4.0 CONCEPTS TO ALTERNATIVES

According to the Land-Based Strategic Nuclear Deterrent (LBSND) Mission Need Statement (MNS), "within the context of the existing Minuteman (MM) basing infrastructure and deployment concepts, which remain key to the deterrent effectiveness and affordability of the system, two potential materiel alternatives appear feasible." They are Minuteman-based variants and new missile systems.

The LBSND MNS states any Minuteman-based variant or new missile system "…must also consider basing infrastructure, ground equipment, C4 systems, information assurance, planning systems, logistical support systems, intelligence support capabilities, security, and training systems."

4.1 Minuteman-Based Variants

According to the LBSND MNS, a Minuteman-based variant is "another round of selected subsystem life extension programs or new development of some MM III subsystems and/or components could be initiated. A comprehensive assessment of all sub-systems and components will determine whether life extension is feasible and practical or new subsystem and/or component development is required. Potential payloads include the Mk12A, Mk21, a newly designed reentry vehicle (RV) that could incorporate low or multiple yield weapons, and a trajectory shaping vehicle (TSV) carrying weapons capable of holding at risk the range of targets previously described and each delivered with enhanced accuracy."

4.2 New Missile System

According to the LBSND MNS, the second option "involves design/integration of a new missile system. Some components may be taken from existing weapon systems or commercial off the shelf (COTS) technology, while others would be new designs or designs using common components and technologies with other services. A new missile system should take advantage of the latest technologies and provide an affordable total cost of ownership. Finally, a new missile system, depending on design, could also accomplish projected mission requirements the current system cannot, such as extended range, heavier payloads, and delivery of previously mentioned post-boost sections."

4.3 Technology & Alternatives Working Group (TAWG) Process

The TAWG incorporates transformational approaches in the areas of Delivery Vehicle (DV), Command, Control, Communications and Computers (C4), and Security. It supports the Analysis of Alternatives (AoA) for the Land Based Strategic Deterrent (LBSD) capability. The nomenclature used throughout Section 4 is as follows:

- ***Concept*** refers to a segment, a subsystem, or a full system (DV, C4, and Security segments) that is submitted through the RFI process or created by the TAWG for AoA consideration.
- ***Segments*** are defined as DV, C4, and Security.
- ***Subsystems*** are the piece parts of the segment such as the RV/RS in the DV segment.

- ***Characteristics*** are the performance description of each subsystem. For instance, the subsystem RS/RV, is described by such characteristics as improved accuracy, high reliability, operational responsiveness, and extended range.
- ***Capabilities*** are descriptors representing qualifications or abilities that apply to a characteristic. For example, the capability of in-flight updates contributes to the characteristic of improved accuracy.
- ***Attributes*** are components of a subsystem that contribute to its capability. Continuing in the description of the RS/RV, its potential attributes are ballistic vs. trajectory shaping.
- ***Performance Parameters*** are used to quantify capabilities (i.e. a specific range or accuracy).
- ***Alternative*** refers to a segment that is representative of the concepts in a particular section of the trade space. There will be multiple separate alternatives for DV, C4, and Security.
- ***Excursion*** refers to a variation of an alternative. There may be a concept that doesn't easily represent the alternative created for a given section of the trade space. This may result from capability or attribute differences, yet it still merits consideration by the teams doing detailed analysis of the alternatives. The TAWG doesn't expect an excursion to be "costed" at the Life Cycle Cost Estimate (LCCE) level. Rather, a Rough Order Magnitude (ROM) cost may be performed to show how it differs from the base alternative.
- ***Trade Space*** is the compilation of capabilities with their specific attributes while considering high-level cost and technical readiness factors for a given segment. The trade space goes from minimal capability to full MNS/CONOPS capabilities.

