Speeding up conformances

SwiftLeeds 2024

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emerge tools

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- Fast is the first adjective used describing Swift on swift.org

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> It is **fast**, **modern**, **safe**, and a **joy** to write.

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- Countless WWDC talks highlight how fast it is

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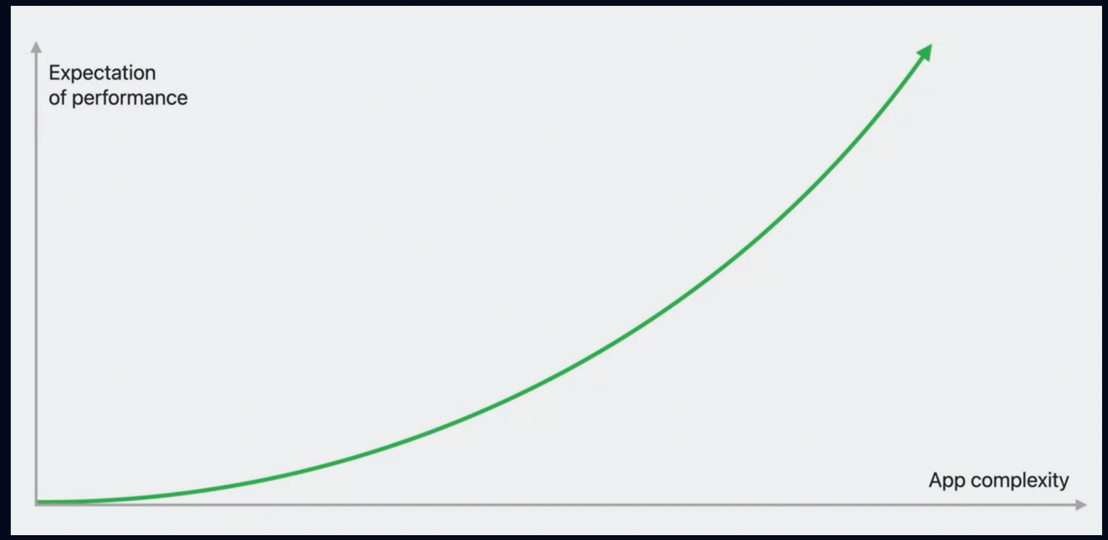

Demystify SwiftUI performance WWDC 23

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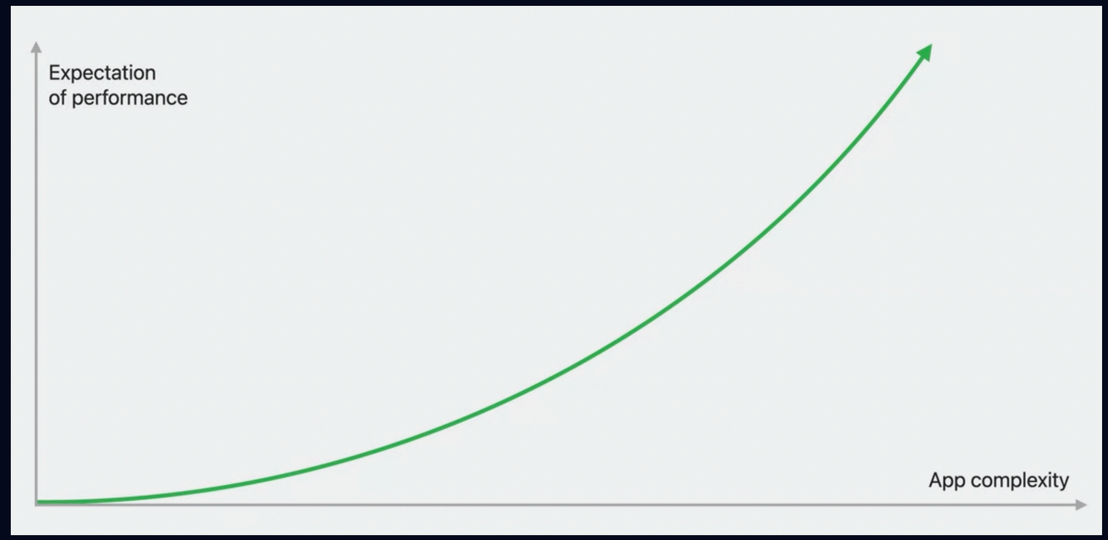

Demystify SwiftUI performance WWDC 23

“Small issues can get amplified, and code that works well for a prototype might not work as well in production.”

Key Takeaway

Write Less Code

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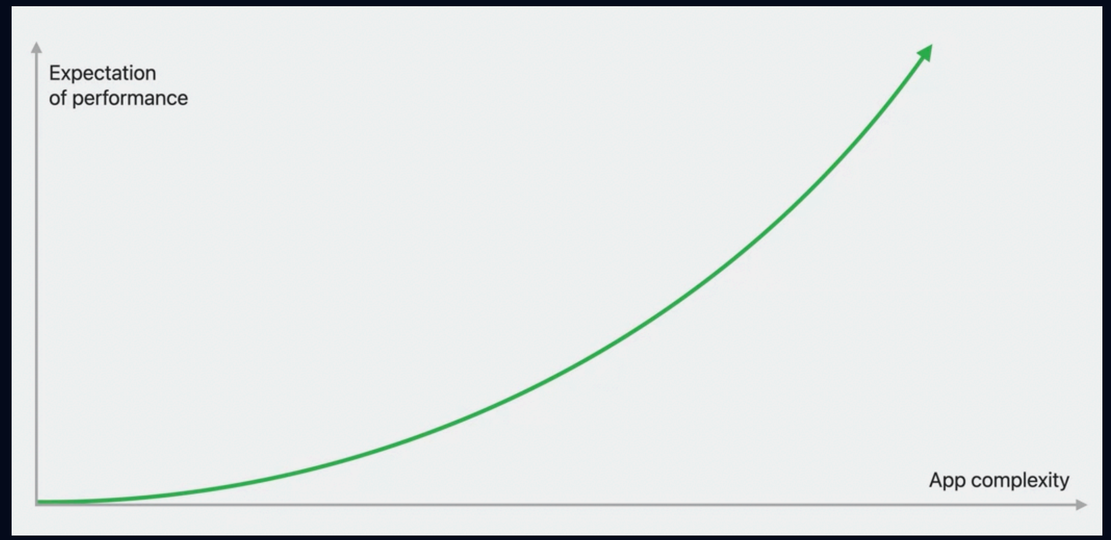

