



The Use of Model-Driven Methodologies and Processes in Aegis Development

Jamie.Durbin@lmco.com

Christopher.M.Thompson@lmco.com

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Open Architecture Evolution

Phase 1: Commercial Technology...



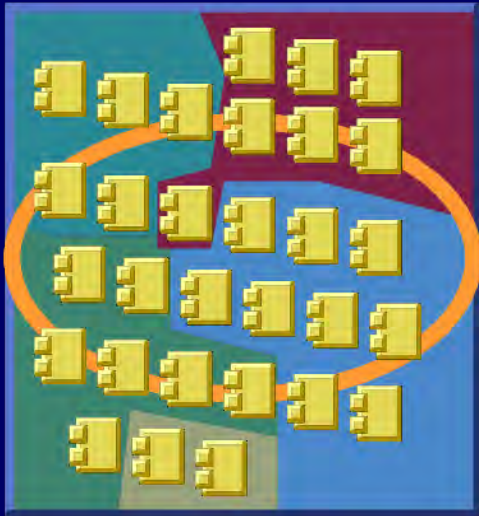
- **Commercial Standards**
- **Commodity Products**
- **Separation of Application/
Infrastructure**
- **Planned Refresh Cycles**



***Leverage the Commercial Marketplace –
Exploit Continuous Increases in Performance***

Open Architecture Evolution

Phase 2: Componentized Software...



- ***Component-Based Designs***
- ***Distributed Processing***
- ***Message-Passing Architectures***
- ***Modern Development Technologies***

***Decreased Development Time –
Reduced Cost***

Open Architecture Evolution

Phase 3: Open Business Model...



- **Open Disclosure / Data Rights**
- **Peer Reviews and Independent Assessments**
- **OAET – Contract Guidebook**
- **SHARE Repository**
- **Industry Days**
- **Technology Collaboration Centers**



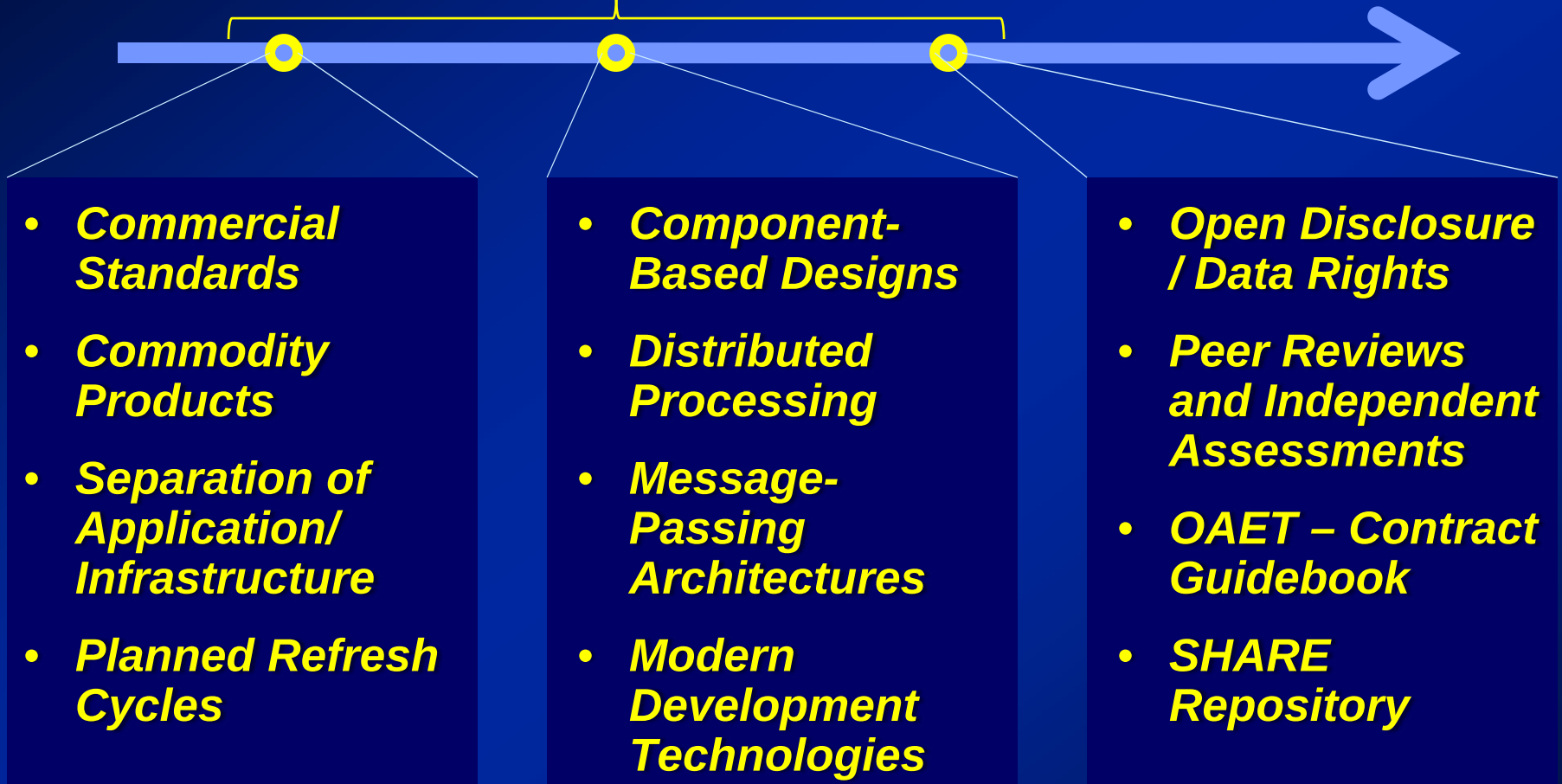
***Increased Number of Players/Opportunities –
Improved Transition of S&T Into Fleet***

Open Architecture Evolution

Step-by-Step...



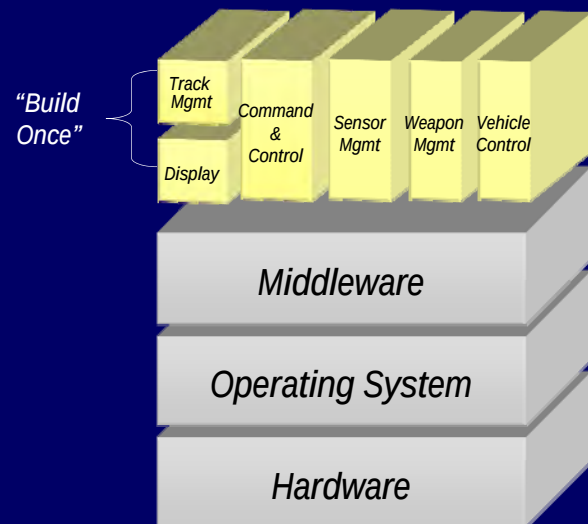
Foundation



Maximizing Affordability

Open Architecture Evolution

Combat System Alignment...

