CS 447/647

Filesystem(s)

Overview

- File Attributes
- Quotas
- Filesystems

File Attributes

- The permission bits
- setuid and setgid
- The sticky bit

The permissions bits

- AKA Portable Operating System Interface (POSIX)
- Made up of 9 bits in 3 groups
  - user (u) 000
  - group (g) 000
  - other (o) 000

001 = 1 Execute

010 = 2 Write

100 = 4 Read

755 = 111 101 101
User - read\write\execute
Group - read\execute
Other - read\execute

Octal	Binary	Perms	Octal	Binary	Perms
0	000	---	4	100	r--
1	001	--x	5	101	r-x
2	010	-w-	6	110	rw-
3	011	-wx	7	111	rwx

Spec	Meaning
u+w	Adds write permission for the owner of the file
ug=rw,o=r	Gives r/w permission to owner and group, and read permission to others
a-x	Removes execute permission for all categories (owner/group/other)
ug=srx,o=	Makes setuid/setgid and gives r/x permission to only owner and group
g=u	Makes the group permissions be the same as the owner permissions

setuid and setgid

- `setuid`
  - Octal 4000
  - Run as owner
  - Used by `passwd` command to change passwords
  - Disabled with `nosuid` mount option
    - `mount -o nosuid /dev/sdc1 /data`
- `setgid`
  - Octal 2000
  - Runs as group
  - When set on a directory all files created in the directory inherit the group

The sticky bit

- Octal 1000
- Historical used as a modifier for binaries
  - Introduced in 1974 to speed up execution of binaries
  - Now obsolete
- If set on a directory, it only allows deletion of files by
  - File Owner
  - Directory Owner
  - root

Permissions

- chmod - Change file mode bits
- chown - Change file owner and group
- chgrp - Change file group

```
chmod 700 1          #Owner RWX, Group ---, Other ---
chmod 755 1          #Owner RWX, Group R-X, Other R-X
chmod 2000 1         #setgid on the directory
chmod -R 700 1       #Recurisve chmod
#chown
chown root:root 1    #Change user and group to root
chown -R root:root   #Recursive chown
chown 1000:1000      #Chown with UID and GID
```

Permissions

- `chmod`, `chown`, `chgrp`
- Use `-R` sparingly
  - Clobbers permissions
- Better to use find with ch*

```
find /path -type f -exec chown 644 {} \;

find /path -type d -exec chown 755 {} \;
```

Permissions - `umask`

- 9 bits that represents what permissions to take away upon file creation
- Stored in /etc/login.defs and applied via PAM
- Unique per process
  - /proc/$PID/status

```
ps aux | grep $USER
grep umask /proc/$PID/status
```

Additional Flags - `lattr` and `chattr`

Flag	FS[a]	Meaning
A	XBE	Never update access time (`st_atime`; for performance)
a	XBE	Allow writing only in append mode[b]
C	B	Disable copy-on-write updates
c	B	Compress contents
D	BE	Force directory updates to be written synchronously
d	XBE	Do not back up; backup utilities should ignore this file
i	XBE	Make file immutable and undeletable[b]
j	E	Keep a journal for data changes as well as metadata
S	XBE	Force changes to be written synchronously (no buffering)
X	B	Avoid data compression if it is the default

a. X = XFS, B = Btrfs, E = ext3 and ext4
b. Can be set only by root

Access Control Lists

- Not a niche
- Very common on Windows
- Any complex environment will need them
  - NFS
  - SAMBA*
  - High-Performance Computing
  - GPFS, ZFS, etc.
- Two types
  - POSIX
  - NFSv4

