Backups and Restoring Data with tar

5.1

Cybersecurity

Archiving and Logging Data Day 1

Class Objectives

By the end of today's class, you will be able to:

Identify and describe use cases for the three kinds of backups.

Create (tar) and archive from existing files and directories.

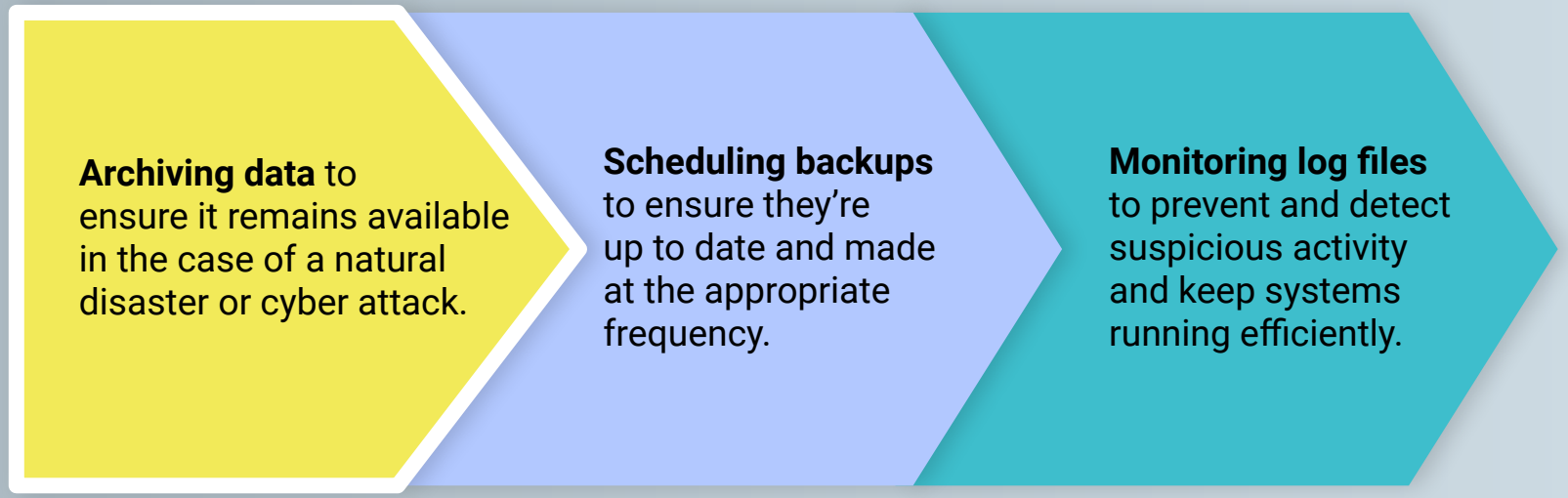
List and search the contents of an existing archive.

Extract the contents of an archive.

Describe and demonstrate two ways to exploit the `tar` command.

Archiving and Logging Data

In this unit, we'll continue to explore how Linux system administrators use keep their system secure by:



Archiving and Logging Data

These skills are used by system administrator to accomplish the following tasks:

- Overseeing or conducting data backup and recovery.
- Determining how long to retain data and the frequency of backups.
- Monitoring and troubleshooting backups and restoration.
- Providing security for compliance requirements.

Archiving with `tar`

Archives are essential in IT security for maintaining regulatory compliance in industries like finance and health.

Finance

In finance, the common standard for data archiving is the **Sarbanes-Oxley Act (SOX)**. It requires all business records and communication to be retained for five years.

Before the signing ceremony of the Sarbanes–Oxley Act, President George W. Bush meets with Senator Paul Sarbanes, Secretary of Labor Elaine Chao and other dignitaries in the Blue Room at the White House on July 30, 2002

Finance

The **Markets in Financial Instruments Directive (MiFID II)** requires the European Union's financial firms to retain and reproduce records of all activity from telephone conversations and electronic communications, including instant messages and social media interactions.

Health

The most common standard is **Health Insurance Portability and Accountability Act (HIPAA)**, which requires healthcare providers to keep records for six years.

Using the `tar` Command

Cyber professionals
Must prepared for and ensure against data loss and interruptions caused by cyberattacks and natural disasters.

Ensuring Availability of Data

When important institutions are under threat, data must remain available.

In 2019, hackers seized important government machines during a ransomware Attack in Baltimore, Maryland.

vox.com

Ensuring Availability of Data

When important institutions are under threat, data must remain available.

In 2019, Hurricane Michael caused massive flooding, destroying homes, businesses, and strategic defense data at Tyndall Air Force Base.

Hurricane-Damaged Air Force Base Has an Opportunity to Rebuild for Resilience

Experts see the recovery effort as a test case for how the U.S. military prepares for climate change

By Courtney Columbus, E&E News on November 9, 2018

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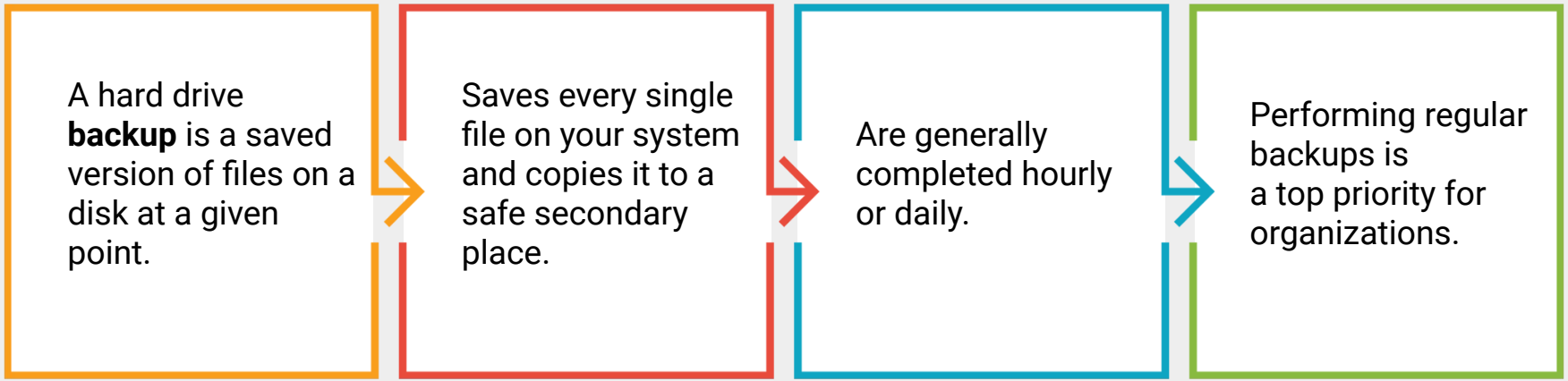
Backing Up Data

System administrators backup data so organizations can quickly recover lost assets and quickly restore systems.



Types of Backups

There are three different types of backup: full, incremental, and differential.

Full backups are more reliable and offer complete restoration , but require large storage space.

Incremental and **differential backups** include only data that changed since the last full or incremental backup. They are fast and use less disk space. Incremental backups require each previous incremental backup to be present to restore the data.

Performing a Backup

`tar`

The `tar` command is a Linux utility that system administrators use to create a backup.

`tar` (tape archive) takes files we want to back up and creates an archive of them.

An archive is a special file that contains a concatenation of files and directories.

