



# Eclipse Embedded Day Stuttgart 2010

## Visual Tools for the Analysis of Embedded Applications





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24. June 2010



# Specific Requirements for Embedded

- Time Predictability
- Safety-Criticality

## Presented Tools

-  *Jamaica VM* ThreadMonitor
-  *VeriFlux*



# ThreadMonitor Overview

- Runtime Monitoring Tool
  - ◆ connects to running VM via socket
  - ◆ VM records low-level scheduling decisions
  - ◆ time stamps using CPU cycle counter
  - ◆ User events also possible



# ThreadMonitor Demo



# VeriFlux Overview

- Static Analysis Tool
  - ◆ based on abstract interpretation
  - ◆ finds superset of possible values for all variables
  - ◆ uses object-context
  - ◆ analyses threads
  - ◆ knows RTSJ (Scoped Memory, NHRTT, etc.)



# Comparison of Methods

## VeriFlux

automatic  
false positives  
no false negatives  
finds runtime errors  
proves absence of errors  
analyses code  
whole program

## JUnit

manual  
no false positives  
tests may be incomplete  
also semantic errors  
inherently incomplete  
executes code  
partial program



# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
  
    int value = s.reading();  
    ...  
}  
...
```



# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
  
    int value = s.reading();  
    ...  
}  
...
```

NullPointer



# How does VeriFlux Work?

- Example

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if (device instanceof MyDevice)  
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    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

ClassCast      NullPointer

# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

ClassCast      NullPointer

NullPointer

# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

ClassCast  
NullPointerException  
NullPointerException

# How does VeriFlux Work?

- Example

```
device != null
...
if (device instanceof MyDevice)
{
    MySensor s = (MySensor) device.sensor;
    int value = s.reading();
    ...
}
...
```

ClassCast

NullPointerException

NullPointerException

# How does VeriFlux Work?

- Example

```

...
device != null
if (device instanceof MyDevice)
{
    MySensor s = (MySensor) device.sensor;
    int value = s.reading();
    ...
}
...

```

Annotations in the code:
 

- A blue oval highlights the condition `device instanceof MyDevice`.
- A blue arrow points from `device != null` to the `device` variable in the `if` condition.
- Red circles highlight `(MySensor)` (labeled **ClassCast**), `device.sensor` (labeled **NullPointer**), and `s.reading()` (labeled **NullPointer**).



# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

device != null

ClassCast

NullPointerException

NullPointerException

NullPointerException ✓



# How does VeriFlux Work?

- Example

values(MyDevice.sensor)

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

Annotations:  
- Red circles around `(MySensor)` and `s.reading()` with the label **NullPointerException**.  
- A blue oval around `device.sensor` with the label **ClassCast**.  
- A green circle around `device` with the label **NullPointerException** and a green checkmark.

# How does VeriFlux Work?

- Example

values(MyDevice.sensor)  
contains only MySensor

```

...
if (device instanceof MyDevice)
{
    MySensor s = (MySensor) device.sensor;
    int value = s.reading();
    ...
}
...

```

ClassCast

NullPointerException

NullPointerException

✓



# How does VeriFlux Work?

- Example

```

...
if (device instanceof MyDevice)
{
    MySensor s = (MySensor) device.sensor;
    int value = s.reading();
    ...
}
...

```

values(MyDevice.sensor) contains only MySensor

ClassCast

NullPointerException

NullPointerException

✓



# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

values(MyDevice.sensor)  
contains only MySensor

ClassCast ✓ NullPointer ✓

NullPointerException

# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

ClassCast ✓ NullPointer ✓

NullPointer

# How does VeriFlux Work?

- Example

`null ∈ values(MyDevice.sensor)`

...

```
if (device instanceof MyDevice)
```

```
{
```

```
    MySensor s = (MySensor) device.sensor;
```

```
    int value = s.reading();
```

```
    ...
```

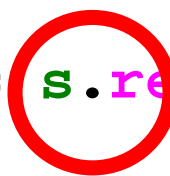
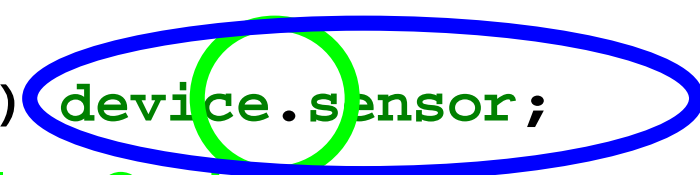
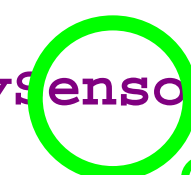
```
}
```

...

NullPointerException

ClassCast

NullPointerException





# How does VeriFlux Work?

- Example

```
...
if (device instanceof MyDevice)
{
    MySensor s = (MySensor) device.sensor;
    int value = s.reading();
    ...
}
...
```

Annotations:

- Blue arrow pointing from `device.sensor` to `s.reading()`
- Blue oval around `device.sensor`
- Green circle around `(MySensor)` with label **ClassCast** ✓
- Green circle around `device.sensor` with label **NullPointerException** ✓
- Red circle around `s.reading()` with label **NullPointerException**

Additional text: `null ∉ values(MyDevice.sensor)`

# How does VeriFlux Work?

- Example

```

...
if (device instanceof MyDevice)
{
    MySensor s = (MySensor) device.sensor;
    int value = s.reading();
    ...
}
...

```

null ∈ values(MyDevice.sensor)  
ClassCast ✓  
NullPointerException ✓  
NullPointerException ✓

# How does VeriFlux Work?

- Example

```
...  
if (device instanceof MyDevice)  
{  
    MySensor s = (MySensor) device.sensor;  
    int value = s.reading();  
    ...  
}  
...
```

ClassCast ✓ NullPointer ✓  
NullPointer ✓



# VeriFlux Demo





# Questions

- ???

