

# Caesium

## iOS启动时间监控

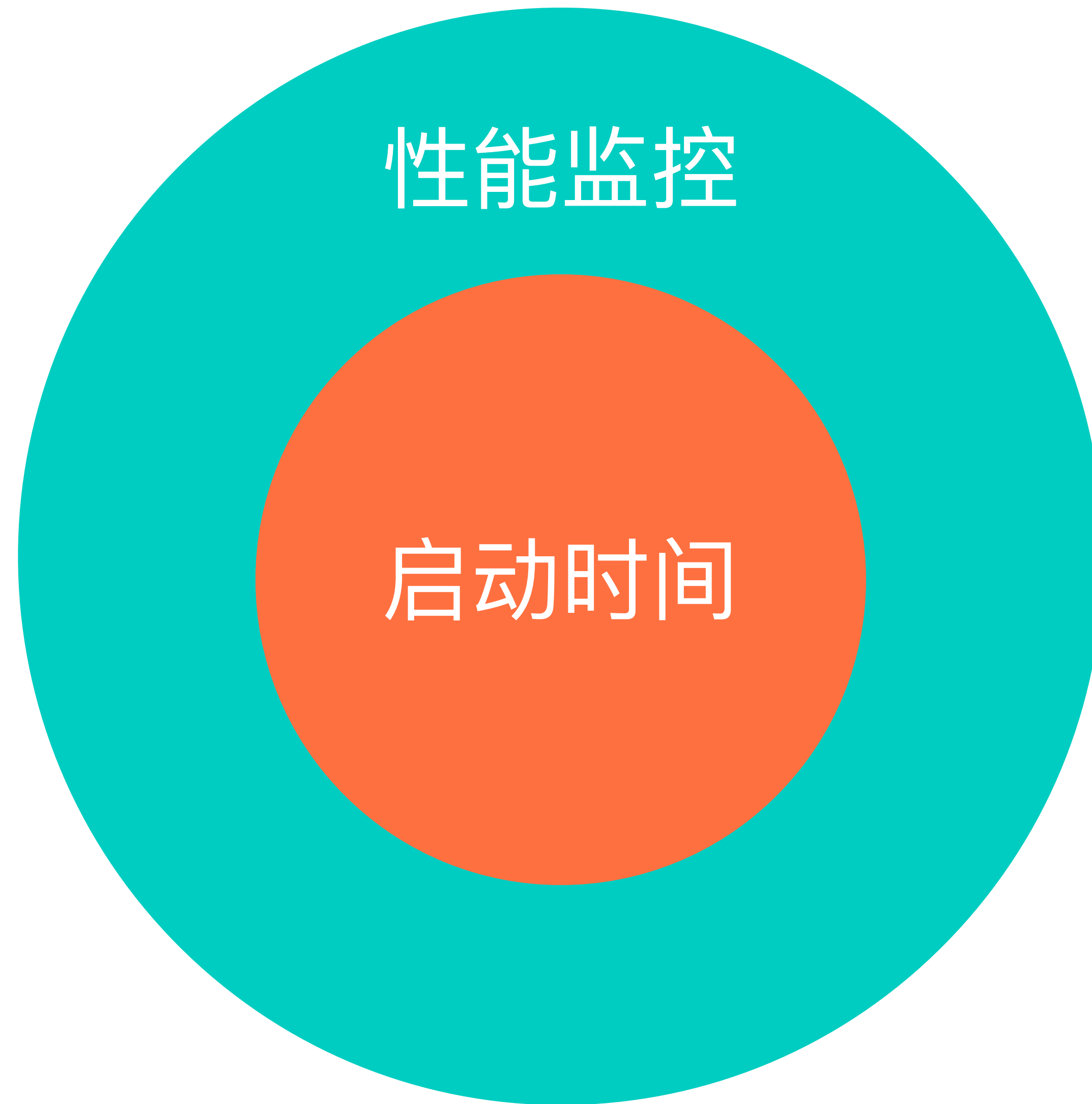
吴君阳



美团平台I技术研发部



吴君阳，美团点评iOS工程师。  
2017年2月加入美团点评，负责性能平台和性能优化相关工作。





# 传统做法



Instruments



美团点评  
技术团队

IT大咖说  
知识共享平台



# 传统做法



Charles



# 传统做法

Charles 4.2.1 - Session 1 \*

Structure Sequence

|  | Code | Method | Host           | Path                                          | Start    | Duration | Size     | Status   | Info    |
|--|------|--------|----------------|-----------------------------------------------|----------|----------|----------|----------|---------|
|  | 200  | GET    | p0.meituan.net | /codeman/12ff749bd7fdf473abd59e2651a...       | 16:15:09 | 15 ms    | 9.97 KB  | Compl... | 132x132 |
|  | 200  | GET    | p0.meituan.net | /codeman/0fe84029cc6cf6ccf12838ce6...         | 16:15:09 | 18 ms    | 11.35 KB | Compl... | 132x132 |
|  | 200  | GET    | p0.meituan.net | /codeman/2ae734d26259e6138ea61f2dc...         | 16:15:09 | 4 ms     | 11.05 KB | Compl... | 132x132 |
|  | 200  | GET    | p1.meituan.net | /codeman/93231059874052e97c0976c8...          | 16:15:10 | 3 ms     | 1.71 KB  | Compl... | 36x36   |
|  | 200  | GET    | p1.meituan.net | /codeman/5b202af2ecf82c69a433a2462...         | 16:15:10 | 7 ms     | 2.15 KB  | Compl... | 36x36   |
|  | 200  | GET    | p1.meituan.net | /codeman/d9c3dee4962ab9c99665c2f2...          | 16:15:10 | 5 ms     | 2.29 KB  | Compl... | 60x60   |
|  | 200  | GET    | s0.meituan.net | /bs/file/?f=meishi.mobile:assets/bee61f5f0... | 16:15:10 | 3 ms     | 5.00 KB  | Compl... | 134x88  |
|  | 200  | GET    | s0.meituan.net | /bs/file/?f=meishi.mobile:assets/e076efca...  | 16:15:10 | 4 ms     | 2.37 KB  | Compl... | 36x36   |
|  | 200  | GET    | s0.meituan.net | /bs/file/?f=meishi.mobile:assets/cb45534a...  | 16:15:10 | 3 ms     | 2.26 KB  | Compl... | 36x36   |
|  | 200  | GET    | s0.meituan.net | /bs/file/?f=meishi.mobile:assets/f9069082...  | 16:15:10 | 4 ms     | 2.53 KB  | Compl... | 36x36   |
|  | 200  | GET    | p1.meituan.net | /poi/a31d4660e817441b9ef5a95d3a30db...        | 16:15:10 | 9 ms     | 3.44 KB  | Compl... | 80x80   |
|  | 200  | GET    | p1.meituan.net | /apiback/f960d1556b2eaf94424a7f1833...        | 16:15:10 | 8 ms     | 5.79 KB  | Compl... | 80x80   |

Filter:  ☐ Focused

Overview Contents Summary Chart Notes

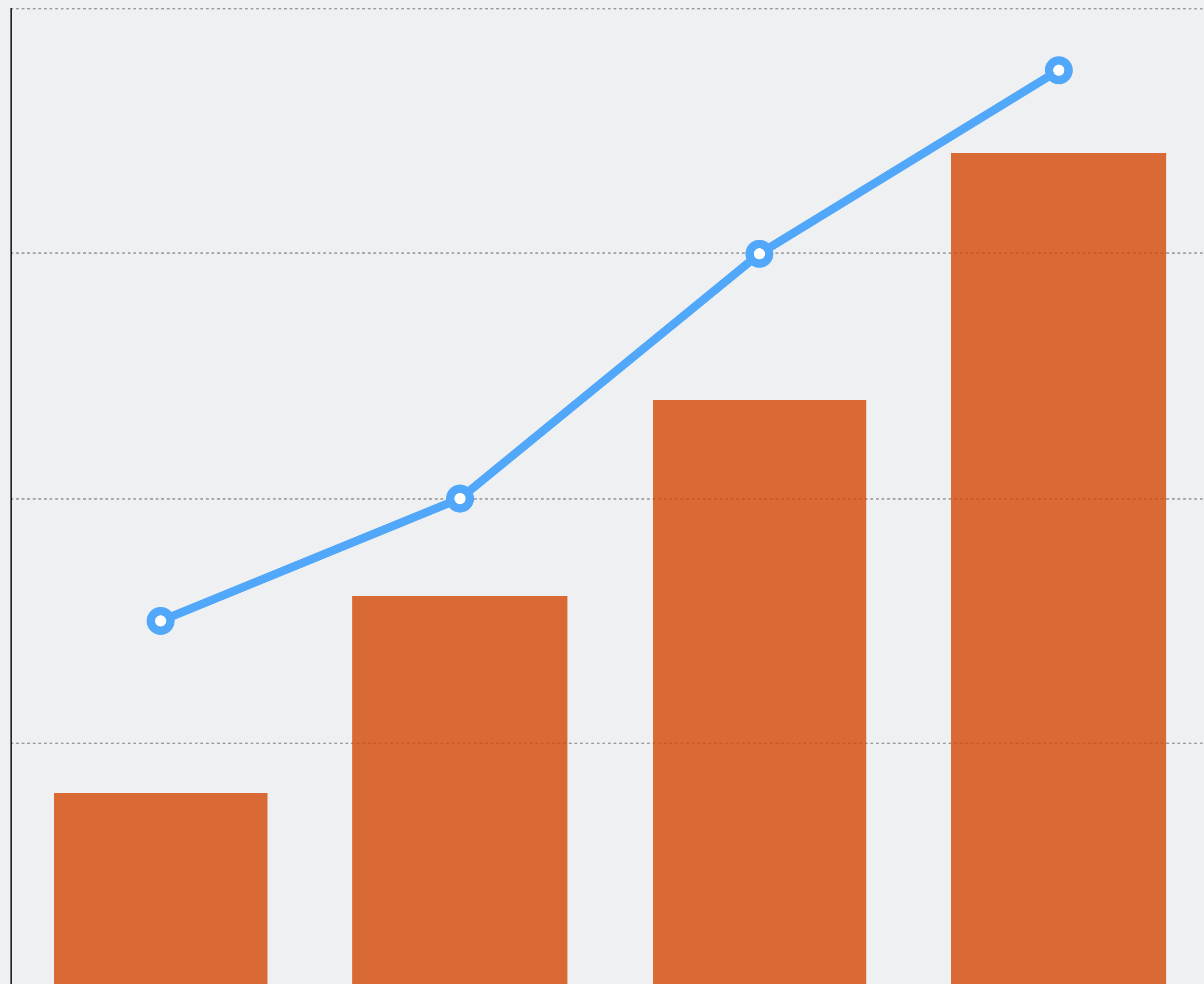
| Name                | Value                                                                             |
|---------------------|-----------------------------------------------------------------------------------|
| URL                 | http://p1.meituan.net/poi/a31d4660e817441b9ef5a95d3a30db1d15701.jpg@80w_80h_1e_1c |
| Status              | Complete                                                                          |
| Response Code       | 200 OK                                                                            |
| Protocol            | HTTP/1.1                                                                          |
| ▼ TLS               | -                                                                                 |
| ▶ Protocol          | -                                                                                 |
| ▶ Session Resumed   | -                                                                                 |
| ▶ Cipher Suite      | -                                                                                 |
| ▶ ALPN              | -                                                                                 |
| Client Certificates | -                                                                                 |
| Server Certificates | -                                                                                 |
| ▶ Extensions        | -                                                                                 |
| Method              | GET                                                                               |

GET https://billing-mobile.meituan.com/api/cpv/action?bottomprice=1.0&adshop\_id=93113975&launch\_city\_id=2&bu=2&pos=1&adidx=3&page\_city\_id=2&mtlaunch\_city\_id=1...

# 当传统做法遇到大型App



# 监控大型App



## 监控耗时久

代码量大  
编译运行一次耗时很长

## 问题定位难

启动时函数调用量大  
数据不够直观

## 无监控体系

无法及时暴露问题

## 成果难保持

难以成为一项常规工作



## 理想的方案

01 数据收集成本低

02 无侵入

03 信息全面

04 数据展示直观

05 体系化

06 对性能影响小



Caesium

# Caesium是什么

在现行国际单位制下，在1967年召开的第13届国际度量衡大会对秒的定义是：铯（Caesium） $^{133}$ 原子基态的两个超精细能阶间跃迁对应辐射的9,192,631,770个周期的持续时间。第一个精确的原子钟便是根据铯- $^{133}$ 的迁越制成的



