



NEW MILLENNIUM PROGRAM

ST 9 Technology Review Boards *Assessing Technological Maturity for ST 9 Technology Validation Experiments*

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11/11/05

Telecon with TRB Members

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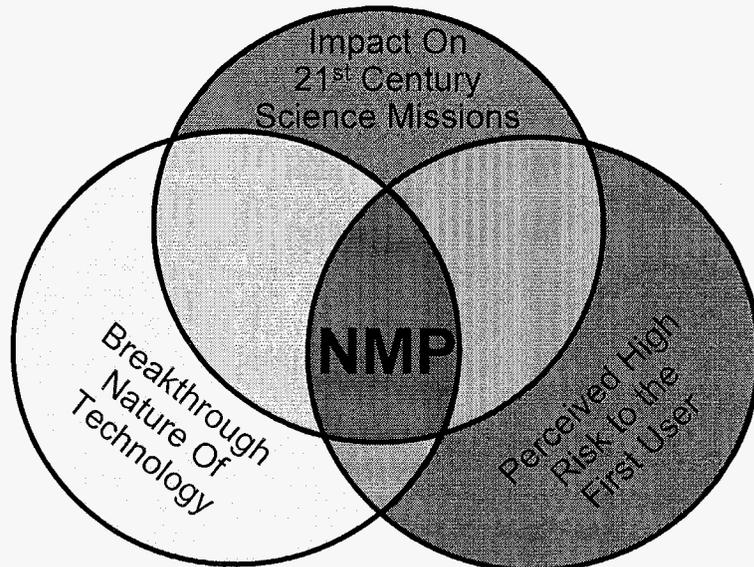
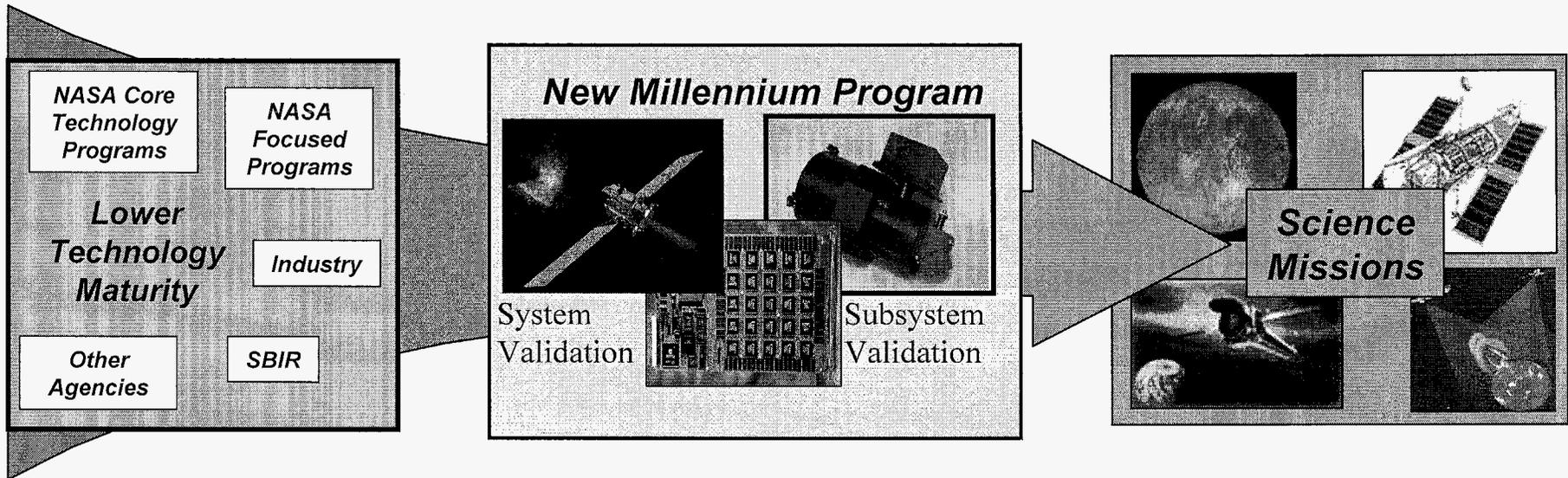
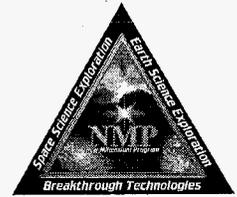
Discussion Points



- **Overview of New Millennium Program**
 - What is NMP?
 - What is ST9?
 - What is the role of the Technology Review Boards?
- **Technological Maturity**
- **Assessing Technological Maturity**
- **Operation of the Technology Review Boards**



Flight Validation of Breakthrough Technologies to Benefit Future Space and Earth Science Missions



