SMB3.1.1 POSIX Protocol Extensions: Summary and Current Implementation Status

Steve French

Azure Storage – Microsoft

Samba Team

SMB 3.1.1

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Outline

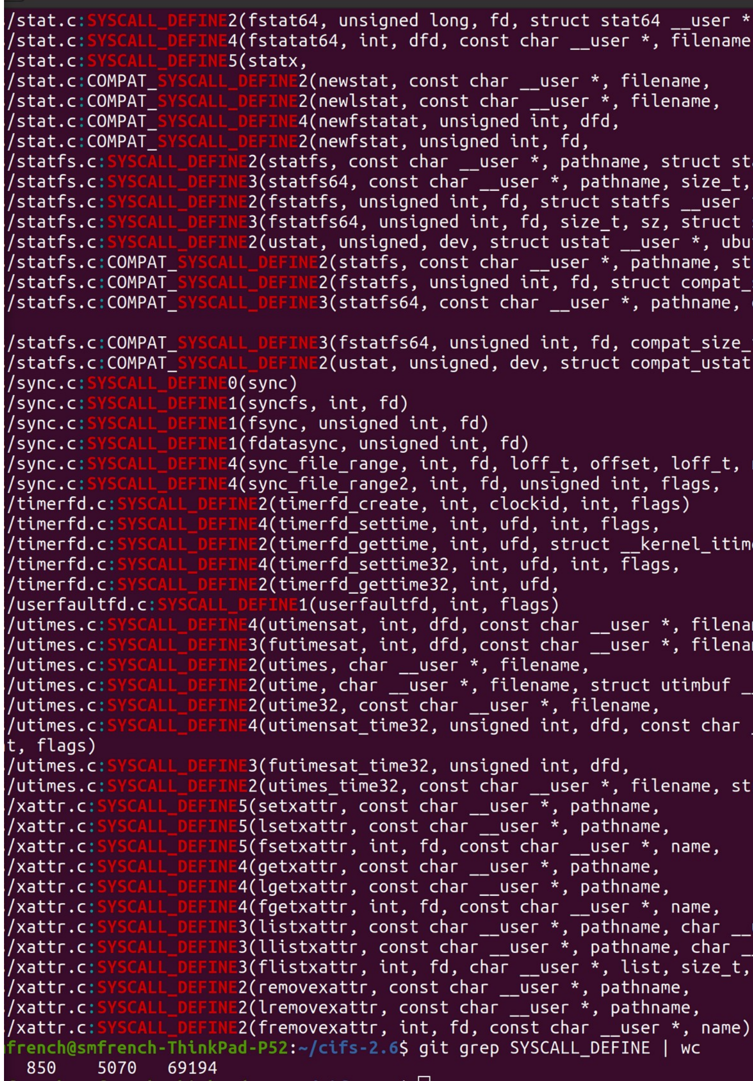
- Linux is a lot more than POSIX ...
- Why do these extensions matter?
- Implementation Status
- What works today?
- Some details
- How to handle Linux continuing to extend APIs, to improve?
- Wireshark and Tracing

Linux > POSIX

- Currently huge number of syscalls! (try “git grep SYSCALL_DEFINE” well over 850 and 500+ are even documented “man syscalls” FS layer has 223). Verified today

  vs

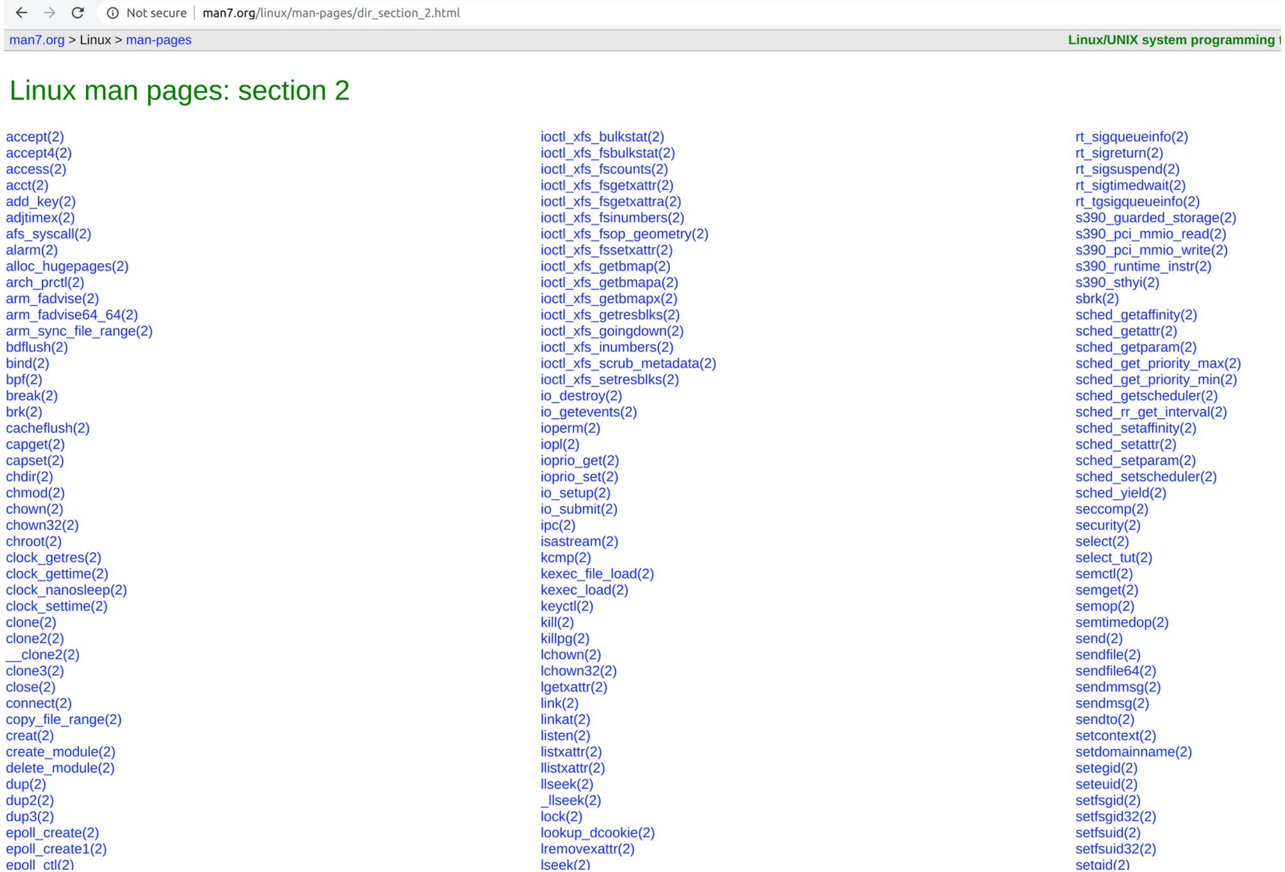
- Only about 100 POSIX API calls



```
/stat.c:SYSCALL_DEFINE2(fstat64, unsigned long, fd, struct stat64 __user *
/stat.c:SYSCALL_DEFINE4(fstatat64, int, dfd, const char __user *, filename
/stat.c:SYSCALL_DEFINE5(statx,
/stat.c:COMPAT_SYSCALL_DEFINE2(newstat, const char __user *, filename,
/stat.c:COMPAT_SYSCALL_DEFINE2(newlstat, const char __user *, filename,
/stat.c:COMPAT_SYSCALL_DEFINE4(newfstatat, unsigned int, dfd,
/stat.c:COMPAT_SYSCALL_DEFINE2(newfstat, unsigned int, fd,
/statfs.c:SYSCALL_DEFINE2(statfs, const char __user *, pathname, struct st
/statfs.c:SYSCALL_DEFINE3(statfs64, const char __user *, pathname, size_t,
/statfs.c:SYSCALL_DEFINE2(fstatfs, unsigned int, fd, struct statfs __user
/statfs.c:SYSCALL_DEFINE3(fstatfs64, unsigned int, fd, size_t, sz, struct
/statfs.c:SYSCALL_DEFINE2(ustat, unsigned, dev, struct ustat __user *, ubu
/statfs.c:COMPAT_SYSCALL_DEFINE2(statfs, const char __user *, pathname, st
/statfs.c:COMPAT_SYSCALL_DEFINE2(fstatfs, unsigned int, fd, struct compat_
/statfs.c:COMPAT_SYSCALL_DEFINE3(statfs64, const char __user *, pathname,

/statfs.c:COMPAT_SYSCALL_DEFINE3(fstatfs64, unsigned int, fd, compat_size_
/statfs.c:COMPAT_SYSCALL_DEFINE2(ustat, unsigned, dev, struct compat_ustat
/sync.c:SYSCALL_DEFINE0(sync)
/sync.c:SYSCALL_DEFINE1(syncfs, int, fd)
/sync.c:SYSCALL_DEFINE1(fsync, unsigned int, fd)
/sync.c:SYSCALL_DEFINE1(fdatasync, unsigned int, fd)
/sync.c:SYSCALL_DEFINE4(sync_file_range, int, fd, loff_t, offset, loff_t,
/sync.c:SYSCALL_DEFINE4(sync_file_range2, int, fd, unsigned int, flags,
/timerfd.c:SYSCALL_DEFINE2(timerfd_create, int, clockid, int, flags)
/timerfd.c:SYSCALL_DEFINE4(timerfd_settime, int, ufd, int, flags,
/timerfd.c:SYSCALL_DEFINE2(timerfd_gettime, int, ufd, struct __kernel_itim
/timerfd.c:SYSCALL_DEFINE4(timerfd_settime32, int, ufd, int, flags,
/timerfd.c:SYSCALL_DEFINE2(timerfd_gettime32, int, ufd,
/userfaultfd.c:SYSCALL_DEFINE1(userfaultfd, int, flags)
/utimes.c:SYSCALL_DEFINE4(utimensat, int, dfd, const char __user *, filena
/utimes.c:SYSCALL_DEFINE3(futimesat, int, dfd, const char __user *, filena
/utimes.c:SYSCALL_DEFINE2(utimes, char __user *, filename,
/utimes.c:SYSCALL_DEFINE2(utime, char __user *, filename, struct utimbuf _
/utimes.c:SYSCALL_DEFINE2(utime32, const char __user *, filename,
/utimes.c:SYSCALL_DEFINE4(utimensat_time32, unsigned int, dfd, const char
t, flags)
/utimes.c:SYSCALL_DEFINE3(futimesat_time32, unsigned int, dfd,
/utimes.c:SYSCALL_DEFINE2(utimes_time32, const char __user *, filename, st
/xattr.c:SYSCALL_DEFINE5(setxattr, const char __user *, pathname,
/xattr.c:SYSCALL_DEFINE5(lsetxattr, const char __user *, pathname,
/xattr.c:SYSCALL_DEFINE5(fsetxattr, int, fd, const char __user *, name,
/xattr.c:SYSCALL_DEFINE4(getxattr, const char __user *, pathname,
/xattr.c:SYSCALL_DEFINE4(lgetxattr, const char __user *, pathname,
/xattr.c:SYSCALL_DEFINE4(fgetxattr, int, fd, const char __user *, name,
/xattr.c:SYSCALL_DEFINE3(listxattr, const char __user *, pathname, char __
/xattr.c:SYSCALL_DEFINE3(llistxattr, const char __user *, pathname, char _
/xattr.c:SYSCALL_DEFINE3(flistxattr, int, fd, char __user *, list, size_t,
/xattr.c:SYSCALL_DEFINE2(removexattr, const char __user *, pathname,
/xattr.c:SYSCALL_DEFINE2(lremovexattr, const char __user *, pathname,
/xattr.c:SYSCALL_DEFINE2(fremovexattr, int, fd, const char __user *, name)
french@smfrench-ThinkPad-P52:~/cifs-2.6$ git grep SYSCALL_DEFINE | wc
    850    5070   69194
```

513 syscalls with man pages!



Not secure | man7.org/linux/man-pages/dir_section_2.html

man7.org > Linux > man-pages

Linux/UNIX system programming t

Linux man pages: section 2

accept(2)
accept4(2)
access(2)
acct(2)
add_key(2)
adjtimex(2)
afs_syscall(2)
alarm(2)
alloc_hugepages(2)
arch_prctl(2)
arm_fadvise(2)
arm_fadvise64_64(2)
arm_sync_file_range(2)
bdflush(2)
bind(2)
bpf(2)
break(2)
brk(2)
cacheflush(2)
capget(2)
capset(2)
chdir(2)
chmod(2)
chown(2)
chown32(2)
chroot(2)
clock_getres(2)
clock_gettime(2)
clock_nanosleep(2)
clock_settime(2)
clone(2)
clone2(2)
__clone2(2)
clone3(2)
close(2)
connect(2)
copy_file_range(2)
creat(2)
create_module(2)
delete_module(2)
dup(2)
dup2(2)
dup3(2)
epoll_create(2)
epoll_create1(2)
epoll_ctl(2)

ioctl_xfs_bulkstat(2)
ioctl_xfs_fsbulkstat(2)
ioctl_xfs_fscounts(2)
ioctl_xfs_fsgetxattr(2)
ioctl_xfs_fsgetxattra(2)
ioctl_xfs_fsinumbers(2)
ioctl_xfs_fsop_geometry(2)
ioctl_xfs_fssetxattr(2)
ioctl_xfs_getbmap(2)
ioctl_xfs_getbmapa(2)
ioctl_xfs_getbmapx(2)
ioctl_xfs_getresblks(2)
ioctl_xfs_goingdown(2)
ioctl_xfs_inumbers(2)
ioctl_xfs_scrub_metadata(2)
ioctl_xfs_setresblks(2)
io_destroy(2)
io_getevents(2)
ioperm(2)
iopl(2)
ioprio_get(2)
ioprio_set(2)
io_setup(2)
io_submit(2)
ipc(2)
isastream(2)
kcmp(2)
kexec_file_load(2)
kexec_load(2)
keyctl(2)
kill(2)
killpg(2)
lchown(2)
lchown32(2)
lgetxattr(2)
link(2)
linkat(2)
listen(2)
listxattr(2)
llistxattr(2)
llseek(2)
_llseek(2)
lock(2)
lookup_dcookie(2)
lremovexattr(2)
lseek(2)

rt_sigqueueinfo(2)
rt_sigreturn(2)
rt_sigsuspend(2)
rt_sigtimedwait(2)
rt_tgsigqueueinfo(2)
s390_guarded_storage(2)
s390_pci_mmio_read(2)
s390_pci_mmio_write(2)
s390_runtime_instr(2)
s390_sthyi(2)
sbrk(2)
sched_getaffinity(2)
sched_getattr(2)
sched_getparam(2)
sched_get_priority_max(2)
sched_get_priority_min(2)
sched_getscheduler(2)
sched_rr_get_interval(2)
sched_setaffinity(2)
sched_setattr(2)
sched_setparam(2)
sched_setscheduler(2)
sched_yield(2)
seccomp(2)
security(2)
select(2)
select_tut(2)
semctl(2)
semget(2)
semop(2)
semtimedop(2)
send(2)
sendfile(2)
sendfile64(2)
sendmmsg(2)
sendmsg(2)
sendto(2)
setcontext(2)
setdomainname(2)
setegid(2)
seteuid(2)
setfsgid(2)
setfsgid32(2)
setfsuid(2)
setfsuid32(2)
setgid(2)

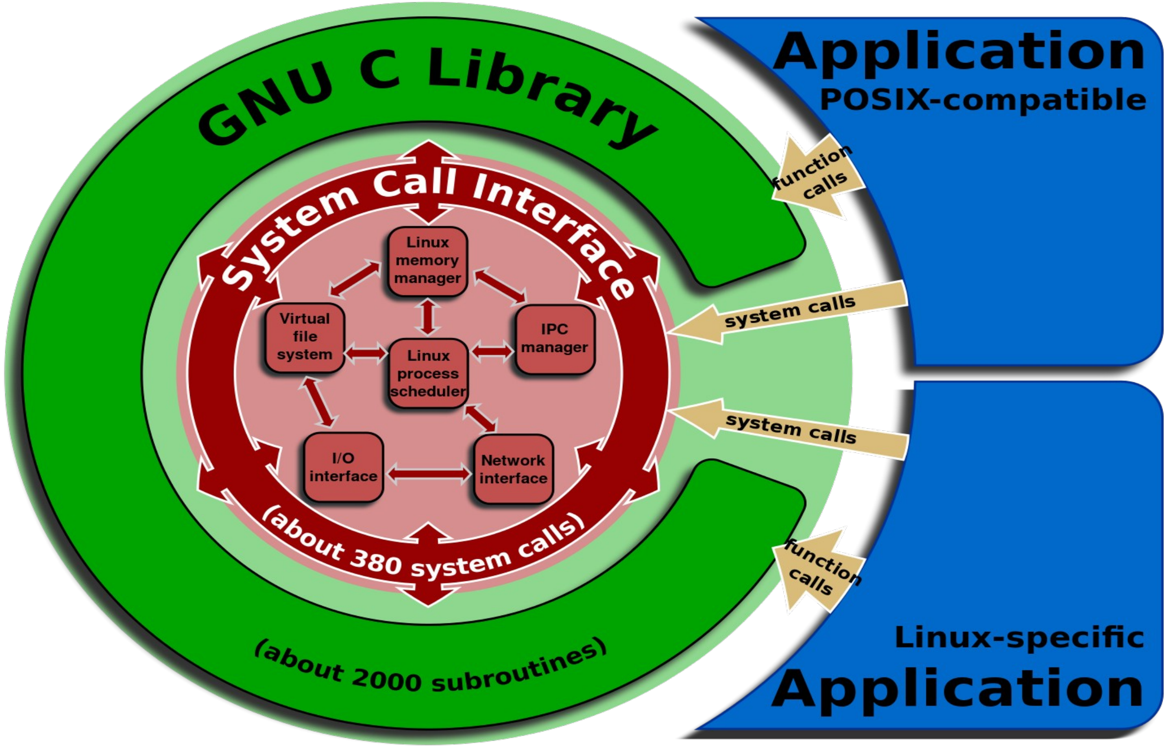
+12 just since last year’s SDC!

