# Constraining application behaviour by generating languages

ELS 2015

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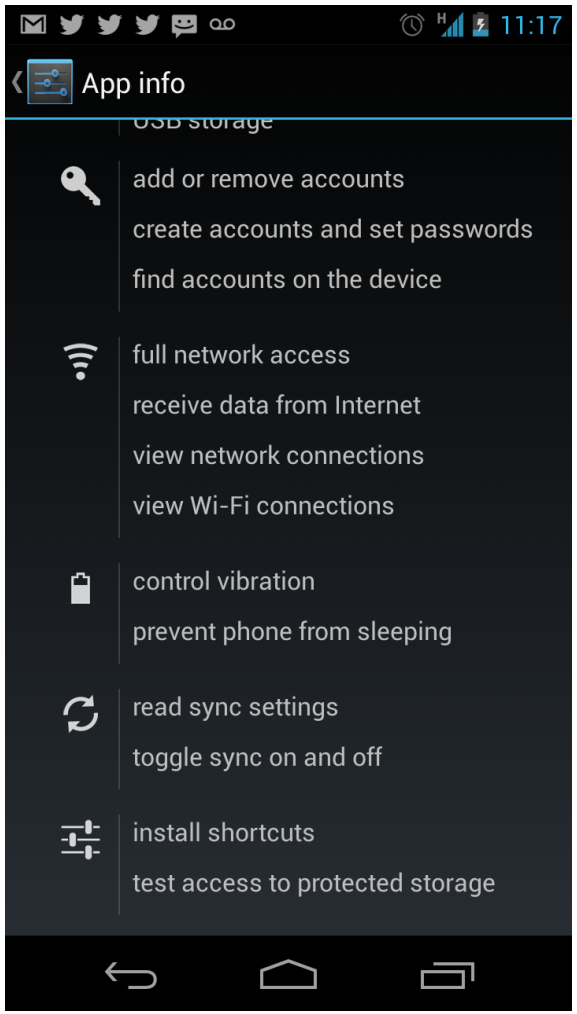
20 April, 2015

# What does this mobile app do?



# On Android permissions

- Android has a notion of "permissions", but
  - Permissions apply to entire app
  - All-or-nothing for the user
- To curb privacy breaches, like
  - Advertising libraries regularly exfiltrate data,
  - Twitter, LinkedIn apps stealing contact list,
  - *etc.*

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  - *etc.*
- We can do better :)

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  → network permission

# Potential data flow

What you hope:

- camera $\rightarrow$ your screen
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- nothing more.

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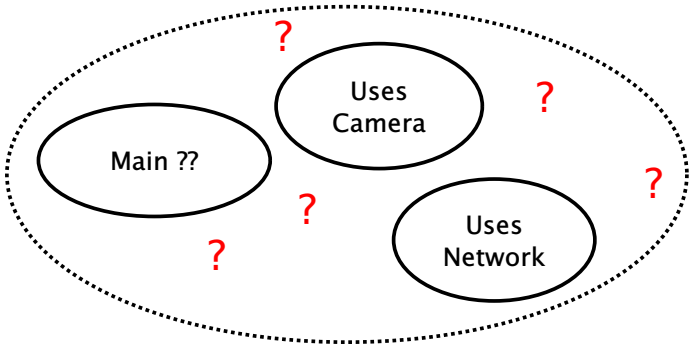
Reality:

- image → `stalkme.net` and `nsa.gov`

# How can we curb this?

The Android permission model:

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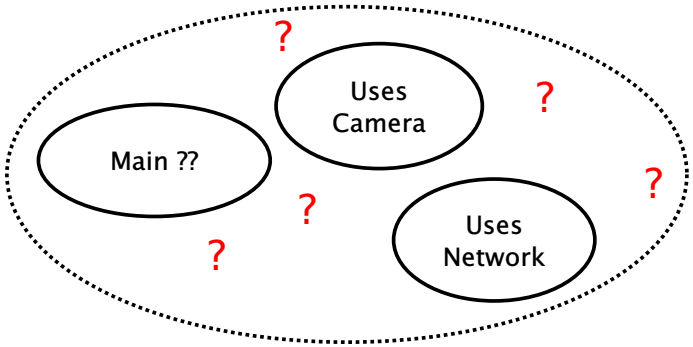


