Challenges and Approaches to Architectural Analysis in the Evolution of SW Intensive System Architectures

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Outline

- Lifecycle Challenges
- Experiences
- Model Driven Engineering Approaches
- UML® 2.0 based approach in an evolving lifecycle
- Open Issues

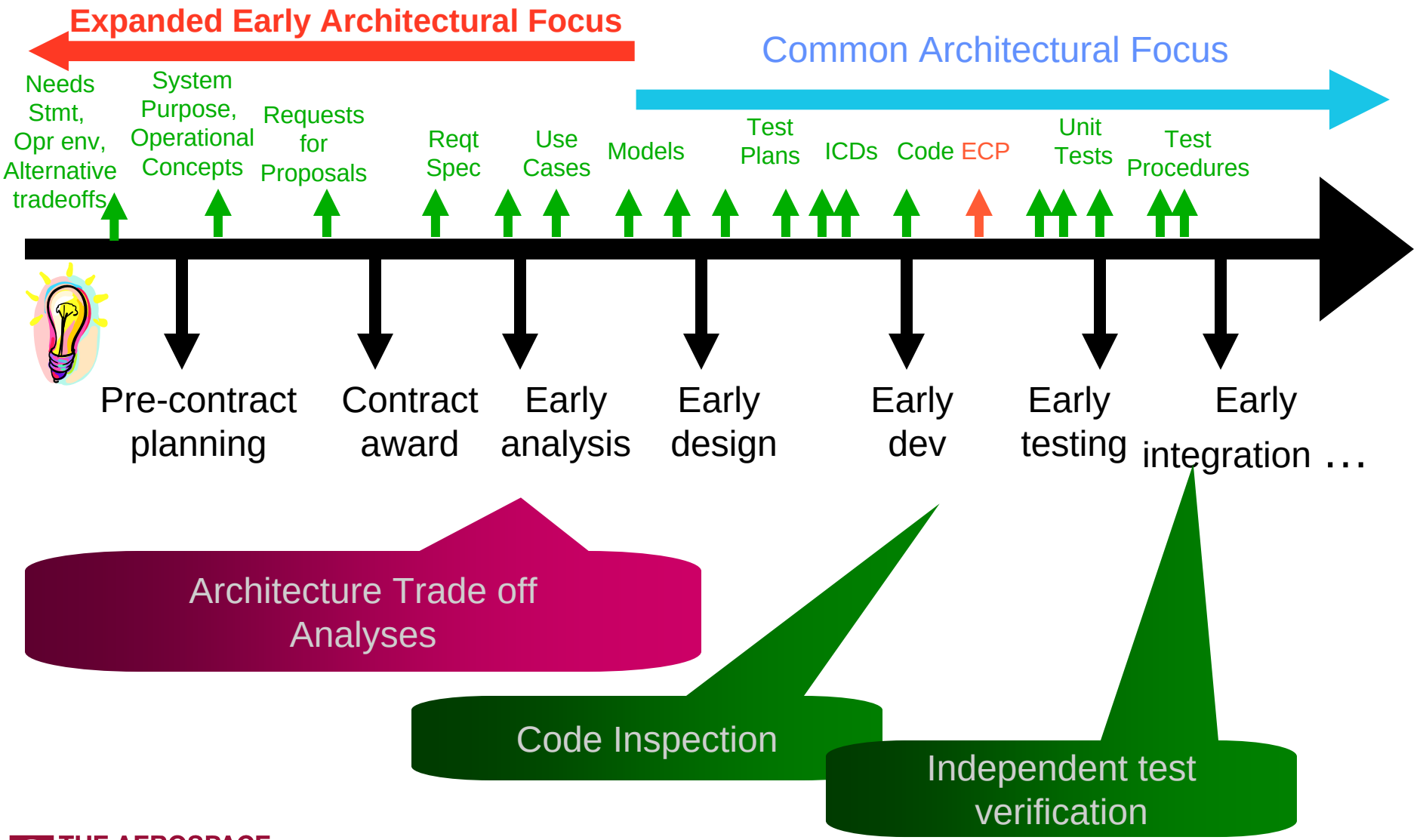
Lifecycle Challenges

- Restore confidence to deliver space systems (processes and products)
- Understand how legacy designs constrain newer innovations
- Scalability of current practices in managing complexity
  - Synthesizing solutions
- Early insight while managing lifecycle change
  - Evolving conceptual models
  - Design optimization from alternative trade-offs

