

#WWDC19

Network Extensions for Modern macOS

Taking the kernel out of Network Kernel Extensions

Jamie Wood, Internet Technologies

Thank you for your feedback.

Content Filter

Transparent Proxy

DNS Proxy

VPN

Virtual Machine

Custom Protocols

Content Filter

Transparent Proxy

DNS Proxy

VPN

Virtual Machine

Custom Protocols

System Extensions

NEW

System Extensions



NEW

Packaged inside of your app

Managed by the OS

Easy to develop and debug

Run independently of any user

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Content Filter

NetworkExtension Framework



NEW

Content Filter

NetworkExtension Framework

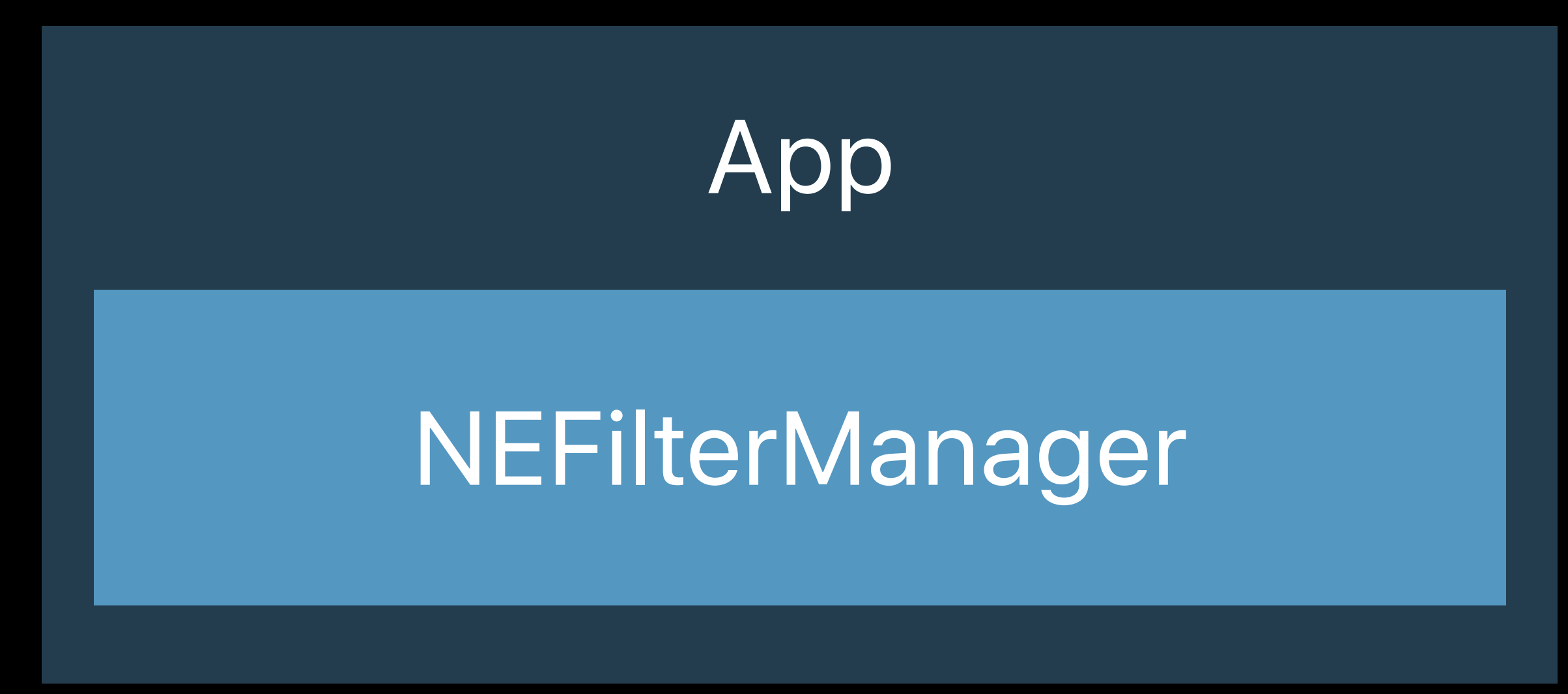
NEW



App

Content Filter

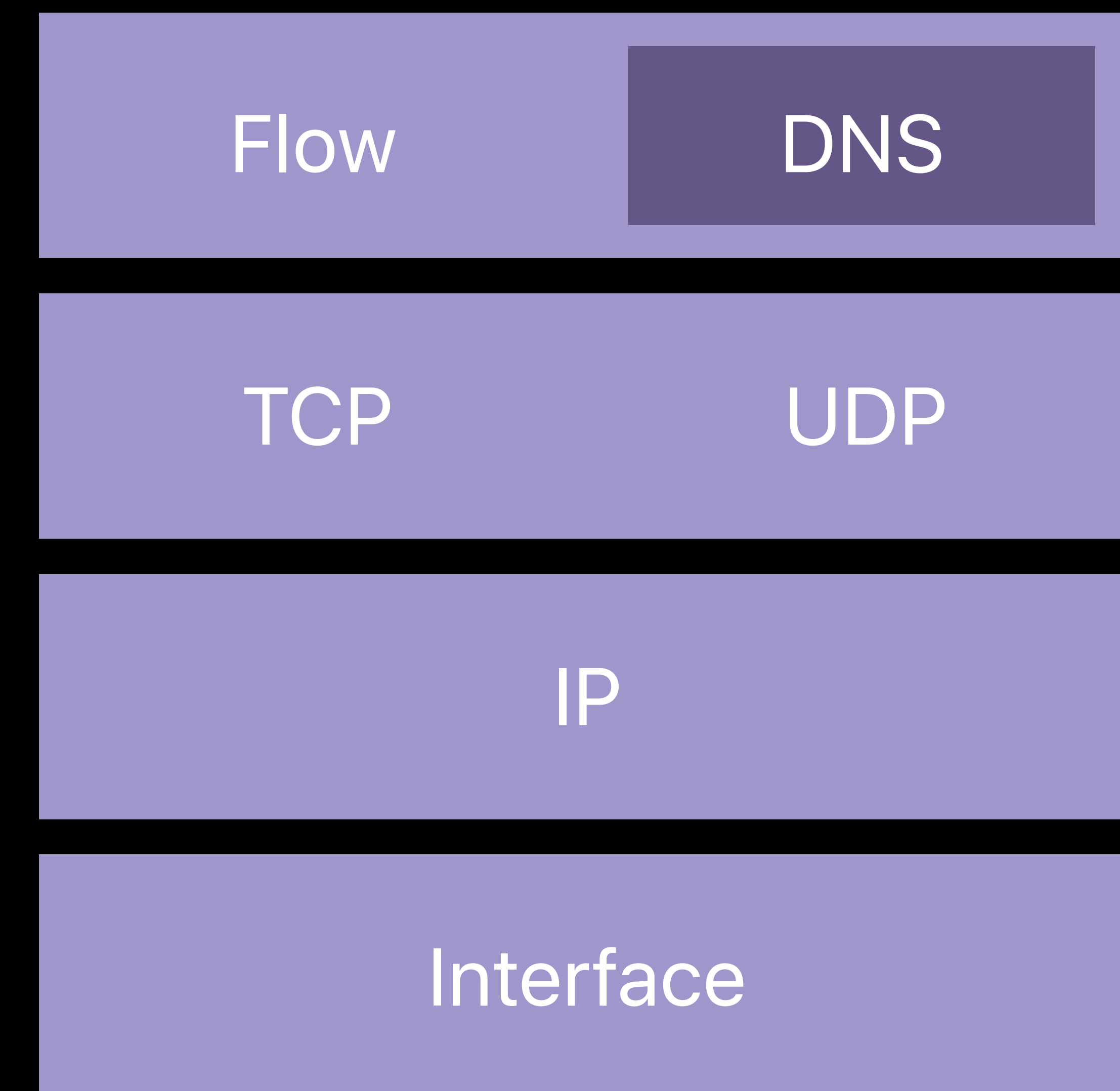
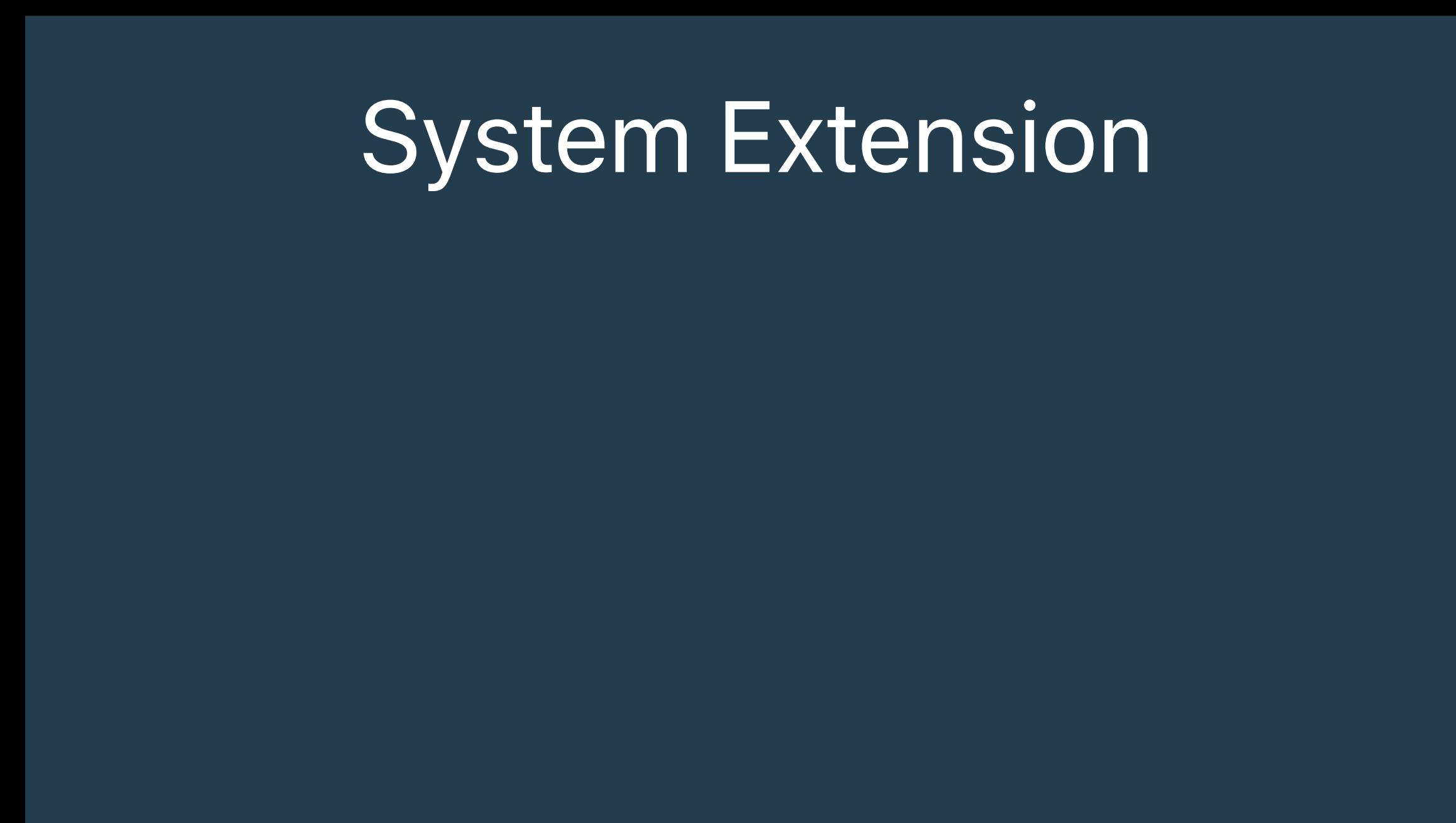
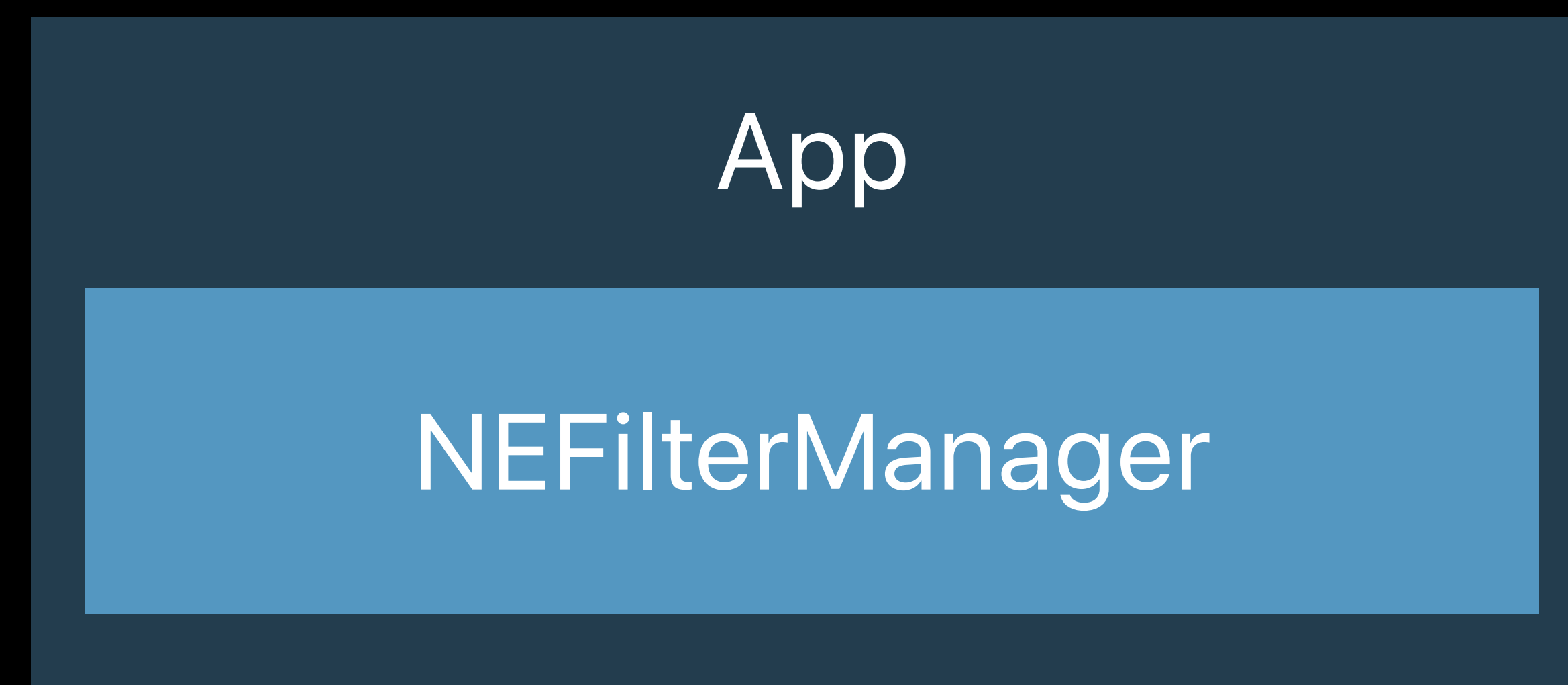
NetworkExtension Framework



