight ESCON links between the ESCON Directors and the control unit. Therefore, the actual maximum concurrent I/O operations that could be achieved in total to the control unit is eight (two to each of the four LCUs). This also requires that the each of the four LCU definitions be defined to use their own two ESCON links.

## 9.8 ESCON and FICON connectivity intermix

Access to any ESCON interface CU from a S/390 9672 G5 or G6 processor image may be from ESCON and/or FICON channels (in FCV mode). Intermixing ESCON (CNC) channels and FICON channels (in FCV mode) to the same CU from the same processor image is supported.

- The degree of intermix is installation-dependent:  
 All eight paths can be from ESCON channels to a logical control unit.  
 All eight paths can be from FICON (FCV) channels to a logical control unit.  
 Or you can use any intermix combination (up to a maximum of eight to any LCU).  
 In the case where a CU can support greater than eight concurrent I/O transfers, more than eight ESCON (CNC) paths would be required to exploit this, but it would require only eight FICON (FCV) paths to exploit this.
- Figure 79 on page 102 shows four ESCON channel paths and four FICON (FCV) channel paths from the same S/390 image to the same control unit images.
- The following channel path rule always applies:  
 You can only define a channel path only *once* to access the a logical control unit (or just a plain control unit).

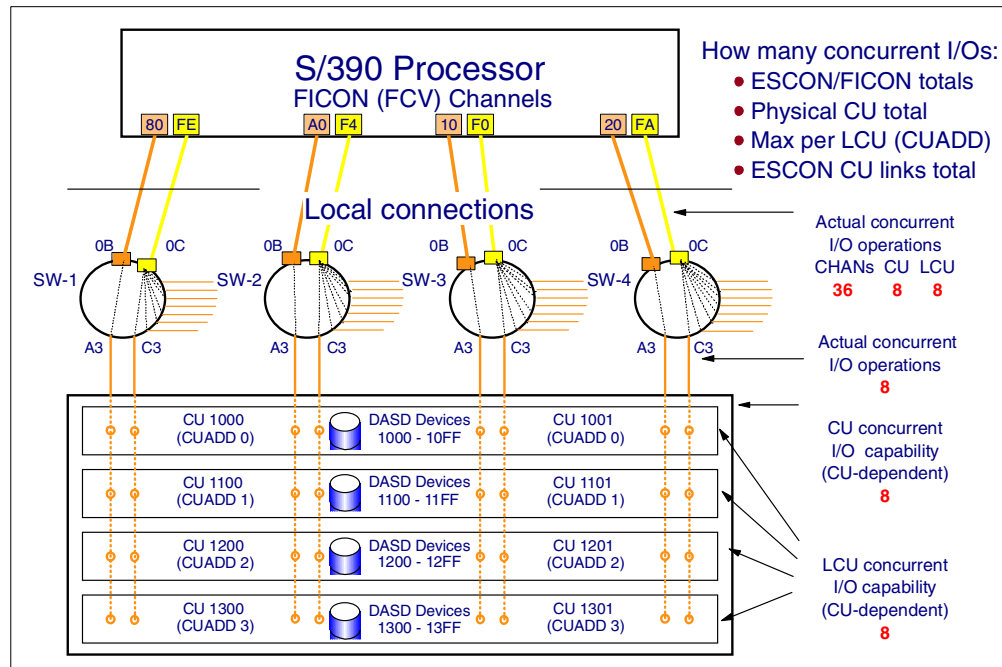


Figure 79. Intermixing ESCON (CNC) and FICON (FCV mode) channel paths

The actual I/O concurrency for the configuration shown in Figure 79 is:

- Up to eight for the physical control unit.
- Up to eight for any one of the logical control units.
- Up to 36 in total for the eight channels used:
  - Up to four for the ESCON channel paths
  - Up to 32 for the FICON (FCV mode) channel paths, but only four of the 32 will be for the control unit configuration shown in Figure 79.

---

## 9.9 Maximum I/O concurrency exploitation

### Control unit, I/O concurrency

- You may install and define more than eight channel paths to any physical control unit (from the same S/390 processor image) when the physical control unit has two or more logical control units. But still a maximum of only eight channel paths may be defined to any one logical control unit. You can use this approach for physical control units that support greater than eight concurrent I/O transfers and that have a customer requirement for a high I/O rate when using ESCON channels. An example of this type of control unit is the IBM ESS (IBM 2105 Enterprise Storage Server).

### I/O device, I/O concurrency

- The IBM ESS (IBM 2105 Enterprise Storage Server) also supports the Parallel Access Volumes (PAV) function. The PAV function provides for one, two, or more concurrent I/O operations to the same DASD volume (PAV is not discussed in any detail in this FICON (FCV mode) planning guide). In addition to customizing the IBM ESS to provide the required number of base devices (3390B) and PAV devices (3390A - alias devices) (using HCD/HCM to define both the 3390 base and alias devices), the customer should also provide enough ESCON or FICON (FCV) channel path connectivity to support the maximum I/O concurrency of the IBM ESS logical control units and its base devices and the PAV alias devices.

The following figures show an IBM ESS disk control unit configuration that supports eight concurrent channel I/O operations to any logical control unit within the physical control unit, and 16 concurrent channel I/O operations (or more) to the physical control unit. It is shown for ESCON (CNC) in Figure 80 on page 104 requiring 16 channels to exploit 16 concurrent I/O transfers and later, using FICON channels (in FCV mode), in Figure 82 on page 106 requiring only eight FICON (FCV) channels to exploit the same control unit concurrent I/O transfer capabilities.

Some newer DASD (disk) control unit Unit Information Modules (UIMs) only support the connection of a device to one control unit definition. Therefore, only one control unit definition is used in the IBM ESS (2105) configuration examples for ESCON and FICON (FCV).

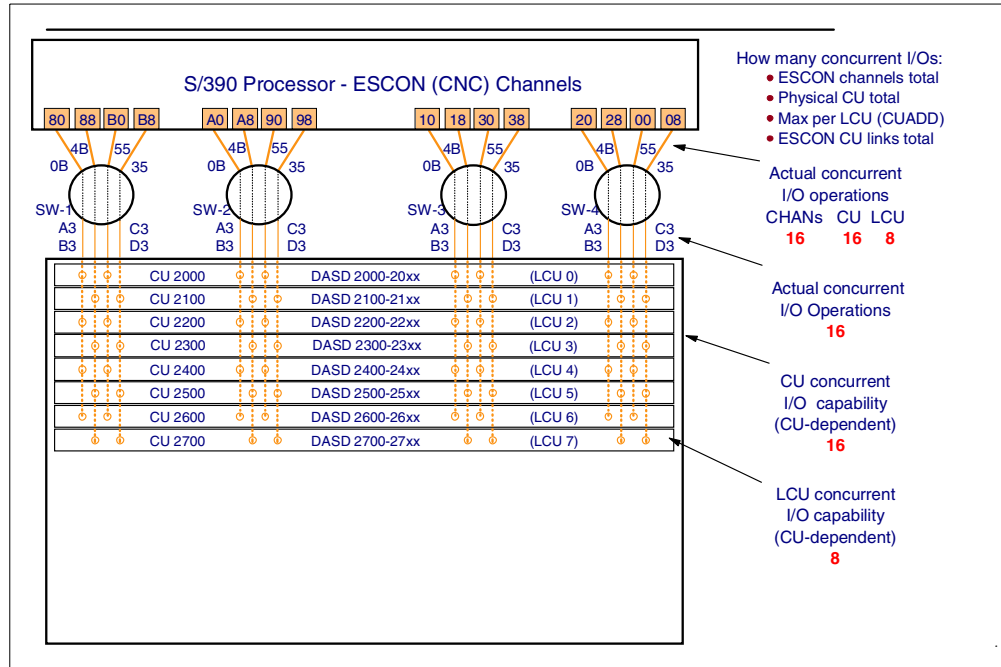


Figure 80. ESCON (CNC) channel configuration - 16 channel paths, 8 LCUs

In the configuration shown in Figure 80, there are 16 ESCON (CNC) channel paths configured to access the IBM ESS. Eight of the ESCON channel paths are defined to access all the even addressed LCUs (CUADDs). The other eight ESCON channels paths are defined to access all the odd addressed LCUs (CUADDs).

With this configuration, the 16 ESCON (CNC) channel paths can support up to 16 concurrent I/O transfers to the one physical control unit. Eight of the concurrent I/O transfers can be from any of the even-addressed LCUs, and the other eight concurrent I/O transfers can be from any of the odd-addressed LCUs.

```

ID MSG1='9672-Z77',
MSG2='ESCON(CNC) MAXIMUM CU I/O CONCURRENCY',
SYSTEM=(9672,6)
RESOURCE PARTITION=((LP1,1),(LP2,2),(LP3,3))
CHPID PATH=(80,B0,88,B8),TYPE=CNC,SHARED,SWITCH=01,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(A0,90,A8,98),TYPE=CNC,SHARED,SWITCH=02,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(10,30,18,38),TYPE=CNC,SHARED,SWITCH=03,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(20,00,28,08),TYPE=CNC,SHARED,SWITCH=04,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
*****
** DASD CU 2000 and Devices 2000 to 207F
*****
CNTLUNIT CUNUMBR=2000,PATH=(80,B0,A0,90,10,30,20,00),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=0,UNIT=2105
IODEVICE ADDRESS=(2000,16),UNITADD=00,CUNUMBR=(2000),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2010,112),UNITADD=10,CUNUMBR=(2000),
STADET=Y,UNIT=3390A
*****
** DASD CU 2100 and Devices 2100 to 217F
*****
CNTLUNIT CUNUMBR=2100,PATH=(88,B8,A8,98,18,38,28,08),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=1,UNIT=2105
IODEVICE ADDRESS=(2100,16),UNITADD=00,CUNUMBR=(2100),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2110,112),UNITADD=10,CUNUMBR=(2100),
STADET=Y,UNIT=3390A
*****
** DASD CU 2200 and Devices 2200 to 227F
*****
CNTLUNIT CUNUMBR=2200,PATH=(80,B0,A0,90,10,30,20,00),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=2,UNIT=2105
IODEVICE ADDRESS=(2200,16),UNITADD=00,CUNUMBR=(2200),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2210,112),UNITADD=10,CUNUMBR=(2200),
STADET=Y,UNIT=3390A
*****
** DASD CU 2300 and Devices 2300 to 237F
*****
CNTLUNIT CUNUMBR=2300,PATH=(88,B8,A8,98,18,38,28,08),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=3,UNIT=2105
IODEVICE ADDRESS=(2300,16),UNITADD=00,CUNUMBR=(2300),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2310,112),UNITADD=10,CUNUMBR=(2300),
STADET=Y,UNIT=3390A
*****
** DASD CU 2400 and Devices 2400 to 247F
*****
CNTLUNIT CUNUMBR=2400,PATH=(80,B0,A0,90,10,30,20,00),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=4,UNIT=2105
IODEVICE ADDRESS=(2400,16),UNITADD=00,CUNUMBR=(2400),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2410,112),UNITADD=10,CUNUMBR=(2400),
STADET=Y,UNIT=3390A
*****
** DASD CU 2500 and Devices 2500 to 257F
*****
CNTLUNIT CUNUMBR=2500,PATH=(88,B8,A8,98,18,38,28,08),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=5,UNIT=2105
IODEVICE ADDRESS=(2500,16),UNITADD=00,CUNUMBR=(2500),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2510,112),UNITADD=10,CUNUMBR=(2500),
STADET=Y,UNIT=3390A
*****
** DASD CU 2600 and Devices 2600 to 267F
*****
CNTLUNIT CUNUMBR=2600,PATH=(80,B0,A0,90,10,30,20,00),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=6,UNIT=2105
IODEVICE ADDRESS=(2600,16),UNITADD=00,CUNUMBR=(2600),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2610,112),UNITADD=10,CUNUMBR=(2600),
STADET=Y,UNIT=3390A
*****
** DASD CU 2700 and Devices 2700 to 277F
*****
CNTLUNIT CUNUMBR=2700,PATH=(88,B8,A8,98,18,38,28,08),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=7,UNIT=2105
IODEVICE ADDRESS=(2700,16),UNITADD=00,CUNUMBR=(2700),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2710,112),UNITADD=10,CUNUMBR=(2700),
STADET=Y,UNIT=3390A

```

Figure 81. IOCP definition for an ESCON connected 16 path, 8 LCU control unit

Figure 81 on page 105 shows the I/O definition support (IOCP statements) to support the I/O configuration shown in Figure 80 on page 104. There are 16 ESCON (CNC) channel paths; eight of the channel paths are defined to access all the even addressed LCUs (CUADDs), and the other eight ESCON (CNC) channel paths are defined to access all the odd addressed LCUs (CUADDs).

