Simplifying

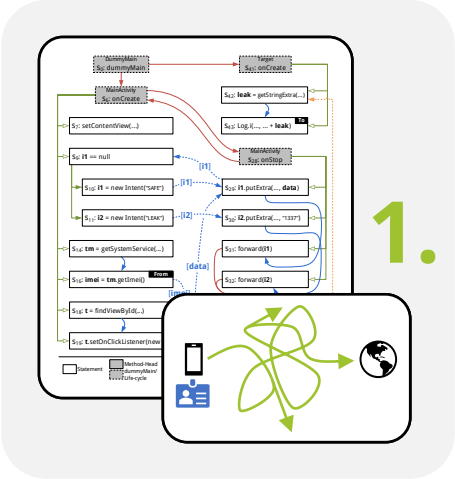
(Slicing)

Cooperative Android App Analysis

Tasks

www.Felix Pauck.de, Heike Wehrheim

9/13/2021



1.

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(Slicing)

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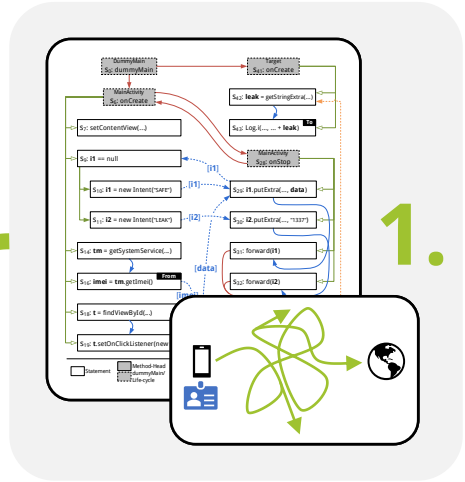

1.

2.

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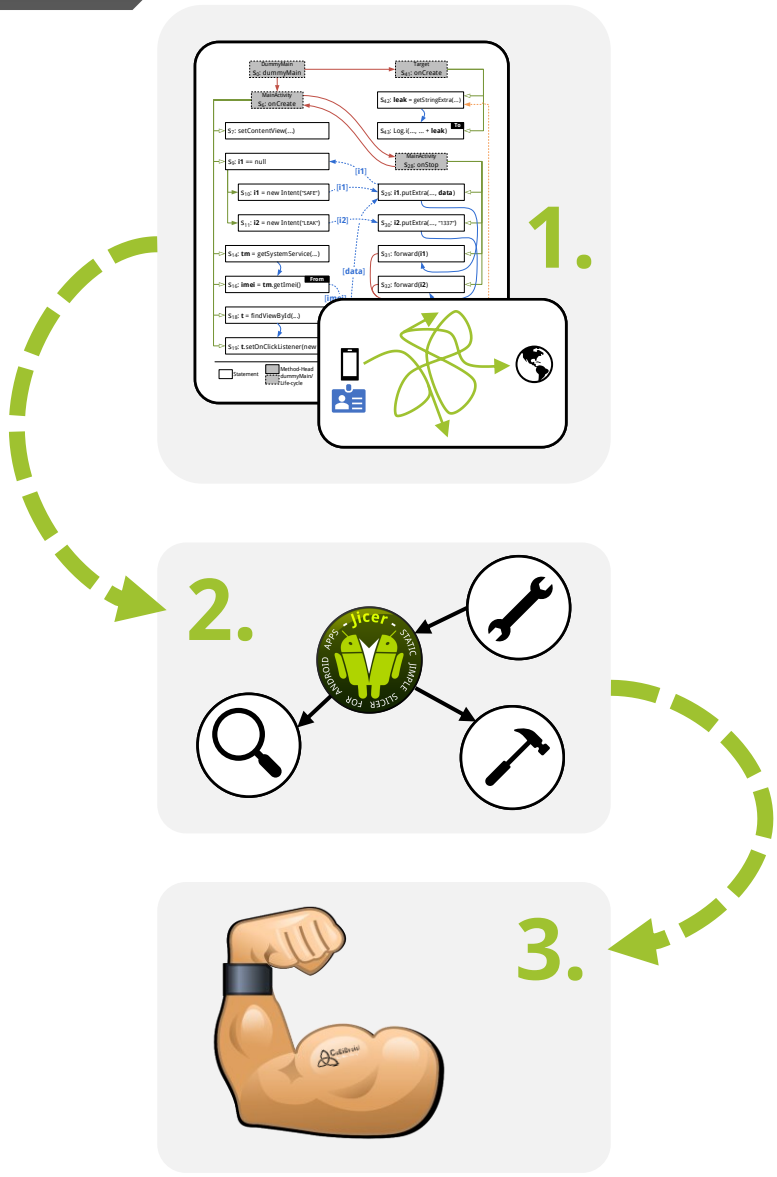

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(Slicing)
Cooperative Android App Analysis
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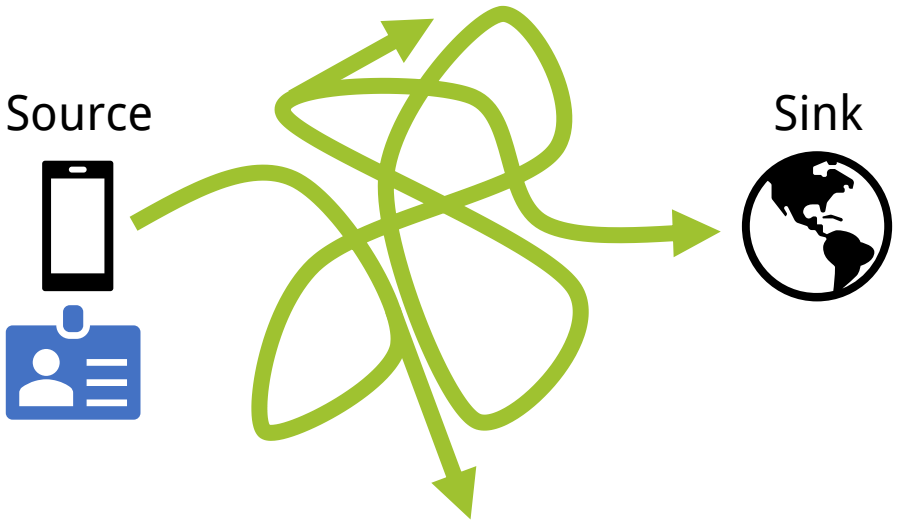
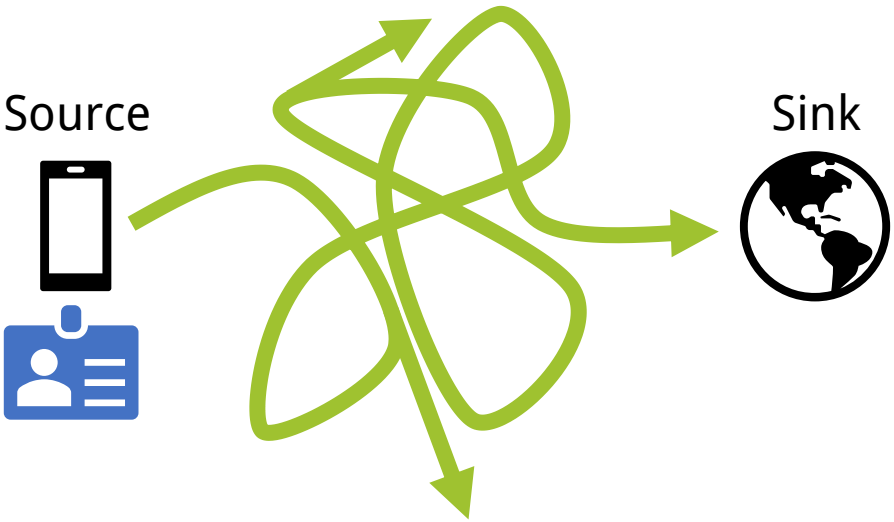
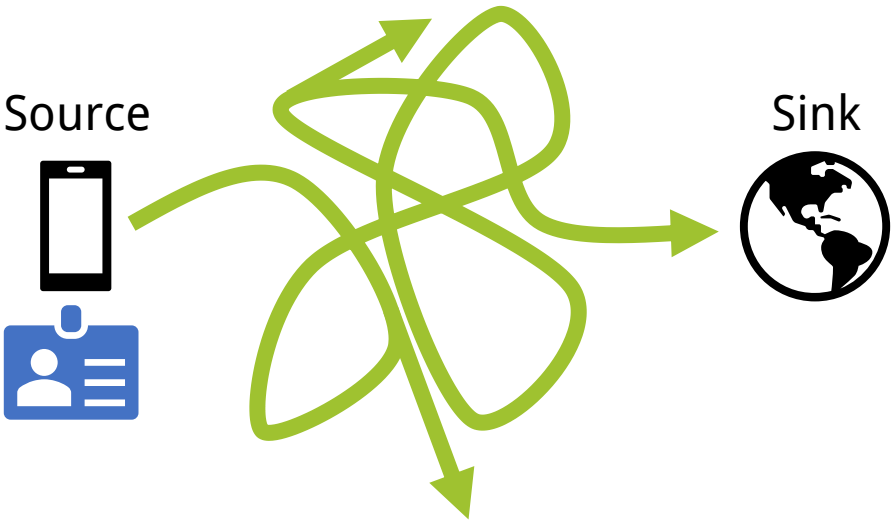
Cooperative Taint Analysis



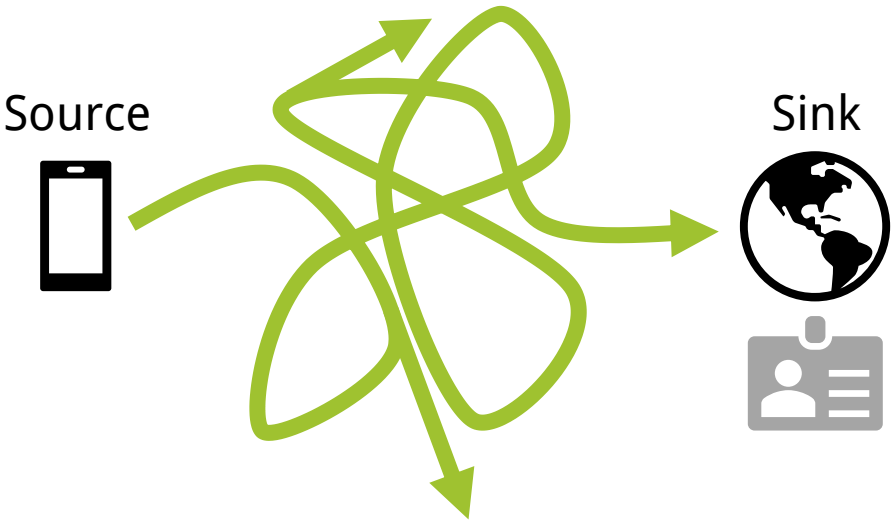
Cooperative Taint Analysis



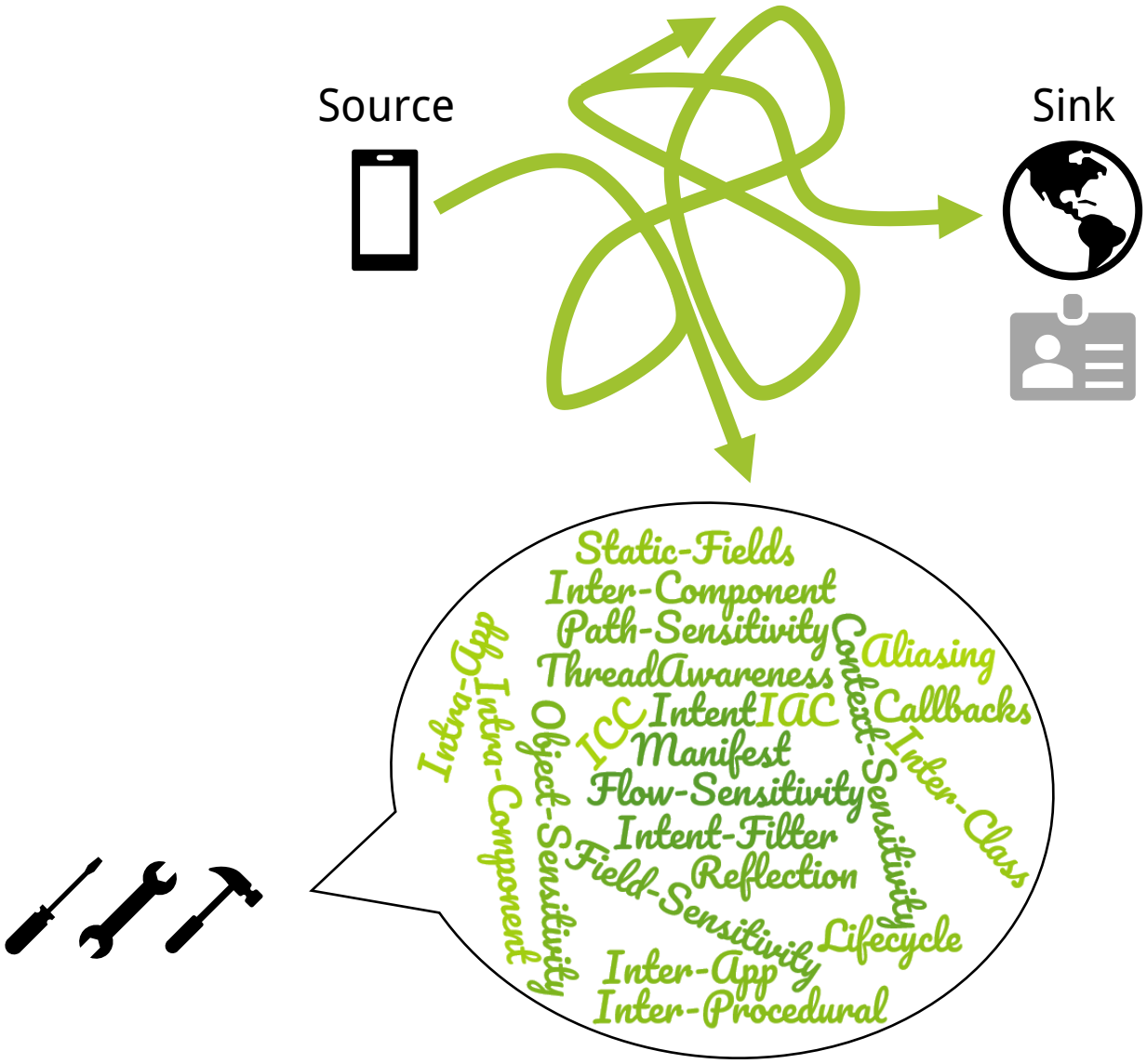
Cooperative Taint Analysis



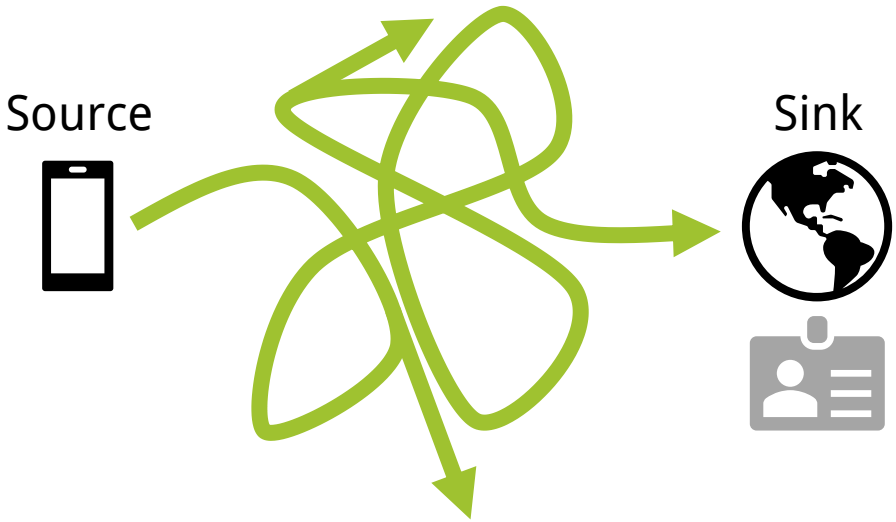
Cooperative Taint Analysis

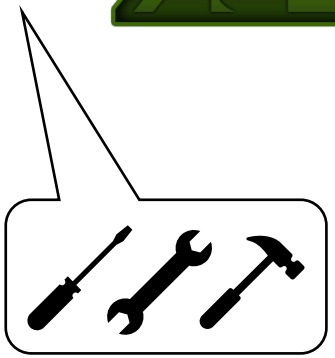


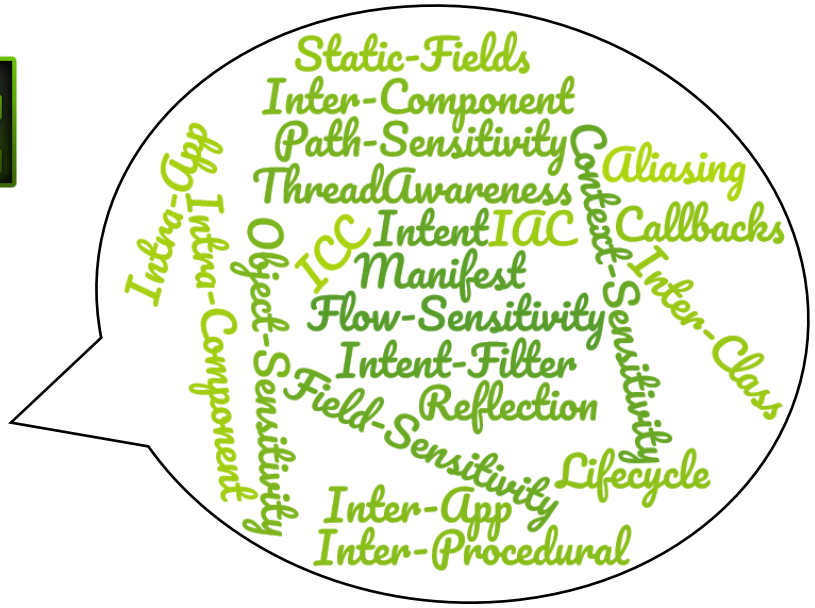
Cooperative Taint Analysis



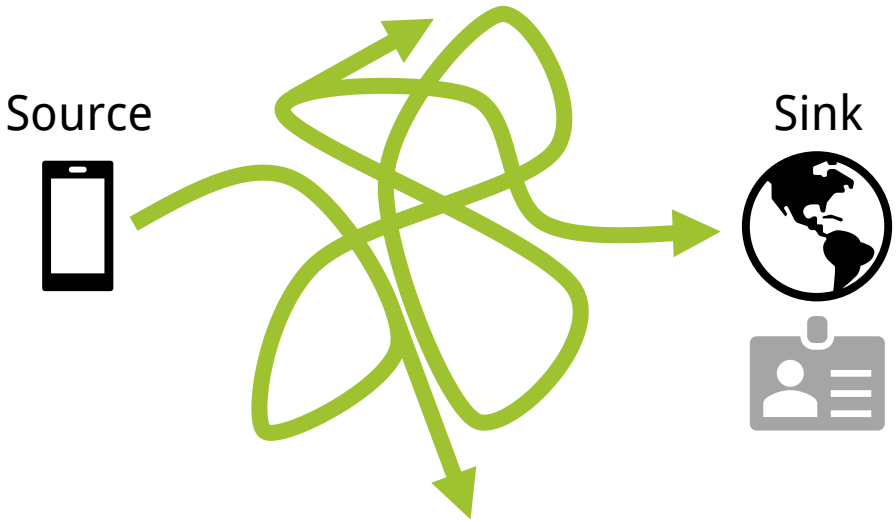
Cooperative Taint Analysis



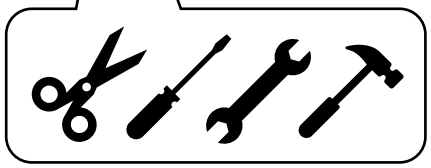


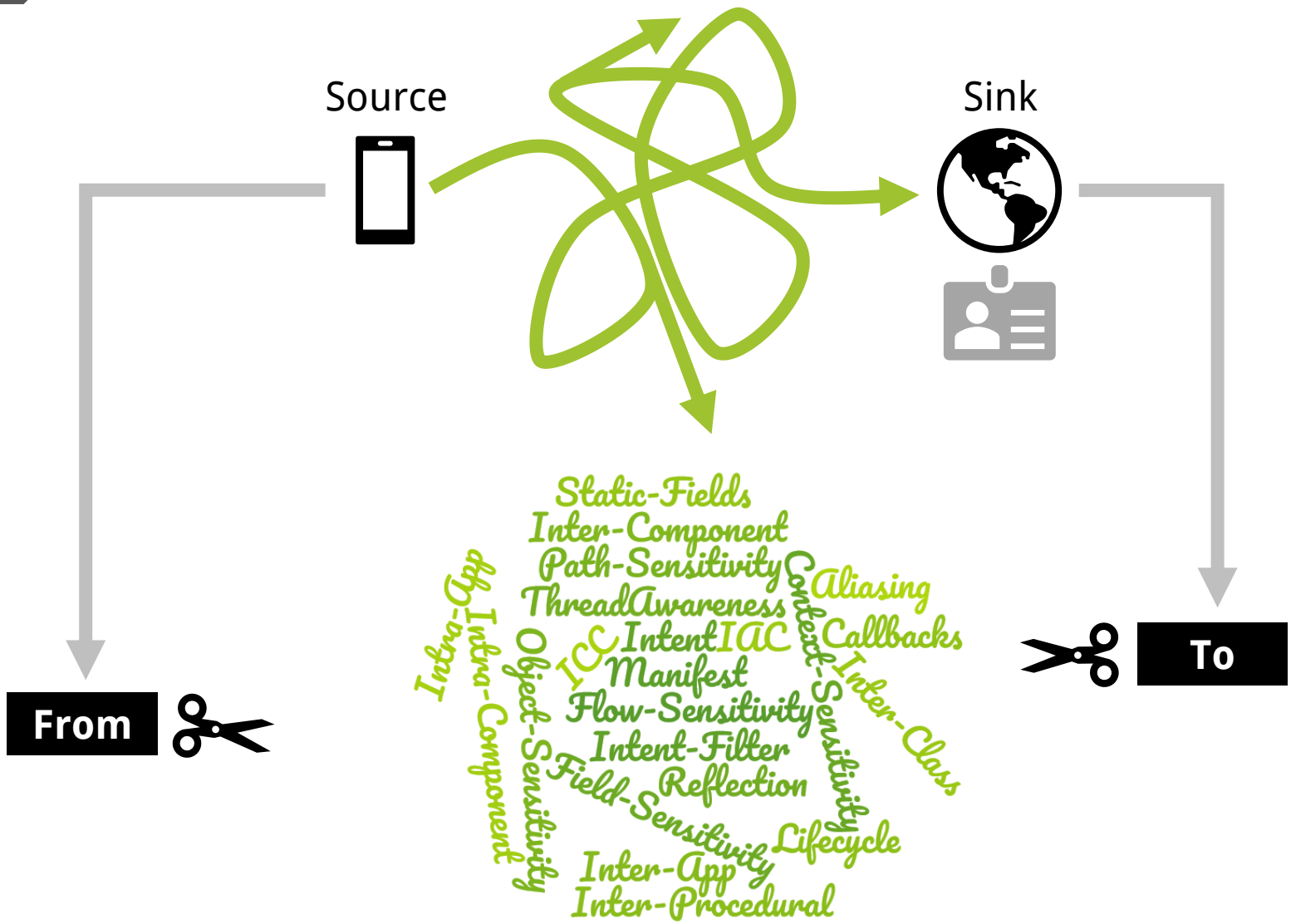


Cooperative Taint Analysis



CoDiDroid
together strong!