Breakthrough technologies

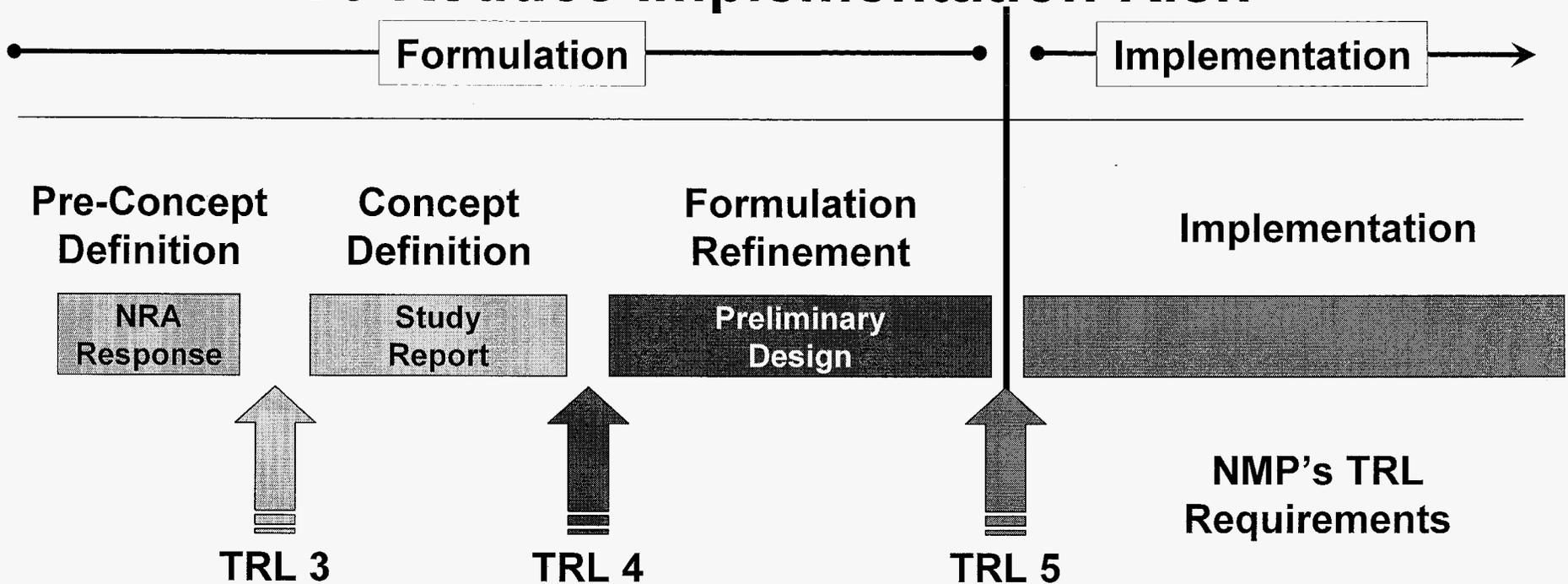
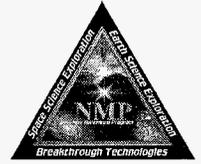
- Enable new capabilities to meet Earth and Space Science needs
- Reduce costs of future missions

Flight validation

- Mitigates risks to first users
- Enables rapid technology infusion into future missions



New Millennium Program Emphasis on Formulation Phase To Reduce Implementation Risk

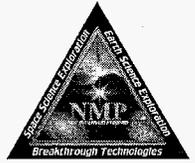


The Technology Review Board is NMP's approach to assessing whether the needed technological maturity has been achieved at key points in a Project's life cycle

- ≥ TRL 3 at the beginning of Concept Definition
- ≥ TRL 4 at the end of Concept Definition
- ≥ TRL 5 at the start of the Implementation Phase
- ≥ Demonstrate advanced maturity at CDR and TRL 6 prior to ATLO



ST 9: An Overview



- **System-level validation project**
- **Five Concepts have been selected for study during the Concept Definition Phase**
 - Solar Sail
 - Large Space Telescopes
 - Precision formation Flying
 - TGALS
 - Aerocapture
- **Each team receives \$1 M to prepare a Concept Definition Study Report describing the validation experiment the team proposes to perform**
- **The selected team then has a budget of \$85 M to execute the experiment it proposed**
 - Does not include the cost of access to space



ST 9: Concept Definition Phase



- **In the Concept Definition Phase**
 - **Each Team prepares a Concept Definition Study Report**
 - Describes the technology validation experiment they propose to perform
 - **Each team brings to TRL 4 the system-level technology advance they propose to validate**
 - **Each team works with its TRB to define the criteria by which the achievement of TRL 4 will be assessed**
 - To aid the proposal process, draft criteria for TRL 5 and TRL 6 will be delineated jointly



