

AAAH!

There is a Leak in my app!!



My Bio

Not that important. (it's in the session :))

Better to know what you do

Java SE? Java EE? Android?

What can I offer?



What can I offer?

- What's a Leak?
- How GC works?
- See Leaky code
 - Find other Leaks
- From Days to Hours
- People be Amazed!

What can I offer?



RoadMap

- Preventing Leaks
 - Hard Leaks
 - GC Pressure
- Finding Leaks
 - Knowing Your App(lication)
 - Heap Dumps (Visual VM)

Preventing Leaks

How They Happen?

How Leaks Happen

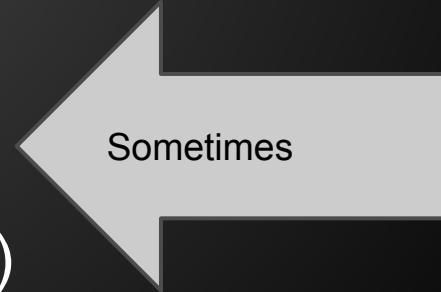


How Leaks Happen

- Unintentionally
 - Hanging Around
- Adding to a Map
 - Never Removing
- Registering a Listener
 - Not Unregistering (lapsed listener)

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Sometimes

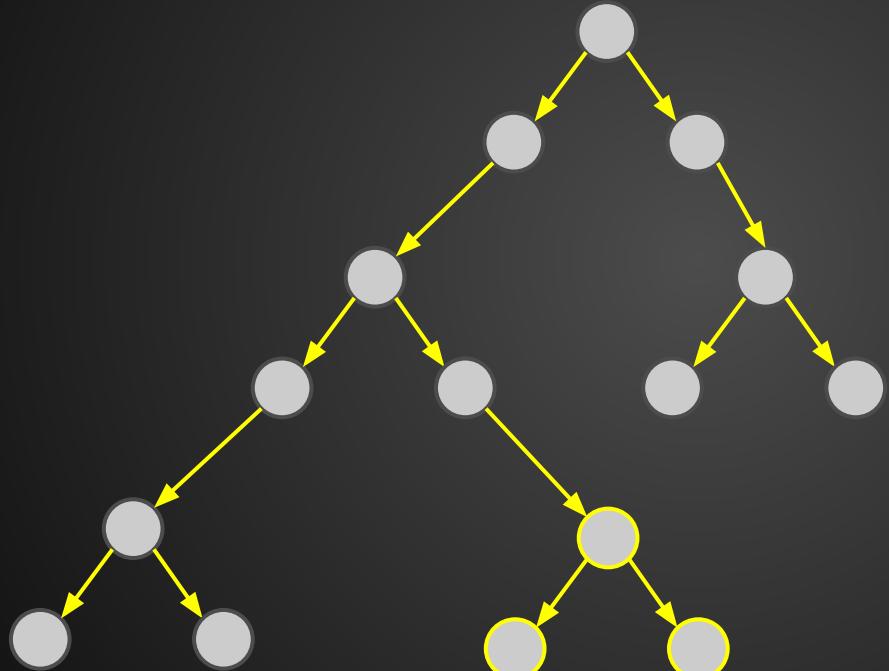
How Leaks Happen



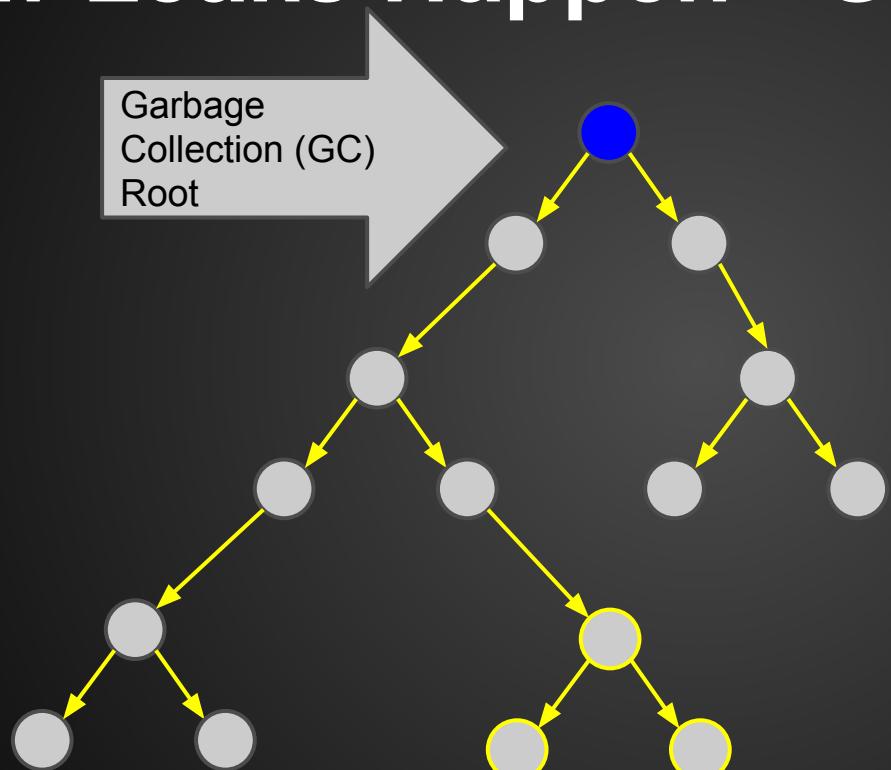
How Leaks Happen

- How GC Works
- Types of References
- (Really) How a Generational GC work

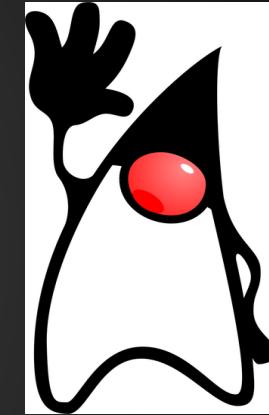
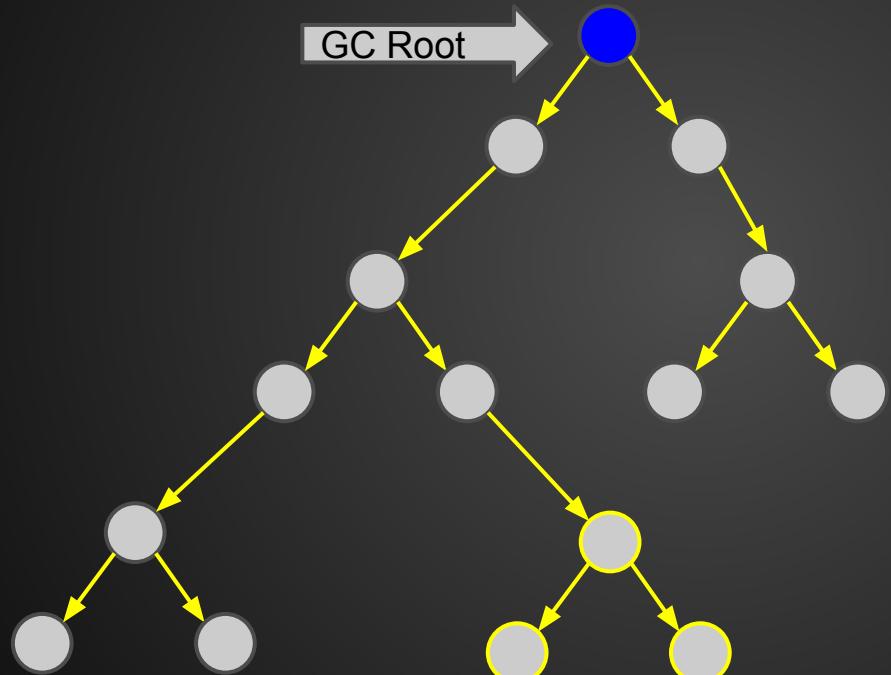
How Leaks Happen - GC



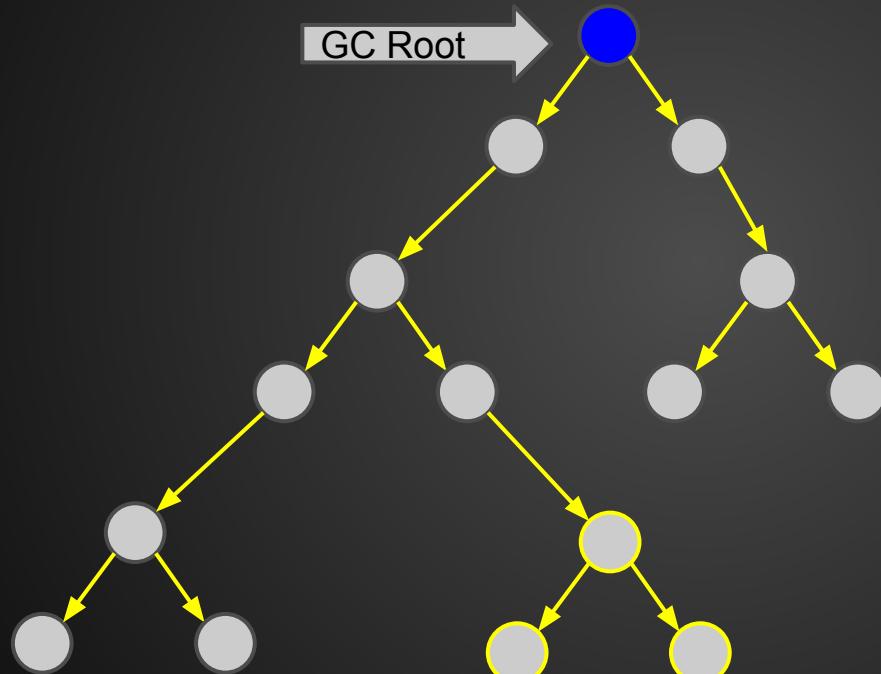
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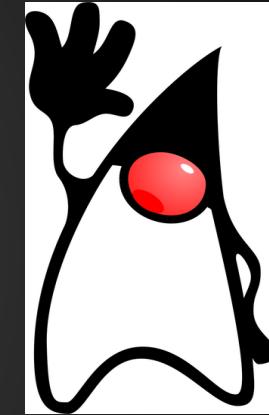
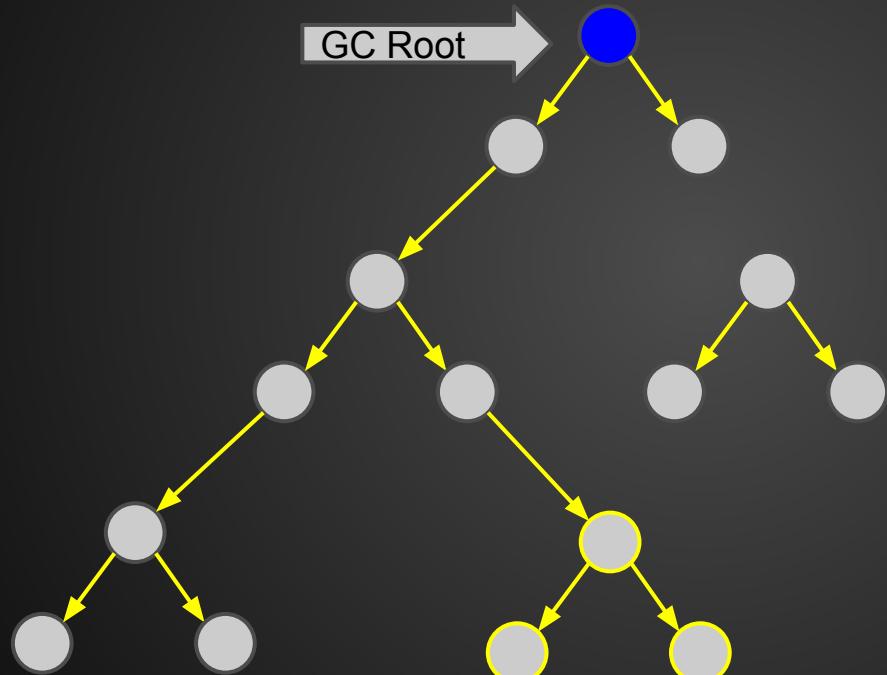
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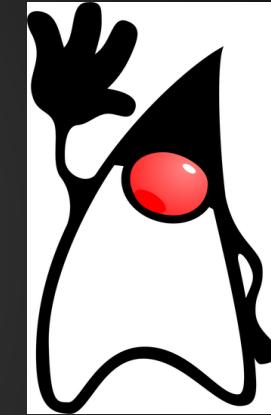
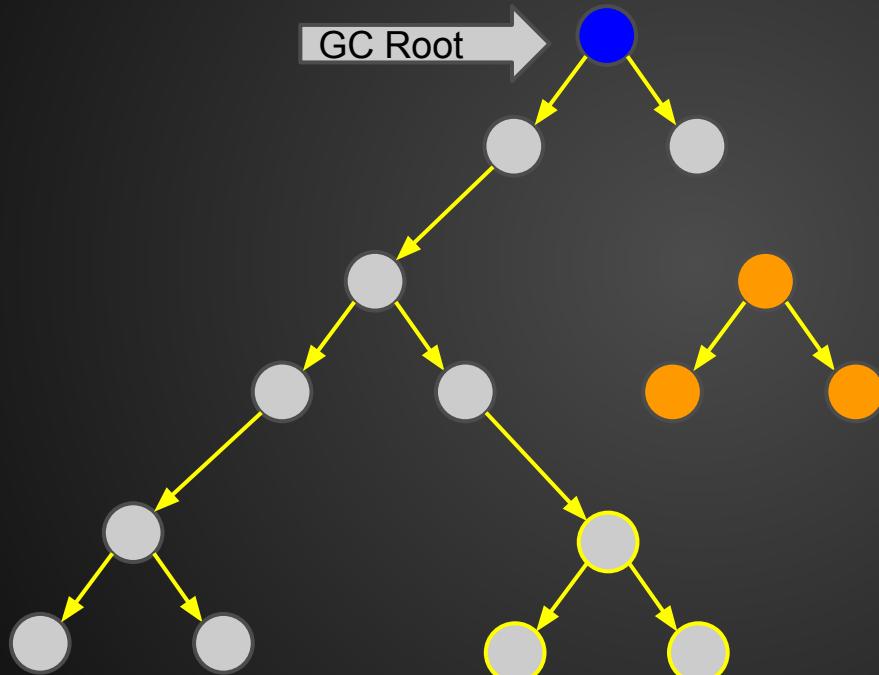
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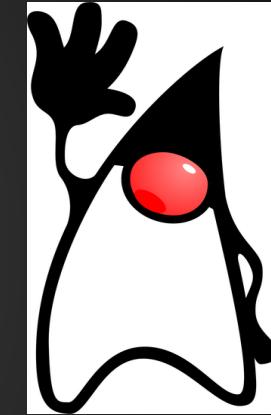
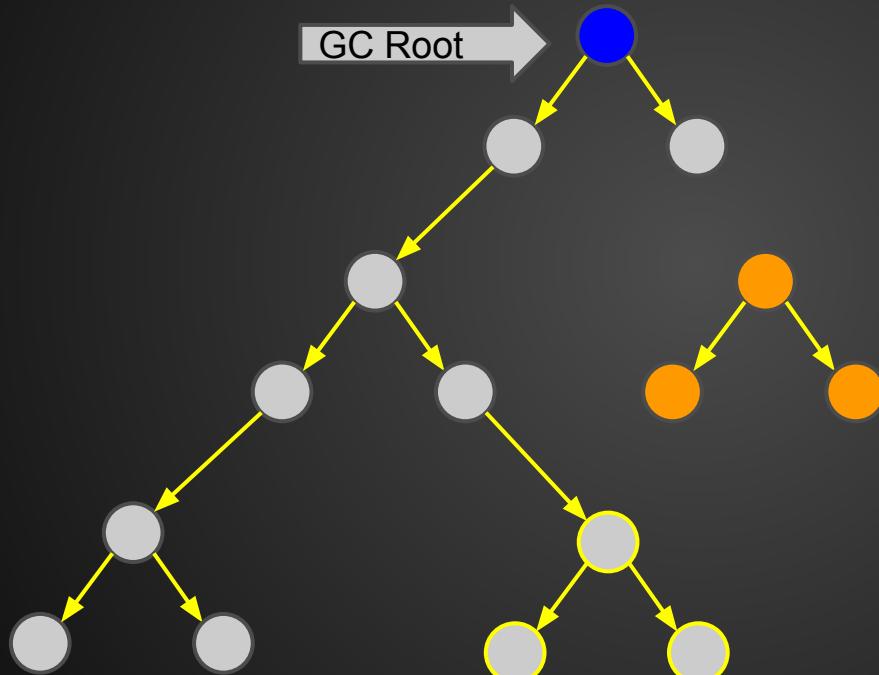
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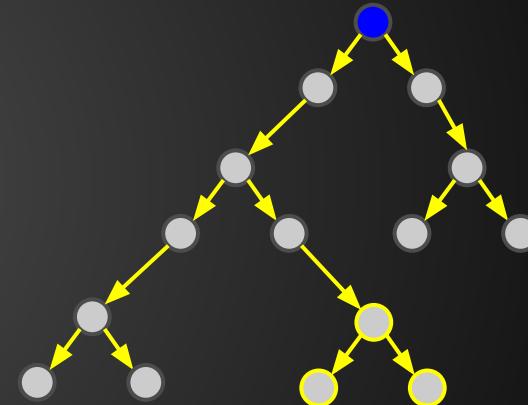
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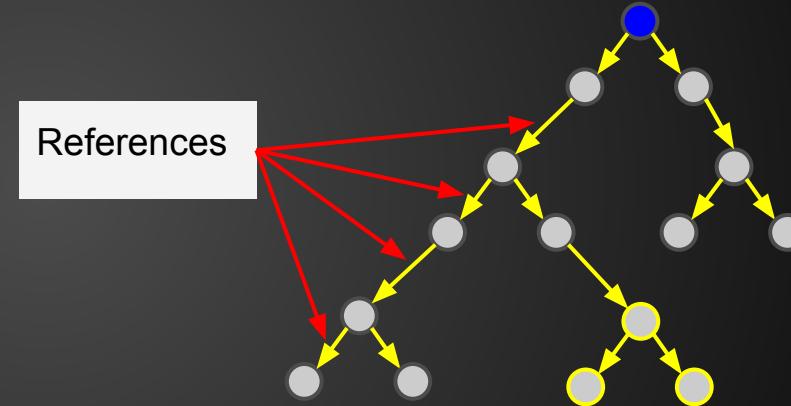
GC Roots?