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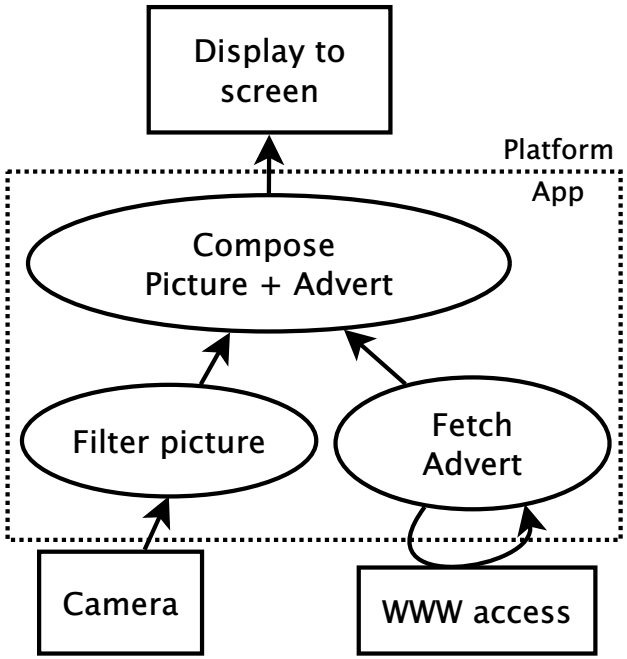
A better way of doing it:



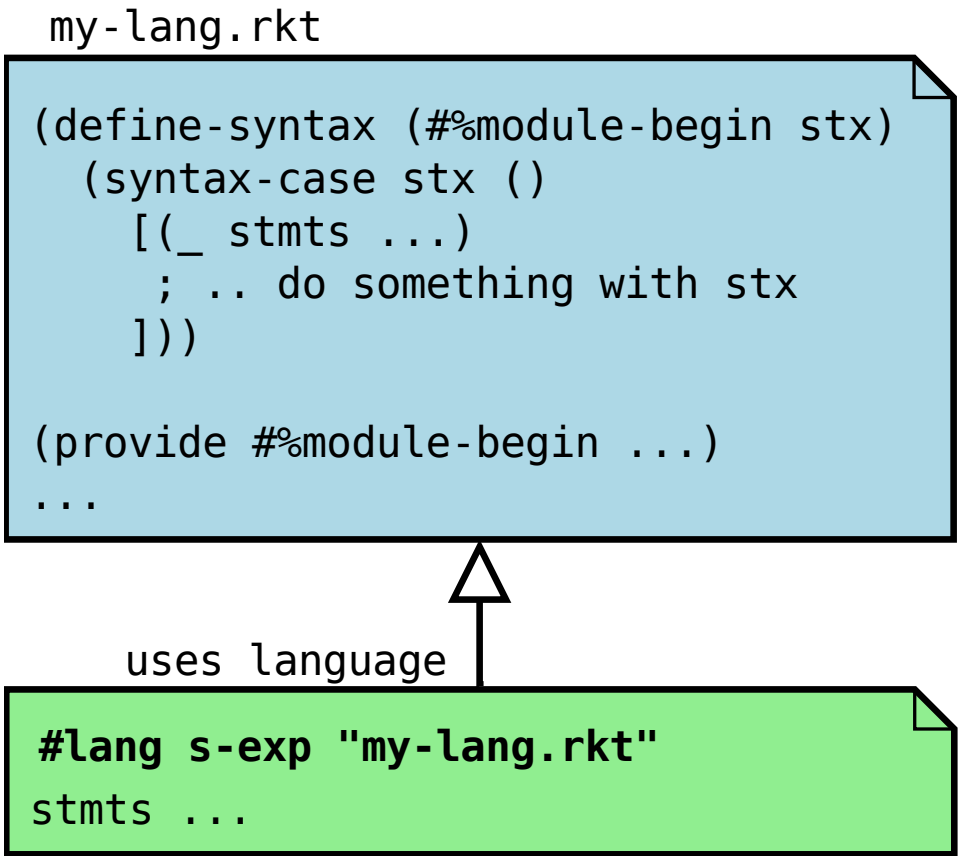
# Our goals

- ✓ Give the user clarity via spec
- ✓ Force the app to conform to spec
- ✓ Guide the developer where possible

# The proposed approach

- Provide a DSL to write up spec
  (encoding of flow diagram shown before)
- Provide another DSL based on that, to implement app
- *I.e.*, tower of languages

# Racket and **#lang**



# `#lang` providing `#lang`

Relation between specifications and implementation:

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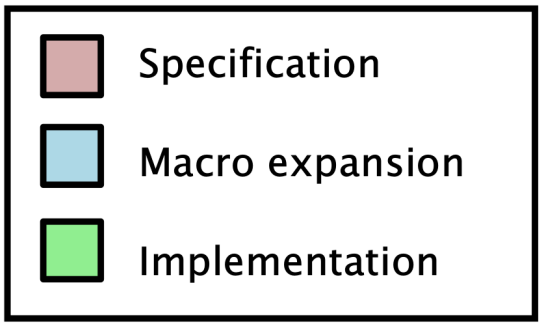
spec.rkt

```
#lang s-exp "framework.rkt"
(define-context Filter ... )
...
```



