



Extra-functional Properties of Programs

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Policy-Aware Real-Time Computing

- Examples of policies:
 - Reliability requirements
 - Timeliness requirements
 - Precision requirements
 - Power and other resources
- Neither exhaustive nor orthogonal
- Policies change in real-time

Typical Examples



- Produce the best result in this estimation loop in 2 milliseconds.
- Use sequential-TMR for attitude control for the next 3 hours.
- Run a low-overhead checker on the gyro's output.
- You have 3 watts for entry.
- Do this in 2 milliseconds, or quit.
- If a processor or comm link fails, try again once.



Requirements

- It must be system code and operate automatically
- It must not involve the programmer
- Operates in real-time



The Extra-functional Properties

- To implement the above, the affected programs need to be able to
 - Start/stop/restart
 - Copy/reproduce
 - Moveat arbitrary points.
- One way to achieve these properties is by writing programs that are functions.
 - But not necessarily.



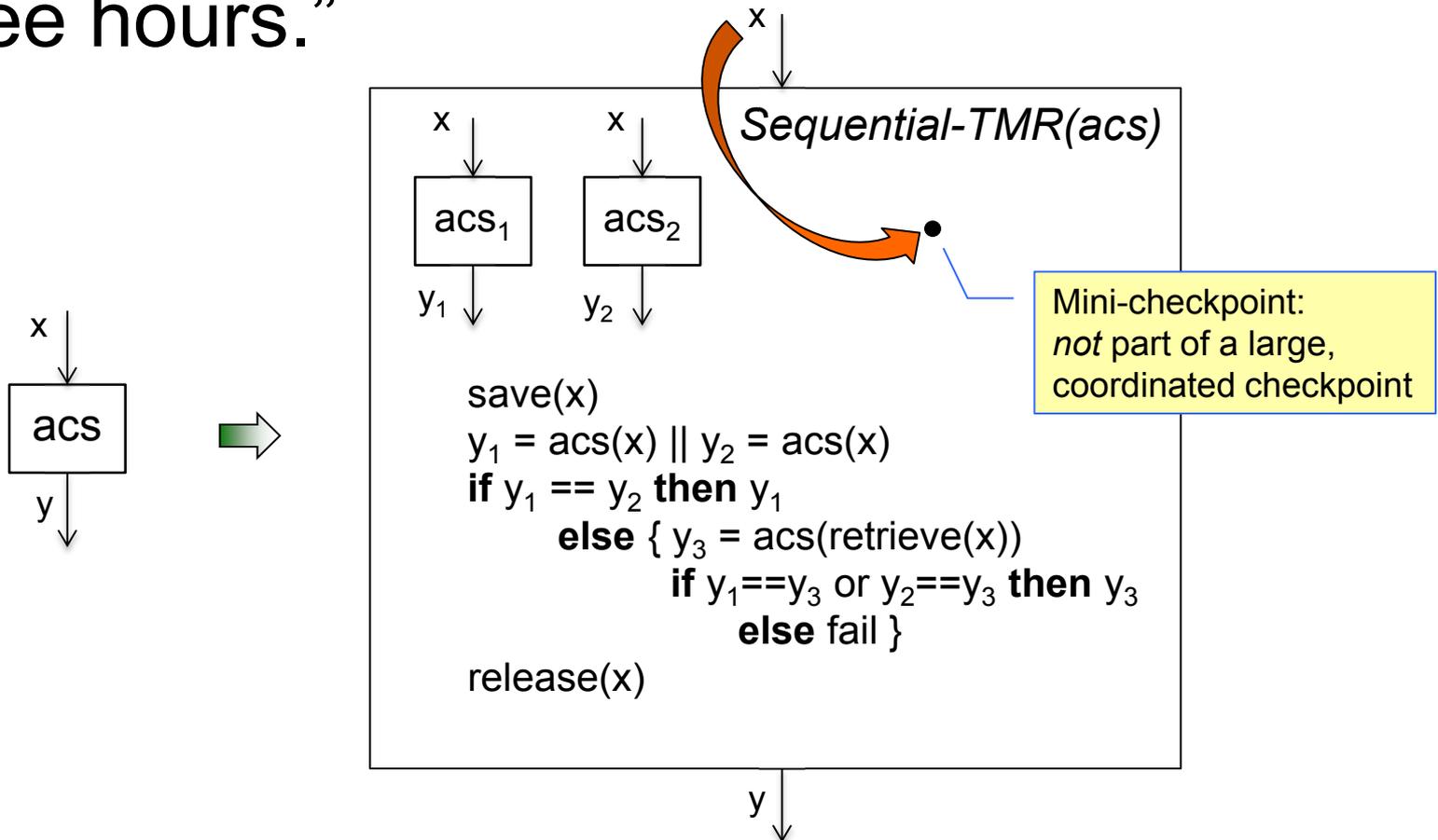
How Do We Implement the System?