- Static variables
- Live Threads
- Local variables or params



How Leaks Happen - References

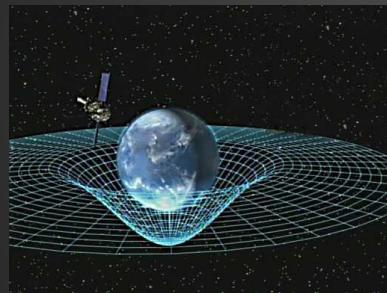
Types of References



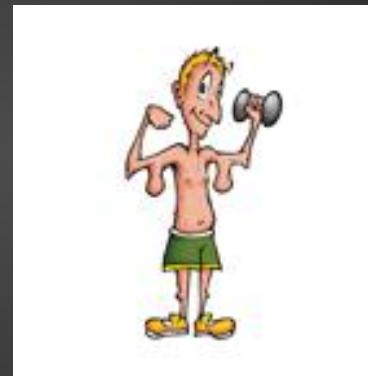
How Leaks Happen - References



STRONG



GRAVITY



WEAK

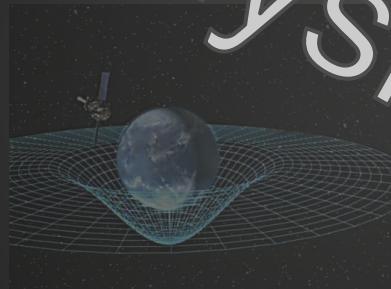


DARK

JEDI Physics Seminar



STRONG



GRAVITY



WEAK



DARK

How Leaks Happen - References



STRONG



SOFT



WEAK



PHANTOM

How Leaks Happen - Strong

```
void myMethod(Object someObject) {  
    this.someObject = someObject  
}
```

```
void addMessage(Message message) {  
    messages.add(message)  
}
```



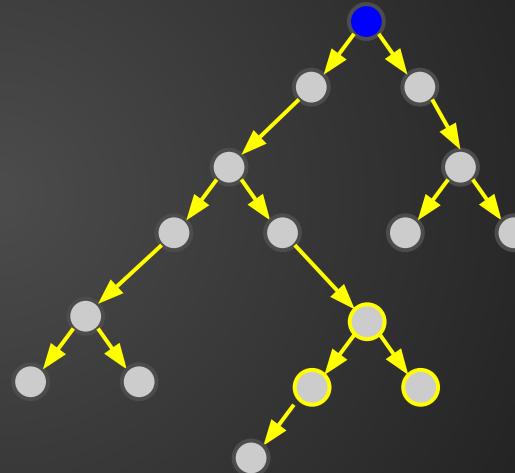
How Leaks Happen - Strong

```
JButton myButton =new JButton("Button # "+number);  
myButton.addActionListener(new ActionListener() {  
    @Override  
    public void actionPerformed(ActionEvent e) {  
        System.out.println("Woohoo! "+number);  
    }  
}) ;
```



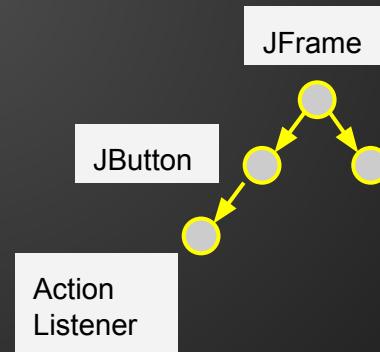
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```



How Leaks Happen - Weak

```
WeakReference<Widget> weakWidget  
    = new WeakReference<Widget>(widget);  
  
...  
  
Widget myWidget = weakWidget.get()  
if (myWidget == null) System.out.println("oh noes");  
  
...  
  
WeakHashMap<Widget, UUID> weakMapByKey;
```



How Leaks Happen - References

- Caching?!



How Leaks Happen - References

- Caching?!



Charlie Hunt



How Leaks Happen - References

- Caching?!



Charlie Hunt

How Leaks Happen - References

- Caching?!
 - Semantics (when/where/which)
 - JVM
 - “You figure it out”
 - Sub-optimal Decision
 - Doesn’t know data



How Leaks Happen - References

- Weak Listeners?!



How Leaks Happen - References

- Weak Listeners?!
 - Changes semantics
 - add
 - not necessarily remove



How Leaks Happen - References

- Weak Listeners?!
 - Changes semantics
 - add
 - not necessarily remove
 - Side effects may include...



How Leaks Happen - References

- For WHAT??!?!?!
- Canonical Maps
 - Many users share Address
 - User Key, Address Value



How Leaks Happen - References

- For WHAT??!?!?!

 - Canonical Maps
 - Many users share Address
 - User Key, Address Value

- Could be resurrected
 - finalize() block



How Leaks Happen - References

Soft

- Till the bitter end!



Phantom

- Never there
 - Keep track of when enqueued
 - cannot be resurrected



How Leaks Happen - Memory Press.

Memory Pressure

- What is it?

How Leaks Happen - Memory Press.

Memory Pressure

- Smells like a leak
- Looks like a leak

How Leaks Happen - Memory Press.

Memory Pressure

- Smells like a leak
- Looks like a leak
- Disappears!

How Leaks Happen - Memory Press.

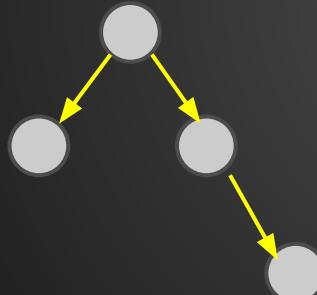
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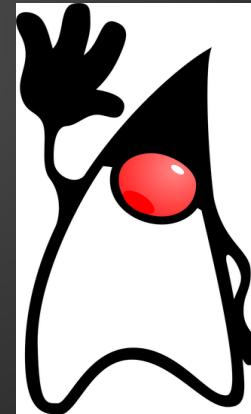
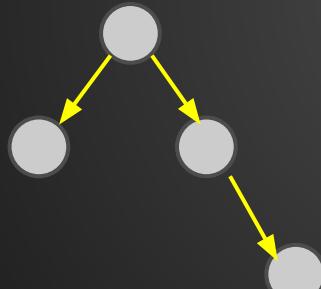
- Generational GC's



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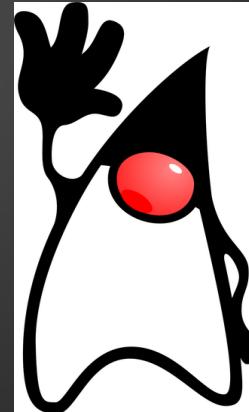
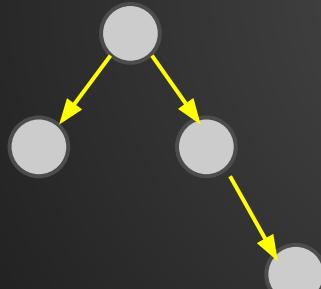
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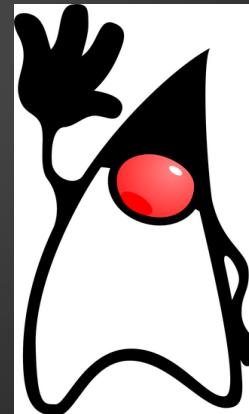
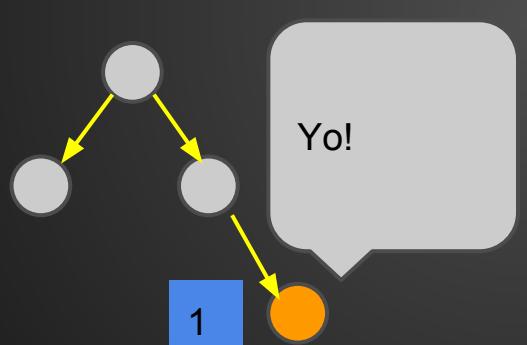


Wassup!

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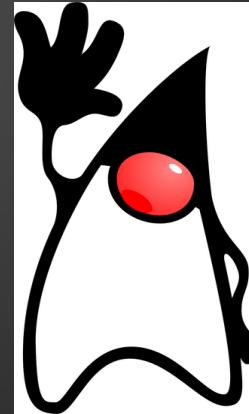
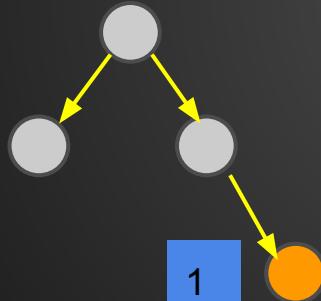
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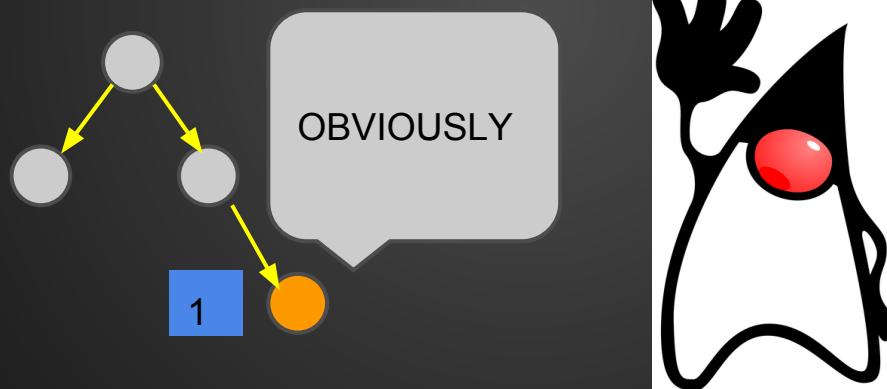


Are you still
Strongly
Referenced?

How Leaks Happen - Memory Press.

Memory Pressure

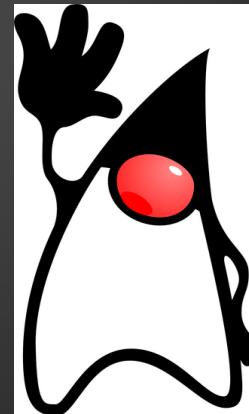
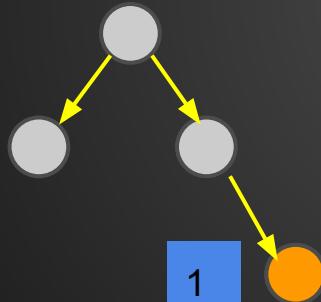
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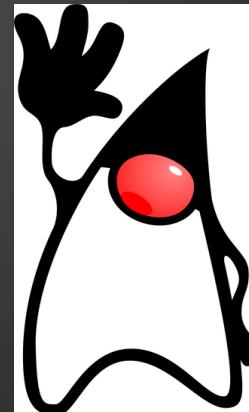
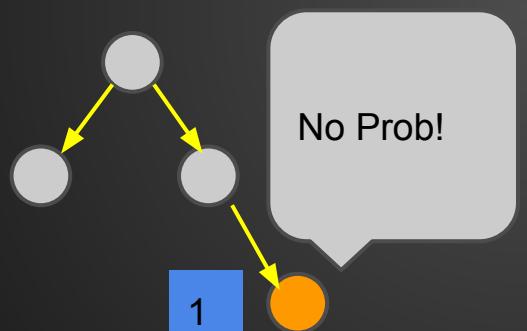


kk... just
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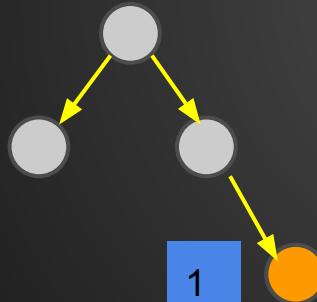
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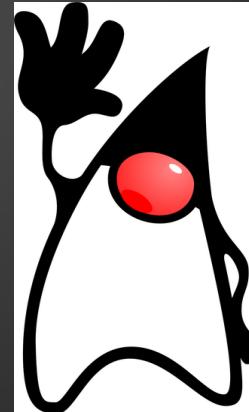
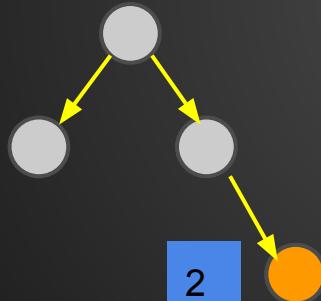
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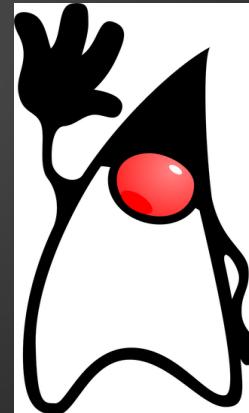
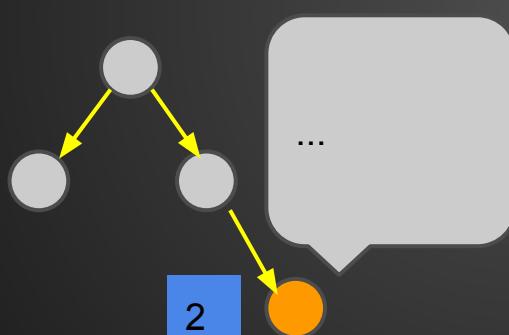


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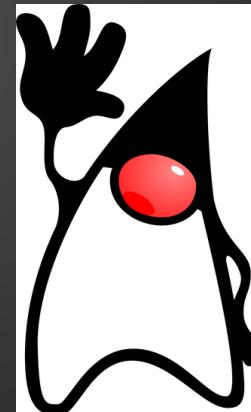
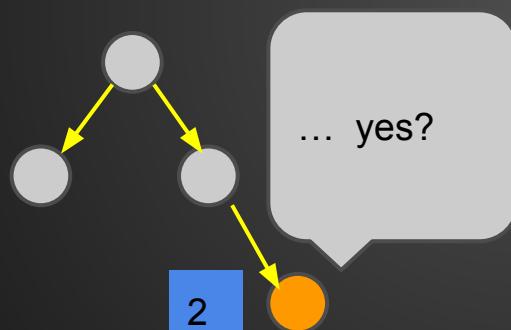
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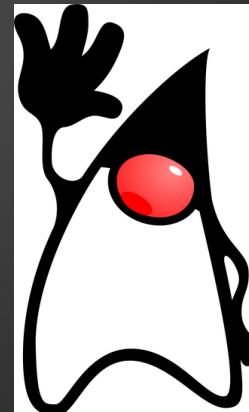
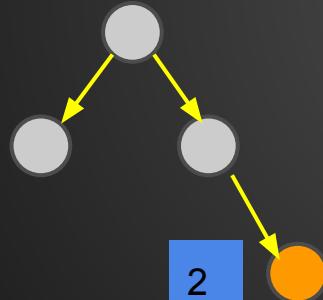
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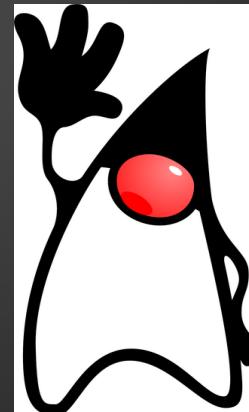
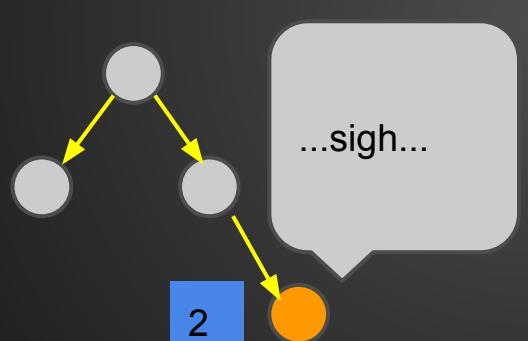


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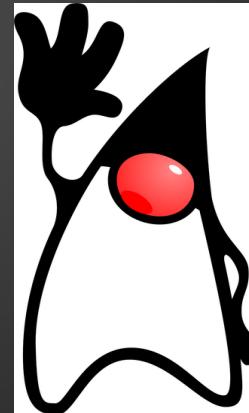
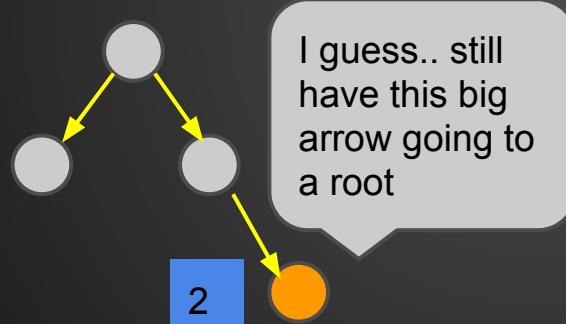
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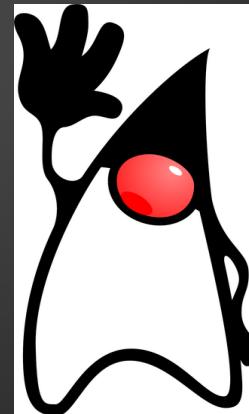
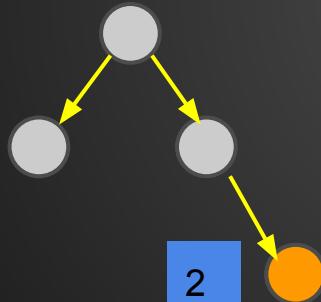
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How Leaks Happen - Memory Press.

Memory Pressure

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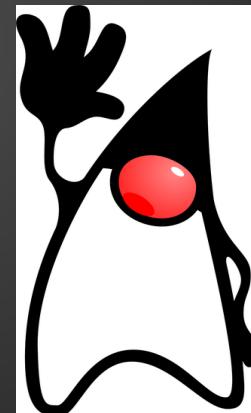
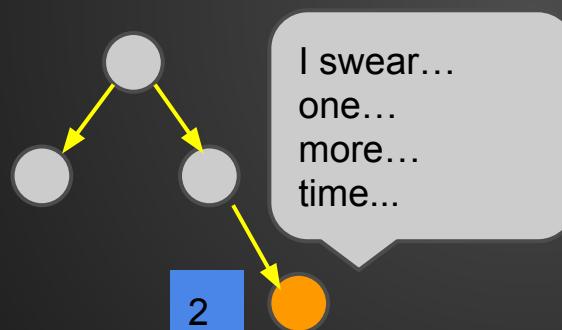


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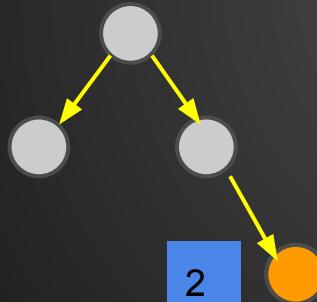
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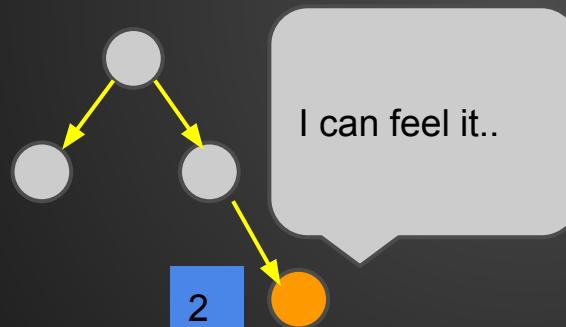
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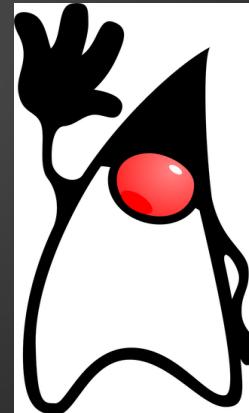
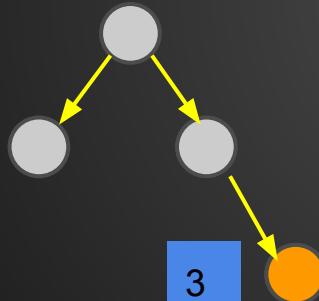
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How Leaks Happen - Memory Press.