An industry-wide Request for Information (RFI) for each of the DV, C4, and Security areas is released to gather concepts that aid in building alternatives and possible excursions. Industry may submit concepts ranging from a full system that incorporates aspects of each segment down to a specific subsystem. Since the TAWG is charged with delivering alternatives for each segment rather than for a complete system, the concepts received are broken out into the appropriate segment or grouped with other subsystem concepts to create a full segment alternative. The TAWG will also develop concepts as needed, to fully cover the trade space or to flesh out an alternative. The TAWG does a high level engineering and cost assessment of the concepts in order to build alternatives. It does not perform cost or effectiveness analysis of the concepts it reviews or of the alternatives it builds.

4.4 Definitions and Assumptions

The following list of definitions and assumptions were developed by the TAWG for use during the alternative development process.

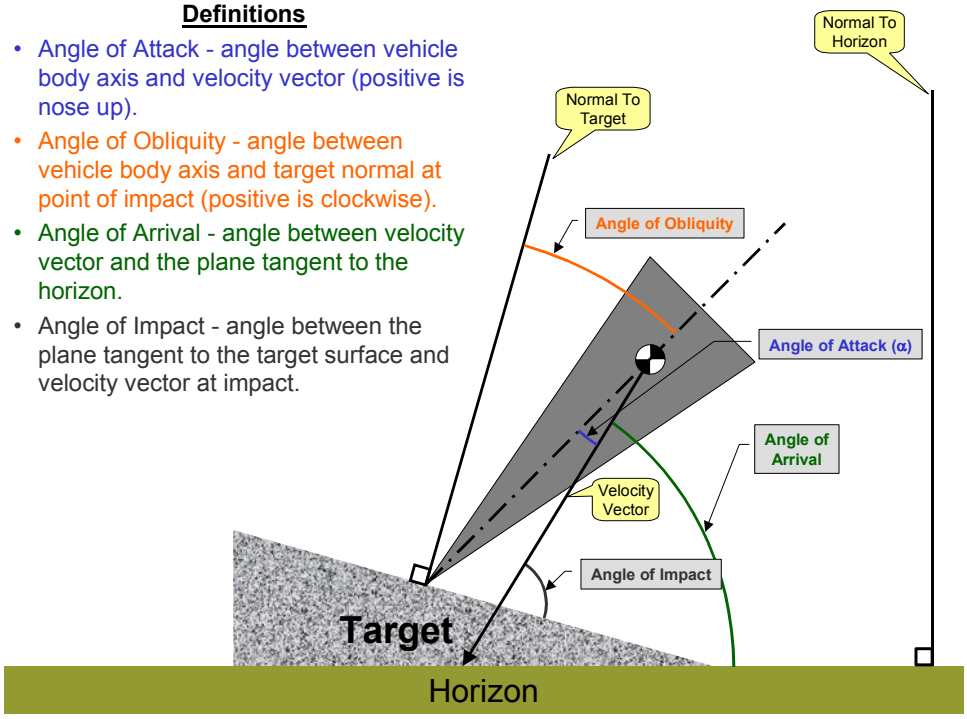
Definitions:

- **All azimuth attack** (CONOPS para 5.3.2) – the RV has the ability to approach the target from any direction

