*Table 2-2 Fmt[2:0] Field Values*

| Fmt[2:0] | Corresponding TLP Format |
|---|---|
| 000b | 3 DW header, no data |
| 001b | 4 DW header, no data |
| 010b | 3 DW header, with data |
| 011b | 4 DW header, with data |
| 100b | TLP Prefix |
| | All encodings not shown above are Reserved (see Section 2.3 ). |

*Table 2-3 Fmt[2:0] and Type[4:0] Field Encodings*

| TLP Type | Fmt [2:0][3] (b) | Type [4:0] (b) | Description |
|---|---|---|---|
| MRd | 000<br>001 | 0 0000 | Memory Read Request |

| TLP Type | Fmt [2:0] (b) | Type [4:0] (b) | Description |
|---|---|---|---|
| MWr | 010<br>011 | 0 0000 | Memory Write Request |
| CplD | 010 | 0 1010 | Completion with Data - Used for Memory, I/O, and Configuration Read Completions. Also used for AtomicOp Completions. |

1. Memory Read : Fmt[2:0],Type[4:0] = 000 00000 or 001 00000
2. Memory Write : Fmt[2:0],Type[4:0] = 010 00000 or 011 00000
3. Completion : Fmt[2:0],Type[4:0] = 010 01010

*Table 2-4 Length[9:0] Field Encoding*

| Length[9:0] | Corresponding TLP Data Payload Size |
|---|---|
| 00 0000 0001b | 1 DW |
| 00 0000 0010b | 2 DW |
| ... | ... |
| 11 1111 1111b | 1023 DW |
| 00 0000 0000b | 1024 DW |

