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Consideration of the CONOPS as Part of the System Development Tradespace

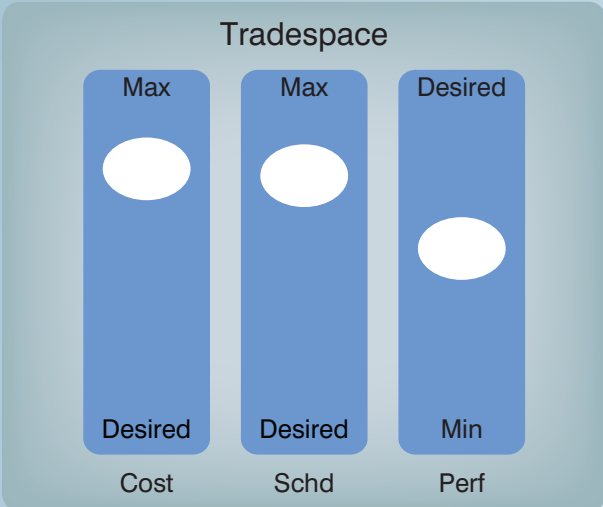
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ABSTRACT

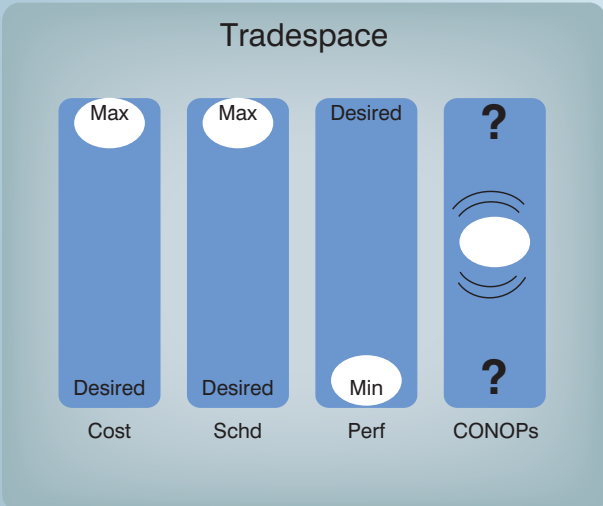
Tradespace is the region within which modifications to achieve the maximum balance between cost, performance, and schedule reside. This space, however, is not always sufficiently broad to achieve the required, or optimal, system balance. When tradeoffs must be found and cost, schedule and performance can not be changed, what other system characteristics can be used as a tradeoff variable?

This research explores use of the system's concept of operations (CONOPs) as a new dimension of the tradespace. Specifically explored is why, when, and how the CONOPs can be used as a tradespace variable. In addition, several DoD systems are presented as case studies of CONOP use with trade assessments. Our research indicated that to remain within the tradespace, the CONOPs must continue to fulfill its intended role in the developmental process, and to function under specific constraints. Three distinct, but related elements serve as the upper limit of the CONOPs tradespace. These elements include: mission, system capability, and operational scenarios.



Traditional Tradespace

Traditionally, tradespace includes cost, schedule, & performance. These elements can be illustrated as slide bars. Changes can be made along any of the slide bars as long as the change is within the parameters of: desired and maximum cost, desired and maximum schedule, and minimum and desired performance.

