Android Services & Local IPC: Overview of the Android Interface Definition Language & Binder Framework

Douglas C. Schmidt
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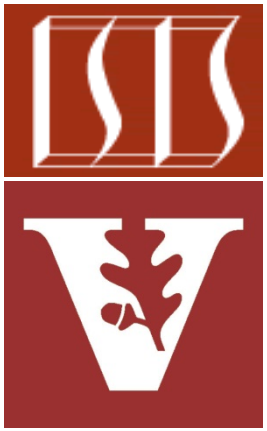
www.dre.vanderbilt.edu/~schmidt



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Institute for Software Integrated Systems

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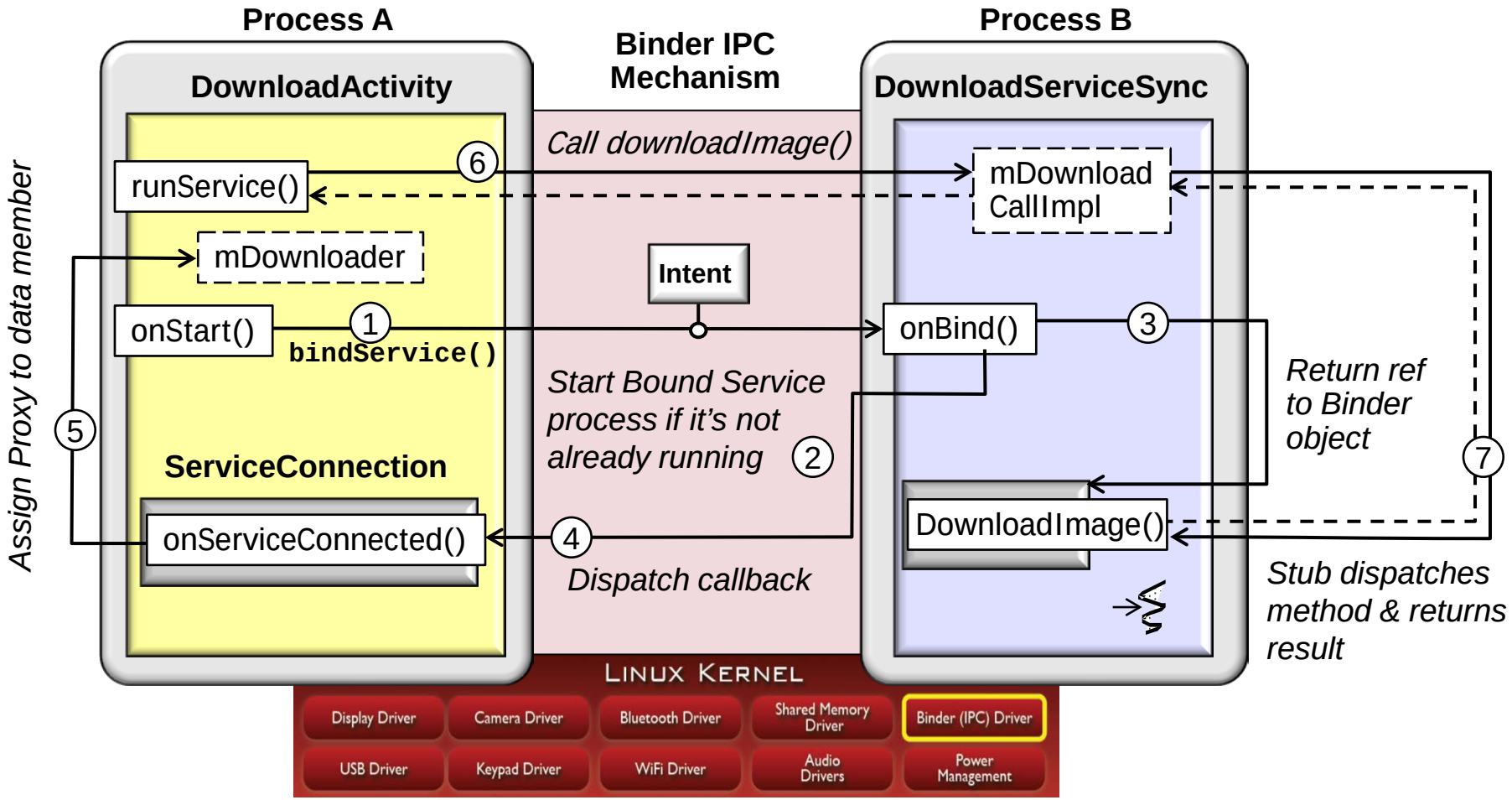
Nashville, Tennessee, USA

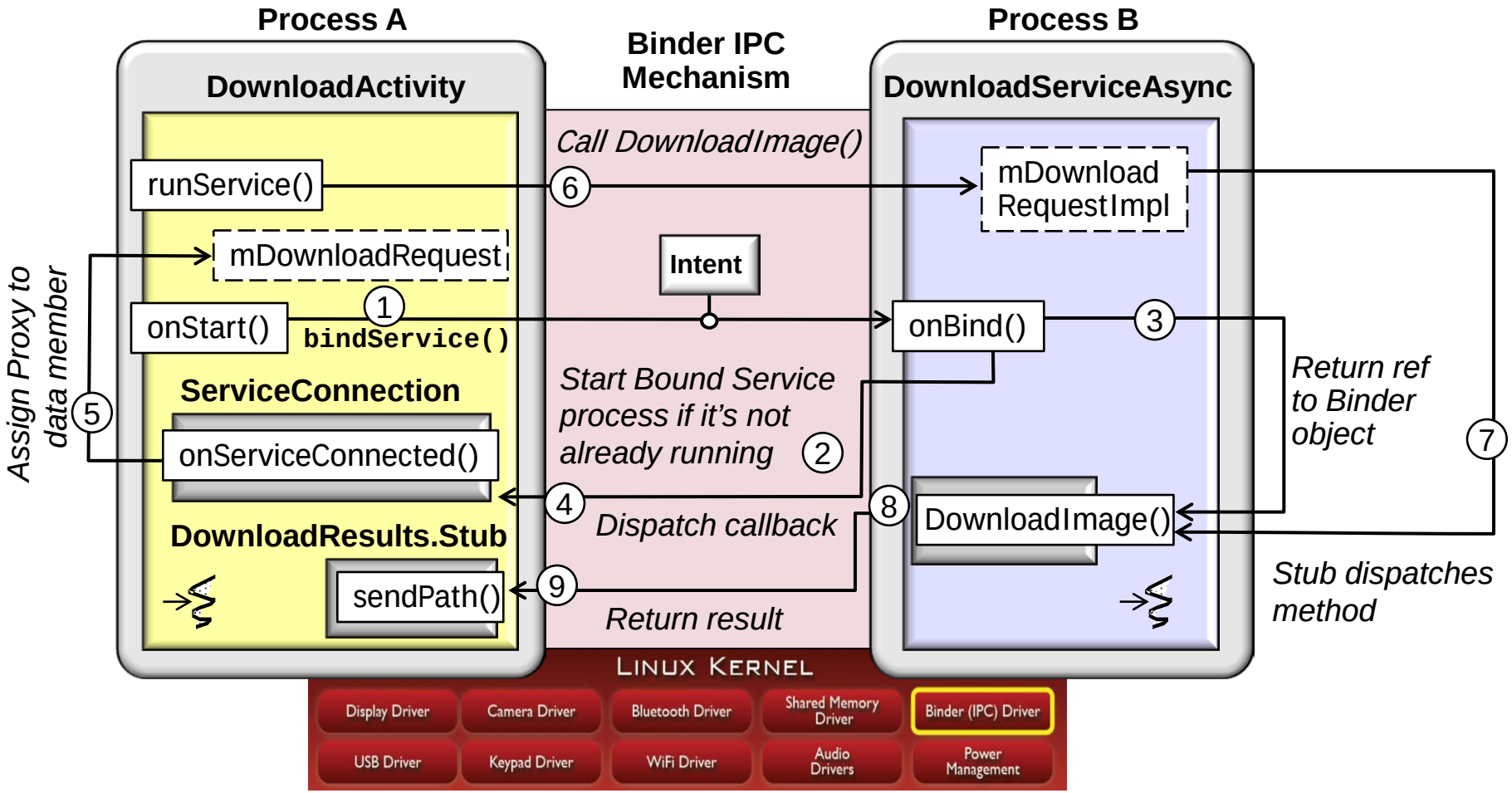
Learning Objectives in this Part of the Module

- Understand AIDL & Binder mechanisms Activities use to communicate with Bound Services synchronously



Learning Objectives in this Part of the Module

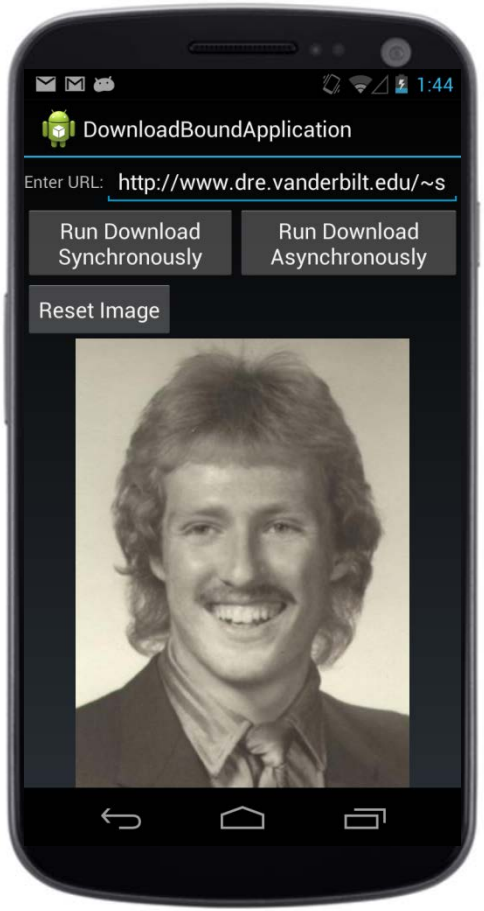
- Understand AIDL & Binder mechanisms Activities use to communicate with Bound Services synchronously & asynchronously

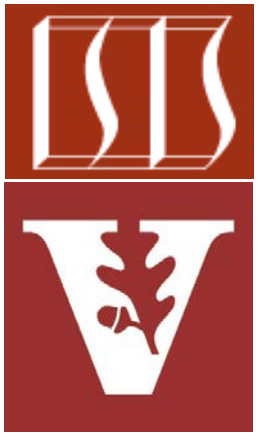


AIDL & Binder provide powerful mechanisms for typed object-oriented IPC

The Bounded Download Application

- BoundDownloadApplication uses AIDL & Binder mechanisms to interact with Bound Services to download/display images synchronously/asynchronously





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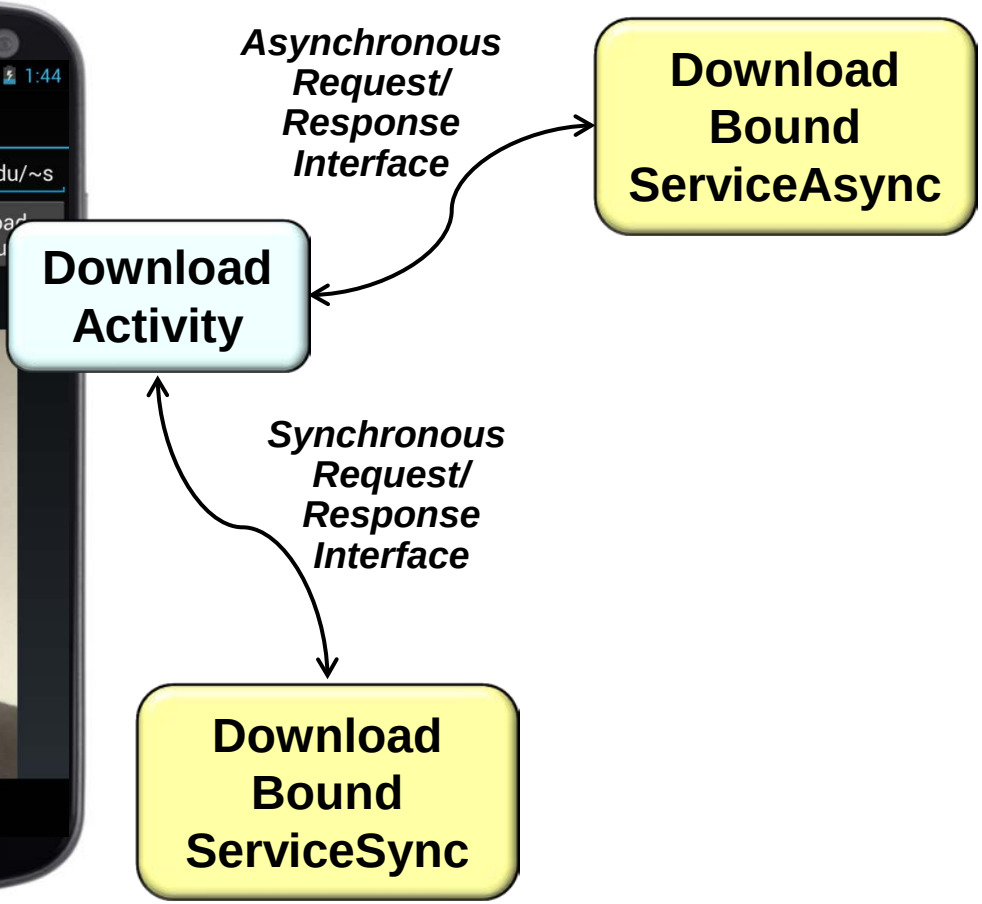

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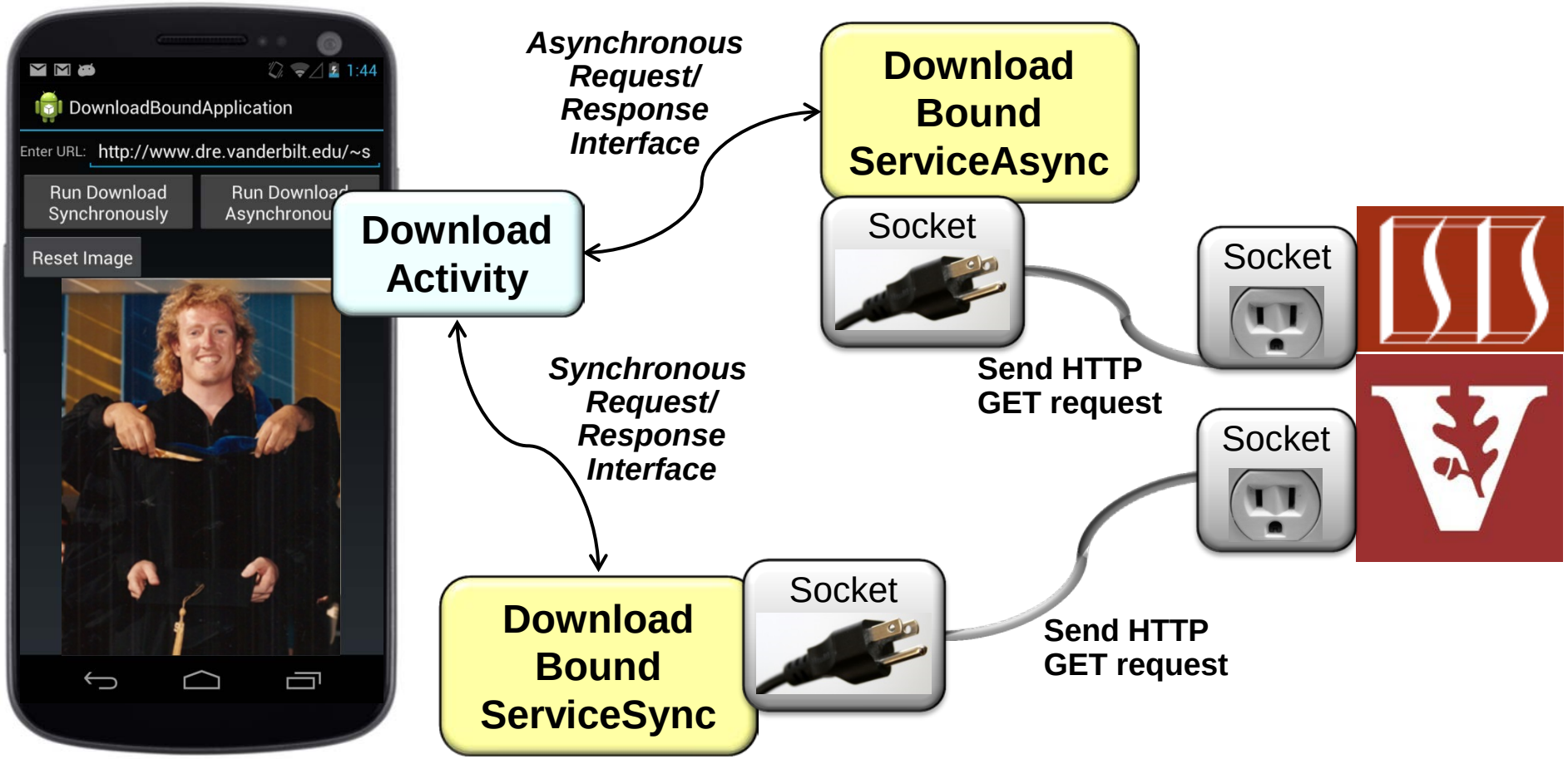

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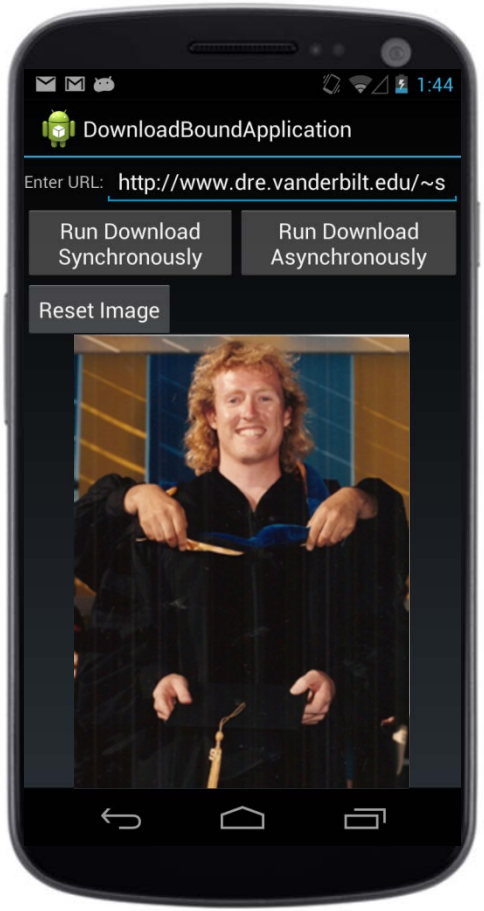

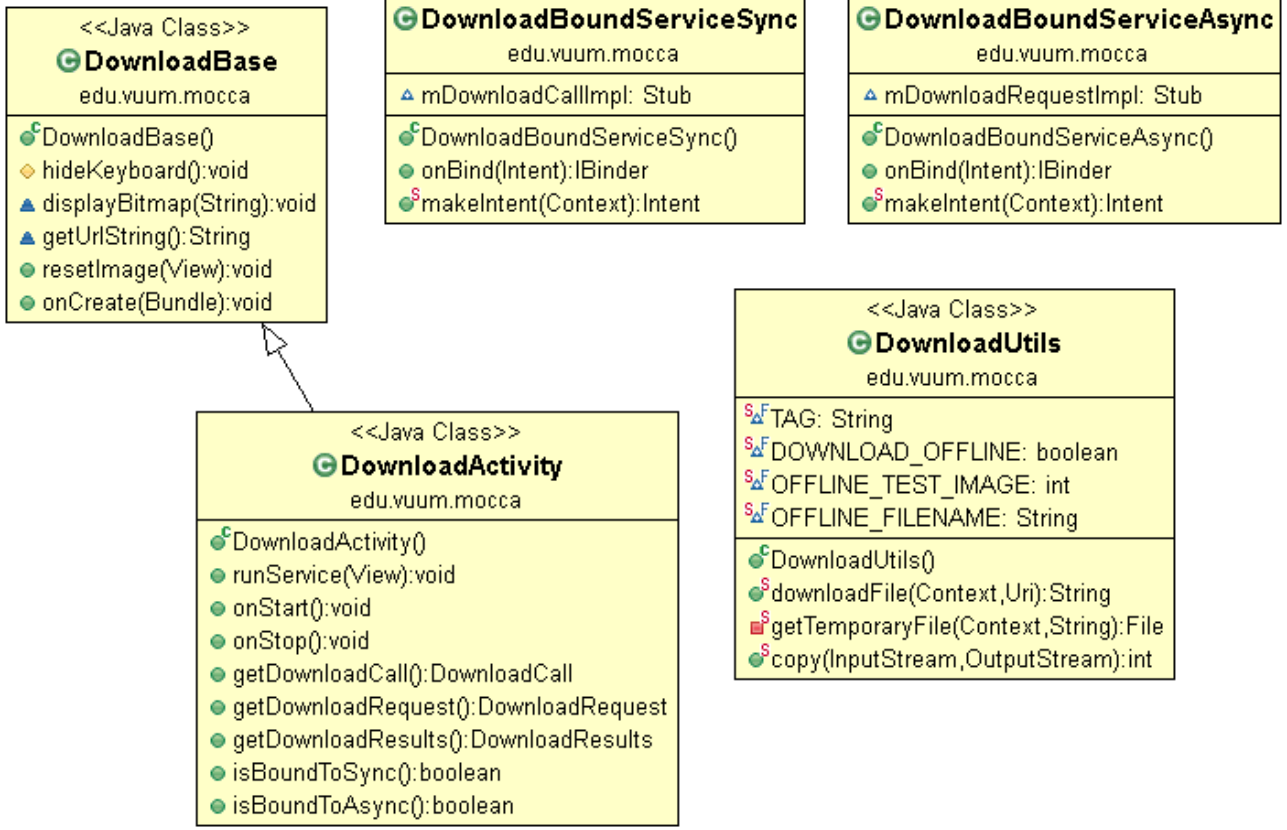

See github.com/douglascraigschmidt/POSA-14/tree/master/assignments/week-8-assignment-7

Supplemental Material on AIDL & Binder

- The AIDL & Binder mechanisms are powerful, but programmers must understand a number of constructs & steps to use them effectively

See videos on “AIDL Syntax & Supported Data Types” & “Implementing AIDL Interfaces”

Motivating the AIDL & Binder (Part 1)

Motivating the AIDL & Binder

- Services may need to run in different processes than their clients

See previous part on “Activity & Service Communication”

