android Bootcamp 2019

Windowing in Q

March 14, 2019

Team Goals for Q

- Wale Ogunwale

android

Team Goals for Q

- Improve codebase architecture
- Deliver high-impact features
- Improve tools and automated test coverage

Improving Codebase - Multi-Year Journey

O

- Window hierarchy
- Layer hierarchy - SurfaceView only
- Improve Keyguard handling
- Task snapshots
- Increased test coverage

P

- Window configuration
- SurfaceControl hierarchy
- Synchronize app transitions
- Activity Life Cycler - client only
- WinScope tool
- Even more tests!

Q

- Unified window hierarchy
- SurfaceFlinger-based input
- Optimized VirtualDisplay
- Public SurfaceControl
- WM flags migration and Inset API rewrite - finish in R
- Even more tests!!

¯_(ツ)_/¯

Unified Window Hierarchy

- Wale Ogunwale

android

Background

- Initial design of framework 10+ years ago had good separation of concerns for the use case then
  - **WindowManagerService (WM):** Responsible for window policies
  - **ActivityManagerService (AM):** Responsible for policies for core components (**activities**, services, broadcast, process management, ...)
- Over the years, the number of uses cases that activities need to support has grown significantly
  - Split-screen, Pip, freeform multi-window, multi-display, keyguard management, …
- Changes (often duplicates) were usually made to both the WM and AM packages since the use cases affected both activities and windows
- The state of hierarchy objects in both packages needed to be kept in sync even though they were under different locks

Background

AM	Link Controllers	WM
ActivityDisplay	DisplayWindowController	DisplayContent
ActivityStack	StackWindowController	TaskStack
TaskRecord	TaskWindowController	Task
ActivityRecord	AppWindowController	AppWindowToken

Objects representing the same entity are present in both AM and WM packages and kept in sync with a third controller object.

Problems with the Model

- Obvious code duplication across the WM and AM packages
- Difficult to make atomic changes to the hierarchy since it is split between the two packages under different locks
- Difficult having a consistent snapshot of other packages in the system
- Lock contention in AM package since it has lots of other responsibilities
- Increased code complexity to manage the interaction between both packages

Problems with the Model

- Awesome bugs like these

```
Use correct windowingMode when computing override config

The StackWindowController was calculating task bounds with
the WM-side windowingMode instead of the AM-side.
In this case, we are resizing during a windowingMode change
(fullscreen -> freeform). Since the windowingMode isn't sent
to WM-side yet, the smallestScreenWidthDp was set using
the old windowingMode resulting in the wrong resources being
used.

This change makes windowingMode one of the parameters (like
bounds/density) used to adjust the configuration.

Bug: 71028905
```

```
Fix issue with where display is removed while creating it in AM and WM

It is possible to a display to be removed while we are in the ctor of
ActivityDisplay in AM, but before we can get the Display object in the
ctor of DisplayWindowController in WM. This causes us to throw an
exception becuase the caller is trying to add a display we can't find in
display manager. Unfortunately there isn't a good way to handle this race.
To work around it we will now pass the Display object from AM to WM to use
and depend on the fact that AM will remove the display shortly after.

Change-Id: Ie3f9d86bad67f5a023e3e7dfce5219b98c796864
Fixes: 72893961
Test: go/wm-smoke
```

```
Don't call into AM finish-recents-animation while holding onto the WM lock

- By default, only call back to AM to finish the animation from callers
  outside of the system, when we are not holding the WM lock

Bug: 78258614
```

Solution

Have a single window hierarchy under the WM package and lock it by moving the activity management from the AM package to WM. This simplifies the interaction model and also solves all of the problems mentioned above.

Not so Easy...Tons of CLs and Code Cruft...

- 45+ CLs and counting
- Work still ongoing for 8+ months
- 90% done, but work will continue into the R release

Insets and Window Flag Migration

- Jorim Jaggi

android

Confusing Flags

`View.SYSTEM_UI_FLAG_FULLSCREEN`

→ Hides status bar, but doesn’t exit split screen

`View.SYSTEM_UI_FLAG_LAYOUT_FULLSCREEN`

→ Draws behind status bar, but doesn’t hide it

`WindowManager.LayoutParams.FLAG_FULLSCREEN`

→ Like `SYSTEM_UI_FLAG_FULLSCREEN`, but different behavior regarding stable frames and immersive mode

Confusing Flags

`WindowManager.LayoutParams.FLAG_NOT_FULLSCREEN`

→ Became public API “by accident”

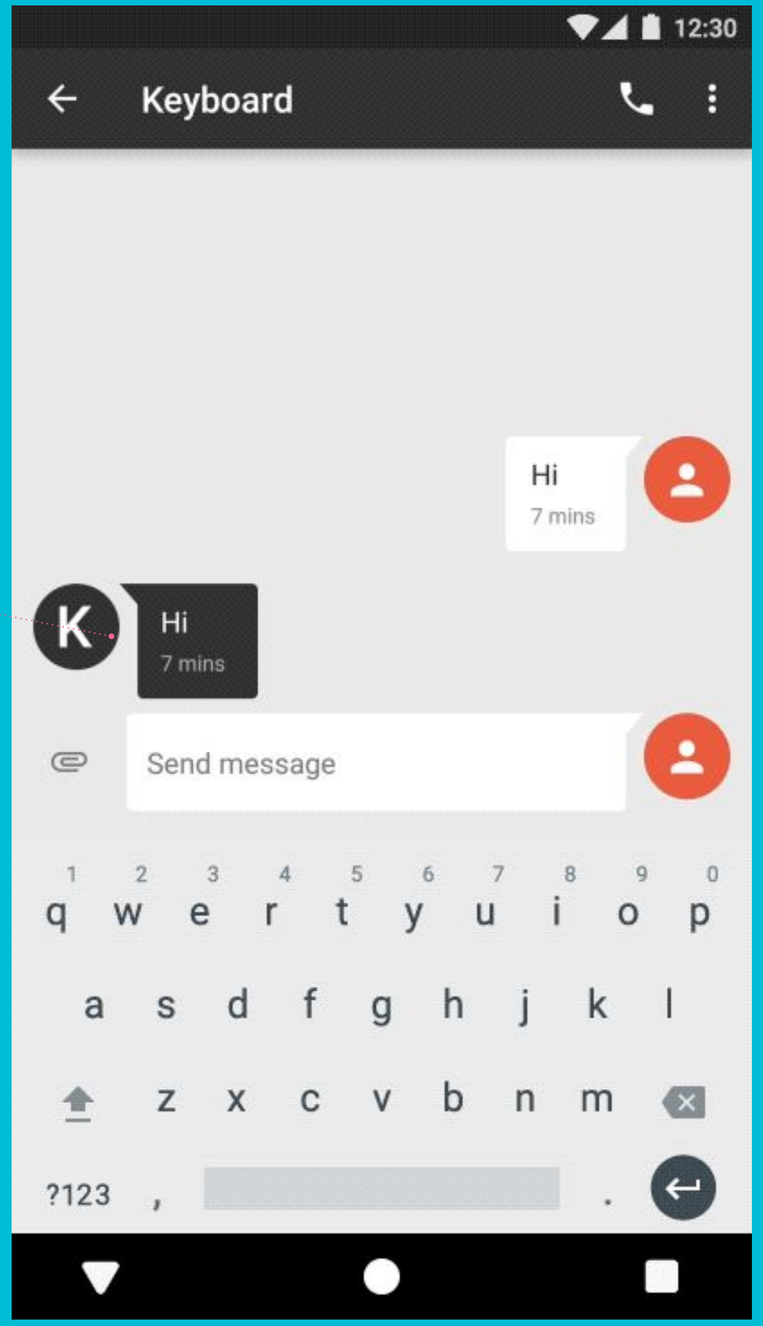
Is IME Visible?