# Caesium是什么

全方位的 精准的 iOS 应用性能分析工具



功能

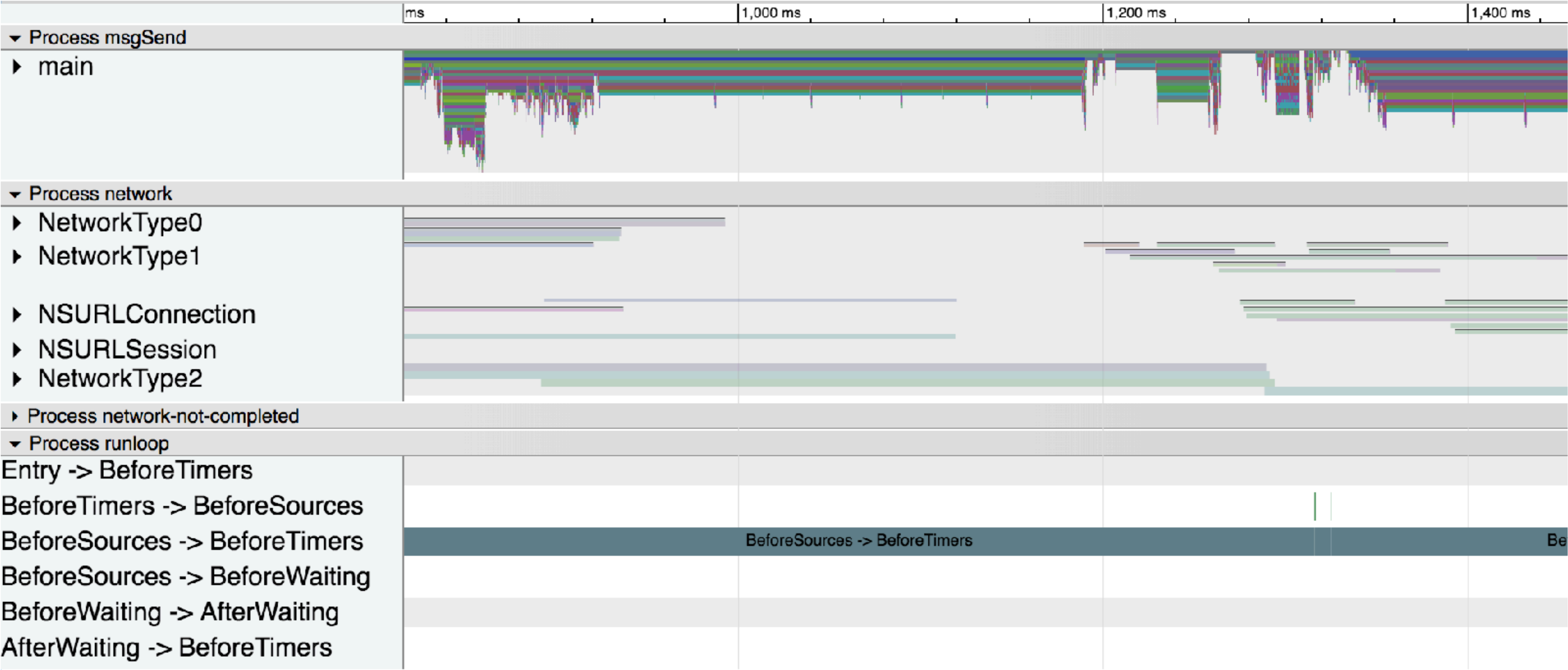
方法调用/网络/RunLoop可视化

数据可对比

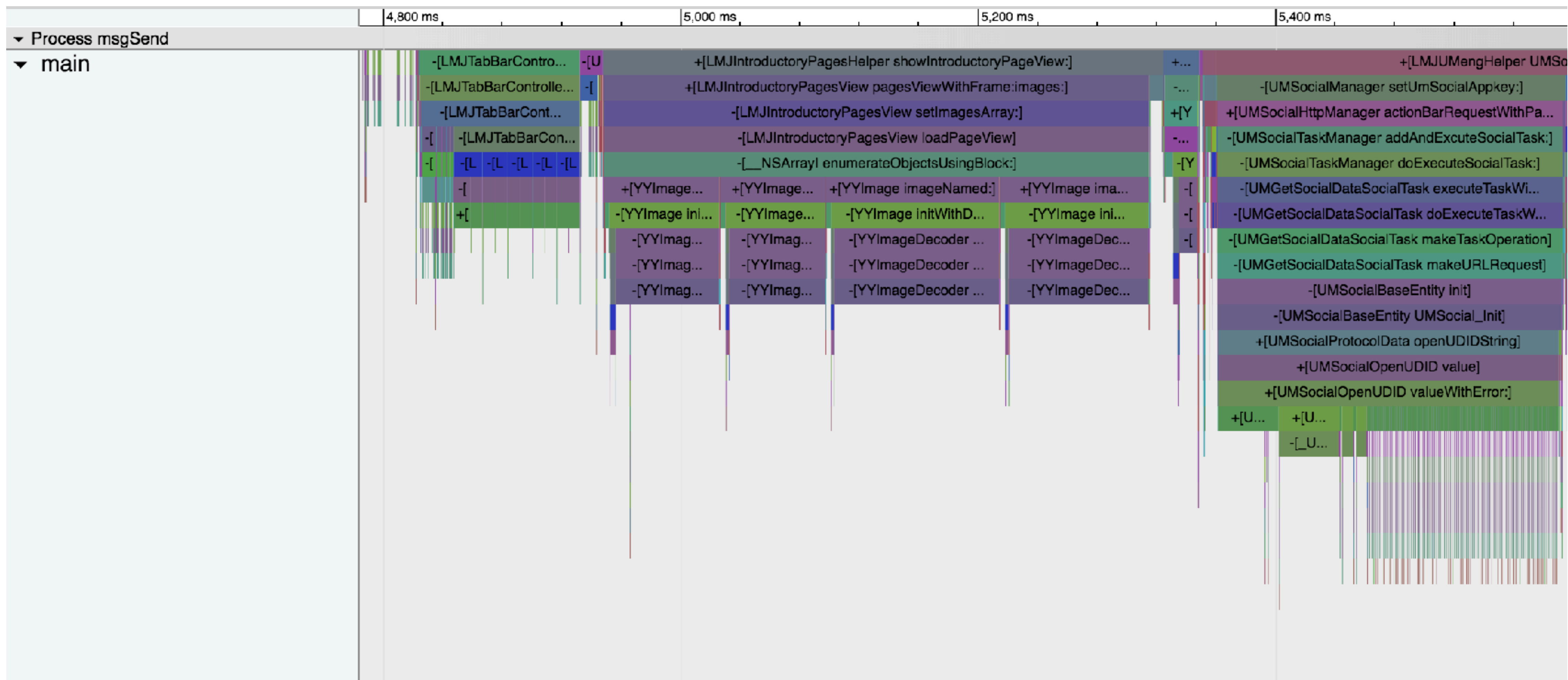
# A Glance



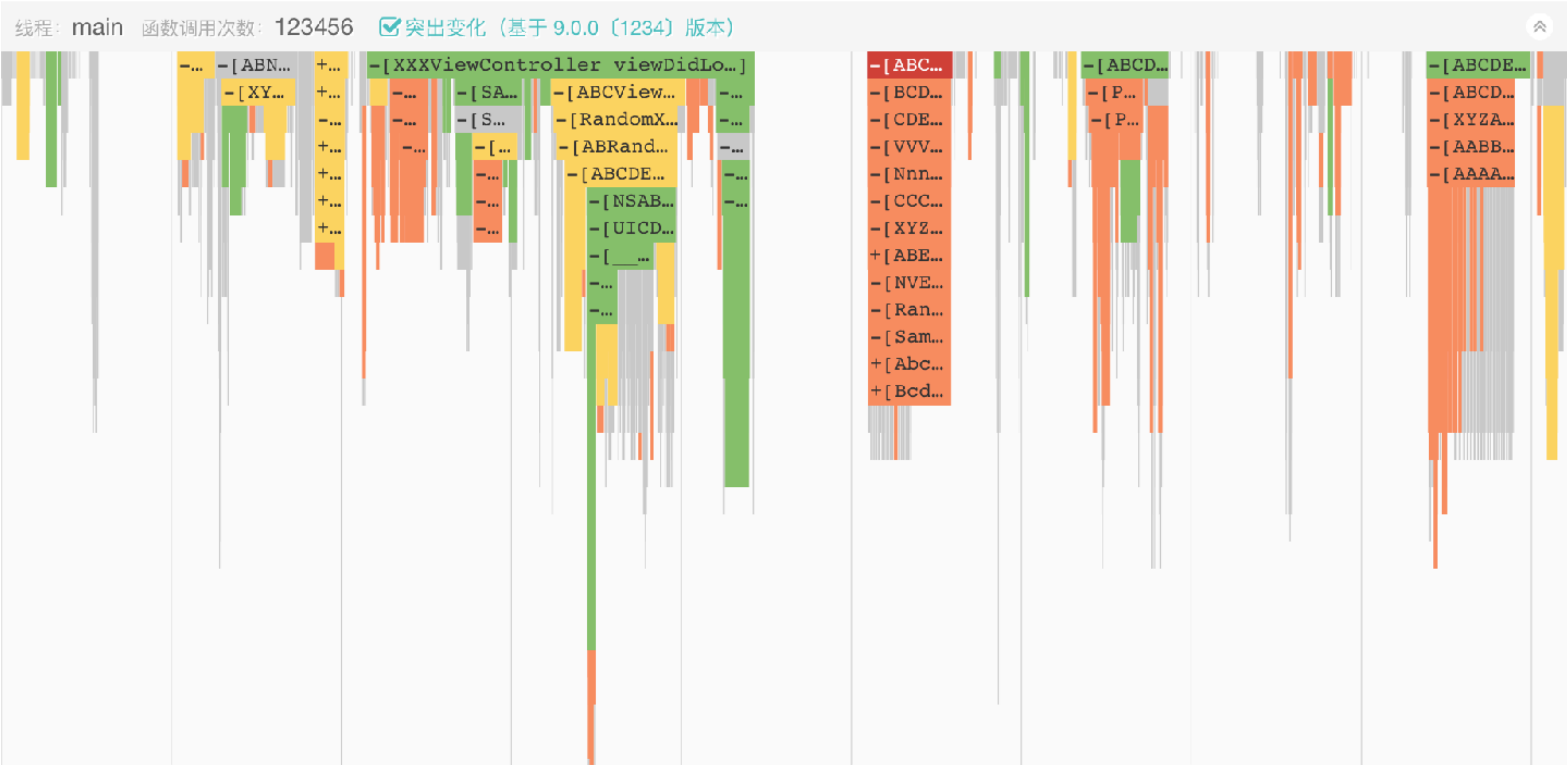




# A Glance



# A Glance



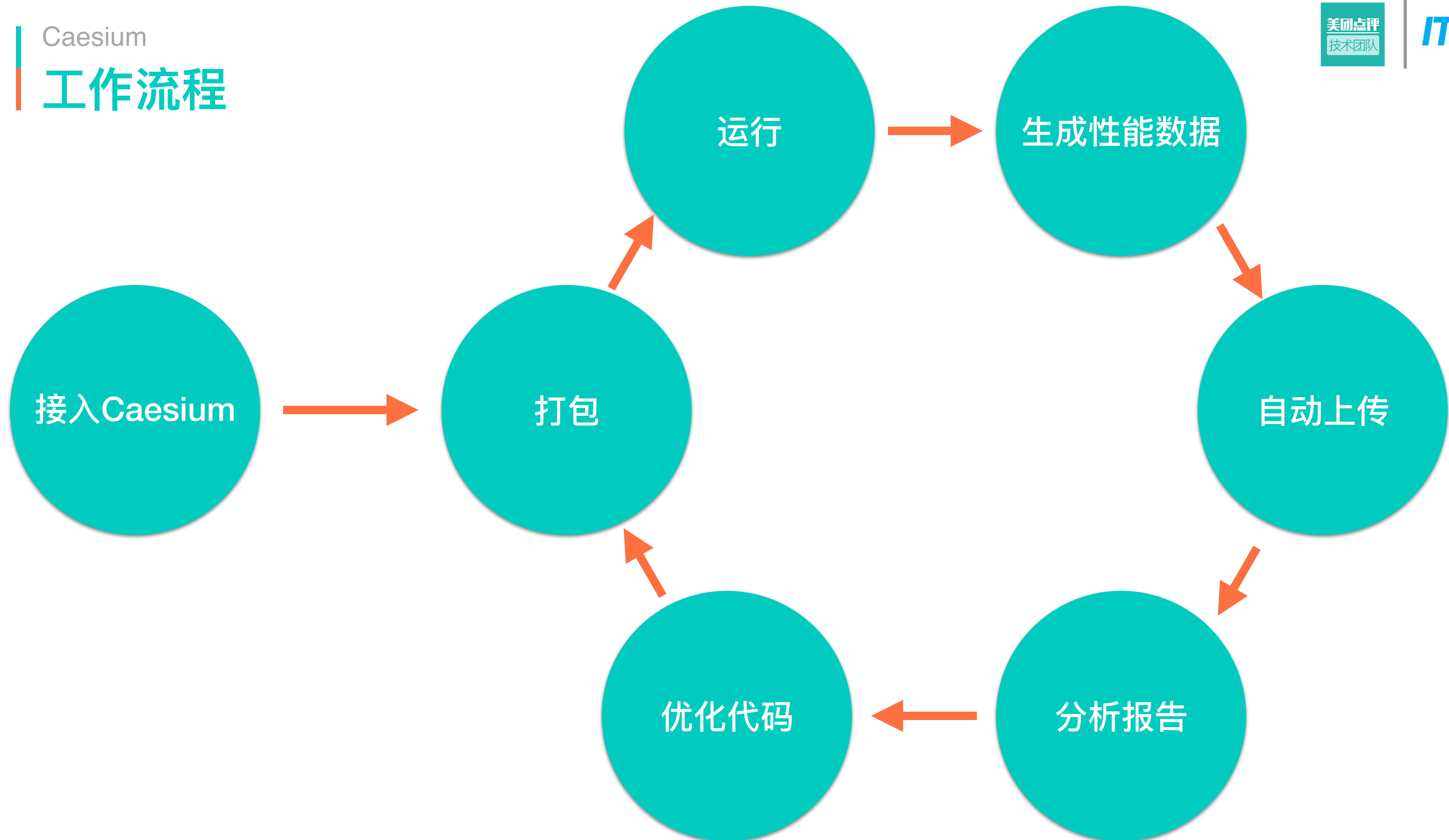


# A Glance



| 函数名                                                           | 总耗时      |         | 耗时变化     |
|---------------------------------------------------------------|----------|---------|----------|
| -[Note allTheMethodsBelow:areRandomlyGenerated:]              | 1139.546 | 338.060 | 29.7% ↑  |
| -[XXXTask start]                                              | 251.215  | 251.215 | 100.0% ↑ |
| -[SomeClass doSthWithThis:that:]                              | 234.748  | 114.282 | 48.7% ↑  |
| +[SomeManager setup]                                          | 99.875   | 69.069  | 69.2% ↑  |
| -[SomeClassA doSomething:]                                    | 112.148  | 59.269  | 52.8% ↑  |
| -[NSNotificationCenter postNotificationName:object:userInfo:] | 70.233   | 40.332  | 57.4% ↑  |
| +[SomeModule setup]                                           | 38.098   | 38.098  | 100.0% ↑ |
| -[__NSArrayI enumerateObjectsUsingBlock:]                     | 27.895   | 27.895  | 100.0% ↑ |
| -[ABCViewController updateData]                               | 60.682   | 25.088  | 41.3% ↑  |
| -[XYZView loadData:]                                          | 24.005   | 24.005  | 100.0% ↑ |
| -[ALongLongClassName aLongLongMethodName:]                    | 19.546   | 19.546  | 100.0% ↑ |
| +[SampleClass showSample]                                     | 17.825   | 17.825  | 100.0% ↑ |
| -[RandomRandom generateSomethingRandom:]                      | 15.595   | 15.595  | 100.0% ↑ |
| -[HahahaManager manageSomething]                              | 15.407   | 15.407  | 100.0% ↑ |
| -[SomeStrangeView setData:]                                   | 14.040   | 14.040  | 100.0% ↑ |
| -[SampleObject reloadAllData]                                 | 54.862   | 13.716  | 25.0% ↑  |
| -[XXXViewController doSthSlow:]                               | 55.612   | 13.715  | 24.7% ↑  |
| +[HugeSingleton sharedInstance]                               | 13.630   | 13.630  | 100.0% ↑ |
| -[AAATableViewController tableView:cellForRowAtIndexPath:]    | 12.994   | 12.994  | 100.0% ↑ |
| -[ThisIsAModule setupModule]                                  | 12.779   | 12.779  | 100.0% ↑ |
| -[ABCDemoManager manageSth:finished:]                         | 12.579   | 12.579  | 100.0% ↑ |
| -[AnotherSampleItem initWithType:]                            | 57.063   | 12.447  | 21.8% ↑  |
| -[AhaSection init]                                            | 57.064   | 12.447  | 21.8% ↑  |
| -[UnknownDataObject whatIsThis:andThat:]                      | 73.785   | 12.017  | 16.3% ↑  |
| -[NSData initWithThis:]                                       | 11.508   | 11.508  | 100.0% ↑ |
| -[NSArray initWithMood:]                                      | 11.309   | 11.309  | 100.0% ↑ |
| -[Wow nice:]                                                  | 10.150   | 10.150  | 100.0% ↑ |
| +[RandomString randomRandom:]                                 | 31.878   | 10.026  | 31.5% ↑  |
| -[AlmostAnModule loadDataIfNeeded]                            | 18.790   | 8.128   | 43.3% ↑  |
| -[FakeClass printEverything]                                  | 20.034   | 6.828   | 34.1% ↑  |

