**A Close Examination of File Allocation for Centruion CPU6 hard drives**

This report compares the file organization of a typical Centurion Hawk drive image file using Centurion\_File\_Tool (free-ware available from this author). Data produced by this tool has been carefully verified against ren14500’s *fsscan*.

With an eye toward making the CEN emulator capable of uploading files from host to the emulator’s disk image, it is necessary to discover how the FAL (Free-space allocation list) files work. To aid in the discovery, an external sector allocation table is generated by the tool, one for each directory (Root and all Libraries).

**HOW ALLOCATION TABLE WORKS**

This table is entirely generated from the UAL files and is a “thing” of the Tool, not as far as I can detect, found anywhere on the actual disk image. It is used as a way of constructing a map of the disk without any reference to the FAL file, in order to use it to explain how the FAL file works.

A byte array is constructed with one byte representing every sector on the disk. The file system directories are scanned and the sectors allocated for each file (the information to do this is stored in the UAT files) and each array entry is recorded with a character indicating the type of allocation (see Legend at the top of each Allocation table printout). It could have been done with characters for “allocated”, “not allocated”, and for the Libraries all sectors outside their scope marked as blanks for “out of bounds”. It seemed useful to mark the system files (LOD, DIR, UAL and FAL) distinctly.

ROOT directory: The byte array is initialized to all unallocated. The directory, not surprisingly, holds the allocation for each Library directory. ROOT is considered to have authority for all sectors on the disk, though it cannot allocate a new file into any Library allocation as they are shown as allocated to the ROOT directory.

LIBRARY directories: have the scope only of sectors allocated to them in the ROOT directory. Everywhere is is out of bounds. Libraries are treated as independent file systems. Note that is is possible that the sectors assigned to the directory may not be contiguous. Note the gap in USAGI directory.

GENERATING the ALLOCATION TABLES.

The tables for one disk image are copies below. Those tables were examined manually and a chart was made for each showing the beginning sector number and length of each string of unallocated sectors.

Centurion\_File\_Tool then produced a similar table using data from the FAL files for each directory. The documentation for the FAL lists is lacking, so the scheme is discerned by observation, trial and error. The latest assumptions of FAL format are listed at the close of this report. The generated tables have the headers:   
 “=== List INDIR File Contents ===”

These tables match the manual lists exactly so it is confirmed the “high likelihood” that FAL format has been determined.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Allocation for ROOT directory \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Legend:

L System Loader F FAL Freespace Allocation List

D Directory X User file allocation

U UAL Allocation List . Free space (unallocated)

<space> Sector not allocated to this LIB

Allocation for ROOT directory

Sector +00............0f +10............1f +20............2f +30............3f

0000: LLLLLLLL LLLLLLLL DDDDDDDD DDDDDDDD DDDDDDDD DDDDDDDD UUUUUUUU UUUUUUUU

0040: UUUUUUUU UUUUUUUU FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF XXXXXXXX XXXXXXXX

0080: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

00c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0100: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0140: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0180: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

01c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0200: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0240: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0280: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

02c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0300: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0340: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0380: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

03c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0400: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0440: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0480: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

04c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0500: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0540: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0580: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

05c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0600: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0640: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0680: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

06c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0700: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0740: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0780: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

07c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0800: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0840: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0880: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

08c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0900: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0940: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0980: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

09c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0a00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0a40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0a80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0ac0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0b00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0b40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0b80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0bc0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0c00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0c40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0c80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0cc0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0d00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0d40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0d80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0dc0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0e00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0e40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX .XXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0e80: X....... ........ .XXXXXXX XXXXXXXX X....... ........ ........ ........

0ec0: .XXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX X....... ........ ........ ........

0f00: .XXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX X....... ........ ........ ........

0f40: ........ ........ ........ ........ ........ ........ ........ ........

0f80: .XXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX X....... ........

0fc0: ........ ........ ........ ........ .....XXX XXXXXXXX XXXXXXXX XXXXXXXX

1000: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1040: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1080: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

10c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1100: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1140: XXXXX... ........ XXXXXXXX XXXX.XXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1180: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

11c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1200: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1240: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1280: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

12c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1300: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1340: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1380: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

13c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1400: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1440: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1480: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

14c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1500: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1540: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1580: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXX... ........ ........