Motivating the AIDL & Binder

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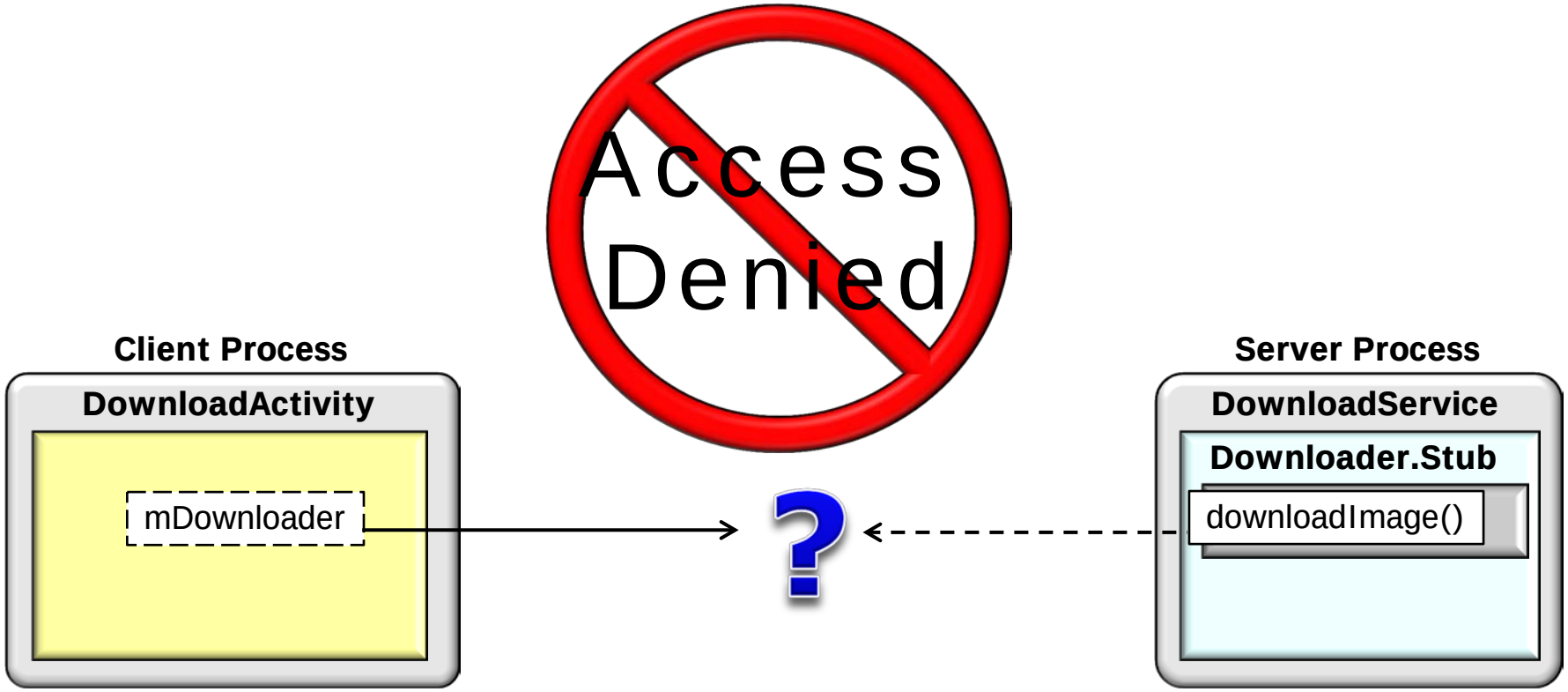
  - Objects in one process on Android cannot normally access objects in the address space of another process



Motivating the AIDL & Binder

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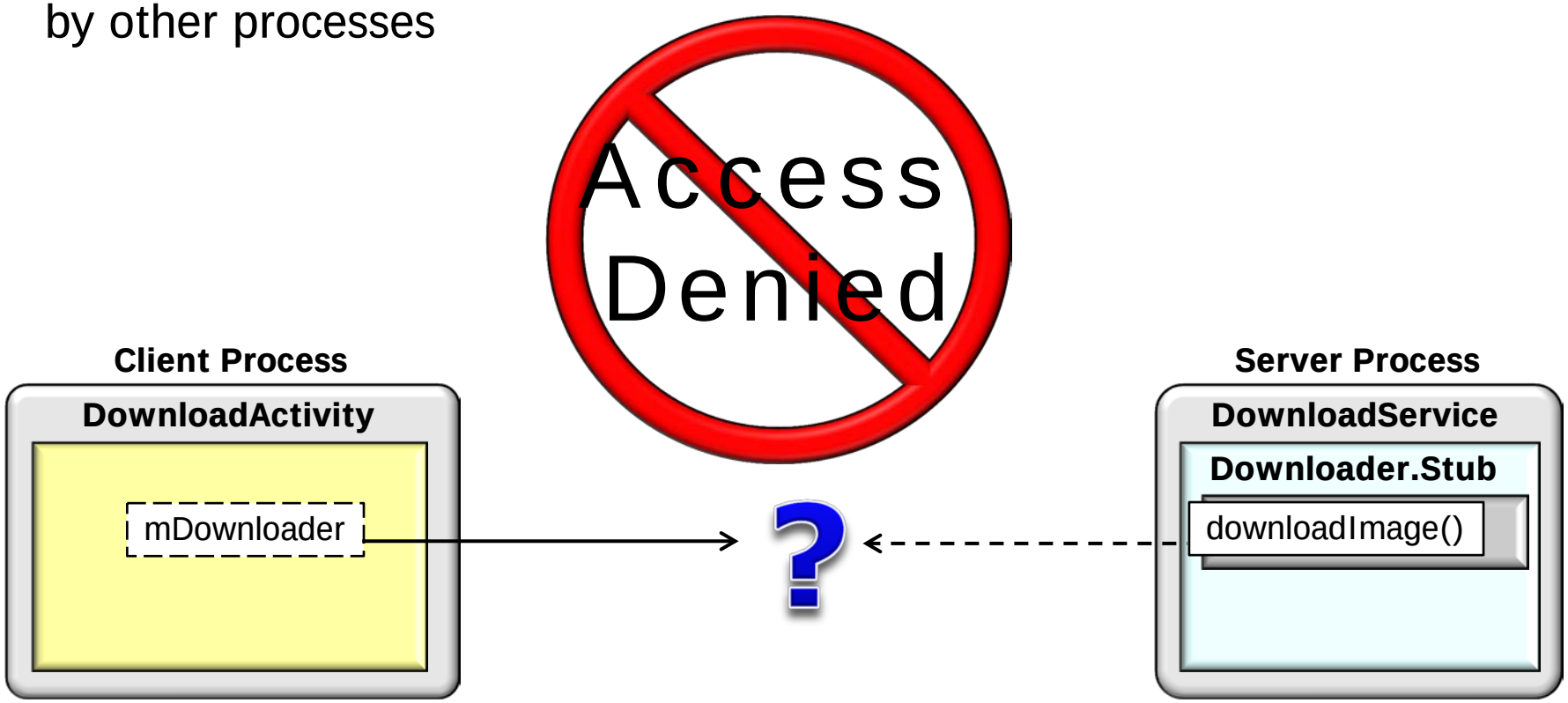
  - Processes are intentionally designed to protect their contents from access by other processes



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en.wikipedia.org/wiki/Process_(computing) has more info

Motivating the AIDL & Binder

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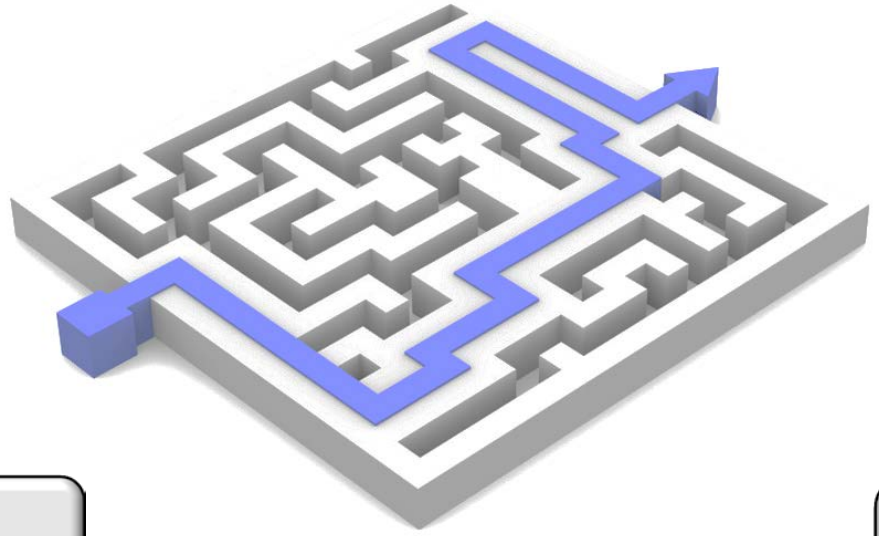

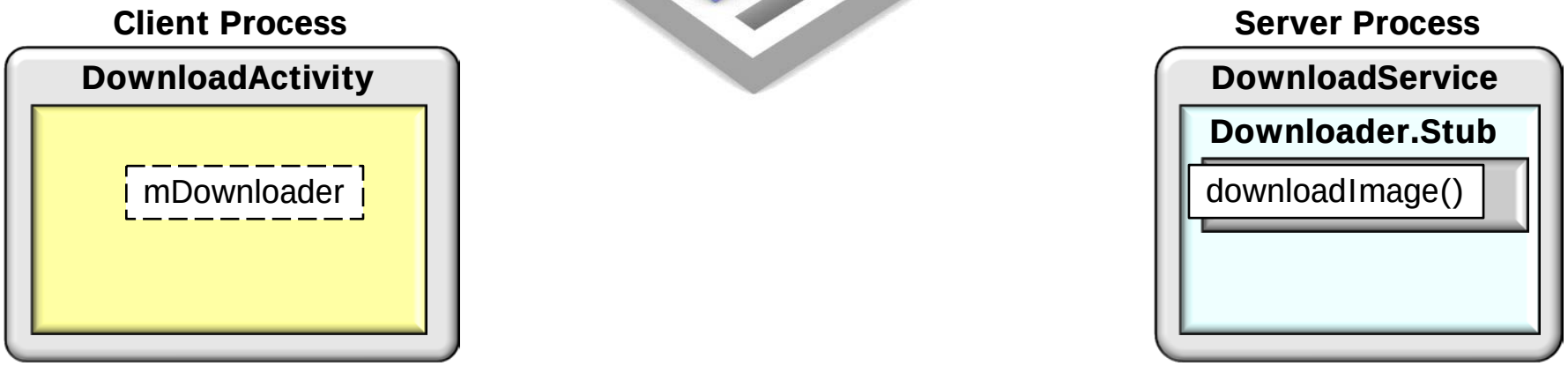

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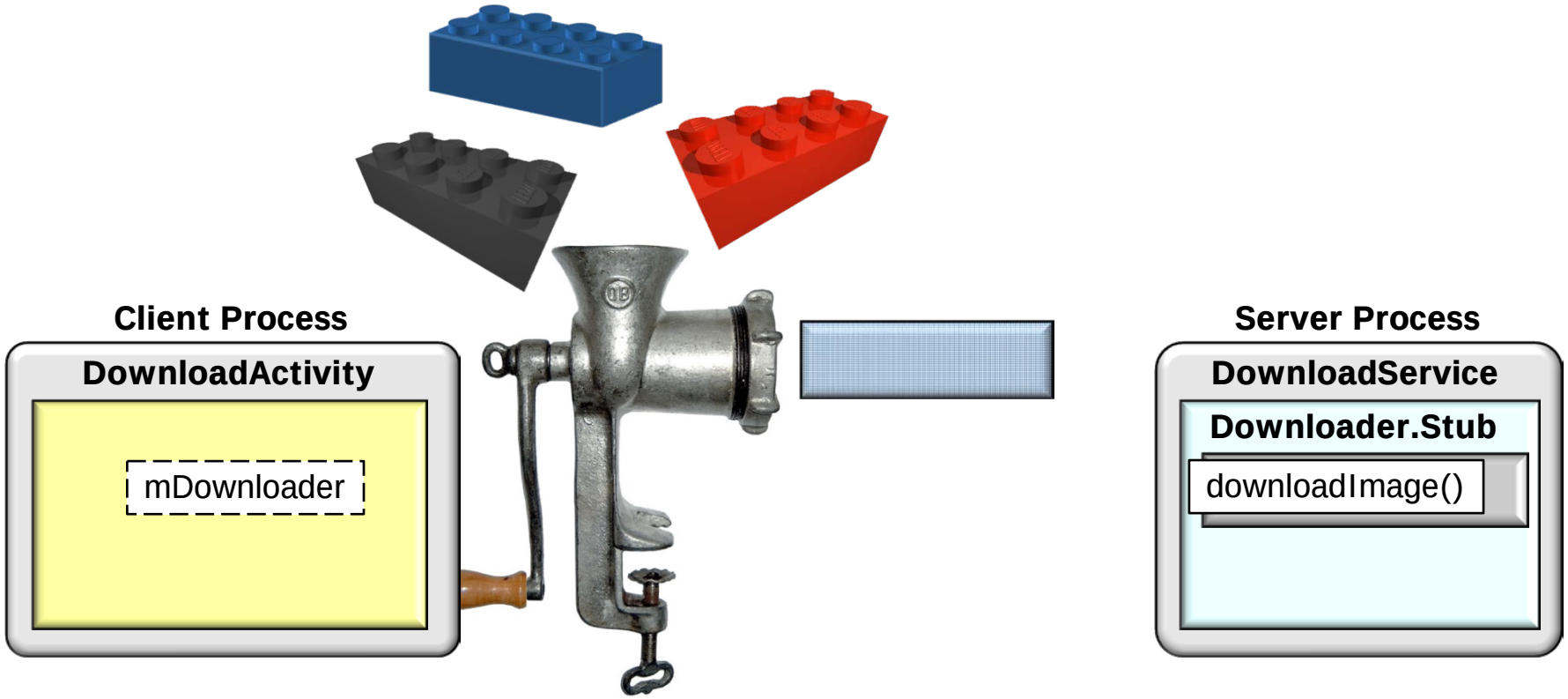
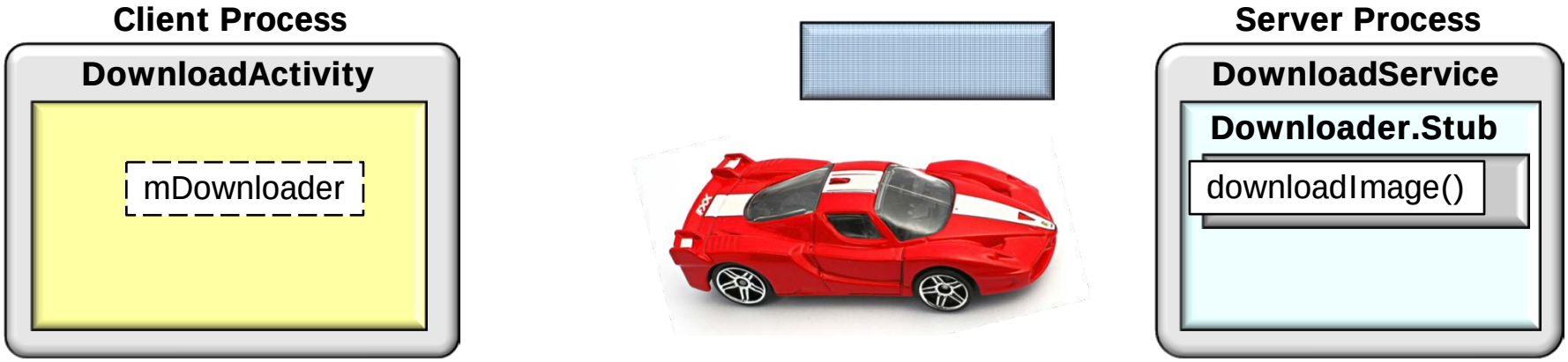


Motivating the AIDL & Binder

- Services may need to run in different processes than their clients
- Activities that communicate with objects in Services residing in other processes must perform additional steps
  - Decompose & transform objects into bytestreams that Linux understands
  - Exchange these byte streams via the Linux IPC mechanisms



Motivating the AIDL & Binder

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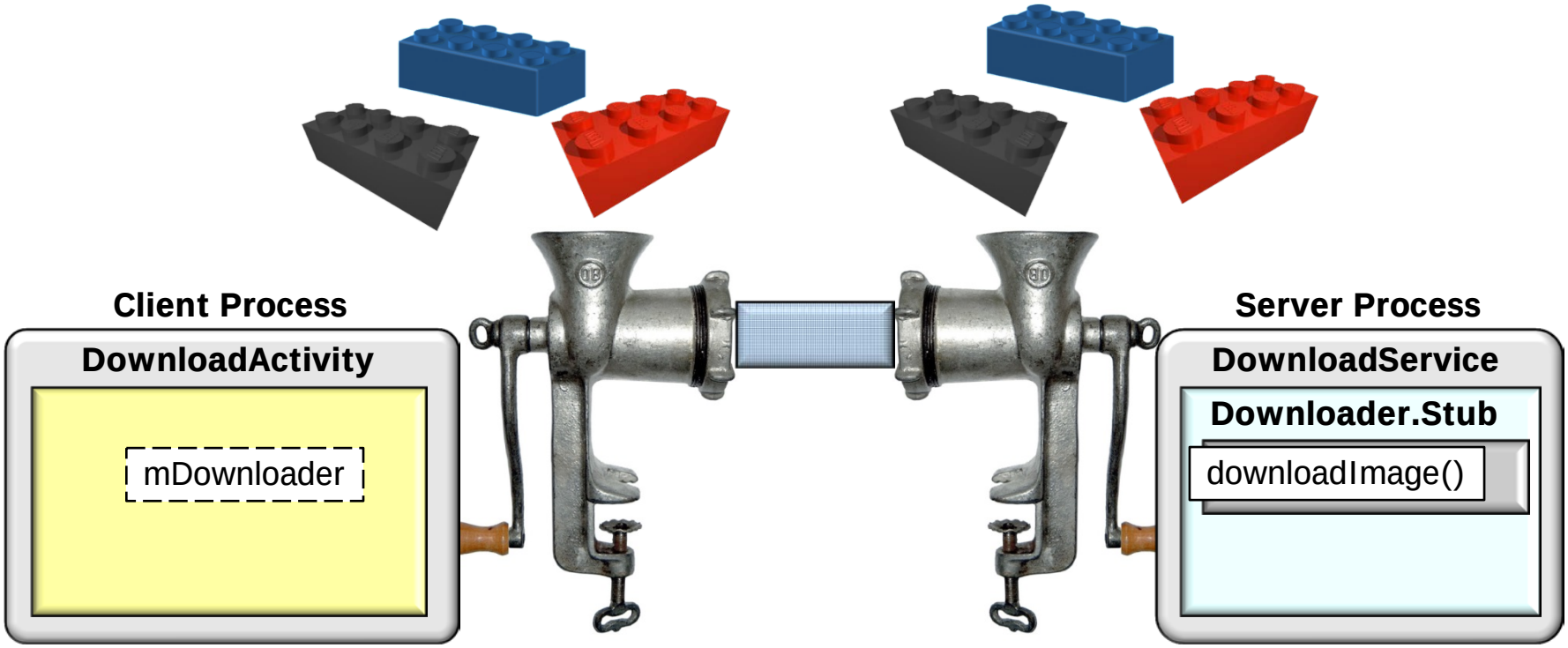

en.wikipedia.org/wiki/Marshalling_(computer_science) has more info

Motivating the AIDL & Binder

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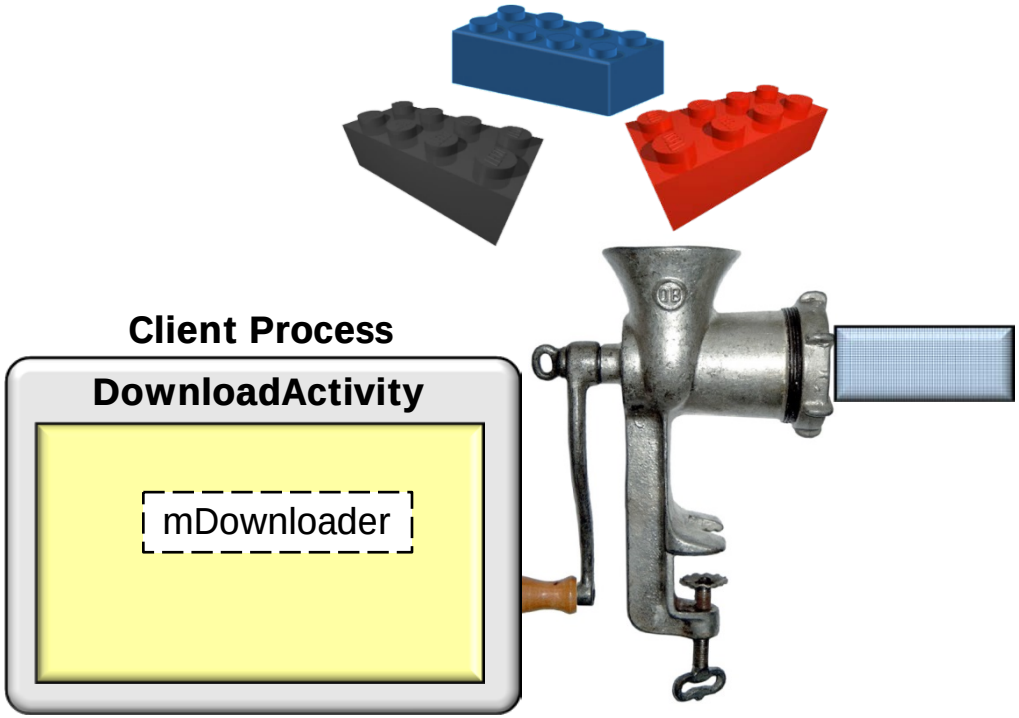