Archives created with `tar` are called Tarballs and use the extension `.tar`.

The file size of a tarball is equal to the sum of the sizes all archived files.

Is it possible to reduce the size of an archive?

`tar` and Compression

Compression transforms files into a format that takes up less space. The most common compression methods are gzip and bzip2.

01 **gzip**

gzip is the industry standard for compression on Unix-like systems.

02 **bzip2**

bzip2 offers better compression, but is much slower than gzip.

`tar` and Compression

`tar` has built-in flags allowing us to compress tarballs when running `tar`.

01 **tgz** and **tar.gz**

gzipped extensions

02 **bz2**

bzipped extension

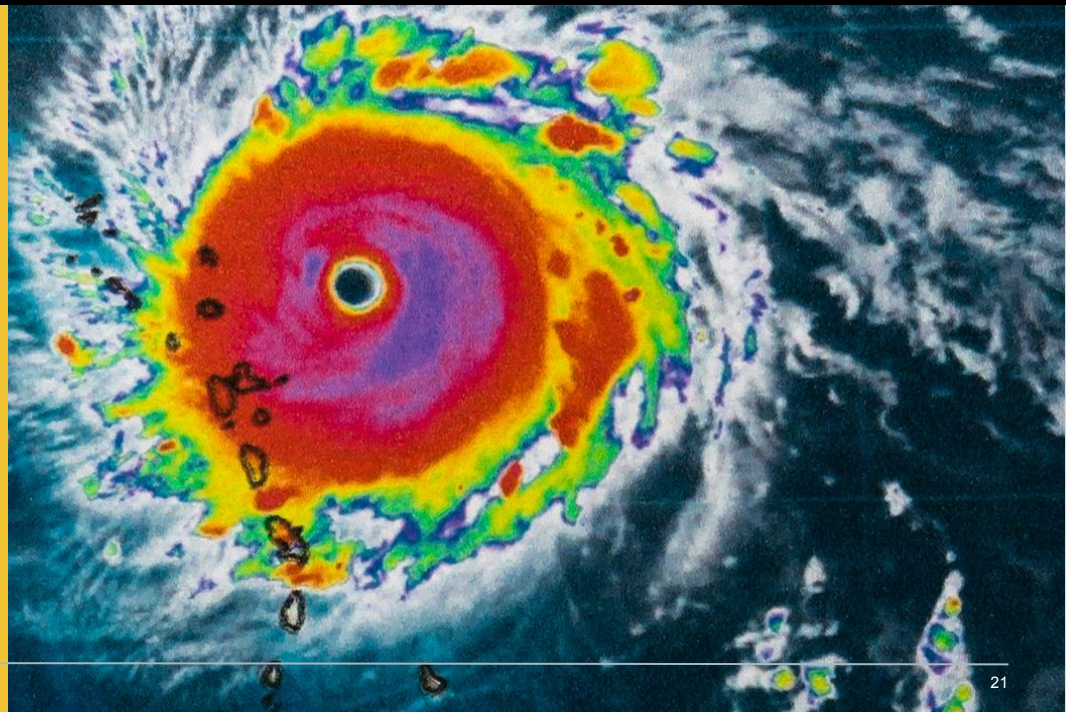
Creating an Archive

The general syntax of the **tar** command is:

```
tar [option(s)] [archive_name] [objects_to_archive]
```

Let's apply this command to following scenario:

The Systems Operations Center at Tyndall Air Force Base is backing up all system data with the approaching threat of Hurricane Michael.



Creating an Archive

Create a **full backup** of all log files in `/var/log` using the `tar` command:

```
sudo tar cvf hurricane-backup-10-11-2018.tar /var/log
```

`sudo` because /var/log contains system files, we'll need administrator rights in order to make a backup of them.

It would compromise security if non-administrative users were able to make backups of system files.

Creating an Archive

Create a **full backup** of all log files in `/var/log` using the `tar` command:

```
sudo tar cvf hurricane-backup-10-11-2018.tar /var/log
```

`tar` is the Linux command to initiate the backup.

Creating an Archive

Create a **full backup** of all log files in `/var/log` using the `tar` command:

```
sudo tar cvf hurricane-backup-10-11-2018.tar /var/log
```

`cvf` are short form options.

c	stands for *create*. Always needed when creating an archive.
v	stands for *verbose*. It will print progress status and useful information as it's running.
f	stands for *create archive file,* followed by the title of the archive.

Creating an Archive

To create a **full backup** of all the log files in /var/log directory, use the following tar command:

```
sudo tar cvf hurricane-backup-10-11-2018.tar /var/log
```

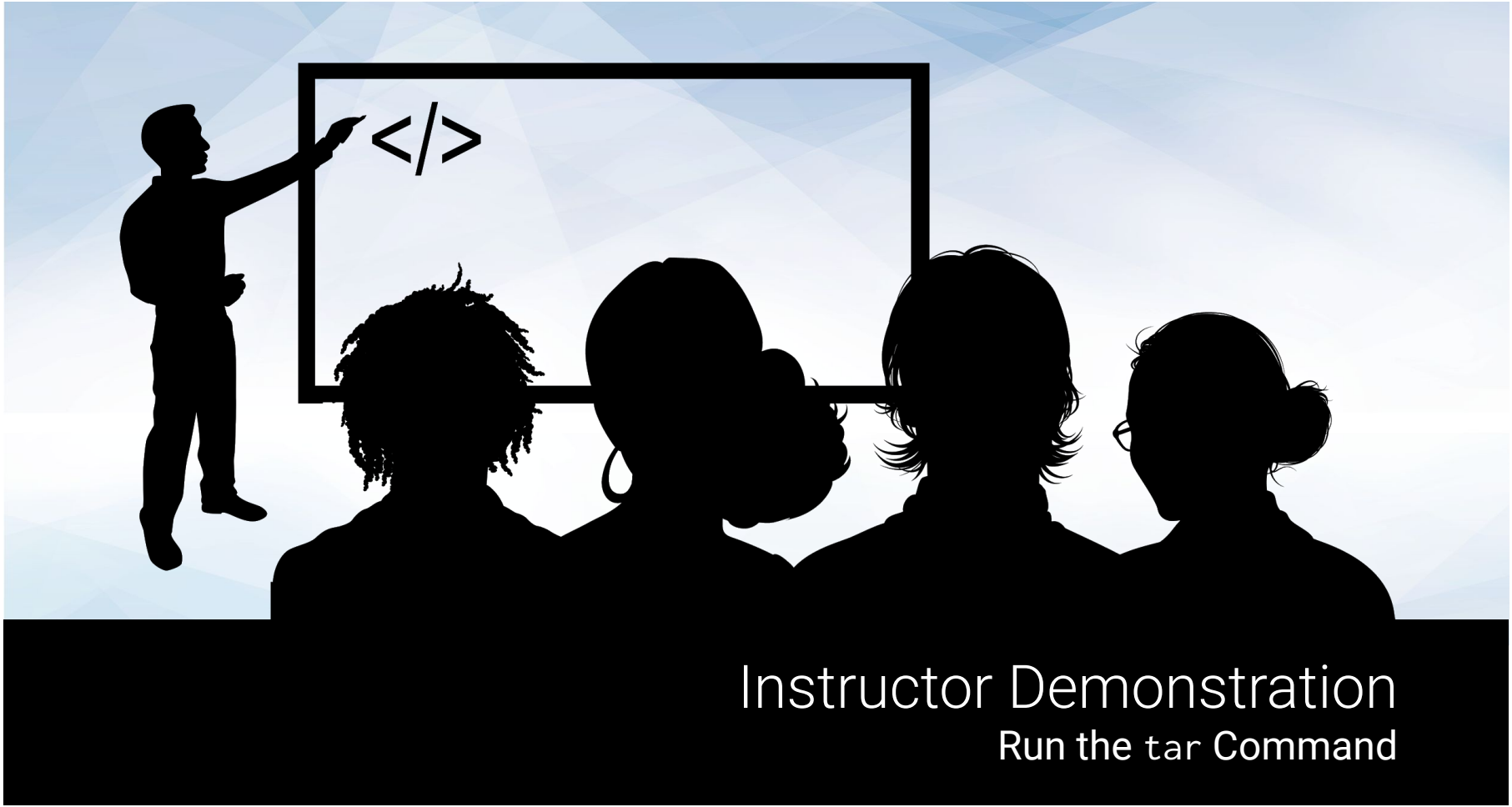
`hurricane-backup-10-11-2018.tar`
is the archive name, indicating the title.