POSIX ACLs

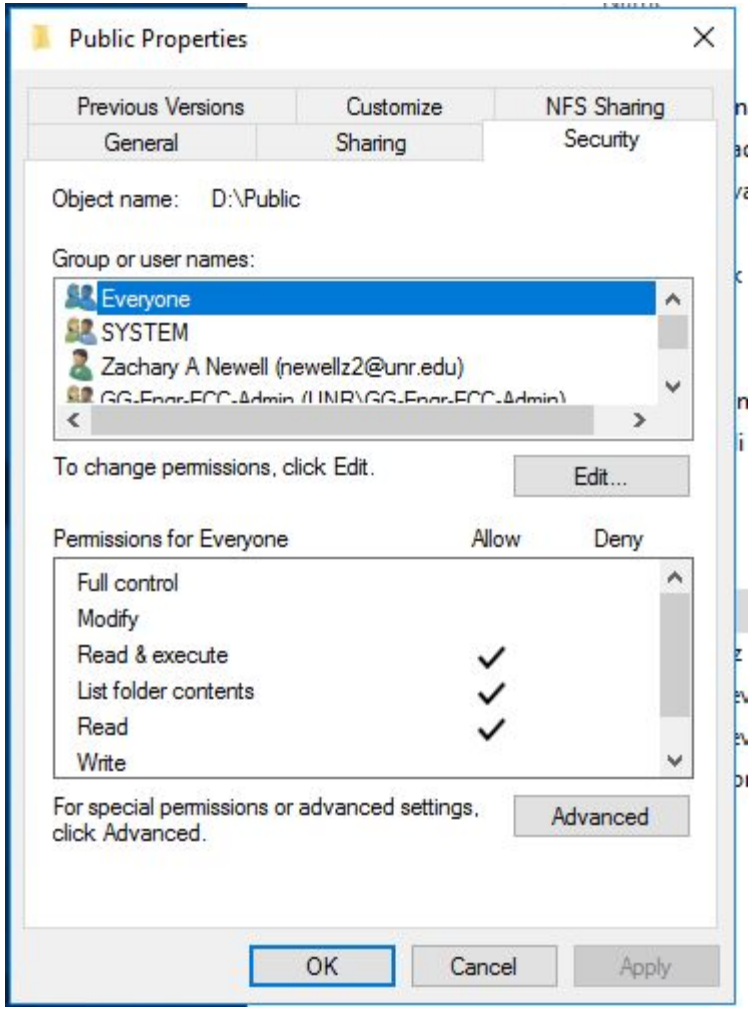
`setfacl` - set ACL

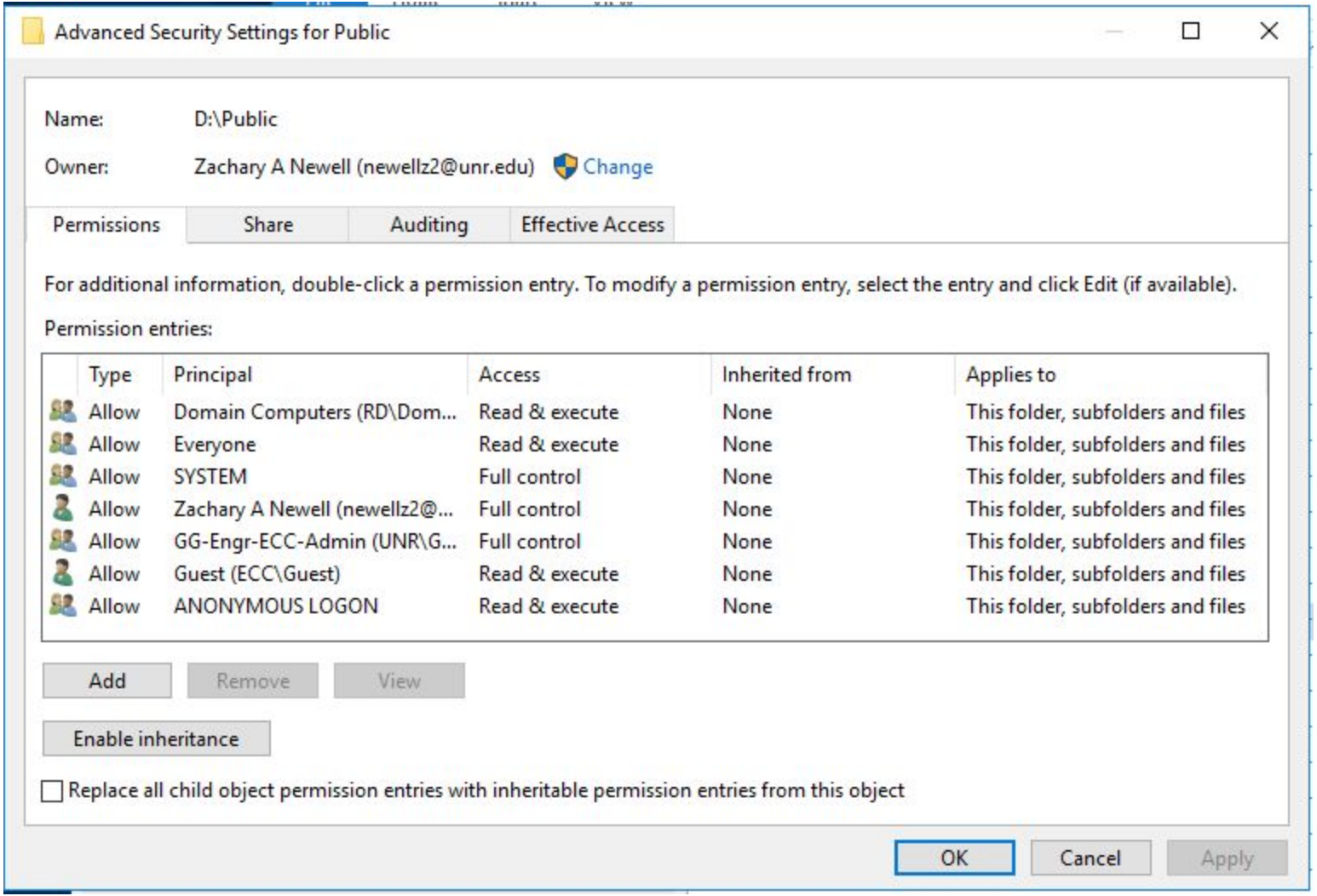
`getfacl` - read ACL

```
apt install -y acl
setfacl -m "u:newellz2:rw" file
setfacl -m "g:cs447:rx" file
setfacl -R -m "u:newellz2:rw" folder
setfacl -d -m "u:newellz2:rw" folder #Files inherit this ACL
```

Windows Permissions

- All permissions are ACLs
- Graphical
  - VB
  - PowerShell
- Inheritance
- System Accounts\Roles
  - Authenticated User
  - Domain Computer
  - System
  - Everyone
  - Guest
  - Anonymous


Public Properties
Previous Versions
Customize
NFS Sharing
General
Sharing
Security
Object name: D:\Public
Group or user names:
Everyone
SYSTEM
Zachary A Newell (newellz2@unr.edu)
To change permissions, click Edit.
Edit...
Permissions for Everyone
Allow
Deny
Full control
Modify
Read & execute
List folder contents
Read
Write
For special permissions or advanced settings, click Advanced.
Advanced
OK
Cancel
Apply


Advanced Security Settings for Public
Name: D:\Public
Owner: Zachary A Newell (newellz2@unr.edu) Change
Permissions Share Auditing Effective Access
For additional information, double-click a permission entry. To modify a permission entry, select the entry and click Edit (if available).
Permission entries:
Type Principal Access Inherited from Applies to
Allow Domain Computers (RD\Dom... Read & execute None This folder, subfolders and files
Allow Everyone Read & execute None This folder, subfolders and files
Allow SYSTEM Full control None This folder, subfolders and files
Allow Zachary A Newell (newellz2@... Full control None This folder, subfolders and files
Allow GG-Engr-ECC-Admin (UNR\G... Full control None This folder, subfolders and files
Allow Guest (ECC\Guest) Read & execute None This folder, subfolders and files
Allow ANONYMOUS LOGON Read & execute None This folder, subfolders and files
Add Remove View
Enable inheritance
Replace all child object permission entries with inheritable permission entries from this object
OK Cancel Apply