Content Filter

NetworkExtension Framework

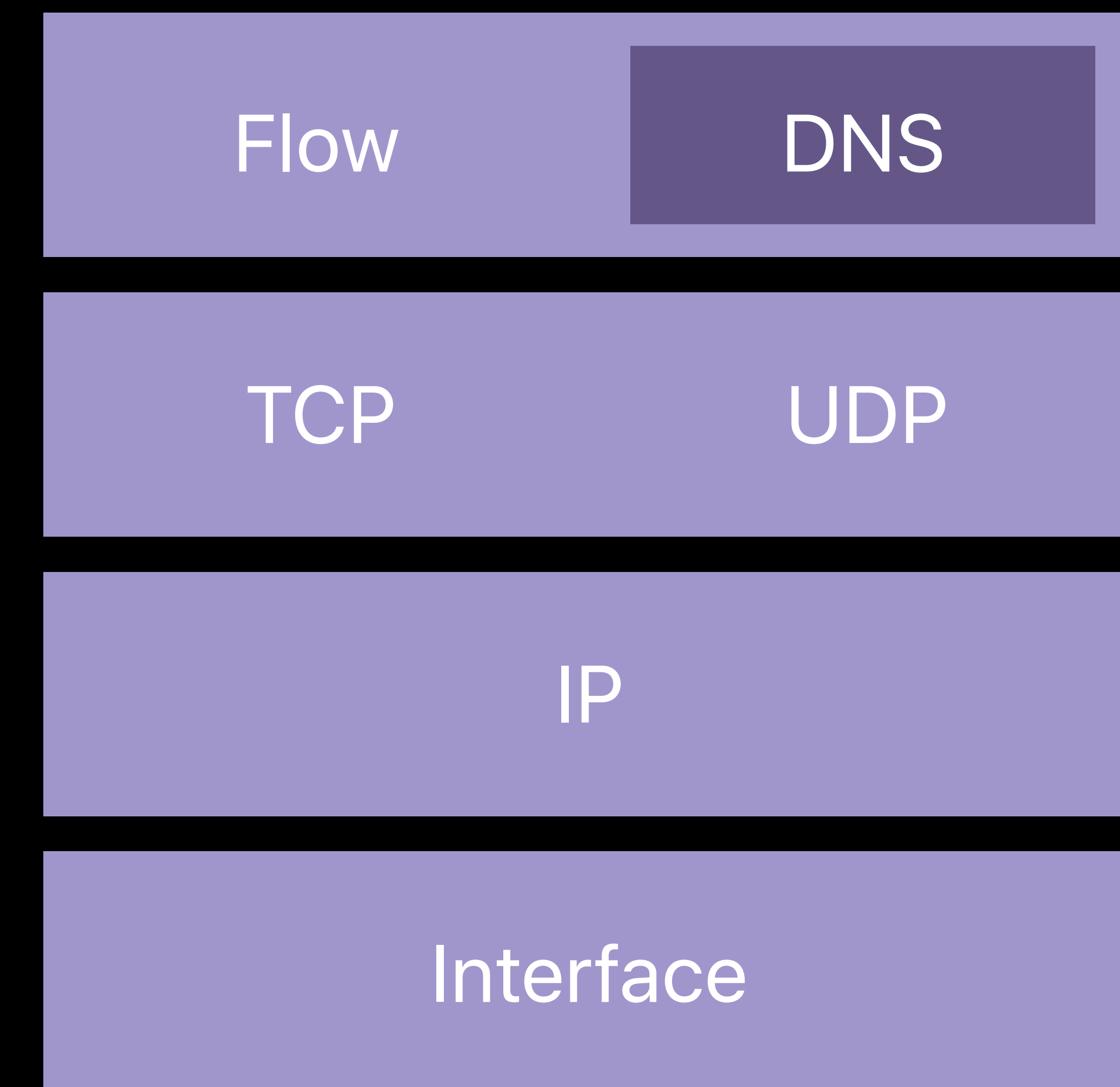
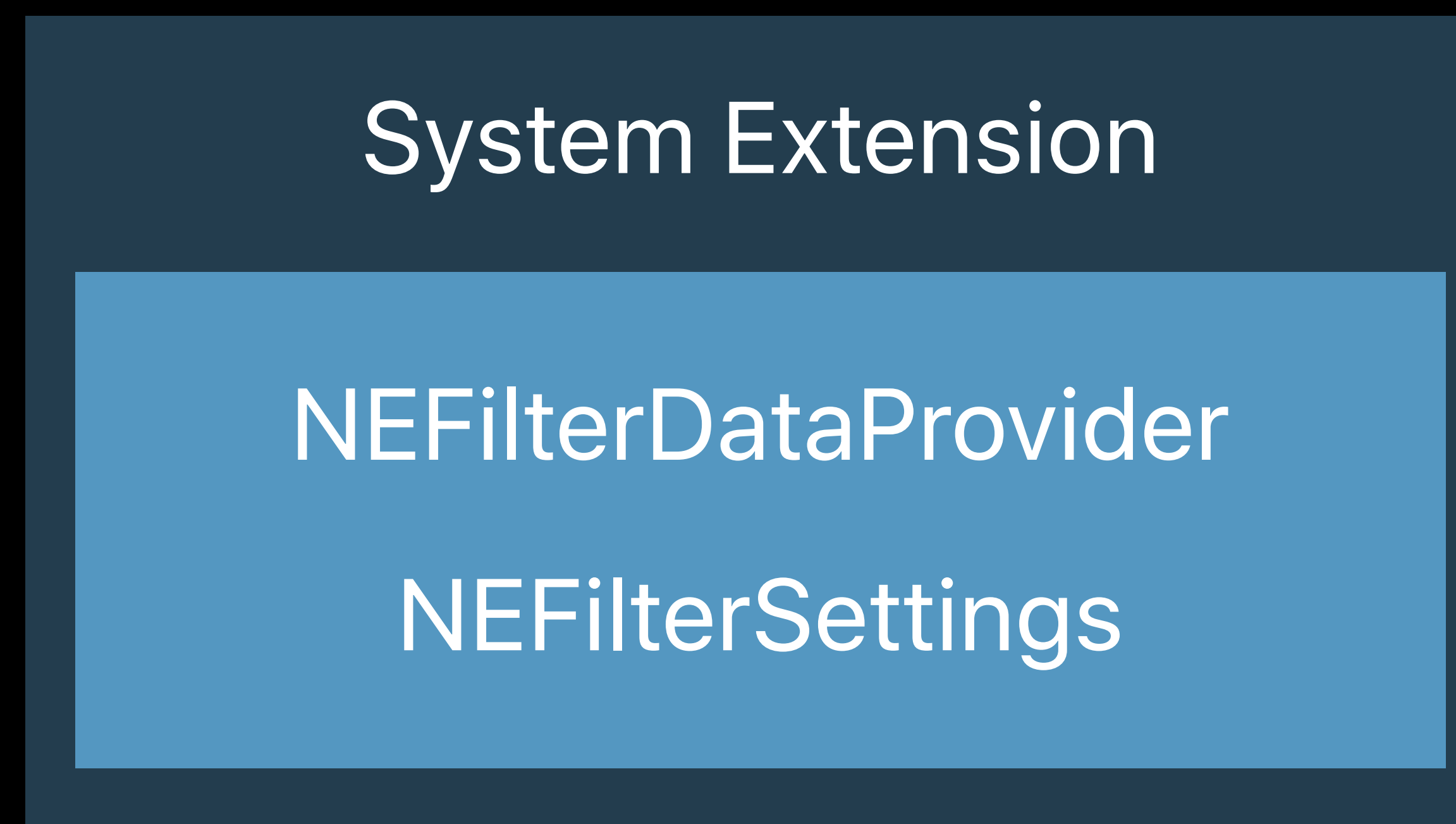
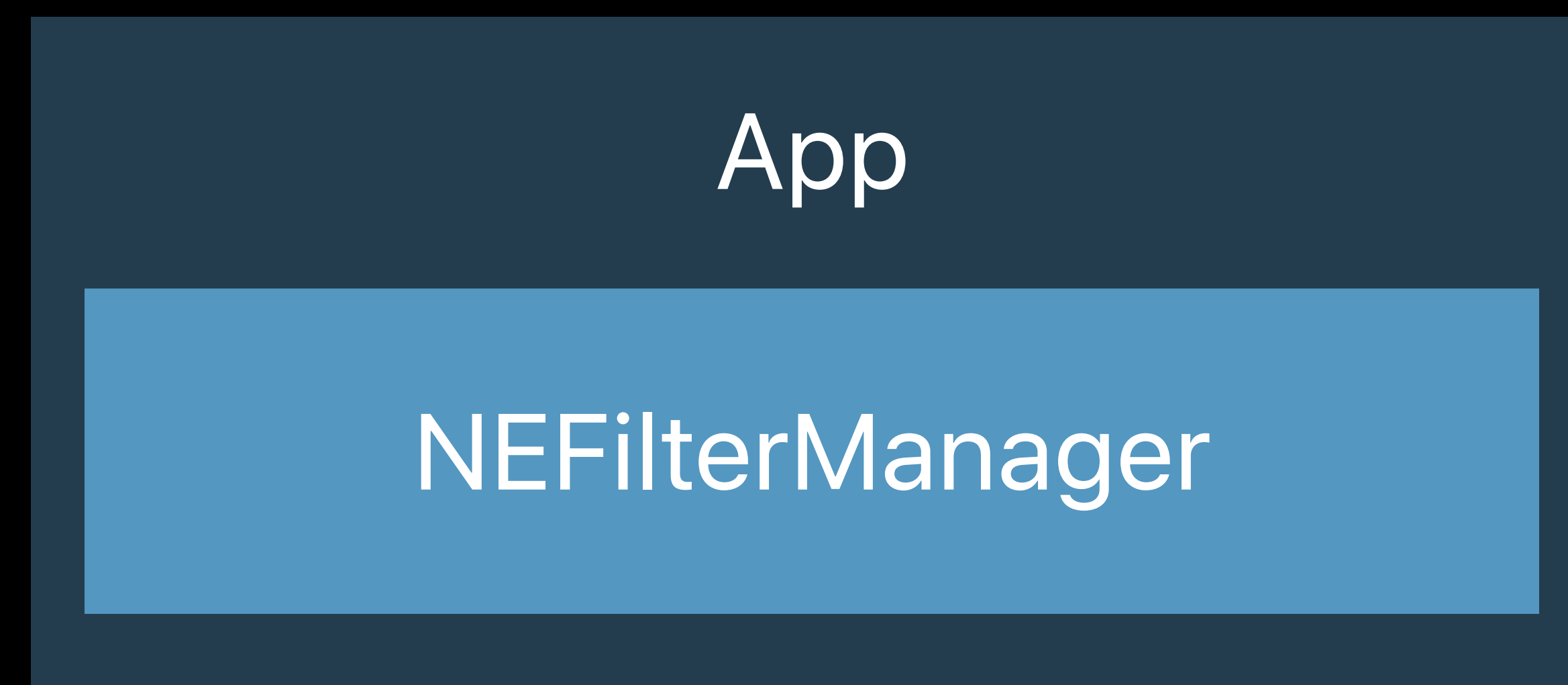
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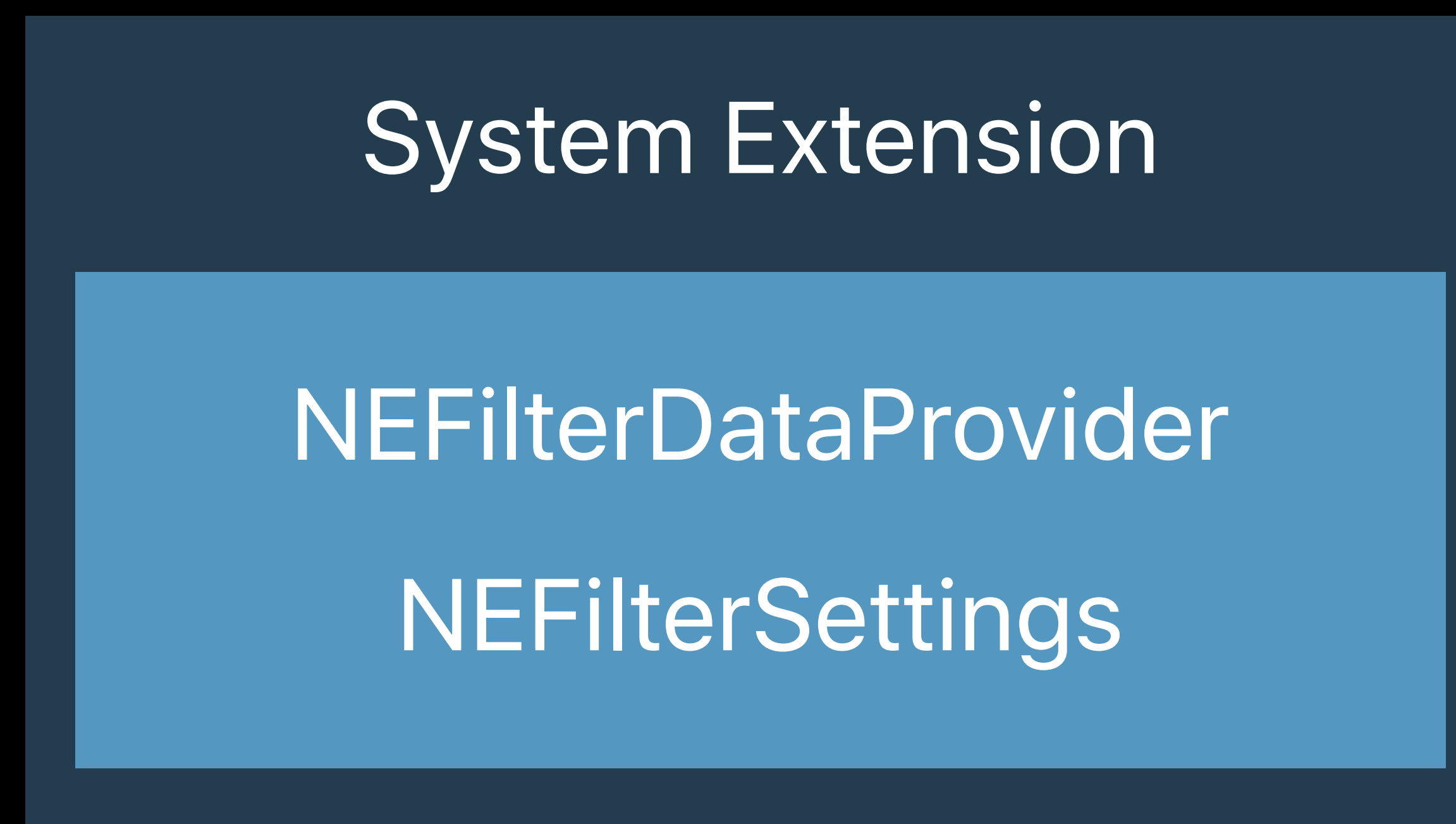
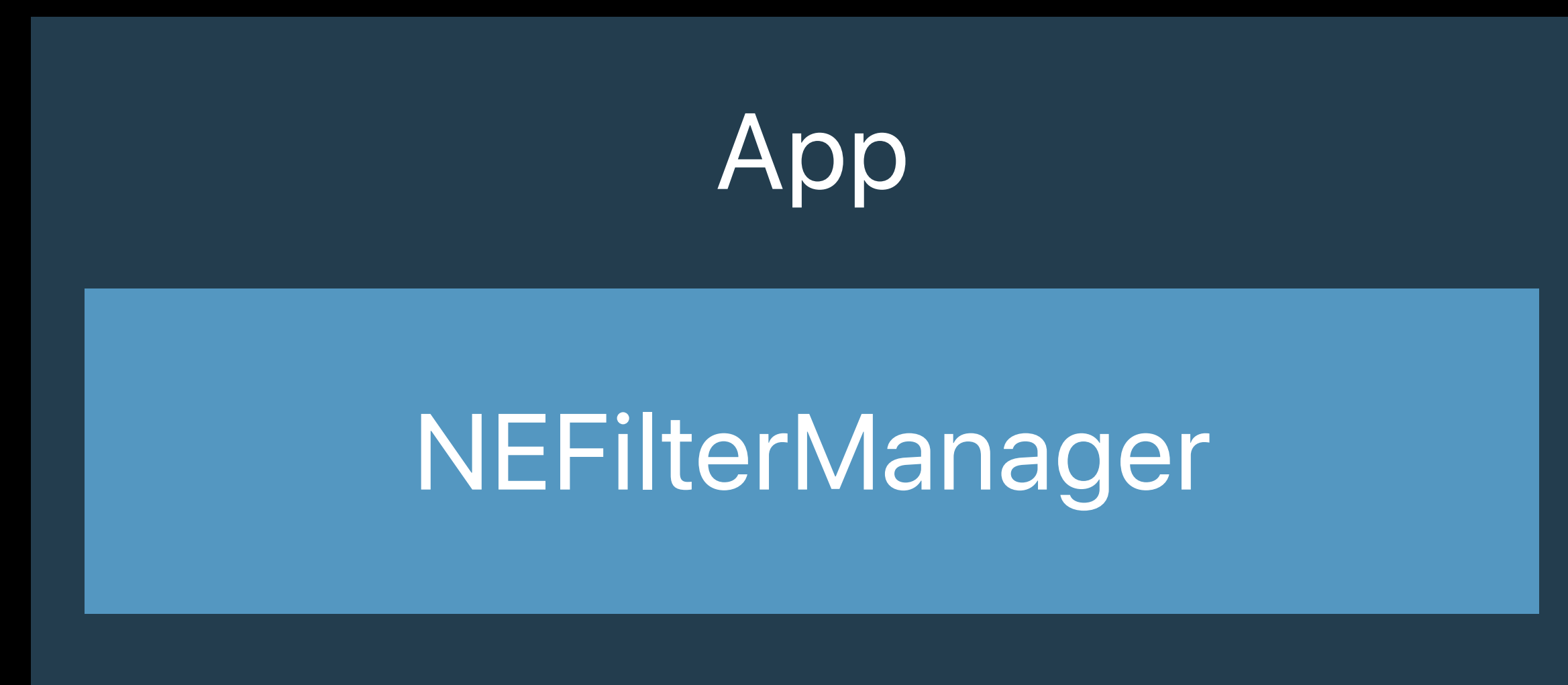
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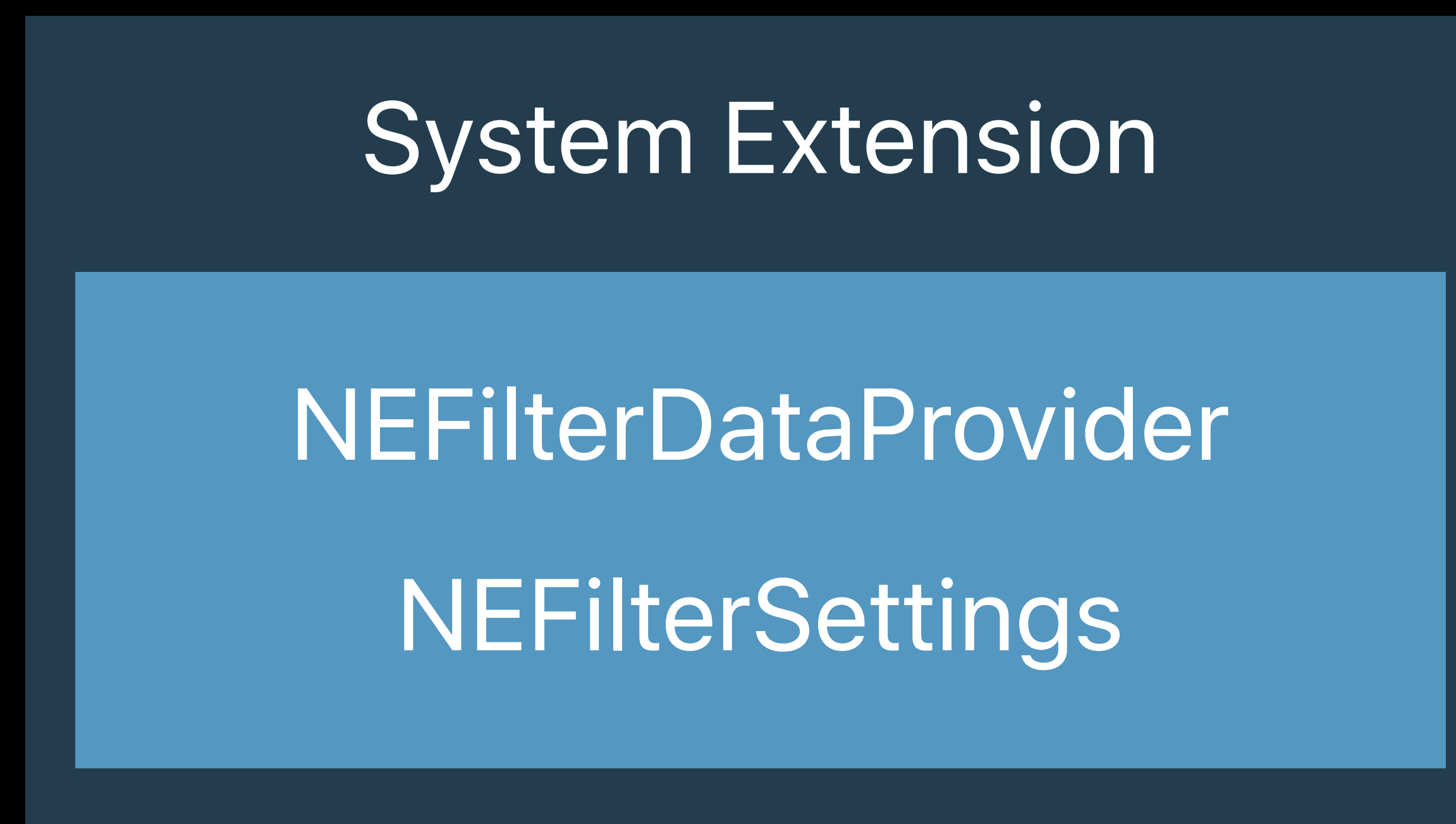
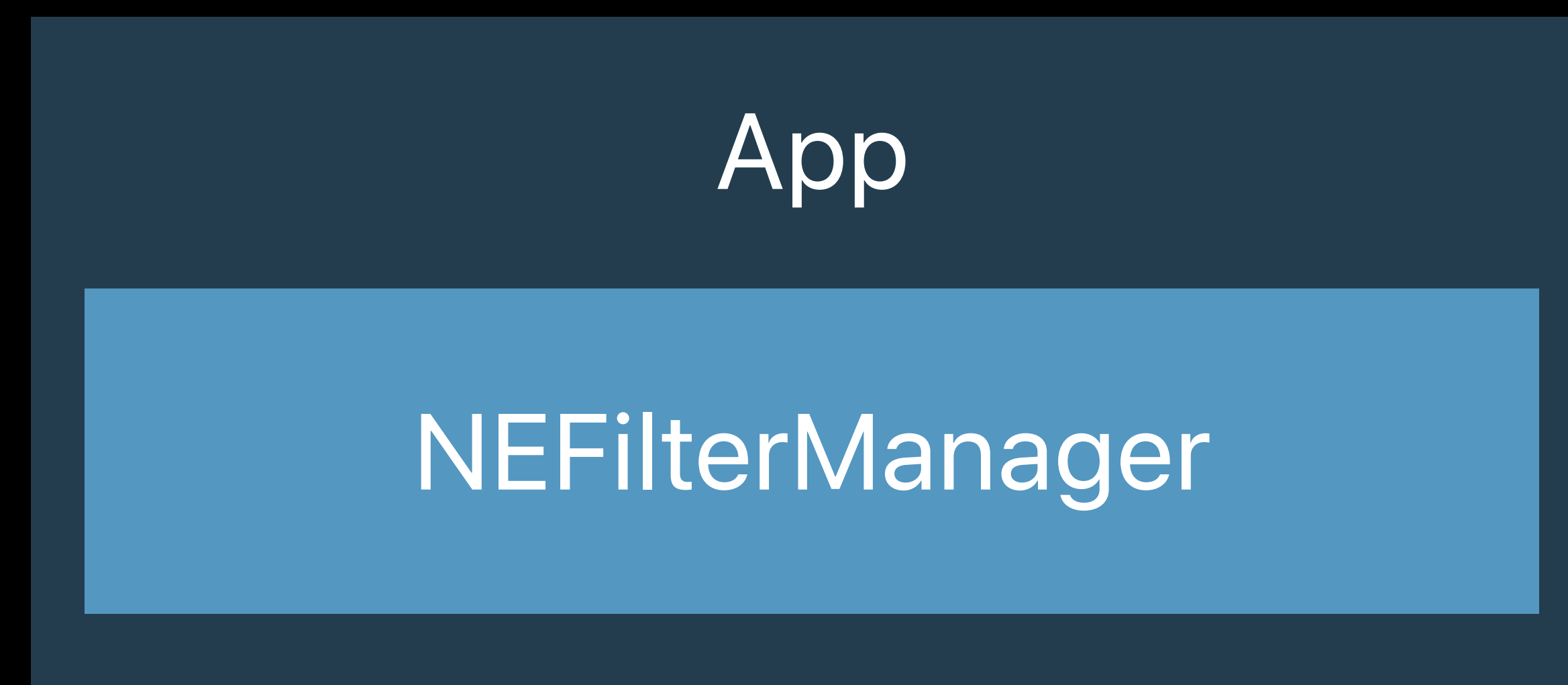
NEW