Creating an Archive

To create a **full backup** of all the log files in /var/log directory, use the following tar command:

```
sudo tar cvf hurricane-backup-10-11-2018.tar /var/log
```

`/var/log` are the objects to archive, indicating the files or directories we want to backup.

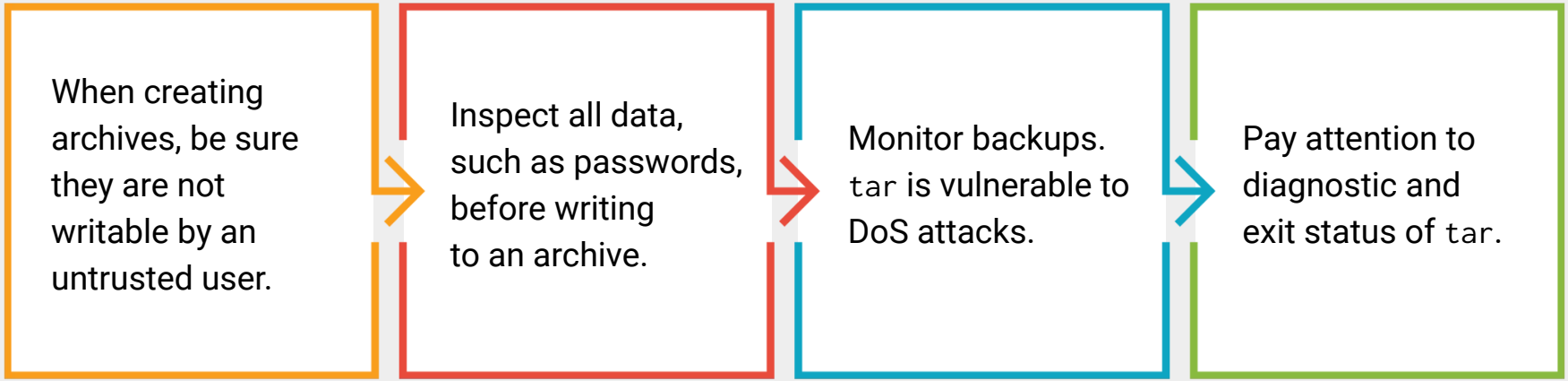


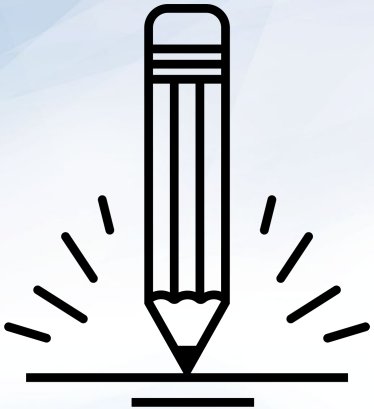
Instructor Demonstration

Run the `tar` Command

Tar: Best Practices

In order to maintain confidentiality, privacy, and integrity:





Activity: Creating a Backup Using `tar`

In this activity, you'll play the role of a junior administrator tasked with backing up patient, doctor, and treatment files.

Suggested Time:
10 Minutes

Time’s Up! Let’s Review.

Activity Review: Creating a Backup Using `tar`

Completing this activity required the following steps:

01 Creating the name of the `tar` archive using YYYYMMDD ISO 8601 standard.

02 Creating a full backup using the `tar` create option.

03 Printing the full listing for each file, including the name, file permissions, and owner information.

04 Verifying the archive after it was written to check for errors.

05 Writing the output of the `tar` command to a file for later review by the SysOps team.

Restoring Data with `tar`

Using a Full Backup to Restore Data

Consider the following scenario:

Your laptop was stolen!

- After buying a replacement laptop, you want to put all the files from your first laptop onto your new one.
- Fortunately, you had a full backup of all your files on an external hard drive, so you have access to everything that was lost.

Using a Full Backup to Restore Data

To restore your laptop, you'll move through the following steps:

01 **Listing**

Listing the contents of your backup to ensure it has the data you want to restore.

02 **Extracting**

Extracting the files, which will copy and restore the file to disk.

Restoring Data from a Full Backup

We'll use the following command:

```
tar xvvf my_laptop_backup.tar
```

x	Extracts the files from the archive and writes them to disk.
vv	Shows information and progress as tar runs
f	specifies the archive file to use.

Restoring Data from a Full Backup

We'll use the following command:

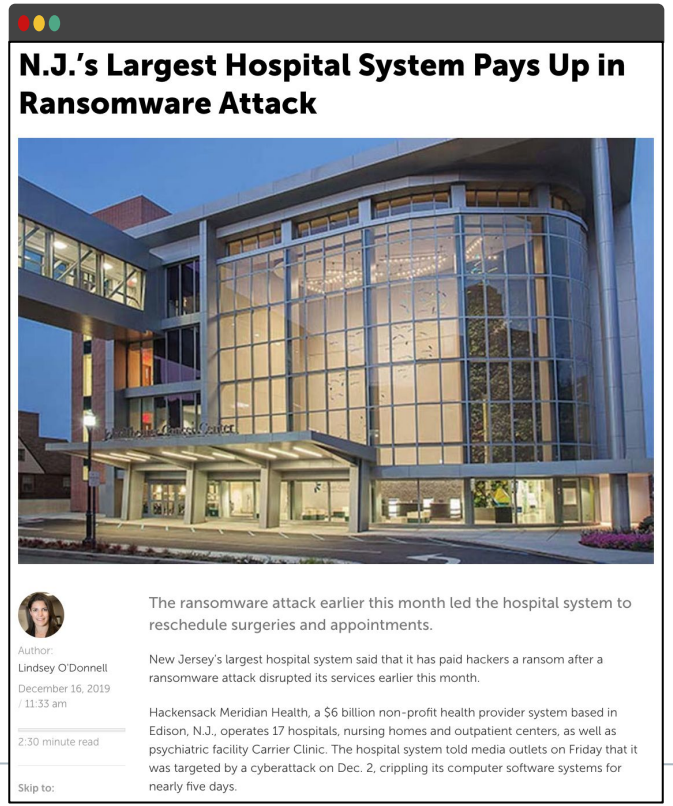
```
tar xvvf my_laptop_backup.tar
```

`my_laptop_backup.tar` is the archive that contains the files from your laptop.