- Extra-functional code wraps the affected programs
- Policy implementation can take place at each function call in user's program



Example: Reliability

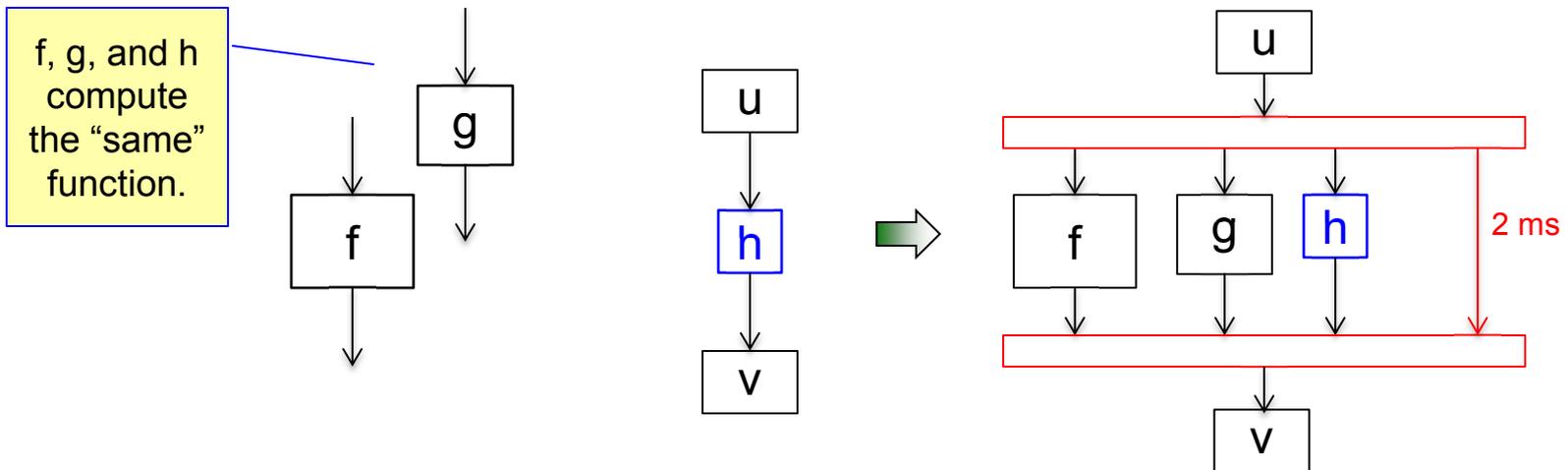
- “Use sequential-TMR on acs for the next three hours.”



Example: Timeliness



- “Get the best estimate you can in 2 ms.”





Example: Power Policy

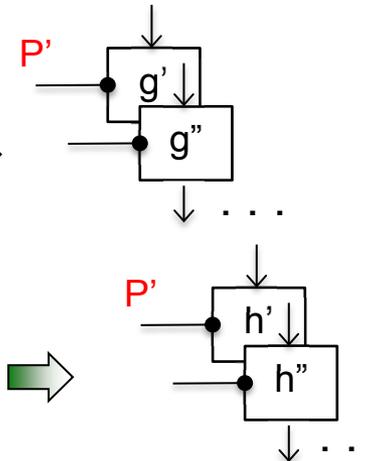
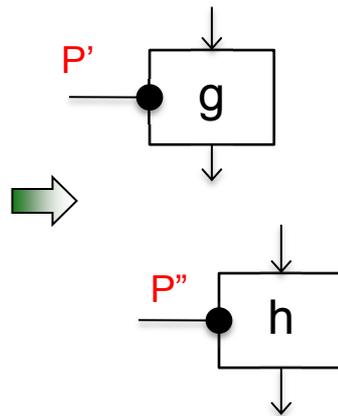
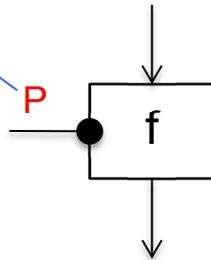
- “You have 3 watts to do entry.”

let $f(x) = \{ \dots g(u) \dots h(v) \dots \}$
where $g(x) = \{ \dots g'() \dots g''() \dots \}$
 $h(x) = \{ \text{etc.} \}$

This might translate into an assignment of 4 cores to function f rather than the usual 1 core.

P is the set of processors allocated by the system to run f and is instantiated at run-time.

$|P| = 4 \text{ vs. } 1$





Summary

- *Policy-based computing* requires extra-functional properties that can apply (almost) everywhere
- The extra-functional properties of interest are
 - Start/stop/restart
 - Copy/reproduce
 - Move
- These properties are assured when the programs are functions.