Overview of Layered Architectures

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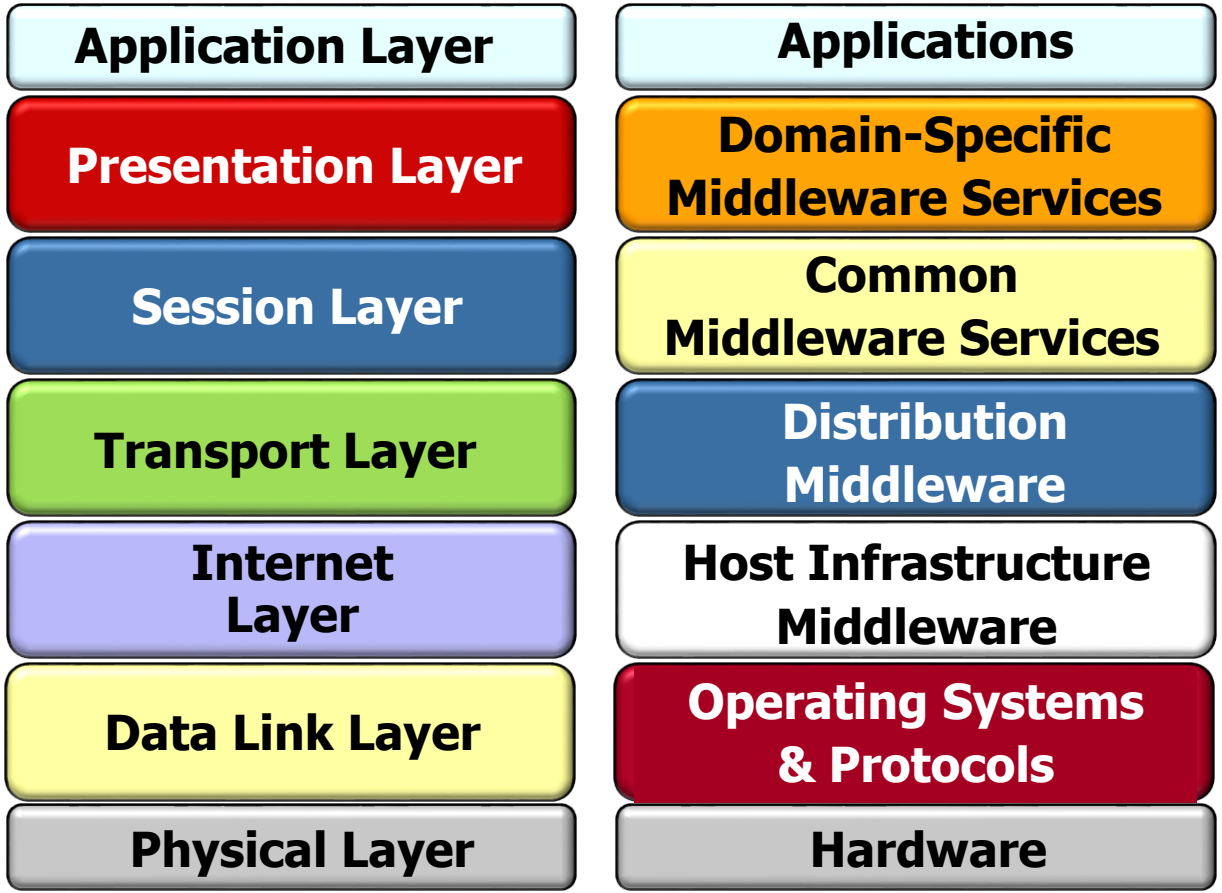
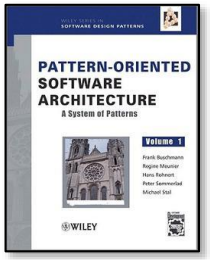
Learning Objectives in this Lesson

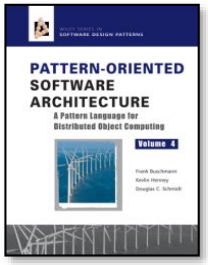
1. Know what layered architectures are

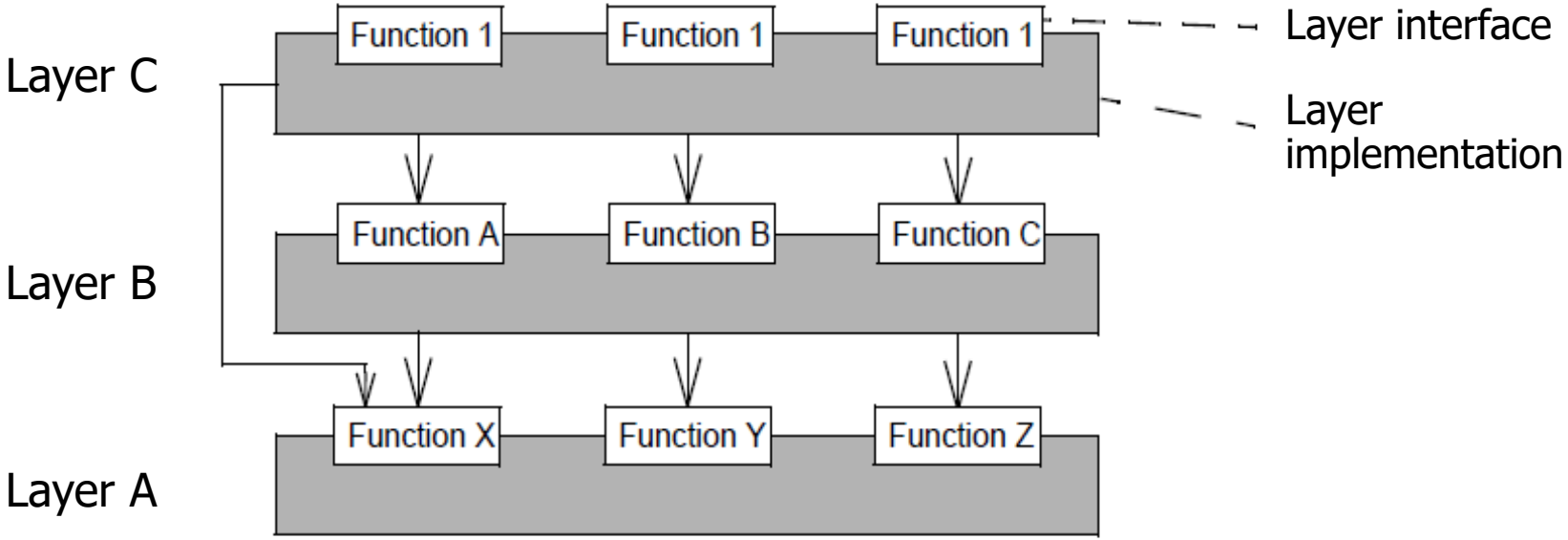


Learning Objectives in this Lesson

1. Know what layered architectures are
2. Understand the *Layers* architectural pattern







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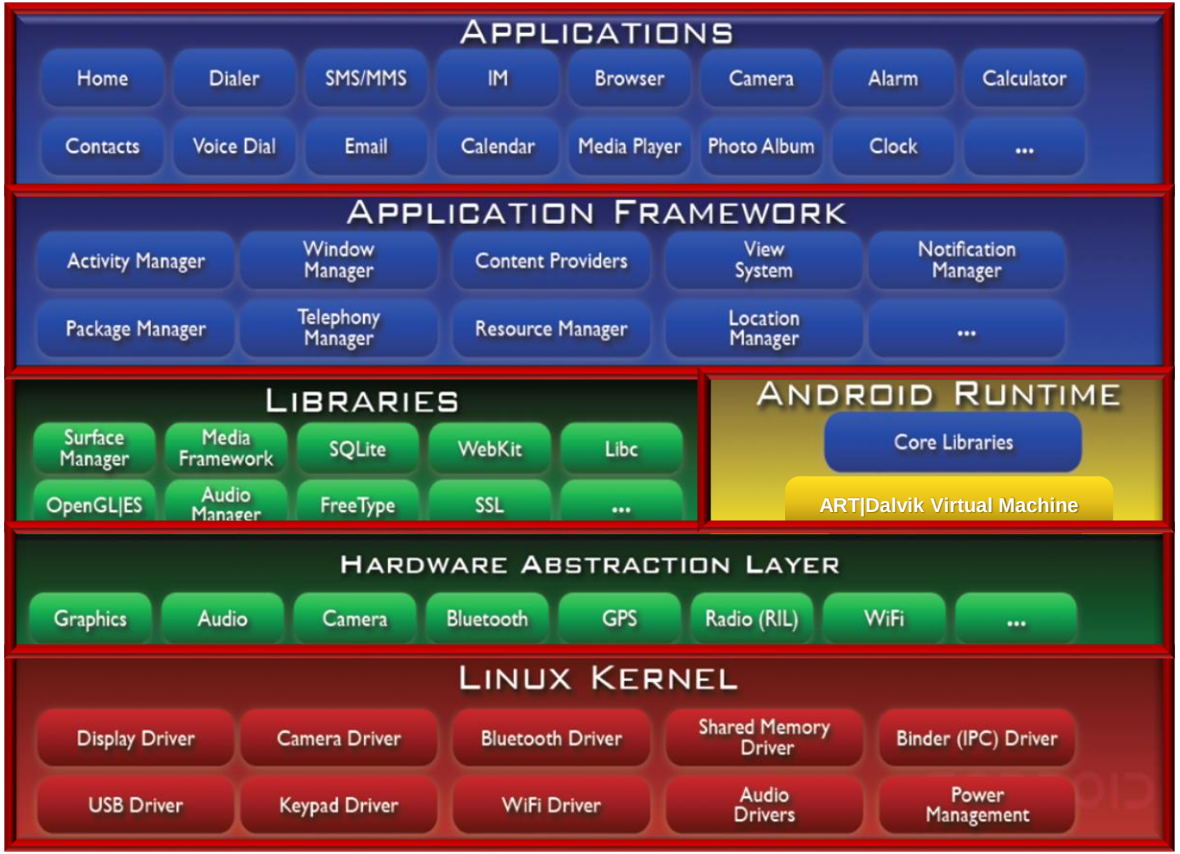
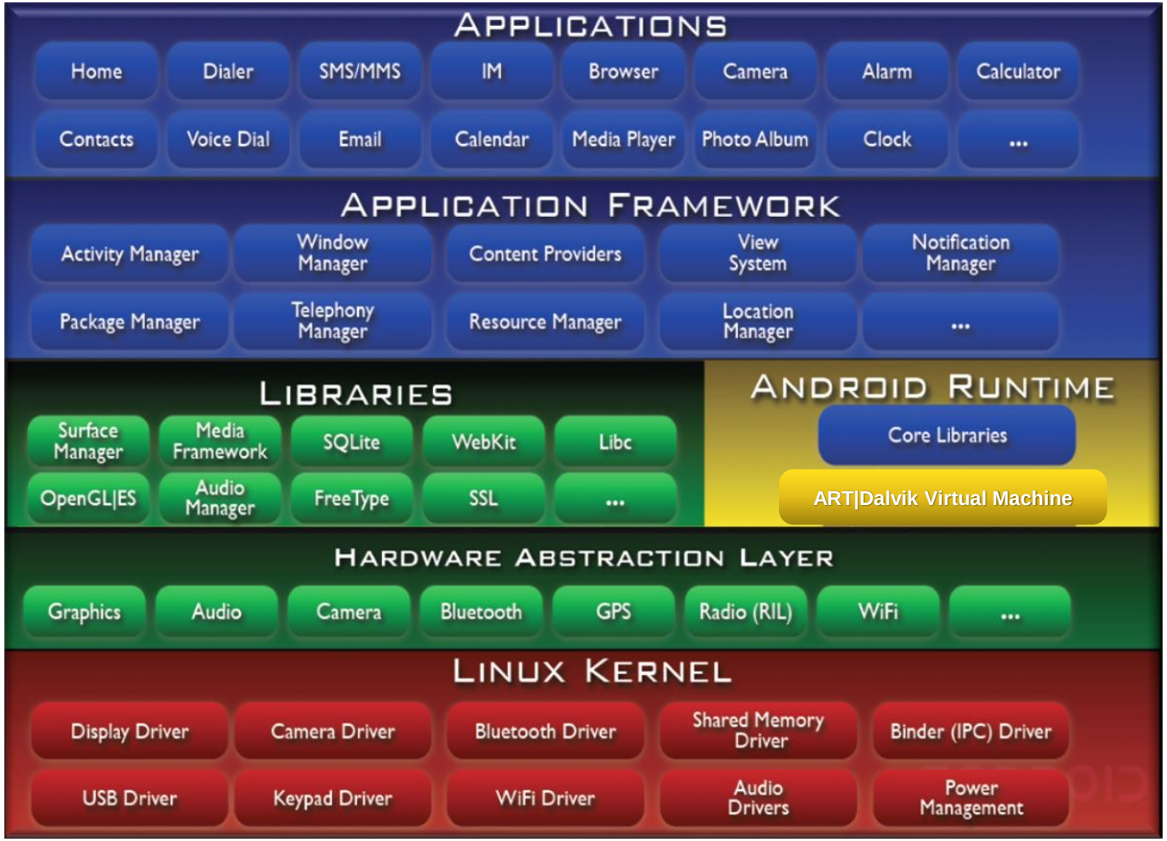
1. Know what layered architectures are
2. Understand the *Layers* architectural pattern
3. Recognize the layers in Android's software stack