Detectives: Why is it slow? 🔎

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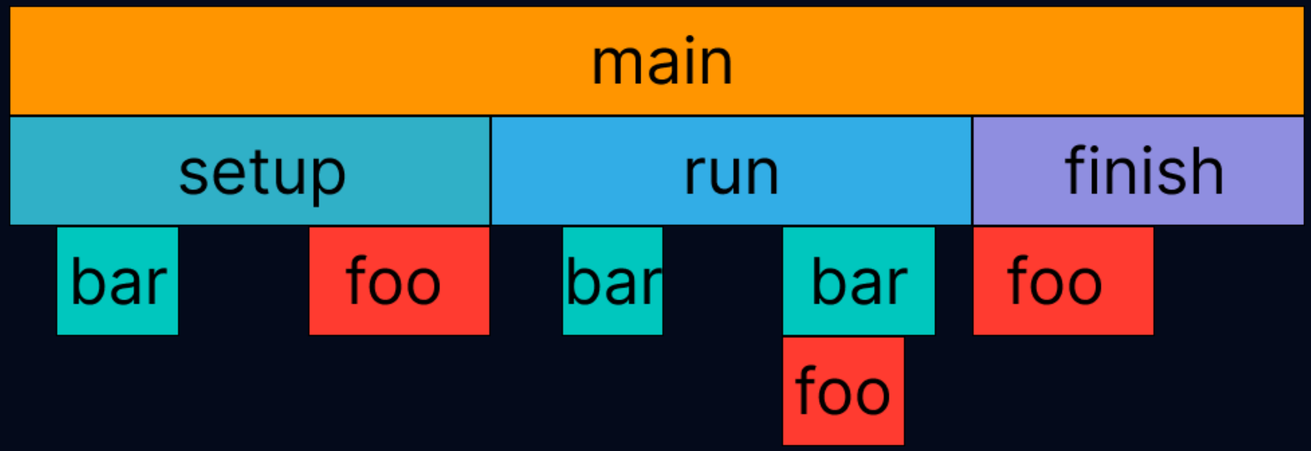

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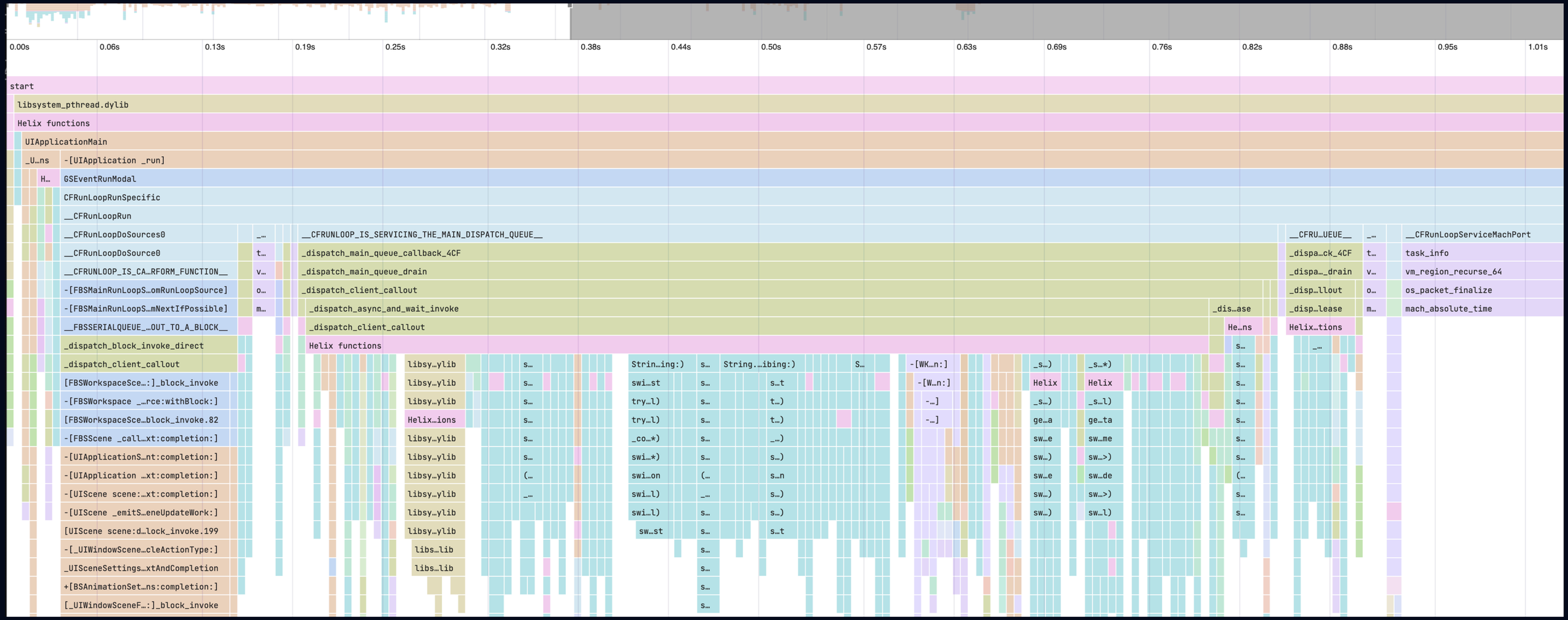

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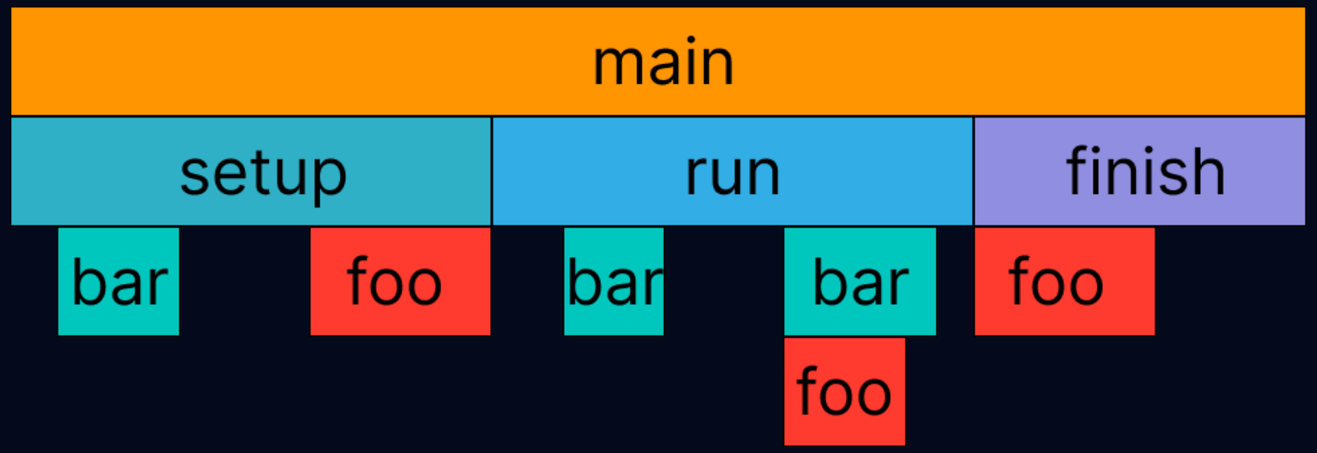

