

Project Wedgetail

Software Design Challenges

2010 ADF Software Symposium



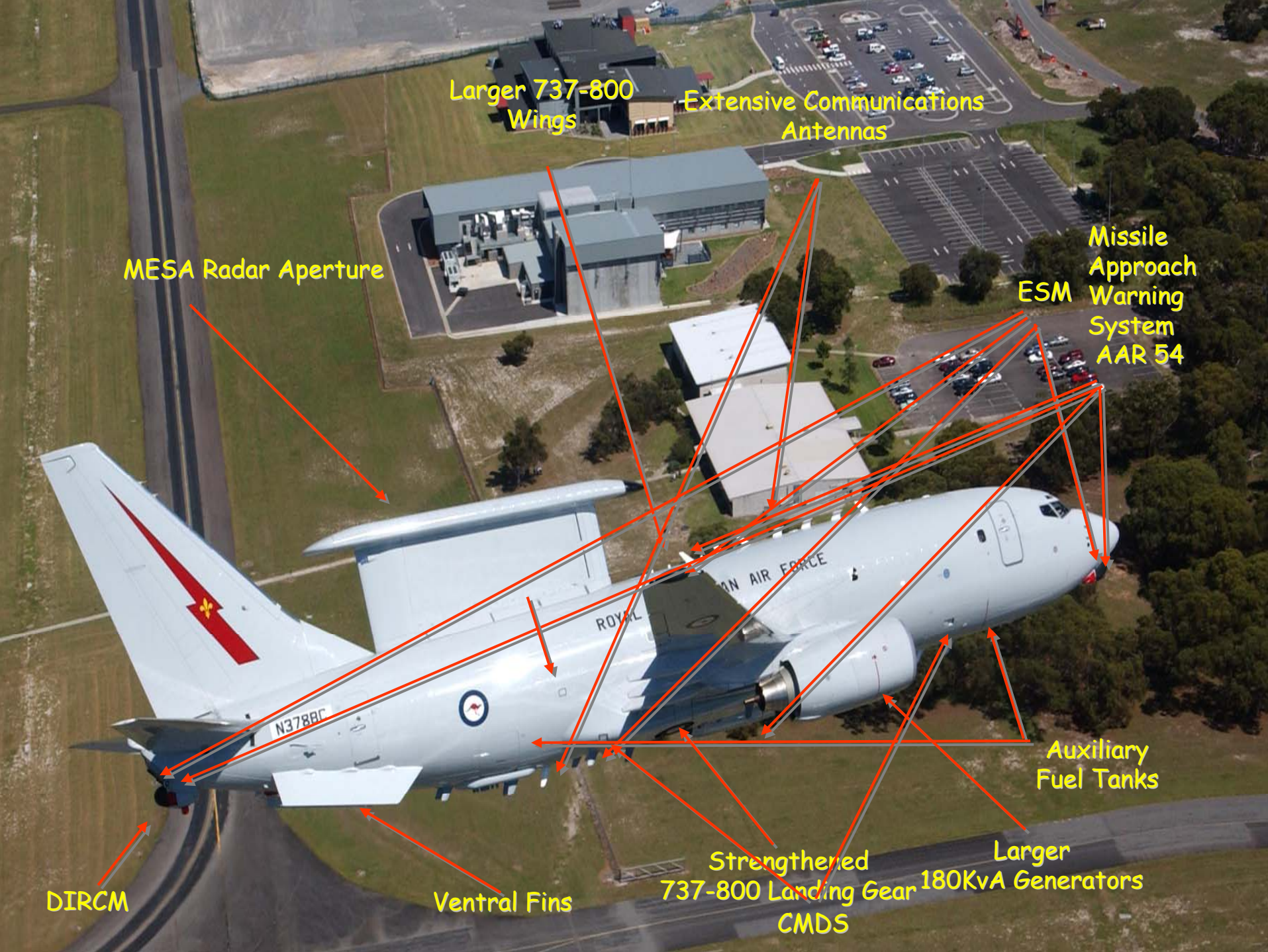
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Scope

