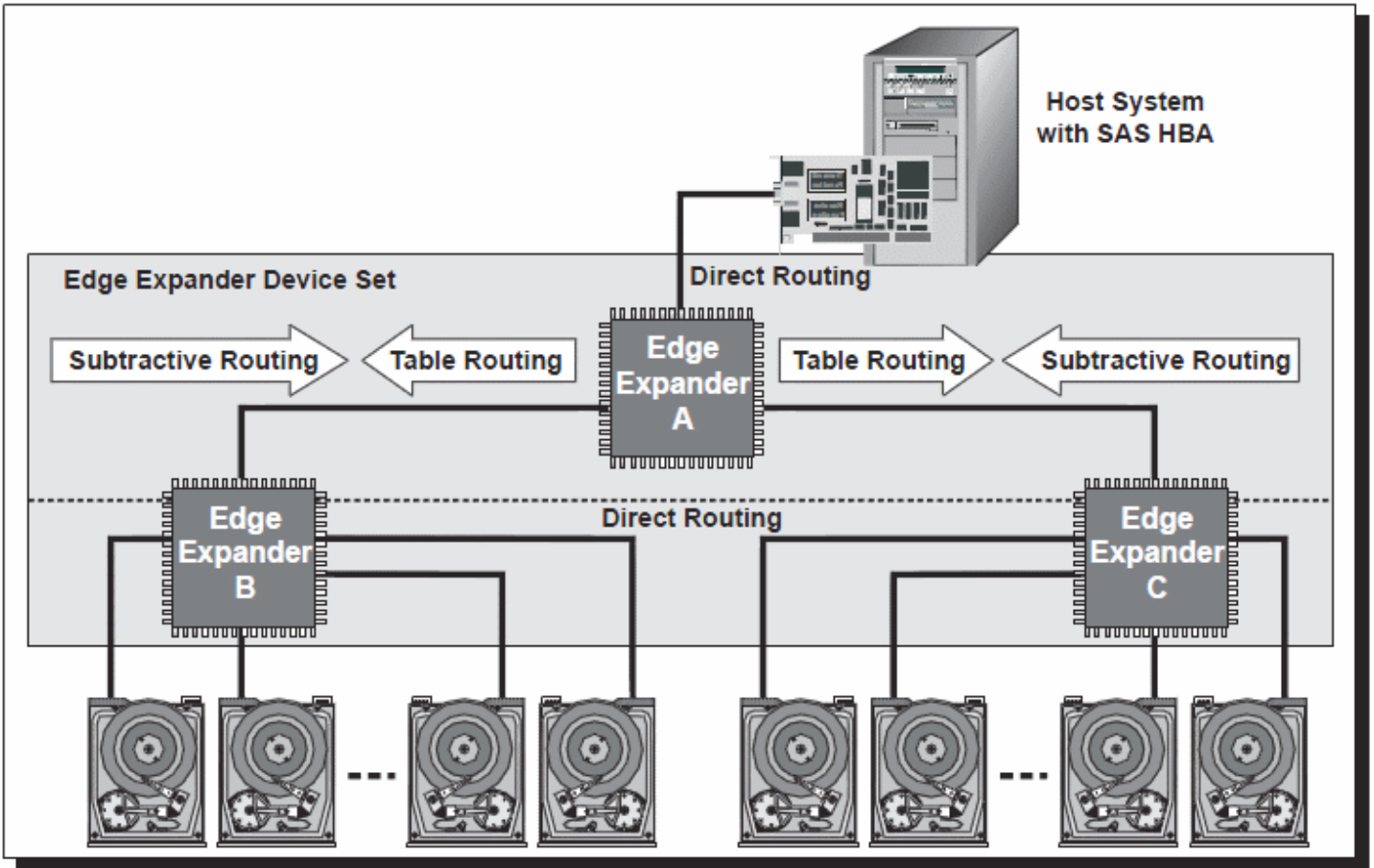




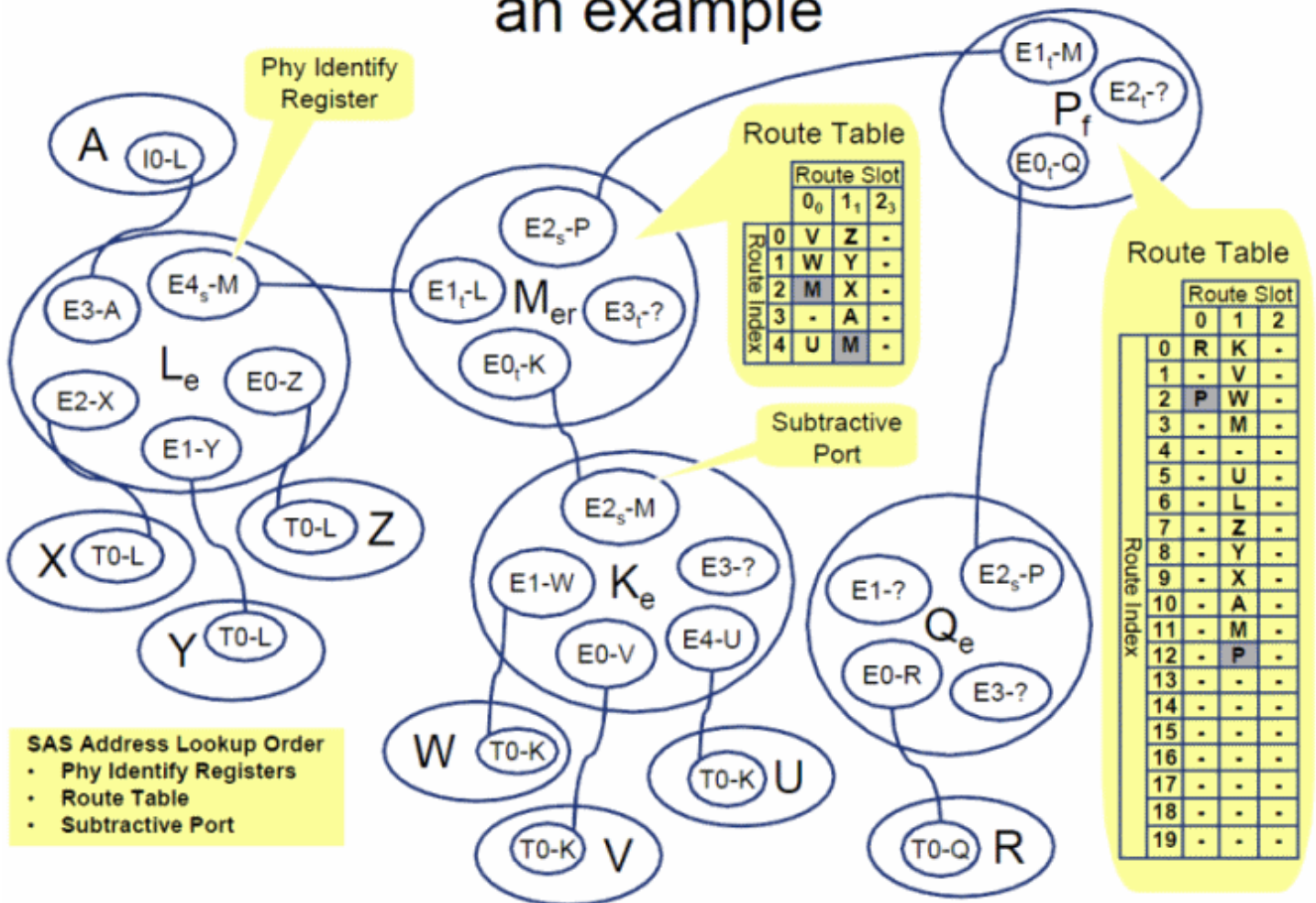
SAS Expander?????????, ??????????????, ??????????. ??direct routing?subtractive routing?????????



