Technology Readiness Assessment
ODUSD(S&T)

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PURPOSE

DODD 5000.1 and DODI 5002, May 12, 2003 require:

- Technology Readiness Assessments (TRAs) for critical technologies prior to MS B and C decisions.
  - Technology Readiness Levels (or some equivalent assessment) will be used.
  - ACAT ID & 1AM Program Only
- Independent Readiness Assessments, if required
- Preliminary TRA required at initiation of shipbuilding programs
- Process for conducting TRAs:
  - Technology readiness assessments shall be conducted by the Services and Agencies to determine technical maturity and examine-
  - Program concepts
  - Technology requirements
  - Demonstrated technology capabilities
- Assessments will be evaluated by the DDR&E and findings forwarded to the OIPT and DAB for MS B and C.

National Defense Authorization Act for Fiscal Year 2002, Conference Report. Section 804

- For each of the calendar years 2002 through 2005, the Secretary of Defense is required to report to Congress on the implementation of DoD policy regarding technology maturity at the initiation of MDAPs. According to Sec. 804 of the NDAA for Fiscal Year 2002, Conference Report, the reports must ;
  - identify each case in which a major defense acquisition program entered system development and demonstration [i.e., passed MS B] during the preceding calendar year and into which key technology has been incorporated that does not meet the technological maturity requirement … [i.e., that technology must have been demonstrated in a relevant environment (or, preferably, in an operational environment) to be considered mature enough to use for product development in systems integration (from Sec. 804, subsection (a))] and provide a justification for why such technology was incorporated; and
  - identify any determination of technological maturity with which the DUSD(S&T) did not concur and explain how the issue has been or will be resolved.

THE 5000 MODEL

Technology Opportunities & User Needs

(BA 1 & 2)

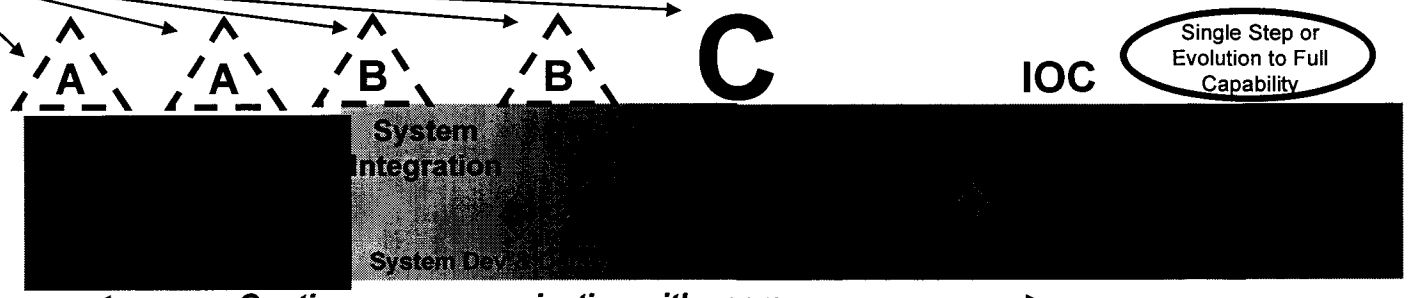
Program Outyear Funding

MS C EXIT CRITERIA

- ☑ *Demonstrated system*
- ☑ *Approved ORD & assured interoperability*
- ☑ *Affordability assessment*
- ☑ *Strategy in place for evolutionary approach, production readiness, and supportability*

- MS A: **Analyze concepts**
- MS B: **Begin development**
- MS C: *Commitment* **to rapid acquisition.**

- Multiple entry points **possible depending on technical/concept maturity**
- Three basic options at each decision point: **Proceed into next phase; do additional work; terminate effort**
- Reviews **are in-phase decision/progress points held as necessary**



Continuous communication with users

Early & continuous testing

Funding: BA 3 | BA 4 | BA 5 | BA 5/Proc | Proc/Operations & Maintenance

Requirements: MNS | ORD

All validated by Requirements Authority or PSA

Concept Exploration

- Paper studies of alternative concepts for meeting a mission
- Exit criteria: Specific concept to be pursued & technology exists.

Component Advanced Development

- Development of subsystems/components that must be demonstrated before integration into a system
- Concept/tech demonstration of new system concepts
- Exit criteria: System architecture & technology mature.

System Integration

- System integration of demonstrated subsystems and components
- Reduction of integration risk
- Exit criterion: System demonstration in a relevant environment (e.g., first flight).

System Demonstration

- Complete development
- Demo engineering development models
- Combined DT/OT
- Exit criterion: System demonstration in an operational environment.

LRIP

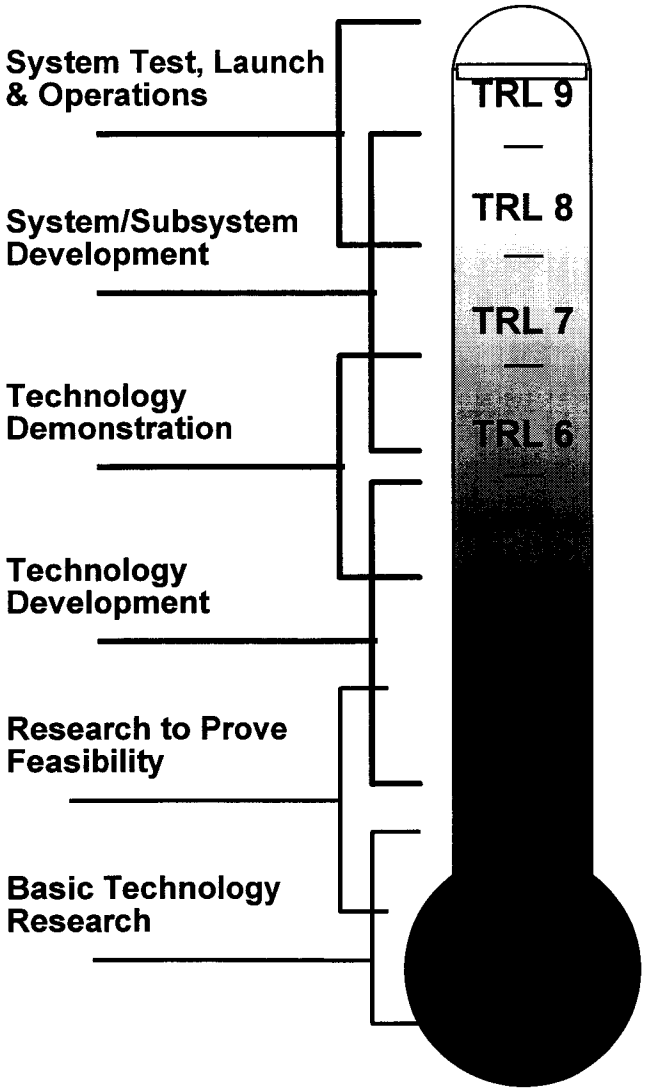
- IOT&E, LFT&E of prod-rep articles
- Create manufacturing capability
- LRIP
- Exit criterion: B-LRIP report.

