Learning Objectives in this Part of the Lesson

- Know what layered architectures are

<table>
<thead>
<tr>
<th>Layer</th>
<th>Services</th>
</tr>
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<tbody>
<tr>
<td>Physical Layer</td>
<td>Hardware</td>
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<tr>
<td>Data Link Layer</td>
<td>Operating Systems &amp; Protocols</td>
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<tr>
<td>Internet Layer</td>
<td>Host Infrastructure Middleware</td>
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<tr>
<td>Transport Layer</td>
<td>Distribution Middleware</td>
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<tr>
<td>Session Layer</td>
<td>Common Middleware Services</td>
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<tr>
<td>Presentation Layer</td>
<td>Domain-Specific Middleware Services</td>
</tr>
<tr>
<td>Application Layer</td>
<td>Applications</td>
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</tbody>
</table>
Overview of Layered Architectures
An Overview of Layered Architectures

- Layering is applied in many domains
Layering is applied in many domains, e.g.

- Computer networking protocol stacks

Enables end-to-end communication by specifying how data should be (un)packetized, addressed, transmitted, routed, & received

Layering is applied in many domains, e.g.

- Computer networking protocol stacks
  - Lower layers handle interactions with the hardware
    - e.g., GSM, DSL, & Ethernet

See en.wikipedia.org/wiki/Link_layer & en.wikipedia.org/wiki/Physical_layer
Layering is applied in many domains, e.g.:

- Computer networking protocol stacks
  - Lower layers handle interactions with the hardware
  - Middle layers exchange packets across hosts & routers
    - e.g., IP, TCP, & UDP

Layering is applied in many domains, e.g.

- Computer networking protocol stacks
  - Lower layers handle interactions with the hardware
  - Middle layers exchange packets across hosts & routers
  - Upper layers implement & interact with applications
    - e.g., PPTP, XDR, CDR, JSON

See [en.wikipedia.org/wiki/Session_layer](en.wikipedia.org/wiki/Session_layer) & [en.wikipedia.org/wiki/Presentation_layer](en.wikipedia.org/wiki/Presentation_layer)
Layering is applied in many domains, e.g.

- Computer networking protocol stacks
  - Lower layers handle interactions with the hardware
  - Middle layers exchange packets across hosts & routers
  - Upper layers implement & interact with applications
  - Applications (& middleware) mostly just deal with the upper layer(s)
    - e.g., FTP, TELNET, SMTP, & SNMP

See [en.wikipedia.org/wiki/Application_layer](en.wikipedia.org/wiki/Application_layer)
Layering is applied in many domains, e.g.
- Computer networking protocol stacks
- Communication middleware in multi-tier enterprise IT systems

Provides services beyond the OS & protocol stacks to enable components in a distributed system to communicate & manage data

See [en.wikipedia.org/wiki/Middleware_(distributed_applications)](en.wikipedia.org/wiki/Middleware_(distributed_applications))
Layering is applied in many domains, e.g.
- Computer networking protocol stacks
- Communication middleware in multi-tier enterprise IT systems
  - Lower layers provide portable APIs for accessing hardware & system resources
    - e.g., Linux, Windows, JVM, & ACE

See [www.dre.vanderbilt.edu/~schmidt/PDF/middleware-encyclopedia.pdf](http://www.dre.vanderbilt.edu/~schmidt/PDF/middleware-encyclopedia.pdf)
Layering is applied in many domains, e.g.

- Computer networking protocol stacks
- Communication middleware in multi-tier enterprise IT systems
  - Lower layers provide portable APIs for accessing hardware & system resources
  - Middle layers shield applications from network programming details
    - e.g., DDS, Web Services, MQTT, Spring, CORBA, etc.

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  - Lower layers provide portable APIs for accessing hardware & system resources
  - Middle layers shield applications from network programming details
  - Upper layers enable domain-specific reuse of capabilities
    - e.g., MD-PnP, IIC, & FACE

See [www.dre.vanderbilt.edu/~schmidt/PDF/middleware-encyclopedia.pdf](http://www.dre.vanderbilt.edu/~schmidt/PDF/middleware-encyclopedia.pdf)
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  - Lower layers provide portable APIs for accessing hardware & system resources
  - Middle layers shield applications from network programming details
  - Upper layers enable domain-specific reuse of capabilities
- Applications may deal with multiple layers

See [www.dre.vanderbilt.edu/~schmidt/PDF/middleware-encyclopedia.pdf](http://www.dre.vanderbilt.edu/~schmidt/PDF/middleware-encyclopedia.pdf)
End of Layered Architectures: Introduction