Case Study: Backing Up Hackensack

In 2019 Hackensack Meridian Health's systems were compromised by a ransomware attack.

- The attack crippled computer systems and forced hospitals to reschedule surgeries and appointments.
- The attackers offered to decrypt the data in exchange for payment, effectively ransoming the hospital's data.
- **Unfortunately, the hospital was not prepared and had to pay the attackers.**



N.J.'s Largest Hospital System Pays Up in Ransomware Attack

The ransomware attack earlier this month led the hospital system to reschedule surgeries and appointments.

Author:
Lindsey O'Donnell
December 16, 2019 / 11:33 am

2:30 minute read

Skip to:

New Jersey's largest hospital system said that it has paid hackers a ransom after a ransomware attack disrupted its services earlier this month.

Hackensack Meridian Health, a $6 billion non-profit health provider system based in Edison, N.J., operates 17 hospitals, nursing homes and outpatient centers, as well as psychiatric facility Carrier Clinic. The hospital system told media outlets on Friday that it was targeted by a cyberattack on Dec. 2, crippling its computer software systems for nearly five days.

Case Study: Backing up Hackensack

We'll respond to a similar ransomware attack that hit hospital systems on the morning of May 11, 2019.

Among the affected systems were:

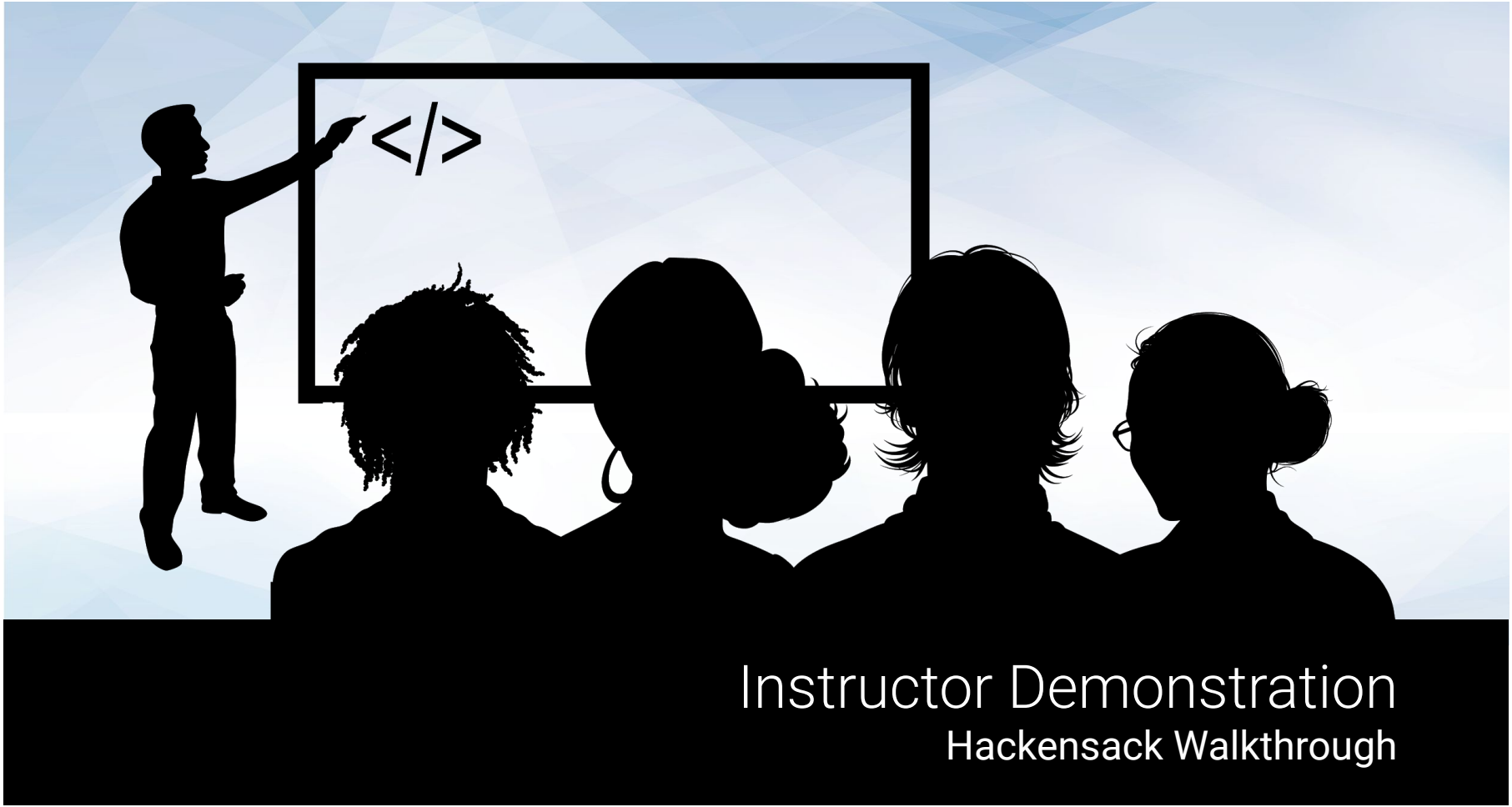
- Doctors
- Patients
- Treatments
- Files

After taking the infected systems offline, we'll need to:

- Restore the operating system and applications using the full backup.
- Restore email data using the full backup.

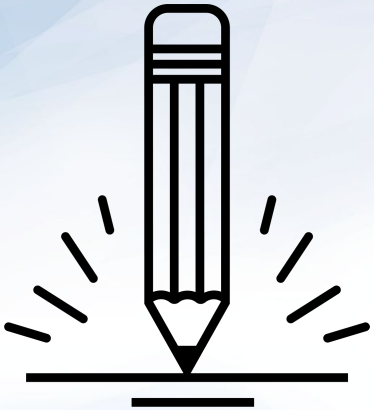
To restore the email data, the SysOps team will use the `tar` command to:

- List the contents of the latest full backup to locate the email data.
- Extract the email data from the archive to a directory on the new system.



Instructor Demonstration

Hackensack Walkthrough



Activity: Restoring Data with `tar`

In this activity, you'll continue as a junior admin.

You must use the `tar` command to search an archive and extract files.

Suggested Time:
10 Minutes

Time’s Up! Let’s Review.