Content Filter

NetworkExtension Framework

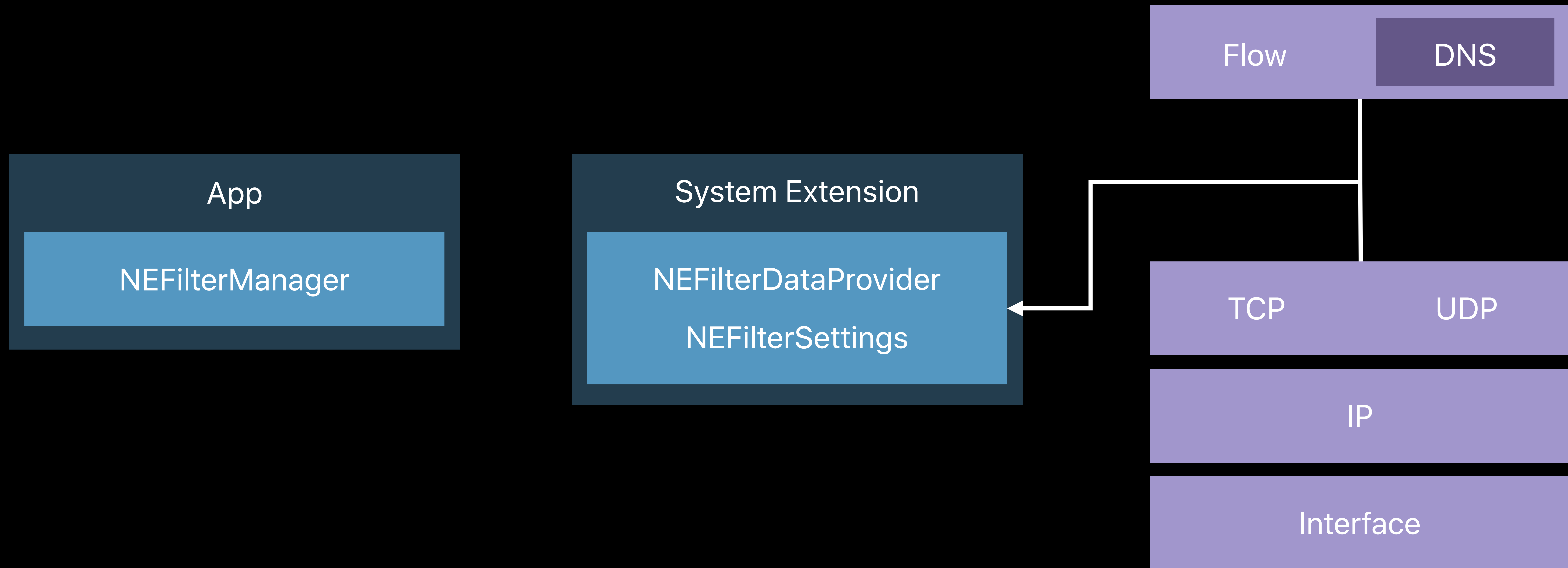
NEW



Content Filter

NetworkExtension Framework

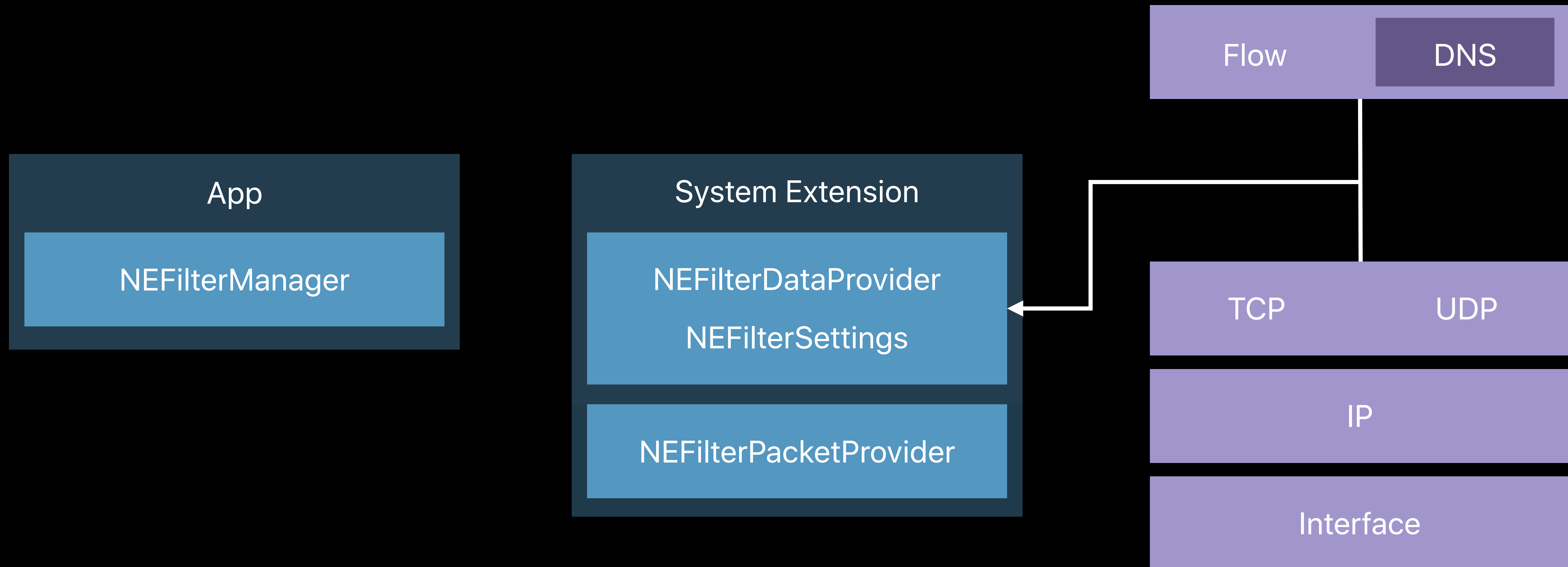
NEW



Content Filter

NetworkExtension Framework

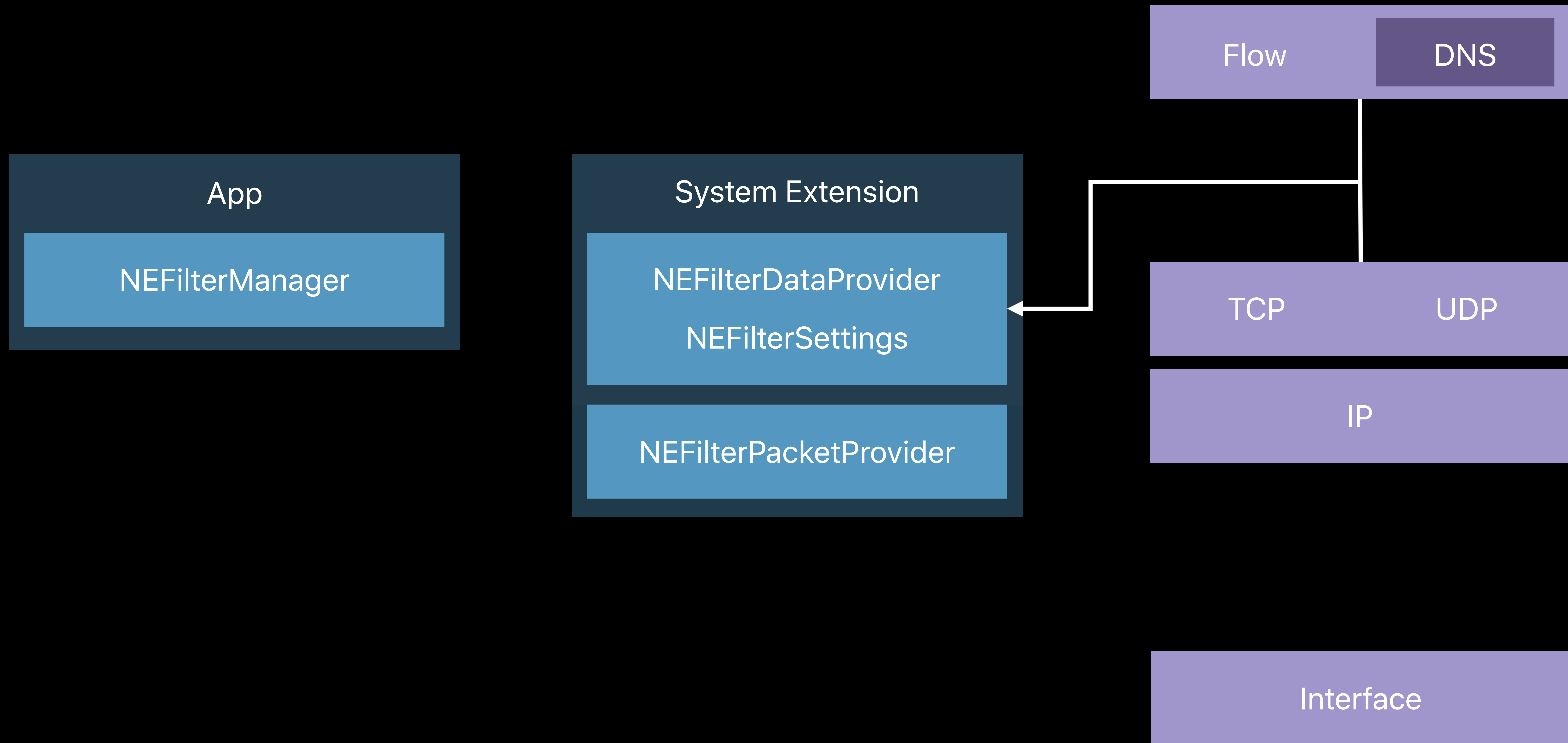
NEW



Content Filter

NetworkExtension Framework

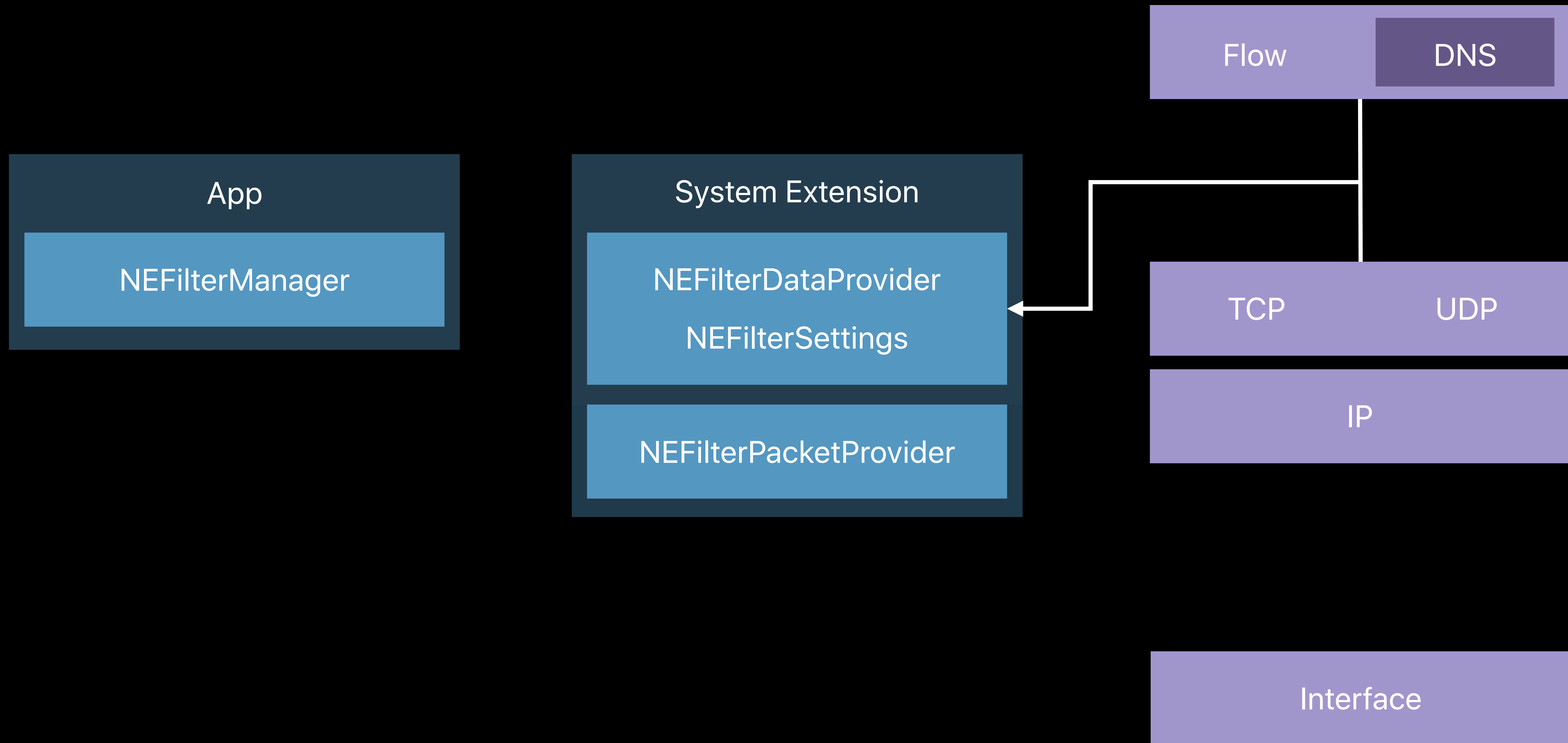
NEW



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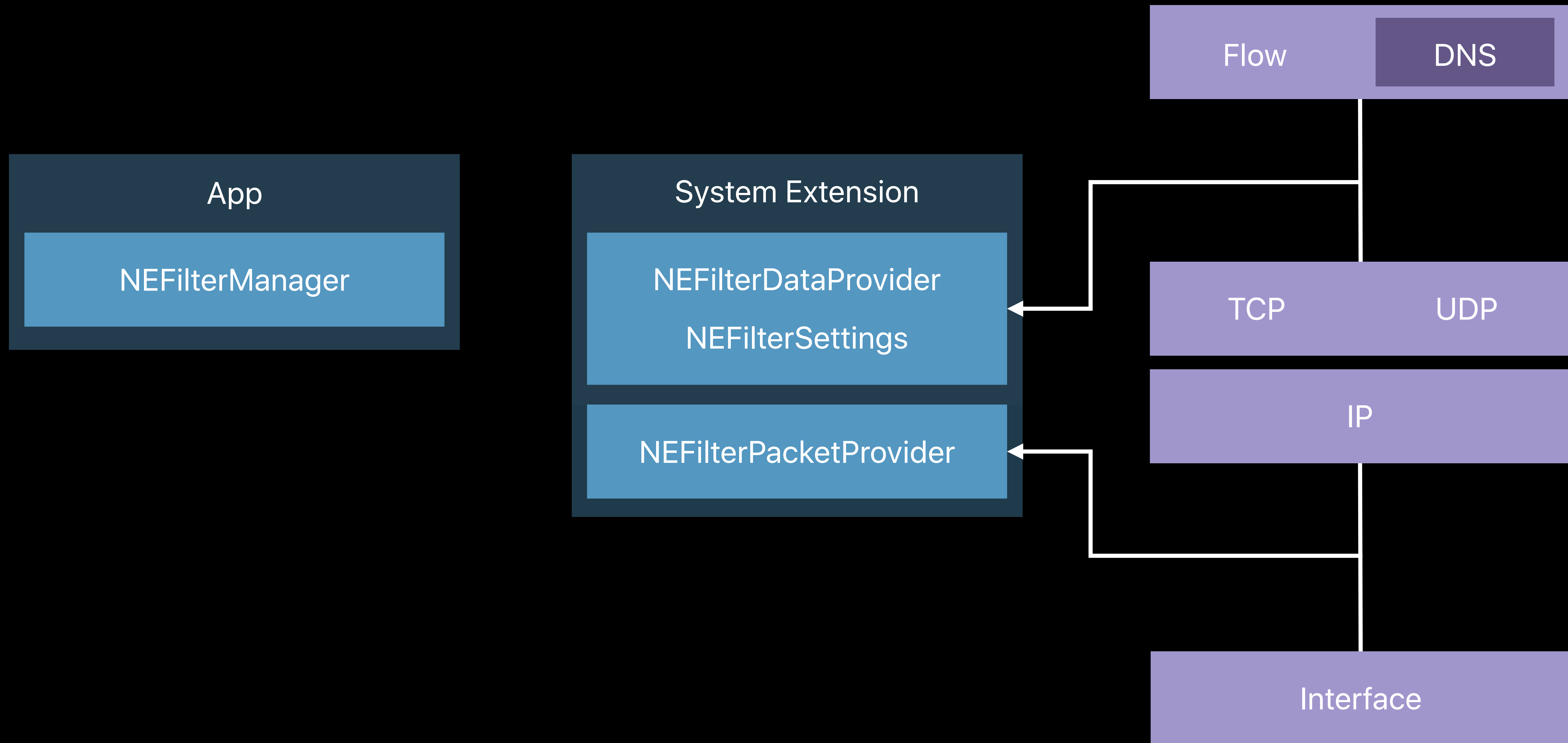
NEW