Learning Objectives in this Lesson

1. Know what layered architectures are
2. Understand the *Layers* architectural pattern
3. Recognize the layers in Android's software stack
4. Realize *why* layering is used in Android



Overview of Layered Architectures

An Overview of Layered Architectures

- Layering is applied in many domains

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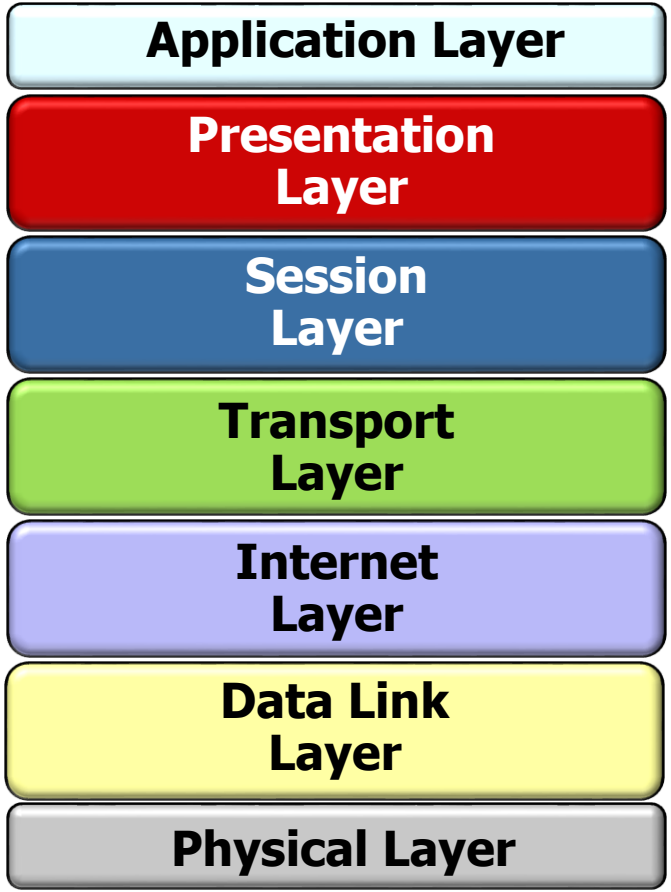
- Layering is applied in many domains, e.g.
  - Computer networking protocol stacks

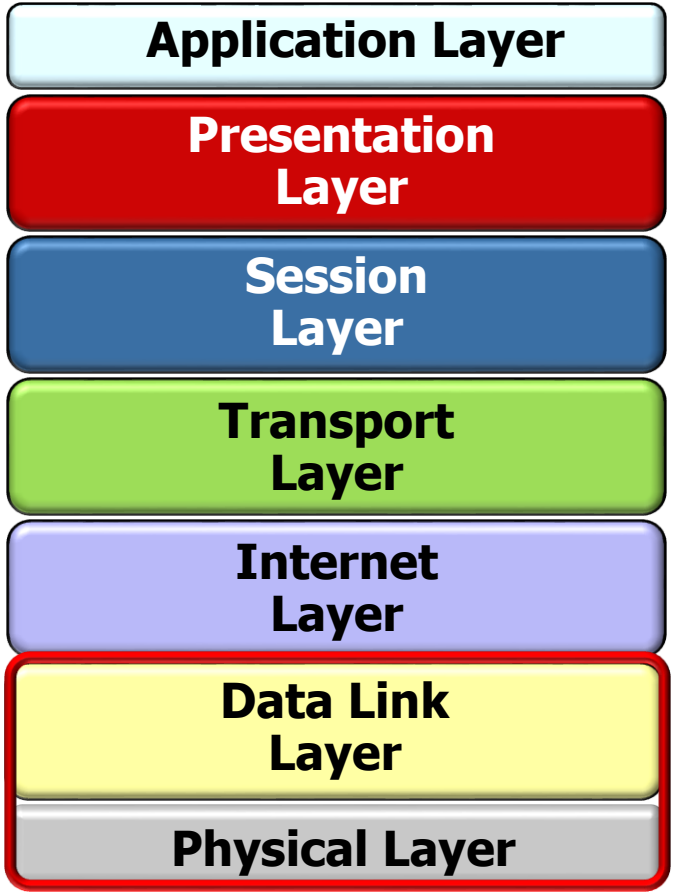
Enables end-to-end communication by specifying how data should be (un)packetized, addressed, transmitted, routed, & received



See en.wikipedia.org/wiki/Protocol_stack

An Overview of Layered Architectures

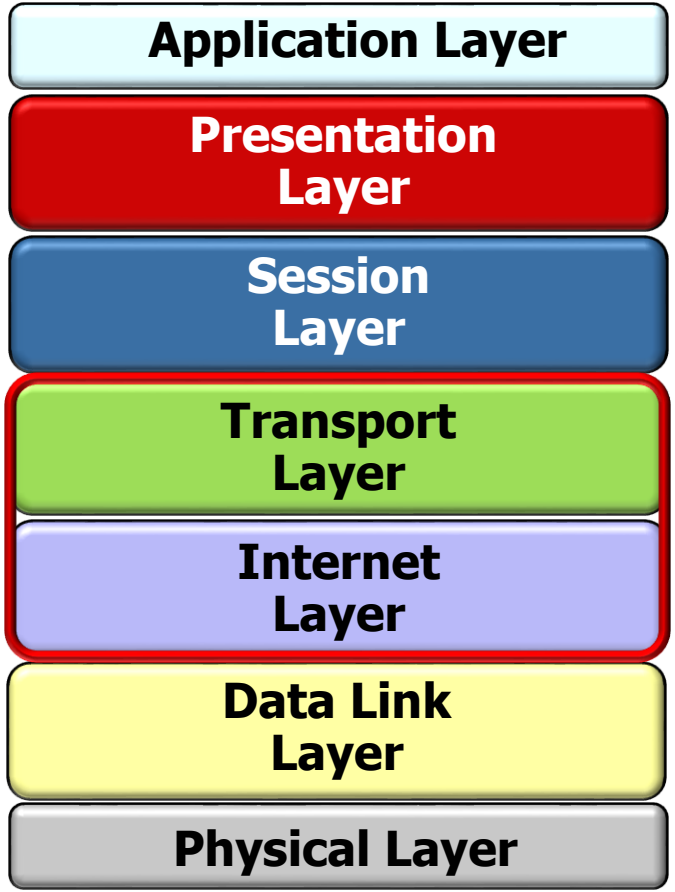
- Layering is applied in many domains, e.g.
  - Computer networking protocol stacks
    - Lower layers handle interactions with the hardware
      - e.g., GSM, DSL, & Ethernet



See en.wikipedia.org/wiki/Link_layer & en.wikipedia.org/wiki/Physical_layer

An Overview of Layered Architectures

- 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



See en.wikipedia.org/wiki/Internet_layer & en.wikipedia.org/wiki/Transport_layer

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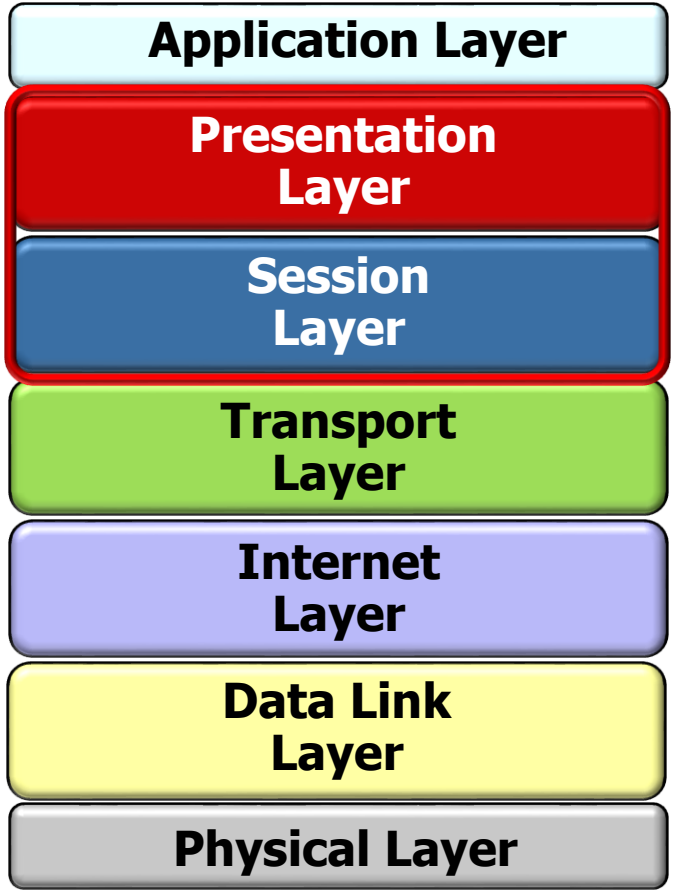
- Layering is applied in many domains, e.g.
  - Computer networking protocol stacks
    - Lower layers handle interactions with the hardware
    - Middle layers exchange packets across hosts & routers
    - Upper layers implement & interact with applications
      - e.g., PPTP, XDR, CDR, JSON



