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CENTER FOR DEFENSE CONCEPTS + TECHNOLOGY

Gaining Decision-Making Advantage through Force Design and Mission Integration

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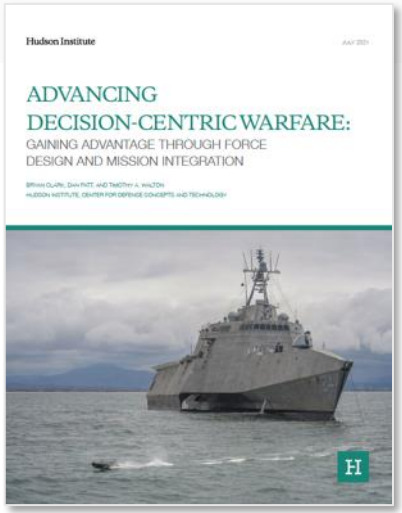
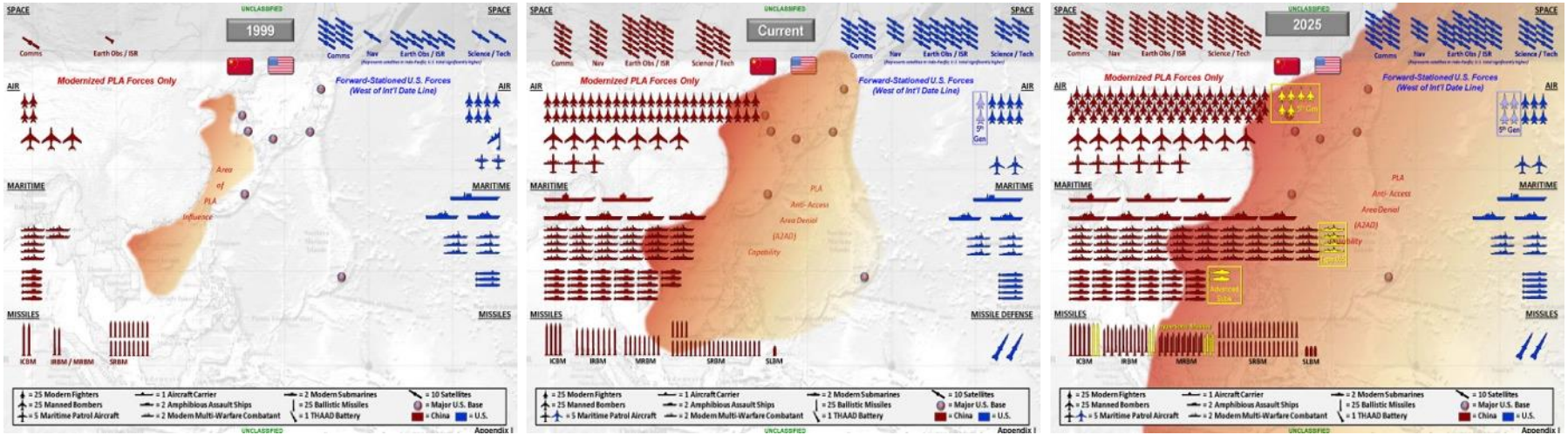


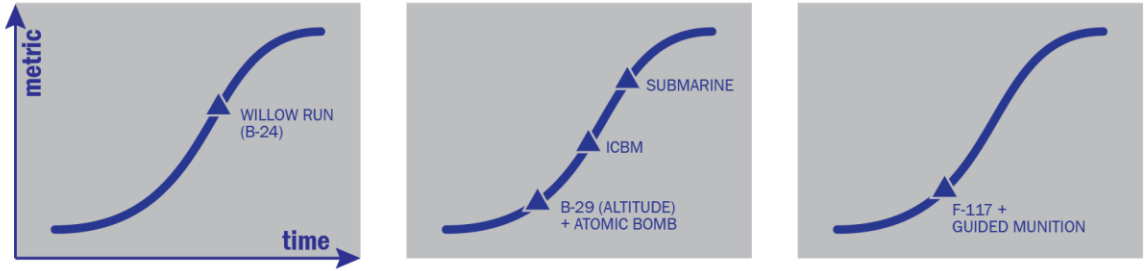
Challenge: More or better gear alone unlikely to yield durable advantages against China