Content Filter

NetworkExtension Framework

NEW



Demo

Content Filter

Transparent Proxy

DNS Proxy

VPN

Virtual Machine

Custom Protocols

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Transparent Proxy

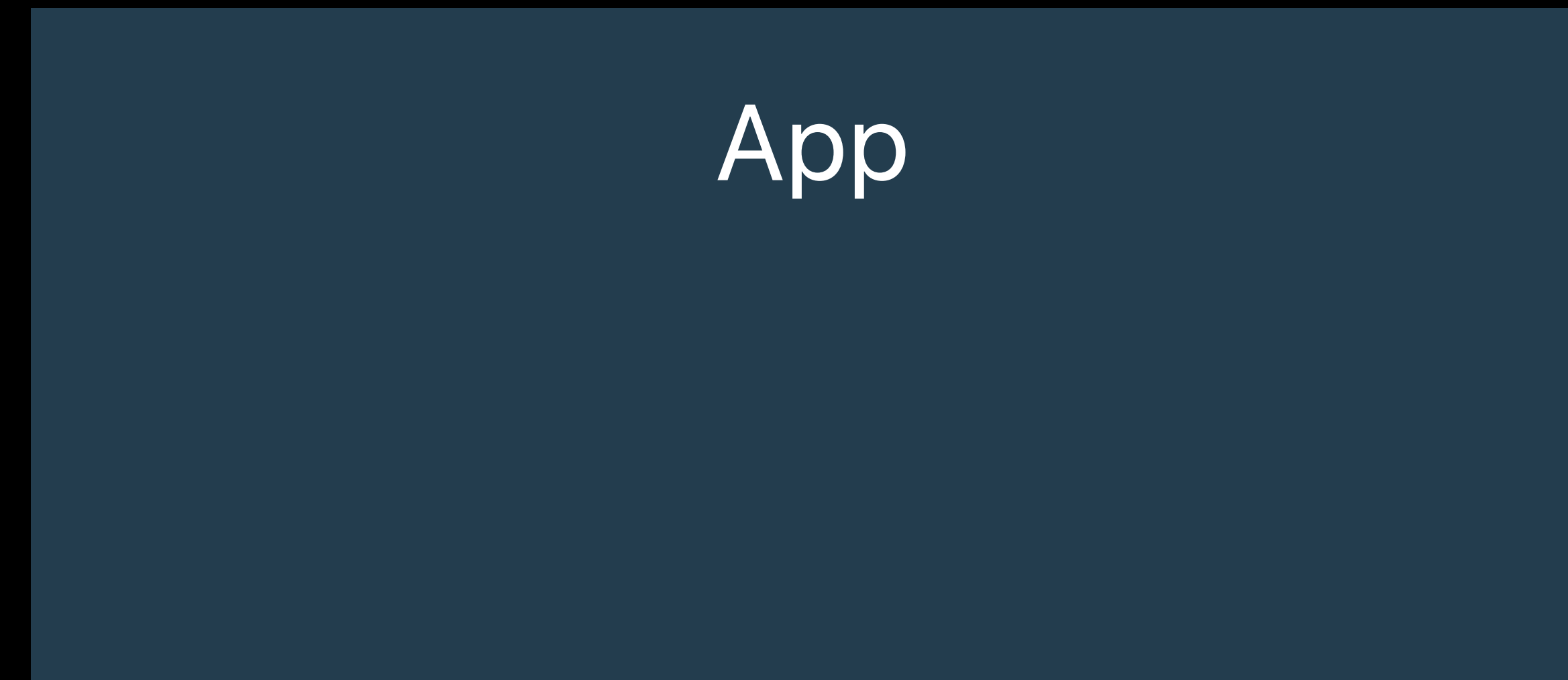
NetworkExtension Framework

NEW

Transparent Proxy

NetworkExtension Framework

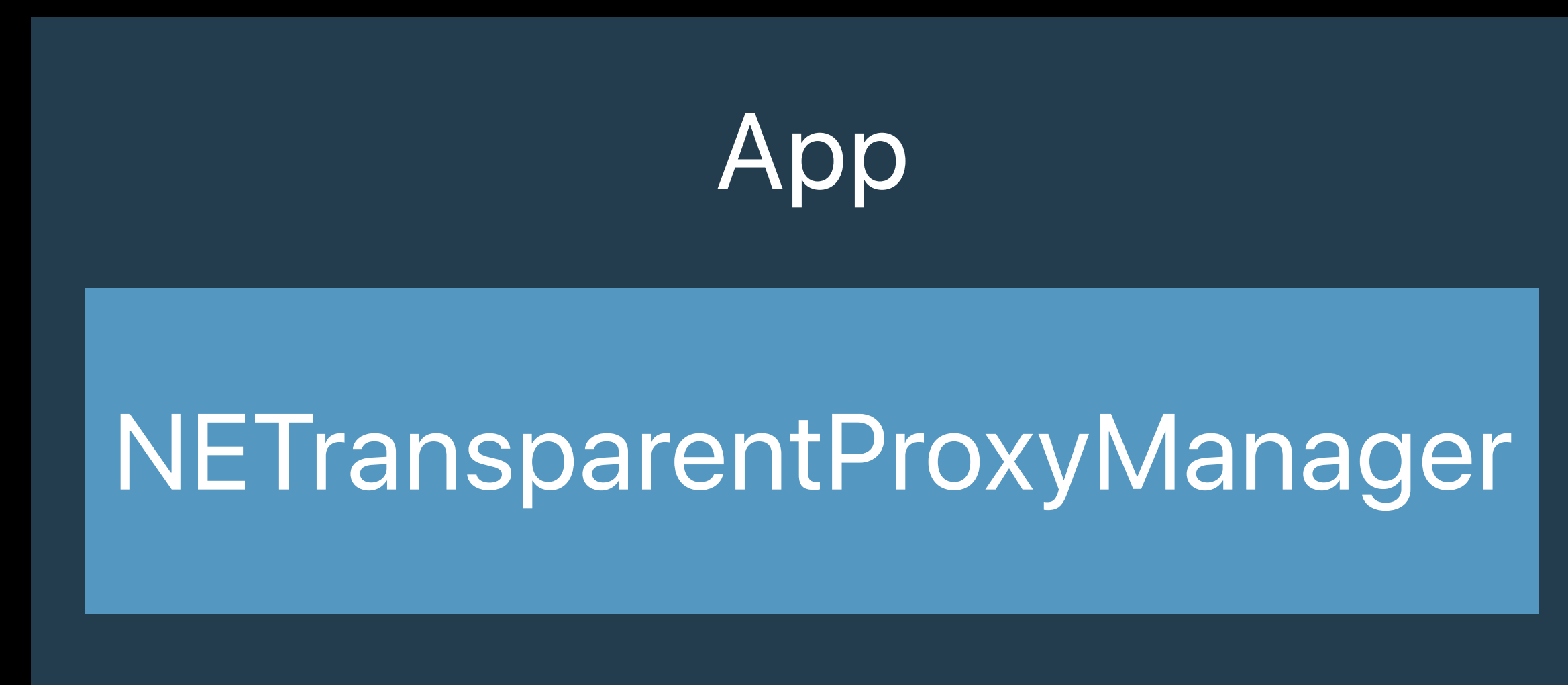
NEW



Transparent Proxy

NetworkExtension Framework

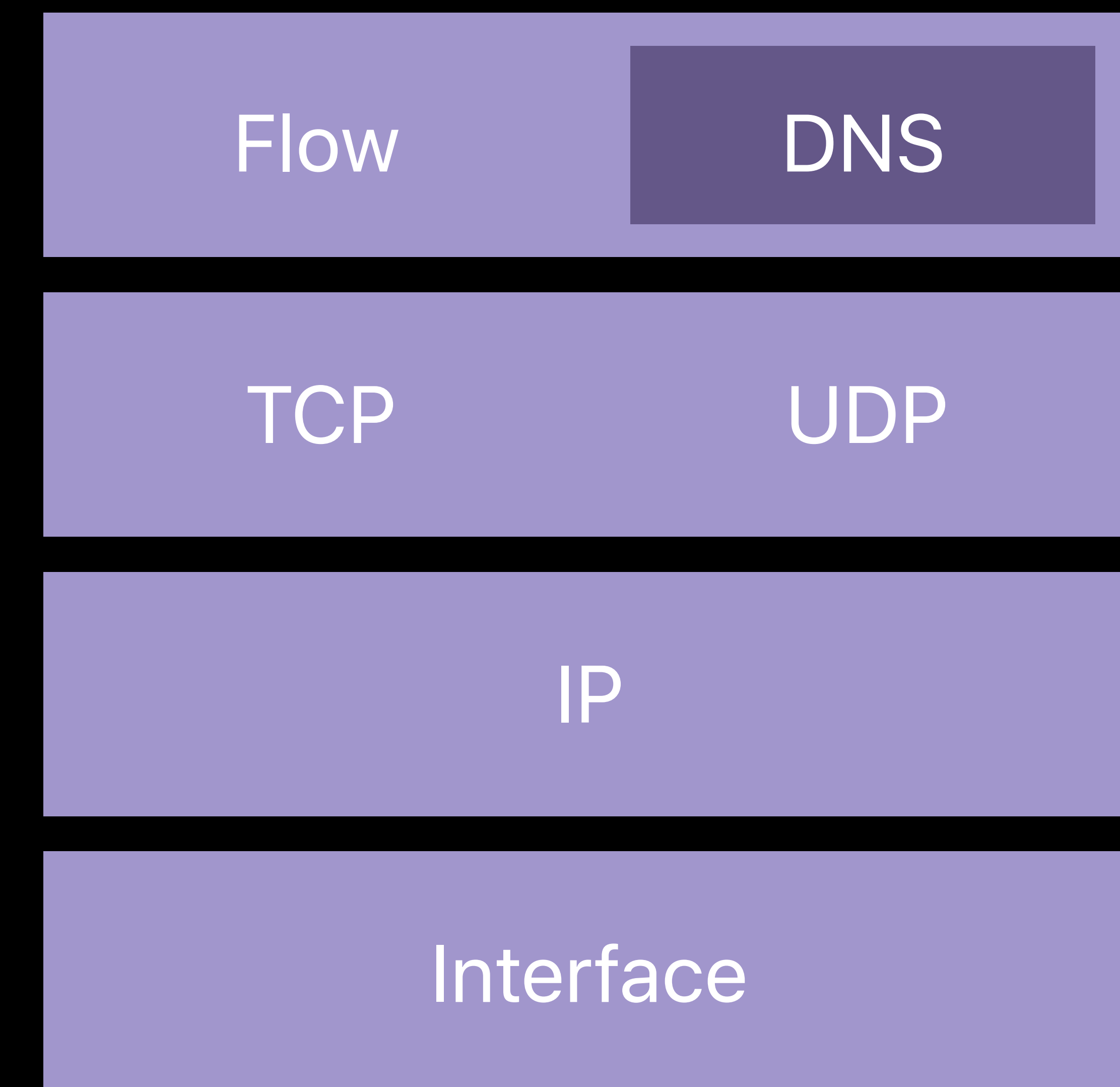
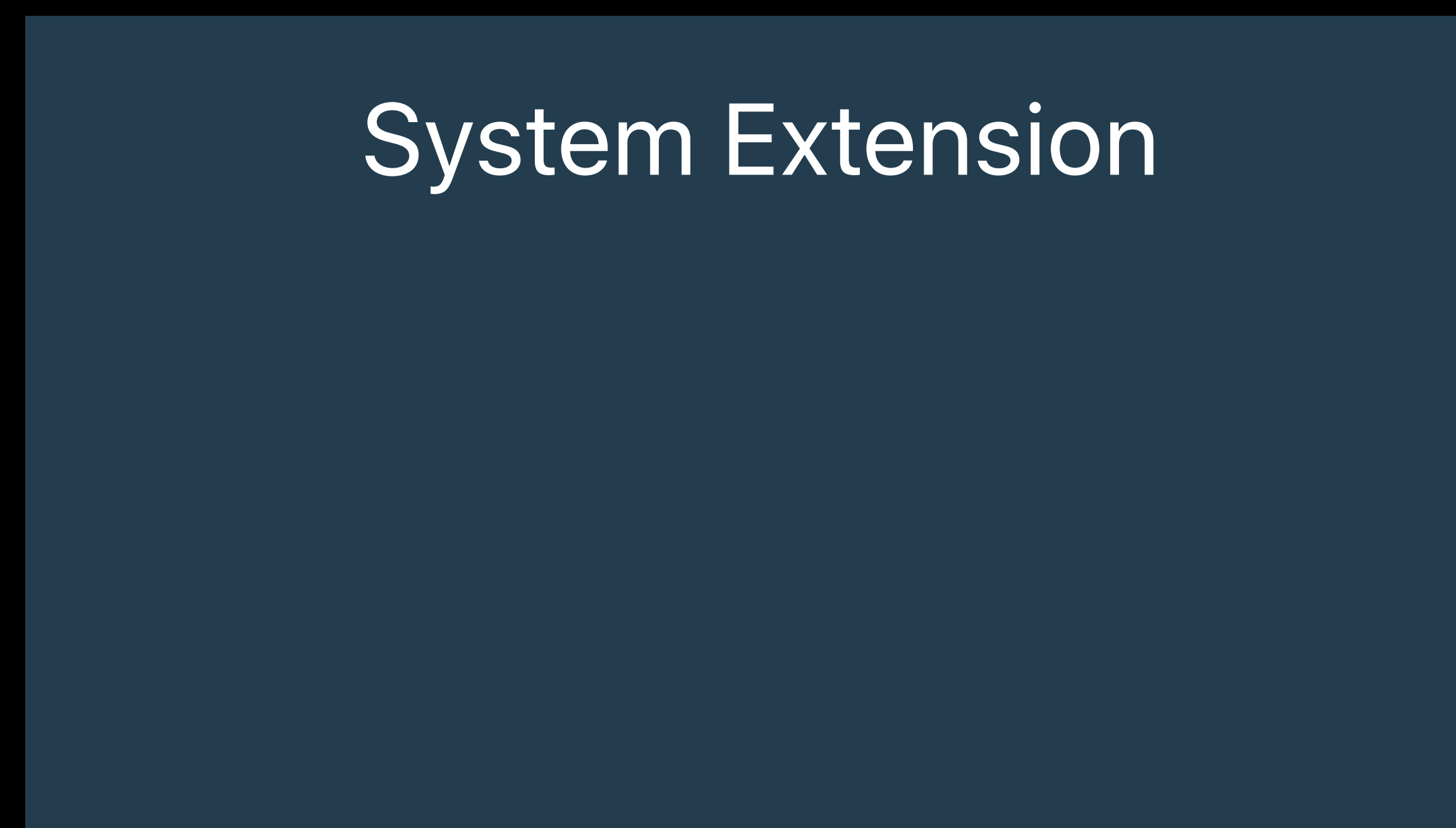
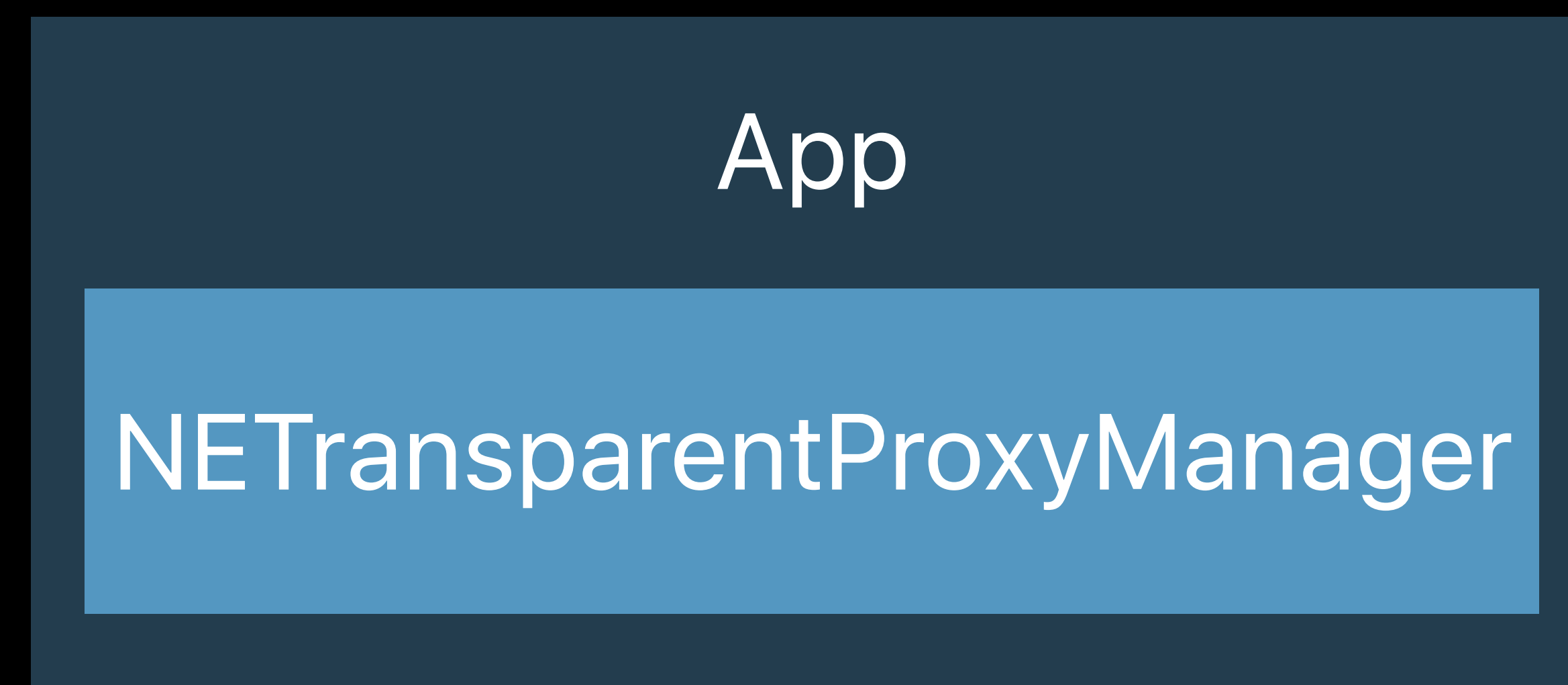
NEW



Transparent Proxy

NetworkExtension Framework

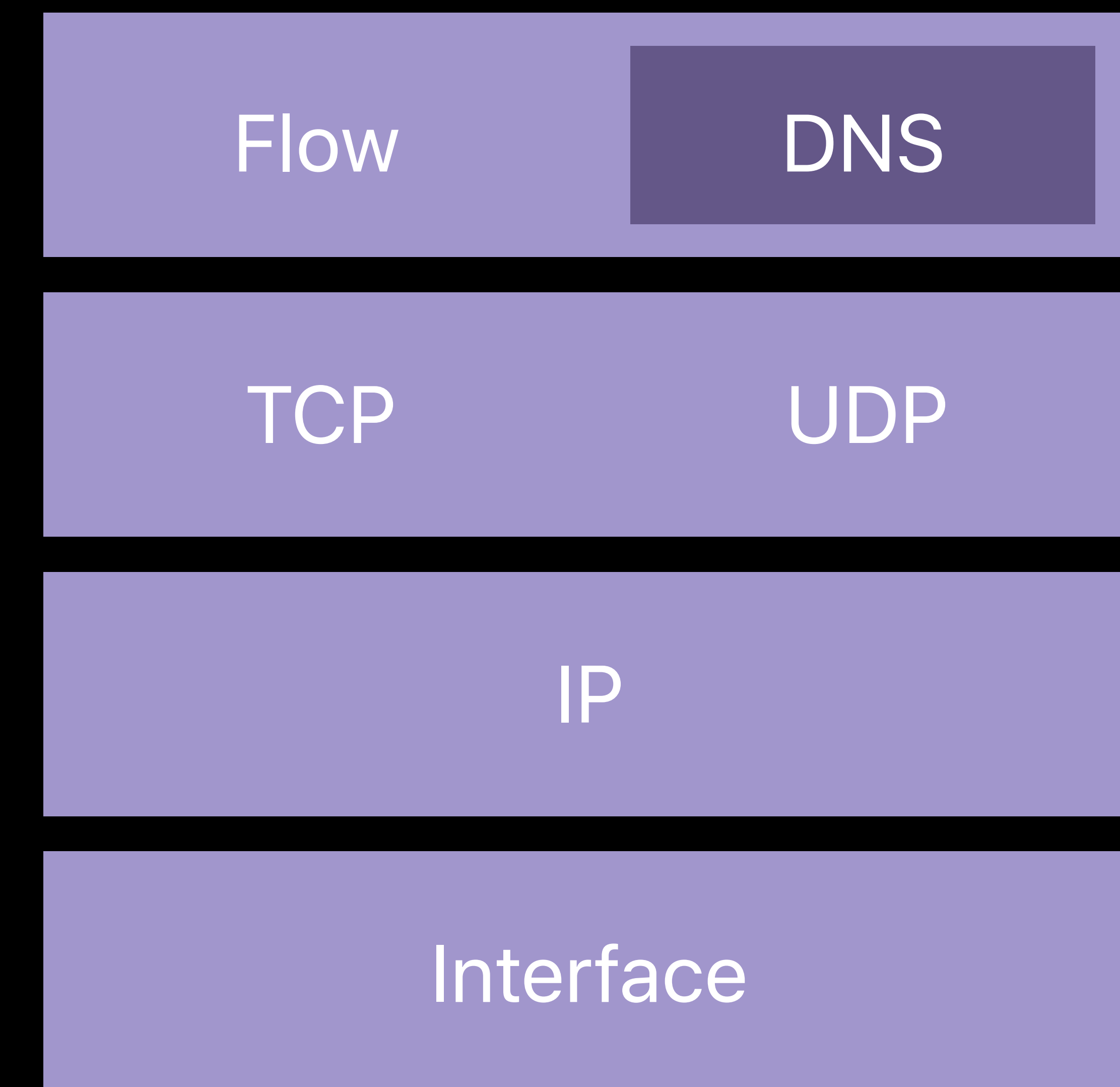
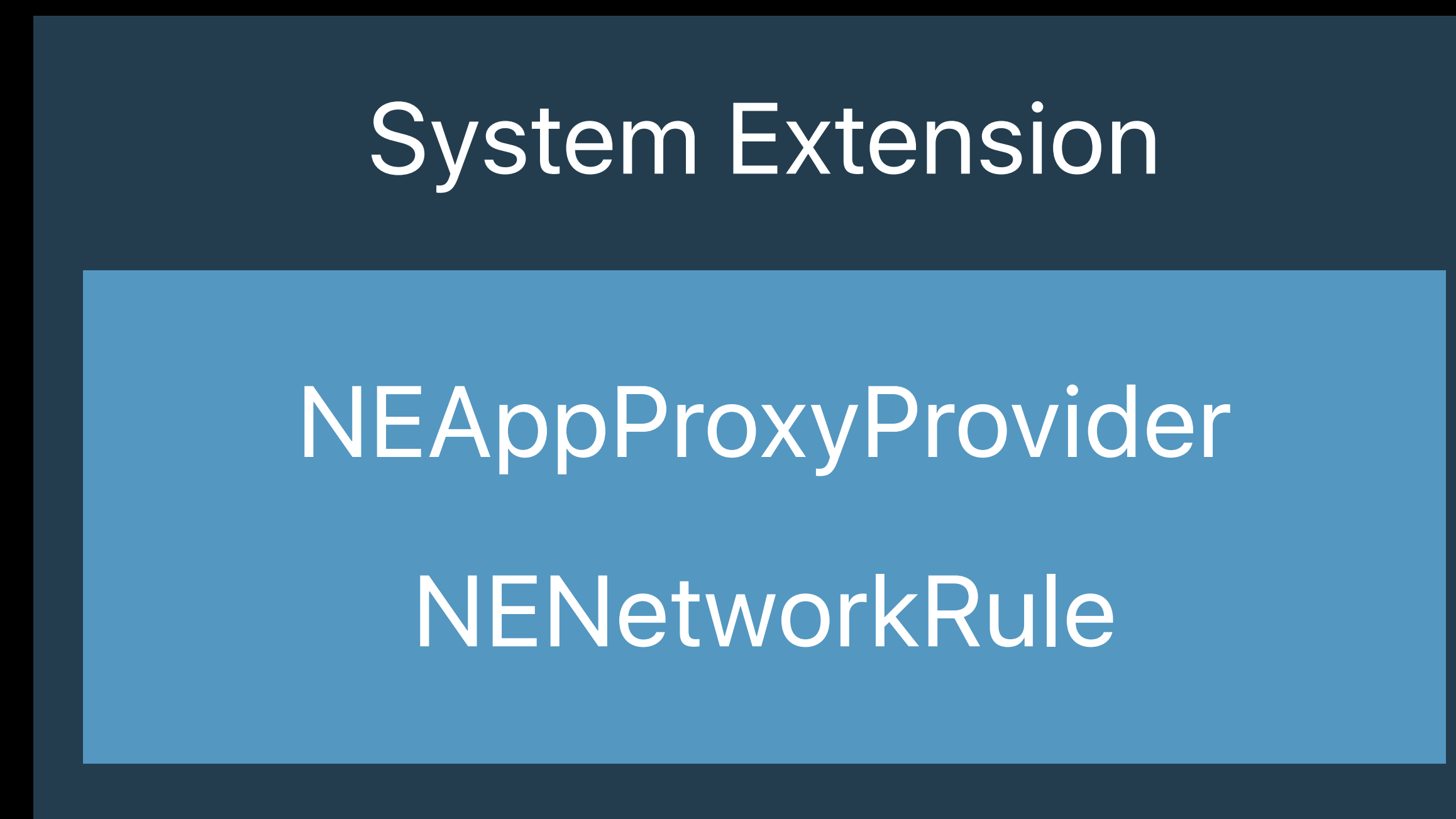
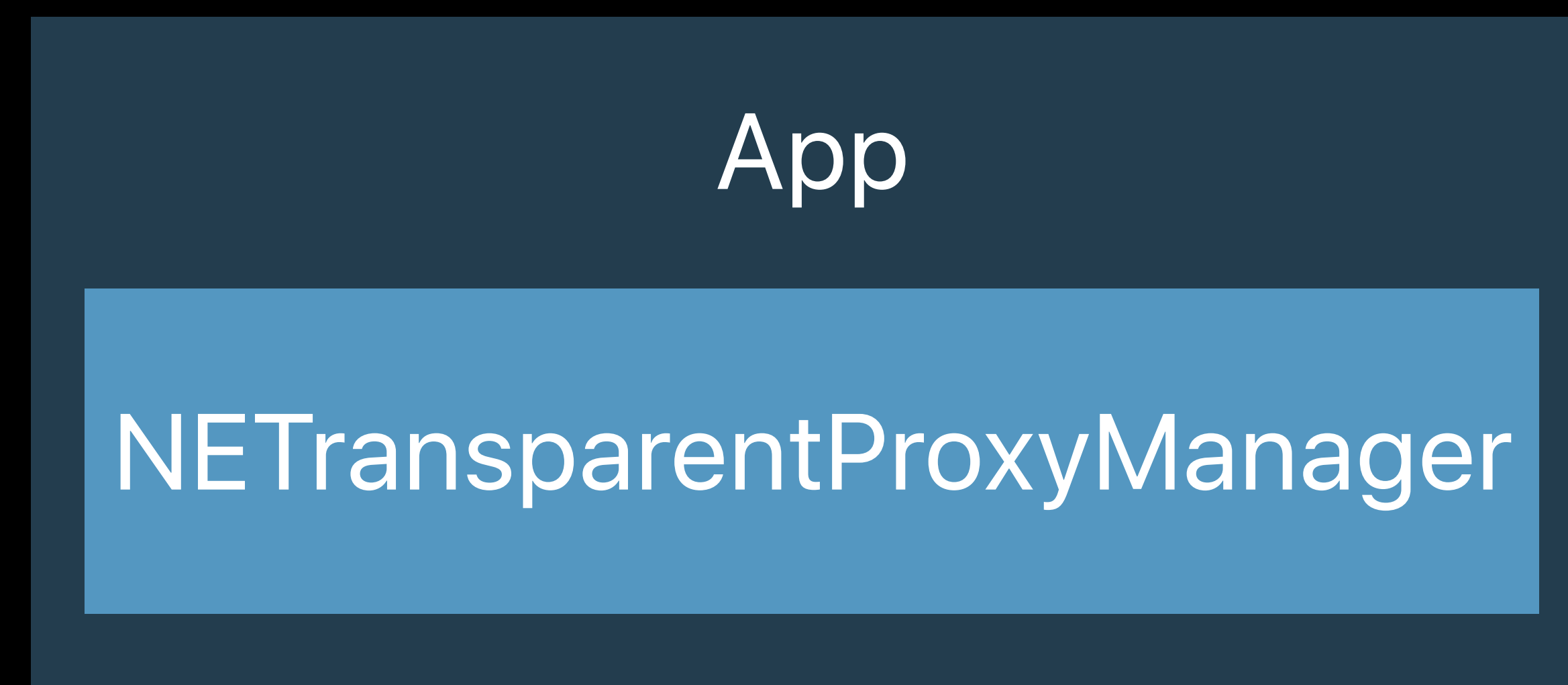
NEW