Experiences

- Conceptual and implementation-oriented models not well managed
  - Goal tradeoffs affecting operational concepts not well supported (e.g. safety vs. security)
  - Better methodologies to represent/analyze evolving conceptual architectures needed
- Evolving requirements refinement and constraint impacts
- Solutions-oriented vs. problem domain-oriented approaches
  - Construct by correction vs. correct by construction
  - Domain abstractions frequently revised: Platform Independent Models not unique!
  - Test driven design is costly
- Complexity of multi-phase builds
  - Split baseline designs complicates re-baselining and testing
  - High risk refactoring/rework from poor problem understanding
- Crosscutting concerns do not match problem ownership decomposition

Idea



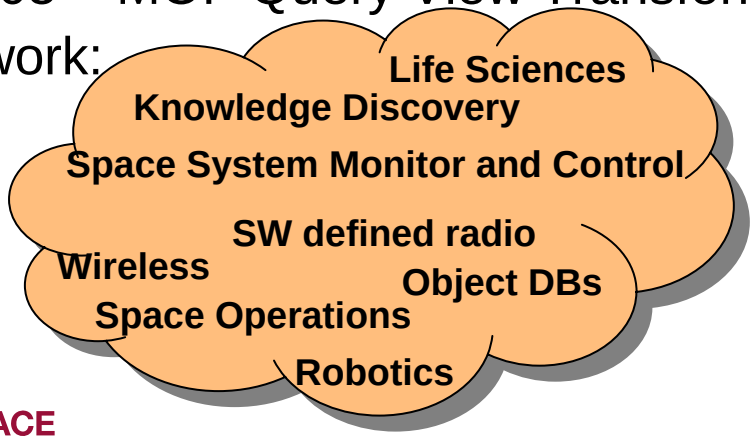
Model Driven Engineering Approaches

- Model Integrated Computing (MIC)
  - Domain Specific Modeling Languages (DSML)
- Model Driven Architecture (MDA®)
  - UML 2 with domain-specific profiles

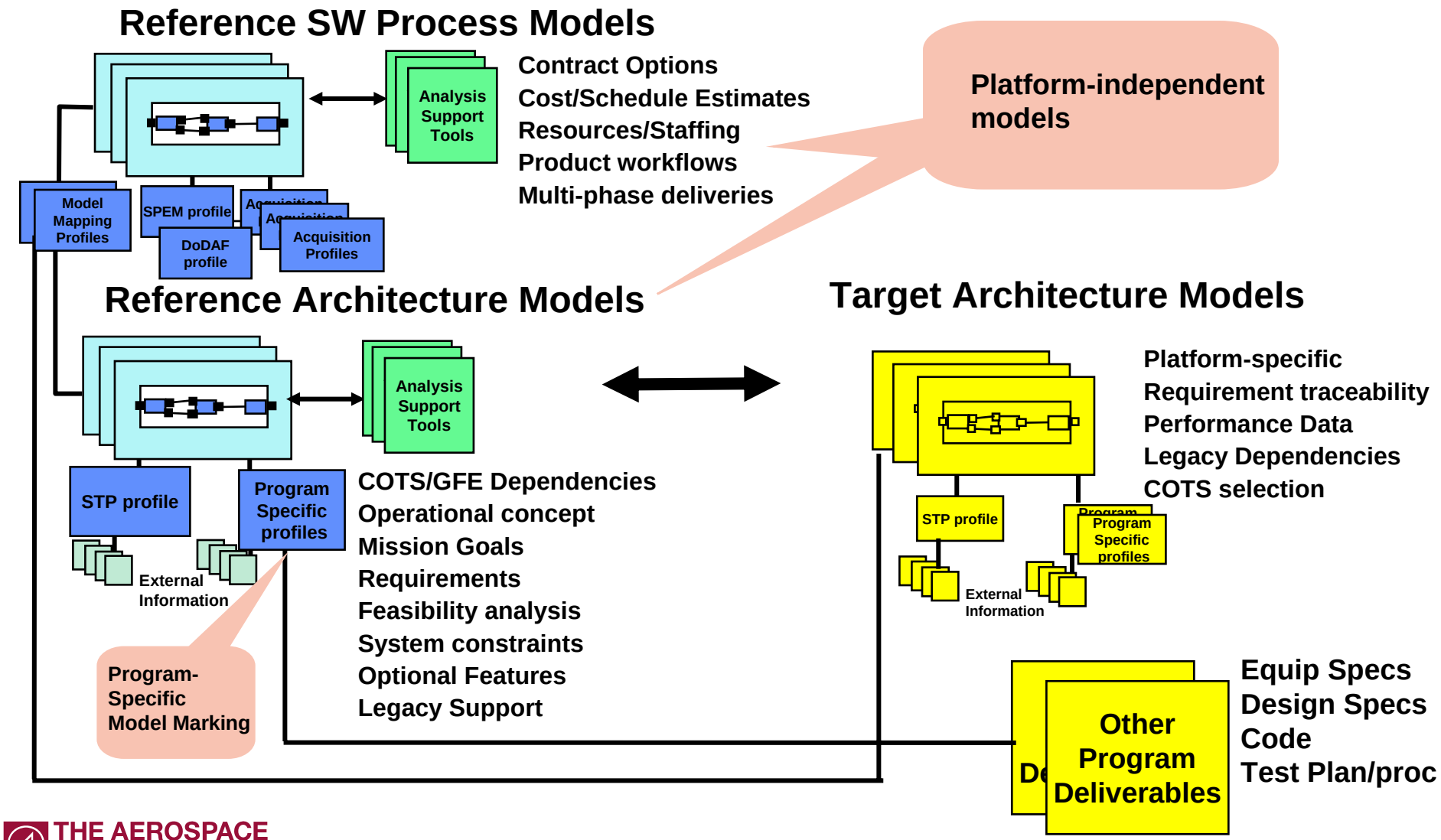
® MDA, Model Driven Architecture is a registered trademark of Object Management Group, Inc. in the United States and other countries