Answer on Stack Overflow

```
getVTO().addOnGlobalLayoutListener(new OnGlobalLayoutListener() {
    @Override public void onGlobalLayout() {
        int heightDiff = getRootView().getHeight() - topView.getHeight();
        if (heightDiff > dpToPx(this, 200)) {
            // if more than 200 dp, it's probably a keyboard...
        }
    }
});
```

Synchronized IME Transitions

- App content is fully synchronized with IME appear animation
- IME can be hidden/shown by scrolling up/down



API Surface

Insets by type

```
getInsets(@Type int type)

getMaxInsets(@Type int type)
```

Animation listener & control

```
setWindowInsetsAnimationListener

controlWindowInsetsAnimation
```

Deprecate System UI flags

1. Window always extends below status and navigation bar
2. Use `Window.setFitsWindowInsets` to avoid placing content in these areas

Insets by Type

```
@Type int Type.systemBars();
@Type int Type.topBar();
@Type int Type.ime();
@Type int Type.sideBars();
@Type int Type.windowDecor();
@Type int Type.all();
```

Insets by Type

```
Insets WindowInsets.getInsets(@Type int type);
```

→ Retrieves the insets of a given type

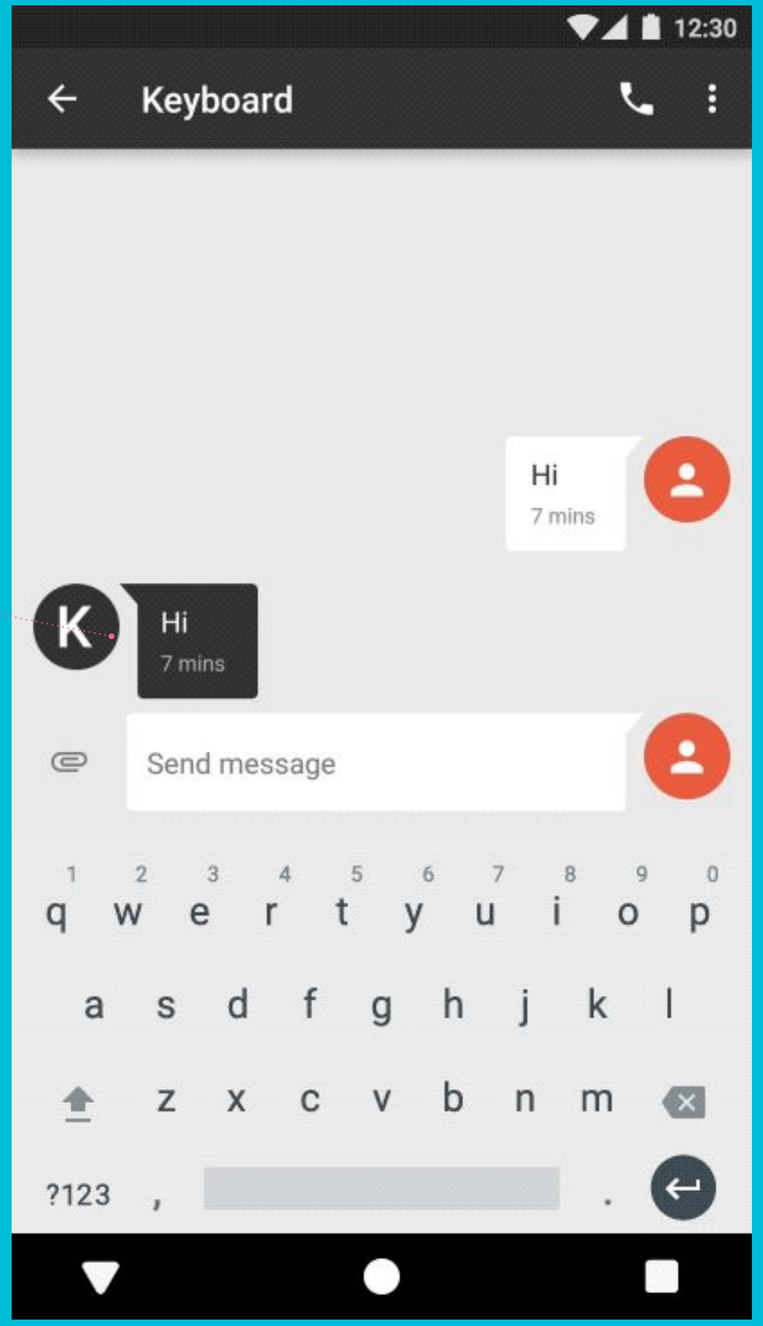
```
boolean WindowInsets.isVisible(@Type int type);

if insets.getInsets(ime()) not empty:
    // IME is showing and occluding my content

if insets.isVisible(ime()):
    // IME is showing, regardless of whether it’s currently occluding my
    // content
```

Synchronized IME Transitions

- **App content is fully synchronized with IME appear animation**
- IME can be hidden/shown by scrolling up/down



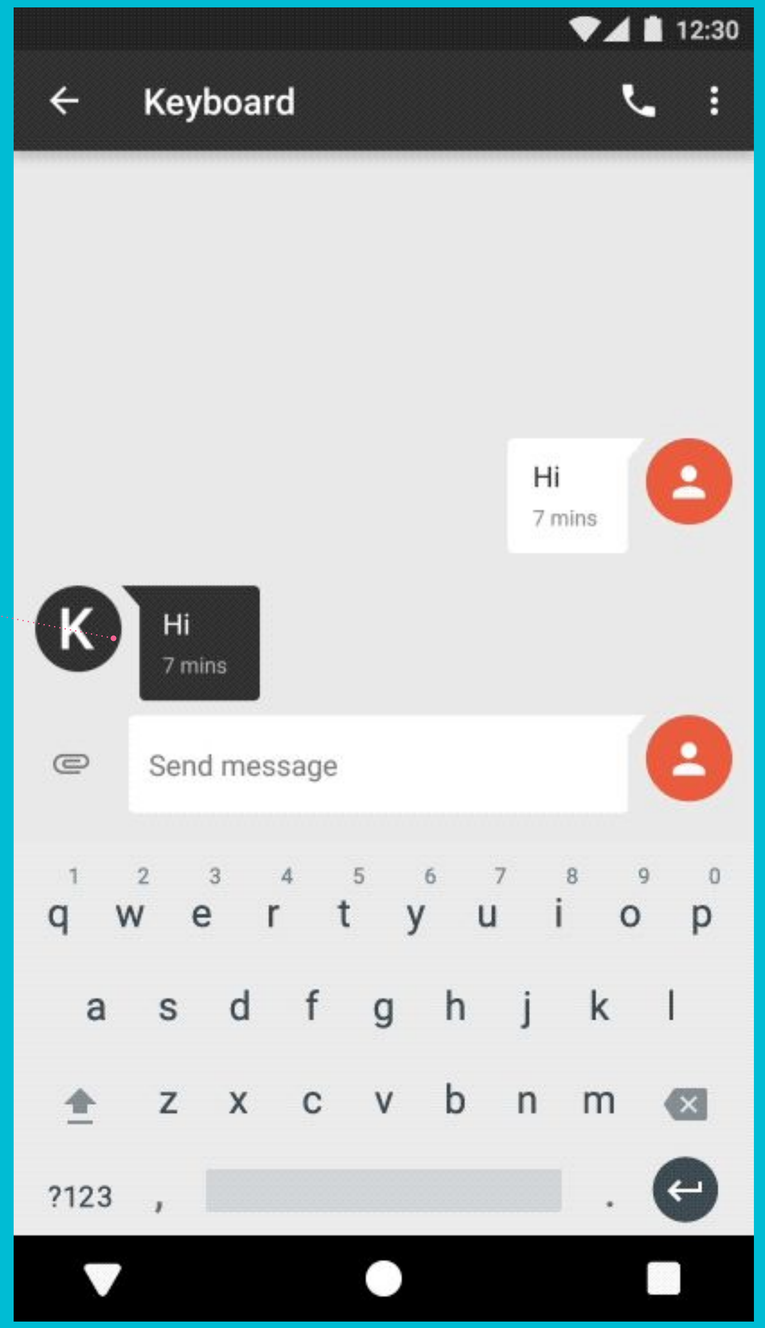
Animation Listeners

```
WindowInsetsAnimationCallback {
    AnimationBounds onStarted(InsetsAnimation anim, AnimationBounds bounds);
    WindowInsets onProgress(WindowInsets insets);
    void onFinished(InsetsAnimation anim);
}

View.setWindowInsetsAnimationCallback(Callback callback);
```

