Nintendo
Entertainment **A**nalysis and **D**evelopment
Lempel-**Z**iv **S**LI **Z**ip Compression

Overview:
The SLI algorithm is a solution devised by Nintendo's Research and Development branch No. 4 to enhance the LZSS algorithm's capabilities for texture and vertex data used by their software titles. Initially, the encoded data had been strategically structured for execution efficiency on their target platform in the mid-nineties: The Nintendo 64.
Officially, there are two known revisions and three distinct structures of encoded SLI data.

Revisions:
Mario - Dictionary word sizes mirror LZSS' length range of 3-18 bytes.
I.D. - 0x4D494F30 (MIO0) -or- 0x534D53523030 (SMSR00)
Formats - Grouped -or- Tabled
Zelda - The predecessor was upgraded to support a range of 3-273 bytes.
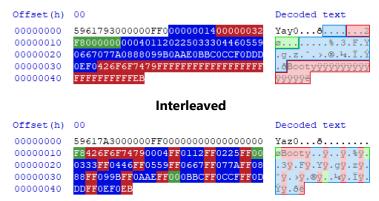I.D. - 0x59617930 (Yay0) -or- 0x59617A30 (Yaz0)
Formats - Tabled -or- Interleaved

Structures:

Grouped

Offset(h)	00	Decoded text
00000000	534D53523030000000000FF0000001E4	SMSR00.....ð...ä
00000010	F800F004F013F027F036F04AF05EF06D	ø.ð.ð.ð'ð6ðJð^ðm
00000020	F081F090F0A4F0B80000F0C7F0DBF0EA	ð.ð.ð¤ð¸..ðÇðÛðê
00000030	F0FEF112F121F135F144F158F16CF17B	ðþñ.ñ!ñ5ñDñXñlñ{
00000040	F18FF19EF1B2F1C6F1D50000F1E9F1F8	ñ.ñžñ²ñÆñÕ..ñéñø
00000050	F20CF220F22FF243F252F266F27AF289	ò.ò ò/òCòRòfòzò‰
00000060	F29DF2ACF2C0F2D4F2E3F2F70000F306	ò.ò¬òÀòÔòãò÷..ó.
00000070	F31AF32EF33DF351F360F374F388F397	ó.ó.ó=óQó`ótó^ó—
00000080	F3ABF3BAF3CEF3E2F3F1F405F4140000	ó«óºóÎóâóñô.ô...
00000090	F428F43CF44BF45FF46EF482F496F4A5	ô(ô<ôKô_ônô‚ô–ô¥
000000A0	F4B9F4C8F4DCF4F0F4FFF513F522F536	ô¹ôÈôÜôðôÿõ.õ"õ6
000000B0	0000F54AF559F56DF57CF590F5A4F5B3	..õJõYõmõ|õ.õ¤õ³
000000C0	F5C7F5D6F5EAF5FEF60DF621F630F644	õÇõÖõêõþö.ö!ö0öD
000000D0	F6580000F667F67BF68AF69EF6B2F6C1	öX..ögö{öŠöžö²öÁ
000000E0	F6D5F6E4F6F8F70CF71BF72FF73EF752	öÕöäöø÷.÷.÷/÷>÷R
000000F0	F766F7750000F789F798F7ACF7C0F7CF	÷f÷u..÷‰÷˜÷¬÷À÷Ï
00000100	F7E3F7F2F806F81AF829F83DF84CF860	÷ã÷òø.ø.ø)ø=øLø`
00000110	F874F883F8970000F8A6F8BAF8CEF8DD	øtøƒø—..ø¦øºøÎøÝ
00000120	F8F1F900F914F928F937F94BF95AF96E	øñù.ù.ù(ù7ùKùZùn
00000130	F982F991F9A5F9B40000F9C8F9DCF9EB	ù‚ù‘ù¥ù´..ùÈùÜùë
00000140	F9FFFA0EFA22FA36FA45FA59FA68FA7C	ùÿú.ú"ú6úEúYúhú|
00000150	FA90FA9FFAB3FAC2FAD60000FAEAFAF9	ú.úŸú³úÂúÖ..úêúù
00000160	FB0DFB1CFB30FB44FB53FB67FB76FB8A	û.û.û0ûDûSûgûvûŠ
00000170	FB9EFBADFBC1FBD0FBE4FBF80000FC07	ûžû.ûÁûÐûäûø..ü.
00000180	FC1BFC2AFC3EFC52FC61FC75FC84FC98	ü.ü*ü>üRüaüuü„ü˜
00000190	FCACFCBBFCCFFCDEFCF2FD06FD150000	ü¬ü»üÏüÞüòý.ý...
000001A0	FD29FD38FD4CFD60FD6FFD83FD92FDA6	ý)ý8ýLý`ýoýƒý'ý¦
000001B0	FDBAFDC9FDDDFDECFE00FE14FE23FE37	ýºýÉýÝýìþ.þ.þ#þ7
000001C0	0000FE46FE5AFE6EFE7DFE91FEA0FEB4	..þFþZþnþ}þ'þ þ´
000001D0	FEC8FED7FEEBFEFAFF0EFF22FF31FF45	þÈþ×þëþúÿ.ÿ"ÿ1ÿE
000001E0	FF540000FF68FF7CFF8BFF9FFFAEFFC2	ÿT..ÿhÿ|ÿ‹ÿŸÿ®ÿÂ
000001F0	FFD64FE5426F6F747900	ÿÖOåBooty.