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Sink
From
To
Static-Fields
Inter-Component
Path-Sensitivity
Aliasing
ThreadAwareness
Context-Sensitivity
Callbacks
Intra-App
IAC
Intent
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Inter-Class
Manifest
Flow-Sensitivity
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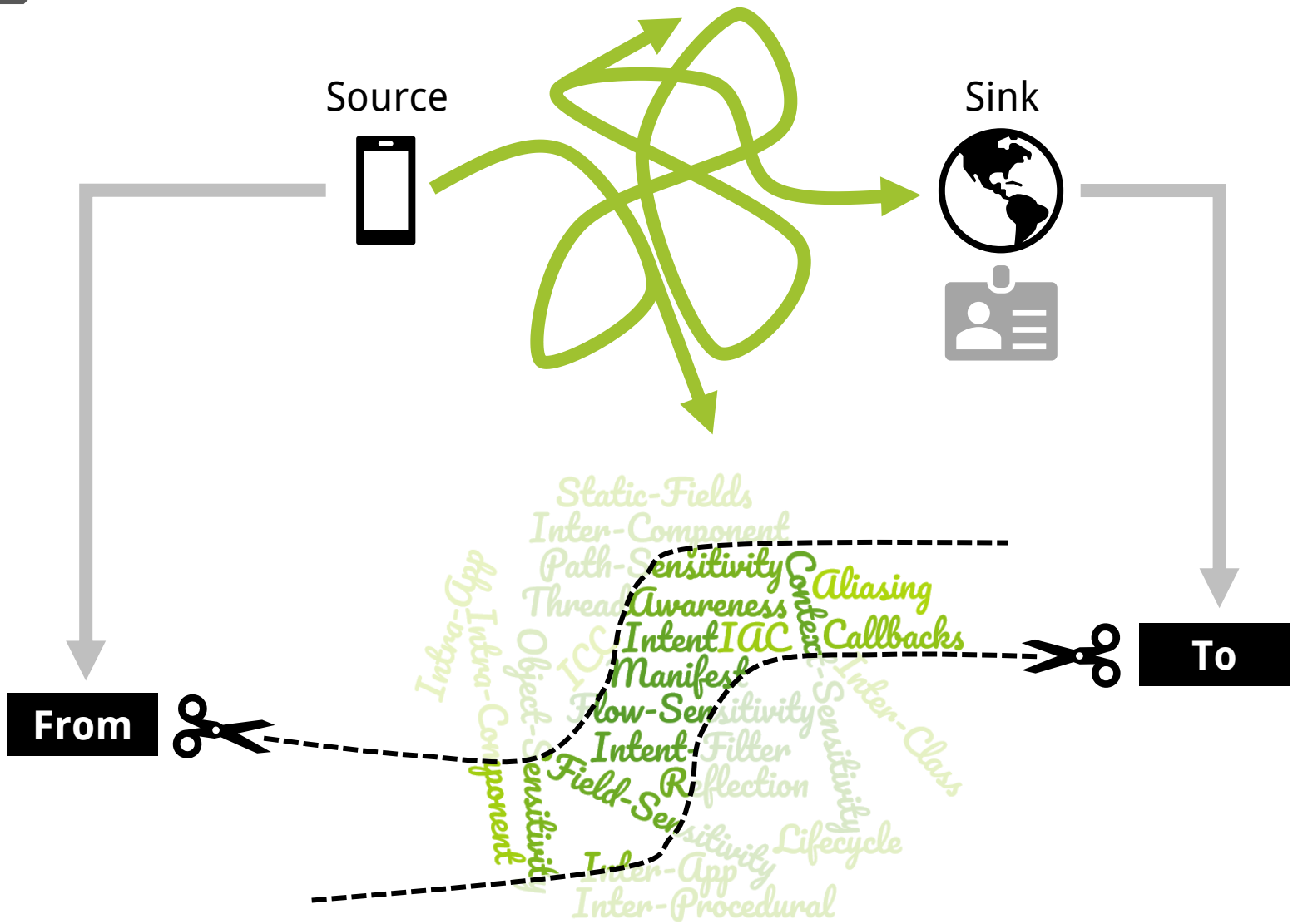
Object-Sensitivity
Intent-Filter
Field-Sensitivity
Reflection
Lifecycle
Inter-App
Inter-Procedural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Path-Sensitivity
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Object-
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Awareness
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Manifest
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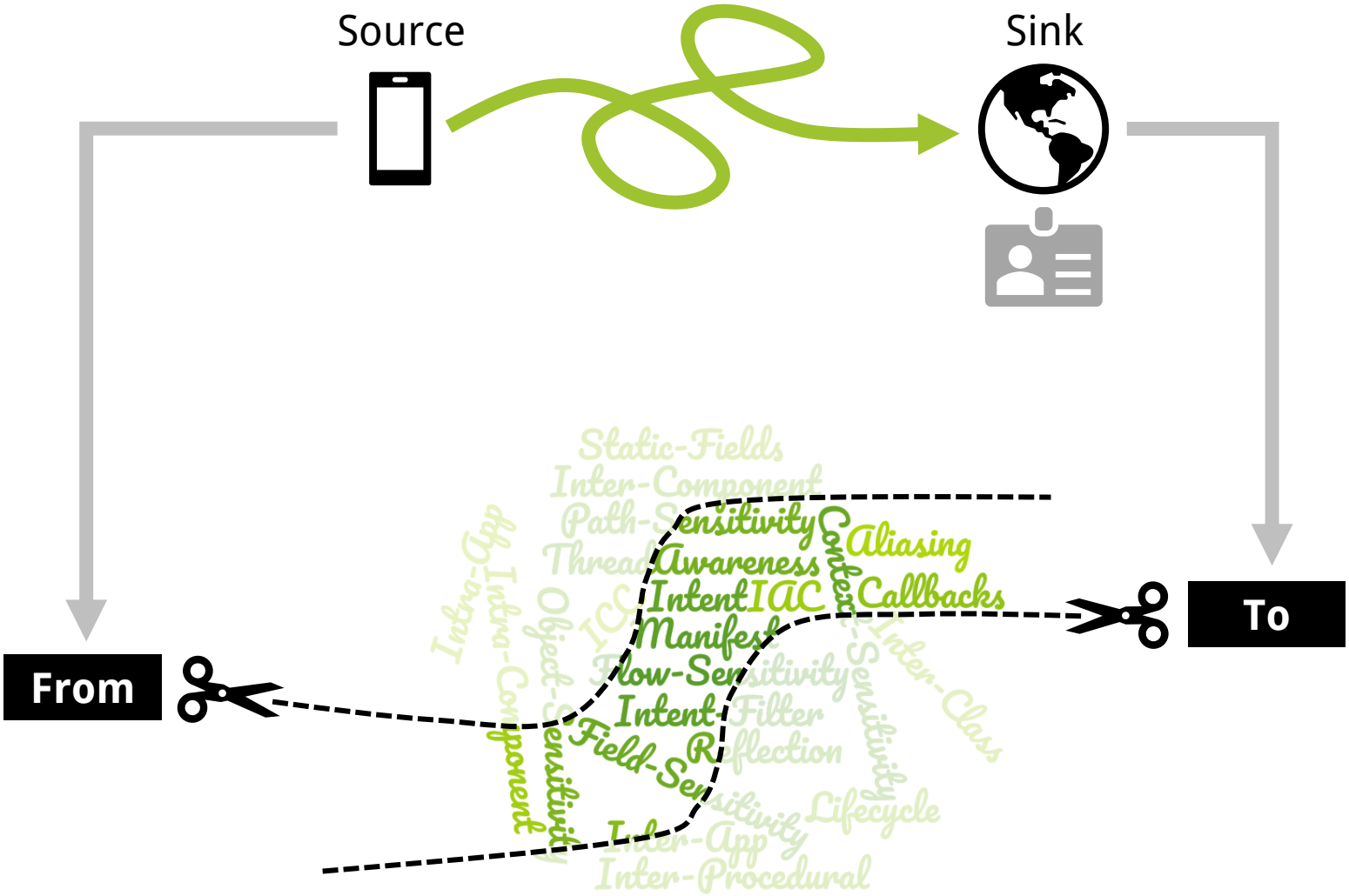
Intent
Field-Sen
Filter
Reflection
Lifecycle
Inter-App
Inter-Procedural
Inter-Class


Source
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From
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Static-Fields
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Field-Sensitivity
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Lifecycle
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Inter-Procedural
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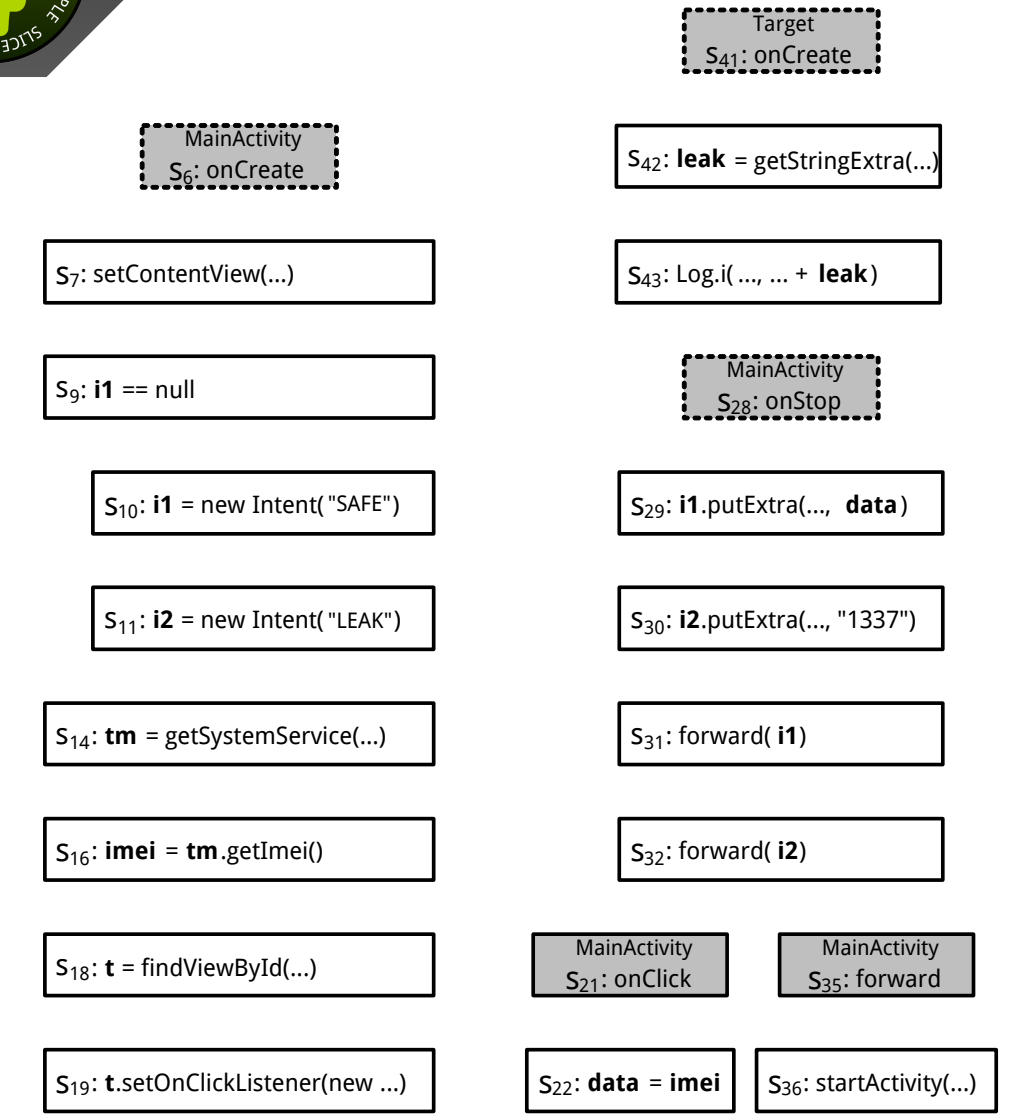
Object-Sensitivity
Inter-Class

Example: Cooperative Taint Analysis



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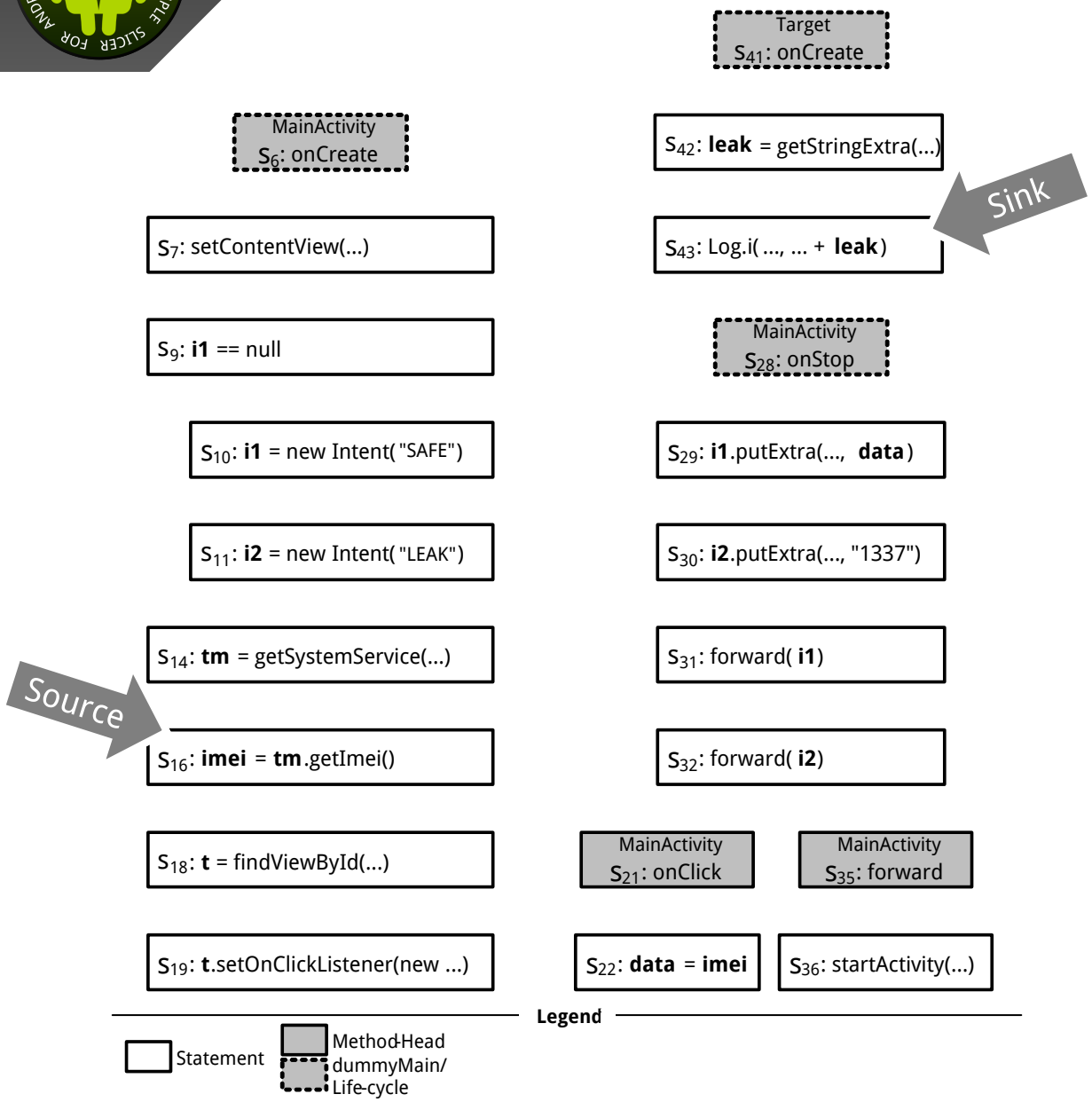

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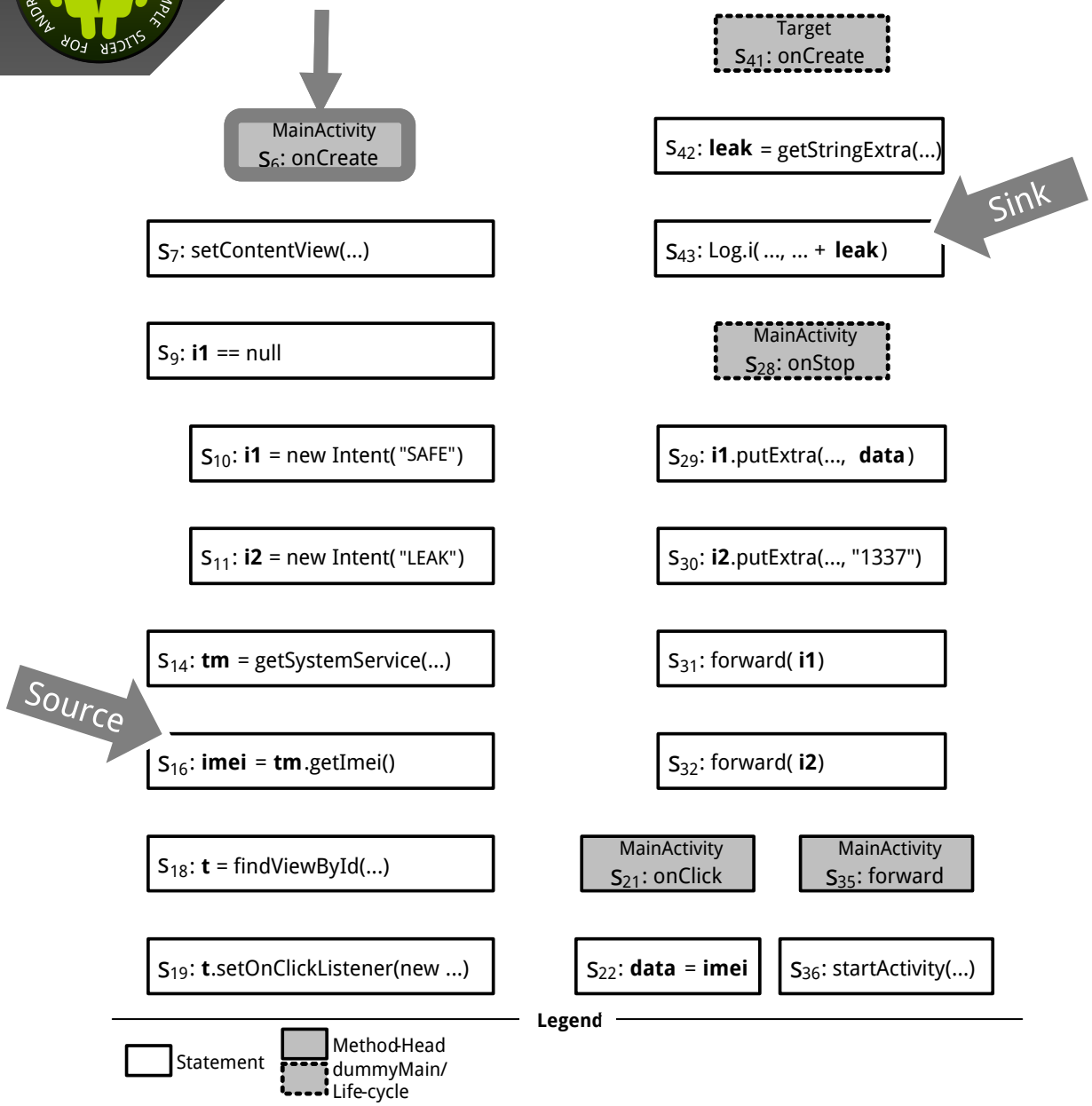
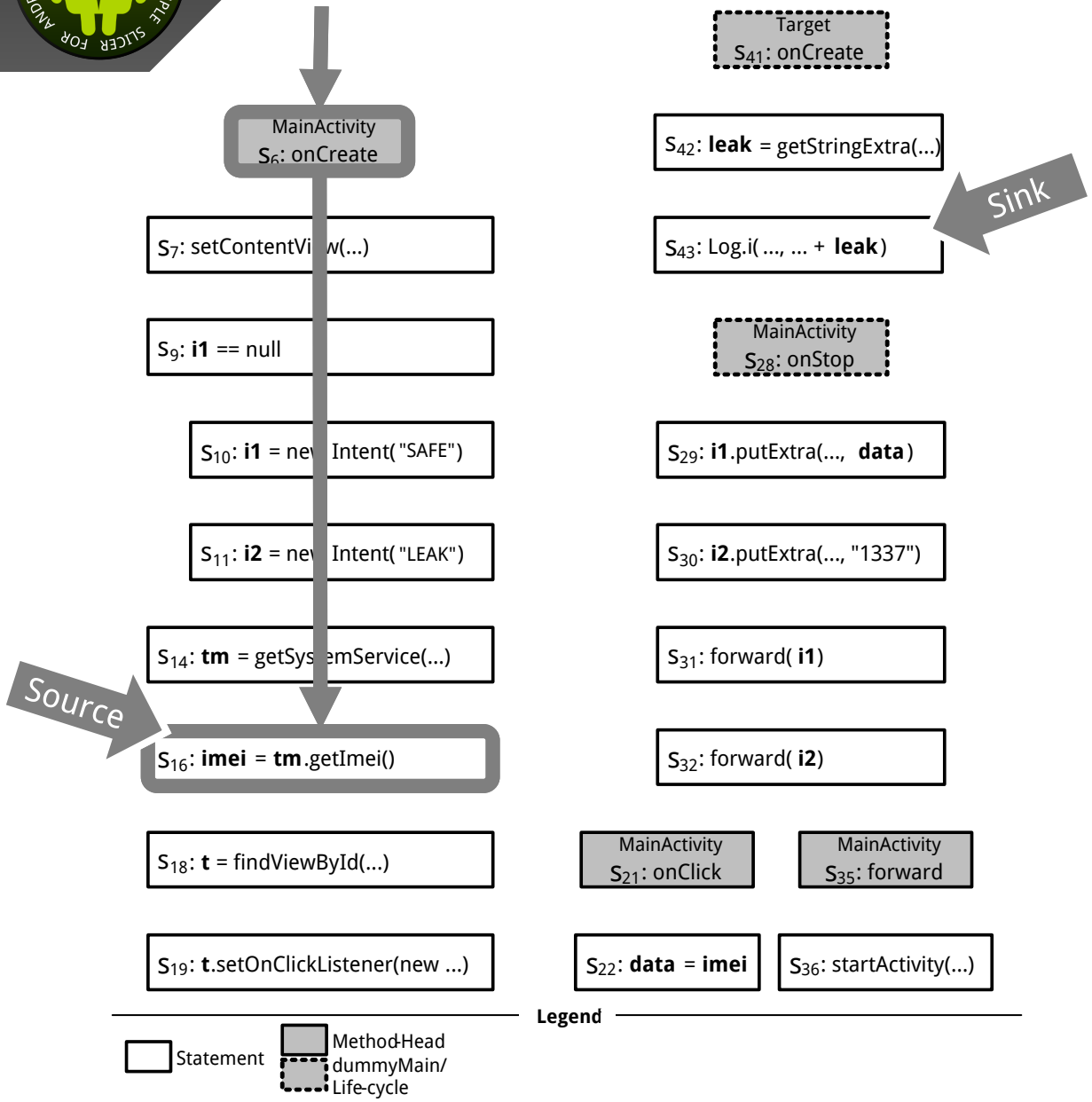
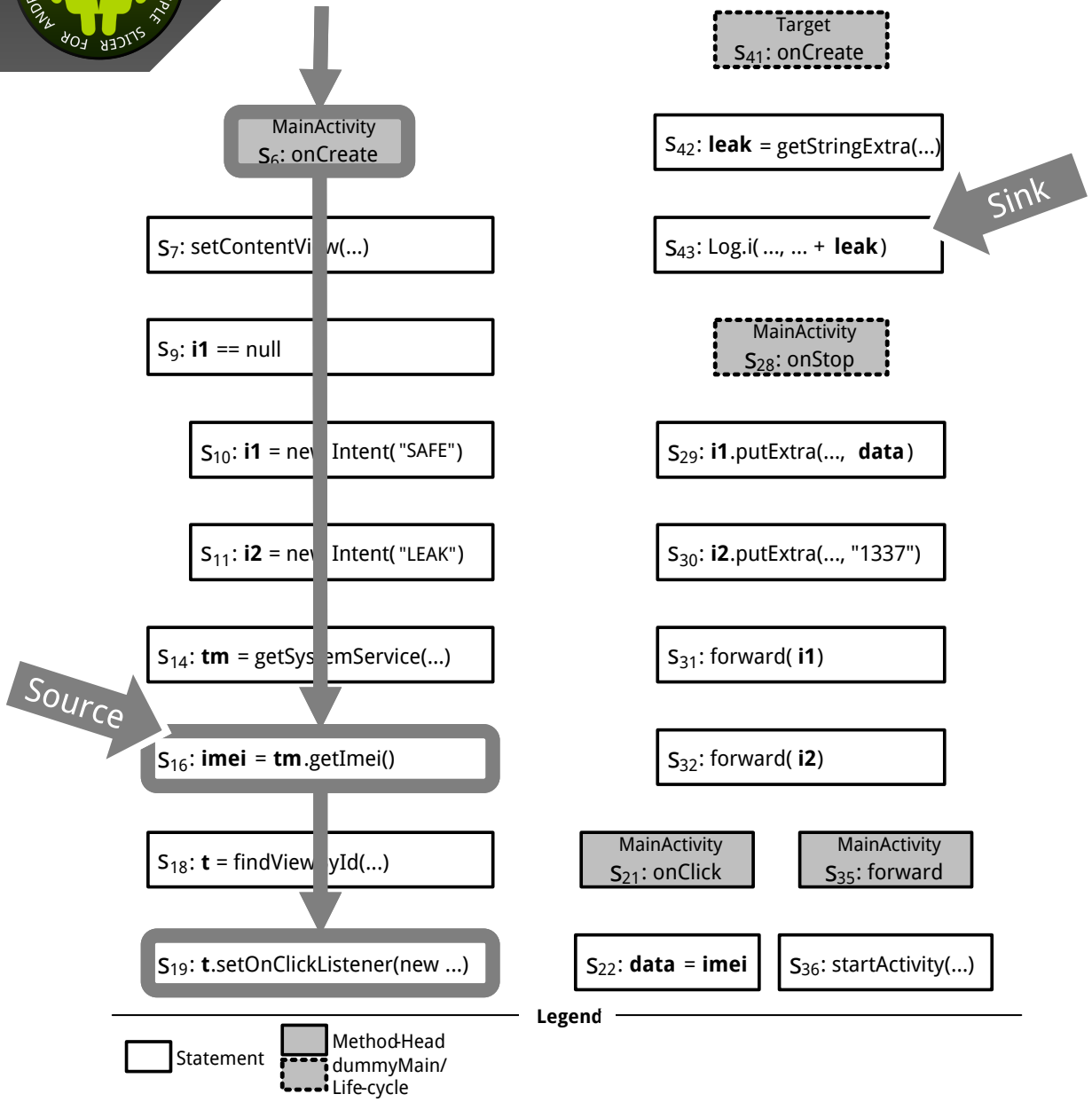