- Overview of the AEW&C Software
- Complexity
- Approach to Design Acceptance
- Challenges in doing Design Acceptance
- Quick look at plan ahead in-service







Larger 737-800 Wings

Extensive Communications Antennas

MESA Radar Aperture

Missile Approach Warning System AAR 54

Auxiliary Fuel Tanks

Strengthened 737-800 Landing Gear
CMDS

Larger 180Kva Generators

Ventral Fins

DIRCM

Project Elements



**737 AEW&C
Aircraft**



**Mission Crew
Simulator**



**Flight Crew
Simulator**



**Mission
Support**



**AEW&C Support
Facility**

Complexity

- Radar – phased array, top hat – first of type
- The “most complex” airborne datalinks message set
- Tracker – data fusion centre
 - Multiple data sources with different levels of quality -> single, accurate and identified track
 - 1500 configurable parameters with 1st, 2nd and 3rd order effects
- Complexity of design re-use from legacy programs
- Internal re-use, mission computing in support segments
- ...then add program complexity – ITARs, geography, Commercial vs FMS, etc.

Software Scope

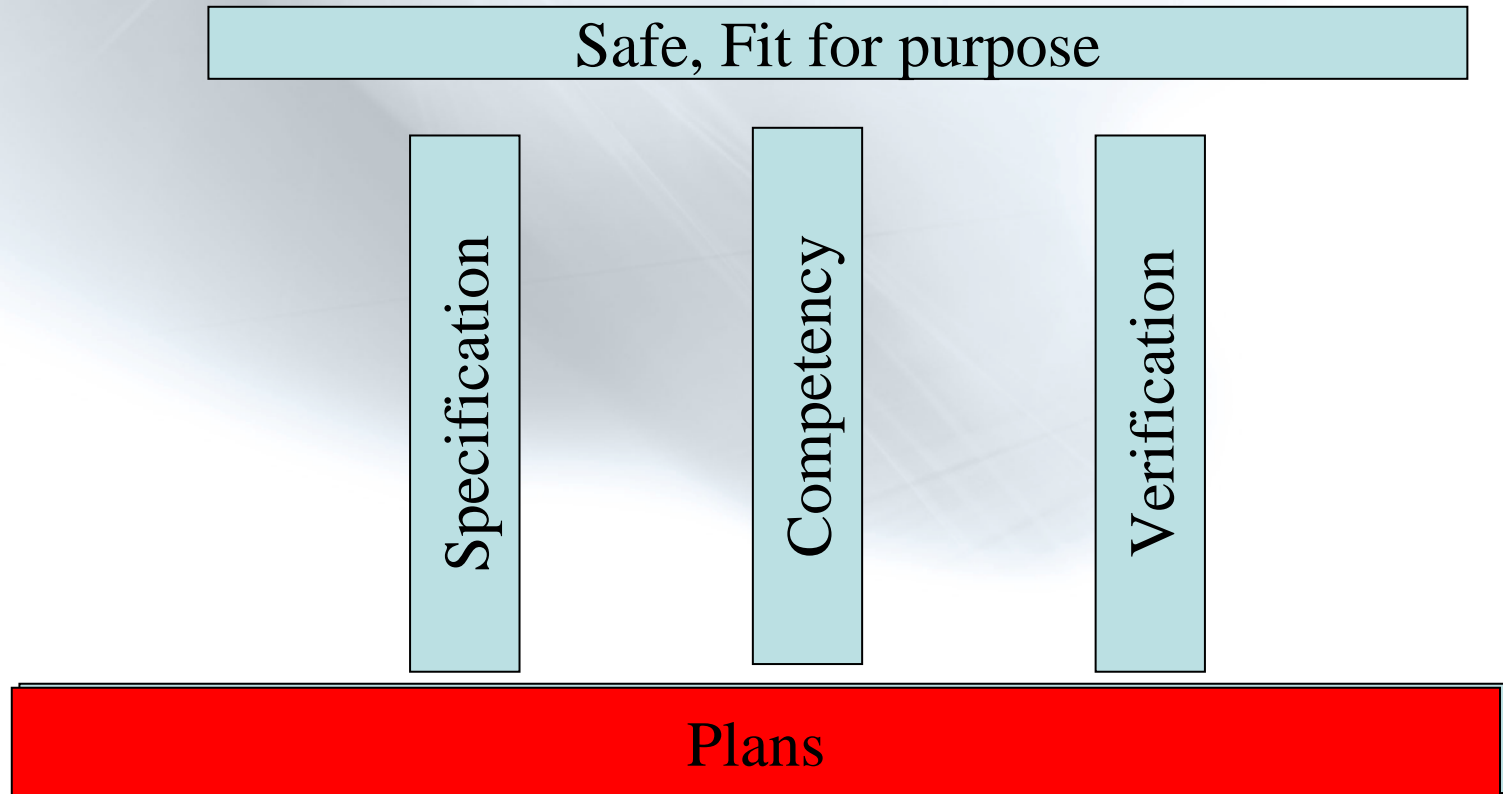
• Software Product Size	KSLOCs		
– New	2,100	(original plan was new ~15%)	
– Modified	60		
– Reuse	2,000		
• Requirements	Primary	Secondary	
– Total	<u>9,800</u>		
– Ground Segments	3,200		
– AMS	6,600	* General	2530
		* Aircraft	660
		* Comm	520
		* EW	1,000
		* Radar	340
		* MCS	1,550
		MCS SRS	2,770
		L16	3,400
		L11	750