Some examples of new fs ones from past 9 months ...

Syscall name	Kernel Version introduced
io_uring_enter	5.1
io_uring_register	5.1
io_uring_setup	5.1
move_mount	5.2
open_tree	5.2
fsconfig	5.2
fsmount	5.2
fsopen	5.2
fspick	5.2

Repeating an old slide ...

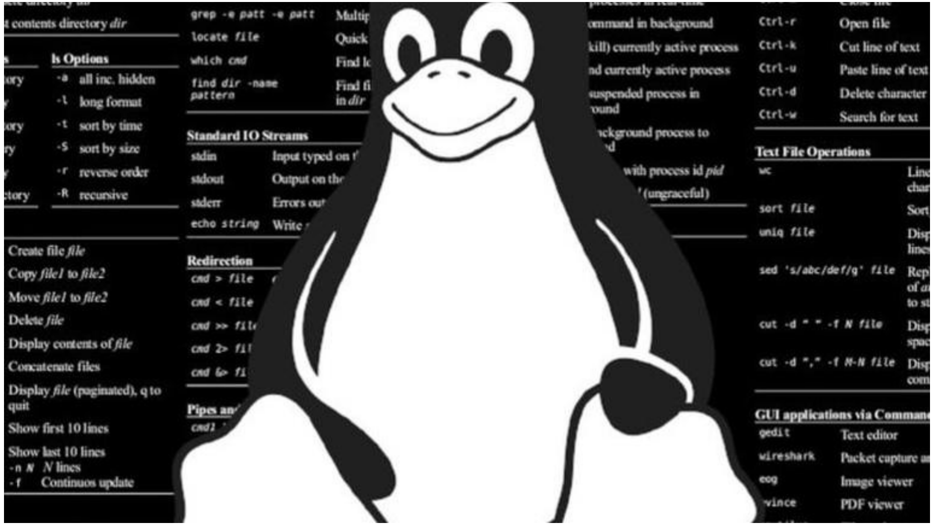
- Remember LINUX > POSIX



And not just new syscalls … new flags ...

- 2 examples of richer Linux vs. simpler POSIX
- fallocate has 7 flags
  - Insert range
  - Unshare range
  - Zero range
  - Keep size
  - But POSIX fallocate has no flags
- Rename (renameat2) has 3 flags
  - noreplace, whiteout and exchange
  - POSIX rename has none

- **Network File systems matter**
  - these extensions to most popular network fs protocol (SMB3) are important
  - block devices struggle to do file system tasks: locking, security, leases, consistent metadata
- Linux Apps need to work over network mounts and continue to work as Linux evolves
- Improve common situations where customers have Linux and Windows and Mac clients
- Make sure extensions work with most secure, most optimal SMB3.1.1 dialect (don’t encourage less secure network file systems, or even SMB1/CIFS)



Quick Overview of Status

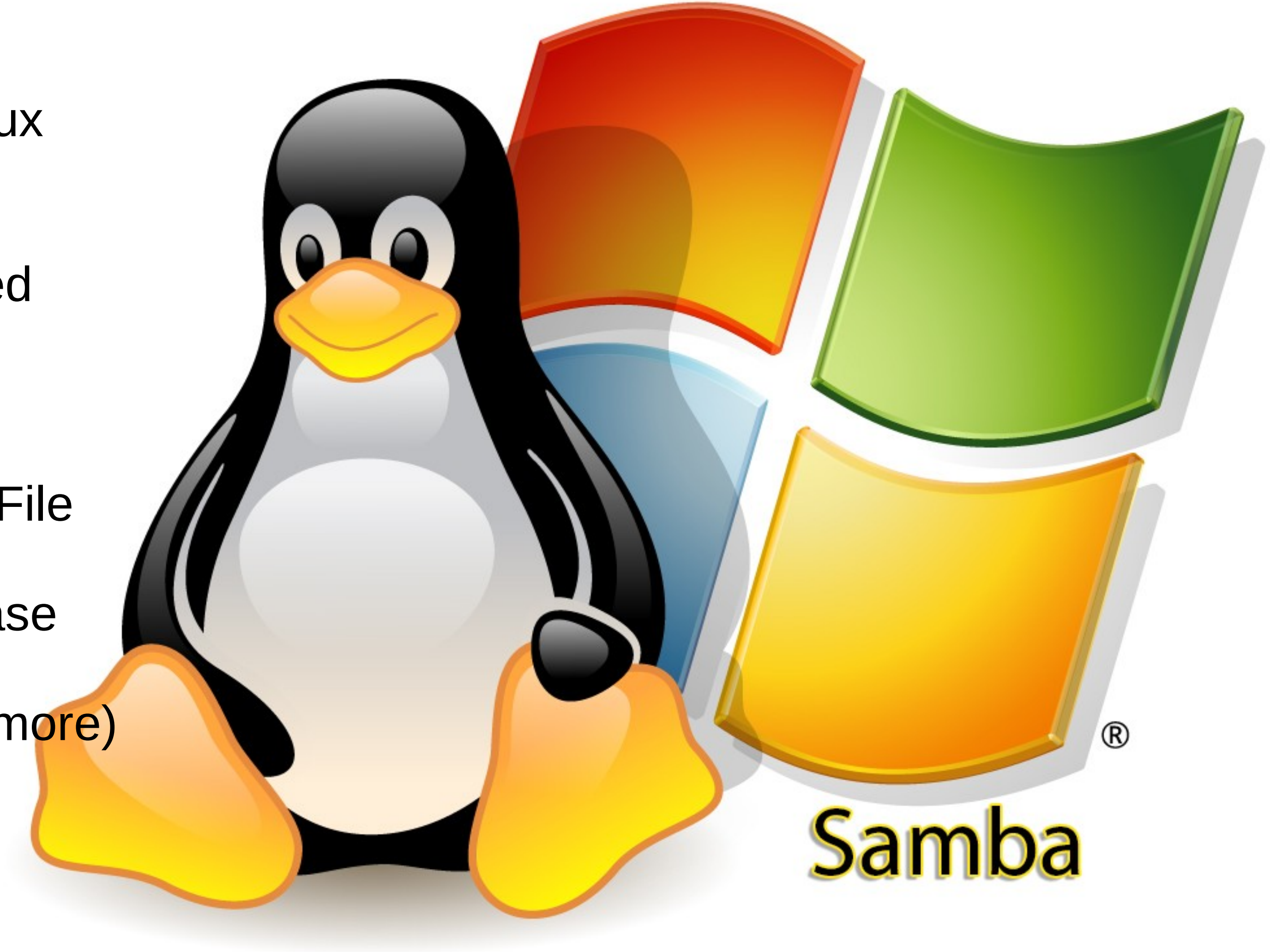
- Linux kernel client:
  - 5.1 kernel or later can be used. Enable with mount option “posix”
    - POSIX readdir support missing, and support for new reparse tags for special files (in progress)
- Samba (experimental tree available, enable with smb.conf parm)
  - Server
    - All major features work. Merge delayed due to time consuming conflicts with other large charges. Special file handling (Sockets, FIFOs, char device handling) needs to be updated
  - Client tools (smbclient)
    - Major features work. Additional options could be added to cmd set
- SMB3 Kernel server (cifsd’s ksmbd.ko)
  - Early investigation
- 3rd party prototypes
- Wireshark patches available (network analysis)

Why Samba?

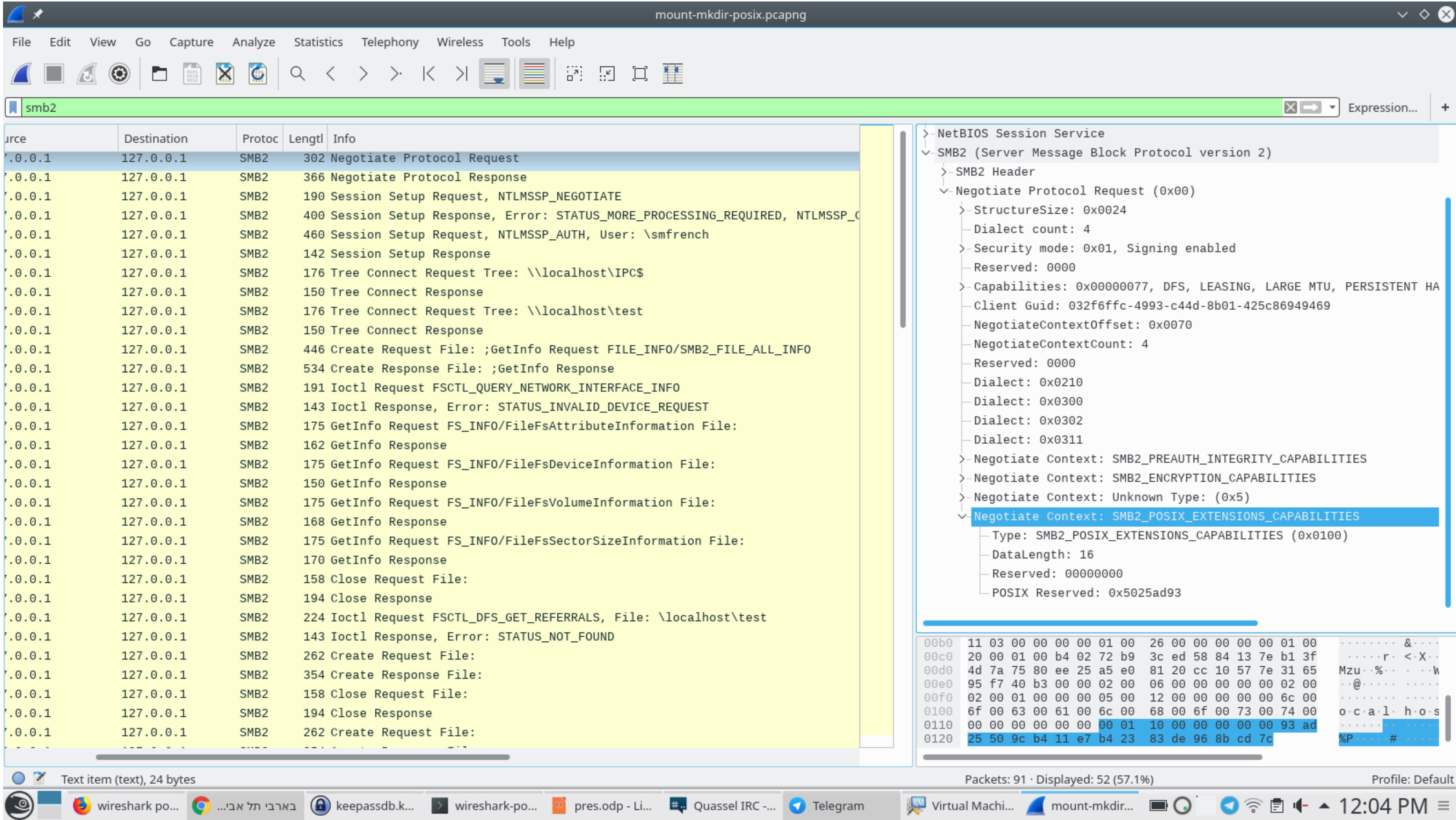
Since 1992 …

Top Server on Linux

- Proven
- Broadly Implemented
- Extensible
- Secure
- Well Tested
- Implements richest File Protocol
- Enormous Client Base (Mac, Windows, now better on Linux! And more)
- 3.5 Million LOC!



Samba.IO.lab
Welcome



smb2

```
urce        Destination  Protoc Lengtl Info
.0.0.1      127.0.0.1    SMB2   302 Negotiate Protocol Request
.0.0.1      127.0.0.1    SMB2   366 Negotiate Protocol Response
.0.0.1      127.0.0.1    SMB2   190 Session Setup Request, NTLMSSP_NEGOTIATE
.0.0.1      127.0.0.1    SMB2   400 Session Setup Response, Error: STATUS_MORE_PROCESSING_REQUIRED, NTLMSSP_C
.0.0.1      127.0.0.1    SMB2   460 Session Setup Request, NTLMSSP_AUTH, User: \smfrench
.0.0.1      127.0.0.1    SMB2   142 Session Setup Response
.0.0.1      127.0.0.1    SMB2   176 Tree Connect Request Tree: \\localhost\IPC$
.0.0.1      127.0.0.1    SMB2   150 Tree Connect Response
.0.0.1      127.0.0.1    SMB2   176 Tree Connect Request Tree: \\localhost\test
.0.0.1      127.0.0.1    SMB2   150 Tree Connect Response
.0.0.1      127.0.0.1    SMB2   446 Create Request File: ;GetInfo Request FILE_INFO/SMB2_FILE_ALL_INFO
.0.0.1      127.0.0.1    SMB2   534 Create Response File: ;GetInfo Response
.0.0.1      127.0.0.1    SMB2   191 Ioctl Request FSCTL_QUERY_NETWORK_INTERFACE_INFO
.0.0.1      127.0.0.1    SMB2   143 Ioctl Response, Error: STATUS_INVALID_DEVICE_REQUEST
.0.0.1      127.0.0.1    SMB2   175 GetInfo Request FS_INFO/FileFsAttributeInformation File:
.0.0.1      127.0.0.1    SMB2   162 GetInfo Response
.0.0.1      127.0.0.1    SMB2   175 GetInfo Request FS_INFO/FileFsDeviceInformation File:
.0.0.1      127.0.0.1    SMB2   150 GetInfo Response
.0.0.1      127.0.0.1    SMB2   175 GetInfo Request FS_INFO/FileFsVolumeInformation File:
.0.0.1      127.0.0.1    SMB2   168 GetInfo Response
.0.0.1      127.0.0.1    SMB2   175 GetInfo Request FS_INFO/FileFsSectorSizeInformation File:
.0.0.1      127.0.0.1    SMB2   170 GetInfo Response
.0.0.1      127.0.0.1    SMB2   158 Close Request File:
.0.0.1      127.0.0.1    SMB2   194 Close Response
.0.0.1      127.0.0.1    SMB2   224 Ioctl Request FSCTL_DFS_GET_REFERRALS, File: \localhost\test
.0.0.1      127.0.0.1    SMB2   143 Ioctl Response, Error: STATUS_NOT_FOUND
.0.0.1      127.0.0.1    SMB2   262 Create Request File:
.0.0.1      127.0.0.1    SMB2   354 Create Response File:
.0.0.1      127.0.0.1    SMB2   158 Close Request File:
.0.0.1      127.0.0.1    SMB2   194 Close Response
.0.0.1      127.0.0.1    SMB2   262 Create Request File:
```

