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Who Moved My Milestone? Cost and Risk Implications of Selected Changes in the New DOD 5000 Defense Acquisition Framework

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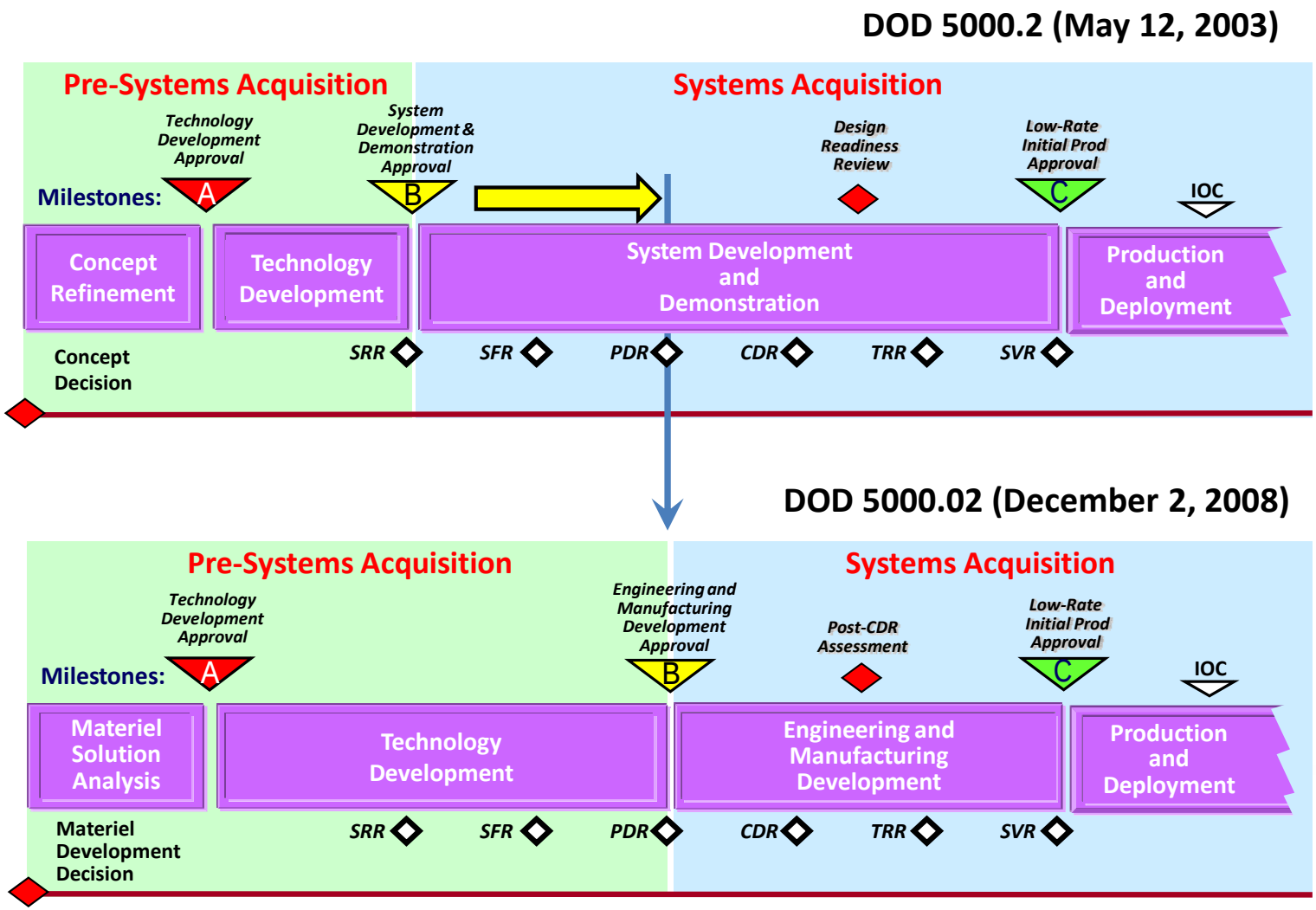
Outline

- Objectives
- Changes to DOD Acquisition Policy
- The Impact on Systems Engineering Effort
- Detour: Software Life Cycle Modeling Basics
- Life Cycle Phases and Software Effort Distribution in the Previous DOD 5000.2 Framework
- Life Cycle Phases and Software Effort Distribution in the Current DOD 5000.02 Framework
- The Impact of Incremental Software Development
- Conclusions
- Acronyms
- References

Objectives

- The presentation's objective is to highlight some consequences of selected changes in the DOD 5000 Instructions
- The focus of inquiry is on the alignment of the Preliminary Design Review (PDR) with the Milestone B decision
- Another aspect of the analysis is to determine the impact of the mandate for increased competition in the Technology Development phase
- Using life cycle modeling and cost estimation research results, we also explore the impact of different, basic software life cycle models