S/W Challenges

- Leading edge – first of type complexity
 - How do you document a complex design?
 - Rational Rose
 - ClearCase & ClearQuest
- Export constraints
 - Code isolation
 - Interface controls
 - Design development paradigms
- Integration complexity
 - Maturing interfaces through concurrent design
- Location of development and integration labs in service
- Staff – keeping the know-how
- Incremental delivery strategy



S/W Design Acceptance Overview



Plans – Challenges

- Good plans reduced staff ramp-up time
- Approval rights on the *right* plans
- Challenge – preventing plans becoming dated as resource constraints increase -> maintain interest
- Maintain cohesion amongst many plans
 - Need to control the number of plans
 - eg: disconnects between support strategies

Specification

- Wedgetail functional baseline
 - All contractual requirements (including the verification approach) maintained in DOORS
- Layers of review by appropriately authorised engineers
- Close interaction with operational community to ensure fit for purpose with CONOPS
- Close control of requirements by Prime and Project Office



Specification – Challenges (2)

- (2) Accurate flowdown of requirements to the Subcontractors
 - Caused by different timings/contract formation and negotiations
 - Resulted in spec gaps that were not detected until late in integration
 - Has potential to invalidate subcontractor results and require re-test, or result in non-compliance products.

- (3) Tolerances in requirements.
 - How much accuracy for coordinate conversions

- (4) HMI – the most visible part of software

- (5) Defining verification requirements well understood - > but also need to consider tools and environments

Competency

- ...tremendous technical competency in contractors
 - Prime <> 737 and AWACS
 - Subs <> Radar, ESM, Tracker etc
- How can CoA get insight to ensure confidence & compliance
 - Insight into software development process
 - Confirmation of understandings from meetings, documentation, reviews
 - Insight into hardware and software performance
 - Insight into maturity of design
 - Understanding of effectiveness and status of recovery plans
- How: reviews, audits, metrics, regular meetings, drops of software defects