Memory Pressure

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Wassup!

How Leaks Happen - Memory Press.

Memory Pressure

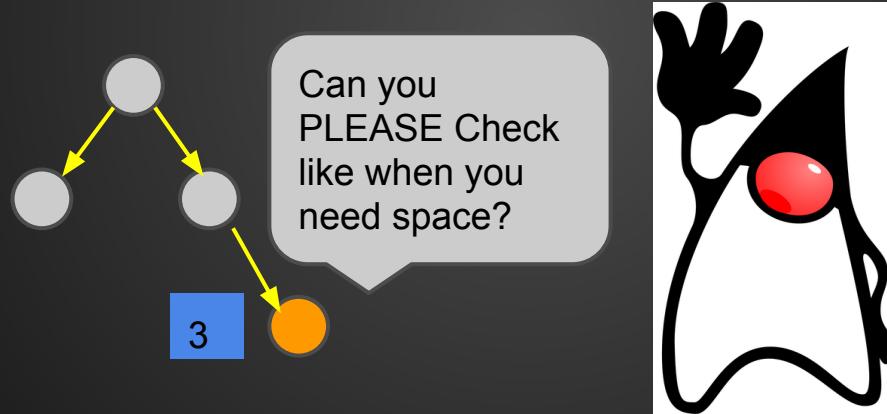
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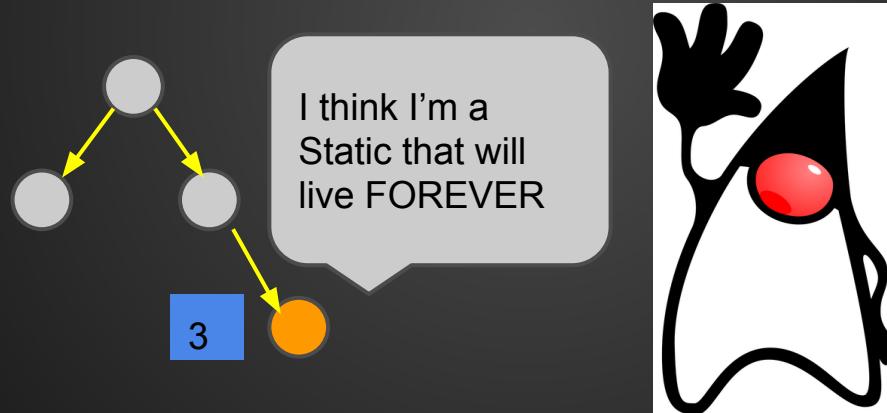
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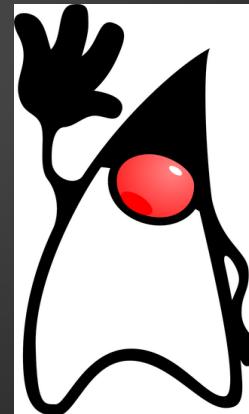
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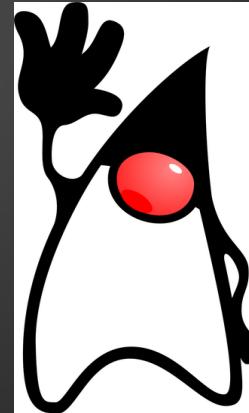
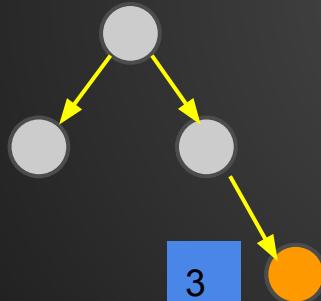
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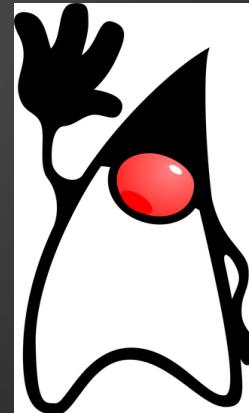
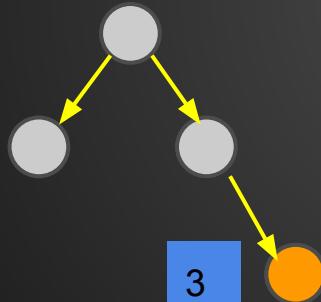


Ah, you're one of
them fancy **Tenured**
Objects

How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

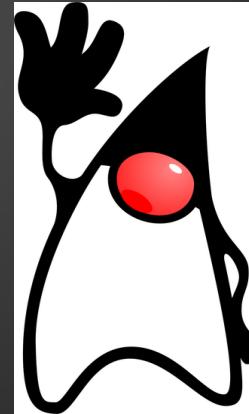
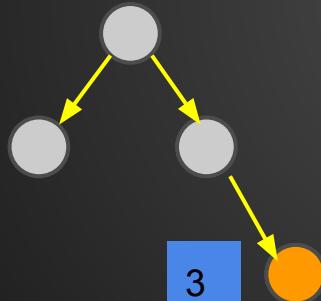


Cool beans dude, I'll move you to a tenured region

How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

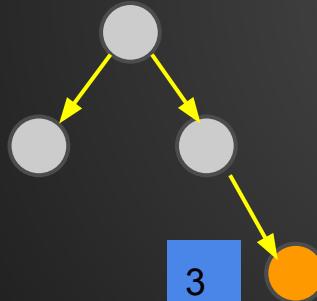


Only if we need the space I'll ask you.

How Leaks Happen - Memory Press.

Memory Pressure

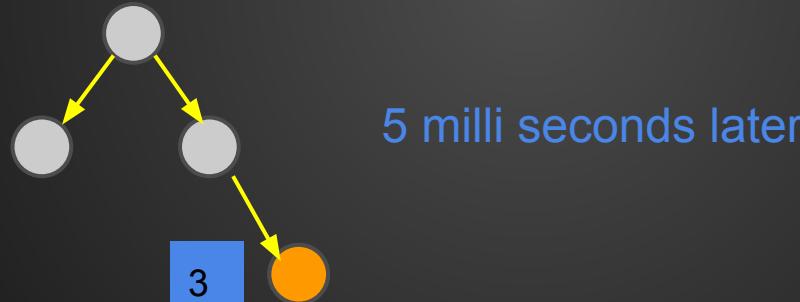
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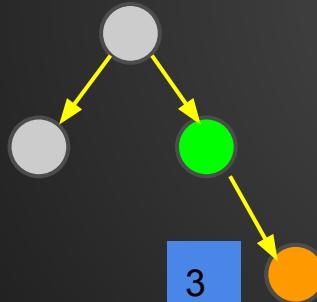
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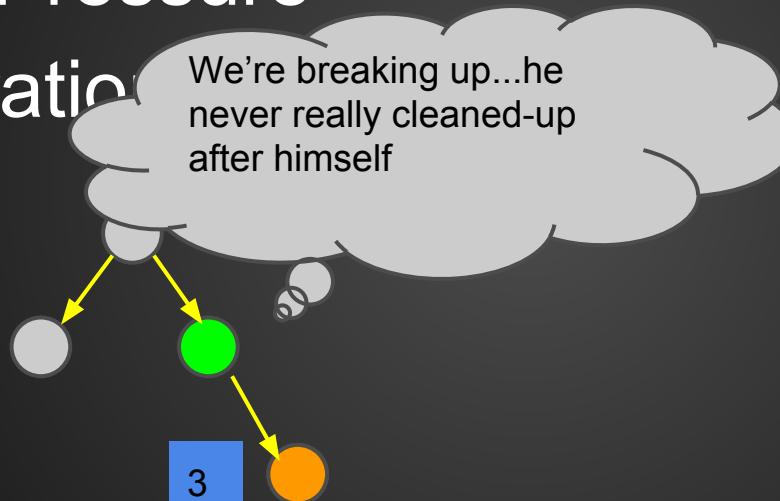
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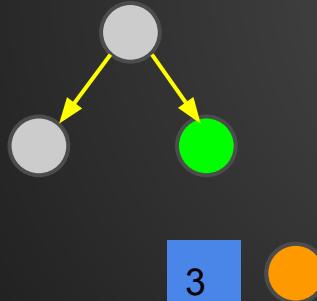
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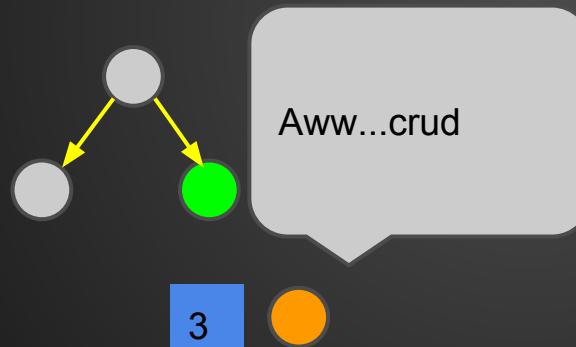
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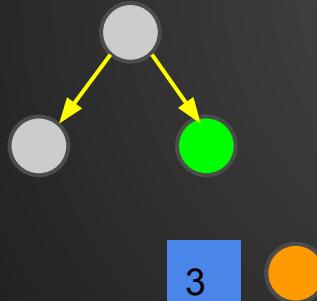
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How Leaks Happen - Memory Press.

Memory Pressure

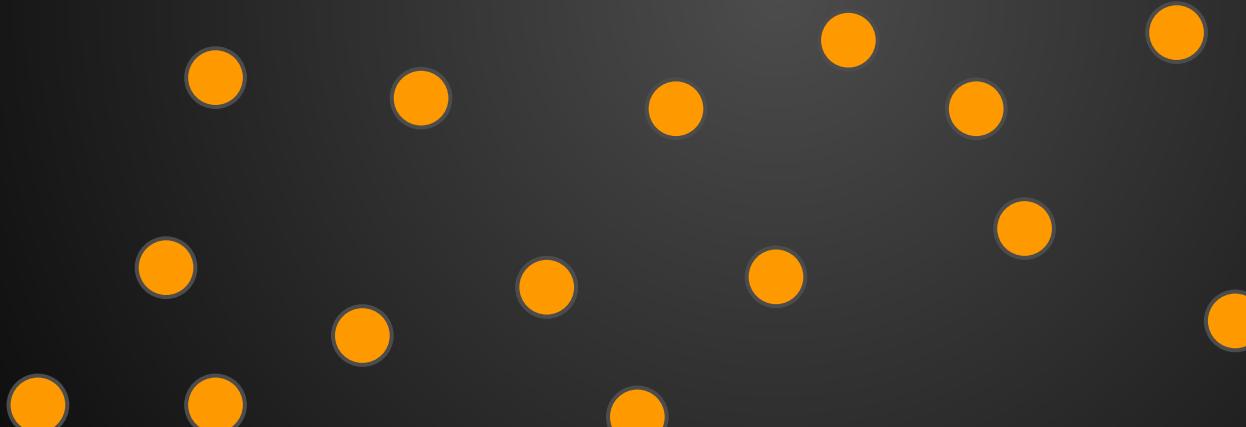
- Generational GC's



How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

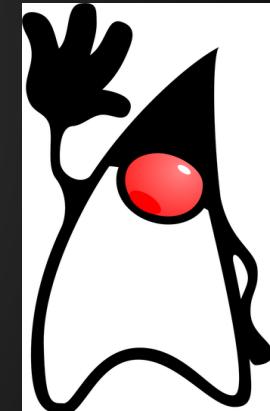
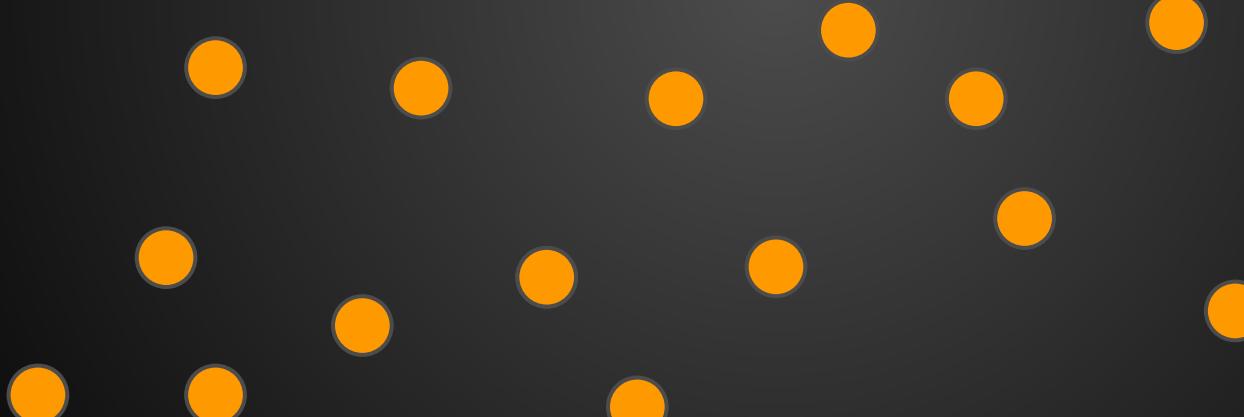


How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

Hey Guys,
I don't want
to be a
bother

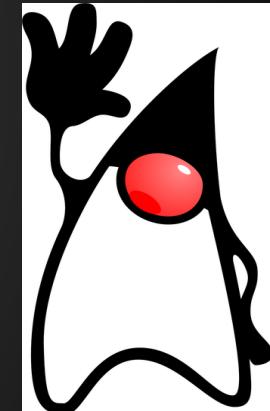


How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

But it seems
we don't
have a lot of
space

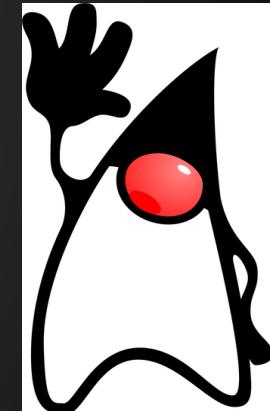
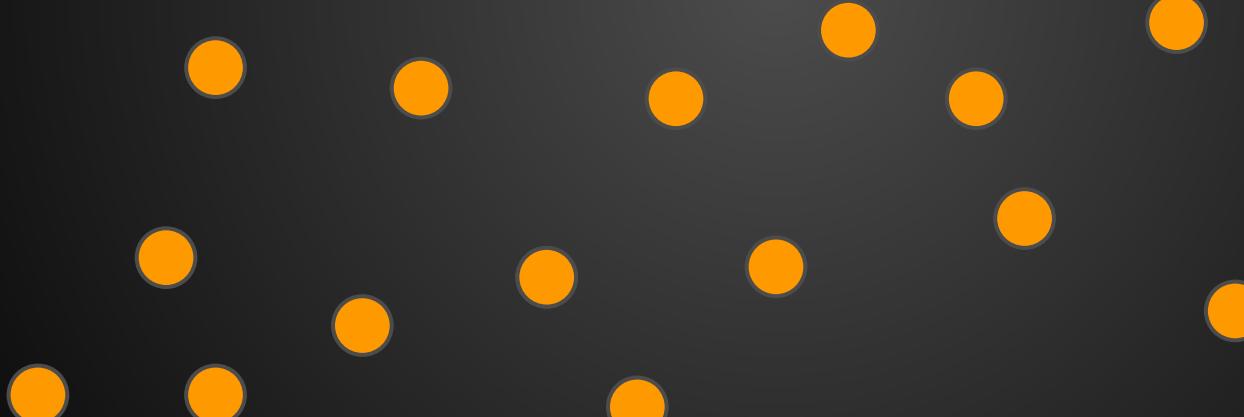


How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

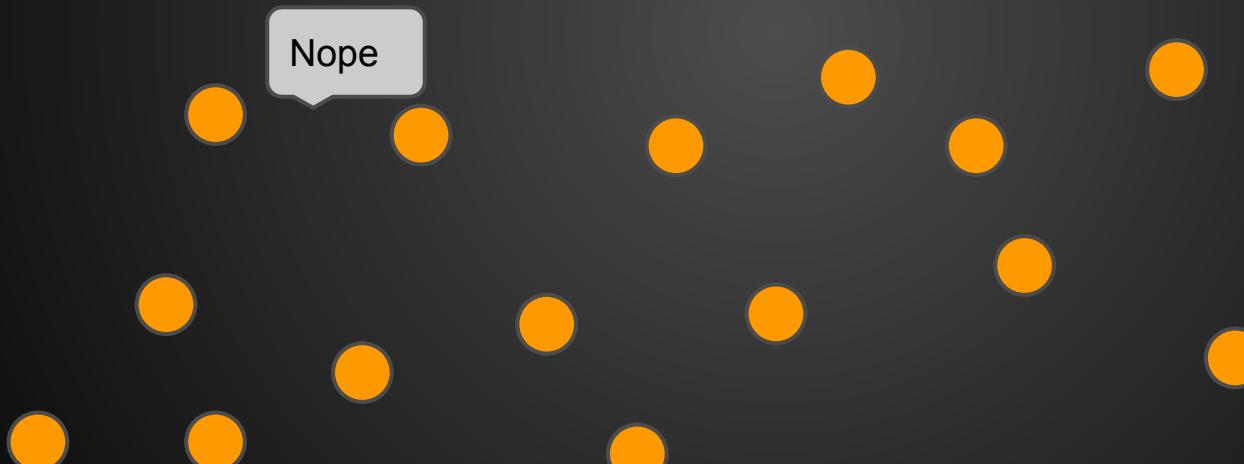
Are any of
you still
STRONGLY
referenced?



How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's



How Leaks Happen - Memory Press.

