Multi-tasking in PHP

About Me

- Formerly CTO for Company52
- Currently work at Brandmovers on Northside Drive
- Self-taught
- Full-time geek since 2007

Multitasking
ROFLCAT.COM

Use Cases

- System resources are not the bottleneck
- Batch processing involving an API:
  - E-Mail
  - Geocoding
  - Electronic billing
- Daemons

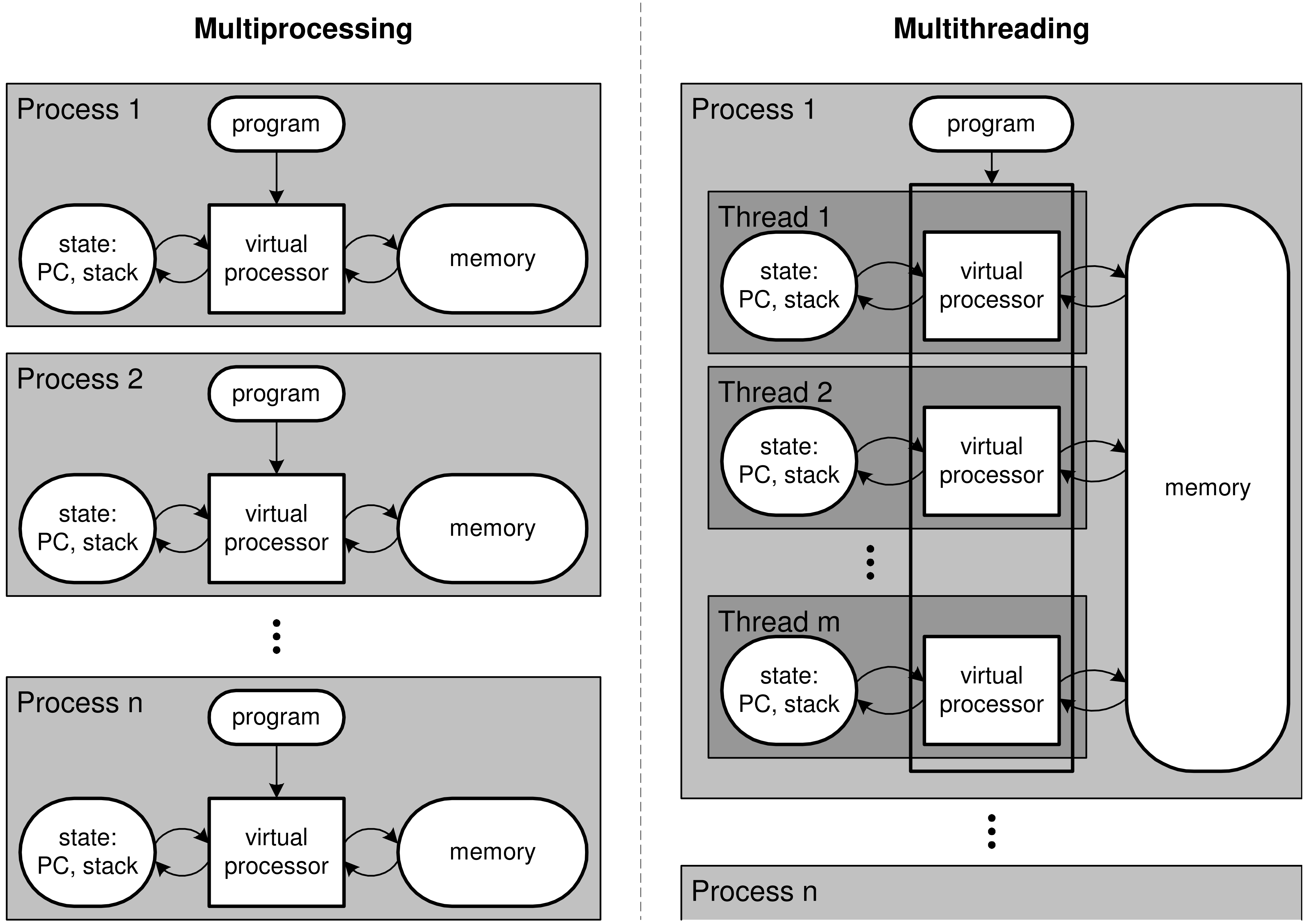
Alternatives

- Gearman
- curl_multi_*
- Other scripting languages

Theory

Two ways to multi-task

Multi-processing	Multi-threading
Separate memory	Shared memory
Errors are isolated	Errors are not isolated
Separate permissions	Same permissions
Linux/UNIX	Windows



Courtesy www.fmc-modeling.org

Multiprocessing

- “The simultaneous execution of two or more programs by separate CPUs under integrated control.”
- Clones the entire process, except resources
- Copy-on-write memory

