2550 Intro to cybersecurity

L13: Authorization

abhi shelat

Thanks Christo for slides!

Authentication:

Authorization

After Authenticating a subject, what next?

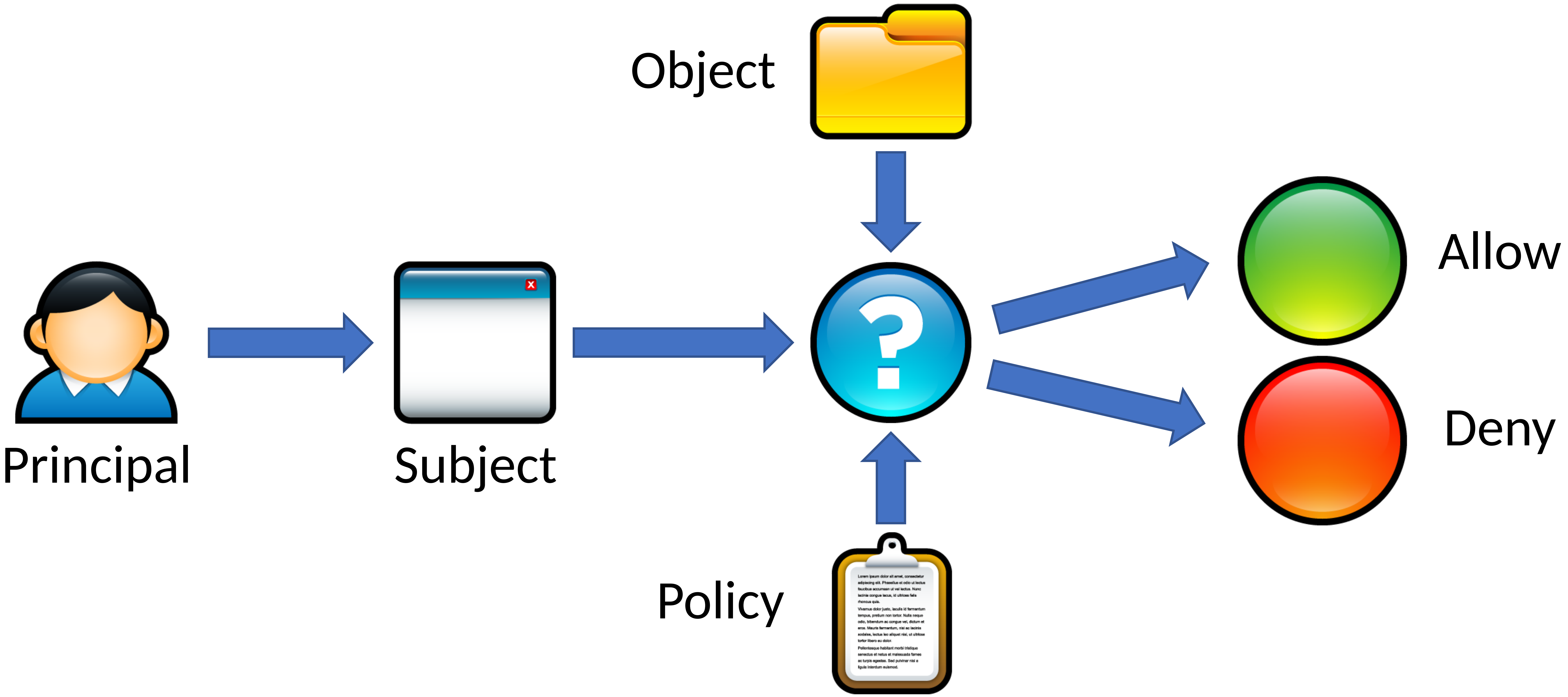
Access Control

- Policy specifying how entities can interact with resources
  - i.e., Who can access what?
  - Requires authentication and authorization
- Access control primitives

Principal	User of a system	
Subject	Entity that acts on behalf of principals	Software program
Object	Resource acted upon by subjects	Files Sockets Devices OS APIs

Access Control Check

- Given an access request from a subject, on behalf of a principal, for an object, return an access control decision based on the policy



Access Control Models

- Discretionary Access Control (DAC)
  - The kind of access control you are familiar with
  - Access rights propagate and may be changed at subject’s discretion

- Mandatory Access Control (MAC)
  - Access of subjects to objects is based on a system-wide policy
  - Denies users full control over resources they create

Discretionary Access Control

Access Control Matrices

Access Control Lists

Unix Access Control

Discretionary Access Control

- According to Trusted Computer System Evaluation Criteria (TCSEC)

"A means of restricting access to objects based on the identity and need-to-know of users and/or groups to which they belong.

Controls are discretionary in the sense that a subject with a certain access permission is capable of passing that permission (directly or indirectly) to any other subject."

Access Control Matrices

Given subjects $s_i \in S$, objects $o_j \in O$, rights {**R**ead, **W**rite, e**X**ecute},

	o_1	o_2	o_3
s_1	RW	RX	
s_2	R	RWX	RW
s_3		RWX	

- Introduced by Lampson in 1971
- Static description of protection state
- Abstract model of concrete systems

Access Control List (ACL)

- Each object has an associated list of subject→operation pairs
- Authorization verified for each request by checking list of tuples
- Used pervasively in filesystems and networks
  - "Users a, b, and c and read file x."
  - "Hosts a and b can listen on port x."

	o_1	o_2
s_1	RW	RX
s_2	R	RWX
s_3		RWX

Access Control List (ACL)

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ACL for o_2

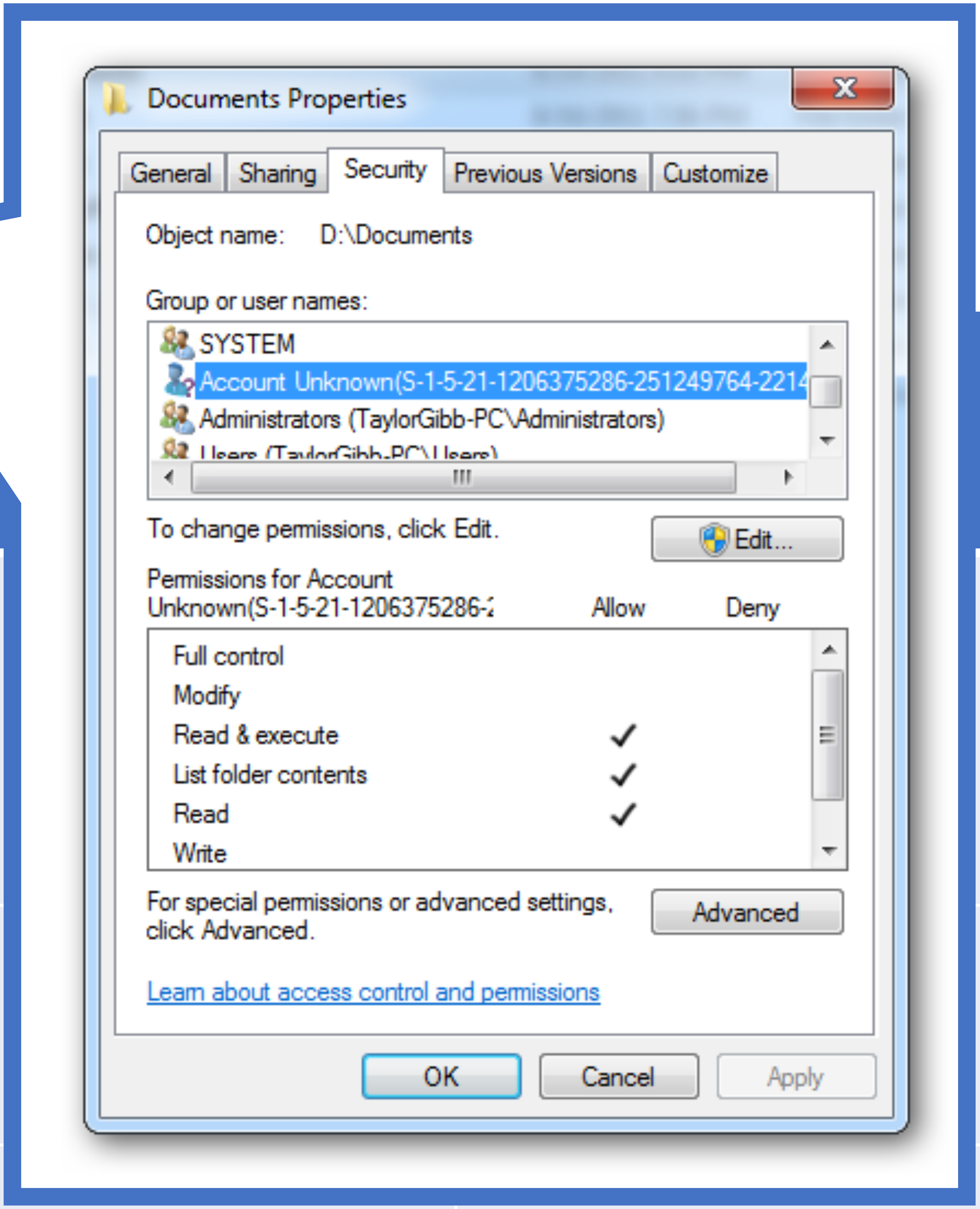
	o_1	o_2
s_1	RW	RX
s_2	R	RWX
s_3		RWX

Windows ACLs

	D:\Music	D:\Images
System	RWX	RWX
Administrators	RW	RW

Windows ACLs

	D:\Music
System	RWX
Administrators	RW



Object name: D:\Documents

Group or user names:

- SYSTEM
- Account Unknown(S-1-5-21-1206375286-251249764-2214
- Administrators (TaylorGibb-PC\Administrators)
- Users (TaylorGibb-PC\Users)

To change permissions, click Edit.