Activity Review: Restoring Data with tar

Completing this activity required the following steps:

01 Listing and viewing the contents of the archive.

02 Using the `grep` command to search the archive for two patient names.

03 Creating a directory to store the Patient directories and files.

04 Extracting only the Patient directory and files to the new directory for review.

05 Using the `-R` option to validate that the archive does not contain a file error.

Incremental Backups with `tar`

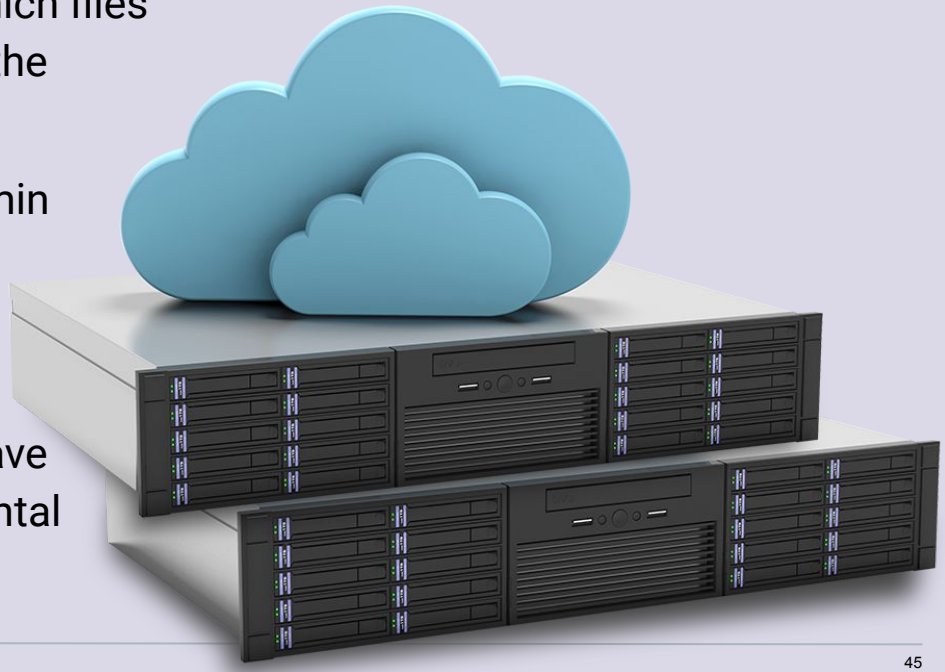
So far, we've been creating full backups.

Now, we'll see how to apply an incremental backup.

Incremental Backup

Incremental backups are completed after a full backup is performed on a system, only capturing what has changed since the last incremental backup.

- Incremental backups store a list of which files have changed in a snapshot file, with the extension `.snar`.
- The snapshot is created when the admin creates the initial level 0 backup.
- Every time an incremental backup completes, a new snapshot is created that contains only files that have changed since the last full or incremental backup.



Incremental Backup

Incremental backups are completed after a full backup is performed on a system, only capturing what has changed since the last incremental backup.

Incremental backups have the following drawback:

Restoring is slower: you must restore the latest full backup, plus all the previous incremental backups.

There may be a loss of data if a single backup is corrupted.

You must verify an archive was created with no errors, using the `tar W` option.

Incremental Backup

```
$ tar cvvWf emerg_back_sun.tar --listed-incremental=emerg_backup.snar --level=0 emergency
```


`--listed-incremental=emerg_backup.snar` indicates this backup will be part of a series of incremental backups, and specifies that information about files added, changed, or removed should be stored in a snapshot file called **`emerg_backup.snar`**.

Incremental Backup

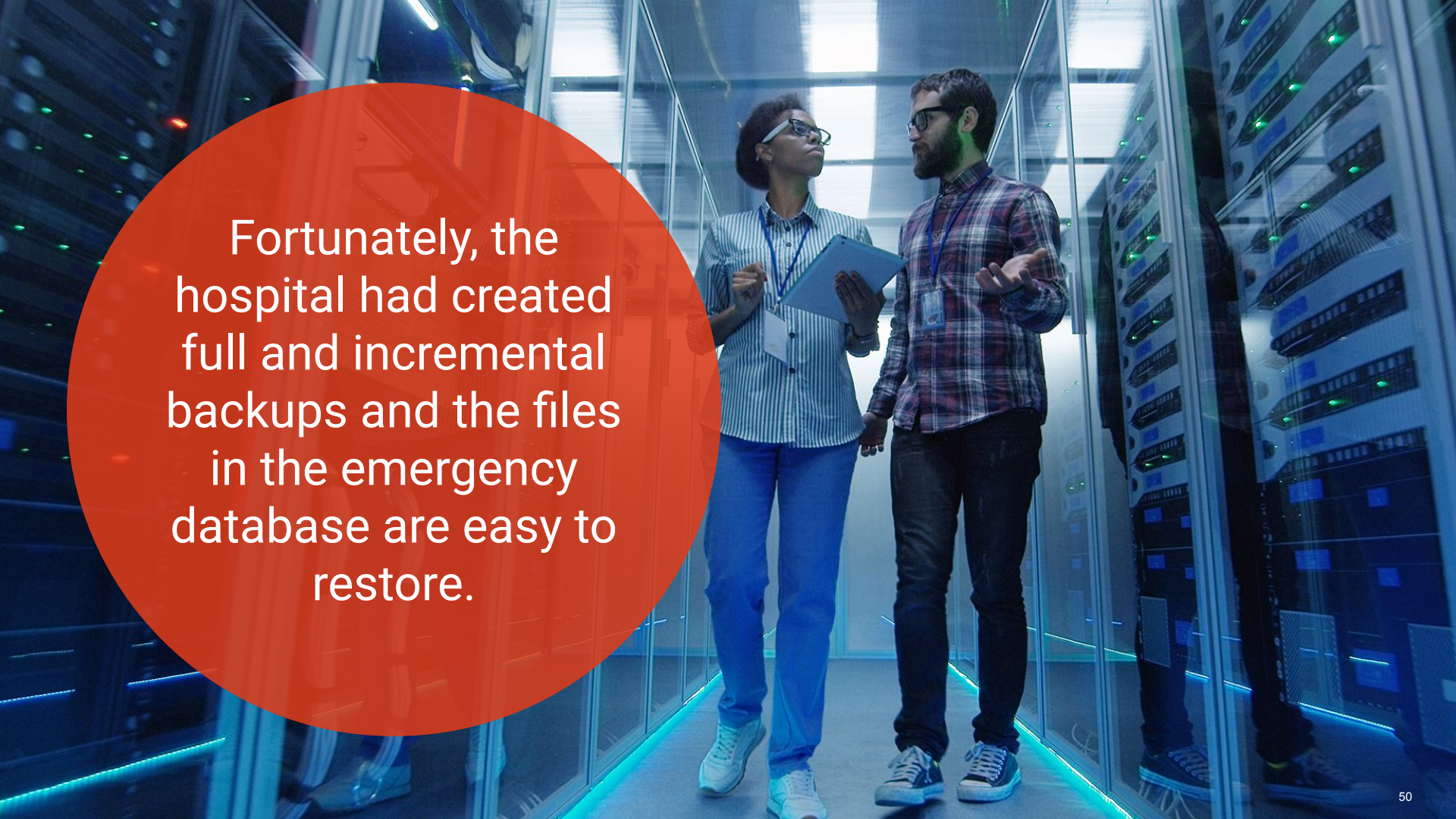
```
$ tar cvvWf emerg_back_sun.tar --listed-incremental=emerg_backup.snar --level=0 emergency
```

`--level=0` tells **tar** that this backup will be the very first backup in the series—in other words, this is the full backup and starting point that will be used as the basis for all later incremental backups.

Incremental Backup Scenario

We'll use the following scenario to demonstrate incremental backups:

Sunday	Monday	Tuesday	Wednesday
A hospital's system operations staff performs a full backup of all the data in the emergency database.	The staff runs an incremental backup which stores all changes made on Monday. This backup is smaller than the full backup.	An incremental backup archives only the changes made on Tuesday to the emergency database.	The hospital is hit with a ransomware attack and all the data in the emergency database is encrypted.


Fortunately, the hospital had created full and incremental backups and the files in the emergency database are easy to restore.