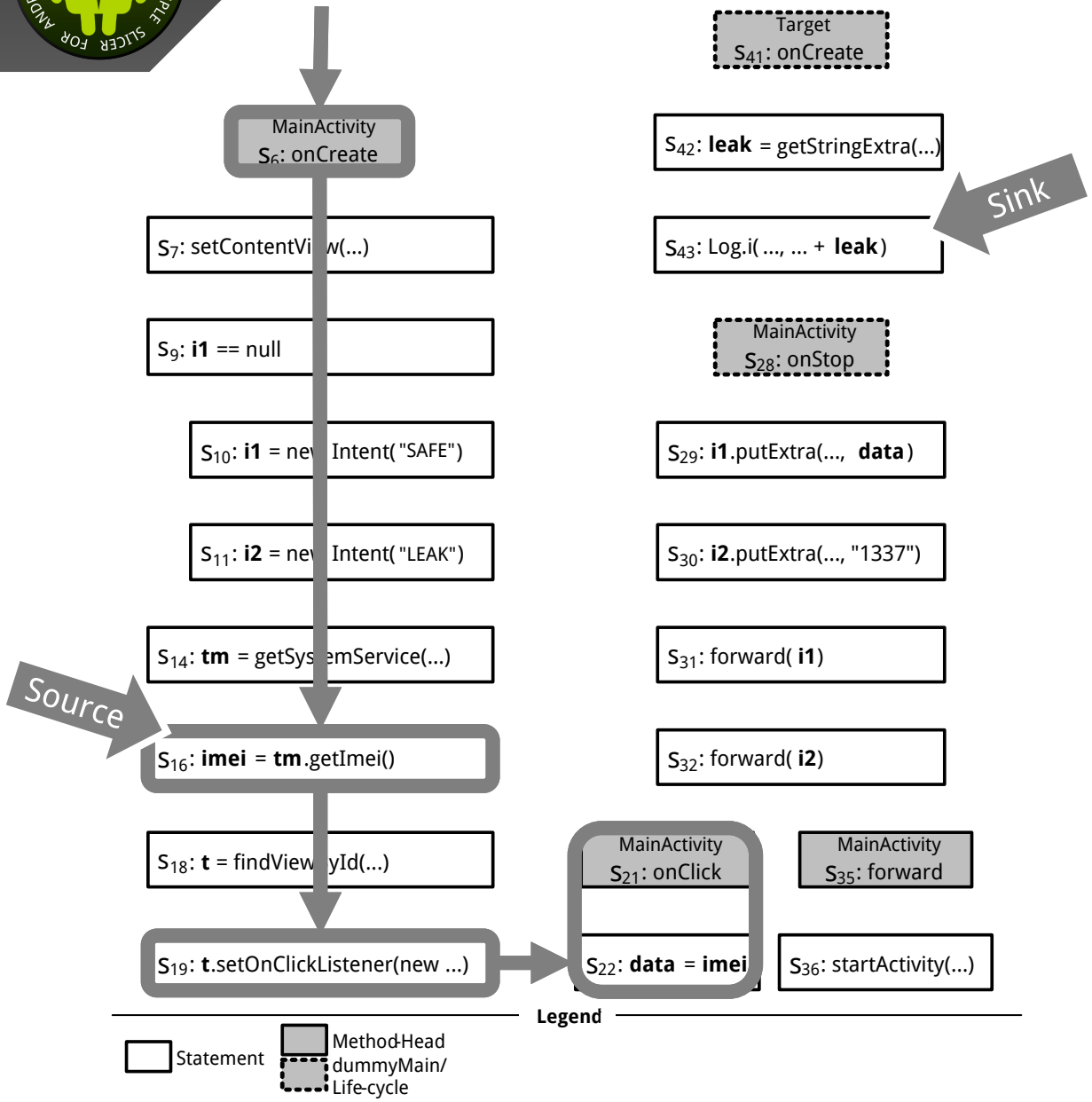
Example: Cooperative Taint Analysis



Example: Cooperative Taint Analysis



Example: Cooperative Taint Analysis



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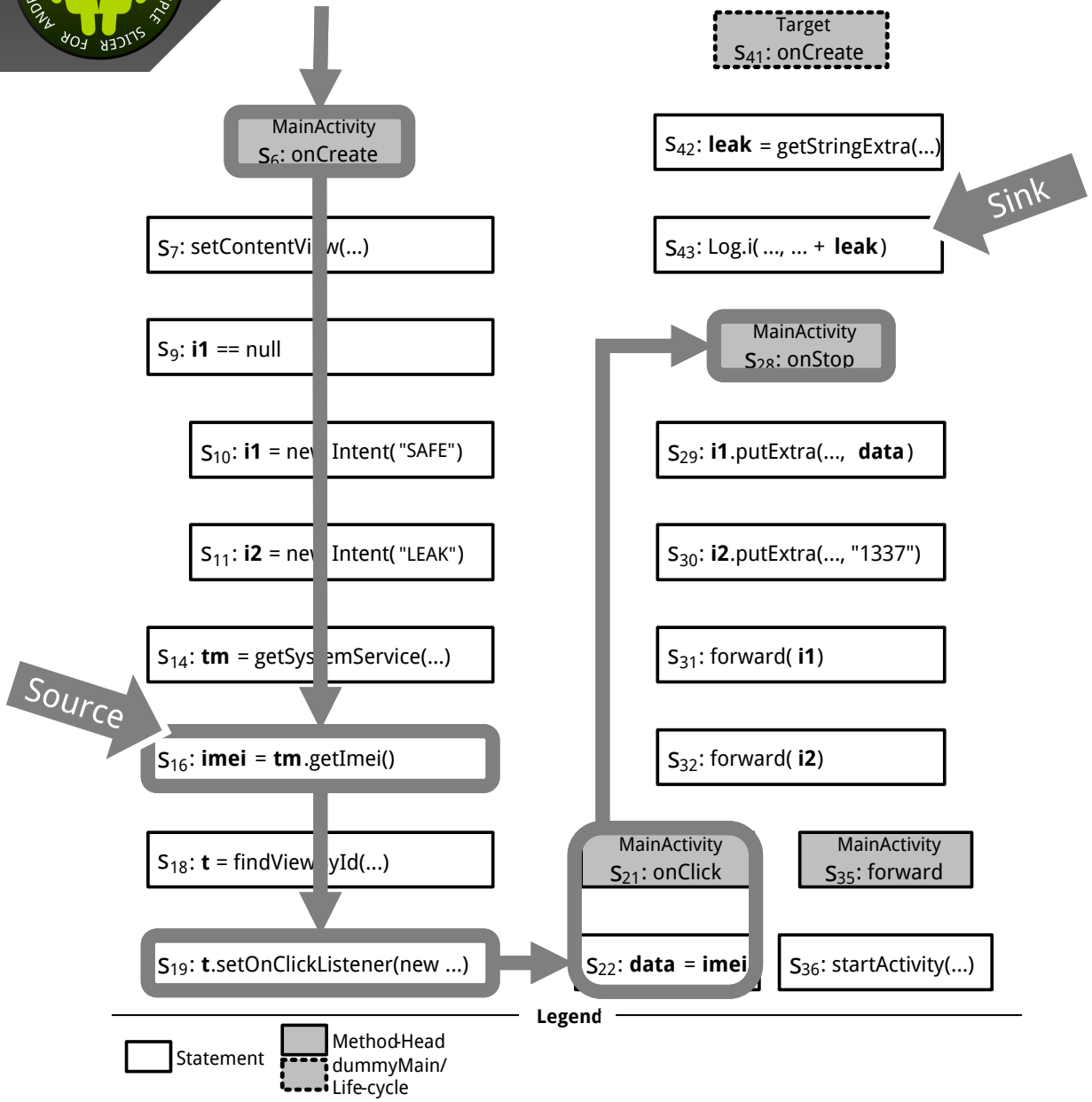
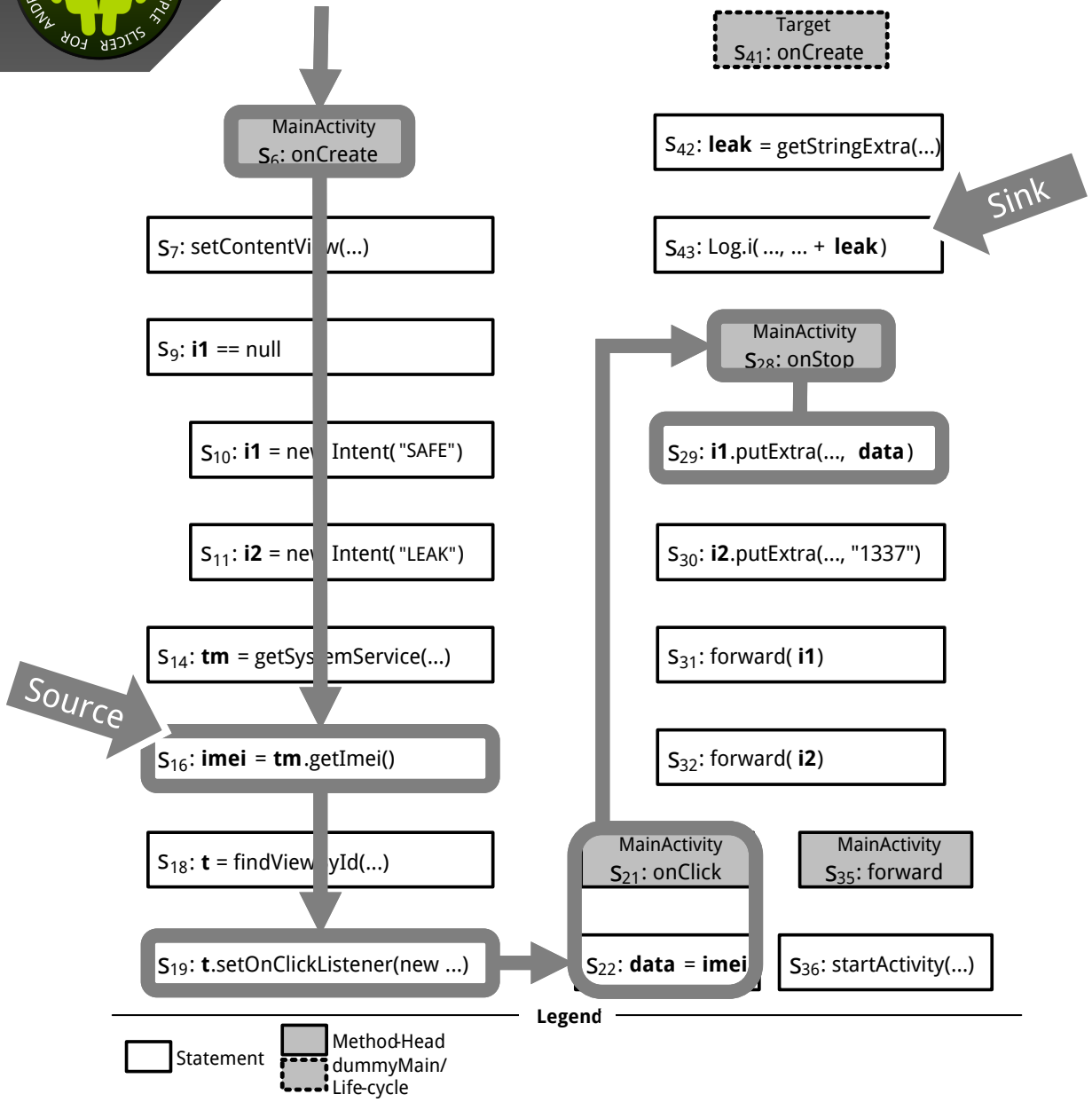
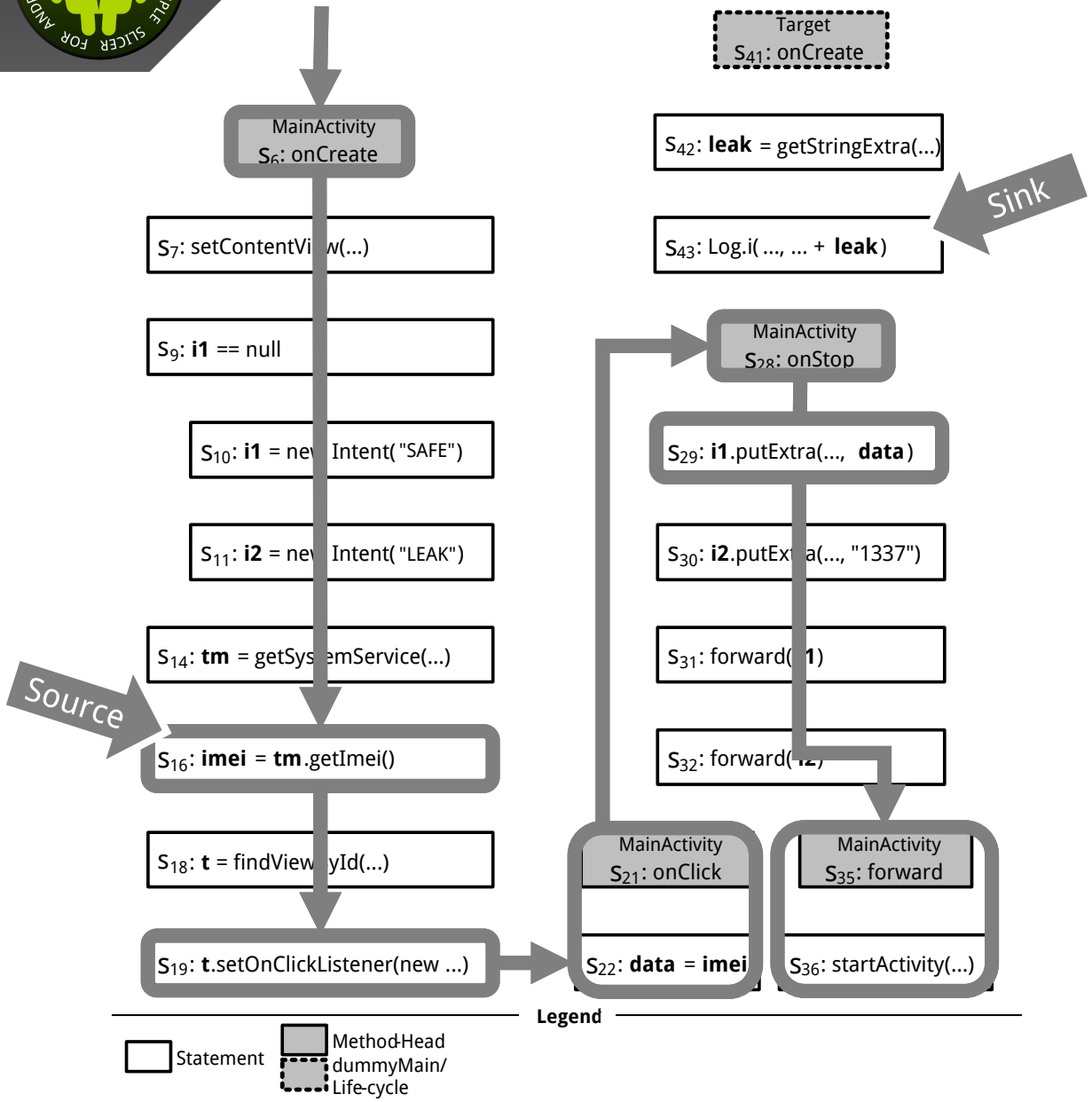


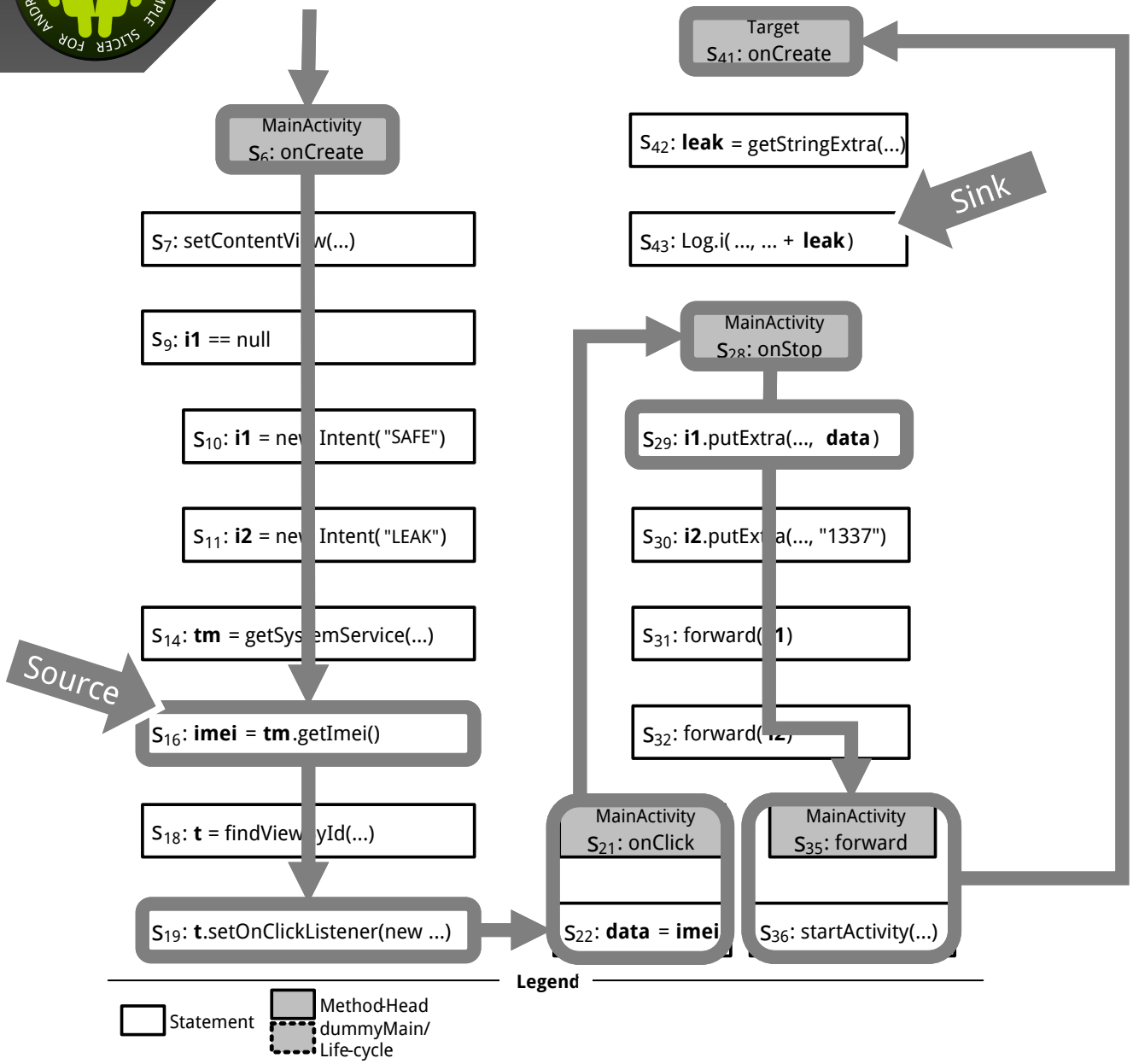
Example: Cooperative Taint Analysis



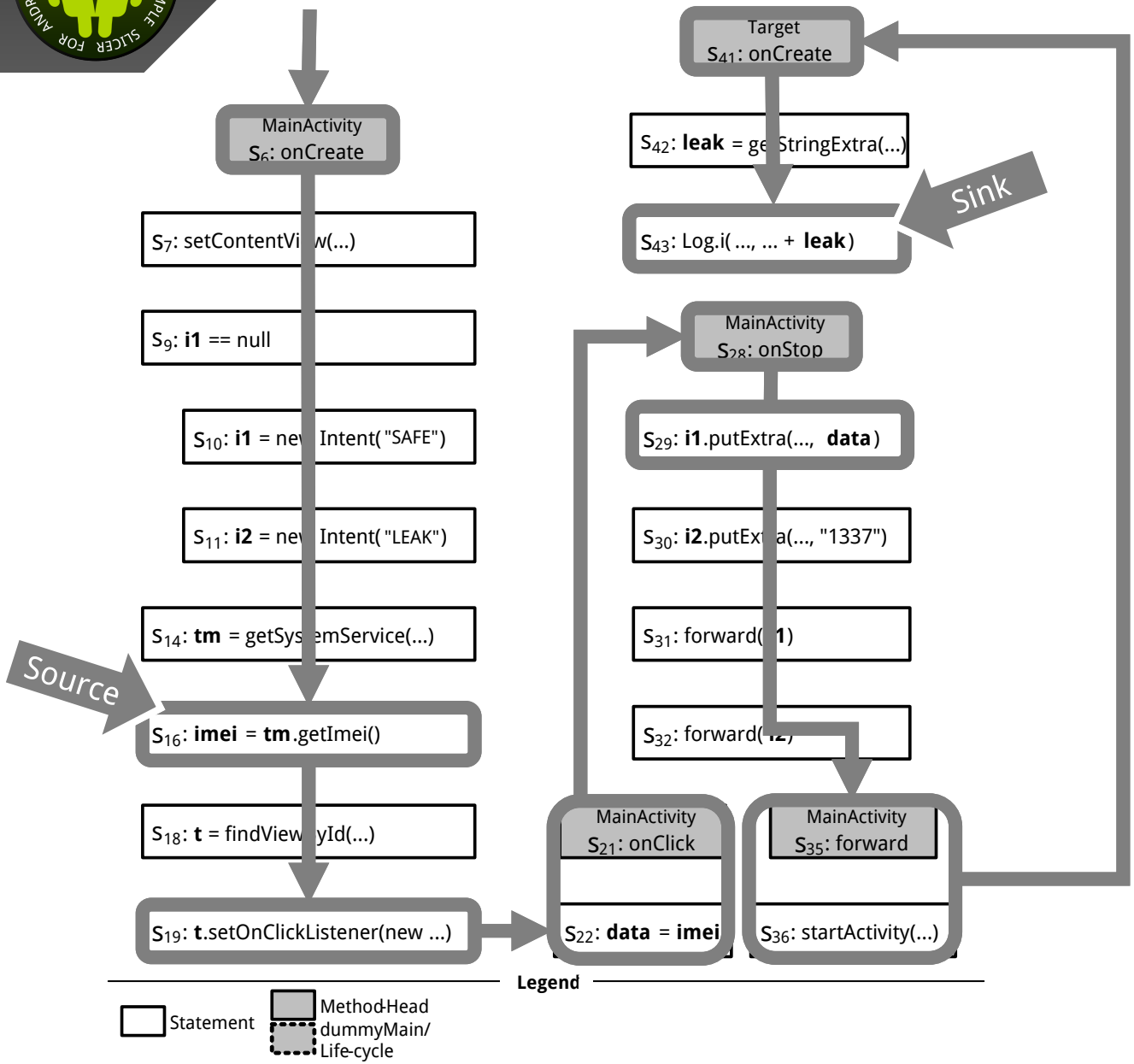
Example: Cooperative Taint Analysis



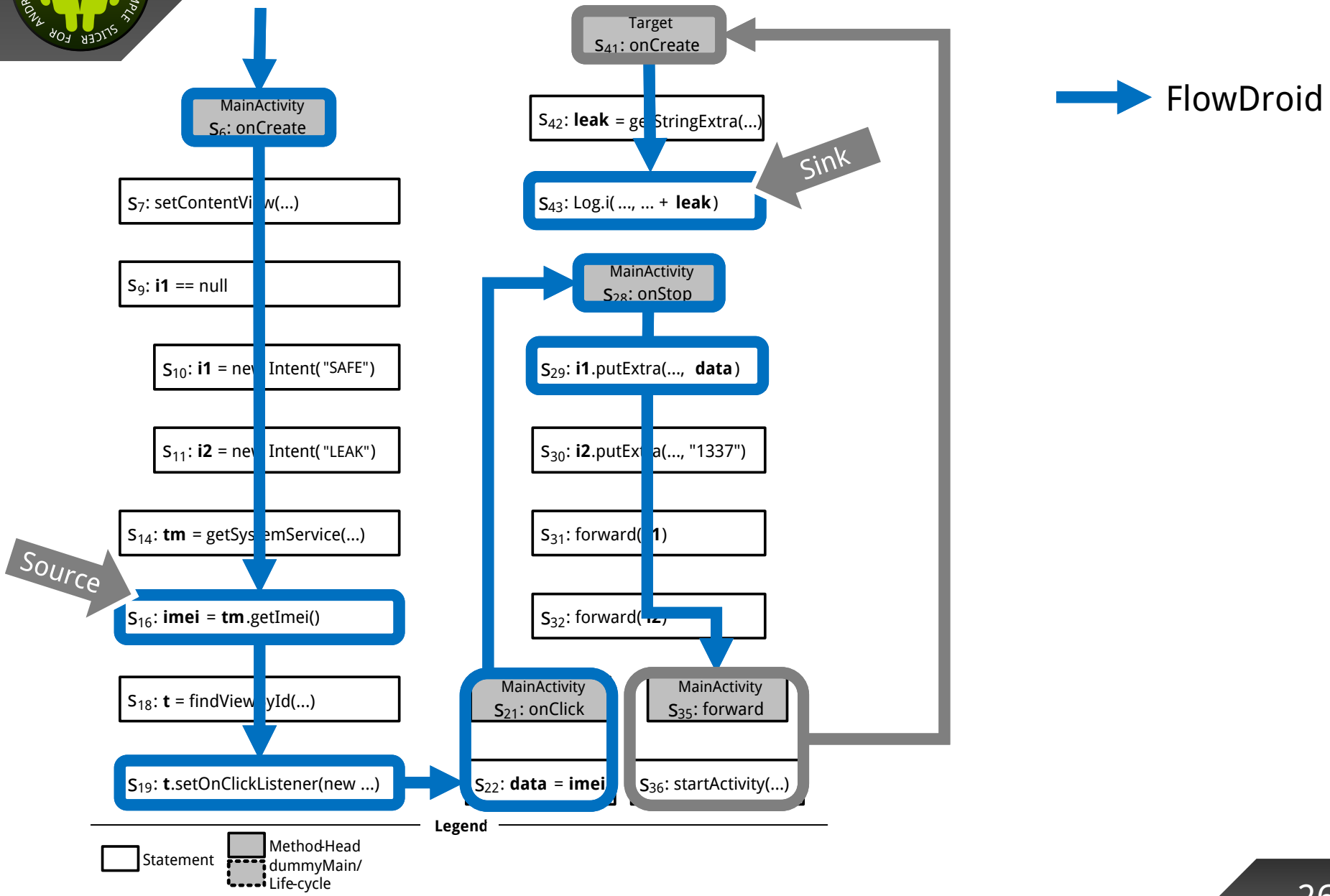
Example: Cooperative Taint Analysis



Example: Cooperative Taint Analysis



Example: Cooperative Taint Analysis



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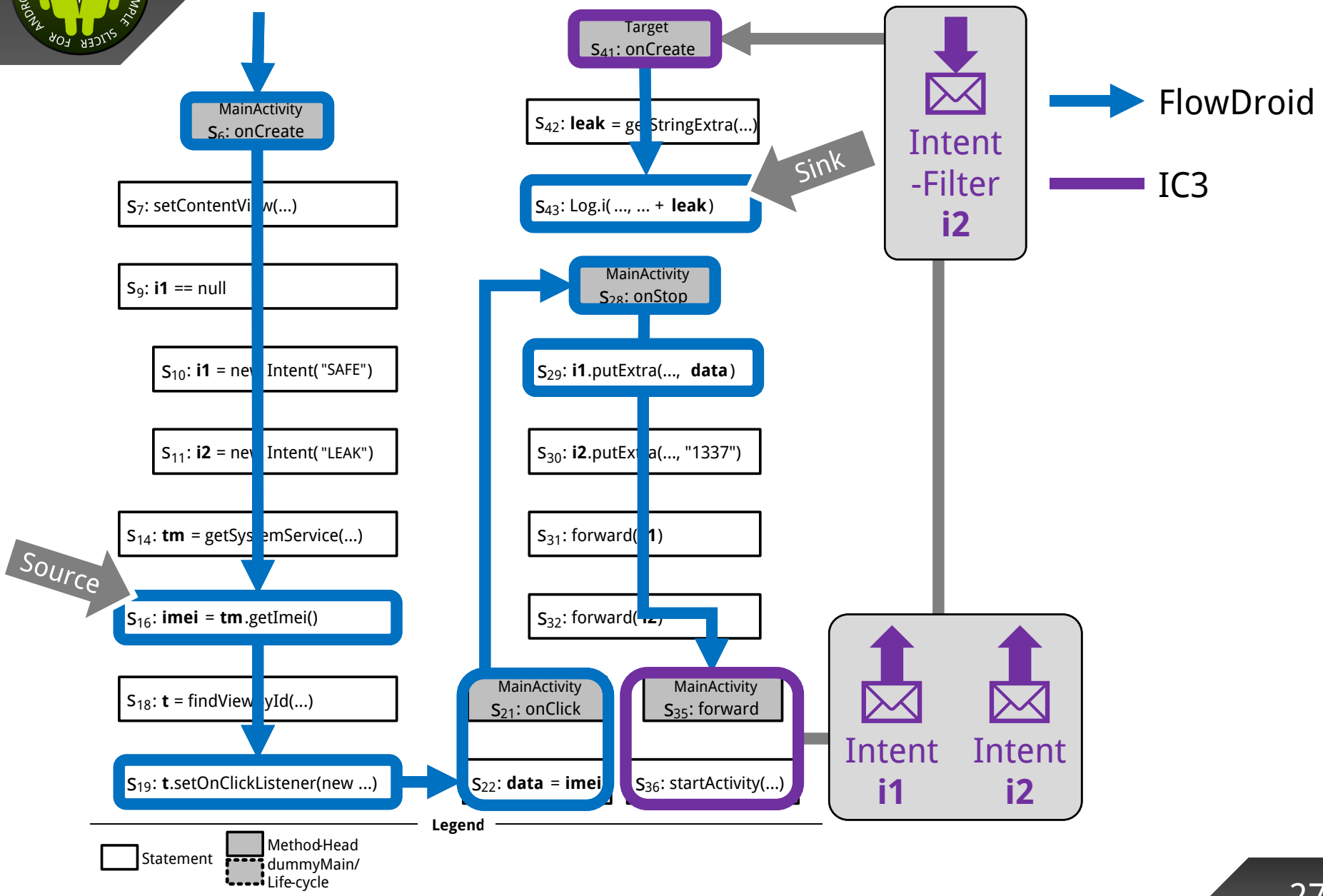