Permissions for Account Unknown(S-1-5-21-1206375286-2	Allow	Deny
Full control		
Modify		
Read & execute	✓	
List folder contents	✓	
Read	✓	
Write		

For special permissions or advanced settings, click Advanced.

Learn about access control and permissions

ACL Review

The Good

- Very flexible
  - Can express any possible access control matrix
  - Any principal can be configured to have any rights on any object

The Bad

ACL Review

The Good

- Very flexible
  - Can express any possible access control matrix
  - Any principal can be configured to have any rights on any object

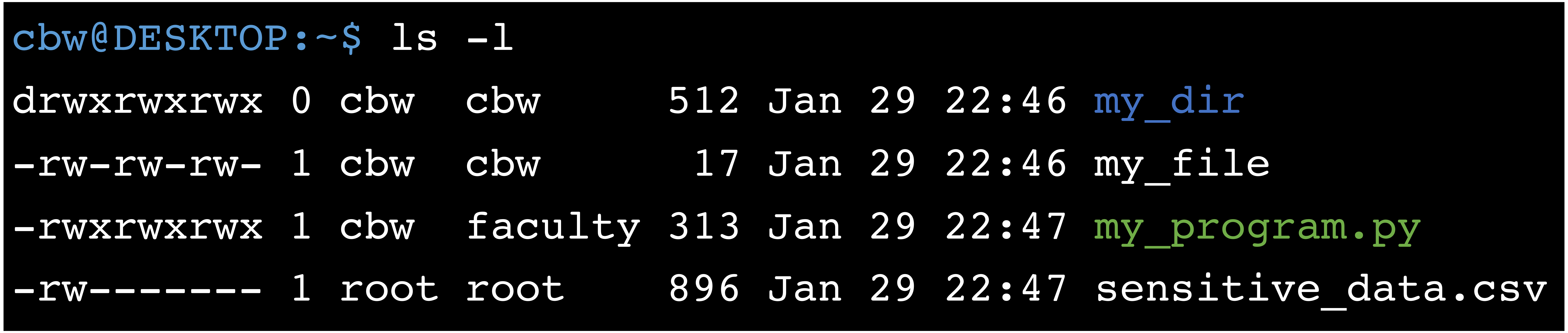
The Bad

- Complicated to manage
  - Every object can have wildly different policies
  - Infinite permutations of subjects, objects, and rights

Unix-style Permissions

- Based around the concept of owners and groups
  - All objects have an owner and a group
  - Permissions assigned to owner, group, and everyone else
- Authorization verified for each request by mapping the subject to owner, group, or other and checking the associated permissions