Competency – Challenges

(1) Keeping Design Reviews technical not programmatic

- CDR replaced with a series of Development Progress Reviews focused on metrics and schedule.
- Need to balance emphasis on compliant technical solution
- Identify “requirement disconnects” before test phase and costly to resolve
- Link Development milestones to functional outcomes

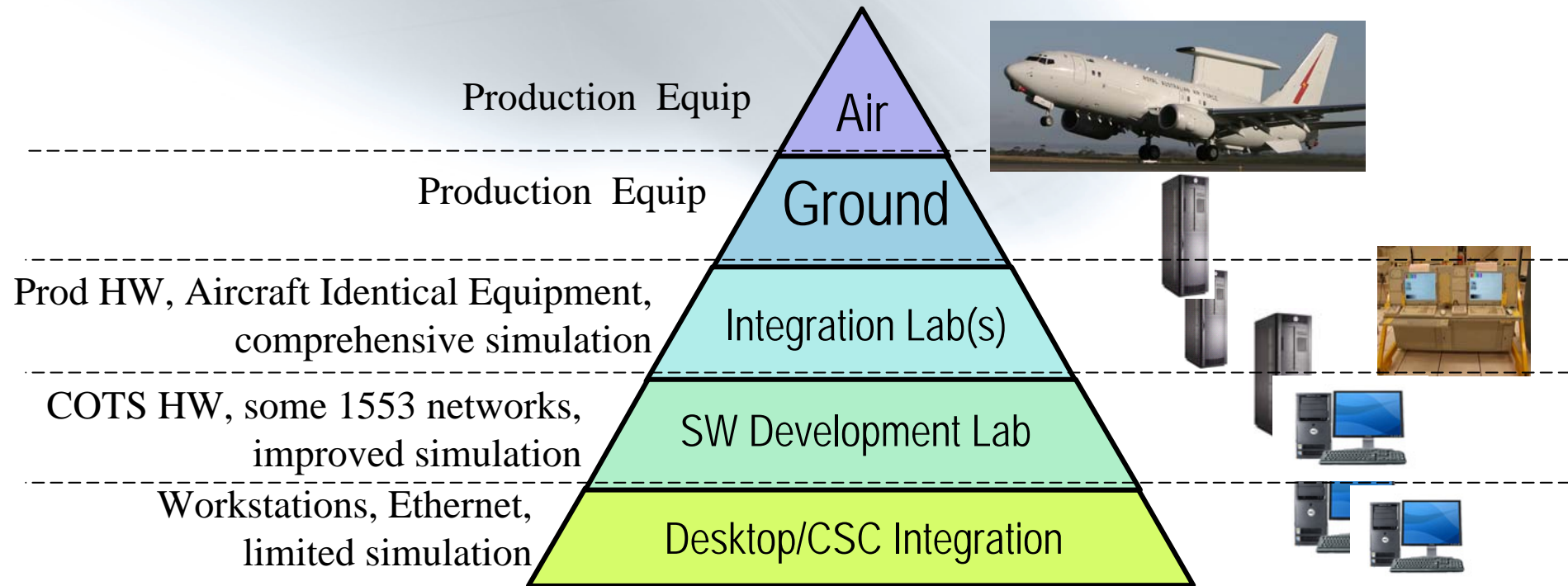
Competency – Challenges with metrics

(2) Software Metrics:

- Measure throughout the lifecycle
 - Need metrics to track integration progress
 - Structure later Milestone payments based on integration in more mature environments (ie, Integration Lab, not on code)
 - Functional build plans need to be specific
- Need agreement on technical performance measures from start
 - Ensure key performance measures collected against the agreed verification approach
 - Avoids shortfalls unnoticed until late
 - Eg: CPU utilisation, Stability
- Quantity not important -> need time to analyse

Verification

- Approach of verification of requirements based on:
 - CoA Approval on Test Procs and Reports
 - Test through multiple phases
 - Progress tracked in DOORS with FCA in mind



Verification – Challenges

- Tremendous value in broad-based regression test to force integration issues
- A complete, functioning integration lab is critical in highly complex systems integration efforts
- Test Procs need to come early – even before the design is ready
- Need to establish flexible test practices that can provide a minimum threshold of test discipline
 - Red-line process
 - Configuration changes during test
- When do you start testing?