Incremental Backup Scenario

We'll use the `tar` command to complete the following steps:

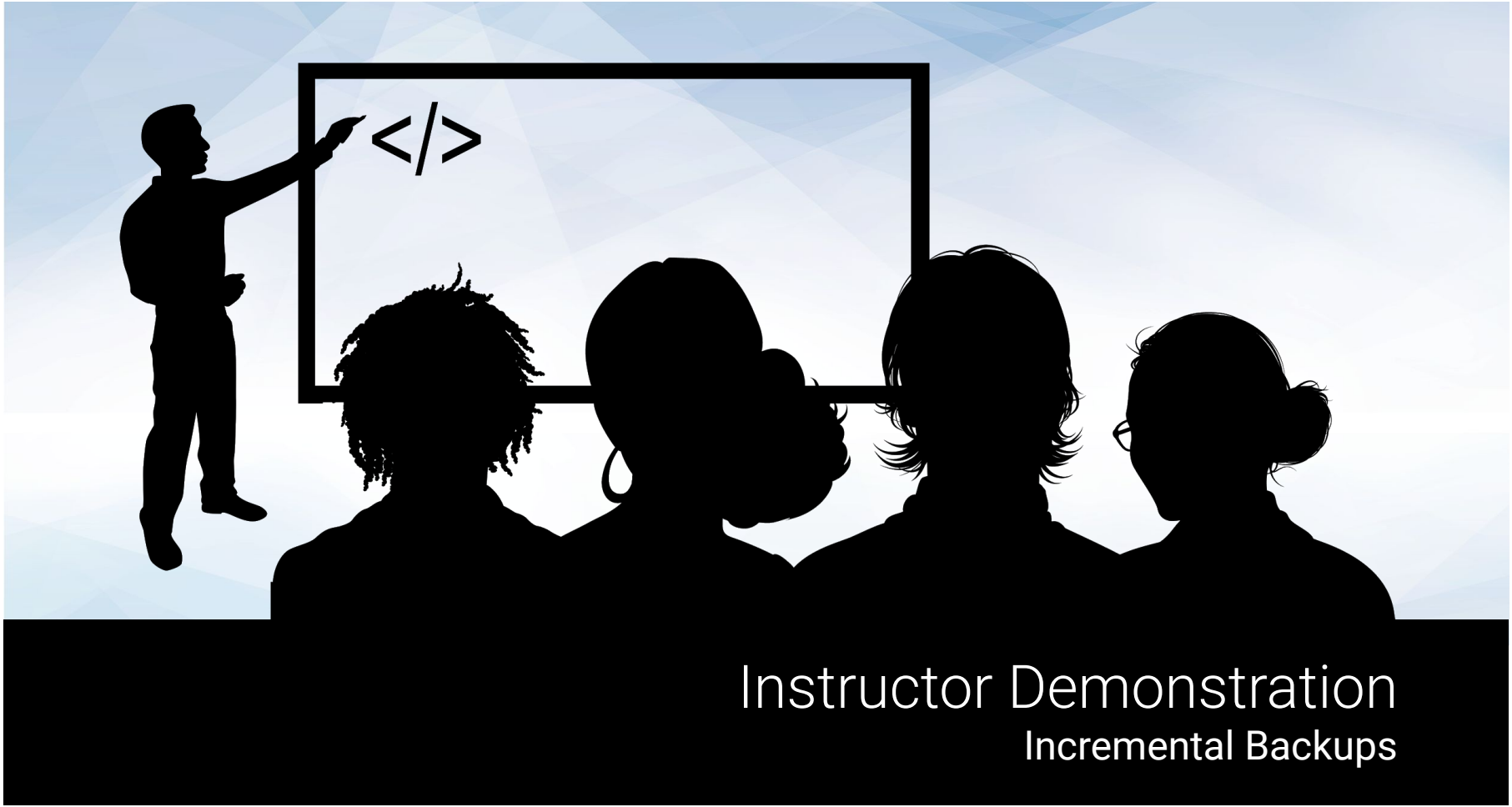
01 **Create** a full backup of the emergency directory and a snapshot file.

02 **Display** the contents of the full backup.

03 **Create** the incremental backups generated on Monday and Tuesday.

04 **Remove** the emergency directory to mimic the ransomware attack on Wednesday.

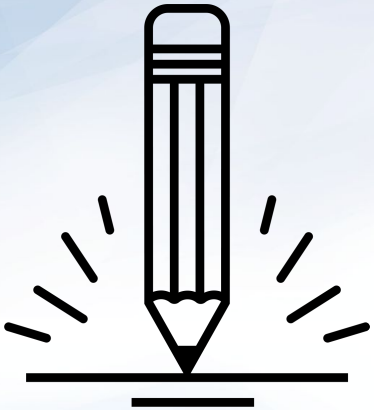
05 **Restore** the emergency directory.



Instructor Demonstration

Incremental Backups


15:00
Break



Activity: Restoring Data with Incremental Backups

In this activity, you and a partner will work as junior admins tasked with restoring the incremental backup of the patient files in a test environment.

Suggested Time:
15 Minutes

Time’s Up! Let’s Review.

Restoring Data with Incremental Backups

Completing this activity required the following steps:

- Perform a level 0 backup of the E-Prescription Treatment directories.
- List the contents of the level 0 backup.
- Copy the extracted files to the Patient directory and confirm that the files were added.
- Perform an incremental backup using the current snapshot file.
- List the contents of the incremental backup to check that the missing files are present.
- Remove the missing files from the Patient directory.
- Restore the system from the incremental backups.
- List the contents of the Patients directory to confirm that we successfully recovered the deleted files.

Exploiting the `tar` Command with the Checkpoint and Wildcard Options

Hackers can combine the tar command with the wildcard character and the checkpoint feature to plant malware on a system.

Using Wildcard with `tar`

Previously, we used the wildcard character (*) when creating an archive.

Sysadmins use the wildcard symbol (*) to specify multiple files in a directory without having to type each filename.

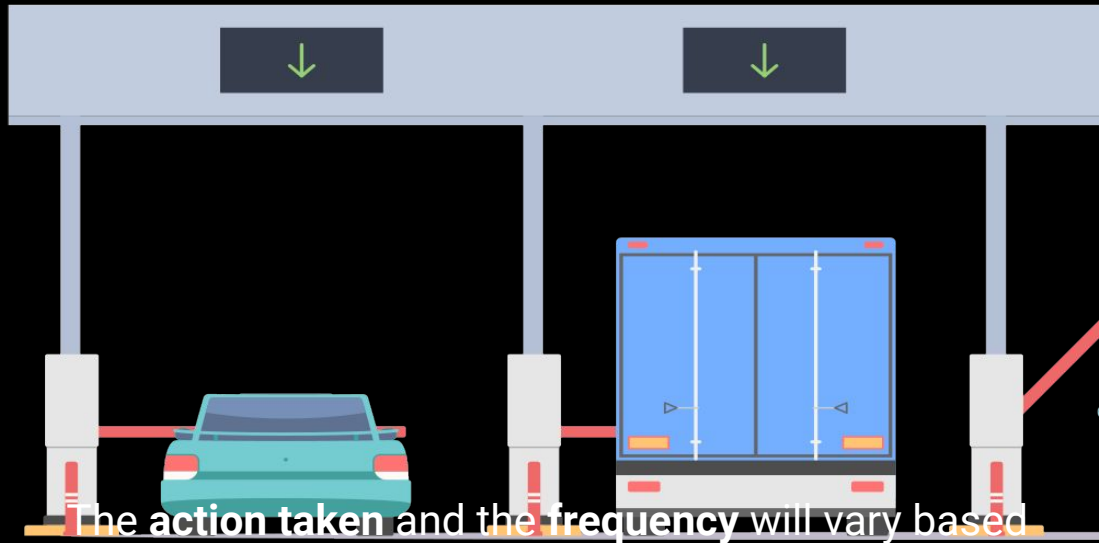
```
cd ~/Documents/ExploitTar
 ls .
    f1
    f2
    f3
    f4
    f5
    f6
    f7
    f8
    f9
    f10
  tar cvf archive.tar ./*
```

Using Checkpoints

A **checkpoint** is a specific stage of a backup or restoration that can trigger designated actions.