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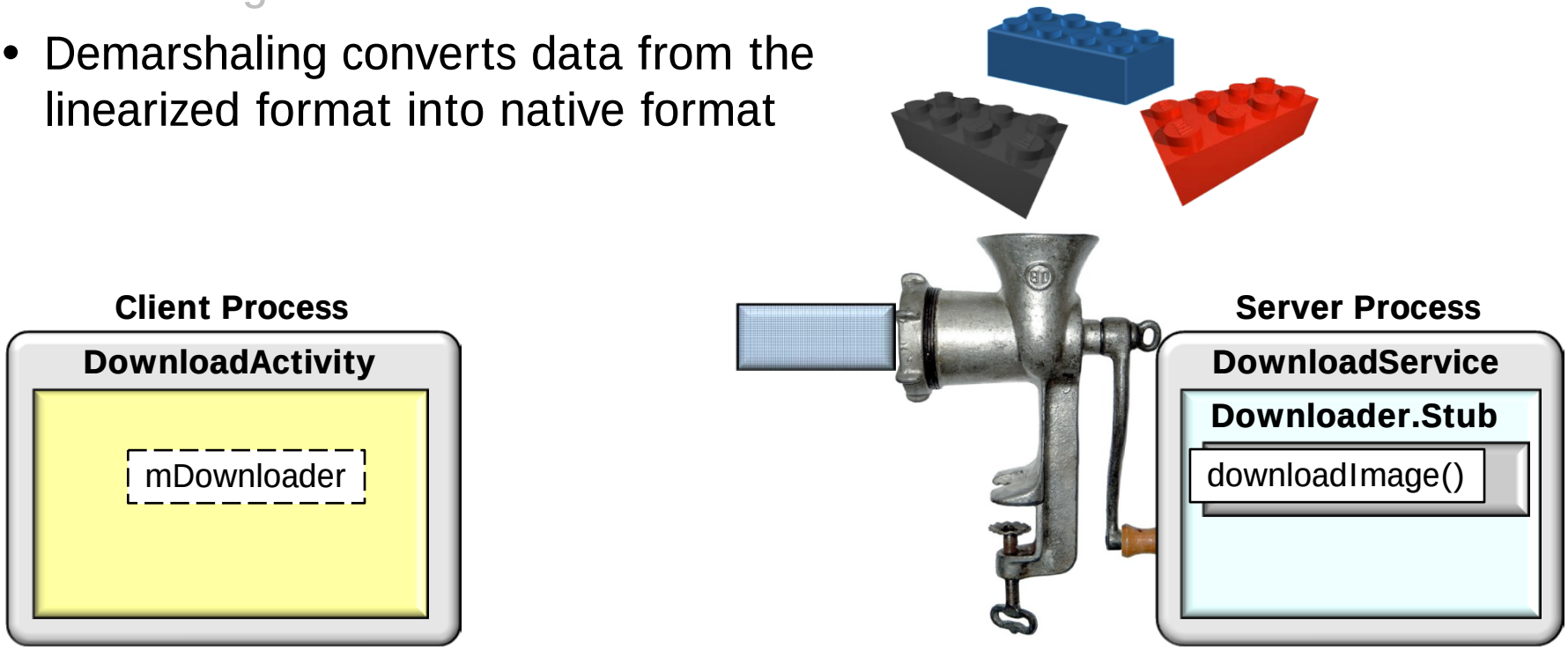

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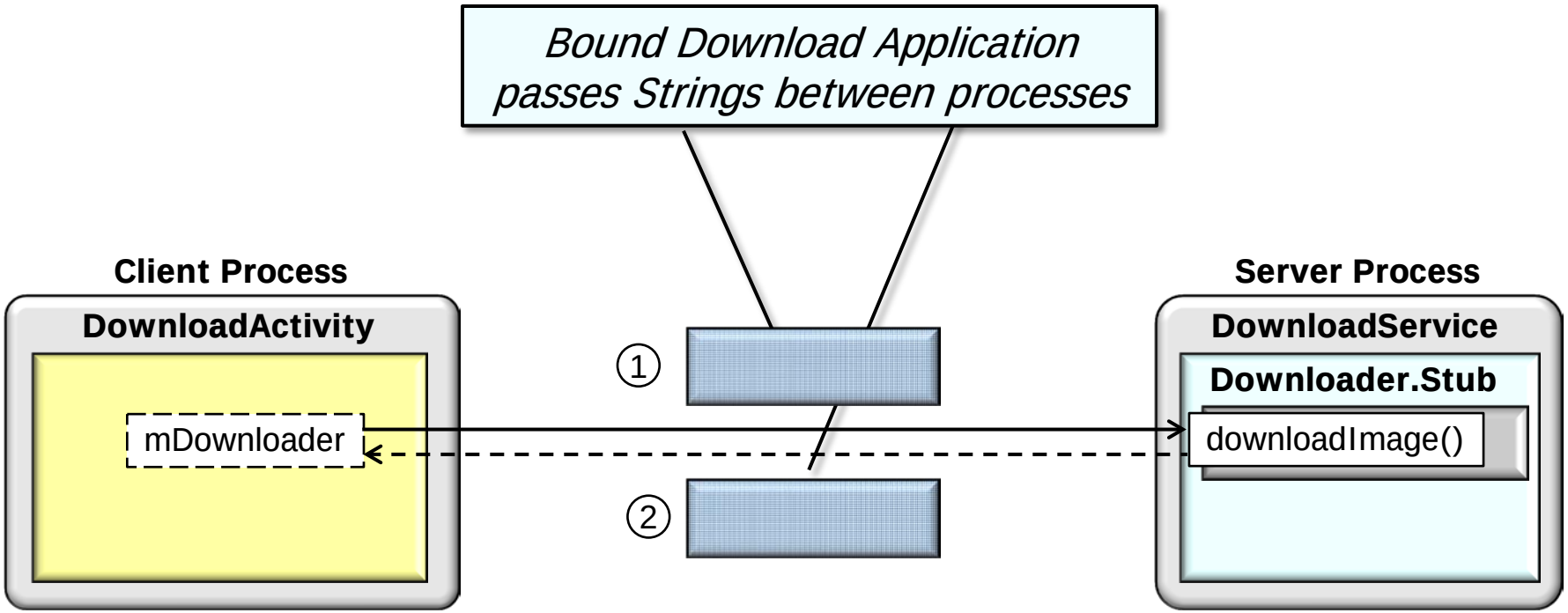

AIDL & Binder support marshaling & demarshaling of a wide range of data types

Motivating the AIDL & Binder (Part 2)

Motivating the AIDL & Binder

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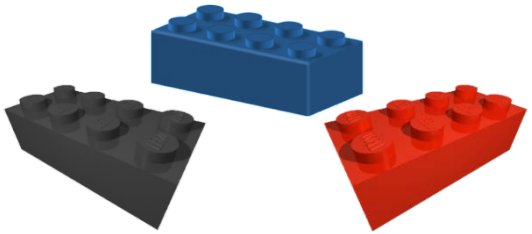

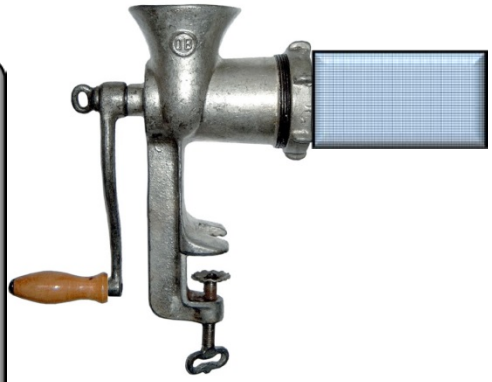

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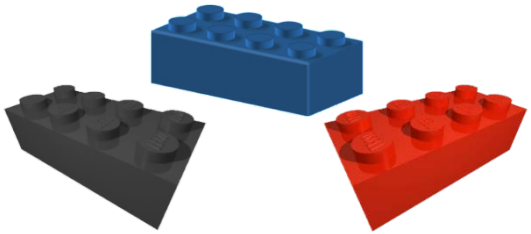

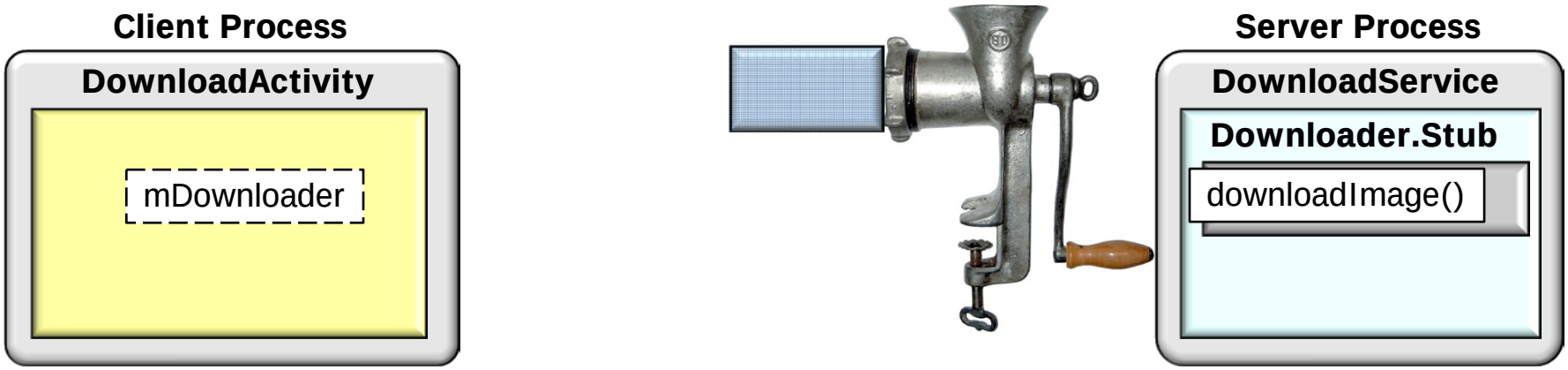

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developer.android.com/guide/components/aidl.html has AIDL overview

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  - AIDL is similar to Java interfaces

class.coursera.org/android-001/lecture/85 has more info on AIDL

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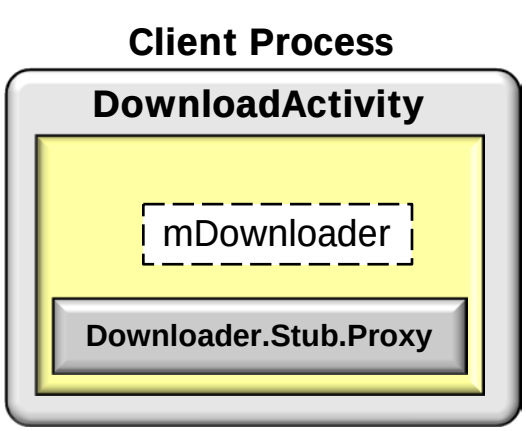


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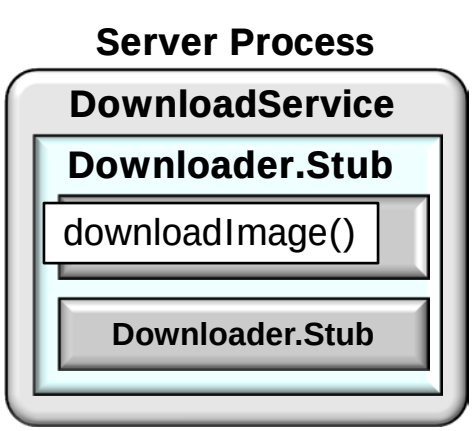

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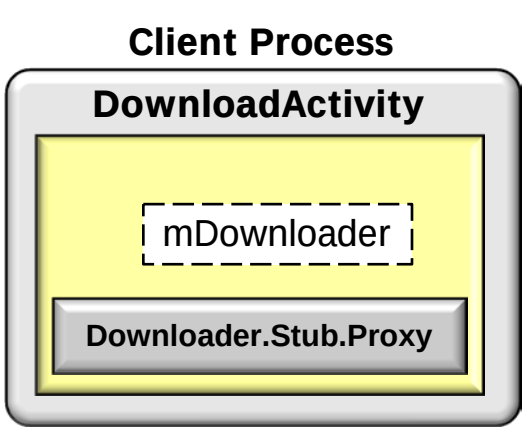


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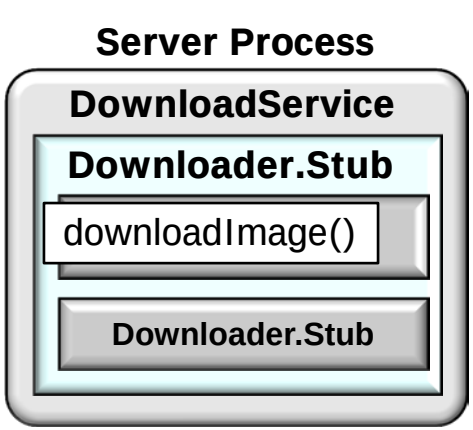

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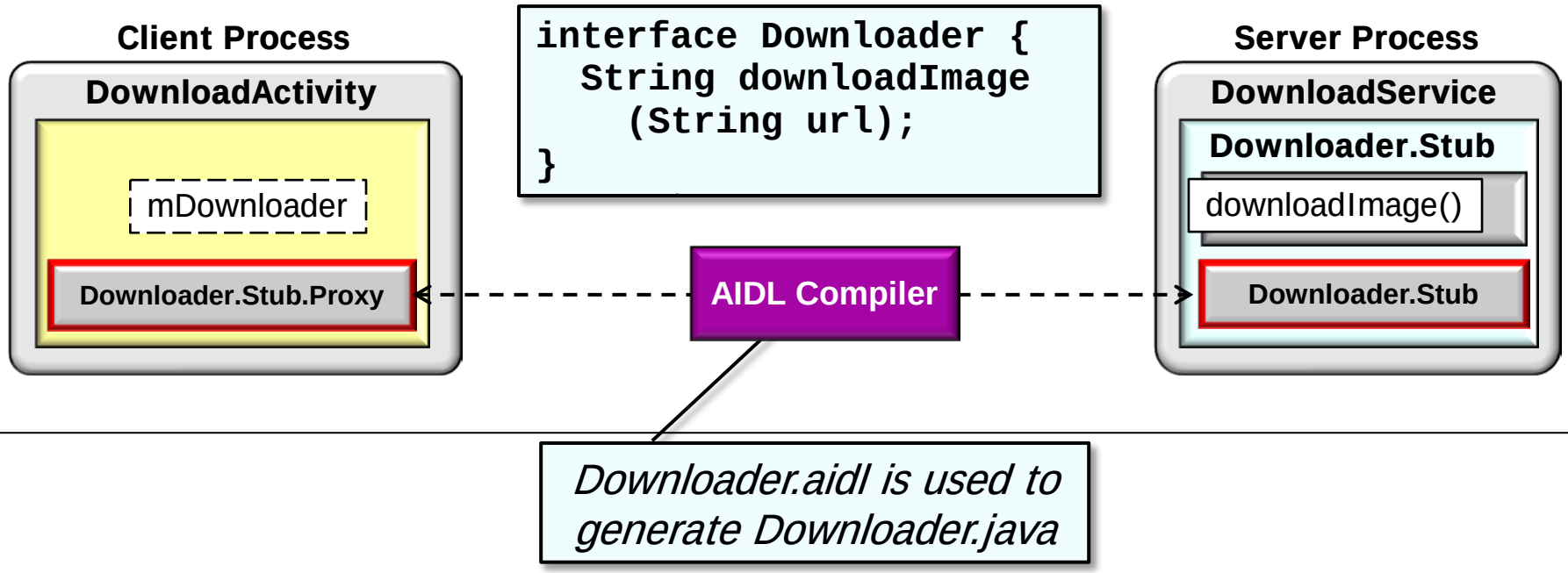
  - Compilation is handled automatically by Eclipse



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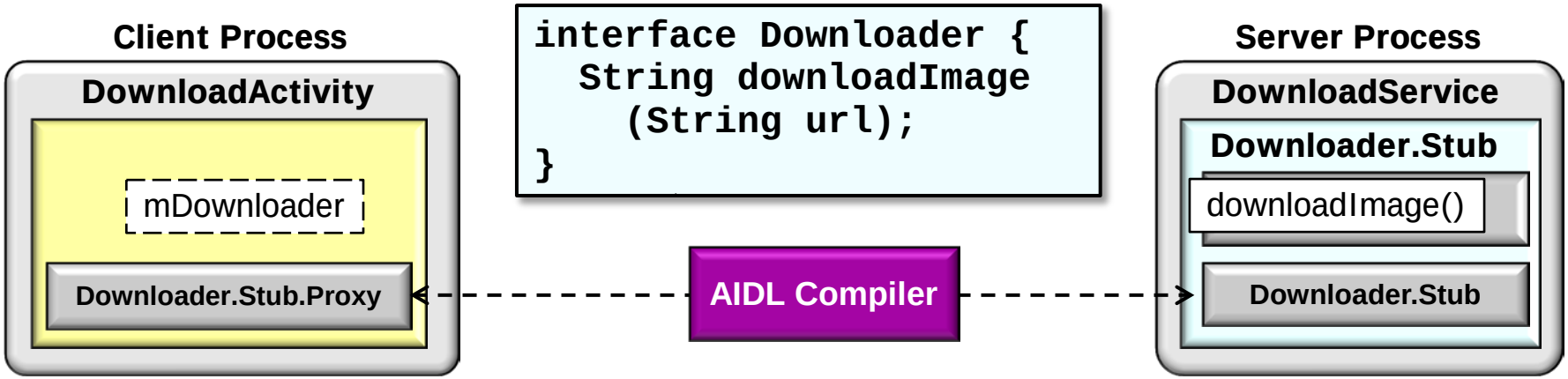

See developer.android.com/guide/components/aidl.html#Defining

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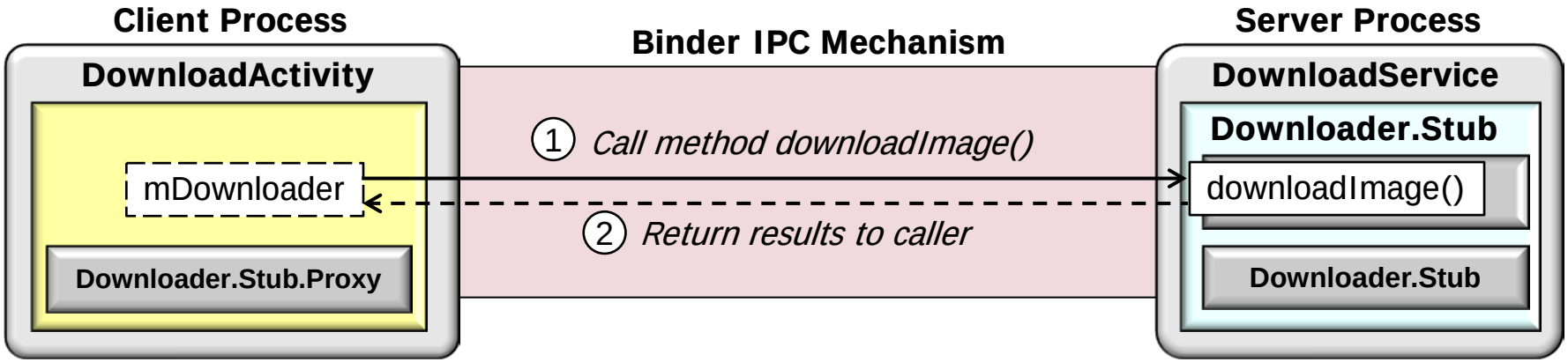

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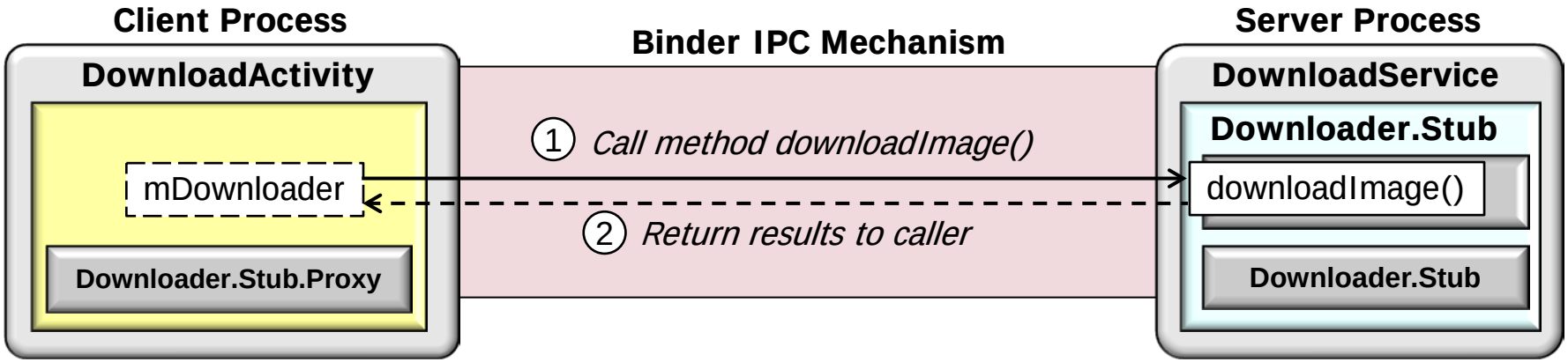
  - Apps rarely access the Binder directly, but instead use AIDL Stubs & Proxies



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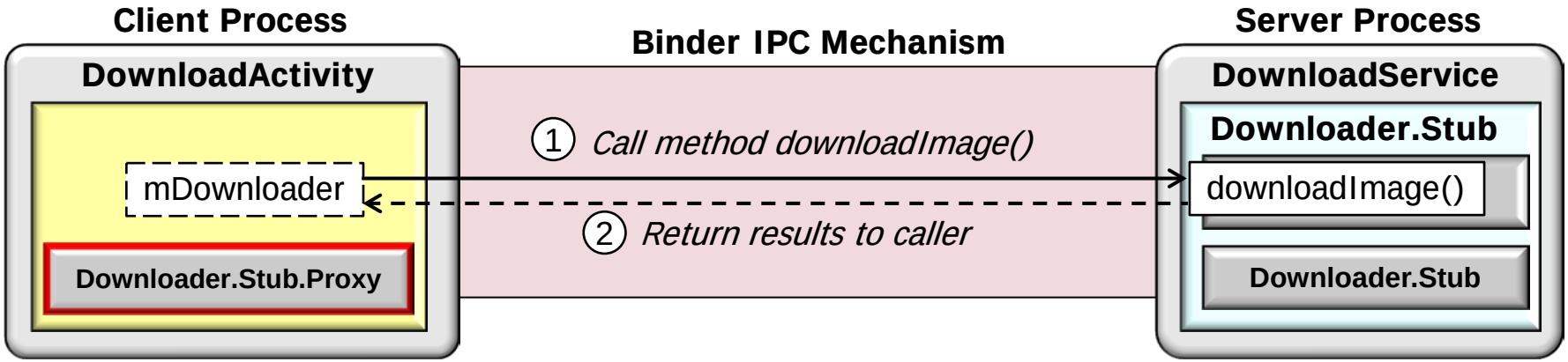