Safe -> Airworthiness

- Airworthiness & Safety Risk?
 - Mission System aspects of design (Radar/IFF, Mission Computing, Communications, Mission Navigation, Electronic Support Measures, and Electronic Warfare Self-Protection) are classed as *On-Aircraft: Capability and Efficiency*
 - ie: does not impact airworthiness, nor affects air or personnel safety
- For flight safety critical -> DO-178B
- Hazards – identified and tracked through development process through a MIL-STD-882C safety case, with issue papers sent to DGTA as required

Fit for purpose -> Mission-worthiness

- Mission-worthiness
 - Challenge -> first of type & new ADF capability
 - Need well-articulated and maintained CONOPS
 - Integrated operational community embedded within project team
 - OPS involved in all facets of design, including reviews and tests
 - Engagement with other like-capabilities
 - Use of Operational Demonstrations to assess capability

In-Service Strategy from Acquisition

- Program benefited from prior ADF in-service weapon system experience (ie: F-111, F/A-18, P3)
- Articulated from the very start in the SWAMP and progressively developed by Prime through a Software Support Plan and the SDMP
- Continual CoA acquisition focus on ensuring tools and documentation transitioned

In-Service Strategy - Fundamentals

- Most of the software acquired with a plan to provide long term support using resources and infrastructure in the ASF and in Australia and overseas industry
 - WLM Centre of Gravity with OEM/Vendor reach back
 - Export restrictions exist on some aspects
 - Some software (DO-178B) back to vendor
 - Some software probably too complex to be tackled
- Fundamentals:
 - Contractor support → truly Through Life Support concept
 - ie: minimum SPO presence and technical expertise
 - Maintenance of functional baseline through DOORS
 - Through life use of key acquisition CDRLs and test approaches
 - Maintenance of the AEW&C safety case
 - Maintain relationship to DSN – including DSTO

Summary

- AEW&C – Complex, Large scale software development
- Integrated software Design Acceptance Approach based on core principles of:
 - Specification
 - Competency
 - Verification
- In-Service Strategy developed and refined throughout Acquisition





Questions &
Comments?

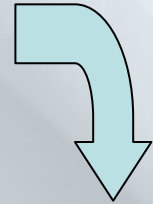
Back up slides

Plans

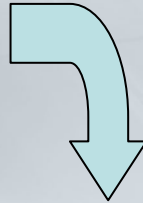
PDAS

- Drafted and maintained by Project Office
- Defines our EMS
- Outlines the big picture Acceptance strategy
- Software a component of the integrated acceptance strategy for the whole AEW&C capability

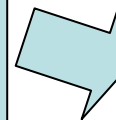
Project Design
Acceptance
Strategy
(PDAS)



Software
Acquisition
Management
Plan
(SWAMP)



Software
Development
Management
Plan (SDMP)



Software
Development
Plan(s) (SDP)

Plans

SWAMP

- Process for monitoring, managing & reporting
- Outlines s/w strategy
 - Develop IAW tailored MIL-STD-498
 - Flight and Safety Critical - > RTCA/DO-178B
- Safety - > FAR 25.1309, FAR AC 25-10, MIL-STD-882C
- Metrics
- COTS and Re-use

Project Design
Acceptance
Strategy
(PDAS)




Software
Acquisition
Management
Plan
(SWAMP)