Forking

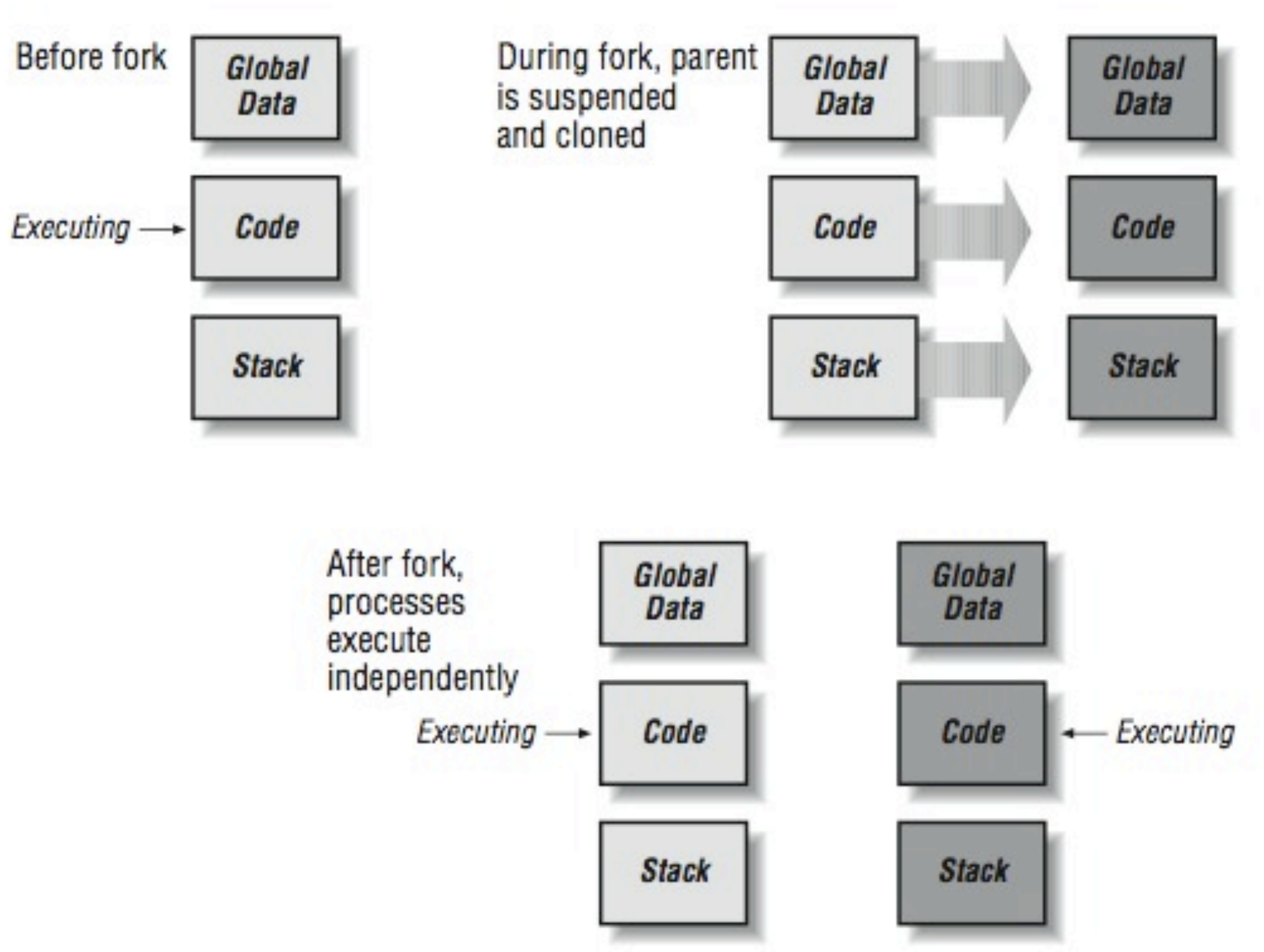


Diagram courtesy cnx.org

Child Process

- A cloned copy of a parent process
- Receives a new process ID and a parent process ID
- Does some work
- Dies

...sort of.

Photo Credit: Christopher Brian (2011 Toronto Zombie Walk)

Parent Responsibilities

- Reproduction
- Monitors child process status
- “Reap” zombie processes

Process Signals

Signal	Description
SIGCHLD	Child process died
SIGINT	User Interrupt
SIGTERM	Terminate
SIGKILL	Forcibly terminate

PHP Implementation

Requirements

- Unix-like operating system
- PHP 4.1+
- PHP PCNTL extension
  (compile with --enable-pcntl)
- PHP Semaphore extension, optional
  (--enable-sysvsem, --enable-sysvshm, --enable-sysvmsg)
- Plenty of memory
- Multiple CPU cores

Overview

1. Define signal handlers
2. Fetch a dataset
3. Fork off one child process for each item
4. Stop forking when a threshold is reached, and sleep
5. Reap a child process whenever SIGCHLD is received
6. If there's more work to do, fork more processes
7. When all child processes have been reaped, terminate

```
declare(ticks = 1);

// Setup our signal handlers
pcntl_signal(SIGTERM, "signal_handler");
pcntl_signal(SIGINT,  "signal_handler");
pcntl_signal(SIGCHLD, "signal_handler");
```

```
function signal_handler($signal)
{
    switch ($signal)
    {
        case SIGINT:
        case SIGTERM:
            // kill all child processes
            exit(0);
        case SIGCHLD:
            // reap a child process
            reap_child();
        break;
    }
}
```

```
$pid = pcntl_fork();

switch($pid)
{
    case 0:
        // Child process
        call_user_func($callback, $data);
        posix_kill(posix_getppid(), SIGCHLD);
        exit;
    case -1:
        // Parent process, fork failed
        throw new Exception("Out of memory!");
    default:
        // Parent process, fork succeeded
        $processes[$pid] = TRUE;
}
```

Repeat for each unit of work

```
function reap_child()
{
    // Check if any child process has terminated,
    // and if so remove it from memory
    $pid = pcntl_wait($status, WNOHANG);
    if ($pid < 0)
    {
        throw new Exception("Out of memory");
    }
    elseif ($pid > 0)
    {
        unset($processes[$pid]);
    }
}
```

Demo Time!