Synchronized IME Transitions

- App content is fully synchronized with IME appear animation
- **IME can be hidden/shown by scrolling up/down**



Animation Control

```
View.getWindowInsetsController().controlWindowInsetsAnimation(@Type int types,
    Listener listener);

Listener {
    onReady(AnimationController controller);
    onCancelled();
}
```

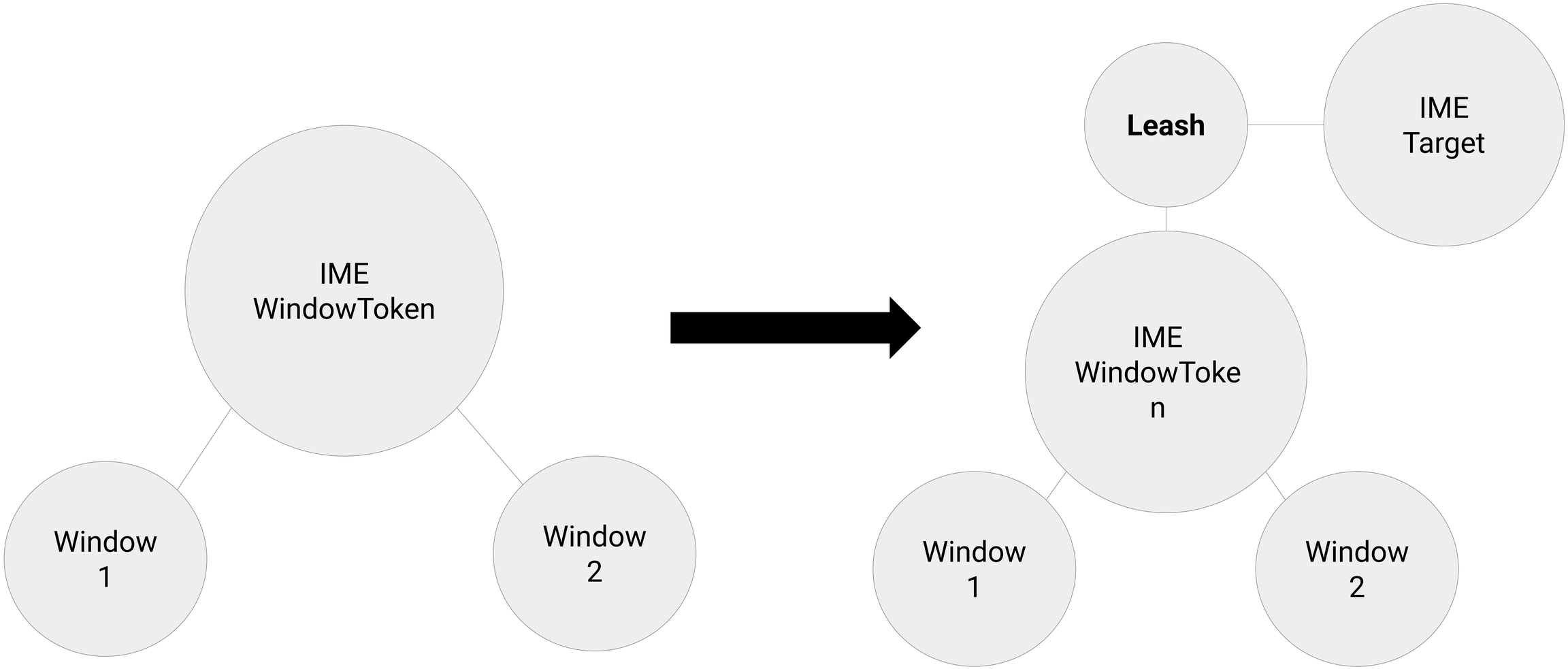
Animation Control

```
AnimationController {
    Insets getShownStateInsets();
    Insets getHiddenStateInsets();
    void changeInsets(Insets insets);
    void finish();
}
```

Animation Control

```
// When scroll starts to reveal ime:
    v.getWIController().controlWIAnimation(ime(), new Listener {
        onReady(AnimationController controller) {
            // Depending on current scroll position, calculate how far IME
            // extends into app content
            Insets insets = calculateImeInsets(...);
            controller.changeInsets(insets);
        }
    });
```

IME Animations: Leash



Deprecating System UI Flags

~~SYSTEM_UI_FLAG_FULLSCREEN~~
~~SYSTEM_UI_FLAG_HIDE_NAVIGATION~~
→ `WindowInsetsController.hide(topBar()/sideBars());`

~~SYSTEM_UI_FLAG_LAYOUT_FULLSCREEN~~
~~SYSTEM_UI_FLAG_LAYOUT_HIDE_NAVIGATION~~
→ `Window.setFitsSystemWindows(~topBar()/~sideBars())`