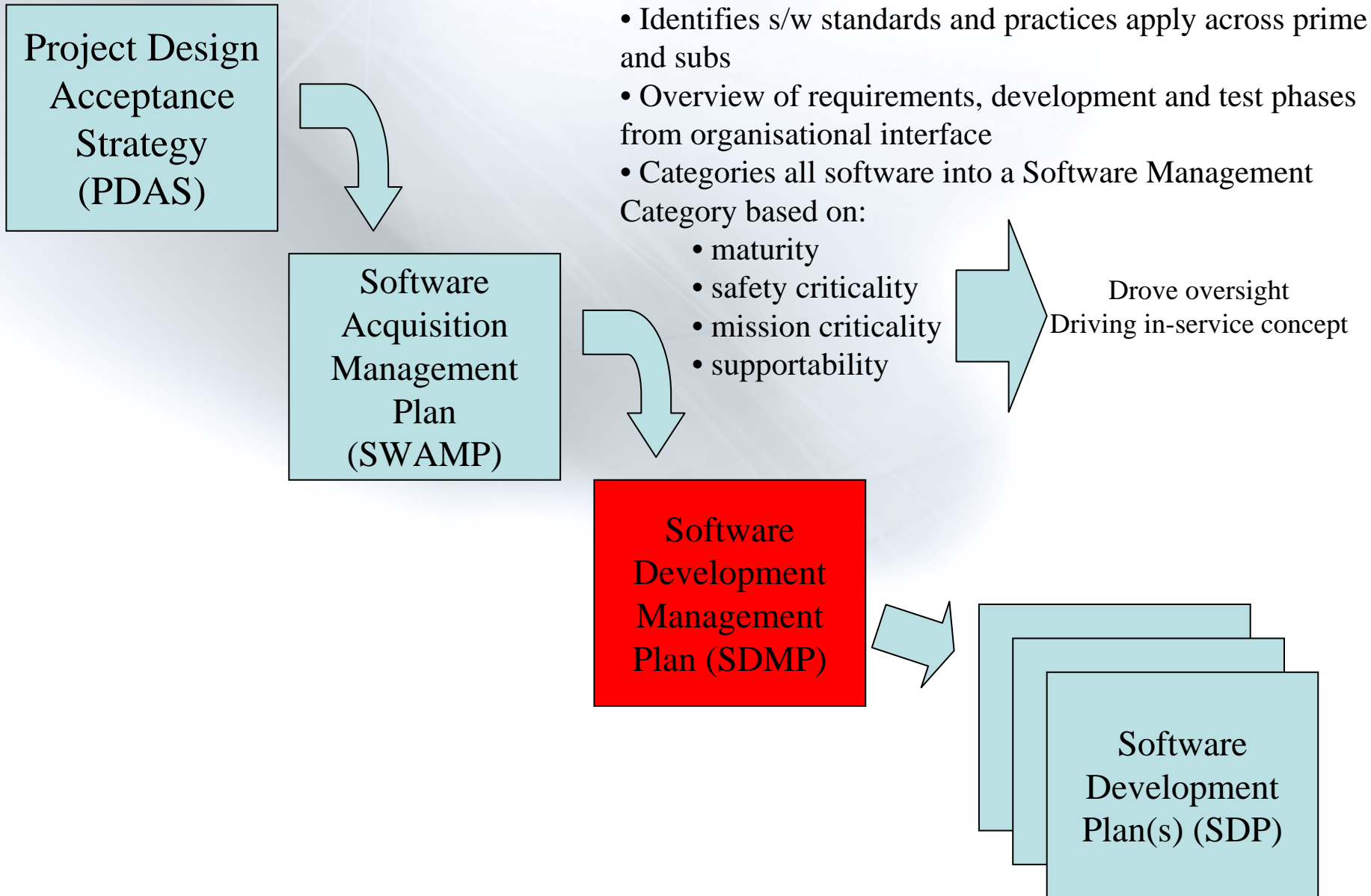
Software
Development
Management
Plan (SDMP)



