Complex Networks and Systems

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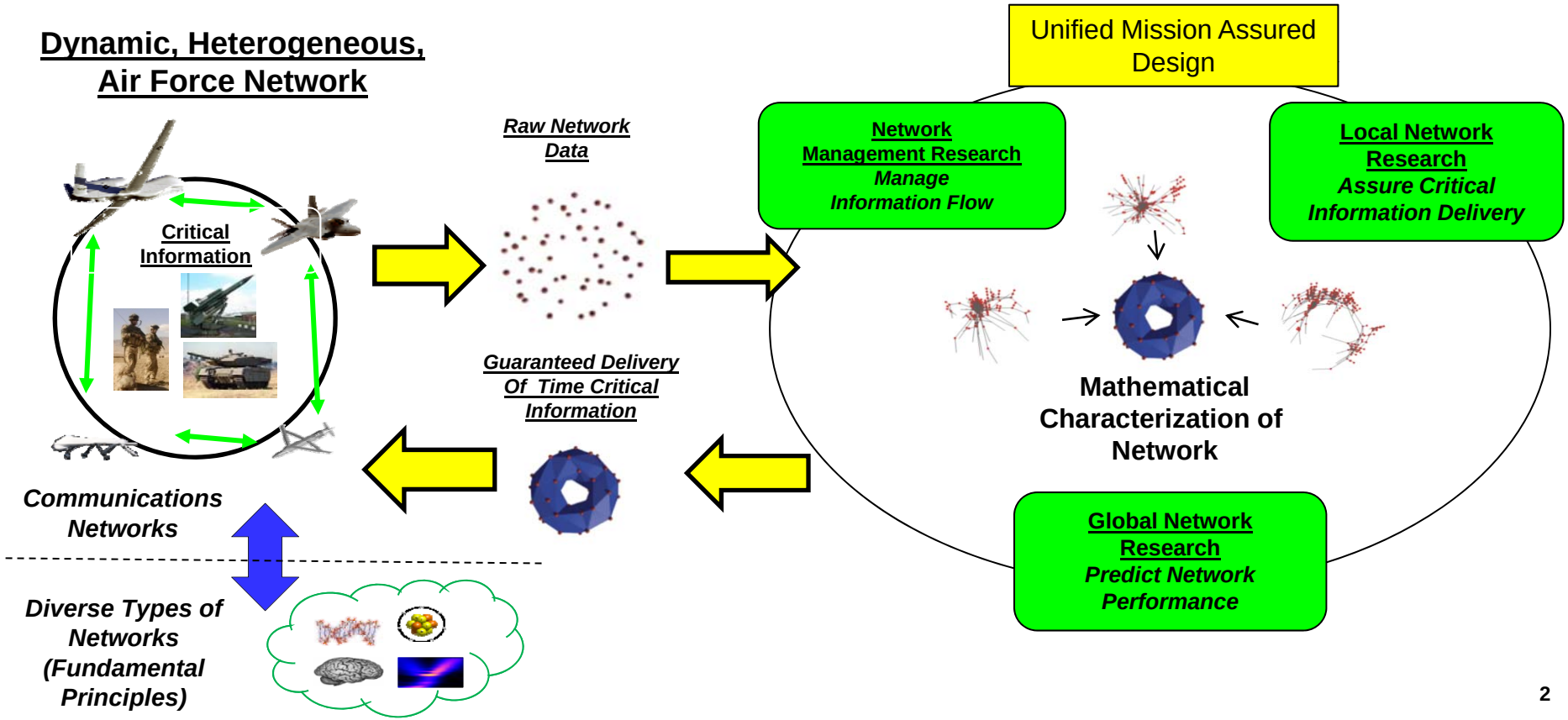
Complex Networks Roadmap

Complex networks uses the results of the mathematical quantification of critical information delivery to assure, manage, predict, and design Air Force networks

