class second half

File systems

2 levels we have to be concerned with

file systems can be read by multiple versions of the file system O.S.

layout

directories  i-node

There is a different way of organizing blocks within a file

(Block, len) □ □ □

you have pointers to first block in row and you increment pointers to access the next one.

File contents

linked list (FAT)

indirect blocks

extent list

Free space is managed by linked list or bitmap. Another way to keep track of free space is extent list. Extent list has advantage to not grow as large with the file system.

Journaling: write record to a log indicating actions you can perform.

Log structure: developed for write once media.
Security: the main principle is working with permissions.

<table>
<thead>
<tr>
<th>file 1</th>
<th>file 2</th>
<th>file 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>user 1</td>
<td>r-</td>
<td>r-</td>
</tr>
<tr>
<td>user 2</td>
<td>r-</td>
<td></td>
</tr>
<tr>
<td>user 3</td>
<td>rwx</td>
<td></td>
</tr>
<tr>
<td>user 4</td>
<td>rw-</td>
<td></td>
</tr>
</tbody>
</table>

Security
User + group permission
ACL (Access Control List)

Capabilities and permissions:

Permissions say what users can perform what action.
Capabilities say what a user can do.

Least privilege: Newer versions of UNIX are designed so that applications have only limited privilege they need to perform their actions.

Code injection

```c
char buf [80]
gets (buf)
... do something
```

get is unsafe as it cannot tell how much memory we are allowed to overwrite.

Hacker overwriting block

Overwriting can be done by websites using URL (Uniform Resource Locators) with weird characters that will be translated into instructions.
Address  
Space  
Layout  
Randomization  

Another way to fight attacks is NX bit. NX for Non-execute. It is implemented by some of the new processors of AMD and Intel. This allow to protect the stack.

\[ \begin{align*}
A_1 & \rightarrow \text{add } s, axc & \text{return to } A_2 \\
A_2 & \rightarrow \text{return to } A_3 \\
A_3 & \rightarrow \text{perform a little bit of code} \\
A_4 & \rightarrow \text{return to } A_3
\end{align*} \]