Rate Prod & Deployment

- Full rate production
- Deployment of system

Measuring Technology Maturity

Technology Readiness Levels



Actual system "flight proven" through successful mission operations

Actual system completed and "flight qualified" through test and demonstration

System prototype demonstration in a operational environment

System/subsystem model or prototype demonstration in a relevant environment

Component and/or breadboard validation in relevant environment

Component and/or breadboard validation in laboratory environment

Analytical and experimental critical function and/or characteristic proof-of-concept

Technology concept and/or application formulated

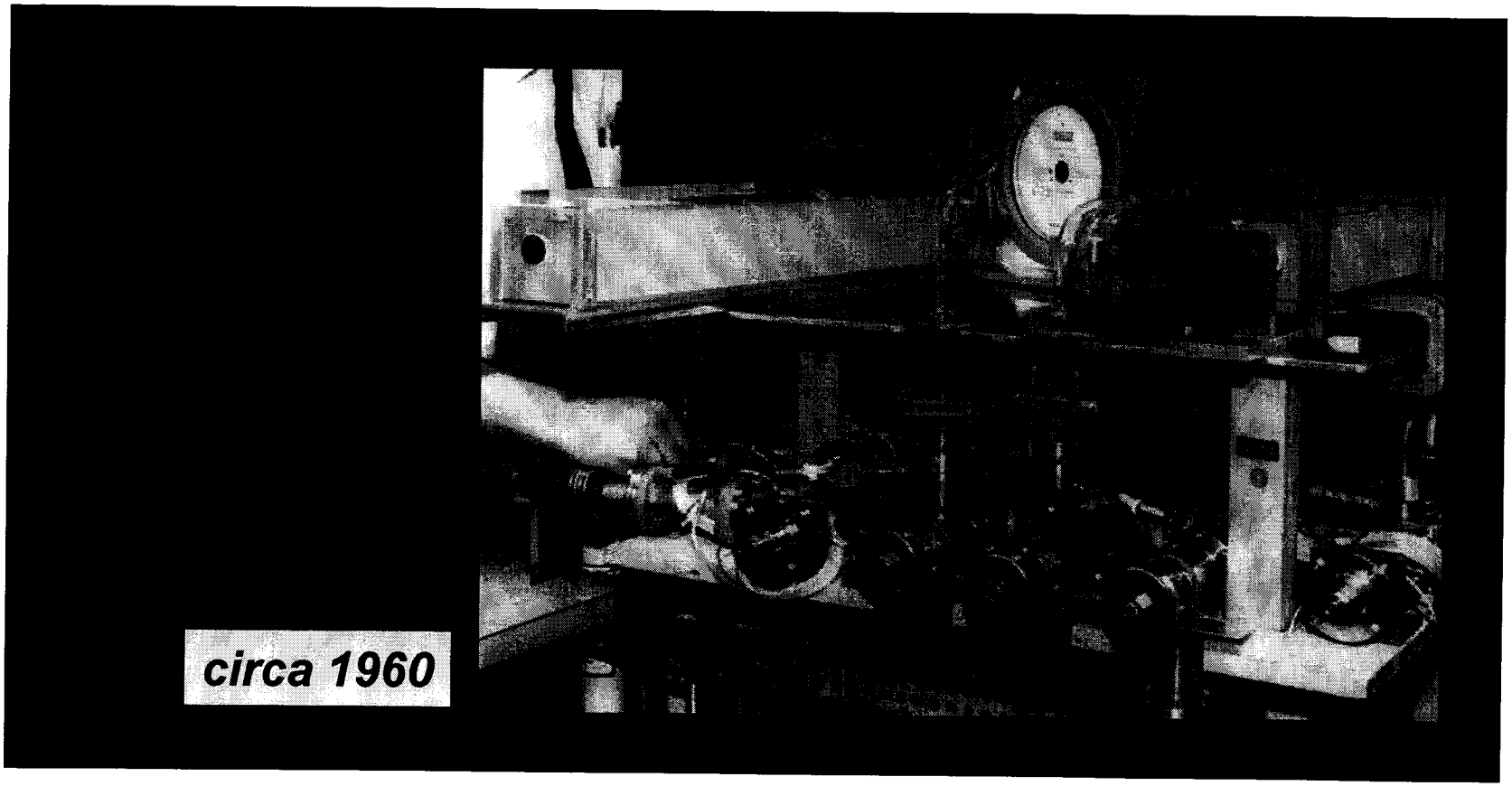
Basic principles observed and reported

Clarification of TRL Definitions

- **BREADBOARD:** Integrated components that provide a representation of a system/subsystem and which can be used to determine concept feasibility and to develop technical data. Typically configured for laboratory use to demonstrate the technical principles of immediate interest. May resemble final system/subsystem in function only.
- **"HIGH FIDELITY":** Addresses form, fit and function. High fidelity laboratory environment would involve testing with equipment that can simulate and validate all system specifications within a laboratory setting.
- **"LOW FIDELITY":** A representative of the component or system that has limited ability to provide anything but first order information about the end product. Low fidelity assessments are used to provide trend analysis.