Changes to DOD Acquisition Policy



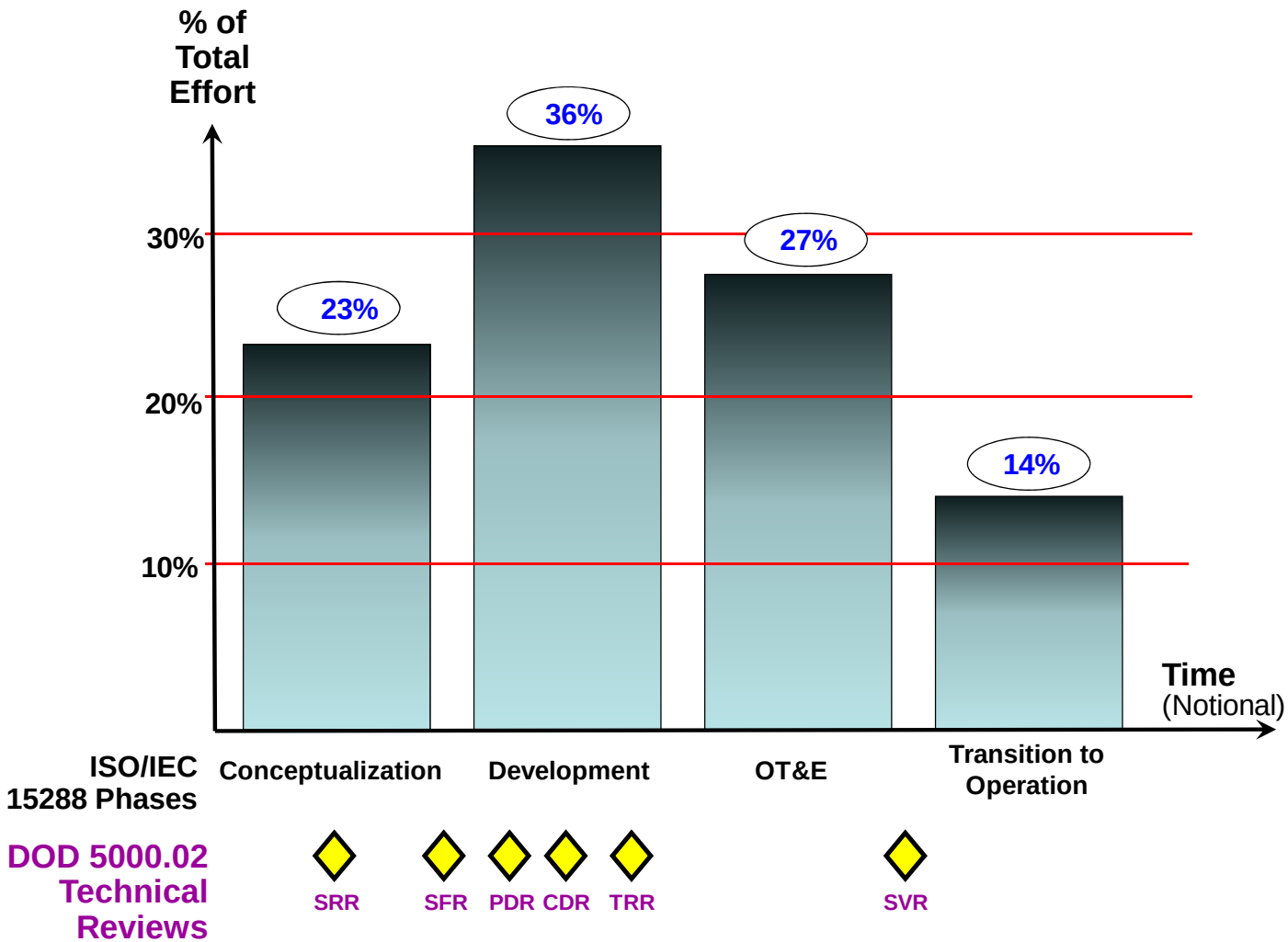
PDR now conducted prior Milestone B

The Rationale Behind the Changes

- Selected aspects of the discussed changes were proposed earlier in the 2006 Defense Acquisition Performance Assessment (DAPA) report*:
  - *For Acquisition Category (ACAT) I and II programs, create contract terms and conditions that require formal subcontractor level competition instead of internal make-or-buy assessments by the prime*
    - According to the report, this higher level of visibility would allow the government to better understand the technical and management risks of the prime contractor's plans
  - *Reposition the Milestone B decision to occur at PDR*
    - According to the report, the maturity of the designs at this phase would allow more realistic program cost determination
    - Industry and Government would be in a better position to agree on a high confidence cost estimate for the desired capability
    - Source Selection Authorities would have a competitive range available to consider the proposals' affordability

** Source: [DAPA 2006]*

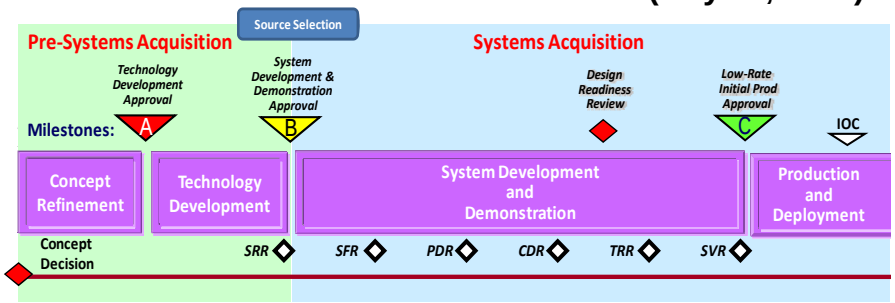
Constructive Systems Engineering Cost Model (COSYSMO) Systems Engineering Effort Distribution*

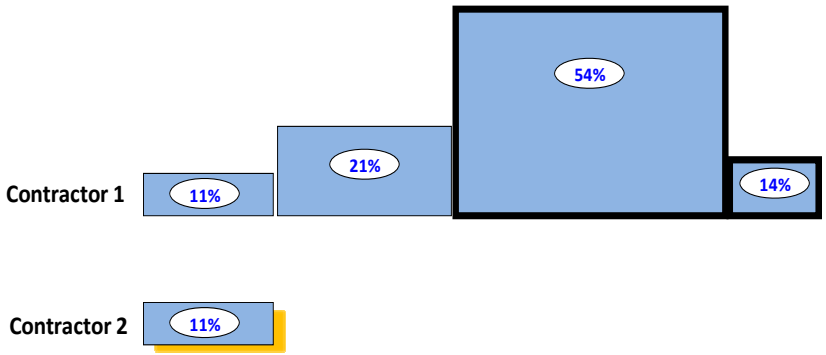


Sources: [Valerdi 2008], [Hantos-Kern 2009]

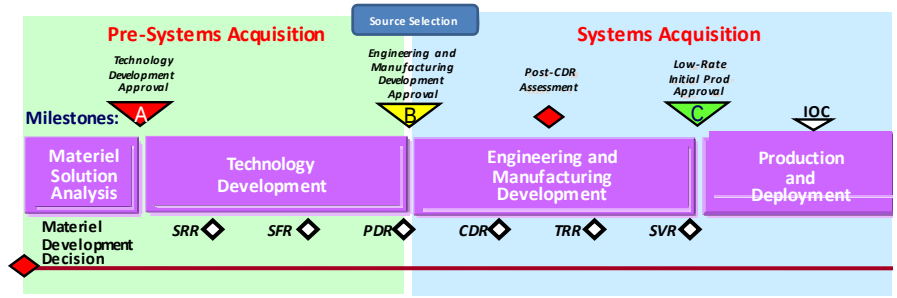
The Impact on the Systems Engineering Effort

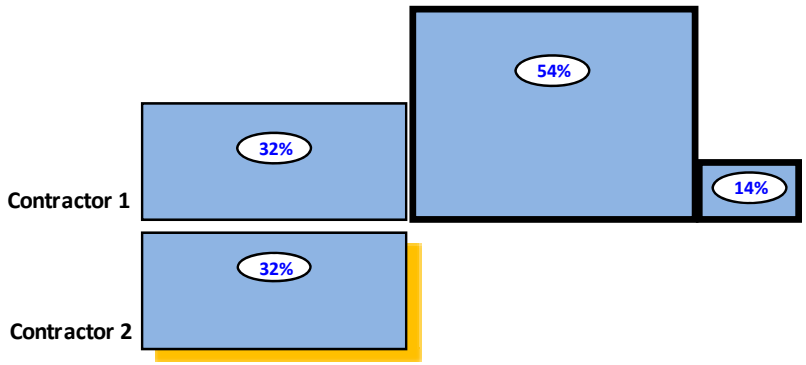
DOD 5000.2 (May 12, 2003)





DOD 5000.02 (December 2, 2008)