- **All azimuth launch** – the missile has the ability to launch on any azimuth, allow for variable attack approaches, and provide adaptive flight planning to mitigate over flight concerns of the launch and aero vehicles [AFSPC/DRM statement at LBSD Industry Day, 3 Oct 03]
- **In-flight guidance update** (CONOPS para 5.1.1) – updates to the missile/RVs obtained from an external source (such as navigational aids) that improve the accuracy of the weapon
- **Sensors** (CONOPS para 5.1.3) – reception capabilities on an RV, RS, and/or guidance system to allow timely in-flight direction and target updates
- **Search** (CONOPS para 5.1.3) – the ability to identify, track, and engage a specific target once in flight (applies to non-nuclear payloads only)
- **Loiter** (CONOPS para 5.1.3) – the ability to remain above a target area until specific instructions are received (applies to non-nuclear payloads only)
- **Generation** (CONOPS para 6.2) – taking a missile from non-alert status to launch-ready status (including target/retarget actions)
- **Dormancy** (CONOPS para 3.3.2) – a guidance system that powers down to a minimal level upon command, but is able to immediately return to full operation and system accuracy levels when commanded
- **Global range** (CONOPS para 5.3) – the ability to reach anywhere on the globe
- **CONUS based** (CONOPS para 3.6.2) – the solution for LBSD will be based in the contiguous 48 states
- **Flexible Effects** (MNS para 2.1.3) – various nuclear and/or conventional yields providing a range of effects from maximum target damage to minimal collateral damage (W87 represents the nuclear yield and currently there is no authorization to develop weapons with a different yield)
- **Redirection capability** (CONOPS para 5.1.3) – an overarching capability defined specifically by the following:
    - **a) Real-time retargeting** (CONOPS para 5.1.1, 5.1.2) – the ability to send new target coordinates to a missile on the ground or in flight (can be direct from the source of the new information or passed through the launch centers) (in-flight portion applies to non-nuclear payloads only)
    - **b) Retarget on the ground** (CONOPS para 5.1.1) – the ability to send new target coordinates to a missile and/or the ability to realign the missile to one of several stored target sets while still on the ground
    - **c) Retarget in flight** (CONOPS para 5.1.1) – the ability to change the target coordinates to ones different from those against which it was launched initially; can occur during boost phase or during reentry (applies to non-nuclear payloads only)
- **Flexible Force Applications** (MNS para 2.1.3) **–** the ability to employ the weapon for a variety of missions

Definitions

- Angle of Attack - angle between vehicle body axis and velocity vector (positive is nose up).
- Angle of Obliquity - angle between vehicle body axis and target normal at point of impact (positive is clockwise).
- Angle of Arrival - angle between velocity vector and the plane tangent to the horizon.
- Angle of Impact - angle between the plane tangent to the target surface and velocity vector at impact.



Assumptions:

- The Common Aero Vehicle (CAV) is currently a specific conventional-only delivery vehicle with high lift-over-drag characteristics.
- A high lift-over-drag vehicle can be designed and built that can carry nuclear weapons.
- The Higher Authority Communications (HAC) process and means to deliver a launch message to the LBSD system are outside the control and the purview of the LBSD AoA. [AFSPC/DRM statement at LBSD Industry Day, 3 Oct 03]
- HAC will be able to integrate with LBSD to support alternative basing modes.
- LBSD will interface with Intelligence, Surveillance, and Reconnaissance (ISR) systems where necessary and will operate within the existing or future ISR infrastructure. C4 hardware and software must be designed in accordance with the Joint Technical Architecture (JTA). [AFSPC/DRM statement at LBSD Industry Day, 3 Oct 03]
- In-flight guidance updates can apply to both nuclear and conventional weapons.
- Over flight is a policy issue. Over flight concerns don't need to be considered when determining global coverage. [AFSPC/DRM, 27 Oct 03]
- Yield is based on the W87 for nuclear alternatives. Although the MNS and CONOPS talk of "sub kiloton" yield and flexible strike, the AoA assumes there is no change in nuclear yield.
- Nuclear weapons will not be retargeted to new coordinates while in flight.
- Nuclear weapons will not be used to loiter.
- Nuclear weapons will not be used to search out targets.
- Nuclear weapons will not use an abort option.

- Minimum acceptable capabilities for a new system are equal to or better than the best of the current systems (Minuteman, Peacekeeper, D-5). [MNS para 2.1.3]
- The baseline alternative sustains MMIII and its capability as much as possible with new procurement done only to replace expended or worn out items.
- The EAWG will analyze the LBSD overall system. The alternatives meeting the three RFIs will be analyzed by the EAWG using both hard and soft analysis as appropriate/necessary.

