GSAW Breakout Session

Process Mismatch with COTS-Based Systems: Problems and Solutions

Developing and Negotiating Requirements

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April 2, 2004

Integral System Background

- Integral Systems, Inc. (ISI), provides satellite ground systems
  - Founded in 1982, 350 employees
  - Headquartered in MD; Offices in CO, OH, & Toulouse
  - Three subsidiaries; RT Logic, Sat Corporation, Newpoint Technologies
- We produce COTS software packages, and offer COS software suites
  - First to market with commercial software for command and control
  - Largest installed base of command and control systems in the world
  - Over 120 command and control systems delivered successfully on five continents
  - 50% world market share for commercial satellites
- We act as system integrators for turnkey systems
  - We provide a suite of COTS solutions
  - We enhance our products through bundling with 3rd party hardware and software
- Prime Contractor for CCS-C
  - Command and Control System – Consolidated
    - Monitors and Controls MILSATCOM Satellites

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Requirements Development (Commercial vs. Government Contracts)

- Initial requirement definition should be limited to high level only
  - Don't force a design, or accommodate "COTS looking for a solution"
  - Less is better

Commercial Contracts

- Typically requirements are defined within several pages of a "Statement of Work" type document
- Any "low level" requirements included are the exceptions to the rule and are usually only specified when something is not obvious
  - For instance, there is no need to specify that a design for new car has a steering wheel instead of a yoke unless you expect to use the car in an unconventional way

Government Contracts

- Requirements are specified more formally
  - Allows more a more equal playing field among competitors
  - Required to meet various FAR (Federal Acquisition Regulation) clauses
- Many times "low level" requirements are specified simply to meet a heritage "Ops Con"

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Requirements Development (Commercial vs. Government Contracts)

- Subsequent mapping of requirements into either COTS vs. custom code allows quick ID of product applicability
- Requirements tracking, mapping, and reporting maintains clear relationships and uncovers holes

Commercial Contracts

- Generally only high level mapping is done, very little documentation is produced to formally show the mapping
- Testing of delivered product can be informal, many times a comprehensive "demonstration" can be done to sign off on a system

Government Contracts

- Formal traceability is documented in various Product Specification and Requirements documents
- Government contracts tend to be "longer" with more builds
  - More sophisticated tracking is needed so that only the appropriate requirements are tested at each phase

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Requirements Development (Commercial vs. Government Contracts)

- COTS allows quick prototyping
  - May lead to new requirements, altered requirements, changed mapping
  - Can provide initial verification of architecture

Commercial Contracts

- Prototypes are crucial to helping our customers develop an Ops Con
  - Many times requirements are written AFTER a prototype has been demonstrated
- Changes to requirements are usually minimal due to the fact that requirements are at a high level
  - When things “change” it usually simply means that a refinement to an interpretation of a requirement has been made

Government Contracts

- Prototypes can be beneficial to demonstrate capabilities
- Lots of early customer interaction is encouraged but can impact the overall progress of the program
  - Contract Negotiations and Systems/Software Development follow two separate path that must meet
  - Good Systems Engineering must be in place to ensure that developers do not act solely on “comments” and that legitimate changes can progress swiftly through the contracting approval process

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Requirements Development for COTS-Based Systems

- COTS requirements should stop at functionality, not go into detailed design (simplifies testing too)
  - If a requirement specifies some type of design, then it may be impossible to meet the requirement with a COTS product even though the COTS product can meet the intent of the requirement
  - Writing a test procedure to verify a requirement is easier to do if the requirement is at a functional level
    - At the test procedure approval phase, if additional detail needs to be added to a procedure to verify something very specific, it can easily be accommodated
    - This allows the test to be focused on what is important
  - It may be difficult to modify a COTS product to include new requirements
    - Even though a company may have access to COTS source code, the product is generally maintained by a separate group whose staffing, funding, and schedule are driven by factors outside any single program