Current UML-related Work

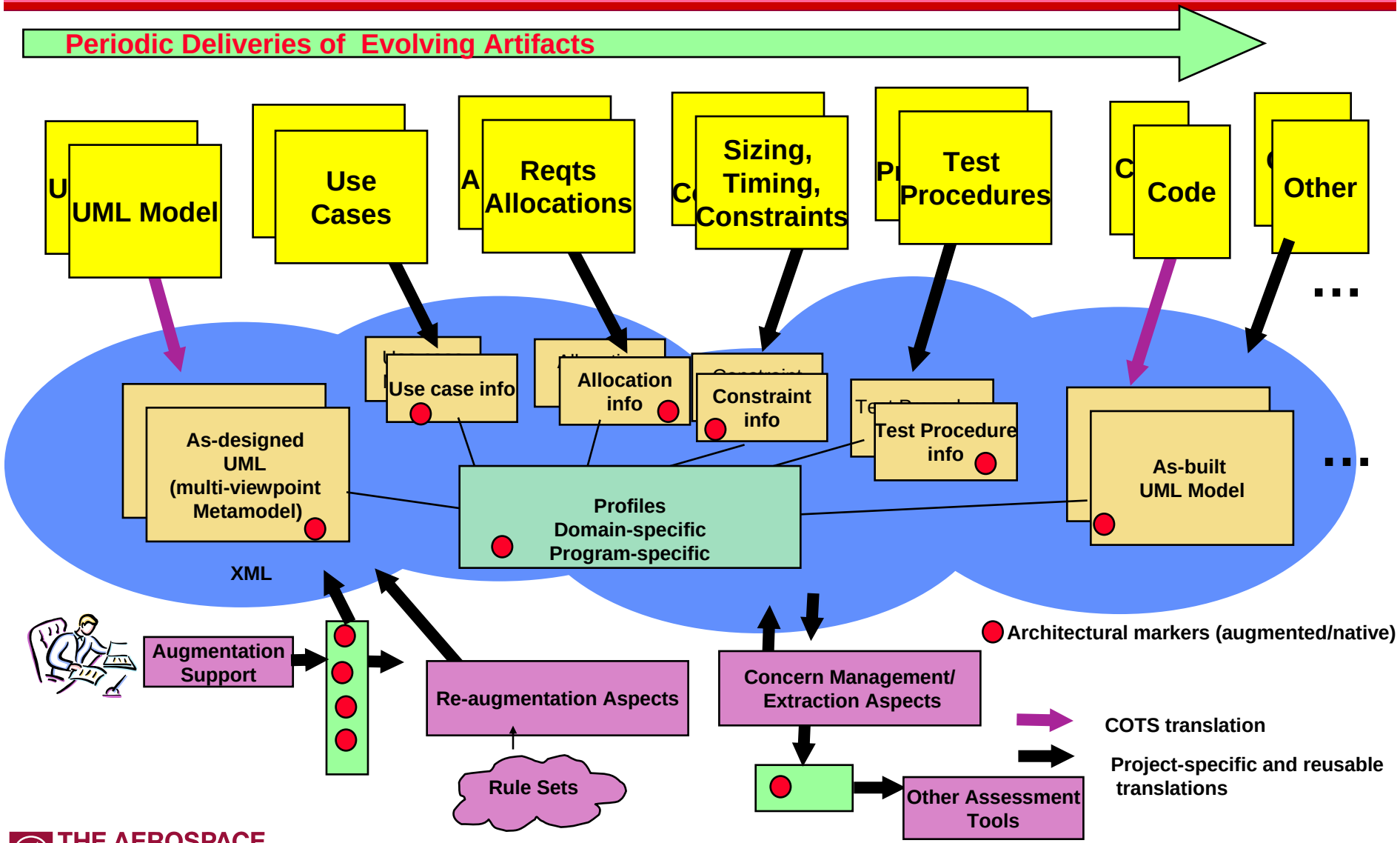
- Dec 2004 – OMG UML Profile for STP v1.1
- Jan 2005 – OMG SPEM v1.1 Software Process Engineering Model
  - Metamodel or UML profile
- Feb 2005 – OMG UML Profile for MARTE RFP
  - STP profile replacement
- Jun 2005 Object Constraint Language 2.0 Spec (working)
- Jul 2005 UML 2 Specs
- Sep 2005 – OMG released UML Profile RFP for DoDAF/MODAF
  - System, technical, operational, strategic views
- Nov 2005 – MOF Query View Transformation Spec
- Other work:



Model Driven Engineering Approach



UML Profile Approach



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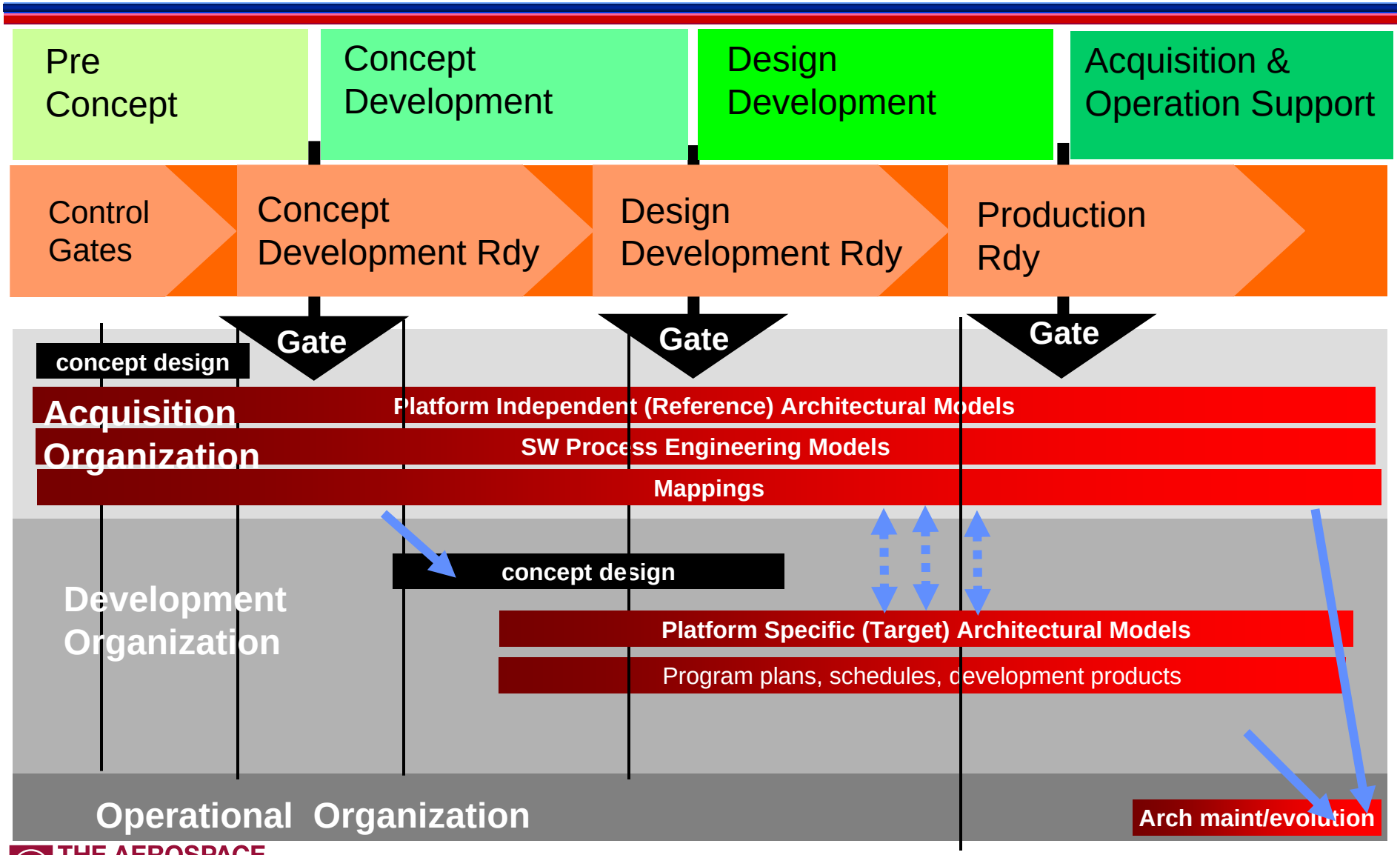
UML Profile Approach