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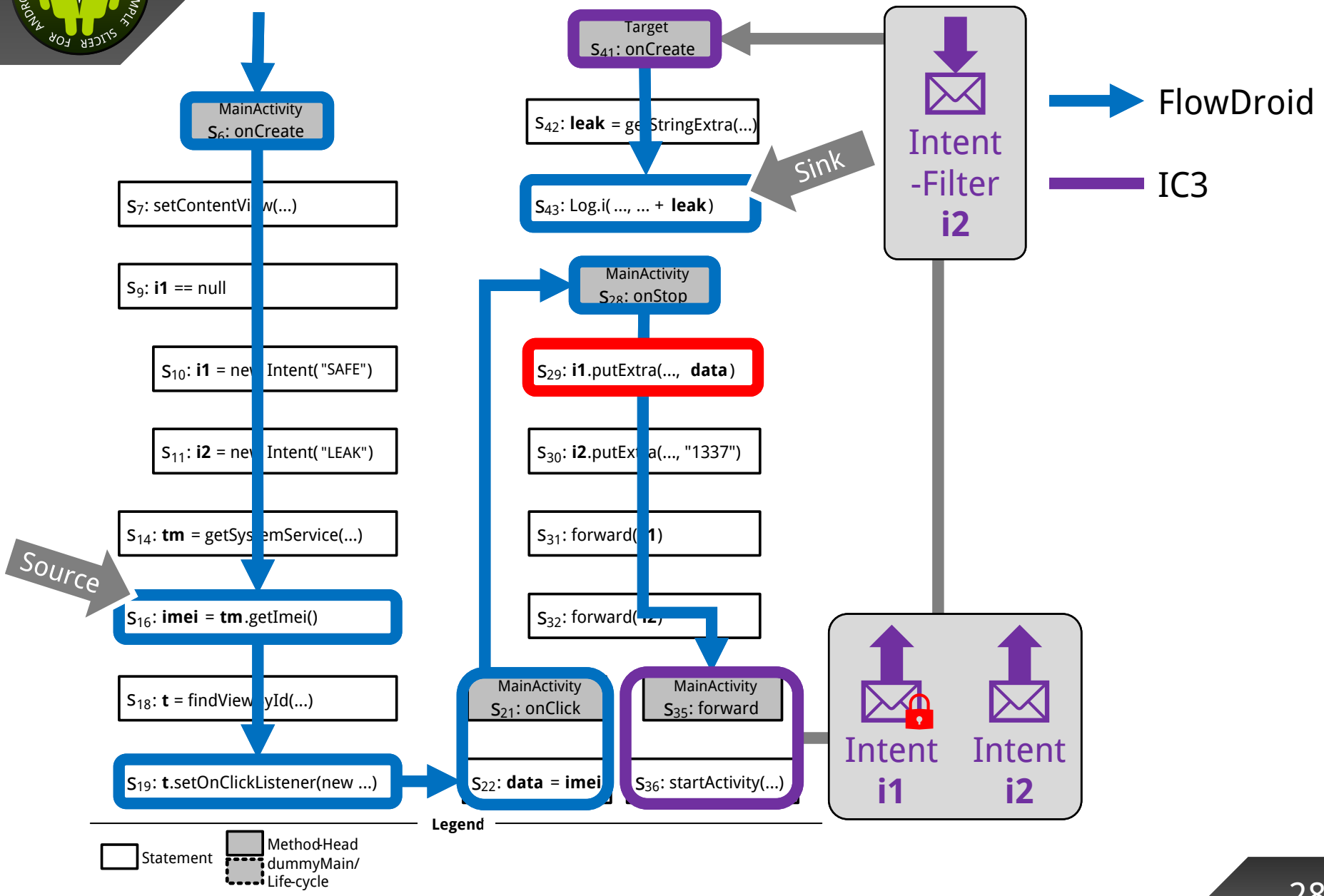

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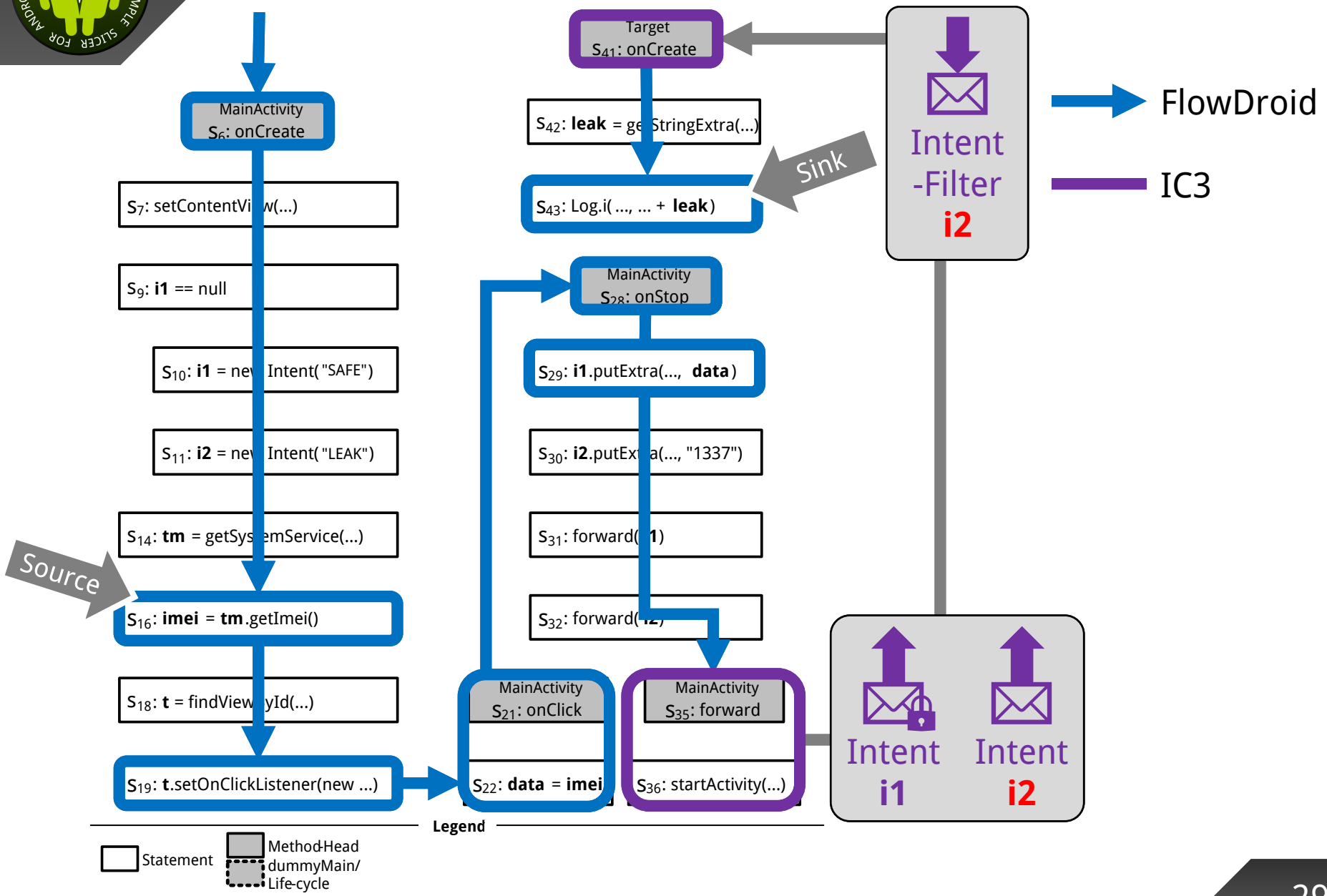

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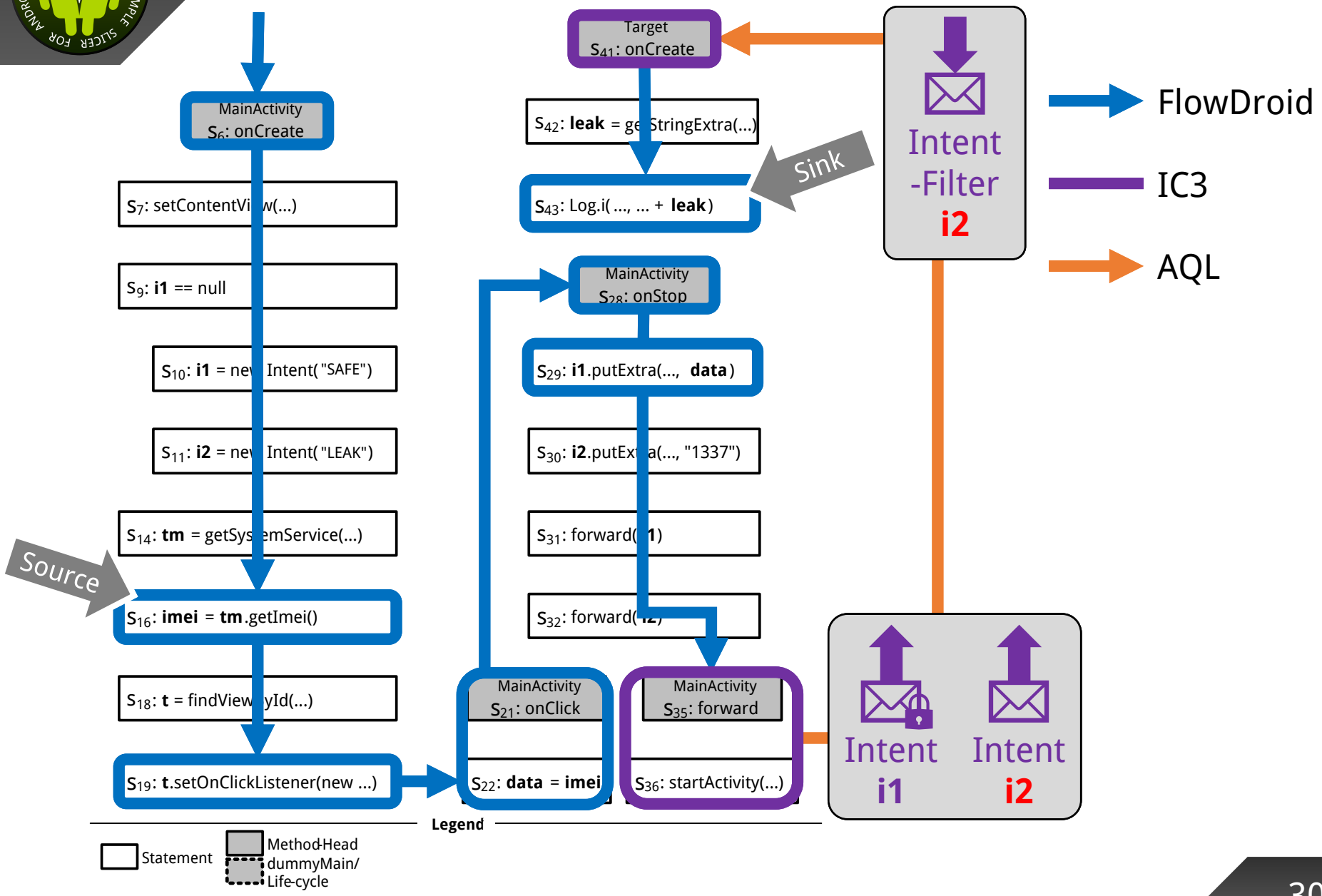

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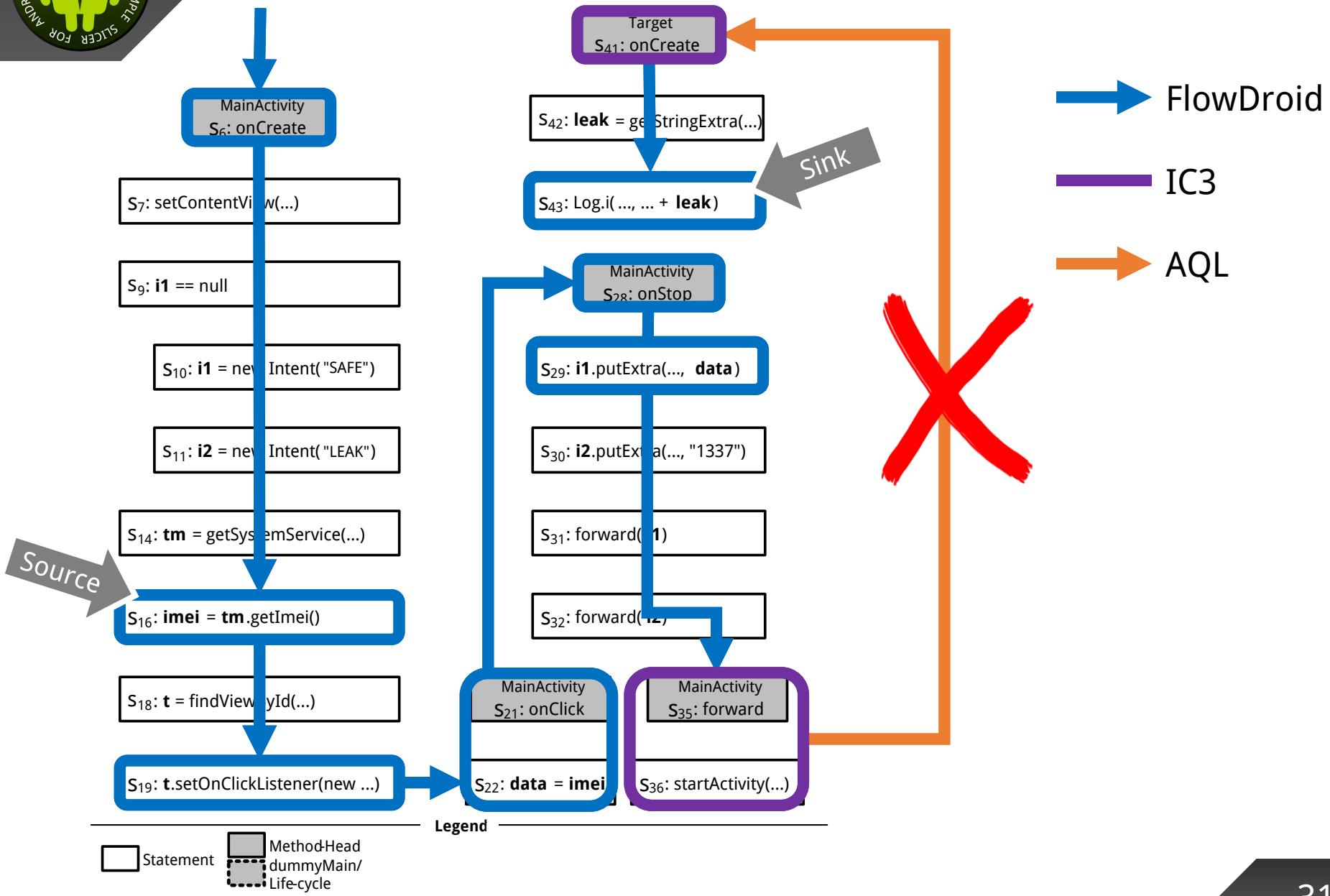

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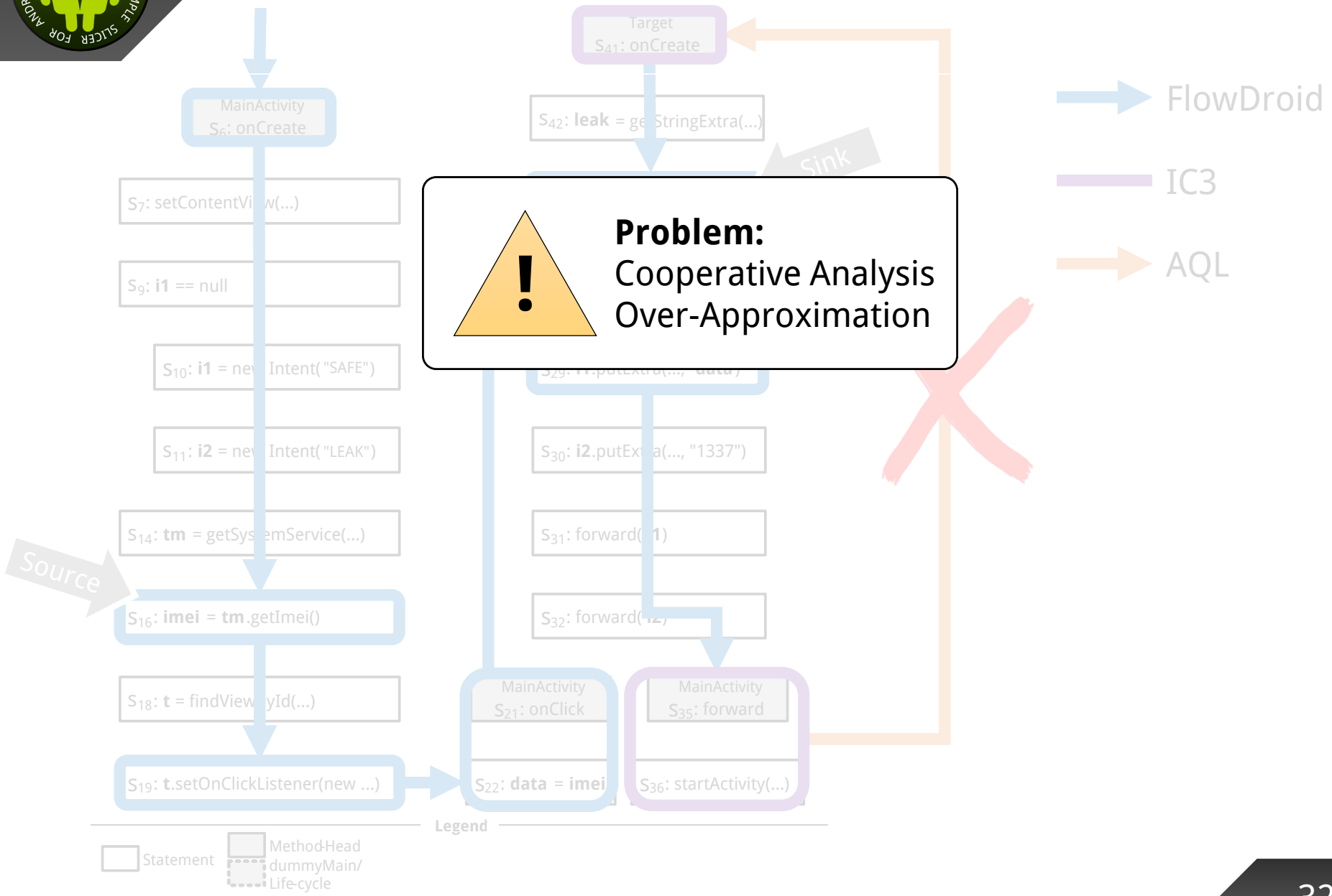

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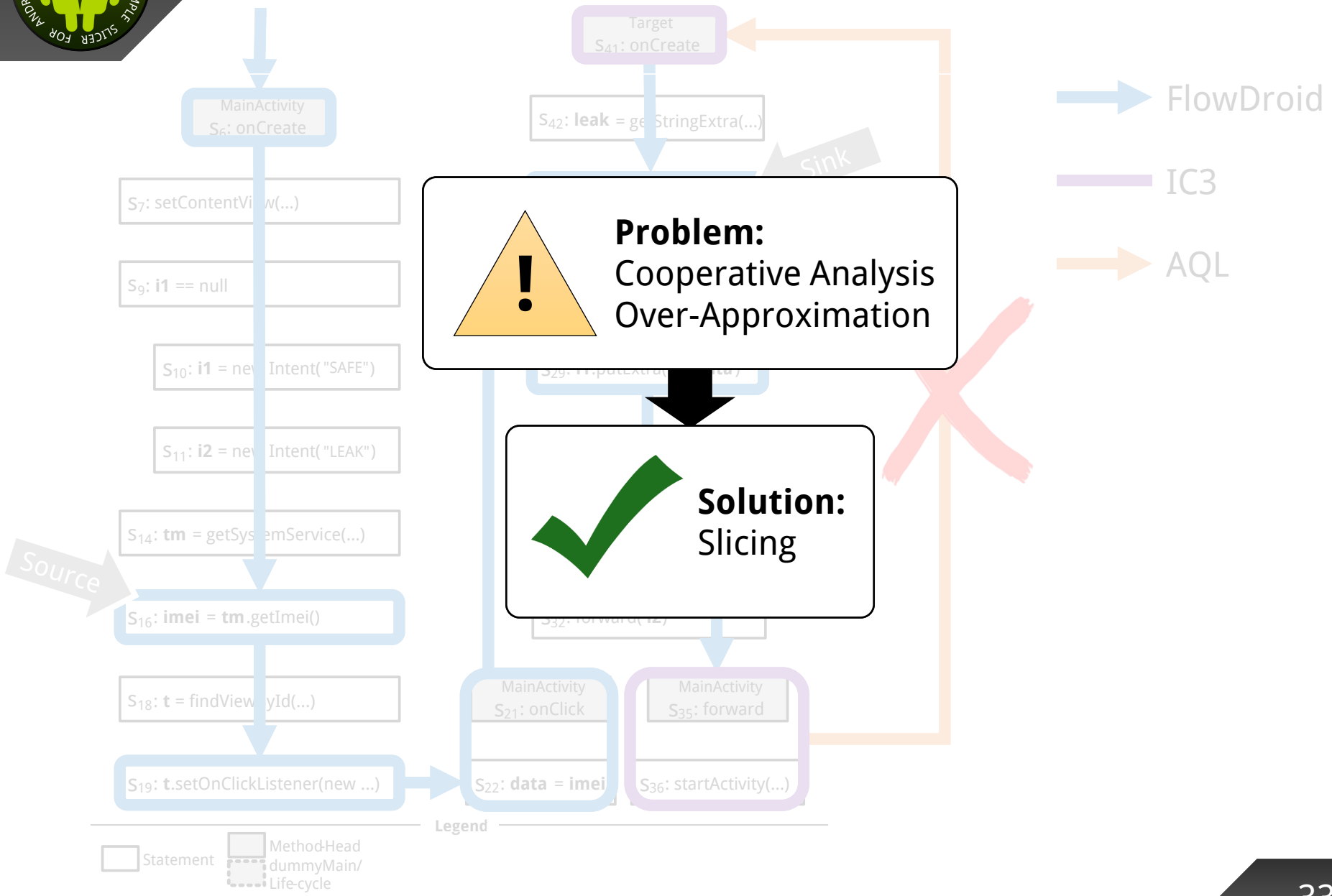
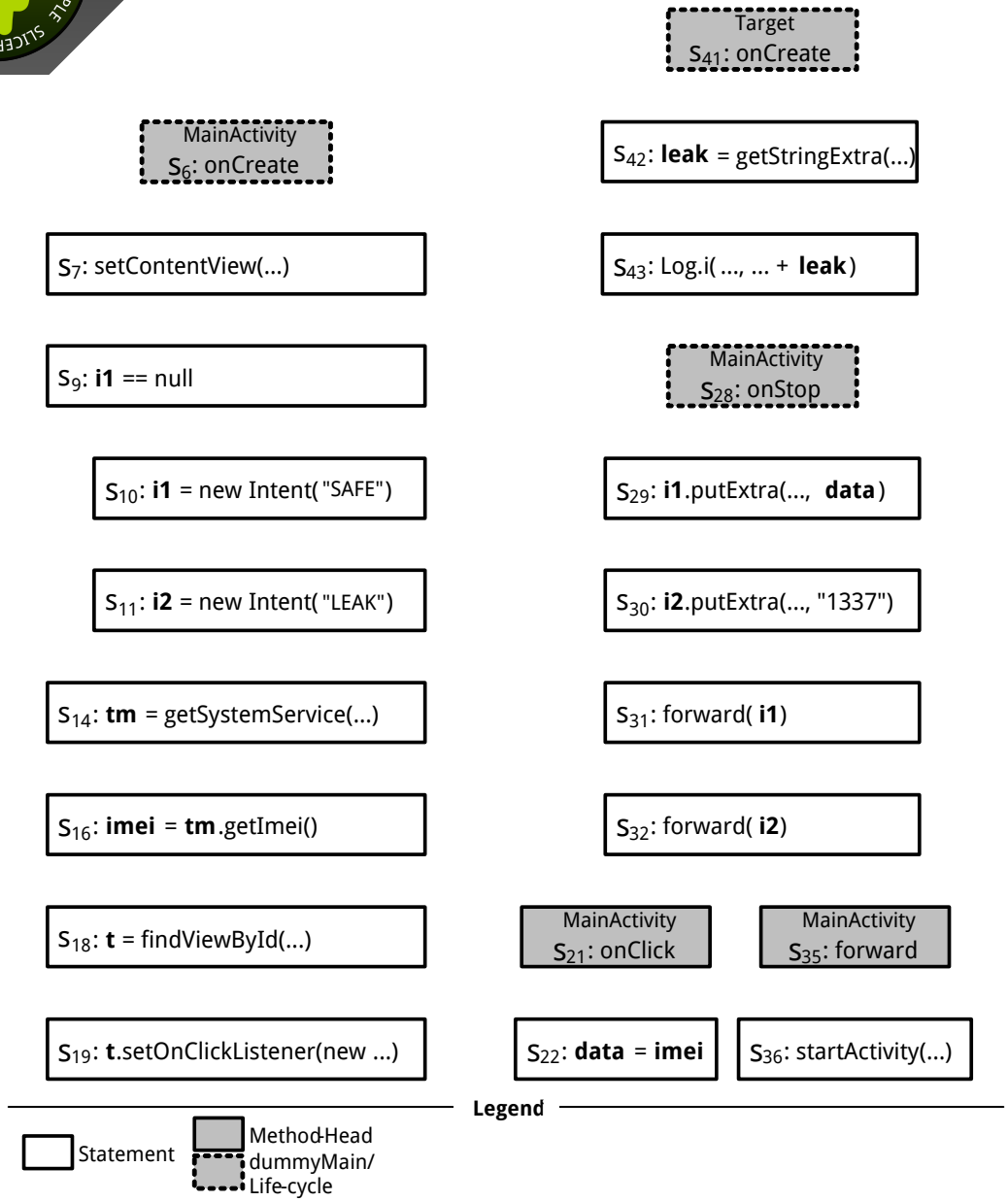