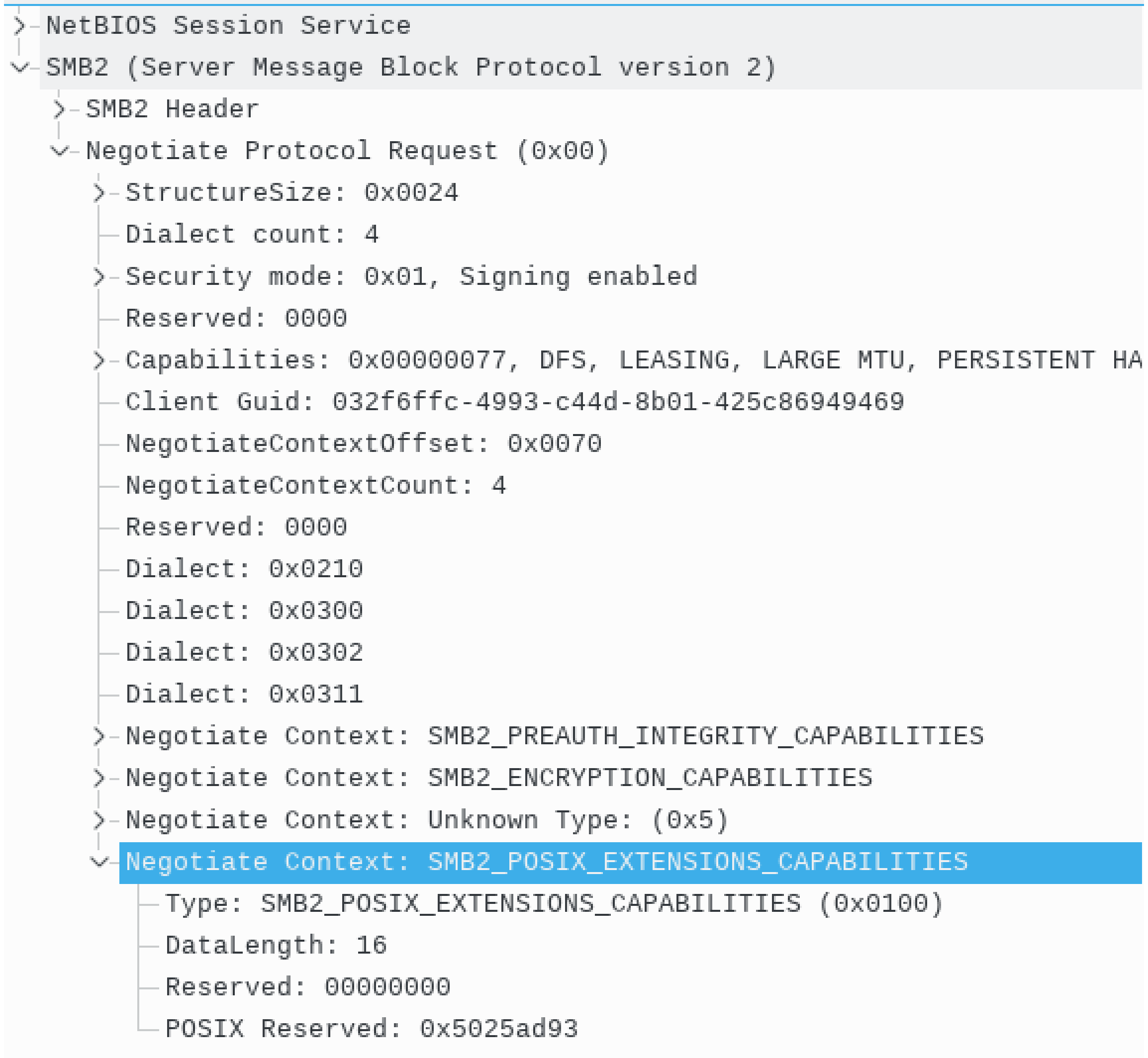
```
> NetBIOS Session Service
v SMB2 (Server Message Block Protocol version 2)
  > SMB2 Header
  v Negotiate Protocol Request (0x00)
    > StructureSize: 0x0024
      Dialect count: 4
    > Security mode: 0x01, Signing enabled
      Reserved: 0000
    > Capabilities: 0x00000077, DFS, LEASING, LARGE MTU, PERSISTENT HA
      Client Guid: 032f6ffc-4993-c44d-8b01-425c86949469
      NegotiateContextOffset: 0x0070
      NegotiateContextCount: 4
      Reserved: 0000
      Dialect: 0x0210
      Dialect: 0x0300
      Dialect: 0x0302
      Dialect: 0x0311
    > Negotiate Context: SMB2_PREAUTH_INTEGRITY_CAPABILITIES
    > Negotiate Context: SMB2_ENCRYPTION_CAPABILITIES
    > Negotiate Context: Unknown Type: (0x5)
    v Negotiate Context: SMB2_POSIX_EXTENSIONS_CAPABILITIES
        Type: SMB2_POSIX_EXTENSIONS_CAPABILITIES (0x0100)
        DataLength: 16
        Reserved: 00000000
        POSIX Reserved: 0x5025ad93
```

```
00b0  11 03 00 00 00 00 01 00  26 00 00 00 00 00 01 00   ········&·····
00c0  20 00 01 00 b4 02 72 b9  3c ed 58 84 13 7e b1 3f    ·····r·<·X··
00d0  4d 7a 75 80 ee 25 a5 e0  81 20 cc 10 57 7e 31 65   Mzu··%·····W
00e0  95 f7 40 b3 00 00 02 00  06 00 00 00 00 00 02 00   ··@···········
00f0  02 00 01 00 00 00 05 00  12 00 00 00 00 00 6c 00   ··············
0100  6f 00 63 00 61 00 6c 00  68 00 6f 00 73 00 74 00   o·c·a·l·h·o·s
0110  00 00 00 00 00 00 00 01  10 00 00 00 00 00 93 ad   ··············
0120  25 50 9c b4 11 e7 b4 23  83 de 96 8b cd 7c         %P····#·····
```

Text item (text), 24 bytes

Packets: 91 · Displayed: 52 (57.1%)

Profile: Default



```
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v SMB2 (Server Message Block Protocol version 2)
  > SMB2 Header
  v Negotiate Protocol Request (0x00)
    > StructureSize: 0x0024
      Dialect count: 4
    > Security mode: 0x01, Signing enabled
      Reserved: 0000
    > Capabilities: 0x00000077, DFS, LEASING, LARGE MTU, PERSISTENT HA
      Client Guid: 032f6ffc-4993-c44d-8b01-425c86949469
      NegotiateContextOffset: 0x0070
      NegotiateContextCount: 4
      Reserved: 0000
      Dialect: 0x0210
      Dialect: 0x0300
      Dialect: 0x0302
      Dialect: 0x0311
    > Negotiate Context: SMB2_PREAUTH_INTEGRITY_CAPABILITIES
    > Negotiate Context: SMB2_ENCRYPTION_CAPABILITIES
    > Negotiate Context: Unknown Type: (0x5)
    v Negotiate Context: SMB2_POSIX_EXTENSIONS_CAPABILITIES
        Type: SMB2_POSIX_EXTENSIONS_CAPABILITIES (0x0100)
        DataLength: 16
        Reserved: 00000000
        POSIX Reserved: 0x5025ad93
```
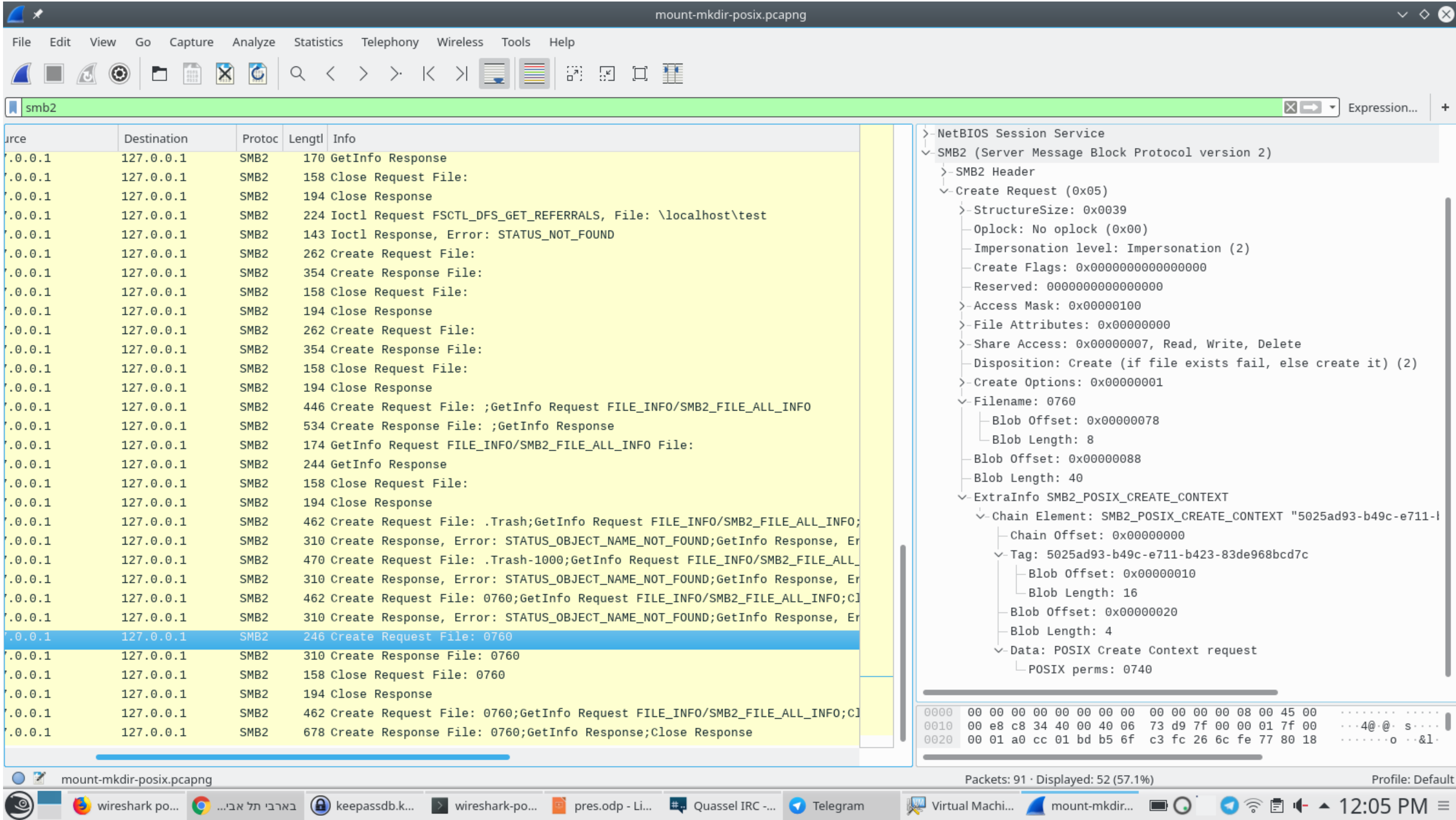



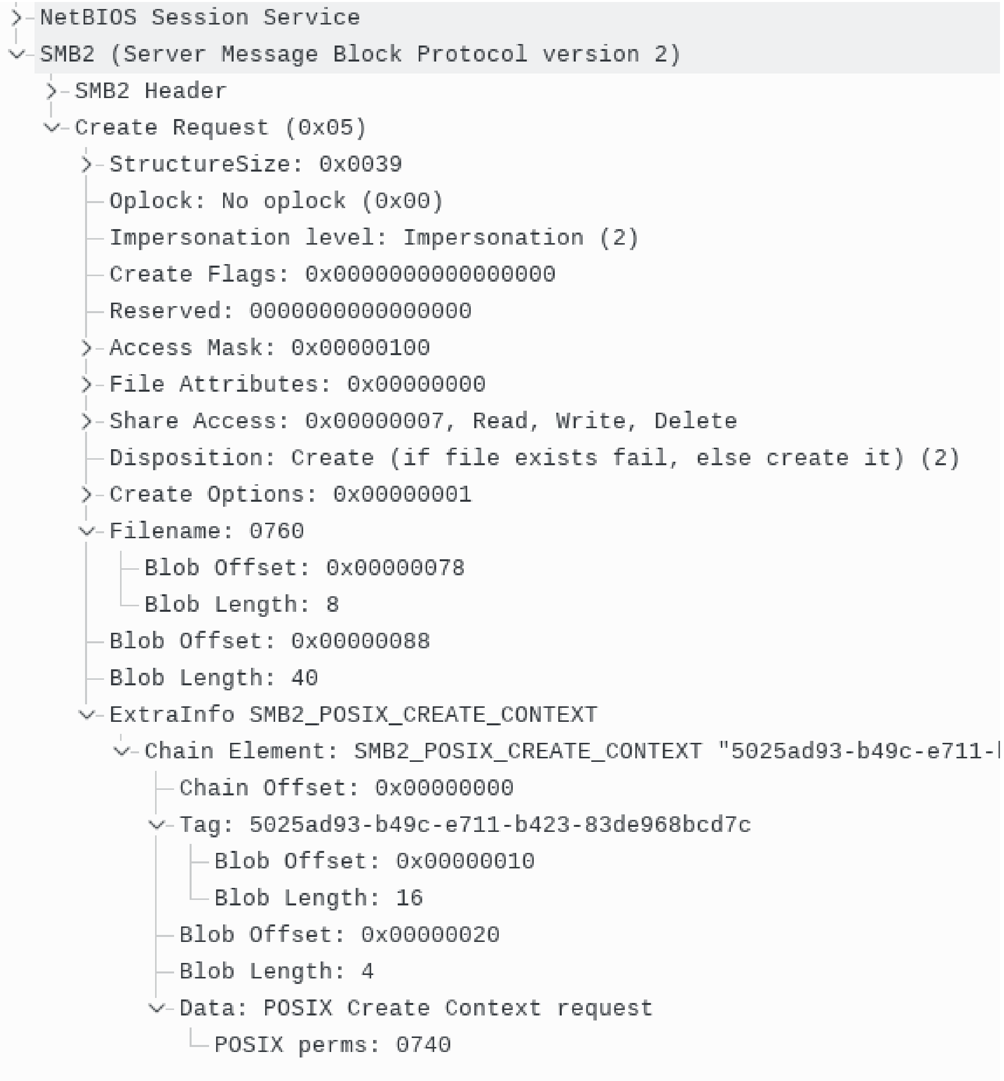
smb2

```
urce        Destination  Protoc Lengtl Info
.0.0.1      127.0.0.1    SMB2   170 GetInfo Response
.0.0.1      127.0.0.1    SMB2   158 Close Request File:
.0.0.1      127.0.0.1    SMB2   194 Close Response
.0.0.1      127.0.0.1    SMB2   224 Ioctl Request FSCTL_DFS_GET_REFERRALS, File: \localhost\test
.0.0.1      127.0.0.1    SMB2   143 Ioctl Response, Error: STATUS_NOT_FOUND
.0.0.1      127.0.0.1    SMB2   262 Create Request File:
.0.0.1      127.0.0.1    SMB2   354 Create Response File:
.0.0.1      127.0.0.1    SMB2   158 Close Request File:
.0.0.1      127.0.0.1    SMB2   194 Close Response
.0.0.1      127.0.0.1    SMB2   262 Create Request File:
.0.0.1      127.0.0.1    SMB2   354 Create Response File:
.0.0.1      127.0.0.1    SMB2   158 Close Request File:
.0.0.1      127.0.0.1    SMB2   194 Close Response
.0.0.1      127.0.0.1    SMB2   446 Create Request File: ;GetInfo Request FILE_INFO/SMB2_FILE_ALL_INFO
.0.0.1      127.0.0.1    SMB2   534 Create Response File: ;GetInfo Response
.0.0.1      127.0.0.1    SMB2   174 GetInfo Request FILE_INFO/SMB2_FILE_ALL_INFO File:
.0.0.1      127.0.0.1    SMB2   244 GetInfo Response
.0.0.1      127.0.0.1    SMB2   158 Close Request File:
.0.0.1      127.0.0.1    SMB2   194 Close Response
.0.0.1      127.0.0.1    SMB2   462 Create Request File: .Trash;GetInfo Request FILE_INFO/SMB2_FILE_ALL_INFO;
.0.0.1      127.0.0.1    SMB2   310 Create Response, Error: STATUS_OBJECT_NAME_NOT_FOUND;GetInfo Response, Er
.0.0.1      127.0.0.1    SMB2   470 Create Request File: .Trash-1000;GetInfo Request FILE_INFO/SMB2_FILE_ALL_
.0.0.1      127.0.0.1    SMB2   310 Create Response, Error: STATUS_OBJECT_NAME_NOT_FOUND;GetInfo Response, Er
.0.0.1      127.0.0.1    SMB2   462 Create Request File: 0760;GetInfo Request FILE_INFO/SMB2_FILE_ALL_INFO;Cl
.0.0.1      127.0.0.1    SMB2   310 Create Response, Error: STATUS_OBJECT_NAME_NOT_FOUND;GetInfo Response, Er
.0.0.1      127.0.0.1    SMB2   246 Create Request File: 0760
.0.0.1      127.0.0.1    SMB2   310 Create Response File: 0760
.0.0.1      127.0.0.1    SMB2   158 Close Request File: 0760
.0.0.1      127.0.0.1    SMB2   194 Close Response
.0.0.1      127.0.0.1    SMB2   462 Create Request File: 0760;GetInfo Request FILE_INFO/SMB2_FILE_ALL_INFO;Cl
.0.0.1      127.0.0.1    SMB2   678 Create Response File: 0760;GetInfo Response;Close Response
```

```
> NetBIOS Session Service
v SMB2 (Server Message Block Protocol version 2)
  > SMB2 Header
  v Create Request (0x05)
    > StructureSize: 0x0039
      Oplock: No oplock (0x00)
      Impersonation level: Impersonation (2)
      Create Flags: 0x0000000000000000
      Reserved: 0000000000000000
    > Access Mask: 0x00000100
    > File Attributes: 0x00000000
    > Share Access: 0x00000007, Read, Write, Delete
      Disposition: Create (if file exists fail, else create it) (2)
    > Create Options: 0x00000001
    v Filename: 0760
        Blob Offset: 0x00000078
        Blob Length: 8
      Blob Offset: 0x00000088
      Blob Length: 40
    v ExtraInfo SMB2_POSIX_CREATE_CONTEXT
      v Chain Element: SMB2_POSIX_CREATE_CONTEXT "5025ad93-b49c-e711-l
          Chain Offset: 0x00000000
        v Tag: 5025ad93-b49c-e711-b423-83de968bcd7c
            Blob Offset: 0x00000010
            Blob Length: 16
          Blob Offset: 0x00000020
          Blob Length: 4
        v Data: POSIX Create Context request
            POSIX perms: 0740
```

```
0000  00 00 00 00 00 00 00 00  00 00 00 00 08 00 45 00   ········ ······E·
0010  00 e8 c8 34 40 00 40 06  73 d9 7f 00 00 01 7f 00   ···4@·@· s·······
0020  00 01 a0 cc 01 bd b5 6f  c3 fc 26 6c fe 77 80 18   ·······o ··&l·w··
```