Similar approach for other flags

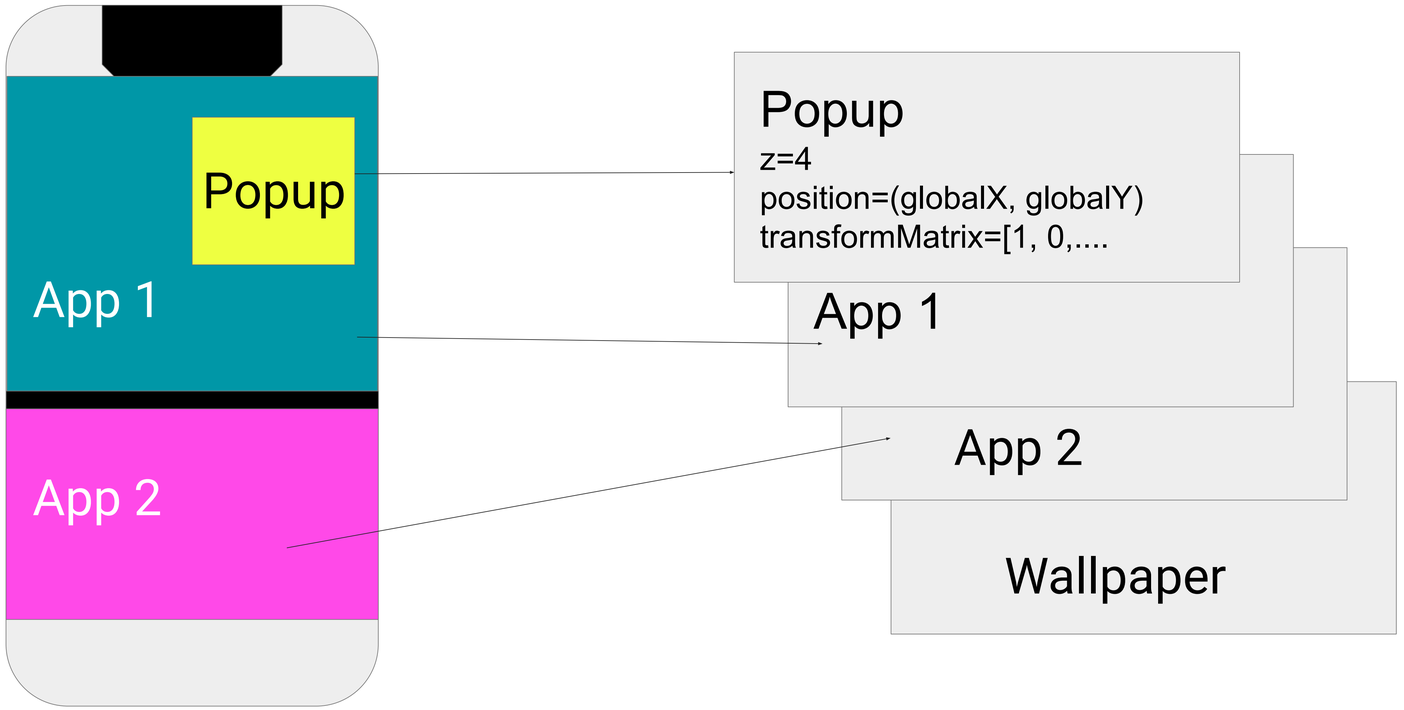
SurfaceFlinger Hierarchy - Part III?

- Rob Carr

android

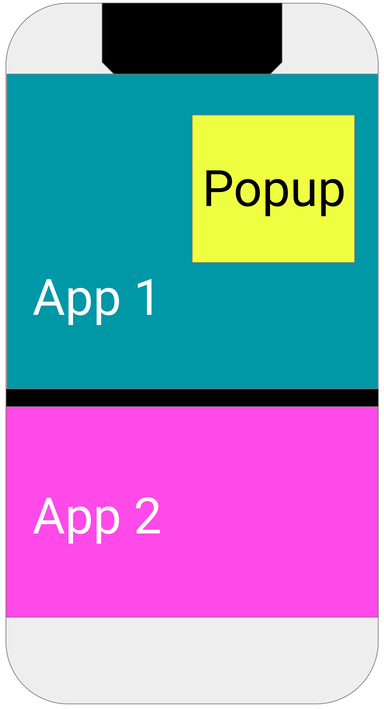
SurfaceFlinger Hierarchy

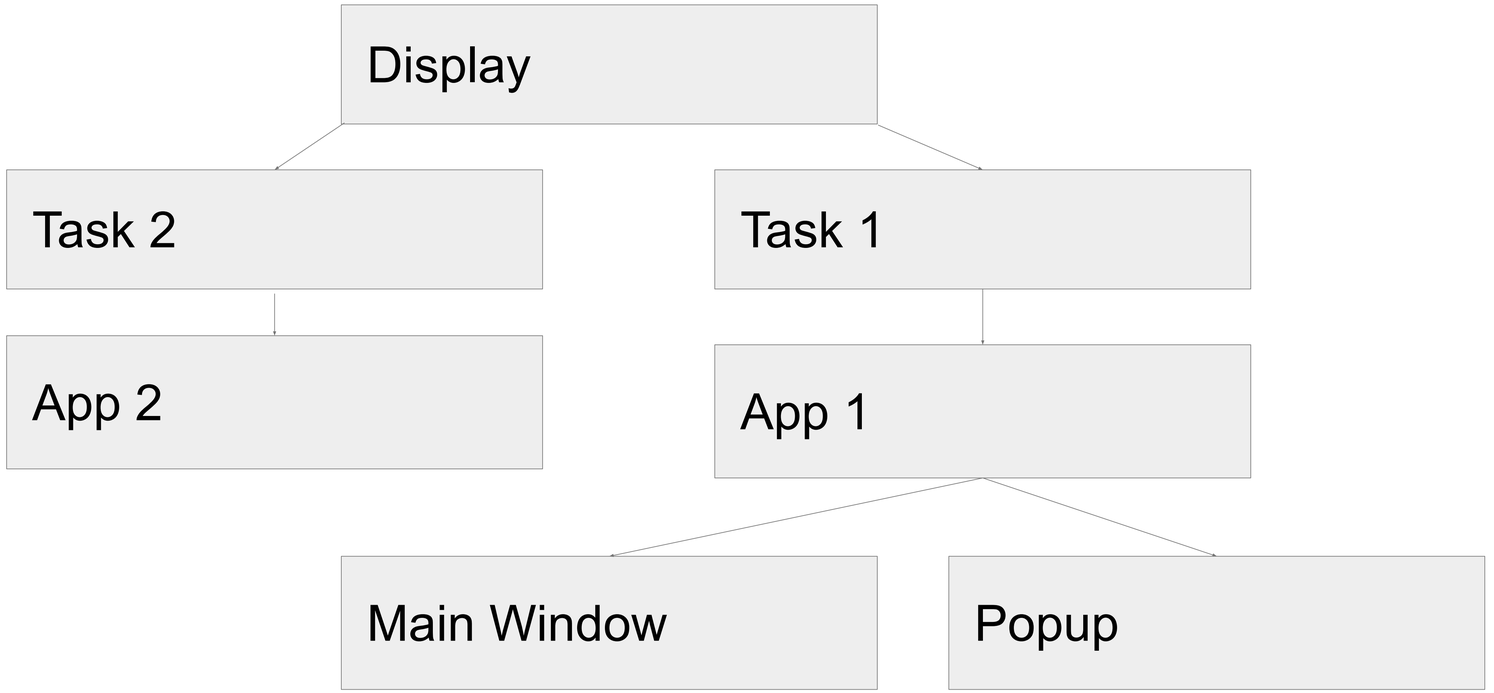
Old Model (SurfaceControl '*Retro*')



SurfaceFlinger Hierarchy

New Model (SurfaceControl *'Nuevo'*)