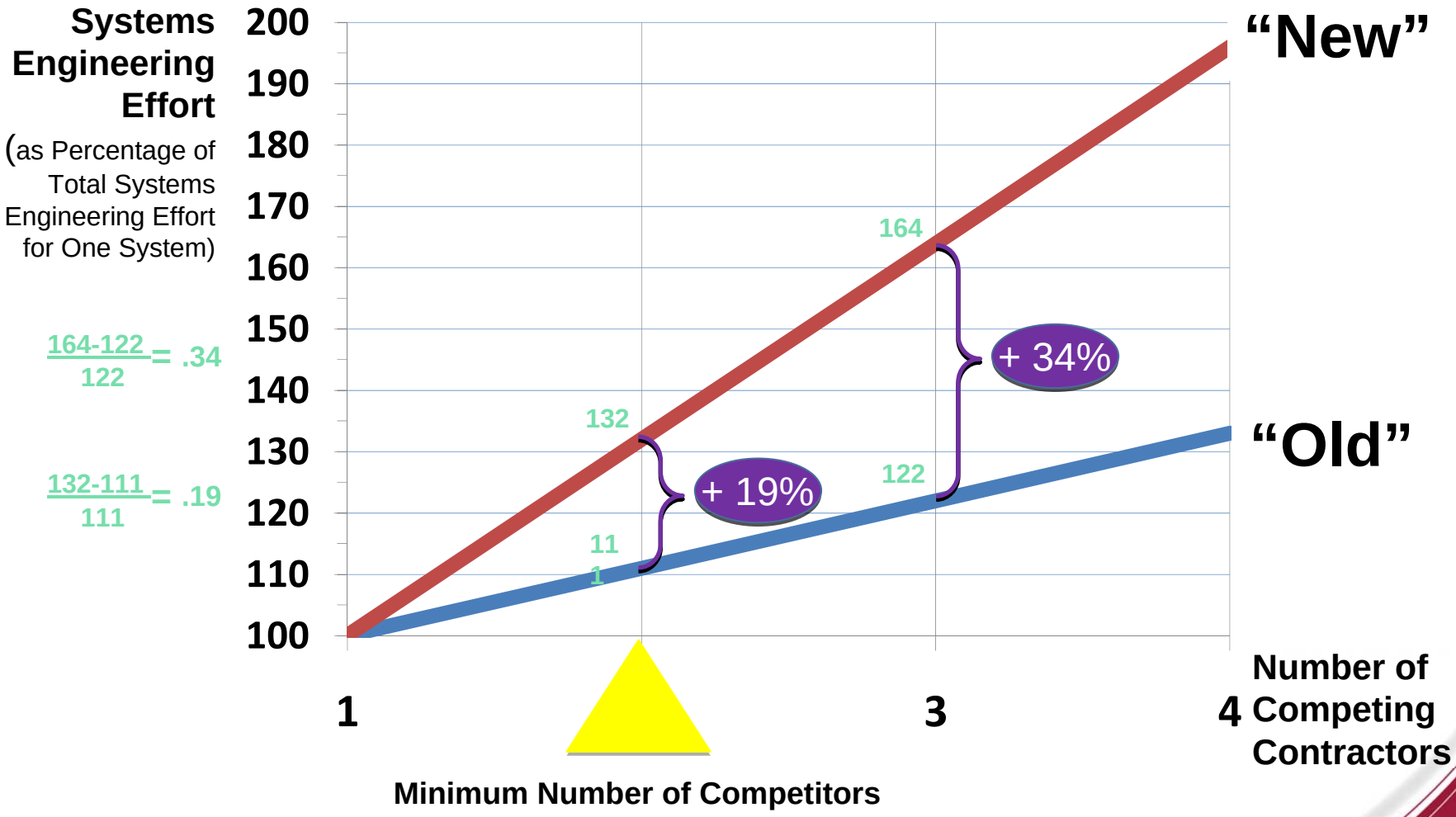
Since program baseline is formalized after MS B, the cost and duration of acquisitions appear to decrease

- However, the overall cost of acquisitions, particularly the costs associated with the initial systems engineering effort involving multiple contractor teams, will significantly increase
- Program Office effort, leading up to and carrying out source selection, needs to significantly increase

Program risk after MS B may be reduced but at increased cost for the overall acquisition

Conclusions from [Hantos-Kern 2009]

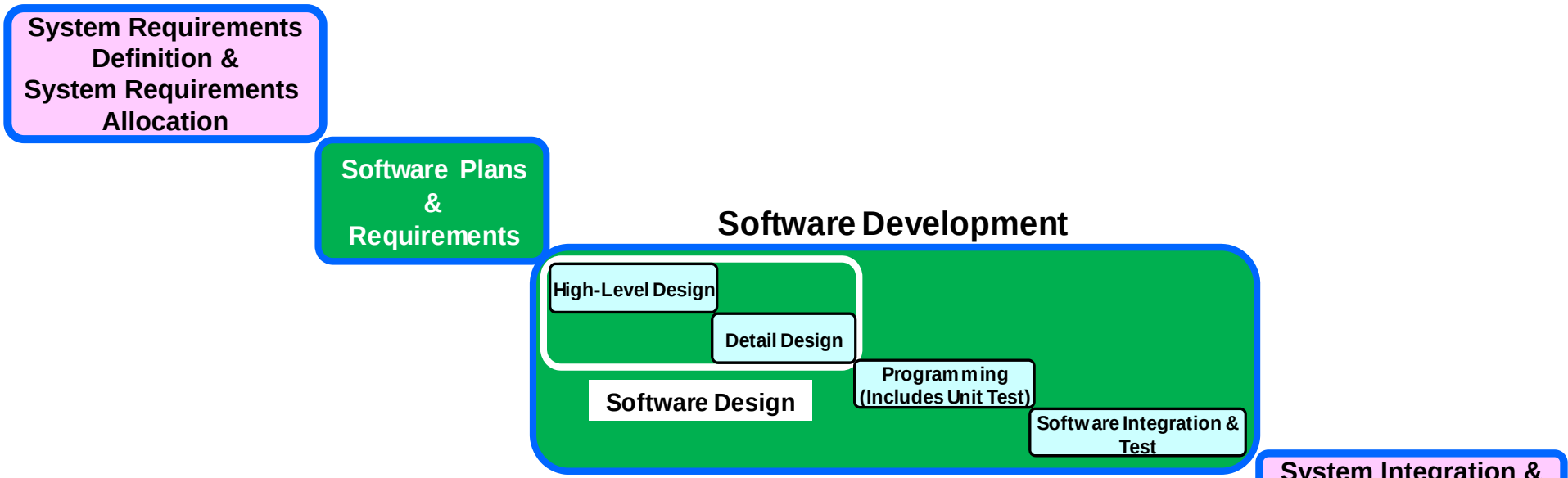
Moving Milestone B Increases the Overall Systems Engineering effort



Source: [Hantos-Kern 2009]