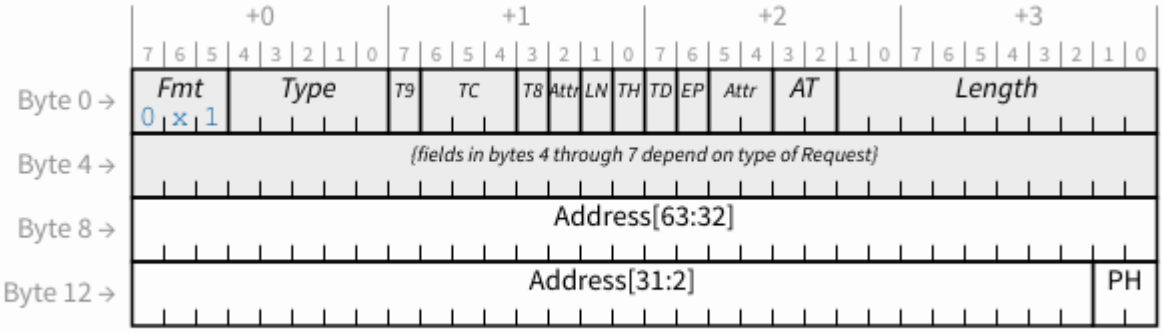



*Figure 2-7 64-bit Address Routing*

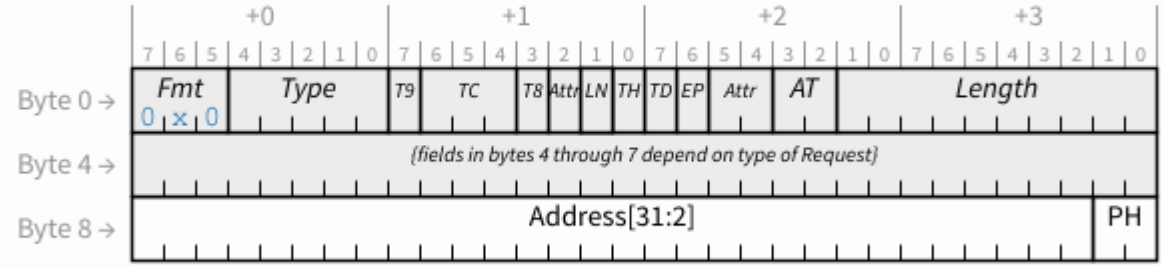



*Figure 2-8 32-bit Address Routing*

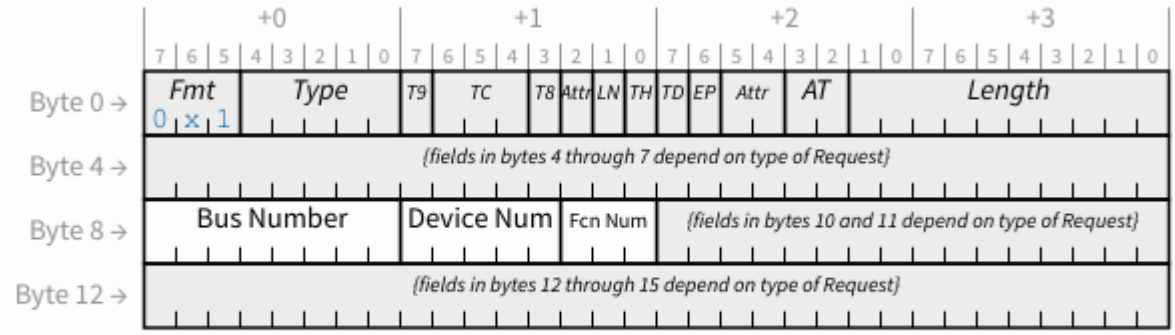



*Figure 2-9 Non-ARI ID Routing with 4 DW Header*

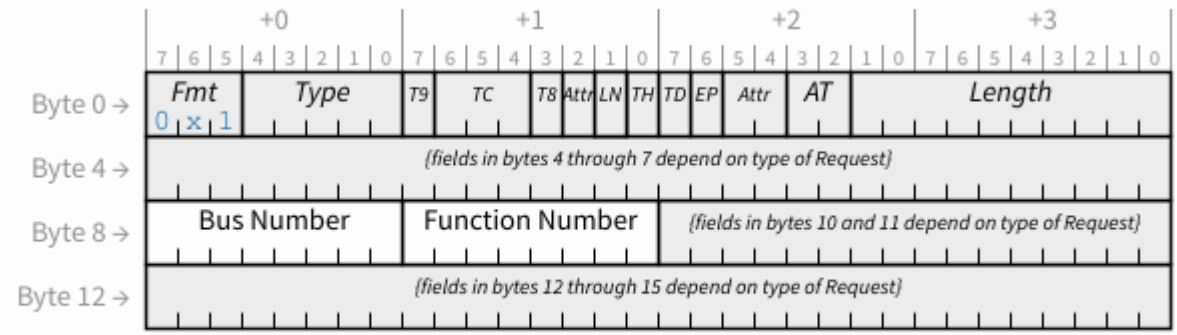



*Figure 2-10 ARI ID Routing with 4 DW Header*

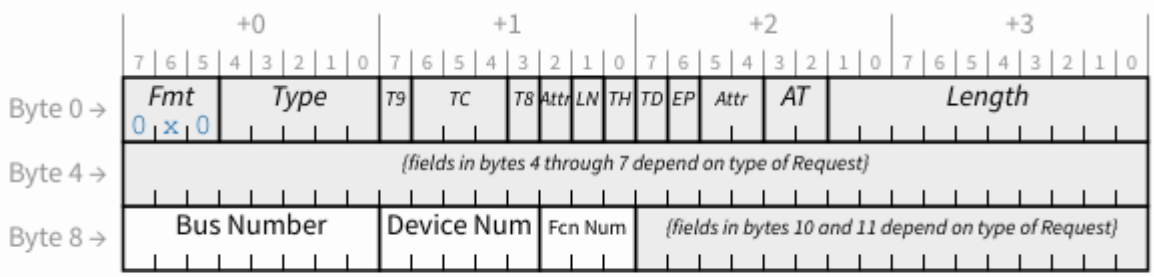



*Figure 2-11 Non-ARI ID Routing with 3 DW Header*

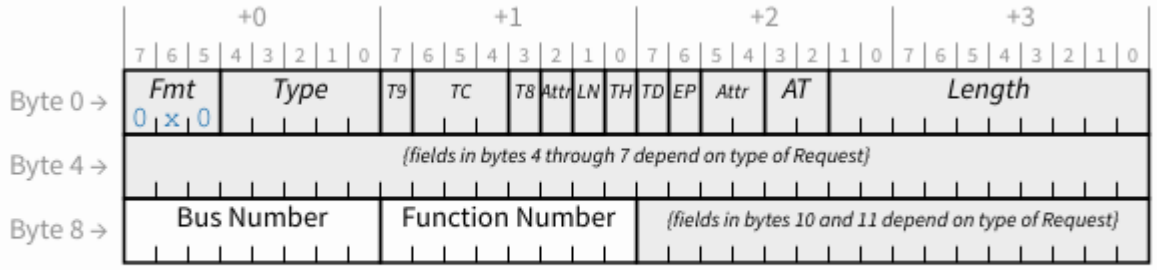