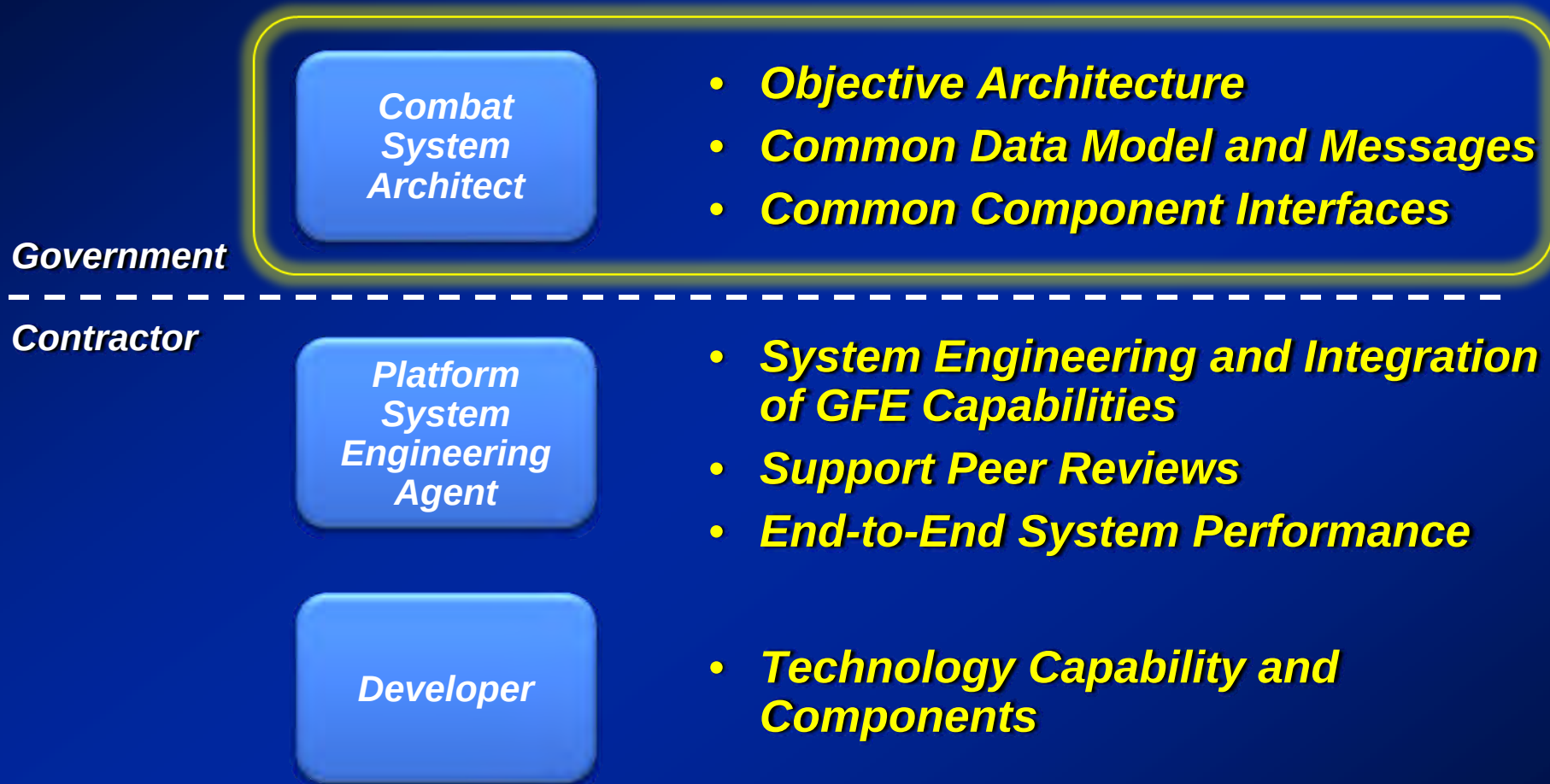


- **Product-Line Approach**
- **Decouple Capability Development from Platform**
- **Government Owned Architecture and Authenticated Interfaces**
- **High-Level Acquisition Strategy**
- **Objective Architecture**

Reuse Capability Improvements – “Build it Once”

Objective Architecture

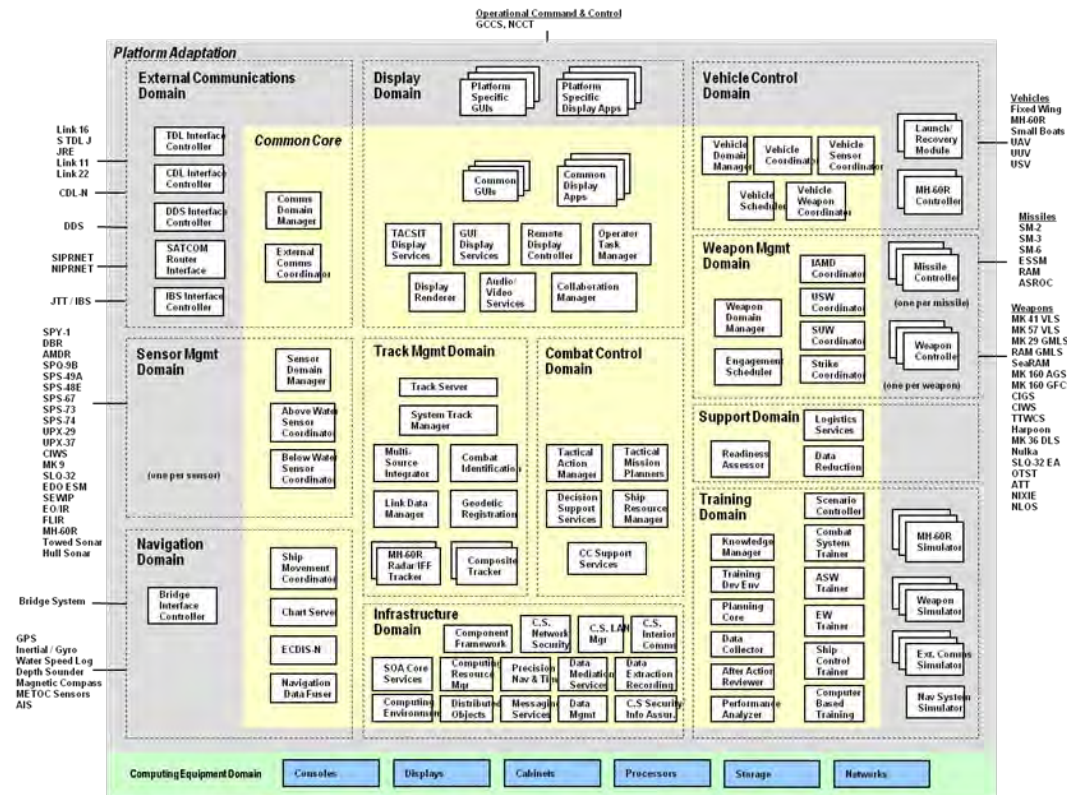
Roles and Responsibilities...



Navy Taking a Lead Role

Objective Architecture

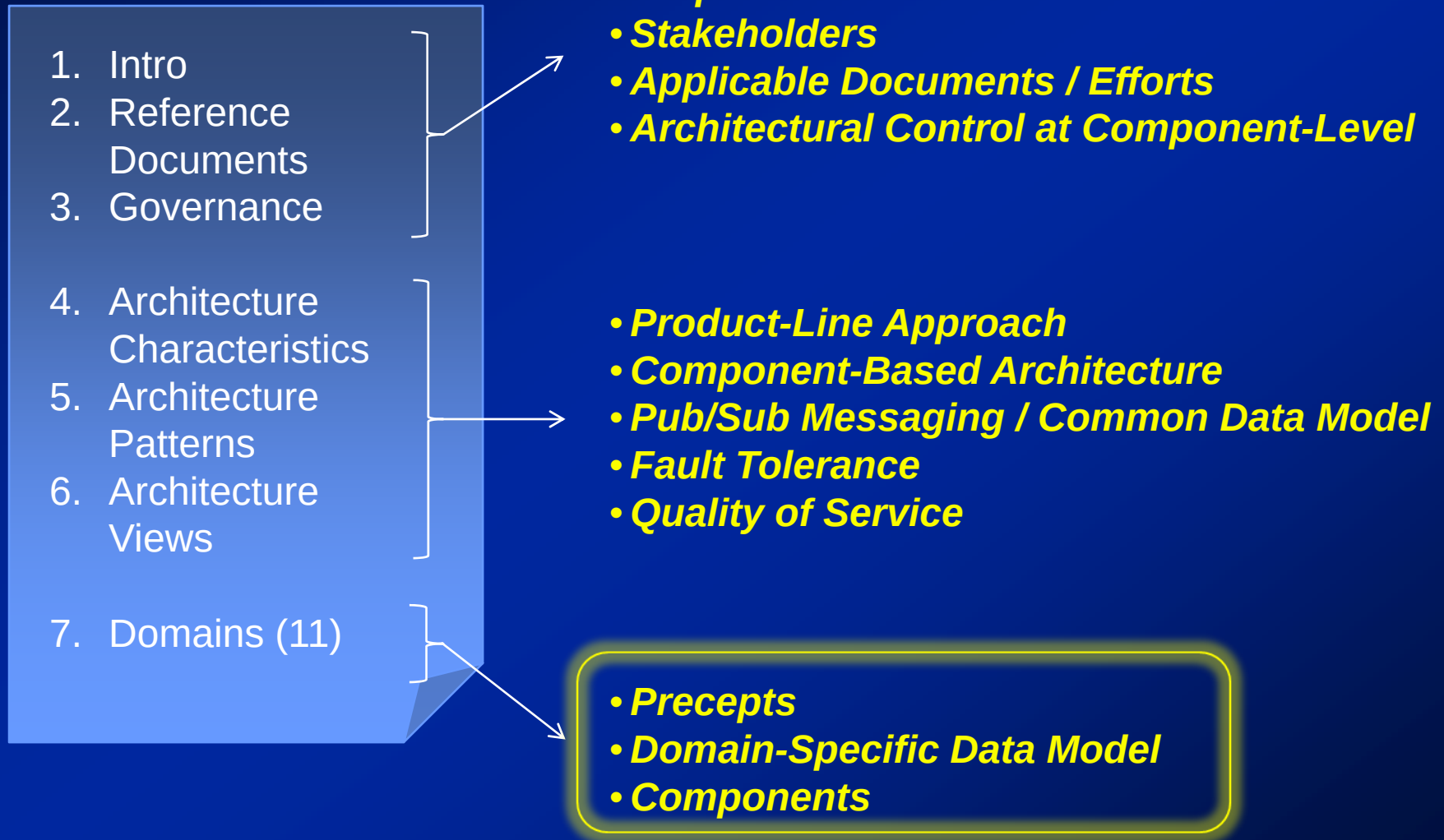
Architectural Context...



- Consistent Domains / Boundaries
- Common Precepts and Methods
- Common Functional Allocation
- Common Data Model
- Core Common Components

**Architecture Definition Document Provides
“Guidance” for Product/Capability Development**

Architecture Description Document



Top Level Objective Architecture

“Functional View...”



Top Level Objective Architecture

“Functional View...”