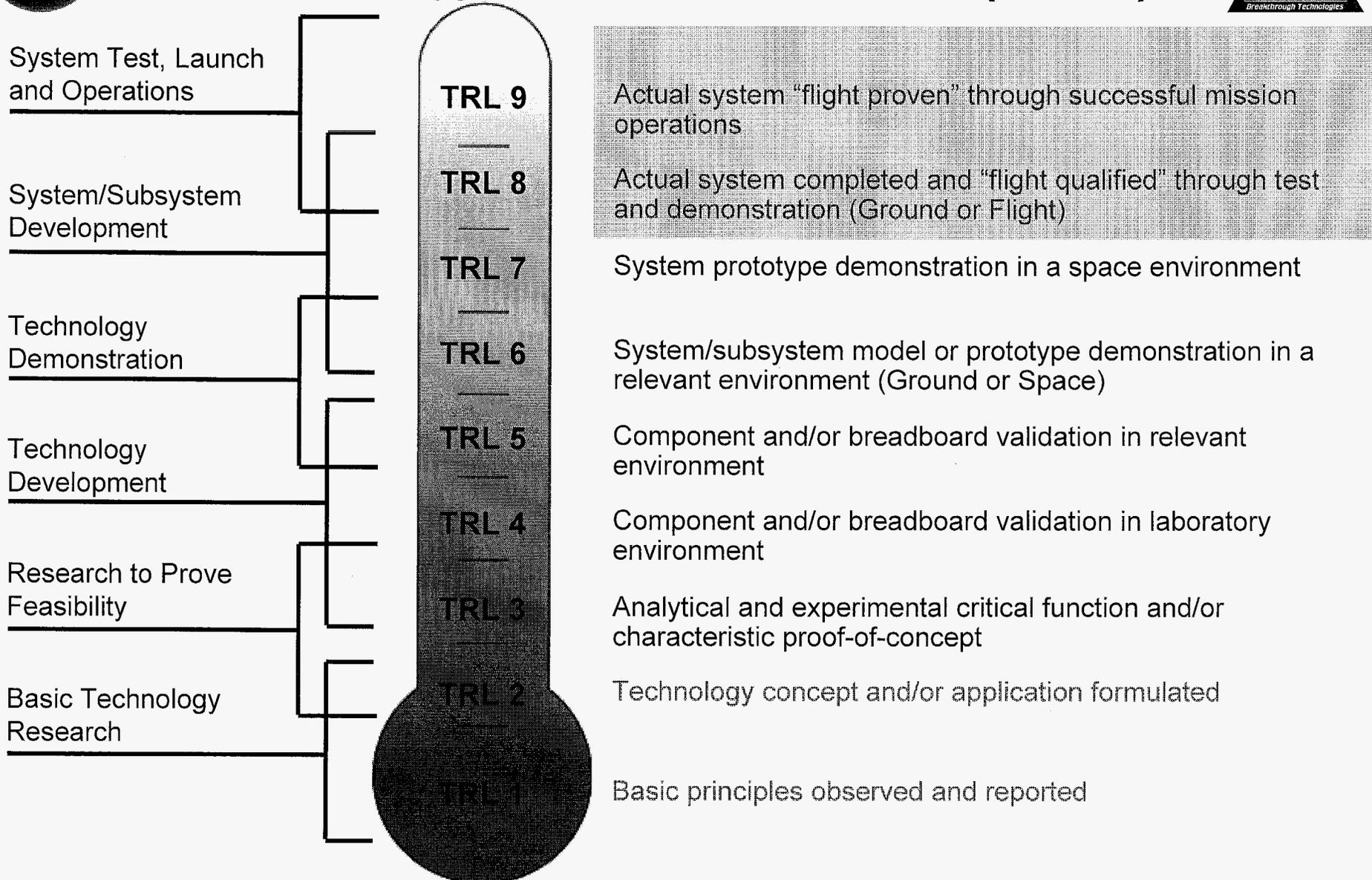
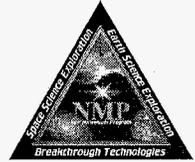
Validation and Technological Maturity



- **Validation of technology advances**
 - Purpose is to mitigate the risk of first use to hasten infusion of the technology advance into operational science missions
 - Validation results, to be effective, must be applicable to the scale at which the technology advance is used in an operational science mission
- **Technological maturity**
 - Refers to the degree to which we can prove that we know how to implement the technology advance in question
- **Assessment**
 - TRL scale and NMP's definition of "exit criteria"
 - TRB and Concept Definition Team work to define specific elements and assessment criteria



New Millennium Program Technology Readiness Levels (TRLs)

