Computer Science & Engineering Department
I. I. T. Kharagpur

Operating System: CS33007
3rd Year CSE: 5th Semester (Autumn 2006 - 2007)
Lecture II (**ELF File**)

Instructors: PDG and GB *Date:* 27th July, 2006

1. Consider the following C program:

```
/***************** merge.c ******************/
#include <stdio.h>
#define MAX 100
#define DATA1 9

int data1[MAX] = {10, 20, 30, 40, 50, 60, 70, 80, 90} ;
int mergedData[MAX] ;
void merge(int [], int) ;

int main(){
     int n, i, data2[MAX] ;

     printf("Enter a positive integer:") ;
     scanf("%d", &n) ;
     printf("\nEnter %d integer data in ascending order:\n", n) ;
     for(i=0; i<n; ++i) scanf("%d", &data2[i]) ;

     merge(data2, n) ;
     for(i=0; i<DATA1+n; ++i) printf("%d ", mergedData[i]) ;
     printf("\n") ;

     return 0;
}
void merge(int dat[], int m){
     int i, j, k ;

     for(i=0, j=DATA1+m-1; i<m; ++i, --j) data1[j] = dat[i] ;
     for(i=k=0, j=DATA1+m-1; k<DATA1+m; ++k)
          if(data1[i] < data1[j]) mergedData[k] = data1[i++] ;
          else mergedData[k] = data1[j--] ;
}
```

2. Compile it to SPARC assembly language code:
$ gcc -Wall -S -O0 merge.c
$ file merge.c merge.s

merge.c: c program text
merge.s: assembler program text
$ ls -l merge.*
-rw-r–r– 1 goutam faculty 768 Jul 3 16:05 merge.c
-rw-r–r– 1 goutam faculty 3782 Jul 10 17:15 merge.s

3. Compile it to object file:
   $ gcc merge.s -c -O0
   $ file merge.o
   merge.o: ELF 32-bit MSB relocatable SPARC Version 1
   $ ls -l merge.o
   -rw-r–r– 1 goutam faculty 2484 Jul 10 2006 merge.o

4. ELF (Executable and Linking Format)

Linking View	**Execution View**
ELF Header	**ELF Header**
Program Header Table (*Opt.*)	**Program Header Table (PHT)**
Section$_0$	**Segments**
...	**Sections**
Section$_k$	...
Section Header Table (SHT)	**Section Header Table**

5. An object module dump: **merge.o.dump**

```
/************                            **********
 *          From /usr/include/sys/elf.h
 *          sun2: 10.5.18.62
 ************                            **********/
/*
 *      ELF header
 */

#define EI_NIDENT       16

typedef struct {
        unsigned char   e_ident[EI_NIDENT];     /* ident bytes */
        Elf32_Half      e_type;                 /* file type */
        Elf32_Half      e_machine;              /* target machine */
        Elf32_Word      e_version;              /* file version */
        Elf32_Addr      e_entry;                /* start address */
        Elf32_Off       e_phoff;                /* phdr file offset */
        Elf32_Off       e_shoff;                /* shdr file offset */
        Elf32_Word      e_flags;                /* file flags */
        Elf32_Half      e_ehsize;               /* sizeof ehdr */
        Elf32_Half      e_phentsize;            /* sizeof phdr */
        Elf32_Half      e_phnum;                /* number phdrs */
        Elf32_Half      e_shentsize;            /* sizeof shdr */
        Elf32_Half      e_shnum;                /* number shdrs */
        Elf32_Half      e_shstrndx;             /* shdr string index */
} Elf32_Ehdr;


/*
 *      Section header
 */

typedef struct {
        Elf32_Word      sh_name;        /* section name */
        Elf32_Word      sh_type;        /* SHT_... */
        Elf32_Word      sh_flags;       /* SHF_... */
        Elf32_Addr      sh_addr;        /* virtual address */
        Elf32_Off       sh_offset;      /* file offset */
        Elf32_Word      sh_size;        /* section size */
        Elf32_Word      sh_link;        /* misc info */
        Elf32_Word      sh_info;        /* misc info */
        Elf32_Word      sh_addralign;   /* memory alignment */
        Elf32_Word      sh_entsize;     /* entry size if table */
} Elf32_Shdr;


/*
```

```
 *      Symbol table
 */

typedef struct {
        Elf32_Word      st_name;
        Elf32_Addr      st_value;
        Elf32_Word      st_size;
        unsigned char   st_info;        /* bind, type: ELF_32_ST_... */
        unsigned char   st_other;
        Elf32_Half      st_shndx;       /* SHN_... */
} Elf32_Sym;

/*
 *      Relocation
 */

typedef struct {
        Elf32_Addr      r_offset;
        Elf32_Word      r_info;         /* sym, type: ELF32_R_... */
        Elf32_Sword     r_addend;
} Elf32_Rela;
```

```
/****************** Byte dump of merge.o ****************/

 ELF Header
 0: 0x7F 0x45 0x4C 0x46         Magic number ELF
 4: 0x1                         32-bit object (4 GB VM)
 5: 0x2                         Big endian data encoding, LSB in higher address
 6: 0x1                         File version - current
 7: 0x0 ... 0x0                 Unused

 16: 0x0 0x1                    Relocatable file

 18: 0x0 0x2                    Machine: SPARC

 20: 0x0 0x0 0x0 0x1            Version: Current

 24: 0x0 0x0 0x0 0x0            Entry-point VA - not for relocatable file

 28: 0x0 0x0 0x0 0x0            File offset of the program-header table,
                                not for relocatable file

 32: 0x0 0x0 0x8 0x4C           File offset (2124 B) of Section-header table.

 36: 0x0 0x0 0x0 0x0            No processor specific flag

 40: 0x0 0x34                   ELF Header size: 52 bytes

 42: 0x0 0x0                    Size of Program-header table entry (NA)

 44: 0x0 0x0                    Number of entries in program-header table (NA)

 46: 0x0 0x28                   Size of section-header table entry: 40 bytes

 48: 0x0 0x9                    Number of entries in the section-header table

 50: 0x0 0x1                    Section-header table index for the section
                                name string table
```