For example:

1. Once the backup reaches 1000 files, a checkpoint triggers the backup to pause and display the amount of remaining disk space.
2. When restoring files from a remote site, a message will print the number of bytes transferred every 5000 files.



The **action taken** and the **frequency** will vary based on the circumstance.

Using Checkpoints

Checkpoints involve two commands. The first defines the checkpoint, and the second specifies the action to be taken at that checkpoint.

For example:

`--checkpoint=1000` indicates how often the checkpoint occurs.

- At every thousandth file an action will take place.
- Syntax: `--checkpoint=[n]`

`--checkpoint-action=du` indicates the action that will take place:

- `du` displays the available disk space on the machine.
- Syntax: `checkpoint=[ACTION]`

Exploiting System Vulnerabilities

In the previous Linux unit, we learned how sysadmins harden systems against exploits.

01

When a weakness is found, hackers can exploit it by changing existing code or using their own code.

This is also known as arbitrary command execution (ACE).

02

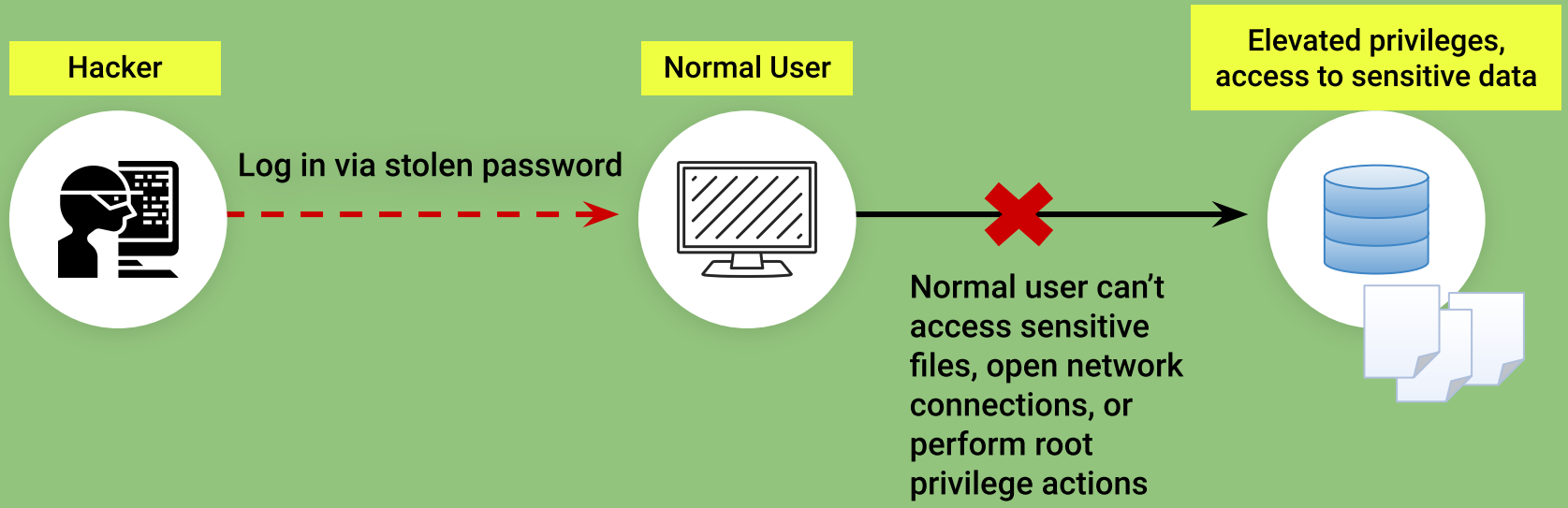
ACE vulnerabilities are extremely dangerous. Attackers can exploit them to accomplish almost anything, including gaining root privileges, which allows them to completely compromise a machine.

03

For our example, hackers have discovered how to use the `tar` checkpoint option with a wildcard to plant malicious code on a system, which they can later run to gain root privileges on the machine.

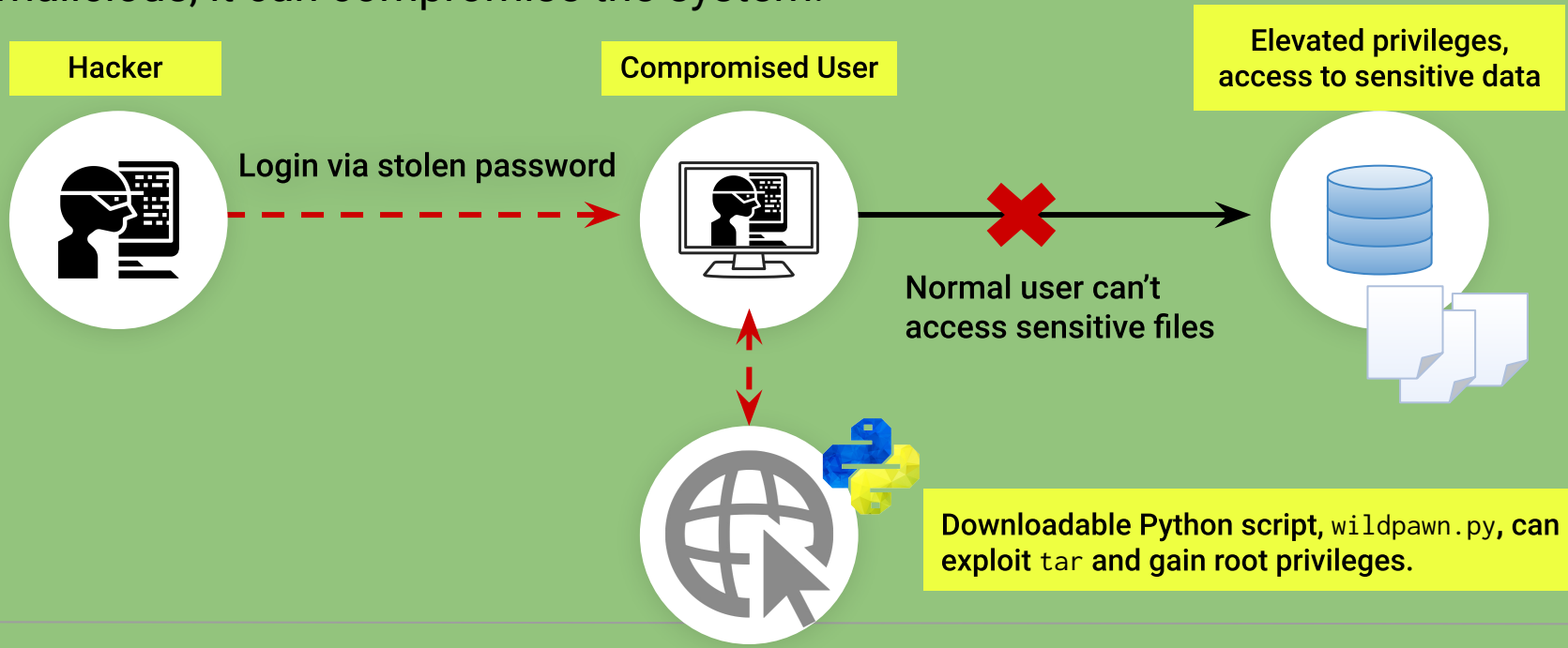
Checkpoint + Wildcard Exploit

First, a hacker gains access to a system by impersonating a normal user.