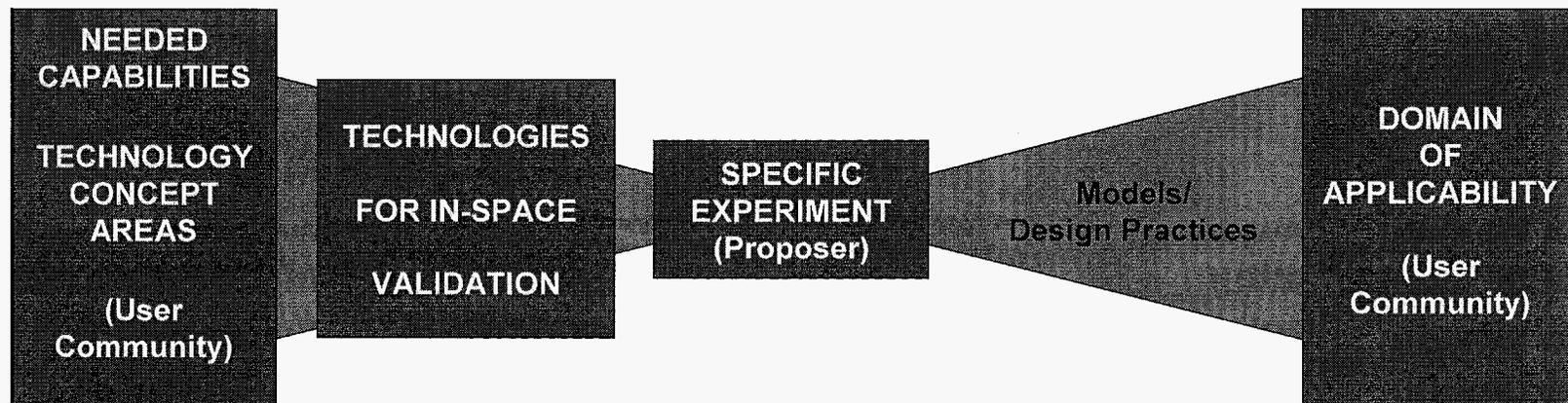




What Is Technology Validation? System and Subsystem

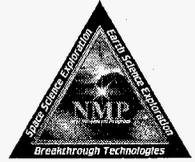


- **Validation, for the New Millennium Program, is**
 - Empirical evidence that the physics associated with the technology advance are understood
- **Characteristics of effective technology validation**
 - Clear definition of the technology advance being validated
 - Integrated data from ground and in-space tests
 - Ground and in-space data combined
 - Validate or improve the model and our understanding
 - Establish a pre-determined level of performance
 - **Wide “Domain of Applicability”**
 - Once validated, the technology advance is scalable and applies to many users

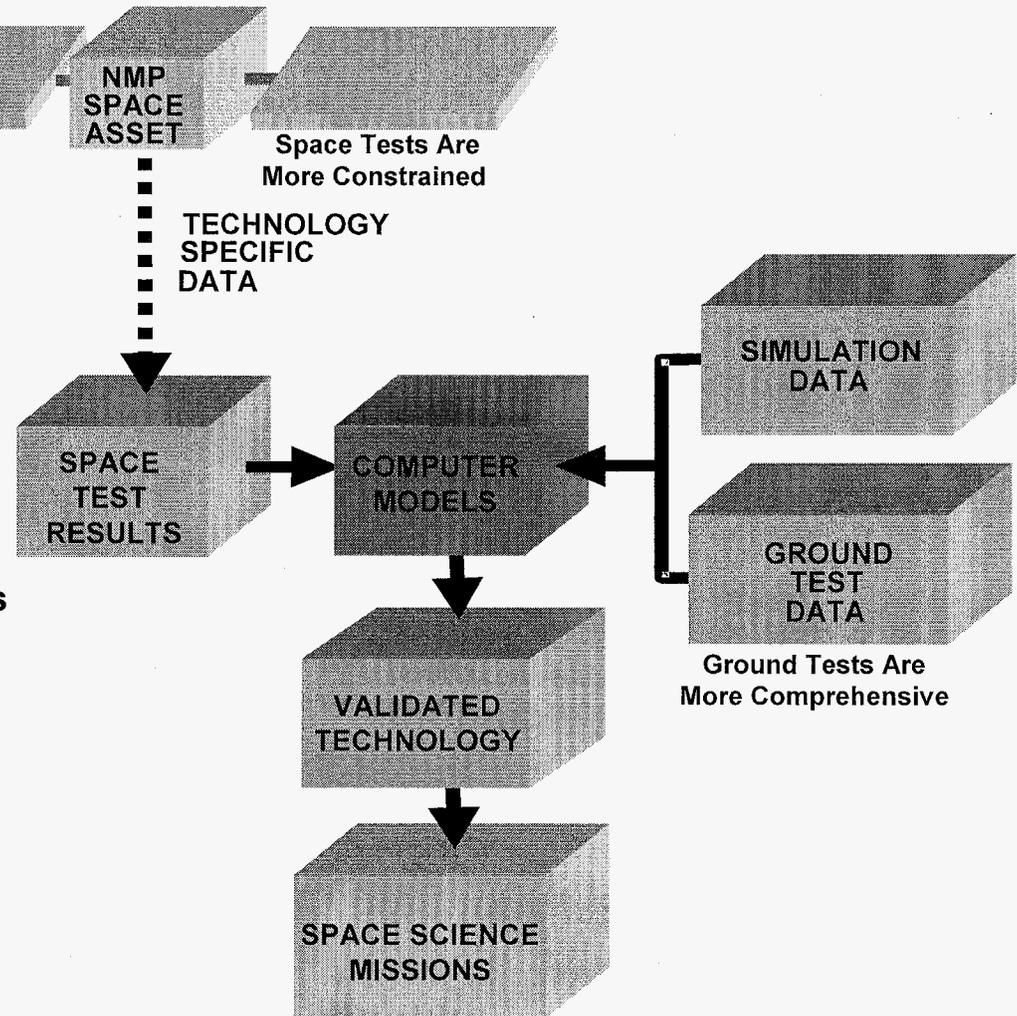




New Millennium Program Technology Validation Is a Comprehensive Effort

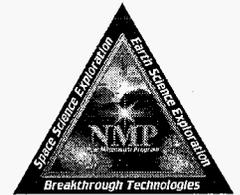


- Validation requires integrated ground and in-space tests coupled with a model of the technology advance being validated.
- Ground tests allow the full range of operating conditions and operating states to be simulated and tested.
- In-space tests allow vacuum, zero-g, etc. to apply, but the range of operating conditions and states is more restricted than for ground tests.
- Models and simulations when coupled with the results of ground and in-space tests allow the physics of the technology advance to be better understood and predictions to be more accurate and credible.