mount-mkdir-posix.pcapng   Packets: 91 · Displayed: 52 (57.1%)   Profile: Default



```
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    > SMB2 Header
    v Create Request (0x05)
        > StructureSize: 0x0039
          Oplock: No oplock (0x00)
          Impersonation level: Impersonation (2)
          Create Flags: 0x0000000000000000
          Reserved: 0000000000000000
        > Access Mask: 0x00000100
        > File Attributes: 0x00000000
        > Share Access: 0x00000007, Read, Write, Delete
          Disposition: Create (if file exists fail, else create it) (2)
        > Create Options: 0x00000001
        v Filename: 0760
              Blob Offset: 0x00000078
              Blob Length: 8
          Blob Offset: 0x00000088
          Blob Length: 40
        v ExtraInfo SMB2_POSIX_CREATE_CONTEXT
            v Chain Element: SMB2_POSIX_CREATE_CONTEXT "5025ad93-b49c-e711-
                  Chain Offset: 0x00000000
                v Tag: 5025ad93-b49c-e711-b423-83de968bcd7c
                      Blob Offset: 0x00000010
                      Blob Length: 16
                  Blob Offset: 0x00000020
                  Blob Length: 4
                v Data: POSIX Create Context request
                      POSIX perms: 0740
```
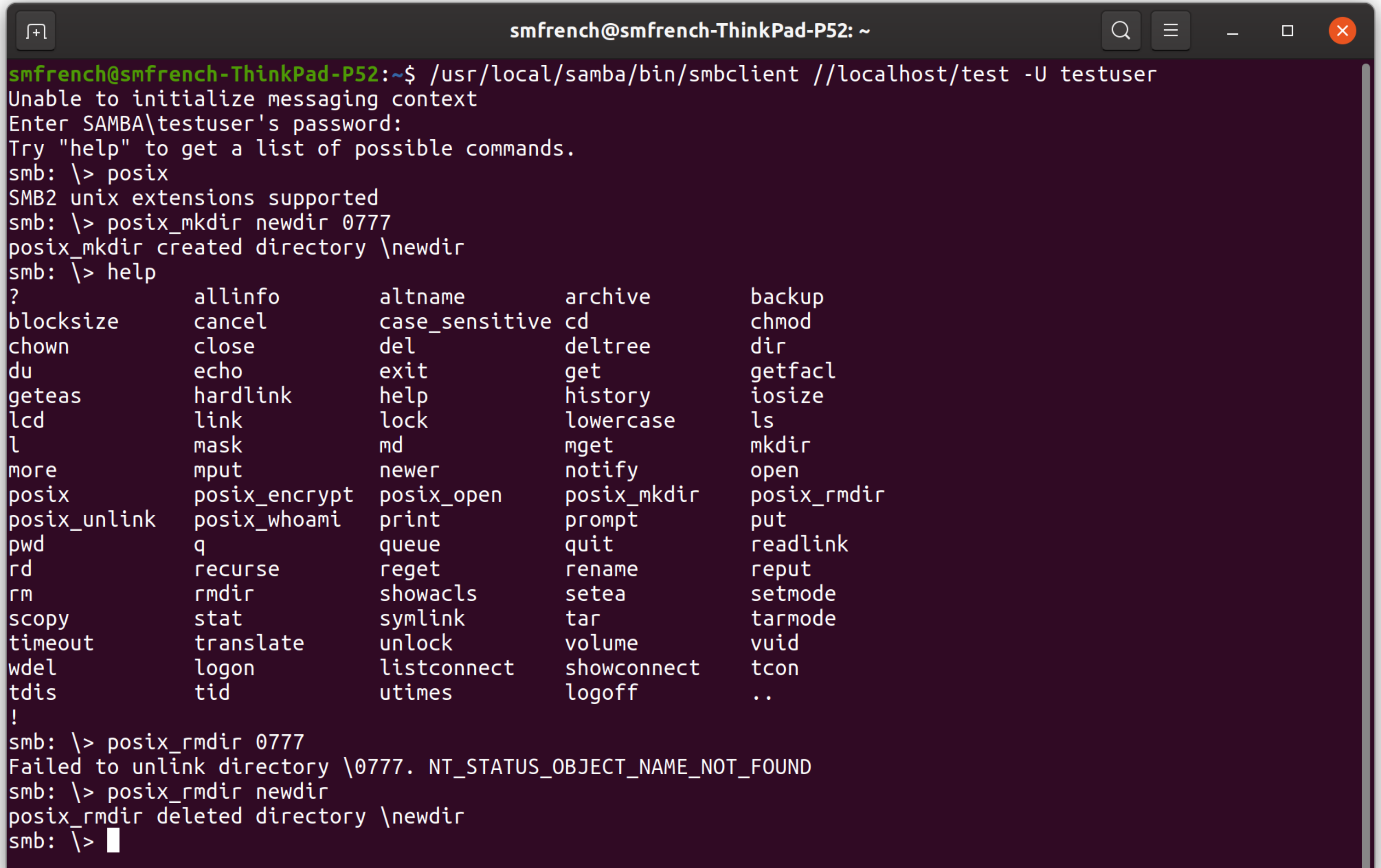

Smbclient now has experimental support for SMB3.1.1 POSIX Extensions

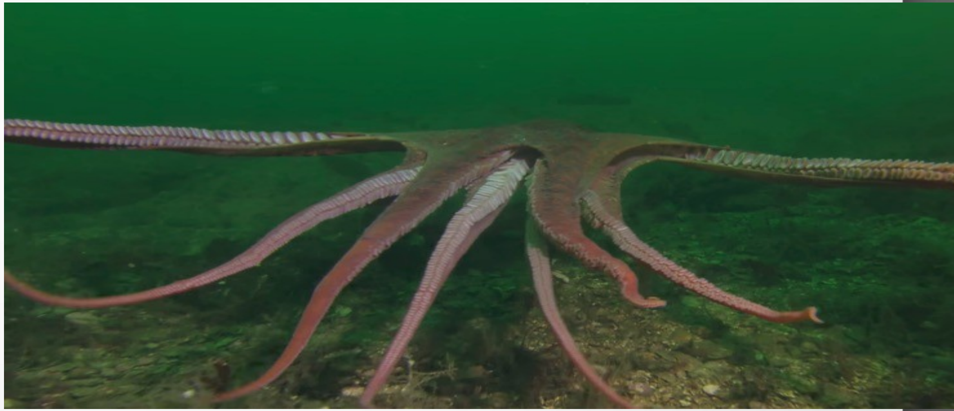


```
smfrench@smfrench-ThinkPad-P52:~$ /usr/local/samba/bin/smbclient //localhost/test -U testuser
Unable to initialize messaging context
Enter SAMBA\testuser's password:
Try "help" to get a list of possible commands.
smb: \> posix
SMB2 unix extensions supported
smb: \> posix_mkdir newdir 0777
posix_mkdir created directory \newdir
smb: \> help
?              allinfo        altname        archive        backup
blocksize      cancel         case_sensitive cd             chmod
chown          close          del            deltree        dir
du             echo           exit           get            getfacl
geteas         hardlink       help           history        iosize
lcd            link           lock           lowercase      ls
l              mask           md             mget           mkdir
more           mput           newer          notify         open
posix          posix_encrypt  posix_open     posix_mkdir    posix_rmdir
posix_unlink   posix_whoami   print          prompt         put
pwd            q              queue          quit           readlink
rd             recurse        reget          rename         reput
rm             rmdir          showacls       setea          setmode
scopy          stat           symlink        tar            tarmode
timeout        translate      unlock         volume         vuid
wdel           logon          listconnect    showconnect    tcon
tdis           tid            utimes         logoff         ..
!
smb: \> posix_rmdir 0777
Failed to unlink directory \0777. NT_STATUS_OBJECT_NAME_NOT_FOUND
smb: \> posix_rmdir newdir
posix_rmdir deleted directory \newdir
smb: \>
```

A year ago … and now …
kernel SMB3 client cifs.ko rapidly improving

- A year ago Linux 5.0-rc4 “Shy Crocodile”

Last week:5.5 “Kleptomaniac Octopus”



For cifs.ko (kernel client) to experiment with POSIX Extensions use 5.1 kernel or backport patch below

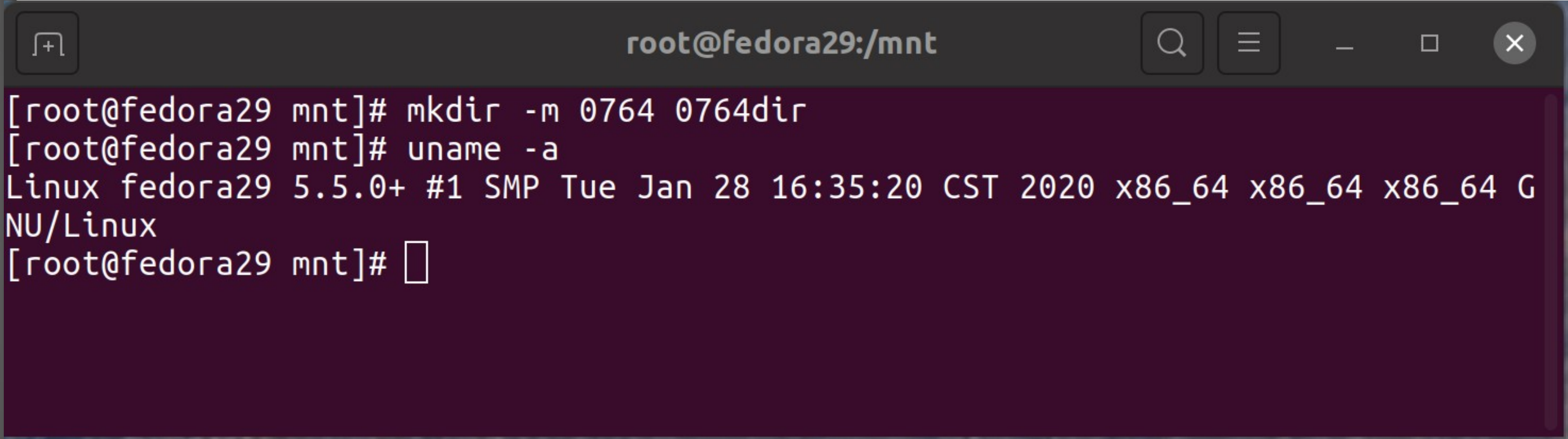
- commit 0d481325a9e5e3a31bf83bfcd3690a7a7152ece1

  Author: Steve French <stfrench@microsoft.com>

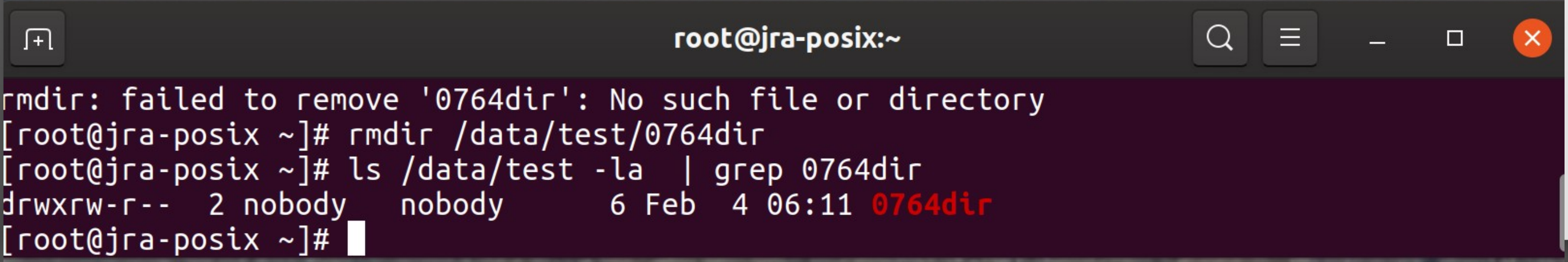
  Date: Sun Feb 24 17:56:33 2019 -0600

      smb3: Update POSIX negotiate context with POSIX ctxt GUID

An example from today (cifs.ko over SMB3.1.1 POSIX) mode bits preserved as expected on mkdir



```
[root@fedora29 mnt]# mkdir -m 0764 0764dir
[root@fedora29 mnt]# uname -a
Linux fedora29 5.5.0+ #1 SMP Tue Jan 28 16:35:20 CST 2020 x86_64 x86_64 x86_64 G
NU/Linux
[root@fedora29 mnt]# 
```



```
rmdir: failed to remove '0764dir': No such file or directory
[root@jra-posix ~]# rmdir /data/test/0764dir
[root@jra-posix ~]# ls /data/test -la  | grep 0764dir
drwxrw-r--  2 nobody   nobody      6 Feb  4 06:11 0764dir
[root@jra-posix ~]# 
```

Quality Much Improved – Top Priority

- More xfstests pass (> 150 and growing) even without POSIX extensions, vast majority of the rest are skipped due to missing features or being inappropriate for network file systems
- Many potential issues pointed out by static analysis addressed
- Starting 14 months ago **The “Buildbot”** … reducing regressions. **VERY** exciting addition for CIT (thanks Ronnie, Aurelien and Paulo)
- POSIX Extensions (jra’s tree) now a buildbot target for automated regression tests. Will be expanding test list run vs. it soon ...