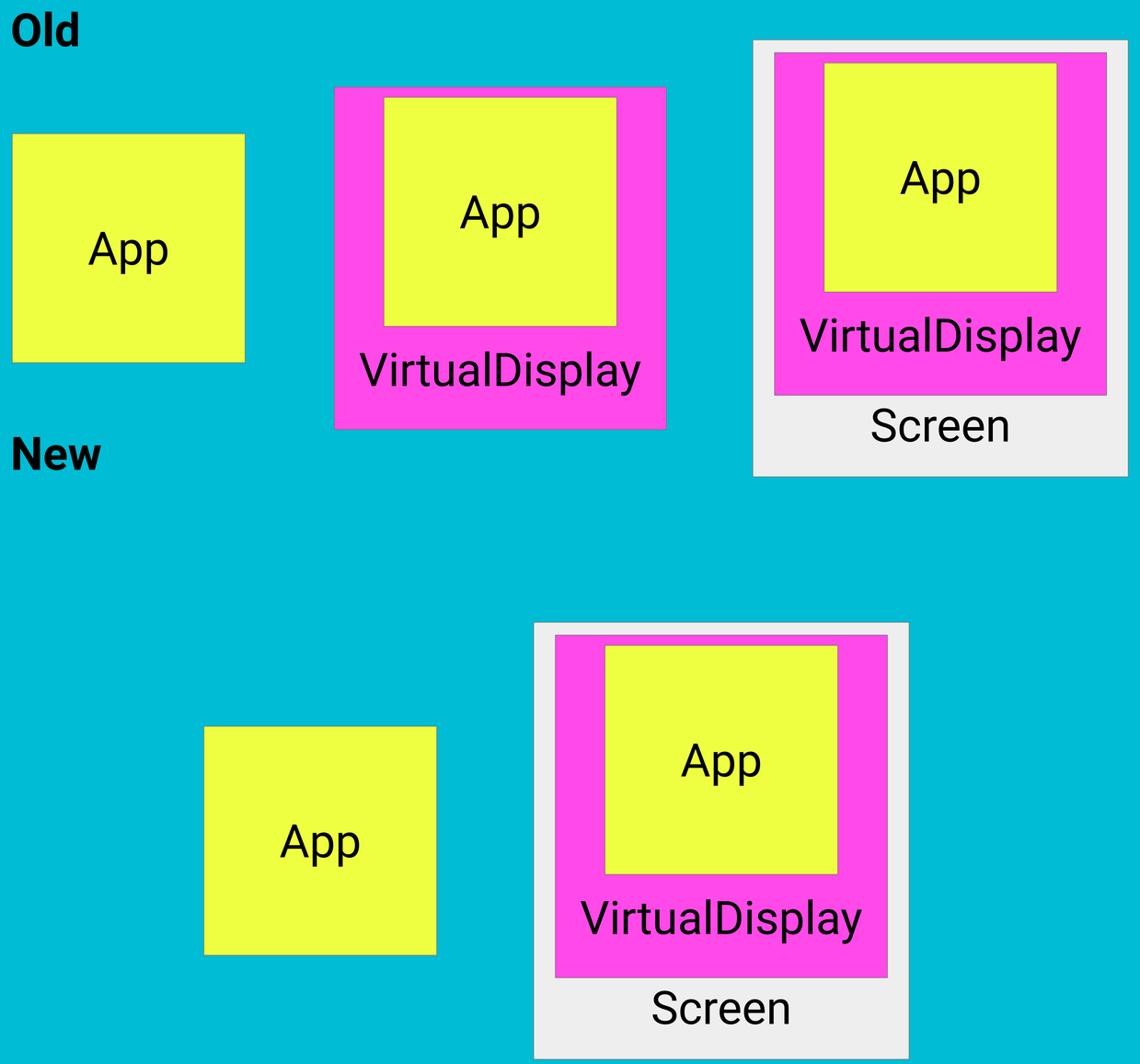
Android O: Implementation, SurfaceView
Android P: WM hierarchy port, app controlled transitions, lock-free animations

Android Q: Virtual Display 2.0, SurfaceFlinger input, public SurfaceControl, BLAST, inset animations

VirtualDisplay and ActivityView 2.0

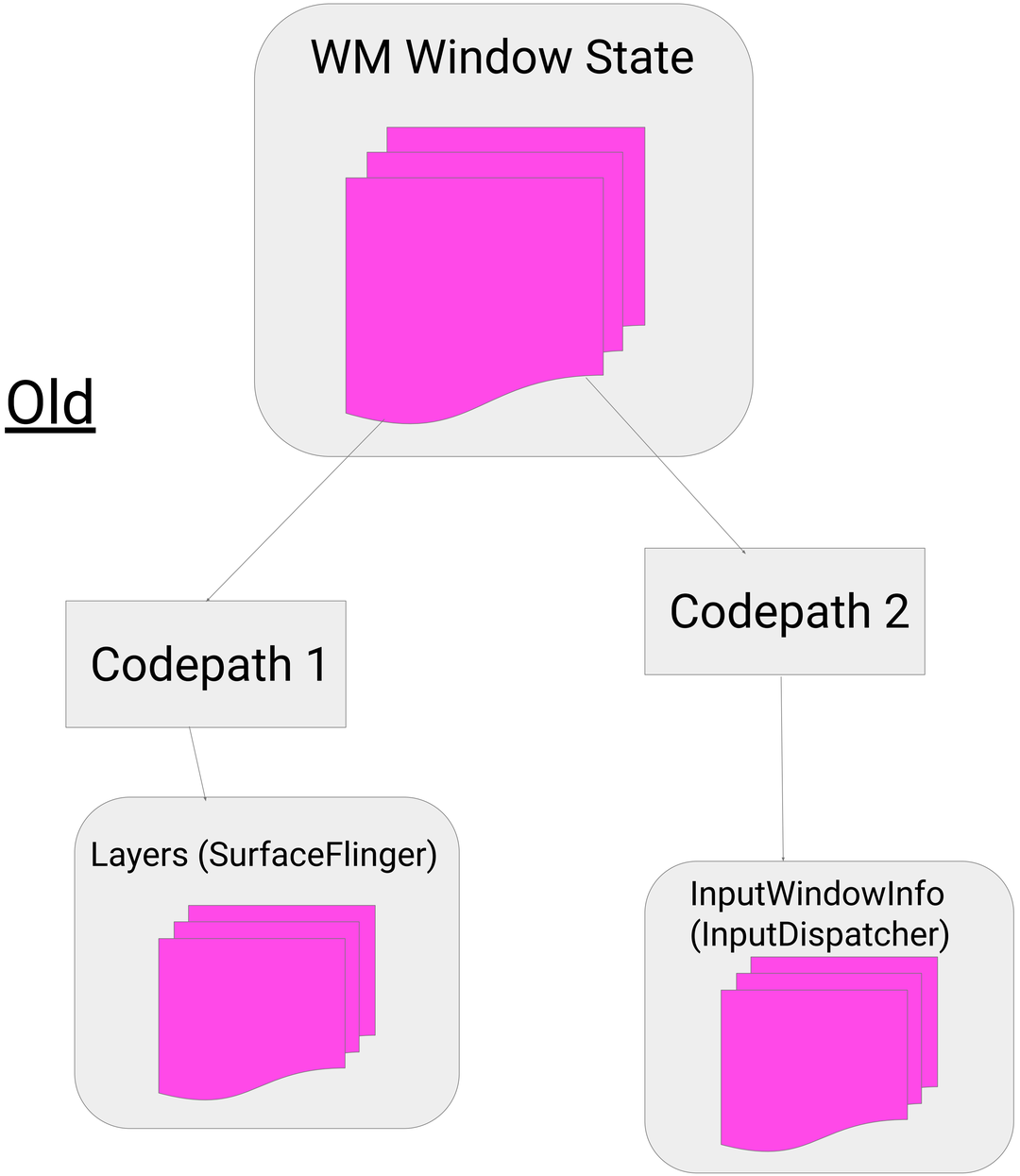
Zero-overhead embedding of activities within view hierarchy.

Based on new implementation of VirtualDisplay which returns a SurfaceControl leash rather than rendering to a surface.