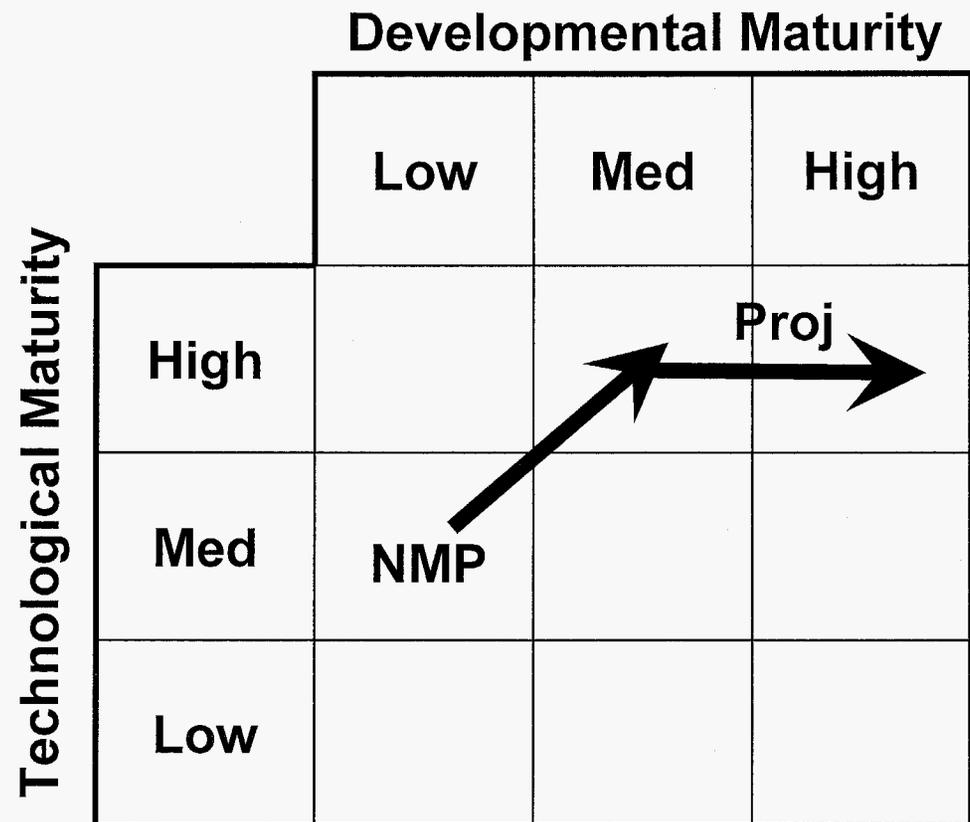




New Millennium Program Technology Maturity vs. Development Maturity



- **Technological Maturity**
 - Refers to our ability to understand how to design, build, and operate a device to achieve a desired capability and performance by implementing a specific approach
- **Developmental Maturity**
 - Refers to the degree to which a specific design to achieve a desired capability and performance has been qualified for space flight





New Millennium Program

Role of Technology Assessment



NMP

- Requires certain levels of technological maturity be achieved at certain points in a Project's life cycle,
- Prepared “exit criteria” to help determine when a specific level of technological maturity is achieved
 - Posted on the NMP web site
 - Made a part of NMP NRAs

TRL 3

- Laboratory tests indicate the potential to evolve to a practical device
- Analytical model(s)
 - Replicate TRL 3 performance
 - Predict performance in breadboard environment
- “Relevant environment” defined

TRL 4

- Component or breadboard version tested in laboratory environment
- Analytical model(s)
 - Replicate TRL 4 performance
 - Predict performance in relevant environment

TRL 5

- Tested in relevant environment
 - Full range of operating points
- Analytical model(s)
 - Replicate the performance observed in the relevant environment
 - Predict performance in prototype or flight-like configuration