4.5 Methodology

The alternatives developed will cover a broad range from current to transformational DV, C4, and Security concepts. A tailored Alternative Development Process (ADP) will be used to guide the TAWG activity. As depicted in Figure 4-1, the ADP includes five major steps. 1) Identify the capabilities called out in the MNS and CONOPS. 2) Collect concepts from various sources. 3) Bin concepts according to DV, C4, and Security and build Technical Description Documents (TDD) from the concepts. 4) Using soft analysis, concepts are grouped according to capabilities to encompass the trade space. 5) Select a representative alternative from each of the trade space regions for submission to the Effectiveness Analysis Working Group (EAWG), Cost Analysis Working Group (CAWG), Operational Employment Working Group (OEWG) and the Working Integrated Product Team (WIPT) chair at AFSPC/DRM. Steps 4 and 5 are done separately for the DV, C4, and Security segments.

Subject Matter Expert (SME) teams consist of representatives from the Intercontinental Ballistic Missile (ICBM) System Program Office (SPO), Air Force Research Laboratories (AFRL), Space and Missile Center (SMC), Air Force Space Command (AFSPC), and Systems Engineering and Technical Assistance (SETA) support. A characteristics table is built with the aid of SMEs to identify segment and subsystem capabilities, thresholds and objectives, performance criteria, and potential trade offs. Engineering analysis will also be accomplished to identify thresholds and objectives for critical capabilities such as range and accuracy. This information is used to differentiate between concepts for placement in a region of the trade space.

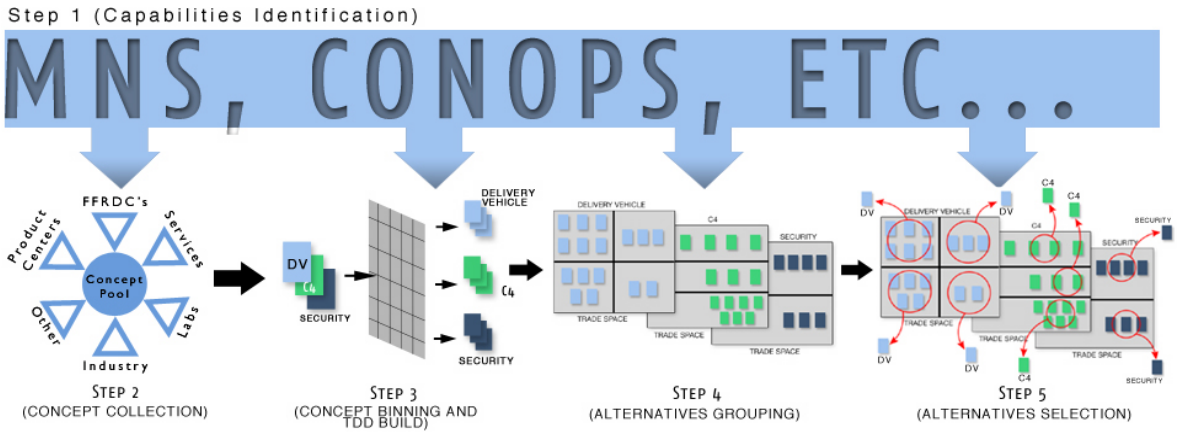


Figure 4-1 Alternatives Development Process (ADP)

4.5.1 Step 1: Capabilities Identification

From sources such as MNS and CONOPS documents, the TAWG will identify desired capabilities that support warfighter needs, set thresholds based on current technologies/capabilities (MM III, PK, and D5), and objectives based on desired capabilities. Through the AoA process the mission needs are identified and quantified into measures of effectiveness (MOEs) and measures of performance (MOPs). Using these as guidance, the ADP starts by clarifying the set of performance capabilities for each characteristic. These initial capabilities are refined as analytical insights are gained, and new ones may be identified. The AoA will report these refined performance capabilities for input into future CONOPS and Capabilities Design Documents (CDD).