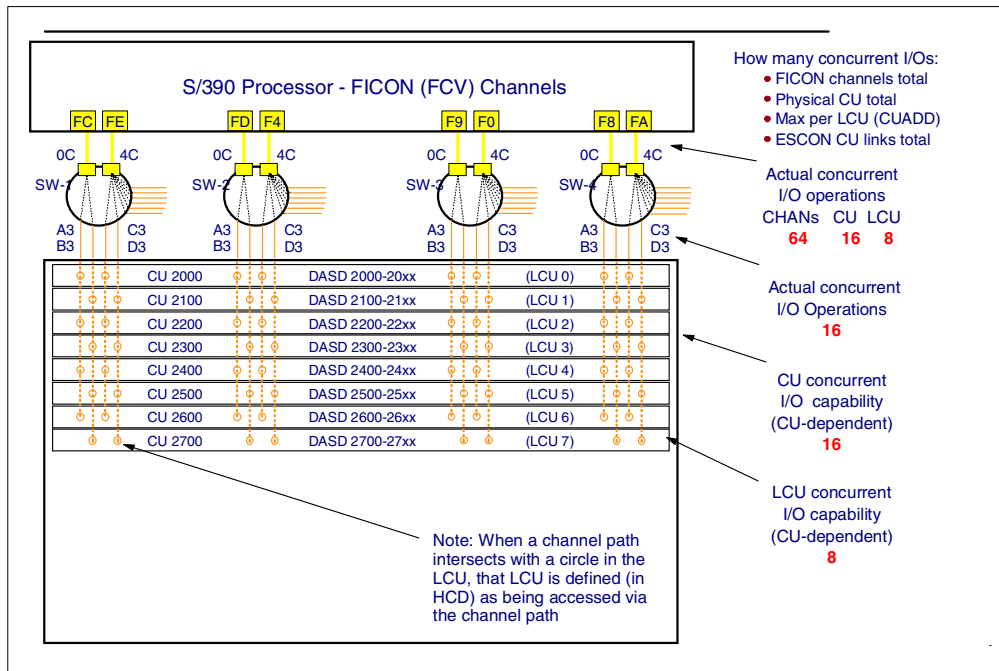


Figure 82. FICON (FCV mode) channel configuration - 8 channels to 8 LCUs

In Figure 82 there are 8 FICON (FCV mode) channel paths configured to access all the even addressed LCUs (CUADDs) via the same set of FICON (FCV mode) channel/destination link address paths, and all the odd addressed LCUs (CUADDs) via the same FICON (FCV mode) channels but using different path definitions (and physical configuration) made up of the FICON (FCV mode) channel/destination link address paths.

With this configuration, the eight FICON (FCV mode) channel paths can support 16 concurrent I/O transfers to the one physical control unit. Eight of the concurrent I/O transfers can be from any of the even addressed LCUs, and the other eight concurrent I/O transfers can be from any of the odd addressed LCUs.

The eight FICON (FCV mode) channel paths can support in total 64 concurrent I/O transfers, up to 16 will be to the ESS control unit; and if 16 concurrent I/O operations were to the ESS control unit, then up to 48 more concurrent I/O operations can be to other control units.

```

ID MSG1='9672-277',
MSG2='FICON (FCV) MAXIMUM CU I/O CONCURRENCY',
SYSTEM=(9672,6)
RESOURCE PARTITION=((LP1,1),(LP2,2),(LP3,3))
CHPID PATH=(FC,FE),TYPE=FCV,SHARED,SWITCH=01,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(FD,F4),TYPE=FCV,SHARED,SWITCH=02,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(F9,F0),TYPE=FCV,SHARED,SWITCH=03,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
CHPID PATH=(F8,FA),TYPE=FCV,SHARED,SWITCH=04,
PARTITION=((LP1,LP2,LP3),(LP1,LP2,LP3))
*****
** DASD CU 2000 and Devices 2000 to 207F
*****
CNTLUNIT CUNUMBR=2000,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=0,UNIT=2105
IODEVICE ADDRESS=(2000,16),UNITADD=00,CUNUMBR=(2000),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2010,112),UNITADD=10,CUNUMBR=(2000),
STADET=Y,UNIT=3390A
*****
** DASD CU 2100 and Devices 2100 to 217F
*****
CNTLUNIT CUNUMBR=2100,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=1,UNIT=2105
IODEVICE ADDRESS=(2100,16),UNITADD=00,CUNUMBR=(2100),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(3110,112),UNITADD=10,CUNUMBR=(2100),
STADET=Y,UNIT=3390A
*****
** DASD CU 2200 and Devices 2200 to 227F
*****
CNTLUNIT CUNUMBR=2200,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=2,UNIT=2105
IODEVICE ADDRESS=(2200,16),UNITADD=00,CUNUMBR=(2200),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2210,112),UNITADD=10,CUNUMBR=(2200),
STADET=Y,UNIT=3390A
*****
** DASD CU 2300 and Devices 2300 to 237F
*****
CNTLUNIT CUNUMBR=2300,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=3,UNIT=2105
IODEVICE ADDRESS=(2300,16),UNITADD=00,CUNUMBR=(2300),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2310,112),UNITADD=10,CUNUMBR=(2300),
STADET=Y,UNIT=3390A
*****
** DASD CU 2400 and Devices 2400 to 247F
*****
CNTLUNIT CUNUMBR=2400,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=4,UNIT=2105
IODEVICE ADDRESS=(2400,16),UNITADD=00,CUNUMBR=(2400),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2410,112),UNITADD=10,CUNUMBR=(2400),
STADET=Y,UNIT=3390A
*****
** DASD CU 2500 and Devices 2500 to 257F
*****
CNTLUNIT CUNUMBR=2500,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=5,UNIT=2105
IODEVICE ADDRESS=(2500,16),UNITADD=00,CUNUMBR=(2500),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2510,112),UNITADD=10,CUNUMBR=(2500),
STADET=Y,UNIT=3390A
*****
** DASD CU 2600 and Devices 2600 to 267F
*****
CNTLUNIT CUNUMBR=2600,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(A3,C3,A3,C3,A3,C3,A3,C3),
CUADD=6,UNIT=2105
IODEVICE ADDRESS=(2600,16),UNITADD=00,CUNUMBR=(2600),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2610,112),UNITADD=10,CUNUMBR=(2600),
STADET=Y,UNIT=3390A
*****
** DASD CU 2700 and Devices 2700 to 277F
*****
CNTLUNIT CUNUMBR=2700,PATH=(FC,FE,FD,F4,F9,F0,F8,FA),
UNITADD=((00,128)),LINK=(B3,D3,B3,D3,B3,D3,B3,D3),
CUADD=7,UNIT=2105
IODEVICE ADDRESS=(2700,16),UNITADD=00,CUNUMBR=(2700),
STADET=Y,UNIT=3390B
IODEVICE ADDRESS=(2710,112),UNITADD=10,CUNUMBR=(2700),
STADET=Y,UNIT=3390A

```

Figure 83. OCP definition FICON (FCV mode), 8 channel path, 8 LCU control unit

Figure 83 on page 107 shows the I/O definition support (IOCP statements) to support the I/O configuration shown in Figure 82 on page 106. There are eight FICON (FCV mode) channel paths defined to access all the even addressed LCUs (CUADDs) via the same set of FICON (FCV mode) channel/destination link address paths, and all the odd addressed LCUs (CUADDs) via the same FICON (FCV mode) channels. But different paths, made up of the FICON (FCV mode) channel/destination, link address paths.



## Chapter 10. S/390 FICON (FCV) CTC support

S/390 FICON channels (in FCV mode) can be used in the same way as ESCON CNC channels in a switched point-to-point configuration to participate in ESCON CTC connections and communication. The CTC control unit function is provided by the ESCON CTC channel.

A FICON channel (in FCV mode) can concurrently connect from one FICON channel (in FCV mode) to up to 8 ESCON CTC channels.

FICON channels (in FCV mode) can intermix the concurrent connections and I/O operations between ESCON CTCs and other ESCON CUs (for example, DASD control units).

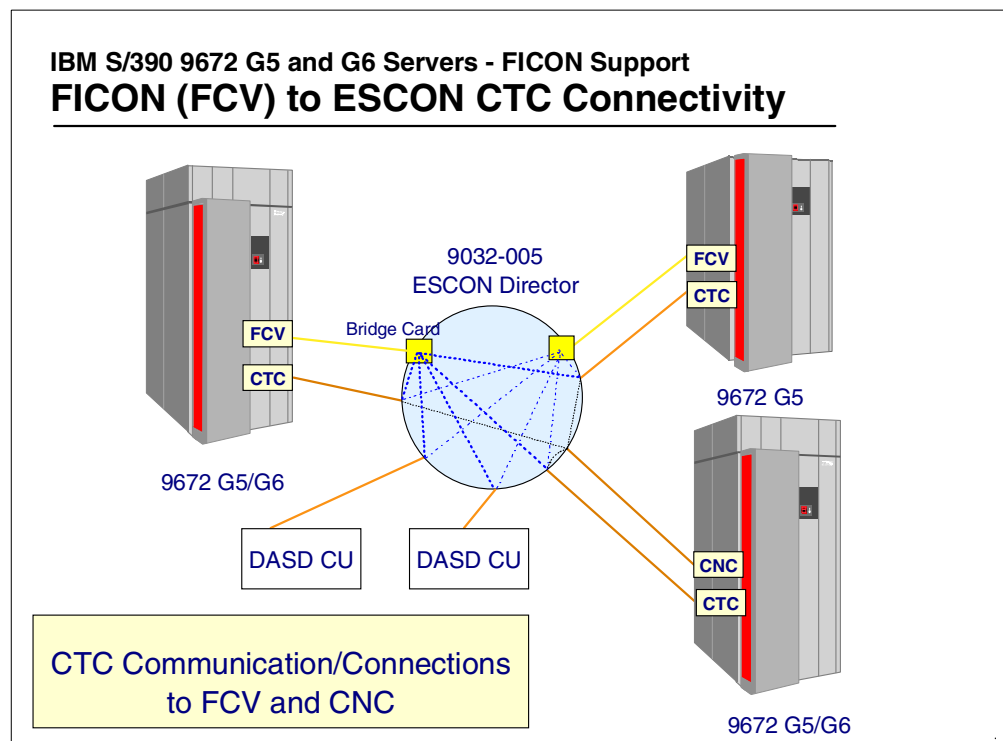


Figure 84. S/390 FICON (FCV) CTC support

In an ESCON CTC environment, there are always two channels involved with the communication: an ESCON channel defined to operate in CTC mode, and an ESCON channel at the other end of the connection defined to operate in CNC mode. This connection can either be point-to-point or switched point-to-point.