Local Network Research: Coding that assures information delivery and security

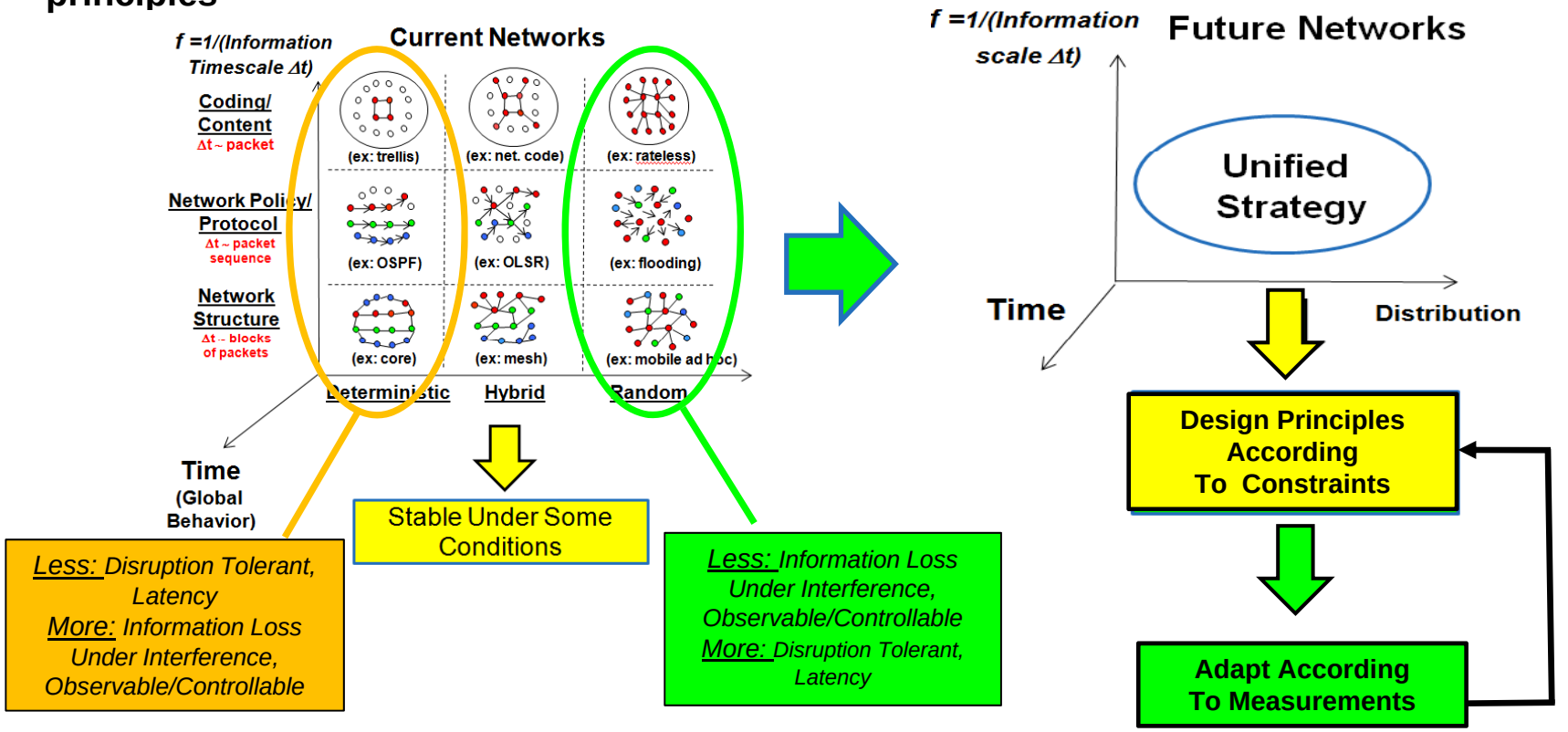
Network Management Research: Network protocol to maximize information flow

Global Network Research: Predict network performance and design robustness



Unified Mission Assured Architecture

- Current networks are managed with multiple protocols depending on their taxonomy
- Air Force networks, particularly Airborne Networks are heterogeneous
- A unified network approach should adapt to the conditions and provide design principles