External Communications Domain

- Provide secure and non-secure voice/data communications
- Perform link management and data forwarding
- Control / monitor comms devices and route data among them
- Report comms status and effective throughput

Display / User Interface Domain

- Display Data (e.g., tracks, tactical situation, operational readiness, ...)
- Provide set of common display services and frameworks for applications
- Support variety of display devices
- Display alerts and status
- Process operator actions
- Provide common/consistent GUIs across platforms
- Provide visualization tools

Vehicle Control Domain

- Launch, recover and control manned air vehicles (fixed wing and helo)
- Deconflict airspace / maintain safety of flight
- Control manned small boats
- Control unmanned vehicles (air, surface, undersea)
- Manage links to controlled vehicles

Weapon Mgmt Domain

- Process engagement orders
- Compute threat engageability
- Select weapons and schedule engagements
- Initialize/control weapons
- Monitor engagement status
- Monitor/control missiles in flight
- Assess engagement effectiveness/ kill
- Report weapon and engagement status

Sensor Mgmt Domain

- Manage and control sensors
- Search/detect objects in background environment
- Transition to track targets
- Report target measurement, track, and attribute data
- Assess and correct measurement errors/biases
- Report sensor status and capabilities

Track Mgmt Domain

- Create System Track File
- Contribute to operational picture
- Determine track ID
- Resolve ID conflicts
- Integrate multiple track data sources
- Perform geodetic registration
- Distribute track data according to need

Command and Control Domain

- Control tactical doctrine
- Evaluate threats
- Evaluate tactical options
- Determine COA
- Plan missions
- Assess mission effectiveness
- Manage resources
- Provide decision aids for operators

Support Domain

- Evaluate overall ship readiness
- Provide data to fleet logistics systems and distance support

Ship Control Domain

- Provide precision Nav/Time data
- Generate power / propel ship
- Provide Integrated Bridge and voyage management services
- Monitor and control ship signature characteristics
- Support Damage Assessment and Control
- Control Access to Secure Areas

Infrastructure Domain

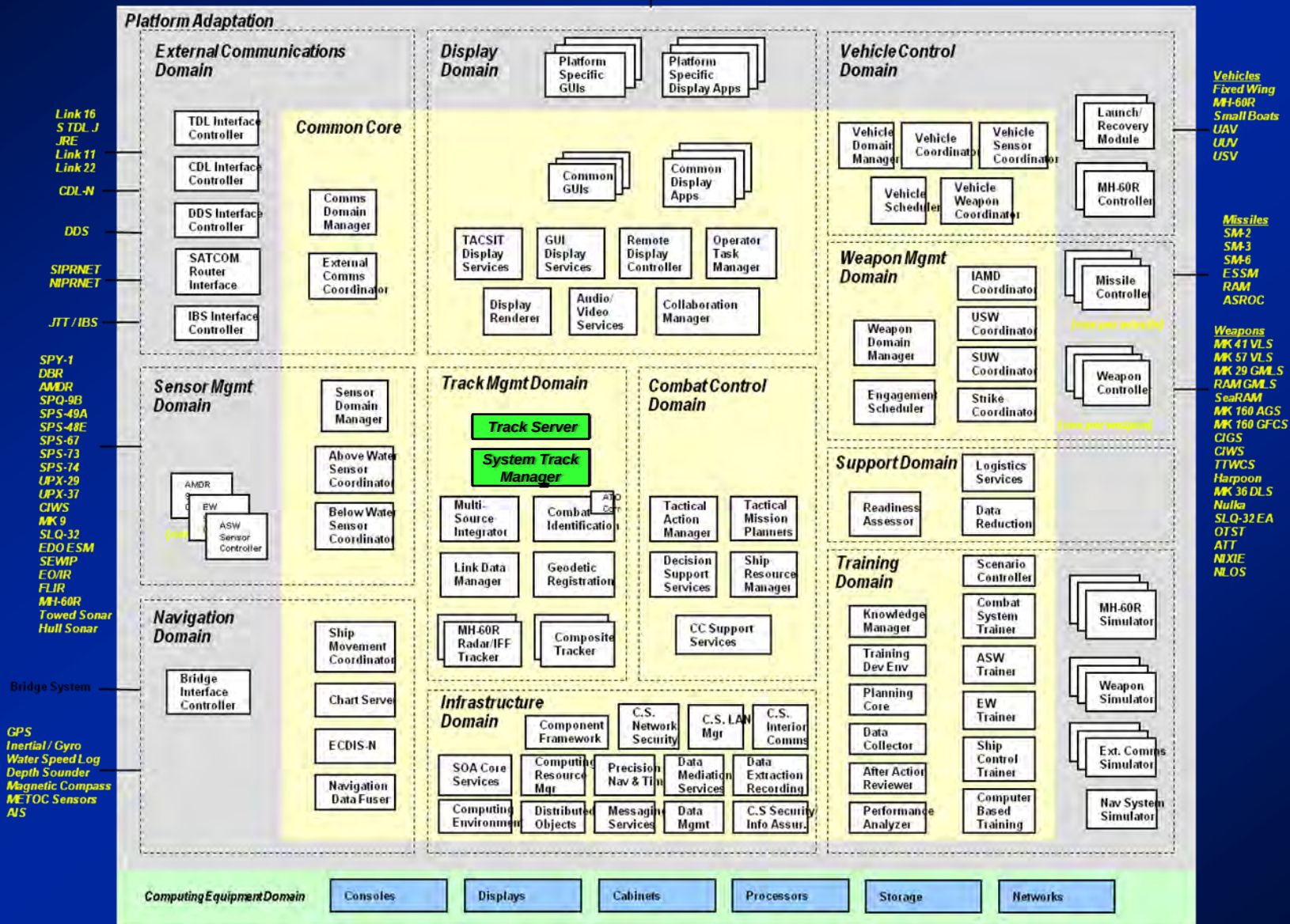
- Provide computing and network services for applications
- Monitor and control computing environment resources and report status

Training Domain

- Provide simulated training environment
- Script and execute training scenarios
- Simulate system inputs IAW scenario
- Control training configuration and events
- Capture training assessment data
- Playback training results and debrief crew
- Provide simulated ship position/movement
- Maintain training record
- Evaluate overall ship readiness
- Provide data to fleet logistics systems and distance support

Top Level Objective Architecture

"Component View..."





Engineering Approach

Engineering Approach

Integrating Product-Line Components into Aegis...



- **Establish Architecture Context:**

- Adopt Consistent Terminology, Allocation and Boundaries
- Define Common Core Components – Key Interactions
- Provide Overall Guidance – Architecture Definition Document (ADD)

- **Normalize Requirements:**

- Utilize Government-led Working Groups
- Compare/Contrast System Requirements and Design Approaches
- Resolve Differences:
 - Establish Common Requirements
 - Establish System-Dependent Behavior
- Verify Using System Threads

- **Utilize Model-Based Tools/Methodologies:**

- Define Data Representation (e.g., Structure, Information-Flow)
- Auto-Generate Code and Specifications/Documents
- Provide Configurable and Flexible Performance

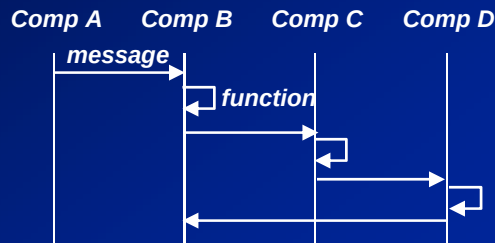
Data Model is Key

Model Driven Architecture

"Defining Components..."