⌵ 显示更多



# 实现方案



```
[someObj someMessage];
```



```
[XXRecordSystem recordStartWithClass:get_class(someObj)  
                                cmd:@"someMessage"  
                                time:currentTime];
```

```
[someObj someMessage];
```

```
[XXRecordSystem recordEndWithClass:get_class(someObj)  
                                cmd:@"someMessage"  
                                time:currentTime];
```

```
[someObj1 someMessage1];  
[someObj2 someMessage2];  
[someObj3 someMessage3];  
[someObj4 someMessage4];  
[someObj5 someMessage5];  
[someObj6 someMessage6];  
[someObj7 someMessage7];  
[someObj8 someMessage8];  
...
```

```
objc_msgSend(id self, SEL _cmd, ...)
```



objc\_msgSend



new\_objc\_msgSend



1. 记录 class, cmd, startTime
2. 调用 orig\_objc\_msgSend
3. 记录 endTime



objc\_msgSend 调用约定

寄存器 r0, r1 ... 栈

new\_objc\_msgSend

汇编

保存寄存器 x0 - x8, q0 - q7 到栈上

记录 class, cmd, startTime

恢复寄存器 x0 - x8, q0 - q7

调用原始 objc\_msgSend

记录 endTime

.....? ? ?

## lr 寄存器 (Link Register)

子方法执行完毕后将会被执行的地址



保存寄存器 x0 - x8, q0 - q7 和 lr 到栈上

记录 class, cmd, startTime

恢复寄存器 x0 - x8, q0 - q7, 以及 lr

调用原始 objc\_msgSend, 记录 lr

保存寄存器 x0 - x8, q0 - q7 和 lr 到栈上

记录 endTime

恢复寄存器 x0 - x8, q0 - q7, 以及 lr

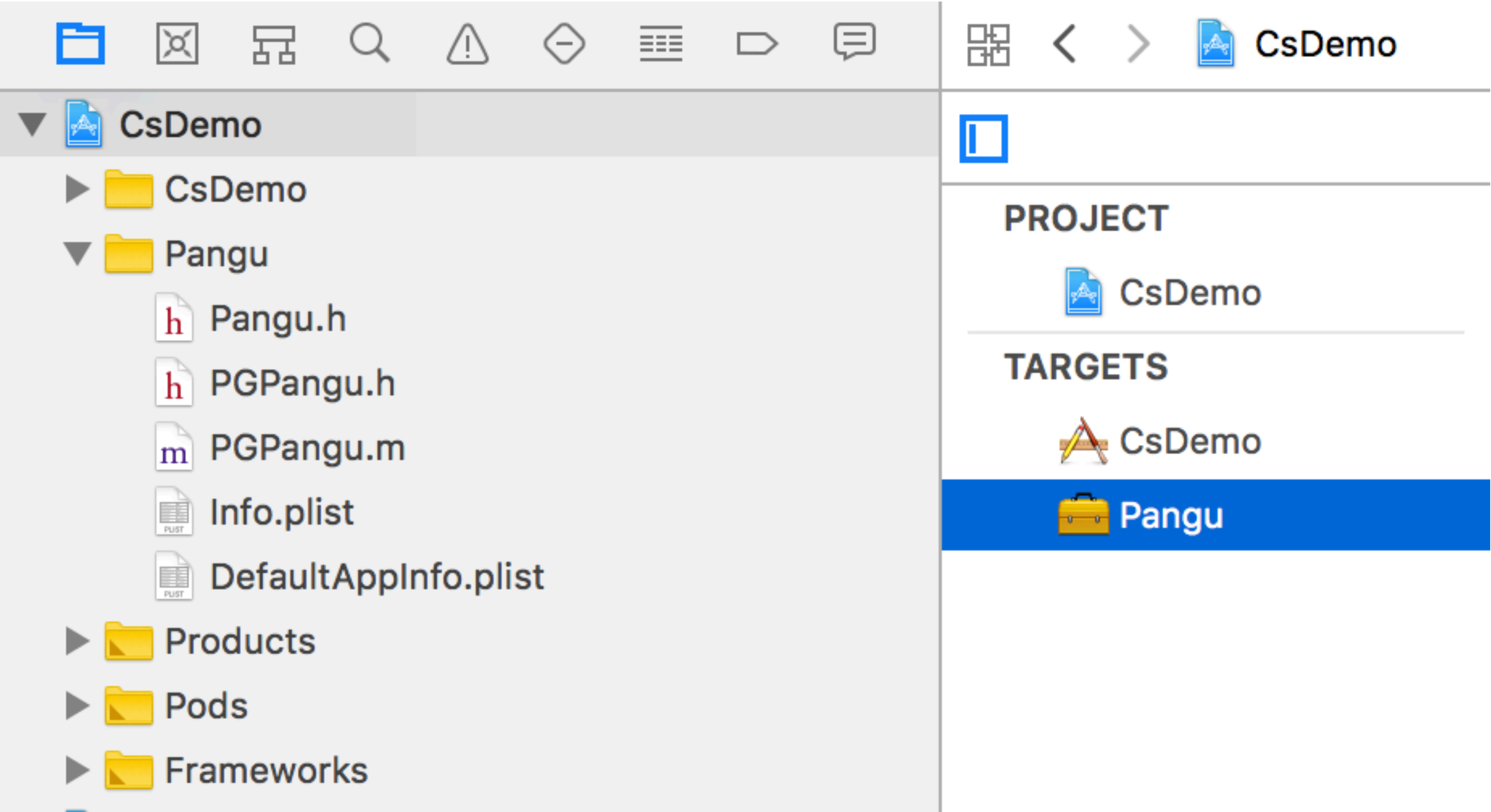
+ (void)load

调用顺序

Pangu



# 替换objc\_msgSend

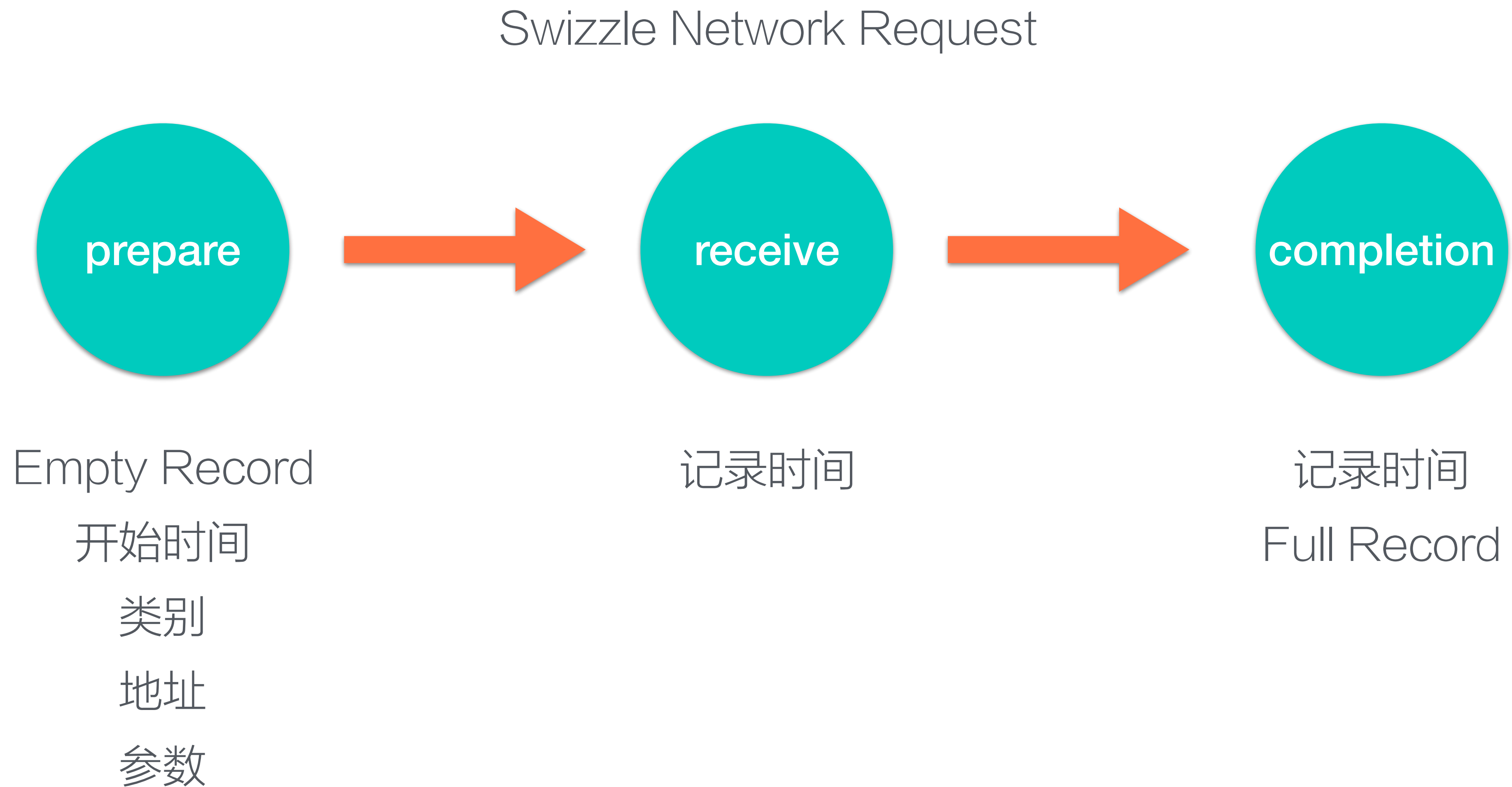


# 替换objc\_msgSend



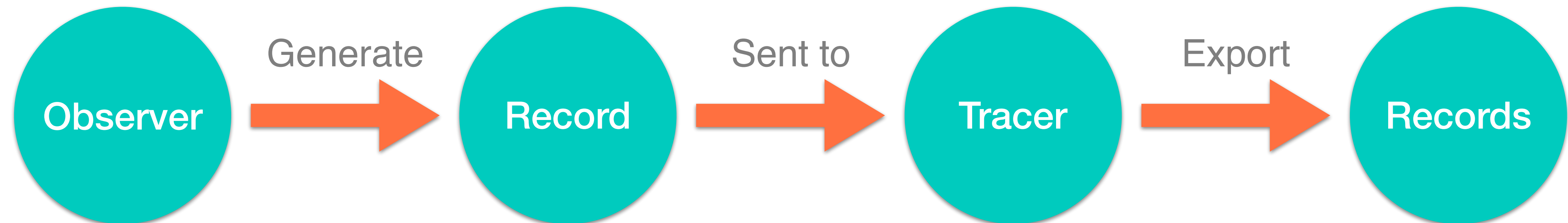
dyld, Mach-O

fishhook





# Tracing Runloop



# Caesium vs 传统方案



01 数据收集成本低

02 无侵入

03 信息全面

04 数据展示直观

05 体系化

06 对性能影响小

01 数据收集成本低

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06 对性能影响小

# 优势

01 数据收集成本低

02 无侵入

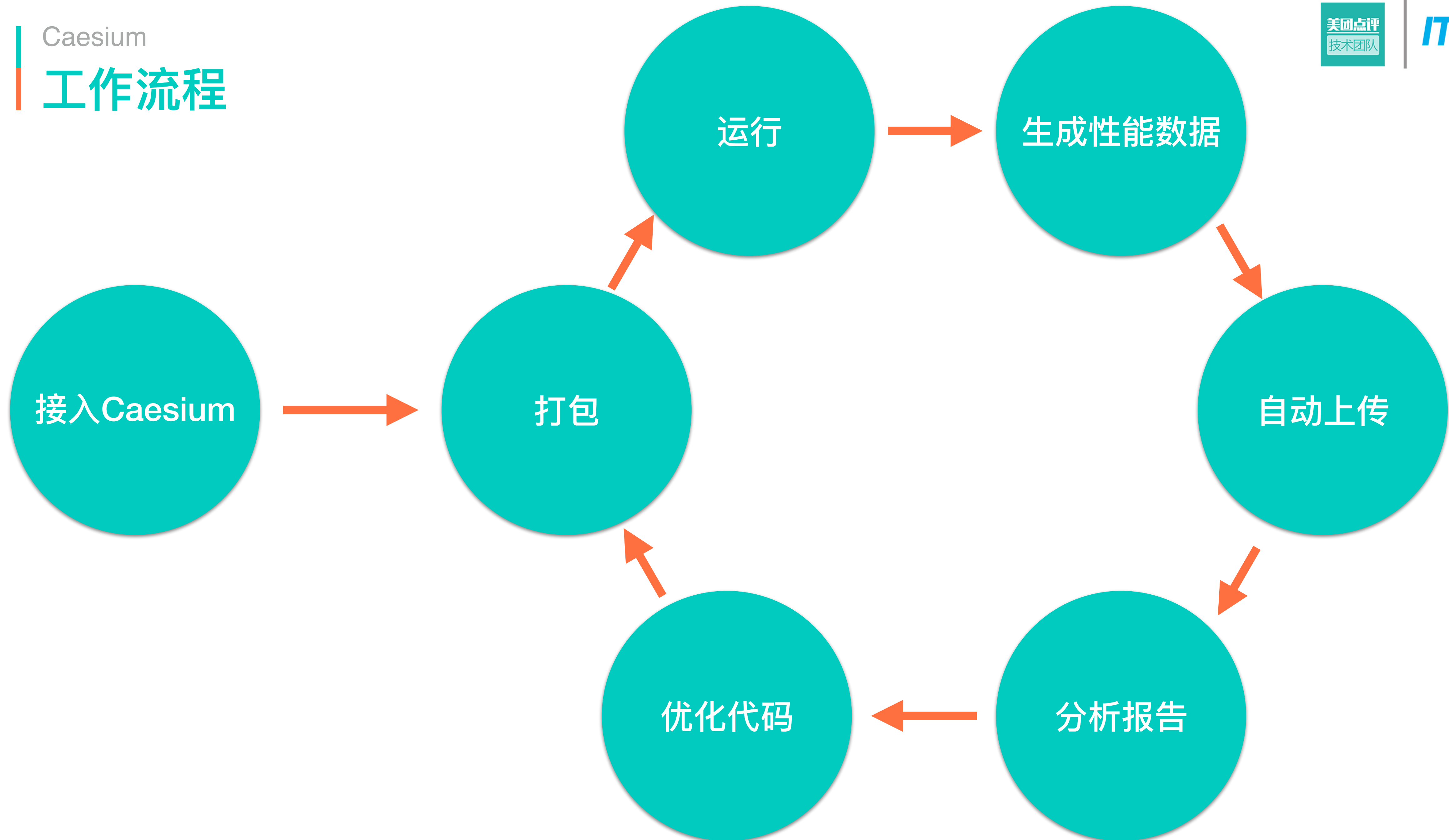
03 信息全面

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# 优势

01 数据收集成本低

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# 优势

01 数据收集成本低

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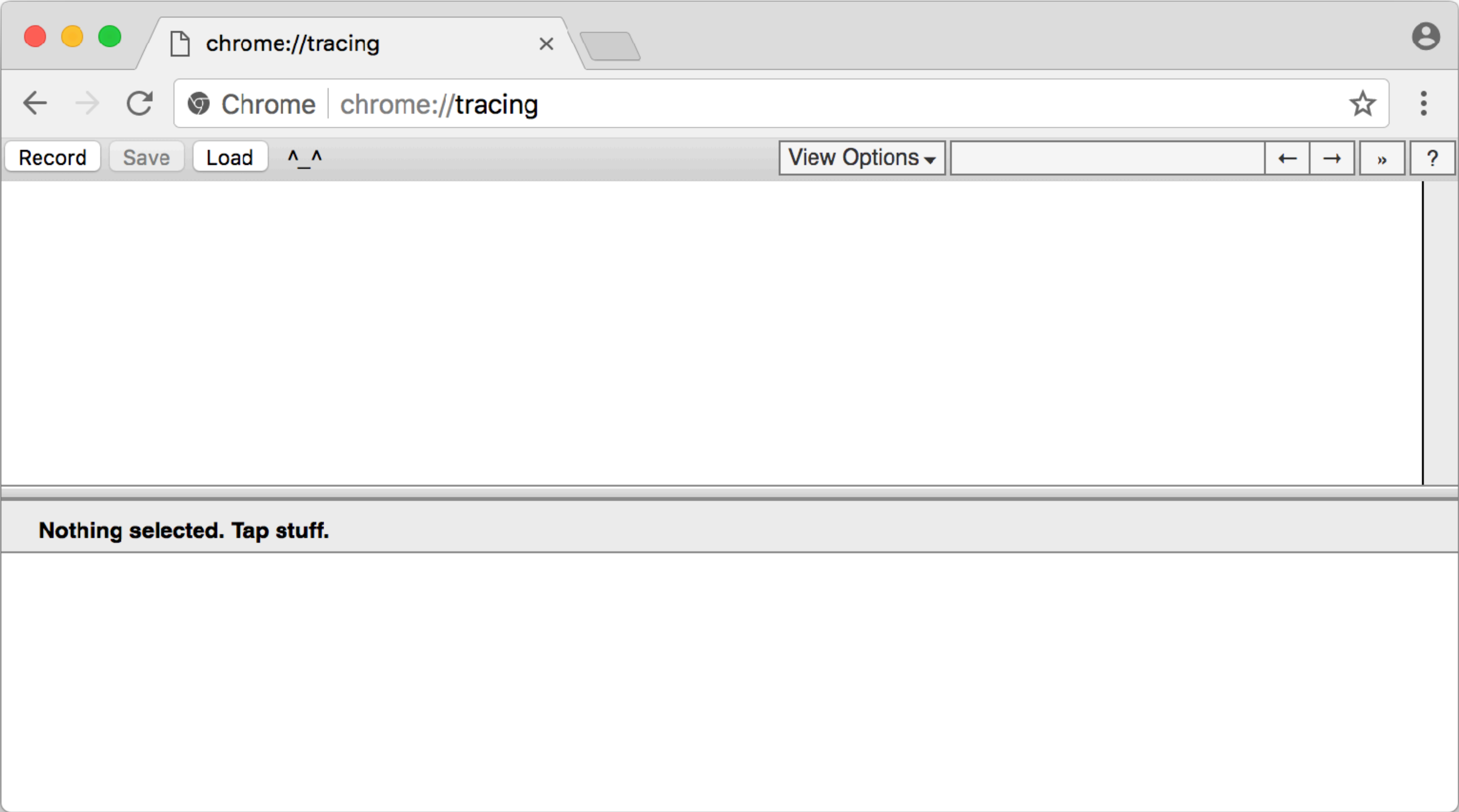