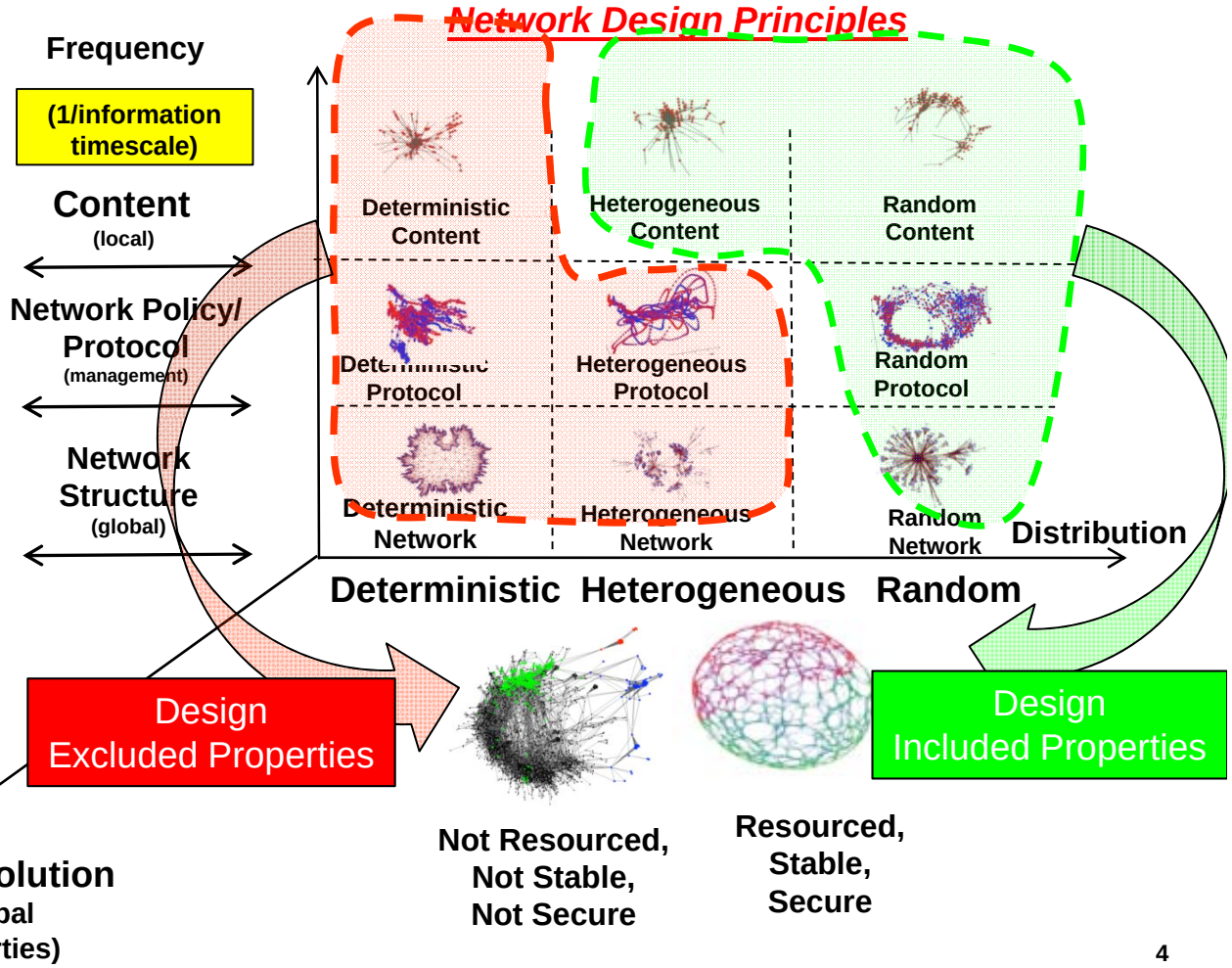
Fundamental Network Principles

Units of information transfer do not have to be packets – generalizing this approach to other scientific areas allows generalized network design and analysis within constraints

- Taking this approach can lead to an integrated strategy of stable design formulation