Memory Pressure

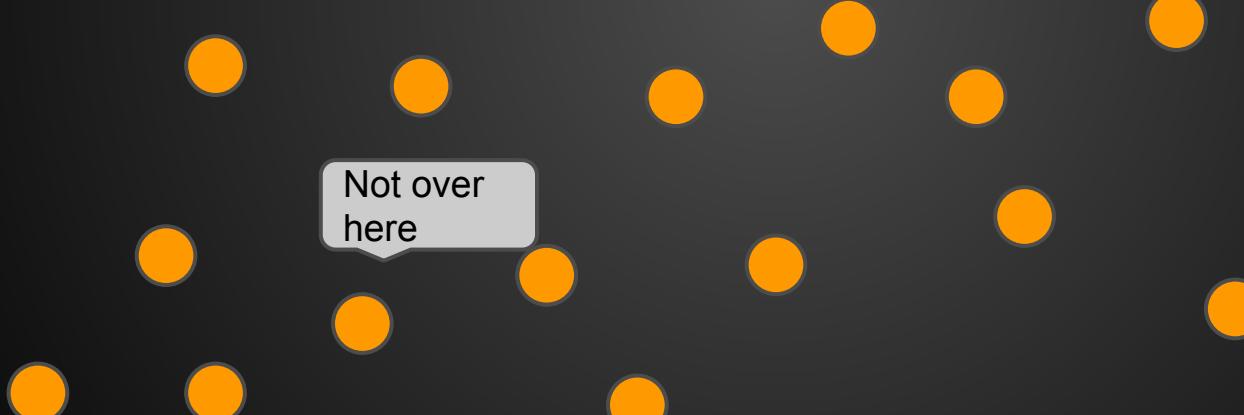
- Generational GC's



How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

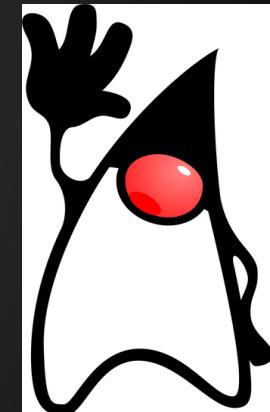
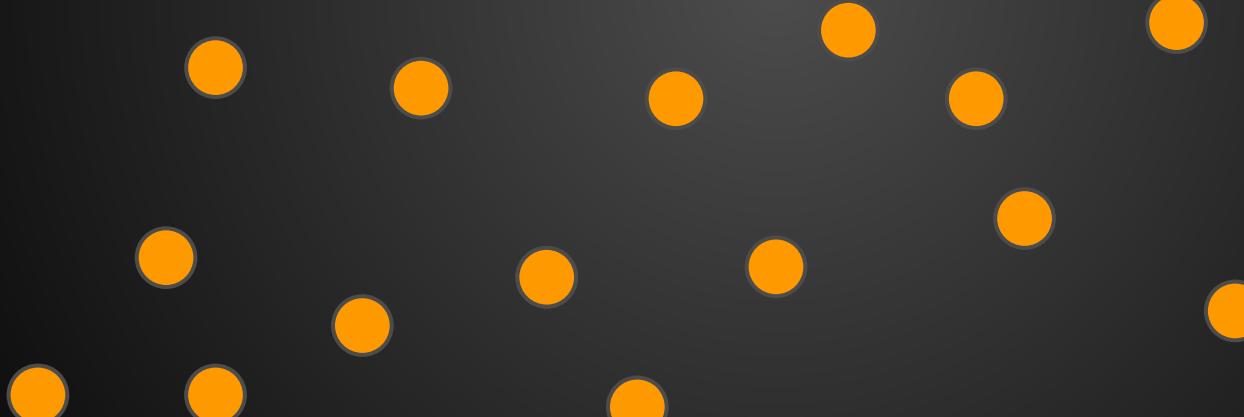


How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

K, This will take a while but I need to finalize

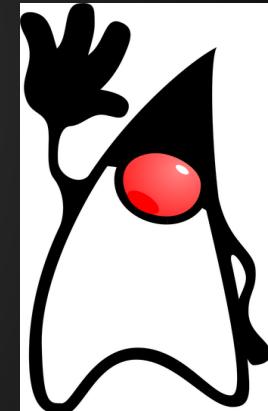


How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's

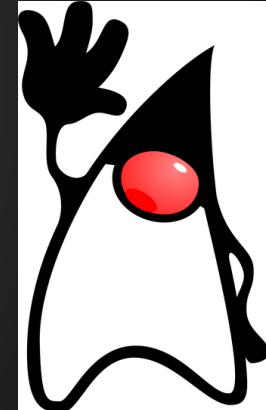
and dispose
of all of you



How Leaks Happen - Memory Press.

Memory Pressure

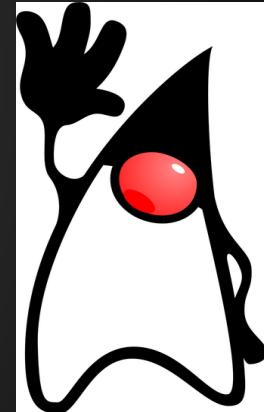
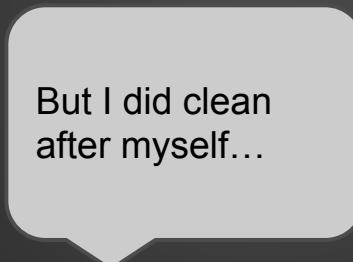
- Generational GC's



How Leaks Happen - Memory Press.

Memory Pressure

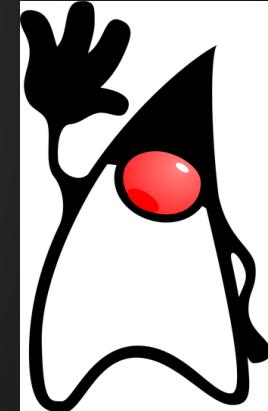
- Generational GC's



How Leaks Happen - Memory Press.

Memory Pressure

- Generational GC's



How Leaks Happen - Memory Press.

Memory Pressure

- Most - Short lived
 - Parameters
 - counters for loops
 - Intermediate variables
- Don't survive eden

How Leaks Happen - Memory Press.

Memory Pressure

- Some
 - Survive just enough (Orange)

How Leaks Happen - Memory Press.

Memory Pressure

- Some
 - Survive just enough (Orange)
 - Shuffled around
 - till the full GC

How Leaks Happen - Memory Press.

Memory Pressure

- Some
 - Survive just enough (Orange)
 - Shuffled around
 - till the full GC
- Is it a leak?

How Leaks Happen - Memory Press.

Memory Pressure

- Some
 - Survive just enough (Orange)
 - Shuffled around
 - till the full GC
- Is it a leak?
 - technically no

How Leaks Happen - Memory Press.

Memory Pressure

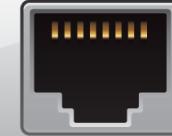
- Some
 - Survive just enough (Orange)
 - Shuffled around
 - till the full GC
- Is it a leak?
 - technically no
 - Leak-like symptoms
 - Long + more frequent Full GC pauses

How Leaks Happen - Memory Press.

I get it...
But how?

How Leaks Happen - Memory Press.

CACHE

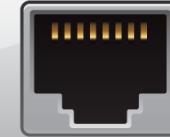


How Leaks Happen - Memory Press.

CACHE



THEO VALUES



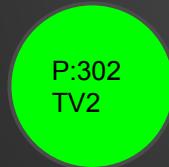
How Leaks Happen - Memory Press.

CACHE

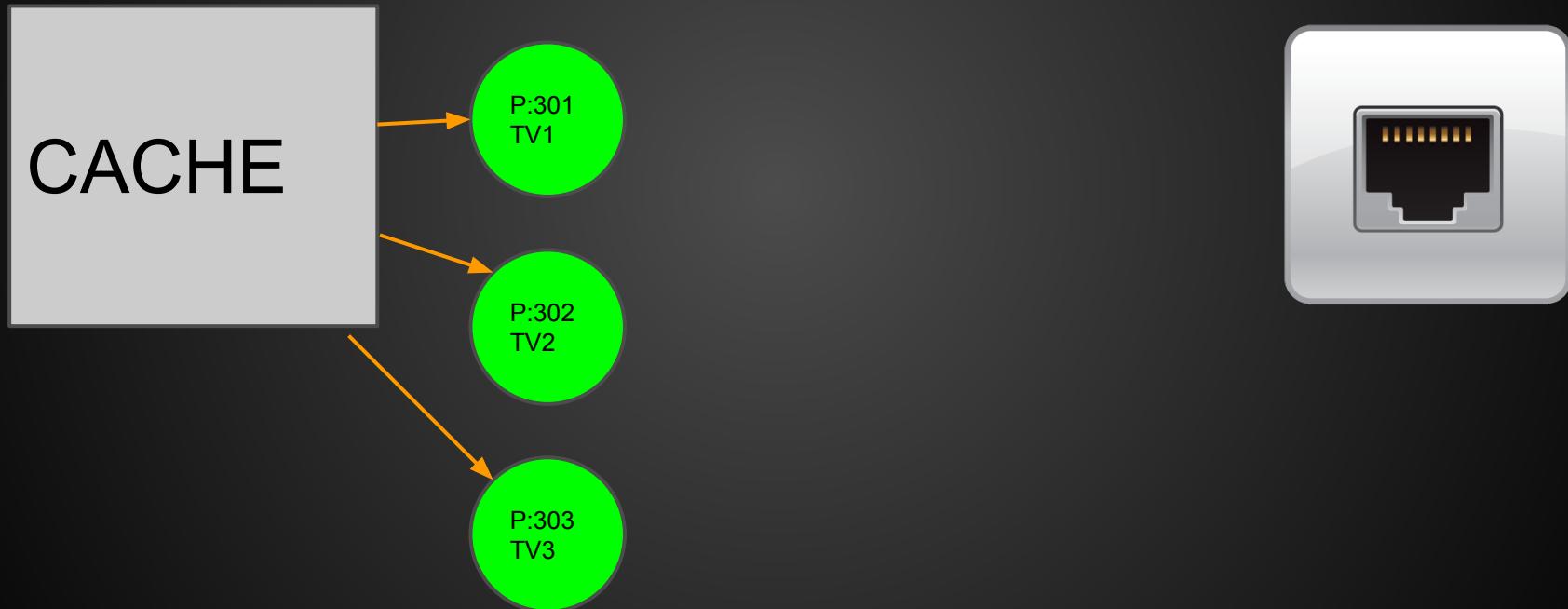


How Leaks Happen - Memory Press.

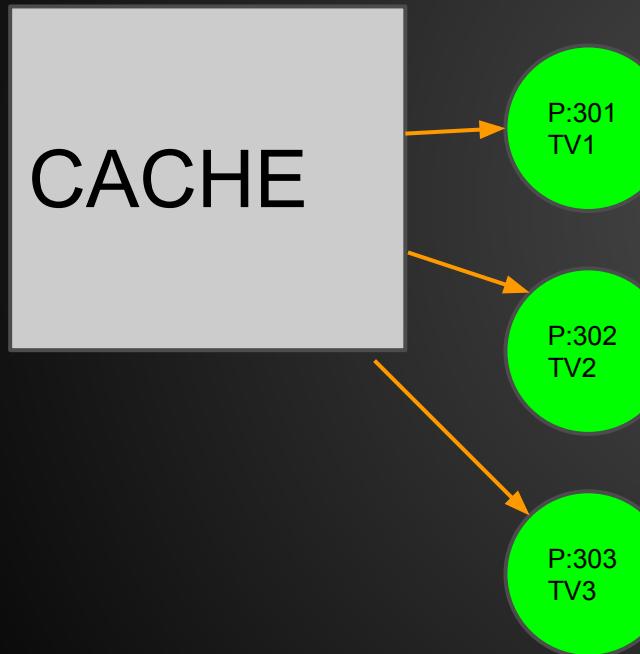
CACHE



How Leaks Happen - Memory Press.

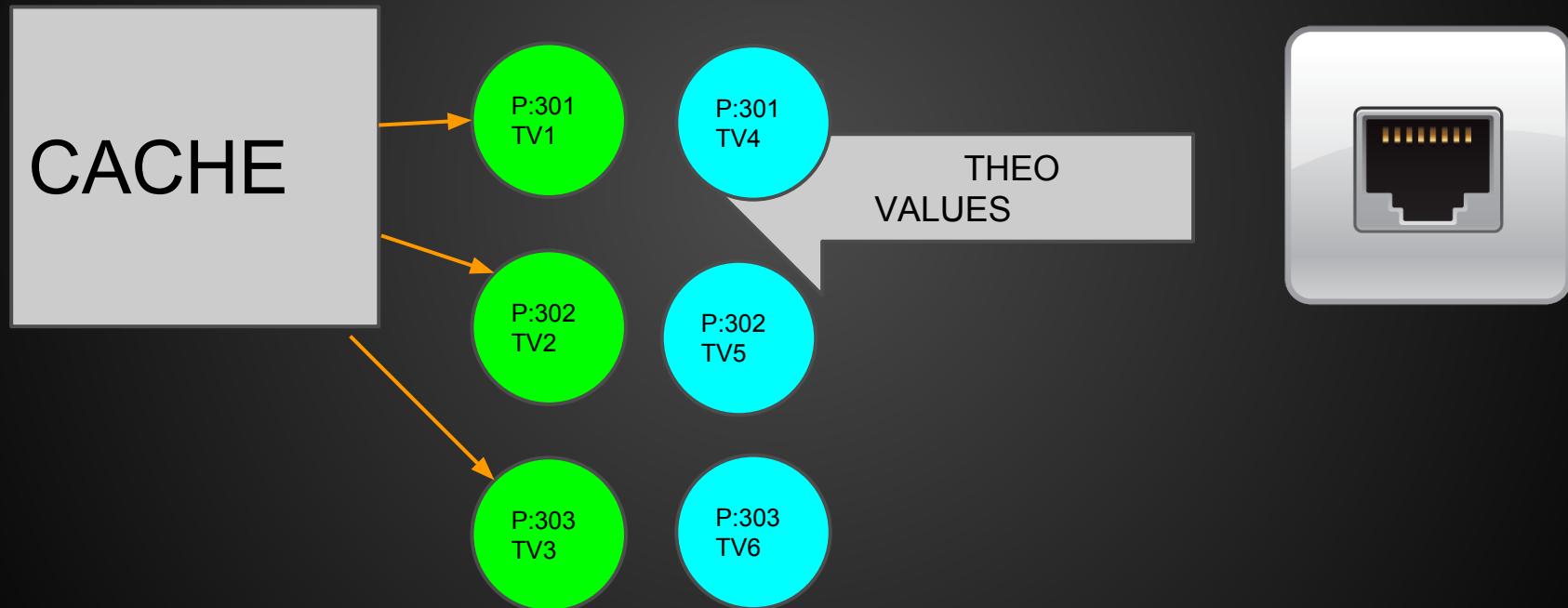


How Leaks Happen - Memory Press.