Section: Section name string table (.shstrtab)

52: 0x0

53: 0x2E 0x73 0x68 0x73 0x74 0x72 0x74 0x61 0x62 0x0 : ".shstrtab"

63: 0x2E 0x74 0x65 0x78 0x74 0x0 : ".text"

69: 0x2E 0x64 0x61 0x74 0x61 0x0 : ".data"

75: 0x2E 0x72 0x6F 0x64 0x61 0x74 0x61 0x0 : ".rodata"

83: 0x2E 0x73 0x79 0x6D 0x74 0x61 0x62 0x0 : ".symtab"

91: 0x2E 0x73 0x74 0x72 0x74 0x61 0x62 0x0 : ".strtab"

99: 0x2E 0x72 0x65 0x6C 0x61 0x2E 0x74 0x65 0x78 0x74 0x0 : ".rela.text"

110: 0x2E 0x63 0x6F 0x6D 0x6D 0x65 0x6E 0x74 0x0 : ".comment"

.shstrtab Ends

119: 0x0

Section: Text or executable code (.text)

Function main:

```
120: 0x9D 121: 0xE3 122: 0xBD 123: 0xF8
124: 0x13 125: 0x0 126: 0x0 127: 0x0
128: 0x90 129: 0x12 130: 0x60 131: 0x0
132: 0x40 133: 0x0 134: 0x0 135: 0x0
136: 0x1 137: 0x0 138: 0x0 139: 0x0
140: 0x92 141: 0x7 142: 0xBF 143: 0xEC
144: 0x15 145: 0x0 146: 0x0 147: 0x0
148: 0x90 149: 0x12 150: 0xA0 151: 0x0
152: 0x40 153: 0x0 154: 0x0 155: 0x0
156: 0x1 157: 0x0 158: 0x0 159: 0x0
160: 0x13 161: 0x0 162: 0x0 163: 0x0
164: 0x90 165: 0x12 166: 0x60 167: 0x0
168: 0xD2 169: 0x7 170: 0xBF 171: 0xEC
172: 0x40 173: 0x0 174: 0x0 175: 0x0
176: 0x1 177: 0x0 178: 0x0 179: 0x0
180: 0xC0 181: 0x27 182: 0xBF 183: 0xE8
184: 0xD0 185: 0x7 186: 0xBF 187: 0xE8
188: 0xD2 189: 0x7 190: 0xBF 191: 0xEC
192: 0x80 193: 0xA2 194: 0x0 195: 0x9
196: 0x6 197: 0x80 198: 0x0 199: 0x4
200: 0x1 201: 0x0 202: 0x0 203: 0x0
204: 0x10 205: 0x80 206: 0x0 207: 0x10
208: 0x1 209: 0x0 210: 0x0 211: 0x0
212: 0x90 213: 0x7 214: 0xBE 215: 0x58
216: 0xD2 217: 0x7 218: 0xBF 219: 0xE8
220: 0x94 221: 0x10 222: 0x0 223: 0x9
224: 0x97 225: 0x2A 226: 0xA0 227: 0x2
228: 0x92 229: 0x2 230: 0x0 231: 0xB
232: 0x15 233: 0x0 234: 0x0 235: 0x0
236: 0x90 237: 0x12 238: 0xA0 239: 0x0
240: 0x40 241: 0x0 242: 0x0 243: 0x0
244: 0x1 245: 0x0 246: 0x0 247: 0x0
248: 0xD0 249: 0x7 250: 0xBF 251: 0xE8
252: 0x92 253: 0x2 254: 0x20 255: 0x1
256: 0xD2 257: 0x27 258: 0xBF 259: 0xE8
260: 0x10 261: 0xBF 262: 0xFF 263: 0xED
264: 0x1 265: 0x0 266: 0x0 267: 0x0
268: 0x92 269: 0x7 270: 0xBE 271: 0x58
272: 0x90 273: 0x10 274: 0x0 275: 0x9
276: 0xD2 277: 0x7 278: 0xBF 279: 0xEC
280: 0x40 281: 0x0 282: 0x0 283: 0x0
284: 0x1 285: 0x0 286: 0x0 287: 0x0
288: 0xC0 289: 0x27 290: 0xBF 291: 0xE8
```