- **MODEL:** A reduced scale, functional form of a system, near or at operational specification. Models will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.
- **OPERATIONAL ENVIRONMENT**: Environment that addresses all of the operational requirements and specifications required of the final system to include platform/packaging.
- **PROTOTYPE:** The first early representation of the system which offers the expected functionality and performance expected of the final implementation. Prototypes will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.
- **RELEVANT ENVIRONMENT:** Testing environment that simulates the key aspects of the operational environment.
- **SIMULATED OPERATIONAL ENVIRONMENTAL**: Environment that can simulate all of the operational requirements and specifications required of the final system or a simulated environment that allows for testing of a virtual prototype to determine whether it meets the operational requirements and specifications of the final system.

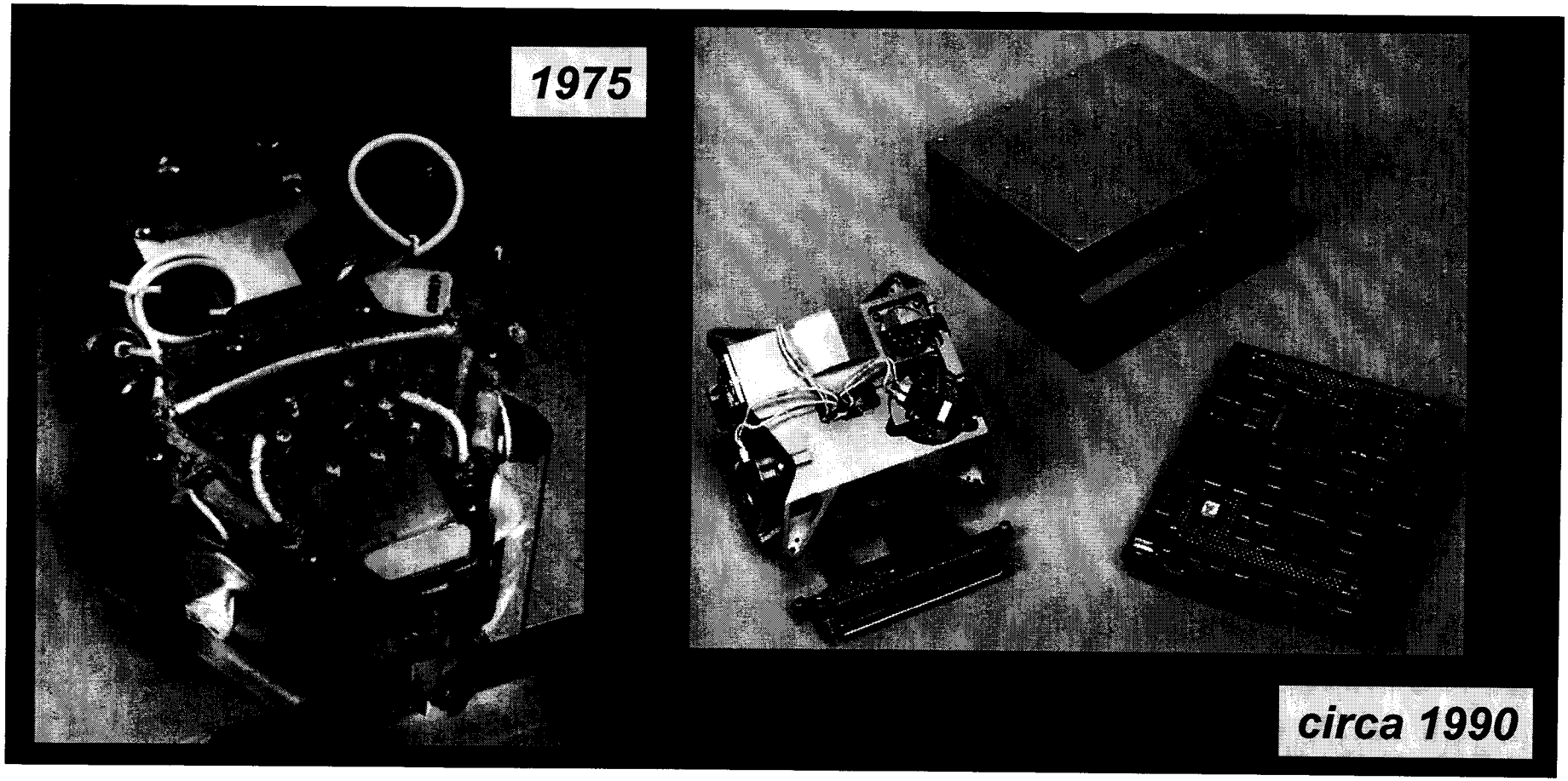
Technology Readiness Example
Missiles

Level	Technology Readiness	Example – HG1700 Inertial Measurement Unit Guided Multiple Launch Rocket System (GMLRS)
1	Basic Principles observed and reported.	**Basic research** – Invention of Gas Laser
2	Technology concept and/or application formulated.	**Basic research** – Invention of Ring Laser. Theoretical description of Ring Laser Gyro.