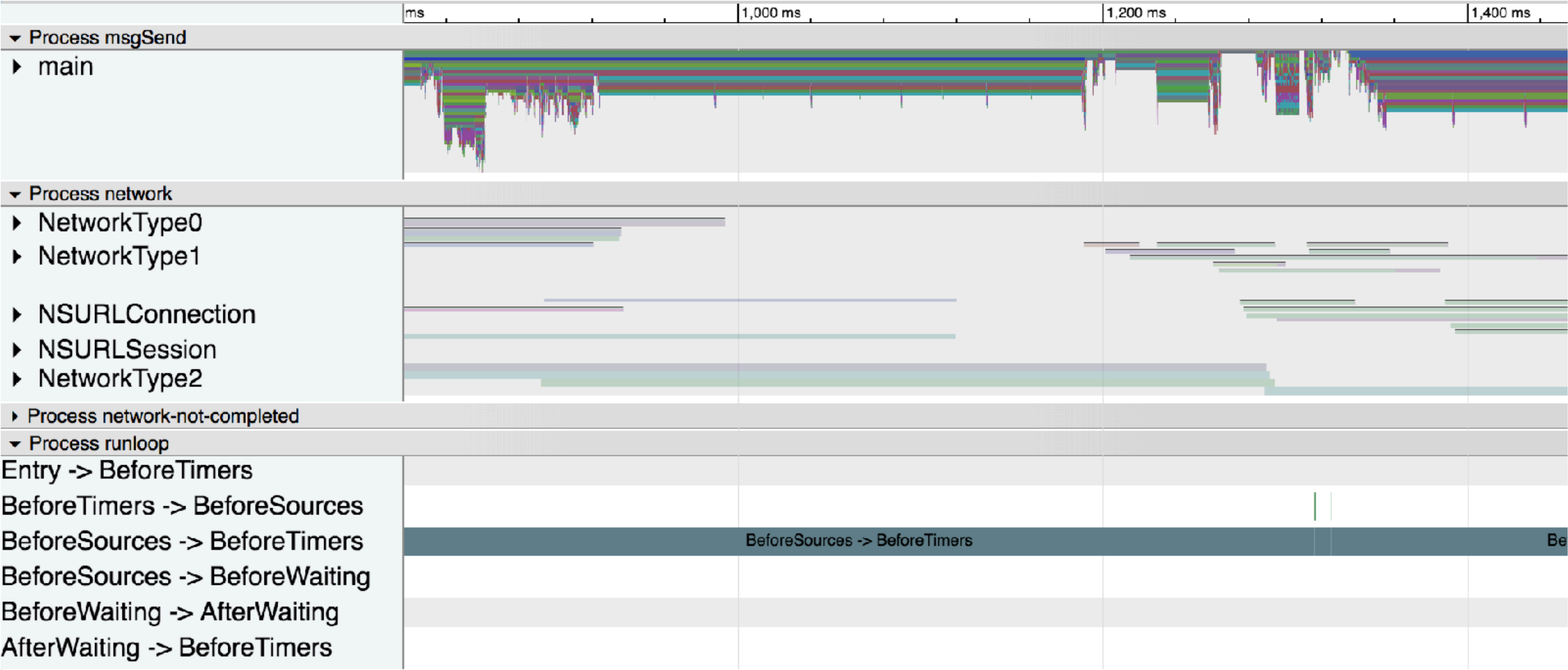
Chrome 性能展示工具

`chrome://tracing`

标准 JSON 格式

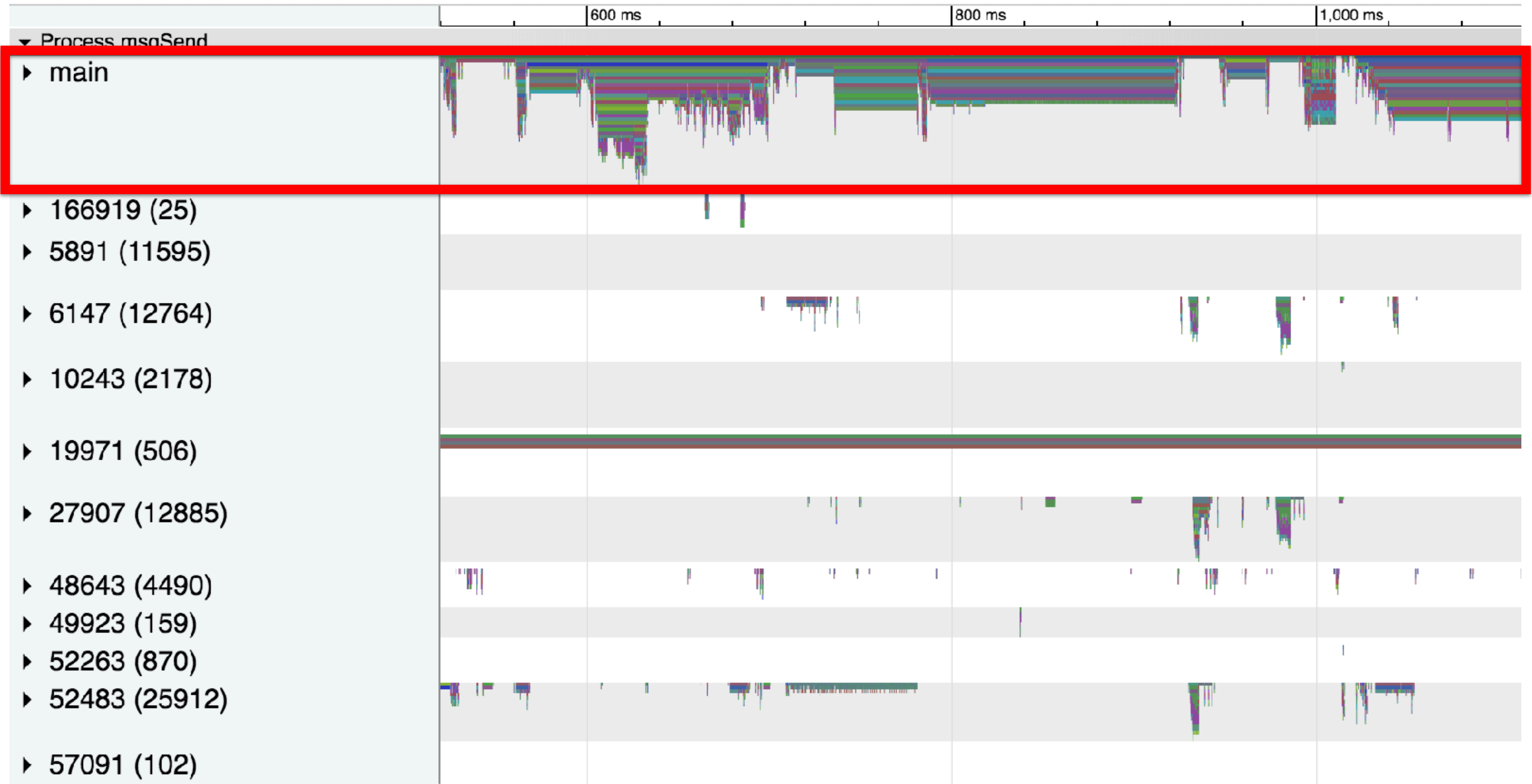
# 本地结果展示

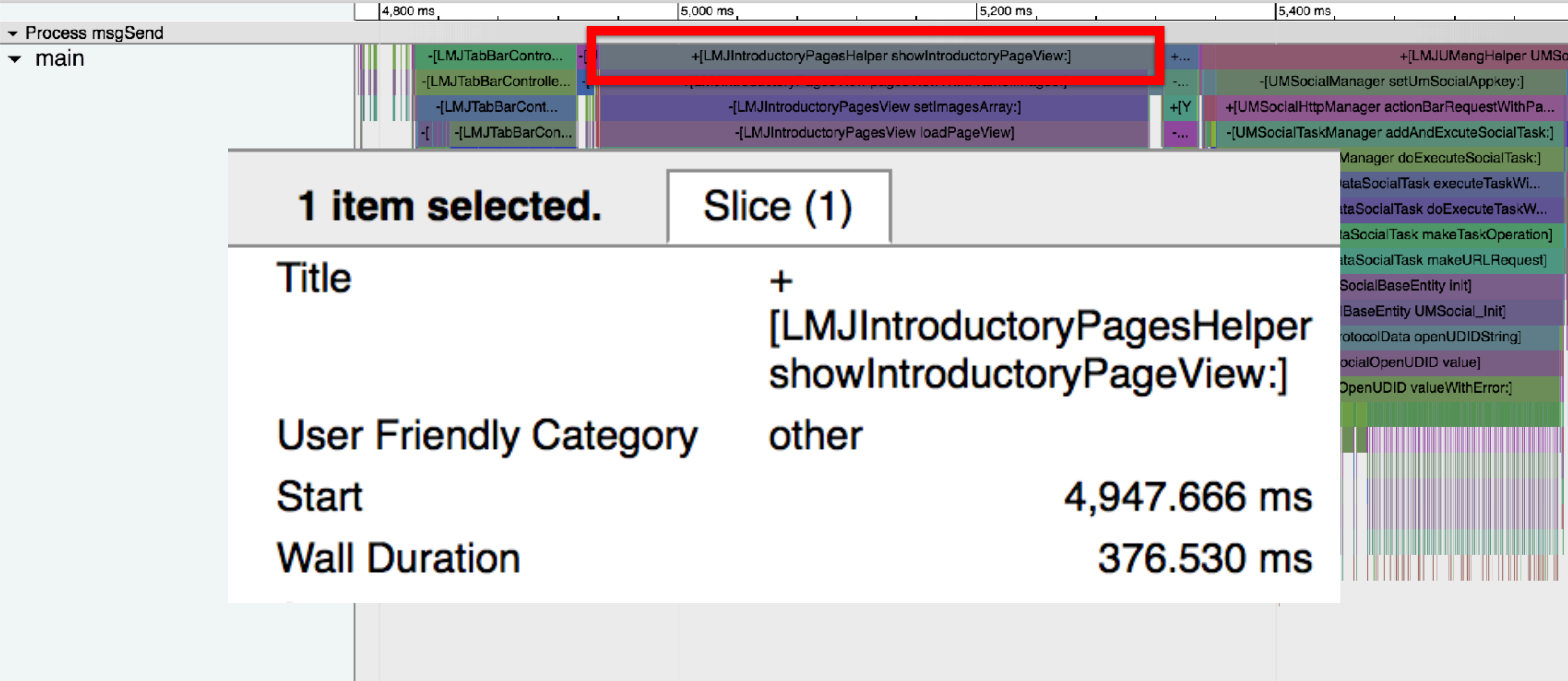






# 本地结果展示

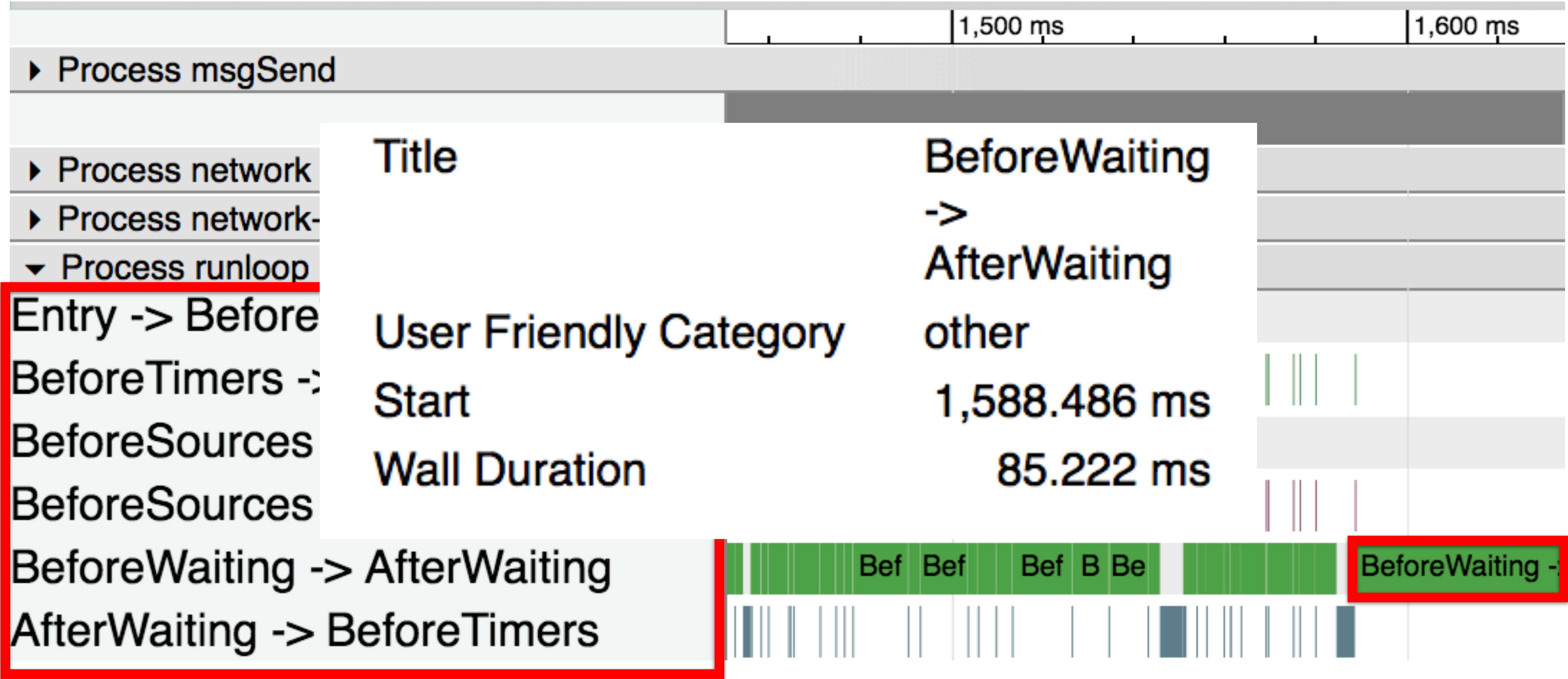






|                                                                                         |                 |                                                             |  |
|-----------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------|--|
| 1 item selected.                                                                        |                 | Async Slice (1)                                             |  |
| <div>▶ Process ms</div> <div>▼ Process ne</div> <div>▼ NSURL</div> <div>▼ NSURL ▼</div> | Title           | https://bj.meituan.com                                      |  |
|                                                                                         | Category        | network_request                                             |  |
|                                                                                         | Start           | 2,182.627 ms                                                |  |
|                                                                                         | Wall Duration   | 678.150 ms                                                  |  |
|                                                                                         | Args            |                                                             |  |
|                                                                                         | Request method  | "GET"                                                       |  |
|                                                                                         | HTTP Headers    | null                                                        |  |
|                                                                                         | Absolute URL    | <a href="https://bj.meituan.com">https://bj.meituan.com</a> |  |
|                                                                                         | Body parameters | null                                                        |  |
|                                                                                         | Timeout         | 60                                                          |  |