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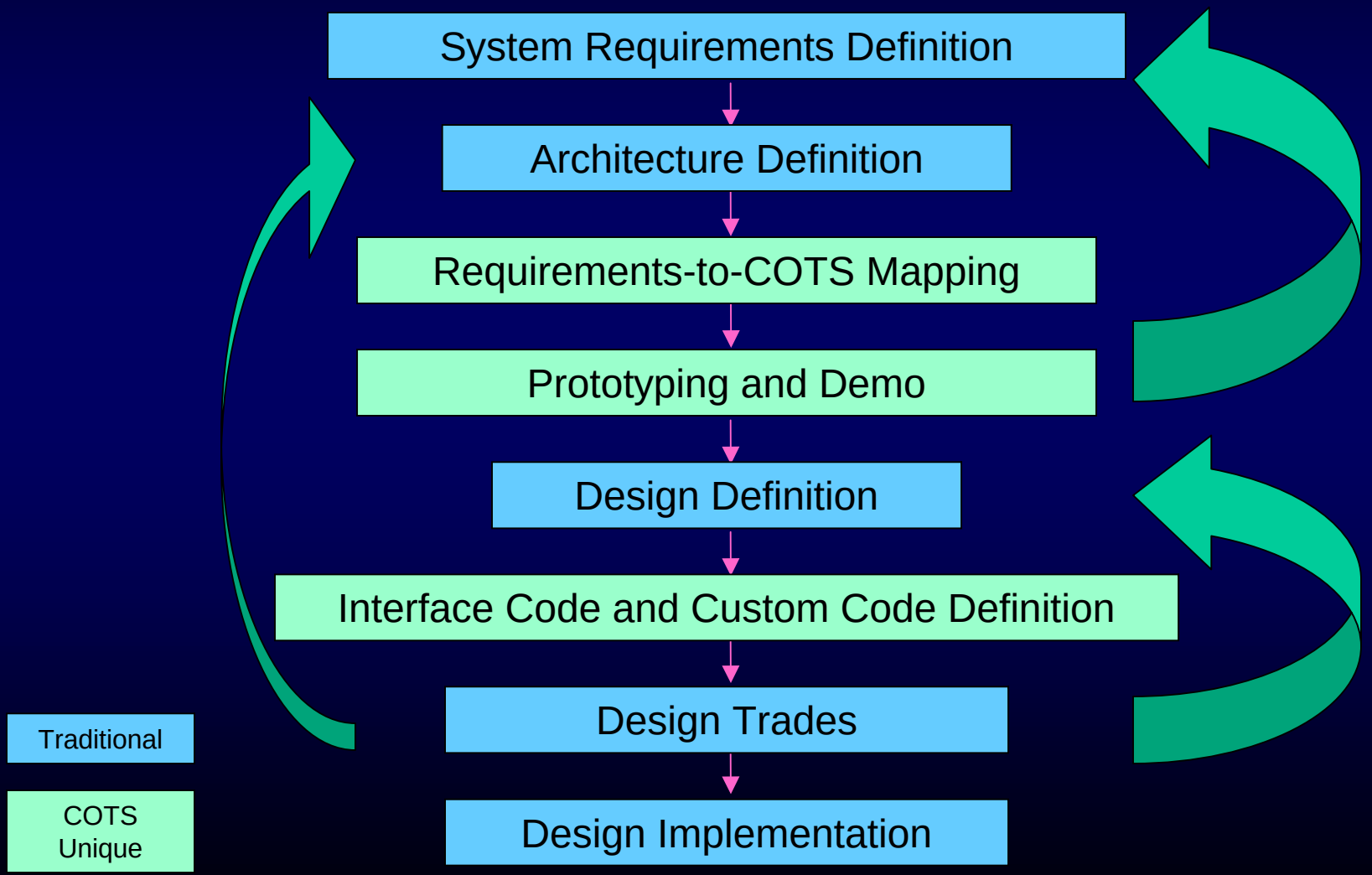
Augmented Process



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CCS-C Example

- For CCS-C the requirements, and therefore architecture, cleanly mapped to COTS components
  - In Phase 1 design competition, requirements were defined, as well as a logical architecture, which included large COTS components
    - Requirements that were first overly restrictive were re-examined and improved
  - In Phase 2 award phase, architecture was refined to include over 30 different COTS components
  - Our COTS-based architecture facilitated a clearer understanding of the system, and how it would be built-out
  - Very few trades were necessary with customer requirements
- Systems Engineering played a key role
  - The DOORS DB tool was used for tracking/mapping requirements to COTS components, and custom elements and components
- CCS-C is an excellent example of a good contractor/customer working relationship
  - Partnership rather than antagonistic