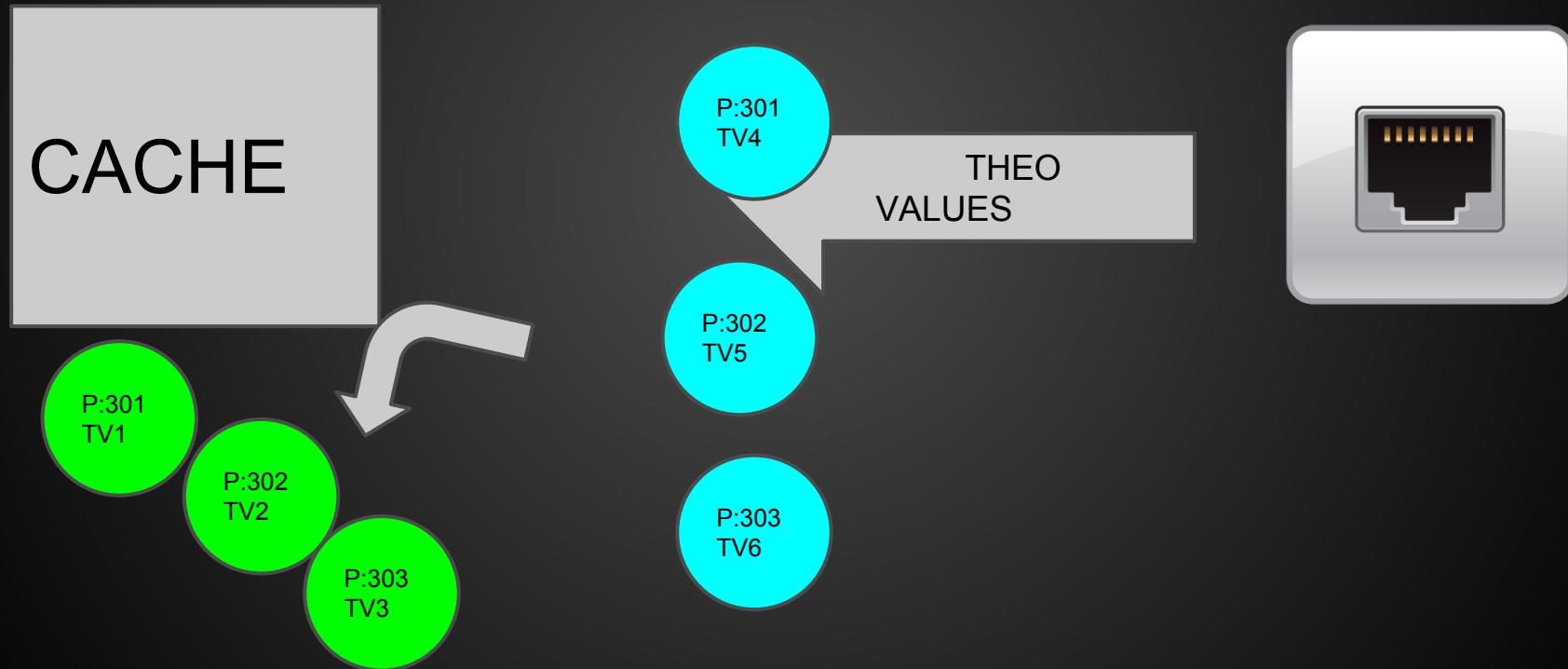


3:00 PM

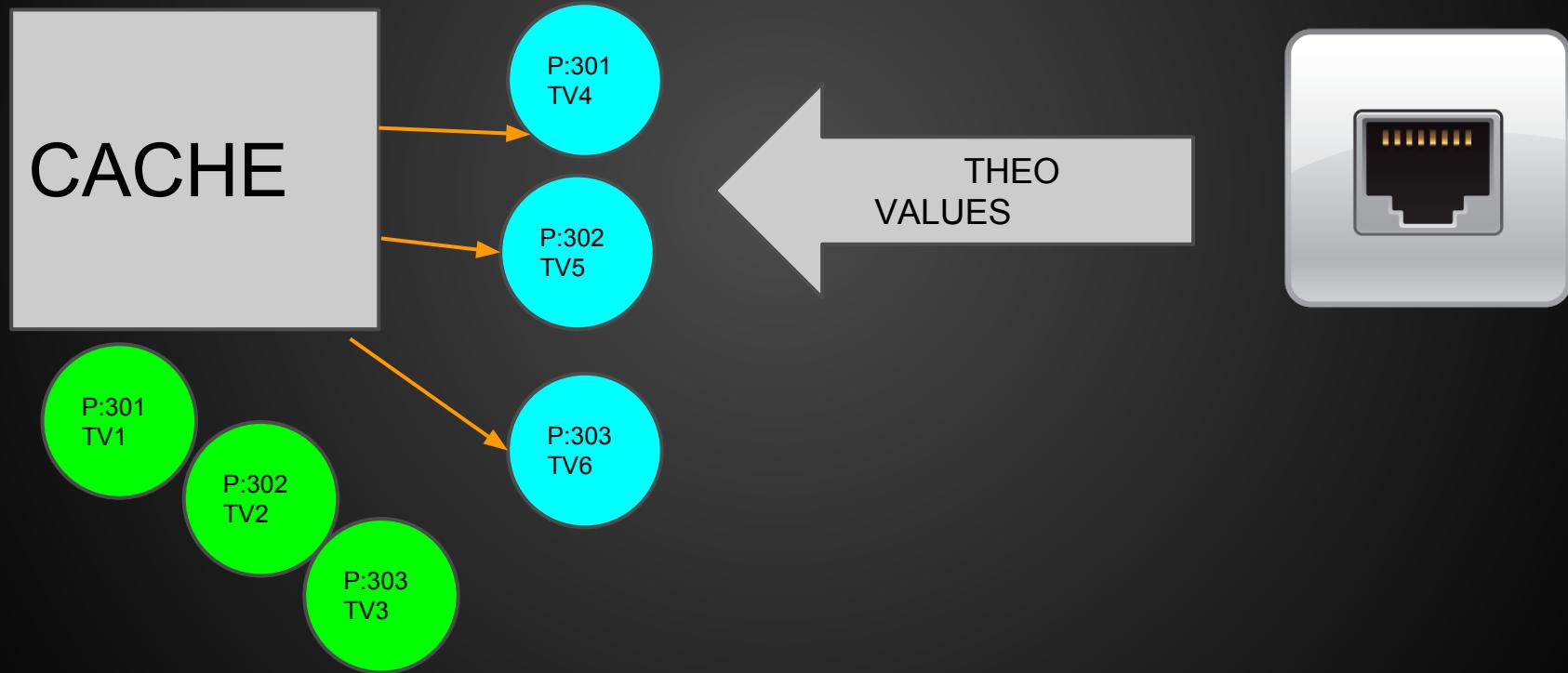
How Leaks Happen - Memory Press.



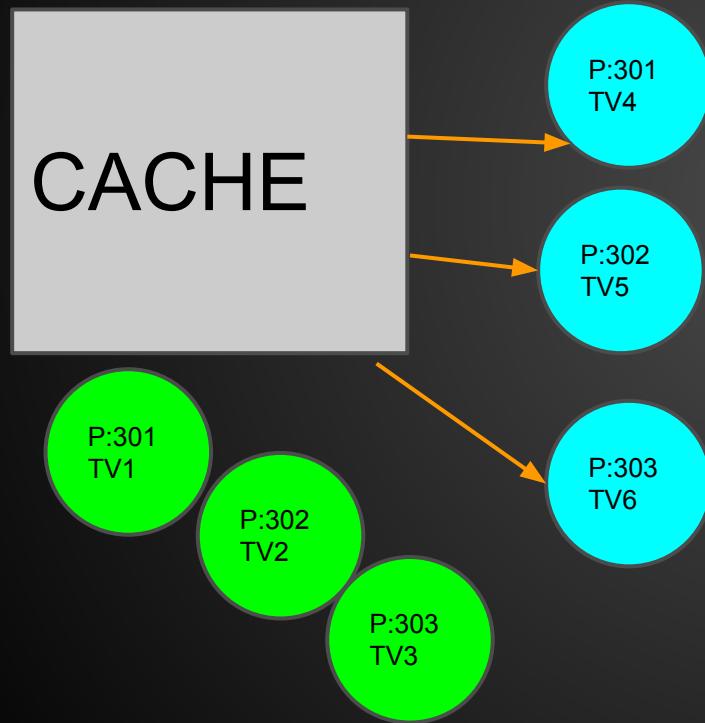
How Leaks Happen - Memory Press.



How Leaks Happen - Memory Press.



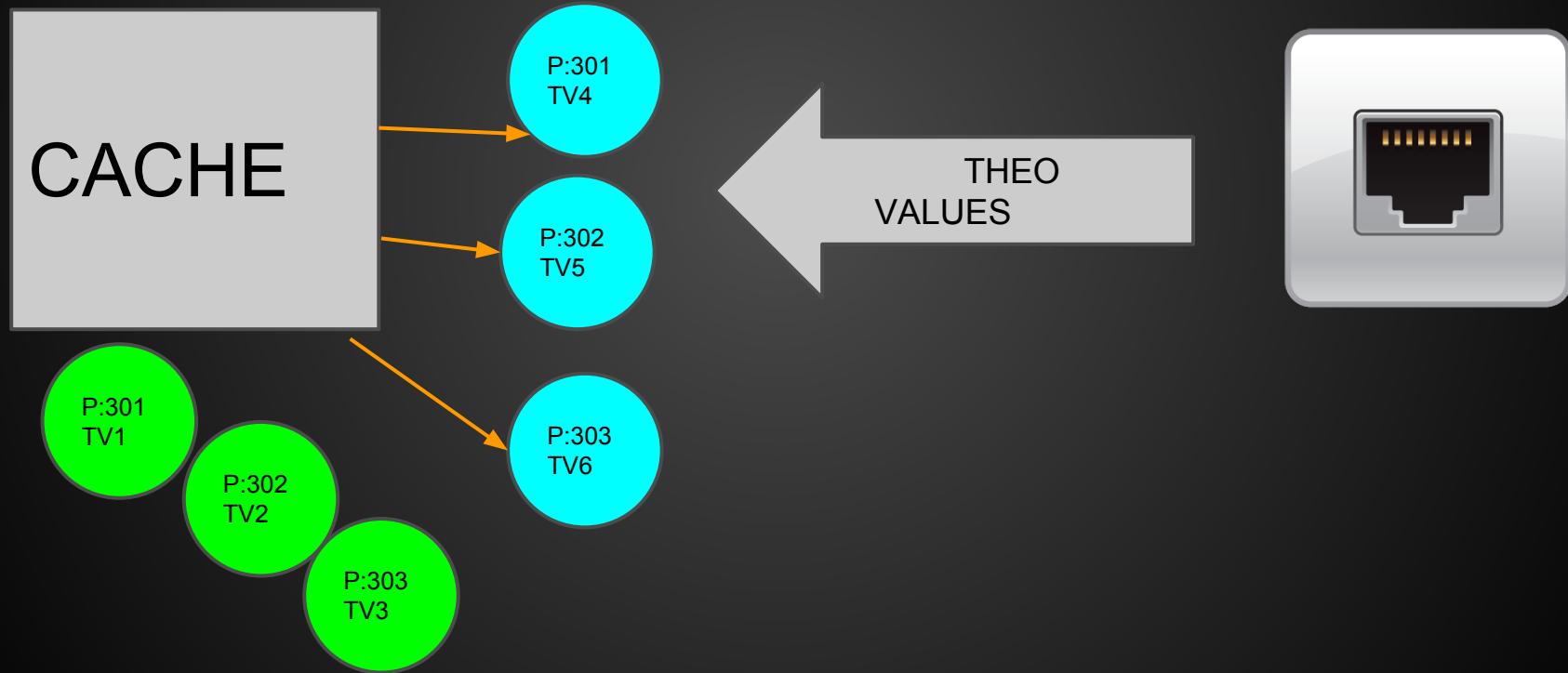
How Leaks Happen - Memory Press.



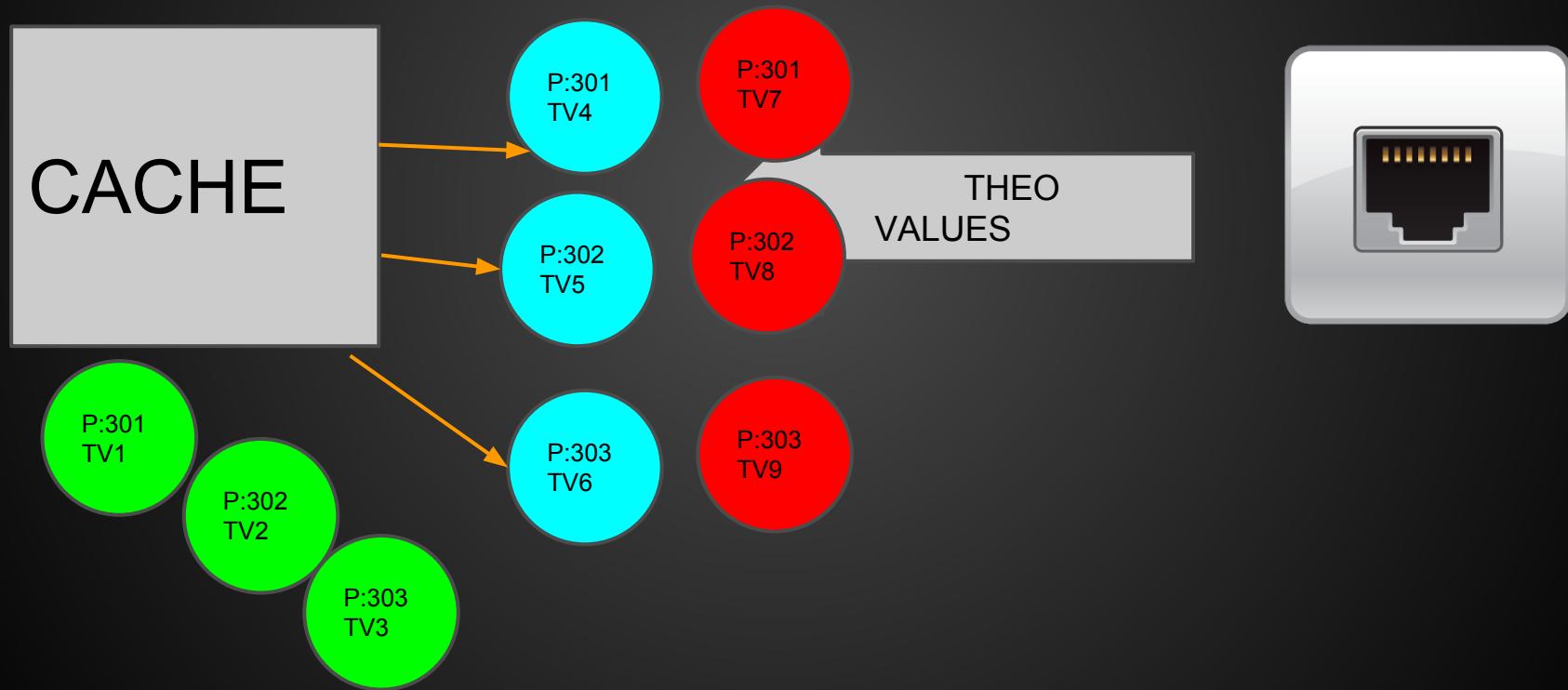
3:10 PM



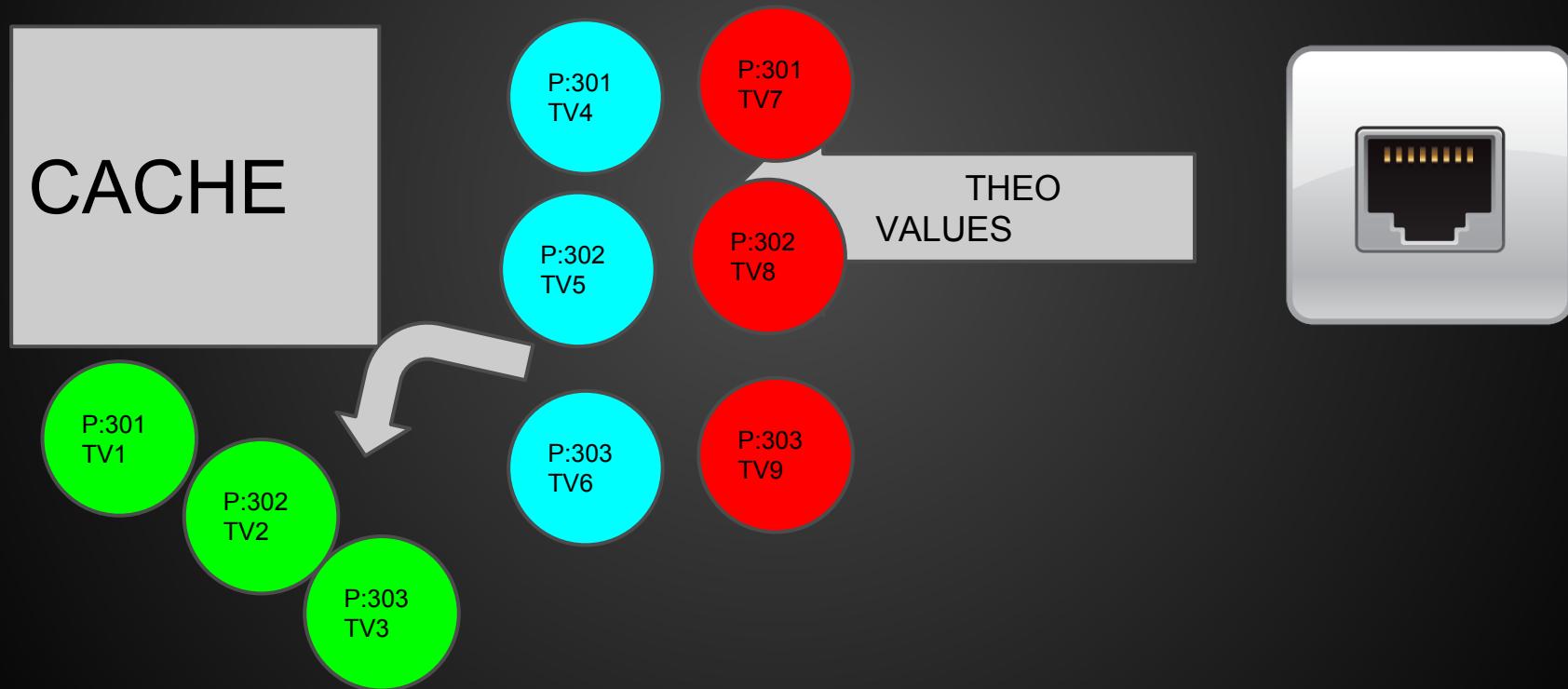
How Leaks Happen - Memory Press.



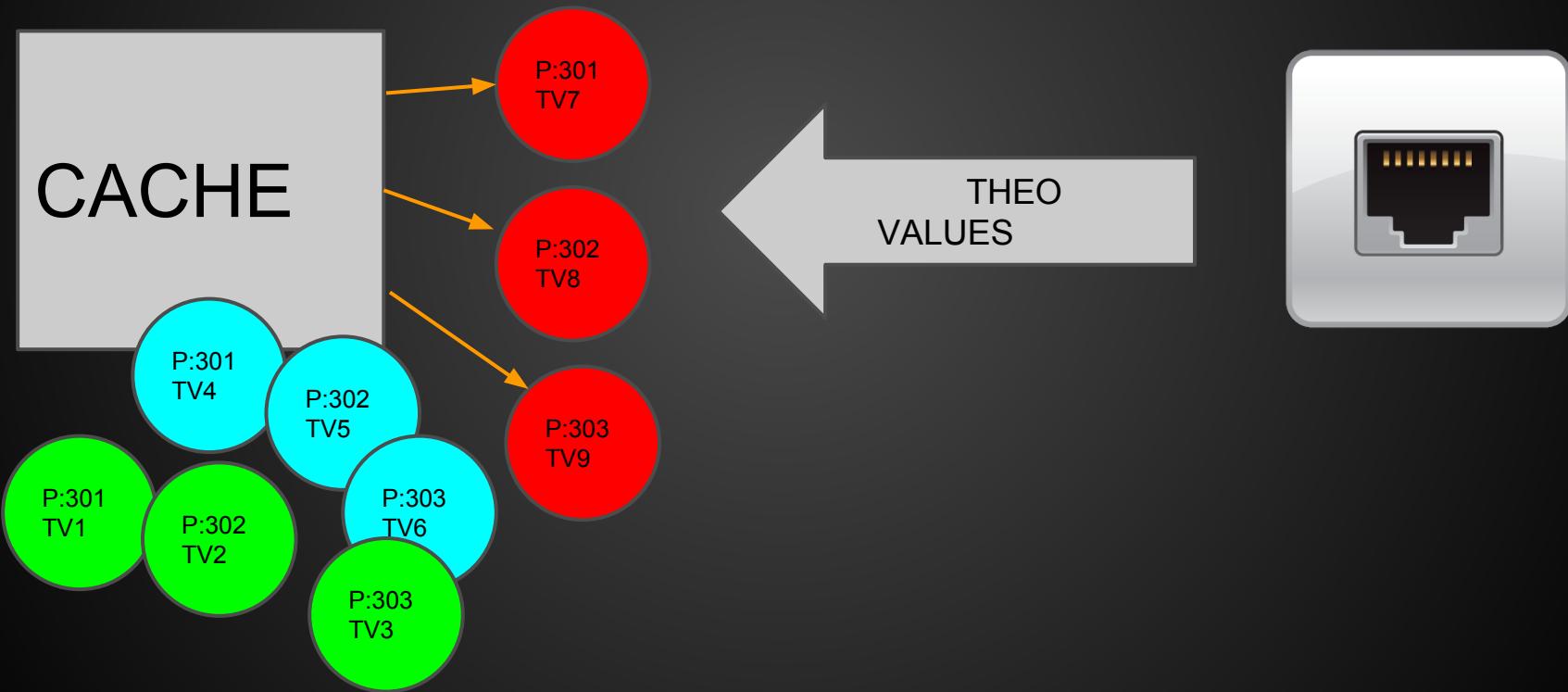
How Leaks Happen - Memory Press.