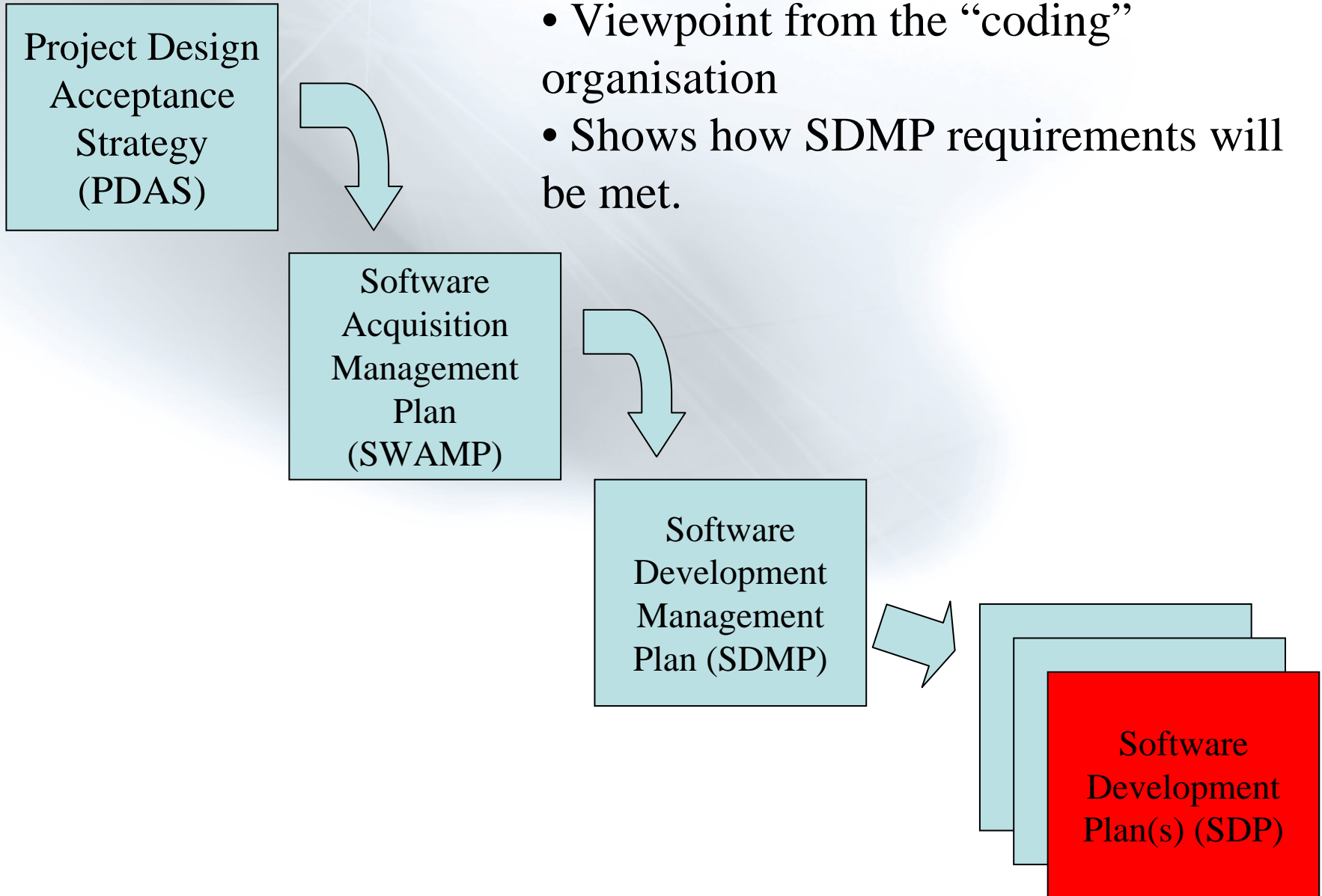
Software
Development
Plan(s) (SDP)



Plans



Plans



SDP

- Viewpoint from the “coding” organisation
- Shows how SDMP requirements will be met.