A FICON (FCV mode) channel can be used instead of an ESCON CNC mode channel. (Note, however, that an ESCON CTC mode channel is still required). When the communication connection is between an ESCON CTC channel and a FICON (FCV mode) channel, the topology is always switched point-to-point.



## Chapter 11. FICON (FCV) configuration scenarios

You must follow the S/390 Processor channel path to control unit (CU) configuration architecture rules at all times for all channel types. Listed here are some of the rules for FICON (FCV mode) channels (both of these rules also apply to ESCON CNC mode channels):

- A logical control unit/device cannot be accessed more than once from the same channel path (CHPID).
- A physical CU that has multiple logical control units (uses CUADD addressing) may be accessed more than once from the same FICON (FCV mode) channel path, but the access is to different CUADDs (different logical control units) within the physical control unit subsystem.

Configuration recommendation:

- Configure at least the same number of data transfer channel paths (ESCON or FICON) to a DASD logical CU as the DASD subsystem supports concurrent channel I/O operations
- Configure additional control units to the FICON (FCV mode) same channel paths as required, based on:
  - The customer's performance requirements
  - The channel bandwidth
- Note: One FICON channel (in FCV mode) can perform up to 8 concurrent I/O operations.

When changing a control unit channel path access from ESCON (CNC) channels to FICON (FCV mode) channels, it may be easy to overlook some of the rules, so be careful. This changing of the control unit access from ESCON (CNC) to FICON (FCV mode) channels is also referred to as *aggregating* from ESCON to FICON channels.

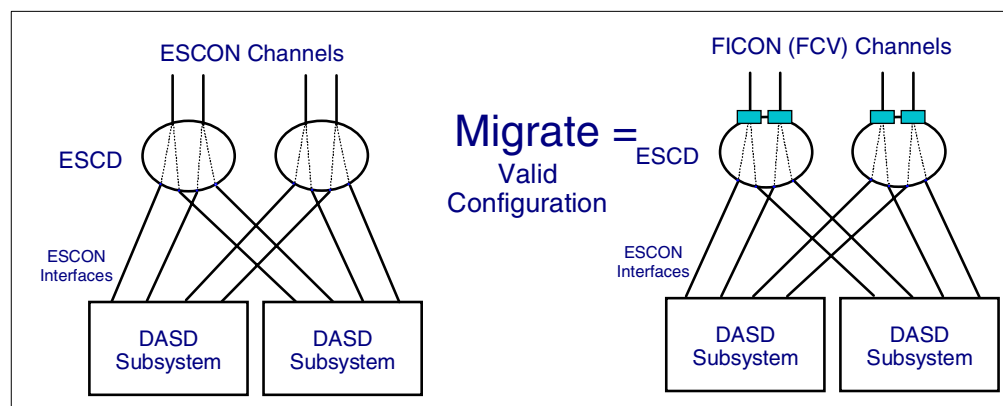


Figure 85. ESCON (CNC) to FICON (FCV) migration

Figure 85 shows a valid change (migration) from ESCON (CNC) channels to FICON (FCV mode) channels.

For the ESCON configuration we recommend that you:

- Configure at least the same number of ESCON data transfer channel paths that the DASD subsystem supports concurrent I/O operations on its upper interfaces.
- Configure additional control units to the same channel paths based on:  
The customer's performance requirements  
The channel bandwidth
- There can be a maximum of 4 concurrent I/O operations for this ESCON configuration. That is a maximum of 1 concurrent I/O operation per ESCON channel.

For the FICON (FCV mode) configuration:

- Configure the same number of FICON (FCV mode) data transfer channel paths as a DASD subsystem supports concurrent I/O operations on its upper interfaces
- Configure additional control units to the same channel paths based on:  
The customer's performance requirements  
The channel bandwidth
- There can be a maximum of 8 concurrent I/O operations for the FICON (FCV mode) configuration. This is a maximum of 2 concurrent I/O operations per FICON (FCV mode) channel to the two DASD subsystems shown. However there could be a maximum of 32 concurrent I/O operations if there were more control units defined to be accessed from these 2 FICON (FCV mode) channels.

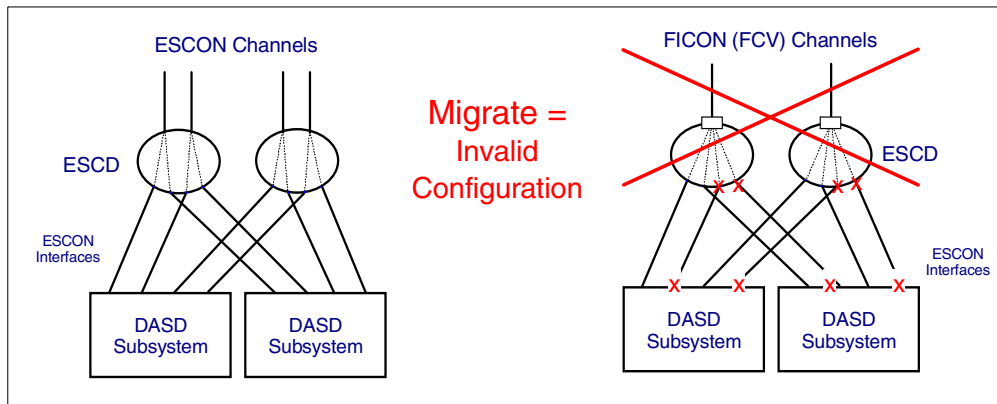


Figure 86. ESCON (CNC) to FICON (FCV) migration - invalid configuration

As Figure 86 shows, when migrating a control unit access from ESCON (CNC) channels to FICON (FCV Mode) channels you cannot “aggregate” two or more ESCON channel paths that go into the same logical control unit into just one FICON channel path. This rule applies to both ESCON and FICON channels:

- A channel path can be used to go to multiple control units, but only once to any individual logical CU.

You must follow the S/390 processor channel path configuration rules:

- The same control unit/device cannot be accessed more than once from the same channel path (see Figure 87).
- A physical control unit that has multiple logical control units (uses the CUADD definition) maybe accessed more than once from the same channel path, but to different logical control units (different CUADDs) within the physical control unit.

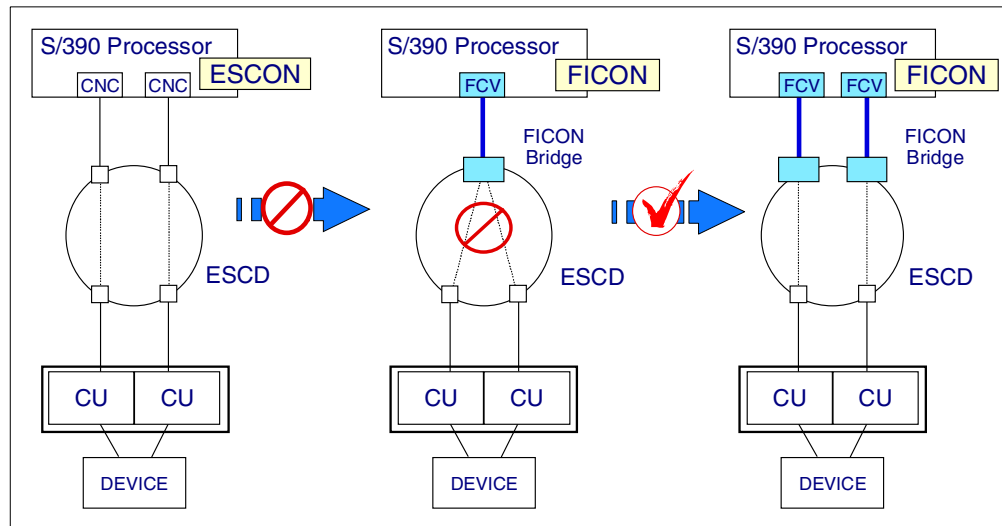


Figure 87. ESCON to FICON (FCV mode) migration - rules

When there are multiple ESCON channel paths to the same device, you cannot aggregate these multiple ESCON device channel paths (that go to the same device - same logical CU), into the one FICON (FCV) channel.

This is not just a FICON (FCV mode) channel path rule, it also applies to ESCON channel paths as well; see Figure 88.

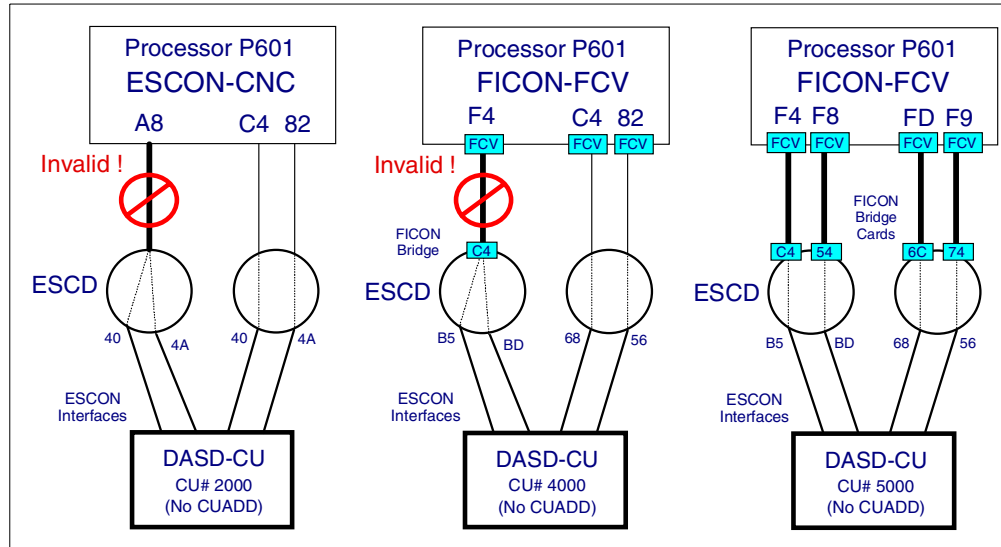


Figure 88. ESCON and FICON (FCV mode) invalid configurations

If you try to define (using OS/390 HCD) the ESCON (CNC) channel to control unit configuration shown in Figure 88, you will get the following HCD error message:

CBDA222I - Duplicate channel path A8 specified for control unit 2000 on processor P601.

If you try to define (using OS/390 HCD) the FICON (FCV mode) channel to control unit configuration shown in Figure 88, you will get the following HCD error message:

CBDA222I - Duplicate channel path F4 specified for control unit 4000 on processor P601.

The rule applies to all ESCON (CNC) and FICON (FCV mode) channel path connected control units, including the 9032 model 5 ESCON director CUP (Control Unit Port - the FE port). This is shown in Figure 89 on page 115.