292: 0xD2 293: 0x7 294: 0xBF 295: 0xEC
296: 0x90 297: 0x2 298: 0x60 299: 0x9
300: 0xD2 301: 0x7 302: 0xBF 303: 0xE8
304: 0x80 305: 0xA2 306: 0x40 307: 0x8
308: 0x6 309: 0x80 310: 0x0 311: 0x4
312: 0x1 313: 0x0 314: 0x0 315: 0x0
316: 0x10 317: 0x80 318: 0x0 319: 0x11
320: 0x1 321: 0x0 322: 0x0 323: 0x0
324: 0x11 325: 0x0 326: 0x0 327: 0x0
328: 0x92 329: 0x12 330: 0x20 331: 0x0
332: 0xD0 333: 0x7 334: 0xBF 335: 0xE8
336: 0x96 337: 0x10 338: 0x0 339: 0x8
340: 0x95 341: 0x2A 342: 0xE0 343: 0x2
344: 0x17 345: 0x0 346: 0x0 347: 0x0
348: 0x90 349: 0x12 350: 0xE0 351: 0x0
352: 0xD2 353: 0x2 354: 0x40 355: 0xA
356: 0x40 357: 0x0 358: 0x0 359: 0x0
360: 0x1 361: 0x0 362: 0x0 363: 0x0
364: 0xD0 365: 0x7 366: 0xBF 367: 0xE8
368: 0x92 369: 0x2 370: 0x20 371: 0x1
372: 0xD2 373: 0x27 374: 0xBF 375: 0xE8
376: 0x10 377: 0xBF 378: 0xFF 379: 0xEB
380: 0x1 381: 0x0 382: 0x0 383: 0x0
384: 0x13 385: 0x0 386: 0x0 387: 0x0
388: 0x90 389: 0x12 390: 0x60 391: 0x0
392: 0x40 393: 0x0 394: 0x0 395: 0x0
396: 0x1 397: 0x0 398: 0x0 399: 0x0
400: 0xB0 401: 0x10 402: 0x20 403: 0x0
404: 0x10 405: 0x80 406: 0x0 407: 0x2
408: 0x1 409: 0x0 410: 0x0 411: 0x0
412: 0x81 413: 0xC7 414: 0xE0 415: 0x8
416: 0x81 417: 0xE8 418: 0x0 419: 0x0

Function merge:

```
420: 0x9D 421: 0xE3 422: 0xBF 423: 0x80
424: 0xF0 425: 0x27 426: 0xA0 427: 0x44
428: 0xF2 429: 0x27 430: 0xA0 431: 0x48
432: 0xC0 433: 0x27 434: 0xBF 435: 0xEC
436: 0xD0 437: 0x7 438: 0xA0 439: 0x48
440: 0x92 441: 0x2 442: 0x20 443: 0x8
444: 0xD2 445: 0x27 446: 0xBF 447: 0xE8
448: 0xD0 449: 0x7 450: 0xBF 451: 0xEC
452: 0xD2 453: 0x7 454: 0xA0 455: 0x48
456: 0x80 457: 0xA2 458: 0x0 459: 0x9
460: 0x6 461: 0x80 462: 0x0 463: 0x4
464: 0x1 465: 0x0 466: 0x0 467: 0x0
468: 0x10 469: 0x80 470: 0x0 471: 0x16
472: 0x1 473: 0x0 474: 0x0 475: 0x0
476: 0x13 477: 0x0 478: 0x0 479: 0x0
480: 0x90 481: 0x12 482: 0x60 483: 0x0
484: 0xD2 485: 0x7 486: 0xBF 487: 0xE8
488: 0x94 489: 0x10 490: 0x0 491: 0x9
492: 0x93 493: 0x2A 494: 0xA0 495: 0x2
496: 0xD4 497: 0x7 498: 0xBF 499: 0xEC
500: 0x96 501: 0x10 502: 0x0 503: 0xA
504: 0x95 505: 0x2A 506: 0xE0 507: 0x2
508: 0xD6 509: 0x7 510: 0xA0 511: 0x44
512: 0x94 513: 0x2 514: 0x80 515: 0xB
516: 0xD6 517: 0x2 518: 0x80 519: 0x0
520: 0xD6 521: 0x22 522: 0x0 523: 0x9
524: 0xD0 525: 0x7 526: 0xBF 527: 0xEC
528: 0x92 529: 0x2 530: 0x20 531: 0x1
532: 0xD2 533: 0x27 534: 0xBF 535: 0xEC
536: 0xD0 537: 0x7 538: 0xBF 539: 0xE8
540: 0x92 541: 0x2 542: 0x3F 543: 0xFF
544: 0xD2 545: 0x27 546: 0xBF 547: 0xE8
548: 0x10 549: 0xBF 550: 0xFF 551: 0xE7
552: 0x1 553: 0x0 554: 0x0 555: 0x0
556: 0x1 557: 0x0 558: 0x0 559: 0x0
560: 0xC0 561: 0x27 562: 0xBF 563: 0xE4
564: 0xC0 565: 0x27 566: 0xBF 567: 0xEC
568: 0xD0 569: 0x7 570: 0xA0 571: 0x48
572: 0x92 573: 0x2 574: 0x20 575: 0x8
576: 0xD2 577: 0x27 578: 0xBF 579: 0xE8
580: 0xD2 581: 0x7 582: 0xA0 583: 0x48
584: 0x90 585: 0x2 586: 0x60 587: 0x9
588: 0xD2 589: 0x7 590: 0xBF 591: 0xE4
592: 0x80 593: 0xA2 594: 0x40 595: 0x8
596: 0x6 597: 0x80 598: 0x0 599: 0x4
```

