Issues in Cyber-Physical Systems Architectures

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Four architectural properties

- System development and debug time
  - Architecture for proliferation

- Safety
  - Architecture for verification/validation/proof of correct behavior

- Performance
  - Architecture for speed/precision

- Security
  - Need a theoretical foundation
Abstractions and architecture for proliferation

What are the abstractions and architecture for convergence of control with communication and computing?

Goal is to enable rapid design and deployment

Critical Resource: Control Designer’s Time

Standardized abstractions

Minimal reconfiguration and reprogramming

Hopefully leading to proliferation
Architecture for verification/validation/proof of correct behavior

Three challenges

– Distributed nature of system
  » Proof of correct interactions

– Temporal behavior
  » Computation and communication must interact in the correct temporal way with physical system

– Complexity of interactions/verification
  » Number of states is large
  » Complex combinatorial behavior

In-Vehicle Networks

Wire harnesses are:
Costly (>\$1000.00)
Complex (>4,000 parts)
Heavy (>40kg)
Warranty issues (>65 IPTV)
Architecture for high performance

High performance may conflict with composable/layered architecture

– Reminiscent of cross-layer design in wireless
  » “If I expose TCP parameters to MAC, then performance can be increased by 10%”

– Tension between architecture and performance?
Architecture of security

Complexity of physical and computational and communication systems and interactions

- Cross-layer attacks

- Need for a holistic theory of security
Thank you