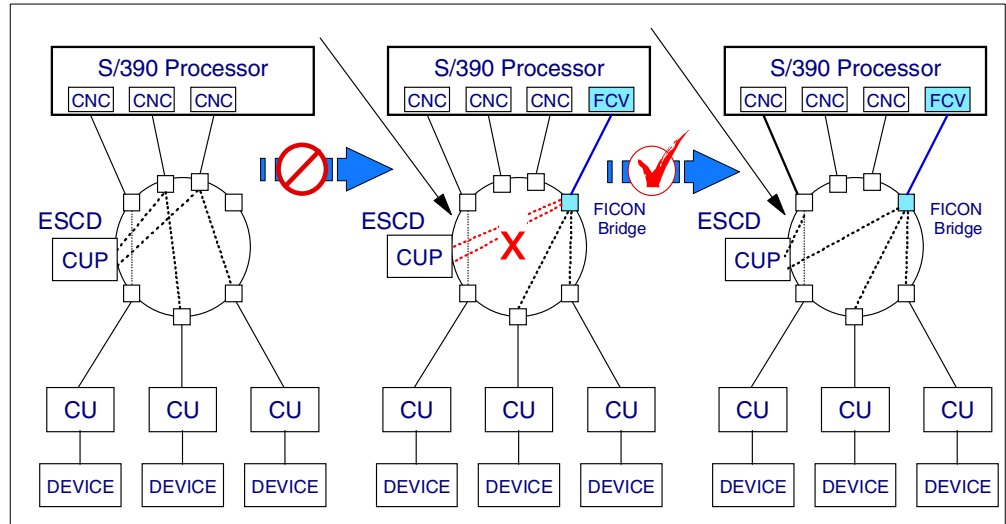


Figure 89. Invalid 9032-5 ESCON (CNC) to FICON (FCV) - CUP path migration

The same rule applies to the ESCD CUP:

- You cannot aggregate multiple ESCON channel paths into a FICON (FCV) channel when two or more of the ESCON channel paths have access to the same device, the ESCD CUP in this example.
- Therefore, first define (move) the second ESCD CUP ESCON (CNC) path to a different ESCON channel path before you start this ESCON to FICON aggregation to free up the ESCON channel from the ESCD CUP.

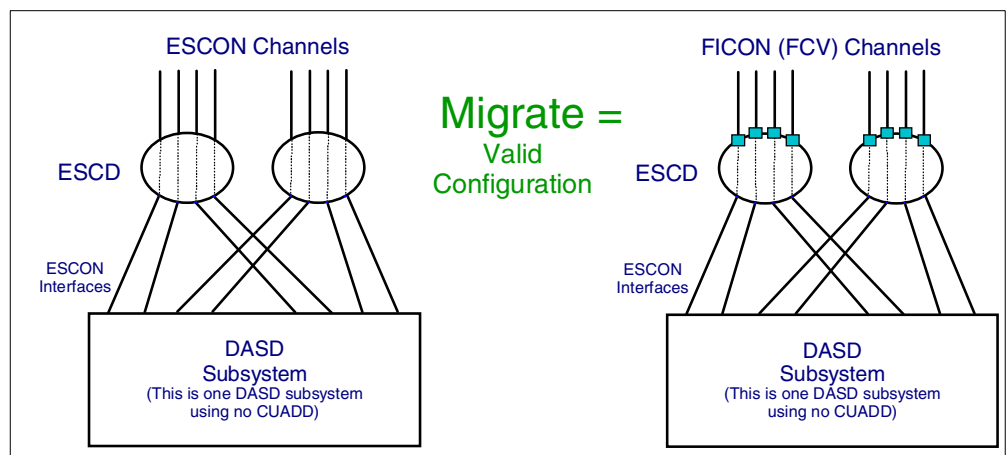


Figure 90. Valid ESCON to FICON configuration

For the ESCON (CNC) channel path configuration shown in Figure 90, there can be up to a maximum of 8 concurrent I/O operations.

For the FICON (FCV mode) channel path configuration shown in Figure 90, there can also be up to a maximum of 8 concurrent I/O operations. For this configuration to go from ESCON (CNC) channel paths to FICON (FCV mode)

channel paths requires that there be 8 FICON (FCV mode) channel paths, if the same I/O concurrency to the control unit is to be maintained. This is because all the channel paths go to the same physical control unit, which only has one logical control unit; therefore, you cannot define any of the FICON (FCV mode) channel paths more than once to this control unit.

The following figure shows a physical control unit that has more than one logical control unit; therefore, you can define to use the FICON (FCV mode) channel paths more than once to the same physical control unit but to different logical control units within the physical CU (i.e. use the CUADD addressing).

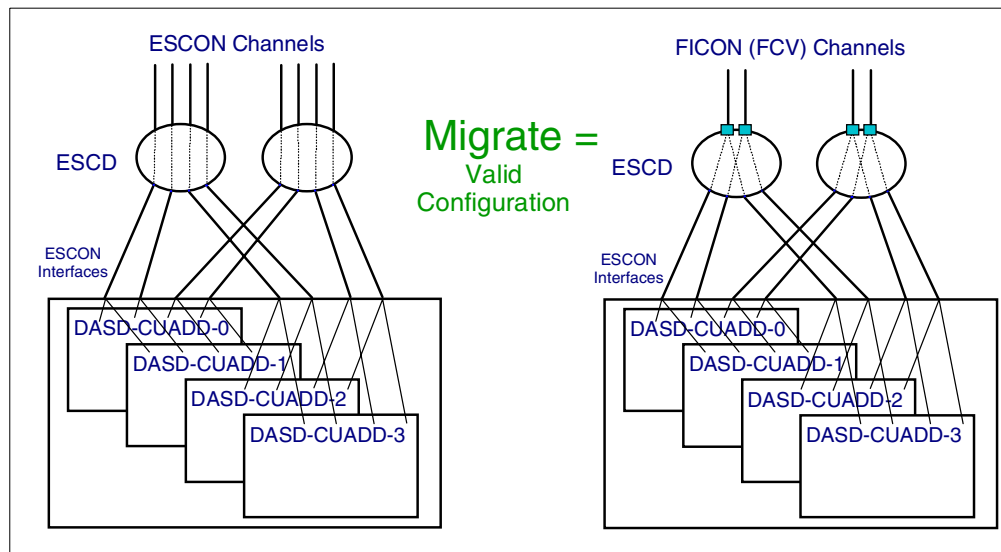


Figure 91. Valid ESCON to FICON (FCV mode) migration to LCUs

The ESCON (CNC) configuration shown in Figure 91 connects to the four logical DASD subsystems in the one physical control unit. Any of the ESCON (CNC) channel paths could be used to get to two (or all four) logical control units, but only one logical CU at any one time could be actively communicating on that ESCON channel path. The configuration shown uses each of the ESCON (CNC) channel paths to access just two of the logical control units.

The FICON (FCV Mode) configuration shown in Figure 91 connects to the four logical DASD subsystems in the one physical control unit. The same FICON (FCV) channel path is used to get to all four logical control units (LCUs). From any one FICON (FCV mode) channel, two LCUs are accessed by one ESCON link and the other two LCUs on the same FICON (FCV mode) channel paths are accessed via another ESCON link. This configuration has reduced the number of channels required, but it can still support 8 concurrent I/O operations from the one physical control unit. The number of concurrent I/O operations can be from 2 to 4 for each LCU, up to a total of 8 for all of the LCUs shown in this configuration.



---

## Chapter 12. ESCON to FICON aggregation

A FICON channel (in FCV mode) can successfully be used to concurrently access a number of control units that were previously accessed by ESCON channels.

ESCON channel performance information and channel path to CU connections need to be reviewed to determine which ESCON channels are good candidates to be aggregated to FICON.

When moving workloads from ESCON to FICON channels (for channel or address constraint cases) you should aim to move 5 to 8 ESCON channel workloads (a minimum of 5) to the FICON channel (in FCV mode) on a 9672.

The way the performance data needs to be reviewed and the selection of ESCON channels requires a certain amount of skill.

- An IBM ESCON-to-FICON aggregation tool can perform this function.
- The customer can determine which ESCON channels to aggregate to FICON.

Installation and use of S/390 9672 FICON channels (in FCV mode) and 9032-5 FICON Bridge port cards may result in some increase in response times for certain I/O operations. Generally the increase will be acceptable to most customers. The customer may wish to determine this for his configuration and environment.

For most distances greater than 10 km, the FICON (FCV) channel to device performance should be better than when using an ESCON (CNC) channel at the same distance.

To assist customers with FICON migration planning, IBM will analyze customer-supplied SMF and configuration data to suggest ESCON channel candidates for aggregation onto FICON channels. Factors including current ESCON channel utilization and I/O rate, and projected FICON channel processor and PCI bus utilization will be included in the analysis. Contact your IBM Sales Representative to request a FICON Channel Aggregation Analysis from the IBM Techline Organization.

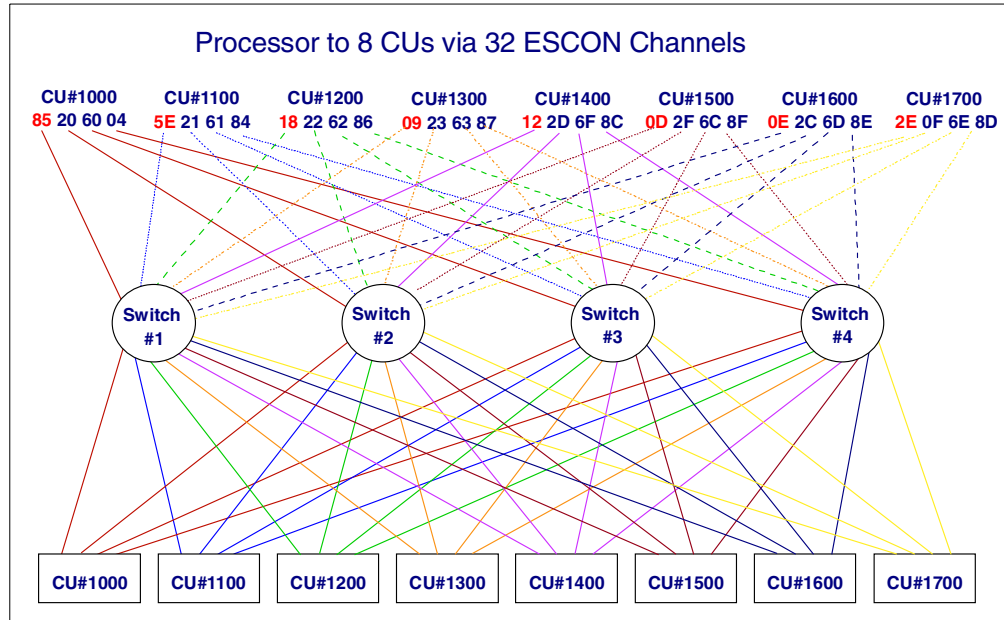


Figure 92. ESCON channel to control unit configuration - aggregation candidates

Figure 92 shows an example of an ESCON (CNC) channel to control unit configuration. Configuration details in the form of an IOCP source file would be one of the inputs provided to the FICON Channel Aggregation Analysis tool. Another input to the FICON Channel Aggregation Analysis is SMF data covering a 24-hour period. The FICON Channel Aggregation Analysis tool allows the selection of valid ESCON channels to be aggregated to a FICON channel. After a valid group of ESCON channel have been selected, the user requests one of a number of measurement results. An example of one of these is shown in the following figure.