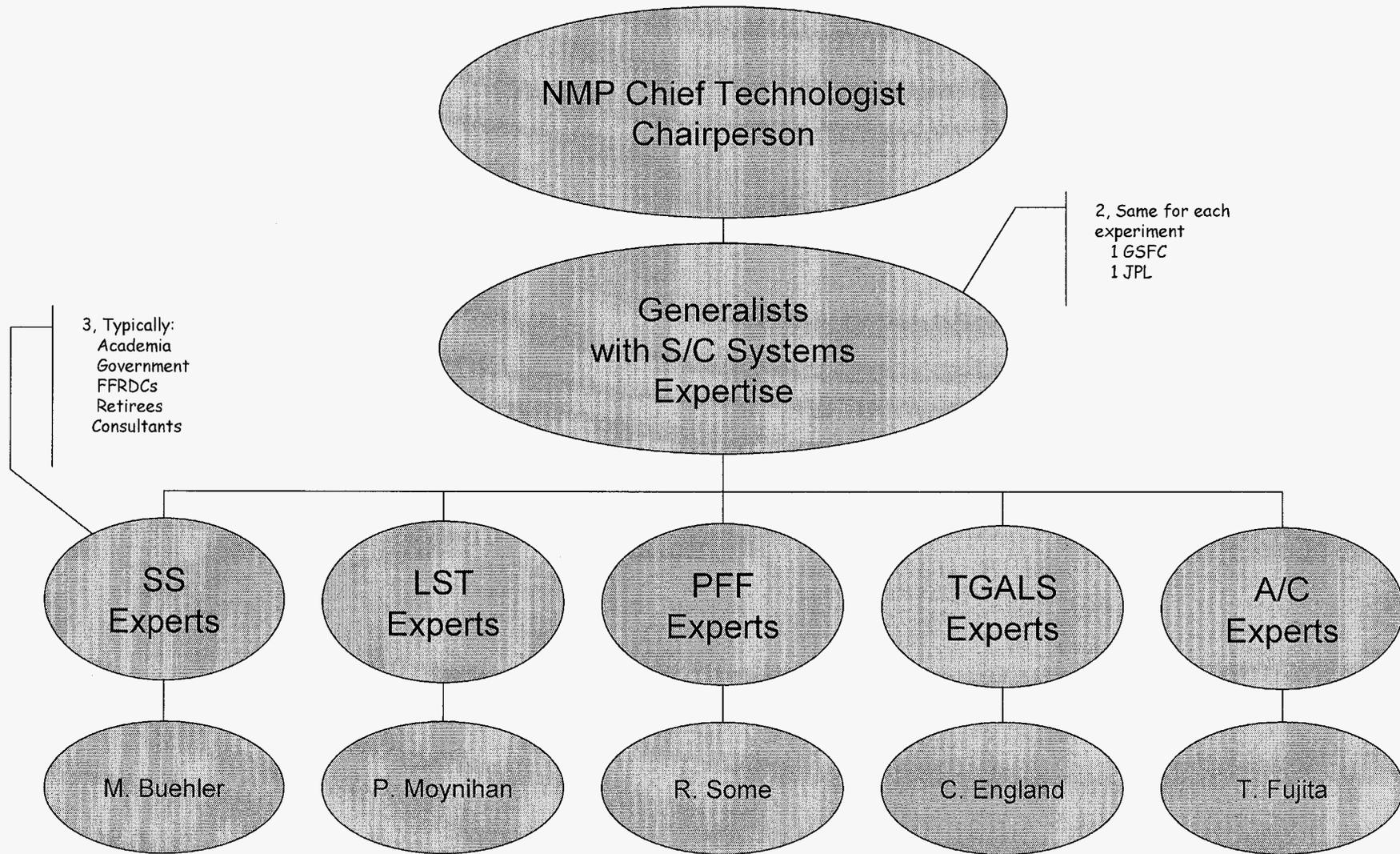
Assessing Technological Maturity



- **NMP's criteria for technological maturity**
 - **TRL Scale**
 - Technology advances less mature than TRL 4 are not eligible for in-space validation by NMP
 - **NMP's exit criteria**
 - Testing of the appropriate item: breadboard; prototype; etc.
 - Testing in the appropriate conditions: laboratory; "relevant environment"; etc.
 - Modeling that replicates the test data and predicts performance at the conditions appropriate to the next higher TRL
- **TRBs work with the Concept Definition Teams to apply these concepts to specific technology advances and experiments**
 - **Criteria for each TRL**
 - Define the appropriate test item
 - Define the appropriate conditions
 - Define the necessary performance
 - **Assess whether the criteria have been met**
 - Is the test the appropriate test?
 - Is the performance adequate?
 - Is the modeling sufficient?



ST 9 TRB Organization in the Concept Definition Phase





Operation of the Technology Review Boards



- **The Technology Review Boards have four functions in the Concept Definition Phase**
 - **Work with the Concept Definition Team and establish criteria for TRL 4 and draft criteria for TRLs 5 and 6**
 - **Meet with the Concept Definition Team and assess the degree to which the criteria have been satisfied and judge whether TRL 4 has been achieved**
 - **Assess the technology validation plan described in the Concept Definition Study Report**
 - **Report findings**
 - NMP Manager
 - Peer Review Panels and Program Review Board
- **Meetings and findings are documented in reports**
 - **1st draft prepared by the Executive Sec'y and sent to TRB**
 - **Approved version incorporates comments from TRB members**