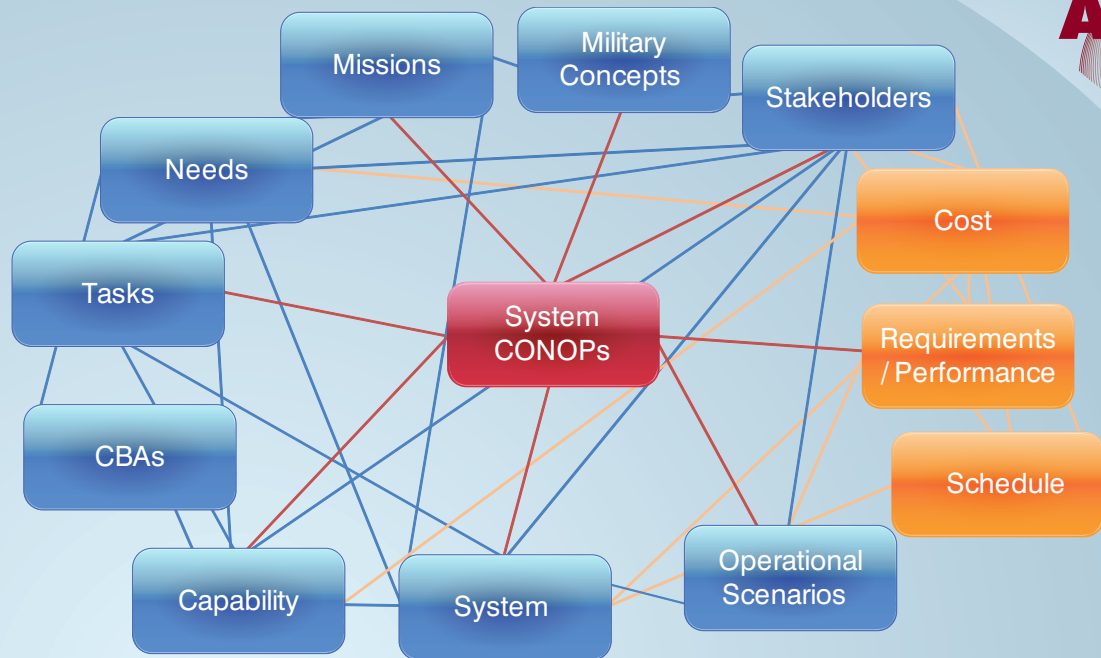


The CONOPs Tradespace

When traditional elements are at their thresholds, can tradespace expand to include CONOPs? If so, what would the parameters of the CONOPS tradespace look like?

Assessing Parameters

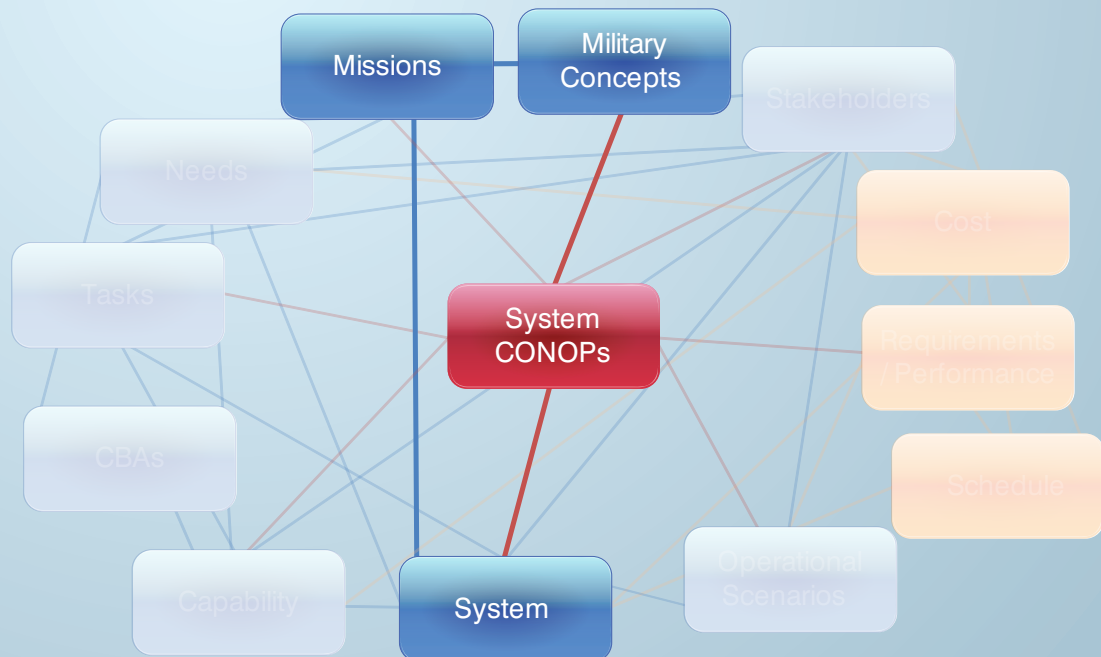
- To assess CONOPs tradespace a modified context diagram tracking direct and indirect relationships was constructed
- This task provided clues to which relationships were most significant



Relationship Thread

Threads (as shown to the right) are traced as follows:

- Military Concepts describe missions
- Missions are achieved using systems
- Systems are described in CONOPs
- CONOPs support achievement of Military Concepts

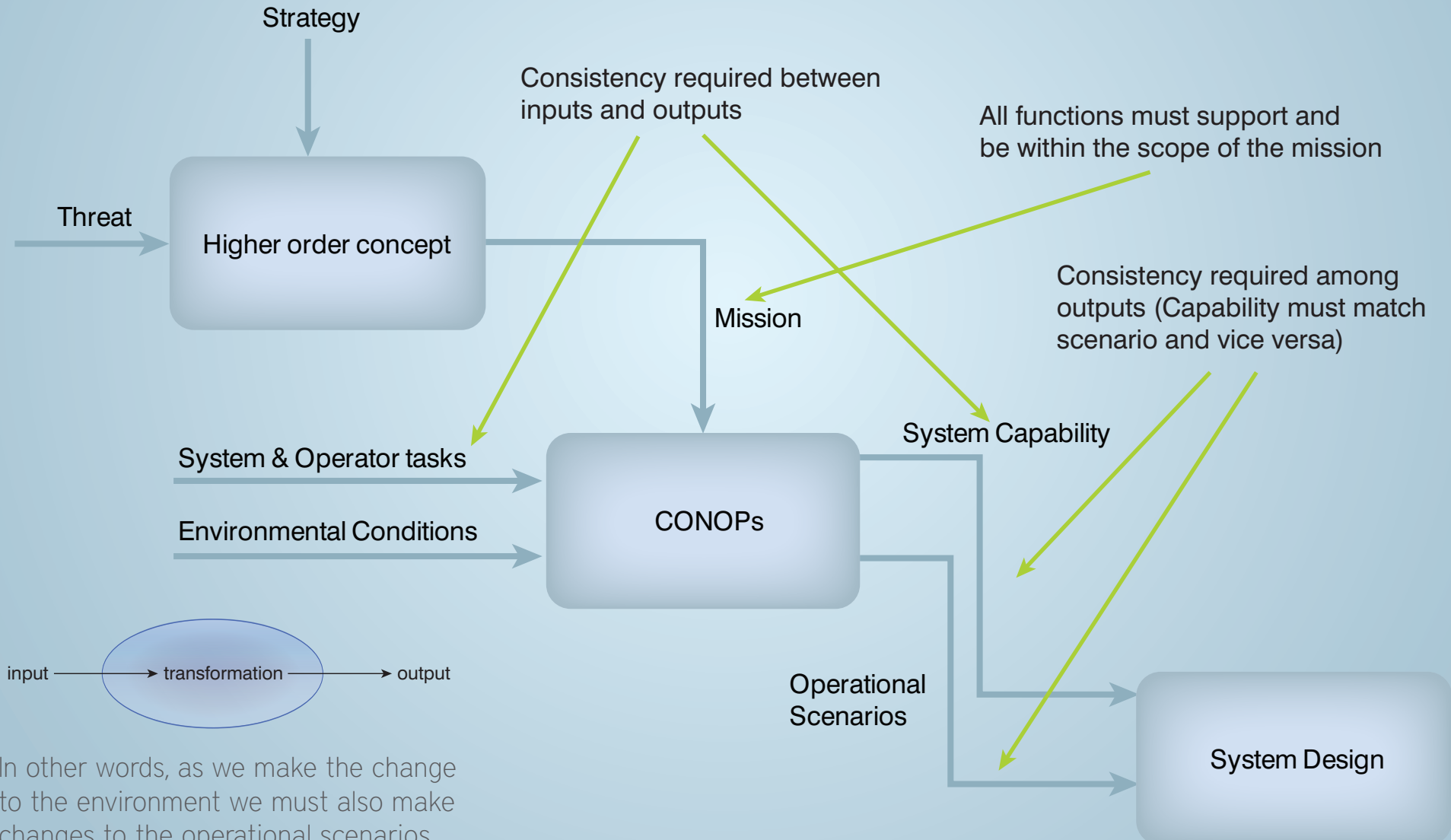


System Recognition

The context diagram was translated into a block diagram. Viewed as block diagram it became evident that we were looking at a system, with inputs, outputs, transformations, and constraints.