See en.wikipedia.org/wiki/Session_layer & en.wikipedia.org/wiki/Presentation_layer

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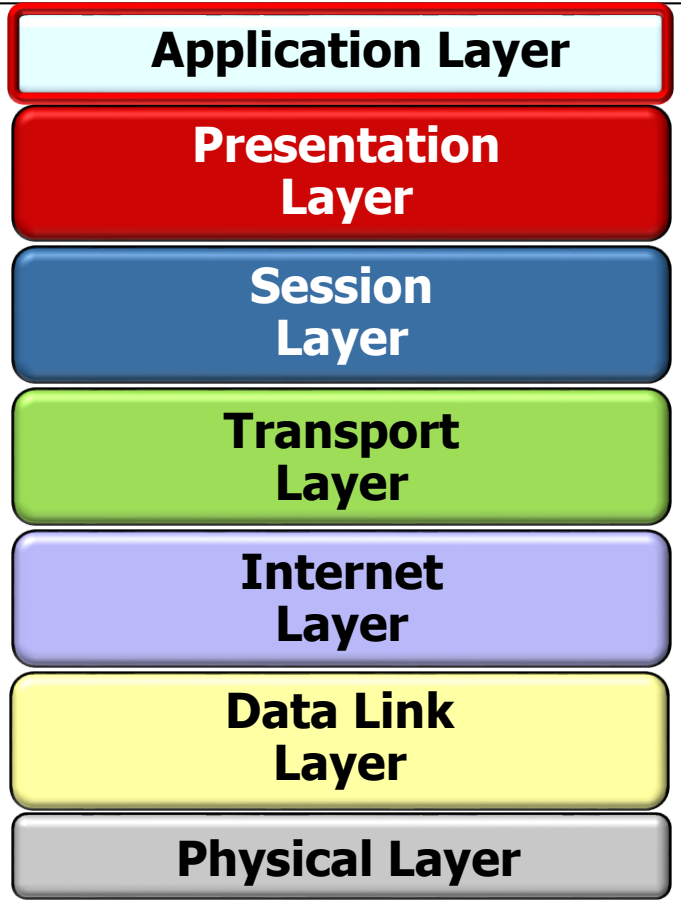
- Layering is applied in many domains, e.g.
  - Computer networking protocol stacks
    - Lower layers handle interactions with the hardware
    - Middle layers exchange packets across hosts & routers
    - Upper layers implement & interact with applications
    - Applications (& middleware) mostly just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



See en.wikipedia.org/wiki/Application_layer

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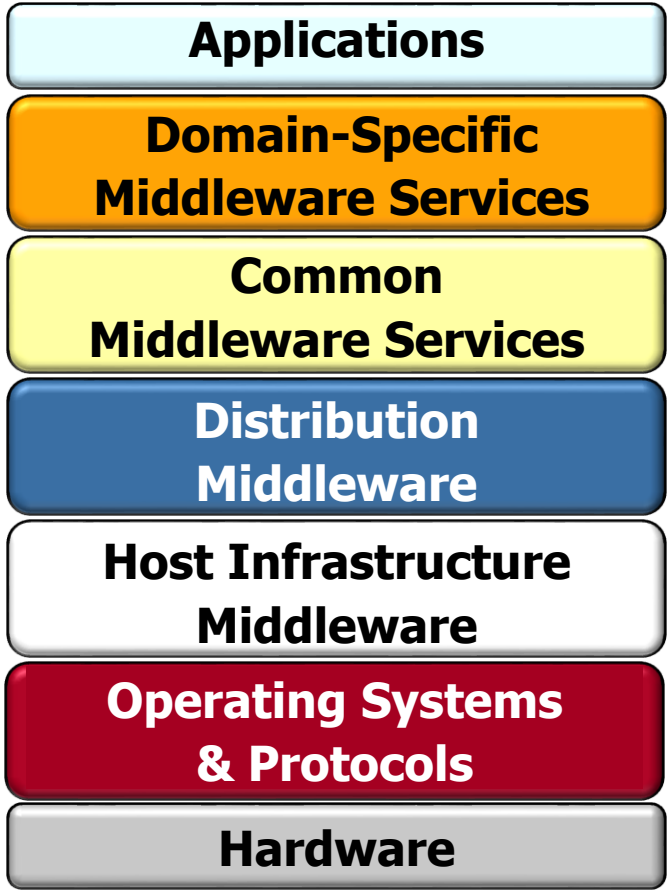
- Layering is applied in many domains, e.g.
  - Computer networking protocol stacks
  - Communication middleware in multi-tier enterprise IT systems



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

See en.wikipedia.org/wiki/Middleware_(distributed_applications)

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- Layering is applied in many domains, e.g.
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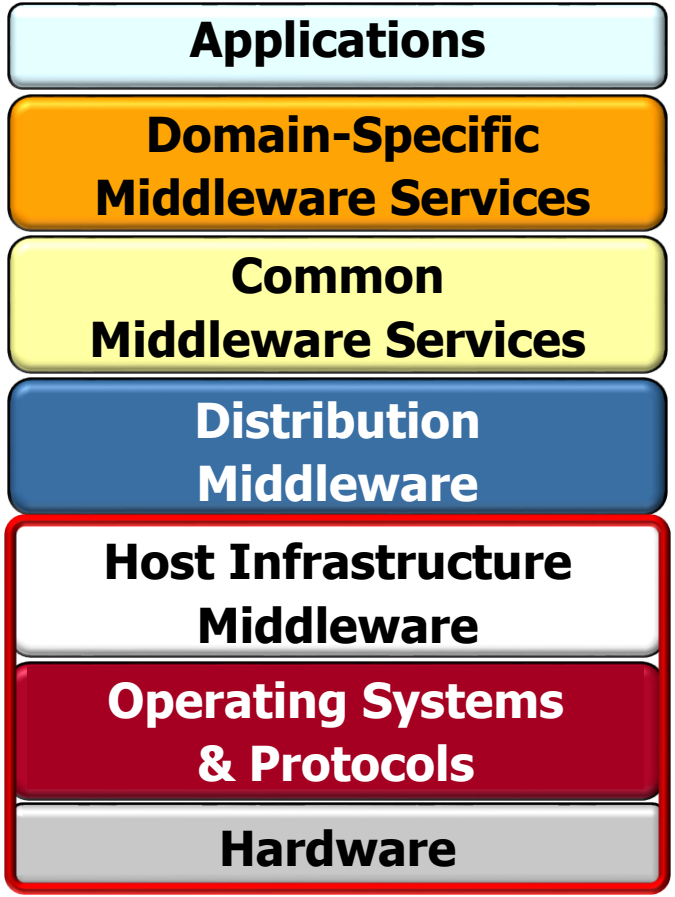
  - Communication middleware in multi-tier enterprise IT systems
    - Lower layers provide portable APIs for accessing hardware & system resources
      - e.g., Linux, Windows, JVM, & ACE



See www.dre.vanderbilt.edu/~schmidt/PDF/middleware-encyclopedia.pdf

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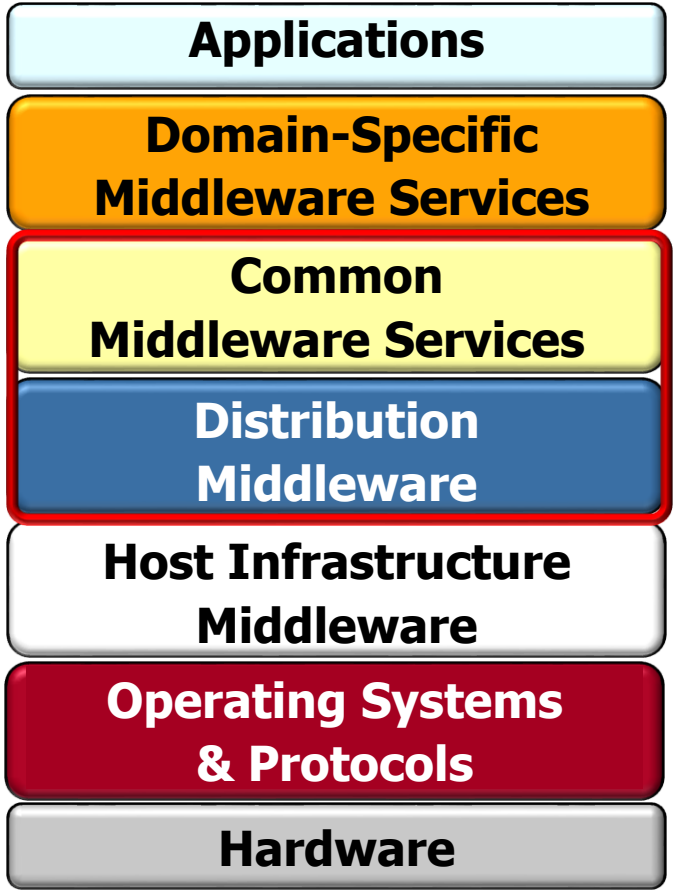
    - Middle layers shield applications from network programming details
      - e.g., DDS, Web Services, MQTT, Spring, CORBA, etc.



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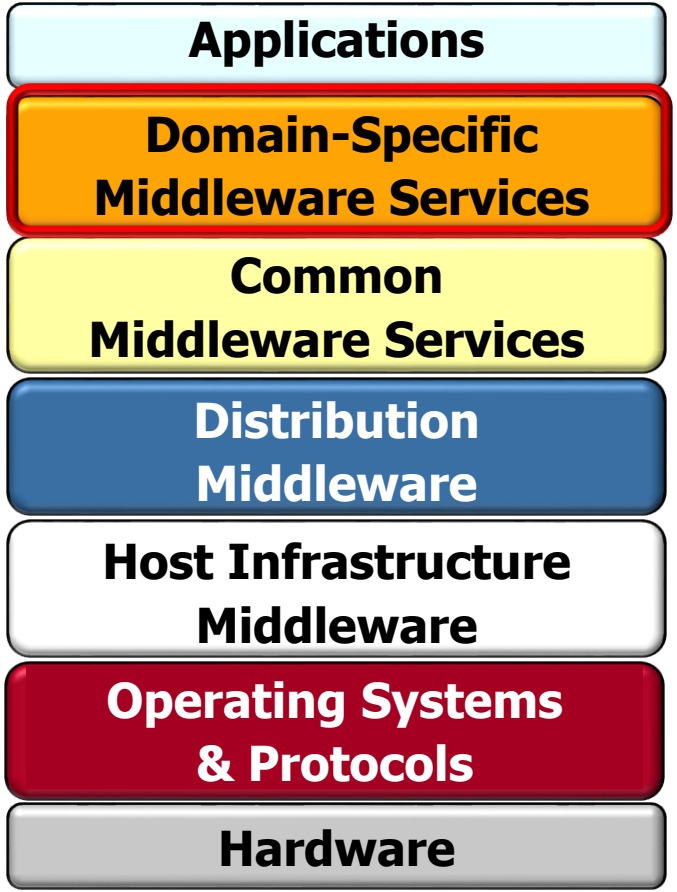
    - Upper layers enable domain-specific reuse of capabilities
      - e.g., MD-PnP, IIC, & FACE