TRB Meetings



- **Criteria Setting Meeting(s) (Concept Definition)**
 - **Attendees**
 - Members of the TRB and a representative of the Concept Definition Team
 - Individuals from the Concept Definition Team, the Program Office, NASA HQ, the Center
 - **Location: JPL or GSFC**
 - **Duration: 1 day (follow-up telecons, if needed)**
- **Assessment meeting (Concept Definition)**
 - **Attendees**
 - Members of the TRB
 - Individuals from the Concept Definition Team or the Project, the Program Office, NASA HQ, the Center
 - **Location: appropriate to the experiment**
 - **Duration: 1 to 1.5 day**



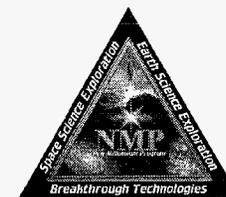
Present Schedule of ST 9 TRB Activities



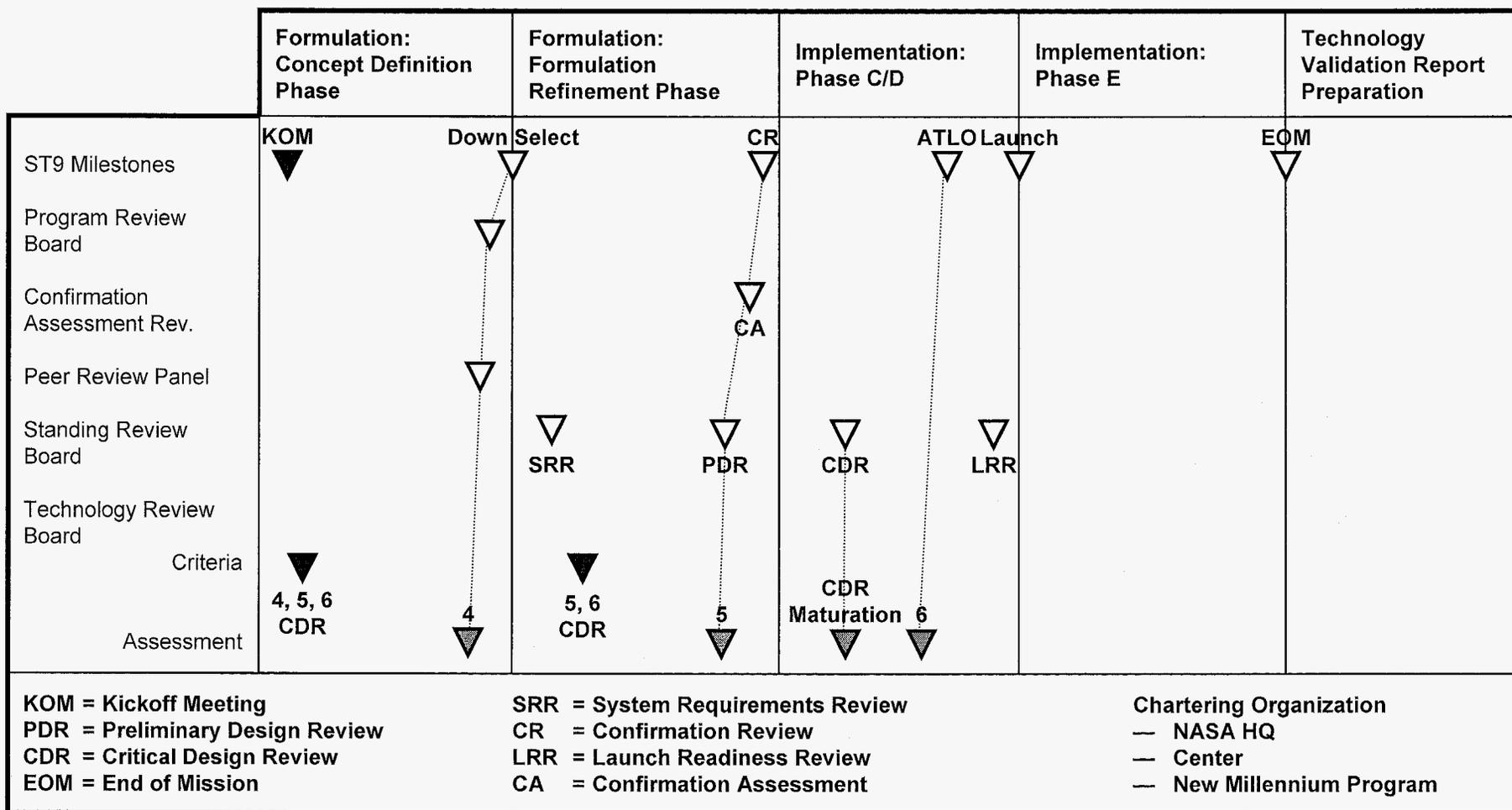
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11/11/05	Start-Up Telecon	12:00 N to 2:00 PM PST	Telecon
11/17/05	Solar Sail Criteria Setting	8:30 AM to 5:00 PM EST	GSFC
11/21/05	Start-Up Telecon Redux	8:00 to 10:00 AM PST	Telecon
11/29/05	Space Telescope Criteria Setting	8:30 AM to 5:00 PM EST	GSFC
12/7/05	Precision Formation Flying Criteria Setting	8:30 AM to 5:00 PM EST	GSFC
1/5/06	Aerocapture Criteria Setting	8:30 AM to 5:00 PM PST	JPL
1/XX/06	TGALS Criteria Setting	8:30 AM to 5:00 PM PST	JPL