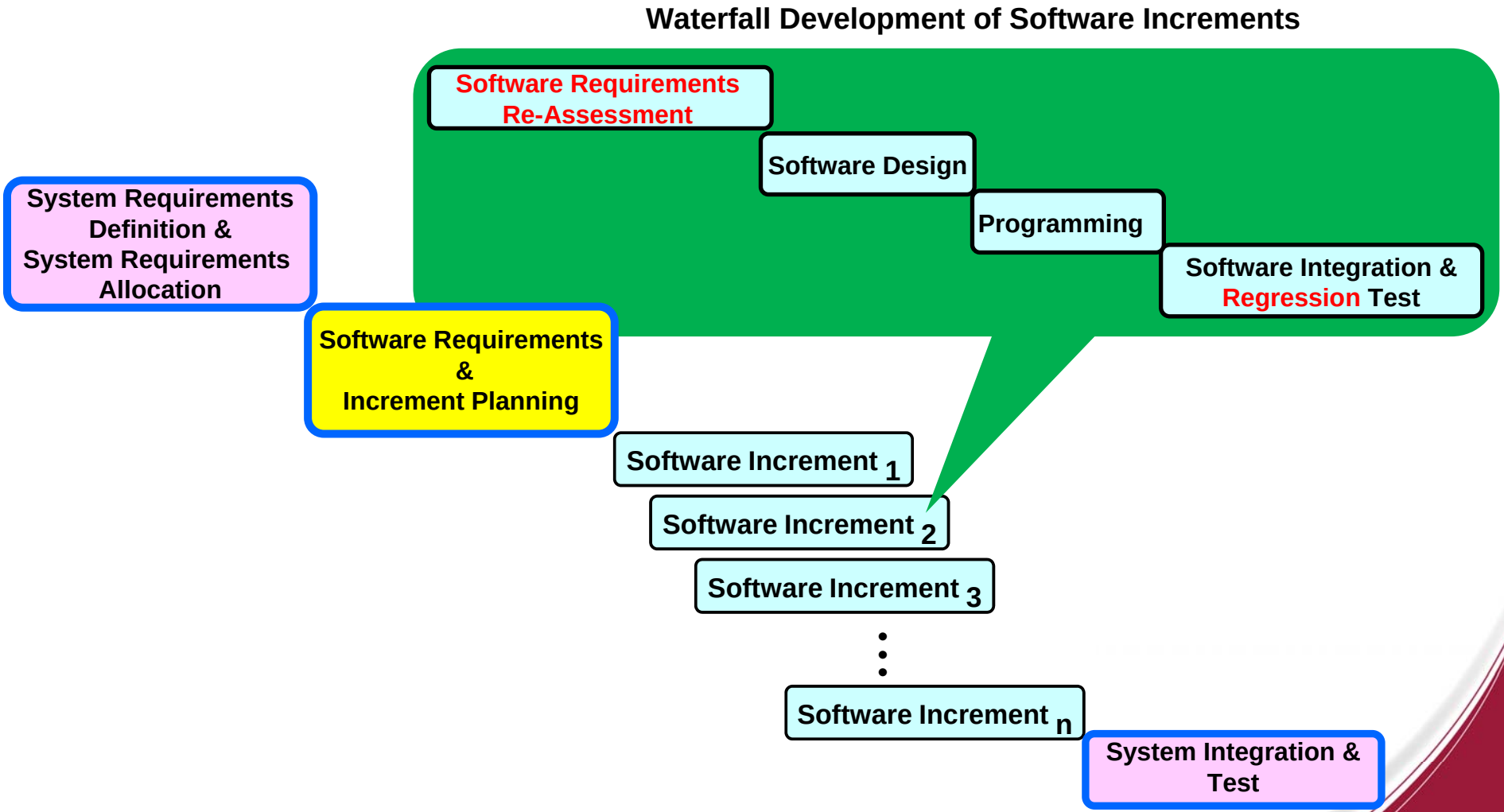
Detour: Software Life Cycle Modeling Basics

Positioning the Classic Software Waterfall Life Cycle Model in Software-Intensive System Development



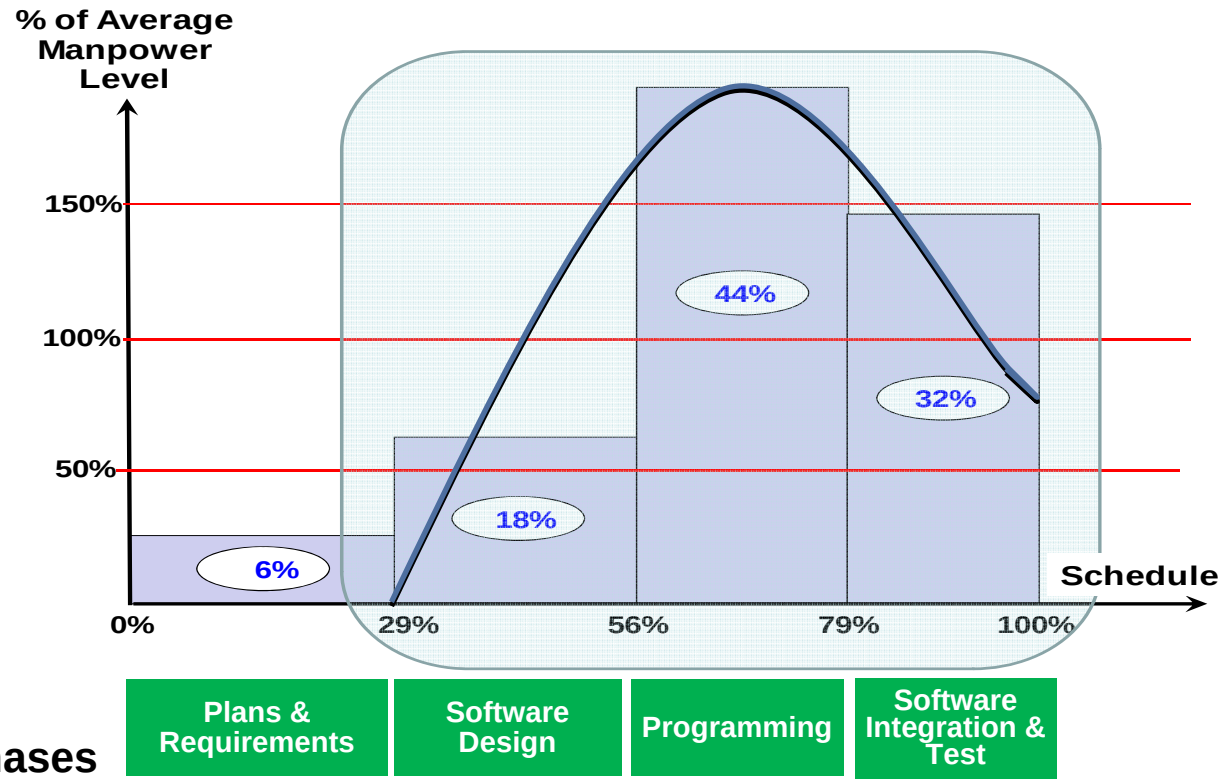
- Waterfall characteristics
  - *All system requirements are defined/allocated to software prior to development*
  - *Software intended to be developed all at once (One single build)*
  - *No significant overlap allowed between development phases*
  - *Typically marred by late problem discovery and resolution*
    - *Can be mitigated via incremental development (Next slide)*

Position of the Incremental Life Cycle Model in Software-Intensive System Development