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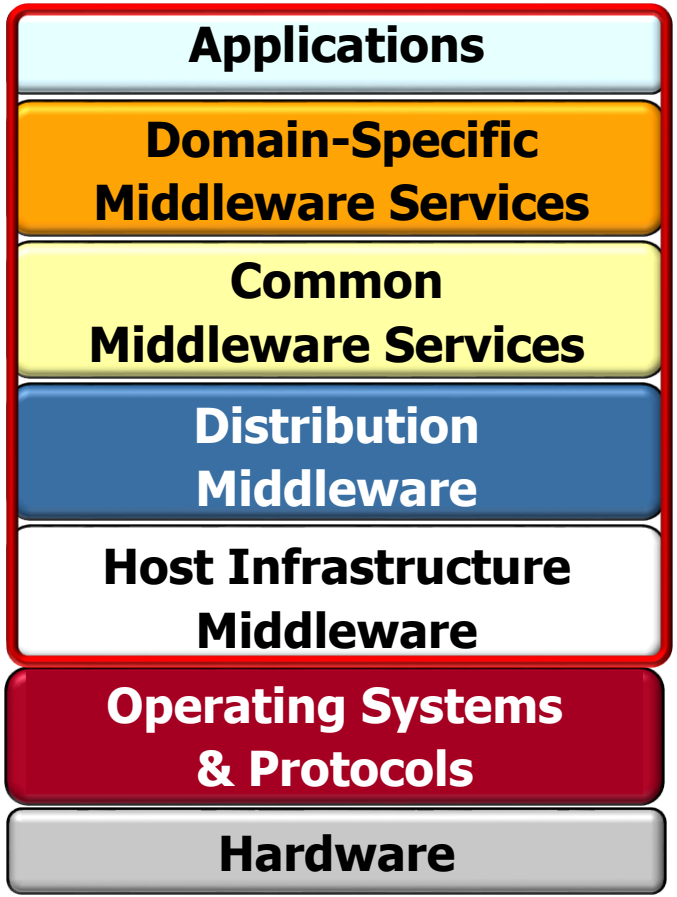
    - Applications may deal w/multiple layers



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Overview of the Layers Architectural Pattern

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- The concept of layering has been expressed as an *architectural pattern*

See www.dre.vanderbilt.edu/~schmidt/POSA

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> *"a structural organization schema for software systems that*
> - *provides a set of predefined subsystems*
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See en.wikipedia.org/wiki/Architectural_pattern

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See en.wikipedia.org/wiki/Architectural_pattern

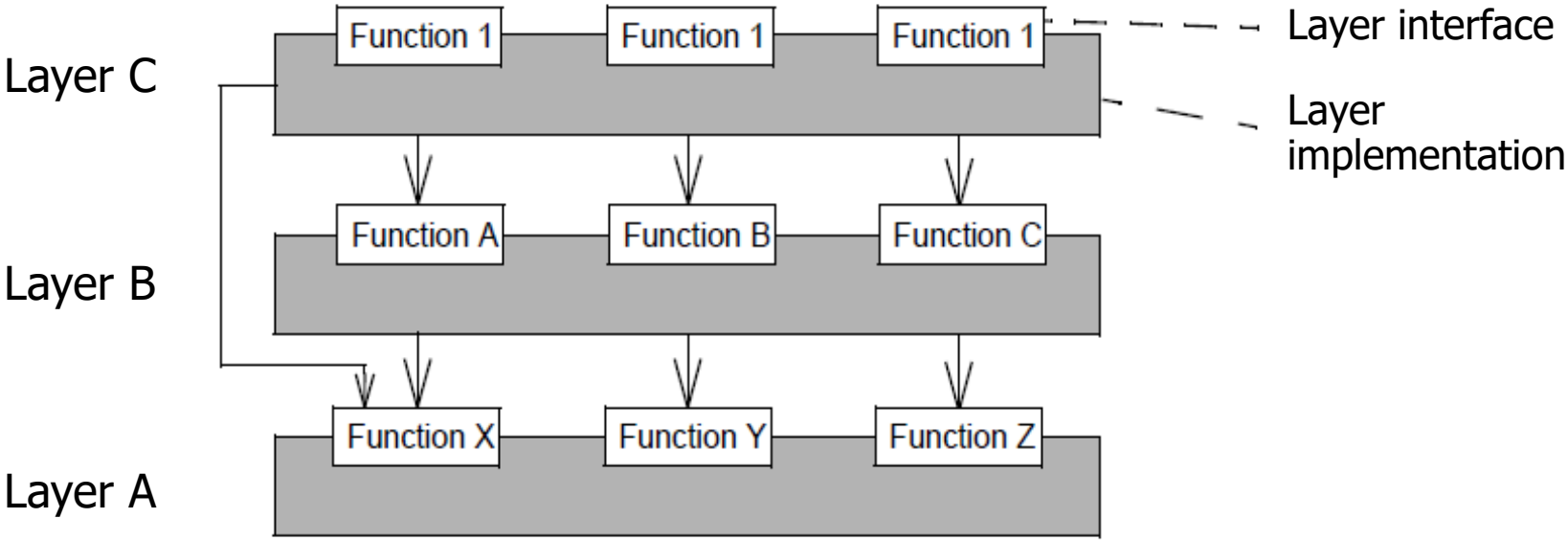
An Overview of the Layers Architectural Pattern

- The *Layers* architectural pattern has been described in various publications

See en.wikipedia.org/wiki/Multilayered_architecture

An Overview of the Layers Architectural Pattern

- The *Layers* pattern structures software apps & infrastructure in several ways



See posa1.blogspot.com/2008/05/layered-architecture-pattern.html

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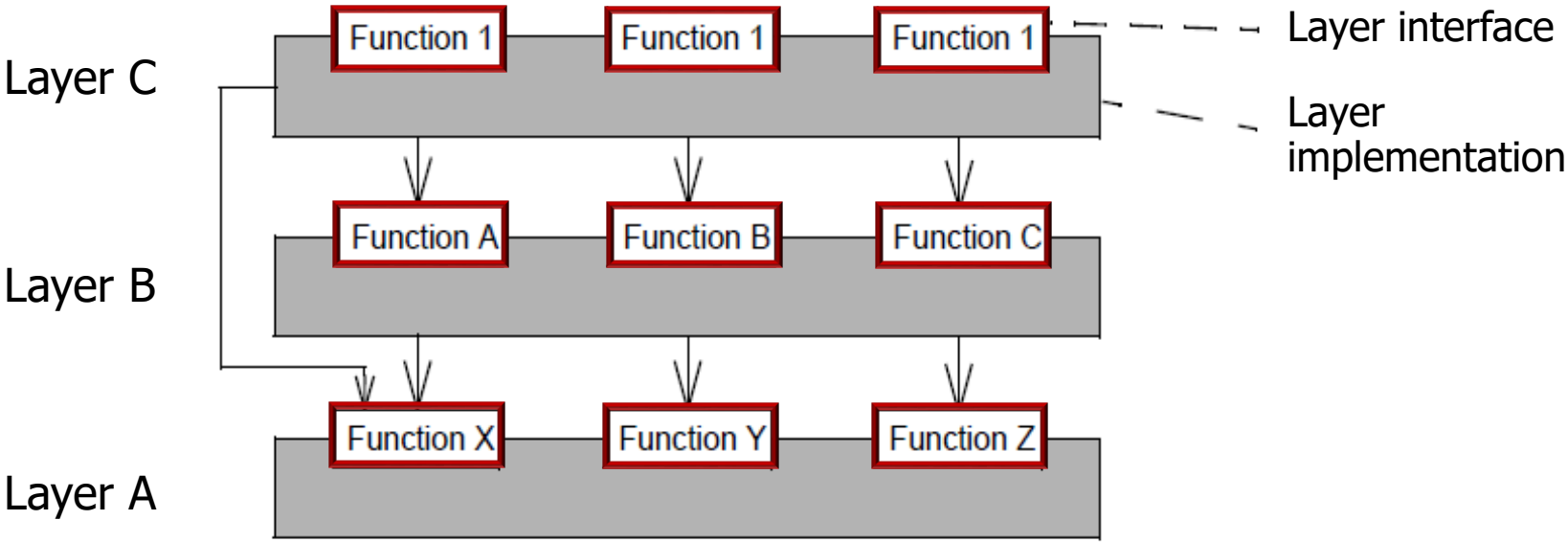
- The *Layers* pattern structures software apps & infrastructure in several ways
  a. Partitions an overall system architecture into groups of subtasks



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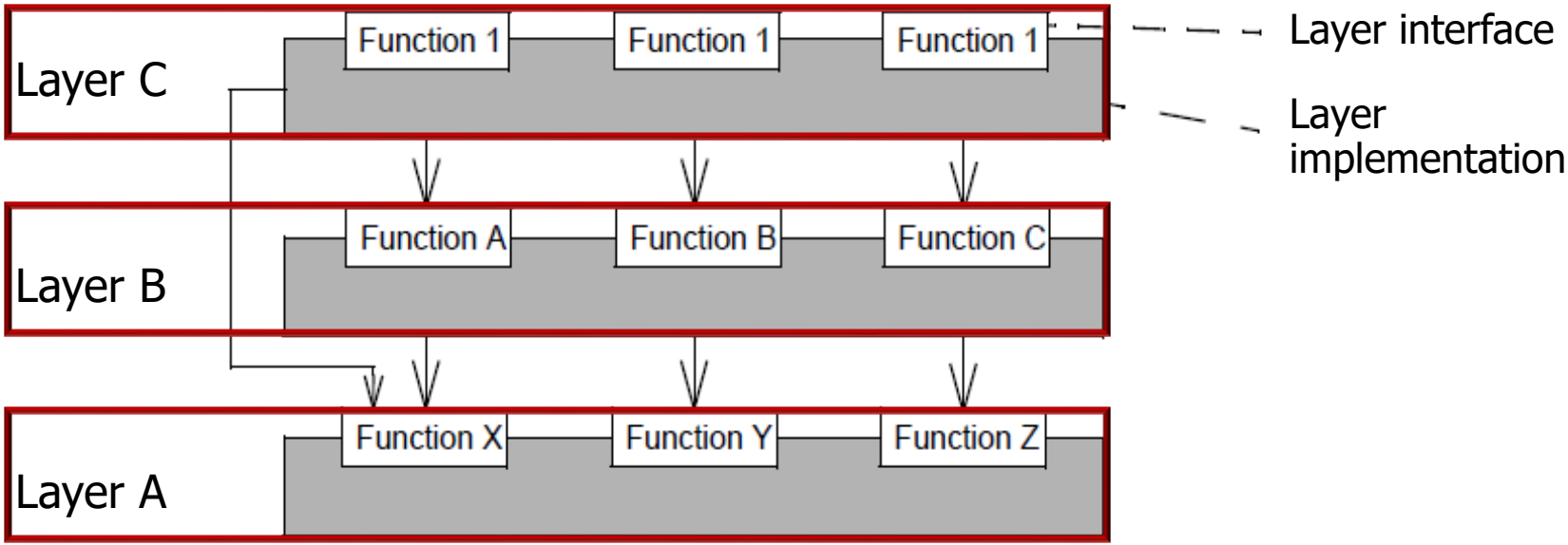
- The *Layers* pattern structures software apps & infrastructure in several ways
  a. Partitions an overall system architecture into groups of subtasks
  b. Decomposes groups of subtasks into levels of abstraction