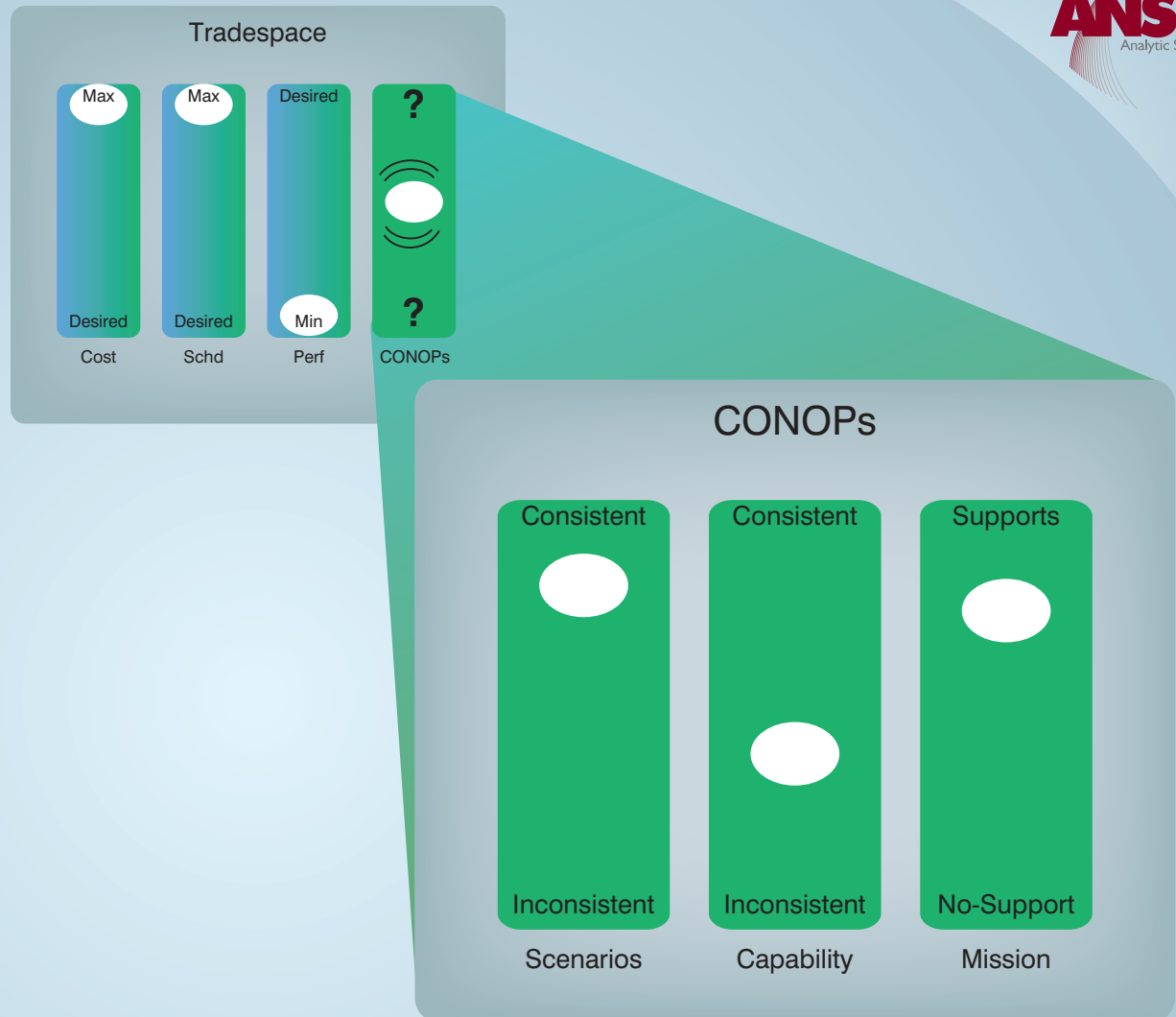
Inputs, Outputs Transformations

For the system to function properly, each input must have an output and visa-versa. At each step consistency must be maintained between and among inputs and outputs.



In other words, as we make the change to the environment we must also make changes to the operational scenarios.