Tabled

```
Offset(h)  00                                Decoded text

00000000   5961793000000FF000000014 00000032   Yay0...ð....  ...2
00000010   F8000000 0004011202250333 04460559   ø............%.3.F.Y
00000020   0667077A0888099B0AAE0BBC0CCF0DDD    .g.z.^.>.®.¼.Ï.Ý
00000030   0EF0 426F6F7479 FFFFFFFFFFFFFFFFFFFF   .ðBootyÿÿÿÿÿÿÿÿÿÿ
00000040   FFFFFFFFFFFEB                        ÿÿÿÿÿë
```

Interleaved

```
Offset(h)  00                                Decoded text

00000000   59617A3000000FF00000000000000000   Yaz0...ð........
00000010   F8 426F6F747490 0004 FF 0112 FF 0225 FF 00   øBooty..ÿ..ÿ.%ÿ.
00000020   0333 FF 0446 FF 0559 FF 0667 FF 077A FF 08   .3ÿ.Fÿ.Yÿ.gÿ.zÿ.
00000030   88 FF 099B FF 0AAE FF 00 0BBC FF 0CCF FF 0D   .¨ÿ.>ÿ.®ÿ..¼ÿ.Ïÿ.
00000040   DD FF 0EF0 EB                           Ýÿ.ðë
```
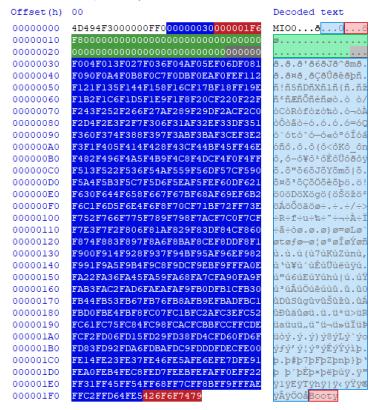
Significance:

The N64 uses a variant of the MIPS R4300i CPU, a VR4300 from NEC of Japan, which despite its performance capabilities in that era, it will suffer greatly from unaligned load operations (special instructions exist for this situation, but at the cost of performance).

EAD's solution was to structure the encoded data in such a way that load operations interface with sections which are aligned for their respective breadths, so that the decoding process is capable of executing with utmost efficiency as specified in their modus operandi.