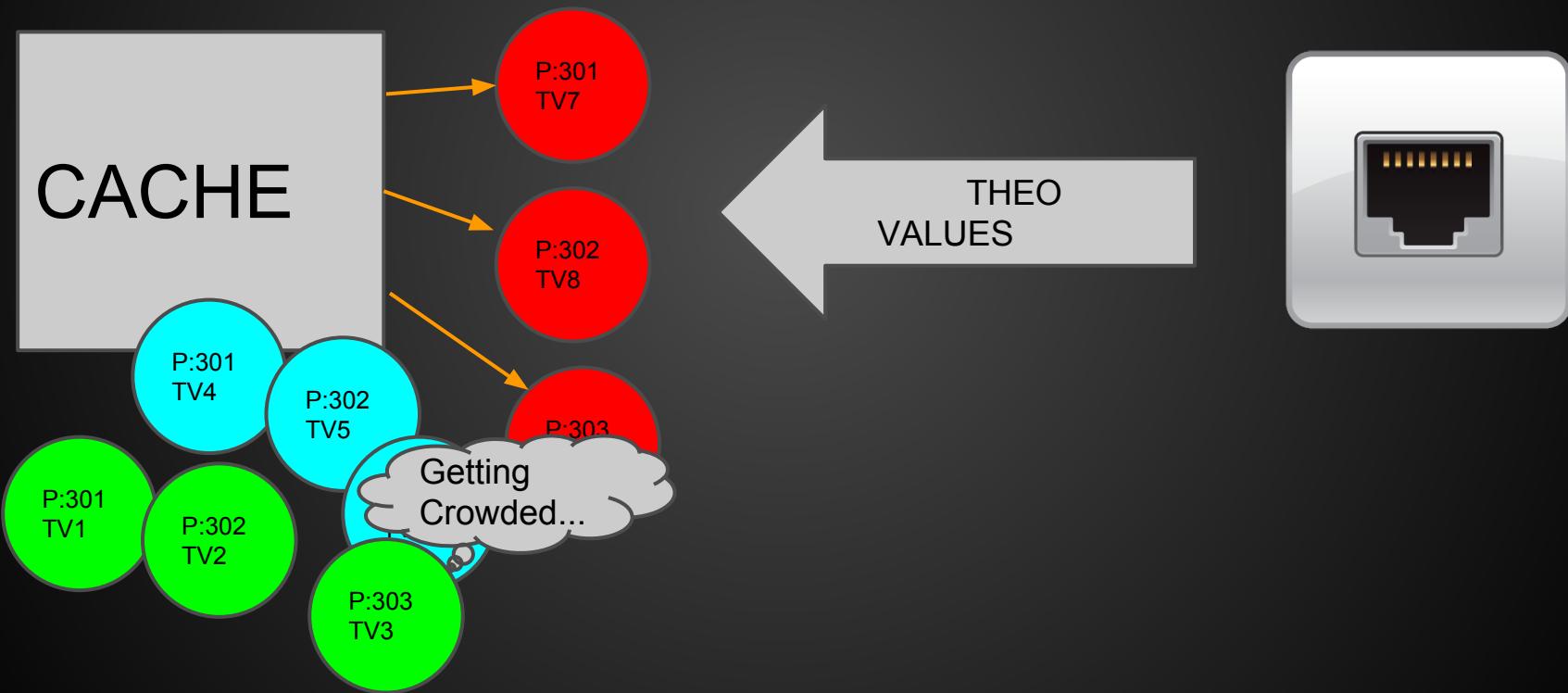
How Leaks Happen - Memory Press.



How Leaks Happen - Memory Press.

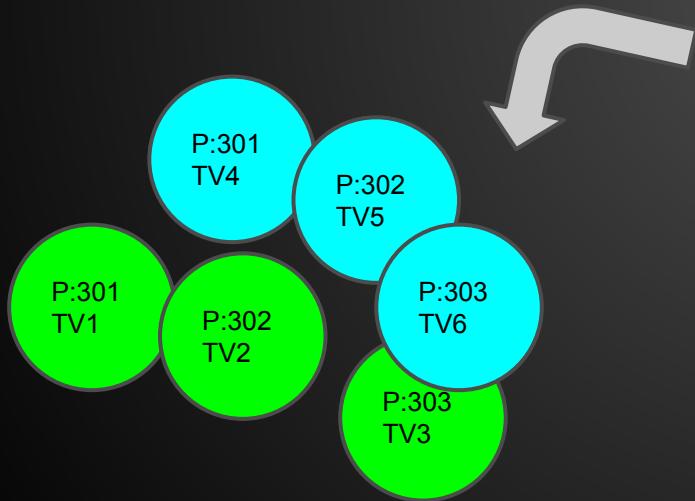


How Leaks Happen - Memory Press.

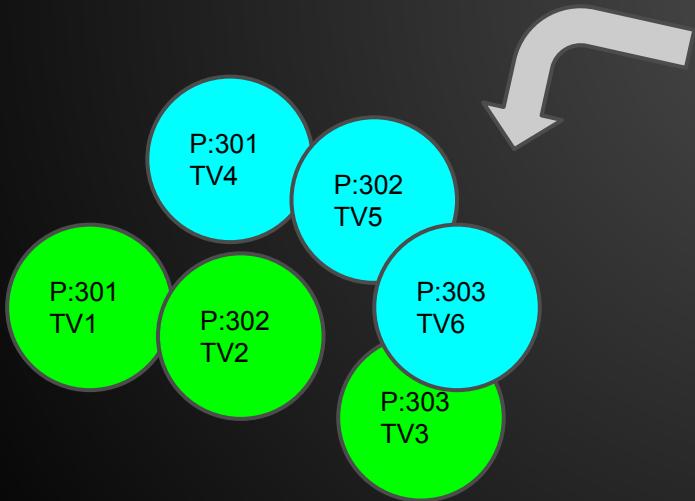


How Leaks Happen - Memory Press.

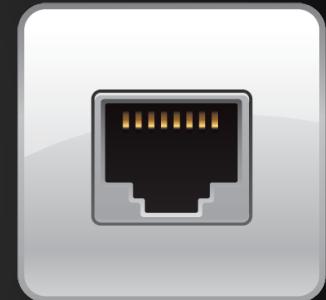
Like “Orange”



How Leaks Happen - Memory Press.

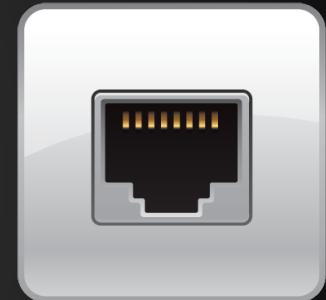
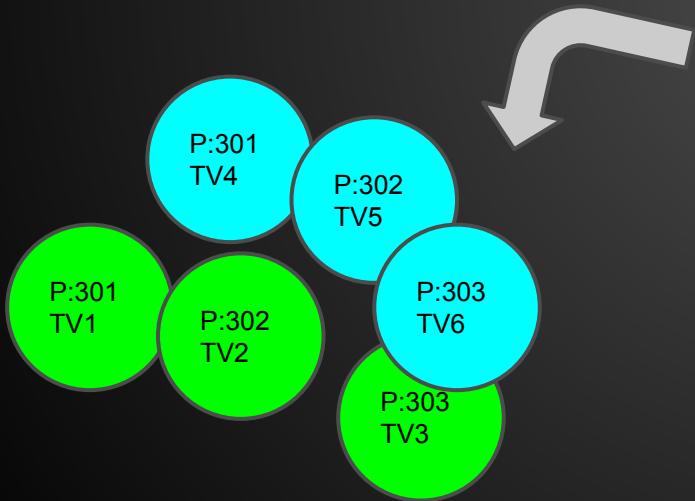


WHY?
(anyone knows?)



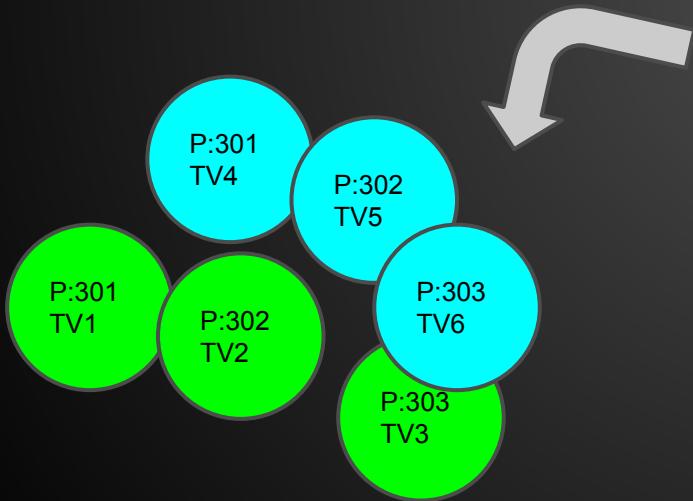
How Leaks Happen - Memory Press.

- Thread Safety



How Leaks Happen - Memory Press.

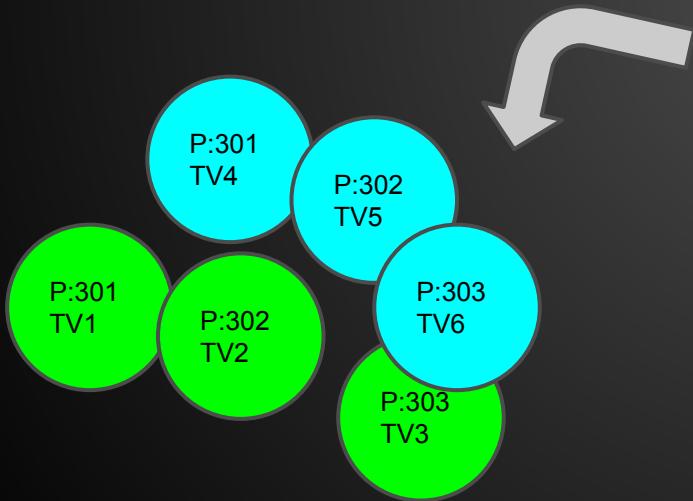
- Thread Safety
 - Immutability



How Leaks Happen - Memory Press.

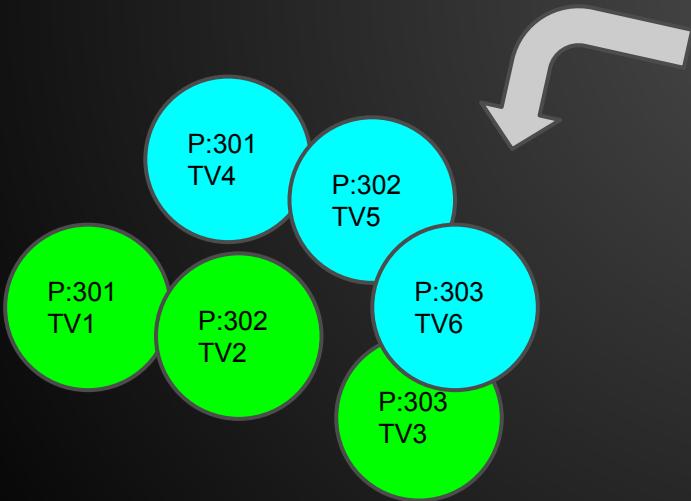
- Thread Safety
 - Immutability

...Backfired...
...sort..of



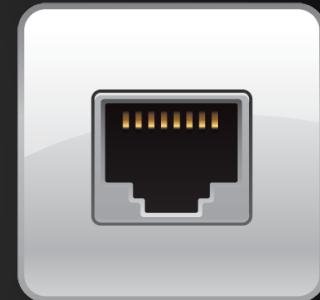
How Leaks Happen - Memory Press.

- Thread Safety
 - Immutability



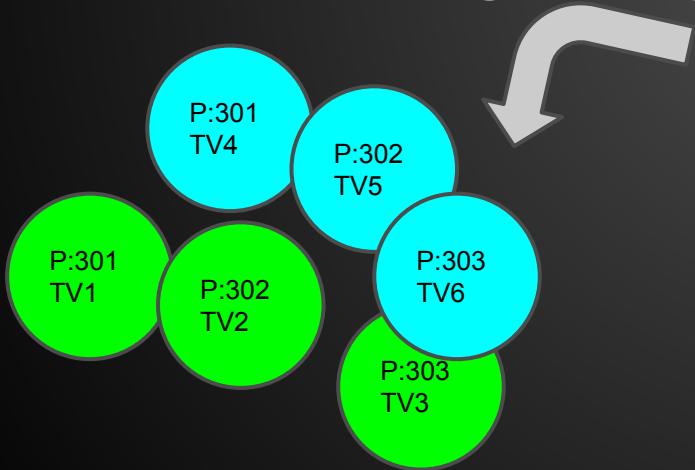
...Backfired...
...sort..of

FOR THIS CASE

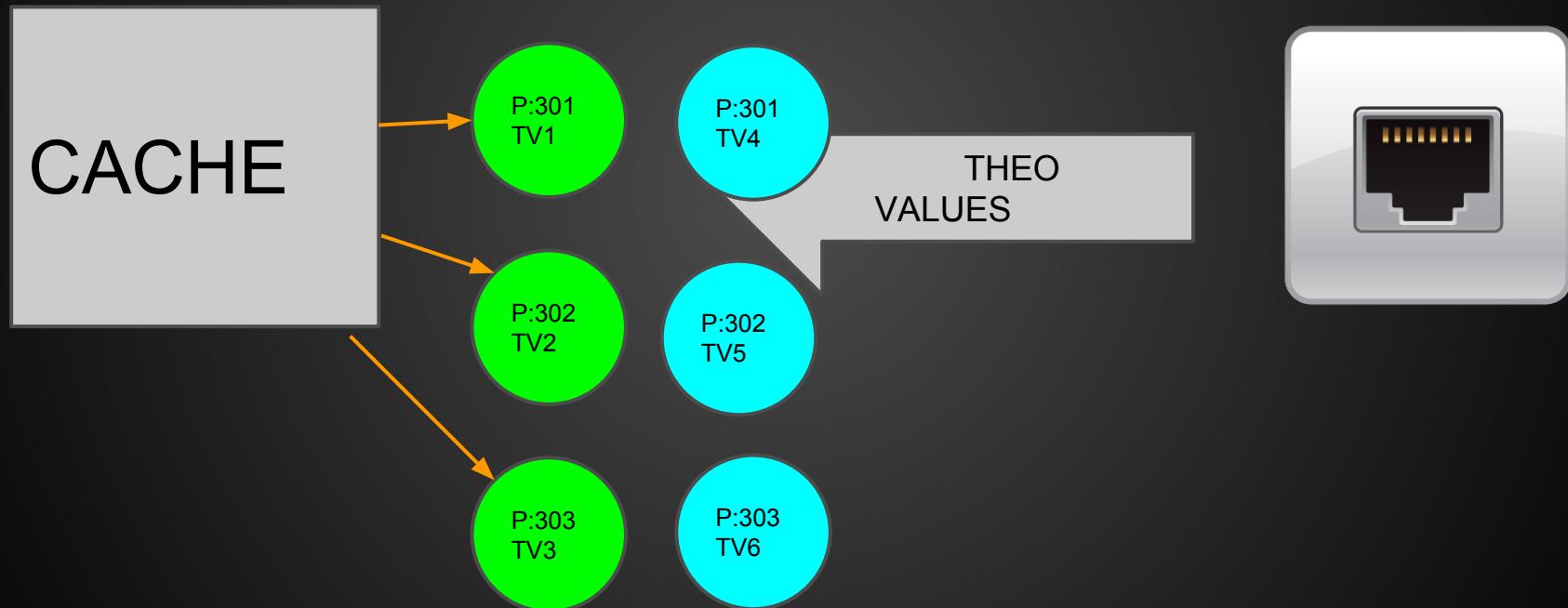


How Leaks Happen - Memory Press.

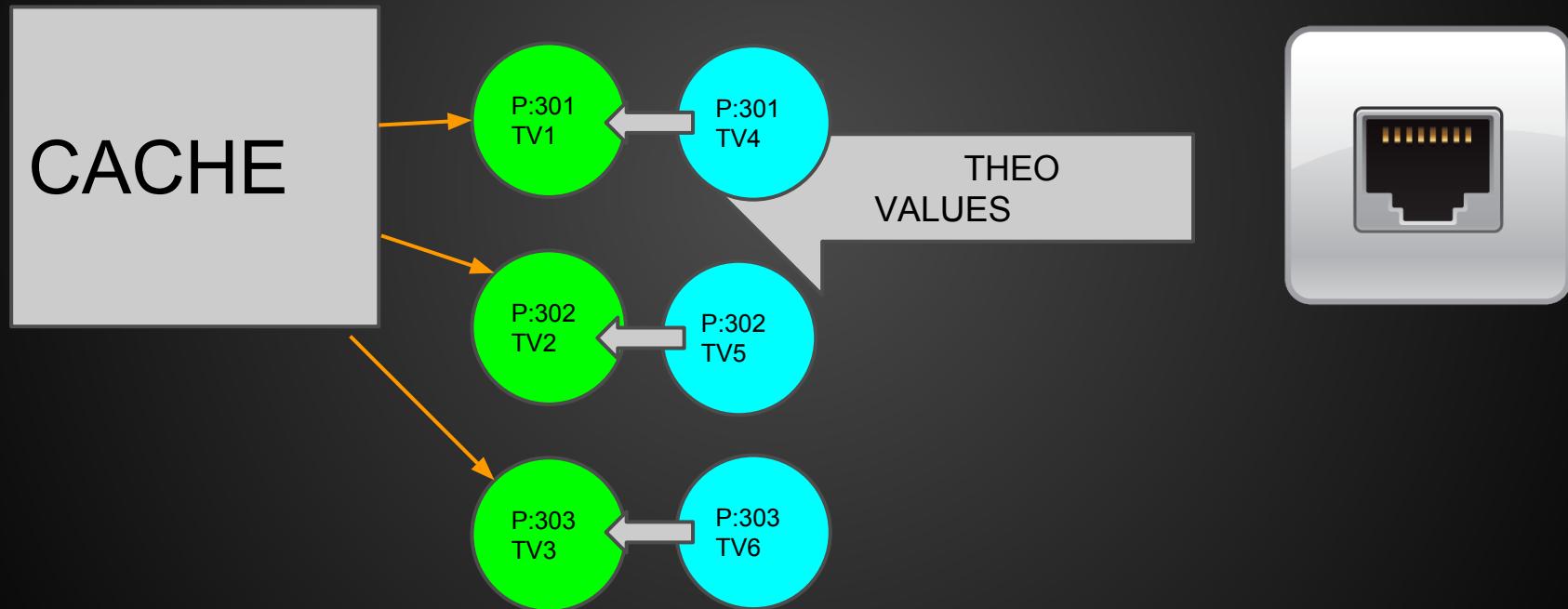
HOW TO FIX IT?