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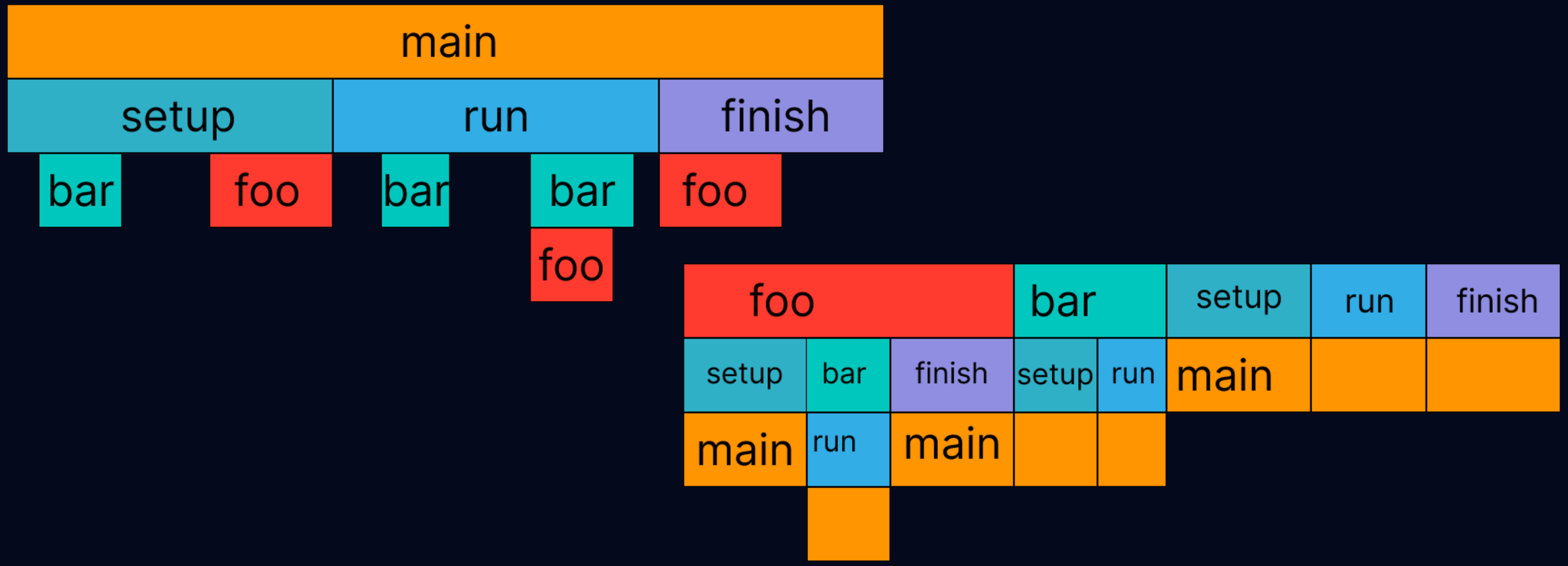

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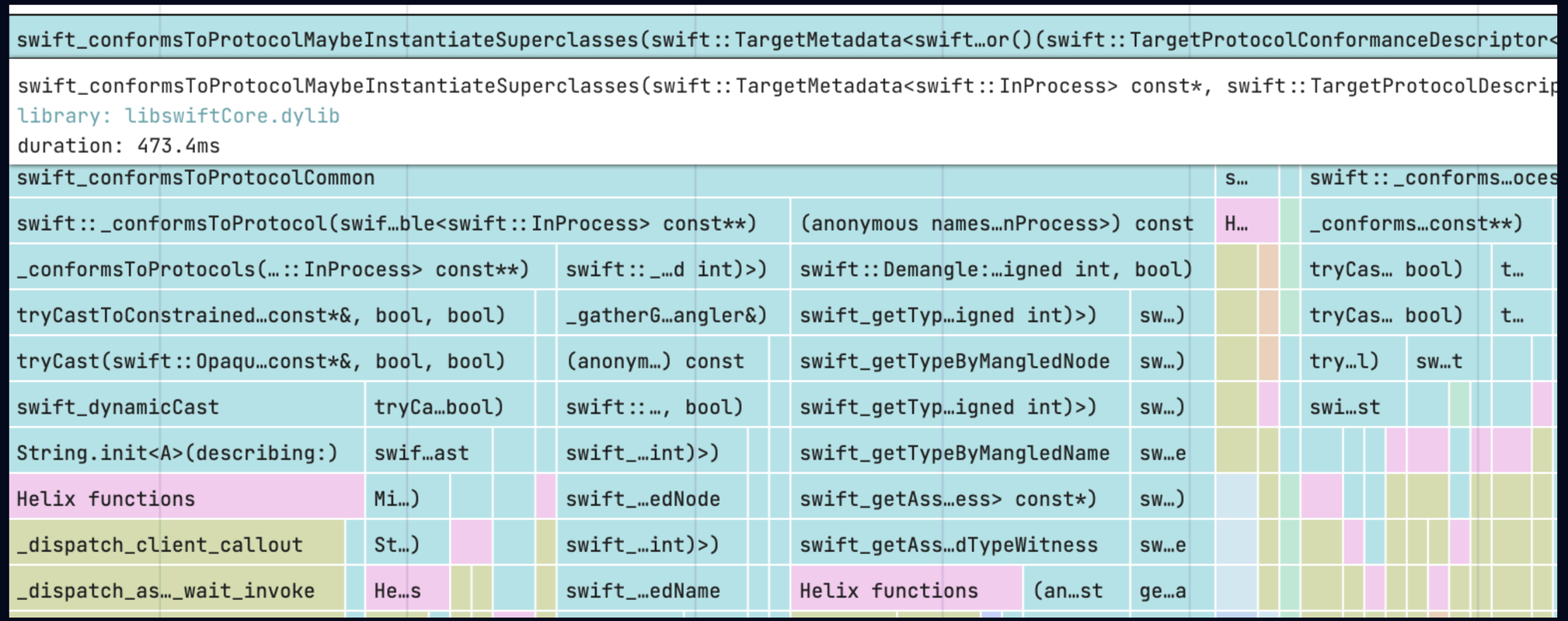

Detectives: Why is it slow? 🔎

Clue #1

```
swift_conformsToProtocol
```

Detectives: Why is it slow? 🔎

Swift 5.4 Release Notes

Protocol conformance checks at runtime are significantly faster, thanks to a faster hash table implementation for **caching previous lookup results**. In particular, this speeds up common runtime as? and as! casting operations.