Motivating the AIDL & Binder

- Services may need to run in different processes than their clients
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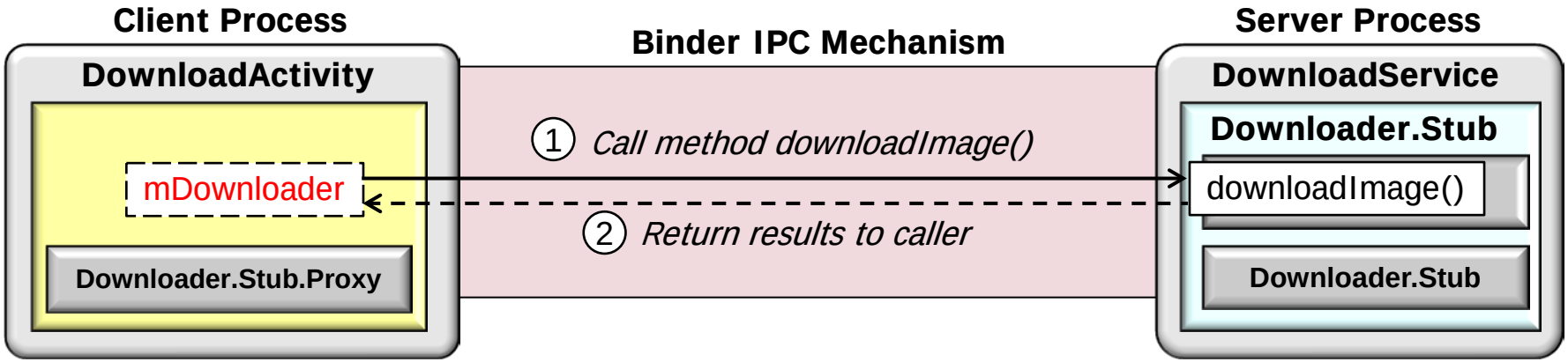

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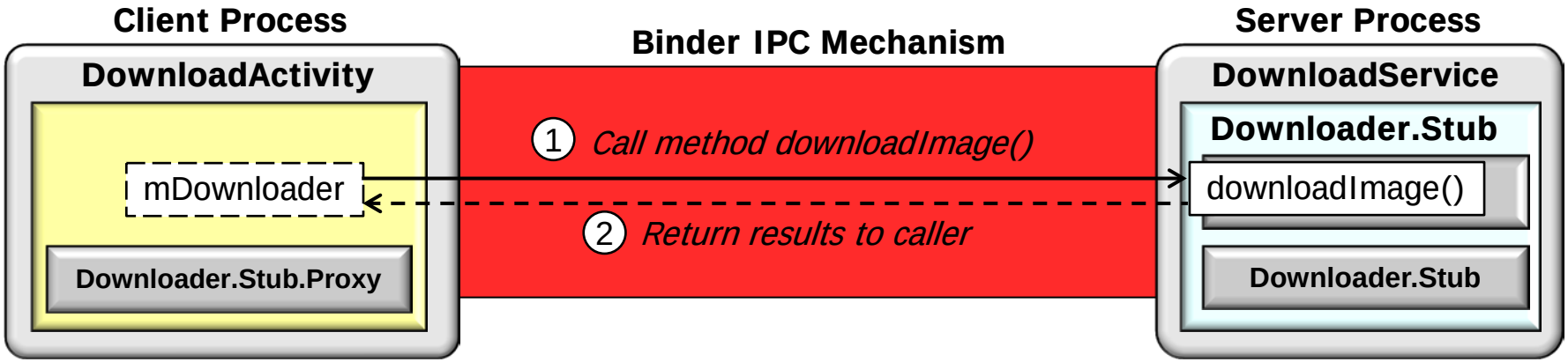

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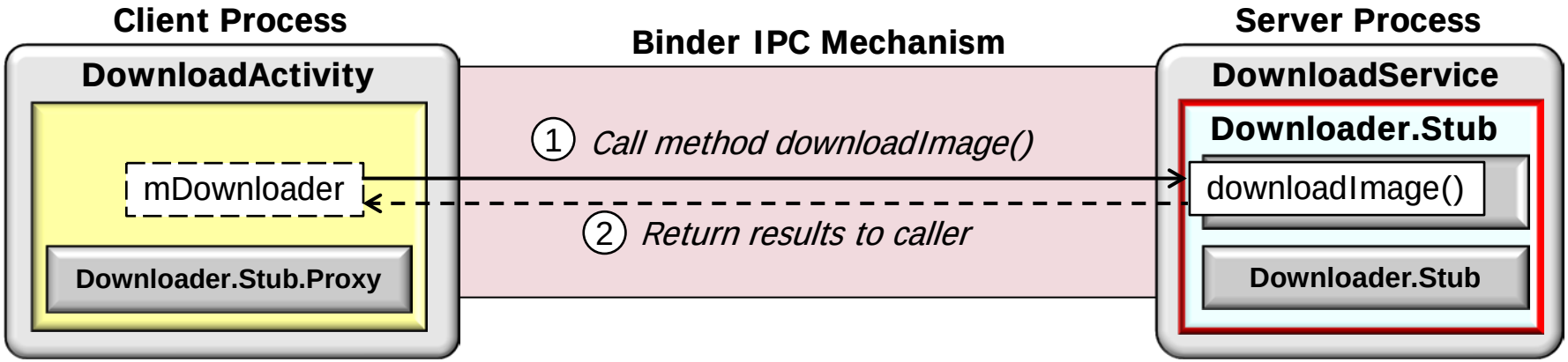

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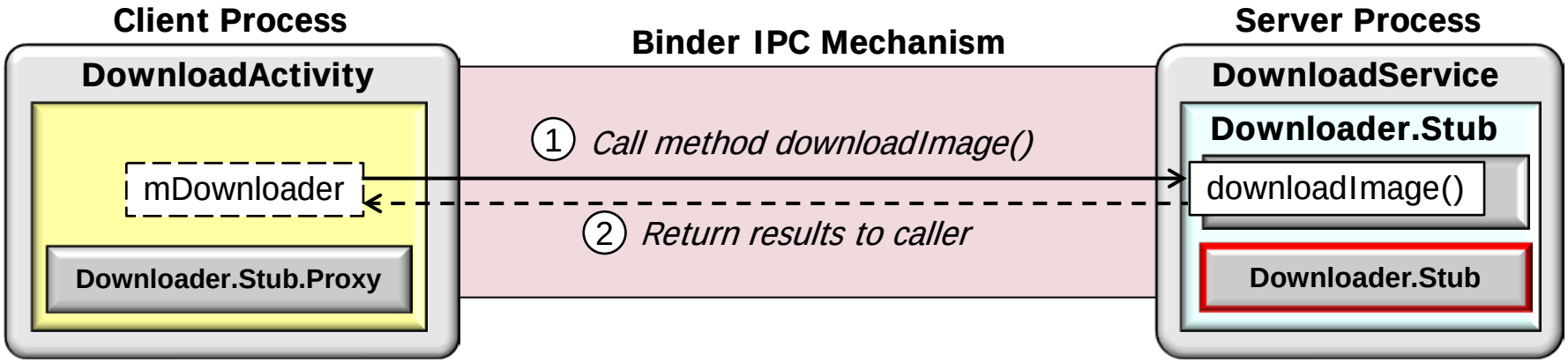

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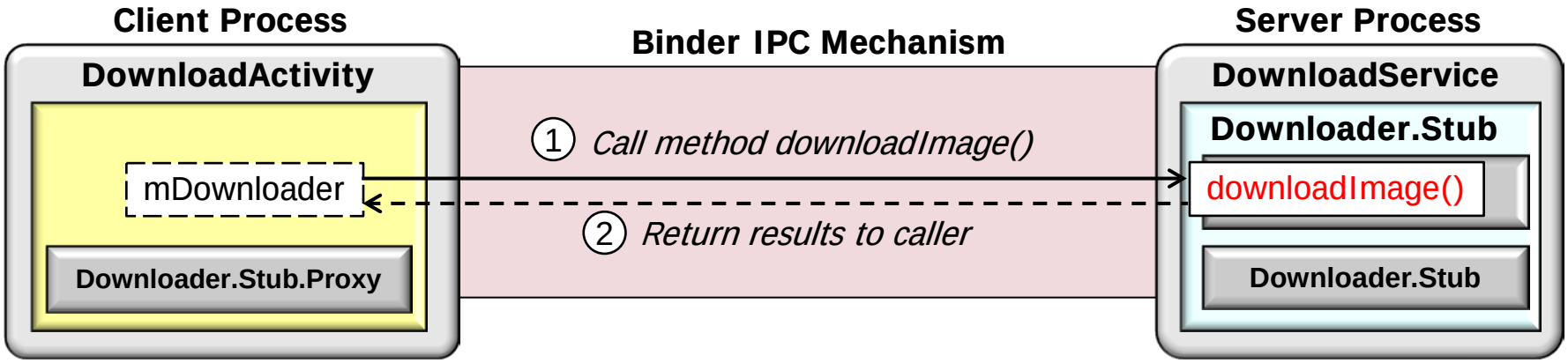

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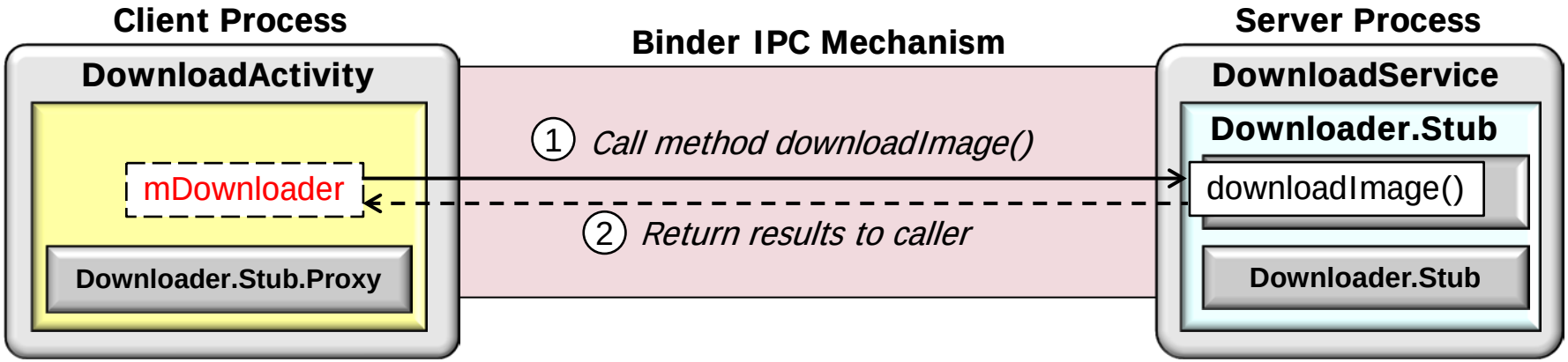

Overview of Android Binder & AIDL (Part 1)

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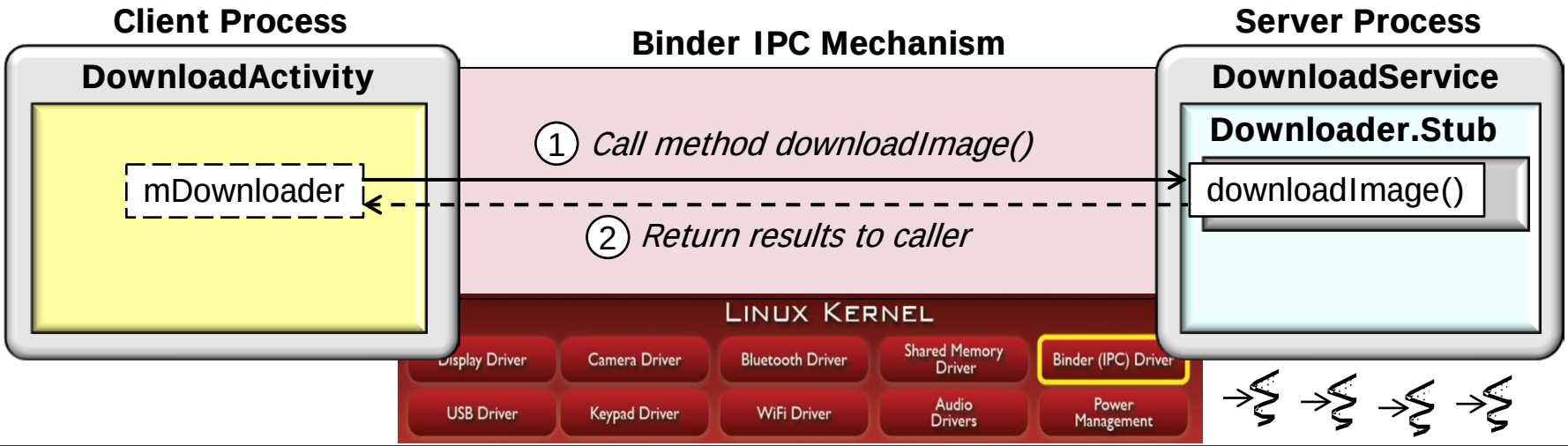

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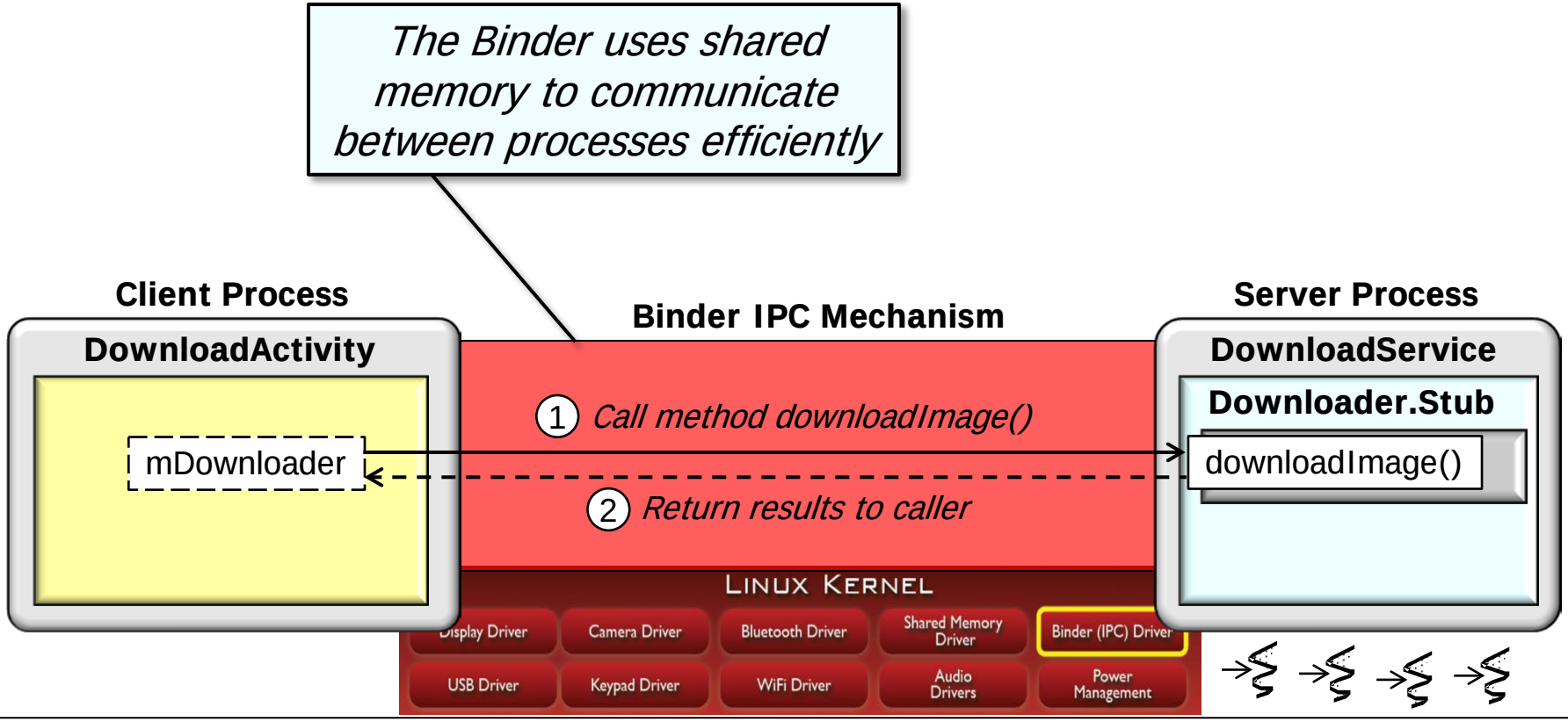

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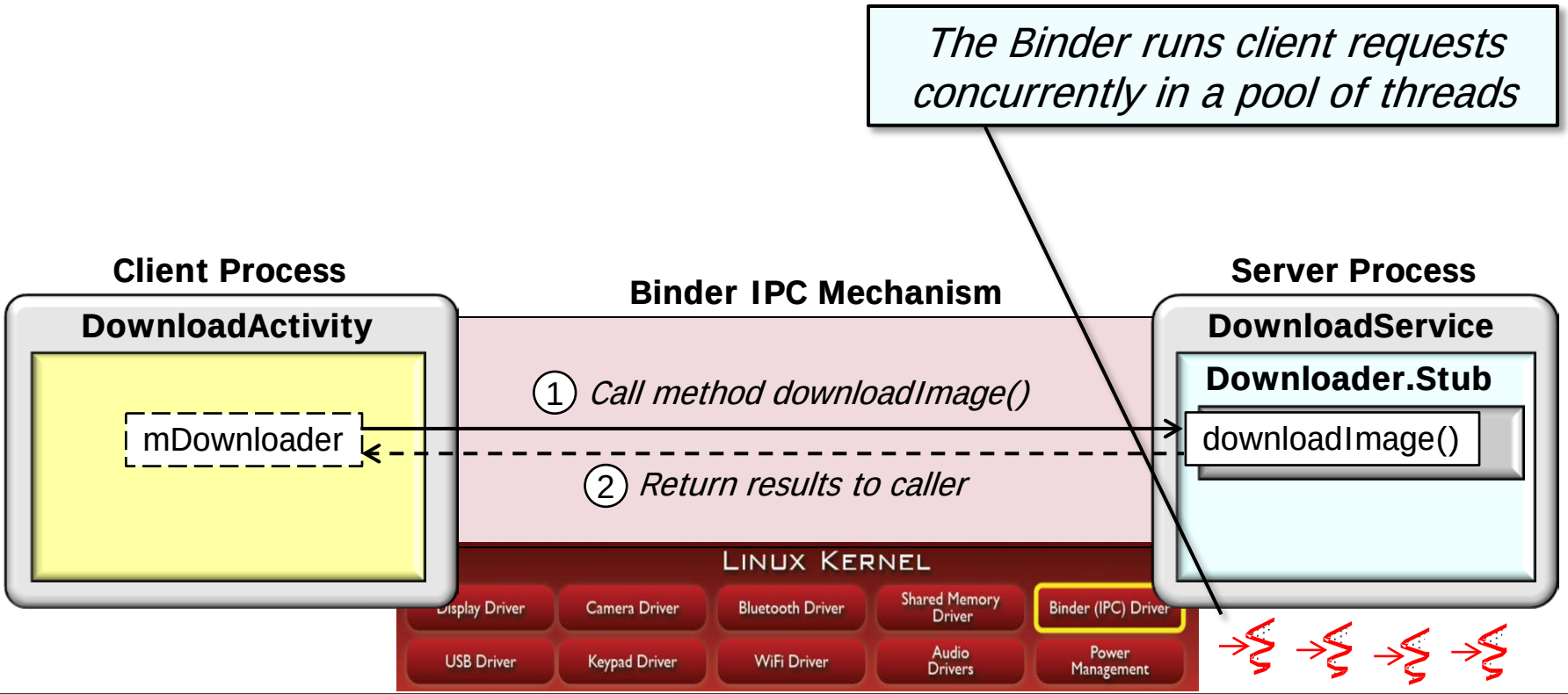

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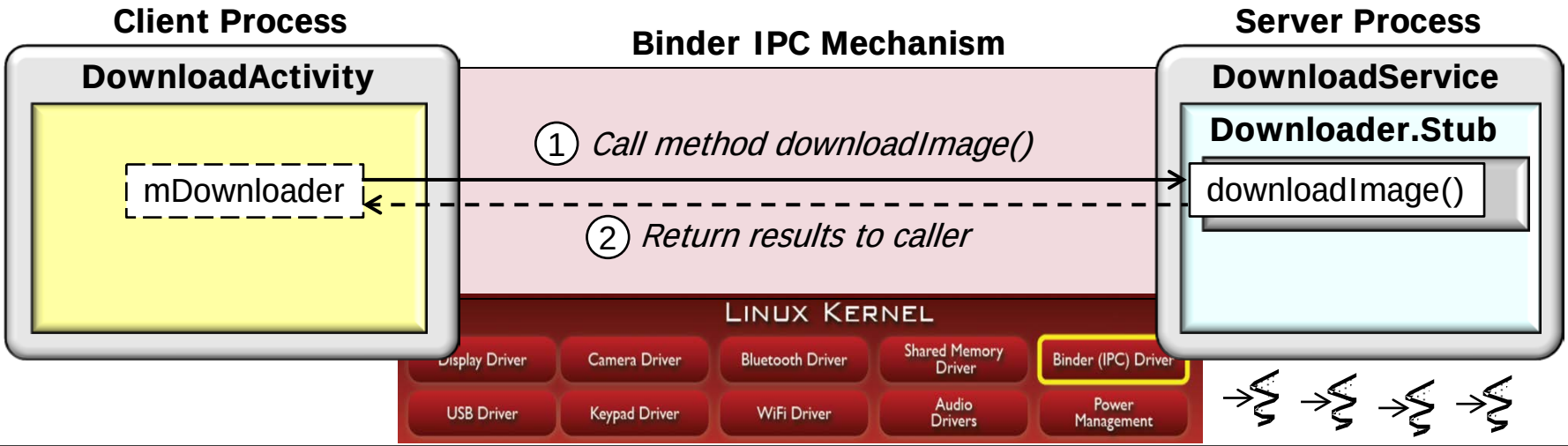

elinux.org/Android_Binder has more info on Android Binder

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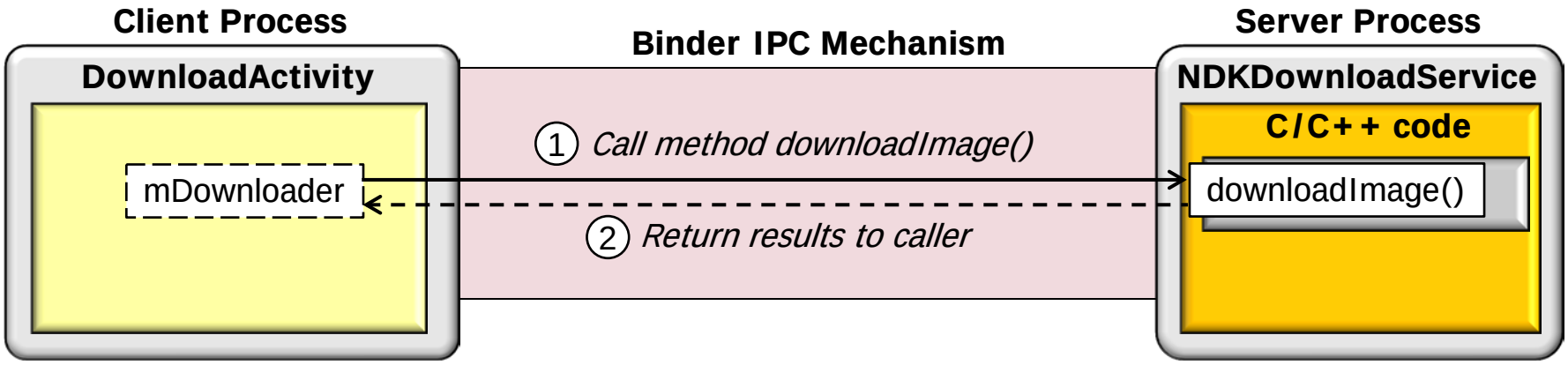