The following characteristics with their specific capabilities were derived from the MNS and CONOPS (using as much as possible, original wording):

- Improved accuracy
    - In-flight updates; self-contained sensors; achieve sufficient lethality in sub-kiloton range; active guidance
- High reliability
    - Minimum maintenance required; cost effectiveness; robust aging surveillance and modernization programs; on-demand force applications
- Operational flexible strike
    - Range of weapons effects; nuclear/conventional; minimal collateral damage; hard and deeply buried and strategic relocatable target defeat
- Extended range
    - Global attack; heavier payloads
- Improved survivability
    - Operate in all environments; backup system; geographically dispersed; enhanced defense penetration; survive asymmetric and WMD attack
- Assured connectivity
    - Secure; redirection capability; interoperability; remote health/status monitoring; nuclear surety compliant; increased bandwidth/data transfer rates; low probability of jamming, interception, detection
- Maintainability
    - Reduced footprint; minimal impact to operations; commonality; rapid removal/replacement of equipment
- Prompt Response
    - Act within minutes; high state of operational readiness; emerging target defeat; promptly neutralize WMD and associated facilities; rapid regeneration without degrading accuracy
- Force protection
    - Delay unauthorized access to critical areas/components at all times under all circumstances to allow response force intervention before access can be achieved; reporting of security alarms to both operators and security forces; reduced manpower requirement; minimal impediment to maintenance activities

- Sustainability
    - Responsive industrial/depot base; spares process compatible with AF system; adaptable to new technologies/COTS; robust flight/weapon system testing to develop accuracy and reliability factors for war planners

4.5.2 Step 2: Concept Collection

Concepts will be gathered from a variety of sources, primarily, through the RFIs. As depicted in Figure 4-2, candidate DV, C4, and Security concepts are assembled from industry sources, Federally Funded Research & Development Corporations (FFRDCs), Branches of the Armed Services, DoD Research Labs, and AF product centers (SMC/ESC/ASC). From concepts submitted, and others developed by the TAWG, the TAWG will have a pool of concepts to build a full spectrum of options for the final set of alternatives.

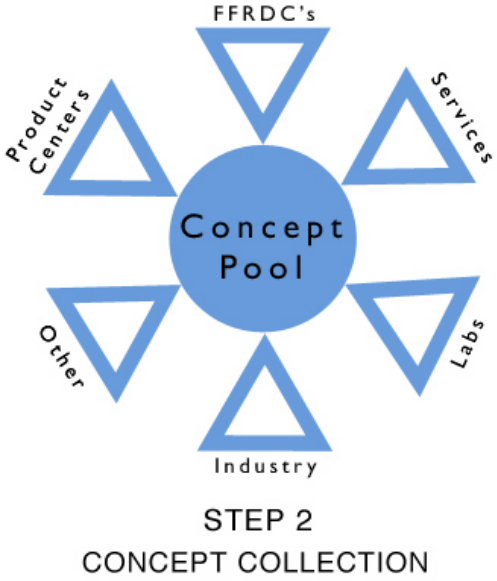
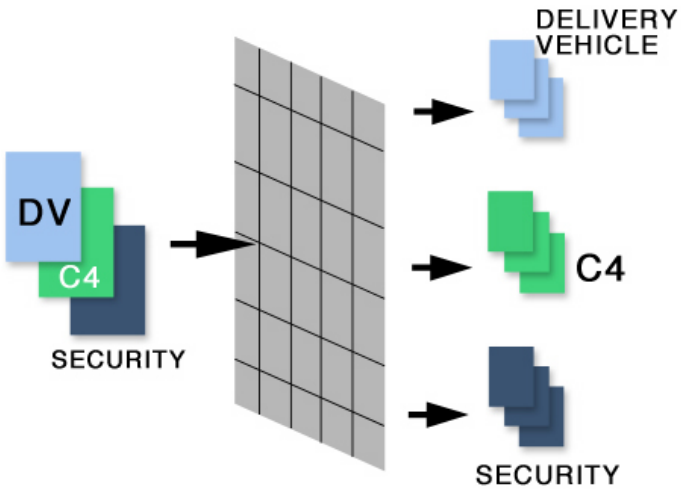


Figure 4-2

The concepts are logged, properly marked, and an administrative group of the TAWG will create generic names for each of the concepts received based on the segment to which the concept applies (i.e. DV 1, C4 1, etc.). The concepts are then distributed to AFSPC/DRM, SMC/TDE, and OO-ALC/LM(4) by the contracting office.