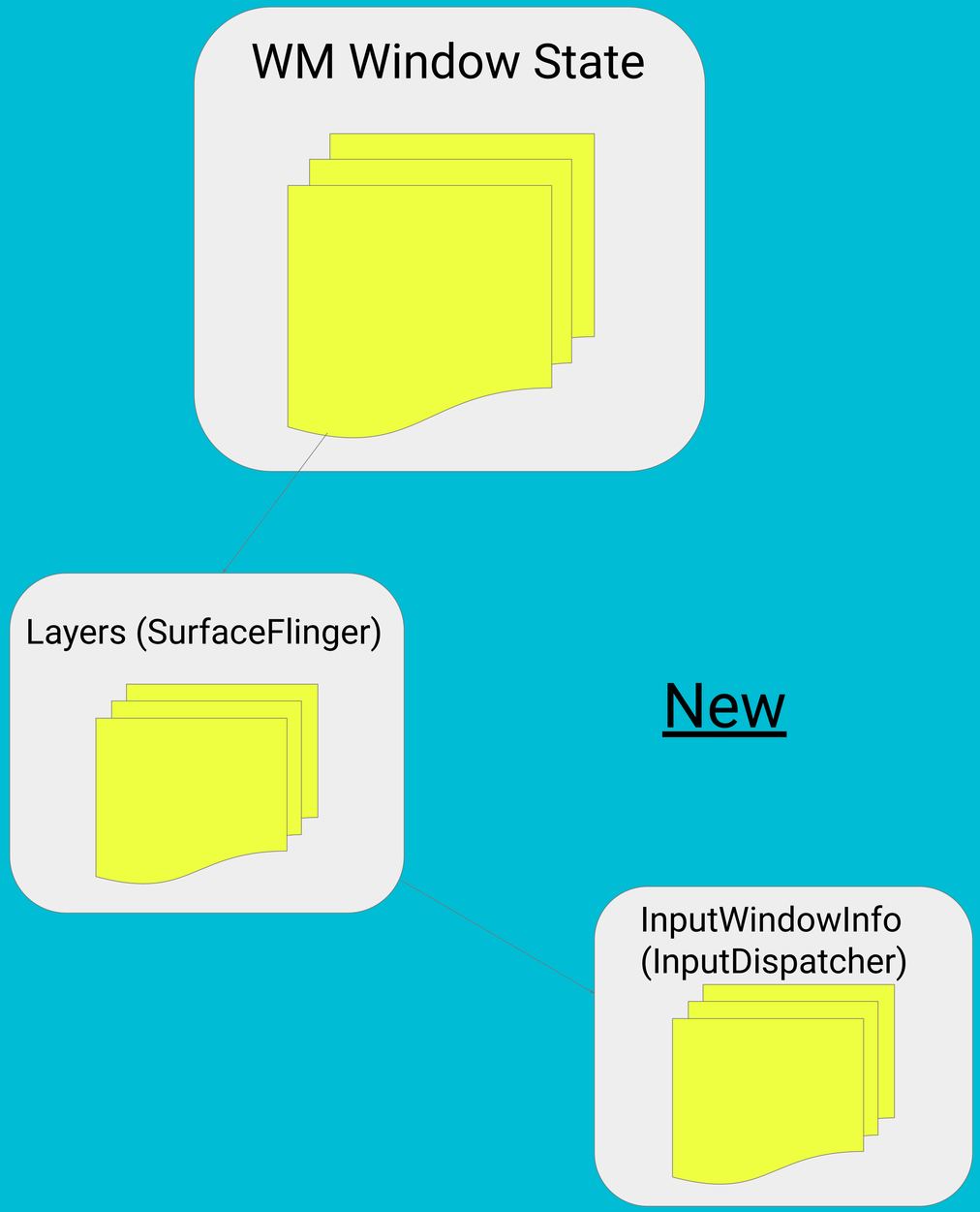


SurfaceFlinger Input

Old



New



Public SurfaceControl API

- Surface control available in SDK and NDK
- Interesting for apps that do a lot of compositing, or have custom lifecycle requirements
- New Buffering API *BLAST* in NDK - lower level than BufferQueue