*Figure 2-12 ARI ID Routing with 3 DW Header*

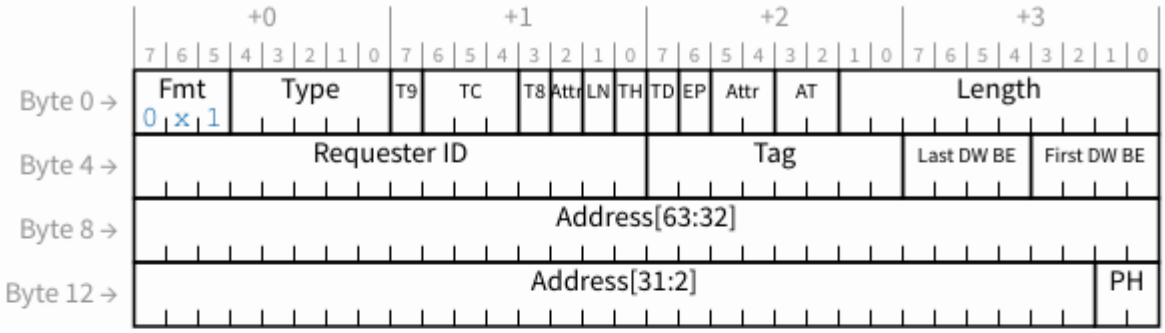



*Figure 2-17 Request Header Format for 64-bit Addressing of Memory*

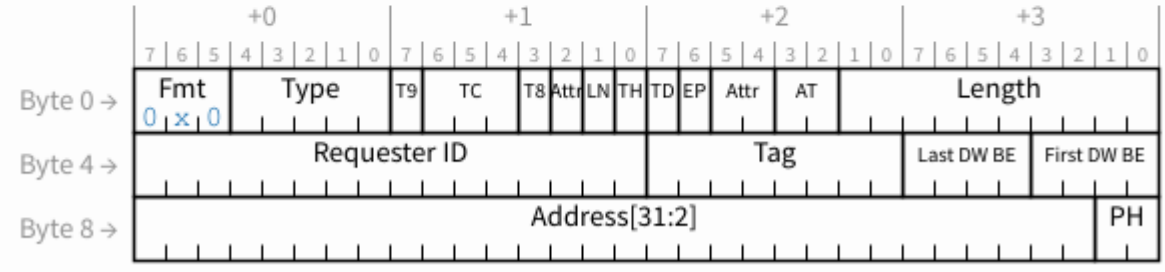
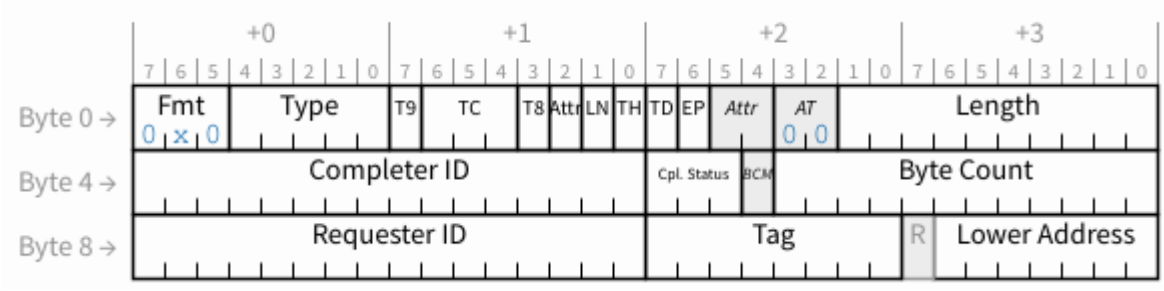



*Figure 2-18 Request Header Format for 32-bit Addressing of Memory*




Flow control

- ➔ DLLP의 일종인 FCPs(Flow Control Packets)를 이용하여 Flow Control information 전달.
- ➔ FCPs의 unit은 4DW(16B, 128bit) 이다.
- ➔ Flow control은 P, NP, Cpl의 3가지 타입으로 구분된다.
- ➔ Flow control은 Headers와 Data를 구분한다.