600: 0x1 601: 0x0 602: 0x0 603: 0x0
604: 0x10 605: 0x80 606: 0x0 607: 0x36
608: 0x1 609: 0x0 610: 0x0 611: 0x0
612: 0x13 613: 0x0 614: 0x0 615: 0x0
616: 0x90 617: 0x12 618: 0x60 619: 0x0
620: 0xD2 621: 0x7 622: 0xBF 623: 0xEC
624: 0x94 625: 0x10 626: 0x0 627: 0x9
628: 0x93 629: 0x2A 630: 0xA0 631: 0x2
632: 0x17 633: 0x0 634: 0x0 635: 0x0
636: 0x94 637: 0x12 638: 0xE0 639: 0x0
640: 0xD6 641: 0x7 642: 0xBF 643: 0xE8
644: 0x98 645: 0x10 646: 0x0 647: 0xB
648: 0x97 649: 0x2B 650: 0x20 651: 0x2
652: 0xD0 653: 0x2 654: 0x0 655: 0x9
656: 0xD2 657: 0x2 658: 0x80 659: 0xB
660: 0x80 661: 0xA2 662: 0x0 663: 0x9
664: 0x16 665: 0x80 666: 0x0 667: 0x13
668: 0x1 669: 0x0 670: 0x0 671: 0x0
672: 0x13 673: 0x0 674: 0x0 675: 0x0
676: 0x90 677: 0x12 678: 0x60 679: 0x0
680: 0xD2 681: 0x7 682: 0xBF 683: 0xE4
684: 0x94 685: 0x10 686: 0x0 687: 0x9
688: 0x93 689: 0x2A 690: 0xA0 691: 0x2
692: 0x15 693: 0x0 694: 0x0 695: 0x0
696: 0x98 697: 0x12 698: 0xA0 699: 0x0
700: 0x94 701: 0x7 702: 0xBF 703: 0xEC
704: 0xD6 705: 0x2 706: 0x80 707: 0x0
708: 0x9A 709: 0x10 710: 0x0 711: 0xB
712: 0x85 713: 0x2B 714: 0x60 715: 0x2
716: 0xD8 717: 0x3 718: 0x0 719: 0x2
720: 0xD8 721: 0x22 722: 0x0 723: 0x9
724: 0x96 725: 0x2 726: 0xE0 727: 0x1
728: 0xD6 729: 0x22 730: 0x80 731: 0x0
732: 0x10 733: 0x80 734: 0x0 735: 0x11
736: 0x1 737: 0x0 738: 0x0 739: 0x0
740: 0x13 741: 0x0 742: 0x0 743: 0x0
744: 0x90 745: 0x12 746: 0x60 747: 0x0
748: 0xD2 749: 0x7 750: 0xBF 751: 0xE4
752: 0x94 753: 0x10 754: 0x0 755: 0x9
756: 0x93 757: 0x2A 758: 0xA0 759: 0x2
760: 0x15 761: 0x0 762: 0x0 763: 0x0
764: 0x98 765: 0x12 766: 0xA0 767: 0x0
768: 0x94 769: 0x7 770: 0xBF 771: 0xE8
772: 0xD6 773: 0x2 774: 0x80 775: 0x0
776: 0x9A 777: 0x10 778: 0x0 779: 0xB
780: 0x85 781: 0x2B 782: 0x60 783: 0x2
784: 0xD8 785: 0x3 786: 0x0 787: 0x2

```
788: 0xD8 789: 0x22 790: 0x0 791: 0x9
792: 0x96 793: 0x2 794: 0xFF 795: 0xFF
796: 0xD6 797: 0x22 798: 0x80 799: 0x0
800: 0xD0 801: 0x7 802: 0xBF 803: 0xE4
804: 0x92 805: 0x2 806: 0x20 807: 0x1
808: 0xD2 809: 0x27 810: 0xBF 811: 0xE4
812: 0x10 813: 0xBF 814: 0xFF 815: 0xC6
816: 0x1 817: 0x0 818: 0x0 819: 0x0
820: 0x81 821: 0xC7 822: 0xE0 823: 0x8
824: 0x81 825: 0xE8 826: 0x0 827: 0x0
```

```
.text Ends
```

```
Section: Writable global data (.data)

828: 0x0 0x0 0x0 0xA            10 (D)
832: 0x0 0x0 0x0 0x14           20 (D)
836: 0x0 0x0 0x0 0x1E           30 (D)
840: 0x0 0x0 0x0 0x28           40 (D)
844: 0x0 0x0 0x0 0x32           50 (D)
848: 0x0 0x0 0x0 0x3C           60 (D)
852: 0x0 0x0 0x0 0x46           70 (D)
856: 0x0 0x0 0x0 0x50           80 (D)
860: 0x0 0x0 0x0 0x5A           90 (D)
864: 0x0
       ................ all zeros
1227: 0x0

.data section Ends
1228: 0x0
1229: 0x0
1230: 0x0
1231: 0x0
```

```
Section: Read-only data (.rodata)

1232: 0x45 0x6E 0x74 0x65 0x72 0x20 0x61 0x20 0x70 0x6F 0x73 0x69
      0x74 0x69 0x76 0x65 0x20 0x69 0x6E 0x74 0x65 0x67 0x65 0x72
      0x3A 0x0 : "Enter a positive integer:"

1258: 0x0 0x0 0x0 0x0 0x0 0x0 - aligned to 8-byte boundary

1264: 0x25 0x64 0x0 : "%d"

1267: 0x0 0x0 0x0 0x0 0x0 - aligned to 8-byte boundary

1272: 0xA 0x45 0x6E 0x74 0x65 0x72 0x20 0x25 0x64 0x20 0x69 0x6E 0x74
      0x65 0x67 0x65 0x72 0x20 0x64 0x61 0x74 0x61 0x20 0x69 0x6E 0x20
      0x61 0x73 0x63 0x65 0x6E 0x64 0x69 0x6E 0x67 0x20 0x6F 0x72 0x64
      0x65 0x72 0x3A 0xA 0x0 :
"\nEnter %d integer data in ascending order:\n"

1316: 0x0 0x0 0x0 0x0 - aligned to 8-byte boundary

1320: 0x25 0x64 0x20 0x0 : "%d "

1324: 0x0 0x0 0x0 0x0 - aligned to 8-byte boundary

1328: 0xA 0x0 : "\n"

.rodata Ends

1330: 0x0
1331: 0x0
```

```
Section: Symbol table (.symtab)
SymTabEntry-0      Null Entry
1332: 0x0
1333: 0x0
1334: 0x0
1335: 0x0
1336: 0x0
1337: 0x0
1338: 0x0
1339: 0x0
1340: 0x0
1341: 0x0
1342: 0x0
1343: 0x0
1344: 0x0
1345: 0x0
1346: 0x0
1347: 0x0

SymTabEntry-1       for the symbol "merge.c"
1348: 0x0 0x0 0x0 0x1          Name: offset in the .strtab: 1 bytes

1352: 0x0 0x0 0x0 0x0          Address: 0 bytes (??)

1356: 0x0 0x0 0x0 0x0          Size: 0 bytes (??)

1360: 0x4                      Info: 0 + 3: Local symbol, name of the source
                                     file

1361: 0x0                      Unused

1362: 0xFF 0xF1                Section: 0xFFF1: absolute value of the symbol,