15c0 – 333f are all unallocated sectors

Sectors Used= 5308

Sectors Total= 13120 40%

=============== List INDIR File Contents: @SFAL0 00a000 ===============

FAL Type Len xx Start | Free Sectors | +offset 0000 |

000000: 00 0001 00 0e60 |@ 0e60: 1 S| @ 0e60

000006: 00 0010 00 0e81 |@ 0e81: 16 S| @ 0e81

00000c: 00 0020 00 0ea1 |@ 0ea1: 32 S| @ 0ea1

000012: 00 0020 00 0ee1 |@ 0ee1: 32 S| @ 0ee1

000018: 00 0060 00 0f21 |@ 0f21: 96 S| @ 0f21

00001e: 00 0034 00 0fb1 |@ 0fb1: 52 S| @ 0fb1

000024: 00 000b 00 1145 |@ 1145: 11 S| @ 1145

00002a: 00 0001 00 115c |@ 115c: 1 S| @ 115c

000030: 00 1cf3 00 15ad |@ 15ad: 7411 S| @ 15ad

000036: ff ffff c4 0004 |.End of List.|

Manual scan ROOT:

#Free Sector

1 @ 0e60

16 @ 0e81

32 @ 0ea1

32 @ 0ee1

96 @ 0f21

52 @ 0fb1

11 @ 1145

1 @ 115c

7411 @ 15ad

Manual scan confirms FAL entries

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Allocation for Library @SYS \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Legend:

L System Loader F FAL Freespace Allocation List

D Directory X User file allocation

U UAL Allocation List . Free space (unallocated)

<space> Sector not allocated to this LIB

Allocation for Library @SYS

Sector +00............0f +10............1f +20............2f +30............3f

0040: DDDDDDUU UUUUUUFX

0080: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

00c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0100: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0140: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0180: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

01c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0200: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0240: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0280: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

02c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXX.. ........ ........ ........

0300: ........ ........ ........ ........ ........ ........ ........ ........

0340: ........ ........ ........ ........ ........ ........ ........ ........

0380: ........ ........ ........ ........ ........ ........ ........ ........

03c0: ........ ........ ........ ........ ........ ........ ........ ........

0400: ........ ........ ........ ........ ........ ........ ........ ........

0440: ........ ........ ........ ........ ........ ........

Sectors Used= 630

Sectors Total= 1024 61%

=============== List INDIR File Contents: @PFAL0 00fc00 ===============

FAL Type Len xx Start | Free Sectors | +offset 0070 |

000000: fe ffff 00 0276 |@ 0276: to end| @ 02e6

Manual scan confirms FAL entry

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Allocation for Library S \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Legend:

L System Loader F FAL Freespace Allocation List

D Directory X User file allocation

U UAL Allocation List . Free space (unallocated)

<space> Sector not allocated to this LIB

Allocation for Library S

Sector +00............0f +10............1f +20............2f +30............3f

04c0: DDDDDDDD UUUUUUUU

0500: FFFFXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0540: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0580: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

05c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0600: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0640: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0680: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

06c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX ........ ........

Sectors Used= 496

Sectors Total= 512 96%

=============== List INDIR File Contents: @PFAL0 0a0000 ===============

FAL Type Len xx Start |....Parsed...|

000000: fe ffff 00 01f0 |65535S @ 01f0| at 04f0+01f0=06e0

Manual scan confirms FAL entry

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Allocation for Library P \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Legend:

L System Loader F FAL Freespace Allocation List

D Directory X User file allocation

U UAL Allocation List . Free space (unallocated)

<space> Sector not allocated to this LIB

Allocation for Library P

Sector +00............0f +10............1f +20............2f +30............3f

06c0: DDDDDDUU UUUUFFFF

0700: FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF FFFFXXXX

0740: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0780: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

07c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0800: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0840: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0880: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

08c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0900: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0940: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0980: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

09c0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0a00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0a40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0a80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0ac0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0b00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXX.. ........

Sectors Used= 1078

Sectors Total= 1088 99%

=============== List INDIR File Contents: @PFAL0 0df800 ===============

FAL Type Len xx Start | Free Sectors | +offset 06f0 |

000000: fe ffff 00 0436 |@ 0436: to end| @ 0b26

Manual scan confirms FAL entry

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Allocation for Library ? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Legend:

L System Loader F FAL Freespace Allocation List

D Directory X User file allocation

U UAL Allocation List . Free space (unallocated)

<space> Sector not allocated to this LIB

Allocation for Library ?