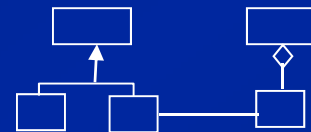


System Threads



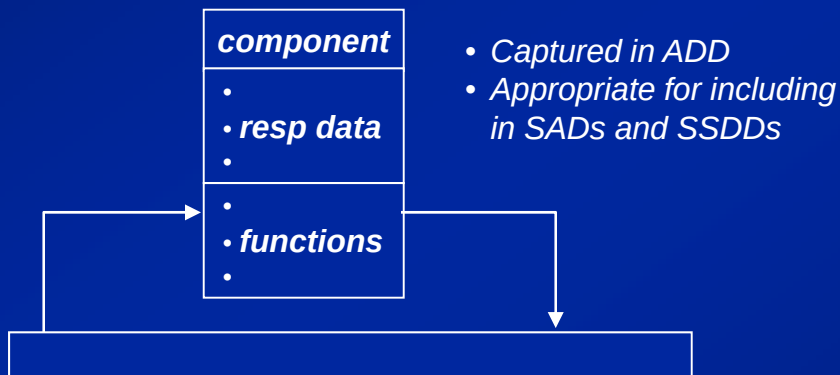
Data Model

Data at Rest
Data in Motion



- Map legacy data
- Normalize it
- Bin into messages

IPO per component



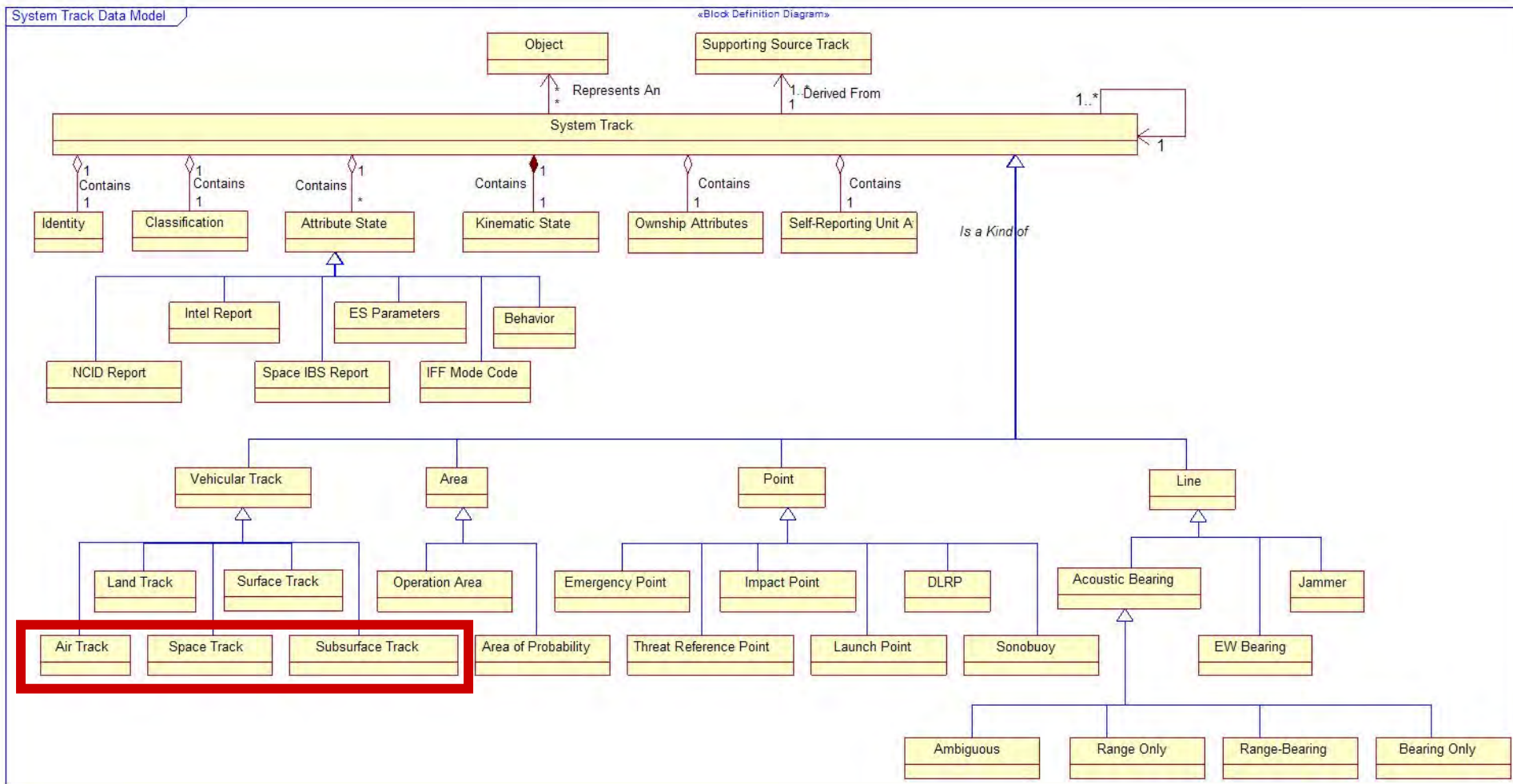
SRS per common component

Applicable legacy requirements
New flowed down requirements



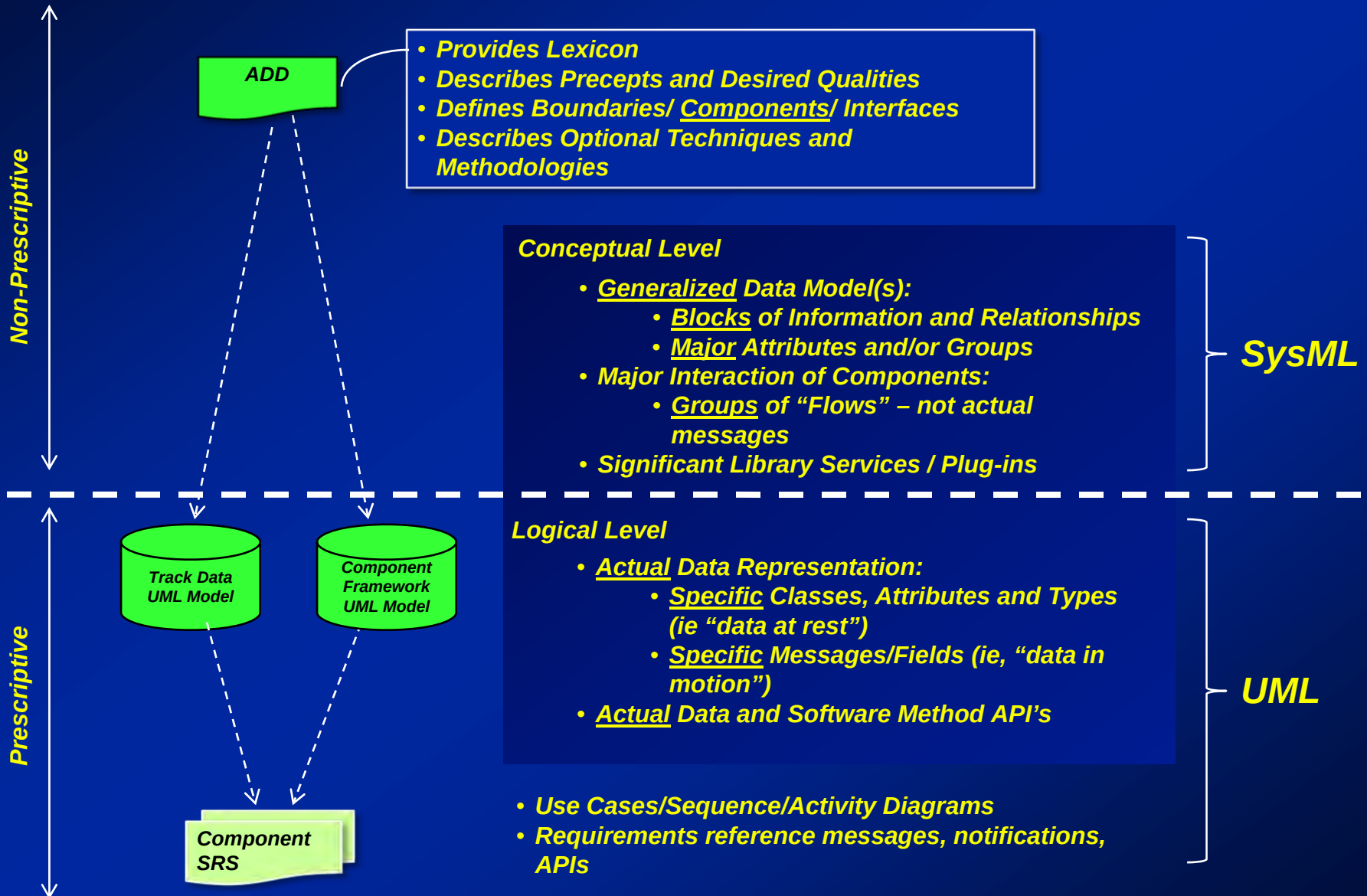


Data Model Overview (cont.)



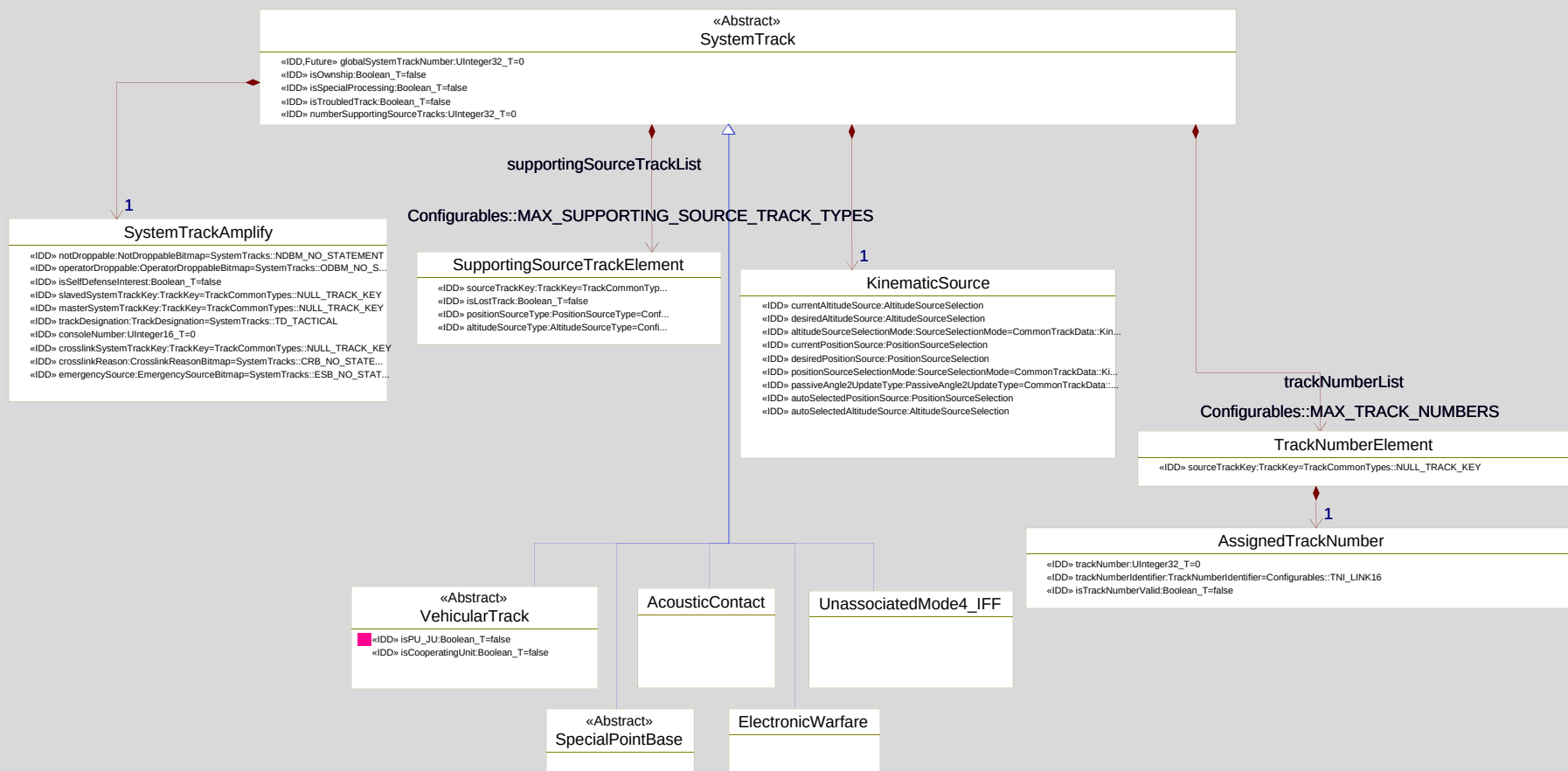
Model Driven Architecture

“Data Model Definition...”