POSIX: What could you try today?

- For obvious reasons these experimental changes not enabled by default:
  - With current mainline Linux (5.1 or later) must mount with “vers=3.1.1”

    AND also specify new mount option “posix” and turn off remapping of reserved characters (ie append “nomapposix”)
  - Limited protocol features (posix open context request) can be tried but this small change VERY useful, enough to experiment with and test various apps
- JRA has a tree on samba.org (git.samba.org/jra/samba/.git in branch “master-smb2”) with prototype server code
- Other vendors testing experimental distinct implementations of POSIX extensions as well

POS

Why Isn’t This Shipped Already ?

- Details are still being explored e.g recent interactions with WSL - Windows Subsystem for Linux
  - WSL defines methods of exporting filesystem types in reparse point tags we want to be compatible with on the wire.
- Samba VFS needs updating to match modern Linux/OpenGroup/POSIX APIs.
  - Samba VFS must change first to use Xxxat() (openat, mkdirat, linkat..) system calls before we can integrate this into Samba master.

What has changed ?

- In order to optimize readdir better (to avoid extra roundtrips for each file):

  Symlinks and Special Files (char, block, fifo, socket) are now distinct reparse point tags (similar to what WSL does) rather than one tag for all (which requires an extra query for each special file)

New Proposed Tags for Special Files

IO_REPARSE_TAG_LX_SYMLINK

Symbolic link. Tag value is 0xA000001D.

IO_REPARSE_TAG_AF_UNIX

UNIX domain socket. Tag value is 0x80000023.

IO_REPARSE_TAG_LX_FIFO

FIFO. Tag value is 0x80000024.

IO_REPARSE_TAG_LX_CHR

Character special file. Tag value is 0x80000025.

IO_REPARSE_TAG_LX_BLK

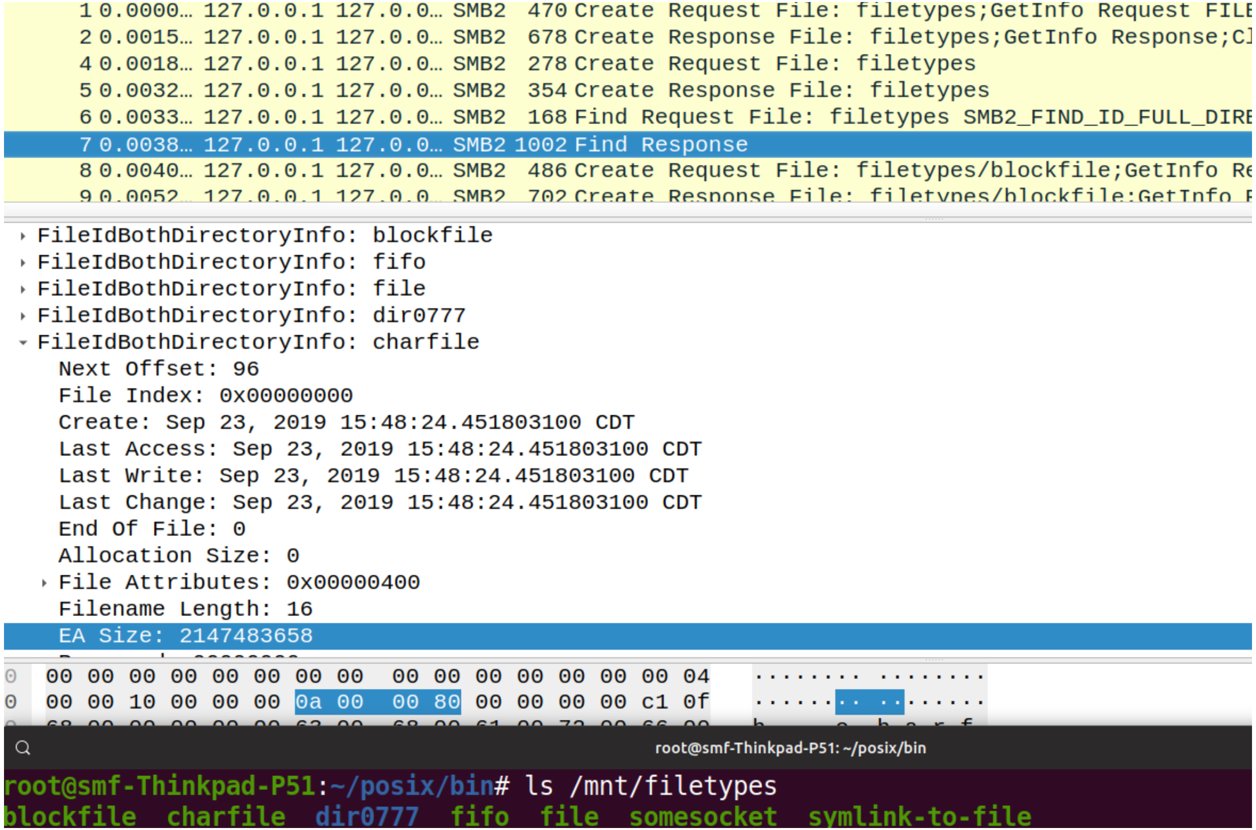
Block special file. Tag value is 0x80000026.

Example: using it today

- On the client:
  - “mount –t smb3 //<address>/<share> /mnt -o username=<user>,password=<pass>, vers=3.1.1,posix,mfsymlinks,nomapposix,noperm
- On the server add to smb.conf:
  - smb2 unix extensions = yes
  - “mangled names = no”
  - “directory mask = 07777”
  - “create mask = 07777”
  - Consider removing “obey pam restrictions”

Note that directory enumeration returns a reparse point tag (for file type).

- The proposed change to add tags this would reduce roundtrips



```
1 0.0000… 127.0.0.1 127.0.0… SMB2  470 Create Request File: filetypes;GetInfo Request FILE
2 0.0015… 127.0.0.1 127.0.0… SMB2  678 Create Response File: filetypes;GetInfo Response;Cl
4 0.0018… 127.0.0.1 127.0.0… SMB2  278 Create Request File: filetypes
5 0.0032… 127.0.0.1 127.0.0… SMB2  354 Create Response File: filetypes
6 0.0033… 127.0.0.1 127.0.0… SMB2  168 Find Request File: filetypes SMB2_FIND_ID_FULL_DIRE
7 0.0038… 127.0.0.1 127.0.0… SMB2 1002 Find Response
8 0.0040… 127.0.0.1 127.0.0… SMB2  486 Create Request File: filetypes/blockfile;GetInfo Re
9 0.0052… 127.0.0.1 127.0.0… SMB2  702 Create Response File: filetypes/blockfile;GetInfo R
```

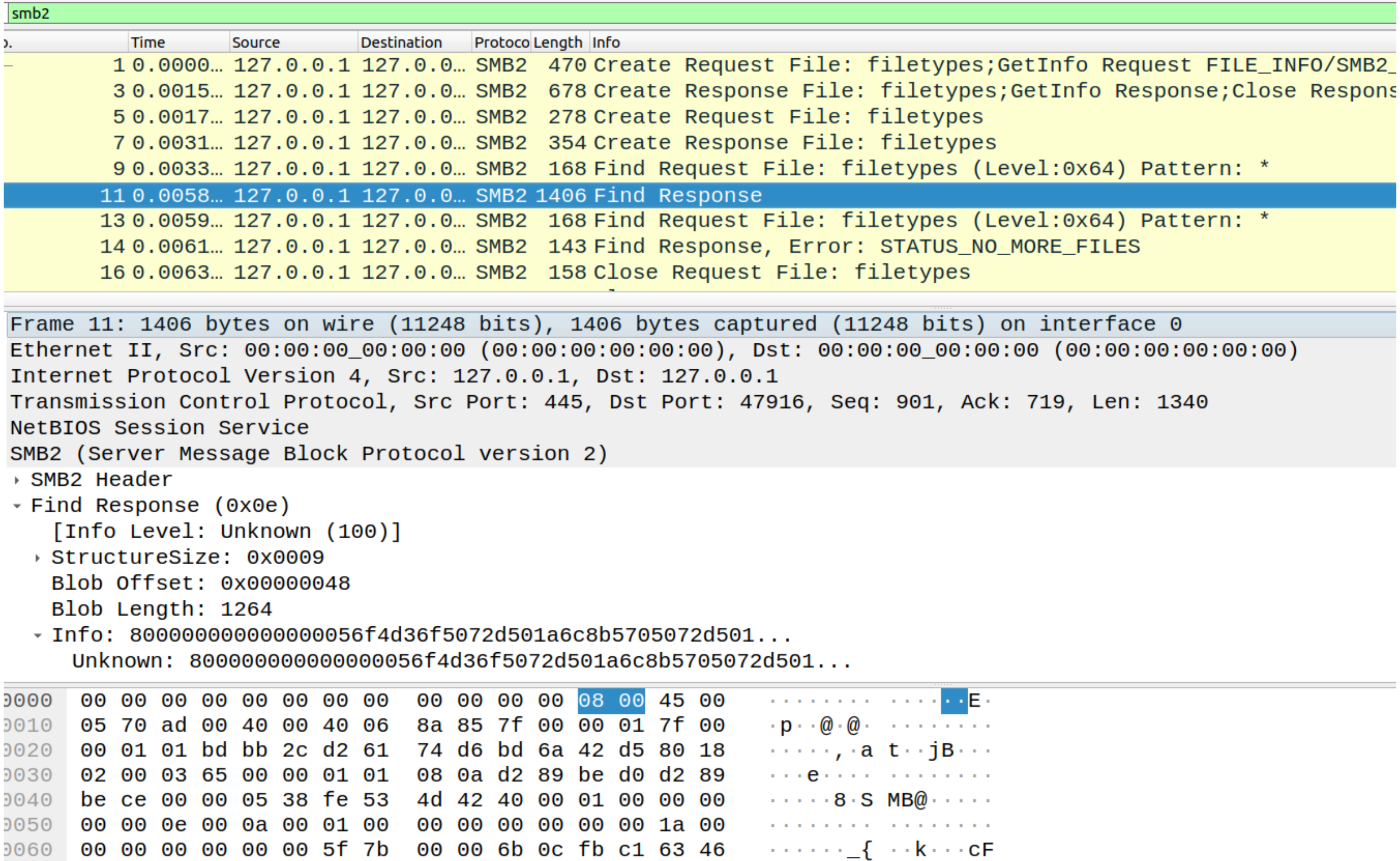
```
› FileIdBothDirectoryInfo: blockfile
› FileIdBothDirectoryInfo: fifo
› FileIdBothDirectoryInfo: file
› FileIdBothDirectoryInfo: dir0777
⌄ FileIdBothDirectoryInfo: charfile
    Next Offset: 96
    File Index: 0x00000000
    Create: Sep 23, 2019 15:48:24.451803100 CDT
    Last Access: Sep 23, 2019 15:48:24.451803100 CDT
    Last Write: Sep 23, 2019 15:48:24.451803100 CDT
    Last Change: Sep 23, 2019 15:48:24.451803100 CDT
    End Of File: 0
    Allocation Size: 0
  › File Attributes: 0x00000400
    Filename Length: 16
    EA Size: 2147483658
```

```
0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 04   ........ ........
0   00 00 10 00 00 00 0a 00  00 80 00 00 00 00 c1 0f   ........ ........
```

root@smf-Thinkpad-P51: ~/posix/bin

```
root@smf-Thinkpad-P51:~/posix/bin# ls /mnt/filetypes
blockfile  charfile  dir0777  fifo  file  somesocket  symlink-to-file
```

SMB3.1.1 POSIX Query Directory



smb2

```
o.     Time       Source     Destination Protoco Length Info
     1 0.0000…  127.0.0.1  127.0.0…  SMB2   470 Create Request File: filetypes;GetInfo Request FILE_INFO/SMB2_
     3 0.0015…  127.0.0.1  127.0.0…  SMB2   678 Create Response File: filetypes;GetInfo Response;Close Respons
     5 0.0017…  127.0.0.1  127.0.0…  SMB2   278 Create Request File: filetypes
     7 0.0031…  127.0.0.1  127.0.0…  SMB2   354 Create Response File: filetypes
     9 0.0033…  127.0.0.1  127.0.0…  SMB2   168 Find Request File: filetypes (Level:0x64) Pattern: *
    11 0.0058…  127.0.0.1  127.0.0…  SMB2  1406 Find Response
    13 0.0059…  127.0.0.1  127.0.0…  SMB2   168 Find Request File: filetypes (Level:0x64) Pattern: *
    14 0.0061…  127.0.0.1  127.0.0…  SMB2   143 Find Response, Error: STATUS_NO_MORE_FILES
    16 0.0063…  127.0.0.1  127.0.0…  SMB2   158 Close Request File: filetypes
```

```
Frame 11: 1406 bytes on wire (11248 bits), 1406 bytes captured (11248 bits) on interface 0
Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
Internet Protocol Version 4, Src: 127.0.0.1, Dst: 127.0.0.1
Transmission Control Protocol, Src Port: 445, Dst Port: 47916, Seq: 901, Ack: 719, Len: 1340
NetBIOS Session Service
SMB2 (Server Message Block Protocol version 2)
 ▸ SMB2 Header
 ▾ Find Response (0x0e)
     [Info Level: Unknown (100)]
   ▸ StructureSize: 0x0009
     Blob Offset: 0x00000048
     Blob Length: 1264
   ▾ Info: 800000000000000056f4d36f5072d501a6c8b5705072d501...
       Unknown: 800000000000000056f4d36f5072d501a6c8b5705072d501...
```

```
0000   00 00 00 00 00 00 00 00  00 00 00 00 08 00 45 00   ········ ······E·
0010   05 70 ad 00 40 00 40 06  8a 85 7f 00 00 01 7f 00   ·p··@·@· ········
0020   00 01 01 bd bb 2c d2 61  74 d6 bd 6a 42 d5 80 18   ·····,·a t··jB···
0030   02 00 03 65 00 00 01 01  08 0a d2 89 be d0 d2 89   ···e···· ········
0040   be ce 00 00 05 38 fe 53  4d 42 40 00 01 00 00 00   ·····8·S MB@·····
0050   00 00 0e 00 0a 00 01 00  00 00 00 00 00 00 1a 00   ········ ········
0060   00 00 00 00 00 00 5f 7b  00 00 6b 0c fb c1 63 46   ······_{ ··k···cF
```

Summary of What works

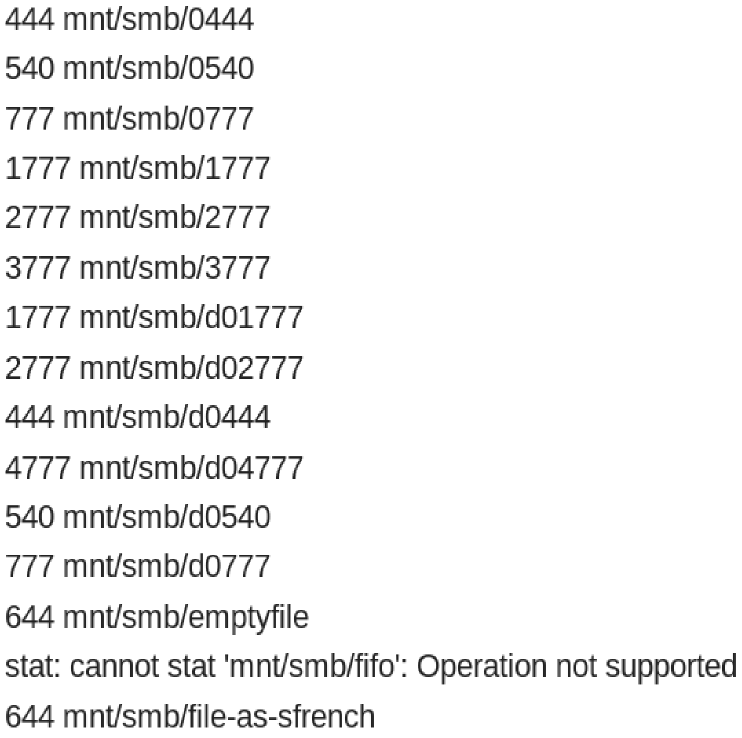
- Without Extensions

- With Extensions

Example (w/o POSIX extensions)

(thank you to Aurelien at SuSE!)