Technology Readiness Example
Missile

Level	Technology Readiness	Example – HG1700 Inertial Measurement Unit Guided Multiple Launch Rocket System (GMLRS)
3	Analytical and experimental critical function and/or characteristic proof of concept.	**Applied research** – Demonstration of Ring Laser as a rate sensor



Technology Readiness Example

Missiles

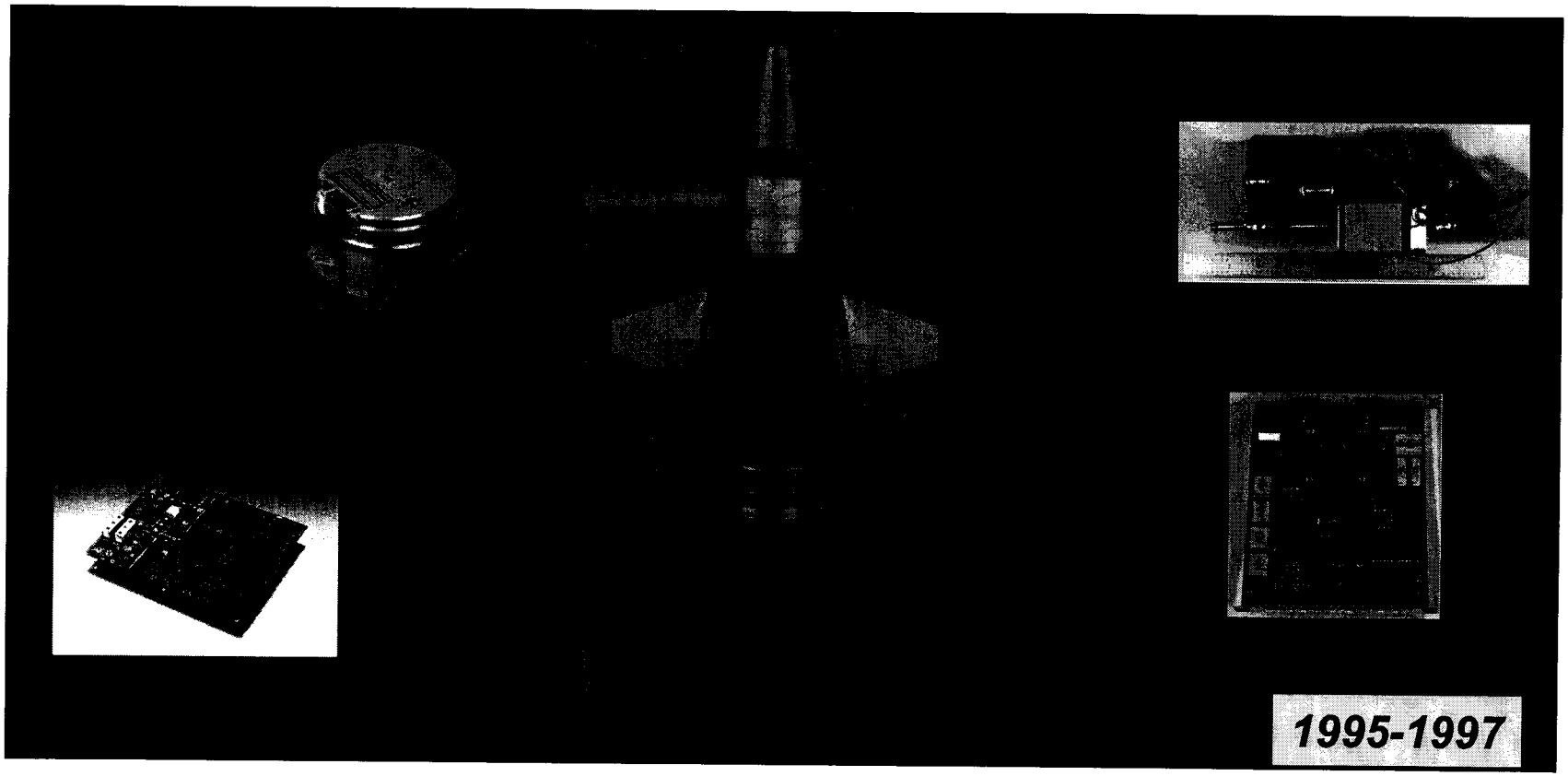
Level	Technology Readiness	Example – HG1700 Inertial Measurement Unit Guided Multiple Launch Rocket System (GMLRS)
4	Component and/or breadboard validation in laboratory environment.	**Applied research** – Demonstration of Ring Laser Gyro (RLG)-based Inertial Measurement Unit (IMU) operation under temperature, shock, vibration, and g-loading

[redacted]