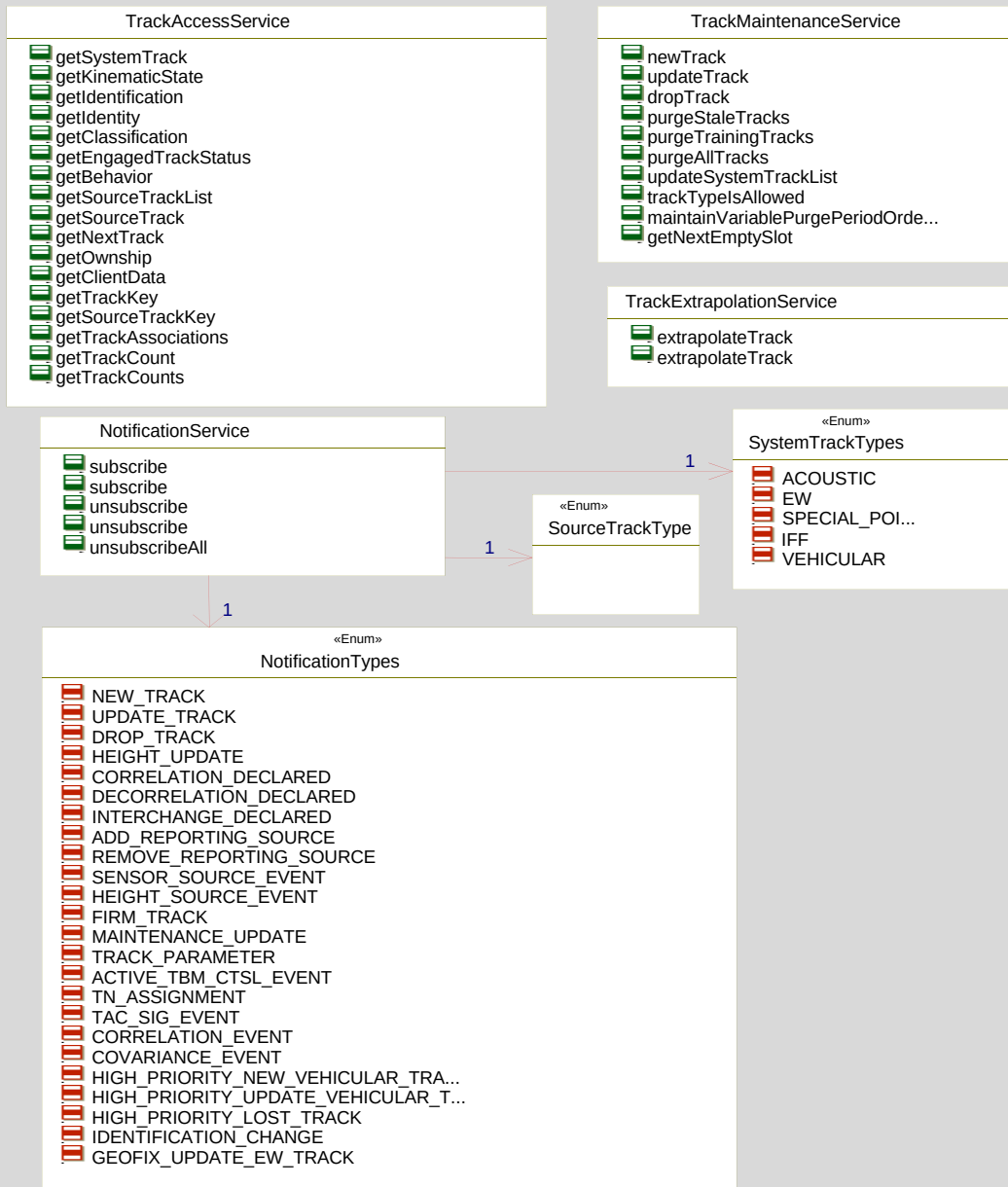
Sample Track Attributes

Extracted from track data model...

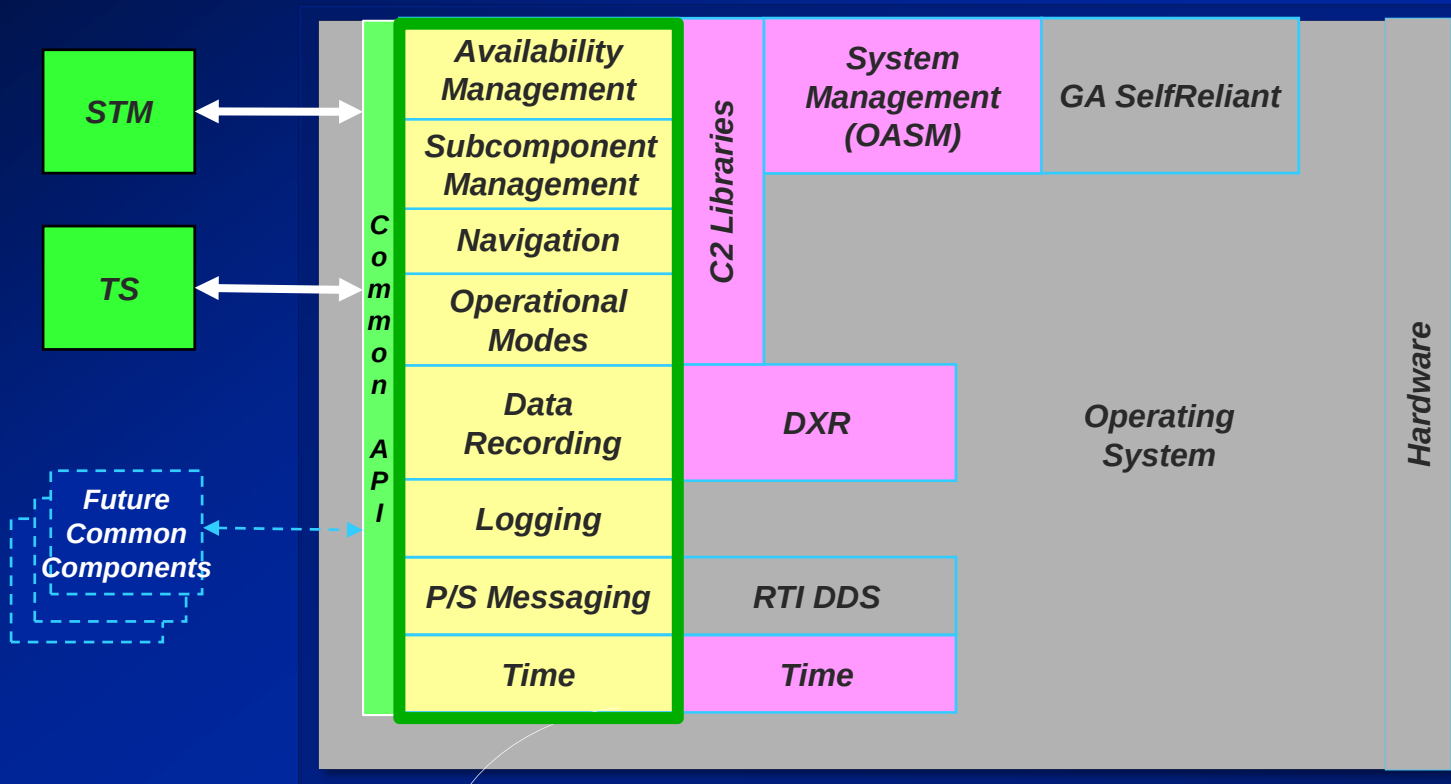


Sample Track Server APIs

Extracted from track data model...