Unix Permissions



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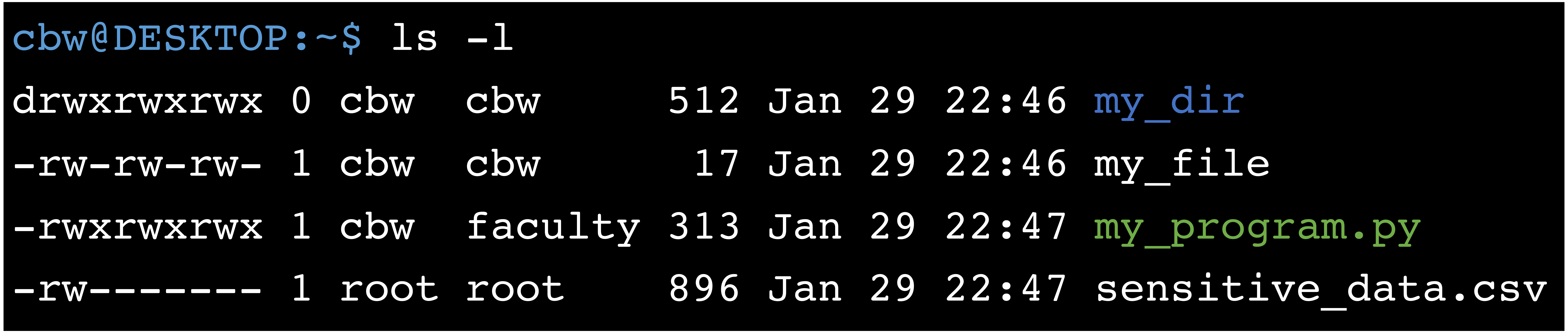
```

d → Directory   **r → Read**   **w → Write**   **x → eXecute**

Unix Permissions



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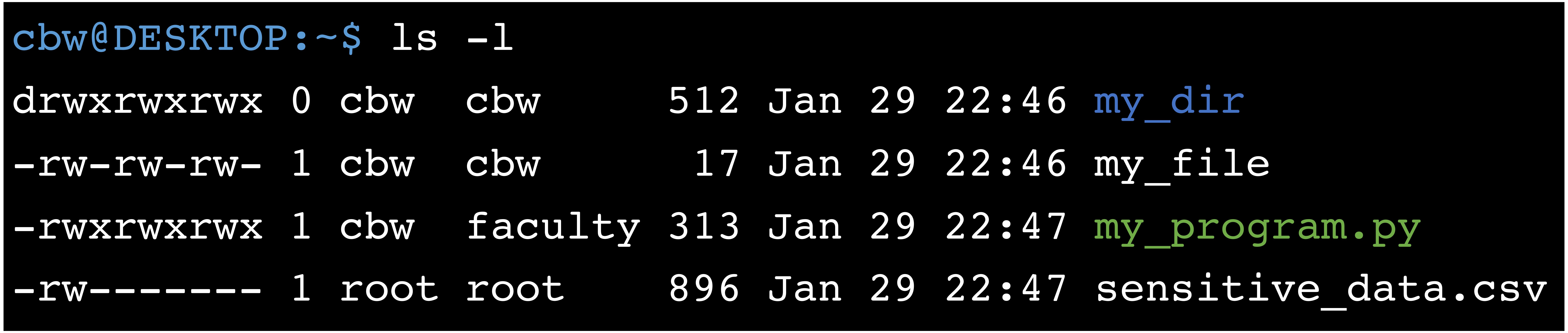
Owner

d →　Directory　　r →　Read　w →　Write　x →　eXecute

Unix Permissions



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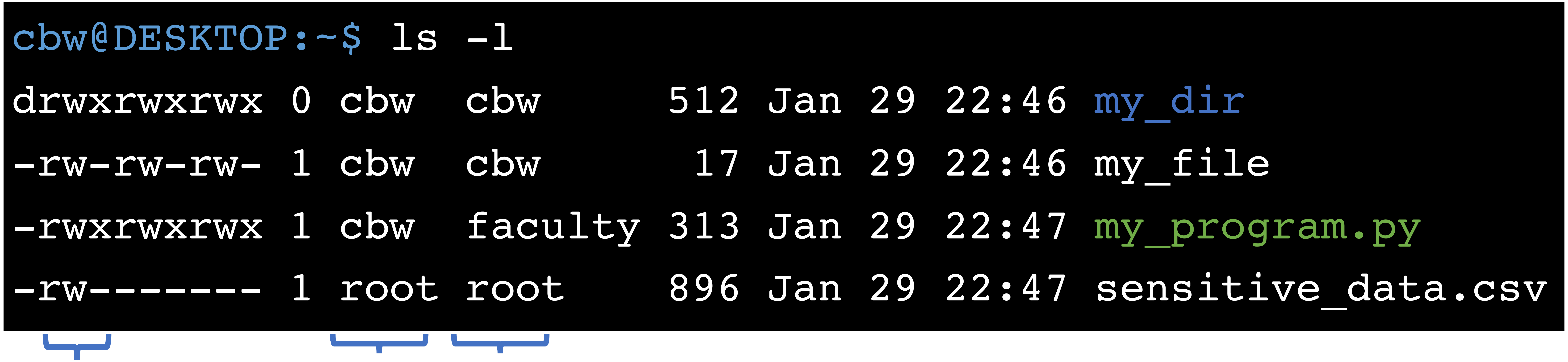
Unix Permissions



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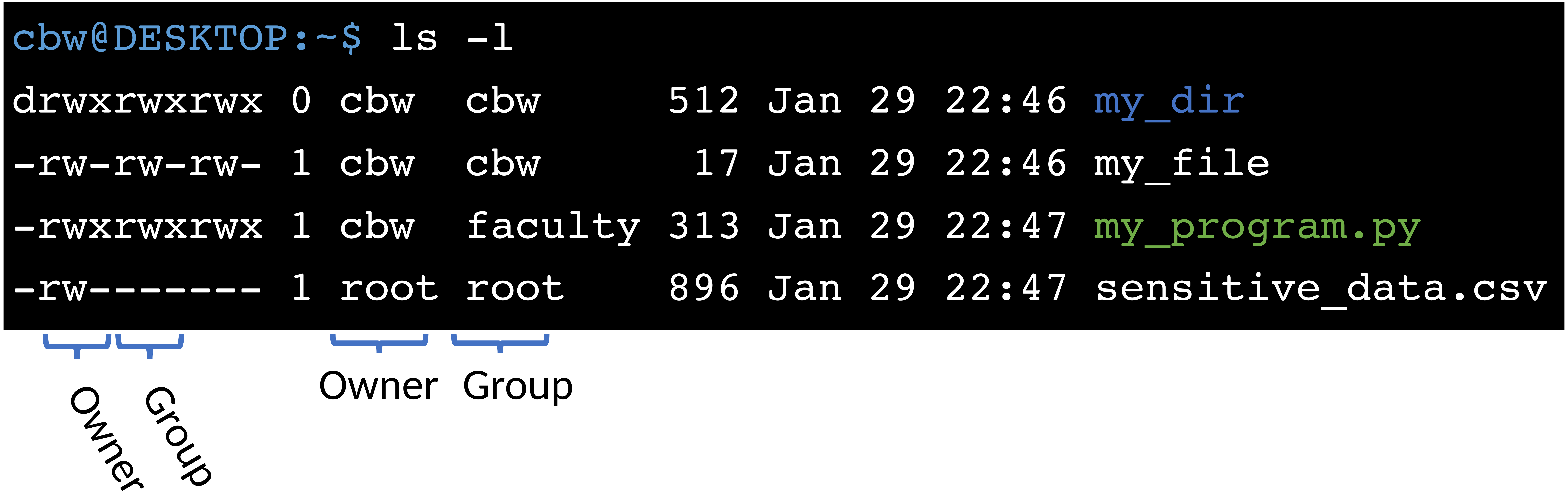
Owner

Owner Group

d → Directory   **r → Read**   **w → Write**   **x → eXecute**

Unix Permissions



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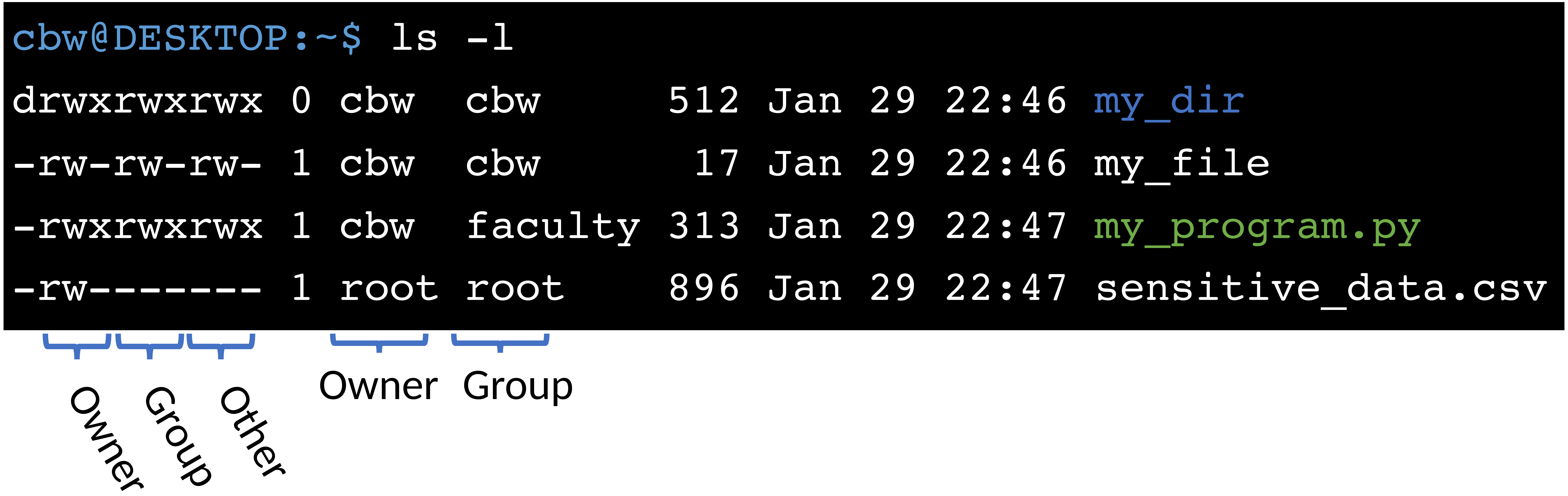

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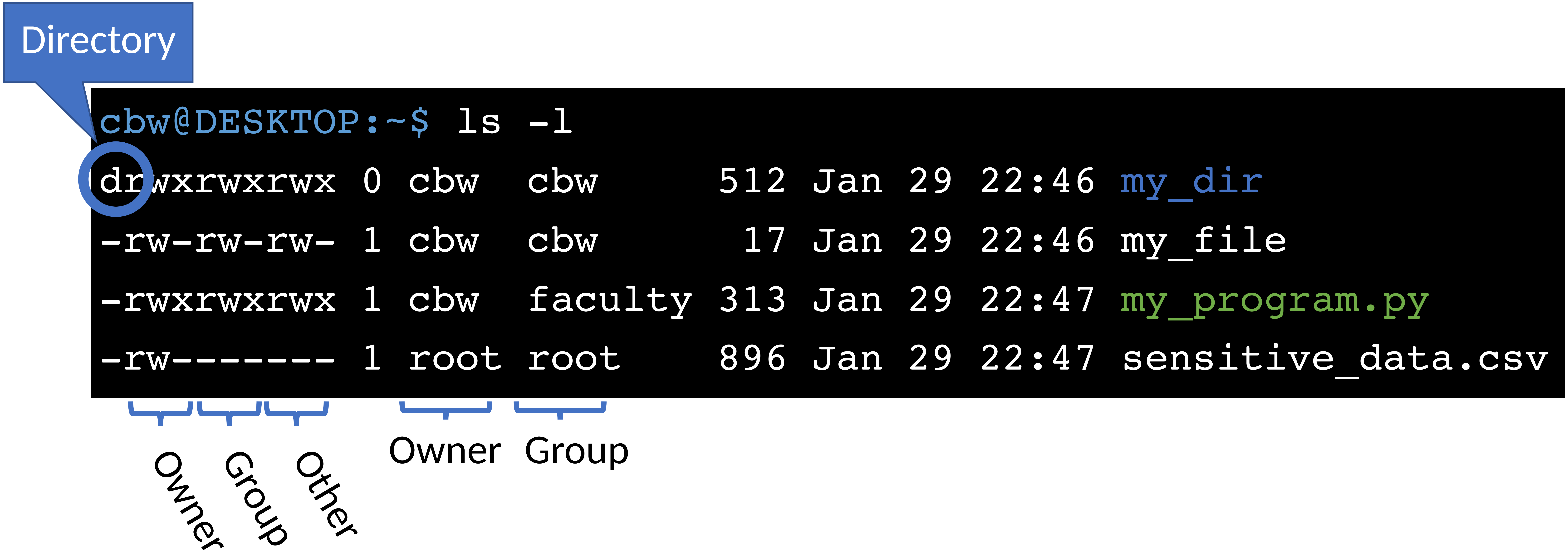

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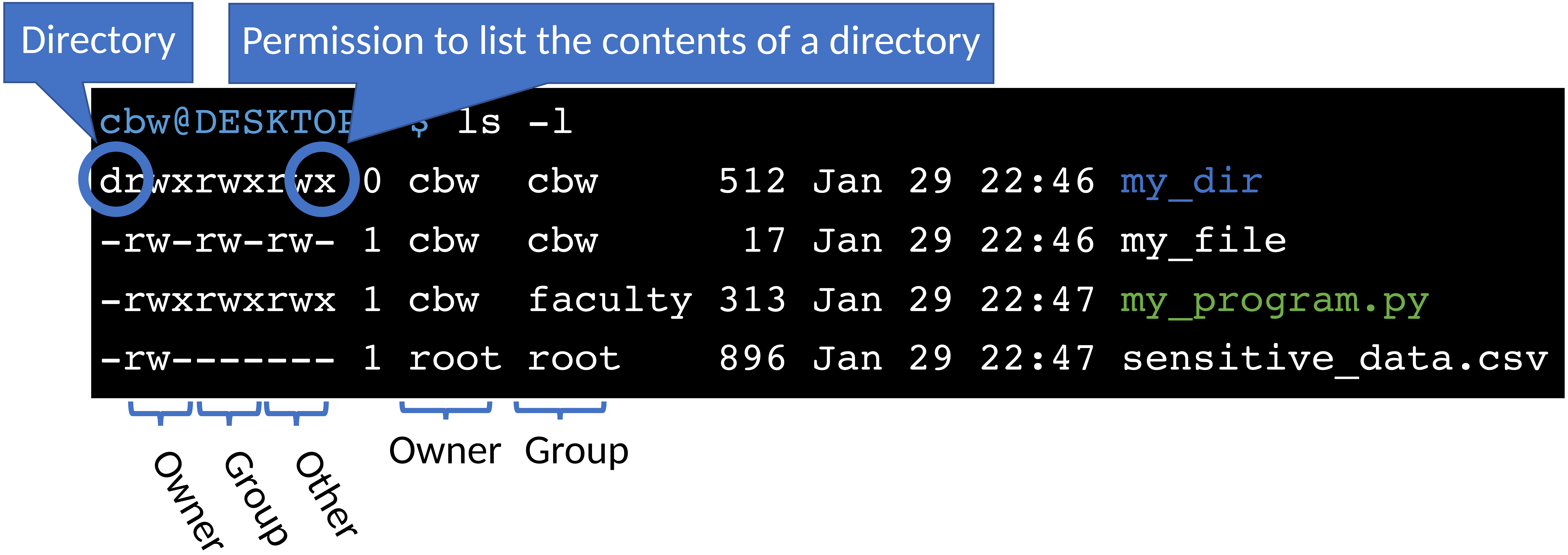
Unix Permissions



Directory

Permission to list the contents of a directory