1992-1994

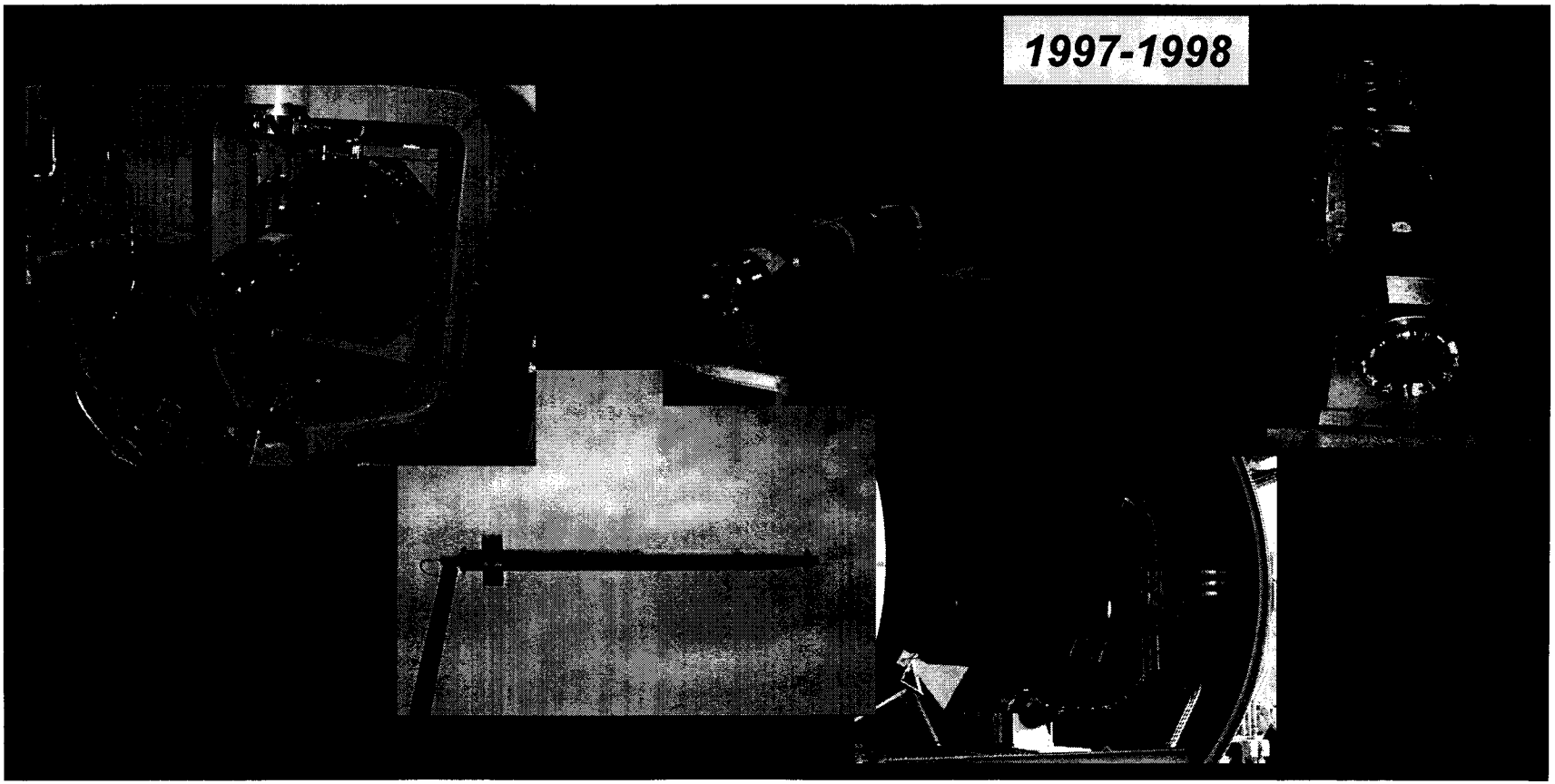
Technology Readiness Example
Missiles

Level	Technology Readiness	Example – HG1700 Inertial Measurement Unit Guided Multiple Launch Rocket System (GMLRS)
5	Component and/or breadboard validation in relevant environment.	**Advanced Technology Demonstration** – Demonstration of HG1700-based guidance set components (IMU, GPS receiver, control system, flight computer) in a high-fidelity hardware-in-the-loop facility