Transparent Proxy

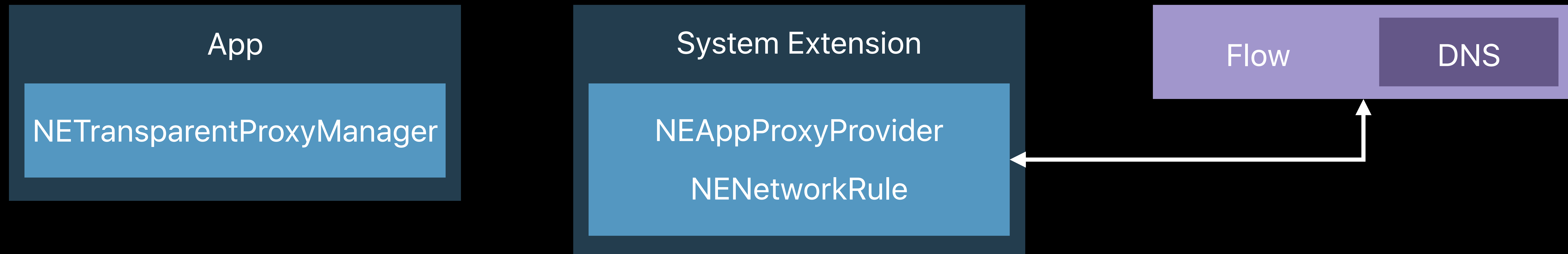
NetworkExtension Framework

NEW



Transparent Proxy

NetworkExtension Framework



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NEW

DNS Proxy

NetworkExtension Framework

NEW

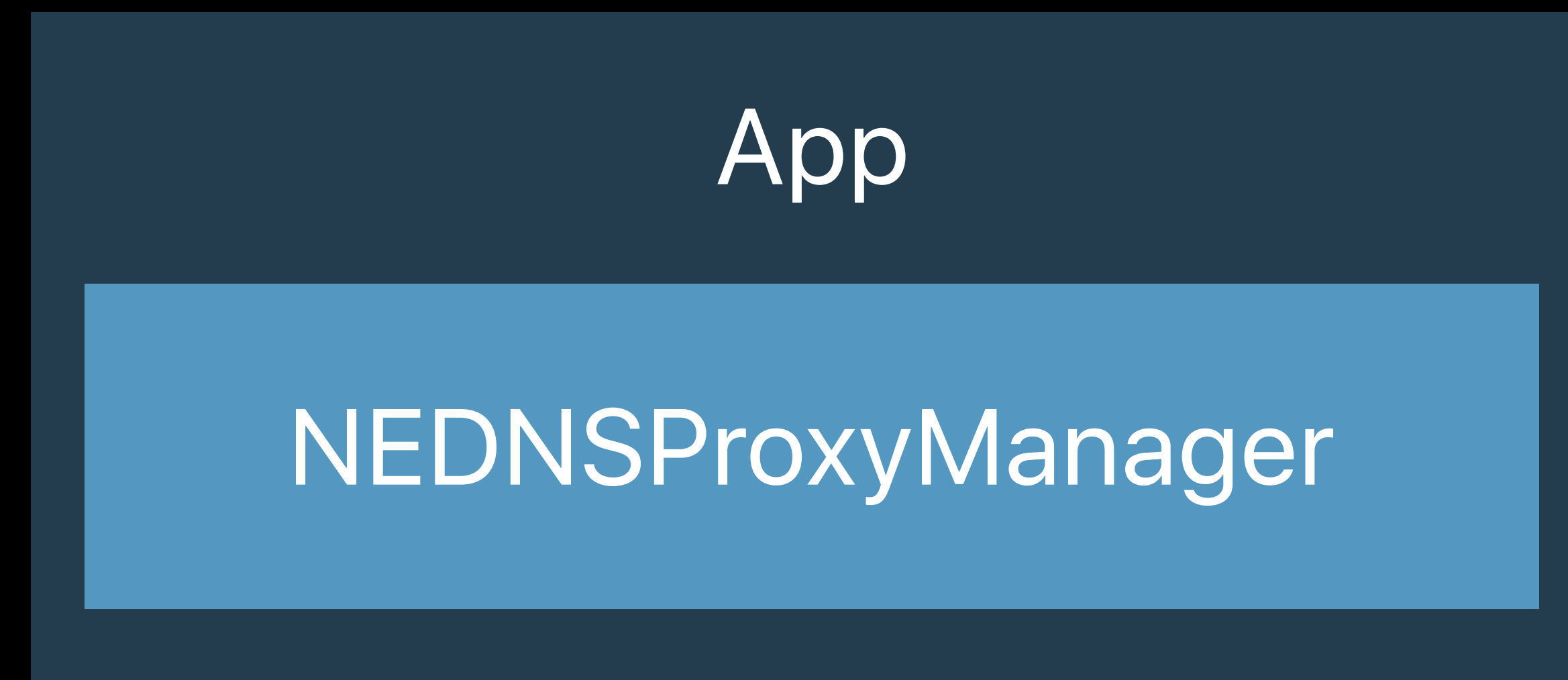


App

DNS Proxy

NetworkExtension Framework

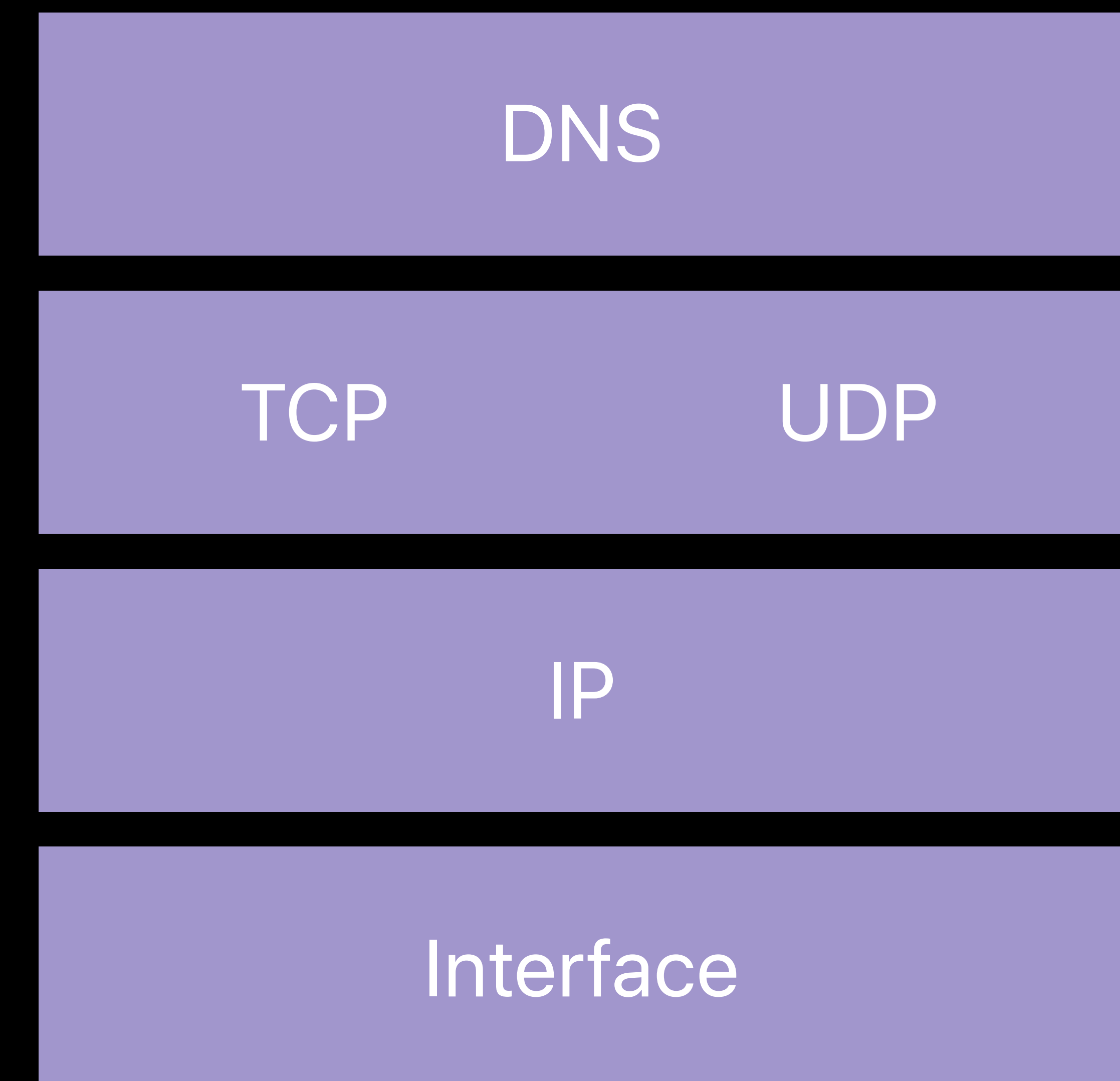
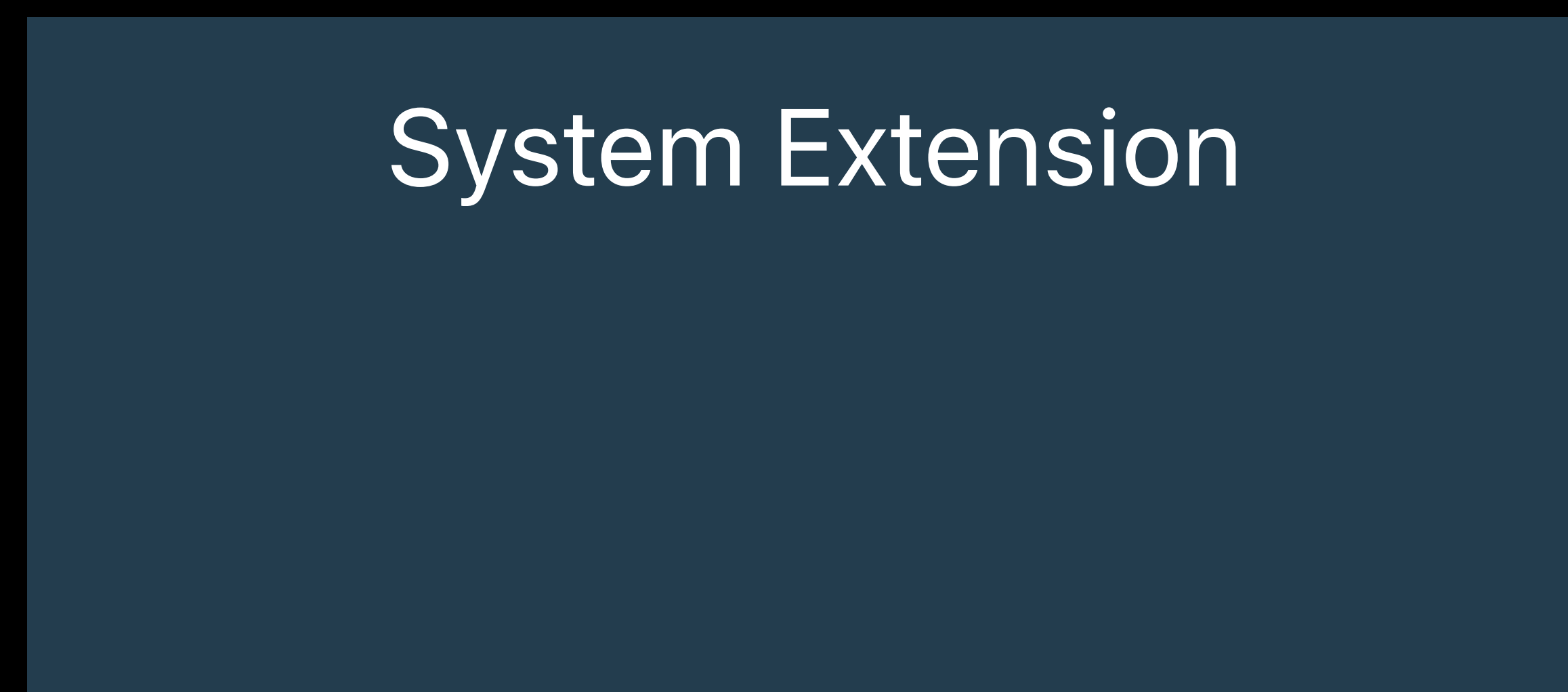
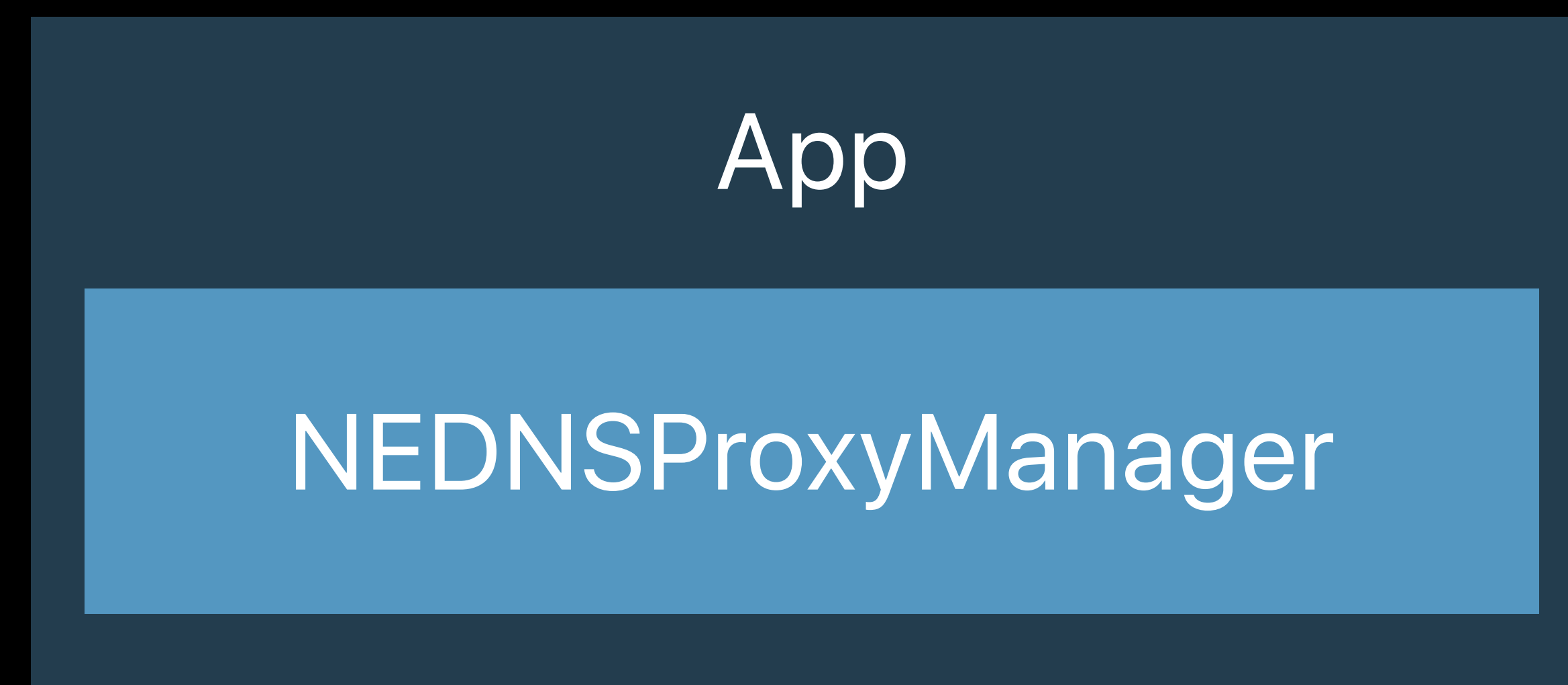
NEW



