L6: Client/server in one computer; atomicity

Nickolai Zeldovich
6.033 Spring 2012

Bounded buffer send

```
send(bb, m):
    while True:
        if bb.in – bb.out < N:
            bb.buf[bb.in mod N] ← m
            bb.in ← bb.in + 1
            return
```

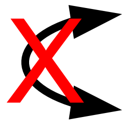
```
send(bb, m):
    while True:
        if bb.in – bb.out < N:
            bb.buf[bb.in mod N] ← m
            bb.in ← bb.in + 1
            return


receive(bb):
    while True:
        if bb.in > bb.out:
            m ← bb.buf[bb.out mod N]
            bb.out ← bb.out + 1
            return m
```

```
send(bb, m):
    while True:
        if bb.in – bb.out < N:
   ?        bb.in ← bb.in + 1
            bb.buf[bb.in-1 mod N] ← m
            return


receive(bb):
    while True:
        if bb.in > bb.out:
            m ← bb.buf[bb.out mod N]
            bb.out ← bb.out + 1
            return m
```

```
send(bb, m):
    while True:
        if bb.in – bb.out < N:
            bb.buf[bb.in mod N] $\leftarrow$ m
            bb.in $\leftarrow$ bb.in + 1
            return
```



```
receive(bb):
    while True:
        if bb.in > bb.out:
            m $\leftarrow$ bb.buf[bb.out mod N]
            bb.out $\leftarrow$ bb.out + 1
            return m
```

Send with locking

```
send(bb, m):
    acquire(bb.send_lock)
    while True:
        if bb.in – bb.out < N:
            bb.buf[bb.in mod N] ← m
            bb.in ← bb.in + 1
            release(bb.send_lock)
            return
```

Does this send work?

```
send(bb, m):
    ~~acquire(bb.send_lock)~~
    while True:
        if bb.in – bb.out < N:
            acquire(bb.send_lock)
            bb.buf[bb.in mod N] ← m
            bb.in ← bb.in + 1
            release(bb.send_lock)
            return
```

File system: no concurrency

```
move(dir1, dir2, name):
    unlink(dir1, name)
    link(dir2, name)
```

Coarse-grained locking

```
move(dir1, dir2, name):
    acquire(fs_lock)
    unlink(dir1, name)
    link(dir2, name)
    release(fs_lock)
```

Fine-grained locking

```
move(dir1, dir2, name):
    acquire(dir1.lock)
    unlink(dir1, name)
    release(dir1.lock)

    acquire(dir2.lock)
    link(dir2, name)
    release(dir2.lock)
```

Fine-grained locking

```
move(dir1, dir2, name):
    acquire(dir1.lock)
    unlink(dir1, name)
    release(dir1.lock)
                          ←  File not in
                             dir1 or dir2
    acquire(dir2.lock)
    link(dir2, name)
    release(dir2.lock)
```

Holding multiple locks

```
move(dir1, dir2, name):
    acquire(dir1.lock)
    acquire(dir2.lock)
    unlink(dir1, name)
    link(dir2, name)
    release(dir1.lock)
    release(dir2.lock)
```

Deadlock

A

```
move(dir1, dir2, na):
    acquire(dir1.lock)
    acquire(dir2.lock)
    unlink(dir1, na)
    link(dir2, na)
    release(dir1.lock)
    release(dir2.lock)
```

B

```
move(dir2, dir1, nb):
    acquire(dir2.lock)
    acquire(dir1.lock)
    unlink(dir2, nb)
    link(dir1, nb)
    release(dir2.lock)
    release(dir1.lock)
```

Avoiding deadlock

```
move(dir1, dir2, name):
    if dir1.inum < dir2.inum:
        acquire(dir1.lock)
        acquire(dir2.lock)
    else:
        acquire(dir2.lock)
        acquire(dir1.lock)
    unlink(dir1, name)
    link(dir2, name)
    release(dir1.lock)
    release(dir2.lock)
```

Summary

- Client/server in one computer: bounded buffers
- Concurrent programming is tricky!
- Locks help make several actions look atomic
  - Before-or-after atomicity