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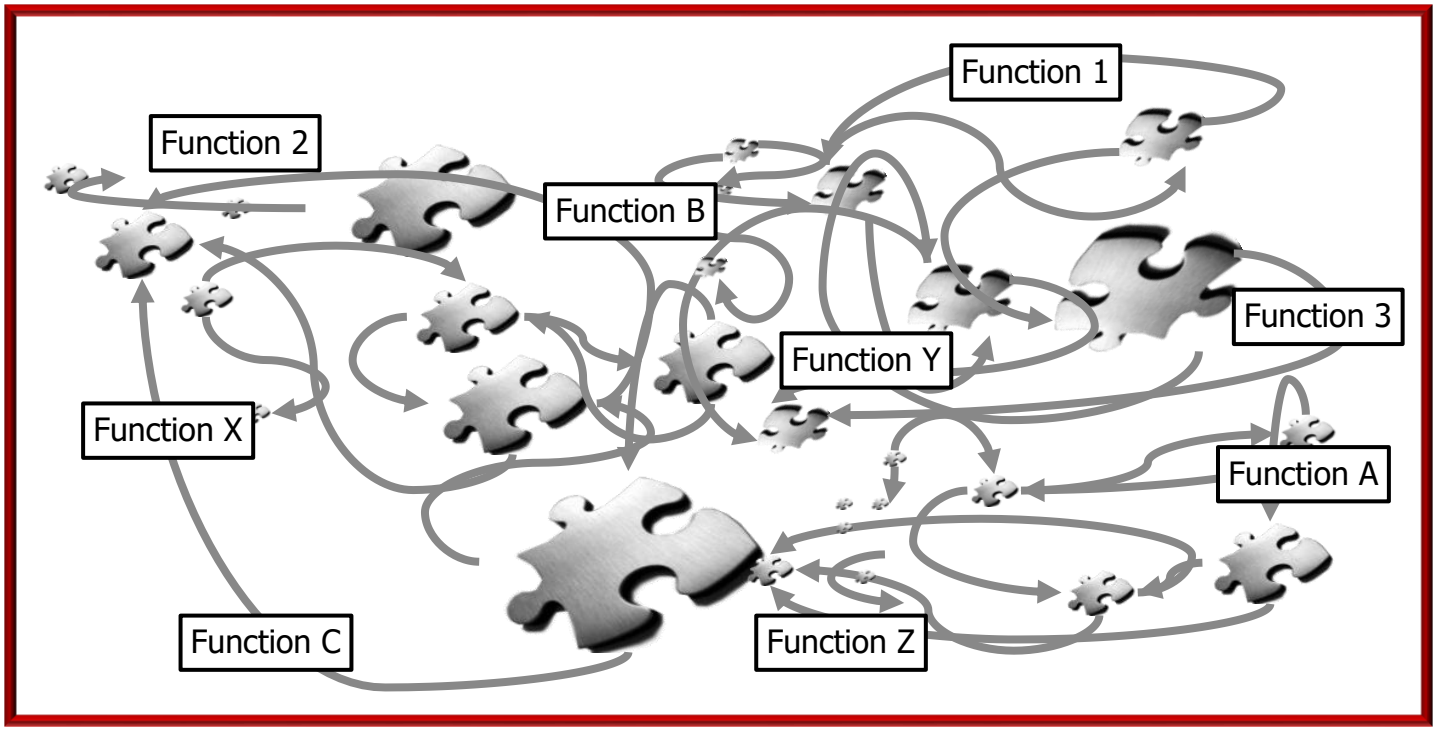
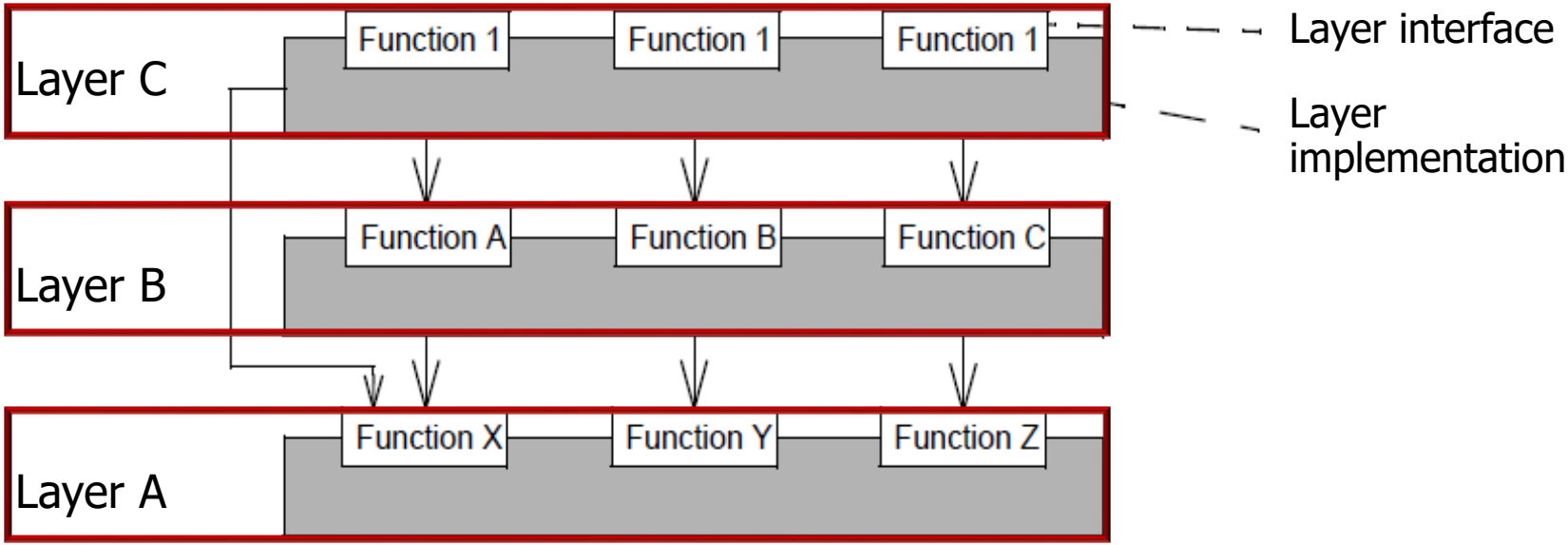
  - e.g., it replaces tightly coupled "big balls of mud"…



See en.wikipedia.org/wiki/Big_ball_of_mud

An Overview of the Layers Architectural Pattern

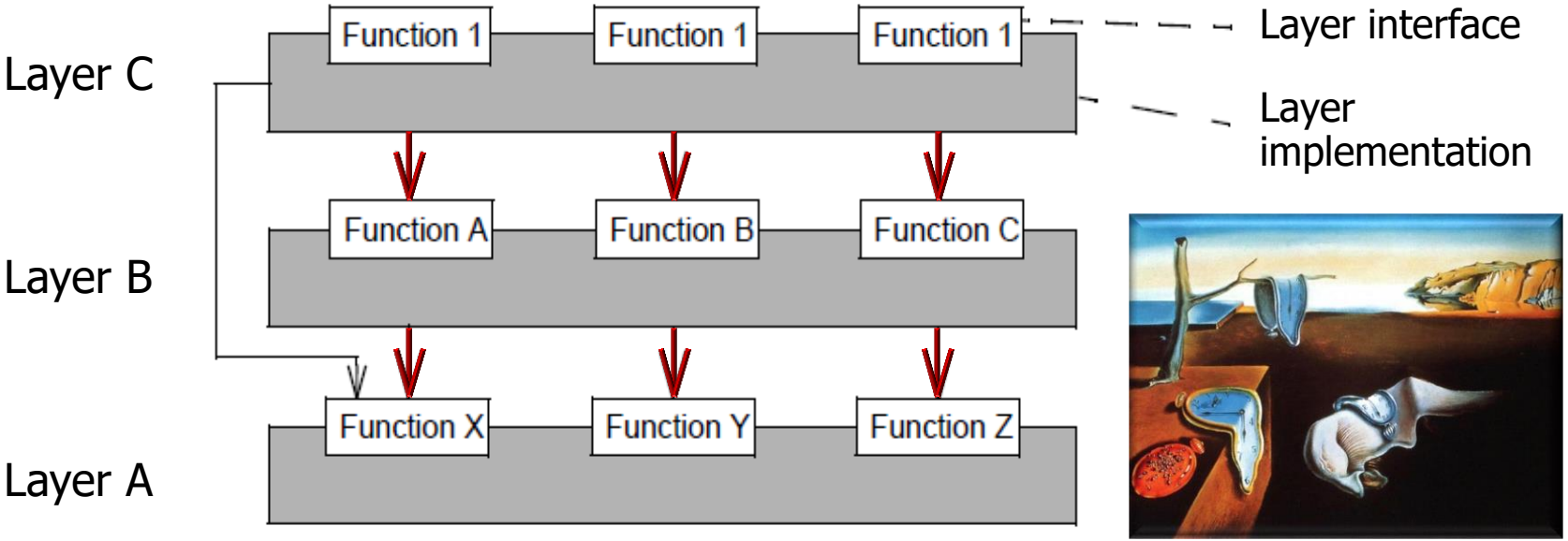
- The *Layers* pattern helps to simplify software development & evolution
  - e.g., it replaces tightly coupled "big balls of mud"… with modular solutions that can be extended & contracted more easily



See www.dre.vanderbilt.edu/~schmidt/family.pdf

An Overview of the Layers Architectural Pattern

- Be careful when implementing a layered architecture to avoid unnecessary overhead when exchanging data between the layers