DNS Proxy

NetworkExtension Framework

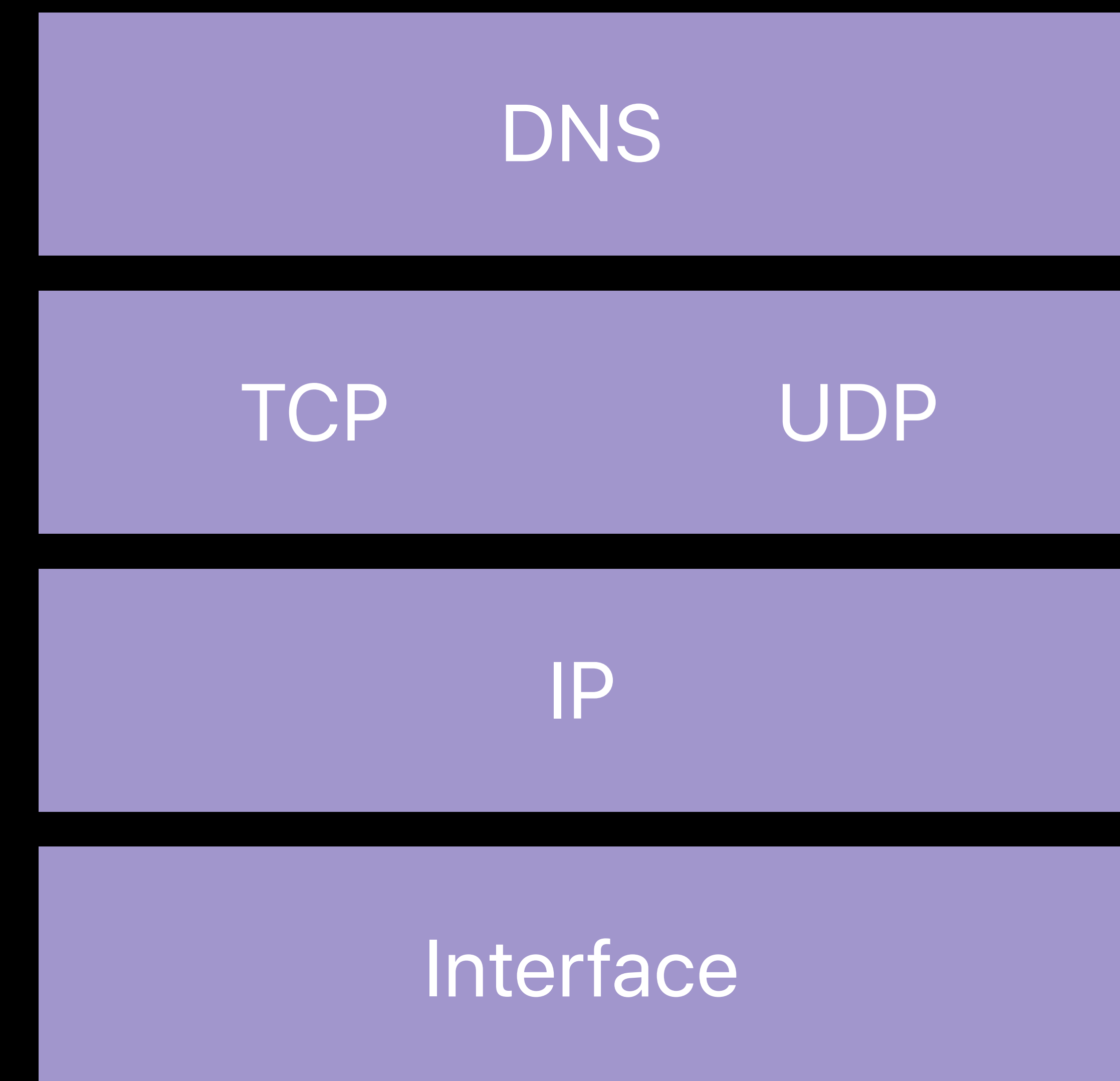
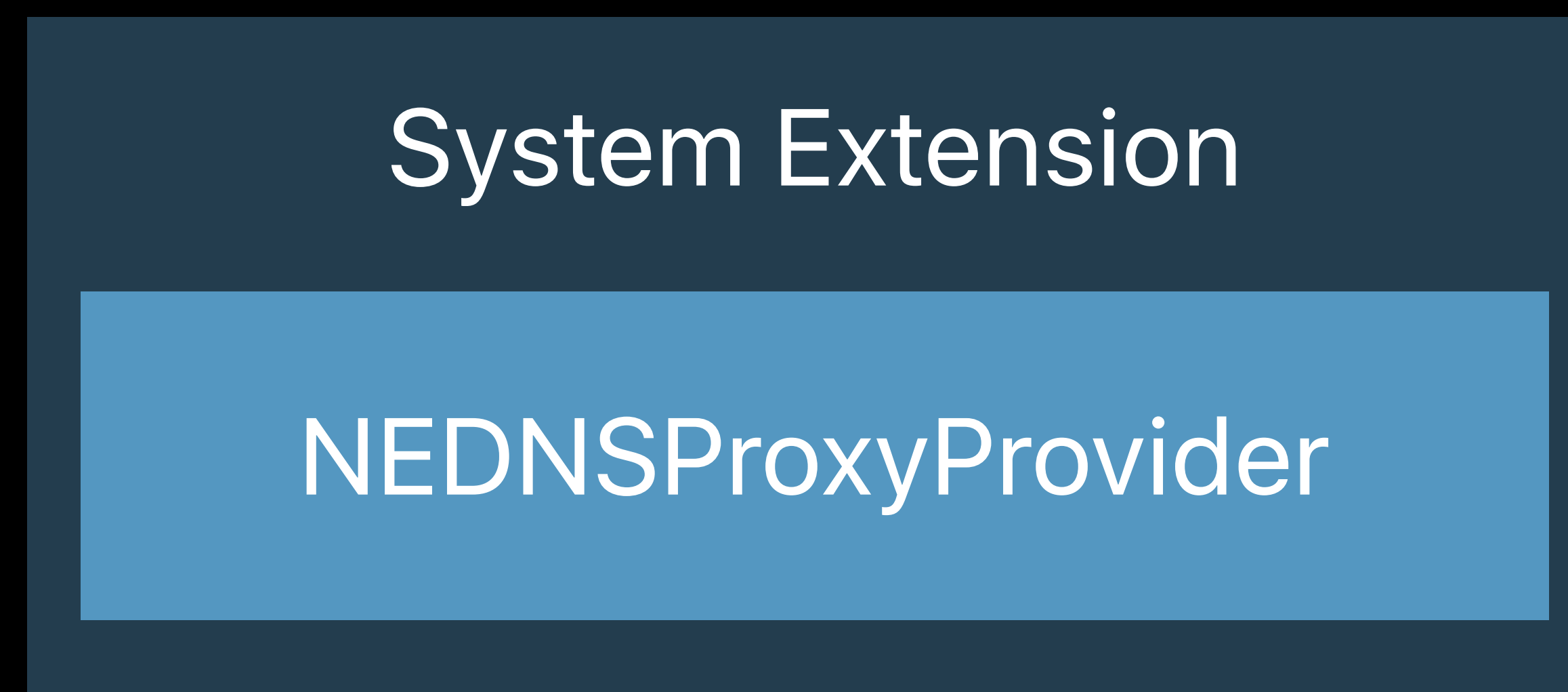
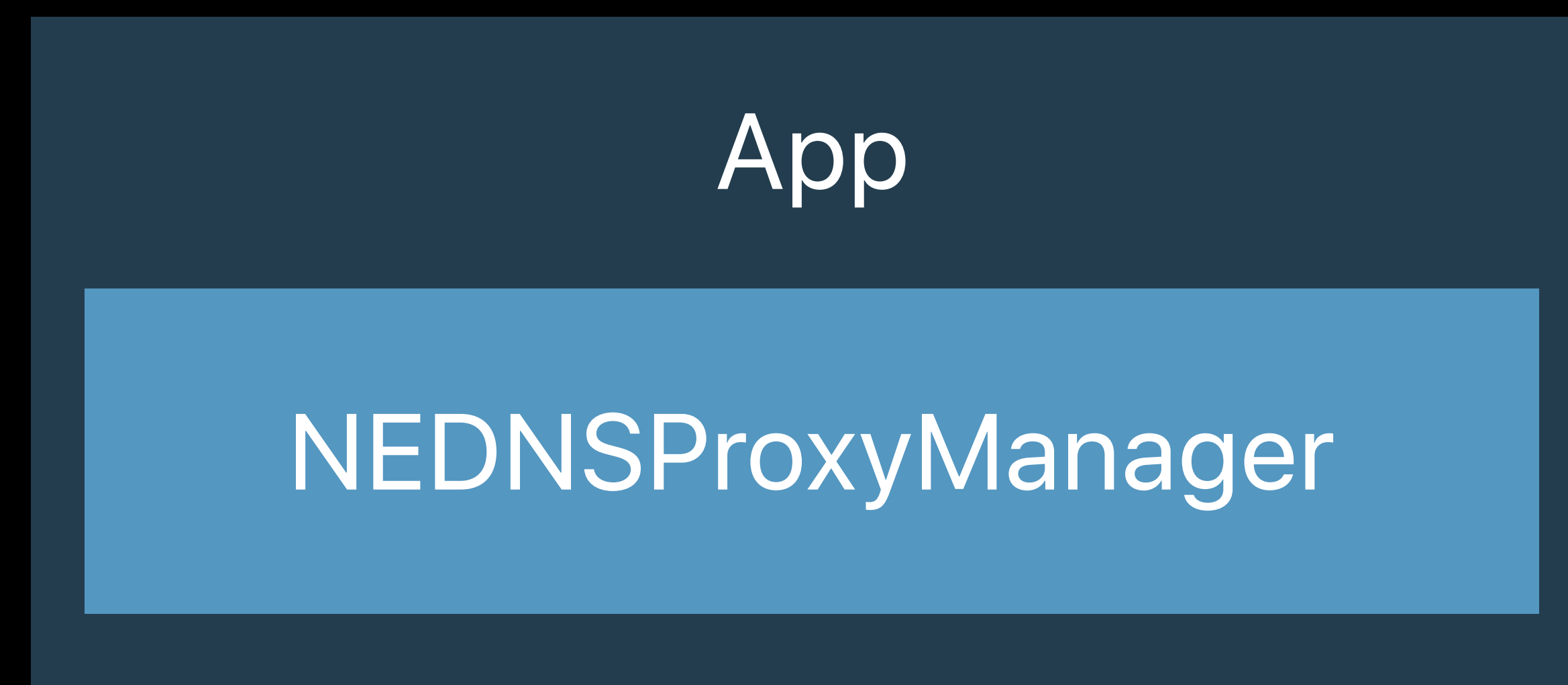
NEW



DNS Proxy

NetworkExtension Framework

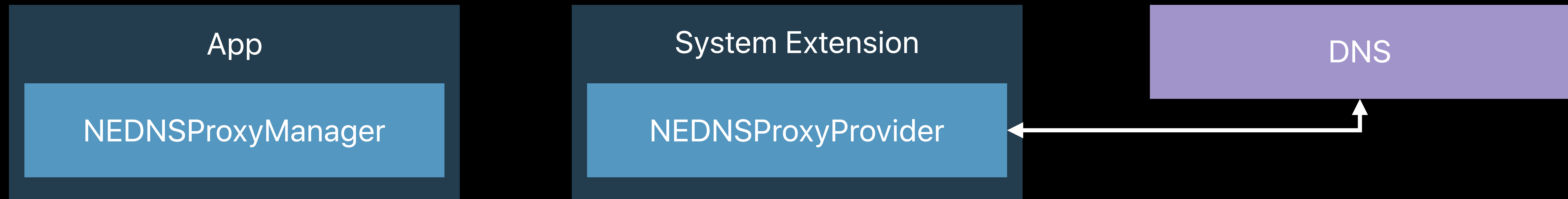
NEW



DNS Proxy

NetworkExtension Framework

NEW



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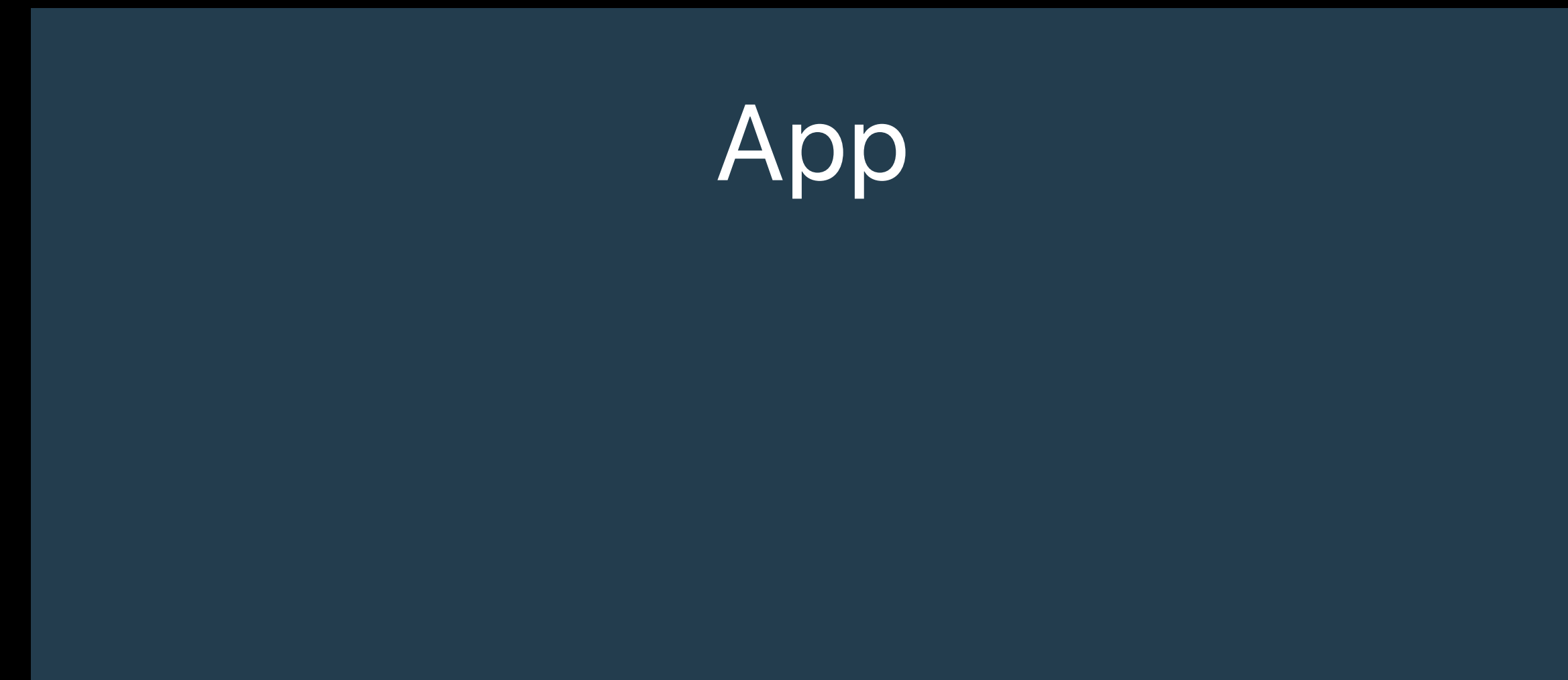
Custom Protocols