                                     no change due to relocation

SymTabEntry-2
1364: 0x0 0x0 0x0 0x0          Name: offset in the .strtab: 0 bytes

1368: 0x0 0x0 0x0 0x0          Address: 0 bytes (??)

1372: 0x0 0x0 0x0 0x0          Size: 0 bytes (??)

1376: 0x3                      Info: 0 + 3: Local symbol for relocation

1377: 0x0                      Unused

1378: 0x0 0x3                  Section: section header table index 2:
                                         .data
```

```
SymTabEntry-3       for the symbol "gcc2_compiled."
1380: 0x0 0x0 0x0 0x9          Name: offset in the .strtab: 9 bytes

1384: 0x0 0x0 0x0 0x0          Address: 0 bytes (??)

1388: 0x0 0x0 0x0 0x0          Size: 0 bytes (??)

1392: 0x0                      Info: 0 + 0: Local + Notype

1393: 0x0                      Unused

1394: 0x0 0x2                  Section: section header table index 2:
                                         .text

SymTabEntry-4
1396: 0x0 0x0 0x0 0x0          Name: offset in the .strtab: 0 bytes

1400: 0x0 0x0 0x0 0x0          Address: 0 bytes (??)

1404: 0x0 0x0 0x0 0x0          Size: 0 bytes (??)

1408: 0x3                      Info: 0 + 3: Local symbol for relocation

1409: 0x0                      Unused

1410: 0x0 0x2                  Section: section header table index 2:
                                         .text

SymTabEntry-5
1412: 0x0 0x0 0x0 0x0          Name: offset in the .strtab: 0 bytes

1416: 0x0 0x0 0x0 0x0          Address: 0 bytes (??)

1420: 0x0 0x0 0x0 0x0          Size: 0 bytes (??)

1424: 0x3                      Info: 0 + 3: Local symbol for relocation

1425: 0x0                      Unused

1426: 0x0 0x4                  Section: section header table index 4:
                                         .rodata

SymTabEntry-6     for the symbol "mergedData"
1428: 0x0 0x0 0x0 0x18         Offset in the .strtab: 24 bytes

1432: 0x0 0x0 0x0 0x4          Address: 4 byte (??)
```

```
1436: 0x0 0x0 0x1 0x90         Size: 400 bytes

1440: 0x11                     Info: 16 + 1=17: Global + Object (data)

1441: 0x0                      Unused

1442: 0xFF 0xF2                Section: 0xFFF2: .common section

SymTabEntry-7    for the symbol "scanf"
1444: 0x0 0x0 0x0 0x23         Name: offset in .strtab: 35 bytes

1448: 0x0 0x0 0x0 0x0          Address: 0

1452: 0x0 0x0 0x0 0x0          Size: 0

1456: 0x10                     Info: 16 + 0: Global + Notype

1457: 0x0                      Unused

1458: 0x0 0x0                  Section: 0x0: section undefined

SymTabEntry-8   for the symbol "printf"
1460: 0x0 0x0 0x0 0x29         Name: offset in .strtab: 41 bytes

1464: 0x0 0x0 0x0 0x0          Address: 0

1468: 0x0 0x0 0x0 0x0          Size: 0

1472: 0x10                     Info: 16 + 0: Global + Notype

1473: 0x0                      Unused

1474: 0x0 0x0                  Section: no section name

SymTabEntry-9   for the symbol "main"
1476: 0x0 0x0 0x0 0x30         Name: offset in .strtab: 48 bytes

1480: 0x0 0x0 0x0 0x0          Address: offset in .text: 0 bytes

1484: 0x0 0x0 0x1 0x2C         Size: 300 bytes

1488: 0x12                     Info: 16 + 2 = 18: Global + Function

1489: 0x0                      Unused

1490: 0x0 0x2                  Section: section header indexi 2: .text
```

```
SymTabEntry-10    for the symbol "data1"
1492: 0x0 0x0 0x0 0x35         Name: offset in .strtab: 53 bytes

1496: 0x0 0x0 0x0 0x0          Address: offset in .data: 0 bytes

1500: 0x0 0x0 0x1 0x90         Size: 400 bytes

1504: 0x11                     Info: 16 + 1 = 17: Global + Object (data)

1505: 0x0                      Unused

1506: 0x0 0x3                  Section: section header index 3: .data

SymTabEntry-11  for the symbol "merge"
1508: 0x0 0x0 0x0 0x3B         Name: offset in .strtab: 59 bytes

1512: 0x0 0x0 0x1 0x2C         Address: offset in the section (.text):
                                        300 bytes

1516: 0x0 0x0 0x1 0x98         Size: 408 byte

1520: 0x12                     Info: 16 + 2 = 18: Global + Function

1521: 0x0                      Not Used

1522: 0x0 0x2                  Section: section header indexi 2: .text

.symtab Ends
```

```