http://gist.github.com/4212160

easy
STAPLES®

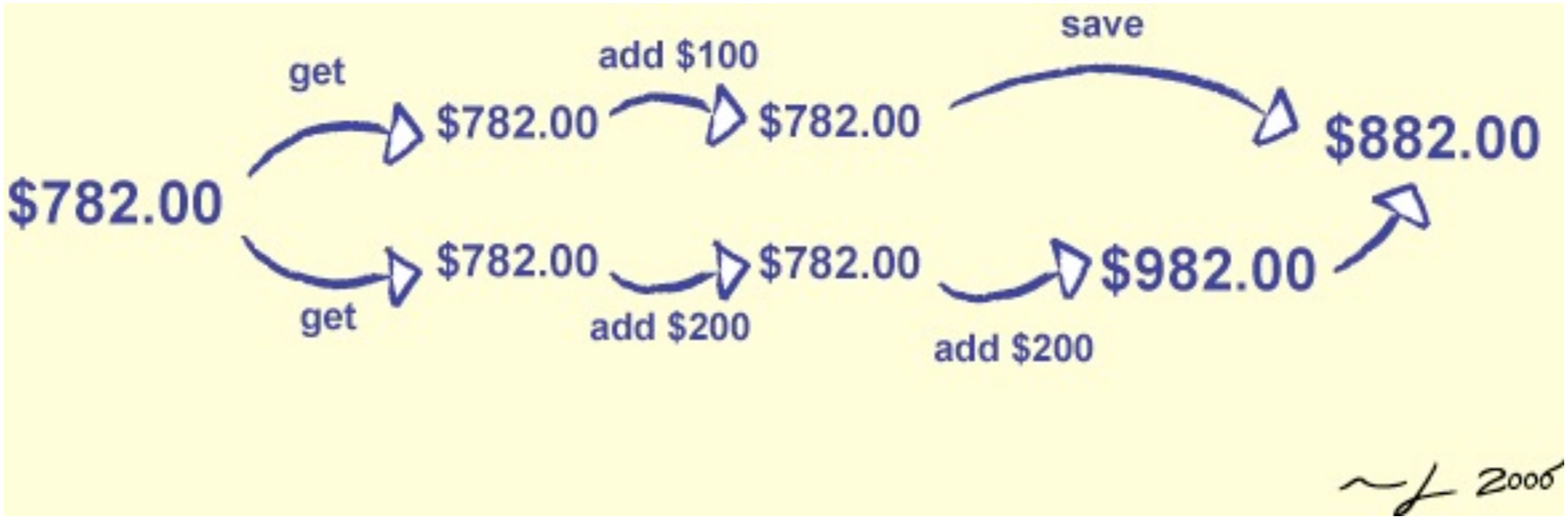
DON'T:

- DON'T fork a web process (CLI only!)
- DON'T overload your system
- DON'T open resources before forking
- DO respect common POSIX signals
- DO remove zombie processes
- DO force new database connections in children
  mysql_reconnect($s, $u, $p, TRUE);

Challenges

Race Conditions

- A logic bug where the result is affected by the sequence or timing of uncontrollable events
- Adding debug logic can change timing
- Dirty reads
- Lost data
- Unpredictable behavior
- Deadlocks, hanging, crashing