Basic Information Unit Scales

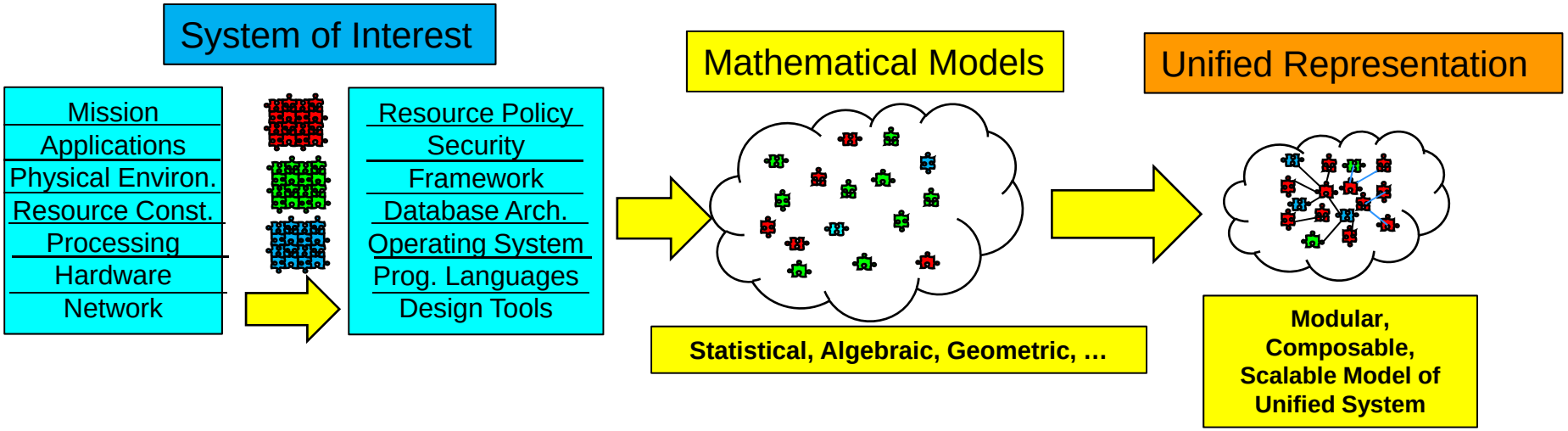
Data Network	*Wireless Network*	*Hardware/ Software*	*Social*	*Biological*
Packet	Modulation Unit	Register/ Variable	Words	*DNA*
Packet Groups	Waveform	Ram/ Subroutine	Phrases	Protein Synth.
Packet Blocks	Signal Array	Virtual Mem./ Program	News Reports/ Blogs	Cell Function
Communications Networks			General Networks	



Comprehensive Systems Modeling

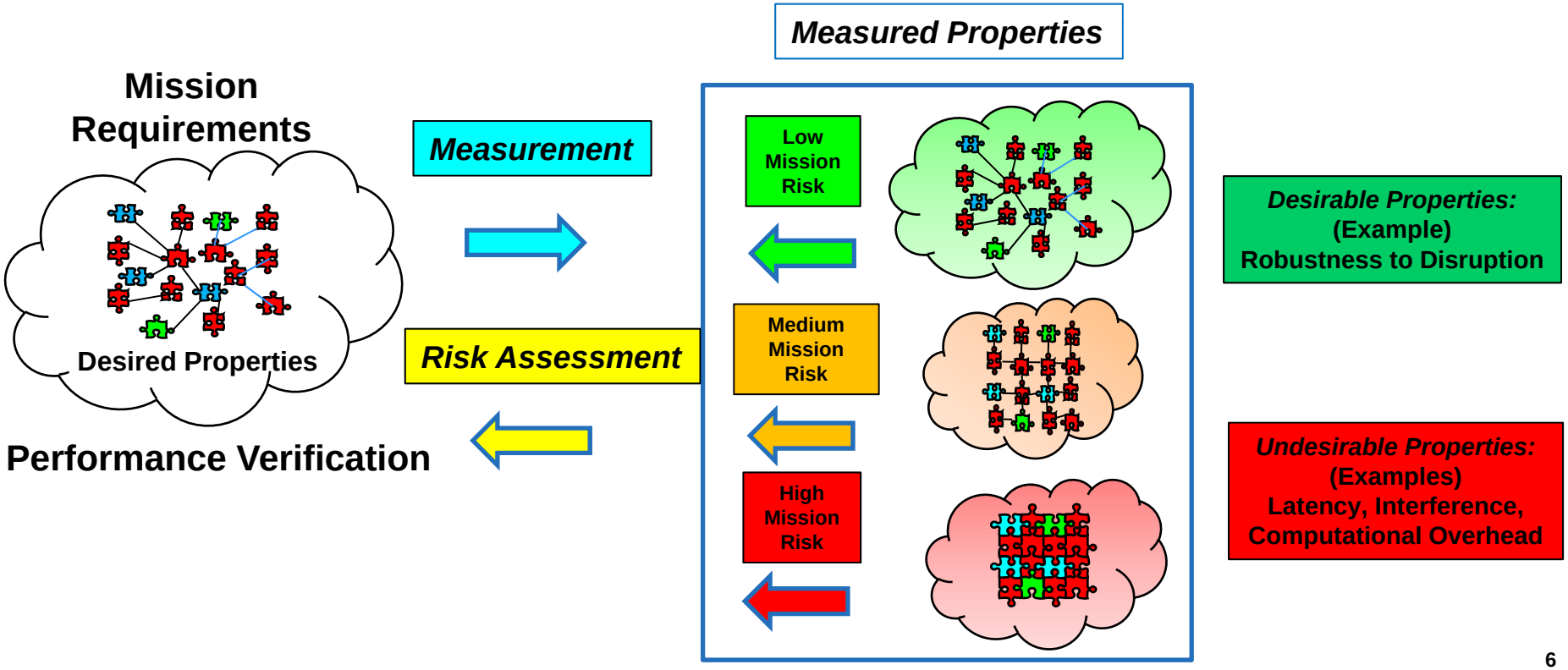
- *Model* heterogeneous distributed systems using unified, modular, composable and scalable mathematical framework from previous measurement and system specification