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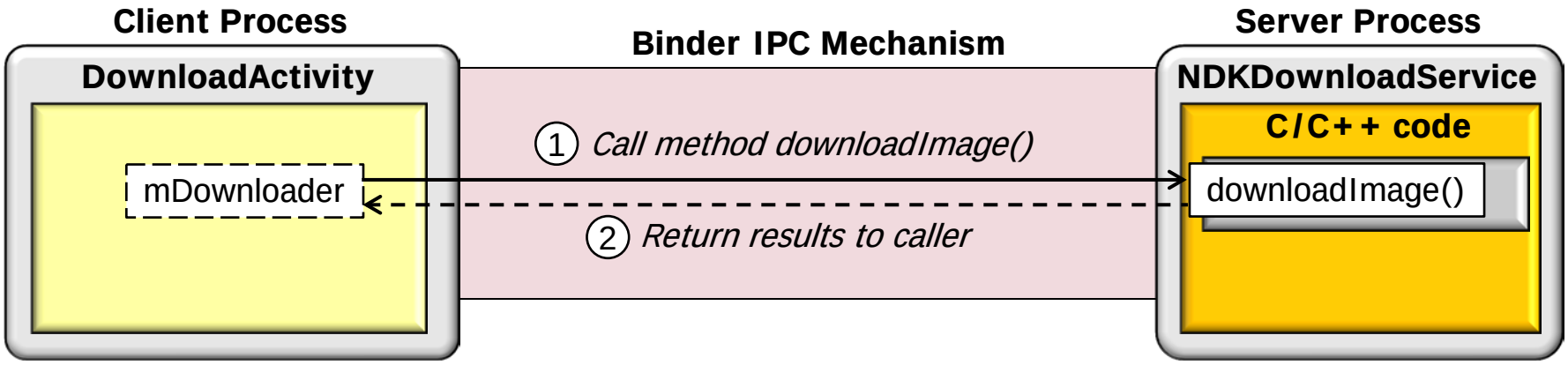

sites.google.com/site/io/anatomy—physiology-of-an-android has more info

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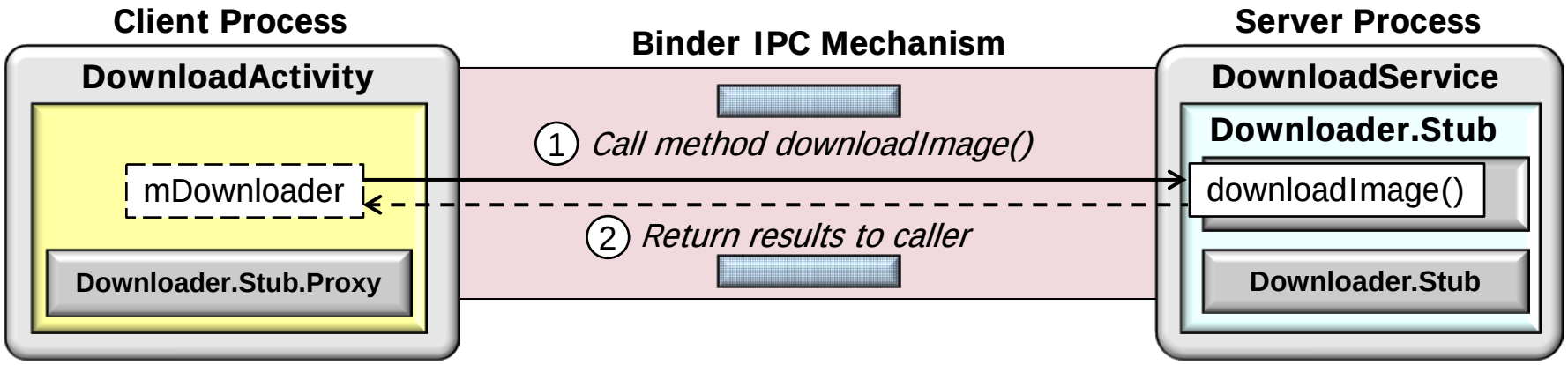

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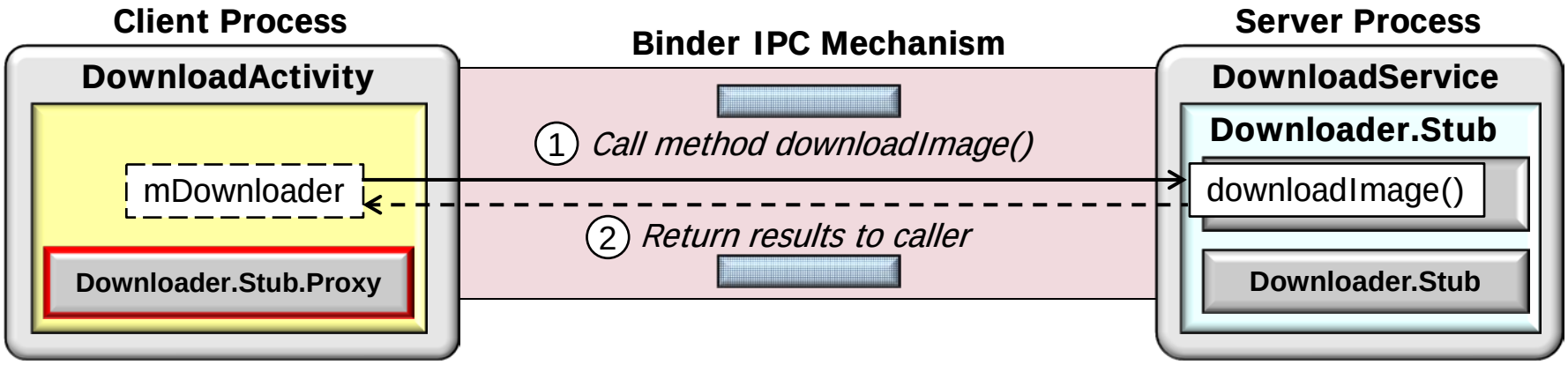

developer.android.com/reference/android/os/Parcel.html has more info

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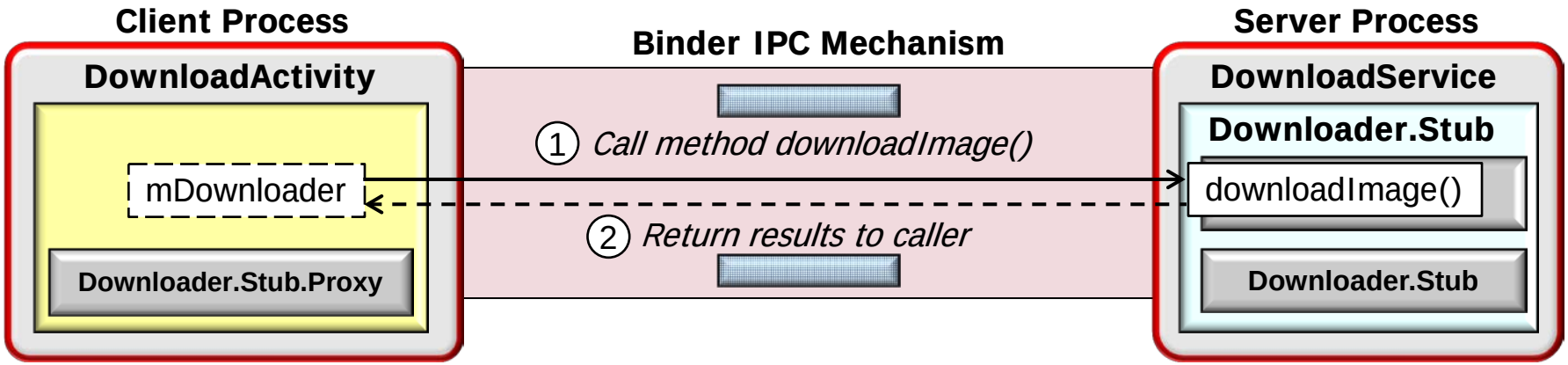

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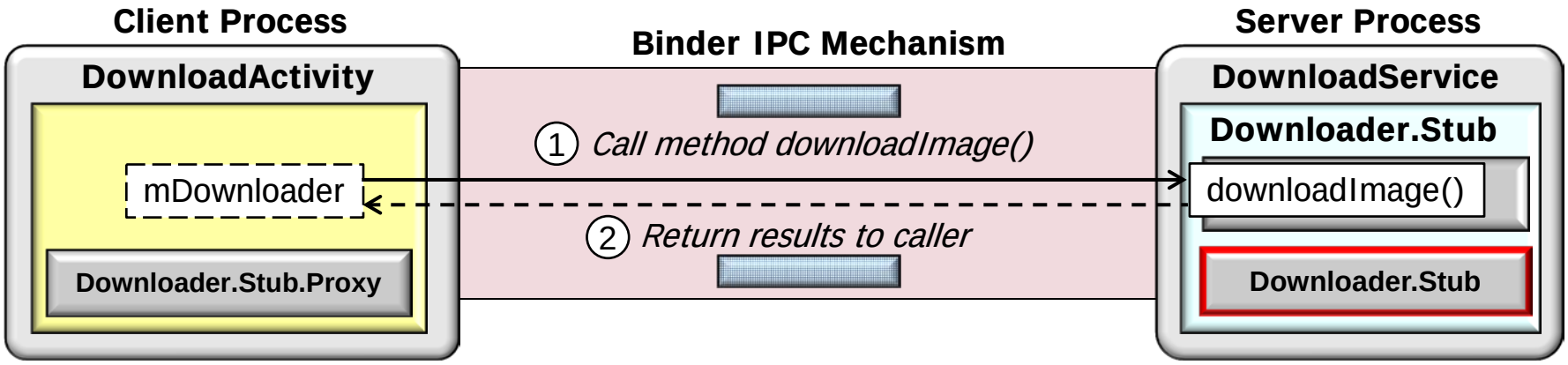

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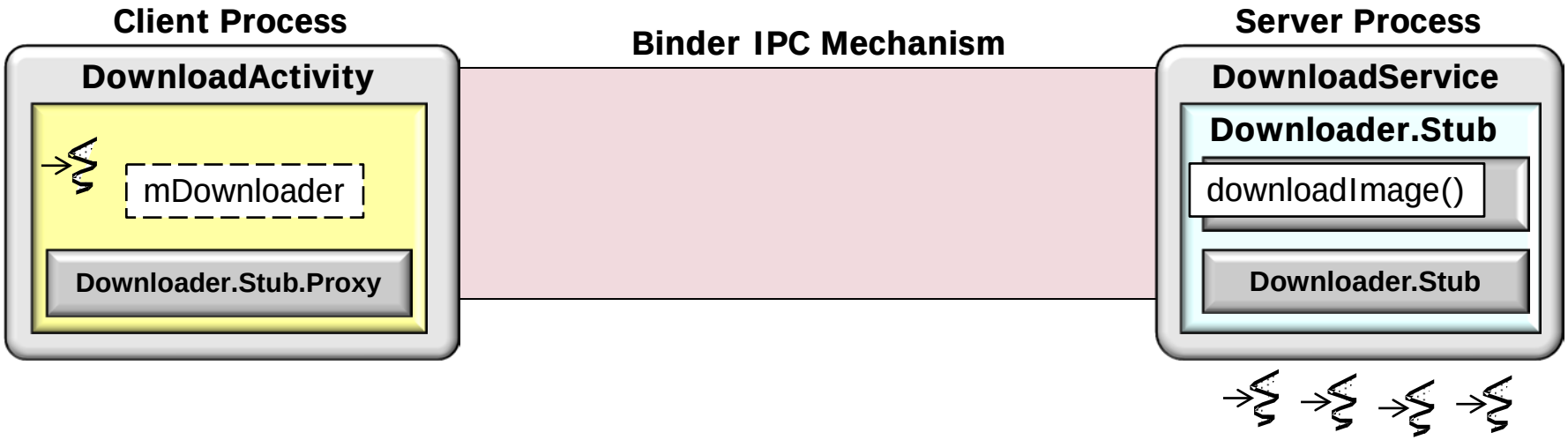

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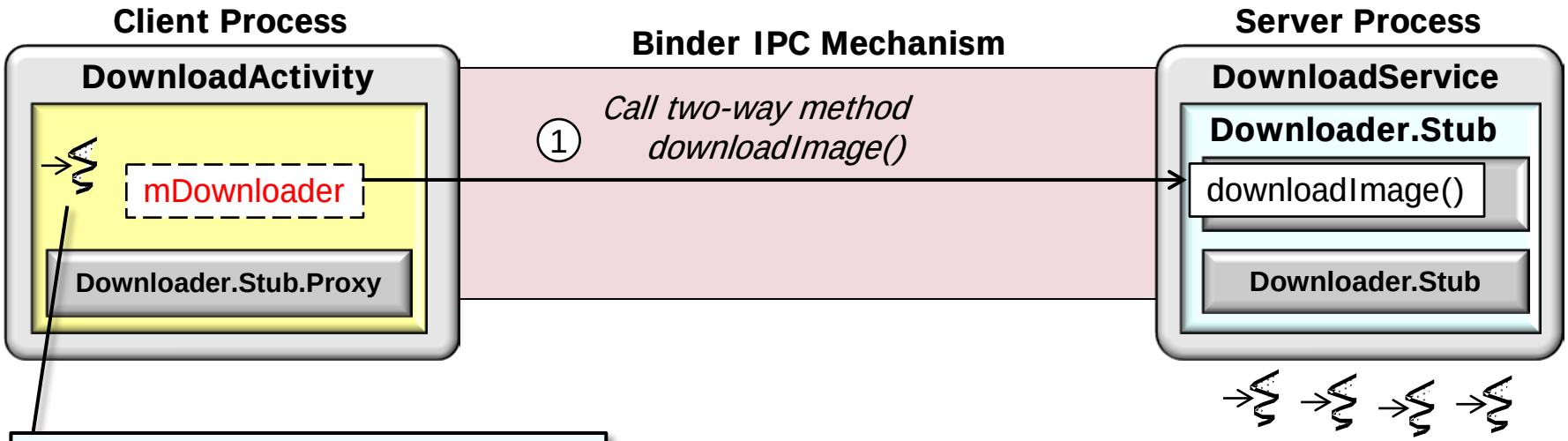

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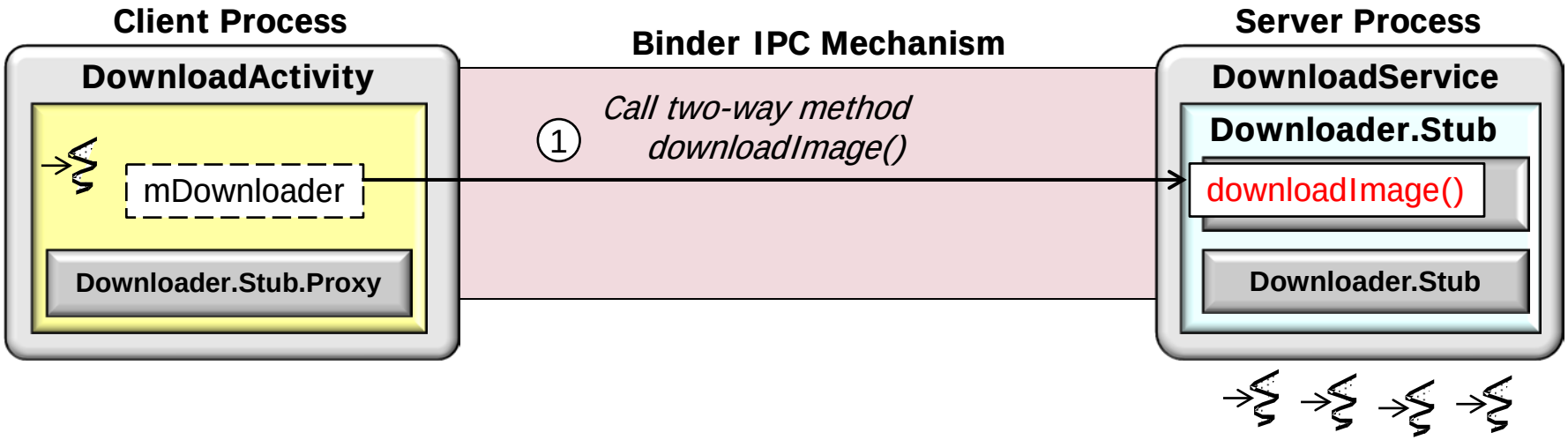

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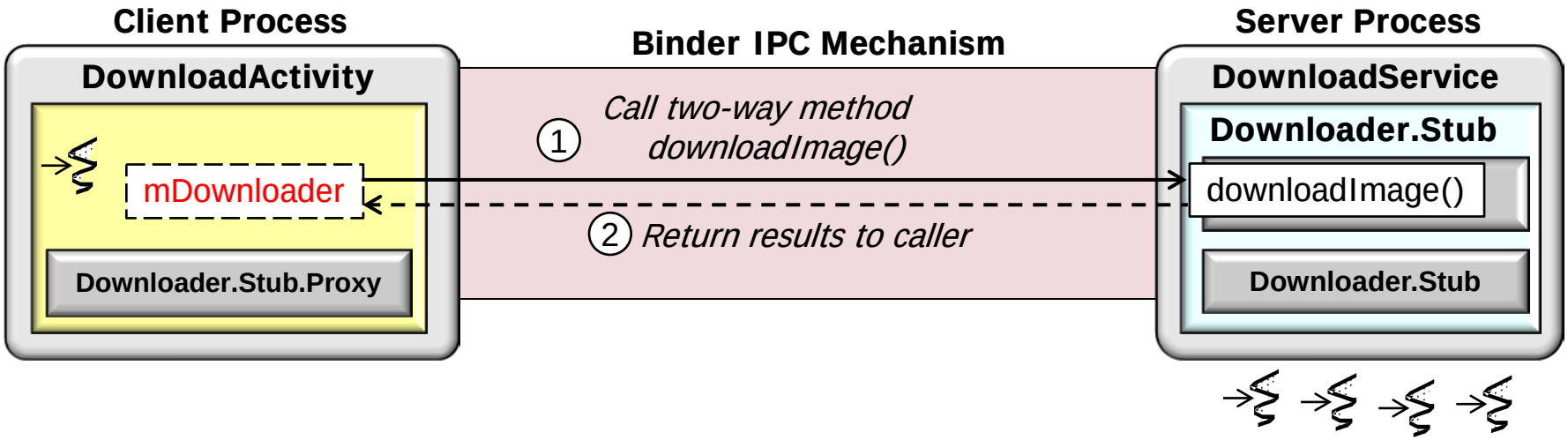

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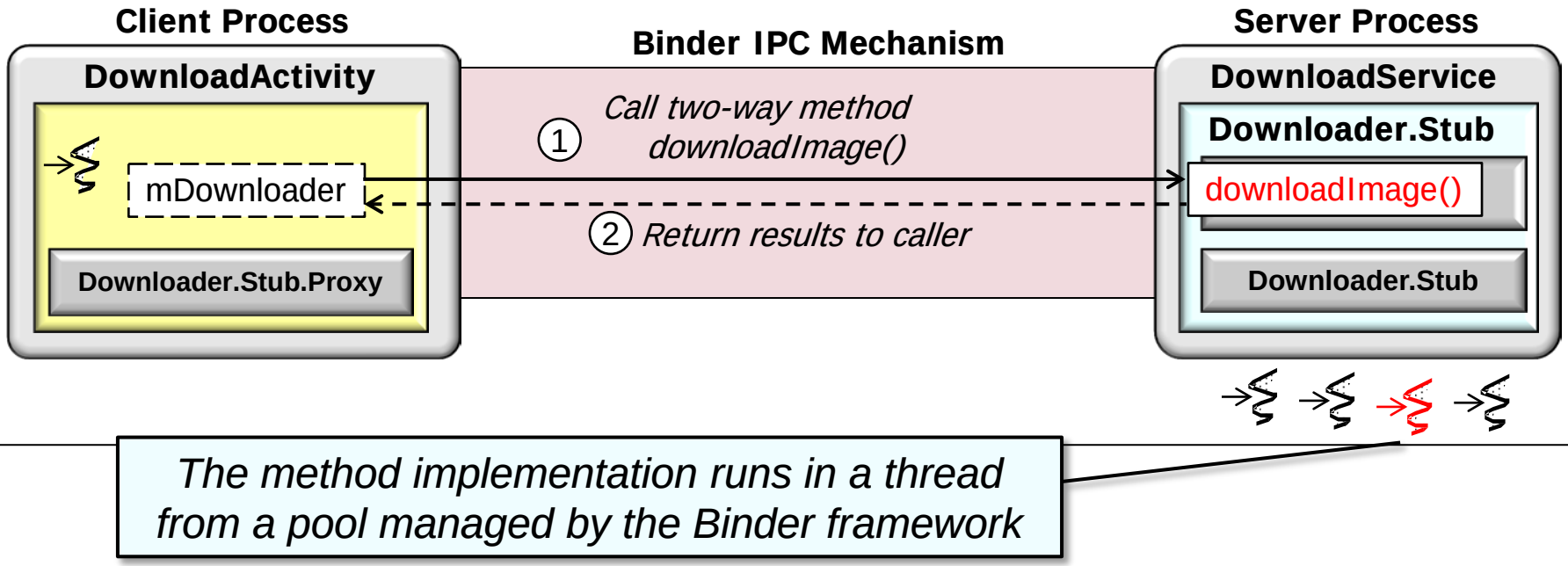