Example: Slicing



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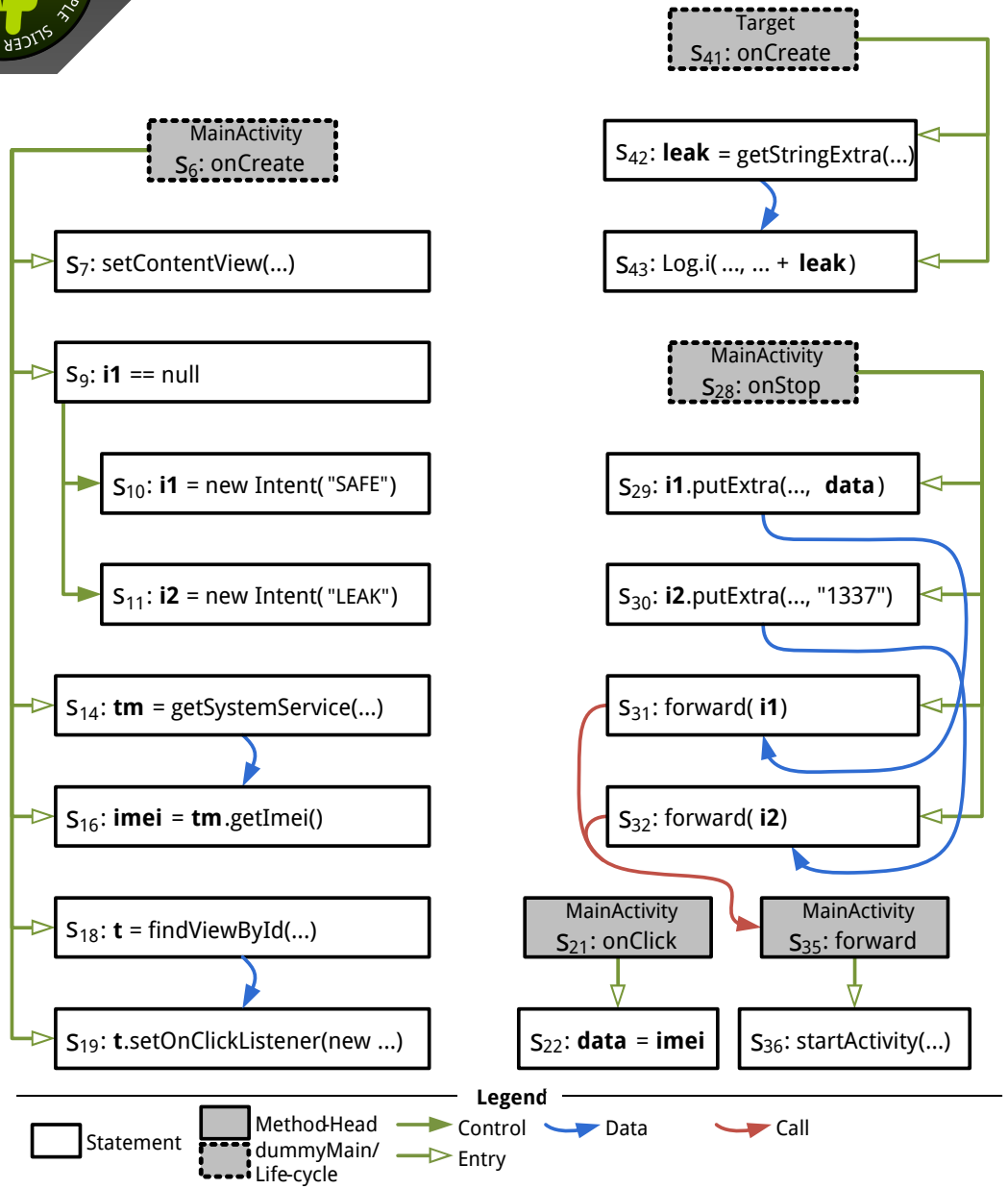
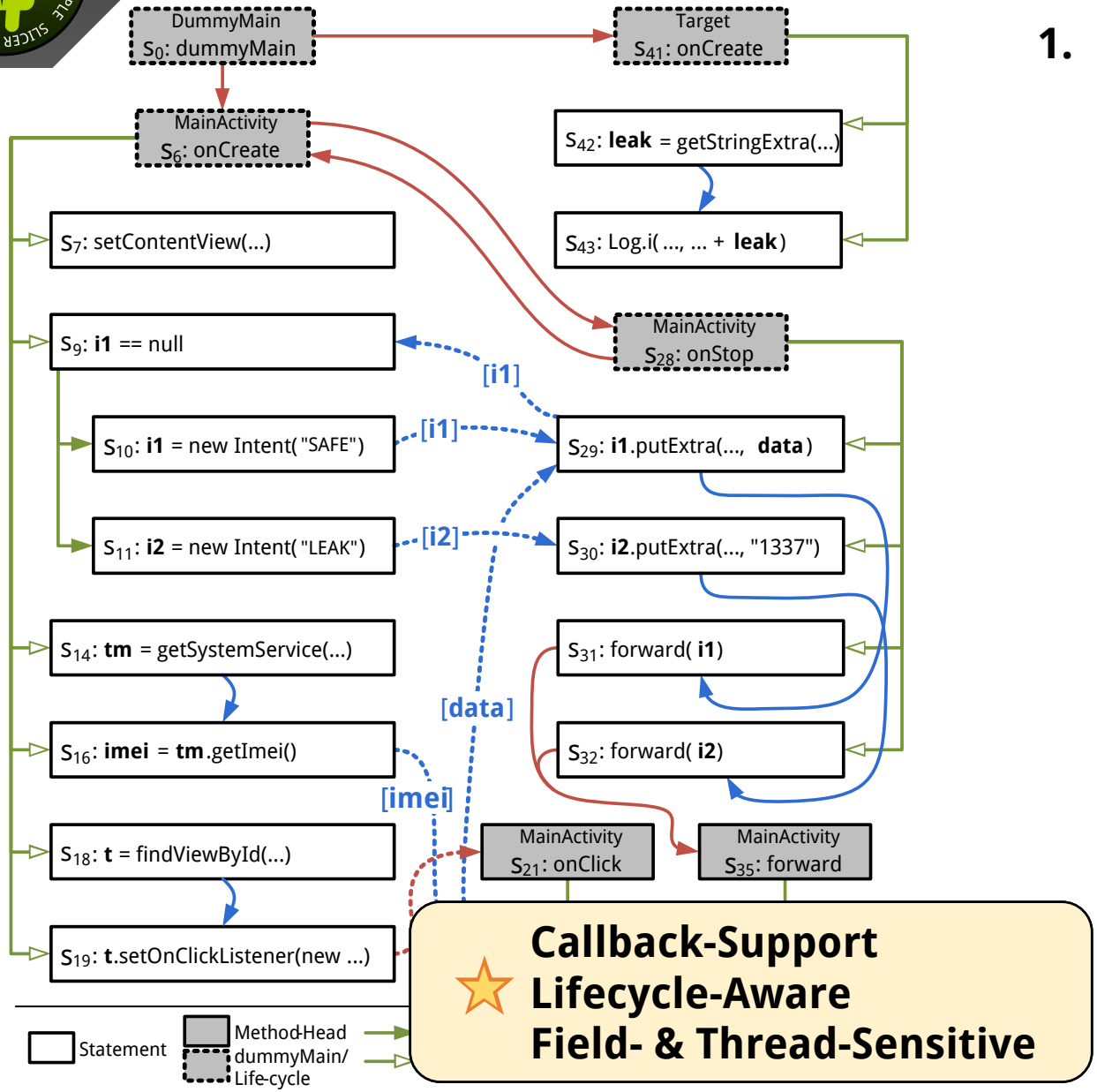


1. **Graph Generation**
   - Build **PDG**
   - Merge to **SDG**

Example: Slicing



1. **Graph Generation**
   - Build **PDG**
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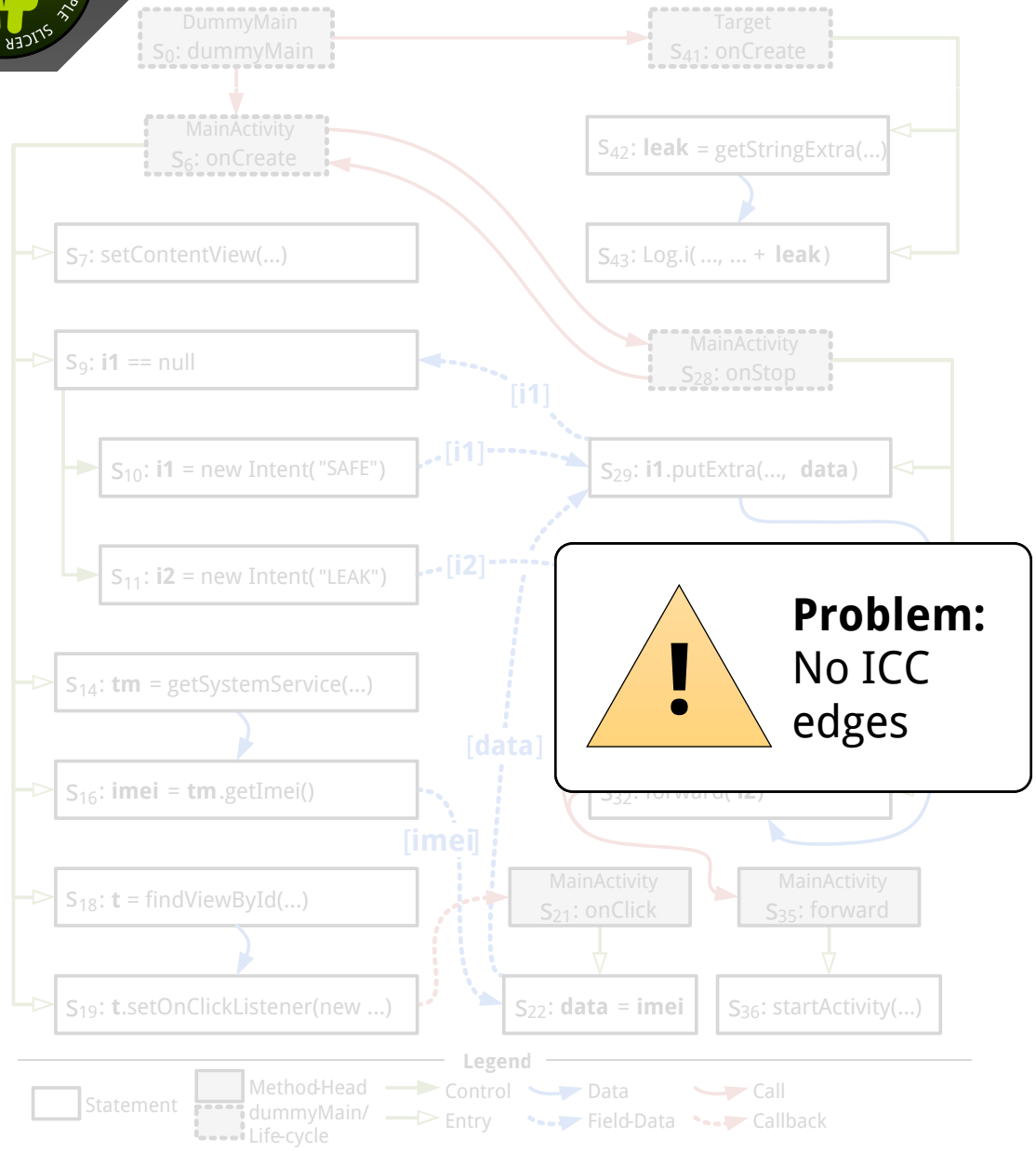
   - Enhance to **ADG**

Example: Slicing



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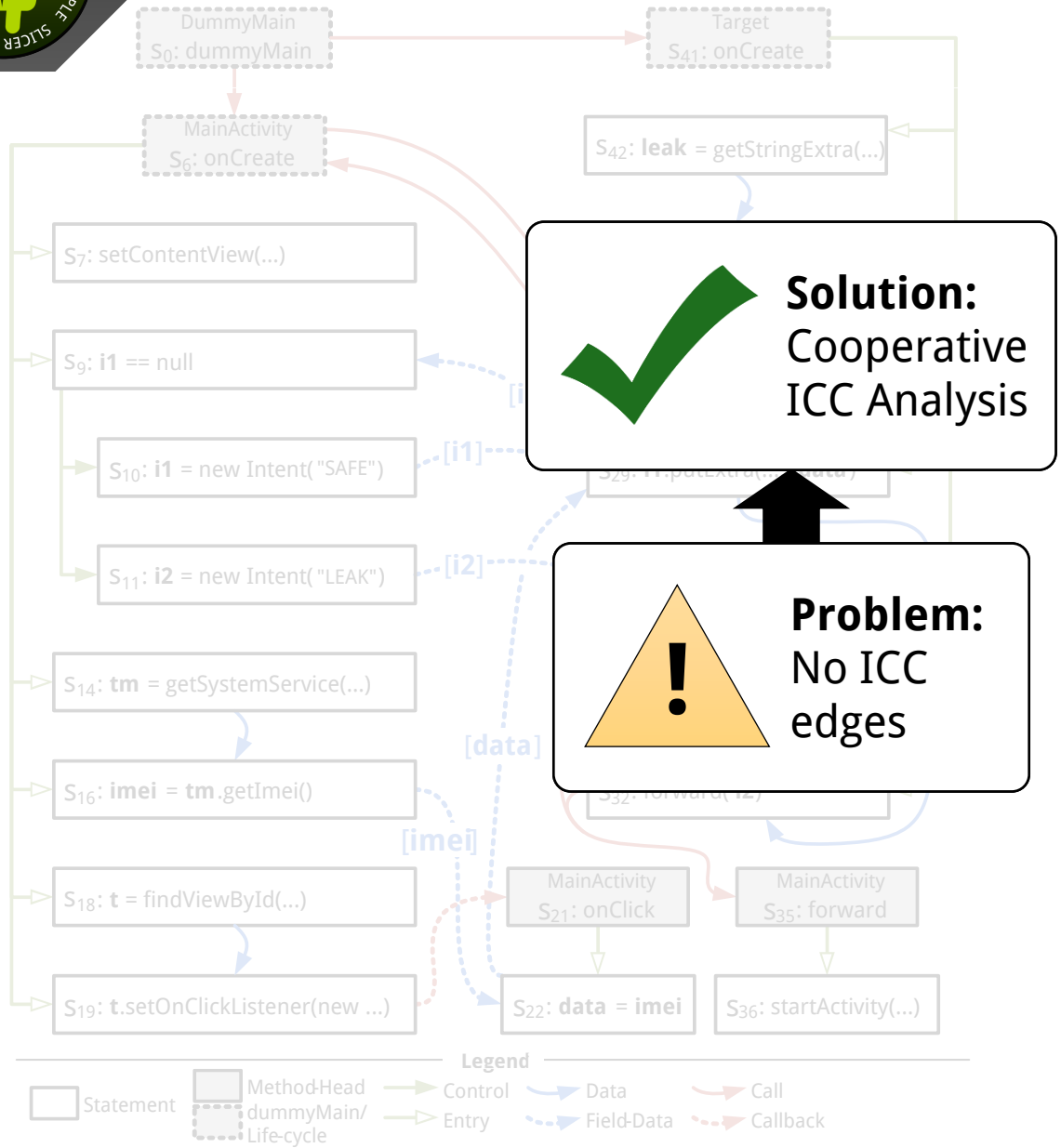
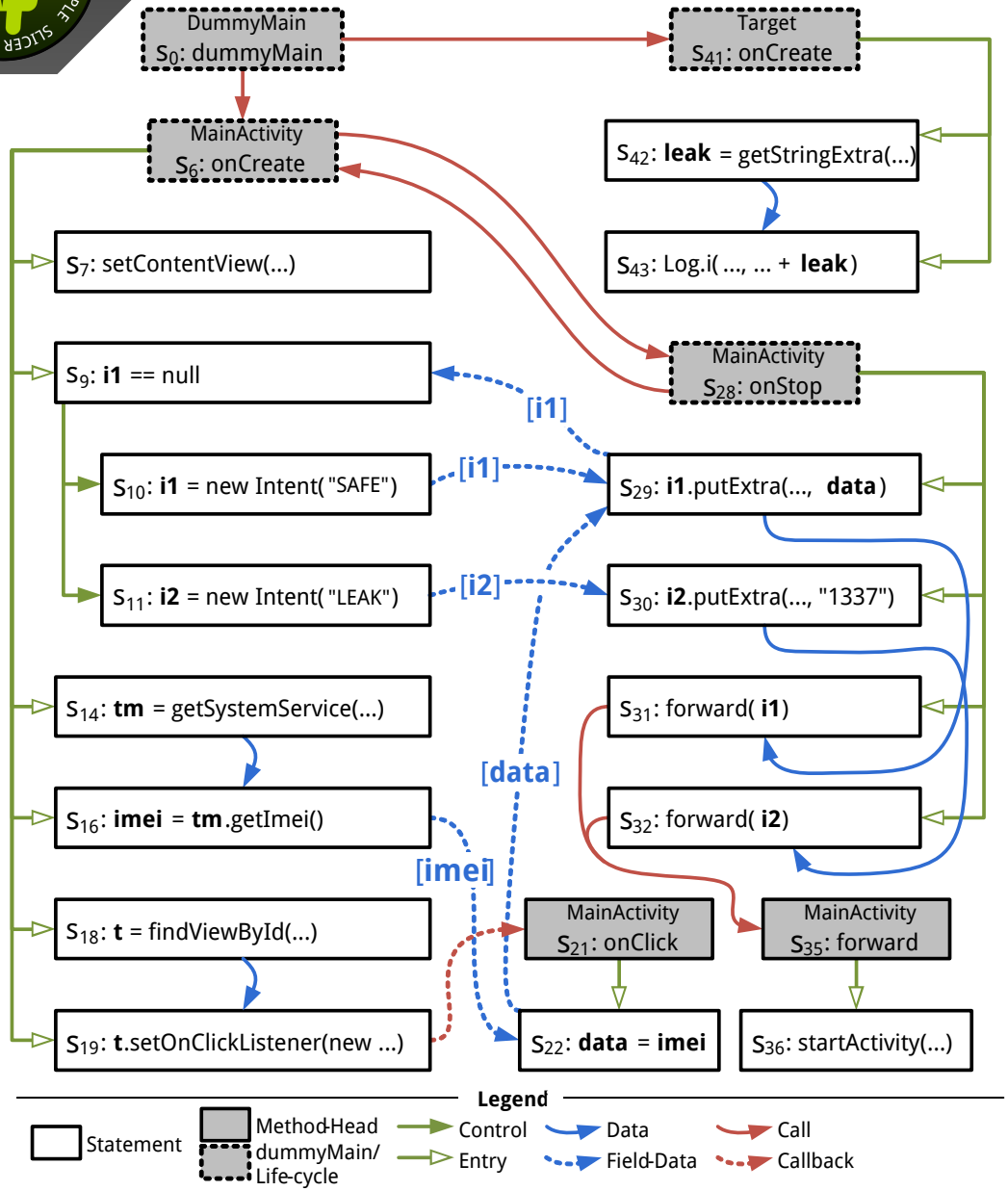


Solution:
Cooperative
ICC Analysis

Problem:
No ICC
edges

1. **Graph Generation**
   - Build **PDG**
   - Merge to **SDG**
   - Enhance to **ADG**

Example: Slicing



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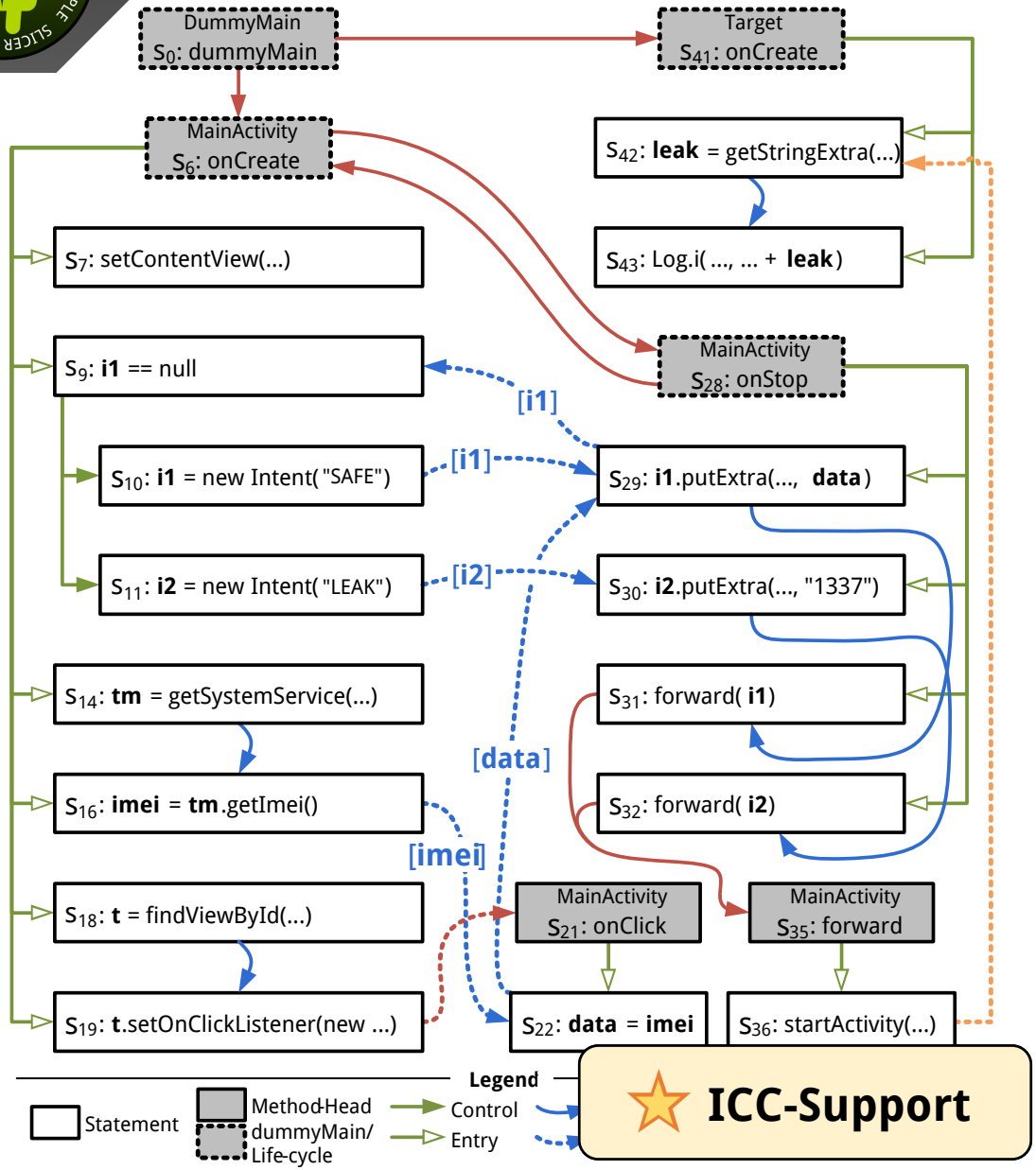