# 优势

01 数据收集成本低

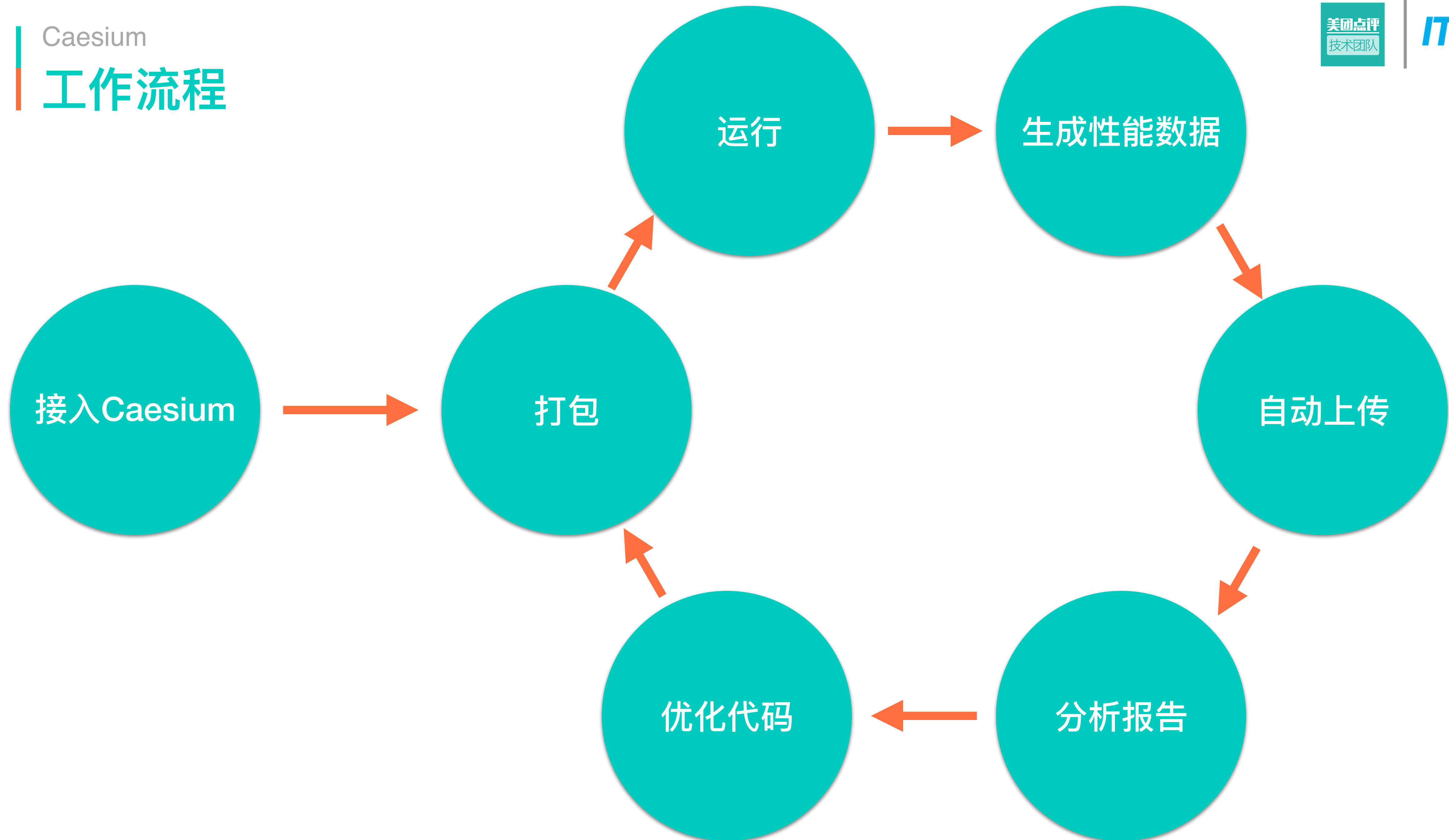
02 无侵入

03 信息全面

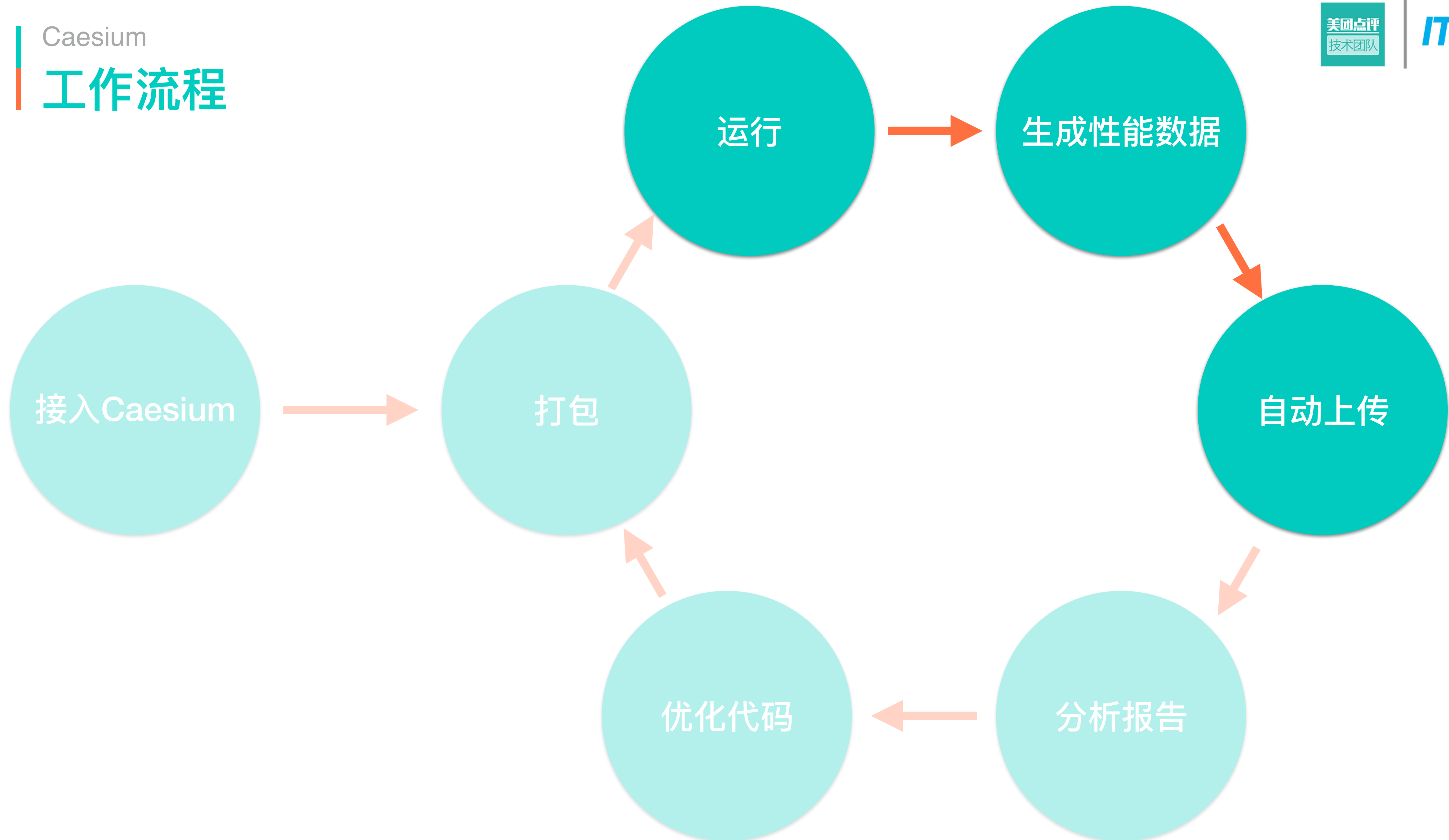
04 数据展示直观

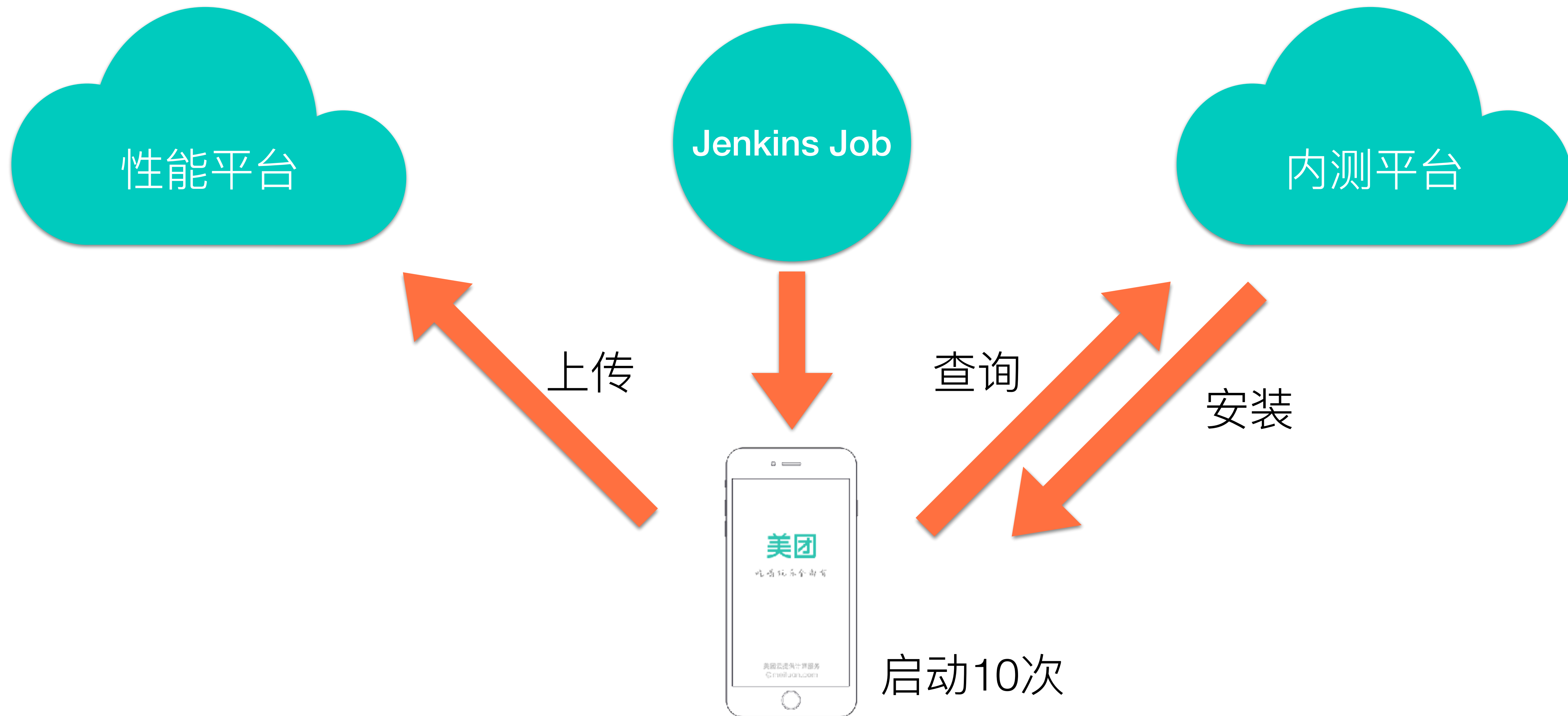
05 体系化

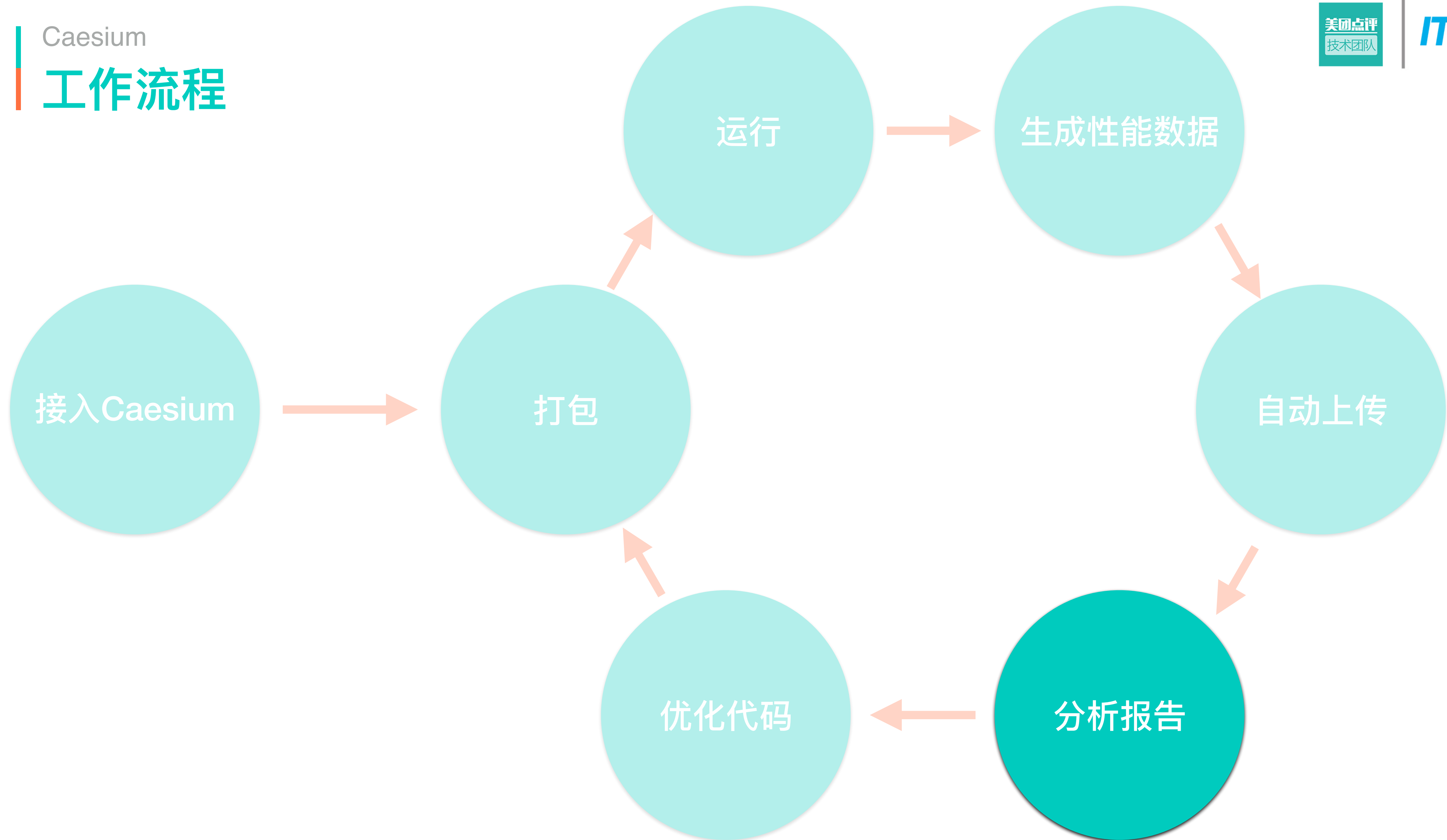
06 对性能影响小





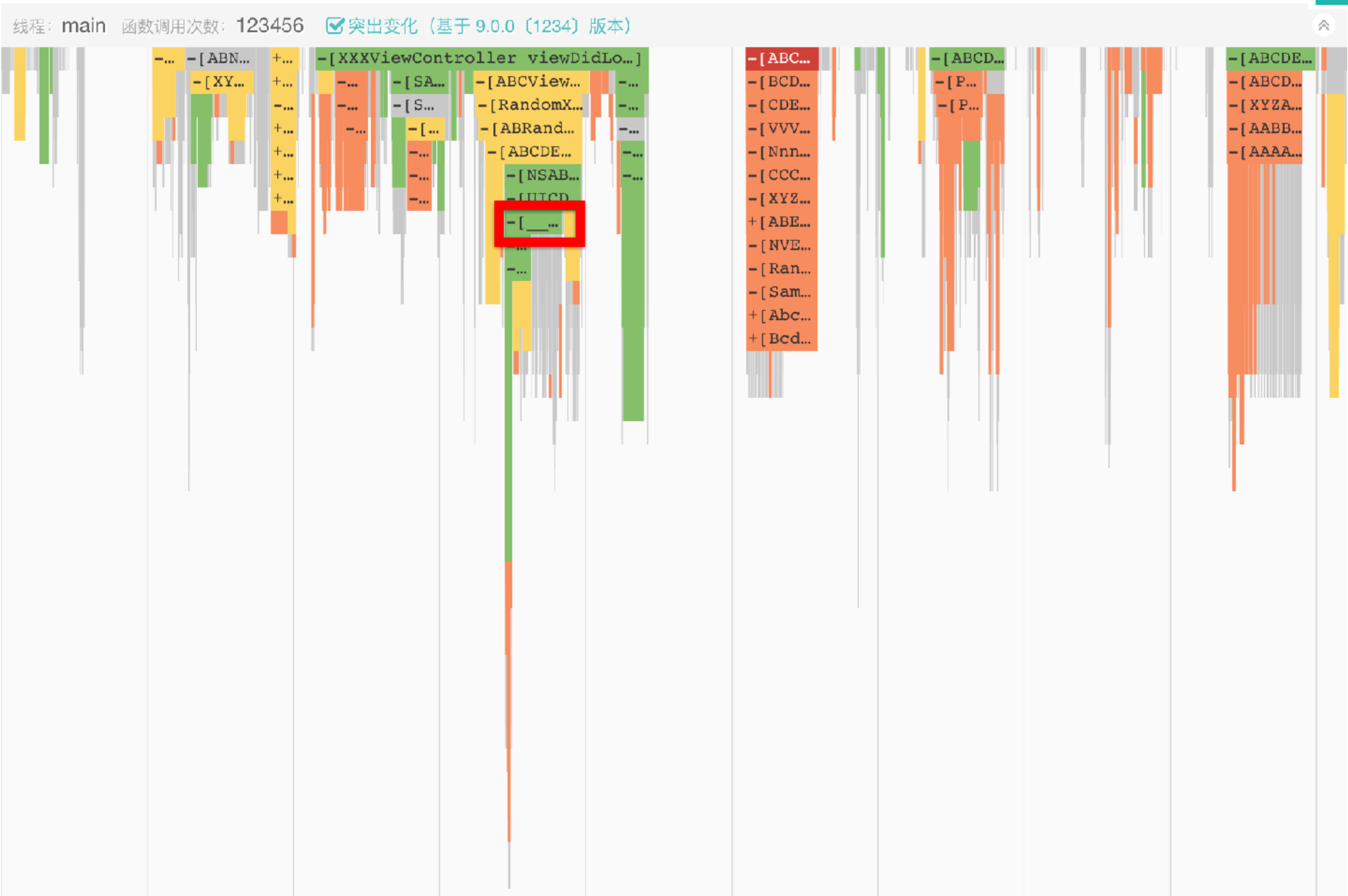








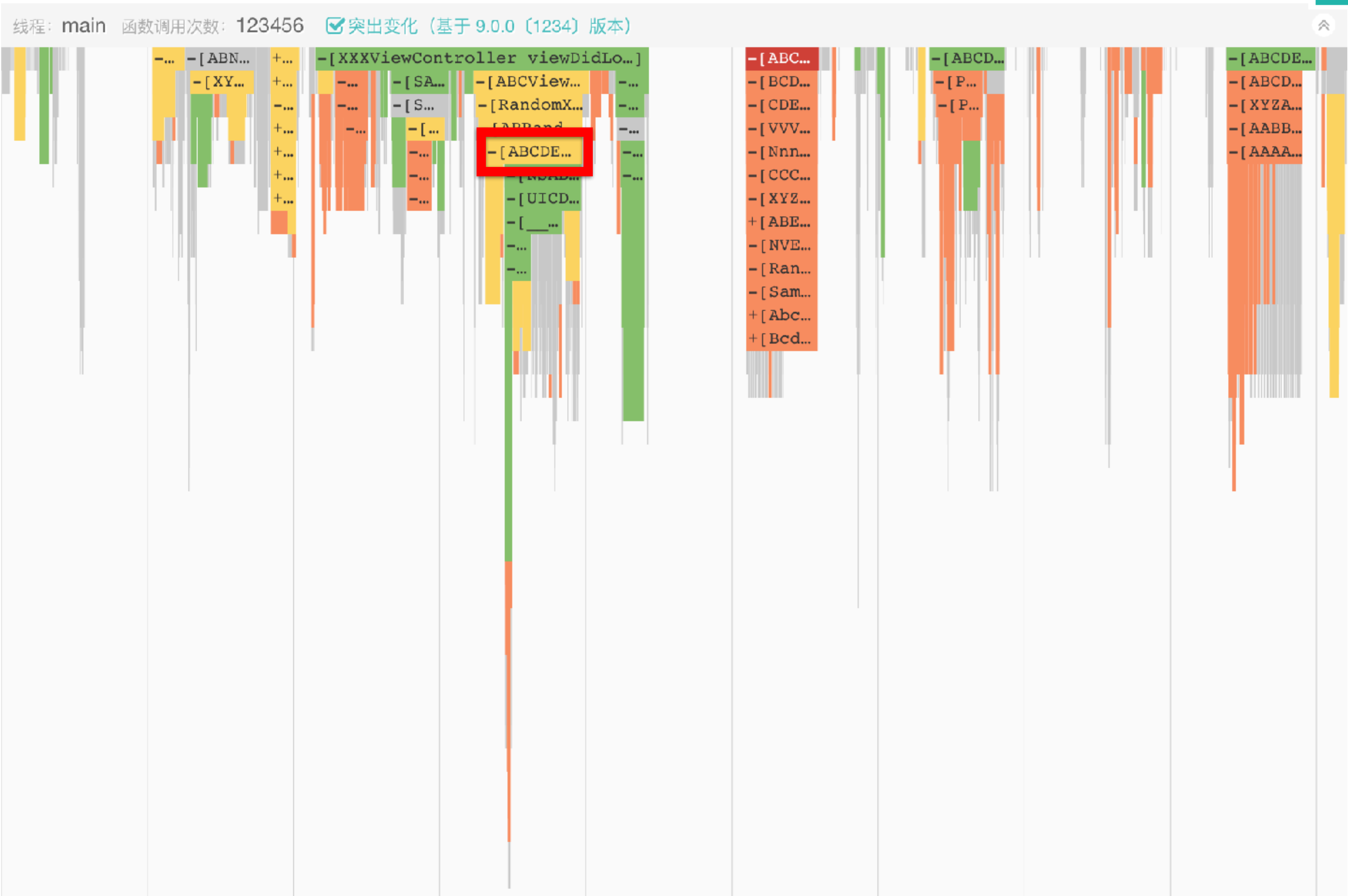
# 展示变化



# 展示变化

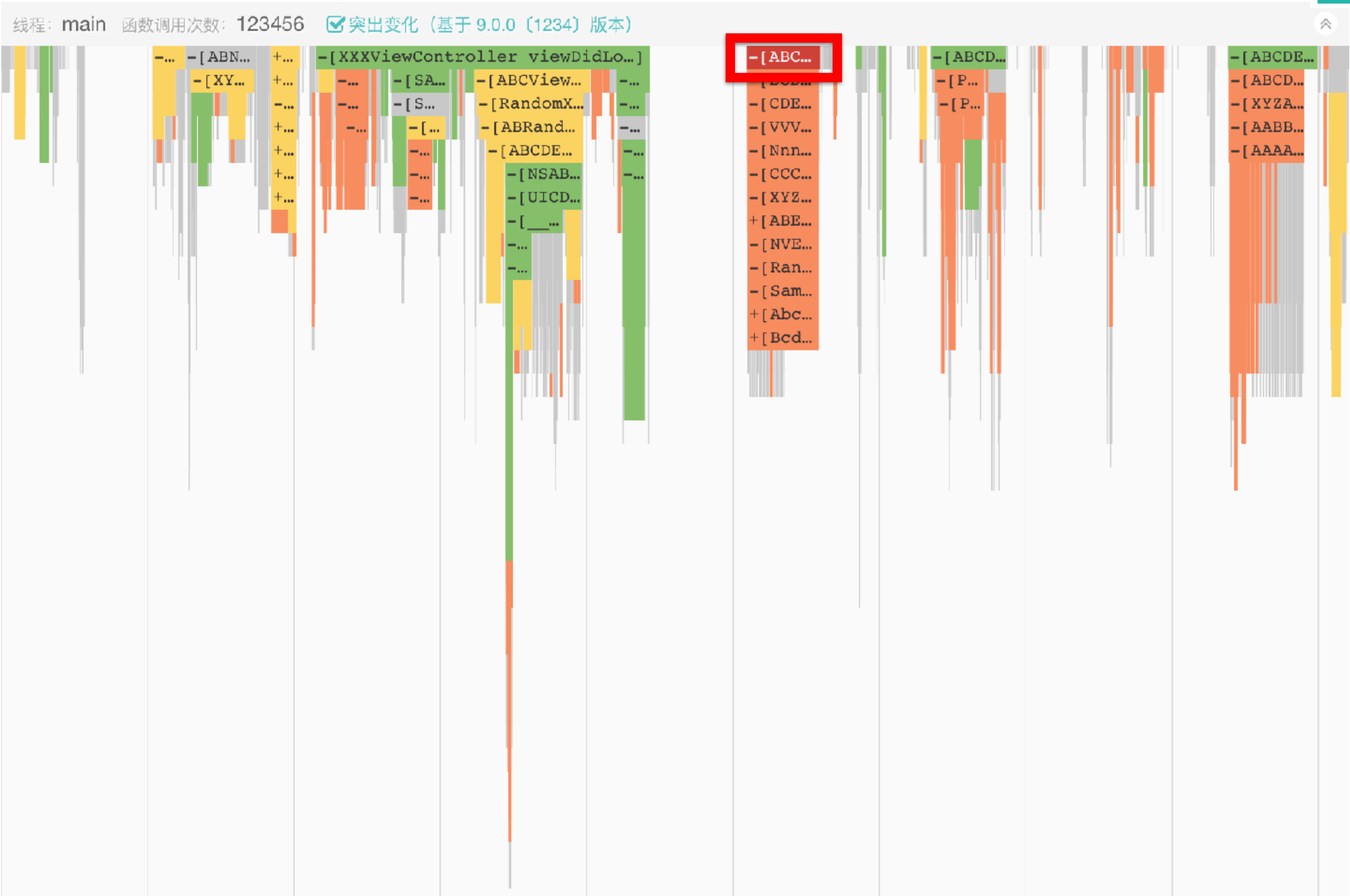


# 展示变化





# 展示变化





函数名

```
-[Note allTheMethodsBelow:areRandomlyGenerated:]
-[XXXTask start]
-[SomeClass doSthWithThis:that:]
+[SomeManager setup]
-[SomeClassA doSomething:]
-[NSNotificationCenter postNotificationName:object:userInfo:]
+[SomeModule setup]
-[__NSArrayI enumerateObjectsUsingBlock:]
-[ABCViewController updateData]
-[XYZView loadData:]
-[ALongLongClassName aLongLongMethodName:]
+[SampleClass showSample]
-[RandomRandom generateSomethingRandom:]
-[HahahaManager manageSomething]
-[SomeStrangeView setData:]
-[SampleObject reloadAllData]
-[XXXViewController doSthSlow:]
+[HugeSingleton sharedInstance]
-[AAATableViewController tableView:cellForRowAtIndexPath:]
-[ThisIsAModule setupModule]
-[ABCDemoManager manageSth:finished:]
-[AnotherSampleItem initWithType:]
-[AhaSection init]
-[UnknownDataObject whatIsThis:andThat:]
-[NSData initWithThis:]
-[NSArray initWithMood:]
-[Wow nice:]
+[RandomString randomRandom:]
-[AlmostAnModule loadDataIfNeeded]
-[FakeClass printEverything]