VPN

NetworkExtension Framework

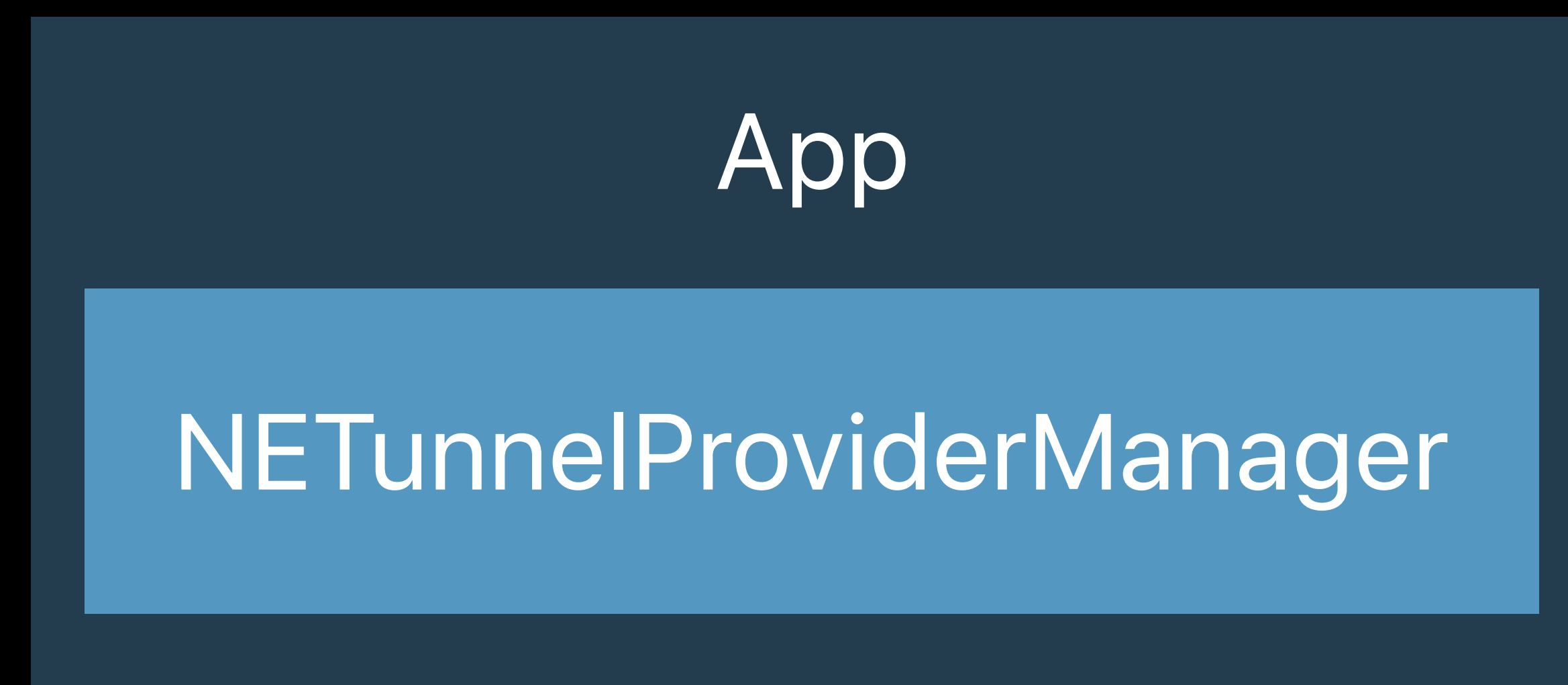
VPN

NetworkExtension Framework



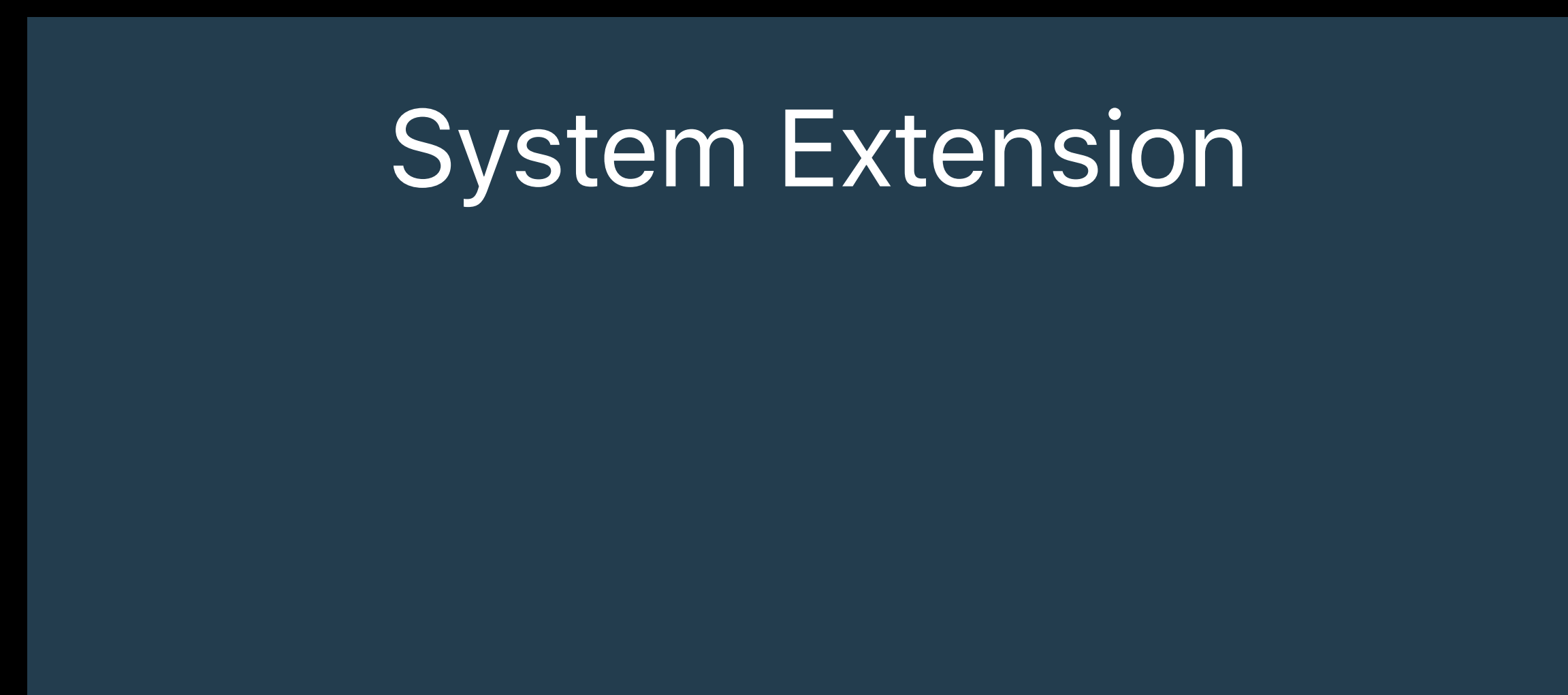
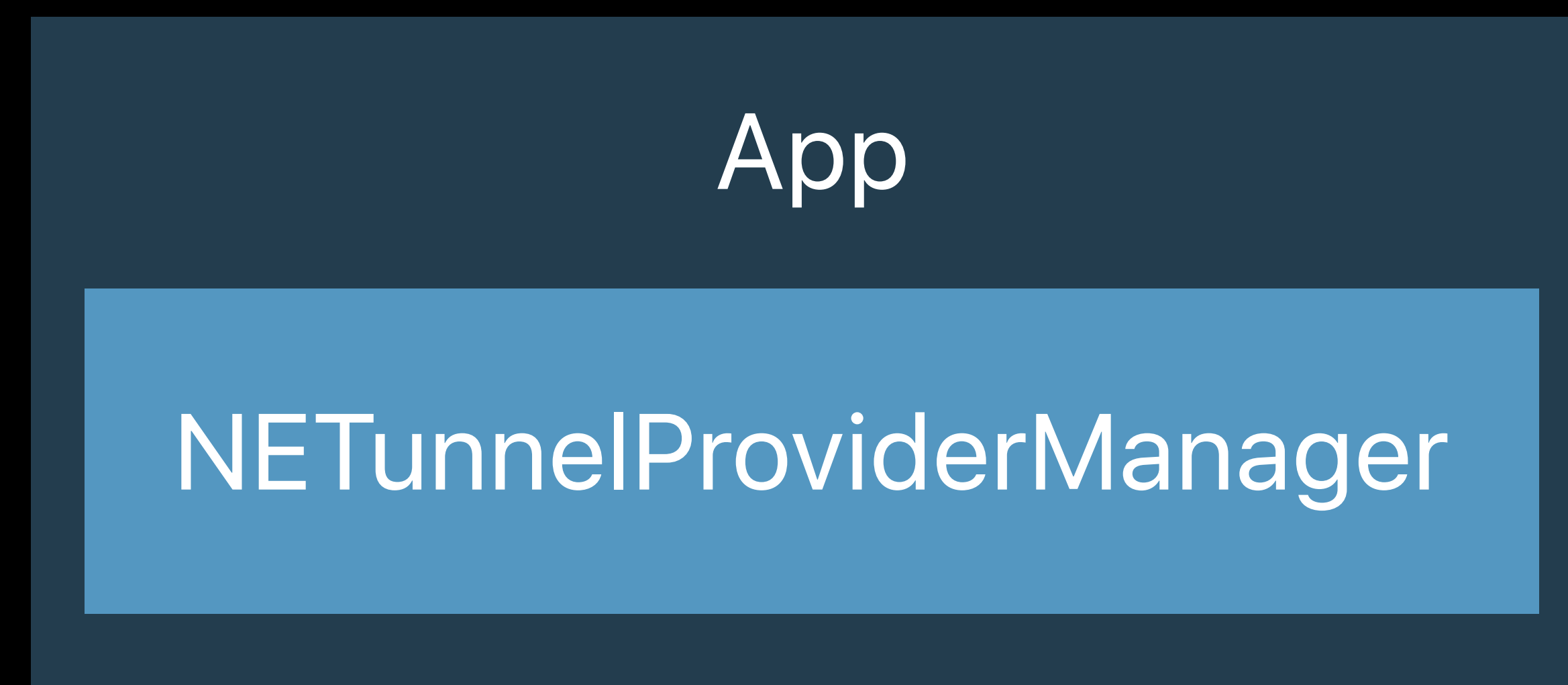
VPN

NetworkExtension Framework



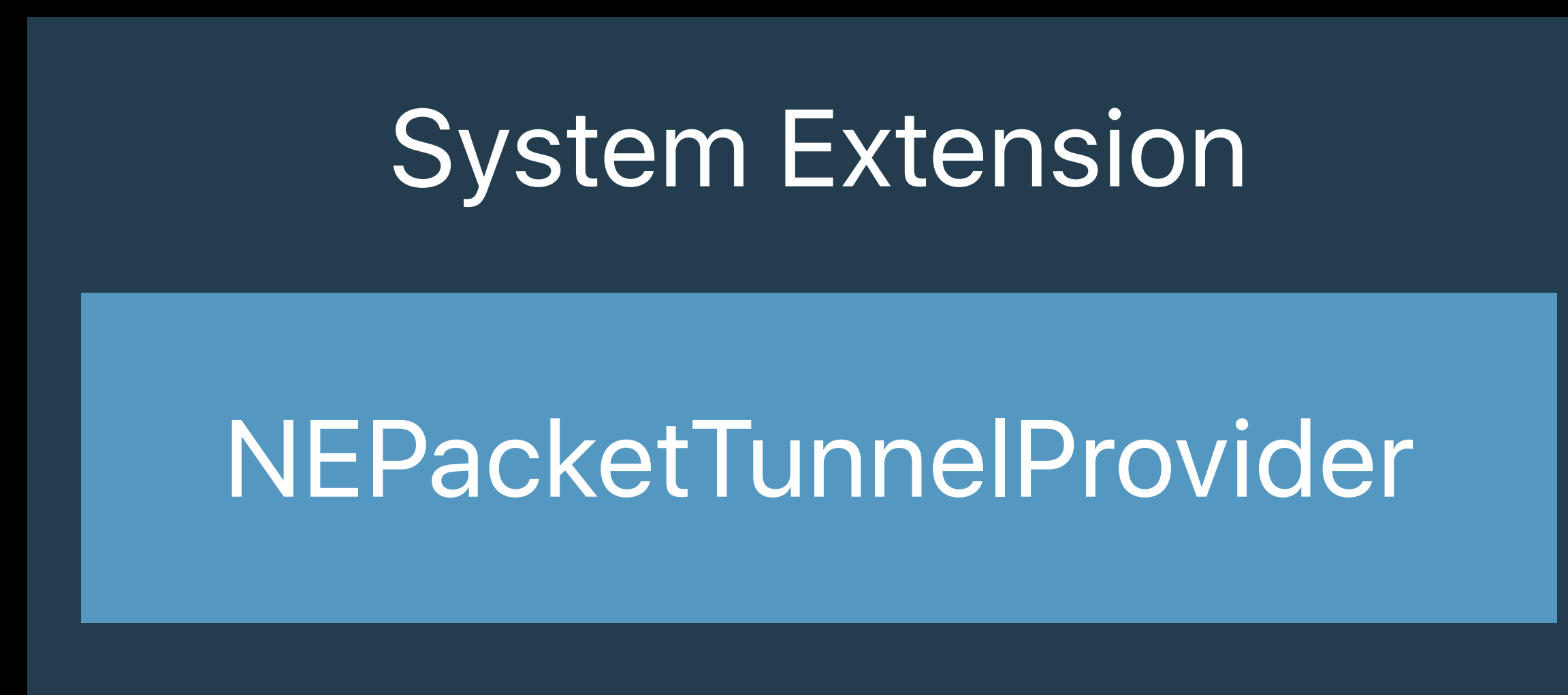
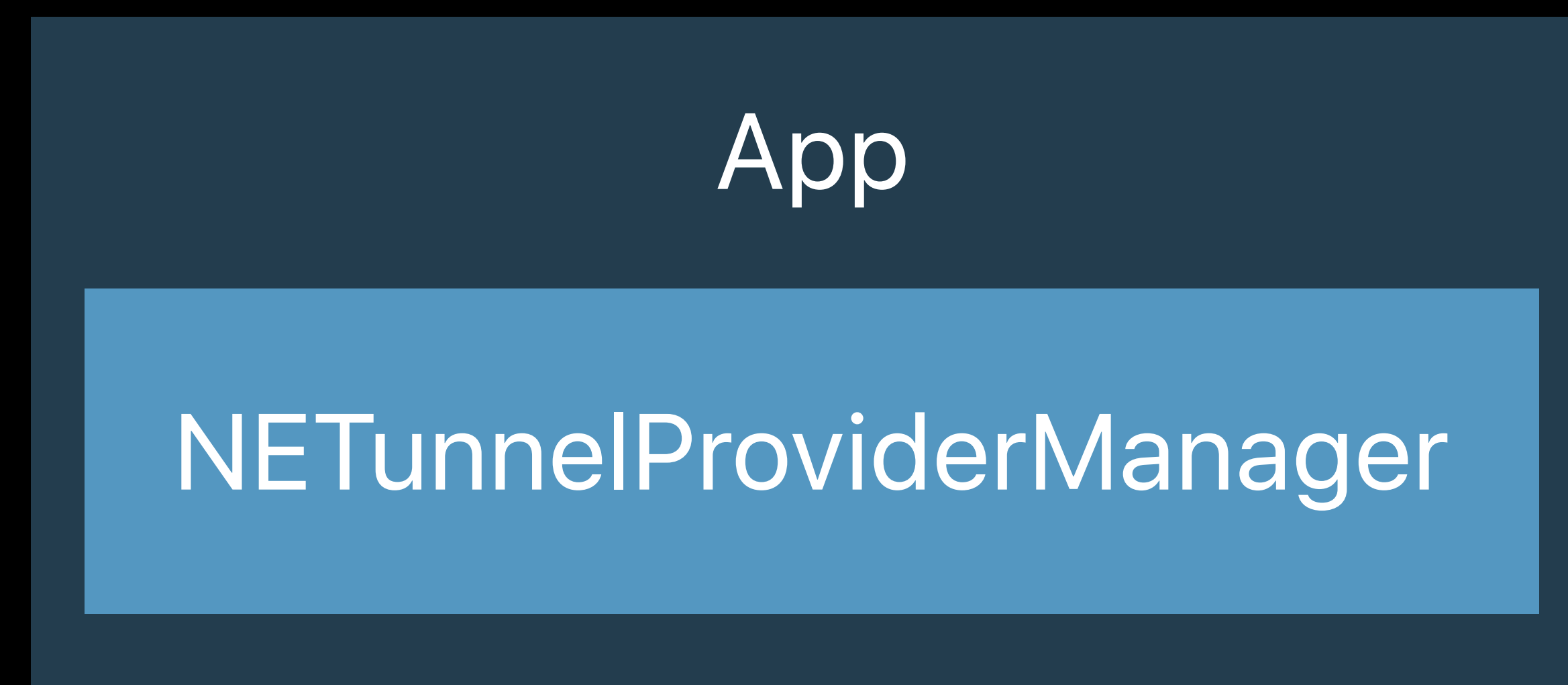
VPN

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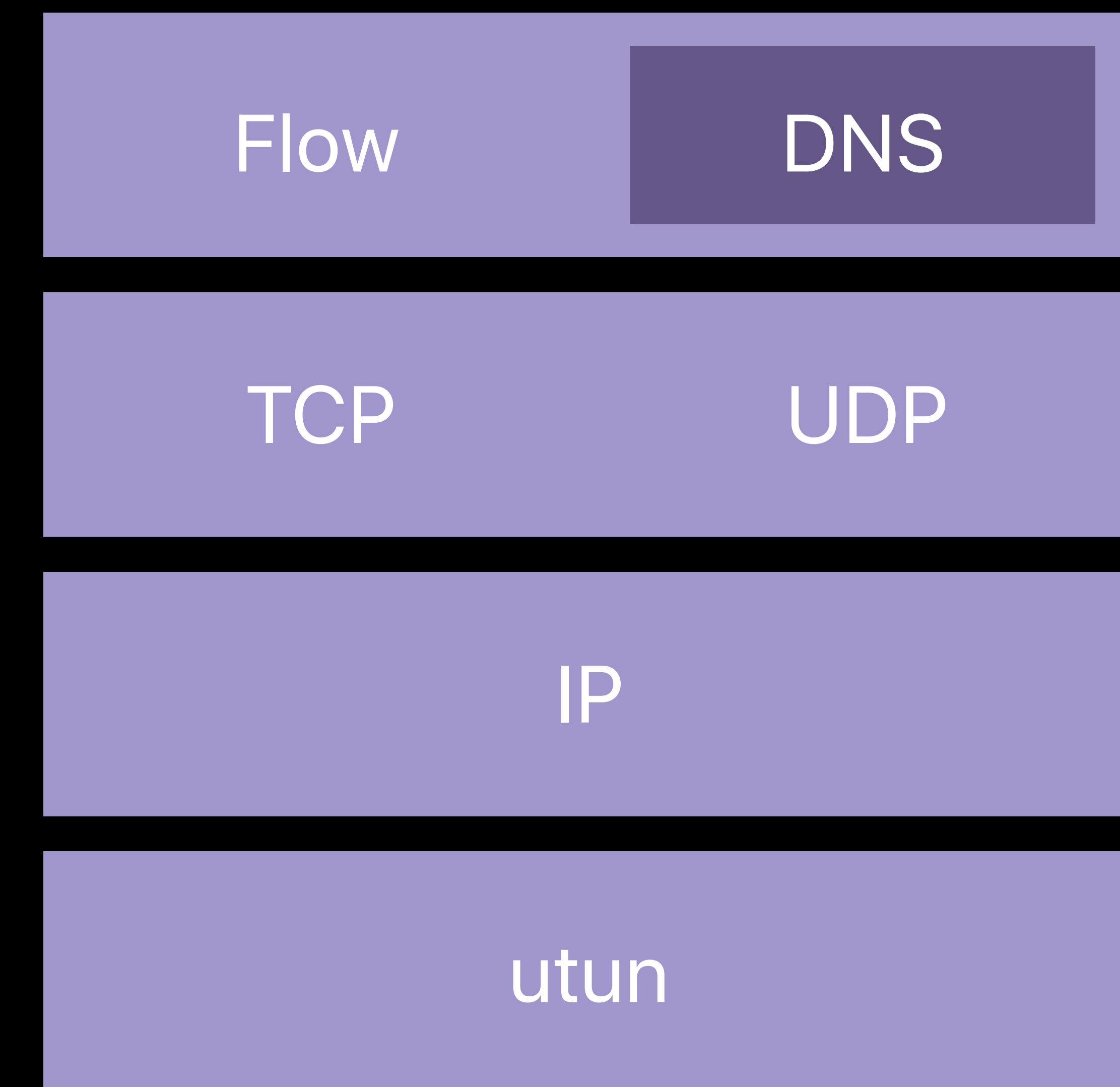
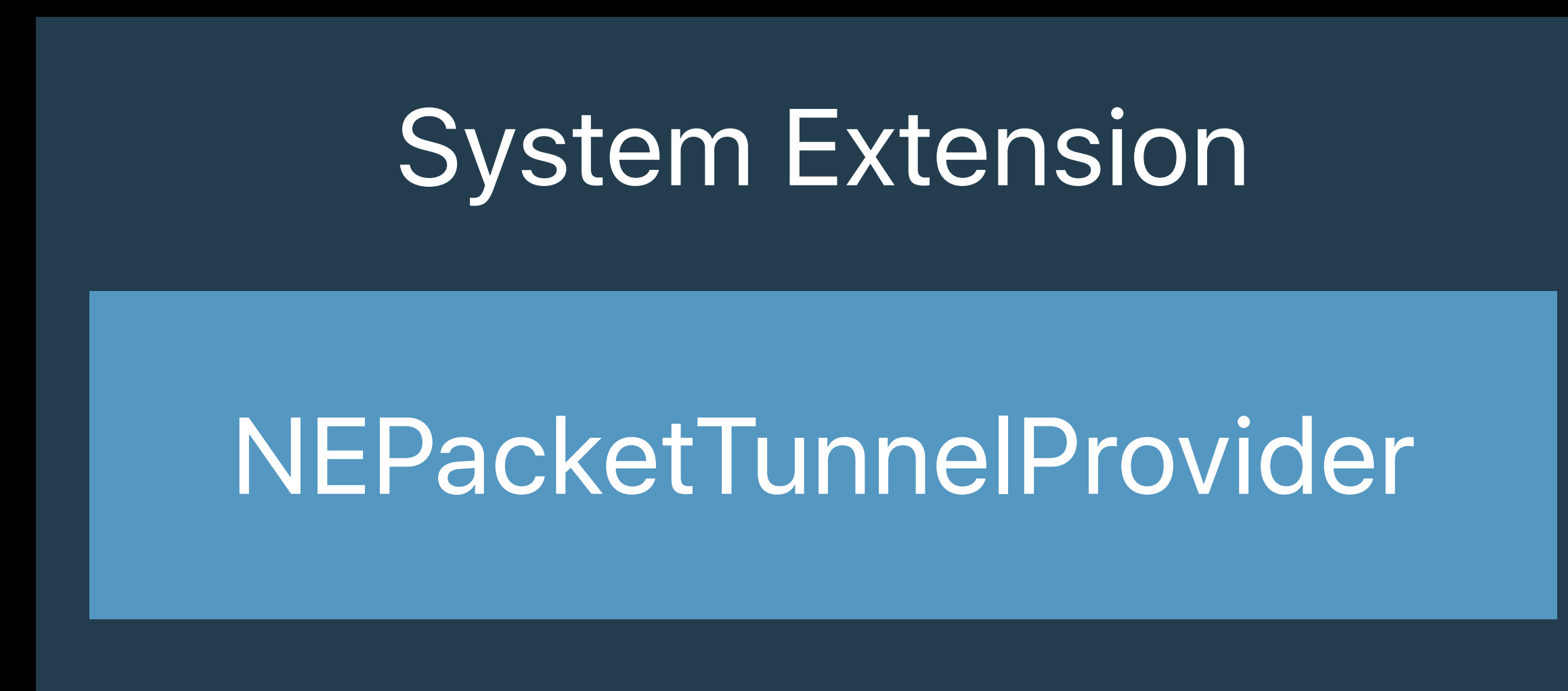
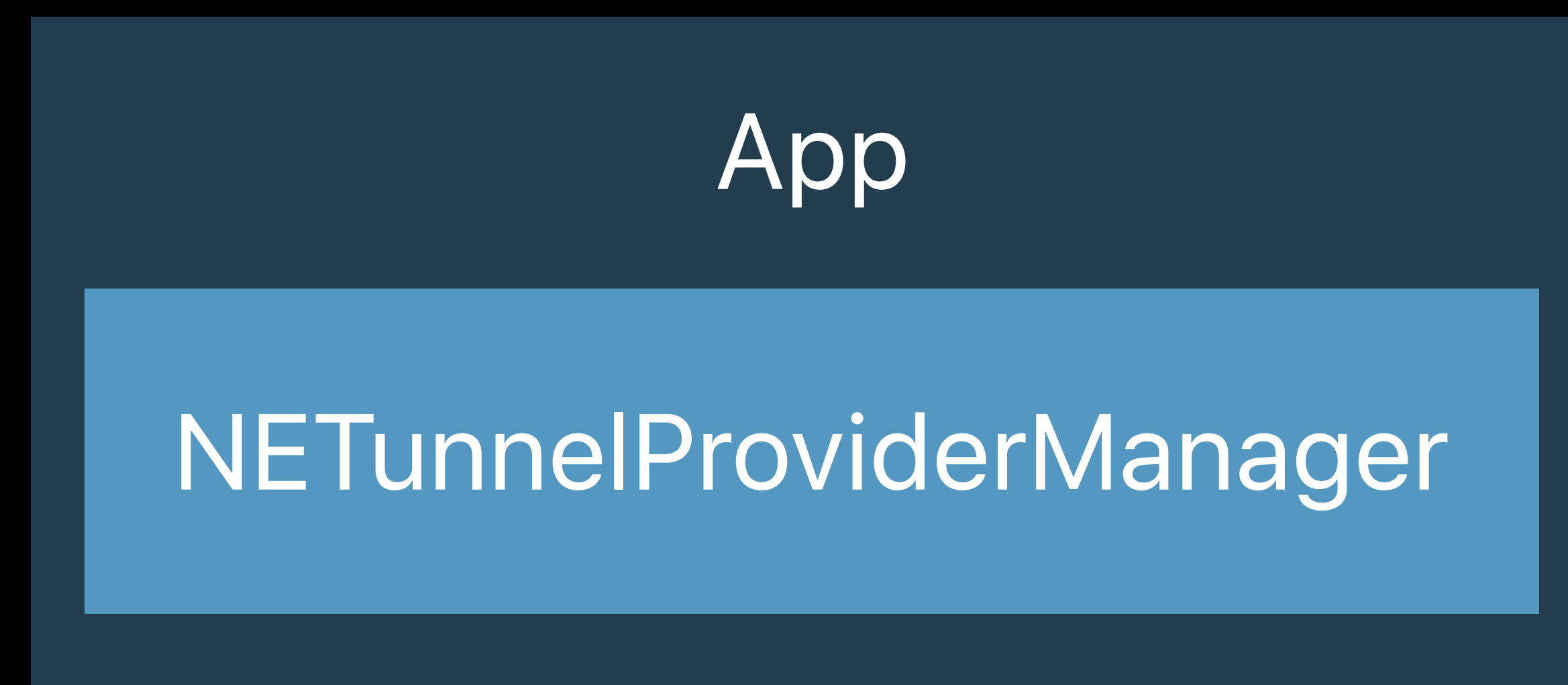
VPN