What is a conformance check?

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Conformances are defined

```
class MyClass: MyProtocol { }
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This is a runtime operation

```
cast(myVar, MyProtocol.self)
```

Summary

- **Found what is slow**
  - Protocol conformance checks
- Why is it so slow?
- How can we make it faster?

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- PR: Reimplement protocol conformance cache with a hash table #33487

Clue #2

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- PR: Reimplement protocol conformance cache with a hash table #33487
- Uses more efficient cache data structure
- 13x speedup
- But this is still a “cache” - a cache miss can be slow

Clue #2

Testing the cache

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- First time: 71ms
- Second time and third time: < 0.1ms

Cache works but the uncached state is slow!

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Fewer conformances

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- App with 10000 protocol conformances

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- Now takes 15ms, less than a quarter of the time!

Dependencies

- Code that doesn’t run affects your code

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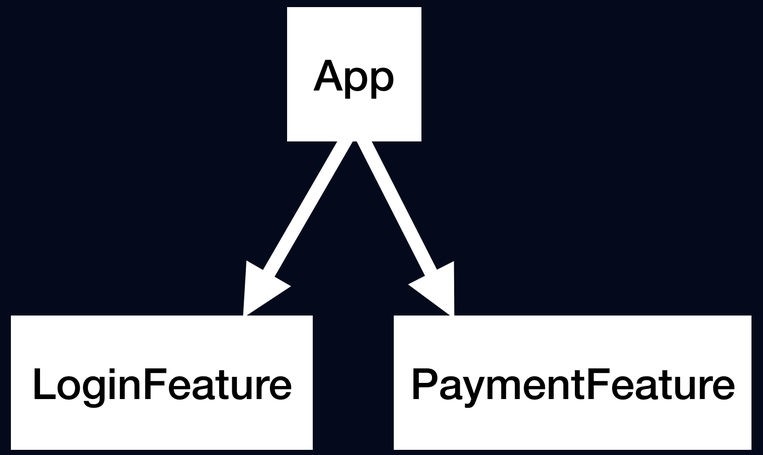