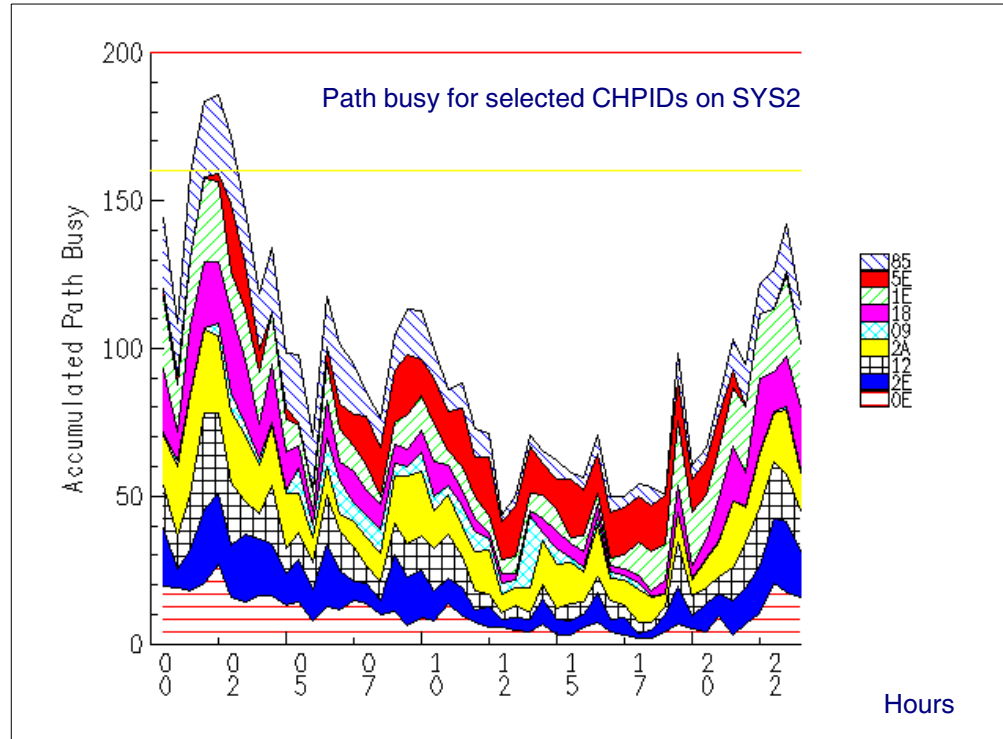


Figure 93. IBM ESCON (CNC) to FICON (FCV) aggregation tool output

The selected path busy chart is one of the outputs of the FICON Channel Aggregation Analysis tool that allows the user to make judgments on the selected ESCON channels to be aggregated.

Basically some conditions of the judgment would be:

- If converting all paths on a set of control units from ESCON (CNC) to FICON (FCV):

Do not exceed a combined ESCON channel utilization of 160% for DASD I/O with a 1ms or less connect time.

Do not exceed a combined ESCON channel utilization of 200% for DASD I/O with a 1ms or greater connect time.

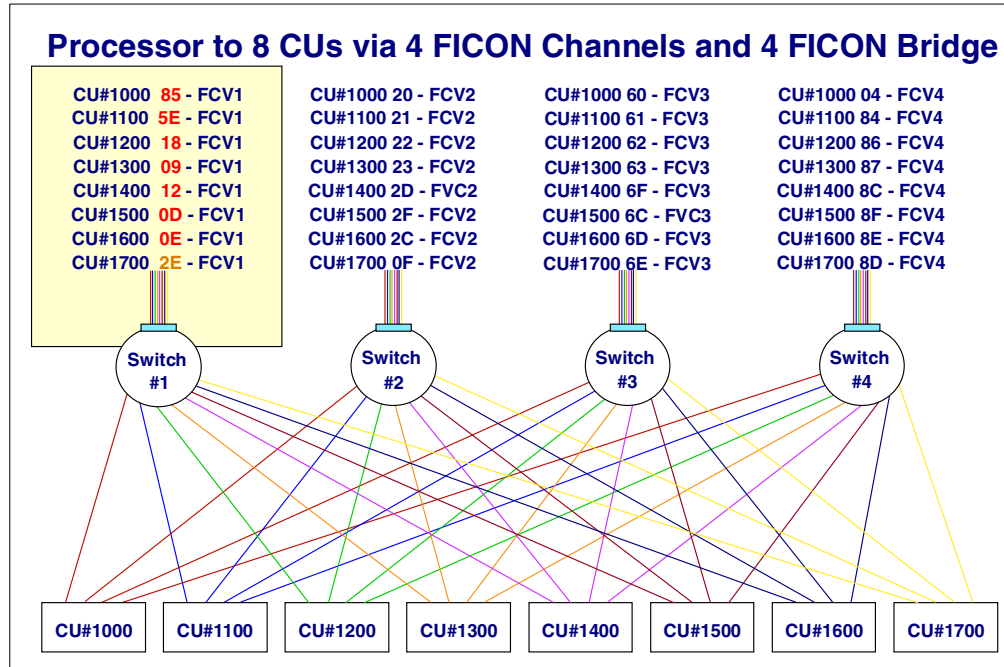


Figure 94. Aggregated FICON (FCV) channel to control unit configuration

If the selected ESCON to FICON (FCV mode) channels were aggregated, it means that all of the control unit paths that were accessed via CHPIDs 85, 5E, 18, 09, 12, 0D, 0E, and 2E would then be accessed via the same FICON (FCV mode) CHPID.

---

## Chapter 13. FICON (FCV) configuration design

FICON (FCV mode) channels can be used within a local site where the processor and control units are installed in the same site and the length of the required fiber cables is less than 122 meters (400 feet) or less than 305 meters (1000 feet) in some cases.

FICON (FCV mode) channels are excellent channels for use between remote sites, where the processor and control units are in different sites and special rules and considerations are required for installing the fiber cables.

Local site configurations and remote configurations have different design requirements and considerations.

Based on the information provided in the previous chapters of this redbook, you should be able to determine for your installation the following requirements.

Local site design considerations:

- What ESCON channels (ESCON control unit interfaces) are to be accessed via FICON (FCV) channels (aggregated)?
- Take into account the workload factor of the nominated ESCON channels (the I/O rate and average connect time, and assumed average transfer rate of 12 MB during the connect time, and the CU type intermix) when determining how many 9672 FICON channels and 9032-5 FICON Bridge cards in total will be required (per processor and per 9032-5 Director) to handle the ESCON workload being transferred to the FICON (FCV) channels.
- Will the FICON (FCV) channels be in addition to the currently installed ESCON and other channels on each processor? Will channels of other types be removed (the order process allows this when the I/O cages in the processor are full)?

Will the 9672 available resources allow this? Are there enough empty I/O slots, unassigned CHPID numbers, and unused STIs?

The current CHPID placement report shows how many I/O slots are in use, CHPID numbers used, and STIs used.

- What fiber cabling will be used to connect the 9672 FICON channel (in FCV mode) to the 9032-5 FICON Bridge cards?
- Will Mode Conditioner Patch cables be required?

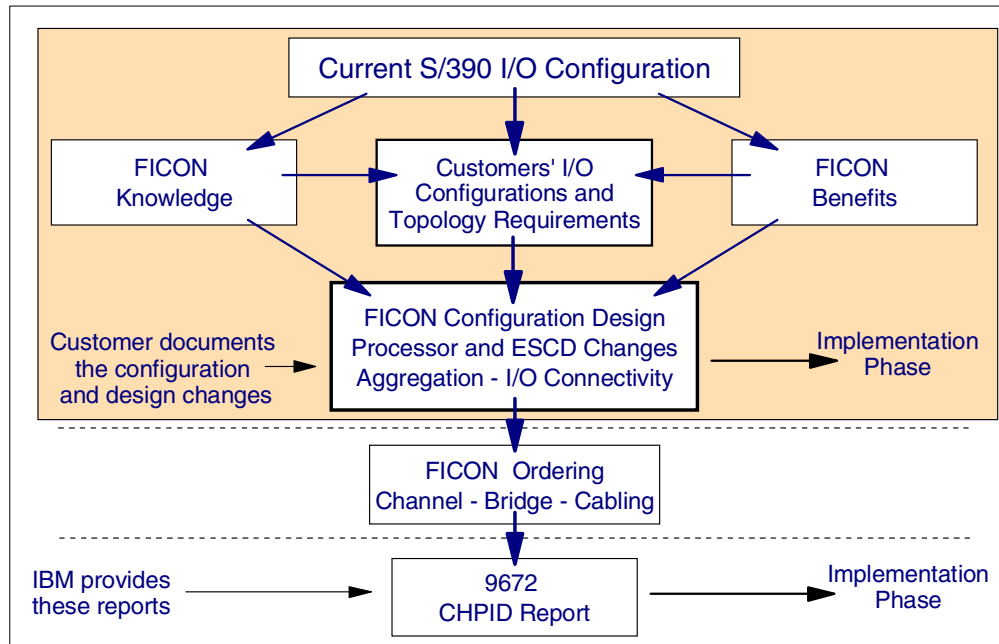


Figure 95. Overall FICON (FCV mode) configuration planning sequence

### 13.1 ESCON (CNC) to FICON (FCV) workload factor

As a general rule, you should be able to transfer the workload of 6 to 8 ESCON (CNC) channels to 1 FICON (FCV mode) channel, taking into account the CU channel usage characteristics and intermix.

Normal ESCON (CNC) to FICON (FCV) workload guidelines, based on response times requirements, are:

- 20% to 25% channel utilization for DASD - 6 to 8 ESCON (CNC) to 1 FICON (FCV) channel
- 60% to 80% channel utilization for Tape, then intermix with DASD, 1 or 2 Tape ESCON (CNC) paths and 4 to 6 DASD ESCON (CNC) paths to 1 FICON (FCV) channel

This takes into account the workload factor of the nominated ESCON channels.

- The I/O rate and average connect time
- An assumed average transfer rate of 12 to 15 MB per second during an I/O operation

### 13.2 ESCON to FICON aggregation for DASD only subsystems

General guidelines for aggregating DASD-only subsystem ESCON (CNC) channels paths to FICON (FCV):

- If converting all paths on a set of control units from ESCON (CNC) to FICON (FCV):

Do not exceed a combined ESCON channel utilization of 160% for DASD I/O with a 1ms or less connect time.

Do not exceed a combined ESCON channel utilization of 200% for DASD I/O with a 1ms or greater connect time.

---

### 13.3 Configuration design and planning phase output

Both the configuration design information and the IBM CHPID report are required for the implementation phase.

The information required from the FICON (FCV) configuration design and planning phase is:

- The quantity of FICON channels to be added  
Number these FICON Z0 to Znn (replace these Zn numbers with actual FICON CHPID numbers later)
- The sets of ESCON channels CHPID numbers to be aggregated to the FICON channels (Zn)
- The customer's ESCON channels (if any) to be deleted (*deleted*, not aggregated). When the 9672 3 I/O cages are full some channels will need to be removed to provide I/O slot space for the installation of the FICON channels.
- The customer's non-ESCON channel types to be deleted (*deleted*, not moved). The customer determines what channel types and quantities are to be removed from the currently installed 9672. The IBM order process determines which of these actual channel types by CHPID number will be removed.
- The customer's other channel types to be added (new channels types or additional channels of types already installed)
- Other planning information required:  
Type of fiber cabling to be used, single-mode or multi-mode. The use of multi-mode fiber by FICON (FCV mode) channels also requires the use of two Mode Conditioner Patch cables, one at each end of the FICON channel optic link, see "Mode Conditioner Patch (MCP) cables" on page 63.  
For every FICON (FCV mode) channel to be installed requires that you must also install a FICON bridge card (or one must already be installed and not in use) in a 9032 model 5 ESCON director.

The configuration design and planning phase output can be entered directly into the Impact Worksheet in the Customer Design Worksheet column. An example of this worksheet is shown in Figure 96 on page 124.

CHIPID Placement Report		Customer Design Worksheet			CHIPID Placement Report	Worksheet ESCON step	Worksheet output	
A	B	C	D	E	F	G	H	I
Channel Type	CARD MOVE and CHIPID CHANGE and DELETE	CHIPID numbers no longer required & not aggregated	New CUs Path requirement by channel type & quantity	ESCON to FICON Aggregation, by ESCON CHIPID number	NEW and CARD MOVE CHIPID numbers by type	ESCON Aggregated CHIPID number not used by any NEW or MOVED CHIPID number	Customer-assigned CHIPID numbers From and To	System Cabling Requirement
ESCON (E)		NONE	New CU #1 8 Paths 1 per FICON New CU #2 8 Paths 1 per FICON New CU #3 8 Paths 1 per FICON	F1 FC B4 B5 48 6A 08 31 => F2 FD F1 E1 E5 E7 49 6B => F3 FF FB F3 E3 AB 9F 81 4B => F4 F0 C0 68 64 82 => F4 C1 E9 65 83 3 new paths => F5 3 new paths => F6 3 new paths => F7 3 new paths => F8 3 new paths => F9 3 new paths => F10 3 new paths => F11 3 new paths => F12				
FICON (H1)								
Parallel (P3/P4)								
OSA-2 EN/TR (2E)								
OSA-2 FDDI								
OSA-2 ATM Multimode(2M)								
OSA-2 ATM Singlmode(2S)								
OSA-EXPRESS								
OSA2 FENET								
Fast-Ethernet(28)								
ISC 1Km (C1)								
ISC-SM (C3)								
ICB (CB)								
IC Channel customer-assigned CHIPID number								

Figure 96. FICON (FCV mode) Impact Worksheet example

A blank copy of this worksheet is provided in Appendix A., “FICON Planning Worksheet” on page 125.