$782.00
get
$782.00
add $100
$782.00
save
$882.00
get
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add $200
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add $200
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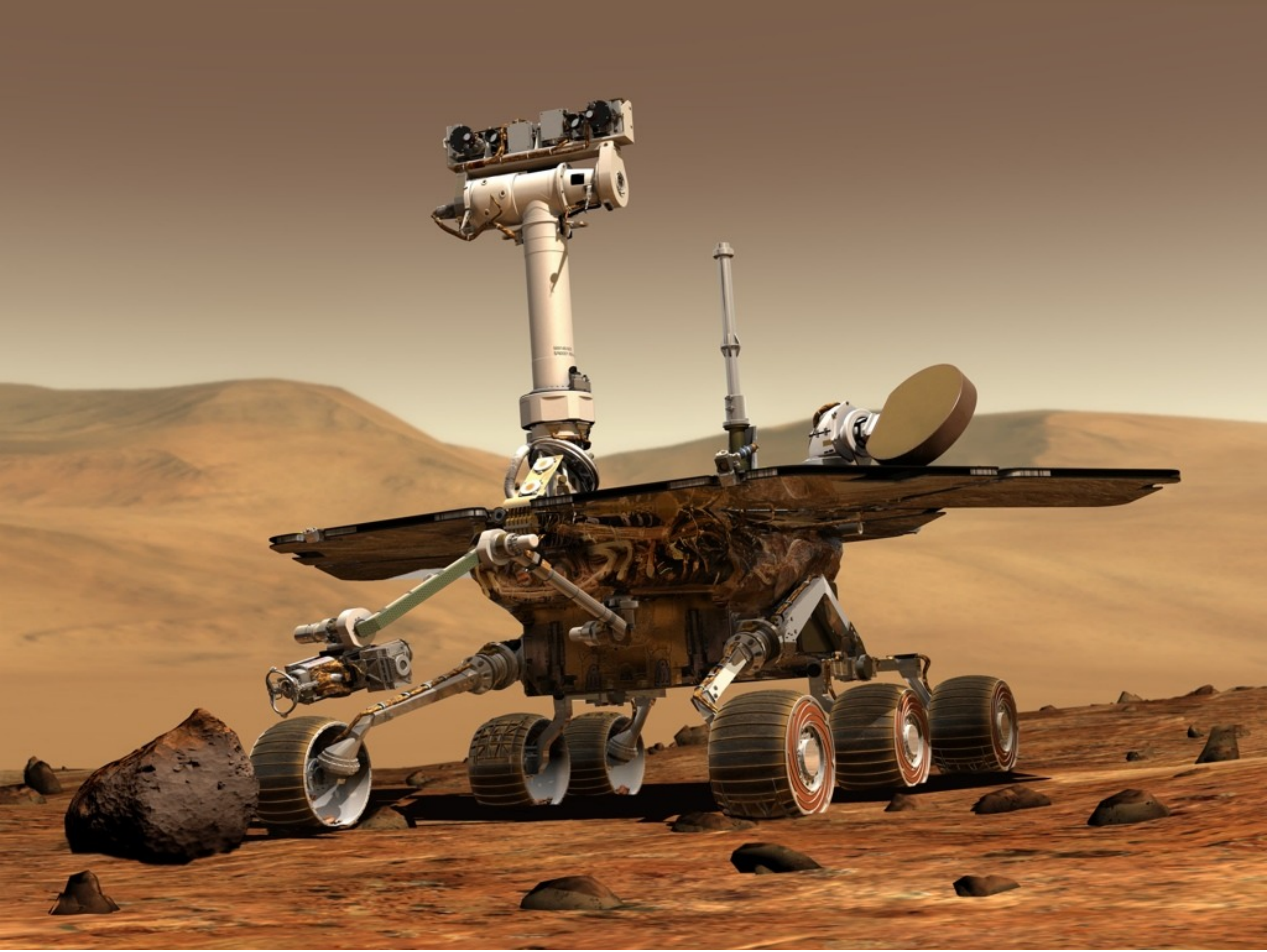
~J 2006



Solutions

- Handle I/O in the parent process exclusively
- Manage resources with semaphores and/or mutexes

Semaphores

- Semaphore = atomically updated counter
- Mutex = binary semaphore with ownership
- PHP: sem_get(), sem_release()
- Transactional databases use semaphores