- Use new statistical, algebraic, and geometric representations and theory for modularized representations and composable into a modeling framework



Measurement-Based System Verification

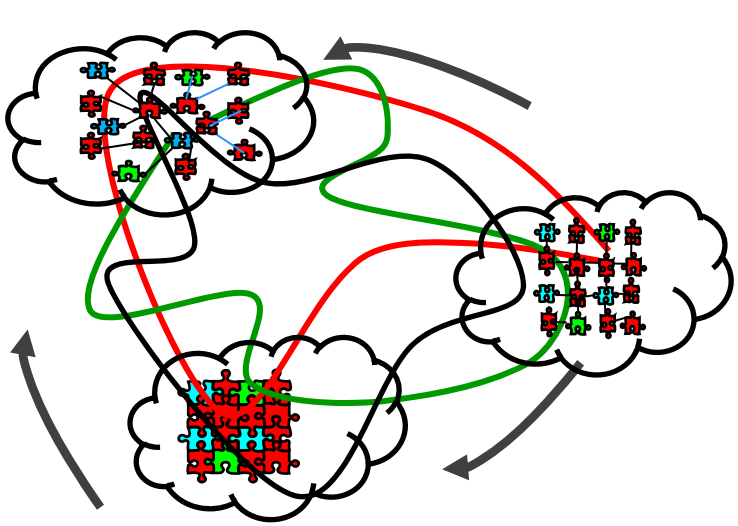
- *Verify* the properties of a given unified system through *measurement* of a limited set of parameters and calculate system *risk* of not meeting mission requirements
  - Assess risk by distance between properties of desired representation (model) and measured properties
  - Incorporate risk of sparse measurement



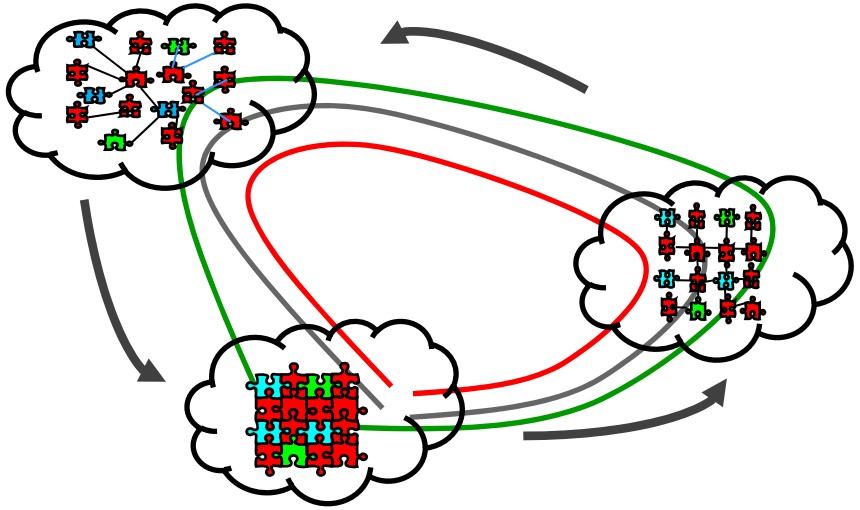
System Design Trade-space

- Define general application architectural and policy *design* principles through unified assessment of system operating risk
  - Apply to existing architectures through policy implementation

System Operating Trade-space



Architecturally Excluded Modalities (high mission risk)



Architecturally Included Modalities (low mission risk)

Systems Engineering Framework

- ***Measure and Model, for Design*** **using a comprehensive, modular, compositional, and scalable framework**
  - **Models inform measurement based verification of system properties**
  - **Strategy enables designs to quantifiably meet mission performance objectives in heterogeneous dynamic systems**