- The threat from China will become increasingly severe during the 2020s
- Decades-long development programs are unlikely to arrive in time within realistic budgets
- China is a peer competitor fighting on their home territory
- **Flexible combinations of systems & concepts could more effectively create a decision-making advantage and impose losses on the enemy**

China's parity reflects culmination of the precision weapons/stealth competition

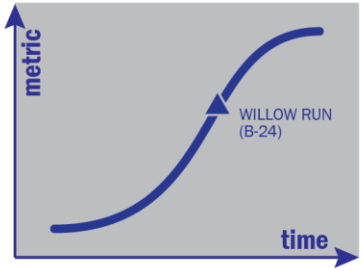
INNOVATIONS (S-CURVES) IN MODERN MILITARY HISTORY

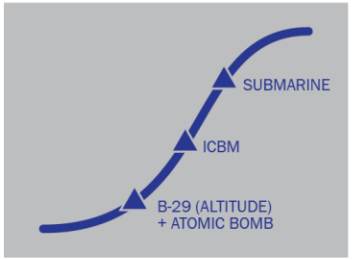


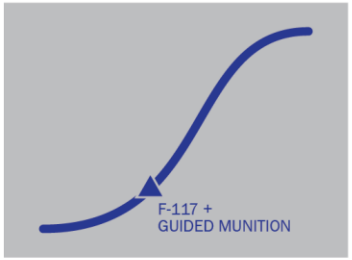
ERA	INDUSTRIAL CAPACITY	NUCLEAR WEAPONS	INVISIBILITY & PRECISION
exemplary metrics	• quantity produced	• yield • number of launch options • prosecutable targets	• signature / detectability • collateral effect size • navigation precision
key technologies	• mass production	• fission • delivery mechanisms	• radio frequency stealth • electronic warfare • computer control
DoD institutional innovation	• effective relations with private industry	• strategic decision making	• performance-driven product development
counters	• centralized state control of industry	• equivalent capability creates stasis	• multi-mode detection • basing denial

Next competition could center on decision-making, using AI & autonomous systems

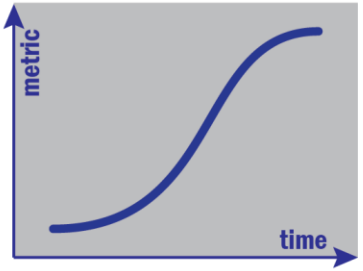
INNOVATIONS (S-CURVES) IN MODERN MILITARY HISTORY