## Appendix A. FICON Planning Worksheet

This is a blank of the FICON Planning (Impact) Worksheet.

CHPID Placement Report		Customer Design Worksheet			CHPID Placement Report	Worksheet ESCON step	Worksheet output	
A	B	C	D	E	F	G	H	I
Channel Type	CARD MOVE and CHPID CHANGE, and DELETE	CHPID numbers no longer required & not aggregated	New CUs Path requirement by channel type & quantity	ESCON to FICON Aggregation, by ESCON CHPID number	NEW and CARD MOVE CHPID numbers by type	ESCON Aggregated CHPID number not used by any NEW or MOVED CHPID number	Customer-assigned CHPID numbers From and To	System Cabling Requirement
ESCON (E)								
FICON (H1)								
Parallel (P3/P4)								
OSA-2 EN/TR (2E)								
OSA-2 FDDI								
OSA-2 ATM Multimode(2M)								
OSA-2 ATM Singlemode(2S)								
OSA-EXPRESS								
OSA2 FENET								
Fast-Ethernet(28)								
ISC 1Km (C1)								
ISC-SM (C3)								
ICB (CB)								
IC Channel customer-assigned CHPID number								



---

## Appendix B. Special notices

This publication is intended to help S/390 I/O configuration specialists to design, configure and define a S/390 channel and I/O configuration that includes the IBM 9672 Models G5 or G6 processor, the IBM 9032-5 ESCON Director with ESCON and/or FICON (FCV) ports. The information in this publication is not intended as the specification of any programming interfaces that are provided by System Automation for OS/390. See the PUBLICATIONS section of the IBM Programming Announcement for System Automation for OS/390 for more information about what publications are considered to be product documentation.

References in this publication to IBM products, programs or services do not imply that IBM intends to make these available in all countries in which IBM operates. Any reference to an IBM product, program, or service is not intended to state or imply that only IBM's product, program, or service may be used. Any functionally equivalent program that does not infringe any of IBM's intellectual property rights may be used instead of the IBM product, program or service.

Information in this book was developed in conjunction with use of the equipment specified, and is limited in application to those specific hardware and software products and levels.

IBM may have patents or pending patent applications covering subject matter in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to the IBM Director of Licensing, IBM Corporation, North Castle Drive, Armonk, NY 10504-1785.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this one) and (ii) the mutual use of the information which has been exchanged, should contact IBM Corporation, Dept. 600A, Mail Drop 1329, Somers, NY 10589 USA.

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The information contained in this document has not been submitted to any formal IBM test and is distributed AS IS. The information about non-IBM ("vendor") products in this manual has been supplied by the vendor and IBM assumes no responsibility for its accuracy or completeness. The use of this information or the implementation of any of these techniques is a customer responsibility and depends on the customer's ability to evaluate and integrate them into the customer's operational environment. While each item may have been reviewed by IBM for accuracy in a specific situation, there is no guarantee that the same or similar results will be obtained elsewhere. Customers attempting to adapt these techniques to their own environments do so at their own risk.

Any pointers in this publication to external Web sites are provided for convenience only and do not in any manner serve as an endorsement of these Web sites.

Any performance data contained in this document was determined in a controlled environment, and therefore, the results that may be obtained in other operating

environments may vary significantly. Users of this document should verify the applicable data for their specific environment.

This document contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples contain the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

Reference to PTF numbers that have not been released through the normal distribution process does not imply general availability. The purpose of including these reference numbers is to alert IBM customers to specific information relative to the implementation of the PTF when it becomes available to each customer according to the normal IBM PTF distribution process.

The following terms are trademarks of the International Business Machines Corporation in the United States and/or other countries:

IBM	RACF
AS/400	RMF
AT	RS/6000
CT	S/390
ESCON XDF	SP
ESCON	SP1
FICON	SP2
MVS/ESA	System/390
Netfinity	XT
OS/390	400
Parallel Sysplex	

The following terms are trademarks of other companies:

Tivoli, Manage.Anything. Anywhere., The Power To Manage., Anything. Anywhere., TME, NetView, Cross-Site, Tivoli Ready, Tivoli Certified, Planet Tivoli, and Tivoli Enterprise are trademarks or registered trademarks of Tivoli Systems Inc., an IBM compay, in the United States, other countries, or both. In Denmark, Tivoli is a trademark licensed from Kjobenhavns Sommer - Tivoli A/S.

C-bus is a trademark of Corollary, Inc. in the United States and/or other countries.

Java and all Java-based trademarks and logos are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and/or other countries.

Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States and/or other countries.

PC Direct is a trademark of Ziff Communications Company in the United States and/or other countries and is used by IBM Corporation under license.

ActionMedia, LANDesk, MMX, Pentium and ProShare are trademarks of Intel Corporation in the United States and/or other countries.

UNIX is a registered trademark in the United States and other countries licensed exclusively through The Open Group.

SET, SET Secure Electronic Transaction, and the SET logo are trademarks owned by SET Secure Electronic Transaction LLC.

Other company, product, and service names may be trademarks or service marks of others.



---

## Appendix C. Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this redbook.

---

### C.1 IBM Redbooks publications

For information on ordering these publications see “How to get IBM Redbooks” on page 133.

- *FICON Introduction*, SG24-5176
- *FICON Implementation*, SG24-5169
- *IBM ESCON Director 9032-5 Presentation*, SG24-2005
- *IBM Fiber Saver (2029) Implementation Guide*, SG24-5608
- *Enterprise Systems Connection (ESCON) Implementation Guide*, SG24-4662

---

### C.2 IBM Redbooks collections

Redbooks are also available on the following CD-ROMs. Click the CD-ROMs button at <http://www.redbooks.ibm.com/> for information about all the CD-ROMs offered, updates and formats.

CD-ROM Title	Collection Kit Number
System/390 Redbooks Collection	SK2T-2177
Networking and Systems Management Redbooks Collection	SK2T-6022
Transaction Processing and Data Management Redbooks Collection	SK2T-8038
Lotus Redbooks Collection	SK2T-8039
Tivoli Redbooks Collection	SK2T-8044
AS/400 Redbooks Collection	SK2T-2849
Netfinity Hardware and Software Redbooks Collection	SK2T-8046
RS/6000 Redbooks Collection (BkMgr Format)	SK2T-8040
RS/6000 Redbooks Collection (PDF Format)	SK2T-8043
Application Development Redbooks Collection	SK2T-8037
IBM Enterprise Storage and Systems Management Solutions	SK3T-3694

---

### C.3 Other resources

These publications are also relevant as further information sources:

- *OS/390 RMF Performance Management Guide*, SC28-1951
- *Planning for the 9032 Model 3, 9033 Model 4, and 9032 Model 5*, SA22-7295
- *S/390 I/O Configuration Program User's Guide and ESCON Channel-to-Channel Reference*, GC38-0401
- *Fiber Optic Link Planning*, GA23-0367
- *Fiber Channel Connection for S/390 I/O Interface Physical Layer*, SA23-0395
- *S/390 (FICON) I/O Interface Physical Layer*, SA24-7172
- *IBM Cabling System Optical Fiber Planning and Installation*, GA27-3943
- *Planning for the 9032 Model 5 with FICON Converter Feature*, SA22-7415
- *Installation Manual-Physical Planning, G5/G6*, GC22-7106





---

## How to get IBM Redbooks

This section explains how both customers and IBM employees can find out about IBM Redbooks, redpieces, and CD-ROMs. A form for ordering books and CD-ROMs by fax or e-mail is also provided.

- **Redbooks Web Site** <http://www.redbooks.ibm.com/>

Search for, view, download, or order hardcopy/CD-ROM Redbooks from the Redbooks Web site. Also read redpieces and download additional materials (code samples or diskette/CD-ROM images) from this Redbooks site.

Redpieces are Redbooks in progress; not all Redbooks become redpieces and sometimes just a few chapters will be published this way. The intent is to get the information out much quicker than the formal publishing process allows.

- **E-mail Orders**

Send orders by e-mail including information from the IBM Redbooks fax order form to:

In United States	<b>e-mail address</b> usib6fpl@ibmmail.com
Outside North America	Contact information is in the "How to Order" section at this site: <a href="http://www.elink.ibm.link.ibm.com/pbl/pbl">http://www.elink.ibm.link.ibm.com/pbl/pbl</a>

- **Telephone Orders**

United States (toll free)	1-800-879-2755
Canada (toll free)	1-800-IBM-4YOU
Outside North America	Country coordinator phone number is in the "How to Order" section at this site: <a href="http://www.elink.ibm.link.ibm.com/pbl/pbl">http://www.elink.ibm.link.ibm.com/pbl/pbl</a>

- **Fax Orders**

United States (toll free)	1-800-445-9269
Canada	1-403-267-4455
Outside North America	Fax phone number is in the "How to Order" section at this site: <a href="http://www.elink.ibm.link.ibm.com/pbl/pbl">http://www.elink.ibm.link.ibm.com/pbl/pbl</a>

This information was current at the time of publication, but is continually subject to change. The latest information may be found at the Redbooks Web site.

### IBM Intranet for Employees

IBM employees may register for information on workshops, residencies, and Redbooks by accessing the IBM Intranet Web site at <http://w3.itso.ibm.com/> and clicking the ITSO Mailing List button. Look in the Materials repository for workshops, presentations, papers, and Web pages developed and written by the ITSO technical professionals; click the Additional Materials button. Employees may access MyNews at <http://w3.ibm.com/> for redbook, residency, and workshop announcements.

---

## IBM Redbooks fax order form

Please send me the following:

Title	Order Number	Quantity

---

First name	Last name
------------	-----------

---

Company
---------

---

Address
---------

---

City	Postal code	Country
------	-------------	---------

---

Telephone number	Telefax number	VAT number
------------------	----------------	------------

---

<input type="checkbox"/> Invoice to customer number	
---	--

---

<input type="checkbox"/> Credit card number	
---	--

---

Credit card expiration date	Card issued to	Signature
-----------------------------	----------------	-----------

**We accept American Express, Diners, Eurocard, Master Card, and Visa. Payment by credit card not available in all countries. Signature mandatory for credit card payment.**

---

## Glossary

This glossary includes terms for the System/390 (S/390) channel, ESCON Director products, and the FICON (FCV) environment.

### A

**active configuration.** In an ESCON environment, the ESCON Director configuration determined by the status of the current set of connectivity attributes. Contrast with *saved configuration*.

**allowed.** In an ESCON Director, the attribute that, when set, establishes dynamic connectivity capability. Contrast with *prohibited*.

**American National Standards Institute (ANSI).** An organization consisting of producers, consumers, and general interest groups, that establishes the procedures by which accredited organizations create and maintain voluntary industry standards in the United States.

**ANSI.** See *American National Standards Institute*.

**APAR.** See *authorized program analysis report*.

**authorized program analysis report (APAR).** A report of a problem caused by a suspected defect in a current, unaltered release of a program.