*Table 2-42 Flow Control Credit Types*

| Credit Type | Applies to This Type of TLP Information |
|---|---|
| PH | Posted Request headers |
| PD | Posted Request Data payload |
| NPH | Non-Posted Request headers |
| NPD | Non-Posted Request Data payload |
| CplH | Completion headers |
| CplD | Completion Data payload |

*Table 2-43 TLP Flow Control Credit Consumption*

| TLP | Credit Consumed[38] |
|---|---|
| Memory, I/O, Configuration Read Request | 1 NPH unit |
| Memory Write Request | 1 PH + n PD units[39] |
| I/O, Configuration Write Request | 1 NPH + 1 NPD<br>Note: size of data written is never more than 1 (aligned) DW |
| AtomicOp Request | 1 NPH + n NPD units |
| Message Requests without data | 1 PH unit |
| Message Requests with data | 1 PH + n PD units |
| Memory Read Completion | 1 CplH + n CplD units |
| I/O, Configuration Read Completions | 1 CplH unit + 1 CplD unit |
| I/O, Configuration Write Completions | 1 CplH unit |
| AtomicOp Completion | 1 CplH unit + 1 CplD unit<br>Note: size of data returned is never more than 4 (aligned) DWs. |

*Table 2-44 Minimum Initial Flow Control Advertisements*[40]

| Credit Type | Minimum Advertisement | | |
|---|---|---|---|
| | No Scaling or Scale Factor 1 | Scale Factor 4 | Scale Factor 16 |
| PH | 1 unit - credit value of 01h. | 4 Units - credit value of 01h. | 16 Units - credit value of 01h. |
| PD | Largest possible setting of the Max_Payload_Size for the component divided by FC Unit Size. For an MFD, this includes all Functions in the device.<br>Example: If the largest Max_Payload_Size value supported is 1024 bytes, the smallest permitted initial credit value would be 040h. | Ceiling(Largest Max_Payload_Size / (FC Unit Size * 4)) + 1. For an MFD, this includes all Functions in the device.<br>Example: If the largest Max_Payload_Size value supported is 1024 bytes, the smallest permitted initial credit value would be 011h. | Ceiling(Largest Max_Payload_Size / (FC Unit Size * 16)) + 1. For an MFD, this includes all Functions in the device.<br>Example: If the largest Max_Payload_Size value supported is 1024 bytes, the smallest permitted initial credit value would be 005h. |
| NPH | 1 unit - credit value of 01h. | 4 Units - credit value of 01h. | 16 Units - credit value of 01h. |
| NPD | Receiver that supports AtomicOp routing capability or any AtomicOp Completer capability: 2 units - credit value of 002h<br>All other Receivers: 1 unit - credit value of 001h. | Receiver that supports AtomicOp routing capability or any AtomicOp Completer capability: 8 units - credit value of 002h<br>All other Receivers: 4 units - credit value of 001h. | Receiver that supports AtomicOp routing capability or any AtomicOp Completer capability: 32 units - credit value of 002h<br>All other Receivers: 16 units - credit value of 001h. |
| CplH | Root Complex (supporting peer-to-peer traffic between all Root Ports) and Switch: 1 FC unit - credit value of 01h<br>Root Complex (not supporting peer-to-peer traffic between all Root Ports) and Endpoint: infinite FC units - initial credit value of all 0s.[41] | Root Complex (supporting peer-to-peer traffic between all Root Ports) and Switch: 4 FC units - credit value of 01h<br>Root Complex (not supporting peer-to-peer traffic between all Root Ports) and Endpoint: infinite FC units - initial credit value of all 0s.[42] | Root Complex (supporting peer-to-peer traffic between all Root Ports) and Switch: 16 FC units - credit value of 01h<br>Root Complex (not supporting peer-to-peer traffic between all Root Ports) and Endpoint: infinite FC units - initial credit value of all 0s.[43] |
| CplD | Root Complex (supporting peer-to-peer traffic between all Root Ports) and Switch: Largest possible setting of the Max_Payload_Size for the component divided by FC Unit Size. | Root Complex (supporting peer-to-peer traffic between all Root Ports) and Switch: Ceiling(Largest Max_Payload_Size / (FC Unit Size * 4)) + 1. | Root Complex (supporting peer-to-peer traffic between all Root Ports) and Switch: Ceiling(Largest Max_Payload_Size / (FC Unit Size * 16)) + 1. |

| Credit Type | Minimum Advertisement | | |
|---|---|---|---|
| | No Scaling or Scale Factor 1 | Scale Factor 4 | Scale Factor 16 |
| | Root Complex (not supporting peer-to-peer traffic between all Root Ports) and Endpoint: infinite FC units - initial credit value of all 0s. | Root Complex (not supporting peer-to-peer traffic between all Root Ports) and Endpoint: infinite FC units - initial credit value of all 0s. | Root Complex (not supporting peer-to-peer traffic between all Root Ports) and Endpoint: infinite FC units - initial credit value of all 0s. |