Improving Debugging

- Nataniel Borges

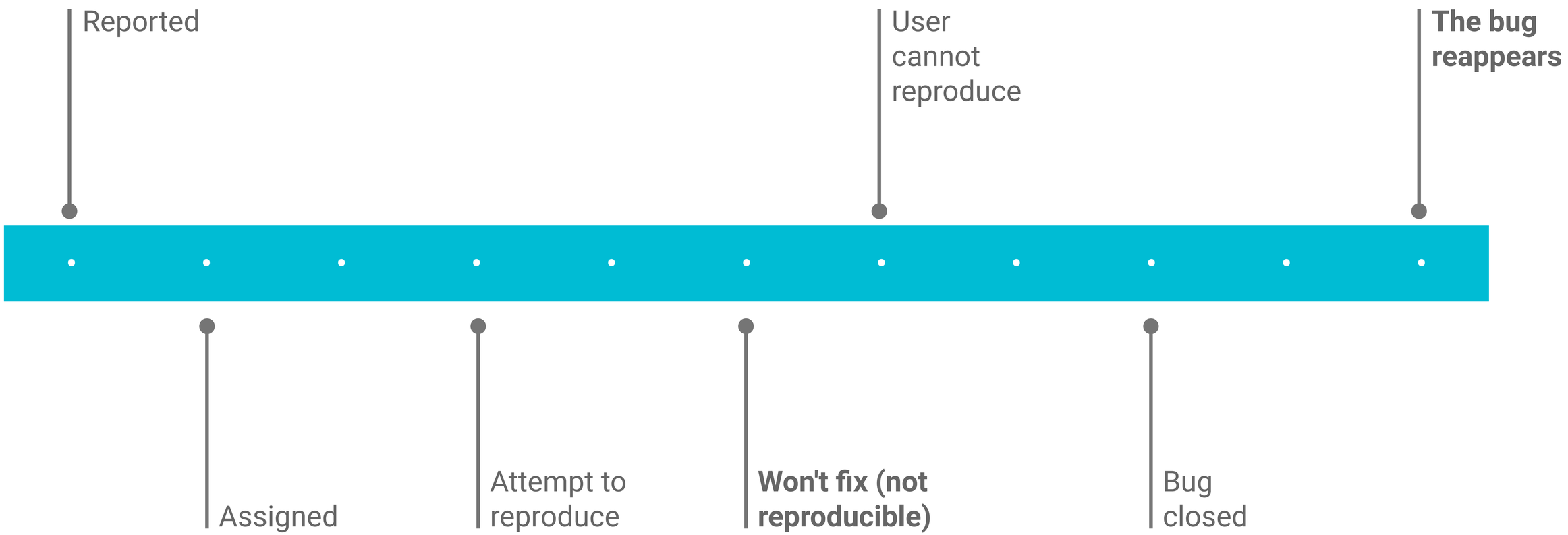
android

Continuous Logging

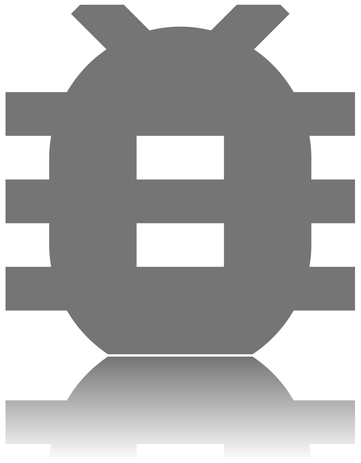
- Nataniel Borges

android

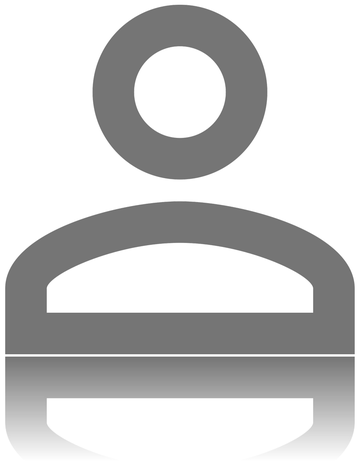
Life of a Bug



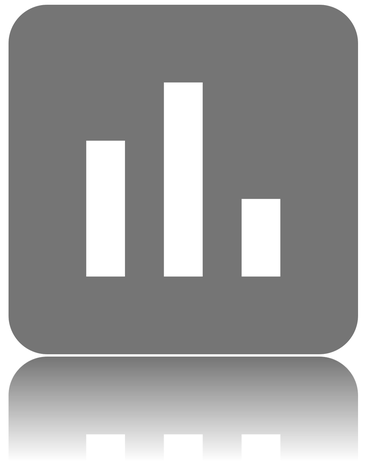
Goal



Traces in all bug reports



No user effort



Minimal overhead

Continuous Logging

Log last WindowManager and SurfaceFlinger states to bug reports

- ~30 seconds
- Minimal overhead
- Only on non-user builds

WindowManager

- WM hierarchy (displays, tasks, apps, windows)
- Animators
- Insets
- Only visible elements

SurfaceFlinger

- SF hierarchy (layers)
- Bounds
- Buffer properties (transform, pixel format)
- All layers

Impact

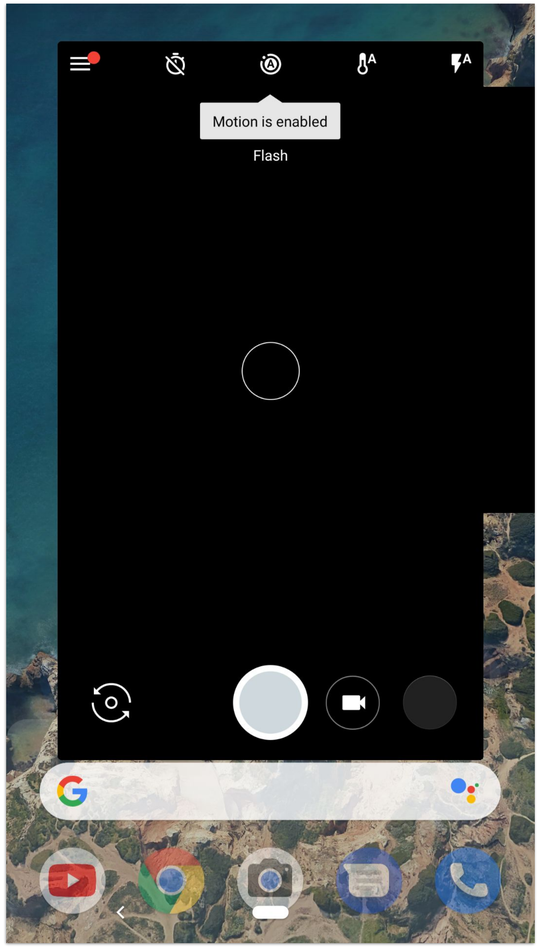
	WindowManager	SurfaceFlinger
Memory	Up to 2MB	Up to 10MB
Performance	~0.4ms Outside critical path	~0.5ms Outside critical path
Battery	0.15% (Average case) 1.15% (Theoretical worst case)	