Deadlocks

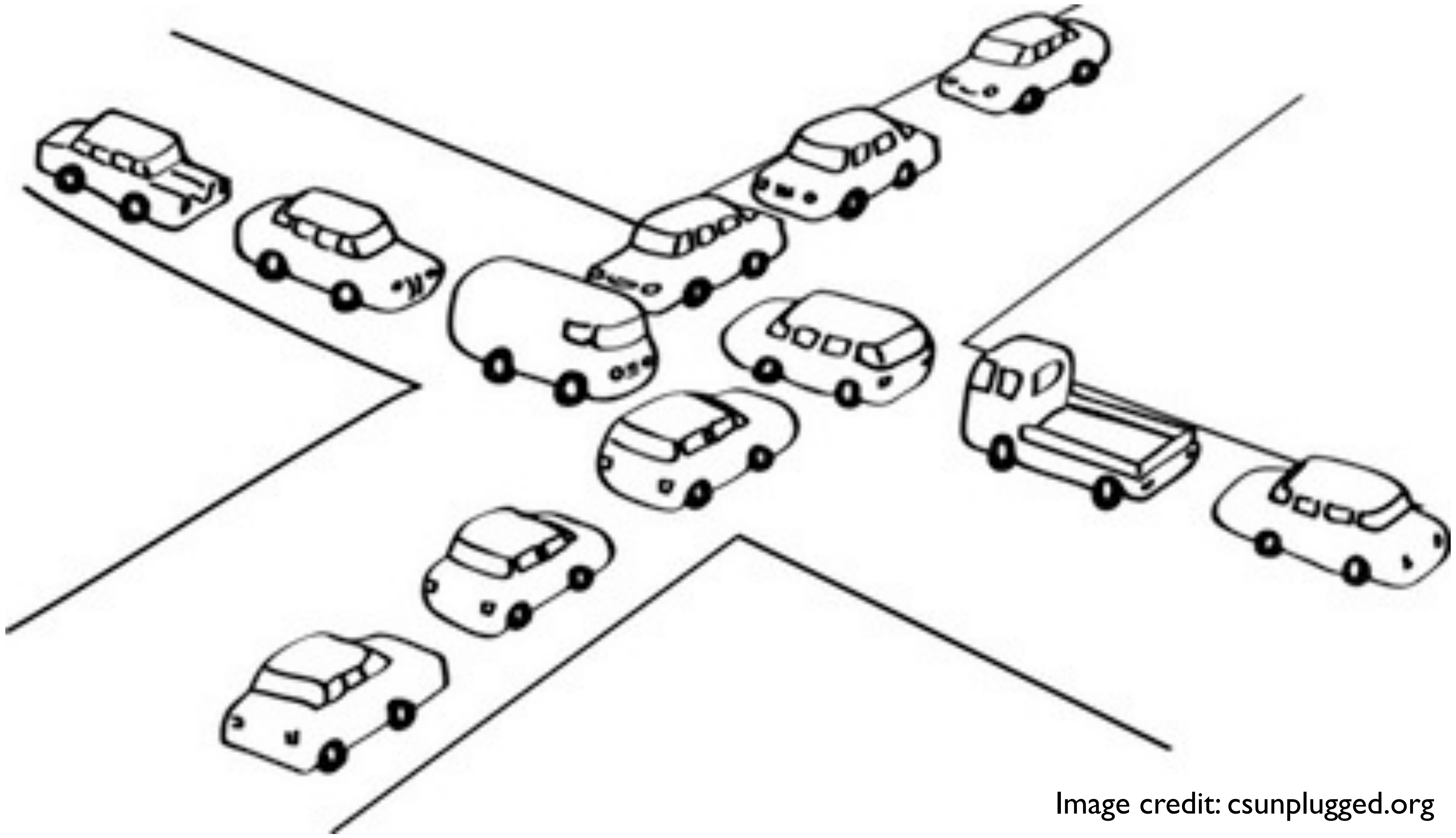


Image credit: csunplugged.org

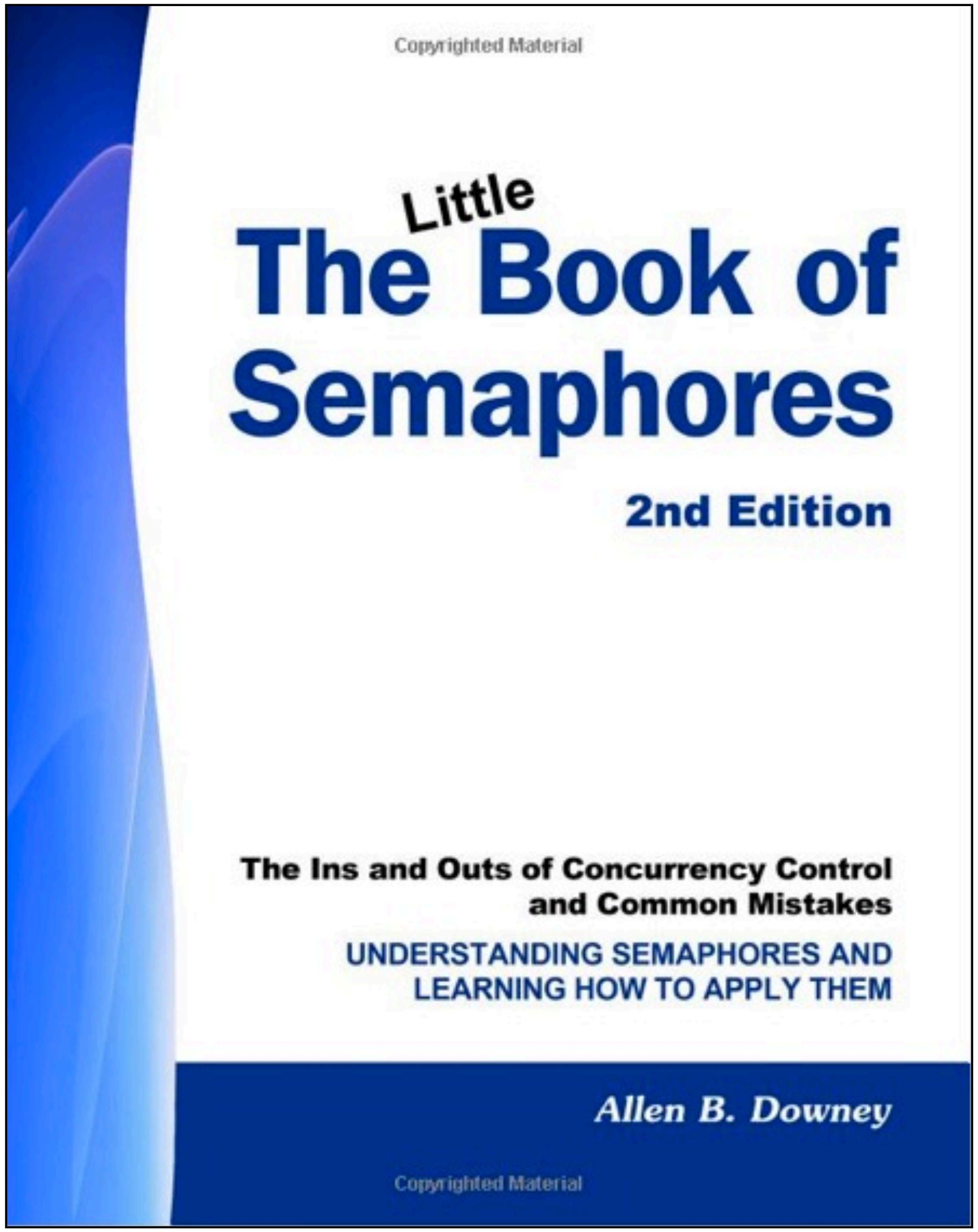
Bonus Slides

Shared Memory

- Advanced inter-process communication
- Pass data back to the parent process
- PHP Shared Memory extension (--enable-shmop)
- PHP System V Shared Memory extension (--enable-sysvshm)
  - More robust
  - Compatible with other languages

Daemonization

- Fork, kill parent
- Orphaned child process continues running
- Signal and error handling are critical
- Server daemons usually fork child processes to handle requests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The Little Book of Semaphores

2nd Edition

The Ins and Outs of Concurrency Control and Common Mistakes

UNDERSTANDING SEMAPHORES AND LEARNING HOW TO APPLY THEM

Allen B. Downey

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