```
cbw@DESKTOP   $ ls -l
drwxrwxrwx 0 cbw  cbw      512 Jan 29 22:46 my_dir
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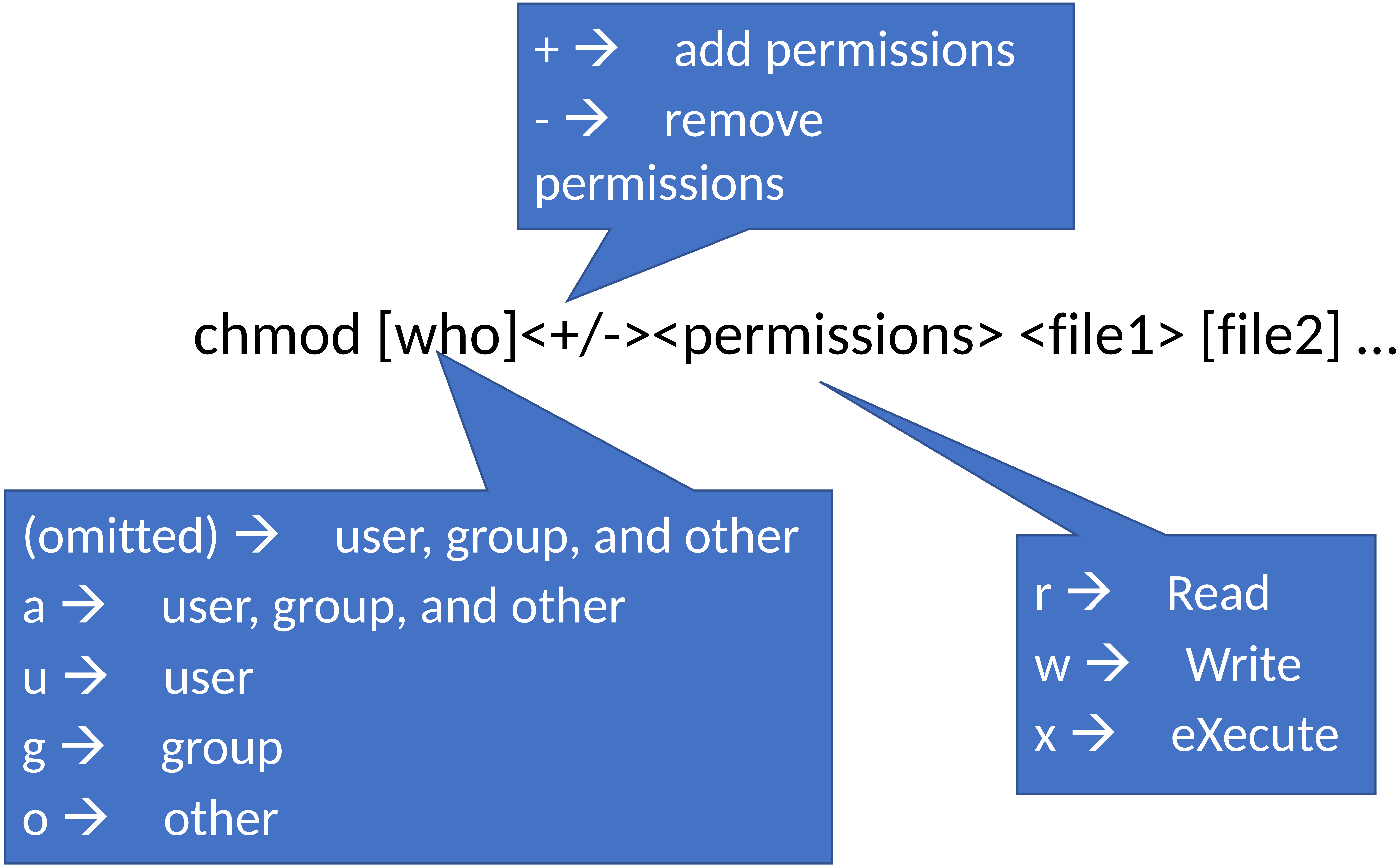
Setting Permissions



+ → add permissions

- → remove permissions

```
chmod [who]<+/-><permissions> <file1> [file2] …
```

(omitted) → user, group, and other

a → user, group, and other

u → user

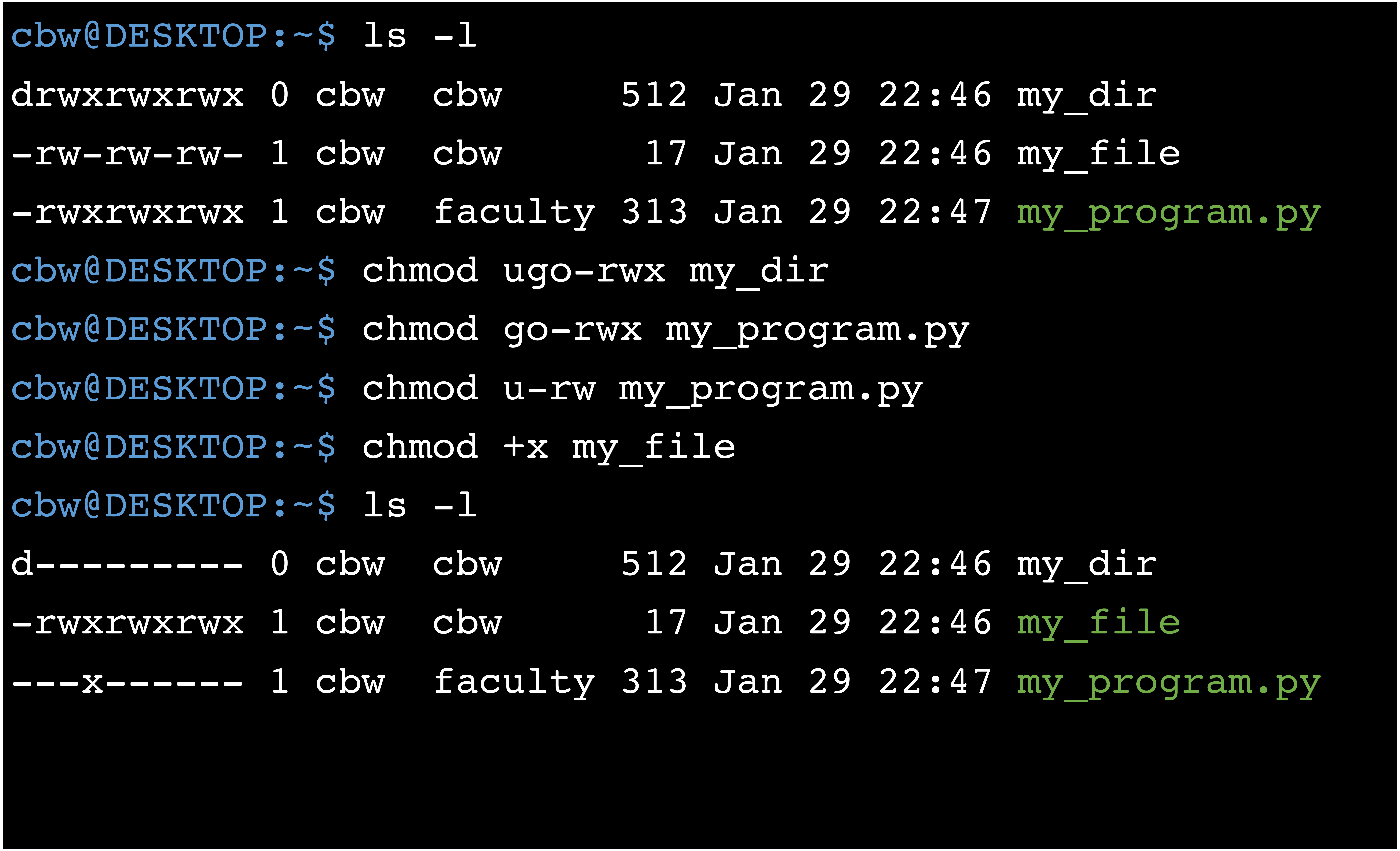
g → group

o → other

r → Read

w → Write

x → eXecute



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cbw@DESKTOP:~$ chmod ugo-rwx my_dir
cbw@DESKTOP:~$ chmod go-rwx my_program.py
cbw@DESKTOP:~$ chmod u-rw my_program.py
cbw@DESKTOP:~$ chmod +x my_file
cbw@DESKTOP:~$ ls -l
d--------- 0 cbw  cbw     512 Jan 29 22:46 my_dir
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```

Alternate Form of Setting Permissions

chmod ### <file1> [file2] …

- #s correspond to owner, group, and other
- Each value encodes read, write, and execute permissions
  - 1 → execute
  - 2 → write
  - 4 → read

Alternate Form of Setting Permissions

chmod ### <file1> [file2] …

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- What if you want to set something as read, write, and execute?