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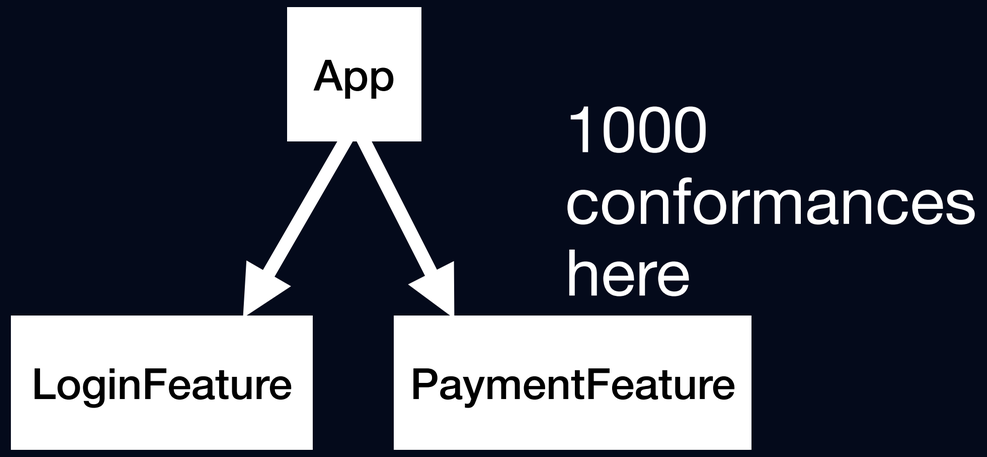

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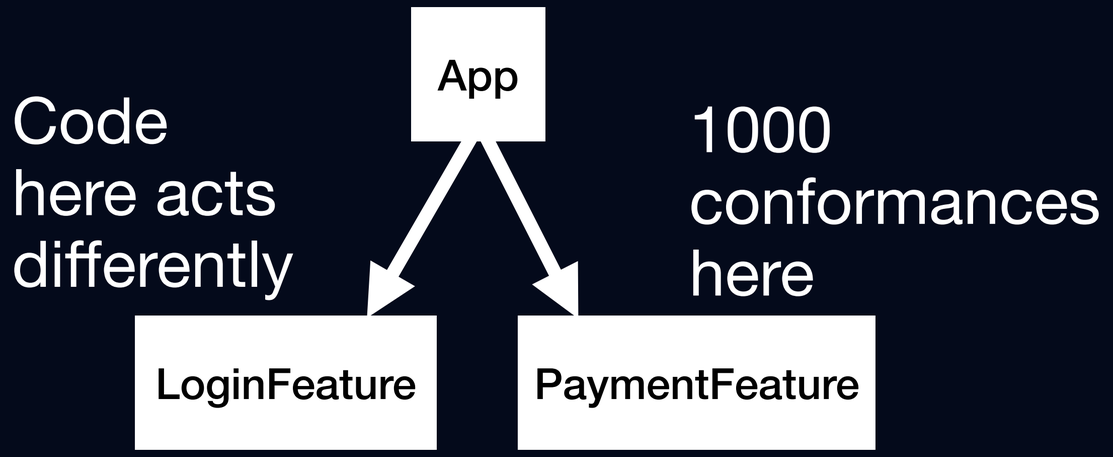

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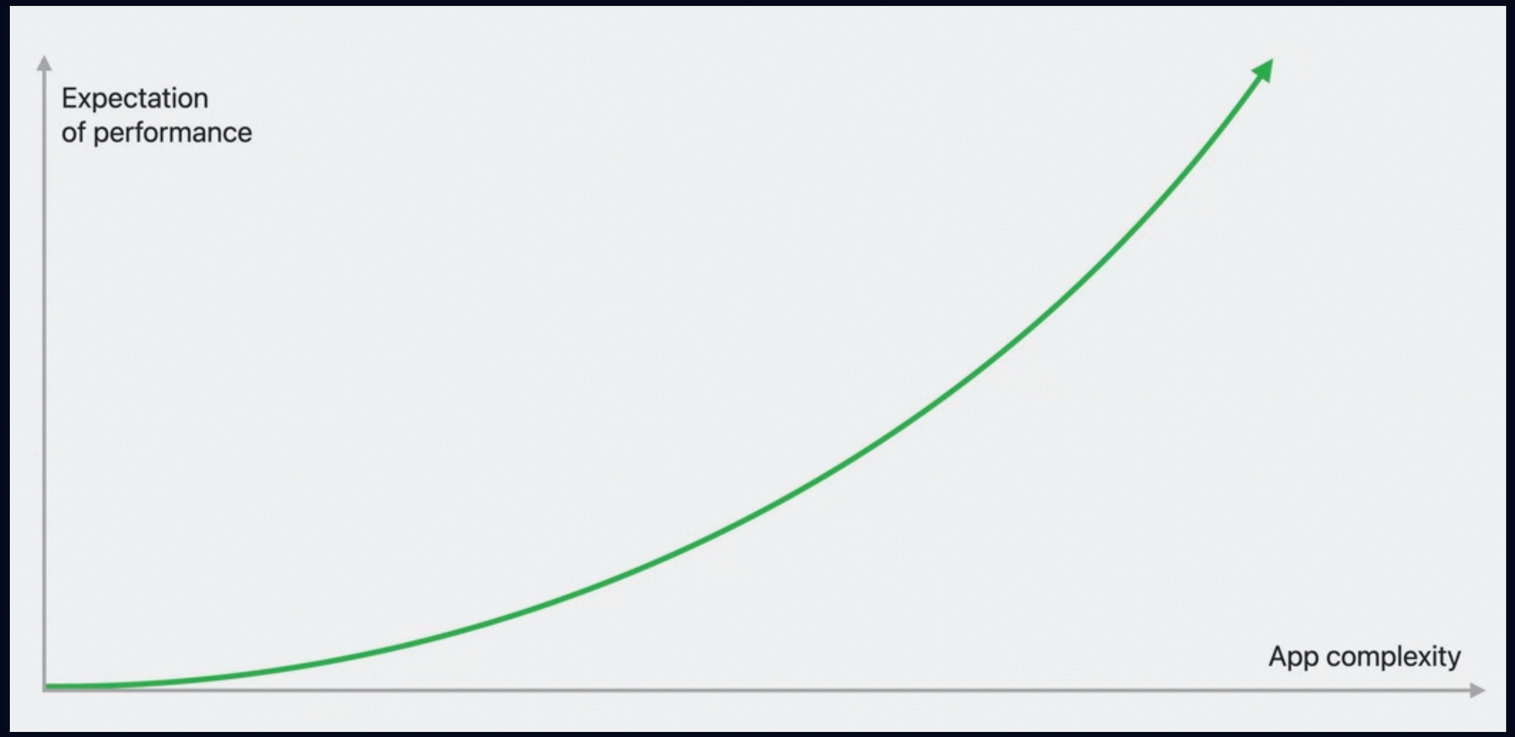

Complexity in unrelated areas of the app affect each other

Key difficulties

Abstractions hide details

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Unpredictable/unexpected behavior

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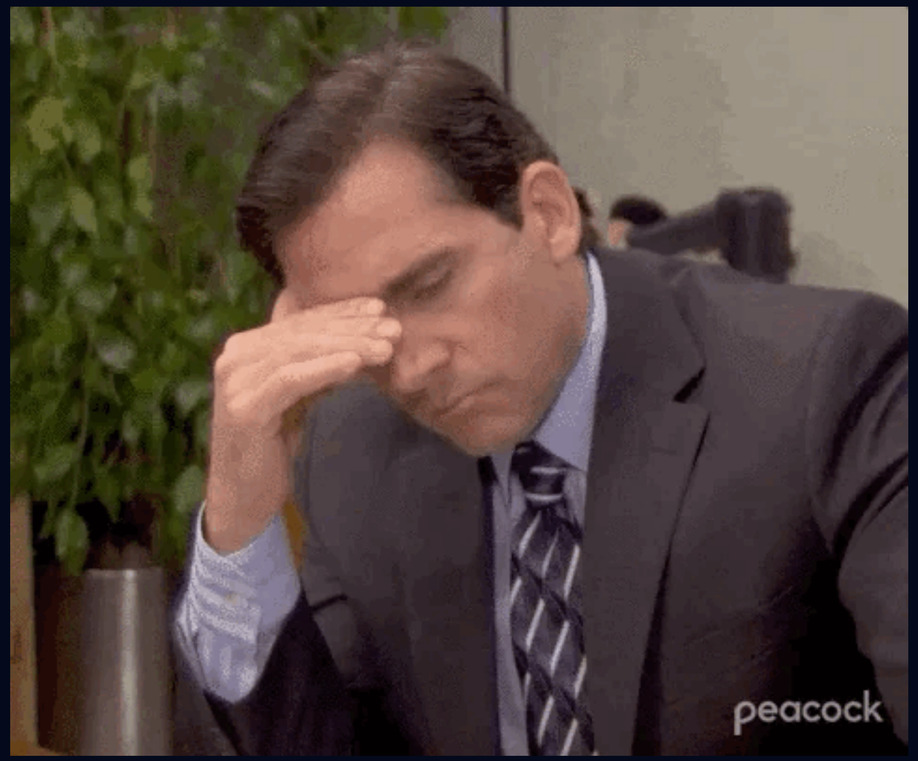
```
struct ProtocolConformanceDescriptor {
  let protocolDescriptor: Int32
  var nominalTypeDescriptor: Int32
  let protocolWitnessTable: Int32
  let conformanceFlags: ConformanceFlags
}
```

Why does this matter?



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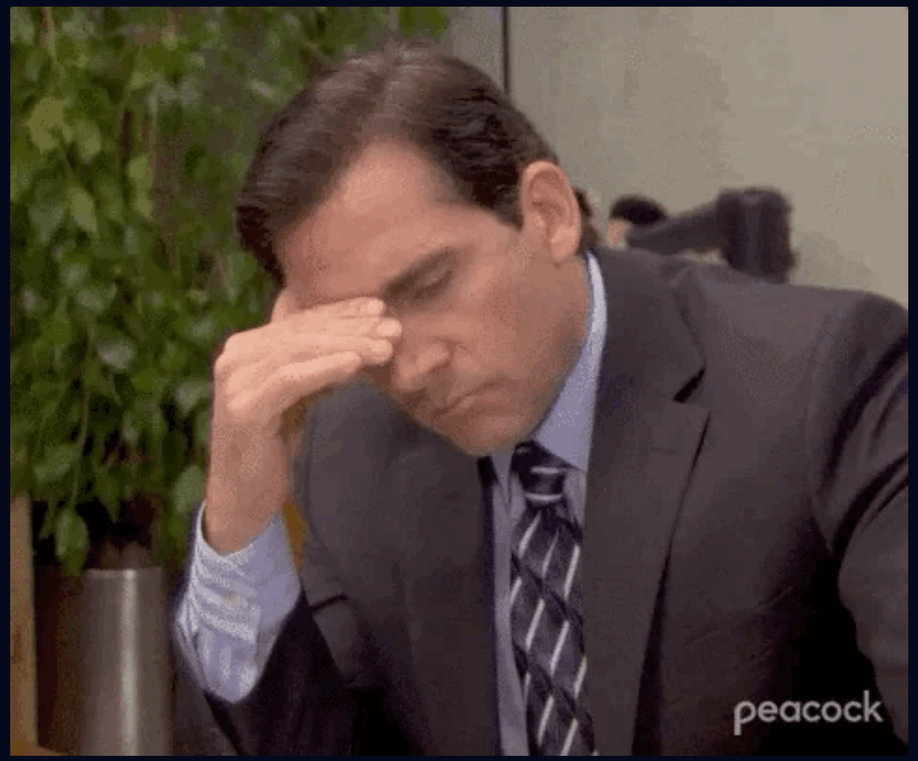

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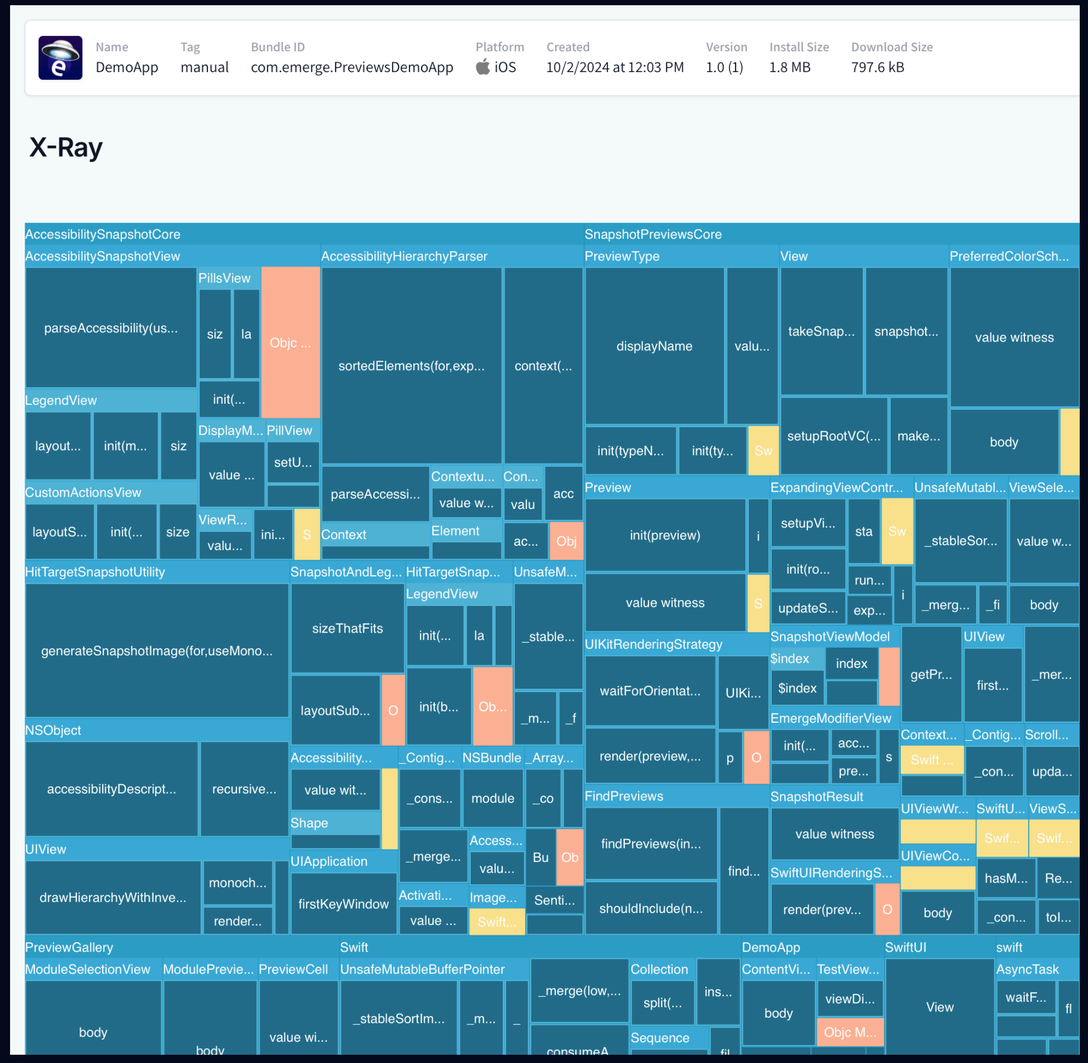

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Used for EmergeTools Snapshot Testing

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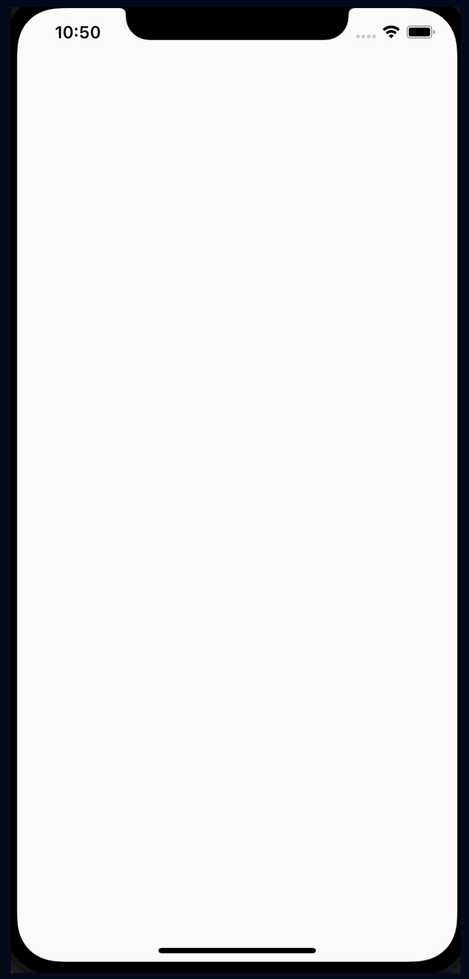

https://github.com/EmergeTools/SnapshotPreviews-iOS

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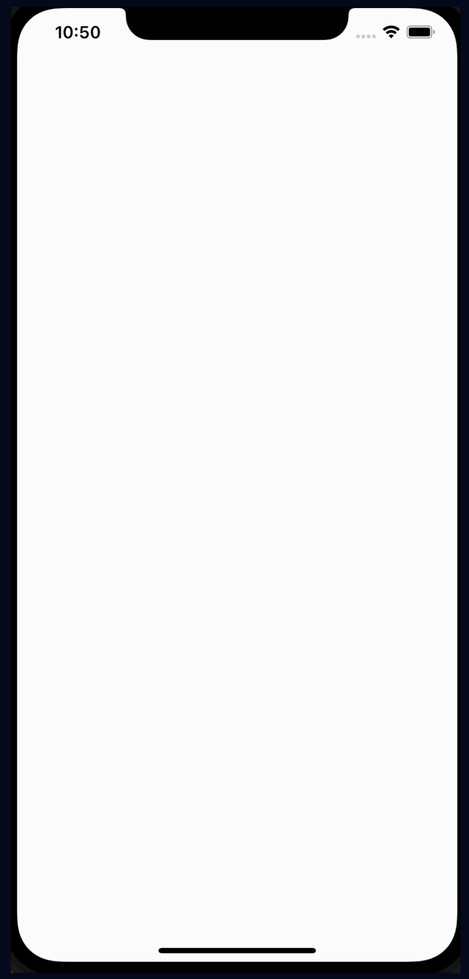

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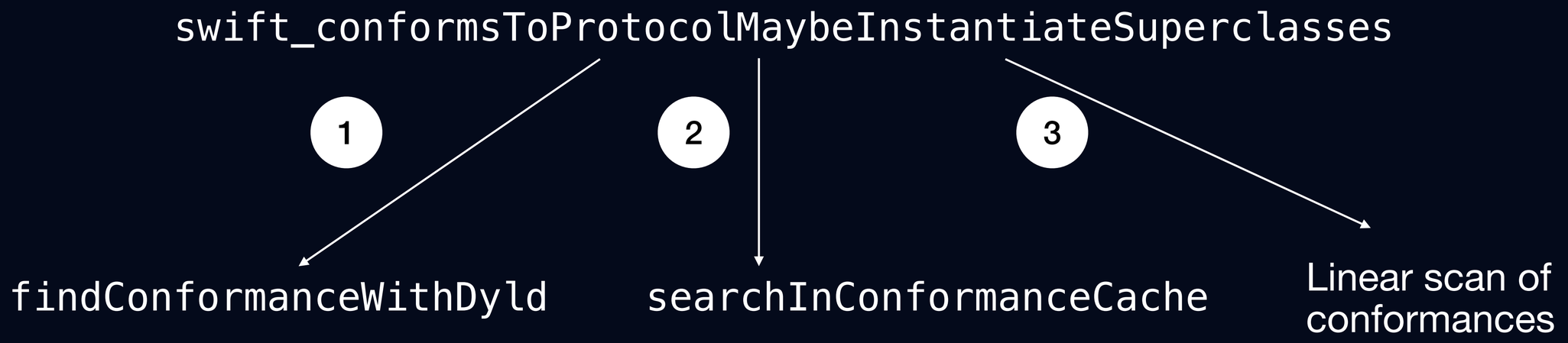