```

总耗时

1139.546  
251.215  
234.748  
99.875  
112.148  
70.233  
38.098  
27.895  
60.682  
24.005  
19.546  
17.825  
15.595  
15.407  
14.040  
54.862  
55.612  
13.630  
12.994  
12.779  
12.579  
57.063  
57.064  
73.785  
11.508  
11.309  
10.150  
31.878  
18.790  
20.034

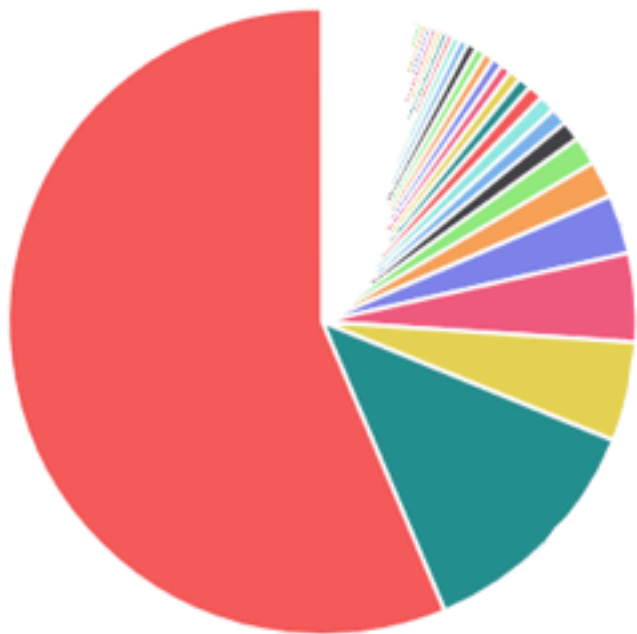
耗时变化

338.060  
251.215  
114.282  
69.069  
59.269  
40.332  
38.098  
27.895  
25.088  
24.005  
19.546  
17.825  
15.595  
15.407  
14.040  
13.716  
13.715  
13.630  
12.994  
12.779  
12.579  
12.447  
12.447  
12.017  
11.508  
11.309  
10.150  
10.026  
8.128  
6.828

29.7% ↑  
100.0% ↑  
48.7% ↑  
69.2% ↑  
52.8% ↑  
57.4% ↑  
100.0% ↑  
100.0% ↑  
41.3% ↑  
100.0% ↑  
100.0% ↑  
100.0% ↑  
100.0% ↑  
100.0% ↑  
100.0% ↑  
25.0% ↑  
24.7% ↑  
100.0% ↑  
100.0% ↑  
100.0% ↑  
100.0% ↑  
21.8% ↑  
21.8% ↑  
16.3% ↑  
100.0% ↑  
100.0% ↑  
100.0% ↑  
31.5% ↑  
43.3% ↑  
34.1% ↑

显示更多

pod库耗时 饼图



| pod库名称 ◆         | 所耗时间比 (%) ◆ |
|------------------|-------------|
| SlowSlowPod      | 56.36       |
| ABCModule        | 12.47       |
| AnotherModule    | 5.12        |
| JustAPod         | 4.56        |
| YetAnotherPod    | 3.05        |
| XYZManager       | 1.89        |
| PowerfulFeature  | 1.47        |
| LegacyCode       | 1.01        |
| SomeDatabase     | 0.9         |
| OurNetworkModule | 0.85        |

⏮ ⏪

1 2 3 4 5

⏩ ⏭