Section: String table (.strtab) for the symbol table (.symtab)
1524: 0x0

1525: 0x6D 0x65 0x72 0x67 0x65 0x2E 0x63 0x0 : "merge.c"

1533: 0x67 0x63 0x63 0x32 0x5F 0x63 0x6F 0x6D 0x70 0x69 0x6C 0x65 0x64
      0x2E 0x0 : "gcc2_compiled."

1548: 0x6D 0x65 0x72 0x67 0x65 0x64 0x44 0x61 0x74 0x61 0x0 : "mergedData"

1559: 0x73 0x63 0x61 0x6E 0x66 0x0 : "scanf"

1565: 0x70 0x72 0x69 0x6E 0x74 0x66 0x0 : "printf"

1572: 0x6D 0x61 0x69 0x6E 0x0 : "main"

1577: 0x64 0x61 0x74 0x61 0x31 0x0 : "data1"

1583: 0x6D 0x65 0x72 0x67 0x65 0x0 : "merge"

.strtab Ends

1589: 0x0
1590: 0x0
1591: 0x0
```

```
Section: Relocation table (.rela.text) for .text and .symtab

Relocation Table: 0
1592: 0x0 0x0 0x0 0x4          Offset: 4 bytes: .text
                                  sethi %hi(.LLC0), %o1
                                  0x13 0x0 0x0 0x0
1596: 0x0 0x0 0x5 0x9          Info: 5 + 9: 5th entry of .symtab + Hi 22-bits
1600: 0x0 0x0 0x0 0x0 Addend: 0

Relocation Table: 1
1604: 0x0 0x0 0x0 0x8          Offset: 8 bytes: .text
                                  or %o1, %lo(.LLC0), %o0
                                  0x90 0x12 0x60 0x0
1608: 0x0 0x0 0x5 0xC          Info: 5 + C: 5th entry of .symtab + Lo 10-bits
1612: 0x0 0x0 0x0 0x0          Addend: 0

Relocation Table: 2
1616: 0x0 0x0 0x0 0xC          Offset: 12 bytes: .text
                                   call printf, 0
                                   0x40 0x0 0x0 0x0
1620: 0x0 0x0 0x8 0x7          Info: 8 + 7: 8th entry of .symtab +
                                                   Displacement 30-bits
1624: 0x0 0x0 0x0 0x0          Addend: 0

Relocation Table: 3
1628: 0x0 0x0 0x0 0x18         Offset: 24 bytes
                                    sethi %hi(.LLC1), %o2
                                    0x15 0x0 0x0 0x0
1632: 0x0 0x0 0x5 0x9          Info: 5 + 9
1636: 0x0 0x0 0x0 0x20         Addend: 32 byte (.LLC1 starts at byte offset
                                       32 of .rodata)

Relocation Table: 4
1640: 0x0 0x0 0x0 0x1C
1644: 0x0 0x0 0x5 0xC
1648: 0x0 0x0 0x0 0x20

Relocation Table: 5
1652: 0x0 0x0 0x0 0x20         Offset: 32 bytes
                                  call scanf, 0
                                  0x40 0x0 0x0 0x0
1656: 0x0 0x0 0x7 0x7          Info: 7 + 7: 7th entry of .symtab + 30-bit
                                              Displacement
1660: 0x0 0x0 0x0 0x0          Addend: 0

Relocation Table: 5
1664: 0x0 0x0 0x0 0x28         Offset: 40 bytes
```

```
                                  sethi %hi(.LLC2), %o1
1668: 0x0 0x0 0x5 0x9          Info: 5 + 9: 5th entry .symtab (.rodata) +
                                             Hi 22-bits
1672: 0x0 0x0 0x0 0x28         Addend: 40 bytes: .LLC2 starts at offset 40
                                   in .rodata

Relocation Table: 6
1676: 0x0 0x0 0x0 0x2C         Offset: 44  bytes
                                   or %o1, %lo(.LLC2), %o0
1680: 0x0 0x0 0x5 0xC
1684: 0x0 0x0 0x0 0x28

Relocation Table: 7
1688: 0x0 0x0 0x0 0x34         Offset: 52 bytes
1692: 0x0 0x0 0x8 0x7              call     printf, 0
1696: 0x0 0x0 0x0 0x0

Relocation Table: 8
1700: 0x0 0x0 0x0 0x70         Offset: 112 bytes
1704: 0x0 0x0 0x5 0x9              sethi %hi(.LLC1), %o2
1708: 0x0 0x0 0x0 0x20

Relocation Table: 9
1712: 0x0 0x0 0x0 0x74         Offset: 116 bytes
1716: 0x0 0x0 0x5 0xC              or %o2, %lo(.LLC1), %o0
1720: 0x0 0x0 0x0 0x20

1724: 0x0 0x0 0x0 0x78         Offset: 120 bytes
1728: 0x0 0x0 0x7 0x7              call scanf, 0
1732: 0x0 0x0 0x0 0x0

Relocation Table: 10
1736: 0x0 0x0 0x0 0xA0         Offset: 160 bytes
                                   call merge, 0
1740: 0x0 0x0 0xB 0x7          Info: 11 + 7: .symtab index 11 (merge)
                                   + 30-bit displacement
1744: 0x0 0x0 0x0 0x0

Relocation Table: 11
1748: 0x0 0x0 0x0 0xCC         Offset: 204 bytes
                                    sethi %hi(mergedData), %o0
1752: 0x0 0x0 0x6 0x9          Info: 6 + 9: .symtab index 6 (mergedData) +
                                        Hi 22-bits
1756: 0x0 0x0 0x0 0x0

Relocation Table: 12
1760: 0x0 0x0 0x0 0xD0
```

```
1764: 0x0 0x0 0x6 0xC
1768: 0x0 0x0 0x0 0x0

Relocation Table: 13
1772: 0x0 0x0 0x0 0xE0              sethi %hi(.LLC3), %o3