4.5.3 Step 3: Concept Binning and TDD Build

The concepts are binned into the categories of DV, C4, and Security. For example, if a concept provider has submitted a “booster” concept, it is binned and grouped with the DV concepts.



STEP 3
CONCEPT BINNING AND TDD BUILD

Figure 4-3

Submitters may provide concepts at a system level. In these cases, the components of the concept will be broken out and grouped with the appropriate segment.

The administrative group then creates TDDs from the concepts. The TDD summarizes the concept to provide tracking and is used by the SMEs as they go through steps 4 and 5.

As the concepts are being collected, TDDs are being built and SME leads are doing an initial review of the concepts, questions may arise. A format for asking questions is used to ensure standardization of the question process. All initial questions are accumulated and then sent out at the same time to ensure each submitter gets equal time and opportunity to respond.

4.5.4 Step 4: Alternatives Grouping

Concepts are grouped together into regions within the trade space based on their capabilities. Those that meet current capabilities will be at one end of the trade space and those that meet or exceed all MNS and CONOPS desired capabilities will be at the other end. Depending on the spread between these two groupings, additional intermediate regions are created. The number of intermediate regions is driven by how the concepts fall into logical associations using soft analysis and based on the thresholds/objectives identified in the characteristics table. The number of alternatives within a region will vary depending on how many concepts are similar.

Many concepts are at the subsystem level. The TAWG will have to group these subsystem concepts into full segment level alternatives. The TAWG may need to create additional concepts to fully flesh out the alternatives and fill the trade space.

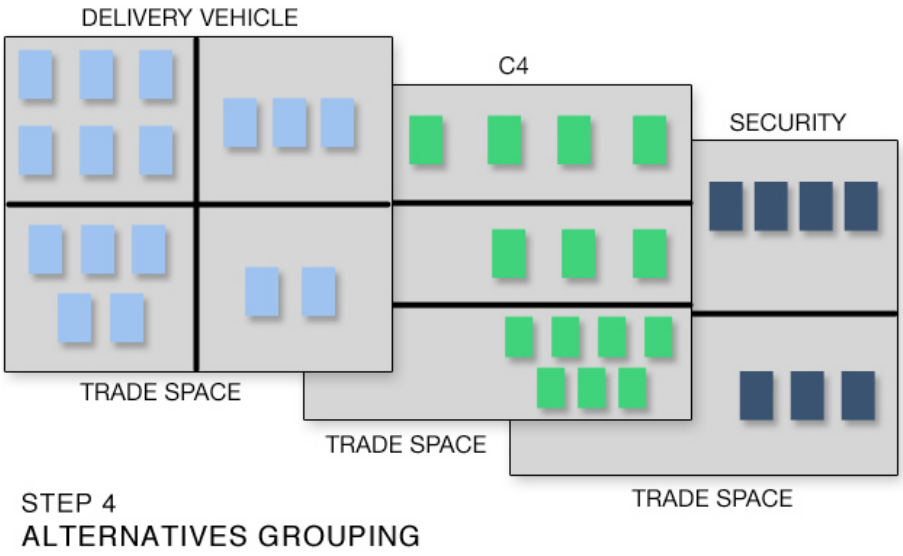


Figure 4-4

During this step, the detailed assessment of the concepts by the SME teams may generate more questions. These questions may require face-to-face interaction between the SME teams and the contractors. All questions generated at this time are accumulated and submitted to the contractors. If necessary, one-on-one sessions are scheduled.