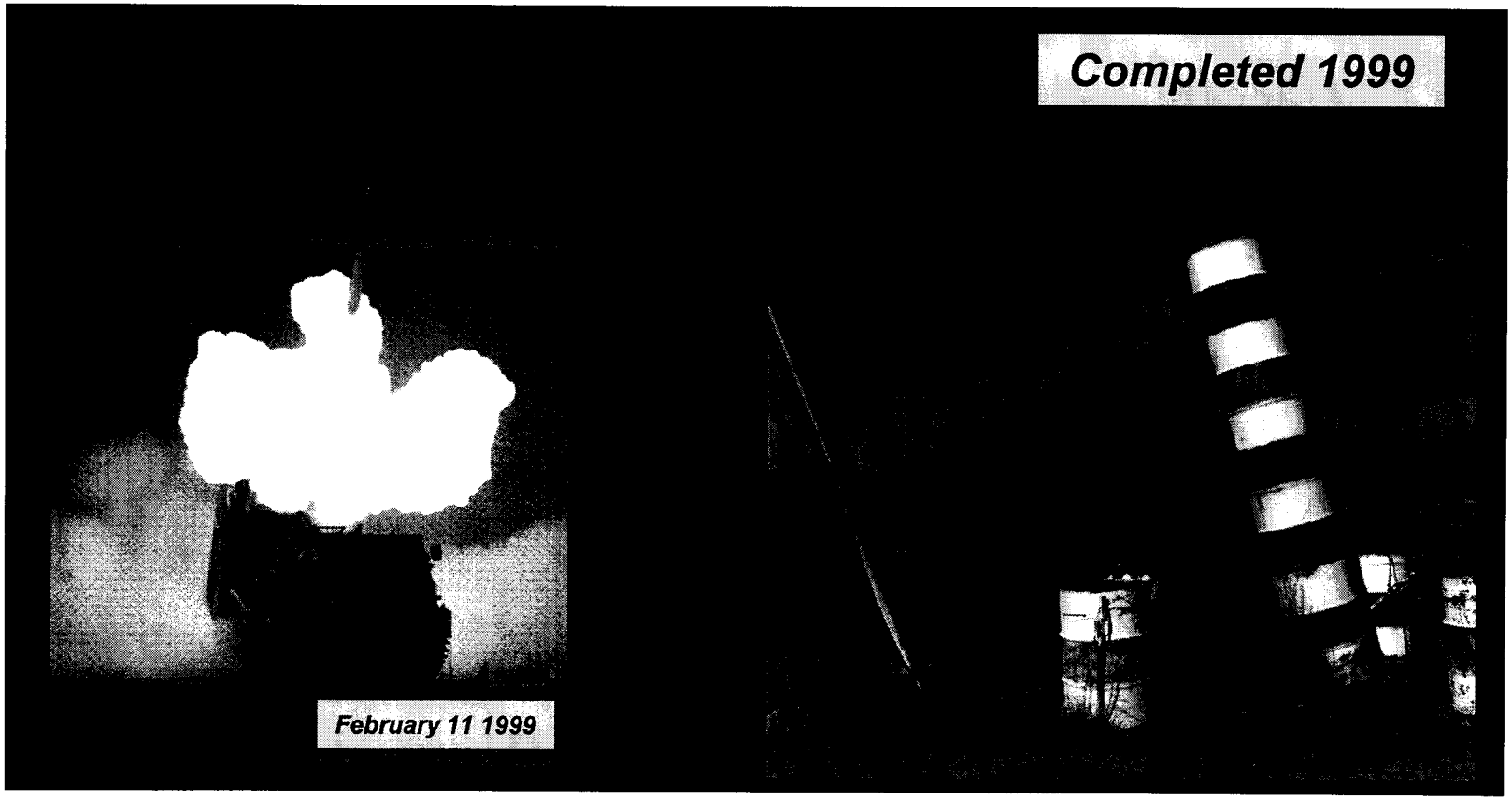
Technology Readiness Example
Missiles

Level	Technology Readiness	Example – HG1700 Inertial Measurement Unit Guided Multiple Launch Rocket System (GMLRS)
6	System/subsystem model or prototype demonstrated in a relevant environment.	**Advanced Technology Demonstration** – Demonstration of actual flight-ready HG1700-based guidance set in a high-fidelity hardware-in-the-loop facility and under expected levels of shock, vibration, altitude and temperature



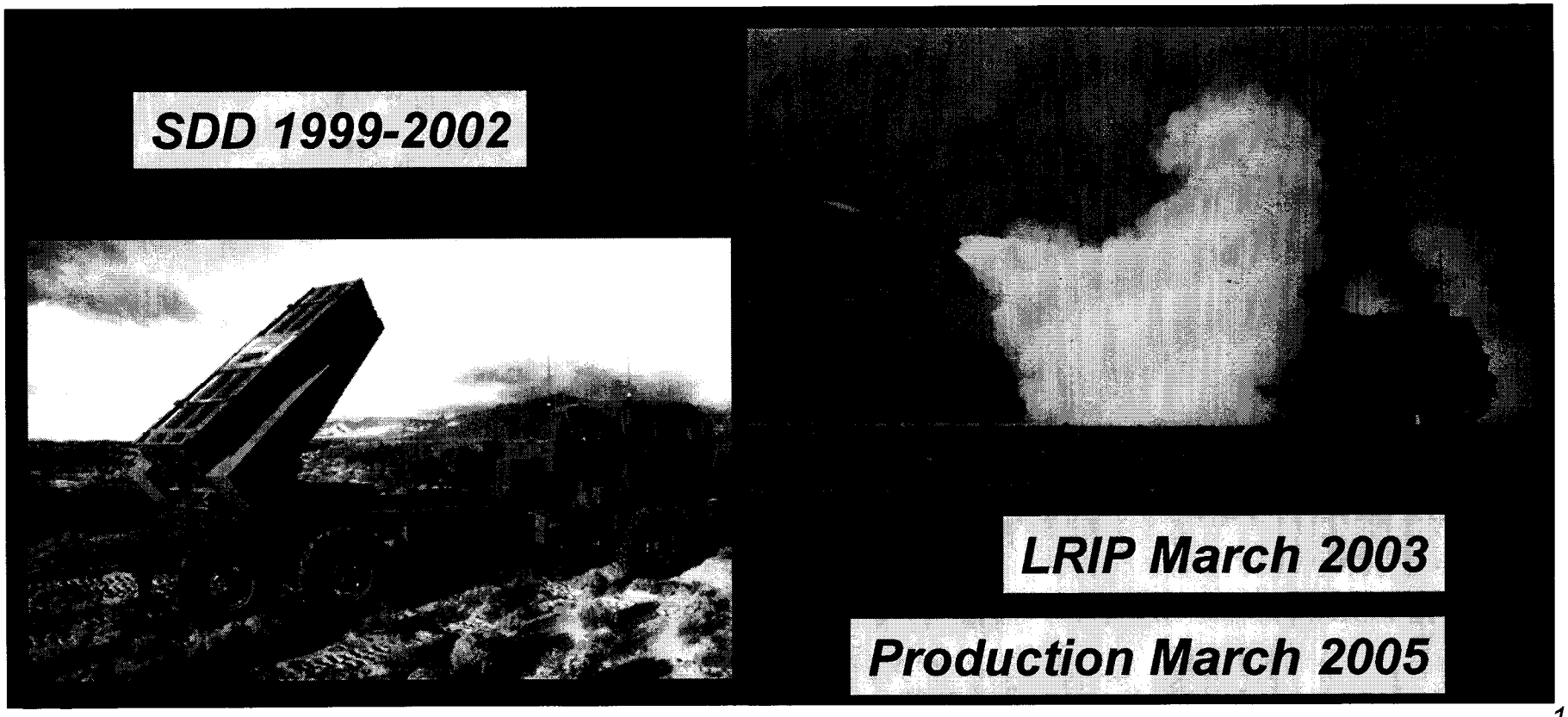
Technology Readiness Example
Missiles

Level	Technology Readiness	Example – HG1700 Inertial Measurement Unit Guided Multiple Launch Rocket System (GMLRS)
7	System prototype demonstrated in an operational environment.	**Advanced Technology Demonstration** of actual Guided MLRS missile in a flight test sequence from an operational launcher. Successful operation in multiple flight demonstrations