*Table 2-45 [Field Size] Values*

| Scaled Flow Control Supported | HdrScale or DataScale | [Field Size] for PH, NPH, CplH | [Field Size] for PD, NPD, CplD |
|---|---|---|---|
| No | x | 8 | 12 |
| Yes | 00b | 8 | 12 |
| Yes | 01b | 8 | 12 |
| Yes | 10b | 10 | 14 |
| Yes | 11b | 12 | 16 |

우리는 scaled flow control 지원X

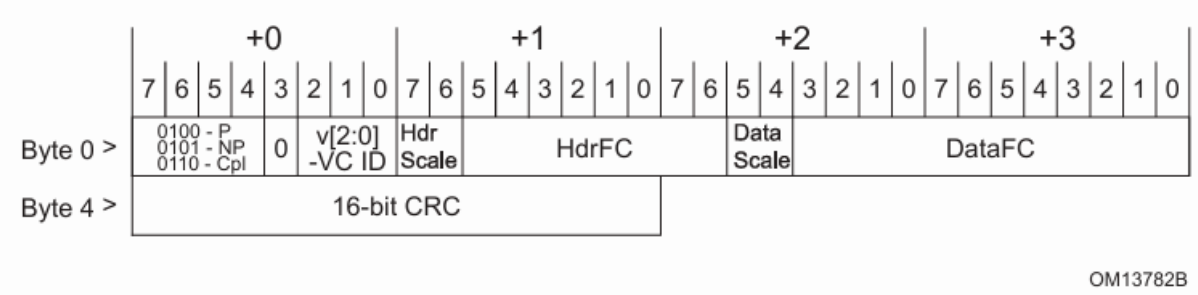



*Figure 3-7 Data Link Layer Packet Format for InitFC1*

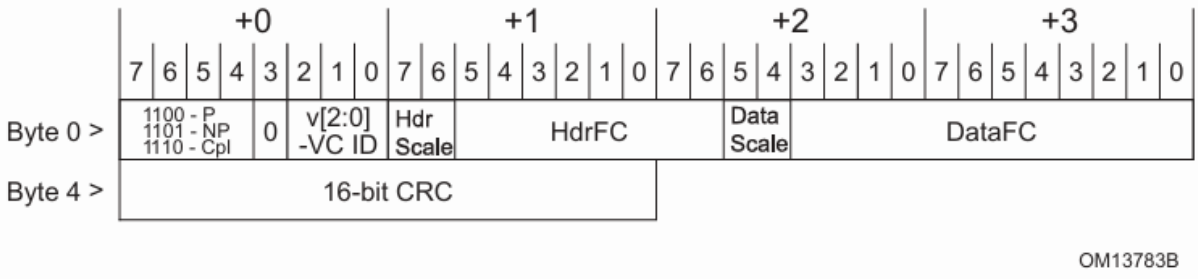



*Figure 3-8 Data Link Layer Packet Format for InitFC2*

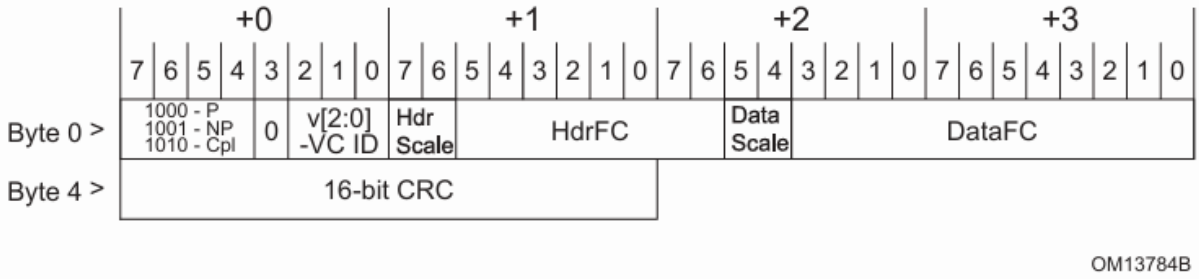
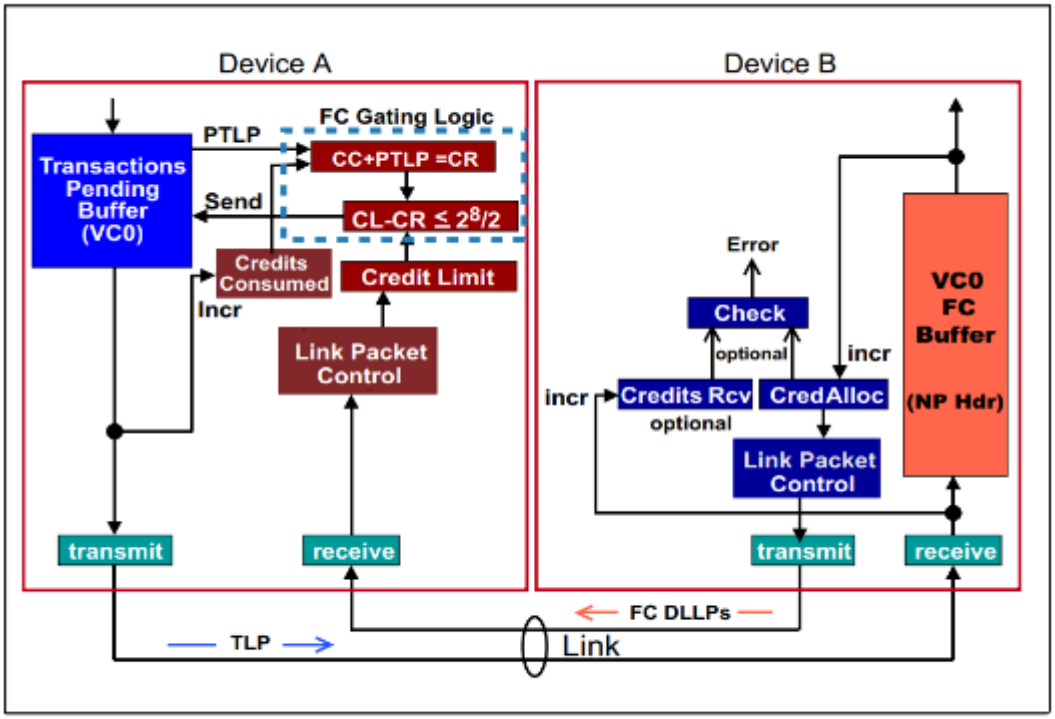



*Figure 3-9 Data Link Layer Packet Format for UpdateFC*

*Figure 6-8: Flow Control Elements*




*Reference) PCI Express Technology 3.0 [mindshare]*

- CA : 초기 할당된 flow control credit + 처리된 총 FC credit
- CL : 수신 측에 의해 업데이트되는 CA 값
- CR = CC + PTLP
- CC : 송신 측에서 보낸 총 credit
- PTLP : 한번 보낼 때 소모되는 TLP의 credit

$$CL-(CC+PTLP) mod 2^{[FieldSize]} \le 2^{[FieldSize]}/2$$

- FCPs unit : 4DW(16B)