Overlap of increments (concurrent builds) are allowed

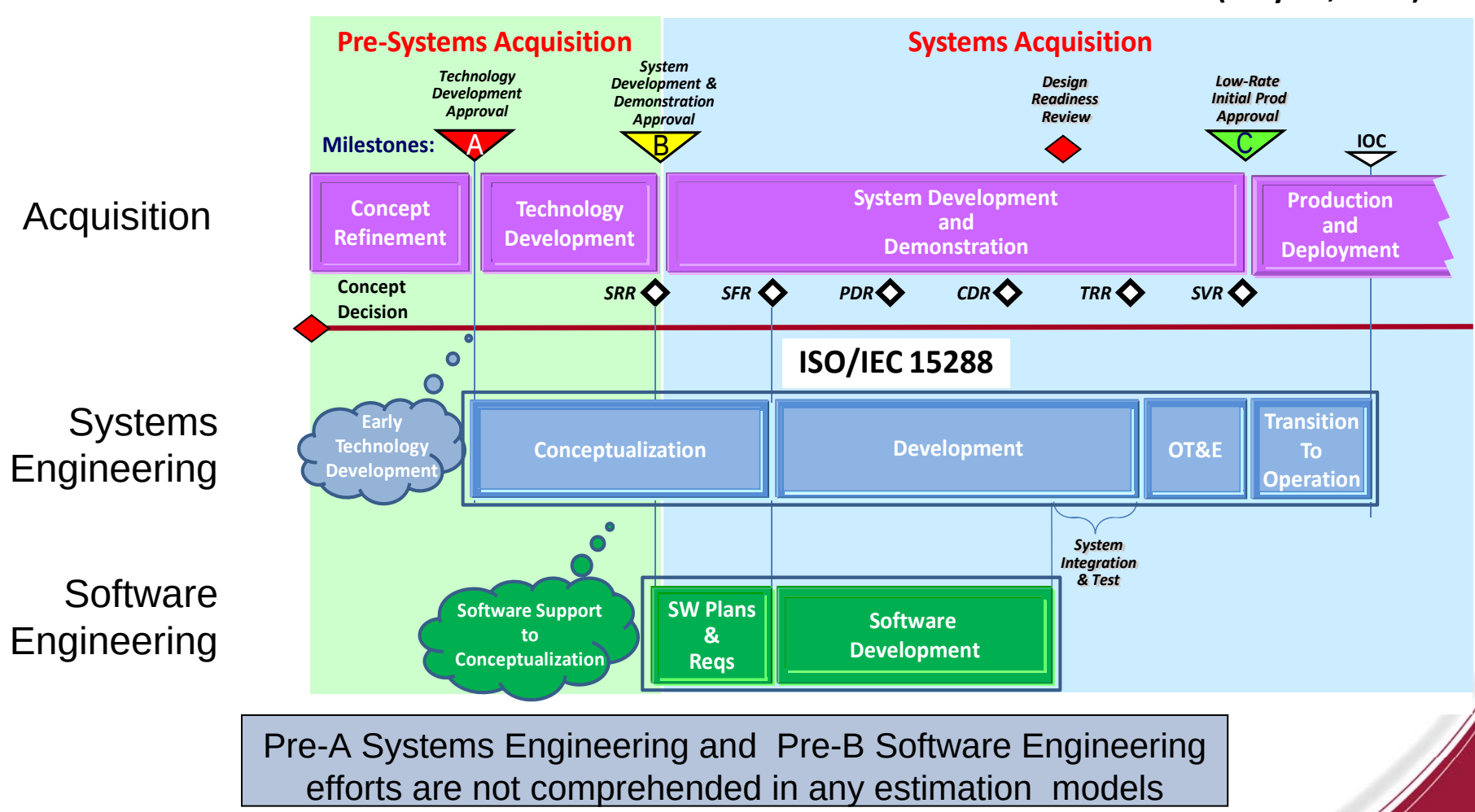
Software Engineering Effort Distribution in the Waterfall Model



- Chart shows the effort-distribution of a typical software system [Boehm 1981]
- The shaded area is an approximation of a Rayleigh curve that is the basis for computing effort-distribution in parametric models*

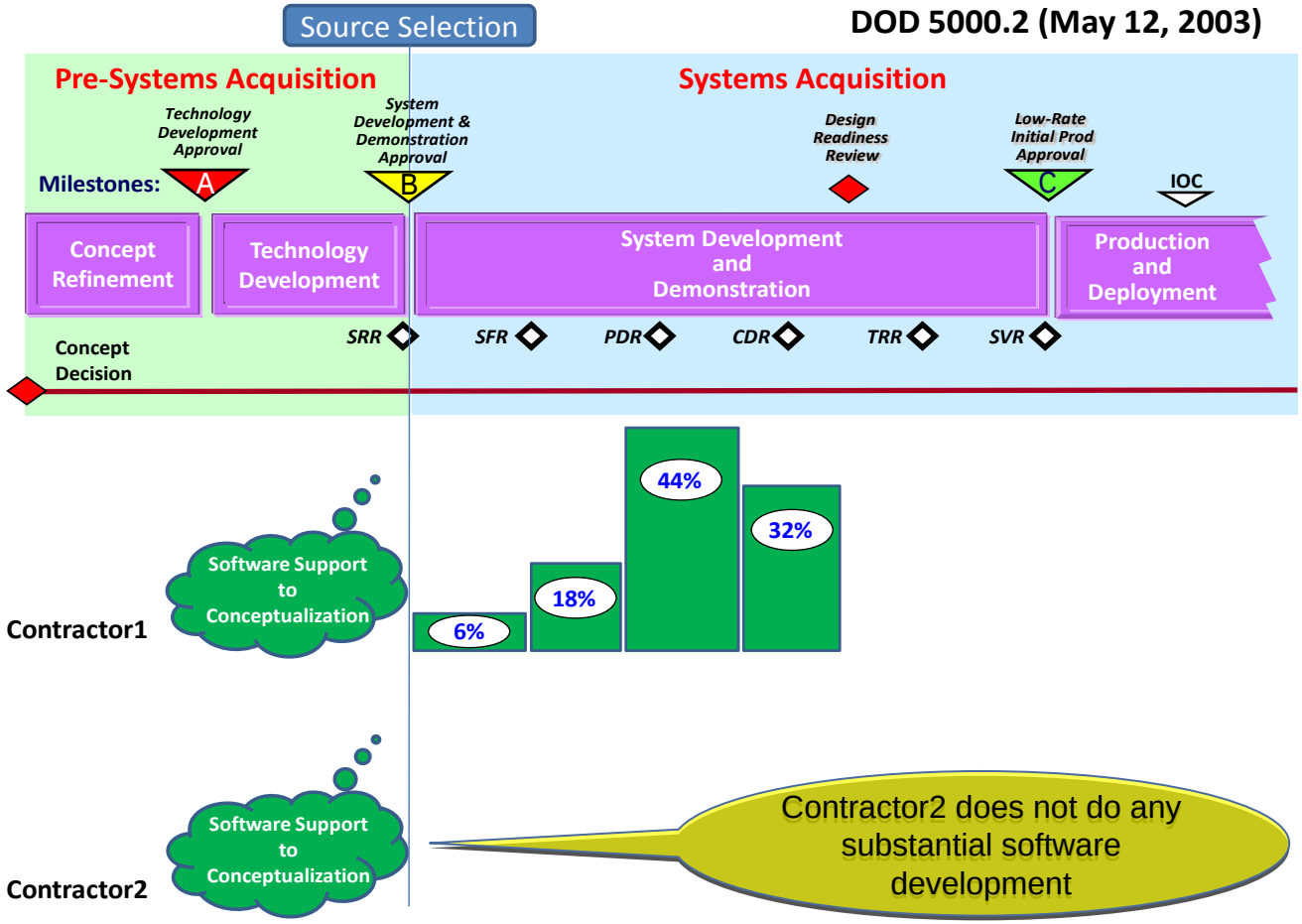
** Note that the effort required for the Plans & Requirements phase is not covered by the Rayleigh curve*

Life Cycle Phases in the Previous DOD 5000.2 Framework (May 12, 2003)



Pre-A Systems Engineering and Pre-B Software Engineering efforts are not comprehended in any estimation models