See www.dre.vanderbilt.edu/~schmidt/PDF/p96-van_renesse.pdf

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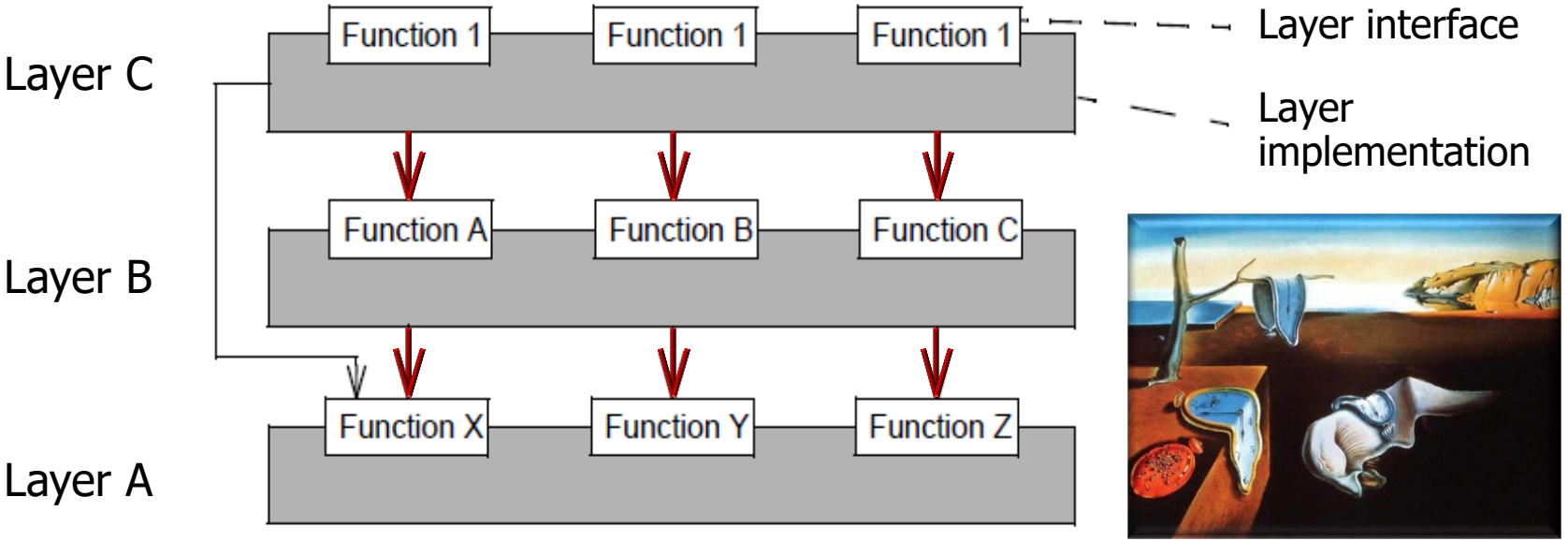
- Be careful when implementing a layered architecture to avoid unnecessary overhead when exchanging data between the layers
  - e.g., minimize context switching, synchronization, & data copying overhead



See www.cs.wustl.edu/~schmidt/PDF/dissertation.pdf

An Overview of Android's Layered Architecture

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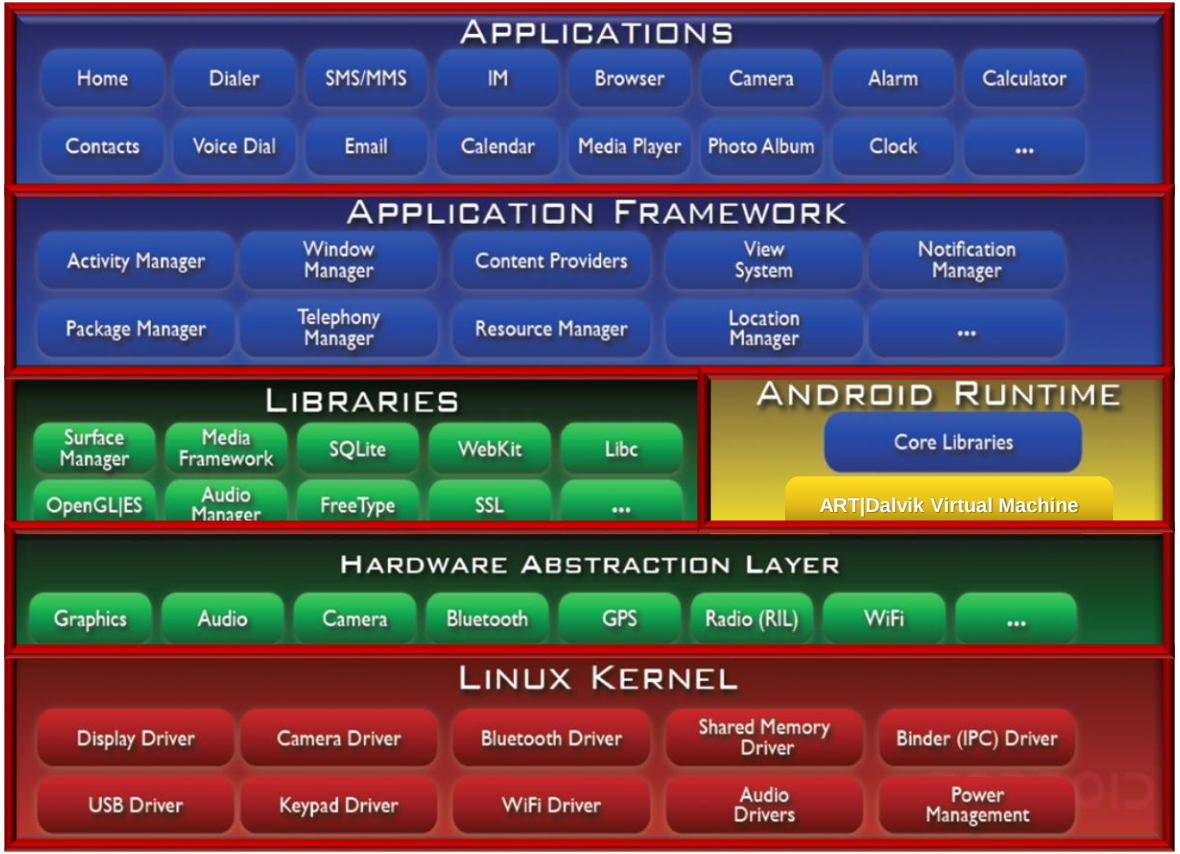
- Android's architecture is structured in accordance to multiple layers



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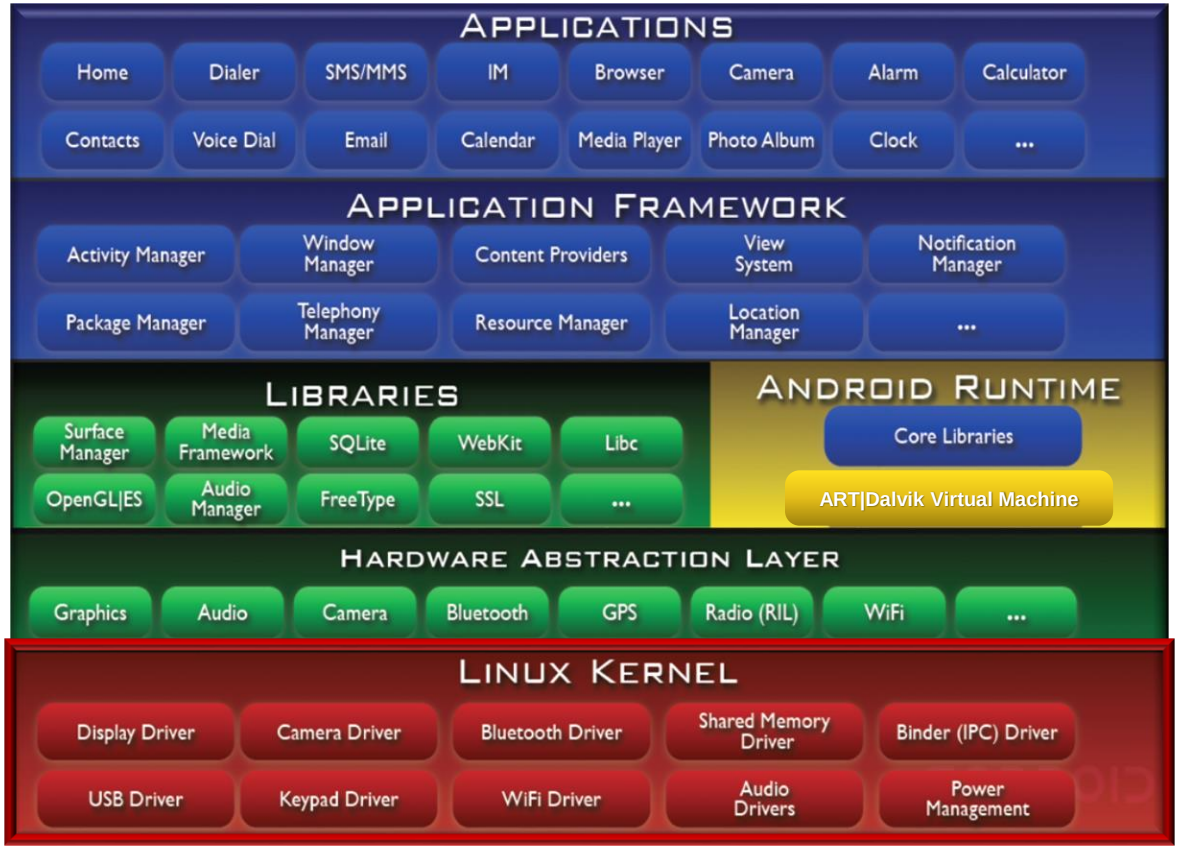

The Android Linux kernel controls hardware & manages system resources

An Overview of Android's Layered Architecture

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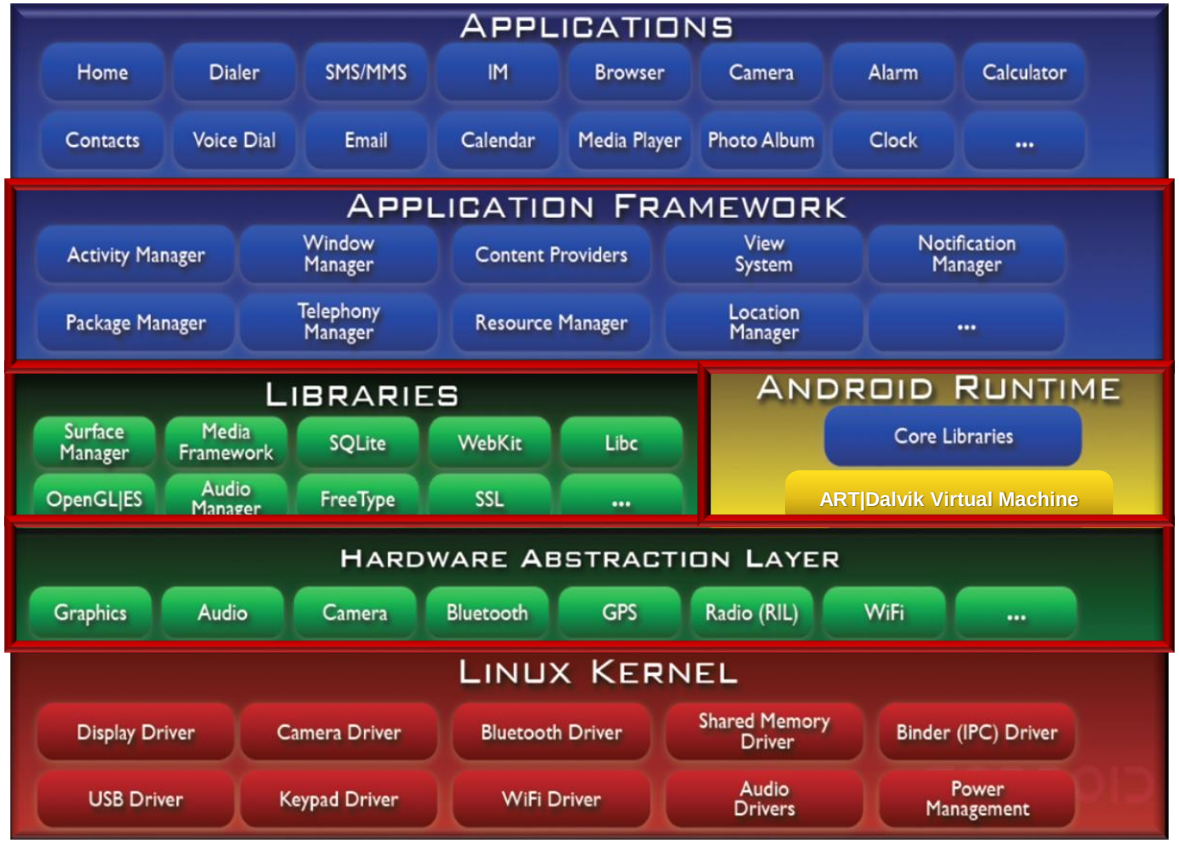