Checkpoint + Wildcard Exploit

A normal user can typically download and execute files from the internet. If a file is malicious, it can compromise the system.



Checkpoint + Wildcard Exploit

Unsuspecting admins with root privileges run a `tar` command containing a wildcard. This will create an archive containing the directory of the malicious script.

`wildpawn.py` **plants three malicious files on the machine: one hidden, and two files with names like `tar` checkpoint commands.**

tar + wildcard

Sysadmin unknowingly creates archive containing planted malicious script.

Hacker can drop into root shell, gaining full access to system.

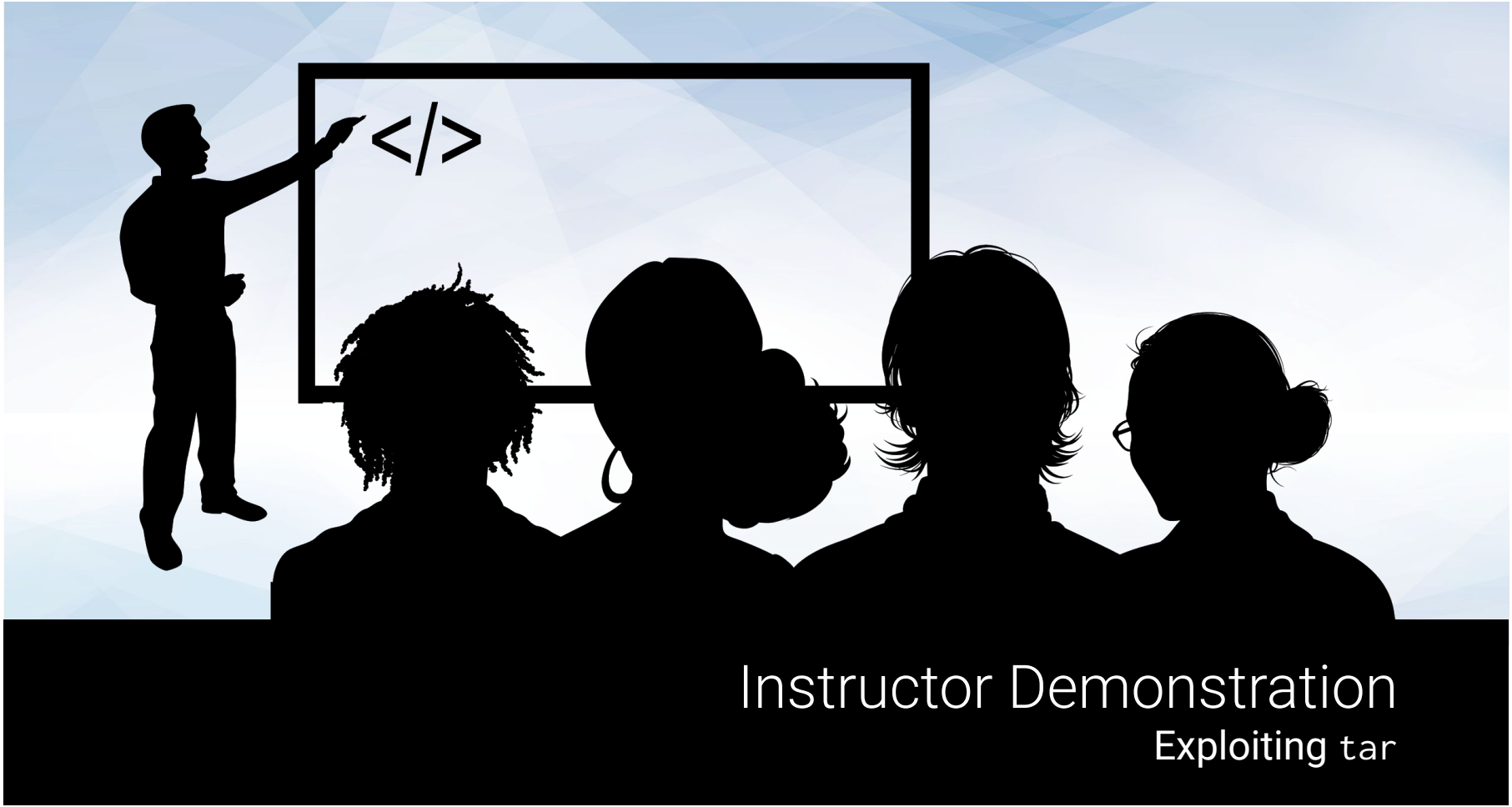
Exploiting `tar`

But how do checkpoints and wildcards fit into this exploit?

When a hacker runs `wildpawn.py`, it creates three files.

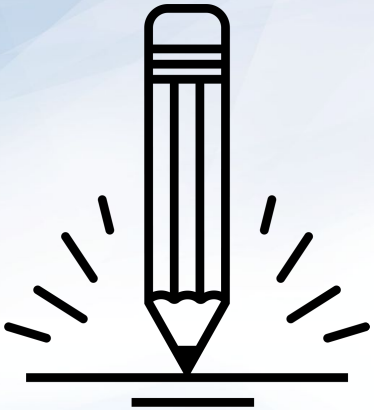
- The hacker is able to create these files even if they only have normal user privileges.
- The files include a malicious hidden script called `.webscript` and two files whose names appear like checkpoint commands:
  - `--checkpoint=1`
  - `--checkpoint-action=exec=sh .webscript`

After adding the first file to the archive, `tar` will execute the malicious `.webscript`.



Instructor Demonstration

Exploiting `tar`



Activity: Exploiting `tar`

In this activity, you will play the role of a penetration tester hunting for vulnerabilities in a target system backup procedure.

Use the `wildpwn.py` tool to verify the vulnerability, then research two mitigation strategies to protect the server.

Suggested Time:
20 minutes

Time’s Up! Let’s Review.

Activity Review: Exploiting `tar`

Completing this activity required the following steps:

01 Downloading `wildpwn.py` using a non-`sudo` user account.

02 Running the script to generate `.webscript.`

03 Verifying that your user can gain `sudo` access.

04 Researching mitigation techniques.

Mitigation Strategies

Consider a few methods for addressing this attack:

Prevent users from downloading malicious files from untrusted sources.

Use a tool like **`tripwire`** to watch the filesystem for suspicious changes. This would alert when users download `wildpwn.py` or when backups create files like `.cache/.cachefile`.

Use a tool like **`lynis`** to scan the system for security vulnerabilities on a regular basis.

Questions?