Explorations in the predictability of Hardware Interface Layers

Shuman Liu (Michelle)
Supervisor : Uwe R. Zimmer
Summery

• What is this project about?
• Why this is necessary?
What is this project about?

STM32F407xx Discovery Board

- Microcontroller
- No operating system
- Direct Access to the registers
- Full control of the hardware

Photo: Uwe R.Zimmer
https://cs.anu.edu.au/courses/comp4330/1-Labs-Assignments.html
What is this project about?

• Improve the hardware interface layer coding to catch more configuration errors in the compiler stage.
  – wrong sequences of enabling registers/ peripherals,
  – non-syntactically invalid input of function calls
  – …
What is this project about?

• Ada
  – Strong type system
  – Contracts
  – …
What is this project about?

– Contracts

```
package Queue_Pack_Contract is
    Queue_Size : constant Positive := 10;
    type Element is new Positive range 1 .. 1000;
    type Queue_Type is private;

procedure Enqueue (Item : Element; Q : in out Queue_Type) with
    Pre  => not Is_Full (Q),
    Post => not Is_Empty (Q) and then Length (Q) = Length (Q’0ld) + 1
          and then Lookahead (Q, Length (Q)) = Item
          and then (for all ix in 1 .. Length (Q’0ld)
                     => Lookahead (Q, ix) = Lookahead (Q’0ld, ix));

procedure Dequeue (Item : out Element; Q : in out Queue_Type) with
    Pre  => not Is_Empty (Q),
    Post => not Is_Full (Q) and then Length (Q) = Length (Q’0ld) - 1
          and then (for all ix in 1 .. Length (Q)
                     => Lookahead (Q, ix) = Lookahead (Q’0ld, ix + 1));

function Is_Empty (Q : Queue_Type) return Boolean;
function Is_Full  (Q : Queue_Type) return Boolean;
function Length  (Q : Queue_Type) return Natural;
function Lookahead (Q : Queue_Type; Depth : Positive) return Element;
```
What is this project about?

That’s the interface in pure Ada…

• How about the interface in C?
• Or in other programming languages?
Why this is necessary?

• Improve the reliability of the interface and the applications that running on it;
• Application programmer’s life would be a lot easier;
• Protect the hardware from being burnt
• …
Q & A