- Mode bits (in special ACE)
  - Mode bits on left
  - File name on right
- NB mkfifo not finished
- Ownership works too



```
444 mnt/smb/0444
540 mnt/smb/0540
777 mnt/smb/0777
1777 mnt/smb/1777
2777 mnt/smb/2777
3777 mnt/smb/3777
1777 mnt/smb/d01777
2777 mnt/smb/d02777
444 mnt/smb/d0444
4777 mnt/smb/d04777
540 mnt/smb/d0540
777 mnt/smb/d0777
644 mnt/smb/emptyfile
stat: cannot stat 'mnt/smb/fifo': Operation not supported
644 mnt/smb/file-as-sfrench
```

- What about the Linux Kernel?
  - New API changes added about once a year to the VFS (minor global changes added more often, but not all could affect what we need to send on the wire in perfect world ...)
  - Need to quickly update protocol when not possible to do over SMB3
  - Need better interaction with key communities (containers, databases and many others) about what they would like to see

SMB3 POSIX Extensions

- Negotiate Protocol
  - SMB3.1.1 (or later required)
    - POSIX Negotiate Context 0x100
    - Version is included in the context by including the GUID of the supported POSIX open context(s) – currently only one supported
  - If POSIX open contexts not supported, negotiate context must be ignored
  - If POSIX open contexts supported for some files then negotiate context is returned, but server must fail opens with POSIX contexts for files where POSIX is not supported (rather than ignoring the POSIX context)
- Tree Connect – in future dialects tree connect contexts may allow more granularity in allowing servers to tell clients which shares they can't use POSIX opens on
- Case sensitivity yes/no can be exposed via existing QFS Info call

POSIX Extension Requirements

- If server returns a POSIX create context on an open:
  - It supports case sensitive names on this path
  - It supports POSIX unlink/rename semantics on this file
  - It supports advisory (POSIX) locking on this file.
    - Actually they are “OFD” not “POSIX” locks (see e.g. https://gavv.github.io/blog/file-locks/#emulating-open-file-description-locks)
  - PATH names are not remapped (no SFU remap needed for * and \ and > and < and : …). UCS2 converted directly to UTF-8 and server supports POSIX pathnames

We Leverage Existing SMB3 features

- Hardlinks use Windows setinfo call (long ago implemented)
- ~~Symlinks, mkfifo, mknod use “nfs reparse point” (MS-FSCC 2.1.2.6)~~ Distinct reparse point tags for each type of special file (ala what “WSL” does) - allows us to better optimize readdir
- ACE with special SID (with mode at end) ala “NFS ACL” mapping can be used to set mode (SID: S-1-5-88-3) see http://people.redhat.com/steved/Bakeathon-2010/SDC2010-NFS-Windows.jbiseda.20100921.pdf
- Other linux extensions, e.g. fallocate are mapped to existing SMB3 operations where possible

SMB311 POSIX Extensions

- Create/Open
    - New POSIX create context
        - If POSIX supported then context must be returned on all opens for which POSIX create context was sent (or open should be failed)
        - It is allowed to have POSIX and non-POSIX opens on the same file
        - It is allowed to have some files in a server which are POSIX and some which are not

Format of the POSIX owner and mid information in the ACL

<NTSecurityAuthority>-<SECURITY_NFS_ID_BASE_RID>-<NfsSidType>-<NfsSidValue>

- Owner SID for UID: “S-1-5-88-1-<uid>”
- Group SID for GID: “S-1-5-88-2-<gid>”
- Mode SID: “S-1-5-88-3-<mode>”
- Everyone: “S-1-5-88-4”

POSIX Infolevels

- Query/SetInfo and Query_DIR (and also FSInfo)
  - Level 0x64 SMB2_FIND_POSIX_INFORMATION
  - Payload variable (Max = 216 bytes)
    - Timestamps
    - File size
    - Dos attributes
    - U64 Inode number
    - U32 device id
    - U32 zero
    - Struct posix_create_context_response

Wireshark

- See Aurelien’s dissector improvements
  - https://github.com/aaptel/wireshark/commits/smb3unix
  - And Pike sample test code
    - https://github.com/aaptel/pike/tree/smb3unix

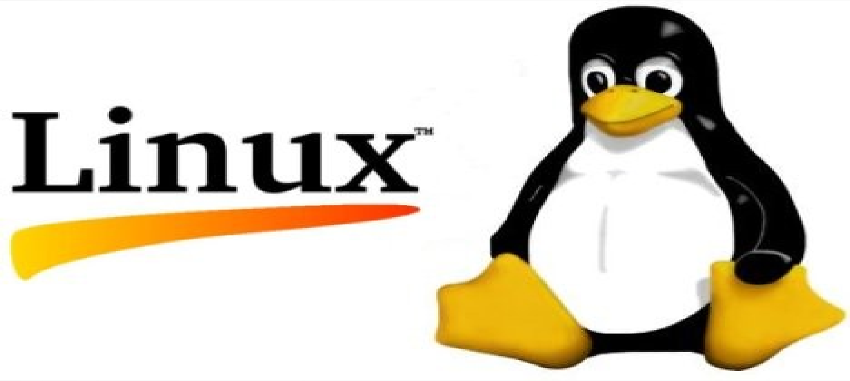
Next Steps

- Continue debugging test implementations (cifs.ko and JRAs Samba POSIX test branch). Current focus (eg at this test event): enhancing smb3 client to better handle POSIX readdir
- Continue to add xfstests to the ‘jraposix’ test group in the buildbot (to regression test the client against Samba server with POSIX extensions)
- Examine EVERY xfstest skip and every xfstest fail for potential match to features in (or to add to) SMB3.1.1 POSIX Extensions
  - e.g. enabling special files (fifos, blkdevs etc.) as reparse points enables five tests.
- Continue extending the wireshark dissectors (see Aurelien)
- Continue testing here
- Continue updating the wiki with details**:**

  https://wiki.samba.org/index.php/SMB3-Linux
- Questions/comments welcome: samba-technical and linux-cifs lists

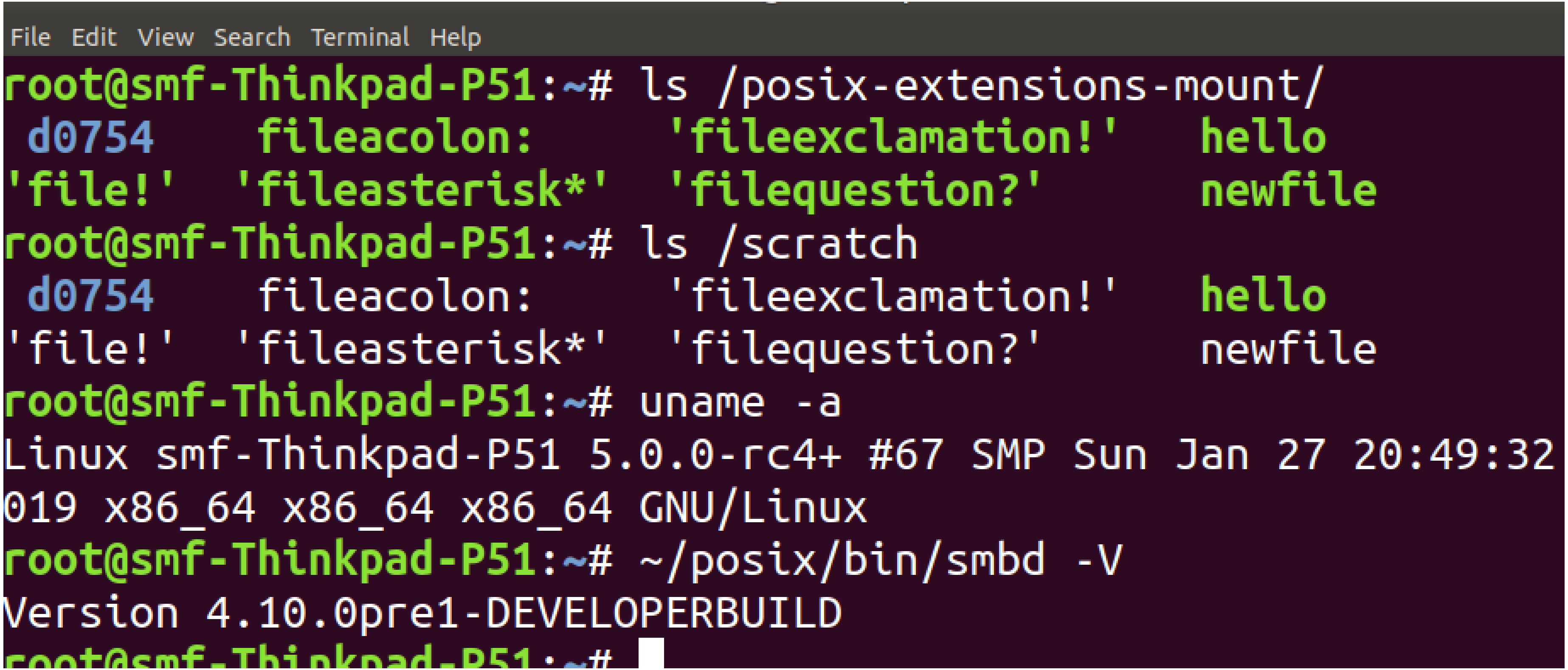
Thank you for your time

- This is a very exciting time for ...



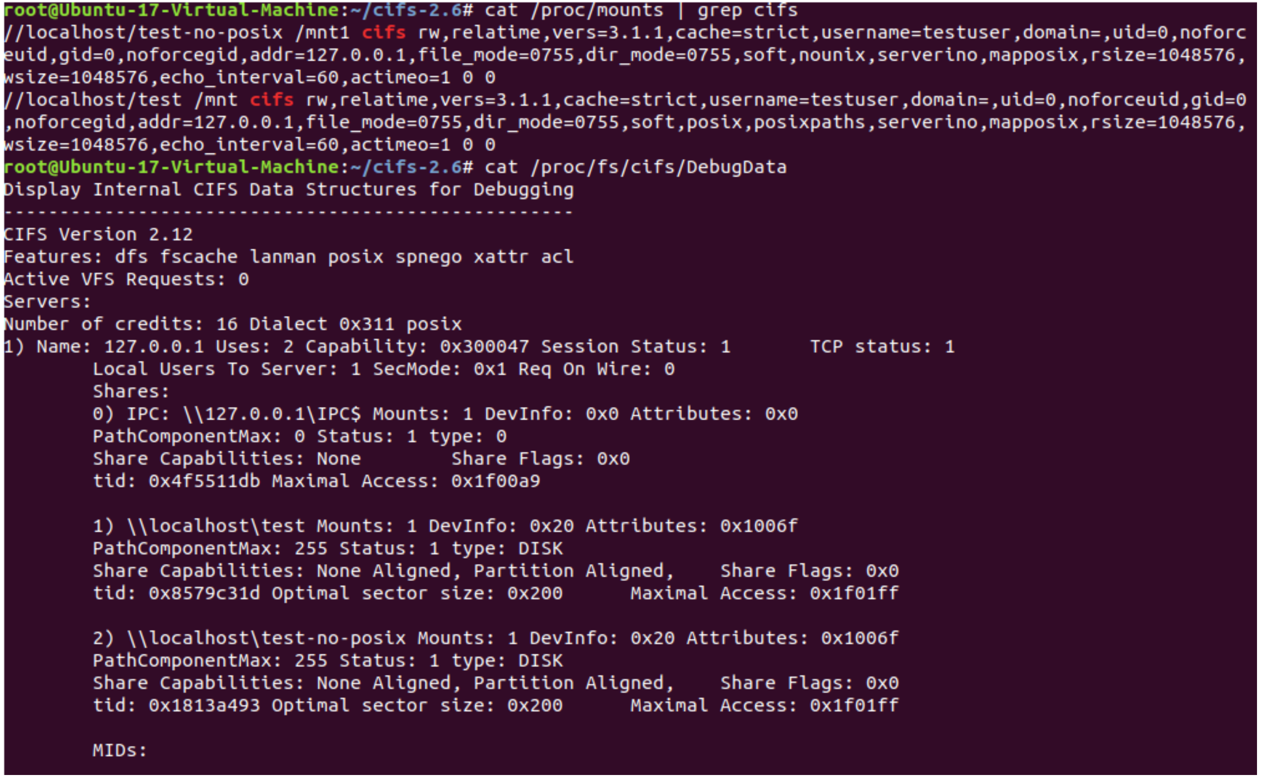
+ ***SMB3***

POSIX Path Names Work



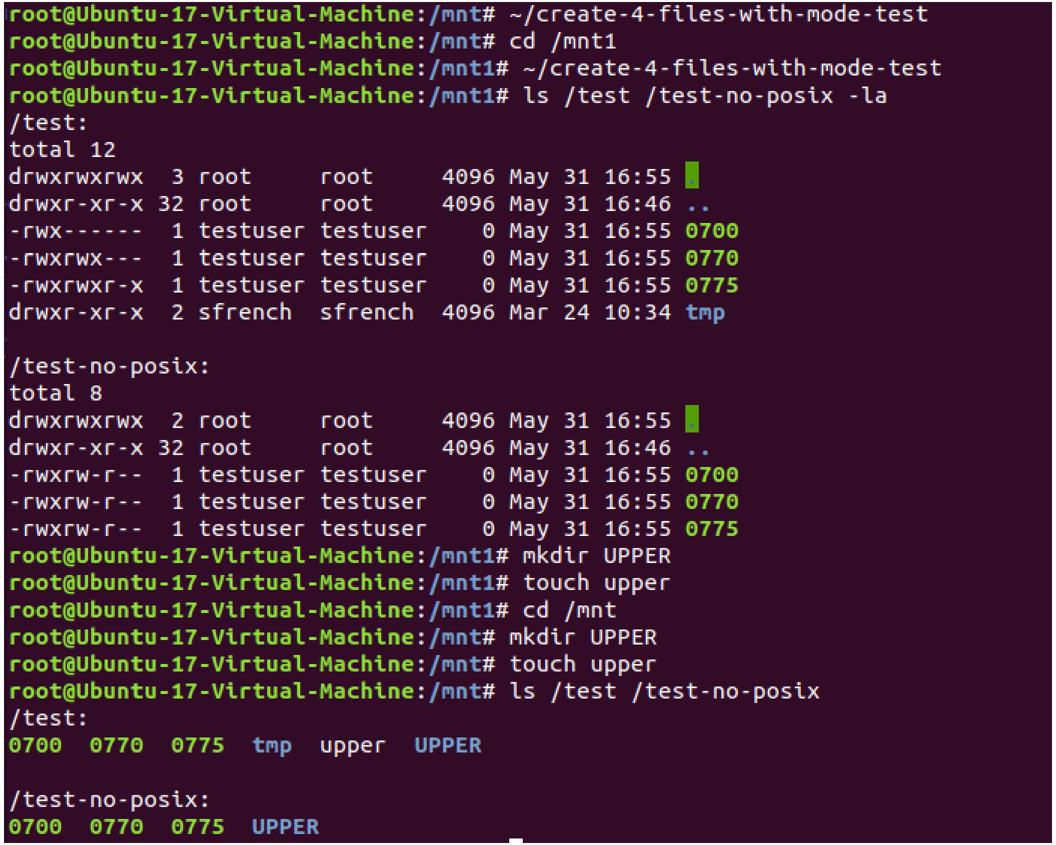
```
root@smf-Thinkpad-P51:~# ls /posix-extensions-mount/
 d0754     fileacolon:       'fileexclamation!'   hello
'file!'   'fileasterisk*'   'filequestion?'       newfile
root@smf-Thinkpad-P51:~# ls /scratch
 d0754     fileacolon:       'fileexclamation!'   hello
'file!'   'fileasterisk*'   'filequestion?'       newfile
root@smf-Thinkpad-P51:~# uname -a
Linux smf-Thinkpad-P51 5.0.0-rc4+ #67 SMP Sun Jan 27 20:49:32
019 x86_64 x86_64 x86_64 GNU/Linux
root@smf-Thinkpad-P51:~# ~/posix/bin/smbd -V
Version 4.10.0pre1-DEVELOPERBUILD
root@smf-Thinkpad-P51:~#
```