Several layers of middleware provide higher-level reusable services to apps

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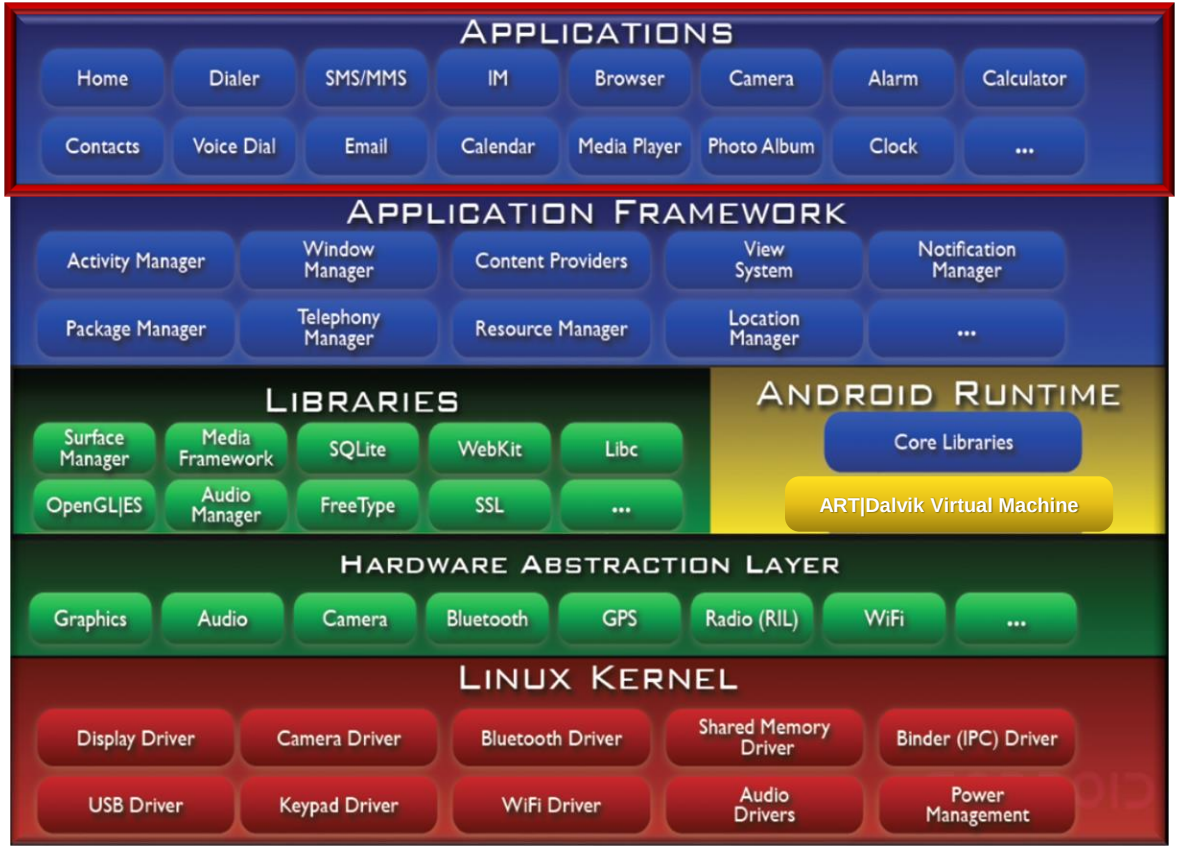

The application layer provides packaged functionality to end-users

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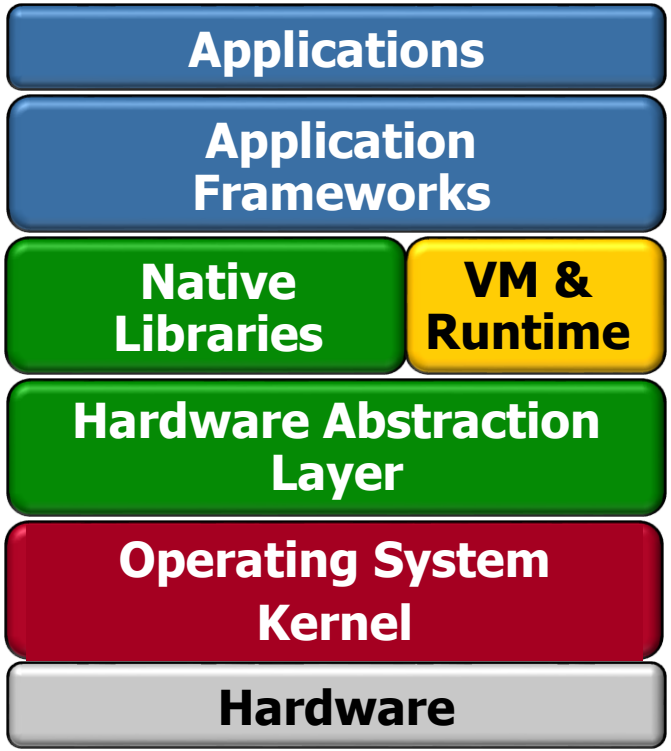
- Layering is applied in complex systems like Android for several reasons



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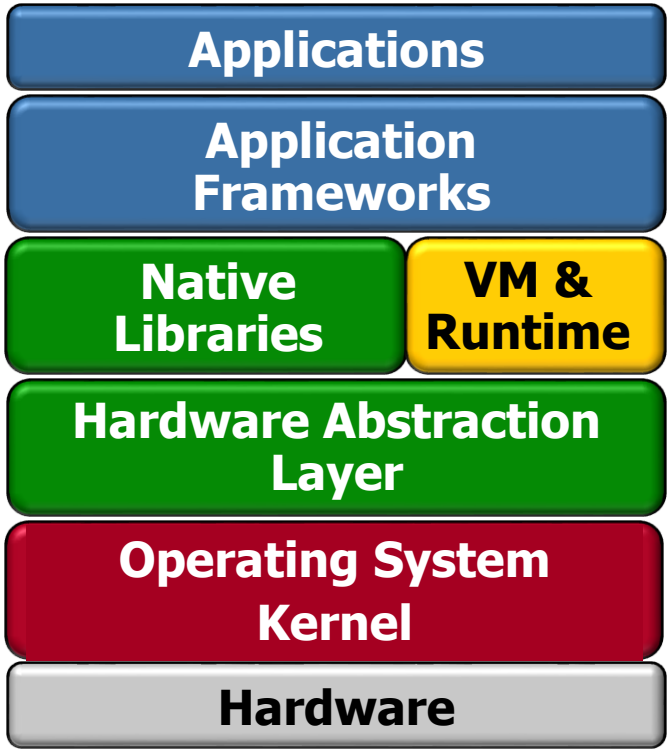
- Layering is applied in complex systems like Android for several reasons, e.g.
  - Enhance systematic software reuse

An intentional strategy for increasing productivity & improving software quality



See en.wikipedia.org/wiki/Code_reuse#Systematic_software_reuse

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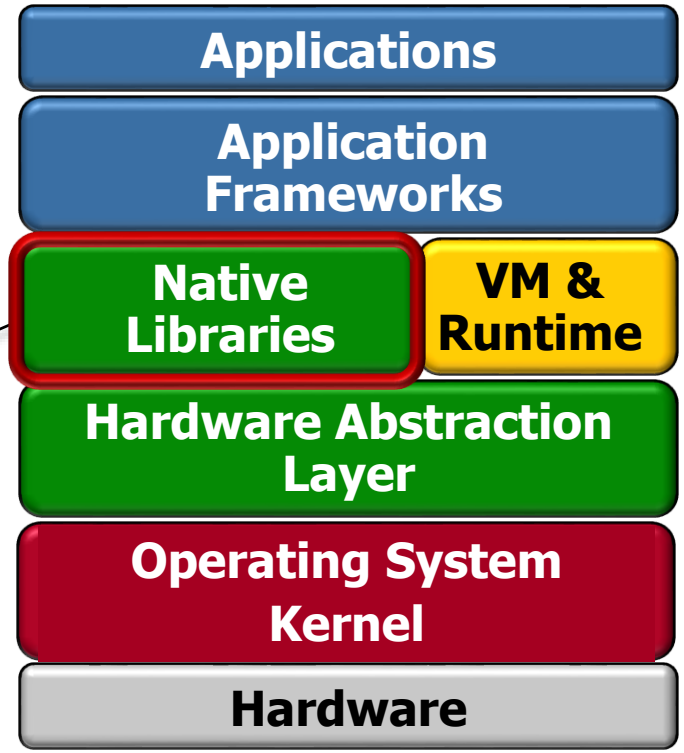
libC provides a common API for accessing OS kernel capabilities



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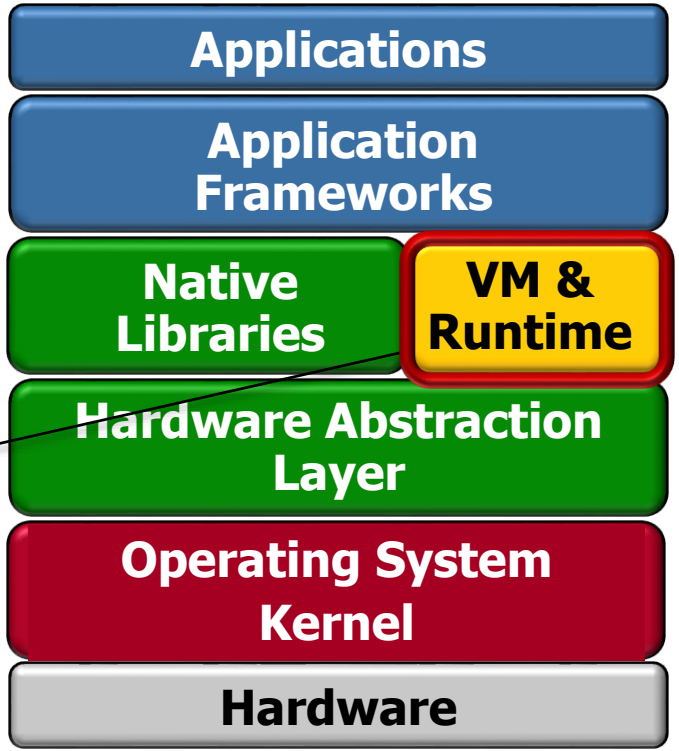
Enable apps to run concurrently over various types of multi-core hardware