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Requirements Development Conclusions

- Keep the requirements high level
  - Allows for easier functional mapping into COTS and custom code
- Allow for iterative process of definition, mapping and refinement
- Keep COTS requirements at black box functional level
- A shoulder-to-shoulder approach between customer and contractor is necessary
  - This approach provided flexibility, and accommodated demands of “process tracking” without being overtaken by process
  - Allows for more detailed requirements to be added under already existing requirements for clarification
- A strong systems engineering effort is necessary
  - Keeps everyone aware of requirements and how they are going to be interpreted and implemented
  - Provides a single focus point (lower level IPTs defined the details and presented them to the community through the SE IPT)
  - Maintained a traceability of requirement changes

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Creating and Validating Architectures

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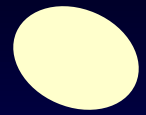
Which came first, the Architecture or the COTS?



- From the beginning…
  - Traditional approaches to requirements and architecture development was linear and most if not all systems were custom
  - Functional decomposition lead to subsystem definitions
  - COTS products were eventually developed that could meet specific subsystem or component needs, fill “niches”

BAD COTS

- Recent History
  - COTS products were touted as low cost “plug ins” to any architecture
  - “COTS glued together” even though the rage, was not effective or cost efficient

GOOD COTS

- Contemporary Answer – ISI’s answer
  - More robust COTS products, used appropriately and combined with good systems engineering practices, are highly cost effective and can be integrated into a flexible, extendable, maintainable architecture.
  - Requirements development can still be process driven, but the process can’t be rigid
  - Systems engineering plays a key role

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Validating COTS-based Architectures

- COTS allows rapid prototyping
  - Demonstration of capability early on of a small scale similar architecture is very effective
  - Factory developed performance tests of similar component quantities and loading is effective
- COTS allows fairly easy reconfiguring – “what if” configurations
  - Findings of performance tests can lead to validation, or drive selection of alternate architectures
- Future validation – formal subsystem and system test – is simplified
  - Its not necessary to test COTS components at code or unit level