Component Framework Services



**Component
Framework
Services**

Key



Common Components



Component Framework Services



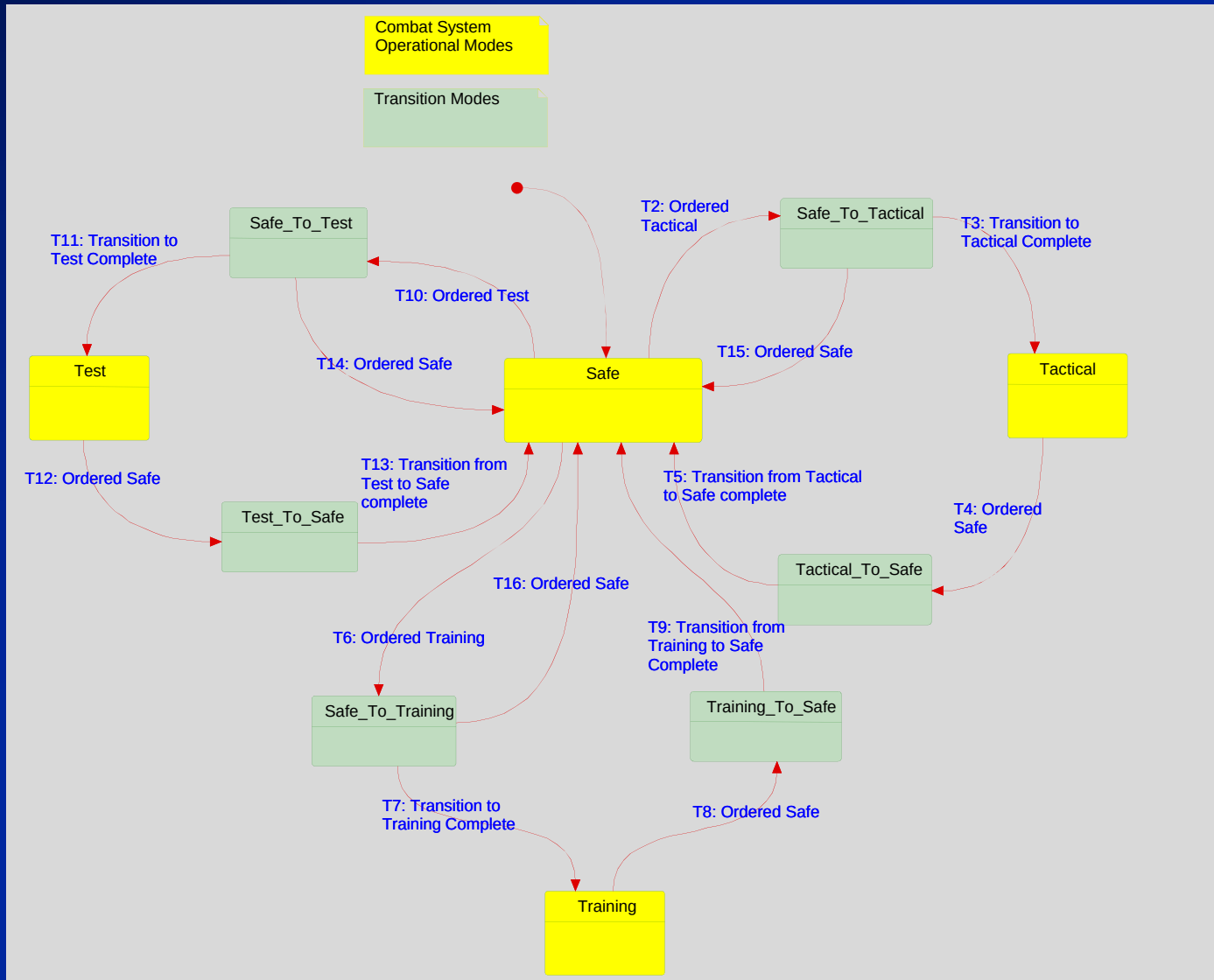
Aegis C2/System Services



COTS

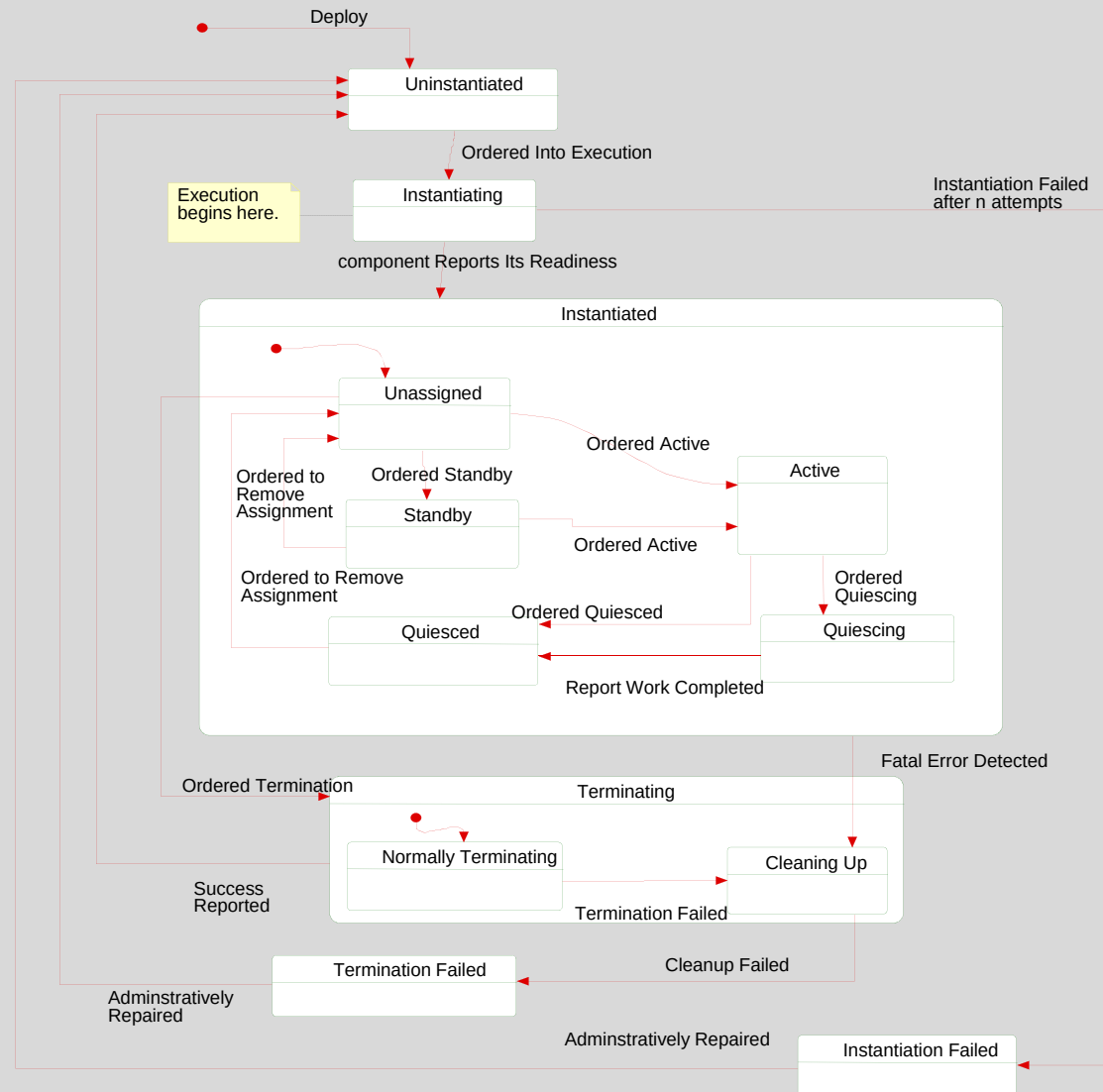
Component Framework

Operational Mode Transitions...



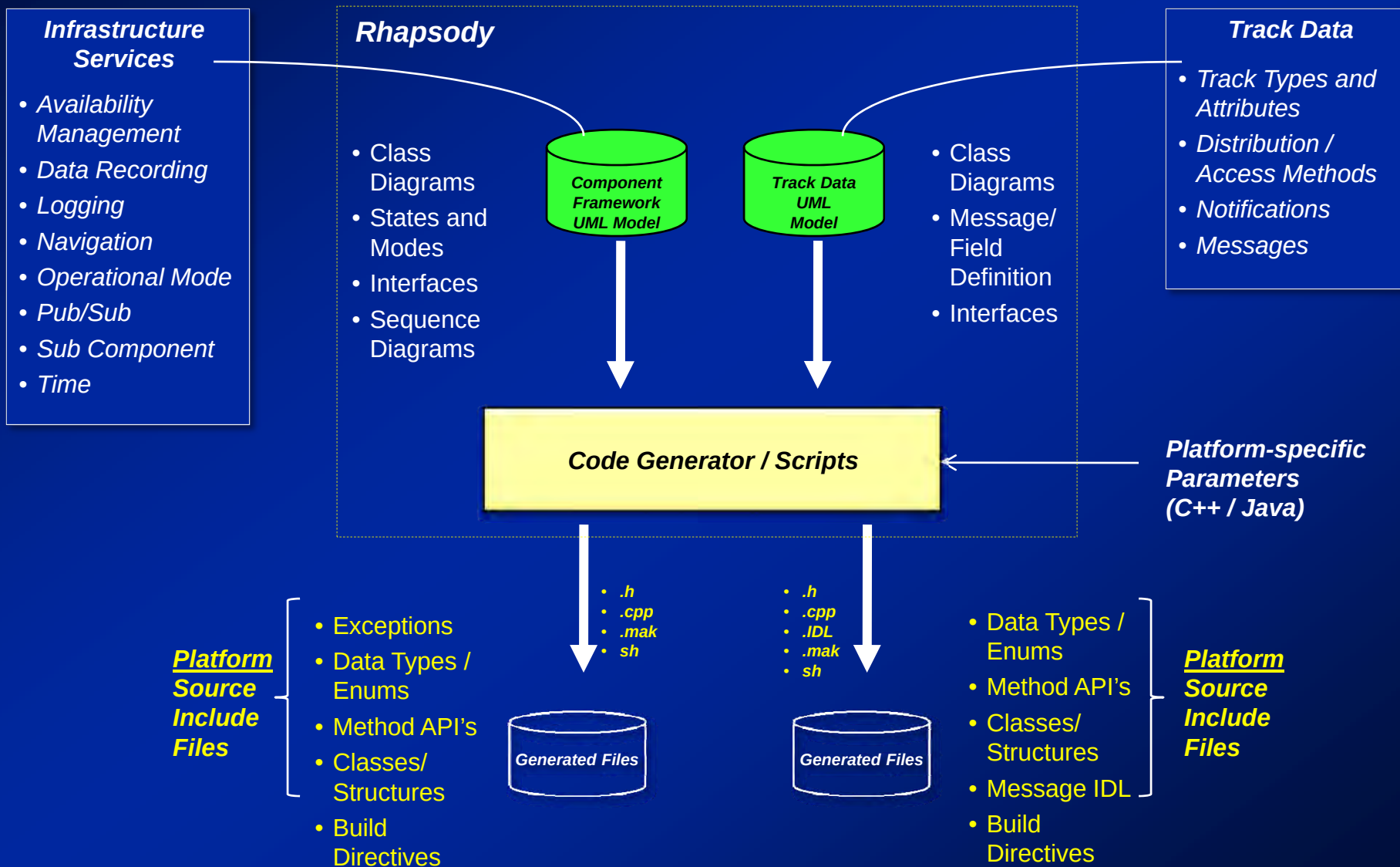
Component Framework

Availability and Presence States...



