TTEthernet in System Architecture, Platform Context Reducing Software and System Complexity

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Distributed Embedded Computing

Distributed System with Sensors, Actuators
and Hard Real-Time Control Loops

Distributed Embedded Computing Platform
Modules operate as a set of states and state transitions

System Integration Technology (Network)
System States and Complexity

Expected System States and Transitions

SYSTEM INTEGRATION TECHNOLOGY
(ETHERNET NETWORK)
Complexity and System State Explosion

SYSTEM INTEGRATION TECHNOLOGY
(ETHERNET NETWORK)

! System after integration!

Challenges for Program Risks, Schedule and Cost Overruns!!
Study on software design in complex integrated systems and avionics found 130 root-causes (!) for software design challenges, …

As expected the majority of challenges with software and application development in complex integrated systems can be related to “inadequate understanding of the requirements and design of a function or interface, not coding errors.”

… but finally there are root-root-causes: “problems in requirements issues, development, testing, and validation and verification of the actual code all revolved around interfaces.”

Steve Jolly, Lockheed Martin, October 2009
NASA Ask Magazine, p.22

Can we describe key system interfaces well?
How the system integration technology or architecture supports that?
Functional coordination among functions via „interfaces“

- Includes temporal/functional behavior of network, middleware, application behavior
- Where is „the interface“ defined in your integrated system?
Clean Layered Model for Critical Functions

Interfaces and temporal behavior defined at network level

- Middleware contains parameter-defined communication abstraction and redundancy management (voting)
- Application can handle only functional aspects without temporal interdependencies (no busy waiting, watchdogs, semaphores, …)
  - All behavior related to progression of time, not dependant on HW or SW platform
  - Supports model-based application design (simple computation tasks!)
- All sensors and actuator access synchronized to μs (using simple IO tasks)
Many virtual links with different QoS can be defined for one Ethernet network

TTEthernet

Enables:
delivery of synchronous services,
A/V, critical controls,
low-latency and standard LAN apps
in one network

TTEthernet Capabilities

Synchronous (TDM) Traffic
Rate-Constrained (RC) Traffic
IEEE AVB/DCB ARINC 864
Priority-based Asynchronous Ethernet Traffic
Best-Effort (BE) Ethernet Traffic
Functional alignment for critical functions at network level

- Simplified sensor fusion
- Simplified distributed processing
- Simplified redundancy management
Impacts system architecture design and all lifecycle phases

- SW Design
- Testing
- Upgrades
- Extensions
- Certification
- Reuse
- Redesign
- Maintenance

Predictable system operation and functional interdependencies

- System Integration Capabilities
  - communication determinism (predictable operation)
  - control of temporal interactions
  - robust bandwidth partitioning and fault isolation

- Platform Capabilities
  - separating temporal and functional behavior
  - control of functional interdependencies
  - unambiguous definition of system interfaces
  - software abstraction
  - robust partitioning of all computing/networking resources

- System/Software Complexity Reduction
- Schedule/Costs Overruns Minimization