- TLP : Header + Data로 구성
- FC는 P, NP, Cpl로 나누어 진행
- Scaled FC를 지원하지 않을 때, HdrScale과 DateScale : X

[Field Size] for PH, NPH, CplH : 8bit

[Field Size] for PD, NPD, CplD : 12bit

- Scaled FC를 지원하지 않을 때,
  PH : 1 unit – credit value of 01h
  PD : 1024B/16B = 64d = 40h
  NPH : 01h
  CplH : RC-Switch -> 1unit – 01h / RC-EP -> infinite units – 0s
  CplD : RC-Switch -> 40h / RC-EP -> infinite units – 0s
- Memory Read request : 1NPH -> 01h (header)
  Memory Write drequest : 1PH + 1PD -> 01h (header) + 40h (data)
  Memory Read Completion : 1CplH + n*CplD -> 01h (header) + n*40h (data)
- VC0만 사용, Scaled 지원 X
- Scaled FC를 지원하지 않는 수신 측은 data payload를 2047개 units 이상, header를 127개 units 이상 누적해서는 안된다.
  - Field size와 관련됨(2^12/2, 2^8/2)
- UpdataFC FCP schedule 조건 (Non infinite – NPH, NPD, PH, CplH)
  - Scaled FC 비활성화 시에는 : 특정 유형의 사용 가능한 credit 수가 0이 되고, 해당 유형의 credit이 1개 이상 새로 제공된 경우
- UpdateFC FCP schedule 조건 (Non infinite – PD, CplD)
  - ARI Device(BF) : function 0?
  - Non ARI Device(BDF) : MAX_Payload_Size