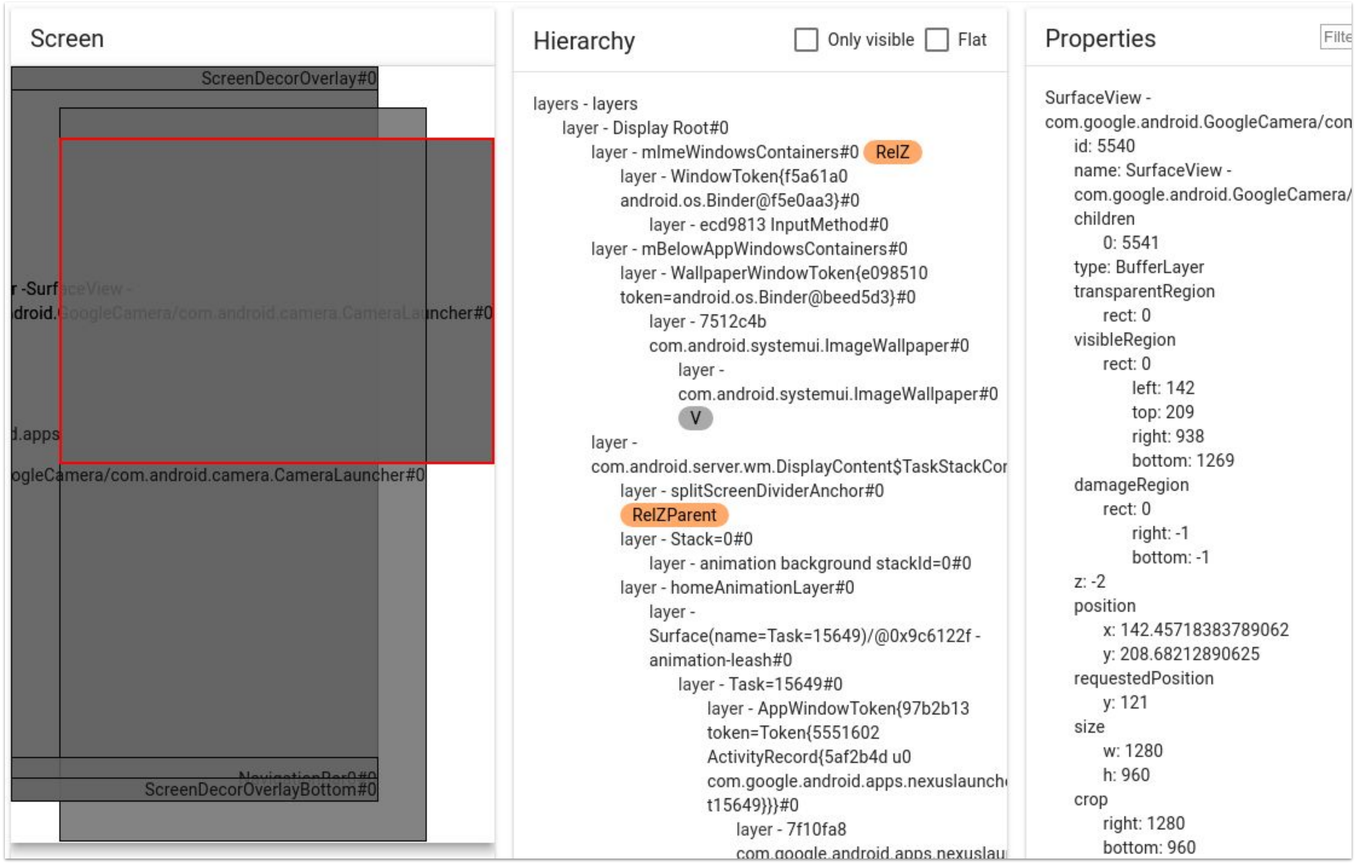
WinScope

- Nataniel Borges

android

WinScope



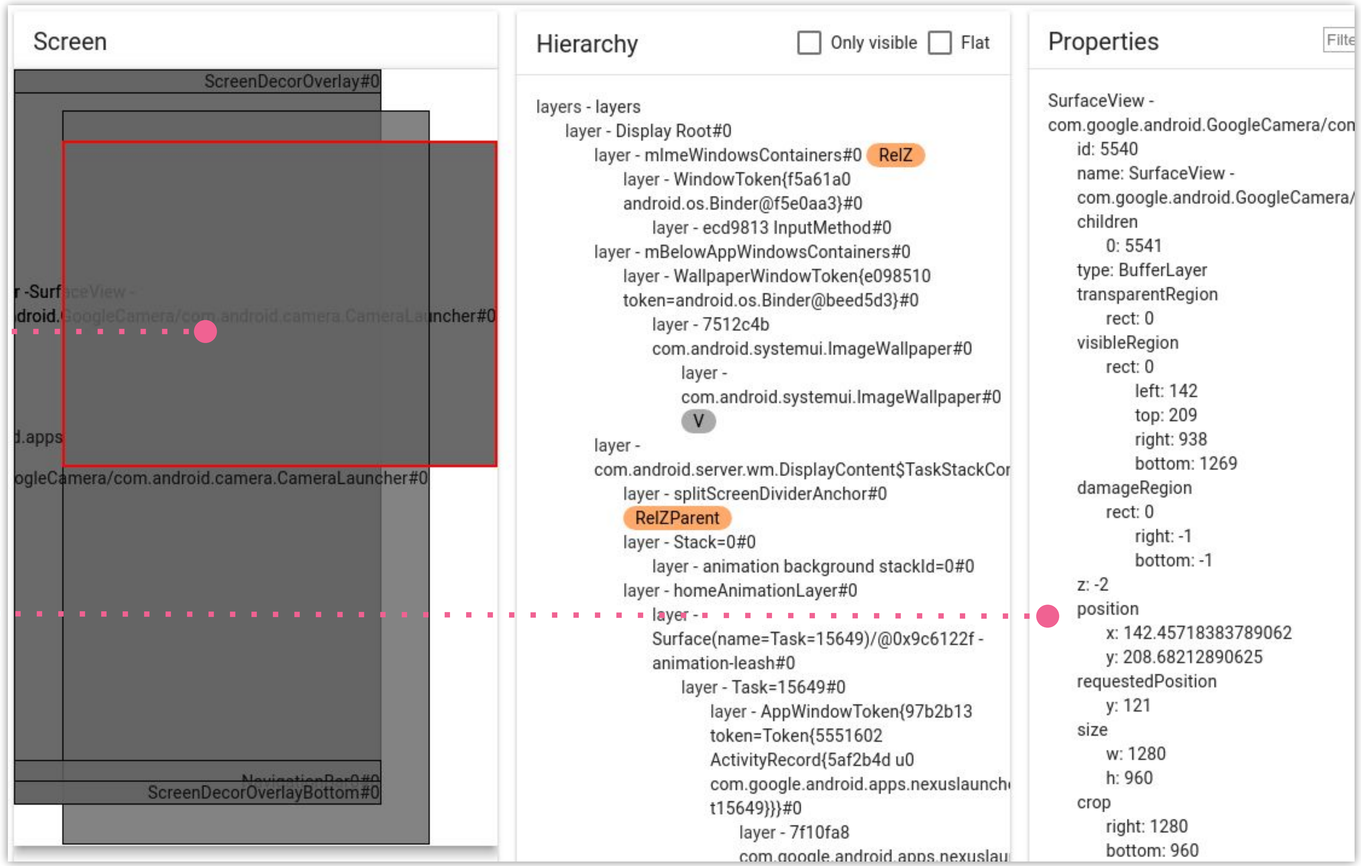


WinScope

View WindowManager and SurfaceFlinger logs

Easily identify errors

Display only changed properties for each element



Intent Playground

- Nataniel Borges

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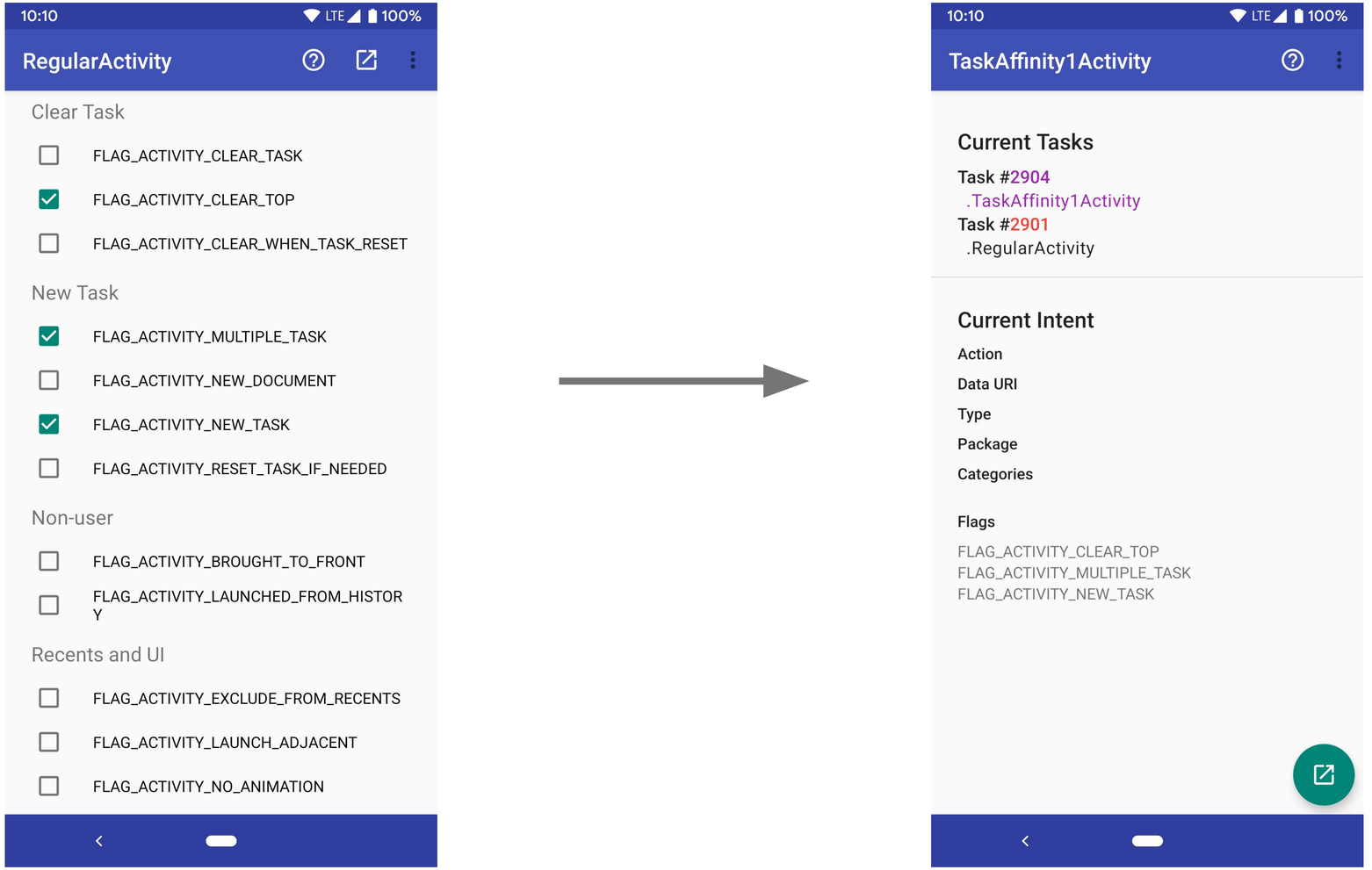
Intent Playground



Q & A

THANK YOU

Up Next...

go/md-foldables-abc-2019