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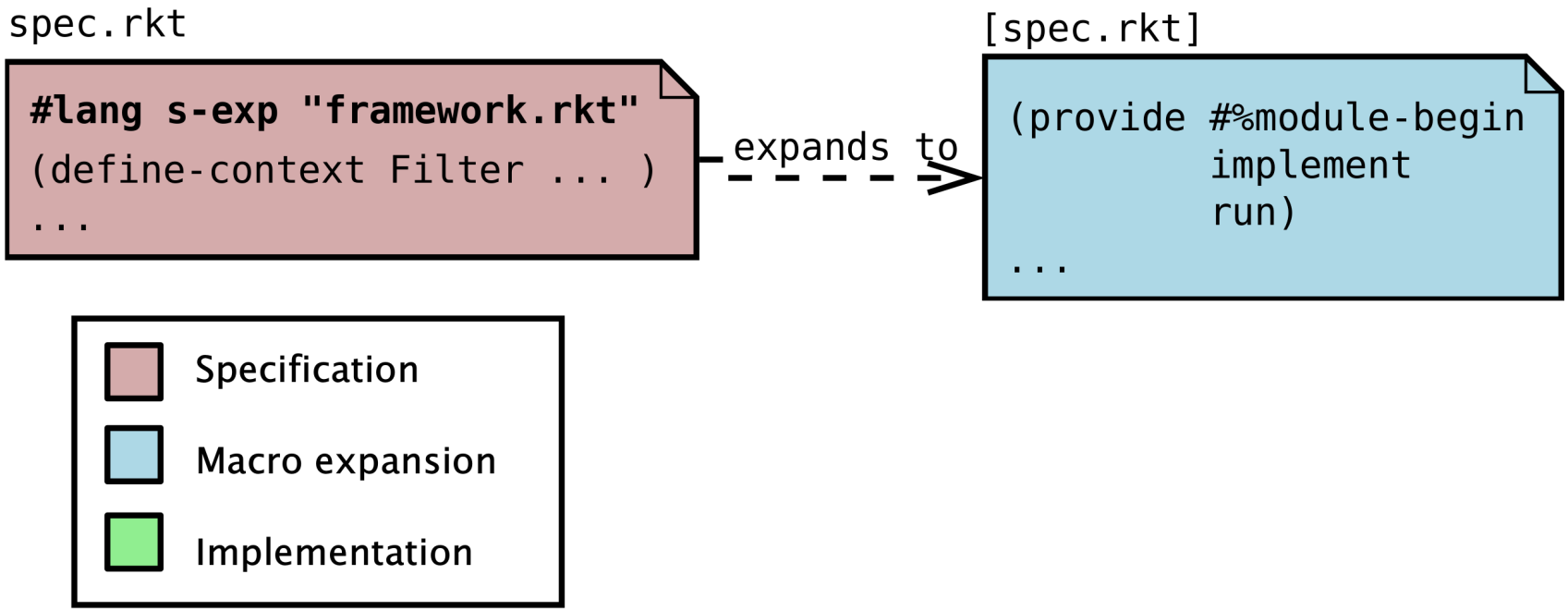

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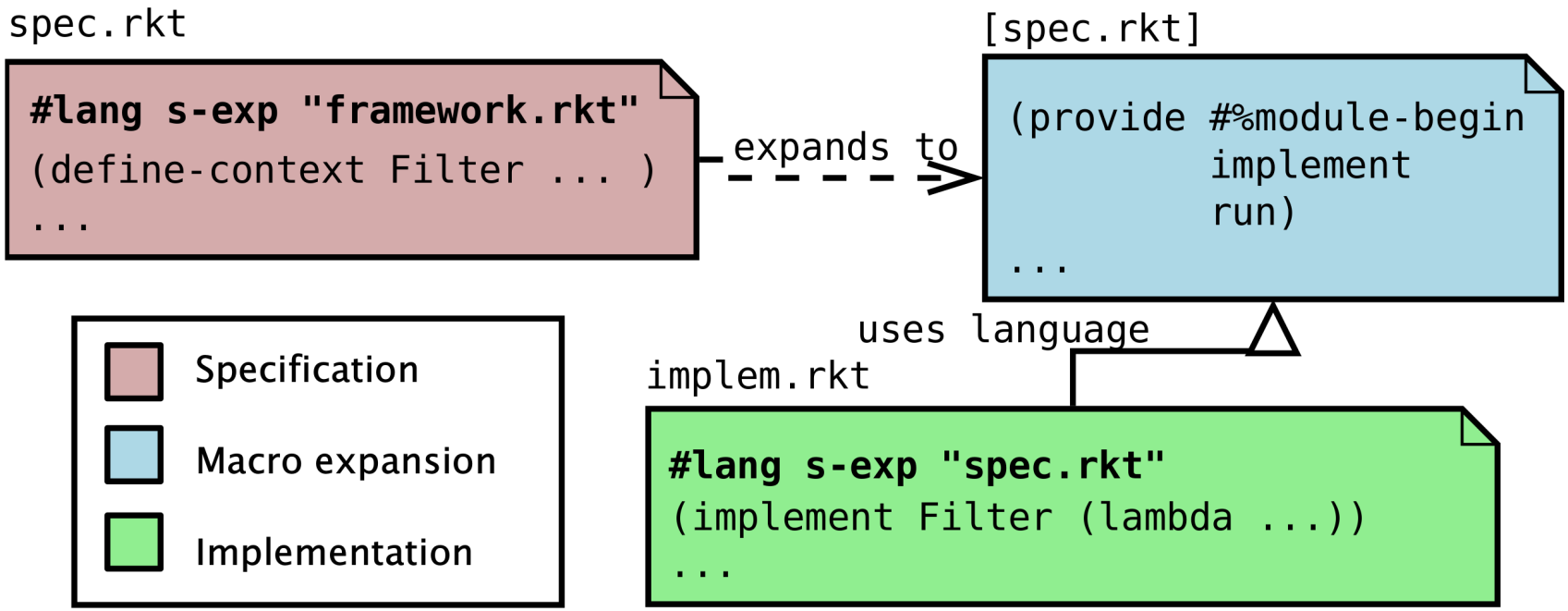