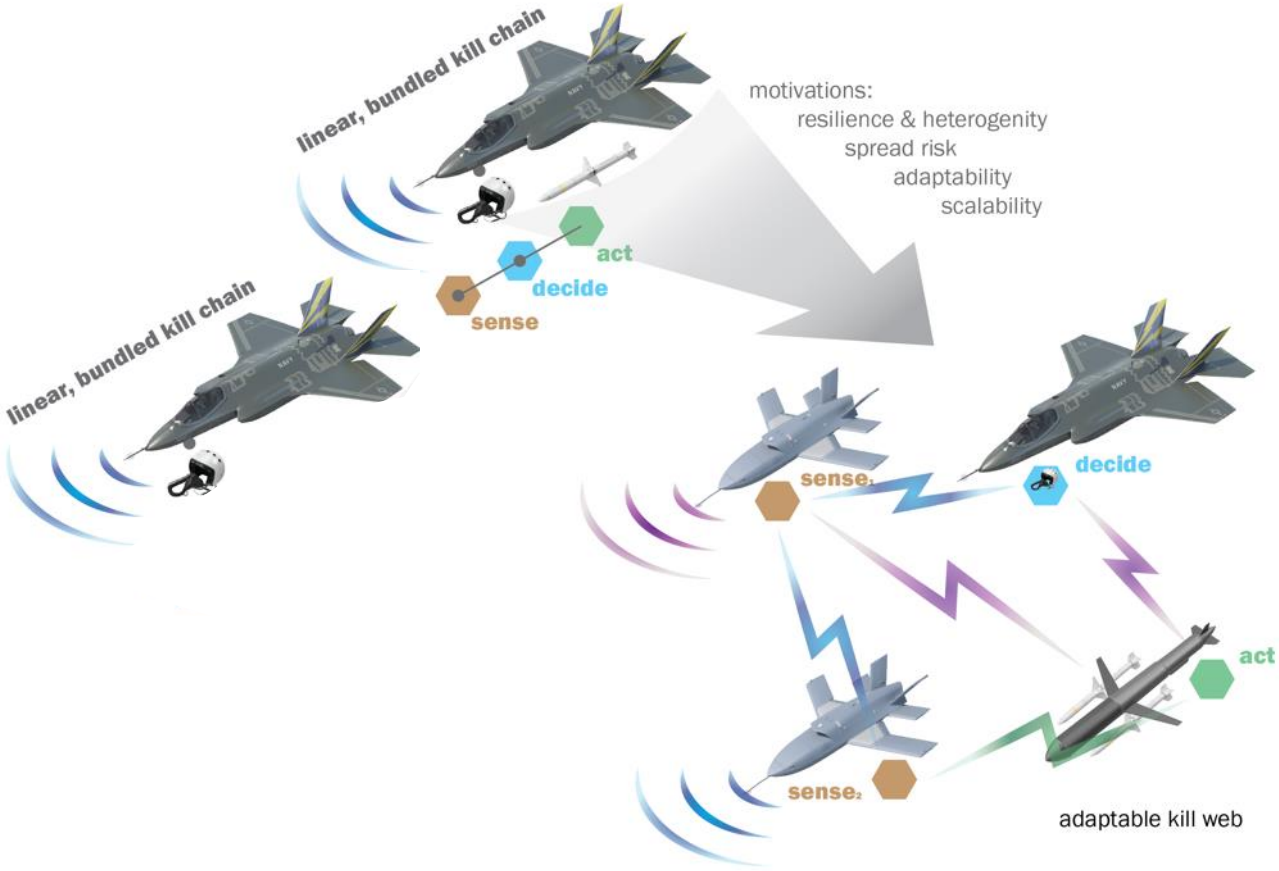


NEW ERA

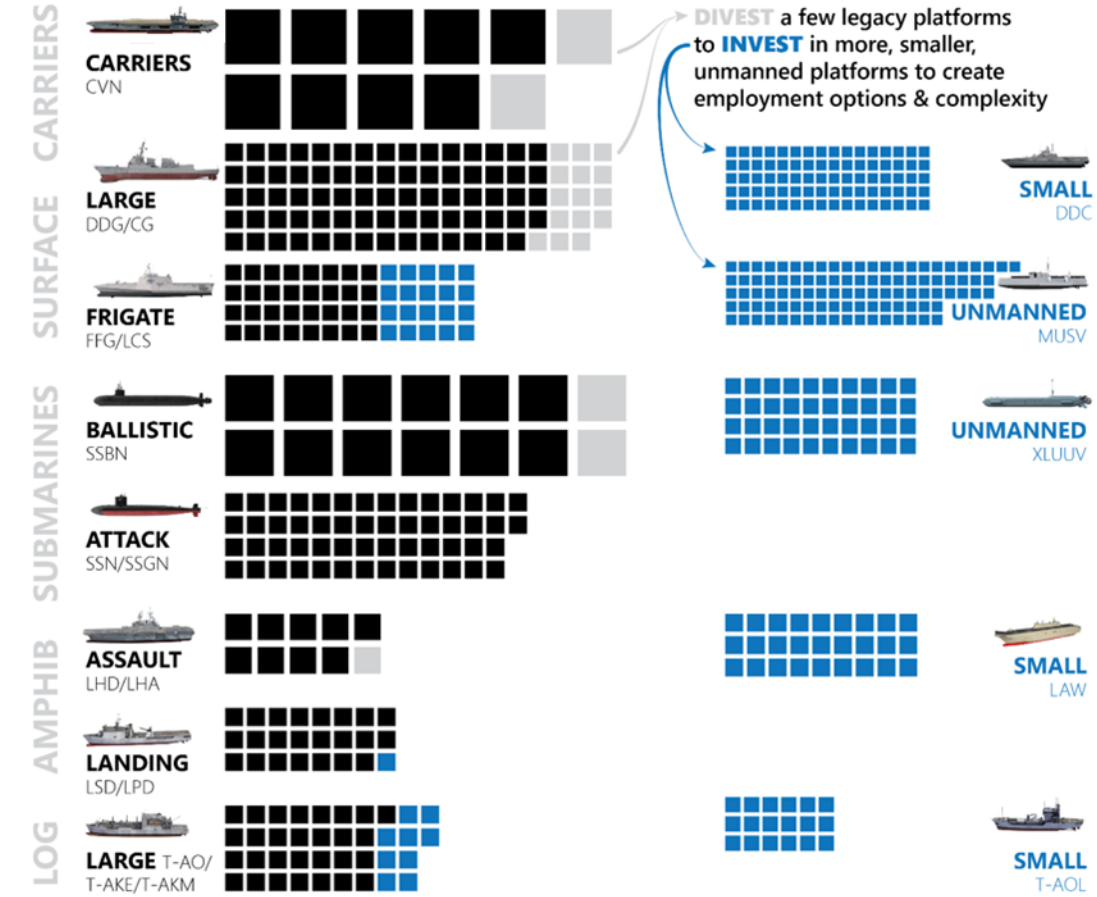


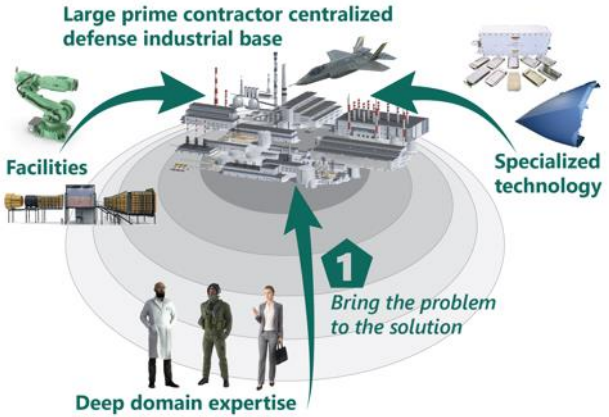
ERA	INDUSTRIAL CAPACITY	NUCLEAR WEAPONS	INVISIBILITY & PRECISION	DECISION-CENTRIC WARFARE
exemplary metrics	• quantity produced	• yield • number of launch options • prosecutable targets	• signature / detectability • collateral effect size • navigation precision	• scale (optionality) • pace • resilience
key technologies	• mass production	• fission • delivery mechanisms	• radio frequency stealth • electronic warfare • computer control	• context-centric C2 • interoperability • software building software
DoD institutional innovation	• effective relations with private industry	• strategic decision making	• performance-driven product development	• agility • mission-centrism
counters	• centralized state control of industry	• equivalent capability creates stasis	• multi-mode detection • basing denial	

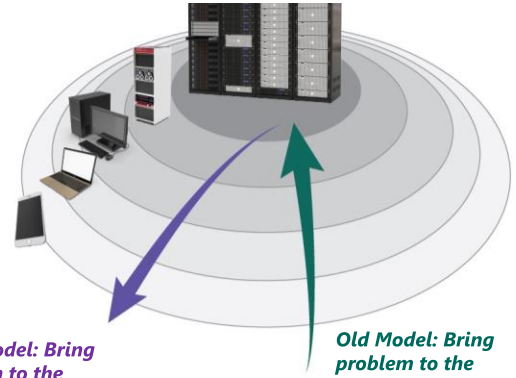
Disaggregating force w/unmanned systems and AI-enabled C2 increases adaptability