Permission Entry for Public

Principal: Zachary A Newell (newellz2@unr.edu) Select a principal

Type: Allow

Applies to: This folder, subfolders and files

Advanced permissions: Show basic permissions

- [x] Full control
- [x] Traverse folder / execute file
- [x] List folder / read data
- [x] Read attributes
- [x] Read extended attributes
- [x] Create files / write data
- [x] Create folders / append data
- [x] Write attributes
- [x] Write extended attributes
- [x] Delete subfolders and files
- [x] Delete
- [x] Read permissions
- [x] Change permissions
- [x] Take ownership

- [ ] Only apply these permissions to objects and/or containers within this container

Clear all

Add a condition to limit access. The principal will be granted the specified permissions only if conditions are met.

User | Group | Member of each | Value | Click Add items | Add items | Remove

Add a condition

OK Cancel

Windows Permissions

```
PS D:\> Get-ACL -Verbose .\Public |  Format-List


Path   : Microsoft.PowerShell.Core\FileSystem::D:\Public
Owner  : UNR\newellz2
Group  : UNR\Domain Users
Access : Everyone Allow  ReadAndExecute, Synchronize
         NT AUTHORITY\ANONYMOUS LOGON Allow  ReadAndExecute, Synchronize
         NT AUTHORITY\SYSTEM Allow  FullControl
         UNR\newellz2 Allow  FullControl
         UNR\GG-Engr-ECC-Admin Allow  FullControl
         RD\Domain Computers Allow  ReadAndExecute, Synchronize
         ECC\Guest Allow  ReadAndExecute, Synchronize
Audit  :
Sddl   : O:S-1-5-21-1275210071-1123561945-682003330-119339G:S-1-5-21-127521
         0a9;;;WD)(A;OICI;0x1200a9;;;AN)(A;OICI;FA;;;SY)(A;OICI;FA;;;S-1-5-
         CI;FA;;;S-1-5-21-1275210071-1123561945-682003330-202991)(A;OICI;0x
```

ACLs Exercise

1. Open a root terminal.
2. Use **`setfacl -m g:account:rx /data/sales`** to give the group account read permissions on the **`/data/sales`** directory, and use **`setfacl -m g:sales:rx /data/account`** to give the group sales read permissions on the **`/data/account`** directory.
3. Use **`getfacl /data/`** to verify that the permissions have been set the way you intended to.
4. Use **`setfacl -m d:g:account:rx,g:sales:rwx /data/sales`** to set the default ACL for the directory sales.
5. Add the default ACL for the directory /**`data/account`** by using **`setfacl -m d:g:sales:rx,g:account:rwx /data/account`**.
6. Verify that the ACL settings are effective by adding a new file in **`/data/sales`**. Use **`touch /data/sales/newfile`** and use **`getfacl /data/sales/newfile`** to check the current permission assignments.

Quotas

xfs

- Created in 1993 by Silicon Graphics Inc. (SGI)
- A 64-bit journaled filesystem
- Suited for large files and filesystems
  - 8 exbibytes max file size
  - 2^64 (1.8446744e+19) max number of files
- Supports
  - Quotas
  - Snapshots
  - Live resizing (growing)
- Standard FS in SUSE and RedHat

Exercise

```
mkdir -p /var/tmp/quotas && cd /var/tmp/quotas

truncate -s 1G xfs_disk.img #Create a sparse file

losetup --find --show xfs_disk.img #Mount the file as a loop dev

mkfs.xfs /dev/loop0 #man mkfs.xfs

mkfs.xfs -f -L data  /dev/loop0 #man mkfs.xfs

mount -o defaults,uquota,gquota /dev/loop0 /mnt
```

Exercise

```
adduser --disabled-password --gecos "" robert

mkdir /mnt/robert && chown robert /mnt/robert

xfs_quota -x -c 'limit bsoft=75m bhard=100m robert' /mnt

xfs_quota -x -c 'limit isoft=3 ihard=4 robert' /mnt #inode limit

dd if=/dev/zero of=/mnt/robert/file.bin bs=1M count=80
chown robert /mnt/robert/file.bin

xfs_quota -x -c 'state'

xfs_quota -x -c 'report'
```