- Use UML2 models and domain-specific profiles as an architectural analysis framework
  - Aspects of interest defined as stereotypes, constraints, tags in domain-specific/project-specific profiles
    - Applicable across entire lifecycle
      - Requirements, constraints, non-functional goals, other model info (legacy)
      - Capture early architectural information prior to contract award
    - Permits augmentation
      - To identify conceptual vs. implementation models
      - Of reverse-engineered legacy assets
      - Reusable across evolving models
    - Crosscutting concerns managed over metamodel space
  - Capture early conceptual reference architectural information in an implementation-independent model
- Model query/transform capabilities
  - Model checking: aspect-oriented architectural analysis
  - Simulation generation for analysis of alternative designs
- Map conceptual model to implementation model
  - Permits project-specific schemas for model augmentation

Applying MDA approach in the System Lifecycle



Open Questions/Issues

- What challenges to analyzing evolving architectures have you found?
- What evaluation techniques have you found useful?
- How should systems acquisition business model change?
- How should architecture artifacts be maintained during life-cycle?
- Ownership, maintenance of conceptual models
- Managing mappings between conceptual and implementation models
- Processes to resolve crosscutting concerns effectively
- Effective interchange of models for analysis

Backup

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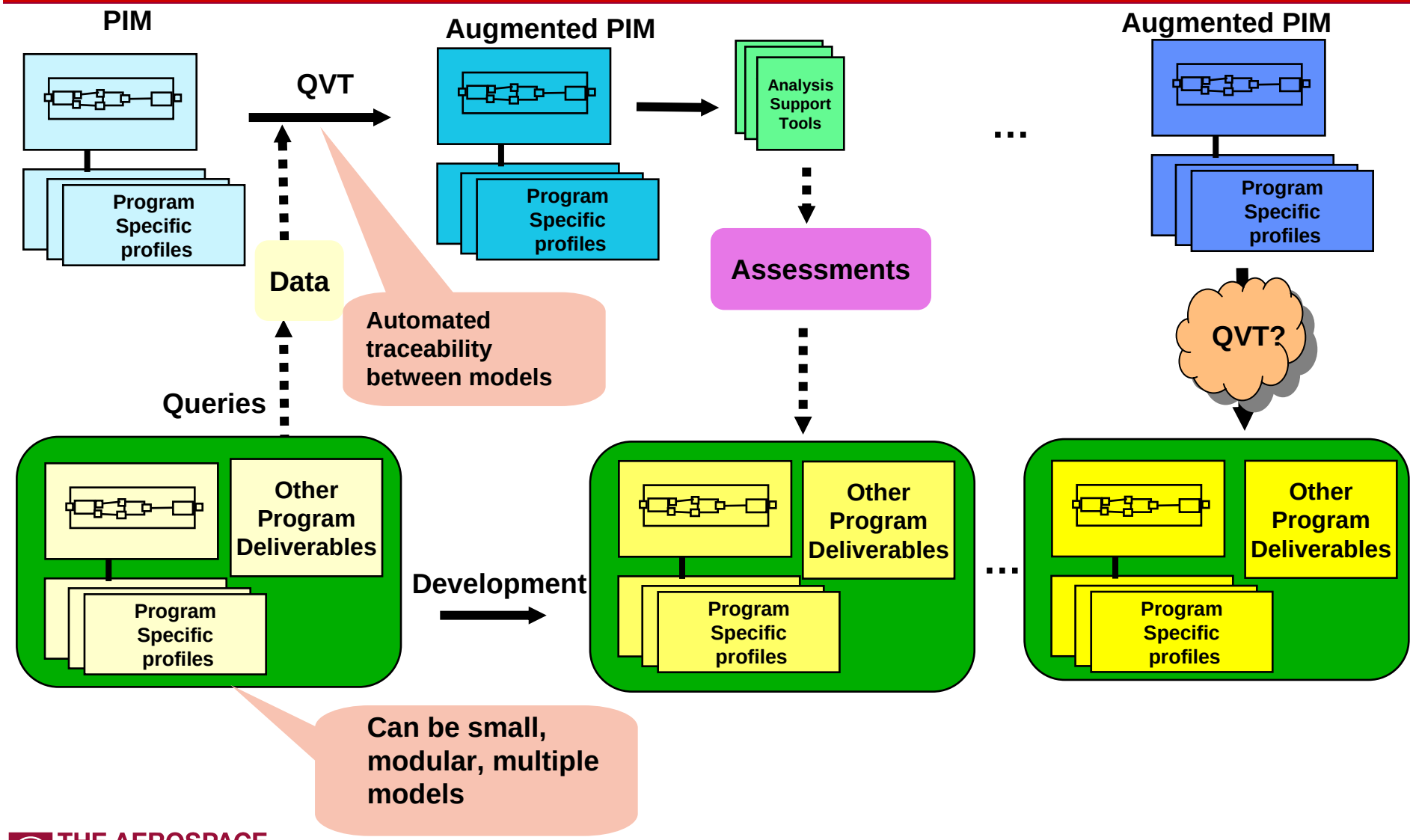
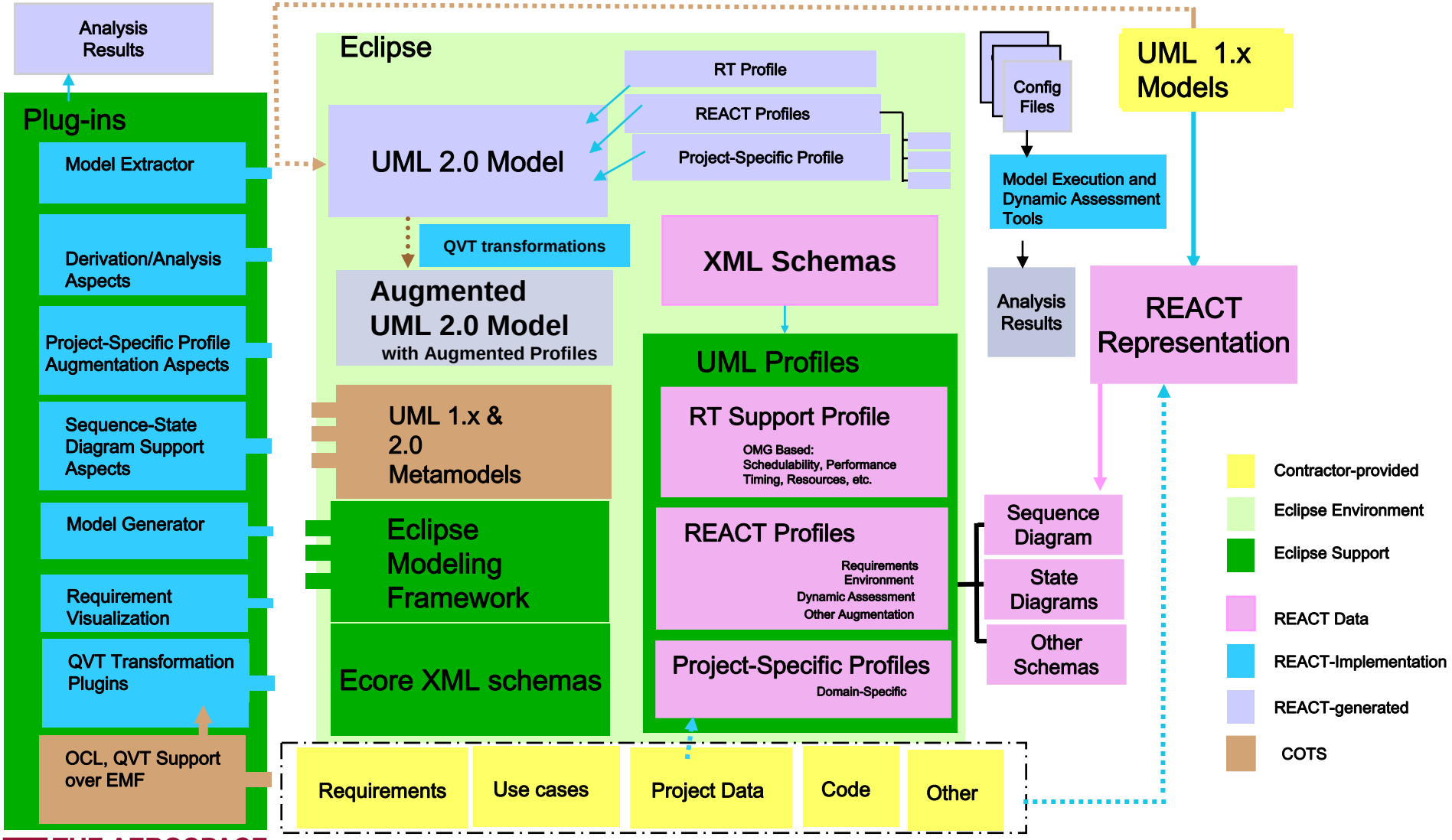
UML Model Evolution Example



