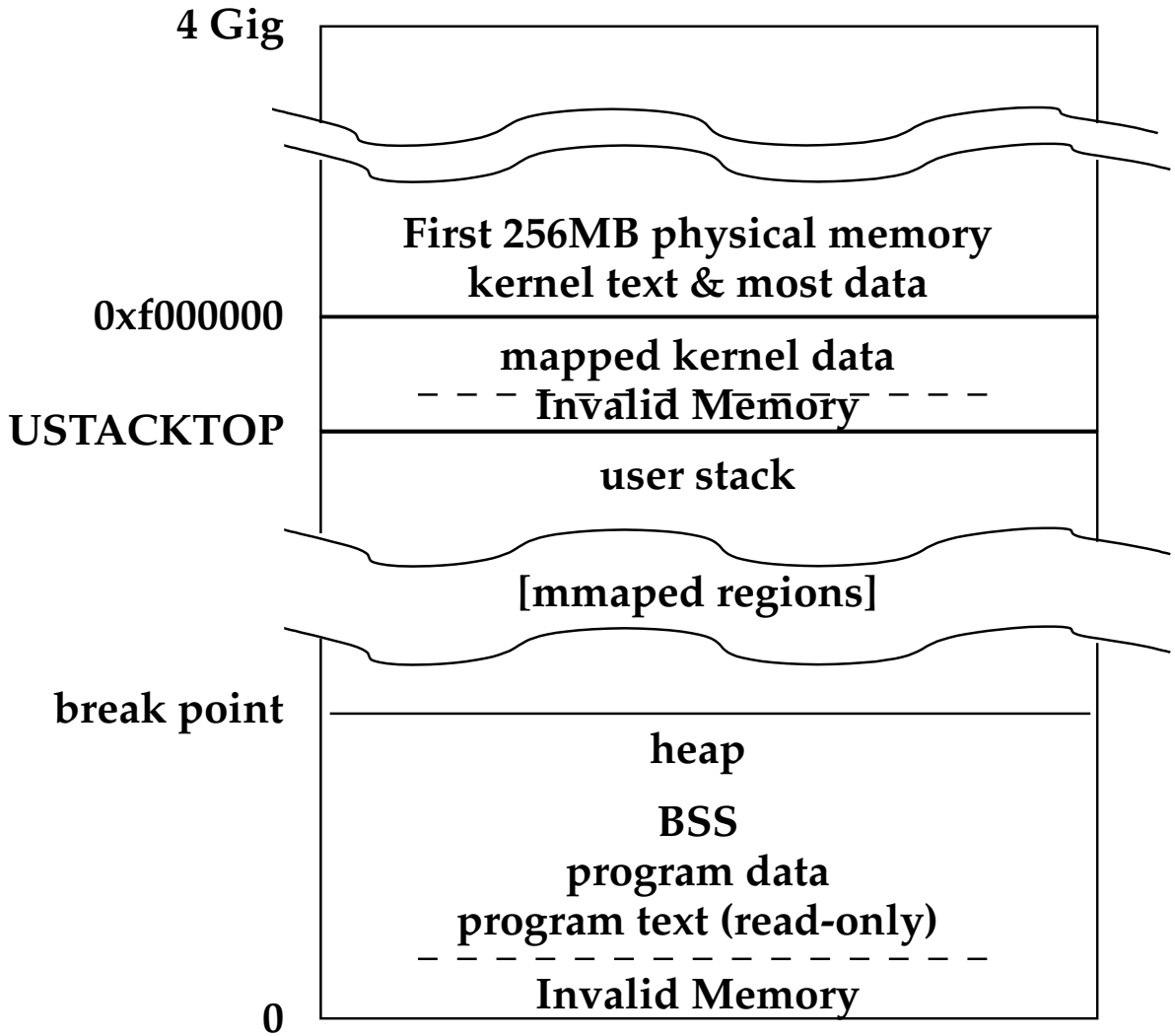
Lab1 notes

- **Due Friday**
- **Hint: Read the manual pages (esp. for *pipe(2)*)**
- **Best if last process in pipeline is child of shell**
  - Consider: `cat file | grep word`
  - `grep` should be a child of `ash` (shell)
  - Don't want to read next command until `grep` is done
  - In background, care more about exit status of `grep`
  - OK to make `cat` a child of `grep`:

```
if (!fork ()) {
  /* set up pipe */
  if (!fork ()) /* exec cat */;
  /* exec grep */;
}
```

Example memory layout



Paging in day-to-day use

- Demand paging
- Growing the stack
- BSS page allocation
- Shared text
- Shared libraries
- Shared memory
- Copy-on-write (fork, mmap, etc.)
- Q: Which pages should have global bit set on x86?

mmap system call

- `void *mmap (void *addr, size_t len, int prot, int flags, int fd, off_t offset)`
  - `prot`: OR of PROT_EXEC, PROT_READ, PROT_WRITE, PROT_NONE
  - `flags`: OR of `MAP_FIXED`, `MAP_ANON`, `MAP_PRIVATE`, `MAP_SHARED`, ...
  - Private means other processes don't see changes until `msync`
  - Q: Can mmap always have exact desired semantics?
- `int msync(void *addr, size_t len, int flags)`
  - If `len == 0`, do entire `mmapped` region
  - `flags`: `MS_ASYNC`, `MS_SYNC`, `MS_INVALIDATE`

More system calls

- `int munmap(void *addr, size_t len)`
  - Removes memory-mapped object
- `int mprotect(void *addr, size_t len, int prot)`
  - Changes protection on pages to `prot` (OR of `PROT_xxx`)
  - Q: What must OS do to implement on x86 hardware?
- `int mincore(void *addr, size_t len, char *vec)`
  - Returns in `vec` which pages present
- `int mlock (void *addr, size_t len)`
  `int munlock (void *addr, size_t len)`
  - Pin/unpin pages in memory

Catching page faults

```
struct sigaction {
  union {                    /* signal handler */
    void (*sa_handler)(int);
    void (*sa_sigaction)(int, siginfo_t *, void *);
  };
  sigset_t sa_mask;     /* signal mask to apply */
  int sa_flags;
};

int sigaction (int sig, const struct sigaction *act,
               struct sigaction *oact)
```

- **Can specify function to run on** `SIGSEGV`

Example: OpenBSD/i386 siginfo

```
struct  sigcontext {
  int sc_gs; int sc_fs; int sc_es; int sc_ds;
  int sc_edi; int sc_esi; int sc_ebp; int sc_ebx;
  int sc_edx; int sc_ecx; int sc_eax;

  int sc_eip; int sc_cs; /* instruction pointer */
  int sc_eflags;         /* condition codes, etc. */
  int sc_esp; int sc_ss; /* stack pointer */

  int sc_onstack;   /* sigstack state to restore */
  int sc_mask;      /* signal mask to restore */

  int sc_trapno;
  int sc_err;
};
```