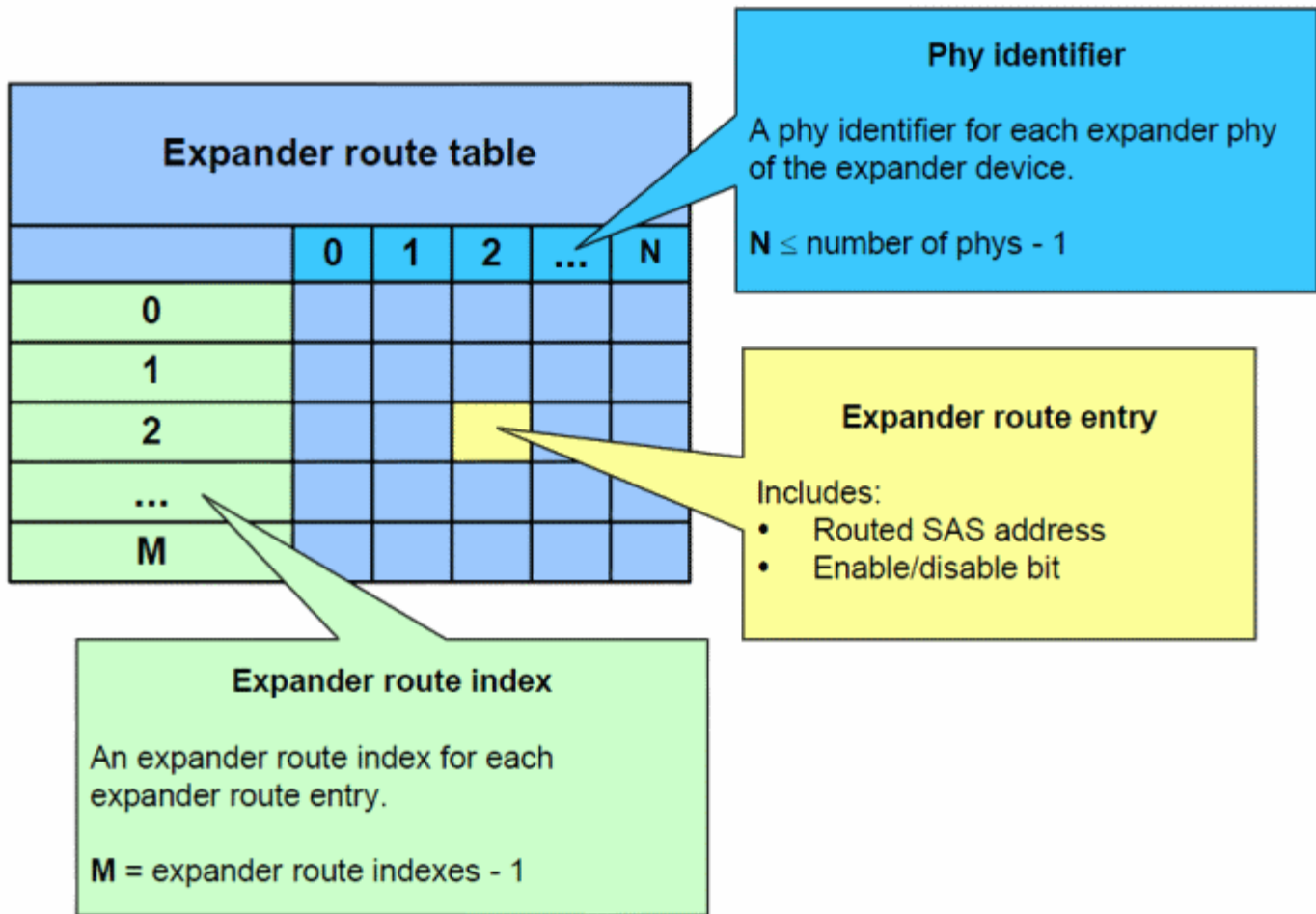
????????????????????, ??Edge Expander Device Set????????cloud. Expander B?C?downstream????end devices, ???no routing?direct routing?????. ?Expander B?C?upstream????, ?????????????????????, ??????? ?Expander?, ??????Expander C?????Expander B????-??target port?, ??Expander B???target port?SAS Address?????Expander C?, ???Subtractive routing?????Expander C.