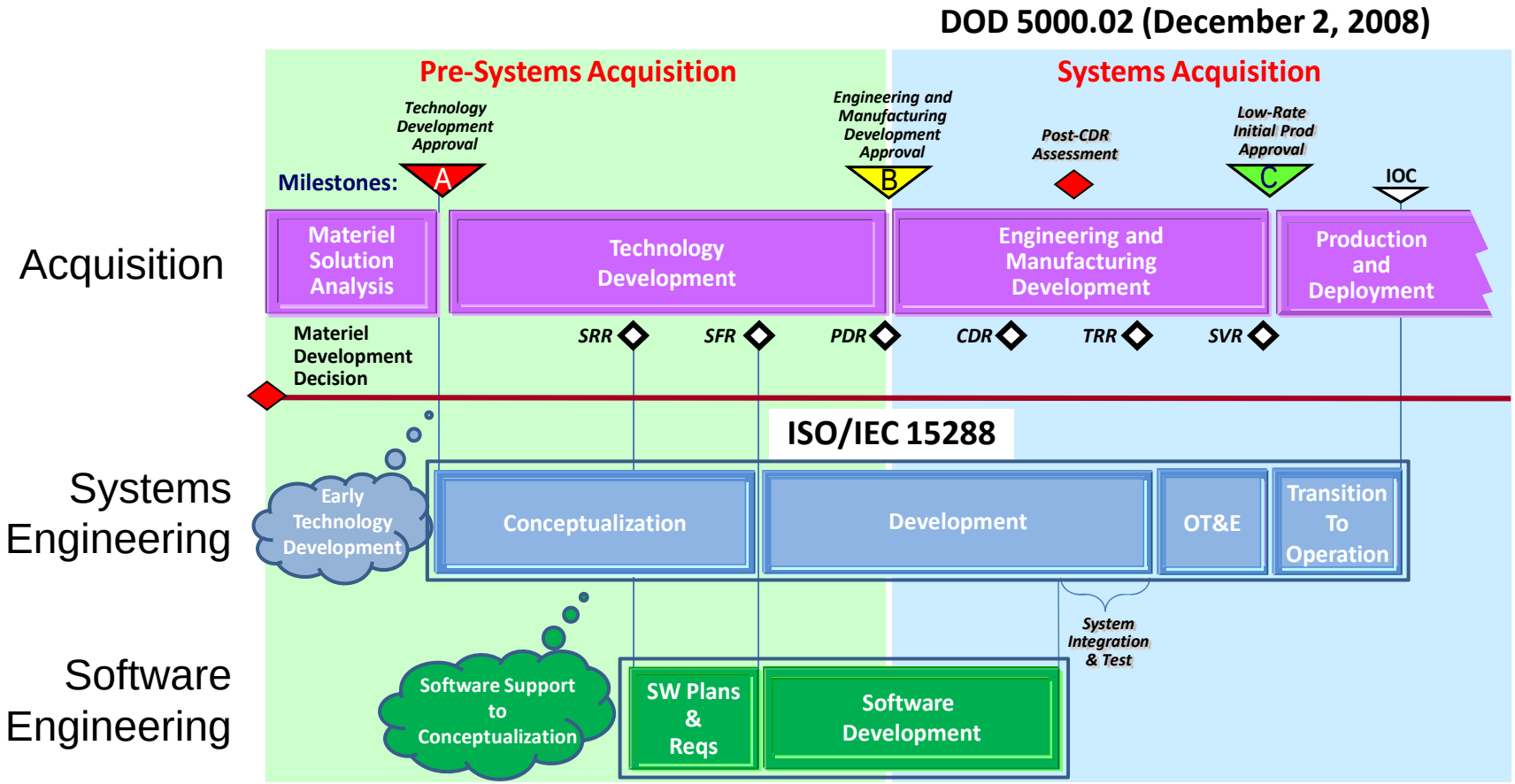
SW Effort Distribution* in the Previous DOD 5000.2 Framework (May 12, 2003)



Structure and Pre-MS B phase naming implies that software is not a "technology"

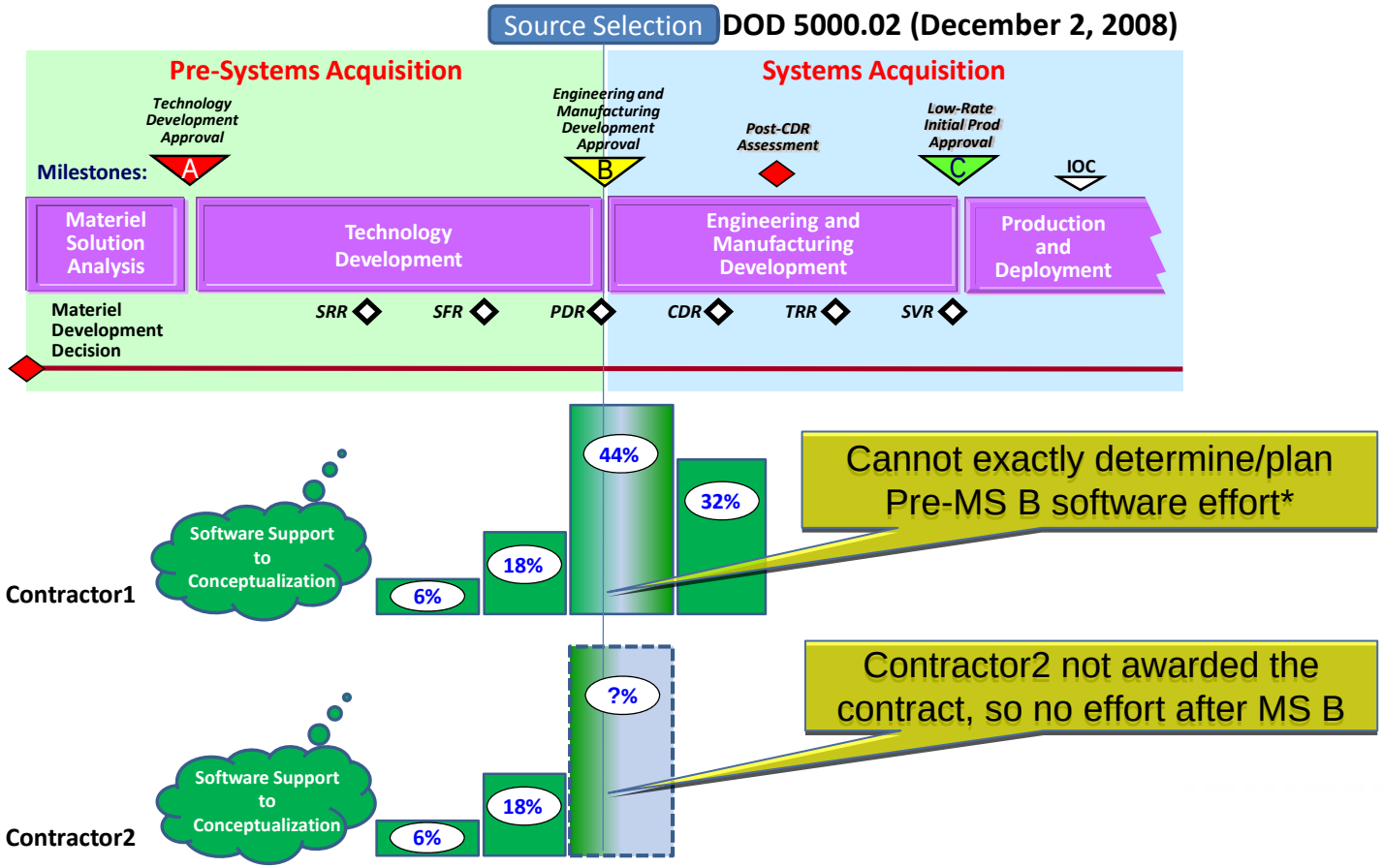
Simplified assumption: Only one software increment and it is Waterfall