Technology Validation Experiment Review Structure

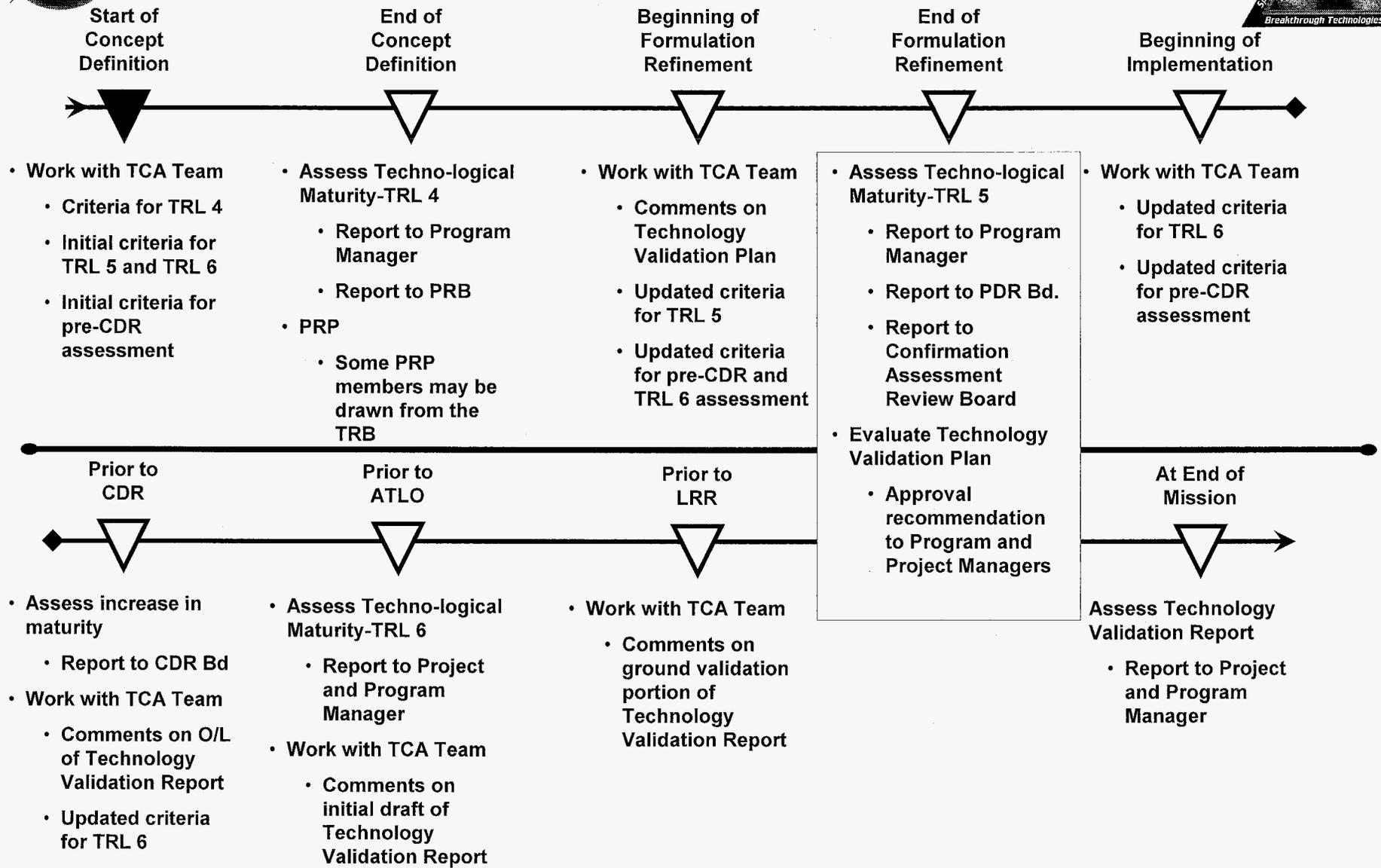
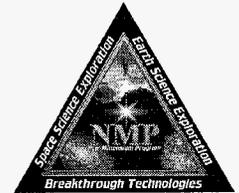


Review Boards and Panels



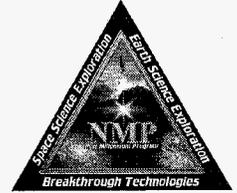


Activities of the TRB





Key Points



- **Five ST 9 Teams are preparing Concept Definition Study Reports describing their individual technology validation experiments**
- **The five ST 9 Technology Review Boards work with the Concept Definition Teams to establish criteria for technological maturity**
- **By helping balance technical value against resource constraints, the TRBs are key to assuring validation experiments that are both achievable and worthwhile**
- **The five TRBs assess the degree to which each team has achieved TRL 4**