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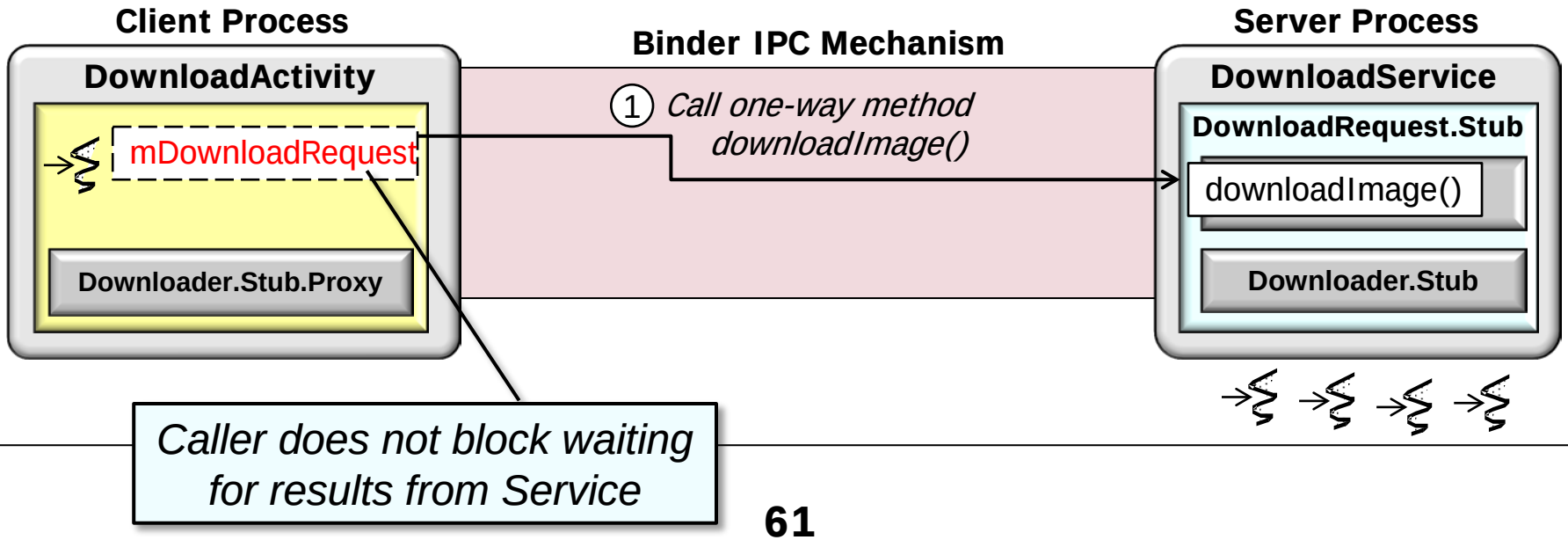

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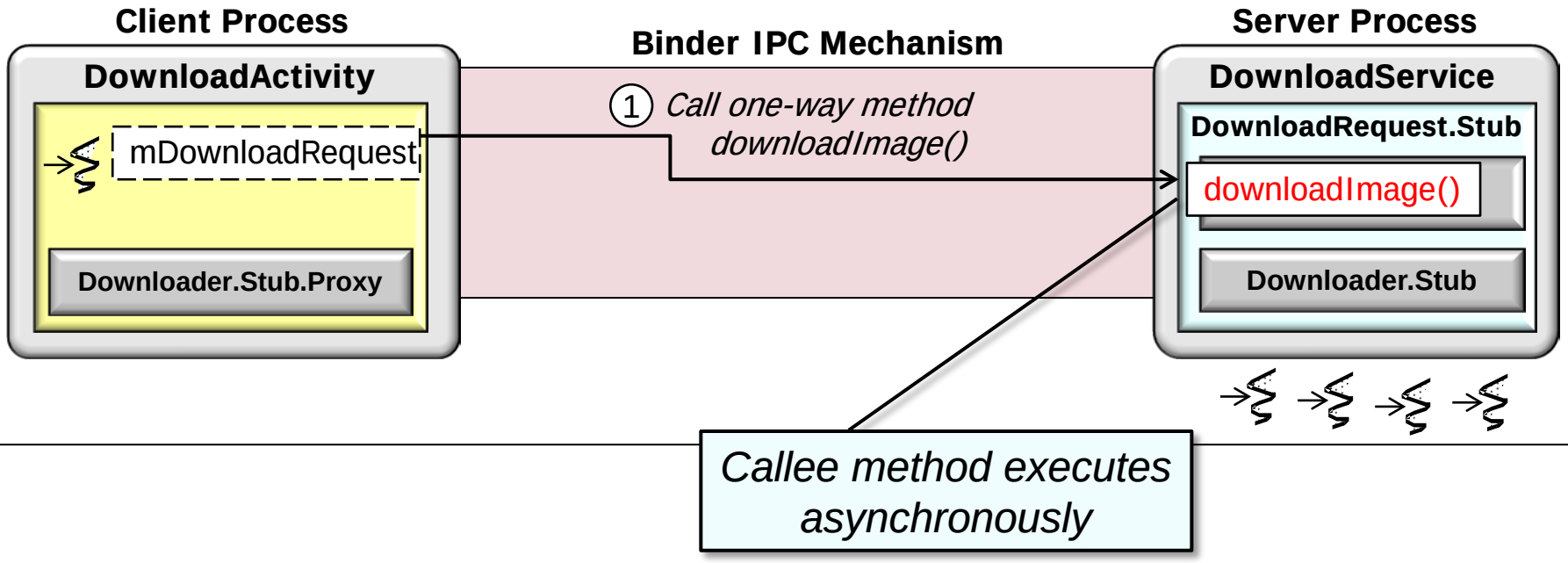

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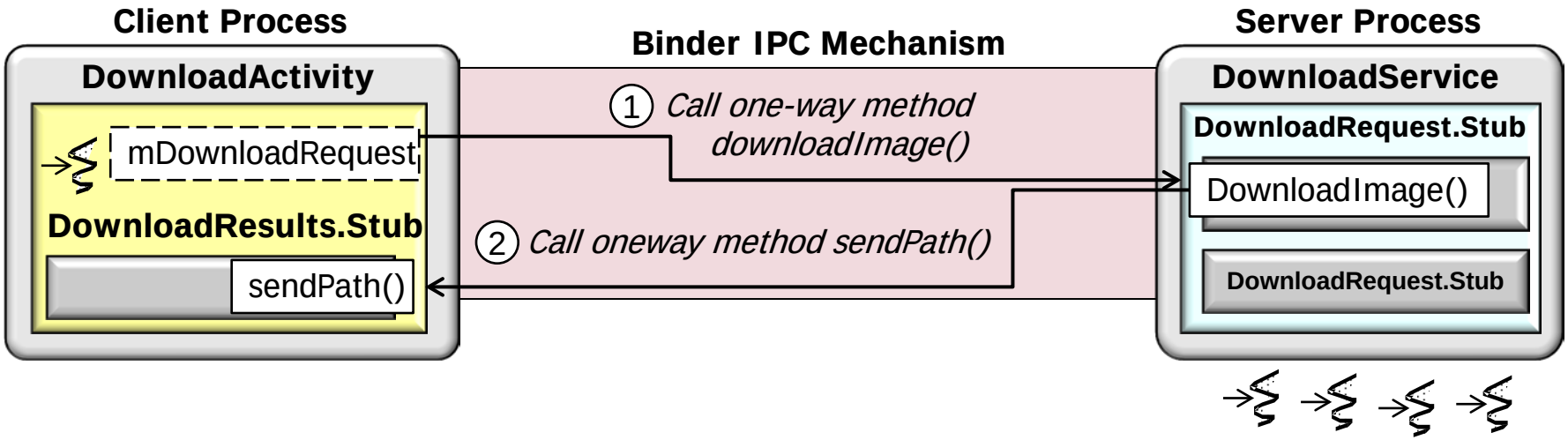

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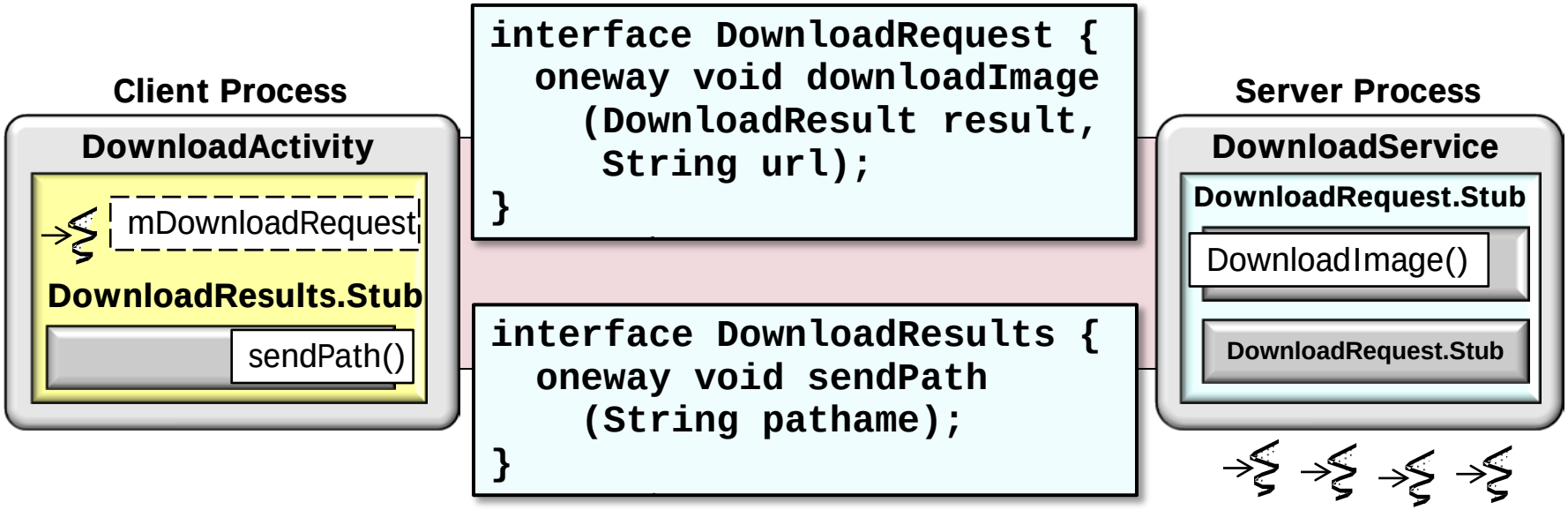

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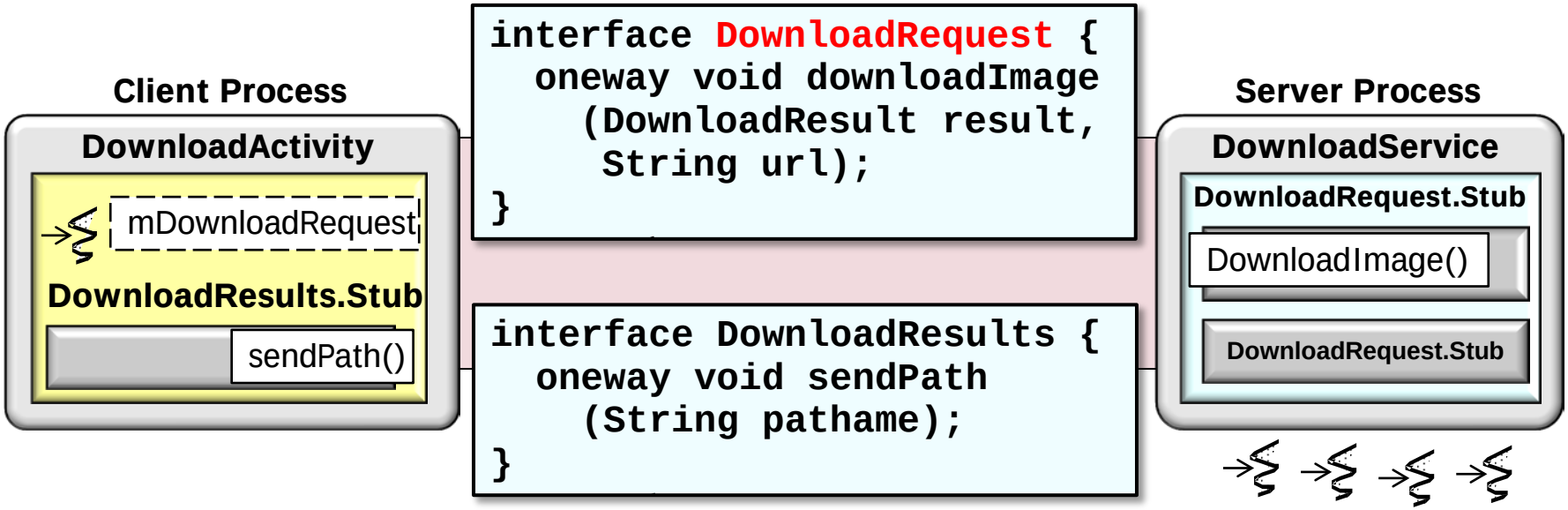

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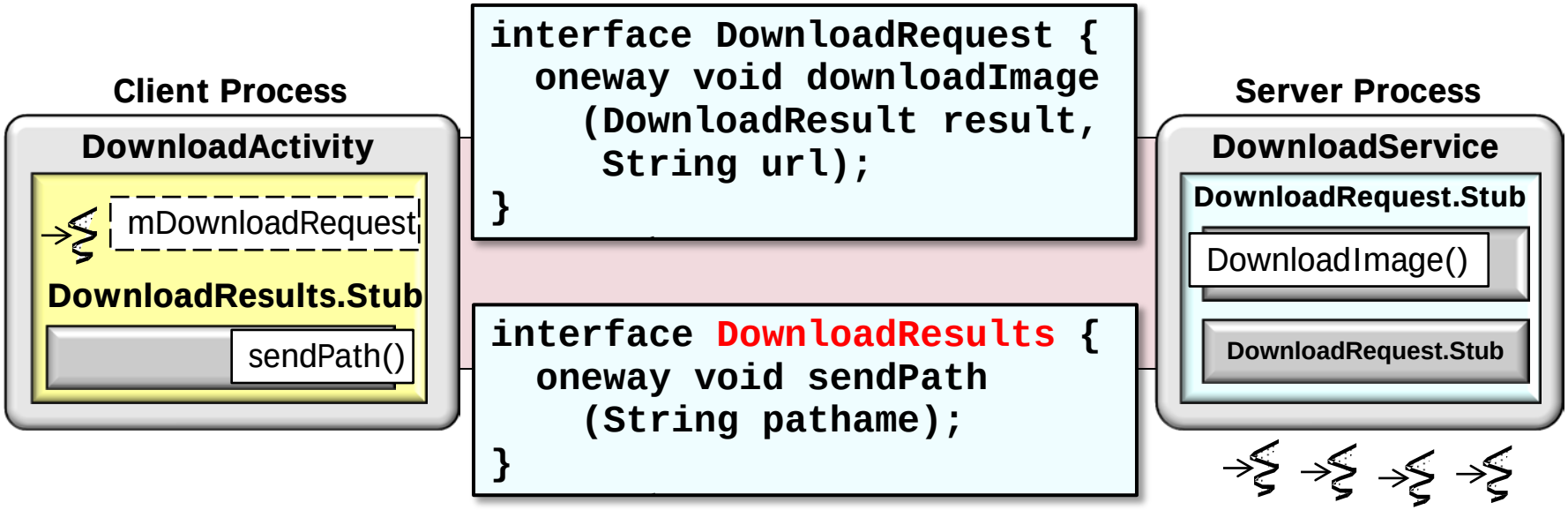

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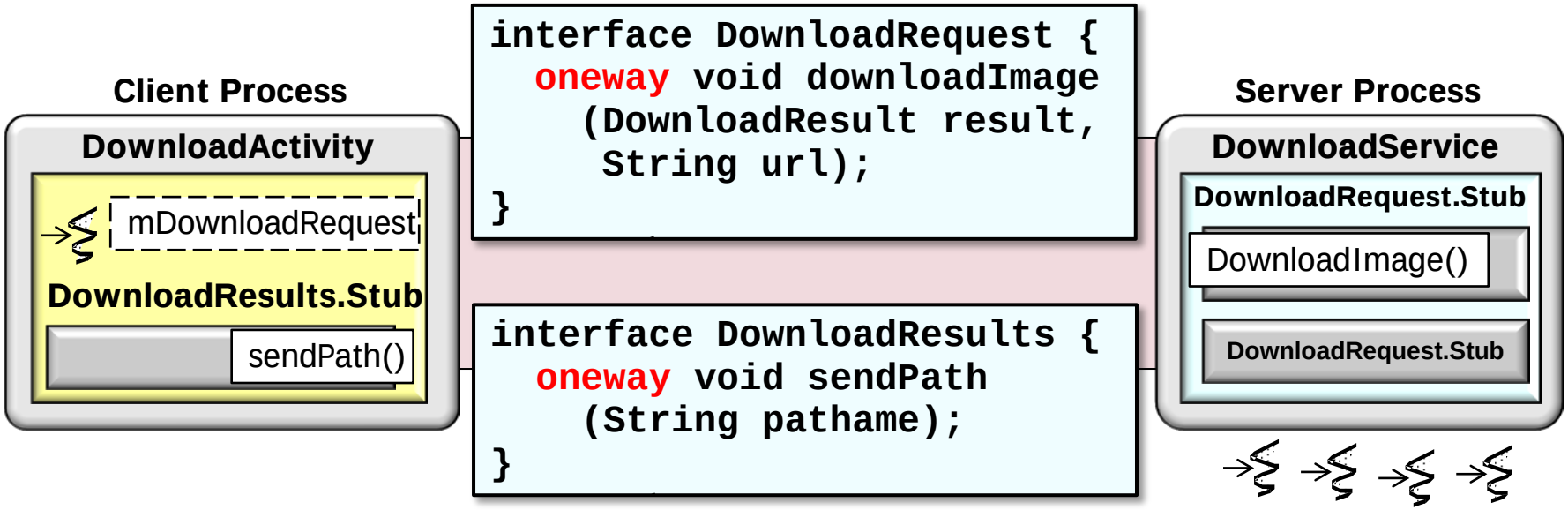

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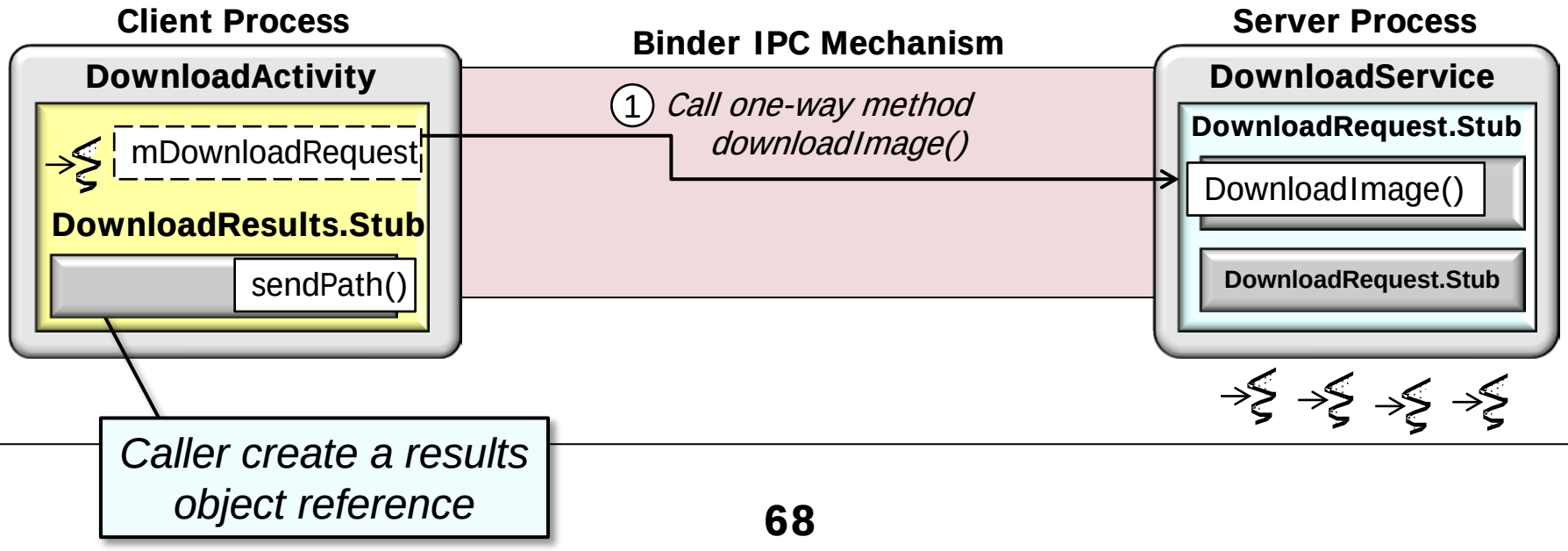

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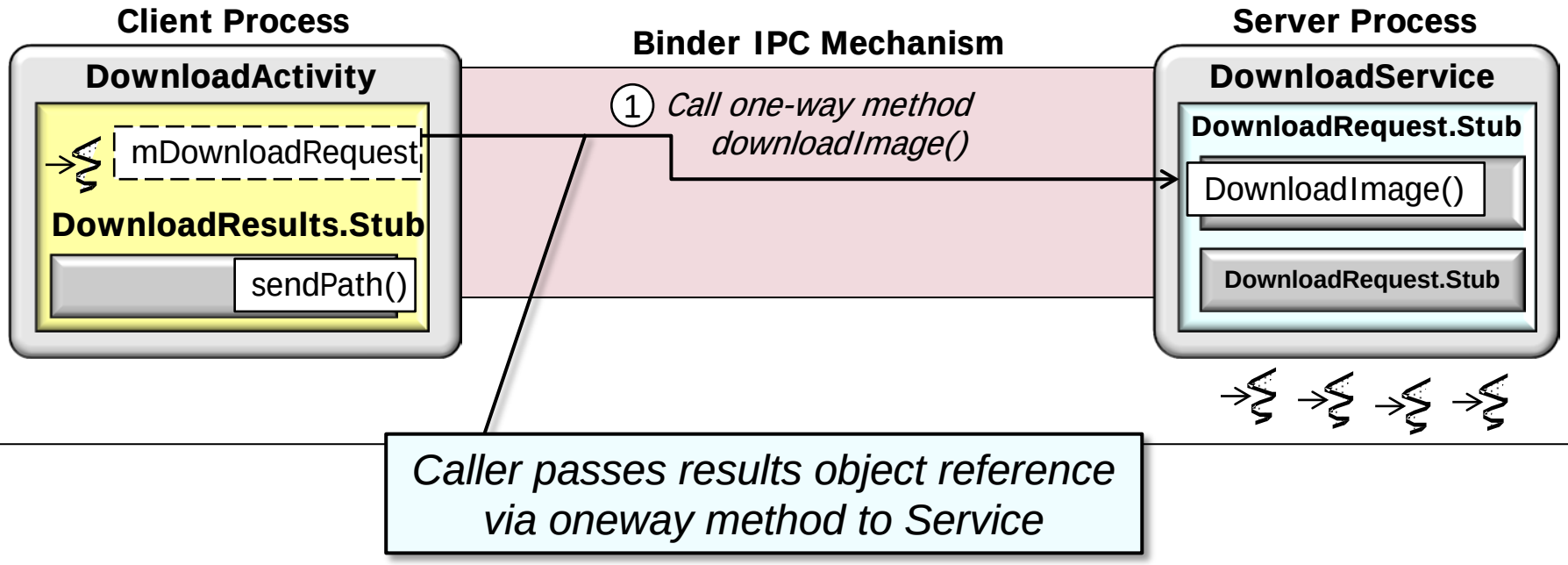