SlowSlowPod内函数耗时 饼图



| 函数名称 ⌵                                    | 所耗时间比 (%) ⌵ |
|-------------------------------------------|-------------|
| -[ABCViewController viewDidAppear:]       | 57.12       |
| -[XXXViewController viewDidLoad]          | 13.57       |
| -[SomeManager loadData]                   | 4.03        |
| -[XXXCenter runWithThis:andThat:]         | 3.48        |
| -[RandomDataGenerator giveMeFive]         | 3.02        |
| -[Coffee explode]                         | 2.37        |
| -[JokingAgent laughWithStyle:volume:]     | 2.22        |
| -[SuperHero savePlanet:retry:]            | 1.49        |
| + [TechSalon isExcellent]                 | 1.42        |
| -[EndingViewController viewDidDisappear:] | 1.35        |

⏮ ⏪ 1 2 3 4 5 ⏩ ⏭

# 优势

01 数据收集成本低

02 无侵入

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06 对性能影响小

|        | Caesium | Instruments |
|--------|---------|-------------|
| 数据收集成本 | 低       | 高           |
| 时间轴    | 有       | 无           |
| 结构化数据  | 是       | 否           |
| 可定制性   | 深度定制    | 简单设置        |
| 可靠性    | 高       | 偶尔卡死        |
| 多语言支持  | 只支持OC   | 支持多种语言      |

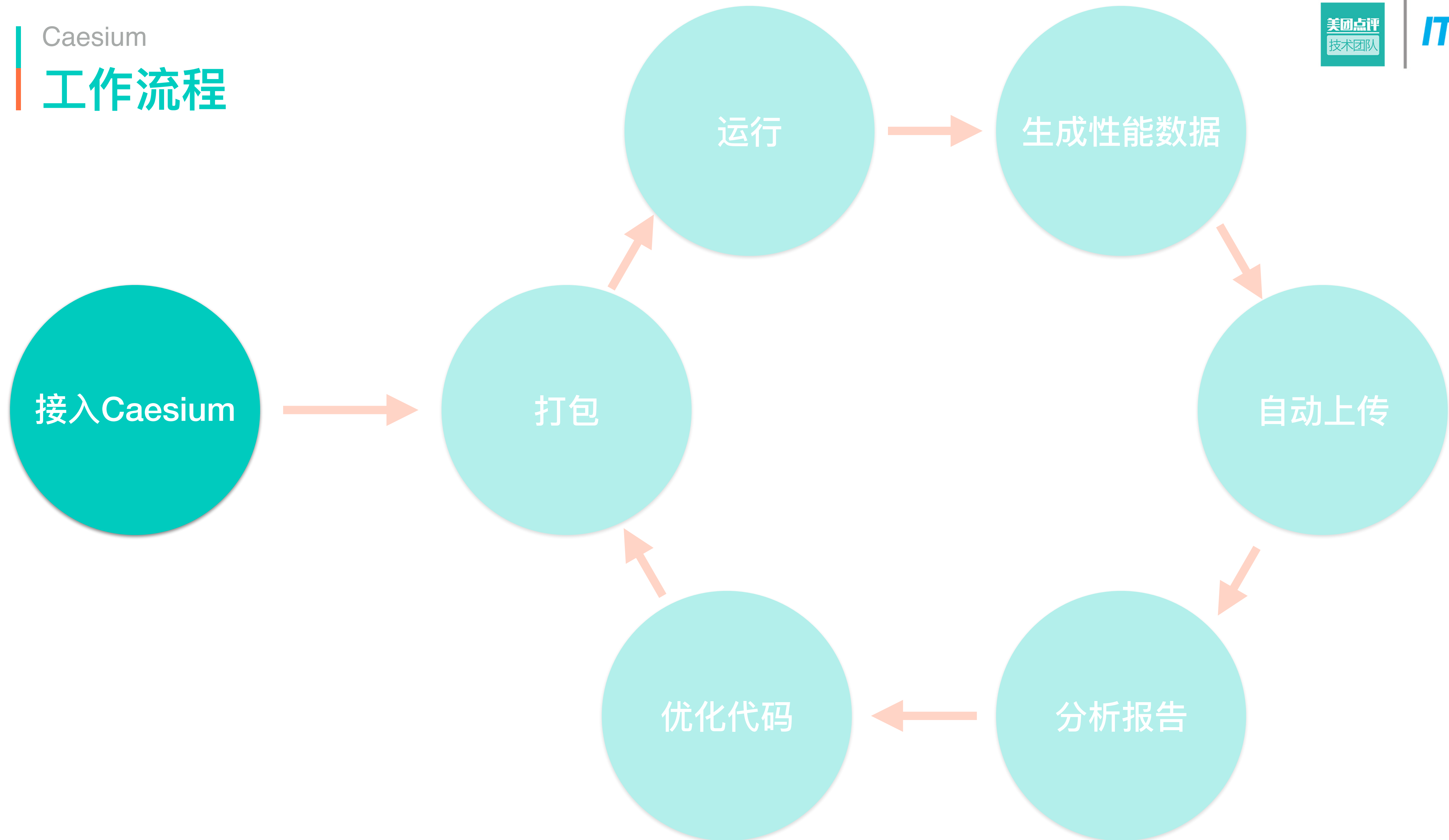


和传统方案的对比

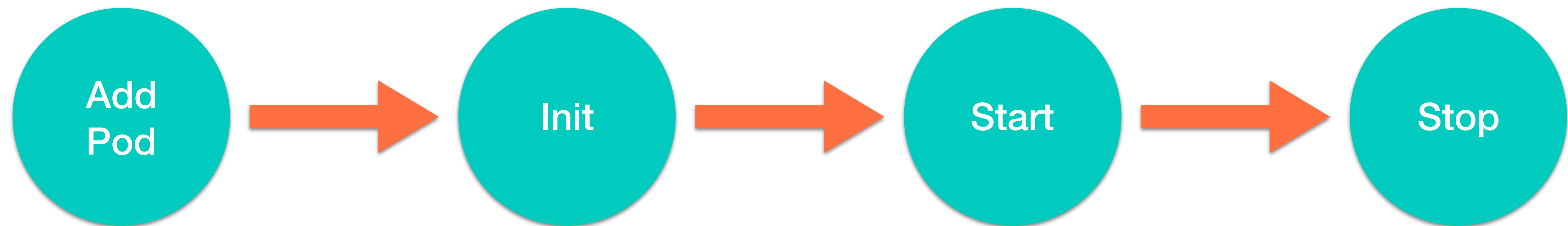
## vs 自定义插桩



|        | Caesium | 自定义插桩 |
|--------|---------|-------|
| 代码覆盖范围 | 较全面     | 有限    |
| 侵入性    | 极低      | 高     |
| 数据收集成本 | 低       | 高     |