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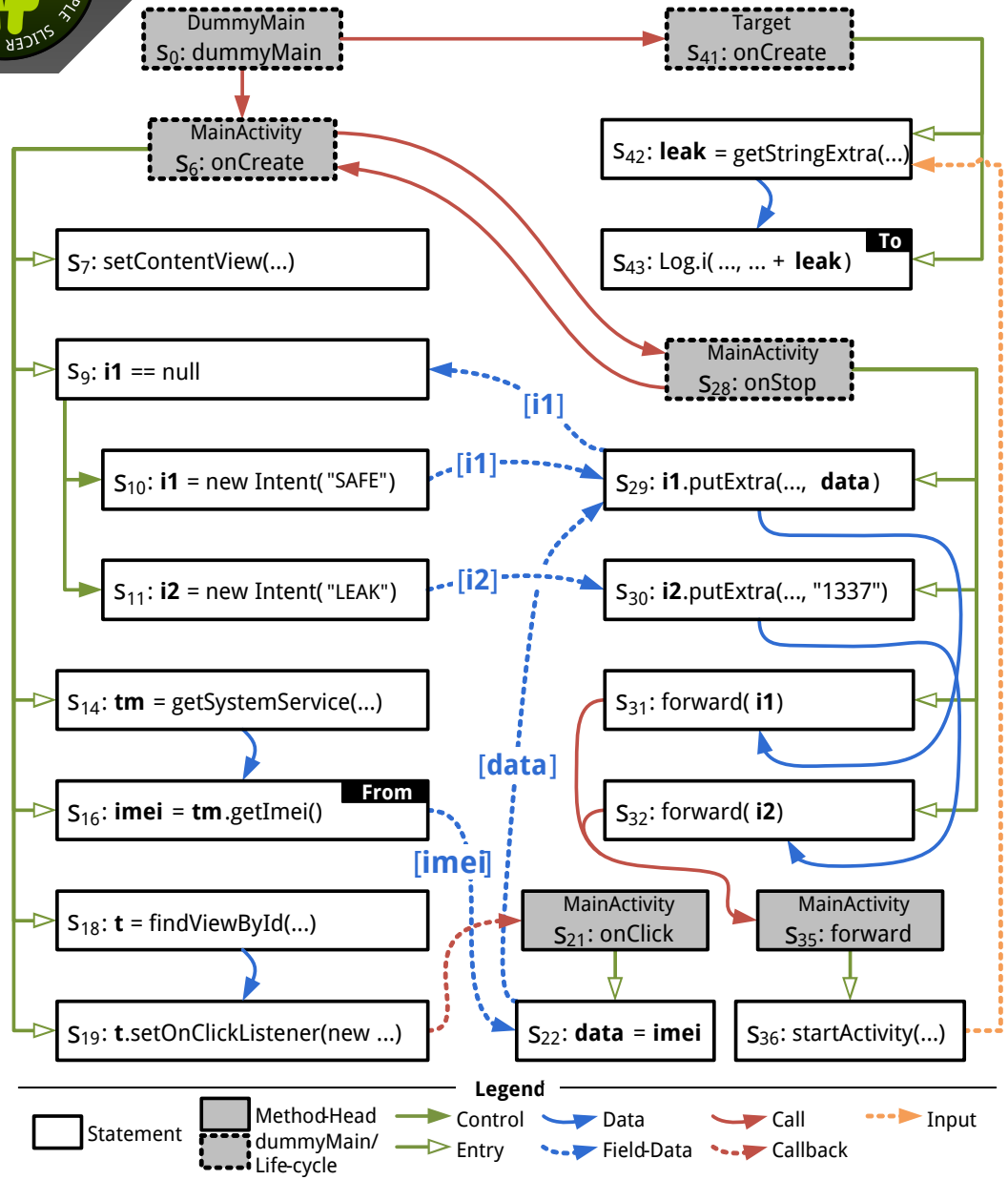

1. **Graph Generation**
   - Build **PDG**
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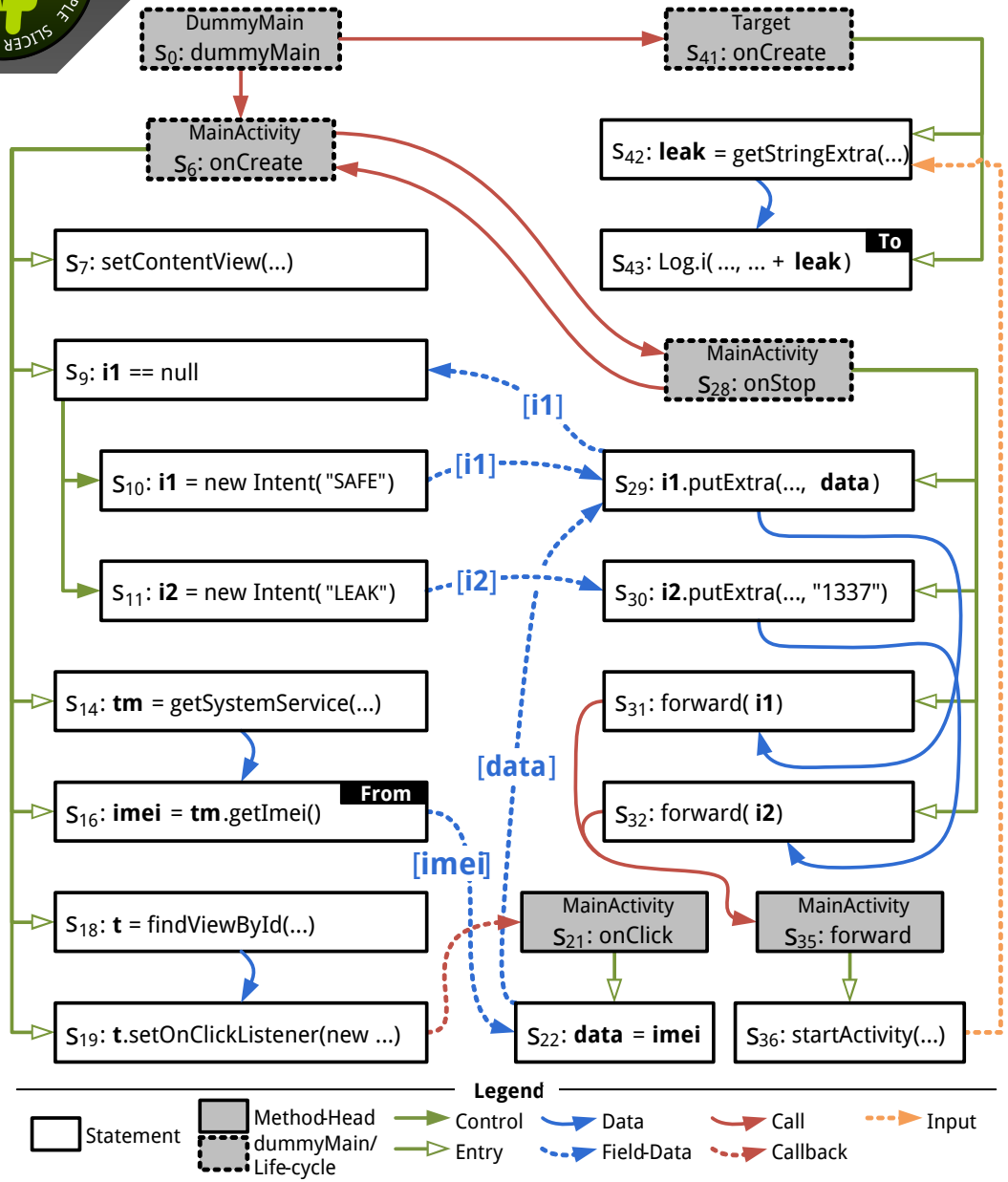
2. **Slicing**
   - Identify Criteria

Example: Slicing



1. **Graph Generation**
   - Build **PDG**
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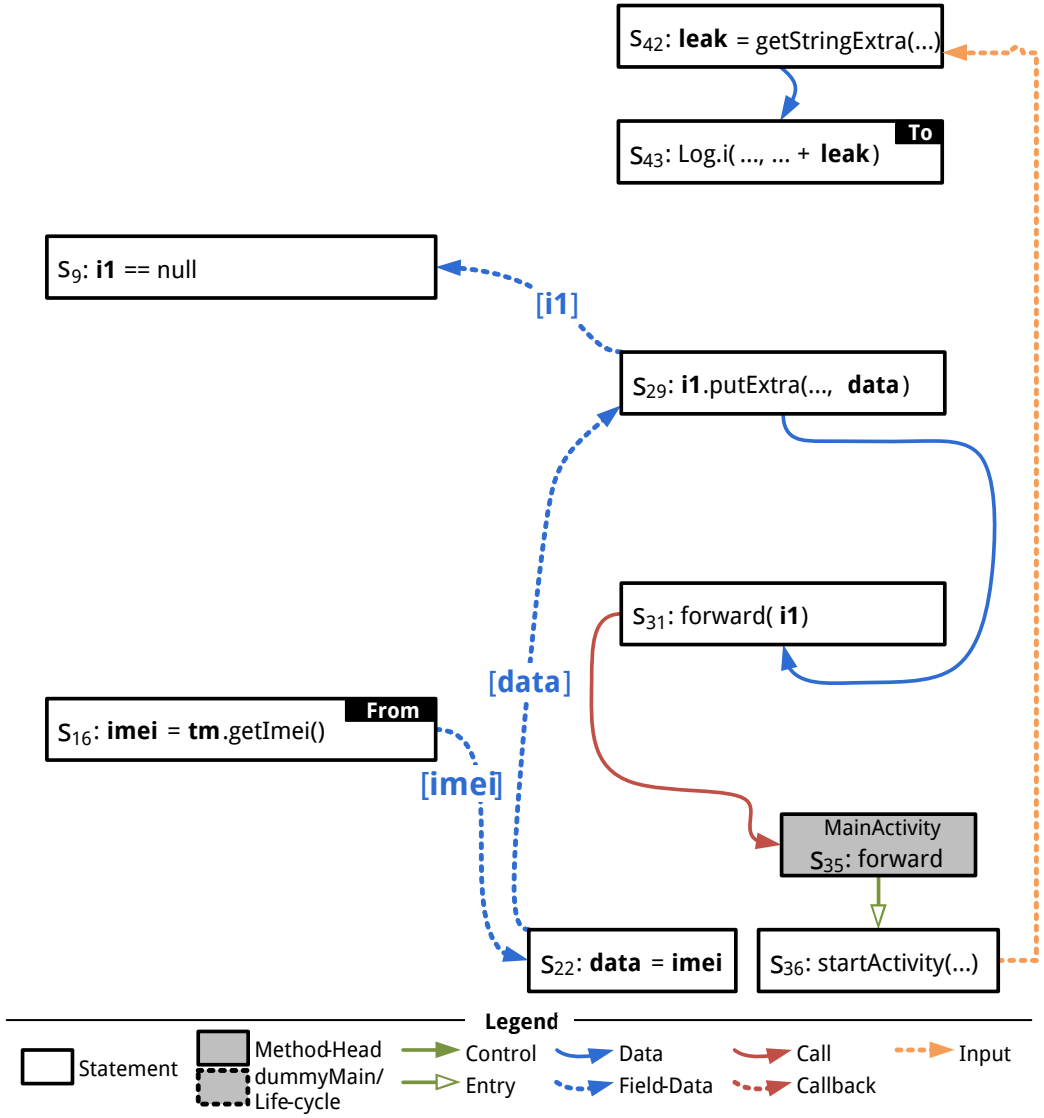
   - Enhance to **ADG**

2. **Slicing**
   - Identify Criteria
   - Slice Forward
     - **FFF:** Forward Field Filtering

Example: Slicing



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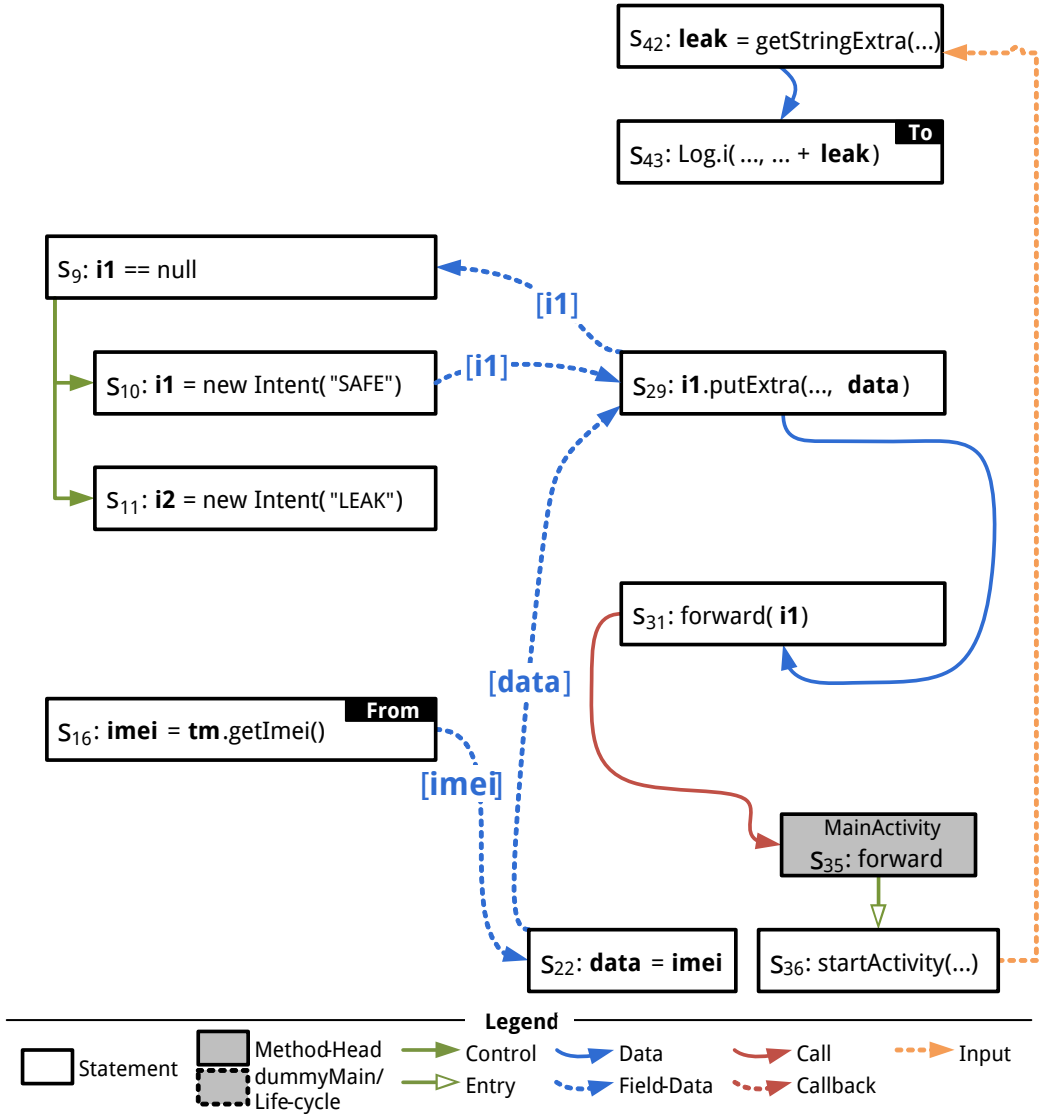

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     - **FFF:** Forward Field Filtering

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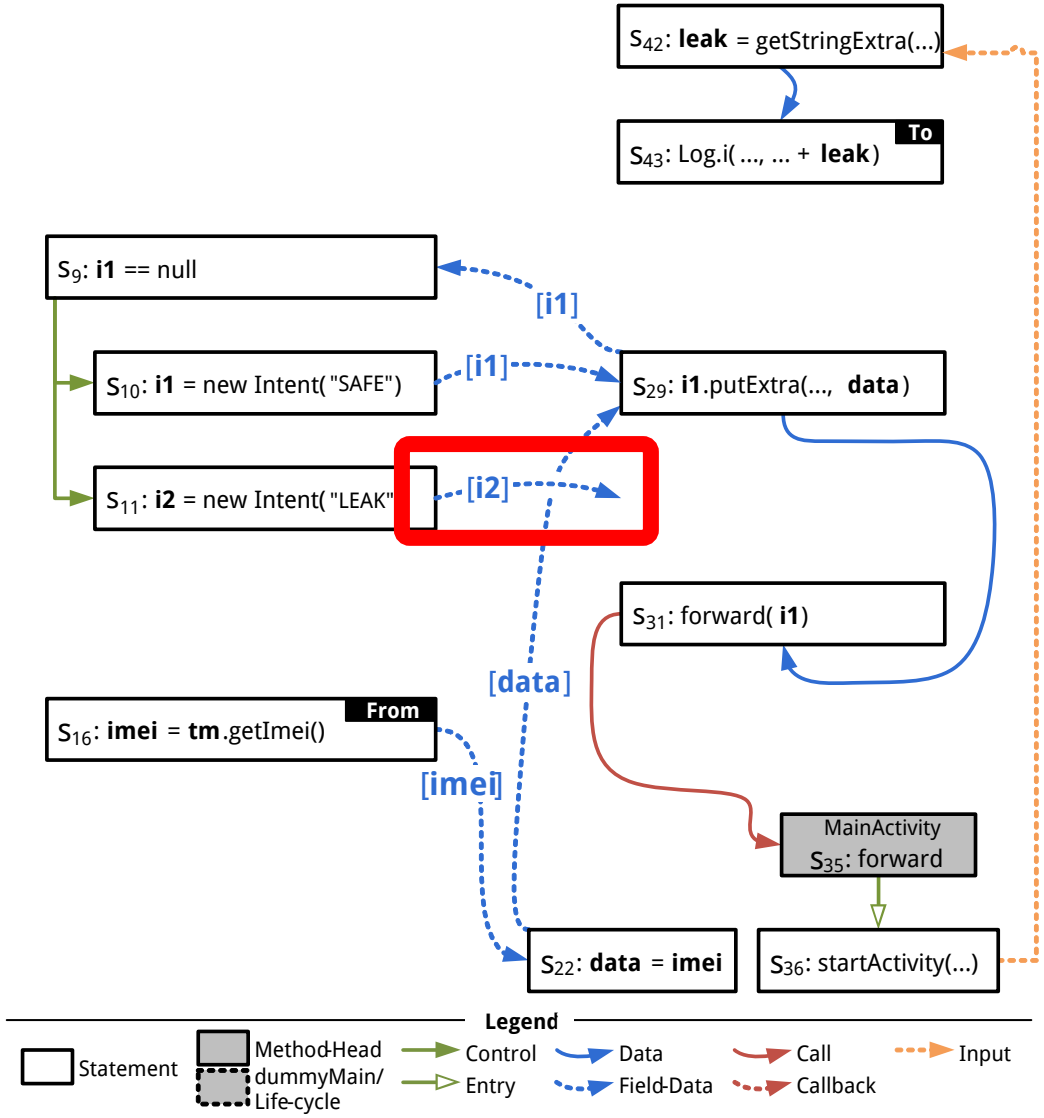

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   - Build **PDG**
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   - Enhance to **ADG**

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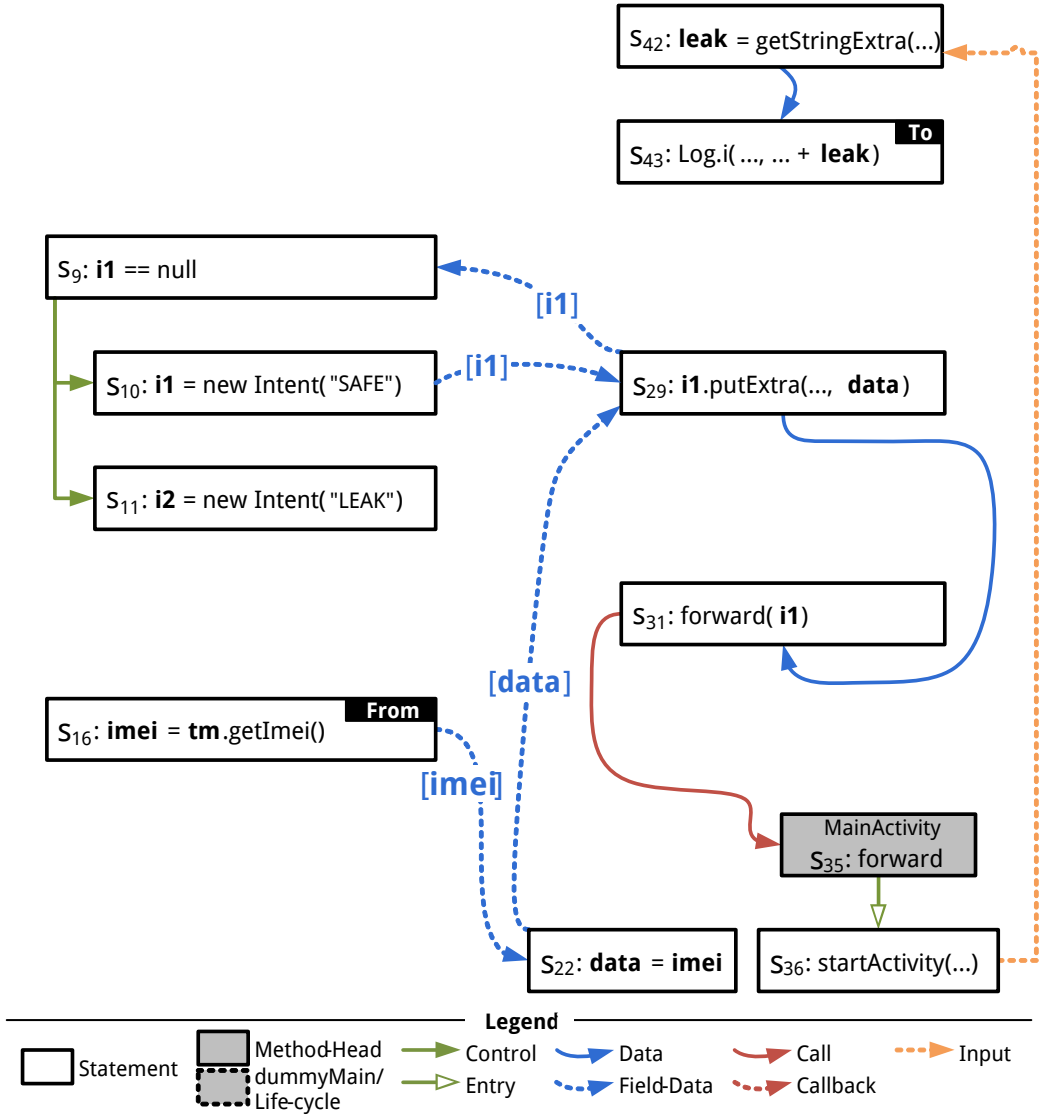
     - **FFF:** Forward Field Filtering



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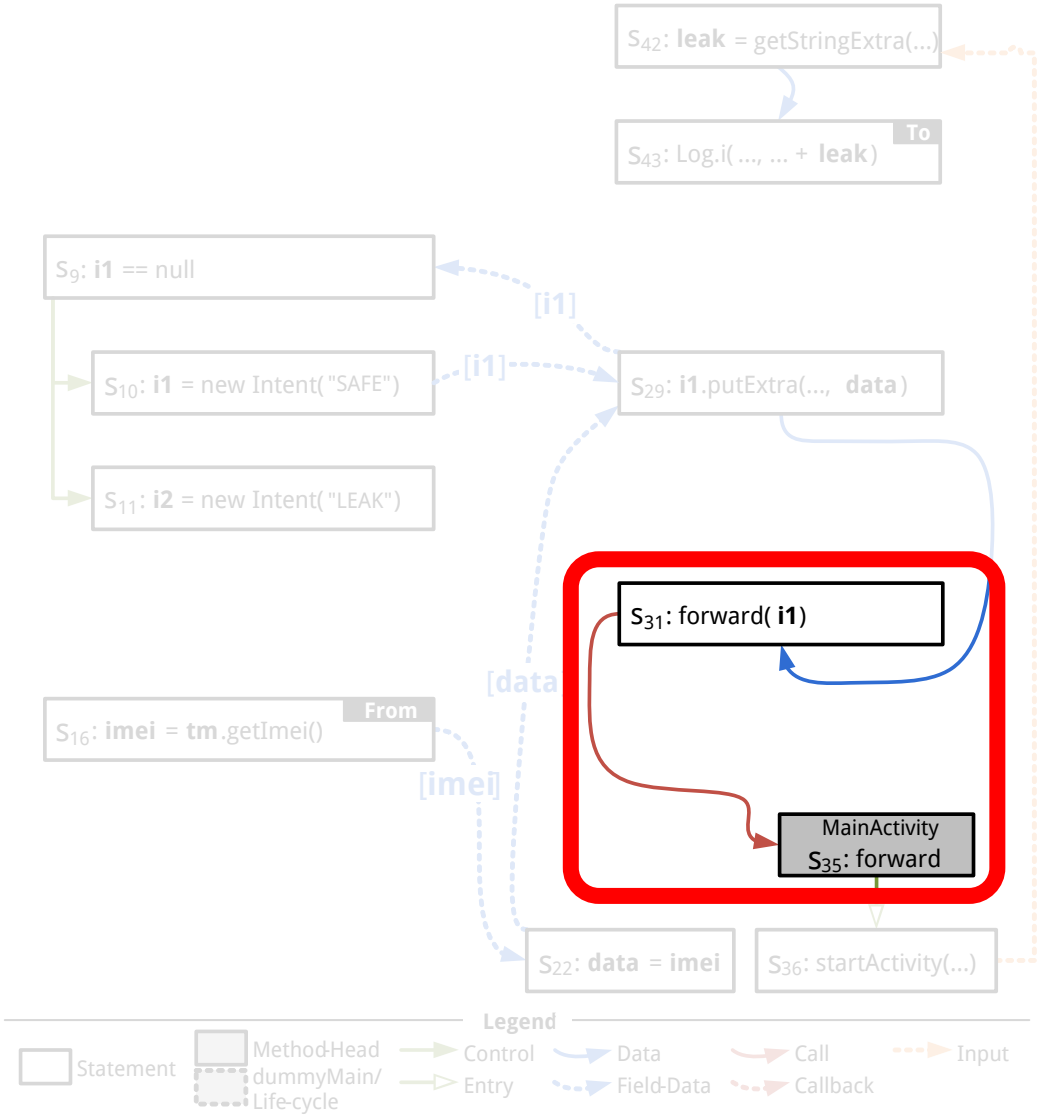