Alternate Form of Setting Permissions

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- #s correspond to owner, group, and other
- Each value encodes read, write, and execute permissions
  - 1 → execute
  - 2 → write
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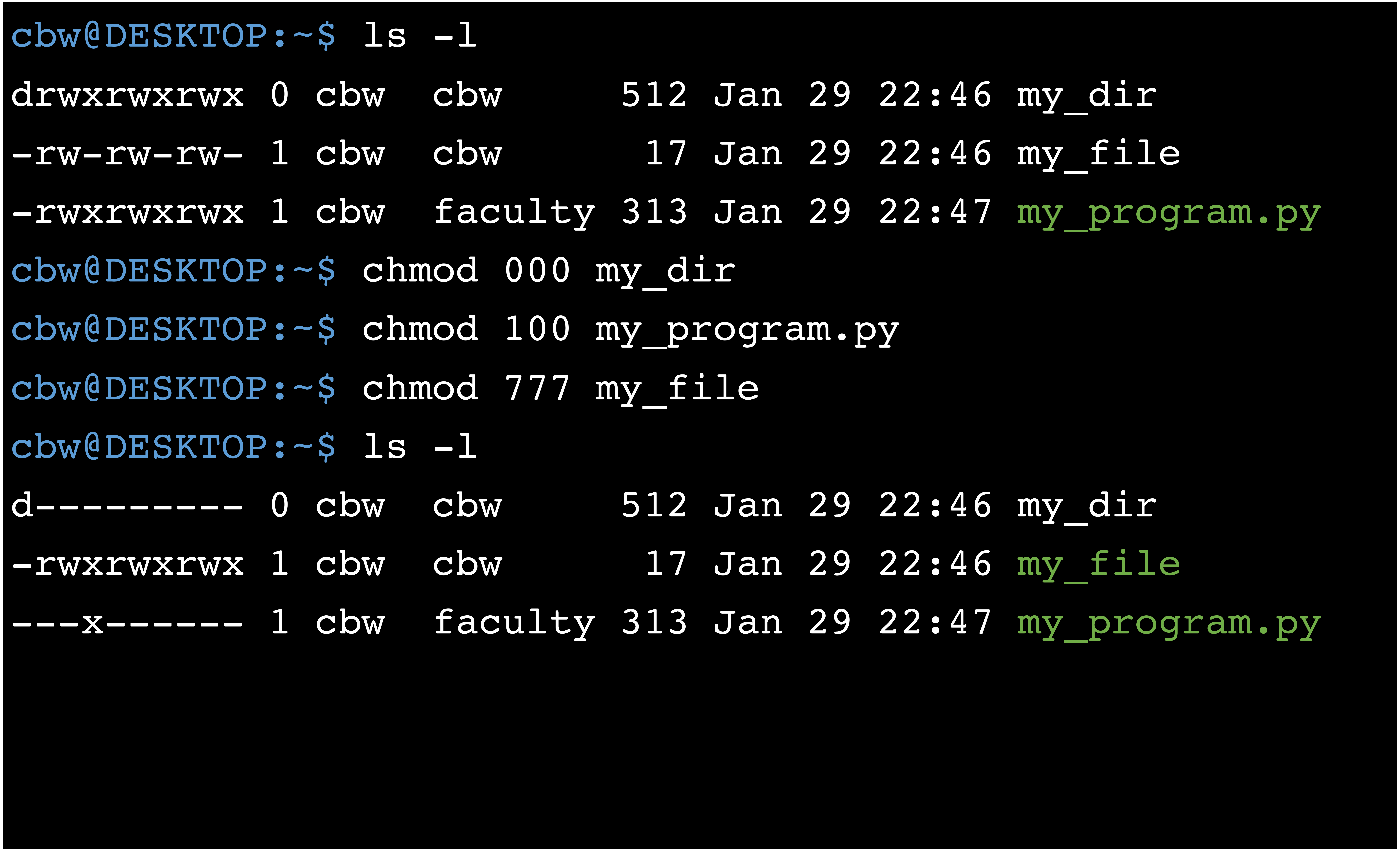
- What if you want to set something as read, write, and execute?
  - 1 + 2 + 4 = 7



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cbw@DESKTOP:~$ chmod 000 my_dir
cbw@DESKTOP:~$ chmod 100 my_program.py
cbw@DESKTOP:~$ chmod 777 my_file
cbw@DESKTOP:~$ ls -l
d--------- 0 cbw  cbw     512 Jan 29 22:46 my_dir
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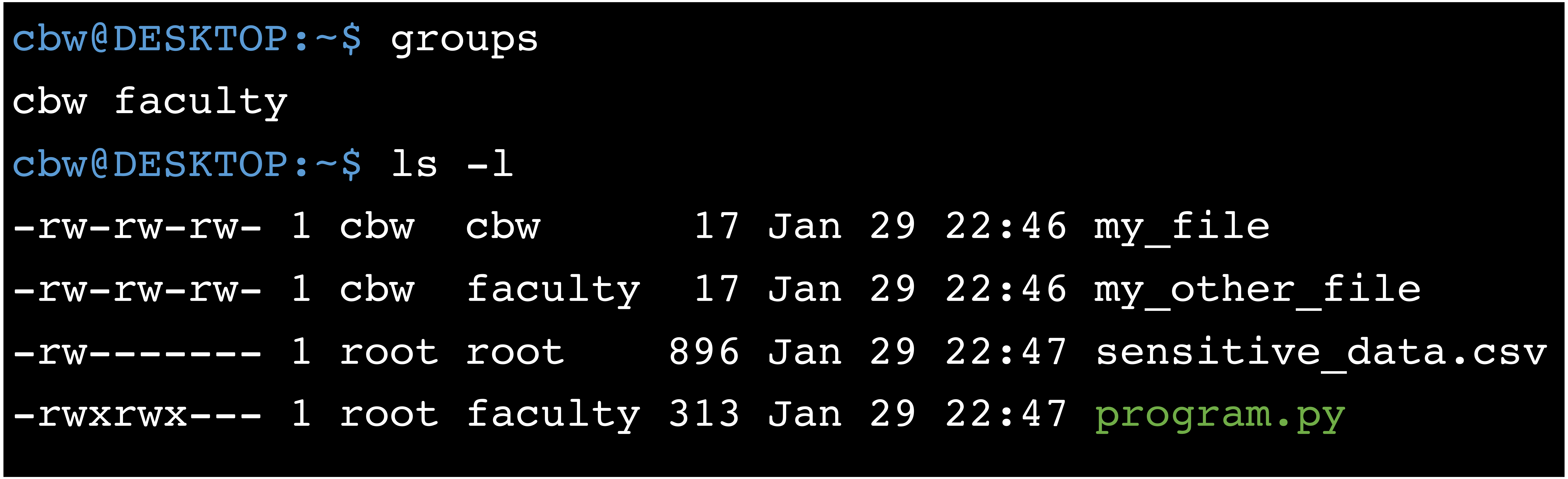
Who May Change Permissions?



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cbw faculty
cbw@DESKTOP:~$ ls -l
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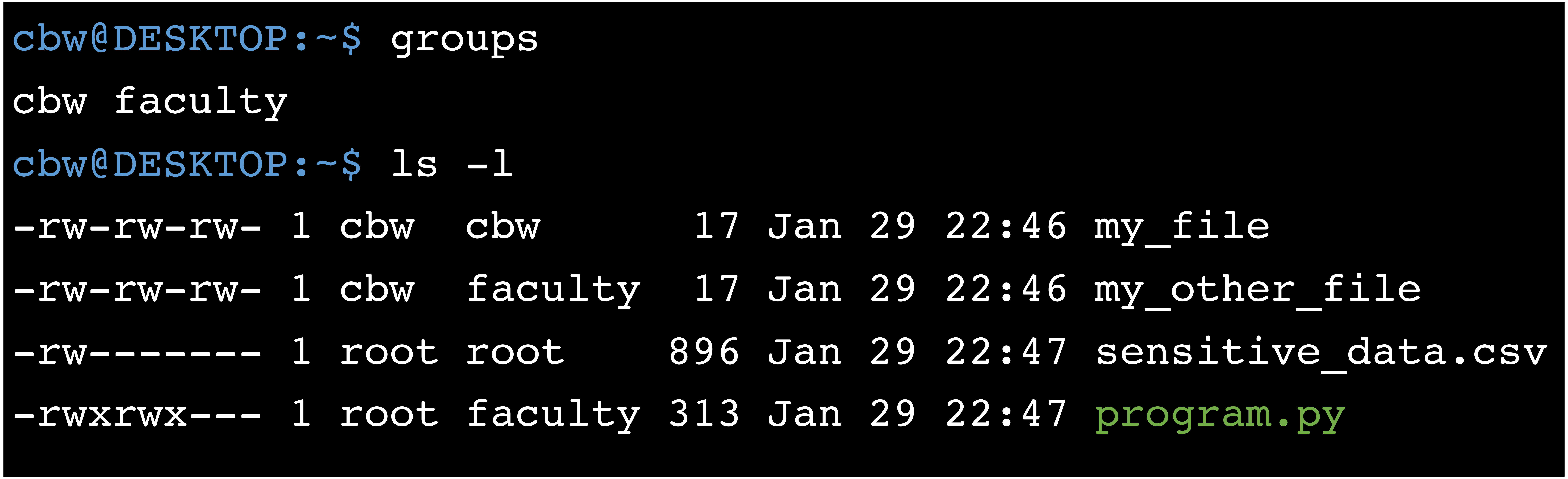
- Which files is user *cbw* permitted to *chmod*?