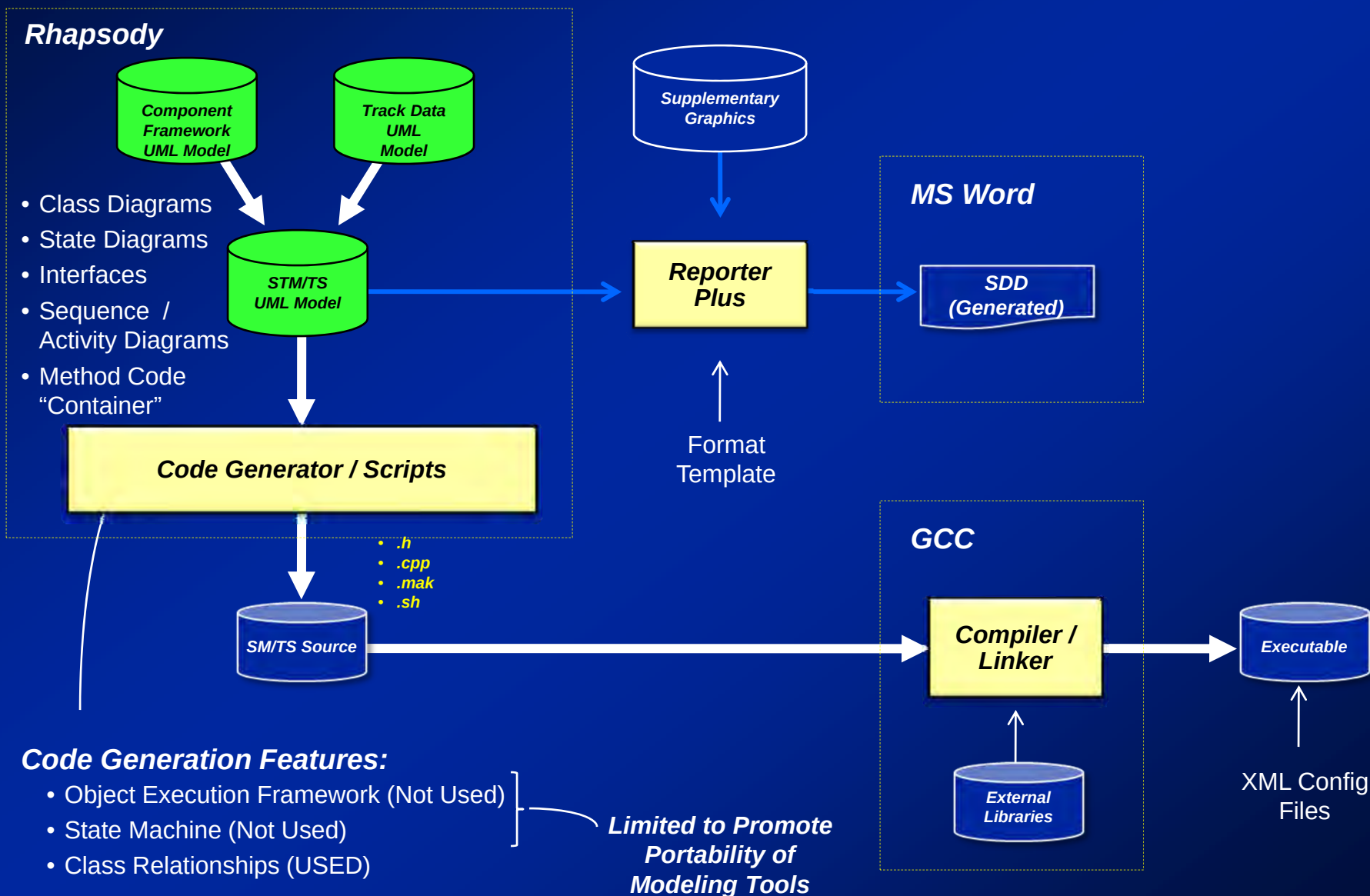
Model Driven Architecture

"Code Generation..."



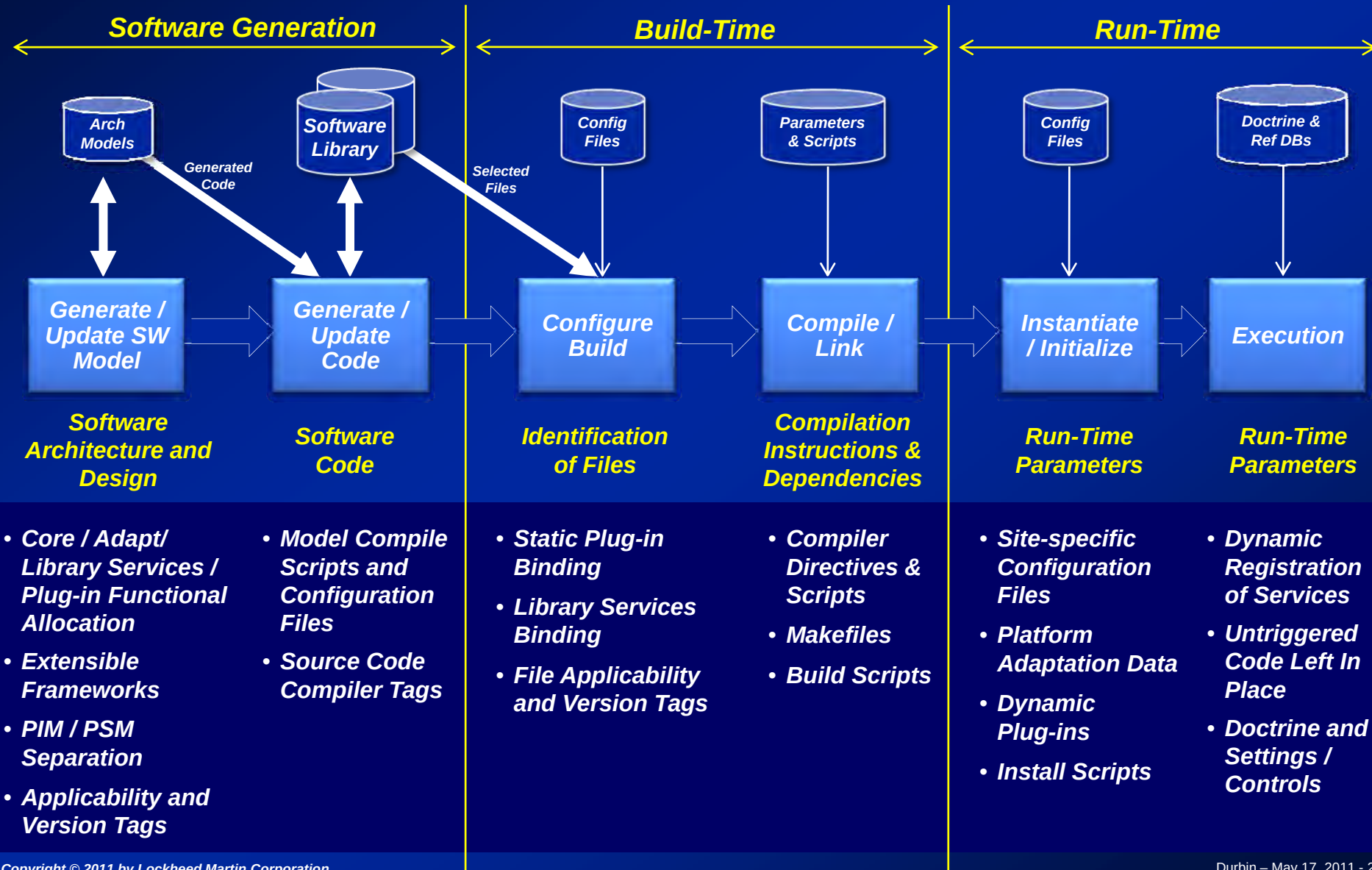
Model Driven Architecture

"Product-Line Component Generation..."