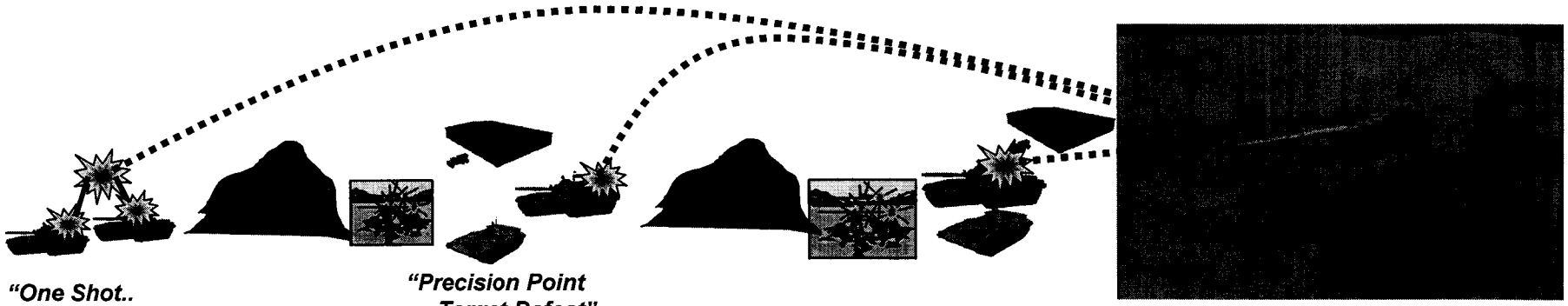
Technology Readiness Example
Missiles

Level	Technology Readiness	Example – HG1700 Inertial Measurement Unit Guided Multiple Launch Rocket System (GMLRS)
8	Actual system completed and "flight qualified" through test and demonstration.	**System Development & Demonstration/Low Rate Initial Production** – Developmental Test and Evaluation of GMLRS in its final form under mission conditions.
9	Actual system "flight proven" through successful mission operations.	**Production** – Operational Test and Evaluation of GMLRS by the soldier, airman, or seaman.



Multi-Role Armament & Ammunition ATD - Army Example

Objective: Demonstrate compact, direct/indirect fire armament system module capable of rapid lethality against the full spectrum of threats at 0-50km range.



"One Shot.. ....At Least One Kill"
NLOS 4-50KM

"Precision Point Target Defeat"
BLOS 2-12km

LOS 0-4Km

Pacing Technologies:

Cannon -
- Recoil Mitigation

Munitions -
- Electro-Thermal-Chemical Propulsion
- Seeker/Guidance & Control
- Multi-Mode Warhead

Warfighter Payoffs:
- Heavy Force Lethality with a 105mm
  - > Multi-range - LOS, BLOS, & NLOS
  - > Multi-Threat Capable
- Reduced logistic footprint
  - > High number of stowed rounds

A Lightweight Armament System For Dominating the Red Zone and Beyond

Multi-Role Armament & Ammunition ATD

FY01	FY02	FY03	FY04	FY05	FY06	FY07

TRL=4
Recoil Mitigation Demo

METRICS: Cannon
- 50% reduced recoil force w/Fire-out-of-battery modified M35 cannon w/ETC ignition

TRL=4
ETC Propellant Demo

METRICS:
Sub Scale firings of Gen II. Model to validate launch velocity.
Full Scale Firing With Adv JA2.
Validate integration

TRL=4
Seeker/G&C Acq Demo

METRICS:
- $P_{acq/Enc}$ to 8km via CFT Demo

TRL=5
Seeker/G&C High-g Demo

METRIC:
- MP-ERM:
  - 18k g's air gun test
- Cargo:
  - 20k g's air gun test

TRL=5
Multi-Mode WHD

METRIC:
- Shaped Charge
  - L/D=1 (vs 1.7)
- EFP
  - 25% increase in armor penetration

TRL=5
Propulsion Demo

METRICS:
Fire Full Scale Case Telescoped Ammo, Demo M829A2 + 20% performance

TRL=5
Recoil Mitigation Demo

METRICS:
- <80K lbs hardstand firing of KE slugs

TRL=6
Seeker/ G&C

METRIC:
- $P_{acq/Enc}$ via Integ Projectile Guide to Hit gun launch to 10km

TRL=6
Multi-Mode WHD

METRIC:
- Integrated WHD demo of 3 lethality modes

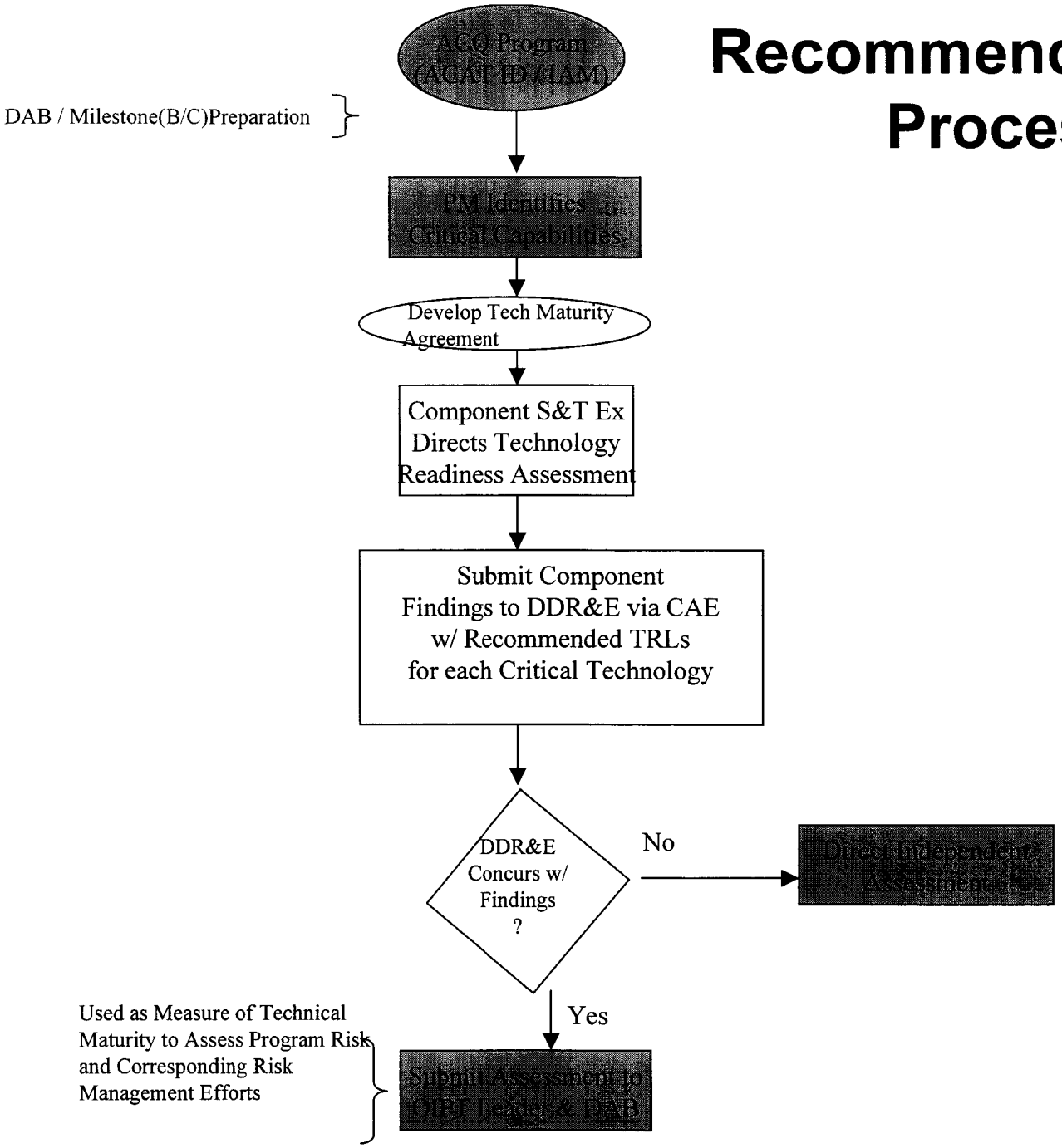
TRL=7
Systems Level Live fire demo of Ammo Suite