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7 (define-source  Camera Picture) ; built-in
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The types allow us to generate function contracts.

# Implementation

The developer does the following:

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1 ;;; Implementation file, webcamimpl.rkt
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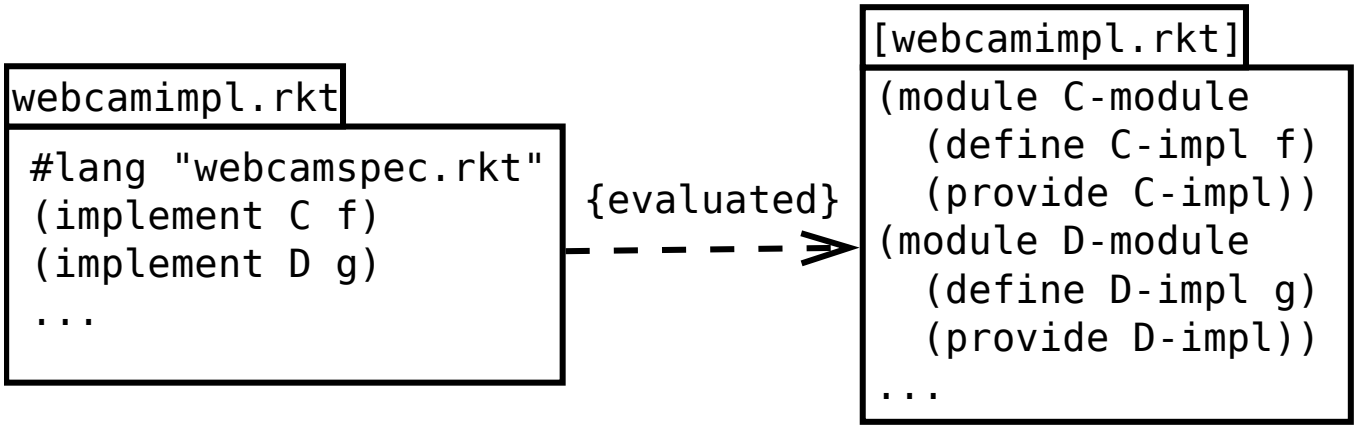
2 #lang s-exp "webcamspec.rkt"
3 (implement Filter
4   (lambda (pic)
5     (let* ([canvas  (make-bitmap pic ..)])
6       ; ... do magic, change colours or whatever
7       canvas)))
8 ;; ...
```

...which will be turned into submodules.

# Separation into submodules

Compartmentalise snippets to enforce safety: $C$ and $D$ cannot communicate.



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`webcamspec` also

- checks that all `defines` have `implements`
- and provides `run`

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- ✓ Submodules ensure no unwanted communication
- ✓ Function contracts give hints to the developer
- ✓ The developer is warned if implementation doesn't match spec

# Want a demo?

– code available on my home page –

http://people.bordeaux.inria.fr/pwalt

# Conclusion

- DSL for tailoring DSLs? :)
- More confidence for user of app
- Relatively nice interface for app developer
- Not 100% practical or watertight – just a proof of concept
  - Use of libraries is tricky
  - Use of `eval` is not permitted
- Would be a great improvement on current mobile permissions systems