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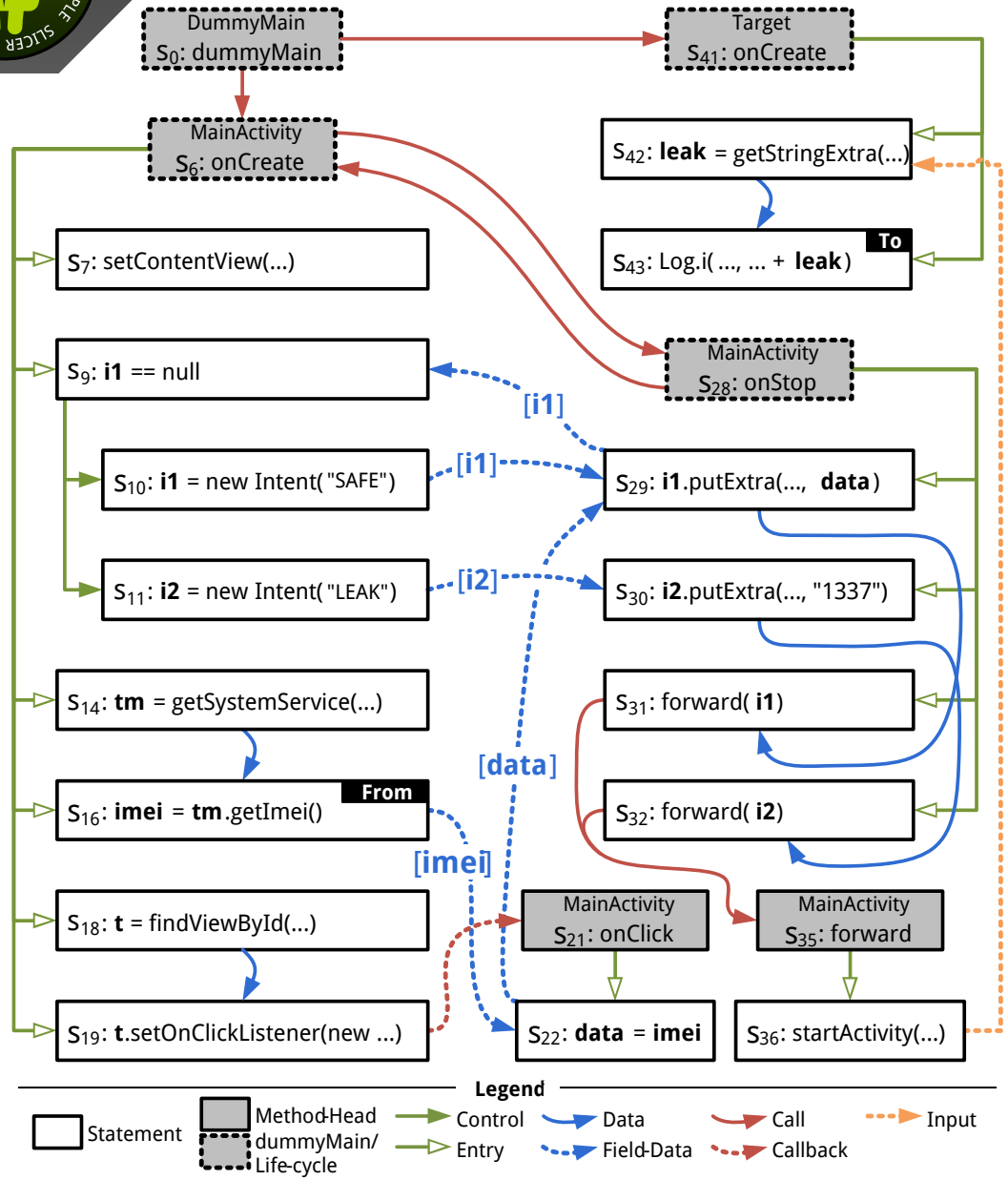
     - **FFF:** Forward Field Filtering

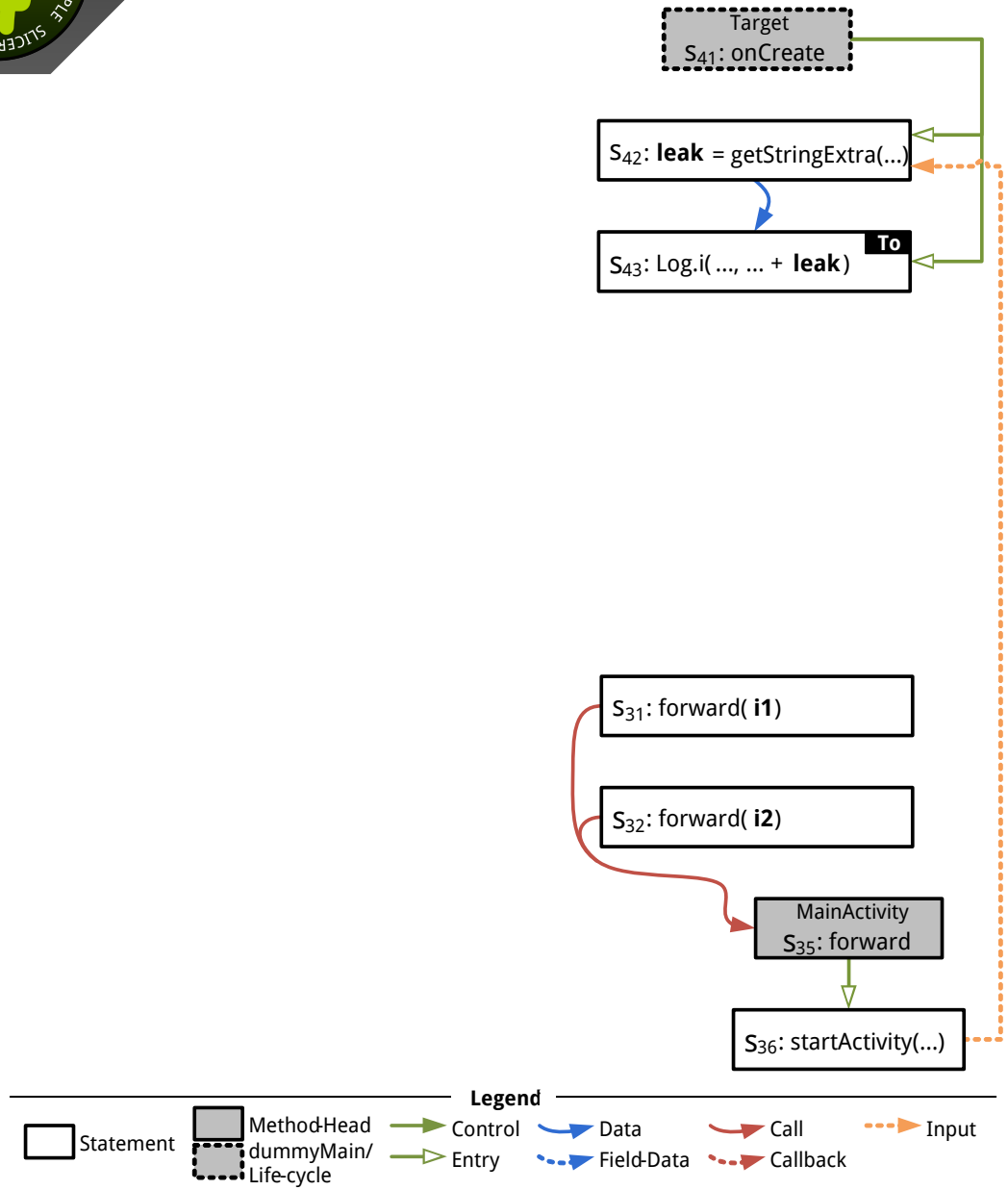
Example: Slicing



1. **Graph Generation**
   - Build **PDG**
   - Merge to **SDG**
   - Enhance to **ADG**

2. **Slicing**
   - Identify Criteria
   - Slice Forward
     - **FFF:** Forward Field Filtering
   - Slice Backward
     - **CSR:** Context-Sensitive Refinement

Example: Slicing



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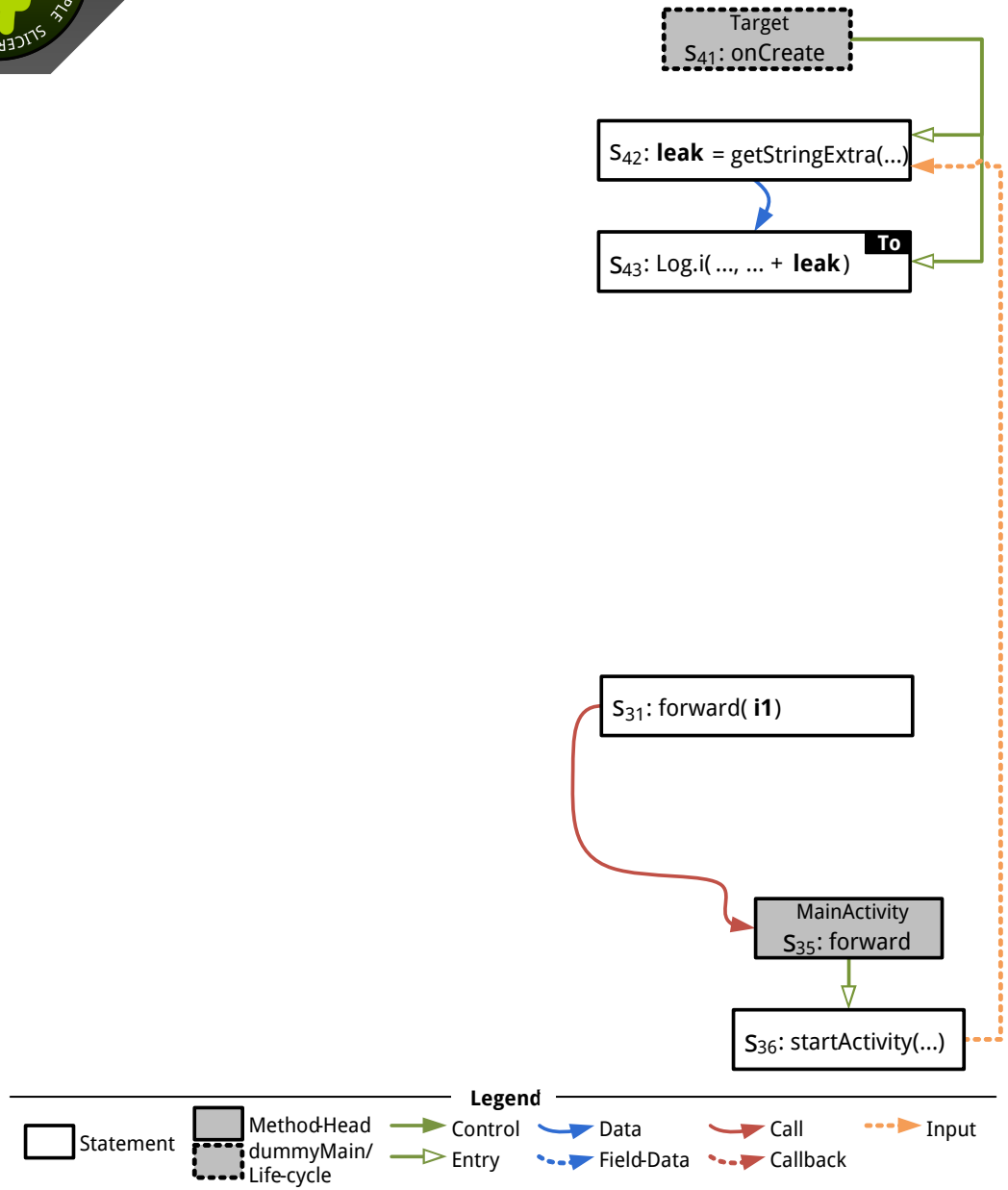

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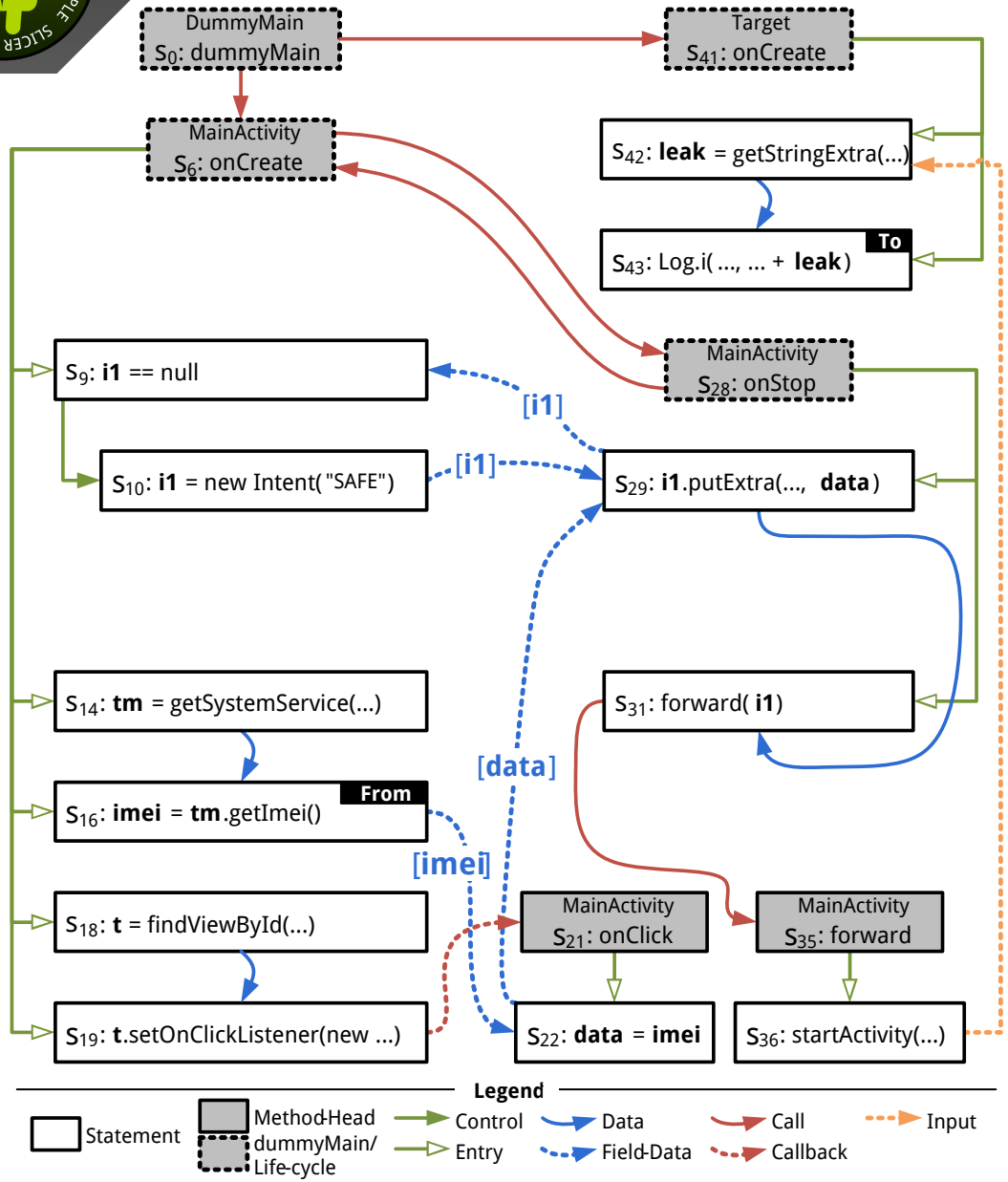

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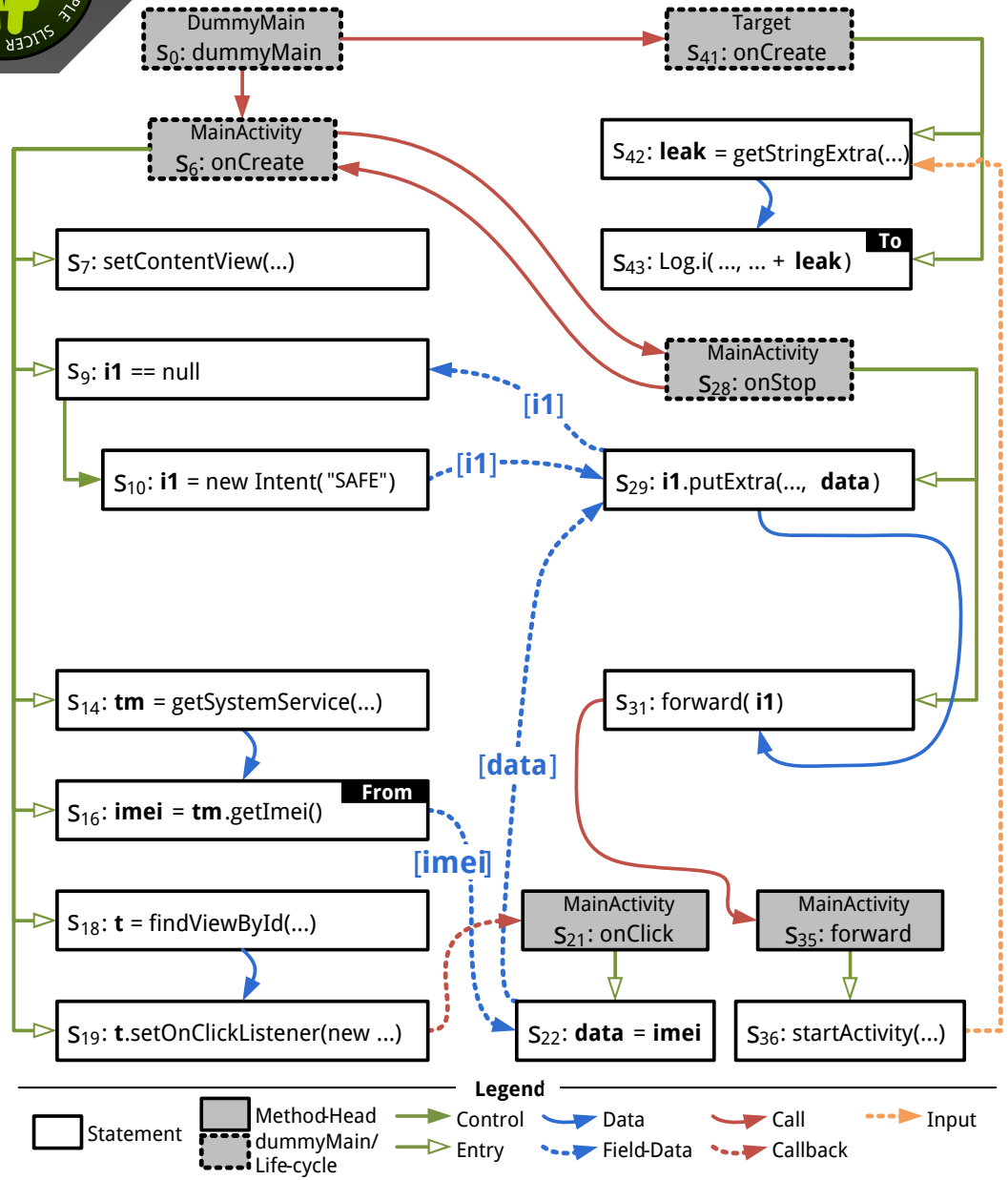

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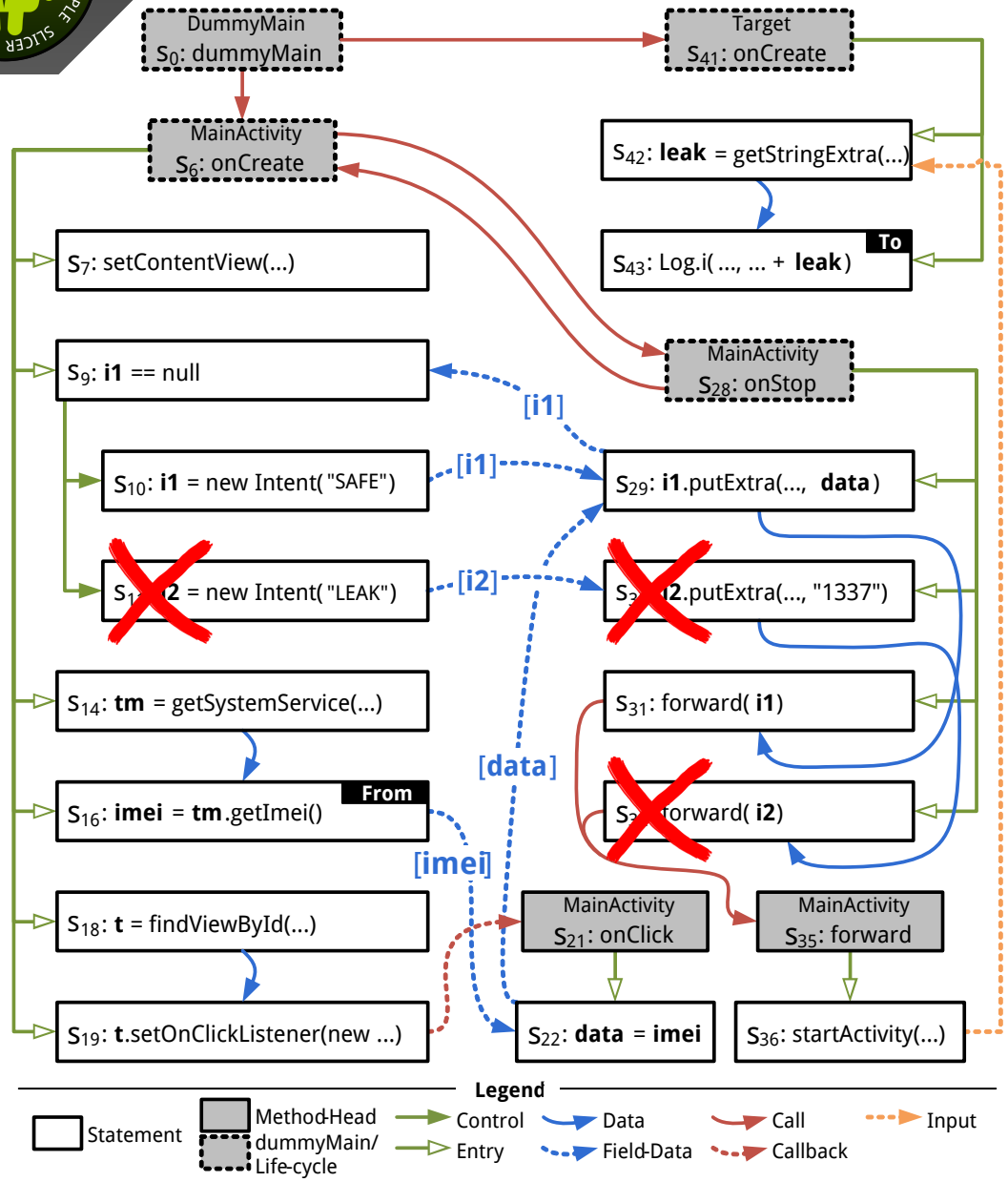