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- The Binder Driver is installed in the Linux kernel to accelerate IPC
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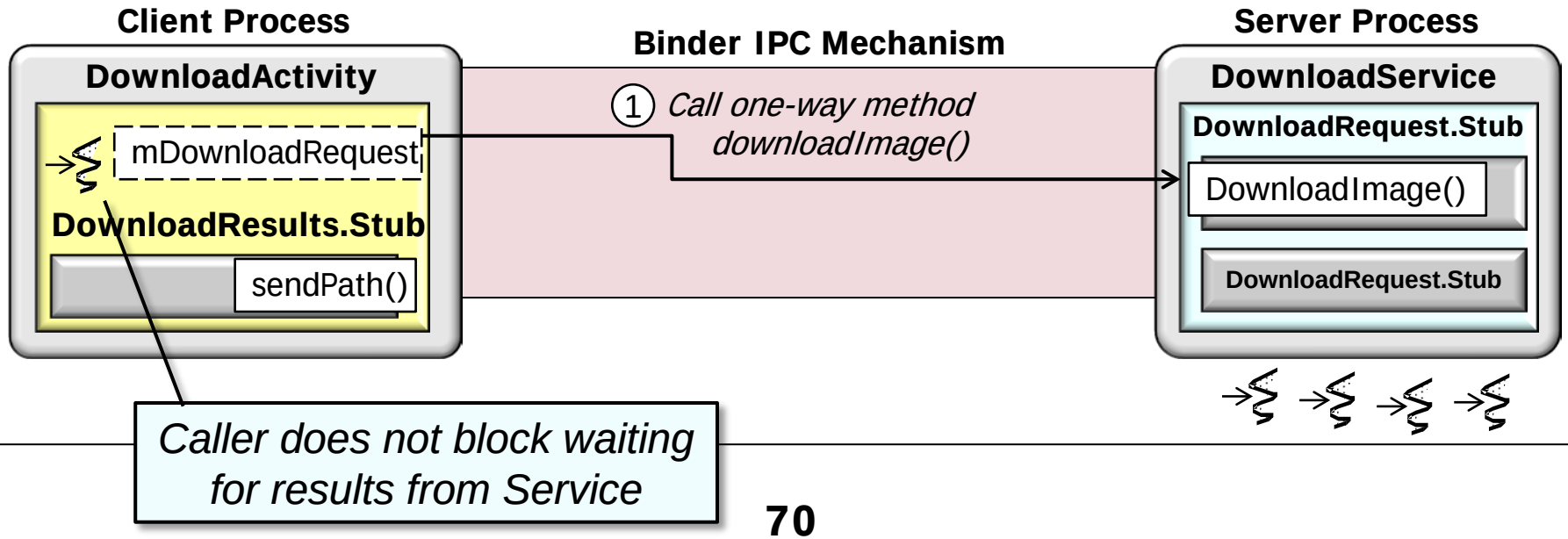

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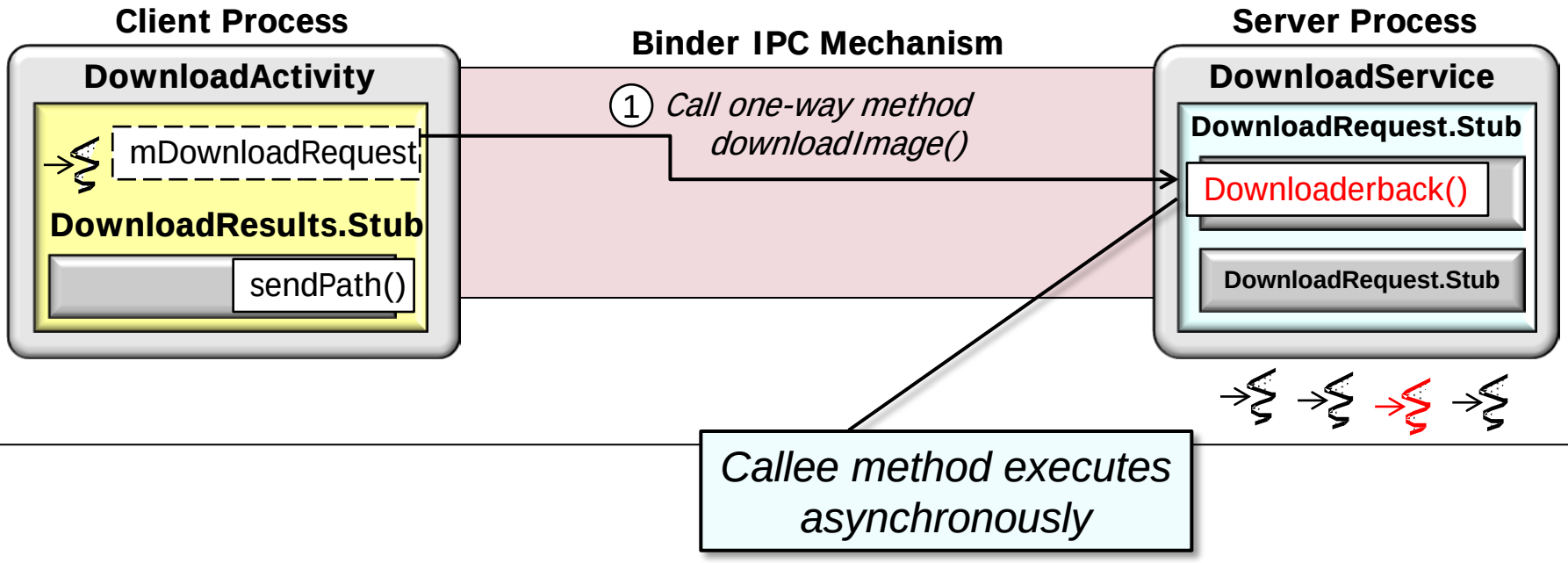

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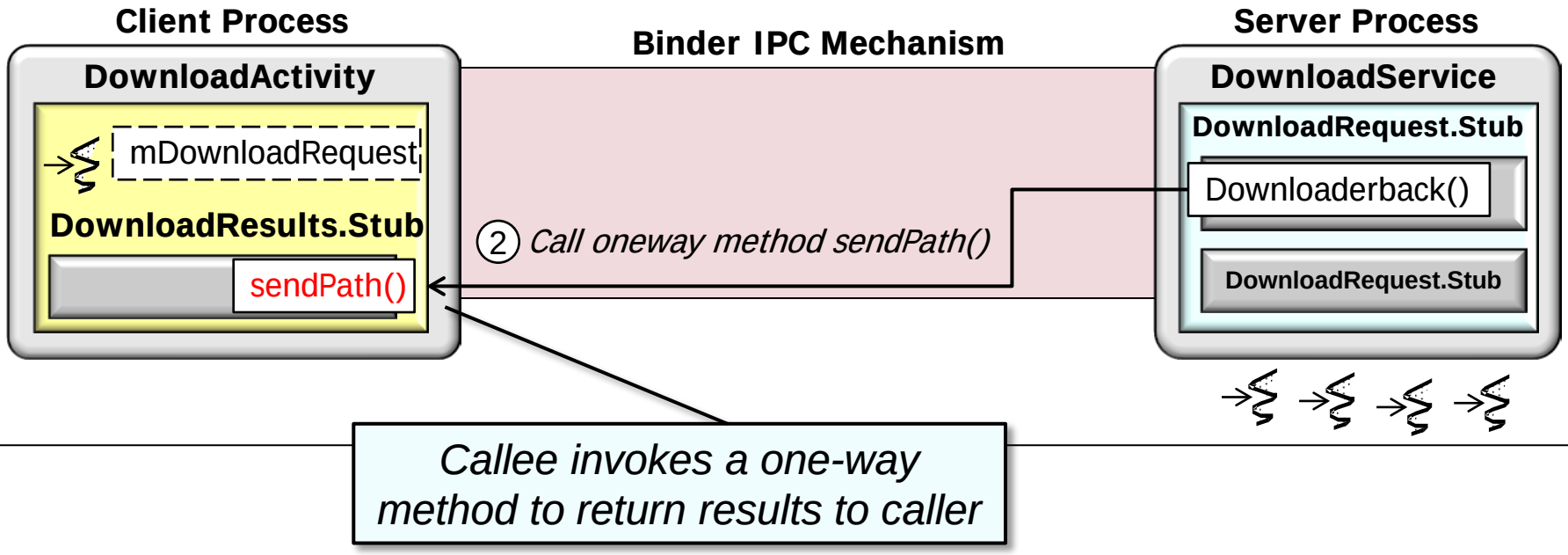

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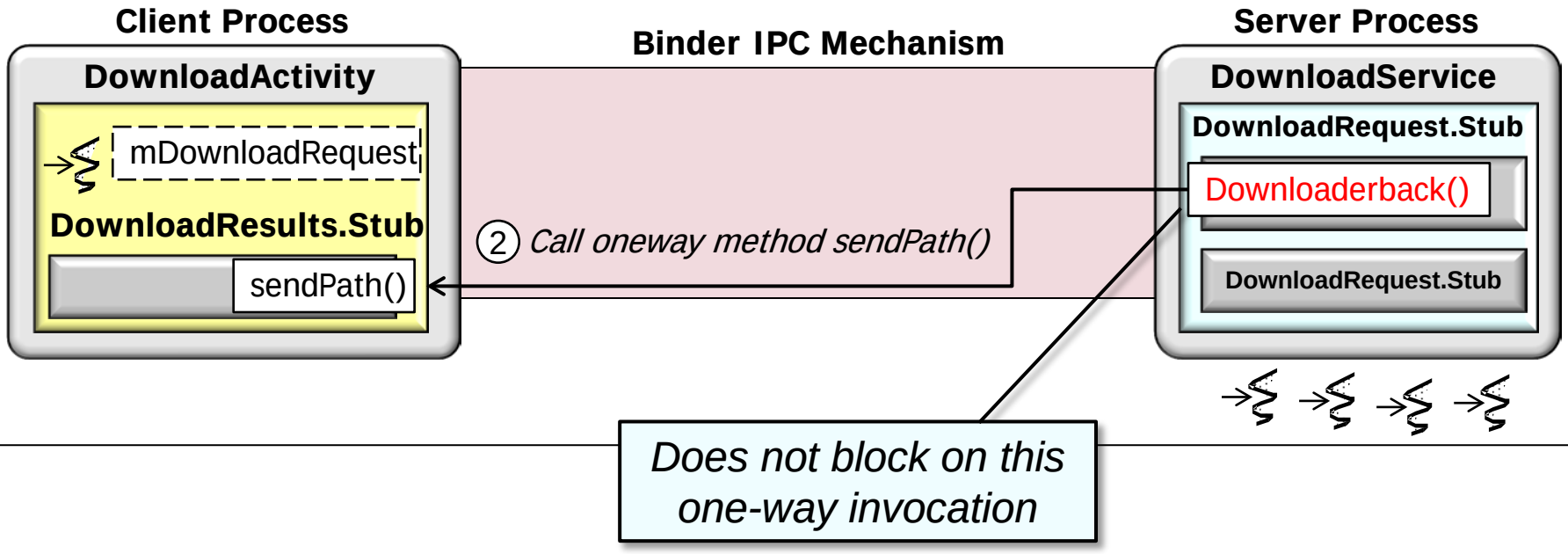

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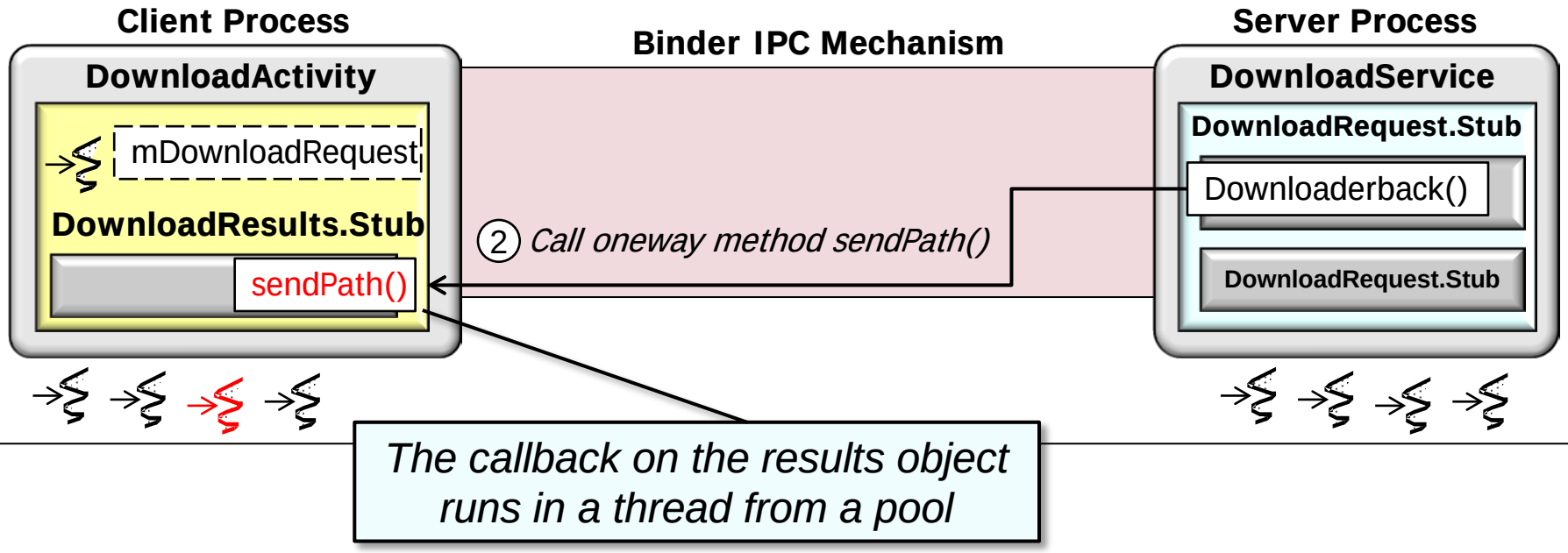

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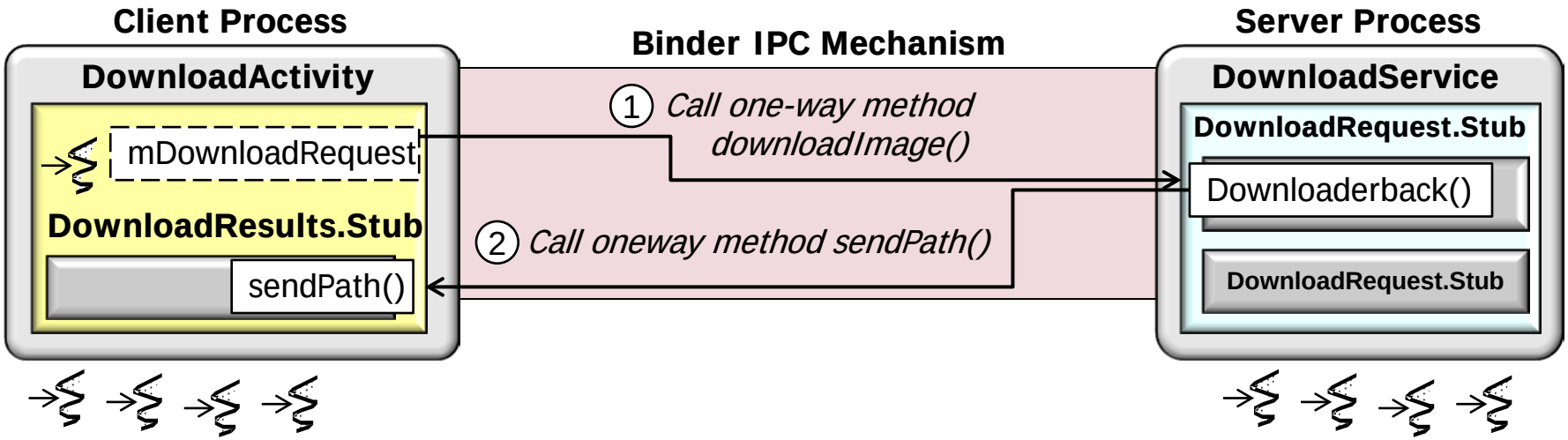

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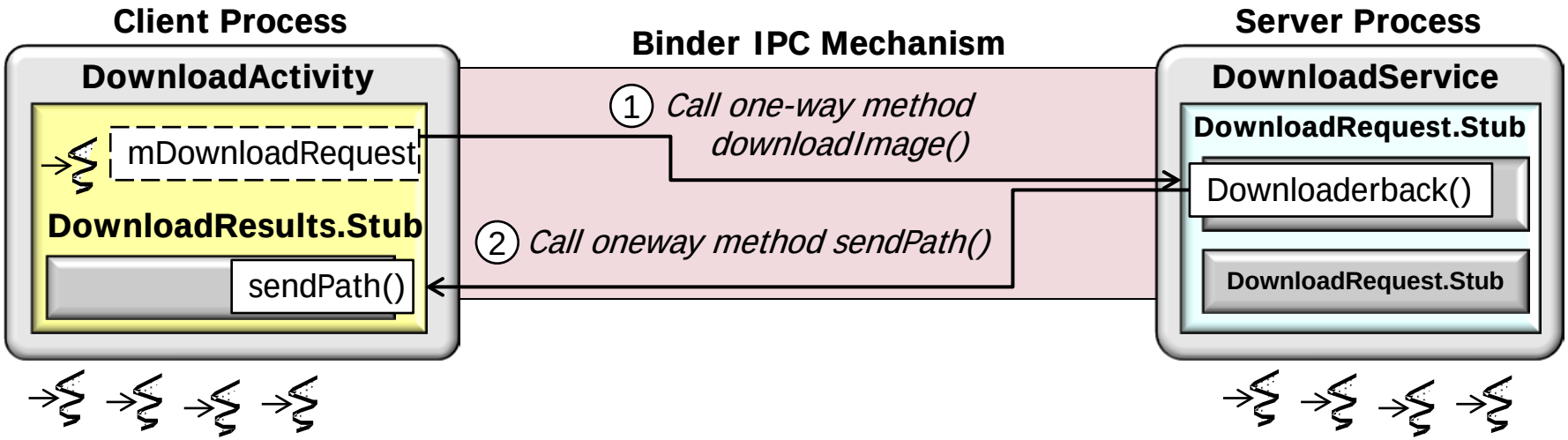
  - Objects must therefore be synchronized to avoid race conditions



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Android Interface Definition Language (AIDL)

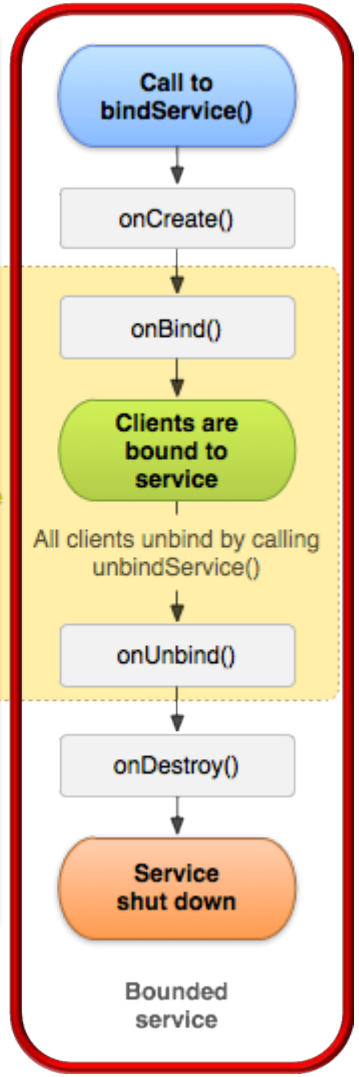
AIDL (Android Interface Definition Language) is similar to other IDLs you might have worked with. It allows you to define the programming interface that both the client and service agree upon in order to communicate with each other using interprocess communication (IPC). On Android, one process cannot normally access the memory of another process. So to talk, they need to decompose their objects into primitives that the operating system can understand, and marshall the objects across that boundary for you. The code to do that marshalling is tedious to write, so Android handles it for you with AIDL.

IN THIS DOCUMENT

SEE ALSO

Bound Services

> **Note:** Using AIDL is necessary only if you allow clients from different applications to access your service for IPC and want to handle multithreading in your service. If you do not need to perform concurrent IPC across different applications, you should create your interface by implementing a Binder or, if you want to perform IPC, but do *not* need to handle multithreading, implement your interface using a Messenger. Regardless, be sure that you understand Bound Services before implementing an AIDL.