Who May Change Permissions?



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```

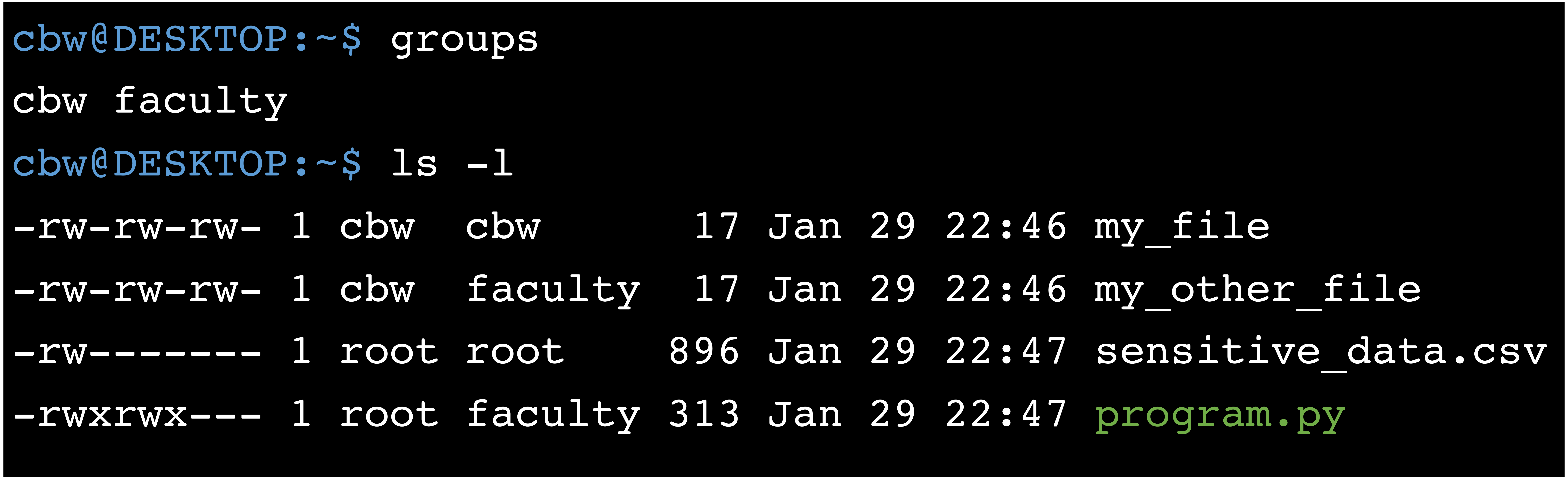
- Which files is user *cbw* permitted to *chmod*?
  - Only owners can *chmod* files
  - *cbw* can *chmod my_file* and *my_other_file*
  - Group membership doesn’t grant *chmod* ability (cannot *chmod program.py*)

Setting Ownership

- Unix uses discretionary access control
  - New objects are owned by the subject that created them
- How can you modify the owner or group of an object?

```
chown <owner>:<group> <file1> [file2] …
```

Who May Change Ownership?



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- Which operations are permitted?

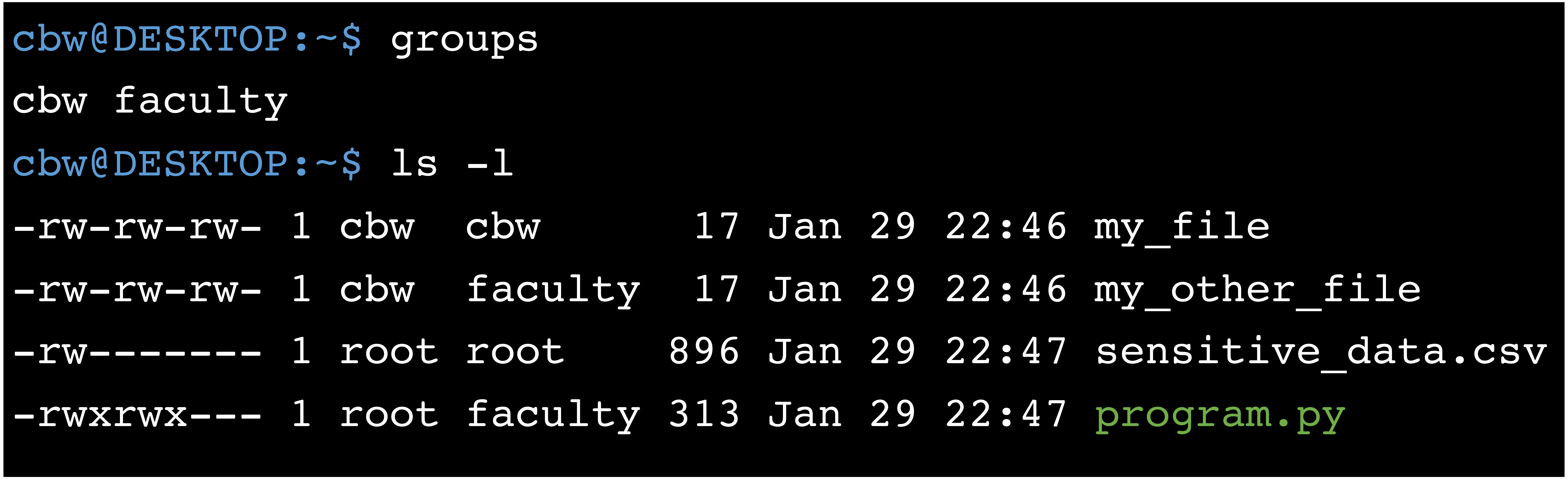
chown cbw:faculty my_file

chown root:root my_other_file

chown cbw:cbw sensitive_date.csv

chown cbw:faculty program.py

Who May Change Ownership?



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```

- Which operations are permitted?

chown cbw:faculty my_file	Yes, cbw belongs to the faculty group
chown root:root my_other_file	No, only root many change file owners!
chown cbw:cbw sensitive_date.csv	No, only root many change file owners!
chown cbw:faculty program.py	No, only root many change file owners!

Unix Access Control Exercise (1)

- What Unix group and permission assignments satisfy this access control matrix?

Desired Permissions

	file1	file2
user1	r--	rwx
user2	r--	rw-
user3	r--	rw-
user4	rwx	rw-

Unix Access Control Exercise (1)

- What Unix group and permission assignments satisfy this access control matrix?

Desired Permissions

	file1
user1	r--
user2	r--
user3	r--
user4	rwx

User	Groups
user1	user1
user2	user2
user3	user3
user4	user4

```
-rwxr--r-- 1 user4  user4  0 file1
-rwxrw-rw- 1 user1  user1  0 file2
```

Unix Access Control Exercise (2)

- What Unix group and permission assignments satisfy this access control matrix?

Desired Permissions

	file1	file2
user1	r--	--x
user2	r-x	rwx
user3	r-x	r--
user4	rwx	r--

Unix Access Control Exercise (2)

- What Unix group and permission assignments satisfy this access control matrix?

Desired Permissions

	file1
user1	r--
user2	r-x
user3	r-x
user4	rwx

User	Groups
user1	user1
user2	user2, group1
user3	user3, group1, group2
user4	user4, group2

```
-rwxr-xr-- 1 user4  group1  0 file1
-rwxr----x 1 user2  group2  0 file2
```

Unix Access Control Exercise (3)

- What Unix group and permission assignments satisfy this access control matrix?

Desired Permissions

	file 1	file 2
user 1	---	rw-
user 2	r--	r--
user 3	rwx	rwx
user 4	rwx	---

Unix Access Control Exercise (3)

- What Unix group and permission assignments satisfy this access control matrix?

Desired Permissions

	file 1	file 2
user 1	---	rw-
user 2	r--	r--
user 3	rwx	rwx
user 4	rwx	---

- Trick question! This matrix **cannot** be represented

Unix Access Control Exercise (3)

- What Unix group and permission assignments satisfy this access control matrix?

Desired Permissions

	file 1	file 2
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- Trick question! This matrix **cannot** be represented
- *file2*: four distinct privilege levels
  - Maximum of three levels (user, group, other)

Unix Access Control Exercise (3)

- What Unix group and permission assignments satisfy this access control matrix?