1776: 0x0 0x0 0x5 0x9          Info: 5 + 9:
1780: 0x0 0x0 0x0 0x58         Addend: 88 bytes - .LLC3 in .rodata

Relocation Table: 14
1784: 0x0 0x0 0x0 0xE4
1788: 0x0 0x0 0x5 0xC
1792: 0x0 0x0 0x0 0x58

Relocation Table: 14
1796: 0x0 0x0 0x0 0xEC
1800: 0x0 0x0 0x8 0x7
1804: 0x0 0x0 0x0 0x0

Relocation Table: 15
1808: 0x0 0x0 0x1 0x8
1812: 0x0 0x0 0x5 0x9
1816: 0x0 0x0 0x0 0x60

Relocation Table: 16
1820: 0x0 0x0 0x1 0xC
1824: 0x0 0x0 0x5 0xC
1828: 0x0 0x0 0x0 0x60

Relocation Table: 17
1832: 0x0 0x0 0x1 0x10
1836: 0x0 0x0 0x8 0x7
1840: 0x0 0x0 0x0 0x0

Relocation Table: 18
1844: 0x0 0x0 0x1 0x64
1848: 0x0 0x0 0xA 0x9
1852: 0x0 0x0 0x0 0x0

Relocation Table: 19
1856: 0x0 0x0 0x1 0x68
1860: 0x0 0x0 0xA 0xC
1864: 0x0 0x0 0x0 0x0

Relocation Table: 20
1868: 0x0 0x0 0x1 0xEC
1872: 0x0 0x0 0xA 0x9
1876: 0x0 0x0 0x0 0x0
```

```
Relocation Table: 21
1880: 0x0 0x0 0x1 0xF0
1884: 0x0 0x0 0xA 0xC
1888: 0x0 0x0 0x0 0x0

Relocation Table: 22
1892: 0x0 0x0 0x2 0x0
1896: 0x0 0x0 0xA 0x9
1900: 0x0 0x0 0x0 0x0

Relocation Table: 23
1904: 0x0 0x0 0x2 0x4
1908: 0x0 0x0 0xA 0xC
1912: 0x0 0x0 0x0 0x0

Relocation Table: 24
1916: 0x0 0x0 0x2 0x28
1920: 0x0 0x0 0x6 0x9
1924: 0x0 0x0 0x0 0x0

Relocation Table: 25
1928: 0x0 0x0 0x2 0x2C
1932: 0x0 0x0 0x6 0xC
1936: 0x0 0x0 0x0 0x0

Relocation Table: 26
1940: 0x0 0x0 0x2 0x3C
1944: 0x0 0x0 0xA 0x9          Info: 10 + 9: index 10 of .symtab (data1)
1948: 0x0 0x0 0x0 0x0

Relocation Table: 27
1952: 0x0 0x0 0x2 0x40
1956: 0x0 0x0 0xA 0xC          Info: 10 + 12: index 10 of .symtab (data1)
1960: 0x0 0x0 0x0 0x0

Relocation Table: 28
1964: 0x0 0x0 0x2 0x6C
1968: 0x0 0x0 0x6 0x9
1972: 0x0 0x0 0x0 0x0

Relocation Table: 29
1976: 0x0 0x0 0x2 0x70
1980: 0x0 0x0 0x6 0xC         Info: 6 + 12: index 6 of .symtab (mergedData) +
                                        Lo 10-bits
1984: 0x0 0x0 0x0 0x0
```

```
Relocation Table: 30
1988: 0x0 0x0 0x2 0x80          Offset: 640 bytes
                                     sethi     %hi(data1), %o2
1992: 0x0 0x0 0xA 0x9           Info: 10 + 9: index 10 of .symtab (data1) +
                                        Hi 22-bits
1996: 0x0 0x0 0x0 0x0

Relocation Table: 31
2000: 0x0 0x0 0x2 0x84          Offset: 644 bytes
                                     or %o2, %lo(data1), %o4
2004: 0x0 0x0 0xA 0xC           Info: 10 + 12: index 10 of .symtab (data1) +
                                        Lo 10-bits
2008: 0x0 0x0 0x0 0x0

.rela.text Ends
```

```
 Section: .comment

 2012: 0x0

 2013: 0x61
 "as: Sun WorkShop 6 update 2 Compiler Common 6.2 Solaris_9_CBE 2001/04/02
GCC: (GNU) 2.95.3 20010315 (release)"
 2122: 0x29
 2123: 0x0

 .comment Ends
```

```
Section-header table:

Entry: 0          Null Entry
2124: 0x0
      ....................
2163: 0x0

Entry: 1          Section name string table (.shstrtab)
2164: 0x0 0x0 0x0 0x1          Section name: offset within the string
                               table - 01

2168: 0x0 0x0 0x0 0x3          Section type: string table

2172: 0x0 0x0 0x0 0x0          Flags: no flag

2176: 0x0 0x0 0x0 0x0          Address: if the section is a memory image

2180: 0x0 0x0 0x0 0x34         Offset of the section in the file: 52 bytes

2184: 0x0 0x0 0x0 0x43         Size of the section: 67 bytes (52 - 118)

2188: 0x0 0x0 0x0 0x0          Link:

2192: 0x0 0x0 0x0 0x0          Info:

2196: 0x0 0x0 0x0 0x1          Alignment: no alignment constraints

2200: 0x0 0x0 0x0 0x0          Entry size: table entry size (NA)

Entry: 2 Code section (.text)
2204: 0x0 0x0 0x0 0xB         Offset within the string table: 11

2208: 0x0 0x0 0x0 0x1          Program bits (code in this case)

2212: 0x0 0x0 0x0 0x6          Flags: 6 = 2 + 4: section occupies memory
                                  during execution, contains code (read-only)

2216: 0x0 0x0 0x0 0x0          Address (NA)

2220: 0x0 0x0 0x0 0x78         Section offset in the file: 120 bytes

2224: 0x0 0x0 0x2 0xC4         Section size: 708 bytes (120 - 827)

2228: 0x0 0x0 0x0 0x0          Link (NA)

2232: 0x0 0x0 0x0 0x0          Info (NA)
```

```
2236: 0x0 0x0 0x0 0x4          Address alignment: 4-byte boundary

2240: 0x0 0x0 0x0 0x0          Entry size (NA)

Entry: 3    Global data section (.data)