Note the new mount option “posix” (vs “nounix”)



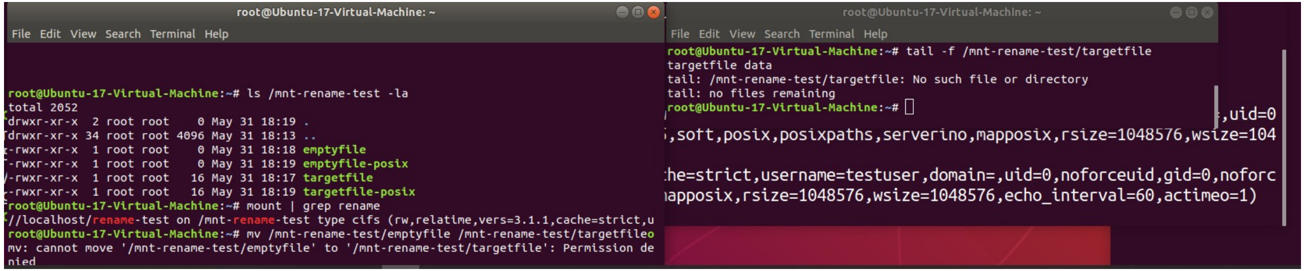
```
root@Ubuntu-17-Virtual-Machine:~/cifs-2.6# cat /proc/mounts | grep cifs
//localhost/test-no-posix /mnt1 cifs rw,relatime,vers=3.1.1,cache=strict,username=testuser,domain=,uid=0,noforc
euid,gid=0,noforcegid,addr=127.0.0.1,file_mode=0755,dir_mode=0755,soft,nounix,serverino,mapposix,rsize=1048576,
wsize=1048576,echo_interval=60,actimeo=1 0 0
//localhost/test /mnt cifs rw,relatime,vers=3.1.1,cache=strict,username=testuser,domain=,uid=0,noforceuid,gid=0
,noforcegid,addr=127.0.0.1,file_mode=0755,dir_mode=0755,soft,posix,posixpaths,serverino,mapposix,rsize=1048576,
wsize=1048576,echo_interval=60,actimeo=1 0 0
root@Ubuntu-17-Virtual-Machine:~/cifs-2.6# cat /proc/fs/cifs/DebugData
Display Internal CIFS Data Structures for Debugging
---------------------------------------------------
CIFS Version 2.12
Features: dfs fscache lanman posix spnego xattr acl
Active VFS Requests: 0
Servers:
Number of credits: 16 Dialect 0x311 posix
1) Name: 127.0.0.1 Uses: 2 Capability: 0x300047 Session Status: 1       TCP status: 1
        Local Users To Server: 1 SecMode: 0x1 Req On Wire: 0
        Shares:
        0) IPC: \\127.0.0.1\IPC$ Mounts: 1 DevInfo: 0x0 Attributes: 0x0
        PathComponentMax: 0 Status: 1 type: 0
        Share Capabilities: None        Share Flags: 0x0
        tid: 0x4f5511db Maximal Access: 0x1f00a9

        1) \\localhost\test Mounts: 1 DevInfo: 0x20 Attributes: 0x1006f
        PathComponentMax: 255 Status: 1 type: DISK
        Share Capabilities: None Aligned, Partition Aligned,    Share Flags: 0x0
        tid: 0x8579c31d Optimal sector size: 0x200      Maximal Access: 0x1f01ff

        2) \\localhost\test-no-posix Mounts: 1 DevInfo: 0x20 Attributes: 0x1006f
        PathComponentMax: 255 Status: 1 type: DISK
        Share Capabilities: None Aligned, Partition Aligned,    Share Flags: 0x0
        tid: 0x1813a493 Optimal sector size: 0x200      Maximal Access: 0x1f01ff

        MIDs:
```

Mode bits on create and case sensitivity work!



```
root@Ubuntu-17-Virtual-Machine:/mnt# ~/create-4-files-with-mode-test
root@Ubuntu-17-Virtual-Machine:/mnt# cd /mnt1
root@Ubuntu-17-Virtual-Machine:/mnt1# ~/create-4-files-with-mode-test
root@Ubuntu-17-Virtual-Machine:/mnt1# ls /test /test-no-posix -la
/test:
total 12
drwxrwxrwx  3 root     root     4096 May 31 16:55 .
drwxr-xr-x 32 root     root     4096 May 31 16:46 ..
-rwx------  1 testuser testuser    0 May 31 16:55 0700
-rwxrwx---  1 testuser testuser    0 May 31 16:55 0770
-rwxrwxr-x  1 testuser testuser    0 May 31 16:55 0775
drwxr-xr-x  2 sfrench  sfrench  4096 Mar 24 10:34 tmp

/test-no-posix:
total 8
drwxrwxrwx  2 root     root     4096 May 31 16:55 .
drwxr-xr-x 32 root     root     4096 May 31 16:46 ..
-rwxrw-r--  1 testuser testuser    0 May 31 16:55 0700
-rwxrw-r--  1 testuser testuser    0 May 31 16:55 0770
-rwxrw-r--  1 testuser testuser    0 May 31 16:55 0775
root@Ubuntu-17-Virtual-Machine:/mnt1# mkdir UPPER
root@Ubuntu-17-Virtual-Machine:/mnt1# touch upper
root@Ubuntu-17-Virtual-Machine:/mnt1# cd /mnt
root@Ubuntu-17-Virtual-Machine:/mnt# mkdir UPPER
root@Ubuntu-17-Virtual-Machine:/mnt# touch upper
root@Ubuntu-17-Virtual-Machine:/mnt# ls /test /test-no-posix
/test:
0700  0770  0775  tmp  upper  UPPER

/test-no-posix:
0700  0770  0775  UPPER
```

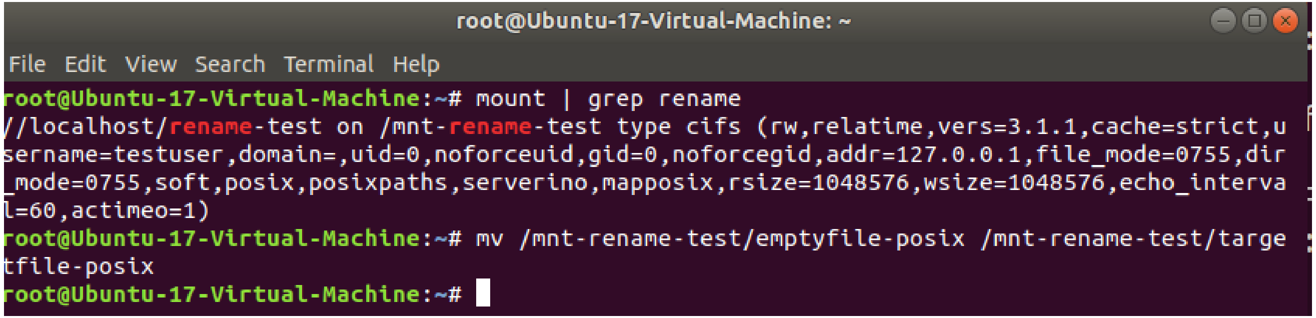
Rename works with POSIX extensions!


root@Ubuntu-17-Virtual-Machine: ~
File Edit View Search Terminal Help
root@Ubuntu-17-Virtual-Machine: ~
File Edit View Search Terminal Help

```
root@Ubuntu-17-Virtual-Machine:~# ls /mnt-rename-test -la
total 2052
drwxr-xr-x  2 root root    0 May 31 18:19 .
drwxr-xr-x 34 root root 4096 May 31 18:13 ..
-rwxr-xr-x  1 root root    0 May 31 18:18 emptyfile
-rwxr-xr-x  1 root root    0 May 31 18:19 emptyfile-posix
-rwxr-xr-x  1 root root   16 May 31 18:17 targetfile
-rwxr-xr-x  1 root root   16 May 31 18:19 targetfile-posix
root@Ubuntu-17-Virtual-Machine:~# mount | grep rename
//localhost/rename-test on /mnt-rename-test type cifs (rw,relatime,vers=3.1.1,cache=strict,u
root@Ubuntu-17-Virtual-Machine:~# mv /mnt-rename-test/emptyfile /mnt-rename-test/targetfileo
mv: cannot move '/mnt-rename-test/emptyfile' to '/mnt-rename-test/targetfile': Permission de
nied
```

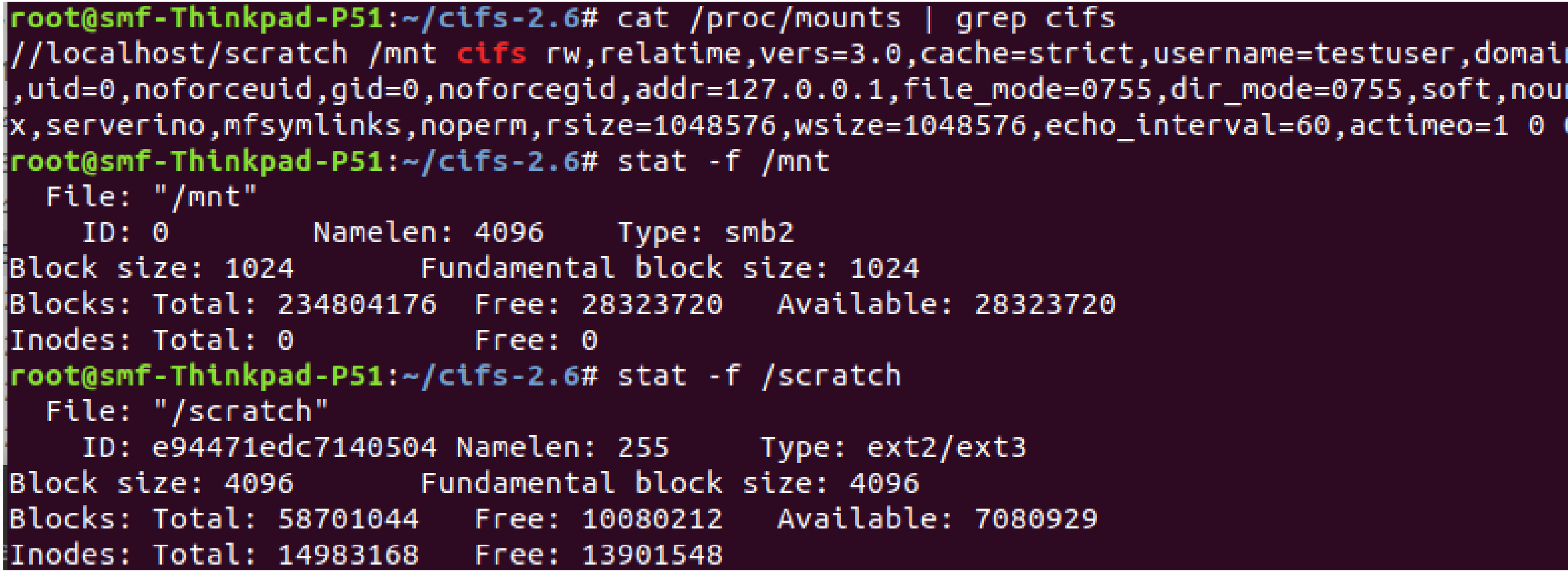
```
root@Ubuntu-17-Virtual-Machine:~# tail -f /mnt-rename-test/targetfile
targetfile data
tail: /mnt-rename-test/targetfile: No such file or directory
tail: no files remaining
root@Ubuntu-17-Virtual-Machine:~# 
```

```
,uid=0
,soft,posix,posixpaths,serverino,mapposix,rsize=1048576,wsize=104

he=strict,username=testuser,domain=,uid=0,noforceuid,gid=0,noforc
apposix,rsize=1048576,wsize=1048576,echo_interval=60,actimeo=1)
```


root@Ubuntu-17-Virtual-Machine: ~
File Edit View Search Terminal Help

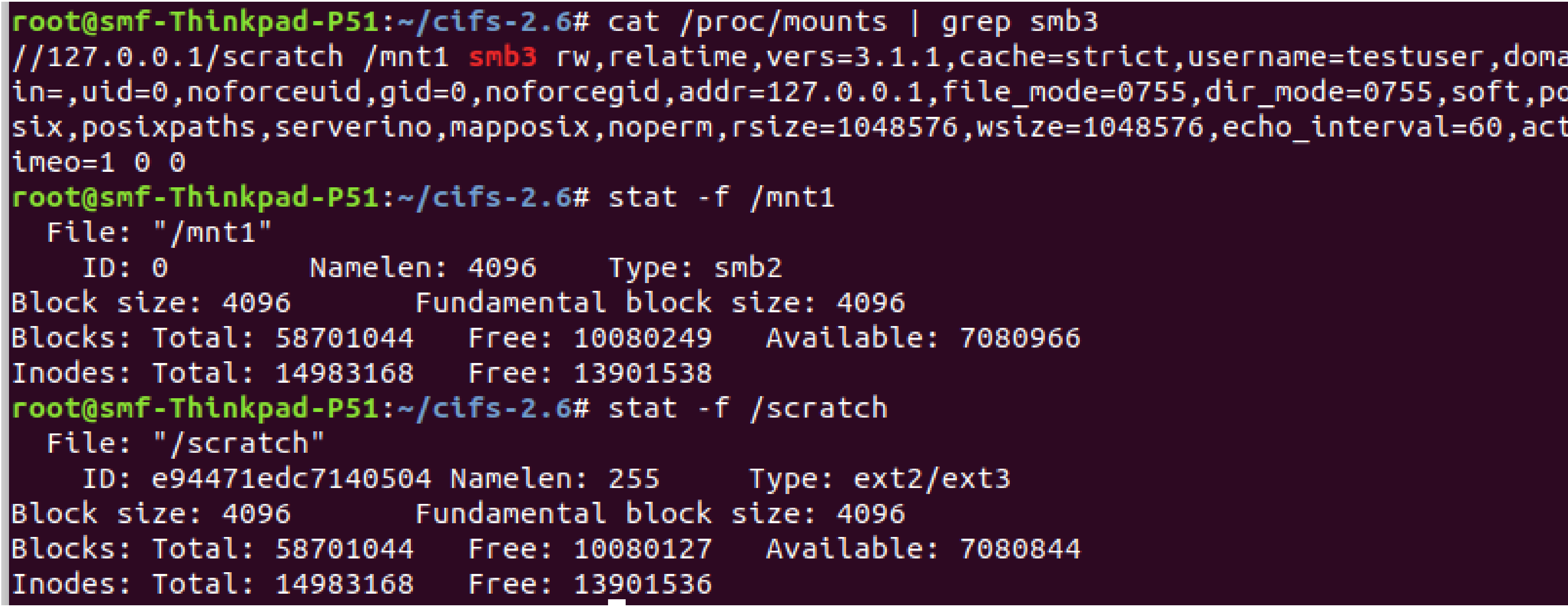
```
root@Ubuntu-17-Virtual-Machine:~# mount | grep rename
//localhost/rename-test on /mnt-rename-test type cifs (rw,relatime,vers=3.1.1,cache=strict,u
sername=testuser,domain=,uid=0,noforceuid,gid=0,noforcegid,addr=127.0.0.1,file_mode=0755,dir
_mode=0755,soft,posix,posixpaths,serverino,mapposix,rsize=1048576,wsize=1048576,echo_interva
l=60,actimeo=1)
root@Ubuntu-17-Virtual-Machine:~# mv /mnt-rename-test/emptyfile-posix /mnt-rename-test/targe
tfile-posix
root@Ubuntu-17-Virtual-Machine:~# 
```