METRICS:
- Turret integrated on candidate vehicle

TRL=6
Seeker/ G&C

METRIC:
- 50-150m CEP to 50km
- Ambient Temp functionality

Recommended TRA Process



Recommended Component TRA Format

Outline

- Executive Summary

1.0 Purpose

- Introduction
- Approach

2.0 Program Overview

3.0 Technology Assessments (by Critical Technology Element)

- Description of the Technology
- Technology Readiness Assessment/Rationale

4.0 Conclusion

- Appendixes

Technology Readiness Assessments Completed

Program	Milestone
Joint Strike Fighter (JSF)	B - 2001
C 5 Reliability and Re-Engineering Program (RERP)	C - 2001
UH-60M Utility Helicopter	B - 2001
Cooperative Engagement Capability (CEC) Block I (surface based)	III/C - 2002
Composite Health Care System II	B - 2002
Joint Tactical Radio System (JTRS) Cluster 1	B - 2002
OHIO Class SSGN Conversion	C - 2002
Teleport (Gen 1)	C - 2002
Business Systems Modernization (BSM)	C - 2002
Future Combat System (FCS)	B - 2003

TRA Lessons Learned

- Start early; guidance and standard;
- Early identification and agreement on critical technologies.
- Flexibility required – No two TRAs will be the same.
- Technology Readiness Assessment must be performed. independently from Risk Assessment.
- Regular IPRs.
- Test data the most difficult to verify.
- Working Group should include representatives from PM, Component S&T Executive, Component Acquisition Executive, and DUSD(S&T).

CURRENT ACTIVITIES

- Major TRAs for CY 2003:
  - Army Future Combat System – FCS (Completed May 6, 2003)
  - Army Global Combat Support System - GCSS
  - Navy Next Generation Aircraft Carrier – CVN 21
  - Air Force Multi Platform Radar Technology Insertion Program - MP (RTIP)

- DAU Distance Learning Module under development

- The DUSD(S&T) has prepared a "Technology Readiness Assessment Desk Book"
  - "How to" manual for execution of TRA duties
  - Useful guide and reference for service action officers of Acquisition Executives, S&T Executives and Programs
  - Regular Updates to reflect changes to 5000 Series

    http://www.acq.osd.mil/dpap

IMPACT OF TRA PROCESS

Identification of Risk Areas for Increased Attention in EMD

Examples:

- Joint Strike Fighter – Information Management & Fusion and Off Board Data
- Joint Tactical Radio System - Multiple Single Levels of Security (MSLS)

Improved Integration of Efforts between S&T and Acquisition Communities on technology transition issues

- TRAs developed primarily thru S&T/acquisition working groups
- Oversight at a high level
- TRA/TRLs used as a tool in technology transition planning for evolutionary development

Major 2003/2004 Technology Readiness Assessment Requirements

Program	DUSD(S&T)OPR	MS Date
Future Combat System	Weapon Systems/ Information Systems	May 2003
CVN 21	Weapon Systems	B Aug 2003
Cobra Judy (Radar)	Space & Sensors	B/C June 2003
MP RTIP (Radar)	Space & Sensors	B Aug 2003
Global Combat Support System	Information Systems	B June 2003
Global Command & Control System	Information Systems	B June 2003
JTRS Cluster 3 (Maritime)	Information Systems	B June 2003
DIMHRS	Information Systems	B June 2003
Common Missile	Weapons Systems	B April 2004
Stryker	Weapons Systems	C Dec 2004
USMC H-1 Upgrades	Weapons Systems	C Feb 2004
Multi-Sensor C2 Aircraft (MC2A)	Space & Sensors	B June 2004

Note - MP RTIP – Multi Platform Radar Technology Insertion Program
DIMHRS - Defense Integrated Military Human Resources System
JTRS – Joint Tactical Radio System

QUESTIONS?

ODUSD(S&T) is the responsible office for Technology Readiness Assessment

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