Because of the nature of CONOPs, the tradespace parameters are far more subjective than traditional tradespace elements. It is important to note that tradeoffs in the CONOPs can potentially change the ranges of the other three tradespace elements. In an effort to quantify the subjective parameters we identified 3 system characteristics that must remain in balance in order for the CONOPs to function effectively; namely: inputs, outputs, and constraints. These 3 characteristics serve as the parameters of the CONOPs tradespace.



Operational Scenarios

- Must be consistent with mission set
- Must be consistent with system capability description

Mission

- Must describe a system that supports achievement of a valid mission

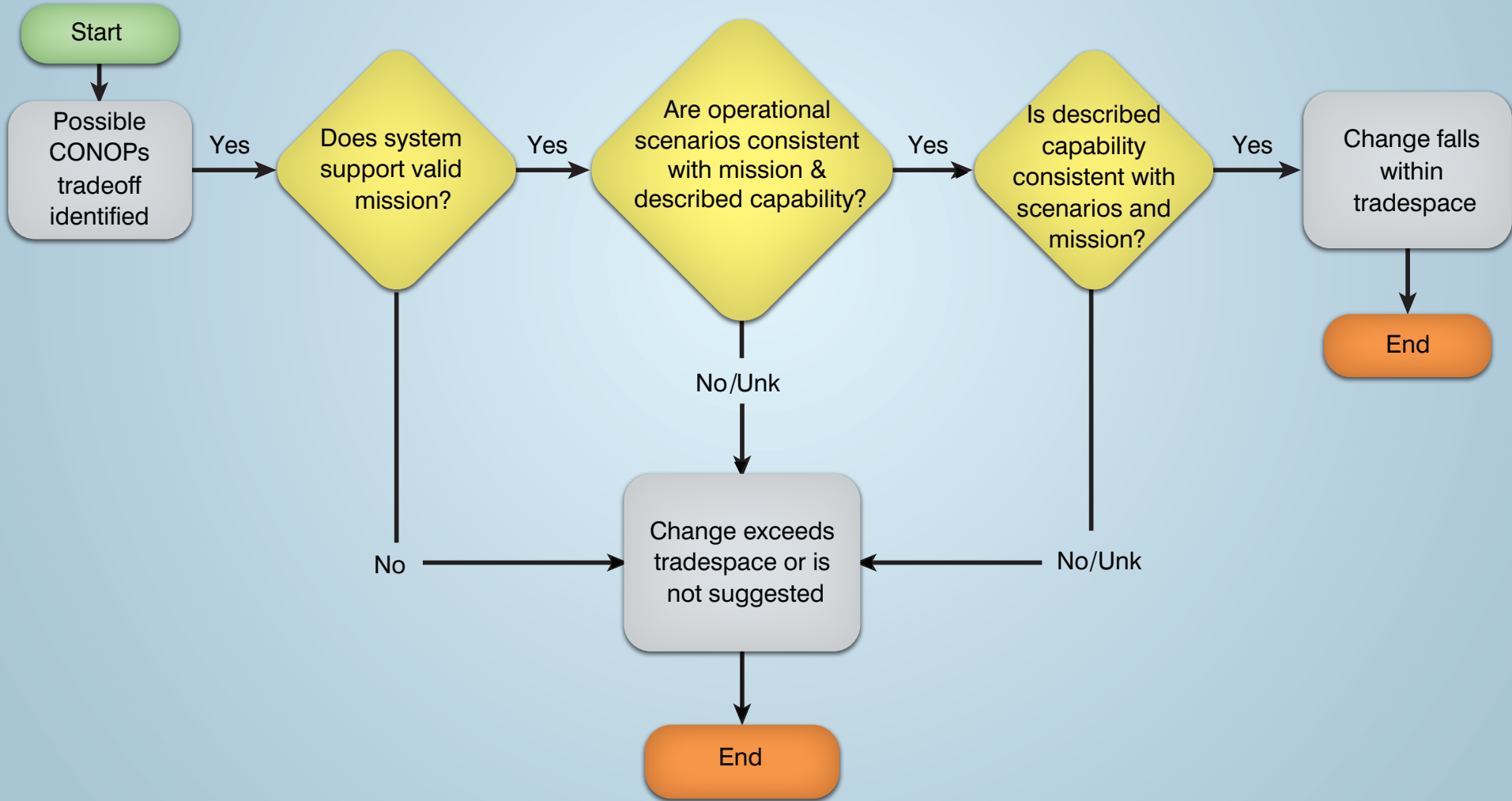
System Capability Description

- Must describe capabilities that support the mission
- Must describe capabilities consistent with operational scenarios

From a slide bar stand point, the CONOPs slide bar consists of three elements. The parameters of these are best described in a “go/no-go” manner.