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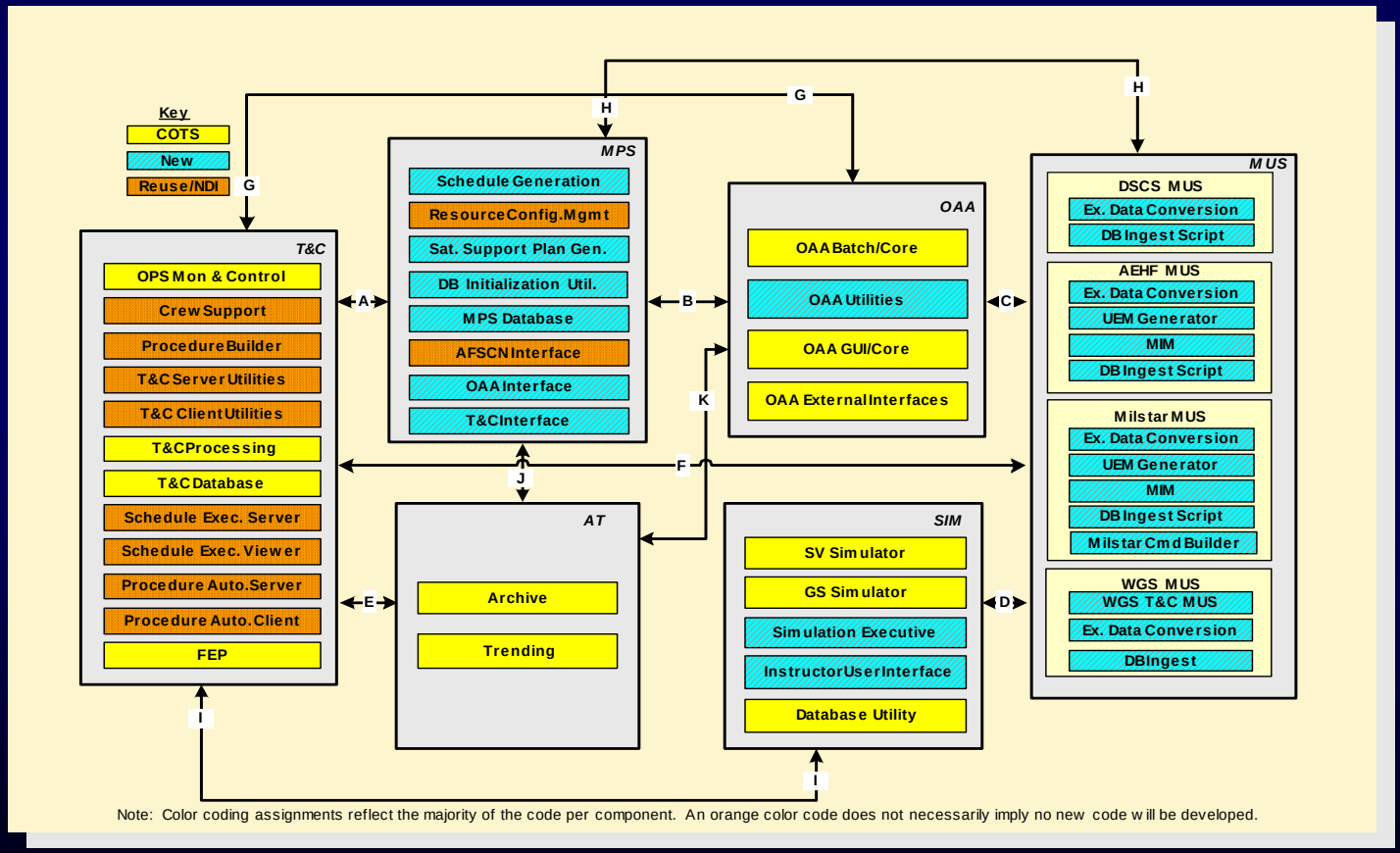
Creating and Validating COTS-Based Architectures

- CCS-C Architecture Example



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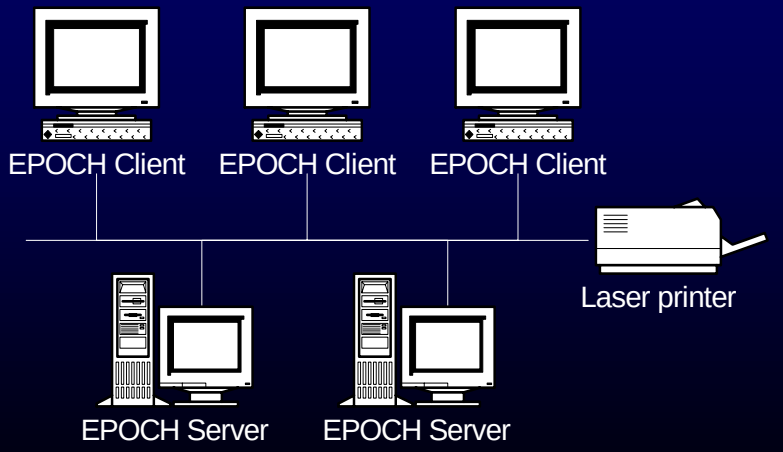
Typical ISI Architecture

- EPOCH Architecture
  - One of more servers and one or more user client workstations interconnected via LAN/WAN
  - Each server can control one or more satellites
  - Each client can connect to any/all servers
  - Spacecraft defined via database
- Open interfaces using industry standards allows integration with other COTS products



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CCS-C Example

- CSC-C used a multi-tired approach to testing
  - Initial performance
    - Initial performance data was available during contract demo phase
    - Performance data was available at CDR
  - Informal Subsystem and system testing
    - Components with custom code required more rigorous testing
    - Component level test done at contractor factory
  - Formal
    - Subsystem, inter-subsystem interface, and some system level testing done at factory
    - Preliminary end-to-end ops and performance testing conducted at factory, and that shaped the formal test on site
    - Subsystem install and regression testing done on site
    - System and external interface testing done on site

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