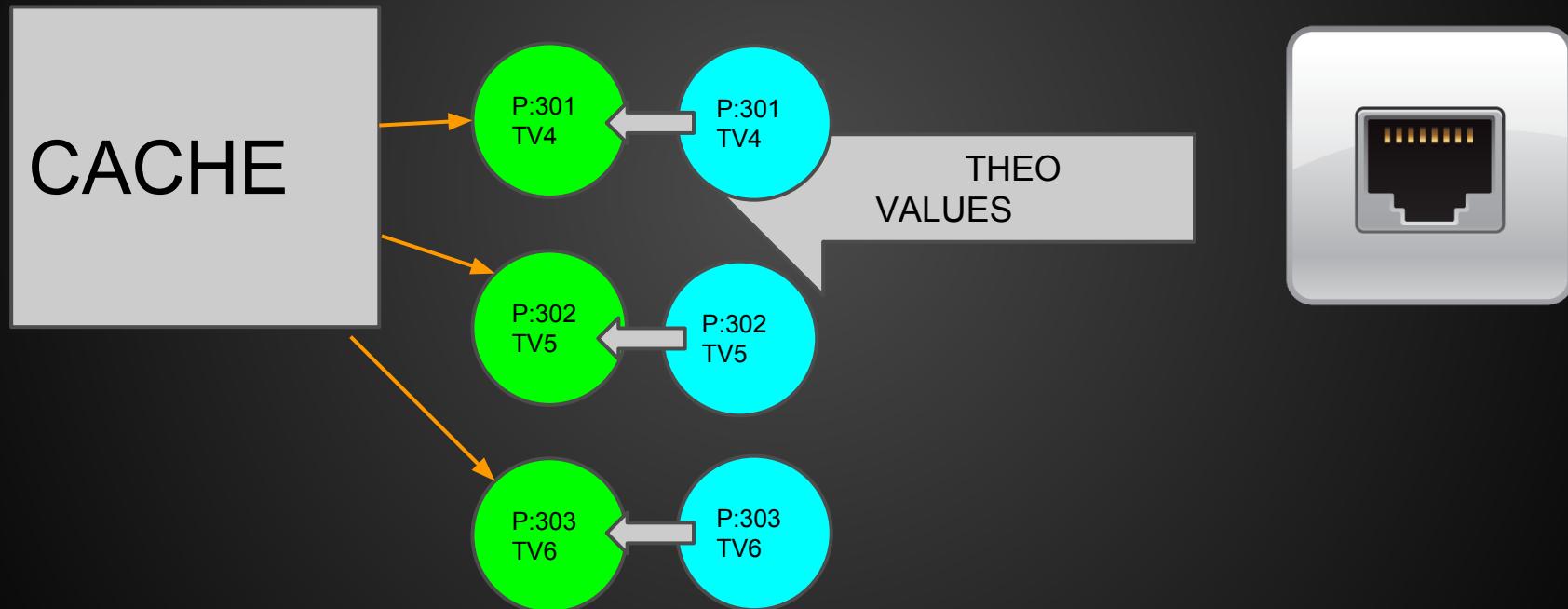
How Leaks Happen - Memory Press.



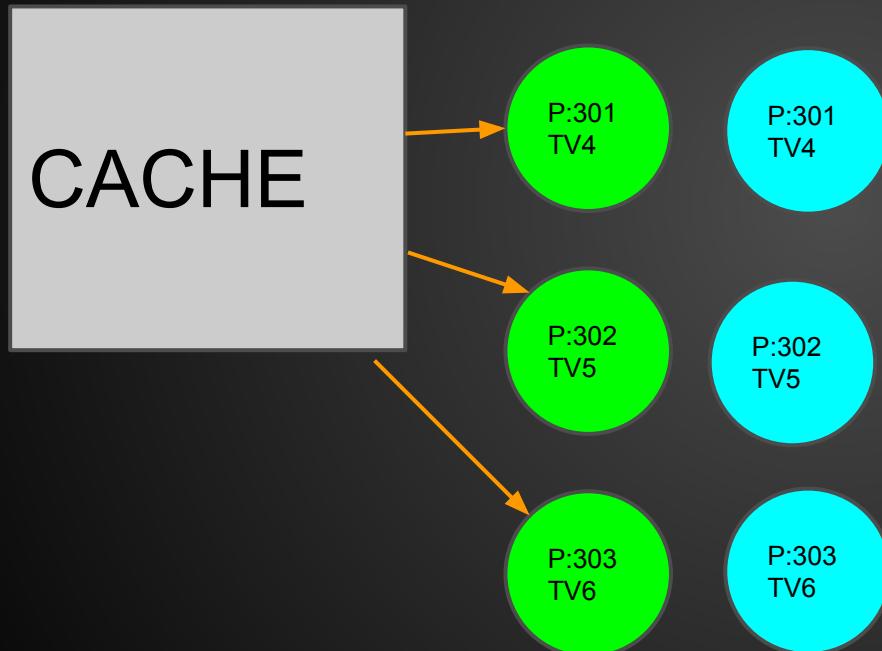
How Leaks Happen - Memory Press.



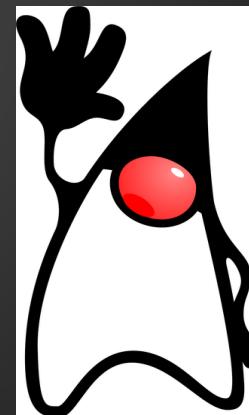
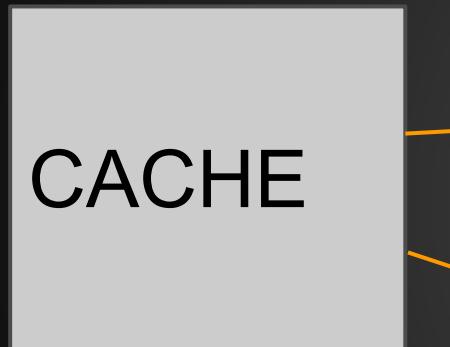
How Leaks Happen - Memory Press.



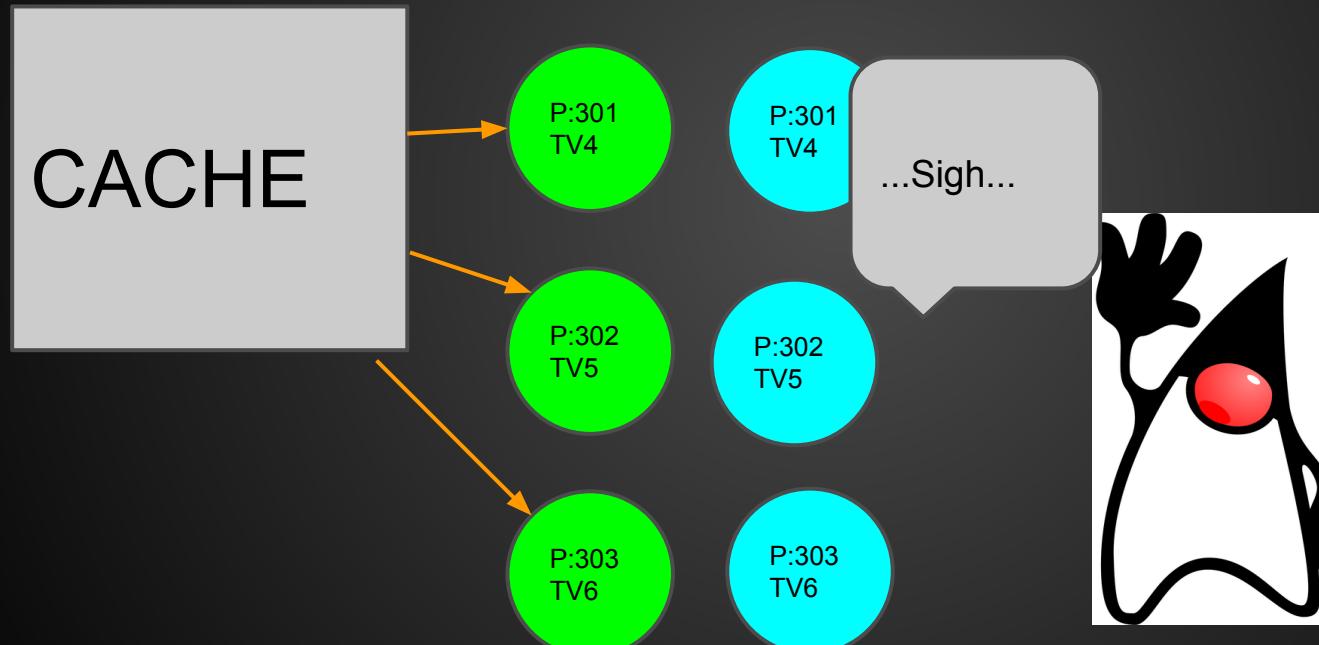
How Leaks Happen - Memory Press.



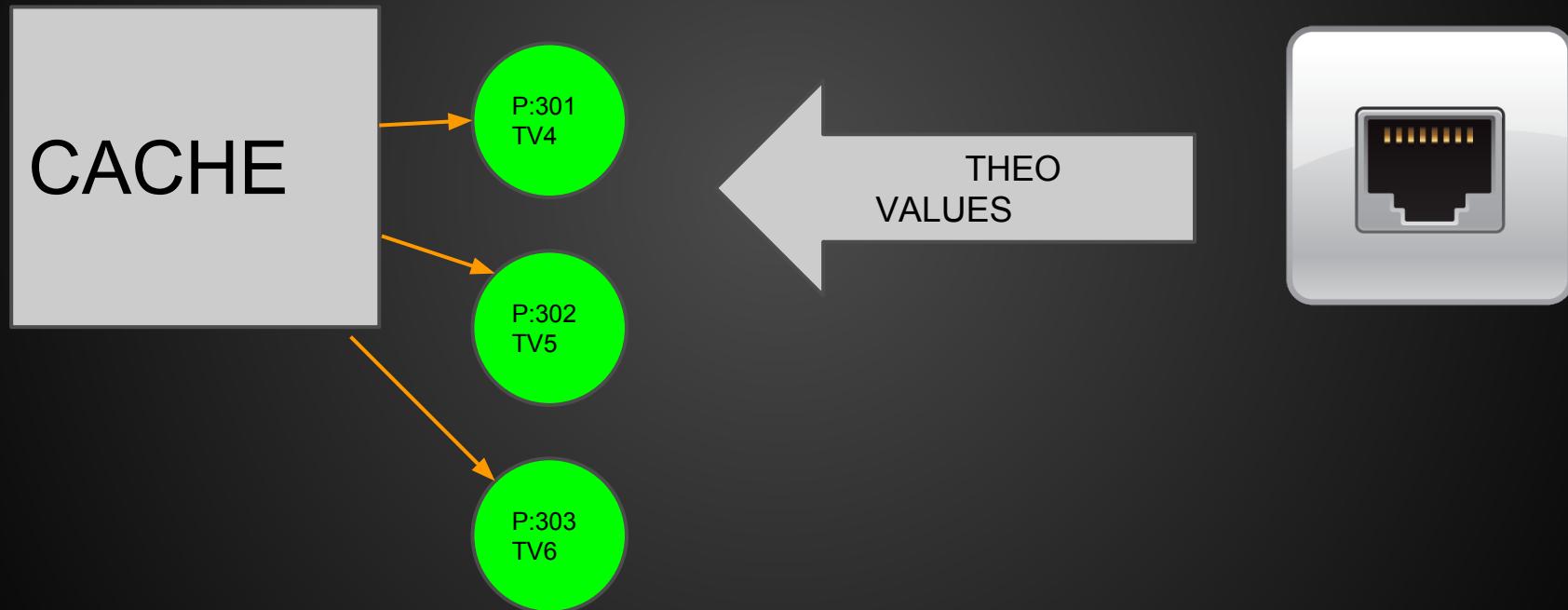
How Leaks Happen - Memory Press.



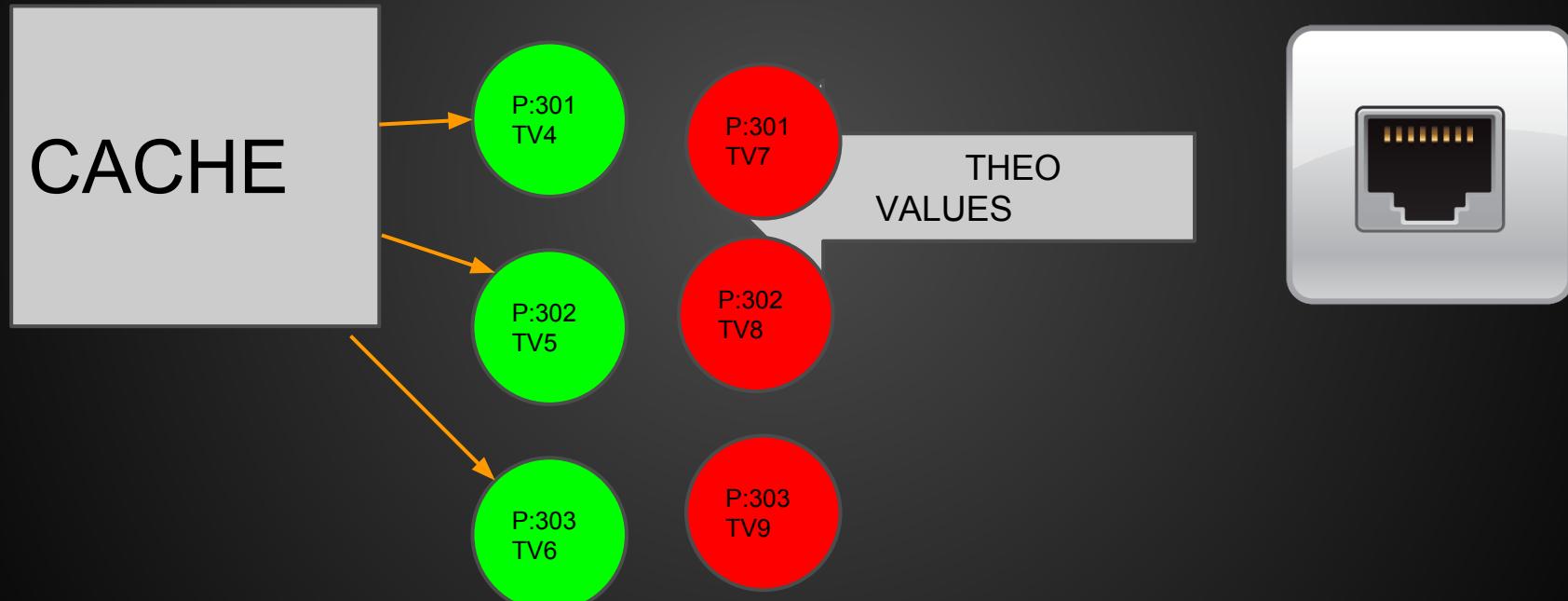
How Leaks Happen - Memory Press.



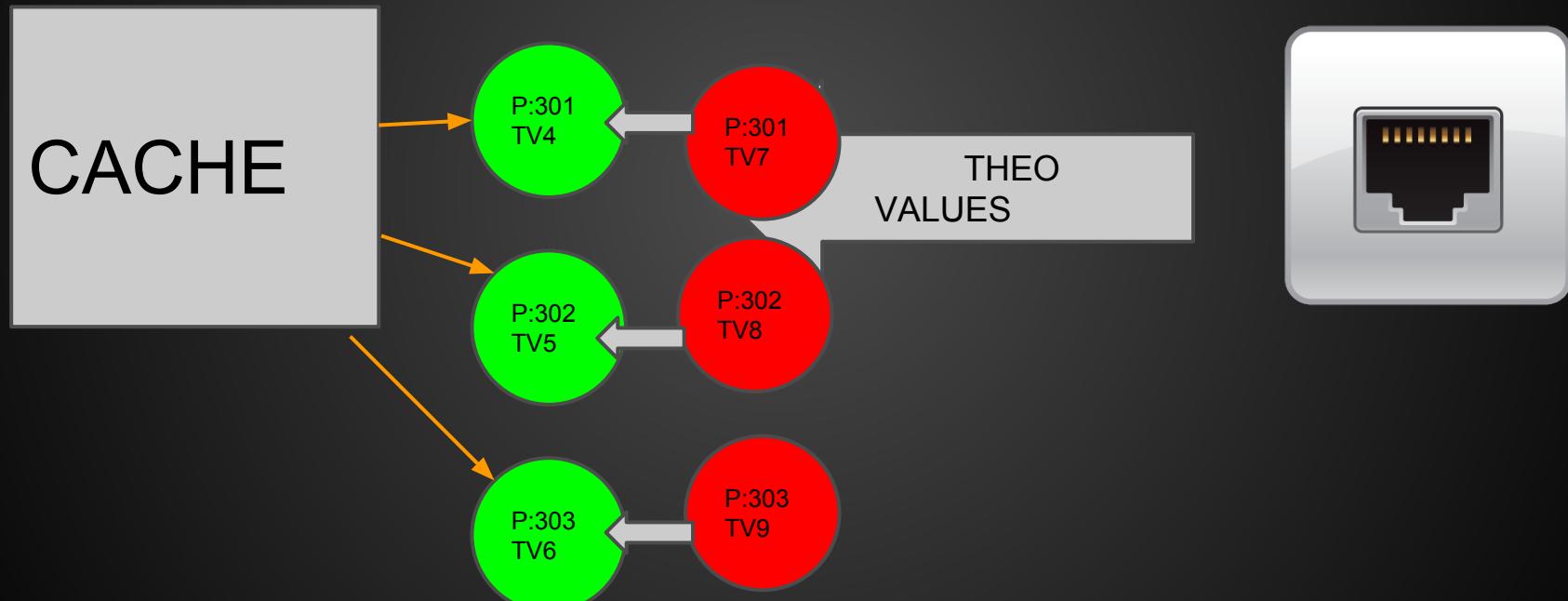
How Leaks Happen - Memory Press.