2244: 0x0 0x0 0x0 0x11         Offset within the string table (.shstrtab) 17

2248: 0x0 0x0 0x0 0x1          Program bits (initialize data)

2252: 0x0 0x0 0x0 0x3          Flags: 1 + 2 = 3 :writable data, there will
                                    be memory allocation

2256: 0x0 0x0 0x0 0x0          Address: (NA)

2260: 0x0 0x0 0x3 0x3C         Section offset in the file: 828 bytes

2264: 0x0 0x0 0x1 0x90         Section size: 400 bytes (828 - 1227)

2268: 0x0 0x0 0x0 0x0          Link: (NA)

2272: 0x0 0x0 0x0 0x0          Info: (NA)

2276: 0x0 0x0 0x0 0x4          Address allignment: 4-byte boundary

2280: 0x0 0x0 0x0 0x0          Entry size: (NA)

Entry: 4      Read-only data section (.rodata)
2284: 0x0 0x0 0x0 0x17         Offset within the string table: 23

2288: 0x0 0x0 0x0 0x1          Program bits

2292: 0x0 0x0 0x0 0x2          Flags: 2 : memory allocation, read-only

2296: 0x0 0x0 0x0 0x0          Address: (NA)

2300: 0x0 0x0 0x4 0xD0         Offset in the file: 1232 bytes

2304: 0x0 0x0 0x0 0x62         Size of the section: 98 bytes (1232 - 1329)

2308: 0x0 0x0 0x0 0x0          Link: (NA)

2312: 0x0 0x0 0x0 0x0          Info: (NA)

2316: 0x0 0x0 0x0 0x8          Address alignment: 8 byte boundary

2320: 0x0 0x0 0x0 0x0          Entry size
```

```
Entry: 5       Symbol table for global symbols (.symtab)
2324: 0x0 0x0 0x0 0x1F         Offset within the string table: 31 bytes

2328: 0x0 0x0 0x0 0x2          Section type: Symbol table

2332: 0x0 0x0 0x0 0x2          Flags: the section occupies memory

2336: 0x0 0x0 0x0 0x0          Address: (NA)

2340: 0x0 0x0 0x5 0x34         Offset in the file: 1332 bytes

2344: 0x0 0x0 0x0 0xC0         Size of the section: 192 bytes (1332 - 1523)

2348: 0x0 0x0 0x0 0x6          Link: section header index of the associated
                                     string table: index 6 (.strtab)

2352: 0x0 0x0 0x0 0x6          Info: ??

2356: 0x0 0x0 0x0 0x4          Address alignment: 4-byte boundary

2360: 0x0 0x0 0x0 0x10         Entry size: 16-bytes

Entry: 6     String table for the symbol table (.strtab)
2364: 0x0 0x0 0x0 0x27         Offset within the string table
                                                 (.shstrtab): 39

2368: 0x0 0x0 0x0 0x3          Type: 3 : string table

2372: 0x0 0x0 0x0 0x2          Flags: the section occupies memory

2376: 0x0 0x0 0x0 0x0          Address: (NA)

2380: 0x0 0x0 0x5 0xF4         Offset in the file: 1524 bytes

2384: 0x0 0x0 0x0 0x41         Size of the section: 65 bytes (1524 - 1588)

2388: 0x0 0x0 0x0 0x0          Link: (NA)

2392: 0x0 0x0 0x0 0x0          Info: (NA)

2396: 0x0 0x0 0x0 0x1          Alignment: none

2400: 0x0 0x0 0x0 0x0          Size of an entry

Entry: 7          Relocation table for .text
2404: 0x0 0x0 0x0 0x2F         Section name: offset within the string
                               table (.rela.text) - 47 bytes
```

```
2408: 0x0 0x0 0x0 0x4         Section type: relocation entry table

2412: 0x0 0x0 0x0 0x2         Flags: 2: memory allocation for this section

2416: 0x0 0x0 0x0 0x0         Address: NA

2420: 0x0 0x0 0x6 0x38        Offset of the section in the file: 1592 bytes

2424: 0x0 0x0 0x1 0xA4        Size of the section: 420 bytes (1592 - 2011)

2428: 0x0 0x0 0x0 0x5         Link: section header index of the
                                corresponding symbol table: 5 (.symtab)

2432: 0x0 0x0 0x0 0x2         Info: section header index of the section
                                where relocation is done: 2 (.text)

2436: 0x0 0x0 0x0 0x4         Alignment: 4-byte boundart

2440: 0x0 0x0 0x0 0xC         Size oof an entry: 12 bytes (35 ntries)

Entry: 8        Section .comment
2444: 0x0 0x0 0x0 0x3A        Offset within the string table
                                          (.comment): 58

2448: 0x0 0x0 0x0 0x1         Type: 1: program bits

2452: 0x0 0x0 0x0 0x0         Flags: writable data

2456: 0x0 0x0 0x0 0x0         Address: NA

2460: 0x0 0x0 0x7 0xDC        Offset in the file: 2012 bytes

2464: 0x0 0x0 0x0 0x70        Size: 112 bytes (2012 - 2123)

2468: 0x0 0x0 0x0 0x0         Link: NA

2472: 0x0 0x0 0x0 0x0         Info: NA

2476: 0x0 0x0 0x0 0x1         Address alignment: Nil

2480: 0x0 0x0 0x0 0x0         Entry size
```