Pragmatic ~~vs.~~ and Systematic Engineering

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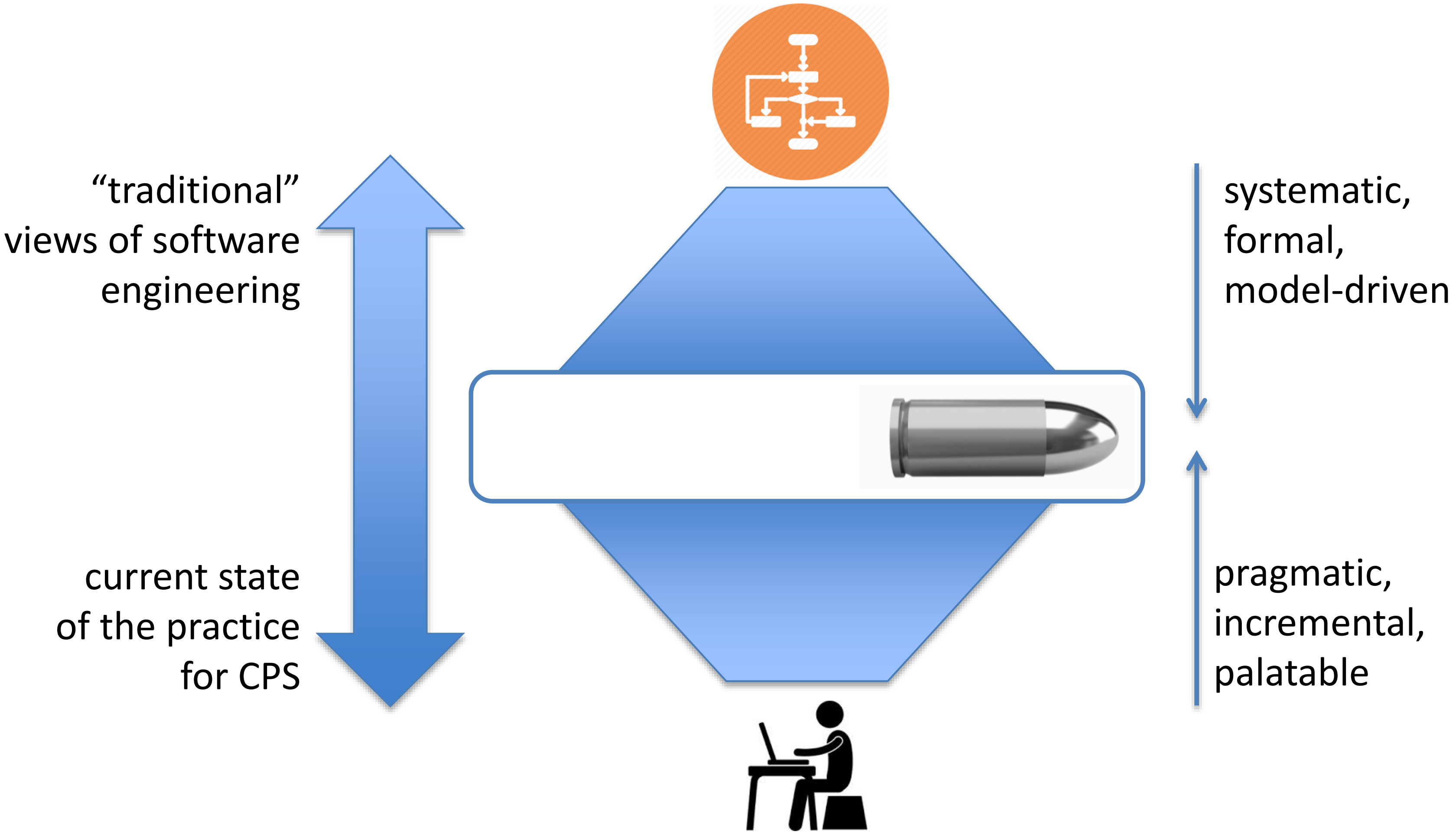
Conceptual Summary