4.5.5 Step 5: Alternatives Selection

The alternatives from each region of the trade space are evaluated at the engineering level based on performance parameters, Technology Readiness Level (TRL) and cost. A representative alternative from each of these regions is then created.

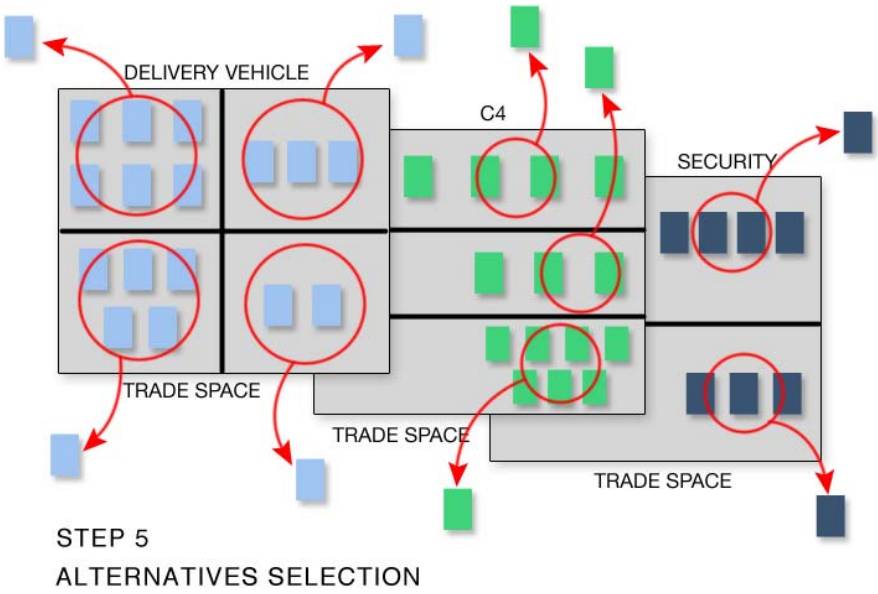


Figure 4-5

Some of the alternatives may have excursions in recognition of their similarities to one or more alternatives. Conducting an excursion may clarify whether or not performance is significantly altered by an outlier within a group of alternatives. These excursions are analyzed by the EAWG and CAWG within resource constraints. Additional excursions may be identified at any point during the AoA process to explore these areas.

Although the goal is to reduce the number of alternatives to no more than four final alternatives for each segment, it is difficult to tell if four will provide an adequate representation of the LBSD Trade Space. Due to the level of effort required by the CAWG to produce an LCCE, it makes sense to minimize the number of alternatives. This is possible where alternatives that are actually variations of a basic Alternative, can be considered an excursion and costed at a ROM level rather than the more intensive LCCE level required for alternatives. The analysis will still be accomplished, but the grouping of the alternatives will make it a more manageable task for the CAWG.

The final product from the TAWG is a TDD representing each alternative that is provided to the CAWG, EAGW, OEWG, and AFSPC/DRM. The TDD will be useful in identifying additional information required for individual concepts. The level of detail is matched to the needs of the EAWG and CAWG. Consequently, the TDD will include annexes describing tables of MOP and WBS-level data as needed.

4.6 TAWG Process Summary

Through the ADP, the TAWG will create alternatives and excursions that provide a wide range of options to the EAWG, CAWG, and OEWG. Capabilities are identified in accordance with the MNS and CONOPS. The concepts are collected from various sources, binned with similar concepts, and entered into working-level TDDs. The SME groups perform soft analysis to further differentiate the trade space for each concept. The concepts are assembled into segment-level alternatives. The alternatives in each region of the trade space are synthesized into a representative alternative. Some alternatives may be analyzed with excursions. The TAWG will document the final alternatives in a TDD for use by the EAWG and CAWG in their modeling and simulation efforts, and by the OEWG for building their concept of employment.