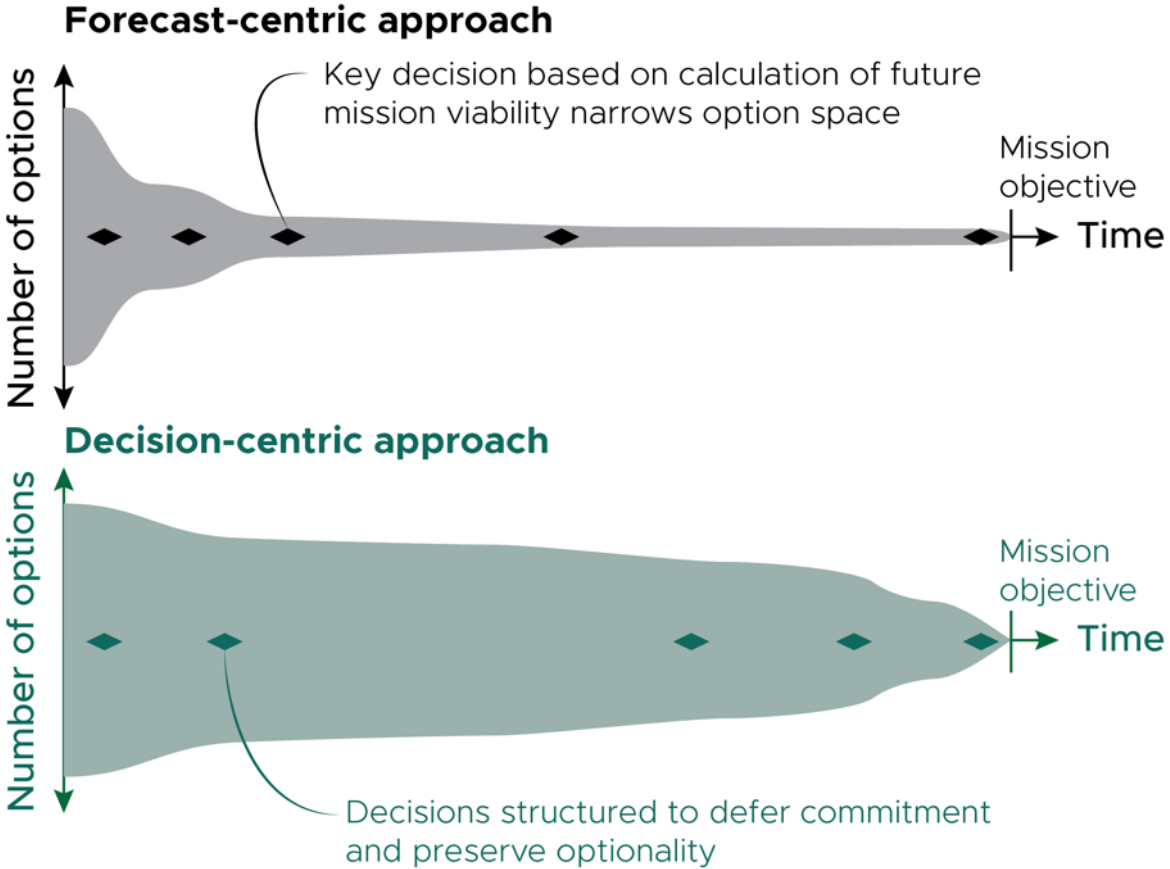
Disaggregation creates heterogeneity at scale that allows tailoring force packages







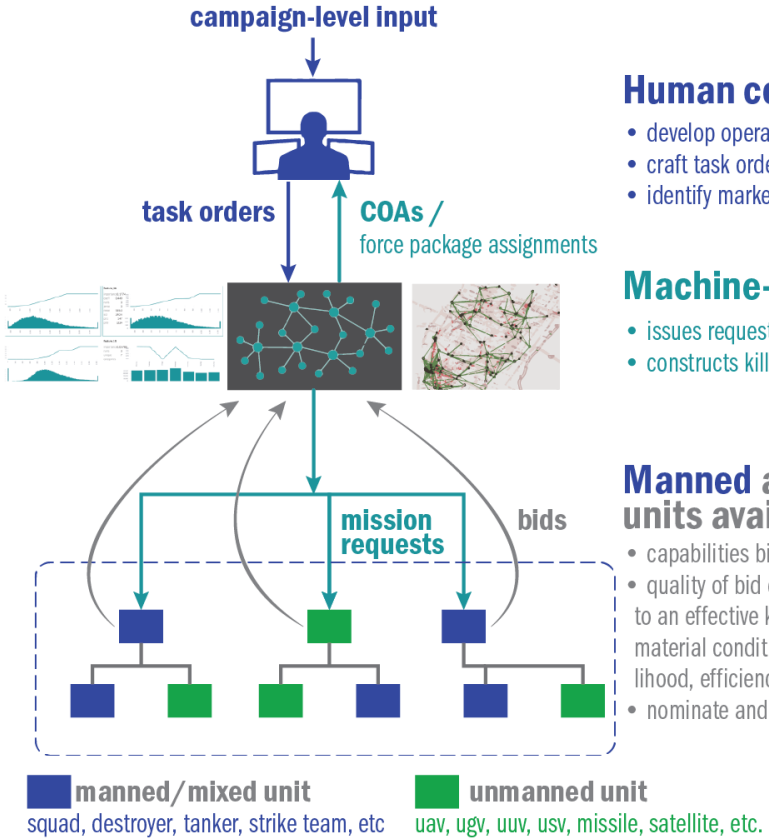
Disaggregated forces provide more options and imposes more complexity on enemy