The *Grouped* format stores 16-bit HalfWords and Octets in two groups where the HalfWords comprise Bitflags and Dictionaries:

```
Offset(h)  00                                Decoded text

00000000   534D535230300000000000FF0 000001E4   SMSR00.....ð.  ...ä
00000010   F800 F004F013F027F036F04AF05EF06D   ø.ð.ð.ð'ð6ðJð^ðm
00000020   F081F090F0A4F0B8 0000 F0C7F0DBF0EA   ð.ð.ð¤ð¸..ðÇðÛðê
00000030   F0FEF112F121F135F144F158F16CF17B   ðþñ.ñ!ñ5ñDñXñlñ{
00000040   F18FF19EF1B2F1C6F1D5 0000 F1E9F1F8   ñ.ñžñ²ñÆñÕ..ñéñø
00000050   F20CF220F22FF243F252F266F27AF289   ò.ò ò/òCòRòfòzò%
00000060   F29DF2ACF2C0F2D4F2E3F2F7 0000 F306   ò.ò¬òÀòÔòãò÷..ó.
00000070   F31AF32EF33DF351F360F374F388F397   ó.ó.ó=óQó`ótó^ó—
00000080   F3ABF3BAF3CEF3E2F3F1F405F414 0000   ó«ºóÎòâóñô.ô..
00000090   F428F43CF44BF45FF46EF482F496F4A5   ô(ô<ôKô_ônô‚ô–ô¥
000000A0   F4B9F4C8F4DCF4F0F4FFF513F522F536   ó¹ôÈôÜðð ÿõ.õ"õ6
000000B0   0000 F54AF559F56DF57CF590F5A4F5B3   ..õJõYõmõ|õ.õ¤õ³
000000C0   F5C7F5D6F5EAF5FEF60DF621F630F644   õÇõÖõêõþö.ö!ö0öD
000000D0   F658 0000 F667F67BF68AF69EF6B2F6C1   öX...ögö{öŠöžö²öÁ
000000E0   F6D5F6E4F6F8F70CF71BF72FF73EF752   öÕöäöø÷.÷.÷/÷>÷R
000000F0   F766F775 0000 F789F798F7ACF7C0F7CF   ÷f÷u..÷‰÷˜÷¬÷À÷Ï
00000100   F7E3F7F2F806F81AF829F83DF84CF860   ÷ã÷òø.ø.ø)ø=øLø`
00000110   F874F883F897 0000 F8A6F8BAF8CEF8DD   øtøƒø—..ø¦øºøÎøÝ
00000120   F8F1F900F914F928F937F94BF95AF96E   øñù.ù.ù(ù7ùKùZùn
00000130   F982F991F9A5F9B4 0000 F9C8F9DCF9EB   ù.ù'ù¥ù´..ùÈùÜùë
00000140   F9FFFA0EFA22FA36FA45FA59FA68FA7C   ùÿú.ú"ú6úEúYúhú|
00000150   FA90FA9FFAB3FAC2FAD6 0000 FAEAFAF9   ú.úŸú³úÂúÖ..úêúù
00000160   FB0DFB1CFB30FB44FB53FB67FB76FB8A   û.û.û0ûDûSûgûvûŠ
00000170   FB9EFBADFBC1FBD0FBE4FBF 8000 FC07   ûžûûÁûÐûäûð..ü.
00000180   FC1BFC2AFC3EFC52FC61FC75FC84FC98   ü.ü*ü>üRüaüuü„ü˜
00000190   FCACFCBBFCCFFCDEFCF2FD06FD15 0000   ü¬ü»üÏüÞüòý.ý...
000001A0   FD29FD38FD4CFD60FD6FFD83FD92FDA6   ý)ý8ýLý`ýoýfý'ý¦
000001B0   FDBAFDC9FDDDFDECFE00FE14FE23FE37   ýºýÉýÝýìþ.þ.þ#þ7
000001C0   0000 FE46FE5AFE6EFE7DFE91FEA0FEB4   ..þFþZþnþ}þ'þ þ´
000001D0   FEC8FED7FEEBFEFAFF0EFF22FF31FF45   þÈþ×þëþúÿ.ÿ"ÿ1ÿE
000001E0   FF54 0000 FF68FF7CFF8BFFF9FFFAEFFC2   ÿT..ÿhÿ|ÿ‹ÿ ÿÿ®ÿÂ
000001F0   FFD64FE5 426F6F747900                   ÿÖÖåBooty.
```