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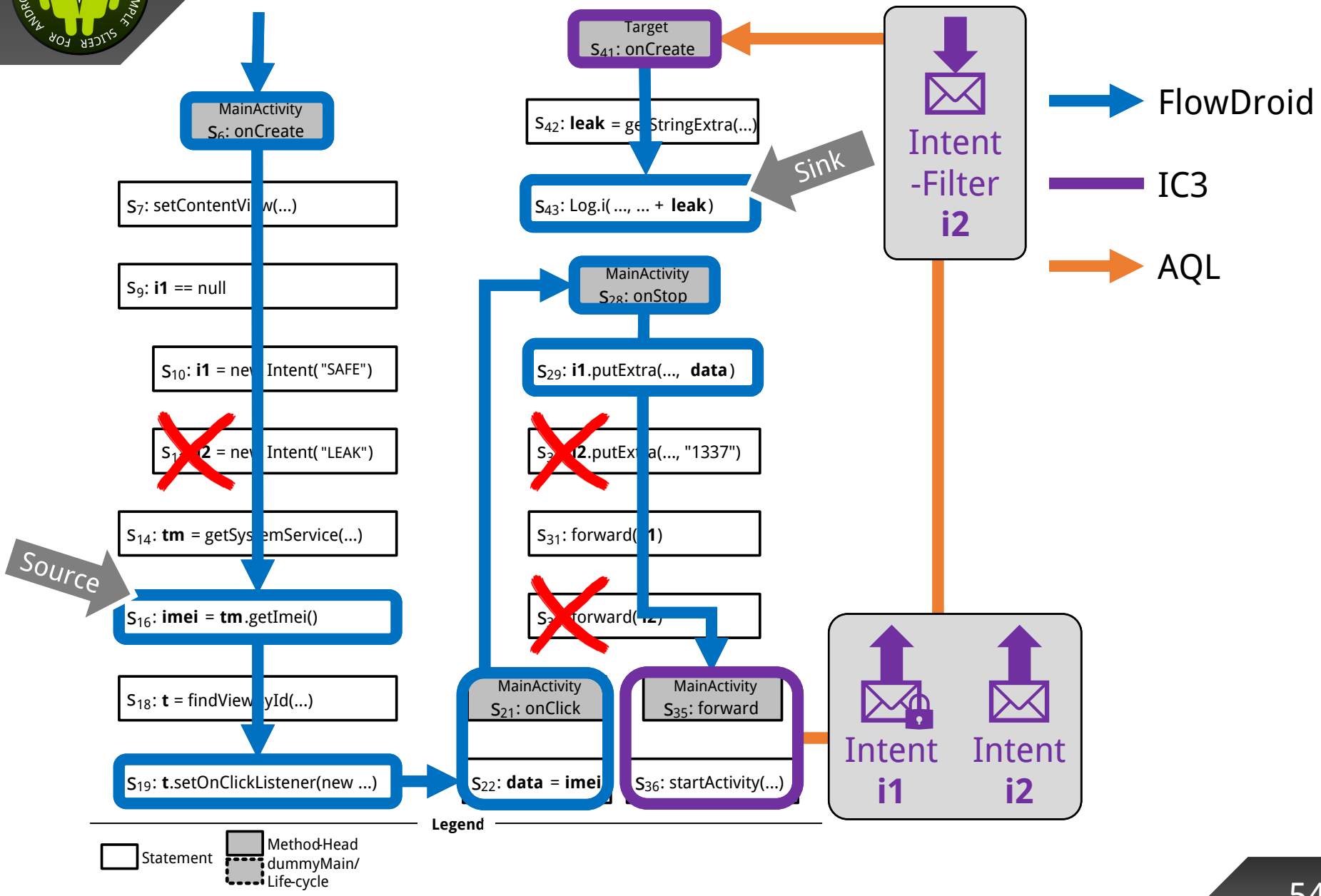
Example: Cooperative Taint Analysis + Slicing



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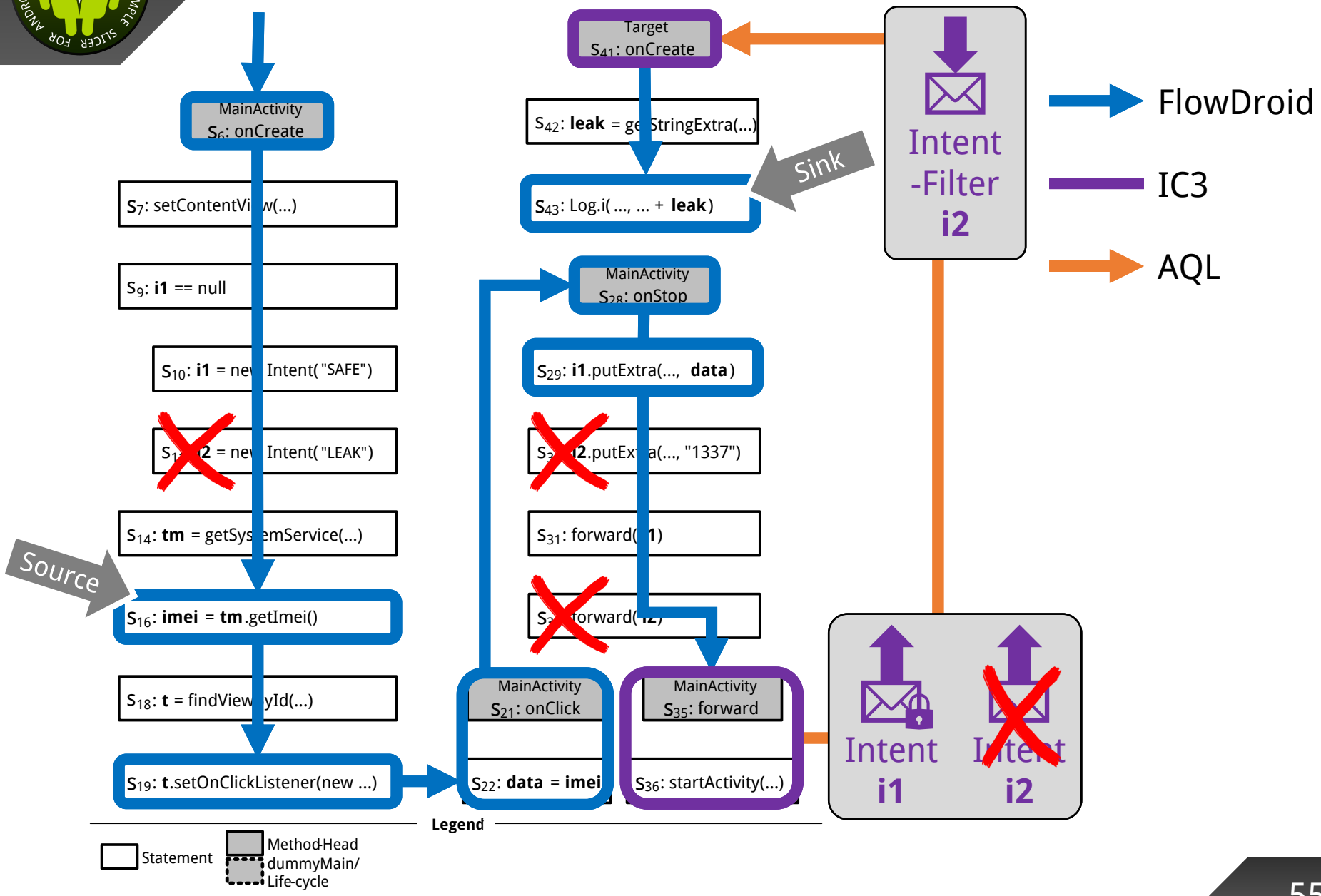

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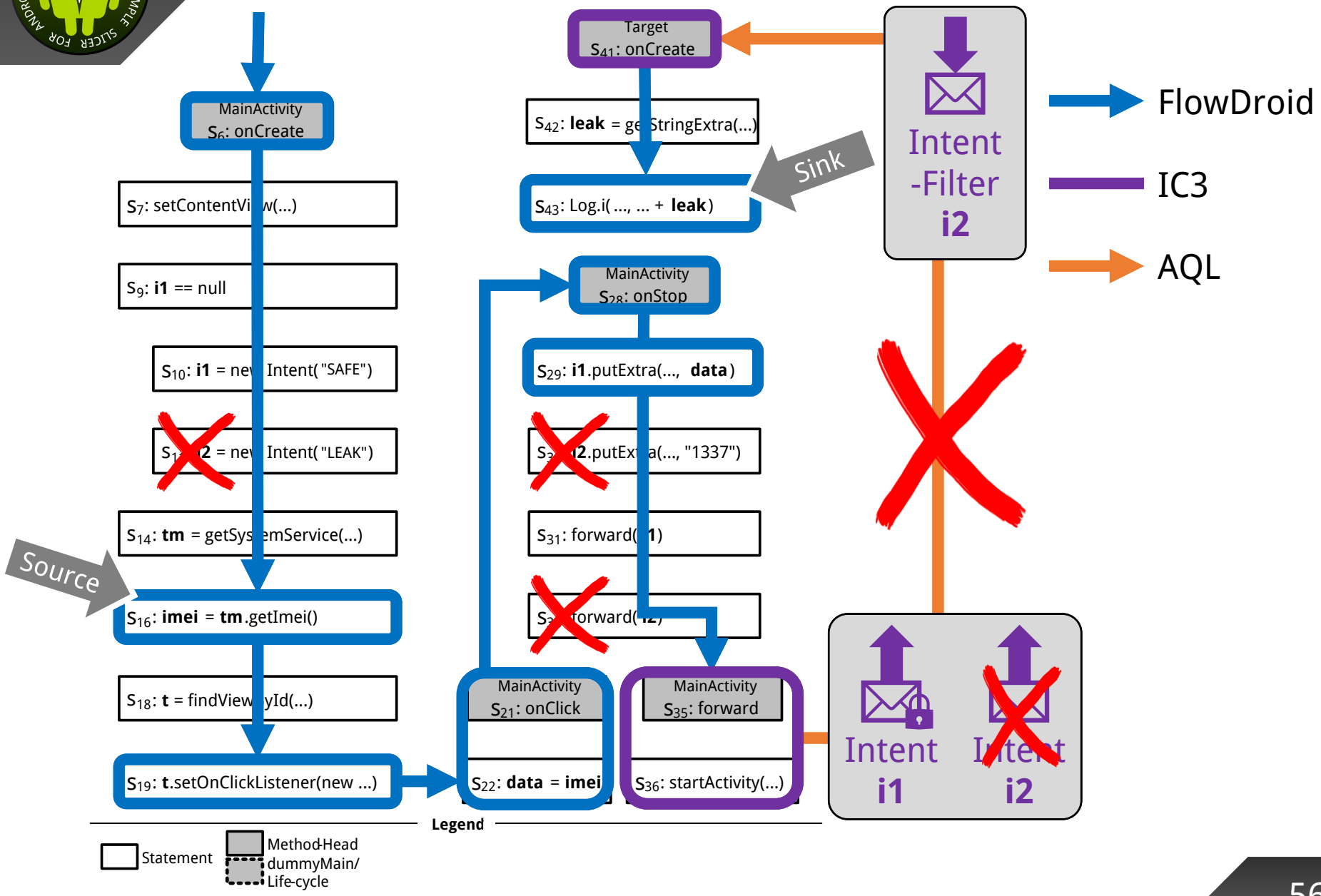

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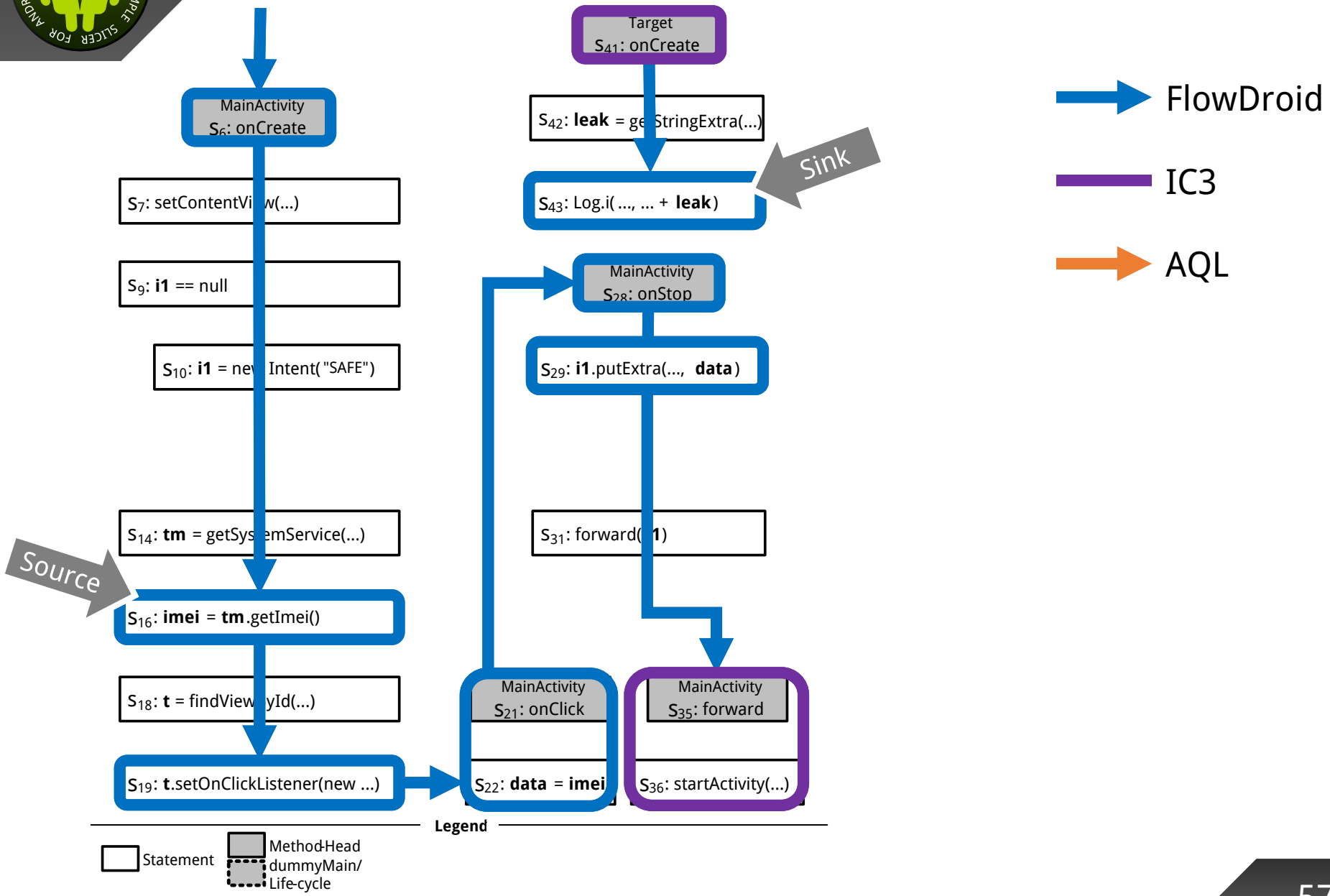

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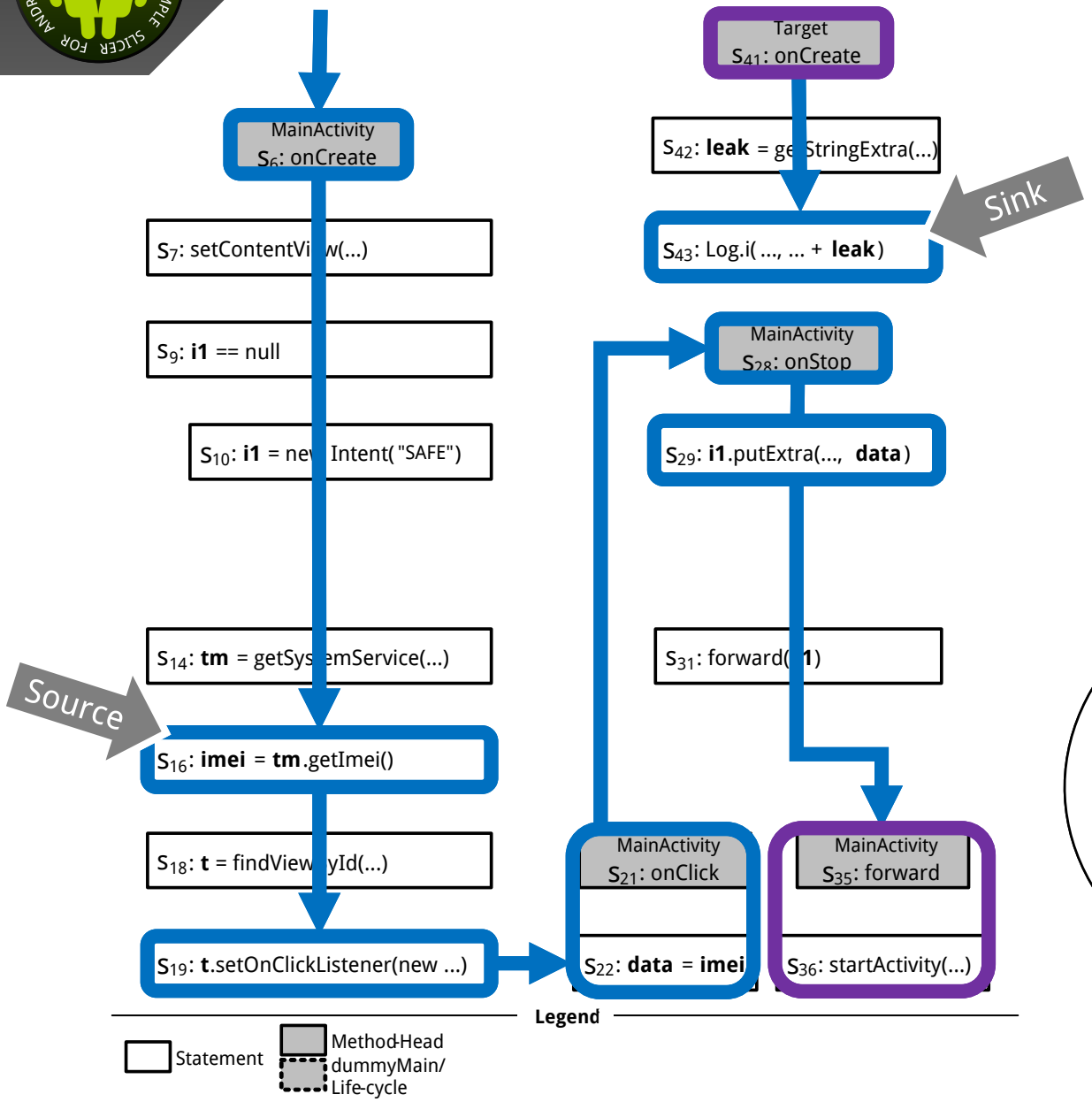


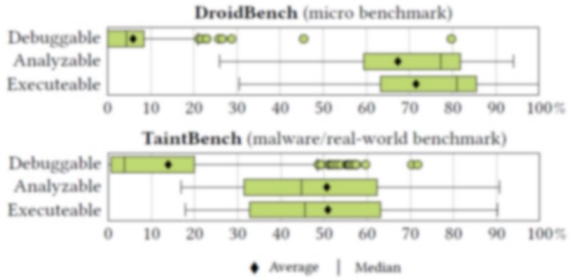
FlowDroid

IC3

AQL

False Positive Eliminated

- **Slice Size**
  - Analyzable/Executeable **>** Debuggable
  - Debuggable slices are still small (< 4%)



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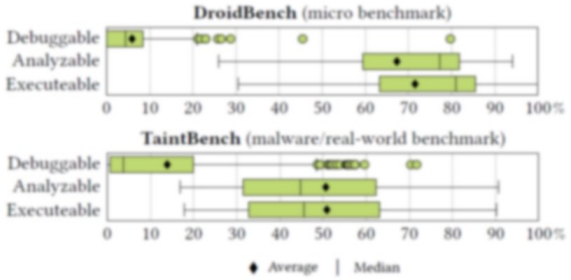
- **Comparison**
  - Dynamic slicers are more precise
  - No need for execution traces/test cases



Slicing Tool	Type	Requirements				USRs				
		1	2	3	4	1	2	3	4	5
AndroidSlicer [5]	dynamic	✔*	✔	✔	✔	✘	✘	✔	✘***	✘
Mandoline [1]	dynamic	✔	✔	✔	?	✔	✘	✔	✘***	✘
Jicer	static	✔**	✔	✔	✔	✔	✔	✔	✔	✔

✔: fulfilled, ✘: not fulfilled, ?: unknown, *: except 1.3, **: except 1.6,
***: 4.1 not fulfilled and 4.2 only fulfilled w.r.t. dynamic analysis tools

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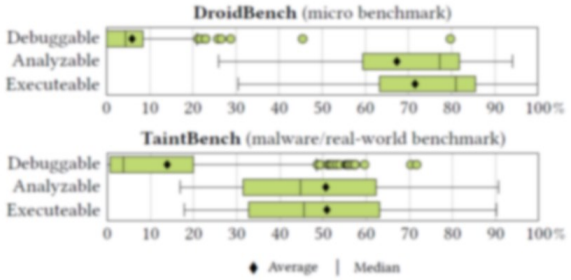

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Mandoline [1]	dynamic	✔	✔	✔	?	✔	✘	✔	✘***	✘
Jicer	static	✔**	✔	✔	✔	✔	✔	✔	✔	✔

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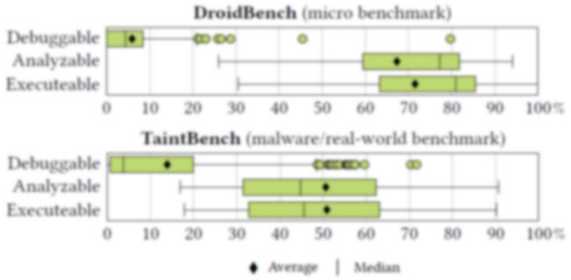

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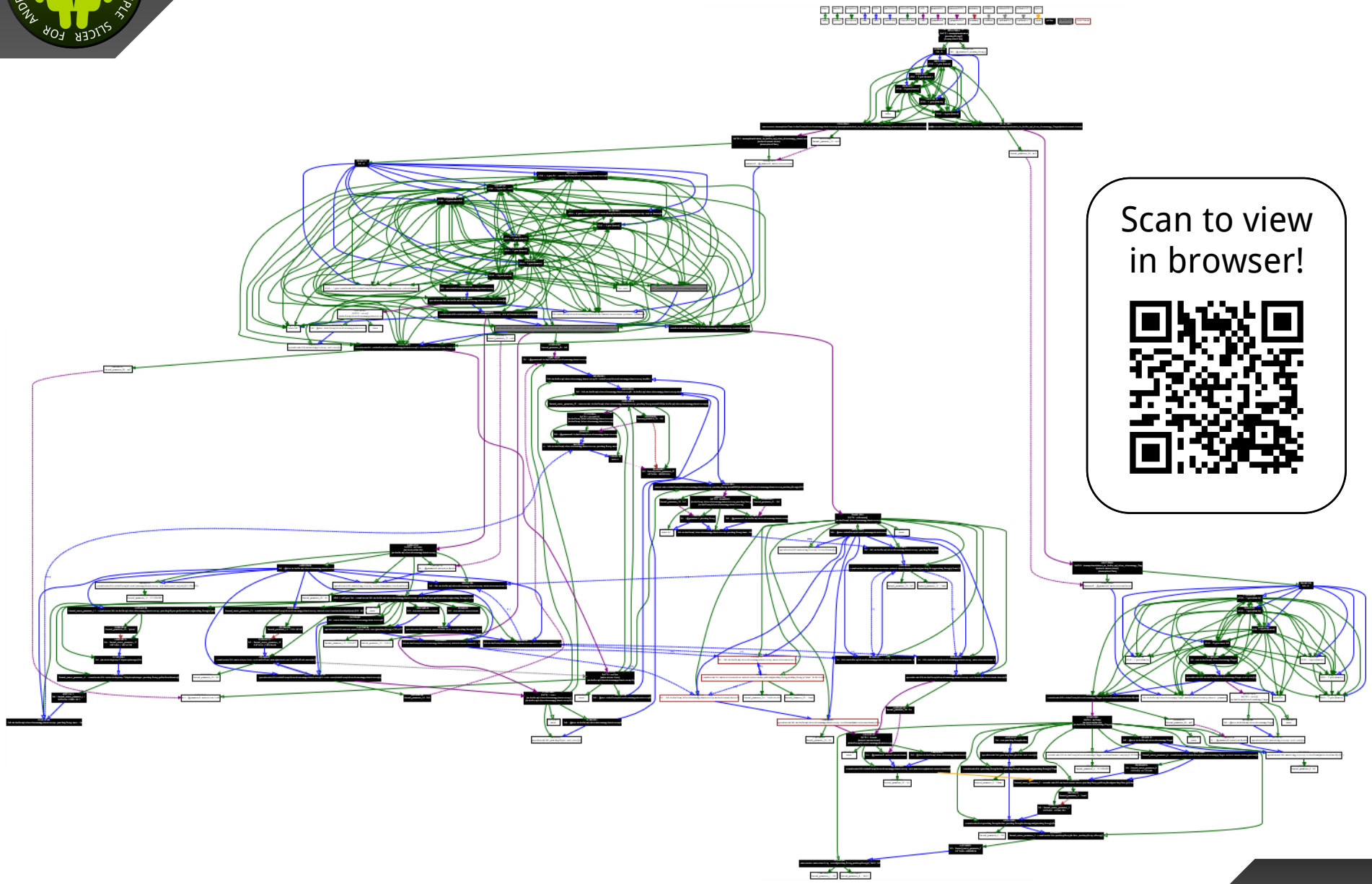
- **Analysis Performance**
  - Analysis time reduced
  - False positives eliminated (> 80%)

Example: Real ADG



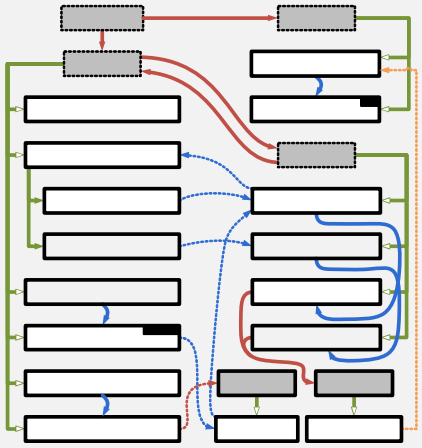
Scan to view in browser!

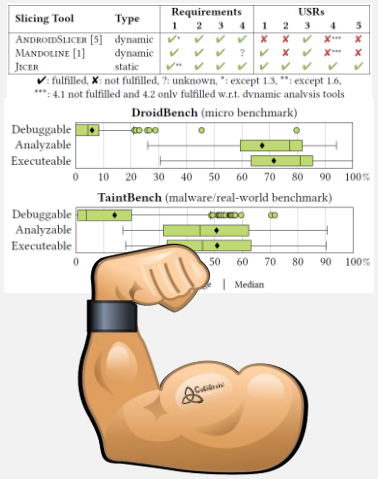
Summary

Jicer is available: https://FoelliX.github.io/Jicer

Jicer is awesome:

- APK/class input
- APK/Jimple output
- ADG Generation
  - flow-, context-, field-, object- and thread-sensitive
  - Callback- & Lifecycle-aware
- Scalable w.r.t. libraries (through StubDroid summaries)
- ICC & IAC support via cooperative analysis (input edges)
- *Debugable*, *Analyzable* or *Executable* output
- Valid code slicing through extra-slicing
- Forward Field Filtering
- Context-Sensitive Refinement
- Prefer Local Data
- Call Graph Enhancing
- GUI … and much more





Related Projects

Android App Analysis Query Language

CoDiDroid

More information on:

- https://FelixPauck.de
- https://FoelliX.github.io