- **Forecast-centric operations pursue efficiency**
  - Goal is defining narrowly-scoped solution for gaps
  - Relies on numerous assumptions
  - Does not prioritize adaptation; could center on ineffective solution

- **Decision-centric operations pursue resilience**
  - Trades efficiency to sustain more options later
  - Relies on fewer assumptions
  - May deliver less-precise capabilities, but better able to adapt as understanding improves
  - More options also acts to constrain choices for enemy

Harnessing heterogeneity at scale requires C2 scheme that assesses entire option space



Human command

- develop operational plans
- craft task orders
- identify marketplace of capabilities

Machine-assisted control

- issues request for bids to accomplish task orders
- constructs kill chain sets from available capabilities

Manned and unmanned units available for tasking

- capabilities bid on orders
- quality of bid depends on ability to contribute to an effective kill chain (i.e. proximity, speed, material condition, key functions, success likelihood, efficiency of capability)
- nominate and refine execution tactics

key principles

Mission command

- viable in contested communications environment where supervision and consultation may not be possible

Maximize optionality

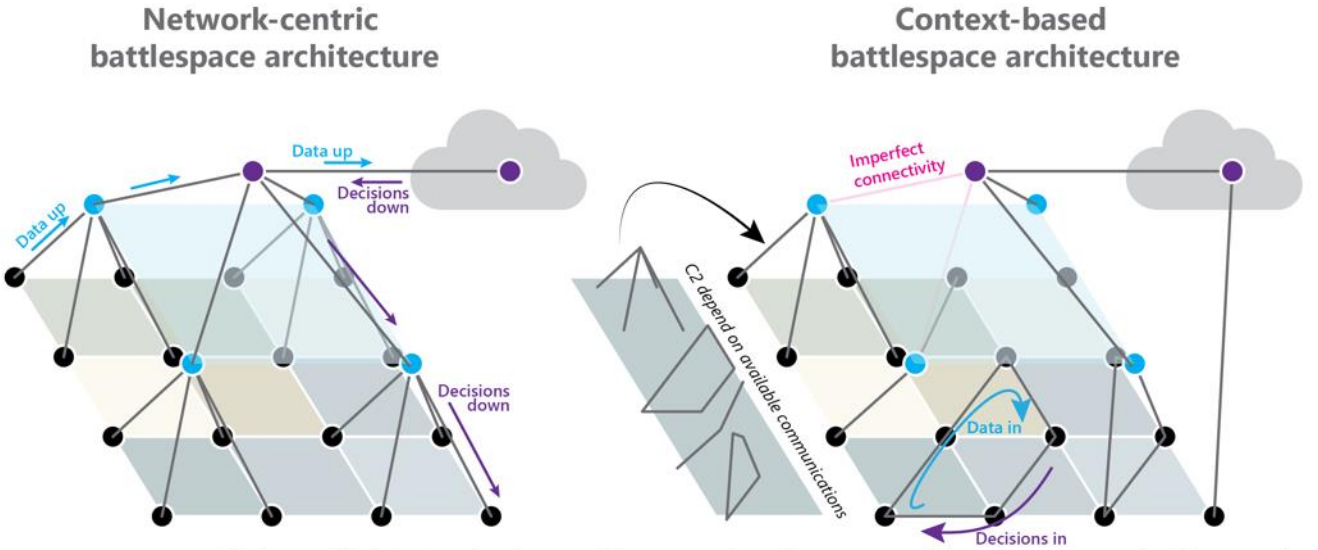
- manage vast distributed resources in an efficient manner
- set up multiple options to enable tactical success