The *Tabled* format stores 32-bit Words, 16-bit HalfWords, and Octets in three delegated partitions of Bitflags, Dictionaries, and Literals; respectively.

```
Offset(h)  00                                Decoded text

00000000   4D494F3000000FF000000030000001F6  MIO0...ð...0...č
00000010   F800000000000000000000000000000000  ø..............
00000020   00000000000000000000000000000000  ..............
00000030   F004F013F027F036F04AF05EF06DF081  ð.ð.ð'ð6ðJð^ðmð.
00000040   F090F0A4F0B8F0C7F0DBF0EAF0FEF112  ð.ð¤ð¸ðÇðÛðêðþñ.
00000050   F121F135F144F158F16CF17BF18FF19E  ñ!ñ5ñDñXñlñ{ñ.ñž
00000060   F1B2F1C6F1D5F1E9F1F8F20CF220F22F  ñ²ñÆñÕñéñøò.ò ò/
00000070   F243F252F266F27AF289F29DF2ACF2C0  òCòRòfòzò‰ò.ò¬òÀ
00000080   F2D4F2E3F2F7F306F31AF32EF33DF351  òÔòãò÷ó.ó.ó.ó=óQ
00000090   F360F374F388F397F3ABF3BAF3CEF3E2  ó`ótó^ó—ó«óºóÎóâ
000000A0   F3F1F405F414F428F43CF44BF45FF46E  óñô.ô.ô(ô<ôKô_ôn
000000B0   F482F496F4A5F4B9F4C8F4DCF4F0F4FF  ô,ô–ô¥ô¹ôÈôÜôðôÿ
000000C0   F513F522F536F54AF559F56DF57CF590  õ.õ"õ6õJõYõmõ|õ.
000000D0   F5A4F5B3F5C7F5D6F5EAF5FEF60DF621  õ¤õ³õÇõÖõêõþö.ö!
000000E0   F630F644F658F667F67BF68AF69EF6B2  ö0öDöXögö{öŠöžö²
000000F0   F6C1F6D5F6E4F6F8F70CF71BF72FF73E  öÁöÕöäöø÷.÷.÷/÷>
00000100   F752F766F775F789F798F7ACF7C0F7CF  ÷R÷f÷u÷‰÷˜÷¬÷À÷Ï
00000110   F7E3F7F2F806F81AF829F83DF84CF860  ÷ã÷òø.ø.ø)ø=øLø`
00000120   F874F883F897F8A6F8BAF8CEF8DDF8F1  øtø^ø—ø¦øºøÎøÝøñ
00000130   F900F914F928F937F94BF95AF96EF982  ù.ù.ù(ù7ùKùZùnù‚
00000140   F991F9A5F9B4F9C8F9DCF9EBF9FFFA0E  ù‘ù¥ù´ùÈùÜùëùÿú.
00000150   FA22FA36FA45FA59FA68FA7CFA90FA9F  ú"ú6úEúYúhú|ú.úŸ
00000160   FAB3FAC2FAD6FAEAFAF9FB0DFB1CFB30  ú³úÂúÖúêúùû.û.û0
00000170   FB44FB53FB67FB76FB8AFB9EFBADFBC1  ûDûSûgûvûŠûžûûÁ
00000180   FBD0FBE4FBF8FC07FC1BFC2AFC3EFC52  ûÐûäûøü.ü.ü*ü>üR
00000190   FC61FC75FC84FC98FCACFCBBFCCFFCDE  üaüuü„ü˜ü¬ü»üÏüÞ
000001A0   FCF2FD06FD15FD29FD38FD4CFD60FD6F  üòý.ý.ý)ý8ýLý`ýo
000001B0   FD83FD92FDA6FDBAFDC9FDDDFDECFE00  ýfý'ý¦ýºýÉýÝýìþ.
000001C0   FE14FE23FE37FE46FE5AFE6EFE7DFE91  þ.þ#þ7þFþZþnþ}þ'
000001D0   FEA0FEB4FEC8FED7FEEBFEFAFF0EFF22  þ þ´þÈþ×þëþúÿ.ÿ"
000001E0   FF31FF45FF54FF68FF7CFF8BFF9FFFAE  ÿ1ÿEÿTÿhÿ|ÿ‹ÿŸÿ®
000001F0   FFC2FFD64FE5426F6F7479            ÿÂÿÖOåBooty
```

At the expense of alignment, the Unused bits effectively serve as padding.

Towards the end of the N64's lifecycle, a formatted octet stream of *Interleaved* coded information had debuted in a few titles before being the final de-facto format that has been in use ever since while the other formats were retired.