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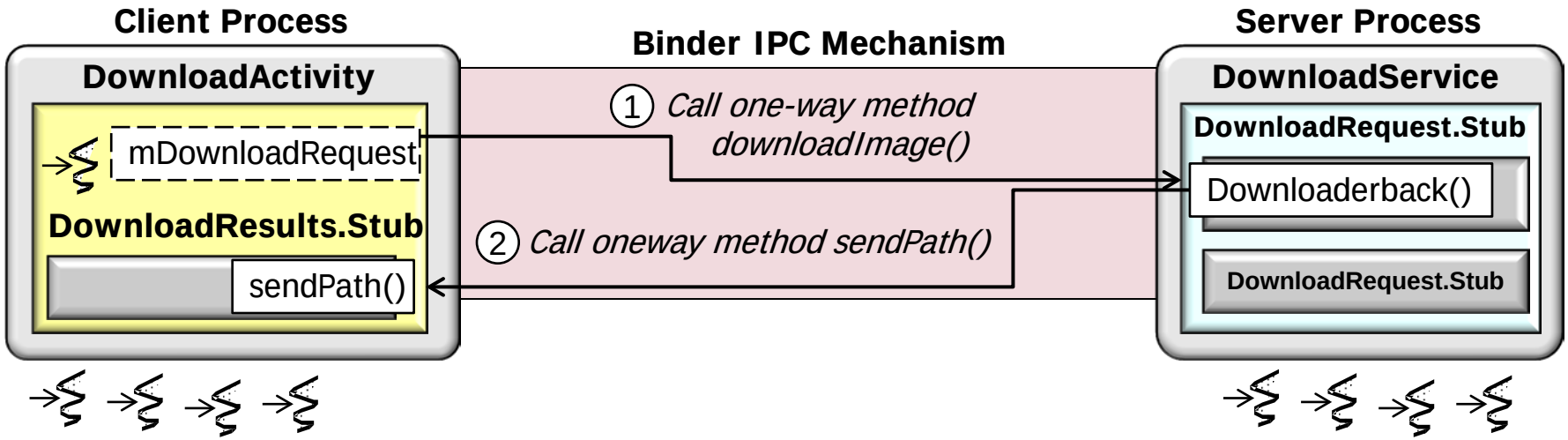

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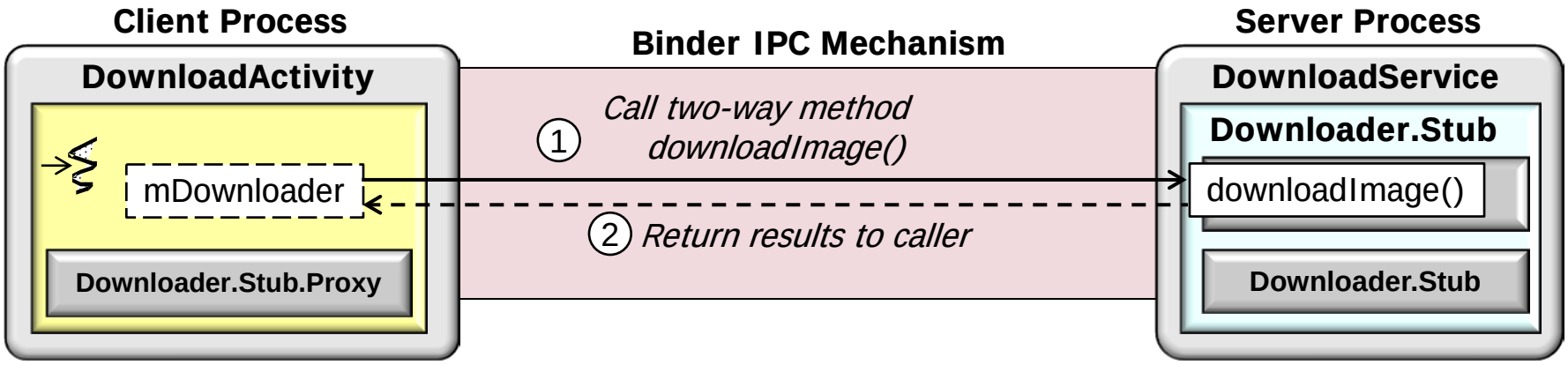

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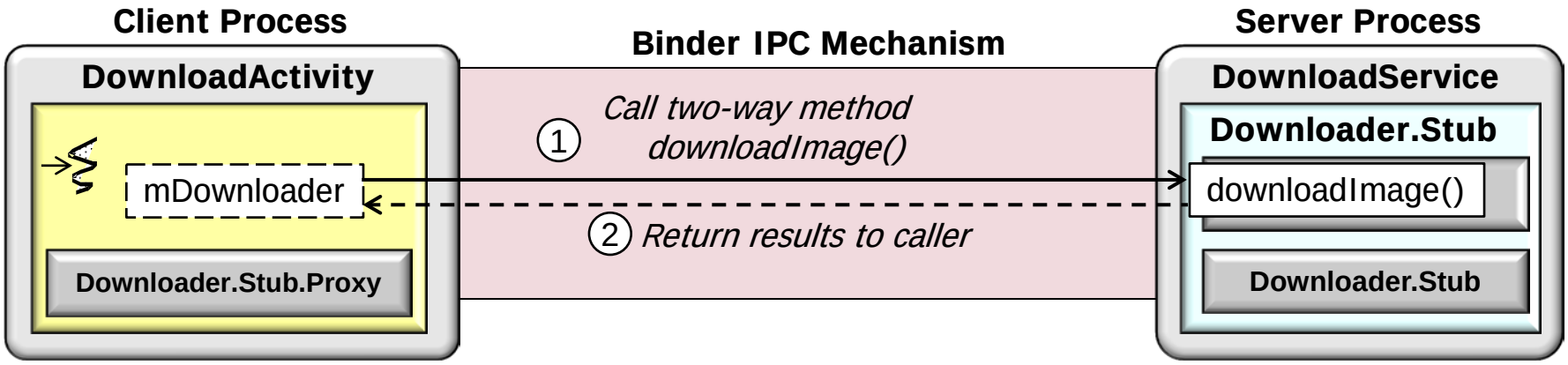

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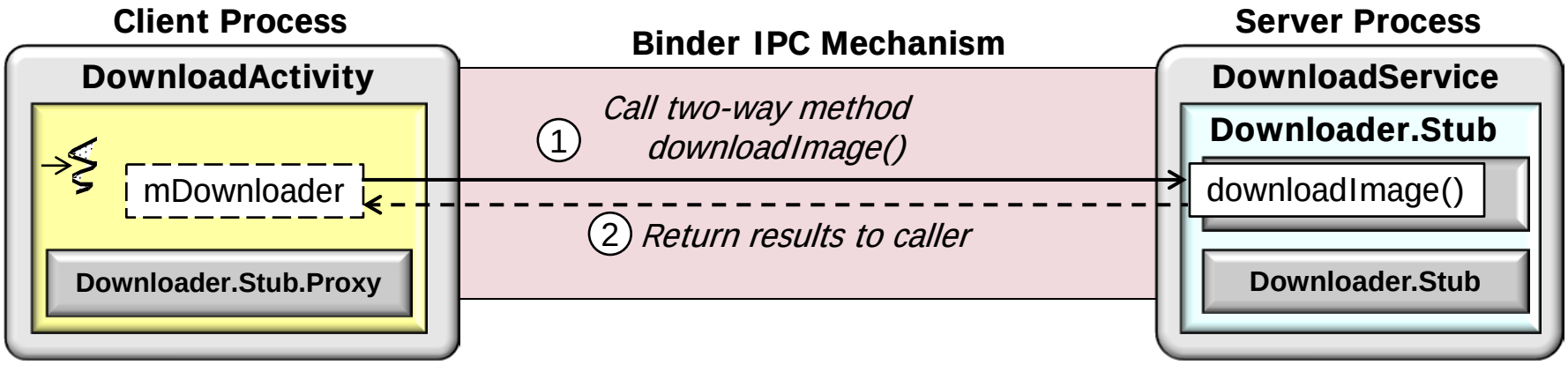
    - Mimics typed method invocations between Java objects
    - Explicitly typed interfaces can be less tedious & error-prone than the Messages sent via the generic Messenger mechanism



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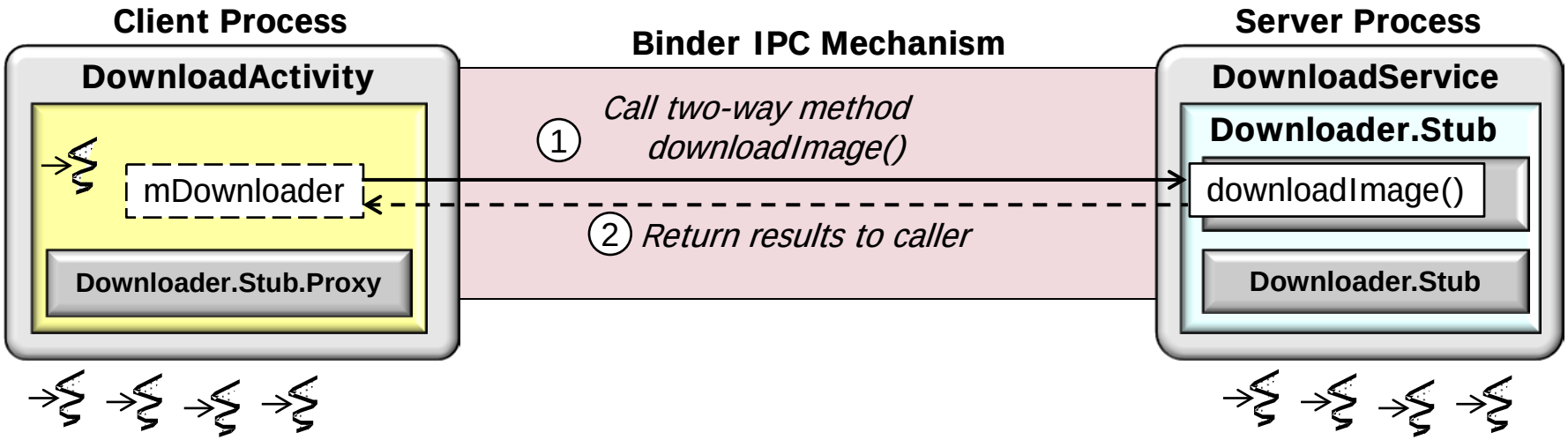

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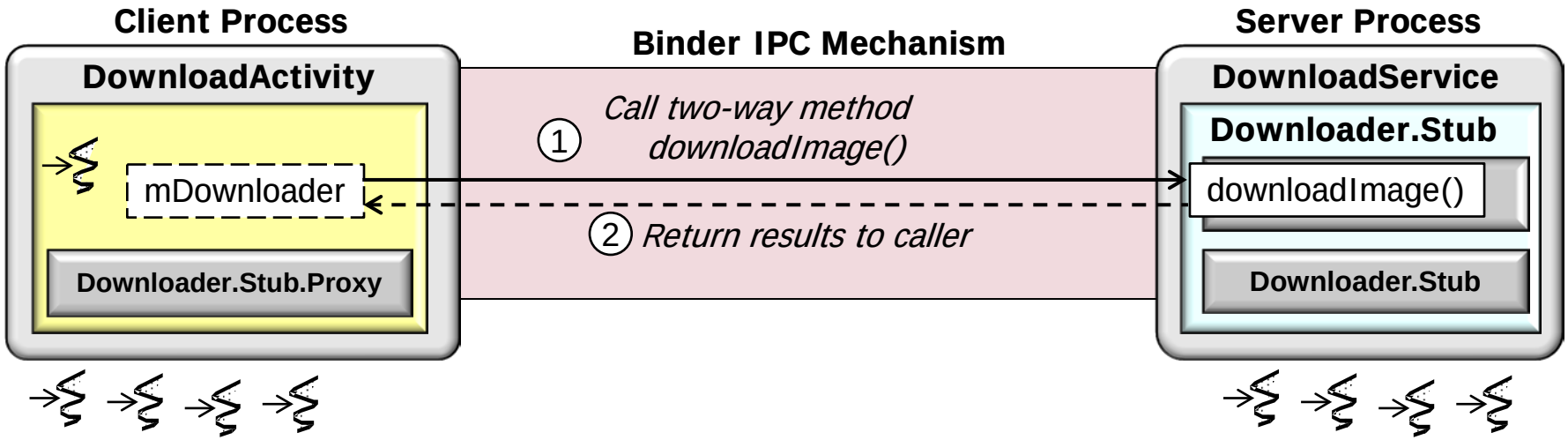

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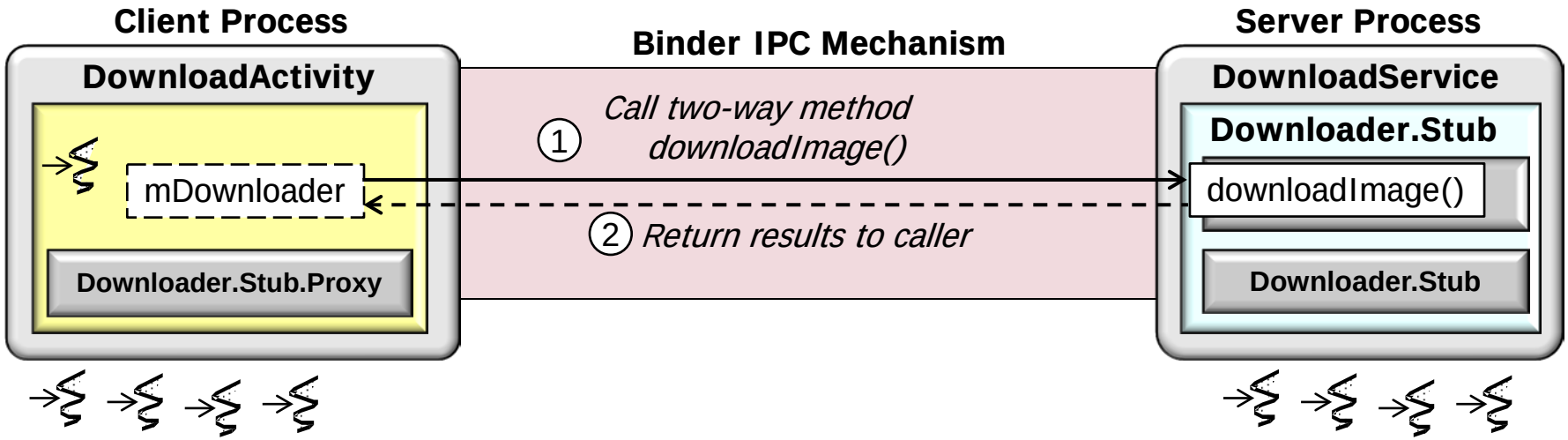
    - Application developers needn't explicitly manipulate Threads, Handlers, Runnables, or Messages



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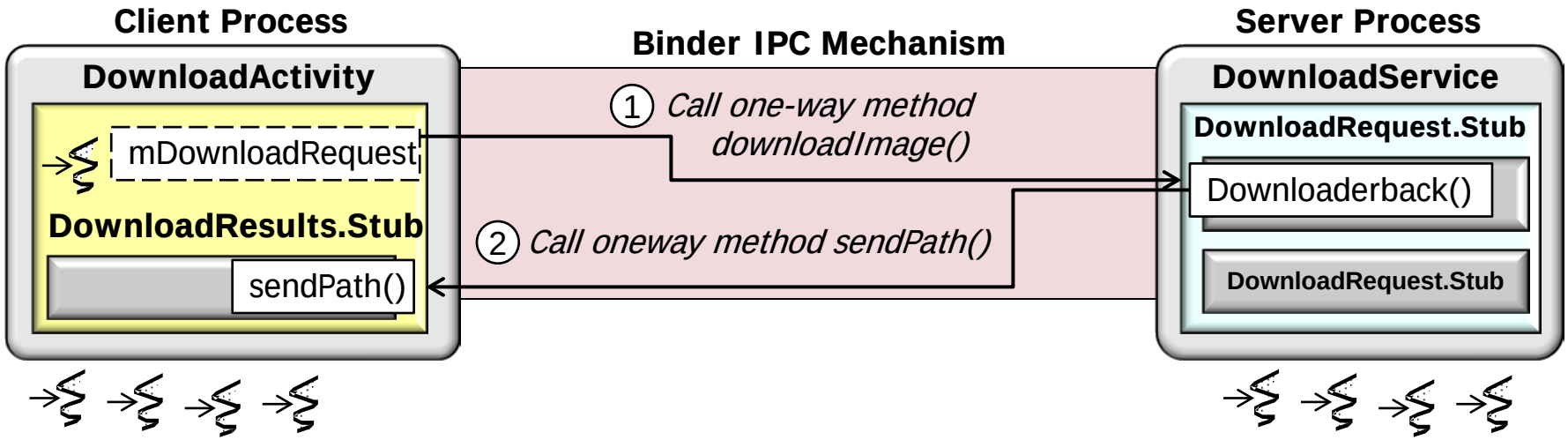

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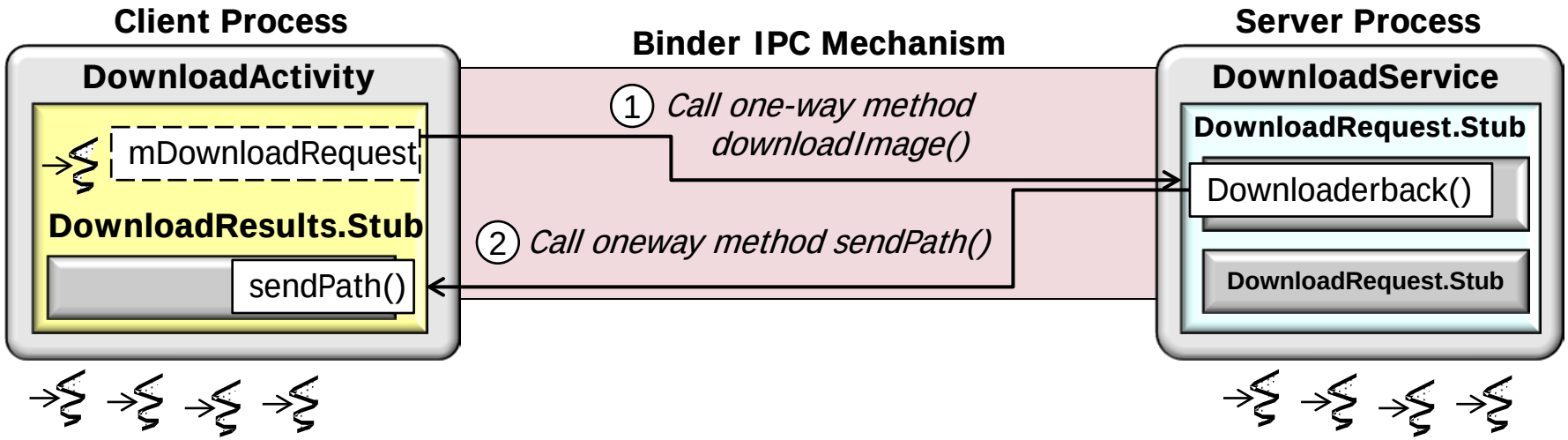
    - Asynchronous programs can be robust & scalable if developers understand key patterns



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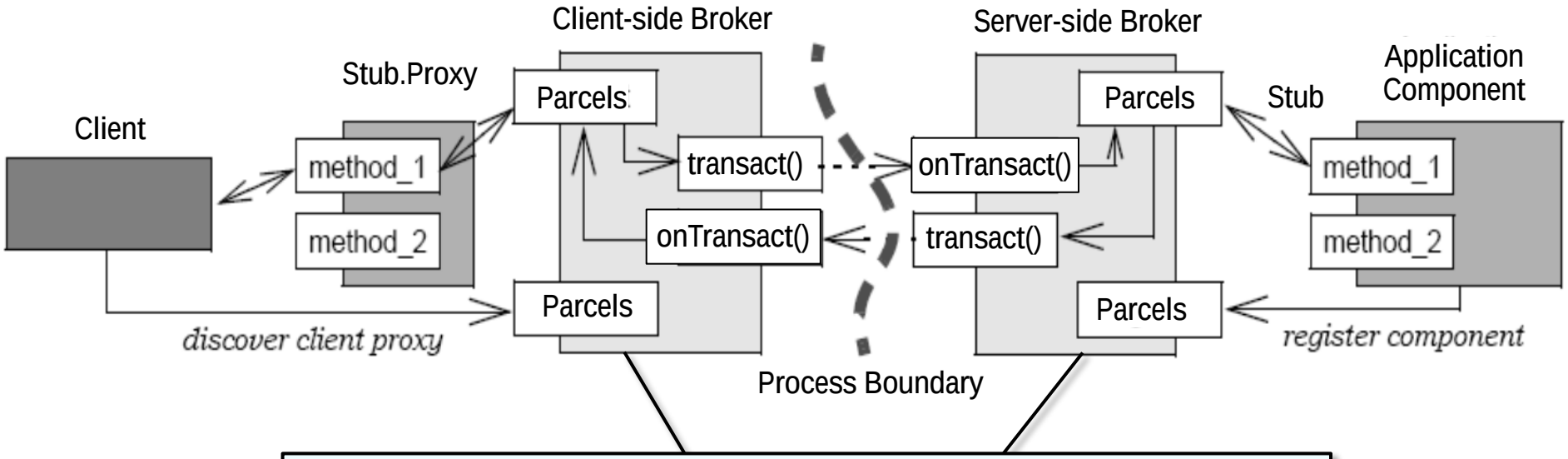

Broker connects clients with objects residing in Bound Services in different address spaces & mediates method invocations from clients to these objects

www.kircher-schwanninger.de/michael/publications/BrokerRevisited.pdf

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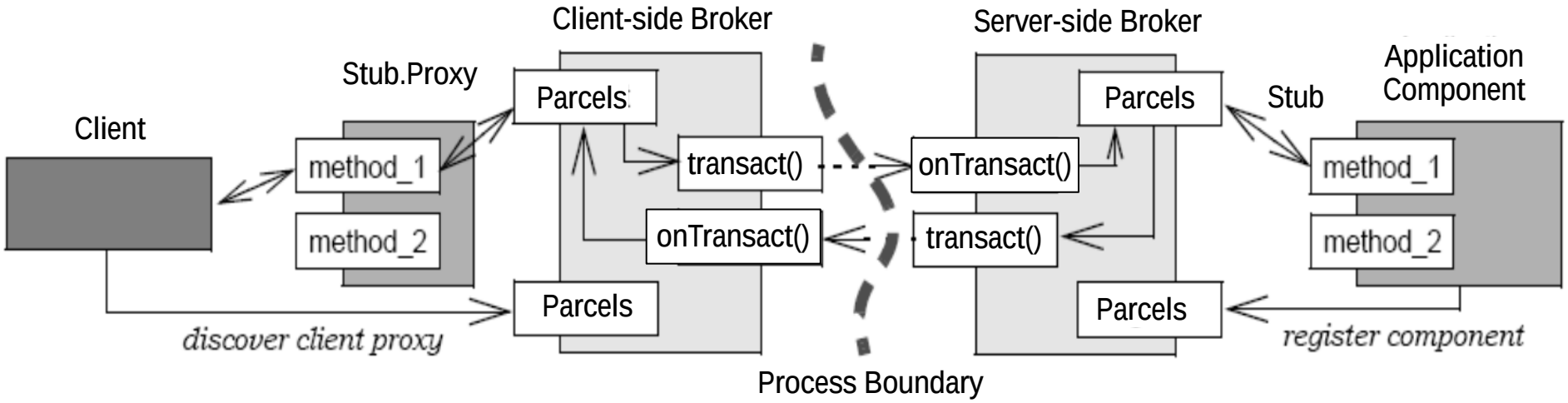
- The AIDL & Binder framework provide several capabilities to applications that communicate with Bound Services residing in separate processes
- The AIDL & Binder implementations apply the *Broker* pattern



- Many other patterns are used to implement AIDL & Binder framework
  - e.g., *Proxy*, *Activator*, etc.

See upcoming section on “Concurrency & Communication Patterns in Android”

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- The AIDL & Binder are used extensively throughout Android's frameworks & packaged applications

  frameworks/base/core/java/android/app/IAlarmManager.aidl
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  frameworks/base/core/java/android/app/IProcessObserver.aidl
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  frameworks/base/core/java/android/app/IServiceConnection.aidl
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