Variation Techniques

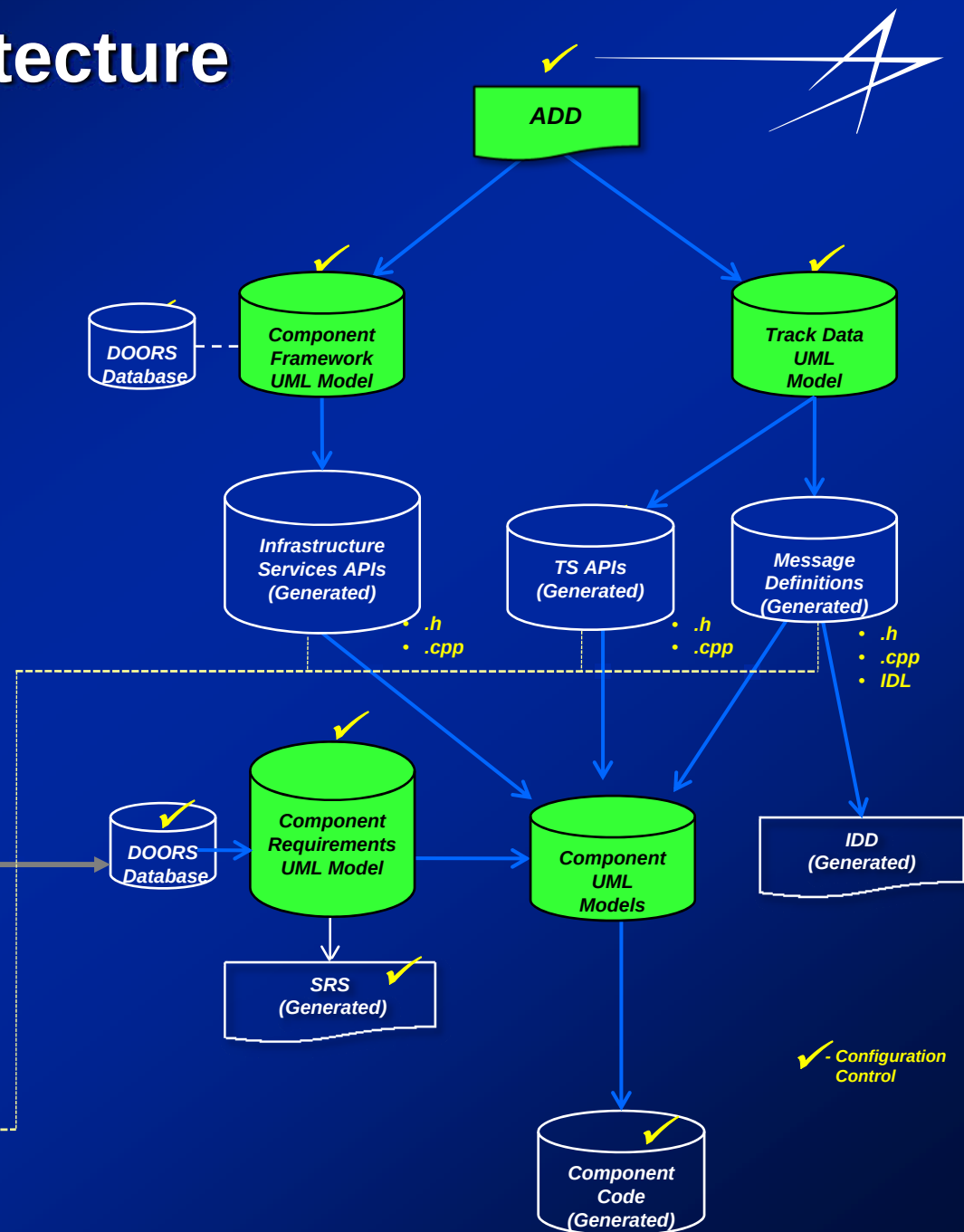
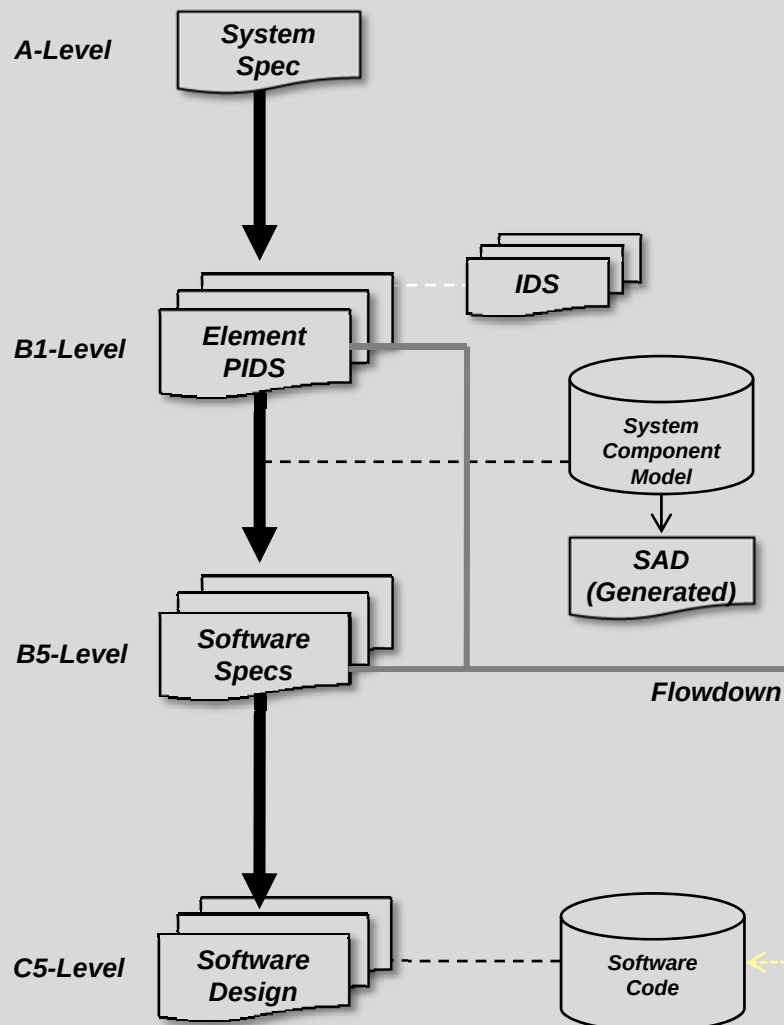
Providing flexibility for SW component behavior...



Model Driven Architecture

"Putting It All Together..."

AMOD ACB 12



Summary



- **Navy Has Followed a Comprehensive Plan Towards Open Architecture**
 - Utilization of COTS Technologies and Products
 - Incorporation of Component-Based Designs
 - Increased Number of Players/Opportunities
- **Product Line Approach Established to Facilitate Combat System Alignment**
 - Government Owned Architecture and Authenticated Interfaces
 - High-Level Acquisition Strategy
 - Robust Reference (aka Objective) Architecture
- **Model-Driven Tools/Methodologies Have Been Used Effectively**
 - Data Model Representation of Information Structure and Flow
 - Auto-Generation of Code and Specifications/Documents
 - Initial Common Components Have Been Successfully Integrated into Aegis Baseline 9



Glossary



Acronym	Description	Acronym	Description
ACB08	Advanced Capability Baseline 2008	LAN	Local Area Network
ACB12	Advanced Capability Baseline 2012	LM	Lockheed Martin
ACS	Aegis Combat System	LOT	Launch on TADIL
ADD	Architecture Definition Document	MMSP	Multi-Mission Signal Processor
Aegis	(not an acronym) Greek Shield of Zeus	MS	MicroSoft
ALIS	Aegis LAN Interconnect System	NIFC-CA	Naval Integrated Fire Control - Counter Air
AMOD	Aegis MODernization	OA	Open Architecture
API	Application Programming Interface	OAET	Open Architecture Enterprise Team
ASCM	Anti-Ship Cruise Missile	OASM	Open Architecture System Management
ASROC	Anti-Submarine ROcket	P/S	Publish/Subscribe
BL	Baseline	PIDS	Prime Item Development Specification
BMD	Ballistic Missile Defense	PIM	Platform Independent Model
C2	Command and Control	PSEA	Platform System Engineering Agent
CCB	Configuration Control Board	PSM	Platform Specific Model
CEC	Cooperative Engagement Capability	Pub/Sub	Publish/Subscribe
CG	Guided Missile Cruisers	RF	Radio Frequency
CIWS	Close In Weapon System	SAD	System Architecture Document
CM	Configuration Management	SAN	Storage Area Network
COTS	Commercial Off-the-Shelf	SBT	Sea-Based Terminal
CPCR	Computer Program Change Request	SI/DA	System Integrator / Design Agent
CR	COTS Refresh	SM	Standard Missile
CSEA	Combat System Engineering Agent	SMP	Symmetric MultiProcessor
CVN	Carrier Vessel Nuclear	SQT	System Qualification Test
DDG	Guided Missile Destroyer	SRS	System Requirements Specification
DDS	Data Distribution Service	SSDD	System/Segment Design Document
DM	Data Model	SSDS	Ship Self Defense System
DOORS	Dynamic Object-Oriented Requirements System	SSR	Software Specification Review
ESSM	Evolved Sea Sparrow Missile	STM	System Track Manager
ETR	Engineering Technical Review	SVC	Service
GCC	GNU Compiler	SW	Software
GFE	Government Furnished Equipment	SysML	Systems Modeling Language
HM&E	Hull, Mechanical and Electrical	T&E	Test and Evaluation
HW	Hardware	TADIL	Tactical Digital Information Link
IAW	In Accordance With	TI	Technology Insertion
IDD	Interface Definition Document	TLAM	Tomahawk Land-Attack Missile
IDS	Interface Design Specification	TOR	Test Observation Report
IMS	Integrated Master Schedule	TS	Track Server
IPO	Input/Output/Process	UML	Unified Modeling Language
IR	Infrared	VLA	Vertical Launch ASROC
JTM	Joint Track Management	VLS	Vertical Launch System
KA	Kill Assessment	XML	eXtensible Markup Language