### B

**basic mode.** A S/390 central processing mode that does not use logical partitioning. Contrast with logically partitioned (LPAR) mode.

**blocked.** In an ESCON Director, the attribute that, when set, removes the communication capability of a specific port. Contrast with *unblocked*.

### C

**CBY.** Mnemonic for an ESCON channel attached to an IBM 9034 convertor. The 9034 converts from ESCON CBY signals to parallel channel interface (OEMI) communication operating in byte multiplex mode (Bus and Tag). Contrast with *CVC*.

**chained.** In an ESCON environment, pertaining to the physical attachment of two ESCON Directors (ESCDs) to each other.

**channel.** (1) A processor system element that controls one channel path, whose mode of operation depends on the type of hardware to which it is attached. In a channel subsystem, each channel controls an I/O interface between the channel control element and the logically attached control units. (2) In the ESA/390 architecture, the part of a channel subsystem that manages a single I/O interface between a channel subsystem and a set of controllers (control units).

**channel path (CHP).** A single interface between a central processor and one or more control units along

which signals and data can be sent to perform I/O requests.

**channel path identifier (CHPID).** In a channel subsystem, a value assigned to each installed channel path of the system that uniquely identifies that path to the system.

**channel subsystem (CSS).** Relieves the processor of direct I/O communication tasks, and performs path management functions. Uses a collection of subchannels to direct a channel to control the flow of information between I/O devices and main storage.

**channel-attached.** (1) Pertaining to attachment of devices directly by data channels (I/O channels) to a computer. (2) Pertaining to devices attached to a controlling unit by cables rather than by telecommunication lines.

**CHPID.** Channel path identifier.

**cladding.** In an optical cable, the region of low refractive index surrounding the core. See also *core* and *optical fiber*.

**CNC.** Mnemonic for an ESCON channel used to communicate to an ESCON-capable device.

**configuration matrix.** In an ESCON environment, an array of connectivity attributes that appear as rows and columns on a display device and can be used to determine or change active and saved configurations.

**connected.** In an ESCON Director, the attribute that, when set, establishes a dedicated connection between two ESCON ports. Contrast with *disconnected*.

**connection.** In an ESCON Director, an association established between two ports that provides a physical communication path between them.

**connectivity attribute.** In an ESCON Director, the characteristic that determines a particular element of a port's status. See *allowed*, *blocked*, *connected*, *disconnected*, *prohibited*, and *unblocked*.

**control unit.** A hardware unit that controls the reading, writing, or displaying of data at one or more input/output units.

**core.** (1) In an optical cable, the central region of an optical fiber through which light is transmitted. (2) In an optical cable, the central region of an optical fiber that has an index of refraction greater than the surrounding cladding material. See also *cladding* and *optical fiber*.

**coupler.** In an ESCON environment, link hardware used to join optical fiber connectors of the same type. Contrast with *adapter*.

**CTC.** (1) Channel-to-channel. (2) Mnemonic for an ESCON channel attached to another ESCON channel.

**CVC.** Mnemonic for an ESCON channel attached to an IBM 9034 convertor. The 9034 converts from ESCON CVC signals to parallel channel interface (OEI) communication operating in block multiplex mode (Bus and Tag). Contrast with *CBY*.

## D

**DDM.** See *disk drive module*.

**dedicated connection.** In an ESCON Director, a connection between two ports that is not affected by information contained in the transmission frames. This connection, which restricts those ports from communicating with any other port, can be established or removed only as a result of actions performed by a host control program or at the ESCD console. Contrast with *dynamic connection*.

Note: The two links having a dedicated connection appear as one continuous link.

**default.** Pertaining to an attribute, value, or option that is assumed when none is explicitly specified.

**destination.** Any point or location, such as a node, station, or a particular terminal, to which information is to be sent.

**device.** A mechanical, electrical, or electronic contrivance with a specific purpose.

**device address.** In the ESA/390 architecture, the field of an ESCON device-level frame that selects a specific device on a control-unit image.

**device number.** (1) In the ESA/390 architecture, a four-hexidecimal-character identifier, for example 19A0, that you associate with a device to facilitate communication between the program and the host operator. (2) The device number that you associate with a subchannel that uniquely identifies an I/O device.

**direct access storage device (DASD).** A mass storage medium on which a computer stores data.

**disconnected.** In an ESCON Director, the attribute that, when set, removes a dedicated connection. Contrast with *connected*.

**disk drive module (DDM).** A disk storage medium that you use for any host data that is stored within a disk subsystem.

**distribution panel.** (1) In an ESCON environment, a panel that provides a central location for the attachment of trunk and jumper cables and can be mounted in a rack, wiring closet, or on a wall.

**duplex.** Pertaining to communication in which data or control information can be sent and received at the same time. Contrast with *half duplex*.

**duplex connector.** In an ESCON environment, an optical fiber component that terminates both jumper cable fibers in one housing and provides physical keying for attachment to a duplex receptacle.

**duplex receptacle.** In an ESCON environment, a fixed or stationary optical fiber component that provides a keyed attachment method for a duplex connector.

**dynamic connection.** In an ESCON Director, a connection between two ports, established or removed by the ESCD and that, when active, appears as one continuous link. The duration of the connection depends on the protocol defined for the frames transmitted through the ports and on the state of the ports. Contrast with *dedicated connection*.

**dynamic connectivity.** In an ESCON Director, the capability that allows connections to be established and removed at any time.

**Dynamic I/O Reconfiguration.** A S/390 function that allows I/O configuration changes to be made non-disruptively to the current operating I/O configuration.

## E

**EMIF.** See *ESCON Multiple Image Facility*.

**Enterprise Systems Architecture/390 (ESA/390).** An IBM architecture for mainframe computers and peripherals. Processors that follow this architecture include the S/390 Server family of processors.

**Enterprise System Connection (ESCON).** (1) An ESA/390 computer peripheral interface. The I/O interface uses ESA/390 logical protocols over a serial interface that configures attached units to a communication fabric. (2) A set of IBM products and services that provide a dynamically connected environment within an enterprise.

**ESA/390.** See *Enterprise Systems Architecture/390*.

**ESCD.** Enterprise Systems Connection (ESCON) Director.

**ESCD console.** The ESCON Director display and keyboard device used to perform operator and service tasks at the ESCD.

**ESCON.** See *Enterprise System Connection*.

**ESCON channel.** A channel having an Enterprise Systems Connection channel-to-control-unit I/O interface that uses optical cables as a transmission medium. May operate in CBY, CNC, CTC or CVC mode. Contrast with *parallel channel*.

**ESCON Director.** An I/O interface switch that provides the interconnection capability of multiple ESCON interfaces (or FICON FCV (9032-5) in a distributed-star topology.

**ESCON Multiple Image Facility (EMIF).** In the ESA/390 architecture, a function that allows LPARs to share an ESCON channel path (and other channel types) by providing each LPAR with its own channel-subsystem image.

## F

**FCS.** See *fibre channel standard*.

**fiber.** See *optical fiber*.

**fiber optic cable.** See *optical cable*.

**fiber optics.** The branch of optical technology concerned with the transmission of radiant power through fibers made of transparent materials such as glass, fused silica, and plastic. (E)

Note: Telecommunication applications of fiber optics use optical fibers. Either a single discrete fiber or a non-spatially aligned fiber bundle can be used for each information channel. Such fibers are often called optical fibers to differentiate them from fibers used in non-communication applications.

**fibre channel standard.** An ANSI standard for a computer peripheral interface. The I/O interface defines a protocol for communication over a serial interface that configures attached units to a communication fabric. The protocol has four layers. The lower of the four layers defines the physical media and interface, the upper of the four layers defines one or more logical protocols (for example, FCP for SCSI command protocols and FC-SB-2 for FICON for ESA/390). Refer to ANSI X3.230.1999x.

**FICON.** (1) An ESA/390 computer peripheral interface. The I/O interface uses ESA/390 logical protocols over a FICON serial interface that configures attached units to a FICON communication fabric. (2) An FC4 proposed standard that defines an effective mechanism for the export of the SBCON command protocol via fibre channels.

**field replaceable unit (FRU).** An assembly that is replaced in its entirety when any one of its required components fails.

**FRU.** See *field replaceable unit*.

## G

**Giga bit.** Usually used to refer to a data rate, the number of Giga bits being transferred in one second.

## H

**half duplex.** In data communication, pertaining to transmission in only one direction at a time. Contrast with *duplex*.

**hard disk drive.** (1) A storage media within a storage server used to maintain information that the storage server requires. (2) A mass storage medium for computers that is typically available as a fixed disk or a removable cartridge.

**HDA.** Head and disk assembly.

**HDD.** See *hard disk drive*.

**head and disk assembly.** The portion of an HDD associated with the medium and the read/write head.

## I

**ID.** See *identifier*.

**Identifier.** A unique name or address that identifies things such as programs, devices or systems.

**initial program load (IPL).** (1) The initialization procedure that causes an operating system to commence operation. (2) The process by which a configuration image is loaded into storage at the beginning of a work day or after a system malfunction. (3) The process of loading system programs and preparing a system to run jobs.

**input/output (I/O).** (1) Pertaining to a device whose parts can perform an input process and an output process at the same time. (2) Pertaining to a functional unit or channel involved in an input process, output process, or both, concurrently or not, and to the data involved in such a process. (3) Pertaining to input, output, or both.

**input/output configuration data set (IOCDs).** The data set in the S/390 processor (in the support element) that contains an I/O configuration definition built by the input/output configuration program (IOCP).

**input/output configuration program (IOCP).** A S/390 program that defines to a system the channels, I/O devices, paths to the I/O devices, and the addresses of the I/O devices. The output is normally written to a S/390 IOCDs.

**interface.** (1) A shared boundary between two functional units, defined by functional characteristics, signal characteristics, or other characteristics as appropriate. The concept includes the specification of the connection of two devices having different functions. (2) Hardware, software, or both, that links systems, programs, or devices.

**I/O.** See *input/output*.

**I/O configuration.** The collection of channel paths, control units, and I/O devices that attaches to the processor. This may also include channel switches (for example an ESCON Director).

**IOCDs.** See *Input/Output configuration data set*.

**IOCP.** See *Input/Output configuration control program*.

**IODF.** The data set that contains the S/390 I/O configuration definition file produced during the defining of the S/390 I/O configuration by HCD. Used as a source for IPL, IOCP and Dynamic I/O Reconfiguration.

**IPL.** See *initial program load*.

## J

**jumper cable.** In an ESCON and FICON environment, an optical cable having two conductors that provides physical attachment between a channel and a distribution panel or an ESCON Director port or a control unit/devices, or between an ESCON Director

port and a distribution panel or a control unit/device, or between a control unit/device and a distribution panel. Contrast with *trunk cable*.

## L

**LAN.** See *local area network*.

**laser.** A device that produces optical radiation using a population inversion to provide *light amplification by stimulated emission of radiation* and (generally) an optical resonant cavity to provide positive feedback. Laser radiation can be highly coherent temporally, or spatially, or both.

**LCU.** See *Logical Control Unit*.

**LED.** See *light emitting diode*.

**licensed internal code (LIC).** Microcode that IBM does not sell as part of a machine, but instead, licenses it to the customer. LIC is implemented in a part of storage that is not addressable by user programs. Some IBM products use it to implement functions as an alternate to hard-wire circuitry.

**light-emitting diode (LED).** A semiconductor chip that gives off visible or infrared light when activated. Contrast *Laser*.

**link.** (1) In an ESCON environment, the physical connection and transmission medium used between an optical transmitter and an optical receiver. A link consists of two conductors, one used for sending and the other for receiving, thereby providing a duplex communication path. (2) In an ESCON I/O interface, the physical connection and transmission medium used between a channel and a control unit, a channel and an ESCD, a control unit and an ESCD, or, at times, between two ESCDs.