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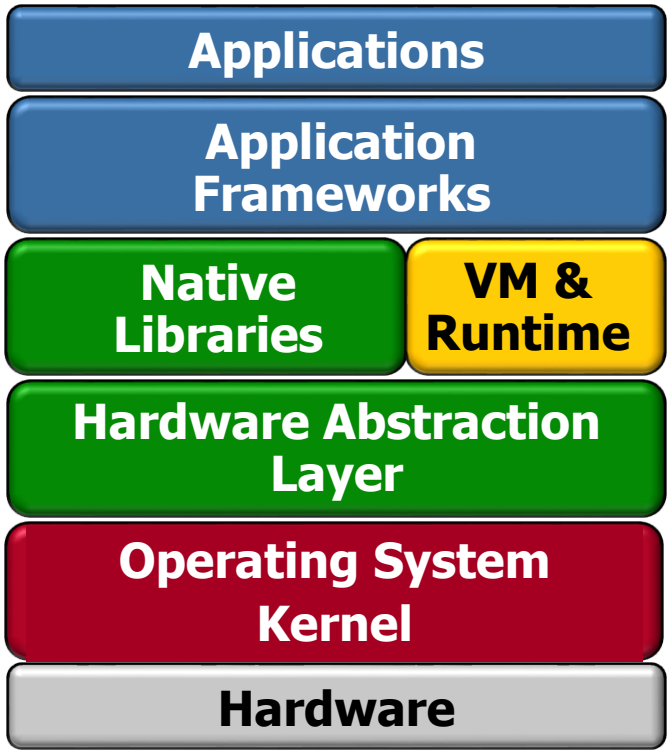
  - Enable "plug & play" replacement of certain layer implementations



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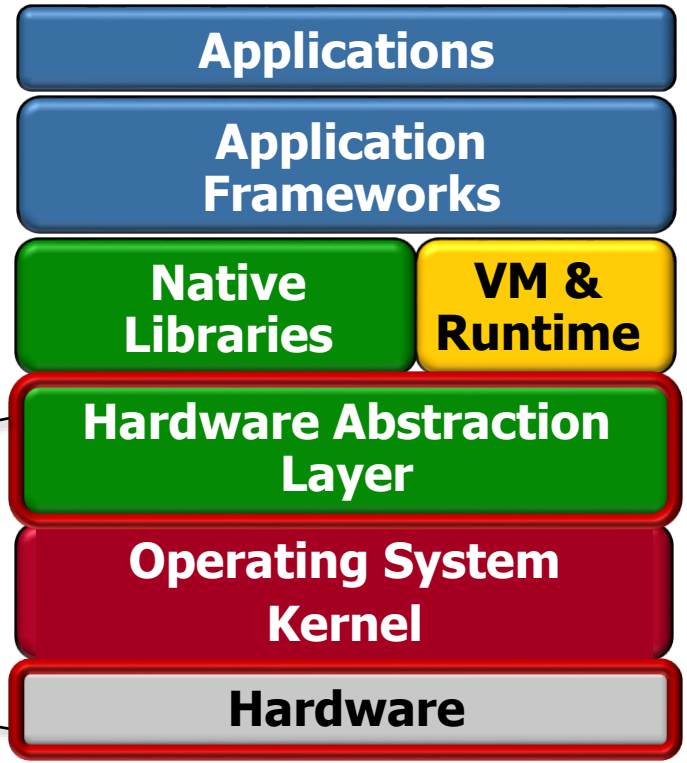
Shield apps from inconsistent hardware APIs



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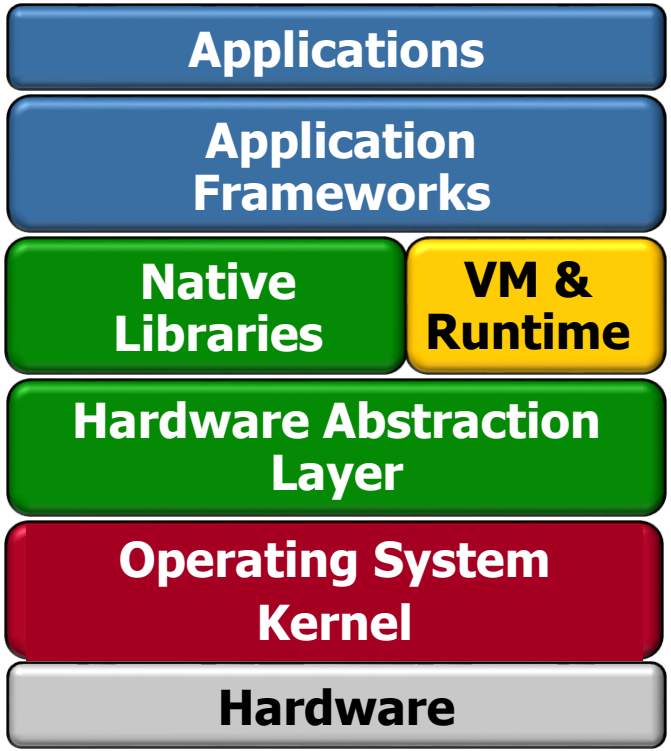

Effects of updates can be confined to the layer whose implementation changes

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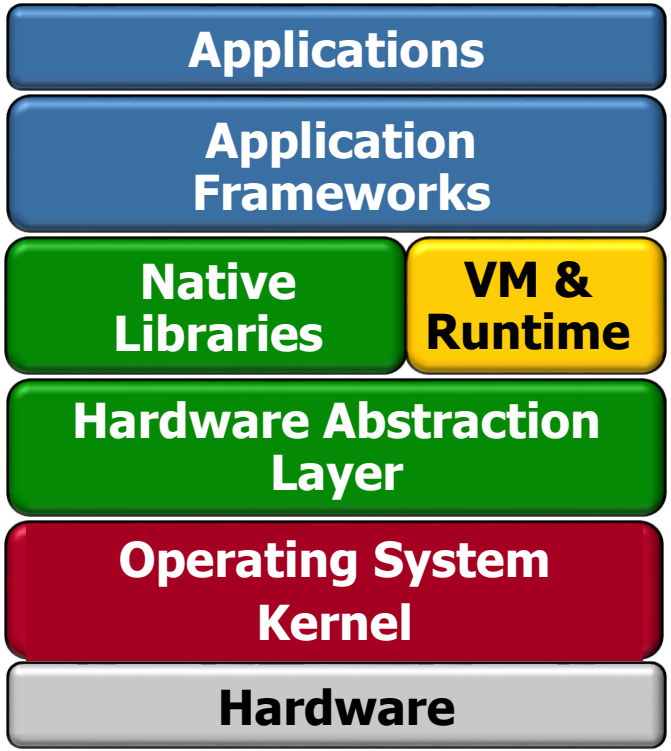

See en.wikipedia.org/wiki/Facade_pattern

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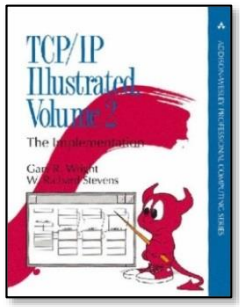
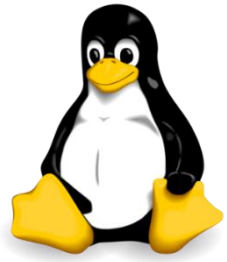
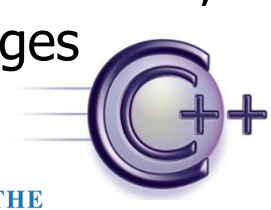
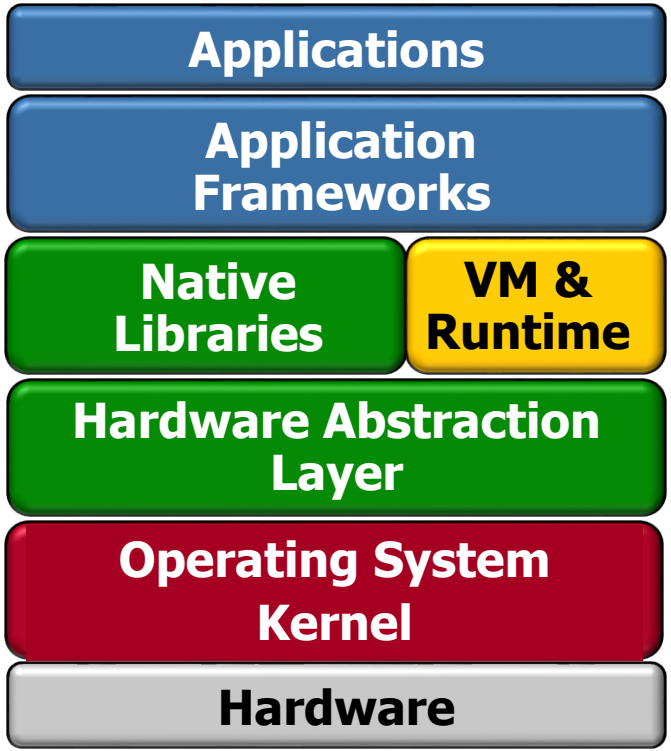
  - Reduce the complexity of APIs that app developers must understand
  - Enable use of popular protocols, APIs, & programming languages





THE C PROGRAMMING LANGUAGE





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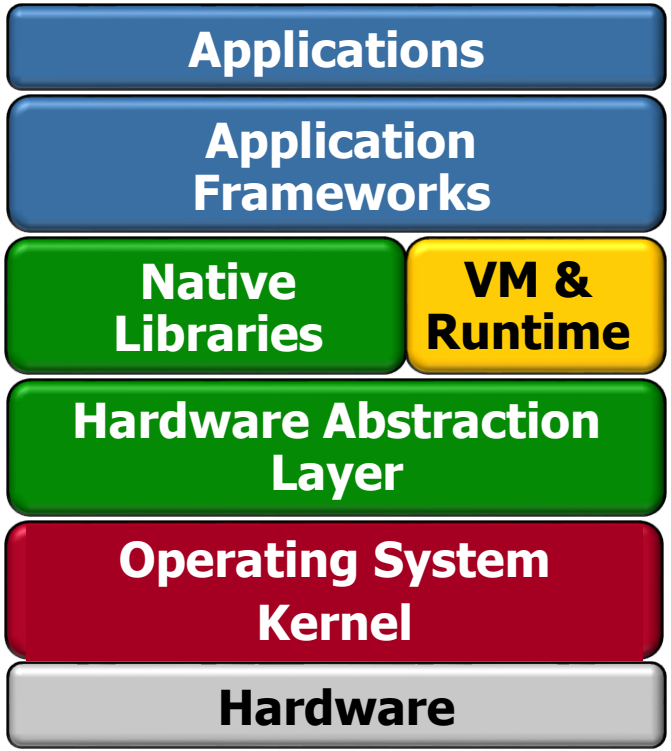
  - Reduce the complexity of APIs that app developers must understand
  - Enable use of popular protocols, APIs, & programming languages
    - These popular protocols & APIs are available in open-source form



See source.android.com & source.android.com/source/building-kernels.html

End of Overview of Layered Architectures