Detectives: Why more types are slower

github.com/apple/swift



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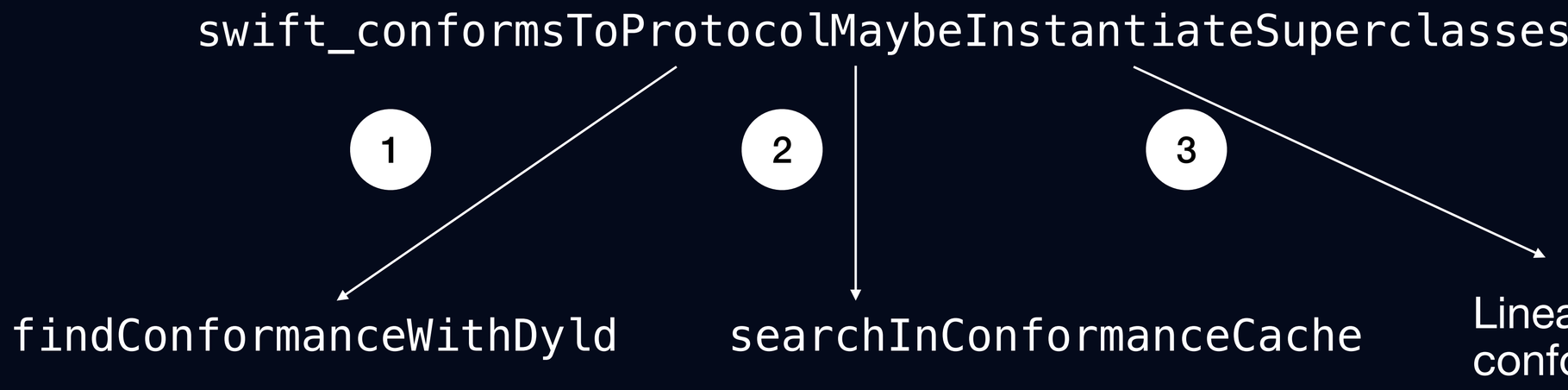

Clue #3

When O(n) becomes O(n^2)

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for type in usedTypes:
    for conformance in allConformances:
        if conformance.type == type:
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- Every unused conformance is wasted time when doing the linear scan
- Dead code detection tools like Periphery and Reaper

Summary

- **Found what is slow**
- **Why is it so slow?**
  - Using all conformances is $O(n^2)$
- How can we make it faster?

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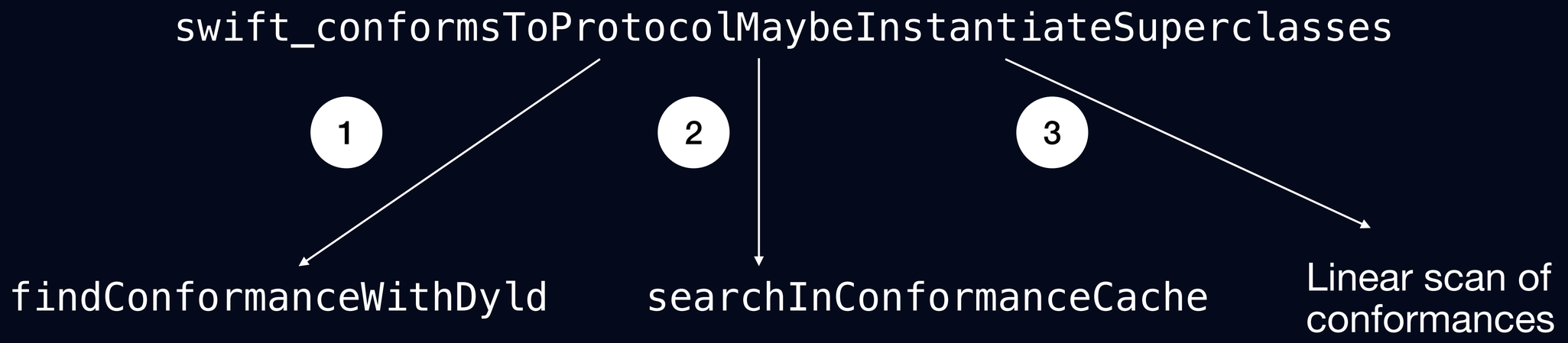
    ```
  - `“\(myVar)”`
  - `Mirror`
    ```

iOS 16 to the rescue

iOS 16 Release Notes

with apps like Lyft or Airbnb launching almost twice as fast thanks to improvement in the dynamic linker.

iOS 16 to the rescue



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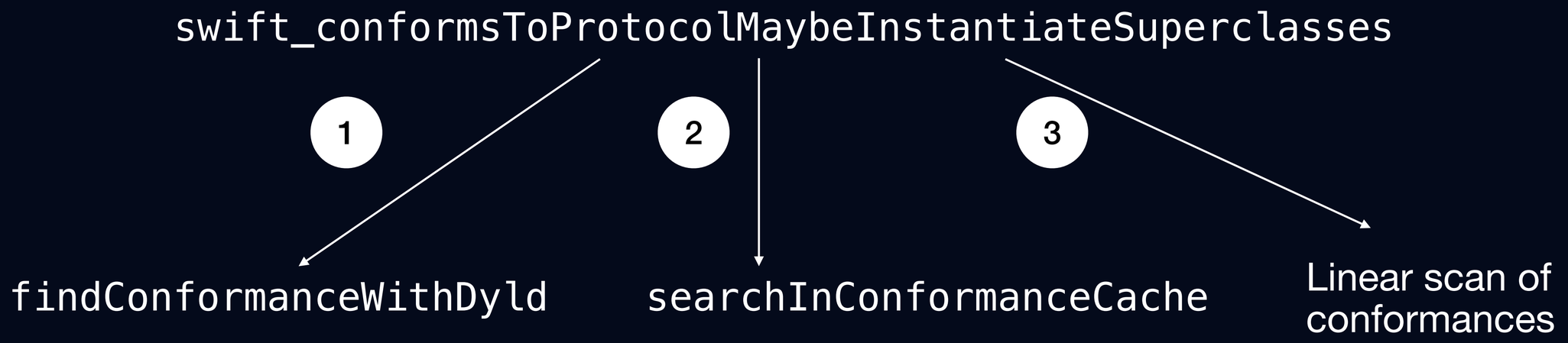

dyld cache

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- Pre-computed on app first launch to enable O(1) lookups
  - It’s a hash table
- Linear scan is done one time - O(n) operation before your code runs
- Cache is saved to disk

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https://github.com/apple-oss-distributions/dyld