No routing?direct routing?Subtractive routing????????????, ?????????????, ??????1?1????, ?????????, ??? ??????????. ?SAS Expander?????????routing table?????????????????????. ?????, ?Expander A????, ?? downstream????????, ??????????????????Expander(B or C???). ??routing table????downstream?SAS Address????????, ?????table routing?. ??????????HP?????????routing table??downstream?SAS Address??.

an example



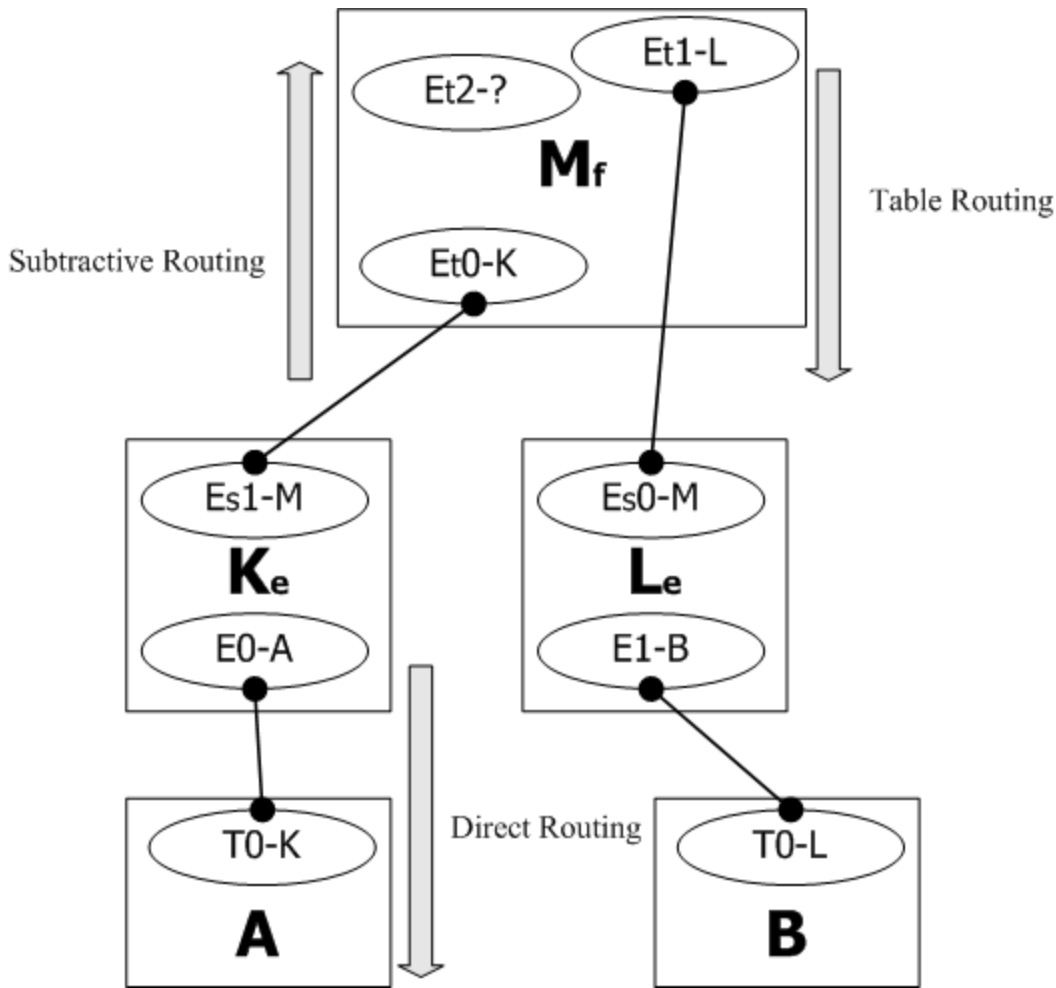
???????routing table???, ??????routing table?????????, ???table?metadata. ??HP???SAS?????????????, ????:



table, column header, column header Expander?????????????????. $N \leq \text{number of phys} - 1$, (index)0????, ?????1; row header????????????(route index), ?????????????????1??, ??????0?????. Expander route entry?????????, column row?????, entry????????SAS Address????????.