NetworkExtension Framework



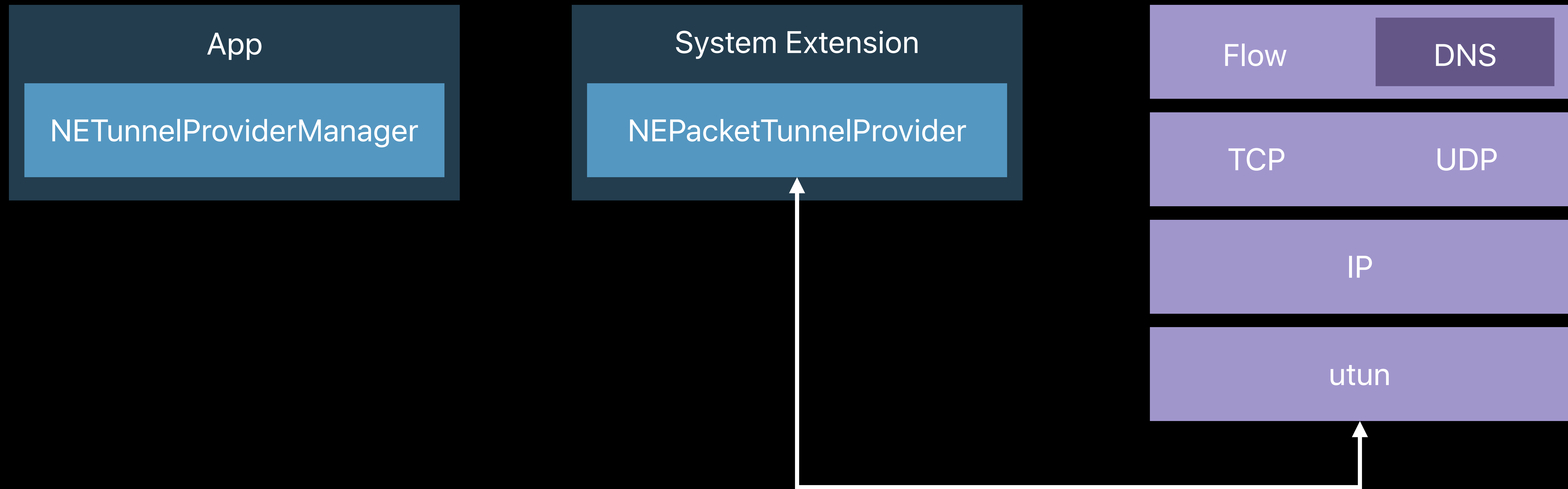
VPN

NetworkExtension Framework



VPN

NetworkExtension Framework



VPN

NetworkExtension Framework



NEW

includeAllNetworks

excludeLocalNetworks

Per-App VPN

NetworkExtension Framework



NEW

MailDomains

CalendarDomains

ContactsDomains

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Custom Protocols

Content Filter

Transparent Proxy

DNS Proxy

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Virtual Machine

Custom Protocols

Virtual Machine

vmnet.framework

Shared Mode enhancements NEW

- IPv6
- Specify IP range of inside network
- Port Forwarding

Bridged Mode NEW

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Custom Protocols

Custom IP Protocol

Network Framework

Custom IP Protocol

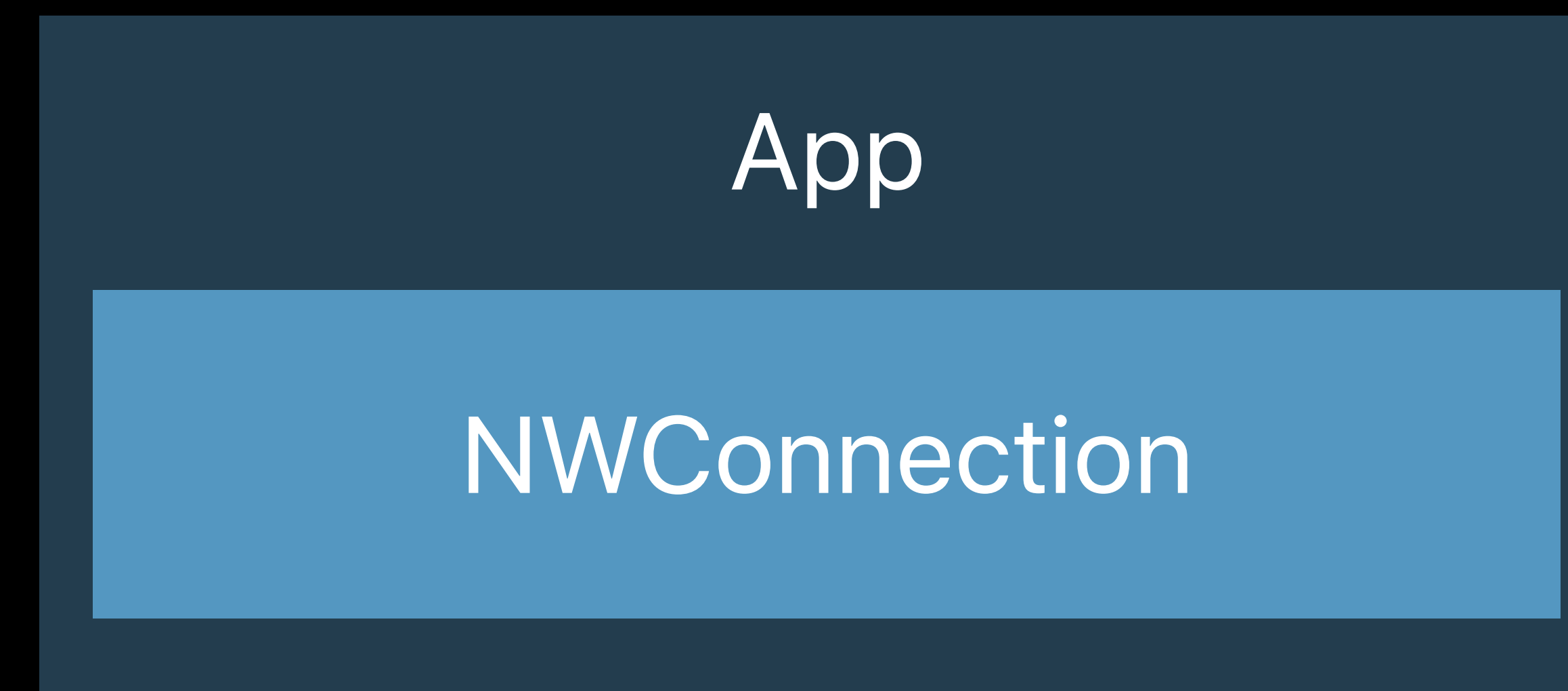
Network Framework



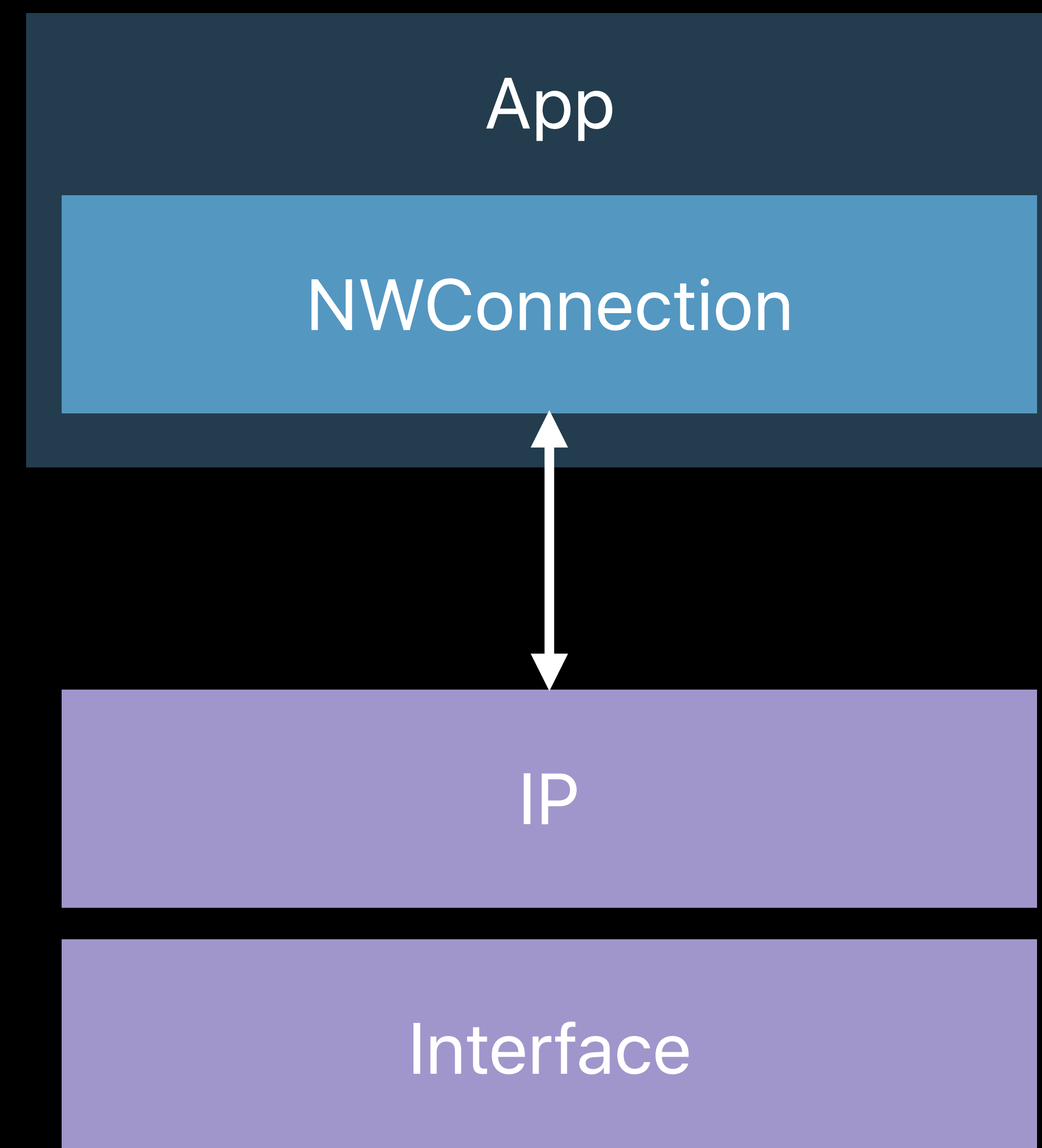
App

Custom IP Protocol

Network Framework



Custom IP Protocol Network Framework



```
let parameters = NWParameters(customIPProtocolNumber: 123)

let destination = NWEndpoint.hostPort(host: "fe80::70", port: 0)
let connection = NWConnection(to: destination, using: parameters)

connection.start(queue: .main)
connection.send(content: packet, completion: .contentProcessed({ error in
    // Check for errors
}))
```

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let parameters = NWParameters(customIPProtocolNumber: 123)

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Custom Link Layer Protocol

Network Framework

Custom Link Layer Protocol

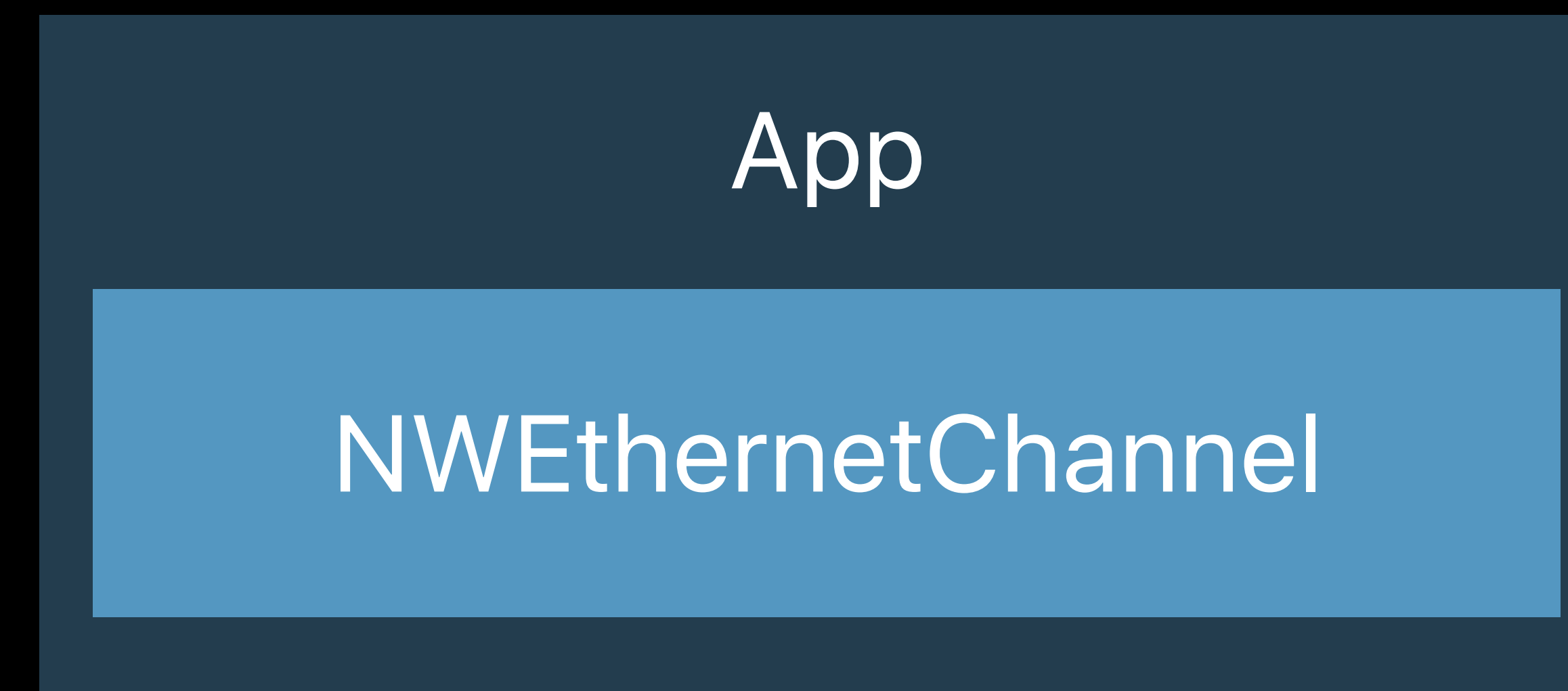
Network Framework



App

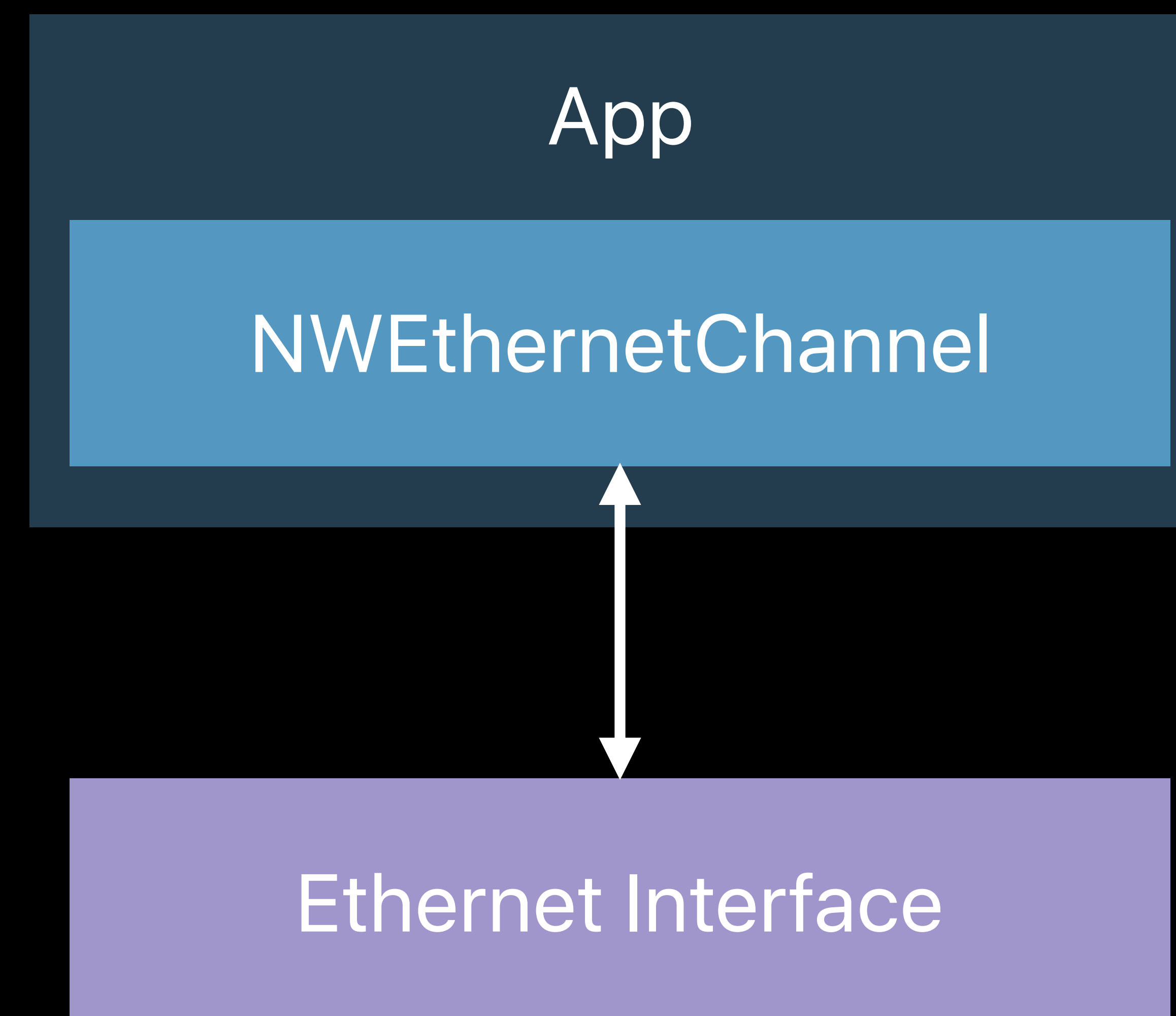
Custom Link Layer Protocol

Network Framework



Custom Link Layer Protocol

Network Framework



```
import Foundation
import Network

let path = NWPathMonitor(requiredInterfaceType: .wiredEthernet).currentPath
guard let interface = path.availableInterfaces.first else {
    // Not connected to ethernet
    fatalError("Not connected to ethernet")
}

let channel = NWEthernetChannel(on: interface, etherType: 0xB26E)
```

```
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import Network

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guard let interface = path.availableInterfaces.first else {
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    // Not connected to ethernet
    fatalError("Not connected to ethernet")
}
```

```
let channel = NWEthernetChannel(on: interface, etherType: 0xB26E)
```

```
channel.stateUpdateHandler = { state in
  switch state {
    case .ready:
      let remoteAddress = NWEthernetChannel.EthernetAddress("CB:A9:87:65:43:21")
      let packet = Data("Hello".utf8)
      channel.send(content: packet, to: remoteAddress!, vlanTag: 0) { error in
        // Handle error
      }
    default:
      break
  }
}
channel.receiveHandler = { packetData, vlanTag, localAddress, remoteAddress in
  // Handle packet
}
```

```
channel.start(queue: .main)
```

```
channel.stateUpdateHandler = { state in
  switch state {
    case .ready:
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```

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Network Kernel Extensions: Endgame

Hard to develop

Hard to debug

Stability problems

Network Kernel Extensions
are deprecated.

Summary

- ✓ New APIs for Network Extension apps
 - Content filter
 - Transparent proxy
 - DNS proxy
 - VPN
 - Virtual machine
 - Custom protocols
- ✗ Network Kernel Extensions are deprecated

More Information

developer.apple.com/wwdc19/714

Networking Lab

Friday, 9:00

System Extensions and DriverKit

WWDC 2019

What's New in Network Extension and VPN

WWDC 2015

 WWDC19