Implementation Approach



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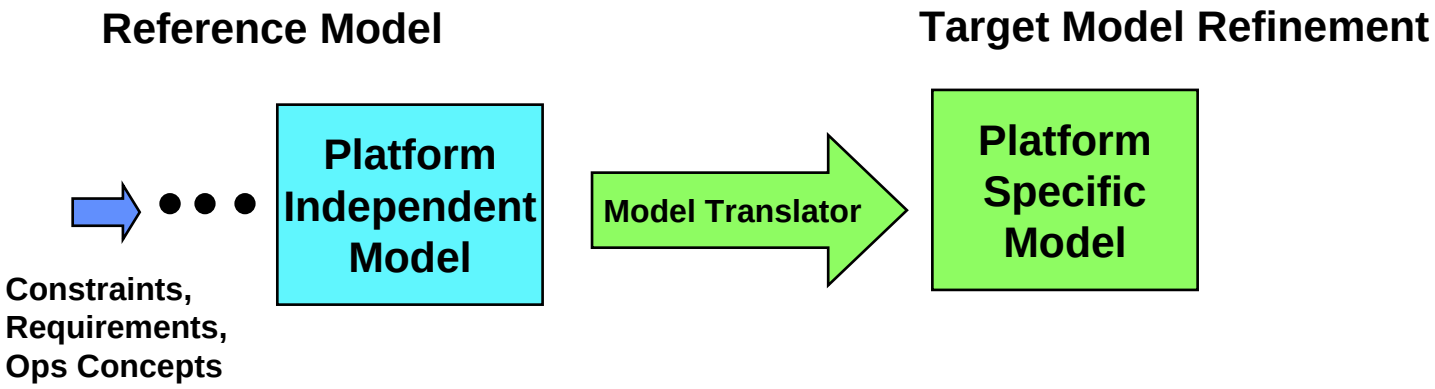
Model Driven Development (Ideal)



Model Driven Development (Evolving)