1. column header: ??Expander?????????????????
2. row header: ??expander route entry?????Expander????(route index)
3. expander route entry: ??column?row?????Expander????(route entry). ??SAS Address?????.

table????, ?????????????, ??????, ?????????????table???routing, ??????????. ?????????????, ??????HP???????:



????????????????, Es1-M???????? T0-L???? Mf???????????? ?????????????? ! ??, ?????????????.

<type> [routing] <index> - <entry>

???????????? expander?? end device???????? (eligible output PHY), ??????????????????. ?????????????.

1. type: ?????????, ?T?? Terminal, ???, ??? end device; ?E?? Expander?
2. routing: ????????? optional, ????????? routing method. ??s???? subtractive routing; t?? table routing. ????????? end device, ??no routing? direct routing.
3. index: ????? table???? expander route index
4. entry: ????? table?? expander route entry. ??entry????????, ????????? entry??.
??PHY????????????, ?????????????.

<entry> [exp_type]

???????????? entry, ?????????, ??? end device?? Expander, ?????????. ??entry???????????? SAS Address????????, ???

?table?expander route entry. entry????????PHY??, ????entry???PHY?. ??????entry????????.

1. entry: ??????expander route entry???. ??????PHY??????.
2. ext_type: ??optional, ?????entry?????Expander??, ??????, ?????Expander?. e??edge expadner; ?f?? fanout expander.

????????????, ??????. ?????????????, ?????entry?????enrty?????????????. ?????????, ?????????:

1. fanout expander: ???downstream???Expander, ???table routing; ?????end device, ???direct routing. fanout expander?????subtractive routing, ?????.
2. edge expander: ?1?1????expander???subtractive routing, ?????????????table routing, ?????end device ???, ?????direct routing.
3. end device: ??expander?????direct routing.

?????????????????. ??????Mf?entry?????fanout expander, ?????subtractive routing, ???table routing, ?????? routing table???, ??table?????????????. ??, Mf????3?PHY??, ??????????expander????, ???Et1-M?PHY??.

Et0-K???expander M?PHY??, route index?0, ??table routing, ??????K?entry?. ??route index???, ?????K??? ?PHY?. ???expander K?????PHY??, ???Es1-M; ???E0-A. ??????PHY?????Mf???routing table?, ?????? ?route index???, E0-A???route index?0, ??????.

	0	1	2
0	A		-

???????A?entry??, ??expander K?????PHY?????, Es1-M??expander K?PHY??, route index?1, ?????? expander M??, ?????expander, ?????1?1???, ???subtractive routing. ???PHY??Mf???routing table?.

	0	1	2
0	A		-
1	M		-

Mf?????expander K????, ???expander L?????. Et1-L?Expander M?PHY??, route index?1, ??table routing, ??L?entry?. ???expander L???PHY??, ???Es0-M; ???E1-B. ???Es0-M, Es0-M???expander L?PHY? ?, route index?0, ??subtractive routing, ??????expander M??.

	0	1	2
0	A	M	-
1	M		-

??Es0-M????, ??E1-B?????. E1-B?????expander L?PHY??, route index?1, ?????routing method, ?????? ?entry???end device- B. ??????Mf?routing table.

	0	1	2
0	A	M	-
1	M	B	-

????????, ???Mf???routing table??, ?????????????Et2-??, ?????????????, ???PHY?????. ??Mf?????

table??table routing??????(request)???. ?????????????????routing table?????, ??????????????????, ?????????????
?HP?????????, ??????????expander????????PHY????, ??????????????.

??HP????????????, ??????????????. ??????????.

<http://www.osslab.com.tw/Storage/Enterprise/SAS%E8%88%87RAID/Protocol/>

[SAS Expander%E6%8A%80%E8%A1%93/](#)

[SAS Expander%E7%9A%84%E8%B7%AF%E7%94%B1%E8%A1%A8%E6%A6%82%E8%A7%80/](#)

[HP%E7%9A%84%E8%B7%AF%E7%94%B1%E8%A1%A8%E6%A1%88%E4%BE%8B](#)