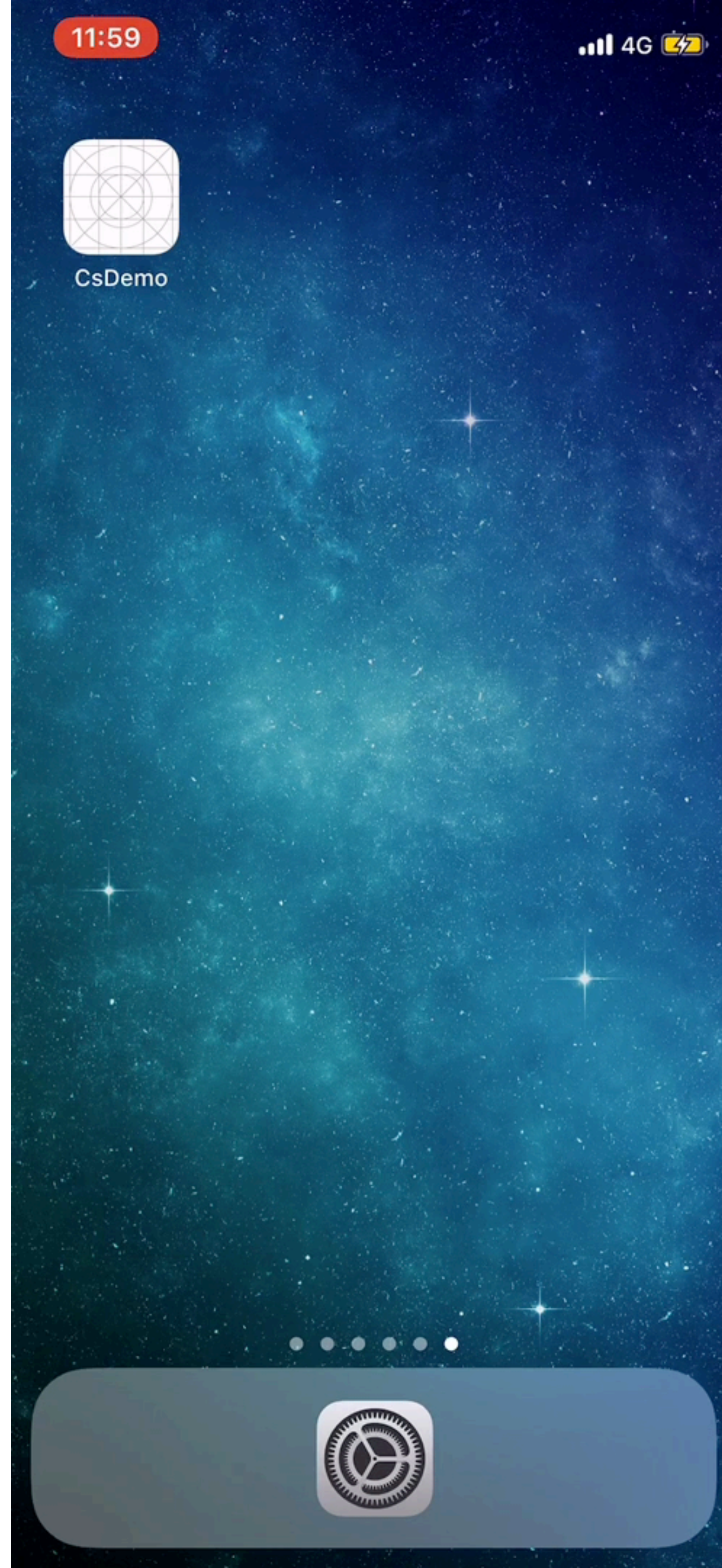
# 接入流程





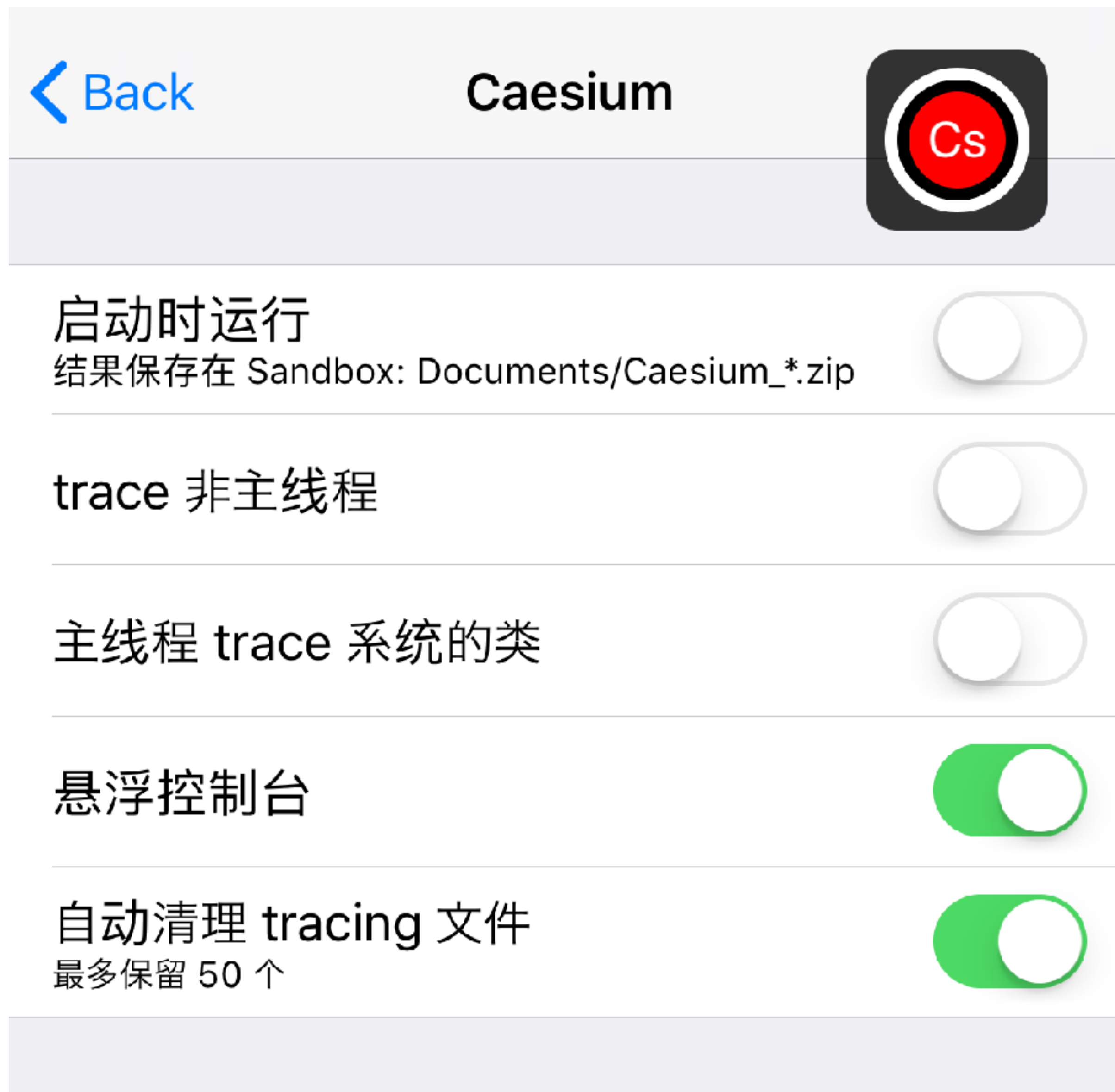
Caesium

# 接入&运行

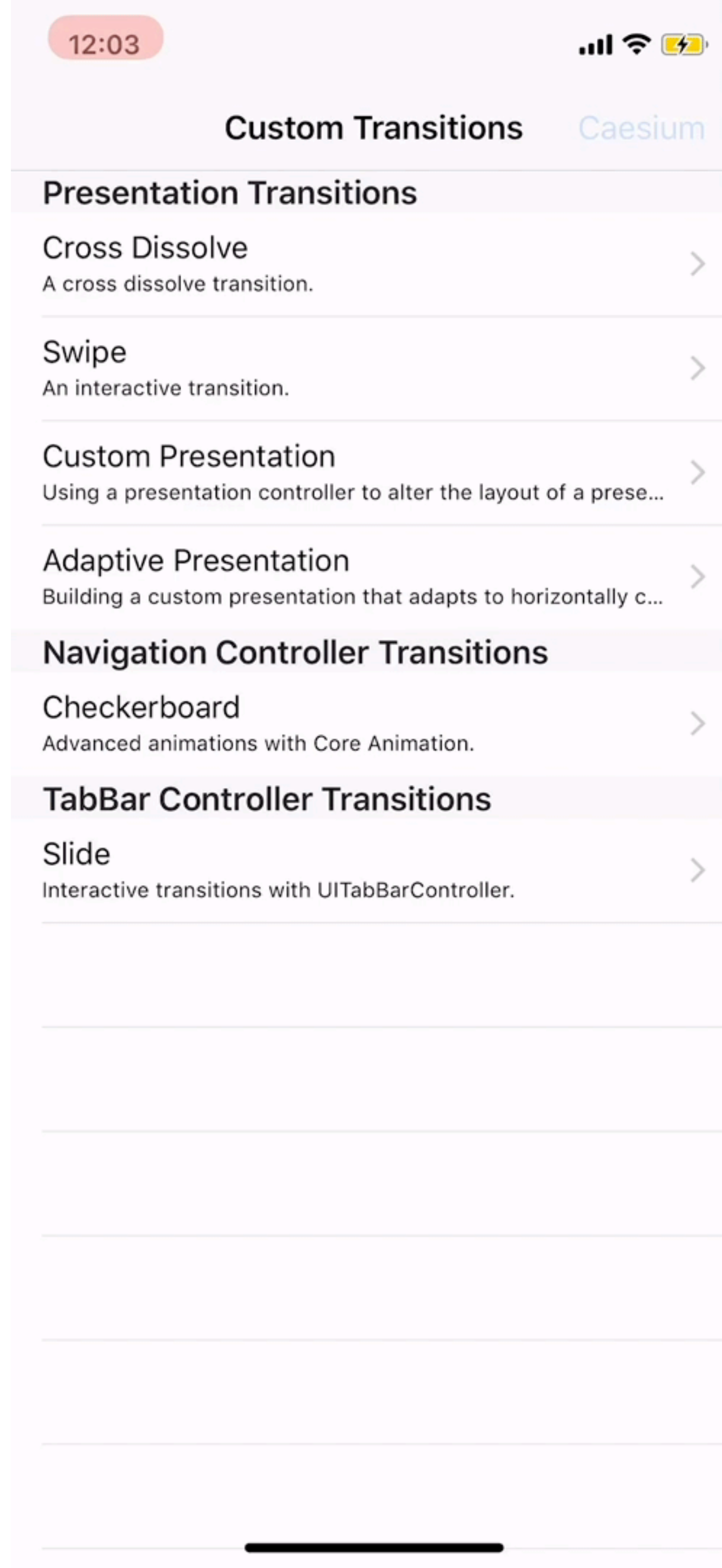


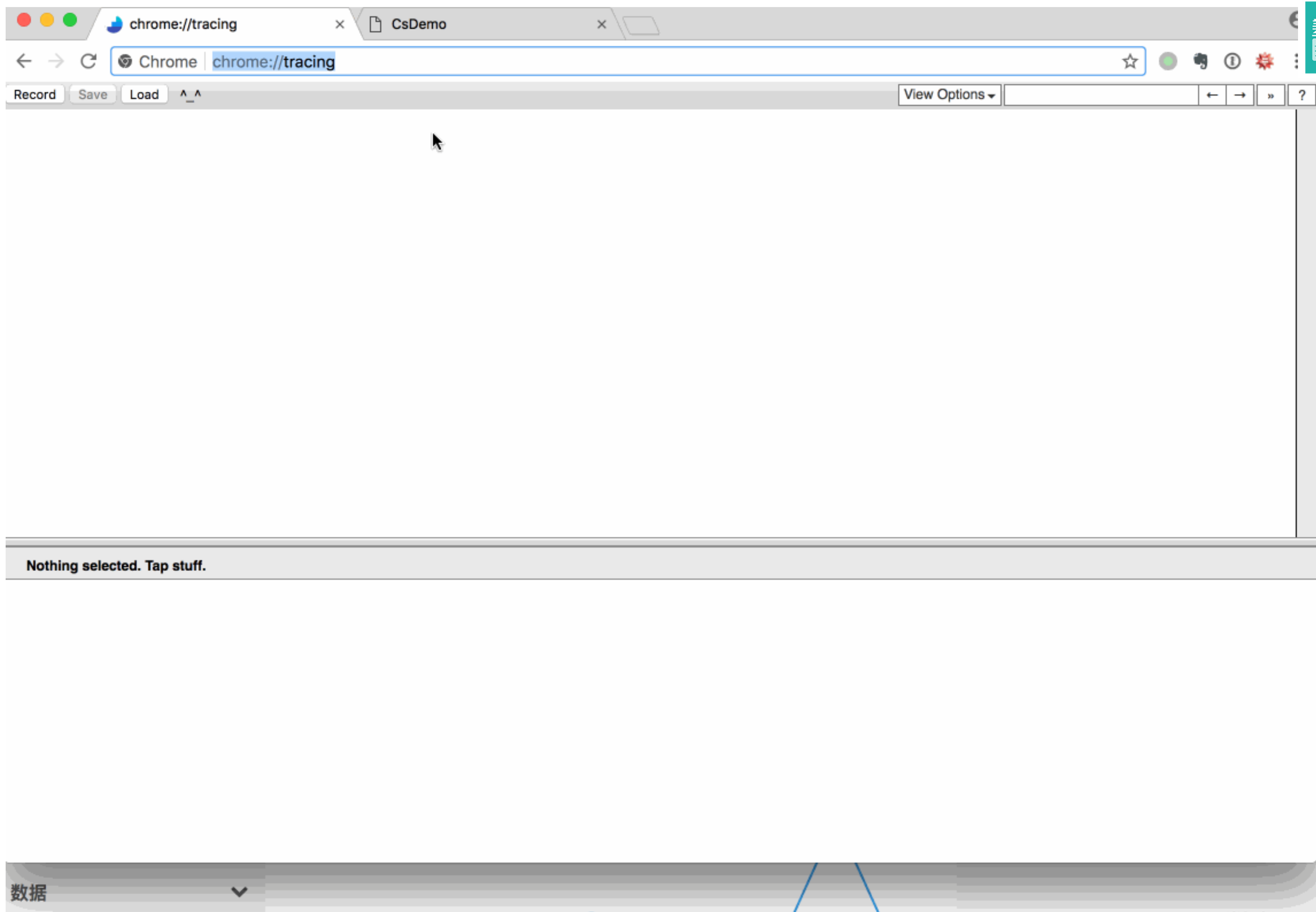


## 不仅是启动



不仅是启动







# 美团App启动优化

2016

“农业时代”

纯手工打造

2017 Q2

“工业时代”

Caesium首次辅助启动优化  
清理无用代码

2017 Q4

“互联网时代”

较完善的监控体系  
网络请求优化  
推迟非紧急任务  
+load治理

启动时间缩短20%以上

# Q&A



# Thanks

*Eat better,Live better.*