> The shared cache Swift optimizations are designed to speed up protocol conformance lookups.
>
> This optimization builds a number of hash tables to speed up these lookups … This saves both time and memory.

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- Cache often disabled: unit testing, simulator, running from Xcode
- dyld is for Apple platforms, not server side Swift

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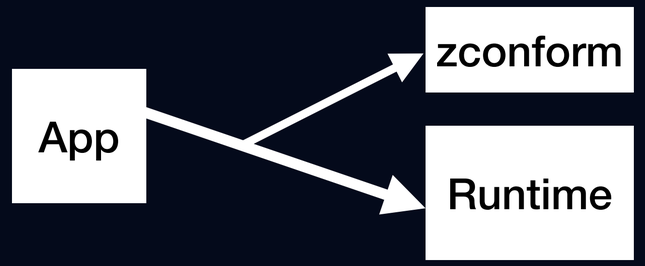

zconform

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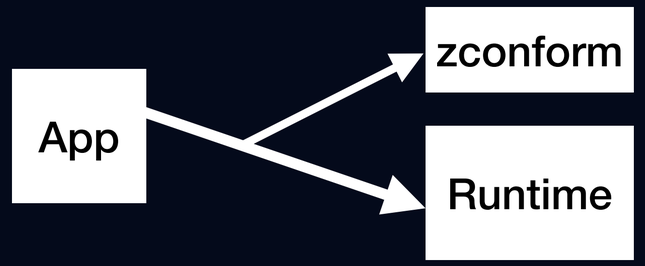

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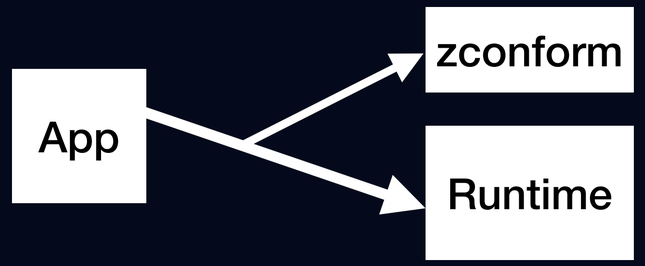

- Builds a cache of conformances on app launch
- Not production ready, but can be used for tests as a CI optimization, and POC for improvements in the OS

https://github.com/EmergeTools/zconform

How we use zconform at Emerge

- Snapshot tests involve repeatedly launching the app

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- Snapshot tests involve repeatedly launching the app
- Each launch is $O(n^2)$ - cache is disabled due to env vars
- Snapshots should be fast, but this adds significant overhead
- Use zconform to remove the overhead

What you can do

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- Prefer generic functions over casts