Action with autonomy

- lower echelon units act with autonomy according to mission-command style task orders

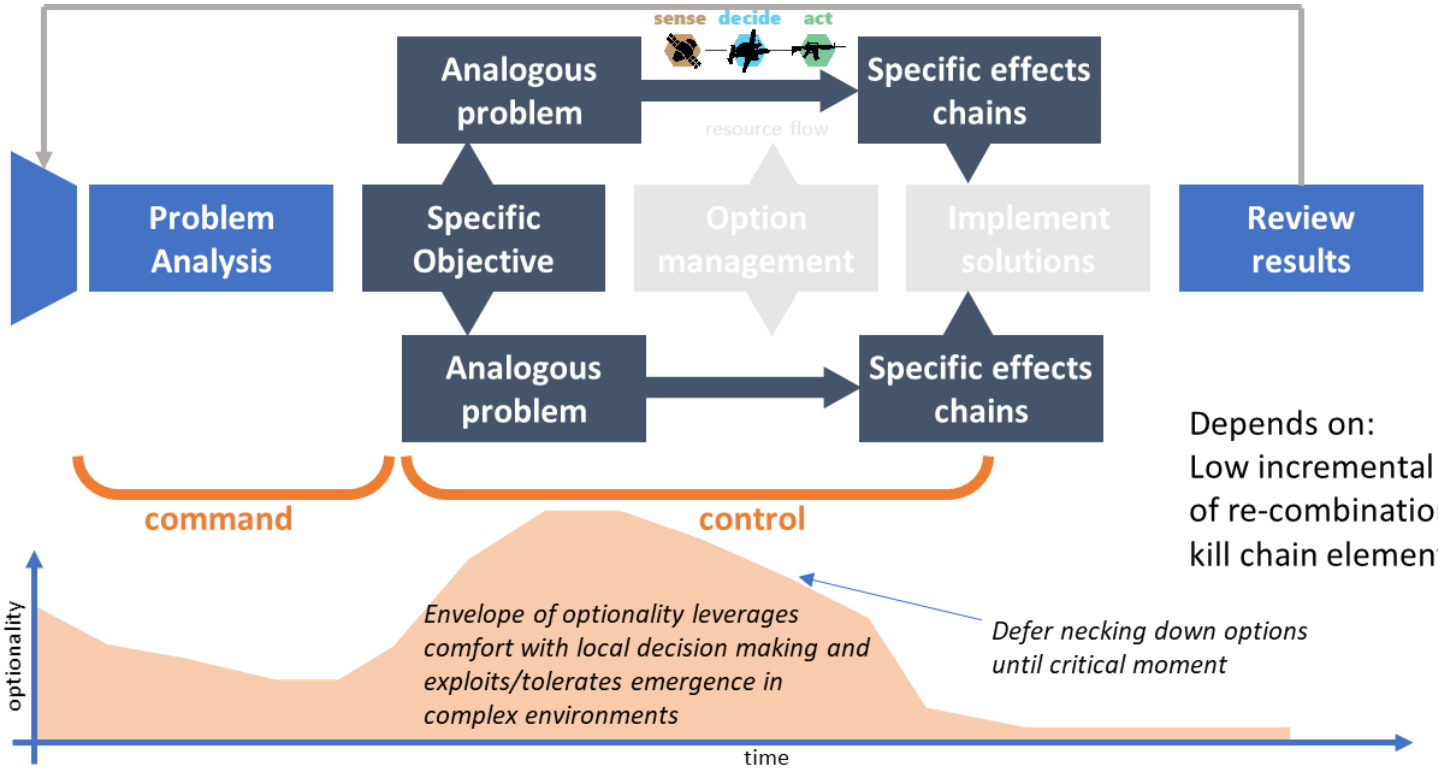
Figure based on Bryan Clark, Dan Patt, and Harrison Schramm, *Mosaic Warfare: Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-centric Operations*, (Washington, DC: CSBA, 2020), p. 36.