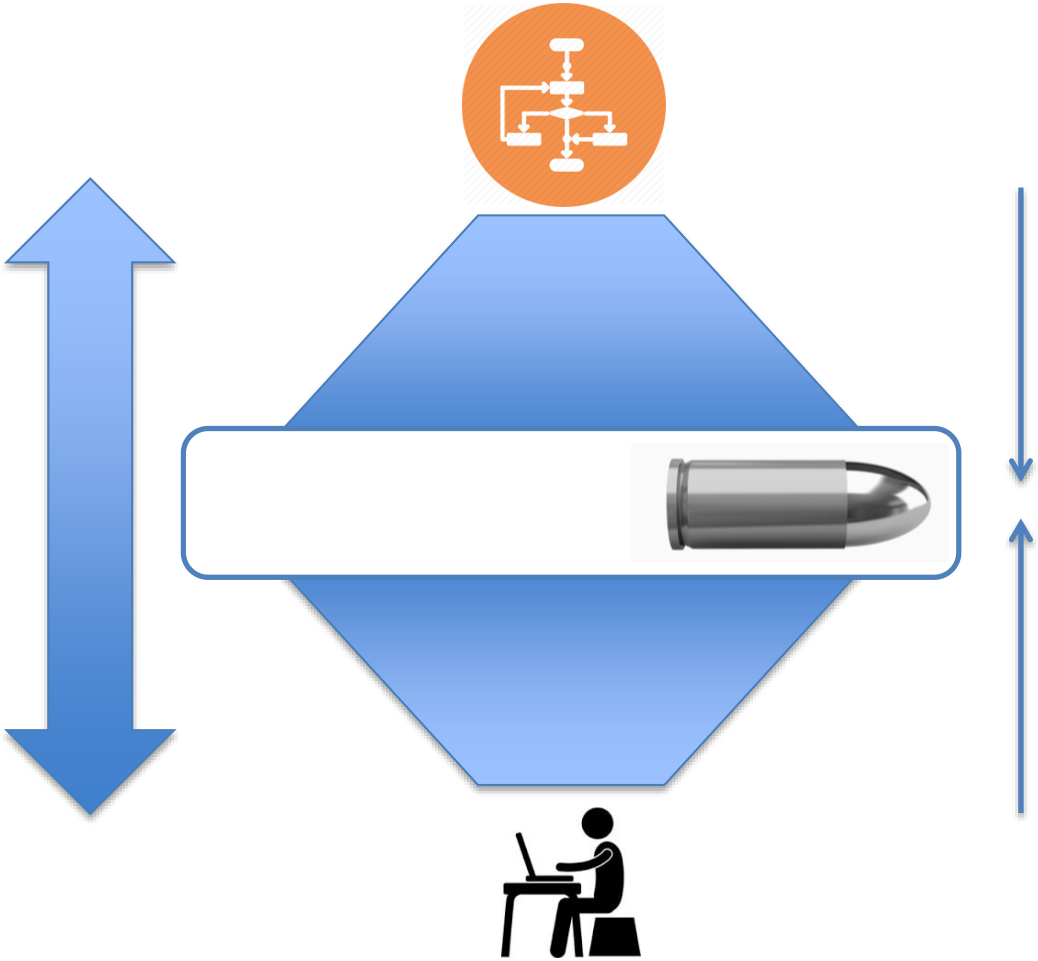
“traditional”
views of software
engineering

current state
of the practice
for CPS

systematic,
formal,
model-driven

pragmatic,
incremental,
palatable

Conceptual Summary



“mission critical” systems

“maker” systems, Internet of Things

systematic,
formal,
model-driven

pragmatic,
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The “Pure” Perspectives

- In “traditional” software engineering, we usually have the goal of abstraction
  - CPS may require balancing this goal with meeting domain experts “at their level”
- From a “purist” perspective, we need:
  - A clear, complete high-level description and a “compiler” that can generate correct code
  - Domain specific languages offer a first step
    - i.e., they make it possible to specify a solution and generate code automatically
  - But generated code is often “not efficient enough”

The Mismatch

- There is a key interdisciplinary problem
  - i.e., a “mismatch” in the languages spoken by the software engineers and the domain experts
- Often what happens is the domain experts build a system
  - When they’re desperate, they call in a software engineer to try to find the problem
  - The software engineer has to become immersed in the domain
- Recent anecdotal efforts hint at interdisciplinary teams that start with domain experts and software engineers

A Continuum of Systems

- There are different categories of systems
  - Mission critical ones may *require* a rigorous approach from the outset
  - However, more “user” level systems (e.g., in the IoT, “maker” systems, etc.) may not
- Systems are almost universally made up of components
  - There is a danger in the components being used for something unintended later

Some Directions

- Can we leverage system “smarts” to aid in high quality systems?
  - Maybe it’s ok for the system to have flaws, as long as it has the smarts necessary to recover or repair itself
- Can we derive models that are inherently composable?
  - We can then model components of a CPS that it is necessary to model and perhaps not others
  - Individual models may then be more tractable
  - “Connectors” across models could account for consistency, timing, security, etc.

Some More Directions

- We need to improve design-time techniques and make them accessible to domain experts
  - However, we may also want to do some of the checking at run-time using real world data
  - Design-time checking will necessarily be more open

A Caveat

- We are not going to replace the domain experts
  - The domain expert needs to be able to rely on tools to *introspect* expressively
    - Provable correctness (even at the component level)
    - Testing in the *your* environment (i.e., a well-defined test suite) – relationship to “certifiable” components
    - Smartness and self-adaptation
  - How do we make the domain experts trust the tools?
    - Time? Mixed teams? Technology transfer?
    - **Evidence**