Statfs ("stat –f") without POSIX extensions:



```
root@smf-Thinkpad-P51:~/cifs-2.6# cat /proc/mounts | grep cifs
//localhost/scratch /mnt cifs rw,relatime,vers=3.0,cache=strict,username=testuser,domai
,uid=0,noforceuid,gid=0,noforcegid,addr=127.0.0.1,file_mode=0755,dir_mode=0755,soft,nou
x,serverino,mfsymlinks,noperm,rsize=1048576,wsize=1048576,echo_interval=60,actimeo=1 0
root@smf-Thinkpad-P51:~/cifs-2.6# stat -f /mnt
  File: "/mnt"
    ID: 0           Namelen: 4096    Type: smb2
Block size: 1024        Fundamental block size: 1024
Blocks: Total: 234804176  Free: 28323720   Available: 28323720
Inodes: Total: 0          Free: 0
root@smf-Thinkpad-P51:~/cifs-2.6# stat -f /scratch
  File: "/scratch"
    ID: e94471edc7140504 Namelen: 255     Type: ext2/ext3
Block size: 4096        Fundamental block size: 4096
Blocks: Total: 58701044   Free: 10080212   Available: 7080929
Inodes: Total: 14983168   Free: 13901548
```

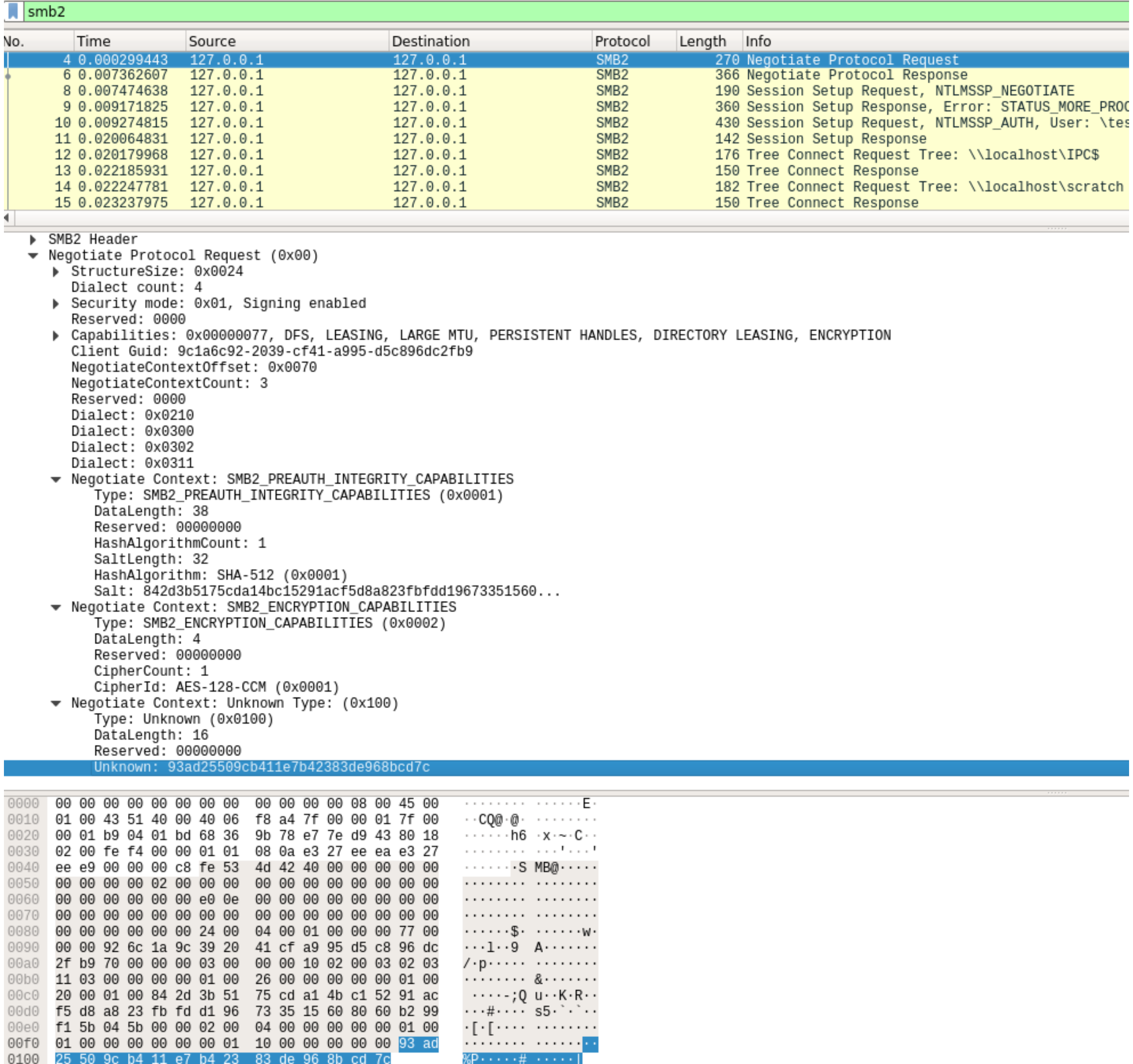
Statfs (“stat –f”) with POSIX extensions – works!



```
root@smf-Thinkpad-P51:~/cifs-2.6# cat /proc/mounts | grep smb3
//127.0.0.1/scratch /mnt1 smb3 rw,relatime,vers=3.1.1,cache=strict,username=testuser,doma
in=,uid=0,noforceuid,gid=0,noforcegid,addr=127.0.0.1,file_mode=0755,dir_mode=0755,soft,po
six,posixpaths,serverino,mapposix,noperm,rsize=1048576,wsize=1048576,echo_interval=60,act
imeo=1 0 0
root@smf-Thinkpad-P51:~/cifs-2.6# stat -f /mnt1
  File: "/mnt1"
    ID: 0            Namelen: 4096    Type: smb2
Block size: 4096       Fundamental block size: 4096
Blocks: Total: 58701044   Free: 10080249   Available: 7080966
Inodes: Total: 14983168   Free: 13901538
root@smf-Thinkpad-P51:~/cifs-2.6# stat -f /scratch
  File: "/scratch"
    ID: e94471edc7140504 Namelen: 255     Type: ext2/ext3
Block size: 4096       Fundamental block size: 4096
Blocks: Total: 58701044   Free: 10080127   Available: 7080844
Inodes: Total: 14983168   Free: 13901536
```

Details – Negotiate Req (w/POSIX)

- Format has changed since 2018 SDC
- Now 16 byte GUID
- Allows versioning



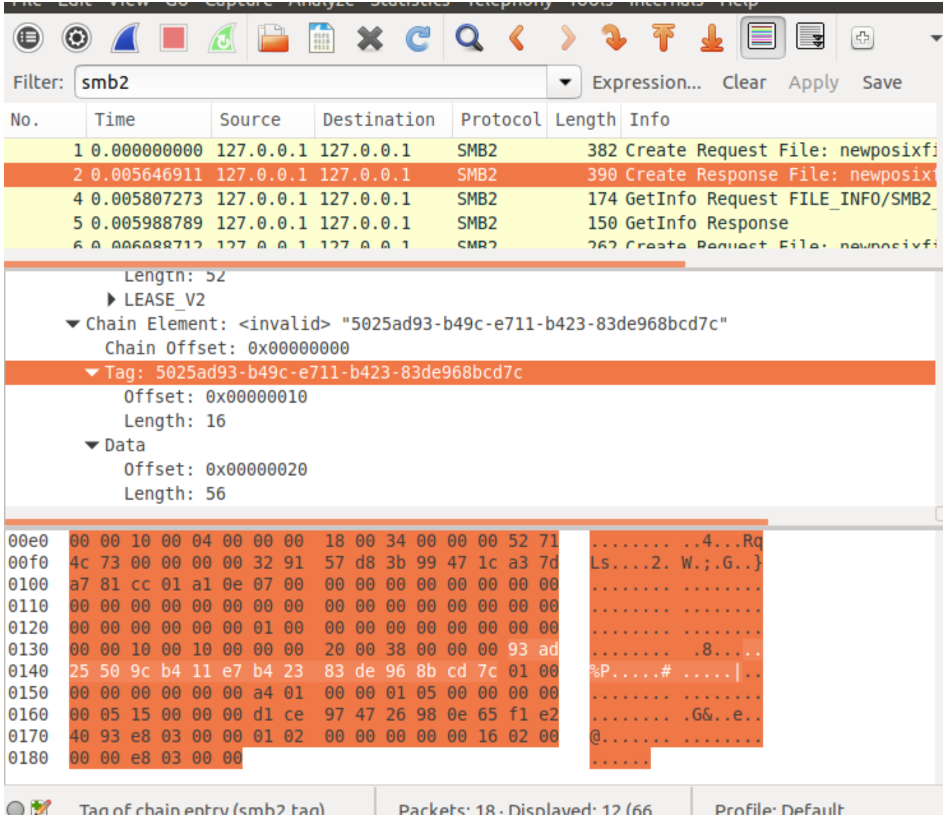
smb2

No.	Time	Source	Destination	Protocol	Length	Info
4	0.000299443	127.0.0.1	127.0.0.1	SMB2	270	Negotiate Protocol Request
6	0.007362607	127.0.0.1	127.0.0.1	SMB2	366	Negotiate Protocol Response
8	0.007474638	127.0.0.1	127.0.0.1	SMB2	190	Session Setup Request, NTLMSSP_NEGOTIATE
9	0.009171825	127.0.0.1	127.0.0.1	SMB2	360	Session Setup Response, Error: STATUS_MORE_PROC
10	0.009274815	127.0.0.1	127.0.0.1	SMB2	430	Session Setup Request, NTLMSSP_AUTH, User: \tes
11	0.020064831	127.0.0.1	127.0.0.1	SMB2	142	Session Setup Response
12	0.020179968	127.0.0.1	127.0.0.1	SMB2	176	Tree Connect Request Tree: \\localhost\IPC$
13	0.022185931	127.0.0.1	127.0.0.1	SMB2	150	Tree Connect Response
14	0.022247781	127.0.0.1	127.0.0.1	SMB2	182	Tree Connect Request Tree: \\localhost\scratch
15	0.023237975	127.0.0.1	127.0.0.1	SMB2	150	Tree Connect Response

```
▸ SMB2 Header
▾ Negotiate Protocol Request (0x00)
  ▸ StructureSize: 0x0024
    Dialect count: 4
  ▸ Security mode: 0x01, Signing enabled
    Reserved: 0000
  ▸ Capabilities: 0x00000077, DFS, LEASING, LARGE MTU, PERSISTENT HANDLES, DIRECTORY LEASING, ENCRYPTION
    Client Guid: 9c1a6c92-2039-cf41-a995-d5c896dc2fb9
    NegotiateContextOffset: 0x0070
    NegotiateContextCount: 3
    Reserved: 0000
    Dialect: 0x0210
    Dialect: 0x0300
    Dialect: 0x0302
    Dialect: 0x0311
  ▾ Negotiate Context: SMB2_PREAUTH_INTEGRITY_CAPABILITIES
      Type: SMB2_PREAUTH_INTEGRITY_CAPABILITIES (0x0001)
      DataLength: 38
      Reserved: 00000000
      HashAlgorithmCount: 1
      SaltLength: 32
      HashAlgorithm: SHA-512 (0x0001)
      Salt: 842d3b5175cda14bc15291acf5d8a823fbfdd19673351560...
  ▾ Negotiate Context: SMB2_ENCRYPTION_CAPABILITIES
      Type: SMB2_ENCRYPTION_CAPABILITIES (0x0002)
      DataLength: 4
      Reserved: 00000000
      CipherCount: 1
      CipherId: AES-128-CCM (0x0001)
  ▾ Negotiate Context: Unknown Type: (0x100)
      Type: Unknown (0x0100)
      DataLength: 16
      Reserved: 00000000
      Unknown: 93ad25509cb411e7b42383de968bcd7c
```

```
0000  00 00 00 00 00 00 00 00  00 00 00 00 08 00 45 00   ········ ······E·
0010  01 00 43 51 40 00 40 06  f8 a4 7f 00 00 01 7f 00   ··CQ@·@· ········
0020  00 01 b9 04 01 bd 68 36  9b 78 e7 7e d9 43 80 18   ······h6 ·x·~·C··
0030  02 00 fe f4 00 00 01 01  08 0a e3 27 ee ea e3 27   ········ ···'···'
0040  ee e9 00 00 00 c8 fe 53  4d 42 40 00 00 00 00 00   ·······S MB@·····
0050  00 00 00 00 02 00 00 00  00 00 00 00 00 00 00 00   ········ ········
0060  00 00 00 00 00 00 e0 0e  00 00 00 00 00 00 00 00   ········ ········
0070  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
0080  00 00 00 00 00 00 24 00  04 00 01 00 00 00 77 00   ······$· ······w·
0090  00 00 92 6c 1a 9c 39 20  41 cf a9 95 d5 c8 96 dc   ···l··9  A·······
00a0  2f b9 70 00 00 00 03 00  00 00 10 02 00 03 02 03   /·p····· ········
00b0  11 03 00 00 00 00 01 00  26 00 00 00 00 00 01 00   ········ &·······
00c0  20 00 01 00 84 2d 3b 51  75 cd a1 4b c1 52 91 ac    ····-;Q u··K·R··
00d0  f5 d8 a8 23 fb fd d1 96  73 35 15 60 80 60 b2 99   ···#···· s5·`·`··
00e0  f1 5b 04 5b 00 00 02 00  04 00 00 00 00 00 01 00   ·[·[···· ········
00f0  01 00 00 00 00 00 00 01  10 00 00 00 00 00 93 ad   ········ ········
0100  25 50 9c b4 11 e7 b4 23  83 de 96 8b cd 7c         %P·····# ·····|
```

Details continued – create response



Filter: smb2

```
No.   Time          Source      Destination  Protocol Length Info
    1 0.000000000  127.0.0.1   127.0.0.1     SMB2          382 Create Request File: newposixfi
    2 0.005646911  127.0.0.1   127.0.0.1     SMB2          390 Create Response File: newposixf
    4 0.005807273  127.0.0.1   127.0.0.1     SMB2          174 GetInfo Request FILE_INFO/SMB2_
    5 0.005988789  127.0.0.1   127.0.0.1     SMB2          150 GetInfo Response
    6 0.006088712  127.0.0.1   127.0.0.1     SMB2          262 Create Request File: newposixfi
```

```
        Length: 52
      ▶ LEASE_V2
    ▼ Chain Element: <invalid> "5025ad93-b49c-e711-b423-83de968bcd7c"
        Chain Offset: 0x00000000
      ▼ Tag: 5025ad93-b49c-e711-b423-83de968bcd7c
          Offset: 0x00000010
          Length: 16
      ▼ Data
          Offset: 0x00000020
          Length: 56
```

```
00e0  00 00 10 00 04 00 00 00  18 00 34 00 00 00 52 71   ........ ..4...Rq
00f0  4c 73 00 00 00 00 32 91  57 d8 3b 99 47 1c a3 7d   Ls....2. W.;.G..}
0100  a7 81 cc 01 a1 0e 07 00  00 00 00 00 00 00 00 00   ........ ........
0110  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ........ ........
0120  00 00 00 00 00 00 01 00  00 00 00 00 00 00 00 00   ........ ........
0130  00 00 10 00 10 00 00 00  20 00 38 00 00 00 93 ad   ........  .8.....
0140  25 50 9c b4 11 e7 b4 23  83 de 96 8b cd 7c 01 00   %P.....# .....|..
0150  00 00 00 00 00 00 a4 01  00 00 01 05 00 00 00 00   ........ ........
0160  00 05 15 00 00 00 d1 ce  97 47 26 98 0e 65 f1 e2   ........ .G&..e..
0170  40 93 e8 03 00 00 01 02  00 00 00 00 00 16 02 00   @....... ........
0180  00 00 e8 03 00 00                                  ......
```

Tag of chain entry (smb2.tag) | Packets: 18 · Displayed: 12 (66 | Profile: Default