Life Cycle Phases in the Current DOD 5000.02 Framework (December 2, 2008)



Note that the Systems Engineering ⟺ Software Engineering life cycle alignment is the same; only the acquisition life cycle part has changed

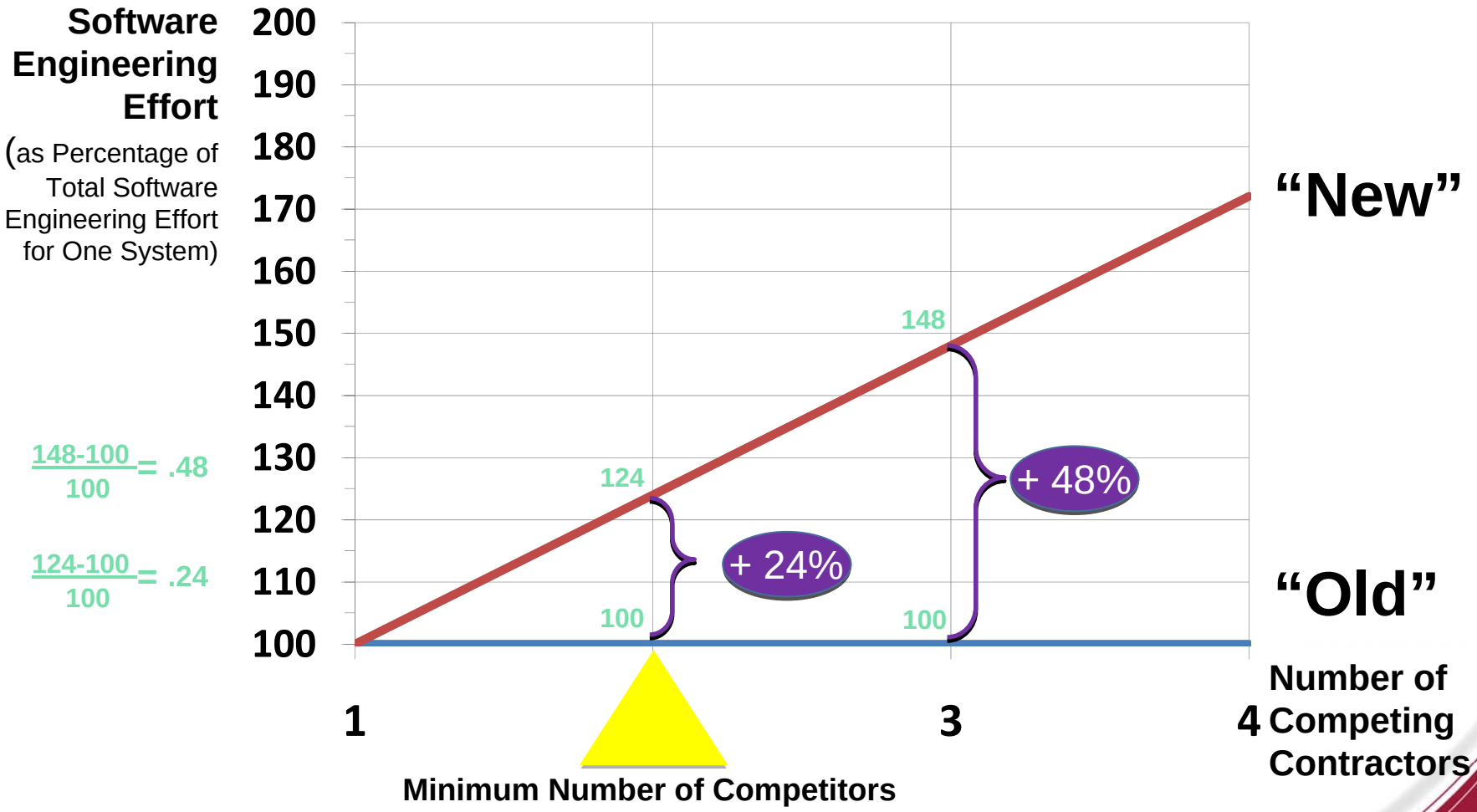
SW Effort Distribution in the Current DOD 5000.02 Framework (December 2, 2008)



PDR is an arbitrary, system-level review from the software development perspective

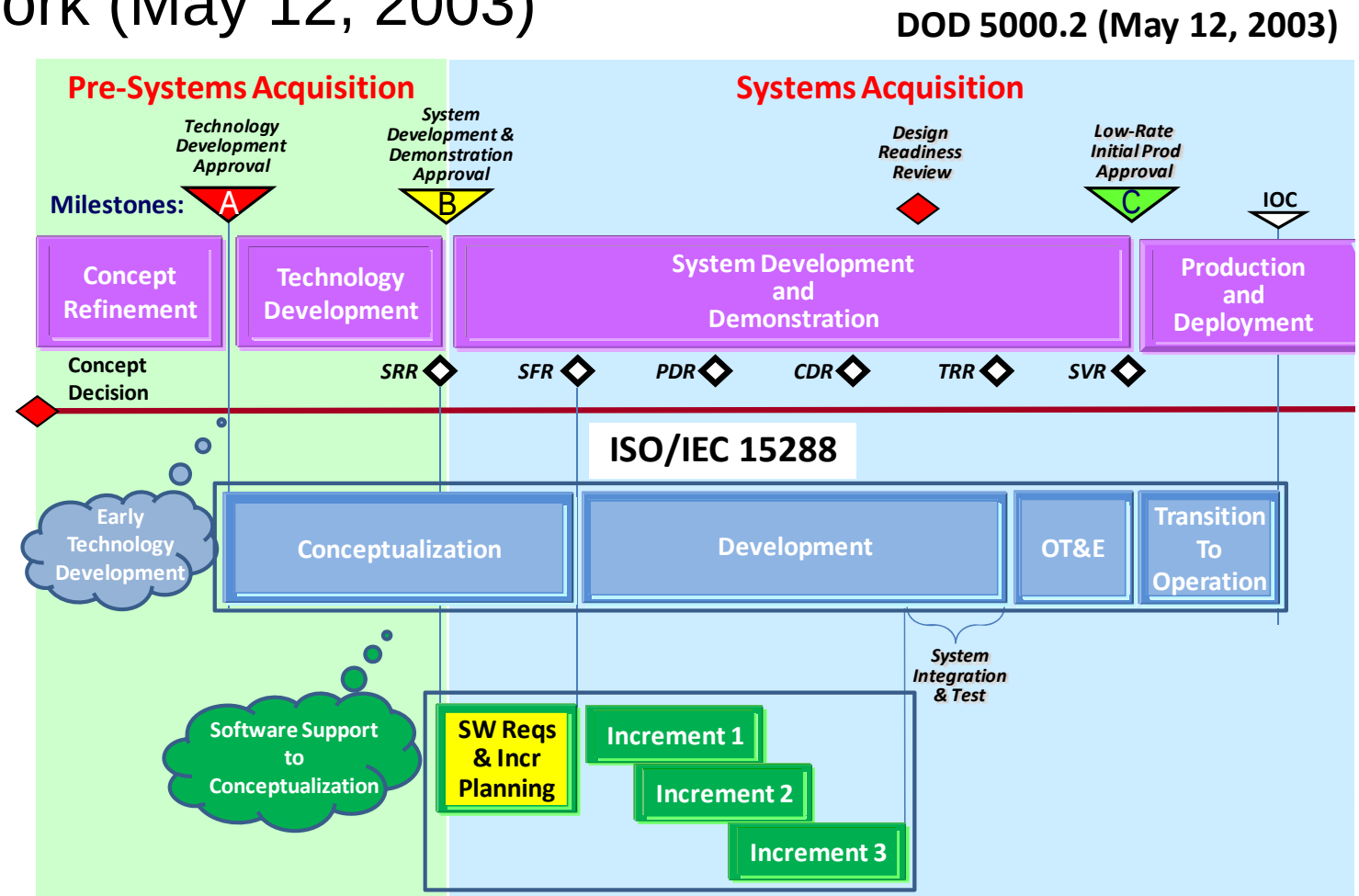
** An additional uncertainty, which is not formally indicated, is that effort curves do not account for any possible software **technology** development*