**link address.** On an ESCON interface, the portion of a source or destination address in a frame that ESCON uses to route a frame through an ESCON director. ESCON associates the link address with a specific switch port that is on the ESCON director. See also *port address*.

**local area network (LAN).** A computer network located in a uses premises within a limited geographic area.

**logical control unit (LCU).** A separately addressable control unit function within a physical control unit. Usually a physical control unit that supports several LCUs. For ESCON, the maximum number of LCUs that can be in a control unit (and addressed from the same ESCON fiber link) is 16; they are addressed from x'0' to x'F'.

**logical partition (LPAR).** A set of functions that create a programming environment that is defined by the ESA/390 architecture. ESA/390 architecture uses this term when more than one LPAR is established on a processor. An LPAR is conceptually similar to a virtual machine environment except that the LPAR is a

function of the processor. Also LPAR does not depend on an operating system to create the virtual machine environment.

**logically partitioned (LPAR) mode.** A central processor mode, available on the Configuration frame when using the PR/SM facility, that allows an operator to allocate processor hardware resources among logical partitions. Contrast with *basic mode*.

**logical switch number (LSN).** A two-digit number used by the I/O Configuration Program (IOCP) to identify a specific ESCON Director.

**LPAR.** See *logical partition*.

## M

**megabyte (MB).** (1) For processor storage, real and virtual storage, and channel volume, 2<sup>20</sup> or 1 048 576 bytes. (2) For disk storage capacity and communications volumes, 1 000 000 bytes.

**multi-mode optical fiber.** A graded-index or step-index optical fiber that allows more than one bound mode to propagate. Contrast with *single-mode optical fiber*.

## N

**National Committee for Information Technology Standards.** NCITS develops national standards and its technical experts participate on behalf of the United States in the international standards activities of ISO/IEC JTC 1, information technology.

**NCITS.** See *National Committee for Information Technology Standards*.

**ND.** See *node descriptor*.

**NED.** See *node-element descriptor*.

**node descriptor.** In an ESCON environment, a node descriptor (ND) is a 32-byte field that describes a node, channel, ESCD port or a control unit.

**node-element descriptor.** In an ESCON environment, a node-element descriptor (NED) is a 32-byte field that describes a node element, such as a DASD (Disk) device.

## O

**OEMI.** See *original equipment manufacturers information*.

**open system.** A system whose characteristics comply with standards made available throughout the industry and that therefore can be connected to other systems complying with the same standards.

**optical cable.** A fiber, multiple fibers, or a fiber bundle in a structure built to meet optical, mechanical, and environmental specifications. See also *jumper cable*, *optical cable assembly*, and *trunk cable*.

**optical cable assembly.** An optical cable that is connector-terminated. Generally, an optical cable that

has been terminated by a manufacturer and is ready for installation. See also *jumper cable* and *optical cable*.

**optical fiber.** Any filament made of dielectric materials that guides light, regardless of its ability to send signals. See also *fiber optics* and *optical waveguide*.

**optical fiber connector.** A hardware component that transfers optical power between two optical fibers or bundles and is designed to be repeatedly connected and disconnected.

**optical waveguide.** (1) A structure capable of guiding optical power. (2) In optical communications, generally a fiber designed to transmit optical signals. See *optical fiber*.

**original equipment manufacturers information (OEMI).** A reference to an IBM guideline for a computer peripheral interface. More specifically, refer to IBM S/360 and S/370 Channel to Control Unit Original Equipment Manufacturer's Information. The interfaces use ESA/390 logical protocols over an I/O interface that configures attached units in a multi-drop bus environment.

## P

**parallel channel.** A channel having a System/360 and System/370 channel-to-control-unit I/O interface that uses bus and tag cables as a transmission medium. Contrast with *ESCON channel*.

**path.** In a channel or communication network, any route between any two nodes. For ESCON this would be the route between the channel and the control unit/device, or sometimes from the operating system control block for the device and the device itself.

**path group.** The ESA/390 term for a set of channel paths that are defined to a controller as being associated with a single S/390 image. The channel paths are in a group state and are on-line to the host.

**path-group identifier.** The ESA/390 term for the identifier that uniquely identifies a given LPAR. The path-group identifier is used in communication between the system image program and a device. The identifier associates the path-group with one or more channel paths, thereby defining these paths to the control unit as being associated with the same system image.

**PCICC.** (IBM's) PCI Cryptographic Coprocessor.

**port.** (1) An access point for data entry or exit. (2) A receptacle on a device to which a cable for another device is attached. (3) See also *duplex receptacle*.

**port address.** In an ESCON Director, an address used to specify port connectivity parameters and to assign link addresses for attached channels and control units. See also *link address*.

**port card.** In an ESCON environment, a field-replaceable hardware component that provides

the optomechanical attachment method for jumper cables and performs specific device-dependent logic functions.

**port name.** In an ESCON Director, a user-defined symbolic name of 24 characters or less that identifies a particular port.

**processor complex.** A system configuration that consists of all the machines required for operation; for example, a processor unit, a processor controller, a system display, a service support display, and a power and coolant distribution unit.

**program temporary fix (PTF).** A temporary solution or bypass of a problem diagnosed by IBM in a current unaltered release of a program.

**prohibited.** In an ESCON Director, the attribute that, when set, removes dynamic connectivity capability. Contrast with *allowed*.

**protocol.** (1) A set of semantic and syntactic rules that determines the behavior of functional units in achieving communication. (2) In SNA, the meanings of and the sequencing rules for requests and responses used for managing the network, transferring data, and synchronizing the states of network components. (3) A specification for the format and relative timing of information exchanged between communicating parties.

**PTF.** See *program temporary fix*.

## R

**route.** The path that an ESCON frame takes from a channel through an ESCD to a control unit/device.

## S

**saved configuration.** In an ESCON environment, a stored set of connectivity attributes whose values determine a configuration that can be used to replace all or part of the ESCD's active configuration. Contrast with active configuration.

**self-timed interconnection (STI).** An interconnect path cable that has one or more conductors that transit information serially between two interconnected units without requiring any clock signals to recover that data. The interface performs clock recovery independently on each serial data stream and uses information in the data stream to determine character boundaries and inter-conductor synchronization.

**service element (SE).** A dedicated service processing unit used to service a S/390 machine (processor).

**Small Computer System Interface (SCSI).** (1) An ANSI standard for a logical interface to a computer peripherals and for a computer peripheral interface. The interface uses a SCSI logical protocol over an I/O interface that configures attached targets and initiators in a multi-drop bus topology. (2) A standard hardware

interface that enables a variety of peripheral devices to communicate with one another.

**subchannel.** A logical function of a channel subsystem associated with the management of a single device.

**subsystem.** (1) A secondary or subordinate system, or programming support, usually capable of operating independently of or asynchronously with a controlling system.

**SWCH.** In ESCON Manager, the mnemonic used to represent an ESCON Director.

**switch.** In ESCON Manager, synonym for ESCON Director.

## T

**trunk cable.** In an ESCON environment, a cable consisting of multiple fiber pairs that do not directly attach to an active device. This cable usually exists between distribution panels and can be located within, or external to, a building. Contrast with *jumper cable*.

## U

**unblocked.** In an ESCON Director, the attribute that, when set, establishes communication capability for a specific port. Contrast with *blocked*.

**unit address.** The ESA/390 term for the address associated with a device on a given controller. On ESCON interfaces, the unit address is the same as the device address. On OEMI interfaces, the unit address specifies a controller and device pair on the interface.



---

## Index

### Numerics

9672 CHPID report 88

### A

addressing 3  
architecture rules 88

### B

bandwidth 13

### C

cabling 59  
    patch panels 61  
    standard sizes 60  
cabling requirements 70  
channel intermix 101  
configuration recommendations 111  
CTC 109  
CUP 115

### D

design and implementation 84  
distance 3  
droop 3

### E

equivalent channels 2  
ESCD CUP 115  
ESCON 98  
    architecture 25  
    channel intermix 102  
    channels 17  
    configuration - less channels 98  
    connectivity 17  
    CTC 109  
    CU configuration 85  
    CU configuration definition 86  
    EMIF 17  
    ESS 104  
    frame transfer 19  
    implementation 25  
    invalid configuration 114  
    LCU connectivity 94  
    remote site configuration 100  
    valid configuration 115  
    valid LCU configuration 116  
ESCON channels  
    comparisons 75  
    operation 77  
    operation 76  
ESS 103  
ESS ESCON 104

### F

FCS 24  
fiber cabling 59  
Fibre Channel Standard 24  
FICO (FCV mode)  
    migration 111  
FICON 86  
    benefits 14, 86  
        local site 14  
        remote site 14  
Bridge 21  
cabling 59  
cabling requirements 70  
channel 13  
configuration support 83  
connectivity 17  
CU characteristics 89  
FC mode 16  
FCV mode 15  
FCV operation 22  
implementation 25  
intermixed channels 62  
performance 81  
performance paradigms 75  
remote site connectivity 70  
Statement of Direction 13  
topology 15  
FICON (FCV mode)  
    aggregation 111  
    basic configuration design 89  
    channel intermix 102  
    configuration scenarios 111  
    configuration - less channels 99  
    configuration design 91  
    connectivity differences 93  
    connectivity recommendations 87  
    CTC connection 109  
    CUP support 115  
    design awareness 92  
    ESS 106  
    I/O definition 92  
    invalid configuration 90, 112, 114  
    LCU connectivity 95  
    LCU definition 97  
    migration rules 113  
    remote site configuration 101  
    valid configuration 115  
    valid LCU configuration 116  
FICON Bridge 21  
FICON channels  
    benefits 78  
    comparisons 76  
    intermixing CUs 79  
    operation 76, 77  
FICON FC  
    connectivity 18  
FICON FCV  
    frame transfer 20

Figure 2  
frames 19

## **I**

I/O concurrency 103  
I/O connectivity 2  
intermixed channels 23

## **M**

MCP cables 63, 65  
    construction 66  
    invalid use 69  
    patch panels 67  
    requirements 64  
    trunk and harnesses 68  
message  
    CBDA222I 114  
migration 111  
Mode Conditioner Patch cables 63

## **P**

Parallel channels  
    connectivity 16  
parallel channels  
    comparisons 75  
    operation 76  
patch panels 61  
performance 81

## **R**

remote site connectivity 70  
remotes sites 100

## **S**

S 78, 109  
sharing 23  
Statement of Direction 13

## **U**

UIM 103

---

## IBM Redbooks evaluation

FICON (FCV Mode) Planning Guide  
SG24-5445-00

Your feedback is very important to help us maintain the quality of IBM Redbooks. **Please complete this questionnaire and return it using one of the following methods:**

- Use the online evaluation form found at <http://www.redbooks.ibm.com/>
- Fax this form to: USA International Access Code + 1 914 432 8264
- Send your comments in an Internet note to [redbook@us.ibm.com](mailto:redbook@us.ibm.com)

Which of the following best describes you?

☐ **Customer**   ☐ **Business Partner**   ☐ **Solution Developer**   ☐ **IBM employee**  
☐ **None of the above**

**Please rate your overall satisfaction** with this book using the scale:  
(1 = very good, 2 = good, 3 = average, 4 = poor, 5 = very poor)

Overall Satisfaction \_\_\_\_\_

**Please answer the following questions:**

Was this redbook published in time for your needs?      Yes\_\_\_ No\_\_\_

If no, please explain:

---

---

---

---

What other Redbooks would you like to see published?

---

---

---

**Comments/Suggestions:      (THANK YOU FOR YOUR FEEDBACK!)**

---

---

---

---

---

**SG24-5445-00**

**Printed in the U.S.A.**