Sector +00............0f +10............1f +20............2f +30............3f

0b00: DDDDDDDD UUUUUUUU

0b40: FFFFXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0b80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0bc0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0c00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0c40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0c80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0cc0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0d00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0d40: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0d80: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0dc0: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0e00: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

0e40: XXXXXXXX XXXXXXXX XXXXXXXX XXXX....

Sectors Used= 812

Sectors Total= 816 99%

=============== List INDIR File Contents: @PFAL0 168000 ===============

FAL Type Len xx Start | Free Sectors | +offset 0b30 |

000006: fe ffff 00 032c |@ 032c: to end| @ 0e5c

Manual scan confirms FAL entry

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Allocation for Library PC \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Legend:

L System Loader F FAL Freespace Allocation List

D Directory X User file allocation

U UAL Allocation List . Free space (unallocated)

<space> Sector not allocated to this LIB

Allocation for Library PC

Sector +00............0f +10............1f +20............2f +30............3f

1140: DDD DDDDDUUU UUUUUFFF FFFFFXXX XXXXXXXX

1180: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXX.....

11c0: ........ ........ ........ ........ ........ .....XXX XXXXXXXX XXXXXXXX

1200: XXXXXXXX XXXXXXXX XXXXXXXX XXX..XXX XXXXXXXX XXXXXXXX XXXXXXXX X.......

1240: ........ ........ ........ .....

Sectors Used= 168

Sectors Total= 256 65%

=============== List INDIR File Contents: @PFAL0 22da00 ===============

FAL Type Len xx Start | Free Sectors | +offset 115d |

000000: 00 0032 00 005e |@ 005e: 50 S| @ 11bb

000006: 00 0002 00 00be |@ 00be: 2 S| @ 121b

00000c: fe ffff 00 00dc |@ 00dc: to end| @ 1239

Manual scan confirms FAL entry

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Allocation for Library USAGI \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Legend:

L System Loader F FAL Freespace Allocation List

D Directory X User file allocation

U UAL Allocation List . Free space (unallocated)

<space> Sector not allocated to this LIB

Allocation for Library USAGI

Sector +00............0f +10............1f +20............2f +30............3f

0fc0: DDD DDDDDUUU UUUUUFFF FFFFFXXX

1000: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1040: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

1080: XXXXXXXX XXXXXXXX XXXXXXXX XX...... .....XXX XXXXXXXX XXXXX... ........

10c0: ........ ........ ........ ........ ........ ........ ........ ........

1100: ........ ........ ........ ........ ........ ........ ........ ........

1140: .....

1240: ... ........ ........ ........ ........

1280: ........ ........ ........ ........ ........ ........ ........ ........

12c0: ........ ........ ........ ........ ........ ........ ........ ........

1300: ........ ........ ........ ........ ........ ........ ........ ........

1340: ........ ........ ........ ........ ........ ........ ........ ........

1380: ........ ........ ........ ........ ........ ........ ........ ........

13c0: ........ ........ ........ ........ ........ ........ ........ ........

1400: ........ ........ ........ ........ ........ ........ ........ ........

1440: ........ ........ ........ ........ ........ ........ ........ ........

1480: ........ ........ ........ ........ ........ ........ ........ ........

14c0: ........ ........ ........ ........ ........ ........ ........ ........

1500: ........ ........ ........ ........ ........ ........ ........ ........

1540: ........ ........ ........ ........ ........ ........ ........ ........

1580: ........ ........ ........ ........ ........ .....

Sectors Used= 197

Sectors Total= 1200 16%

=============== List INDIR File Contents: @PFAL0 1fea00 ===============

FAL Type Len xx Start | Free Sectors | +offset 0fe5 |

000000: 00 000b 00 00b5 |@ 00b5: 11 S| @ 109a

000006: fe ffff 00 00d0 |@ 00d0: to end| @ 10b5

Manual scan confirms FAL entry

**FAL List Format**

FAL list is contain in file @SFAL0 for the Root directory and @PFAL0 for each Librarydirectory.