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	file 1	file 2
user 1	---	rw-
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user 4	rwx	---

- Trick question! This matrix **cannot** be represented

- *file2*: four distinct privilege levels
  - Maximum of three levels (user, group, other)

- *file1*: two users have high privileges
  - If *user3* and *user4* are in a group, how to give *user2* read and *user1* nothing?
  - If *user1* or *user2* are owner, they can grant themselve write and execute permissions :(

Unix Access Control Review

The Good

- Very simple model
  - Owners, groups, and other
  - Read, write, execute
- Relatively simple to manage and understand

The Bad

Unix Access Control Review

The Good

- Very simple model
  - Owners, groups, and other
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The Bad

- Not all policies can be encoded!
  - Contrast to ACL

Unix Access Control Review

The Good

- Very simple model
  - Owners, groups, and other
  - Read, write, execute
- Relatively simple to manage and understand

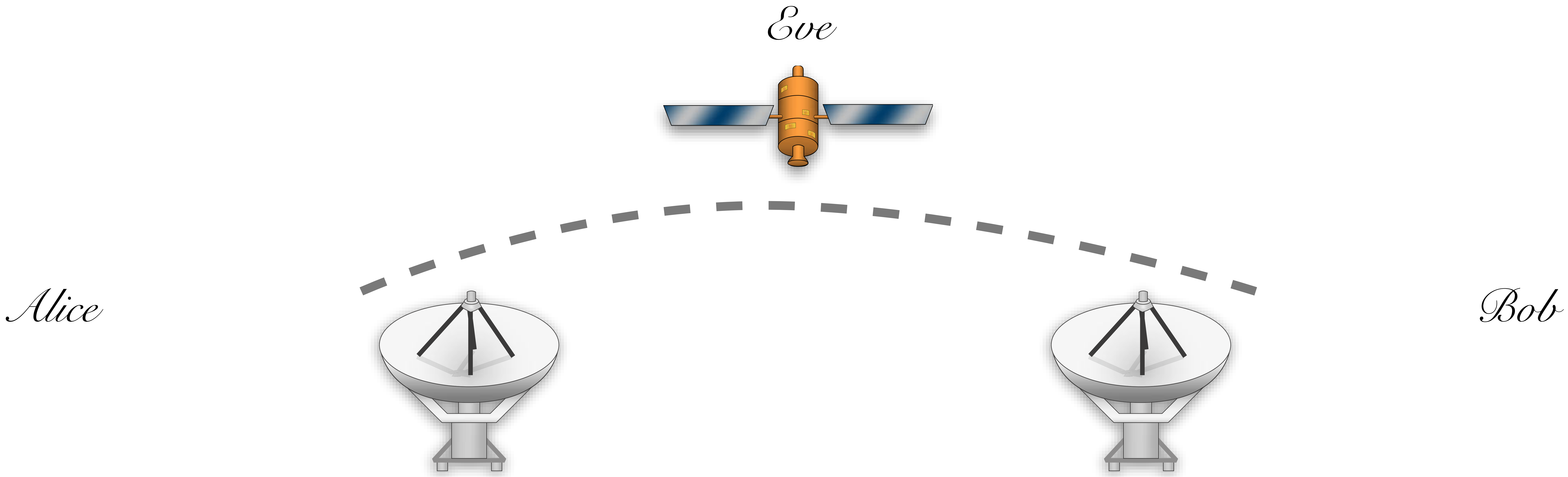
The Bad

- Not all policies can be encoded!
  - Contrast to ACL
- Not quite as simple as it seems
  - setuid