```
func logEvent(_ event: Event) {
  if let severity = (event as? EventSeverityProviding)?.severity {
    sendToServer("Received log \(event.description)", severity: severity)
  } else {
    sendToServer("Received log \(event.description)")
  }
}
```

What you can do

- Delete unnecessary protocols with only one conforming type
- String(describing:) -> ObjectIdentifier
- Prefer generic functions over casts

```
func logEvent<T: Event & EventSeverityProviding>(_ event: T) {
  sendToServer("Received log \(event.description)", severity: event.severity)
}
func logEvent(_ event: Event) {
  sendToServer("Received log \(event.description)")
}
```

Summary

- **Found what is slow**
- **Why is it so slow?**
- **How can we make it faster?**
  - iOS 16 helped
  - zconform
  - Do fewer conformance checks

Ongoing conversation

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- “the cadence of our updates mean that the majority of users will have a poor experience once a week”
- “Many engineering teams may be wasting time trying to understand why their application is taking so much time”
- Could build a faster lookup into Swift to avoid the linear scan

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- The linear scan is here to stay for ABI stability
- The dyld cache does solve this problem, it only needs to be updated to not be skipped on first launch
- Still issues with non-Apple platforms

Concluding Thoughts

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- Complexity -> poor performance
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- Get in touch @sond813