Moving Milestone B, Combined with Mandated Pre-MS B Competition, Increases the Software Engineering Effort



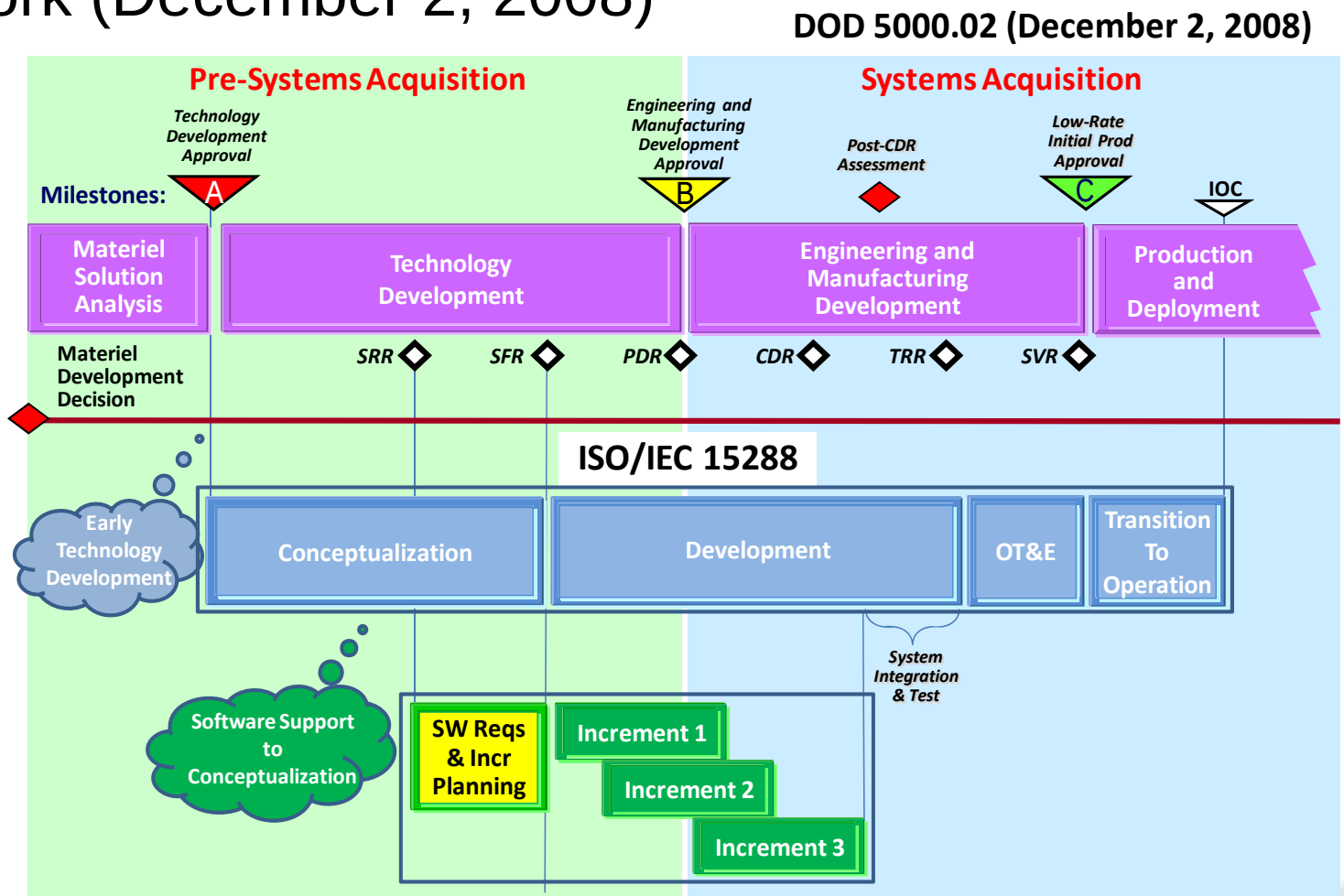
Due to the mentioned uncertainties, the chart only shows the minimum increase; actual values are always higher

Incremental Development in the Previous DOD 5000.2 Framework (May 12, 2003)



Incremental Development decision took place only after MS B and did not have an impact

Incremental Development in the Current DOD 5000.02 Framework (December 2, 2008)



Incremental Development does not change the main conclusions, only increases uncertainty

Conclusions

- The repositioning of MS B and new rules for competition will explicitly increase both the systems and software engineering effort for the program (minimum **19%** and **24%**, respectively)
- Various scenarios have been analyzed, but actual cost/schedule impacts still remain to be seen
  - *The vision for systems during the Pre-MS A phase is usually quite vague; consequently, estimates based on that vision have always high level of uncertainty*
  - *The expected effort increase in both cases is in the front-end, i.e., in the Technology Development phase*
    - However, in addition to technical considerations, the reality is that the actual determination of Technology Development funding will be based on various component and other, higher level negotiations, adding further uncertainty and instability to the estimates
- **Both under- or over-estimation of resources for Technology Development can put the program in jeopardy**
  - *If the estimates seem to be too high at MS A then the program might not be even initiated or Technology Development could be underfunded*
  - *Underestimation of resources will definitely cause major tensions and schedule/cost problems later*

Acronyms

ACAT	Acquisition Category
CDR	Critical Design Review
COSYSMO	Constructive Systems Engineering Cost Model
DAPA	Defense Acquisition Performance Assessment
DOD	Department of Defense
IEC	International Electrotechnical Commission
ISO	International Standards Organization
IOC	Initial Operational Capability
PDR	Preliminary Design Review
SFR	System Functional Review
SRR	System Requirements Review
SVR	System Verification Review
SW	Software
TRR	Test Readiness Review

References

Boehm 1981	Software Engineering Economics, Prentice-Hall, 1981
DAPA 2006	Defense Acquisition Performance Assessment (DAPA) Report, March 2006
Hantos-Kern 2009	Hantos, P., Kern, N., *Cost and Risk Impacts of the New DOD 5000 Defense Acquisition Framework*, NDIA 12th Annual Systems Engineering Conference, San Diego, CA, 27 October 2009
Valerdi 2008	Valerdi, R., The Constructive Systems Engineering Cost Model (COSYSMO), VDM Verlag Dr. Mueller, 2008

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