Cyber-Physical Systems Design & Analysis at Georgia Tech

Presented By: Christopher Cargal

AADL Tool Demonstration Day

2-14-2019

One Course, Two Monikers

CS 7639 : Cyber-Physical Design
(Offered since Fall 2017)
AE 6561 : Reliable Control Software
(Offered for the first time in Spring 2019)

- Dr. Eric Feron
(Georgia Institute of Technology)

- Dr. Jerome Hugues
(ISAE-Supaero)

- With Guest Lecturer: Bruce Lewis
(Adventium Labs)

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No Physical Classroom: So what is this?

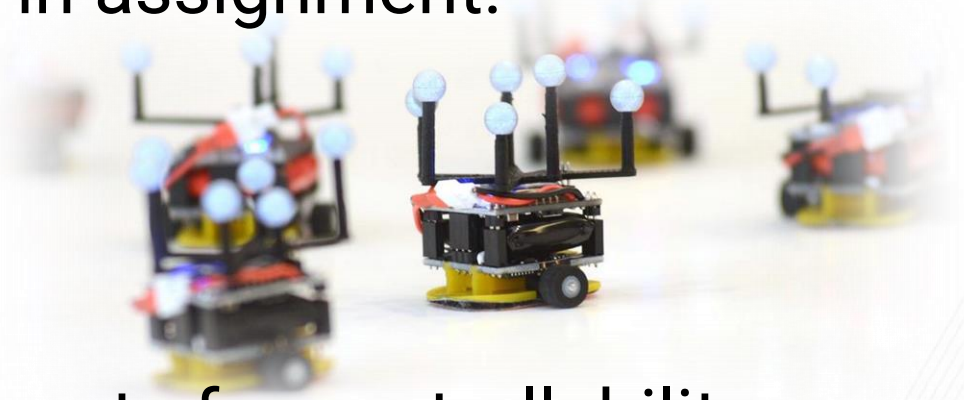
- Video lectures offered online through Udacity to students in both sections.

- “This course introduces (...) cyber-physical system development,(…) model-based development methods, (…) modern verification, and validation techniques” -

https://www.udacity.com/course/cyber-physical-systems-design-analysis--ud9876

Prerequisites and Content

- Incoming students are assumed to have an undergraduate degree in engineering or computer science.
- Concepts and motivation covered in lectures, with practical applications in assignment.



- Emphasis on requirements for controllability motivates the second part of the course.

Course Scope

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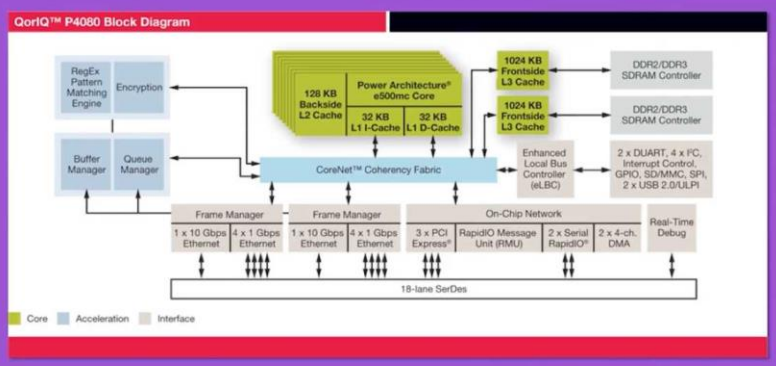

What the Pilot Sees with FA4 'MCP'

Short Period Quiz

Replace the +/- signs in the below second order equation:

$$\frac{d^2}{dt^2}\Delta\alpha \pm \left(-M_q + \frac{L_\alpha}{V_n}\right)\frac{d}{dt}\Delta\alpha \pm \left(1 - \frac{L_\alpha}{V_n}\right)M_\alpha + \frac{L_\alpha}{V_n}M_\alpha\Delta\alpha = \left(\left(1 - \frac{L_\alpha}{V_n}\right)M_{\delta e} + \frac{L_{\delta e}}{V_n}\right)\Delta\delta e \pm \frac{L_{\delta e}}{V_n}M_q\frac{d}{dt}\Delta\delta e$$

to match the first-order vector differential equation:

$$\begin{bmatrix} \Delta\dot{q} \\ \Delta\dot{\alpha} \end{bmatrix} = \begin{bmatrix} M_q & M_\alpha \\ \left(1 - L_q/V_N\right) & -L_\alpha/V_N \end{bmatrix}\begin{bmatrix} \Delta q \\ \Delta\alpha \end{bmatrix} + \begin{bmatrix} M_{\delta E} \\ -L_{\delta E}/V_N \end{bmatrix}\Delta\delta E$$

```
-- Model a sequential execution flow
subprogram Spg                          --  Spg represents a C function,
features                                --  in file "foo.c", that takes one
  in_param : in parameter foo_data;     --  parameter as input
properties
  Source_Language => C;
  Source_Text => ("foo.c");
end Spg;

-- Model a schedulable flow of control
thread bar_thread                       --  bar_thread is a sporadic thread :
features                                --  dispatched whenever it
  in_data : in event data port foo_data; --  receives an event on its port
properties
  Dispatch_Protocol => Sporadic;
end bar_thread;
```

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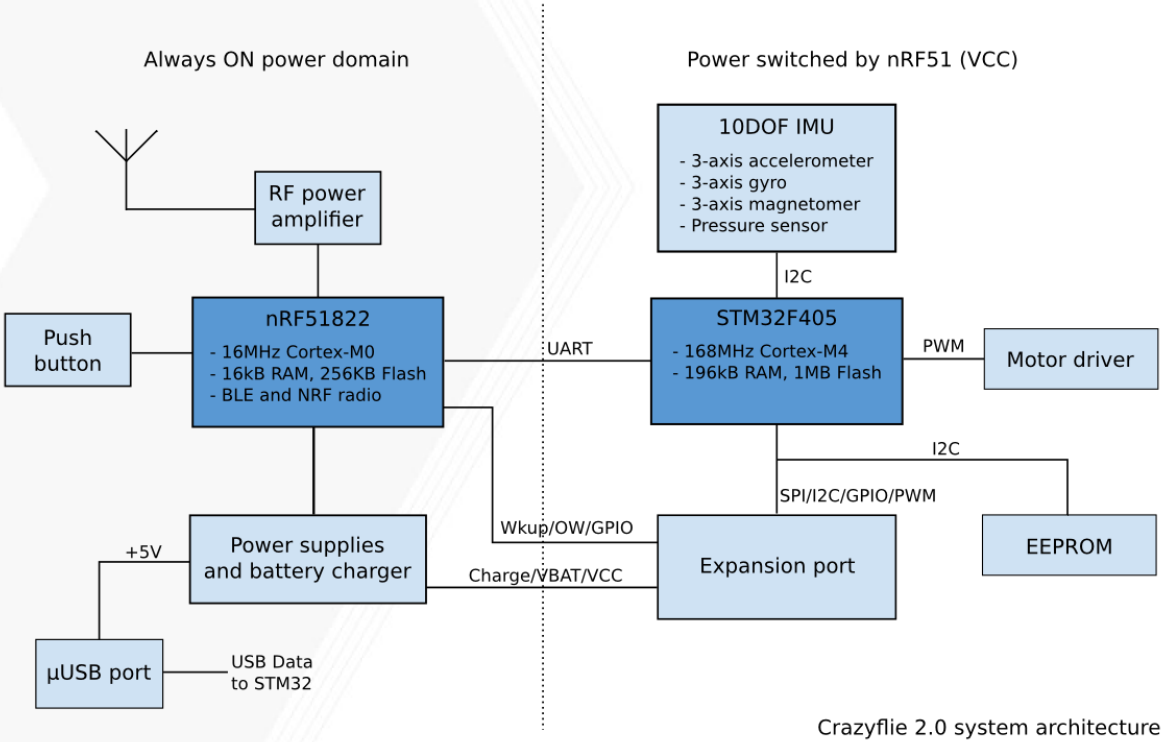
AADL in the Course

- Now that we care about timing and sensor monitoring, we consider the cyber effects.



Crazyflie 2.0 system architecture

- The Crazyflie is modeled in AADL.
- Hardware and software visibility directly from the developer.

Photo Credit: www.bitcraze.io/crazyflie-2/

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AADL Scope

- A model is provided in course assignments with gaps to be filled in by students.
- Flow latency, scheduling, reliability, and error propagation are analysis domains with passing and failing requirements are seen.
- Conceptually covered in lectures, but assignments and supplement material facilitate a deeper learning.

Thank You

Questions?

Lectures available for free at:

https://www.udacity.com/course/cyber-physical-systems-design-analysis--ud9876