Midterm review

Security modeling

Symmetric Encryption

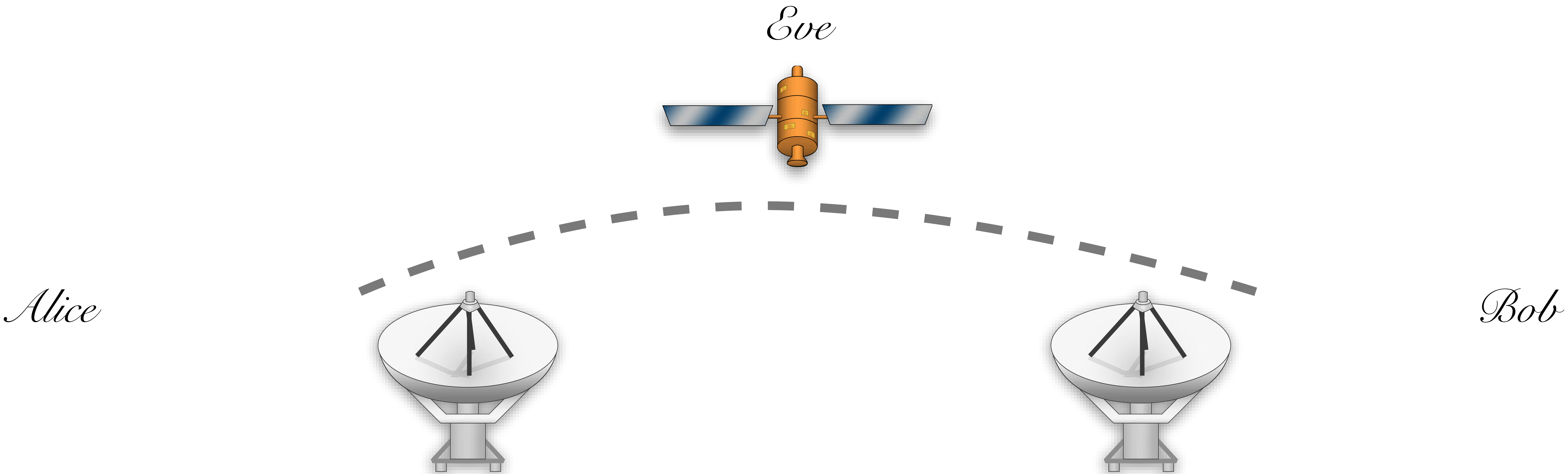


Eve

Alice

Bob

Public Key Encryption

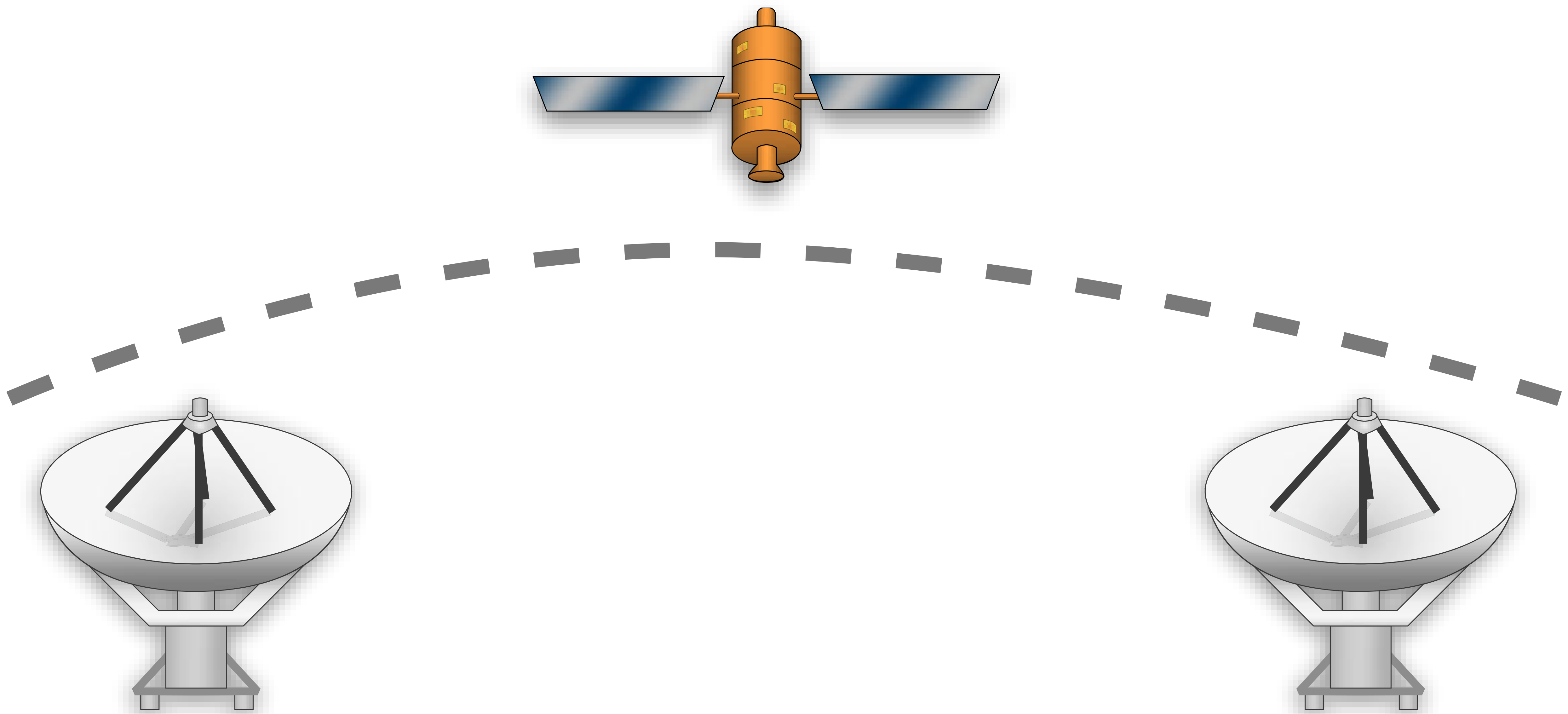


Eve

Alice

Bob

MAC



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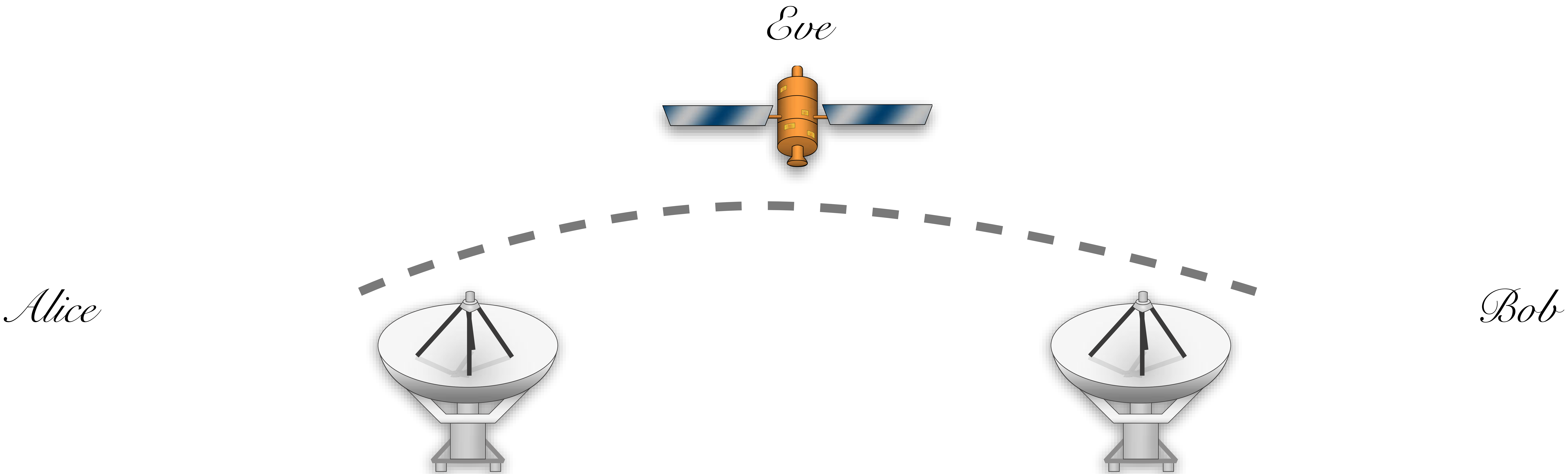
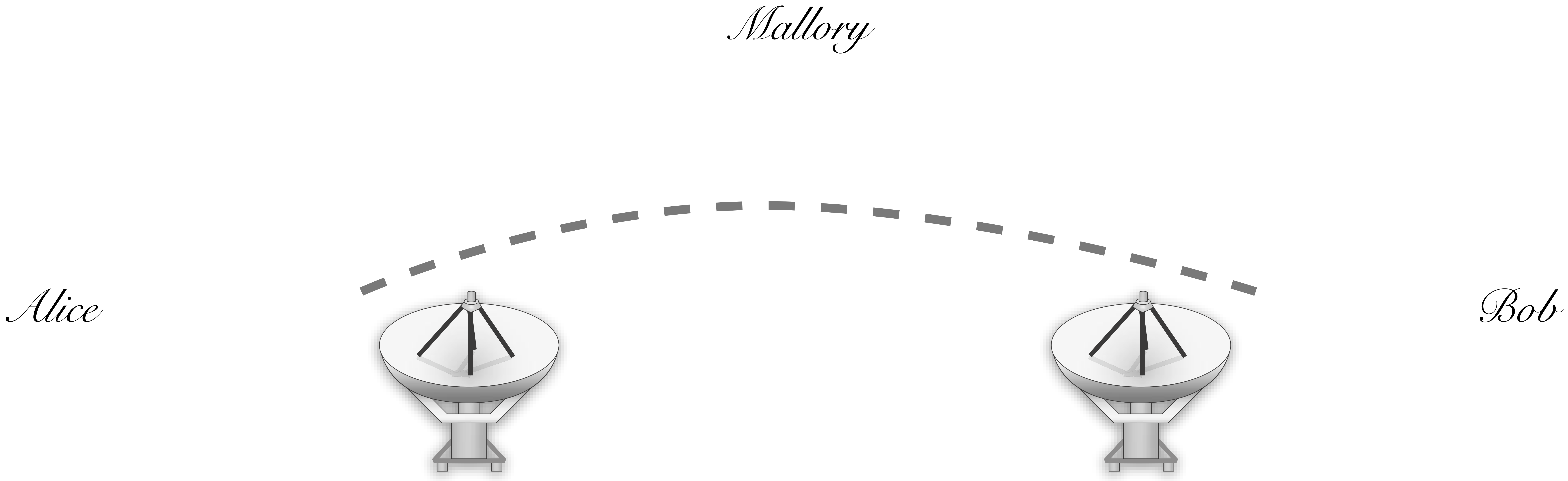
Bob

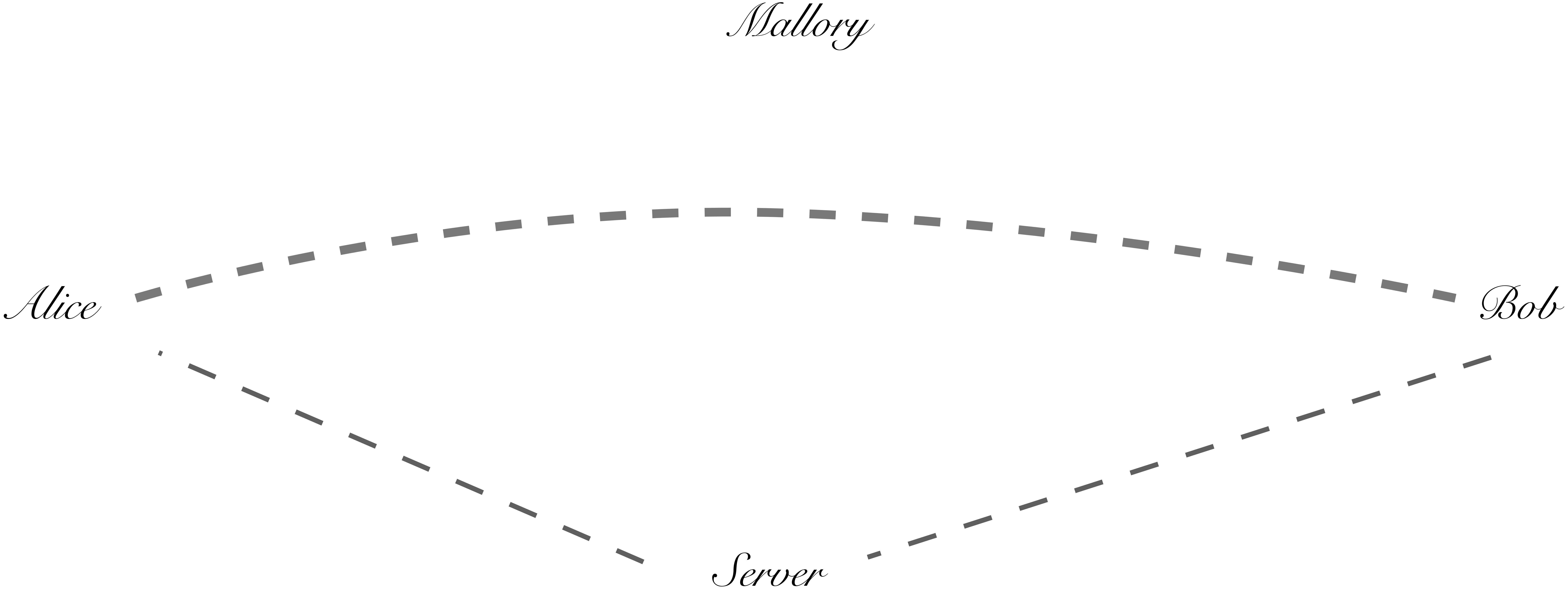
Digital Signatures



Password Authentication



Distributed Password Authentication



Mallory

Alice

Bob

Server

Security Model for Snell Library

Mallory

Alice

Snell Library

Topics

- Kerchoff’s principle
- Security experiments
- Given an example scenario, be prepared to develop a threat model and a security game to capture the threat
- Review our example cast of attackers, they may come in handy if you are asked to develop a threat model on the exam.
- Confidentiality, Authentication, Integray, Non-repudability
- Perfect and Shannon security
- One time pad
- Computational Indistinguishability
- Pseudo-random generators
- Symmetric key encryption
- Pseudo-random functions
- Message authentication codes
- Hash functions, definitions, security experiment, examples
- Public key encryption, IND-CPA security game, RSA cryptosystem example
- Digital Signature security game, why textbook RSA signing is insecure
- Password storage systems, salting and hashing, slow hash functions
- Pros and cons of biometrics
- two-factor authentication, U2F
- biometrics, their strengths, and their shortcomings
-