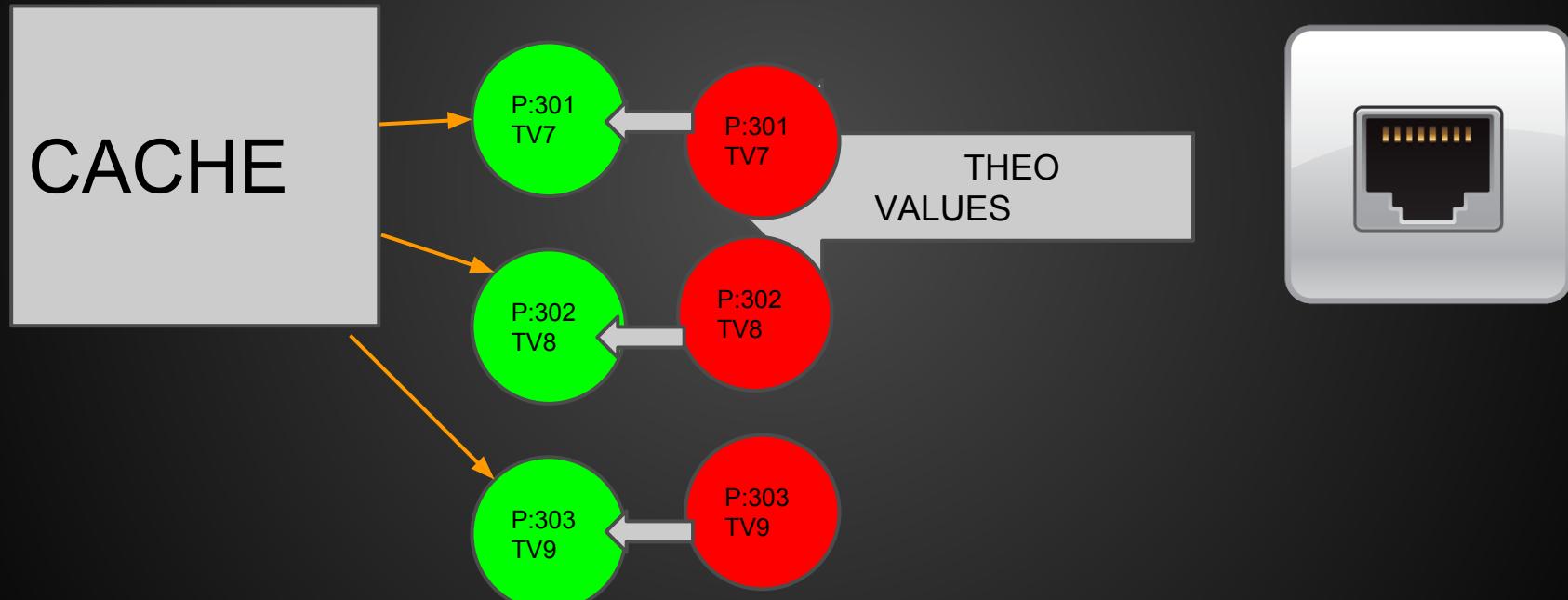
How Leaks Happen - Memory Press.



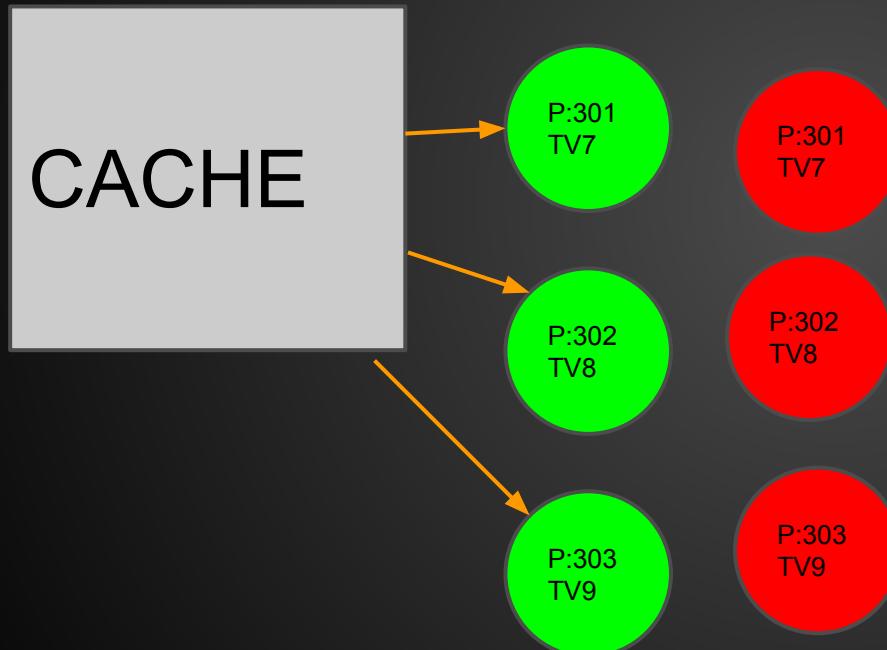
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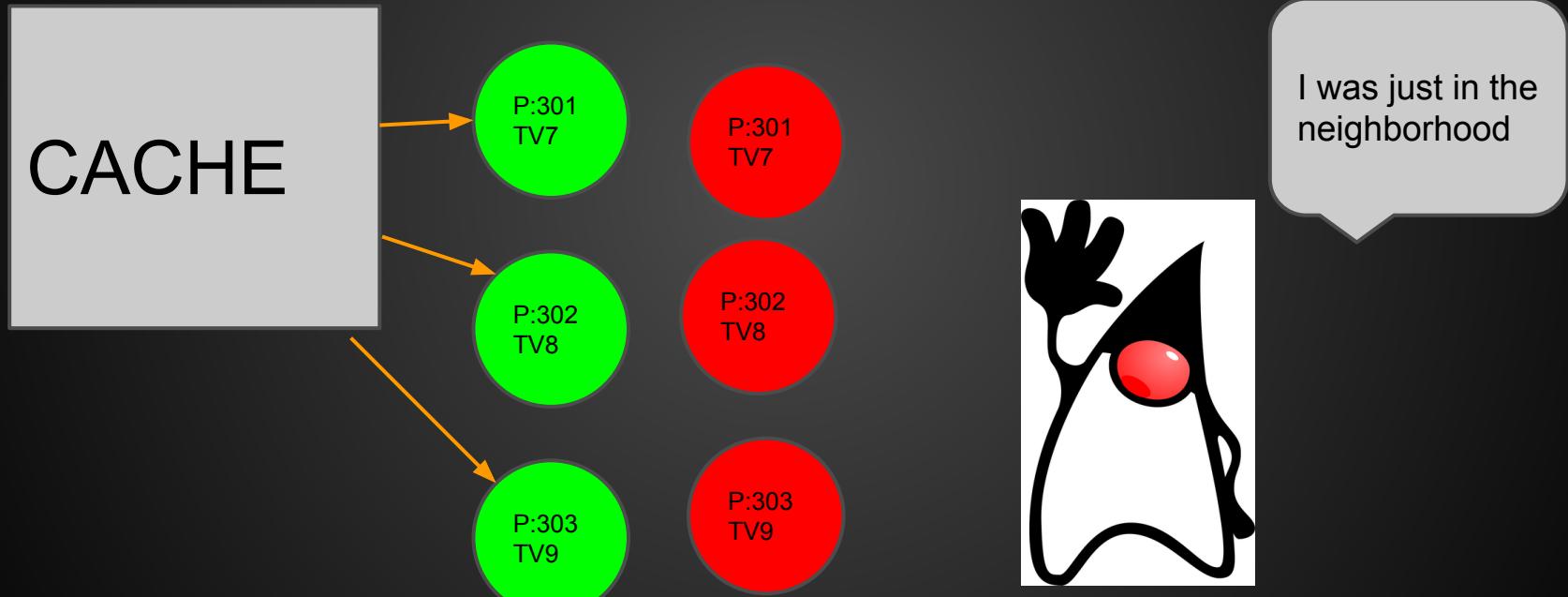
How Leaks Happen - Memory Press.



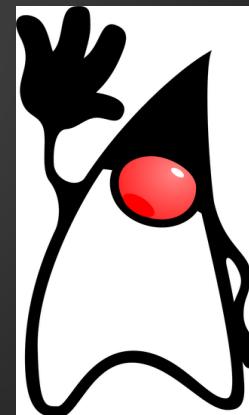
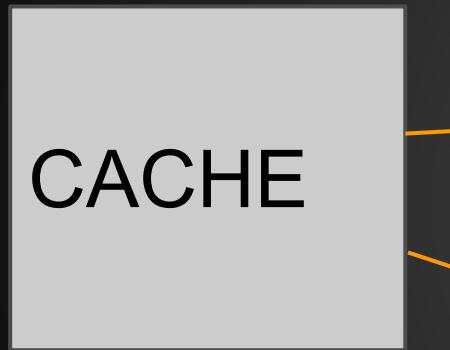
How Leaks Happen - Memory Press.



How Leaks Happen - Memory Press.

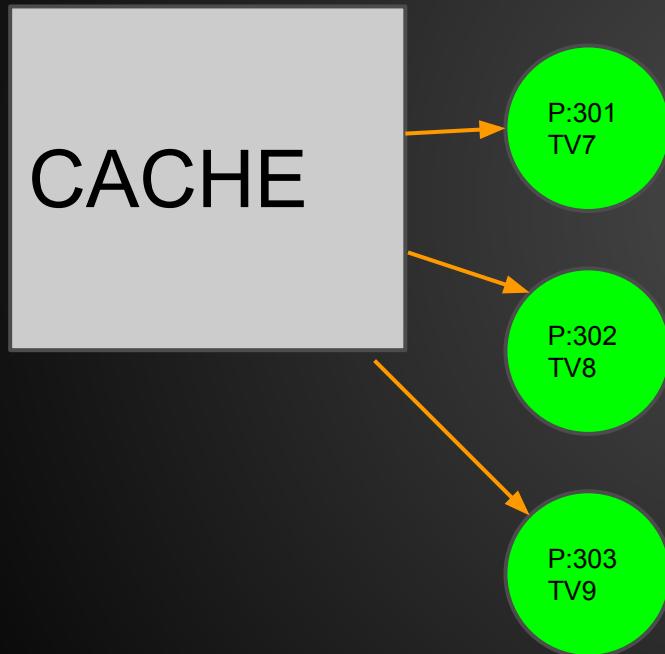


How Leaks Happen - Memory Press.



Oh.. you guys
are coming
w/me

How Leaks Happen - Memory Press.



How Leaks Happen - Starvation

Starvation

- Not a “hard leak”
- Run out-of-memory
 - Doesn’t matter 10 or 1000gb

How Leaks Happen - Starvation

- Producer/Consumer queues

How Leaks Happen - Starvation

- Producer/Consumer queues
 - Consumers are unbounded

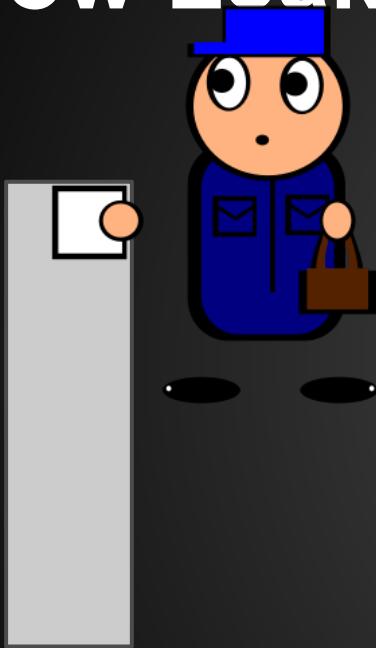
How Leaks Happen - Starvation

- Producer/Consumer queues
 - Consumers are unbounded
 - Can't keep up with Producers

How Leaks Happen - Starvation



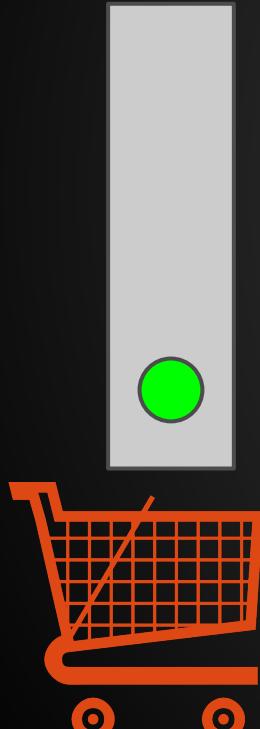
How Leaks Happen - Starvation



How Leaks Happen - Starvation



How Leaks Happen - Starvation



How Leaks Happen - Starvation



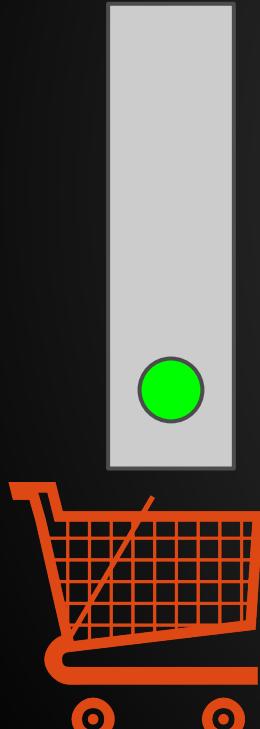
How Leaks Happen - Starvation



How Leaks Happen - Starvation



How Leaks Happen - Starvation



How Leaks Happen - Starvation

When Consumers go wrong...

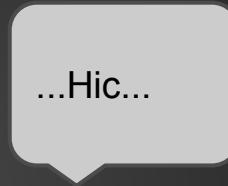
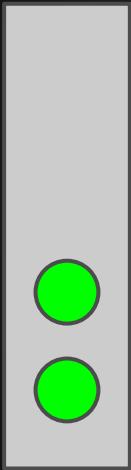
How Leaks Happen - Starvation



How Leaks Happen - Starvation



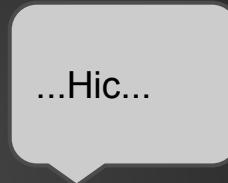
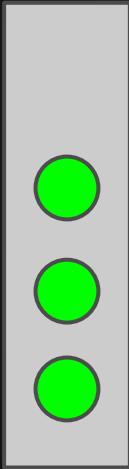
How Leaks Happen - Starvation



How Leaks Happen - Starvation



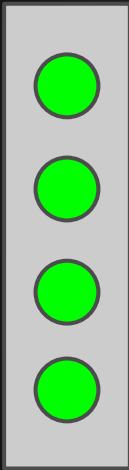
How Leaks Happen - Starvation



How Leaks Happen - Starvation



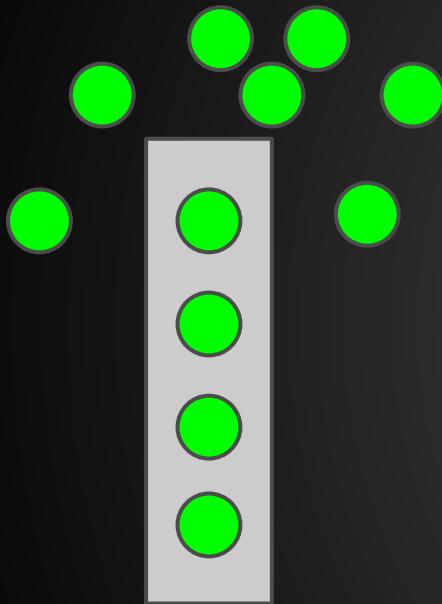
How Leaks Happen - Starvation



Can't....
make...
it...



How Leaks Happen - Starvation



Can't....
make...
it...



Finding Leaks

Finding Leaks - The Tools



Finding Leaks - The Tools

- JMap (Heap dump)
 - Mostly on Server
 - Can cause a (significant) pause
 - `jmap -dump:format=b,file=cheap.bin <pid>`
- VisualVM (UI analysis)



Finding Leaks - Your App

- The Larger the leak

Finding Leaks - Your App

- The Larger the leak
 - The easier to find



Finding Leaks - Your App

- Collect a Heap Dump
 - Evidence!



Finding Leaks - Your App

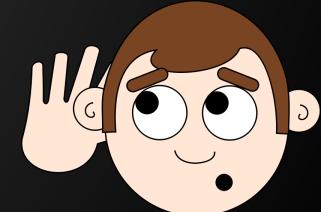
- Collect a Heap Dump
 - Evidence!



Finding Leaks - Your App

- Collect a Heap Dump
 - Evidence

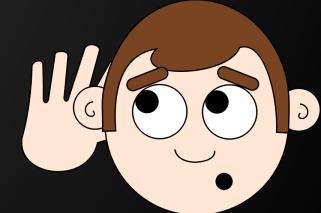
I'm taking a Heap Dump of the production Server



Finding Leaks - Your App

- Collect a Heap Dump
 - Evidence!

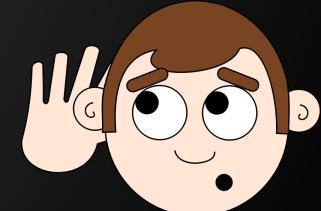
Is it large?



Finding Leaks - Your App

- Collect a Heap Dump
 - Evidence

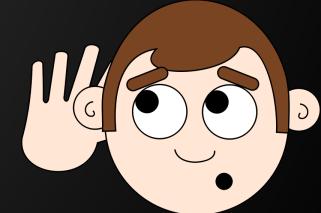
Yep..**huge**, 64gb



Finding Leaks - Your App

- Collect a Heap Dump
 - Evidence!

Better make some space



Finding Leaks - Your App

- Collect a Heap Dump
 - Evidence!



Finding Leaks - Your App

- Collect a Heap Dump
 - VisualVM
 - Strong References
 - Object Sizes

Finding Leaks

Let's go Plumbing

SHOW ME THE CODE

In Conclusion

What causes

- Strong References
- Thread Starvation
- GC Pressure (Premature Promotion)
- Starvation (Producer/Consumer)

In Conclusion

Trusty VisualVM

- Getting Heap Dumps
- Navigate Objects



Congratulations!



Want to hear more?

www.javapubhouse.com

@fguime (twitter)

freddy.guime@cjug.org

mentors@cjug.org

[github.com/
windust/MemoryLeak1](https://github.com/windust/MemoryLeak1)

The screenshot shows the homepage of Java Pub House. At the top, there's a navigation bar with links for Home, About the Podcast, Presentations, and Software. A stick figure icon holding a beer is on the right. Below the navigation, there are social media links for Twitter and RSS, and a "Subscribe to our Podcast!" button. The main content area features a post titled "Friday, January 9, 2015" and "Episode 47. Stop. Maven Time!". It includes a video thumbnail showing a stick figure with a beer, a "Paypal" button, and a "Lambda Expression" sidebar with a cartoon illustration of a person playing a guitar. On the right side, there are sections for "About the Podcast", "Subscribe to our Podcast!!!", and "Episodes". A large grey arrow points from the bottom right towards the "Episodes" section.