Go/ No-go based Decision Flow Chart

A simple flow chart can enable the decision process by identifying trades outside or within the tradespace. Tradeoffs where the impact is unknown are considered outside the tradespace.



A decision matrix can be used to evaluate if a proposed change is within or outside a system's CONOPs tradespace.

In this situation a military Service is short on money and time and cannot reduce system performance. Changes to the CONOPs are considered as a means of achieving the cost, schedule, and performance goals.

A notional decision matrix documenting CONOPs alternatives is provided. Each alternative is compared for its consistency with identified missions, system capabilities, and operational scenarios. In this example, alternatives 1 and 3 fall within the CONOPs tradespace.

Alternate 3: 4-12 hour shifts (12 on/12 off for 24 hour total) in contaminated environment. Get contaminated, get new ensemble from asset pool. Service member retains & wears 1 ensemble and pools the other ensemble

Alternate 1: 4 - 12 hour shifts (12 on/12 off for 24 hour total) in contaminated environment. Contamination on installation = get new ensemble from personal bag up to 4 times for total 96 hours. Service member retains all ensembles

		Alternative 1	Alternative 2	Alternative 3
	Support Functional Concept for Personnel Protection	Y	Y	Y
	Support Combat Operations	Y	Y	Y
Does the CONOPs describe operational scenarios consistent with the identified mission set & described capabilities?	Scenario perform 96 hours continuous operations	Y	N	Y
	4-24 shifts (12 hours on/12 hours off)	Y	Y	Y
	Change suit every 24 hours	Y	N	Y
	Operate in contaminated environment	Y	Y	Y
Does the CONOPs describe system capabilities appropriate for the identified operational scenarios?	System is capable of providing 24 hours of liquid protection	Y	Y	Y
	System is capable of providing 24 hours vapor protection	Y		
	System allows for operations (comfort, fit)	Y		

Alternate 2: 4 - 12 hour shifts (12 on/12 off for 24 hour total) in contaminated environment. Contamination on installation = get new ensemble from personal bag up to 2 times for total 96 hours. Service member retains all ensembles

Conclusions

- The study provides a framework from which to understand how to incorporate CONOPs into a systems developmental tradespace.
- The Framework provides sound options; not solutions

Tradespace options must be compared to assess best option

Additional Cases

OTH-B Radar

		Alternative 1	Alternative 2		Alternative 1	Alternative 2
		No Change	Change Mission		No Change	Change Mission
Does the CONOPs describe a system that supports a valid mission?	Defeat Soviet Threat	N	Y	CONOPs describe a system that supports a valid mission?	N	Y
Does the CONOPs describe operational scenarios consistent with the identified mission set & described capabilities?	Detect hostile aircraft approaching U.S. airspace	Y	Y	CONOPs describe operational scenarios consistent with the identified mission set & described capabilities?	Y	Y
	Relay detection information					
Does the CONOPs describe system capabilities appropriate for the identified operational scenarios?	System is capable of detecting aircraft outside US airspace			CONOPs describe system capabilities appropriate for the identified operational scenarios?		
	System is capable of signaling an aircraft is detected	Y	Y		Y	Y
	System is capable of transferring information	Y	Y		Y	Y
				Win the war on drugs	N	Y
				Detect hostile aircraft approaching U.S. airspace	Y	Y
				Relay detection information		
				System is capable of detecting aircraft outside US airspace		
				System is capable of signaling an aircraft is detected	Y	Y
				System is capable of transferring information	Y	Y

References

Bahill, A. & Henderson, S. (2004). *Requirements, Development, Verification, and Validation Exhibited in Famous Failures*. Systems Engineering 8(1).

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Alternative 1: Soviet threat is gone. Therefore while system continues to function as expected the system is not supporting a valid mission set

Alternative 2: War on Drugs is a valid mission. The operational scenarios and system capabilities are consistent with this mission