Each entry consists of six bytes:

For example:

byte[0] byte[1]-byte[2] byte[3] byte[4]-byte[5]

00 00 0b 00 00 b5

Byte[0] TYPE uint8\_t value 00 for free space entry designated sector count and start sector number

Byte[1]-[2] COUNT uint16\_t Number of free sectors for this entry

Byte[3] ?? uint8\_t unused (see speculation below)

Byte[4]-[5] START uint16\_t Sector address of the first sector in this unassigned block

Bytes[0]-[1]-[2] ff ff ff Designates the end-of -list (optional)

fe ff ff Designates that the remainder of the sectors beginning with START are  
 all unassigned. This also serves as enf-of-list.

00 00 00 Designates a null entry, to be ignored

If there is no end-of-list all zeroes will follow and the scan terminates at the end of the FAL file sector list.

SPECULATION:

It may be that Byte[0]-[1][2] are a 3 byte uint24\_t COUNT whenever it is not 00 00 00, fe ff ff, or ff ff ff.

It may be that byte[3]-[4]-[5] are a 3 byte uint24\_t START.

This could be for compatibility with the tape system, or in anticipation of then-future disks with greater capacity. It is not necessary to finalize this with the Hawk images we are now using.

**How to Allocate a New File**

For emulator use, for example, to drag and drop a file from host computer onto the emulated file system.

To be reported after I have demonstrated this. For now, consider this section as speculation.

* Specify file name, library (if any), file size increment, file size, file type
* Calculate initial file size in sectors
* Examine FAL list in destination directory. Find a starting sector with enough sectors.
  + If necessary due to fragmentation, use several existing FAL entries to get the sectors needed
  + Alternatively, use the fe ff ff entry, modify its starting sector to follow the new allocation
  + Generate a new FAL with the changes or additional entries made, write it to the .IMG file
* Create a new directory entry
  + Find an all-zero entry in the DIR file
  + Format the entry, including the entry for UAL file
  + Write new DIR entry
  + Merge new UAL entry into UAL list and write to UAL file

**Decoding the FAL table**

These (modified for development) FAL listings detect end-of-list only by ff ff ff. All-zero entries are not printed.

=============== List INDIR File Contents: P.@PFAL0 0df800 ===============

FAL Type Len xx Start | Free Sectors | +offset 06f0 |

000000: fe ffff 00 0436 |@ 0436: to end| @ 0b26

000006: fe ffff 00 0436 |@ 0436: to end| @ 0b26

The first entry is valid as confirmed by the UAL derived allocation table.

The second entry duplicates the first. Assuming FE FF FF also functions as end-of-list, the second entry is left-over meaningless data and to be ignored.

=============== List INDIR File Contents: ?.@PFAL0 FAL @168000 ===============

From Rick.IMG

FAL Type Len xx Start | Free Sectors | +offset 0b30 |

000000: 00 0000 00 0245 |@ 0245: 0 S| @ 0d75

000006: fe ffff 00 032c |@ 032c: to end| @ 0e5c

00000c: fe ffff 00 032c |@ 032c: to end| @ 0e5c

000012: fe ffff 00 031e |@ 031e: to end| @ 0e4e

000018: fe ffff 00 031e |@ 031e: to end| @ 0e4e

00001e: fe ffff 00 0338 |@ 0338: to end| @ 0e68

The first entry, at 000000 is a zero-length free-space, possibly a previous entry which was used to allocate a new file, it could be used now to store a newly unassigned block of sectors.

Entries after 00000c appear to be obsolete, left-overs to be ignored. 00000c duplicates 000006. 000018 duplicates 000012 and points to a currently allocated block so is invalid. Entry 00001e also points to a currently allocated block so is invalid.

The best consideration is that the first fe ff ff is the only one to be considered. It should be treated as giving an allocation of free space AND as end-of-list.

Differences between ROOT FAL and LIB FAL

ROOT uses 0000 as directory base address. There is no sectorMap list for ROOT as the whole disk is considered “in-bounds”. ROOT does not appear to use the fe ff ff “here to end of sectorlist” entry, but uses a normal free-space entry followed by ff ff ff for end-of-list. LIBs appear always to end with fe ff ff instead. I see no instance of a LIB file with FF FF FF used.

fe ff ff must be used for allocating a new file with caution as it is necessary to use the root directory recored entry for the sector map and the sectors from the offset given to the end of the list may not be contiguous.

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