The past, present and future of Samba messaging

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SerNet

- Founded 1996
- Offices in Göttingen and Berlin
- Topics: information security and data protection
- Specialized on Open Source Software
- Samba: Windows/Linux interoperability, clustering and private cloud
- SAMBA+: Samba for Enterprise Linux
- verinice.: Open Source ISMS Tool
- Firewalls and VPN solutions for mid-size and large corporations
- Old economy: no venture capital, no loans

Overview

- General motivation for Samba's IPC
- Basic standard Posix IPC mechanisms
- Past Samba messaging implementation: tdb and signals
- Current mechanism: Unix Domain Datagram sockets
- Future developments

Parallelism based on messages

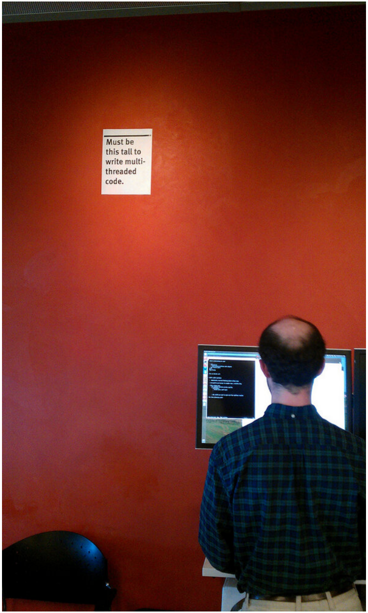
- Wikipedia: An actor is a computational entity that, in response to a message it receives, can concurrently:
  - send a finite number of messages to other actors;
  - create a finite number of new actors;
  - designate the behavior to be used for the next message it receives.
  - There is no assumed sequence to the above actions and they could be carried out in parallel.
- Many languages embed message passing these days
  - Erlang, Google go, Akka for JVM
- Some problems with threaded programming disappear with message-based parallelism
  - Others of course get created :-)

Why Inter *Process* Communication?

- Erlang, Go and others provide intra-OS-process messages
  - Threading based on OS threads plus VM threads
  - All in one memory space
- Dependency on the virtual machine
- Distribution to processes possibly more reliable
  - A crash in one OS process has less effect on others
- Better NUMA affinity
  - Isolated memory maps
- Process architecture has helped Samba to go clustered
- Interoperability to other languages

Samba architecture

- Traditional Unix architecture
- One listener process
  - Every client gets its own worker process
- Helper Threads for asynchronous I/O
  - Linux has no good general kernel-level aio
- Multi process single thread is vastly simpler than multi thread to us
- Samba has to communicate: The oplock break
  - Process A needs to ask process B to release an oplock
- Architecture makes clustered SMB possible
  - Multi-process enforces IPC discipline
- Going more async: Notifyd


Must be
this tall to
write multi-
threaded
code.

Unix Signals

- One of the oldest Unix IPC mechanism
  - Asynchronous delivery
  - Almost no information transferred
- Difficult to use together with threads
  - If possible, receive signals in one thread only
- When used, not much can be done in a signal handler
  - Posix lists only 135 functions as aync signal safe
- Watch out for EINTR result of most syscalls

Shared Memory

- Same memory pages visible in multiple processes
  - Blurs the distinction between threads and processes
- Fastest IPC mechanism
  - No kernel involvement for data transfer
  - Good for transferring mass data
- Limited use for message passing
  - No good signalling mechanism
- Needs coordinated access
  - Locks, Mutexes

fcntl locks

- Advisory byte range locks
  - Shared (F_RDLCK) or exclusive (F_WRLCK) locks
  - Just an IPC mechanism: fcntl locks do not block read/write
- Weird semantics regarding duplicated file descriptors
  - Closing any fd on a file loses locks on dup'ed fds
- Very bad scaling
  - fcntl locks maintained in a linked list
  - Posix suggests deadlock detection → locks are not per-file
  - Linux has (had?) one big global spinlock for all fcntl lock operations
  - Thundering herd when thousands of waiters are unblocked
- Automatic cleanup at process exit
  - Lock waiters are not notified that a process crashed

Process Shared Robust Mutexes

- pthread_mutex_t: pthread API to implement critical sections
  - Originally intended for multiple threads within a single process
- Implementation under Linux with atomic operations
  - No syscall in the non-contended case
  - Waiting for a locked mutex uses a syscall
- PTHREAD_PROCESS_SHARED: Mutexes in shared memory
  - Downside: If a mutex holder crashes, nobody can clean up
- PTHREAD_MUTEX_ROBUST: EOWNERDEAD
  - When a mutex holder dies, a subsequent pthread_mutex_lock gets EOWNERDEAD
  - Linux and Solaris only

Samba Messaging

- Samba has a multi-writer key/value hash table: TDB
  - Shared Memory
  - Coordination via fcntl locks
  - Where available: Process Shared Robust Mutexes
- Very fast for heavy concurrent small record updaters
- Messaging based on tdb:
  - Every process has a record in a tdb as a mailbox
  - Signalling via SIGUSR1
- Simple, but bad under high load
  - fcntl load brings system down
  - With robust mutexes it is okay

Unix Domain Datagram Sockets

- "UDP" on the local box
  - Contrary to UDP, AF_UNIX DGRAM sockets are reliable
- One socket per participating process
  - Limited message size, sender must fragment
- FD passing possible via sendmsg()
- Asynchronous send into full queue:
  - Poll with nonblocking send: High load by senders
- Blocking connected send scales well under Linux
  - No thundering herd, contrary to thousands of writers into a pipe
  - Well tuned for syslog via /dev/log
- Access to the socket dir can become a bottleneck

Replace ctdb messaging

- All cluster communication goes through ctdbd
  - Single Process, Single Threaded
  - Only 1 CPU used for inter-node messaging
- Samba assumes reliable messaging
  - Stream Socket, i.e. TCP between nodes
  - TCP connection setup too expensive per message
- One proxy process per peer
  - Open a normal Unix DGRAM socket
  - Forward to another node
  - Sender process decides which proxy to use

Unix Domain Stream Sockets

- Datagram Sockets not overload-safe on FreeBSD
  - ENOBUFS returned under overload
  - Unlike Linux, FreeBSD can't do graceful blocking send
- Every message involves namespace operations
  - Not truly scalable, requires a read lock on the socket directory
- File Descriptors are cheap
  - epoll/kqueue designed to scale
- $N * M$ Stream Sockets between processes

tmond

- How to pass stream socket fds?
  - Every smbd listens on a stream socket
  - connect() does not behave nicely under overload
- tmond provides a central hub
  - Every messaging process connects() once
- Fresh stream to a peer: socketpair() and sendmsg() via tmond
- Process Monitoring via tmond
  - Locks in user space: Wait for a process to go away, retry
  - General replacement for ctdb_watch_us/ctdb_unwatch

Questions?

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