Machine control allows adapting C2 structure to communications availability



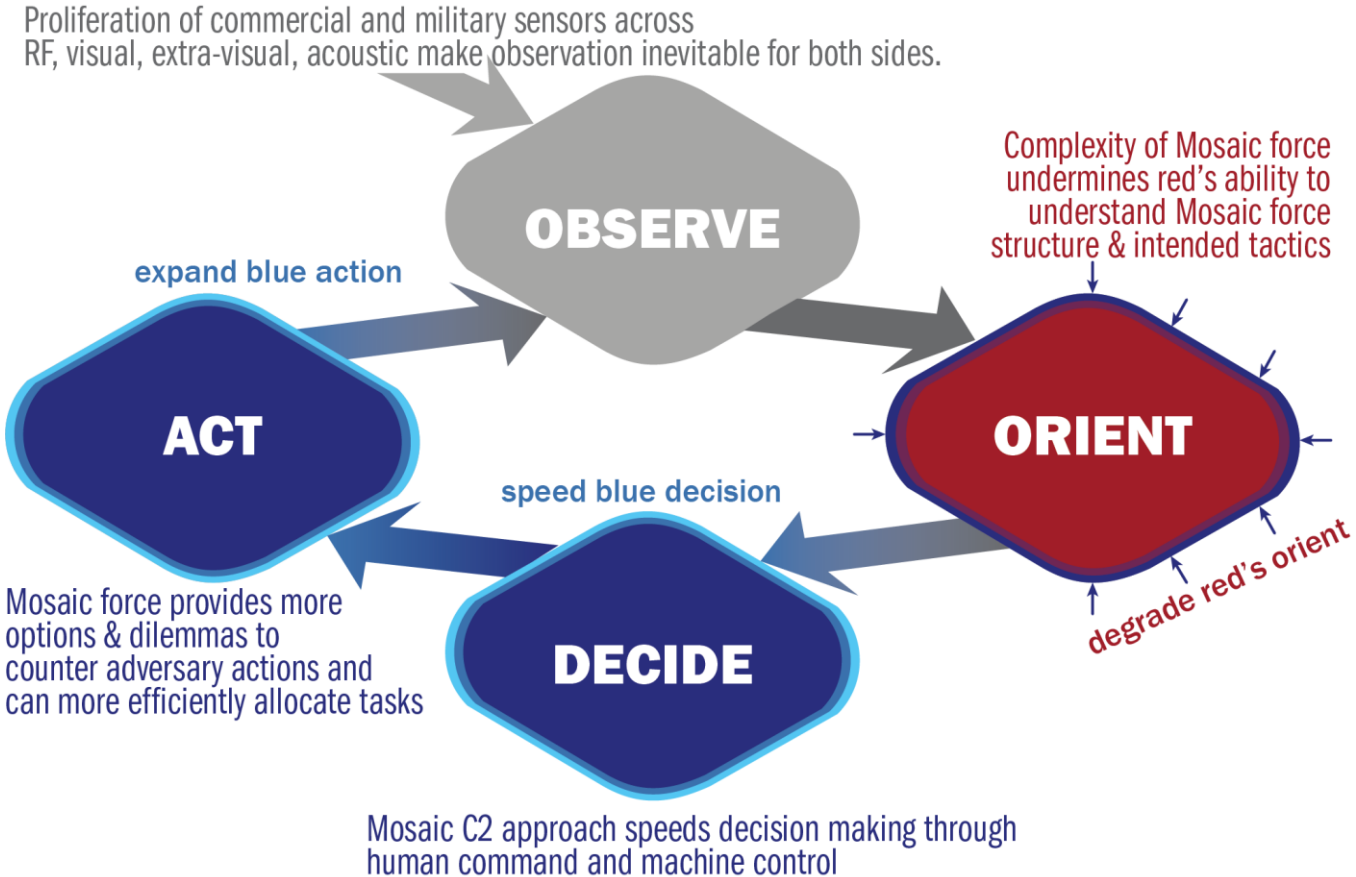
Network-centric battlespace architecture		Context-based battlespace architecture
Universal joint standard for communication, data	**Communications & Interoperability**	Diverse communications and on-demand interoperability
Forecast joint force & mission threads, enforce standards compliance	Design approach	Architectural principles, but evolutionary/emergent design
Optimized directive control based on global picture	**C2 approach**	Local decision making based on opportunity
Attrition-centric	Warfighting Concept	Decision-centric

Analogous problem-solving would enable AI C2 systems to rapidly build COAs

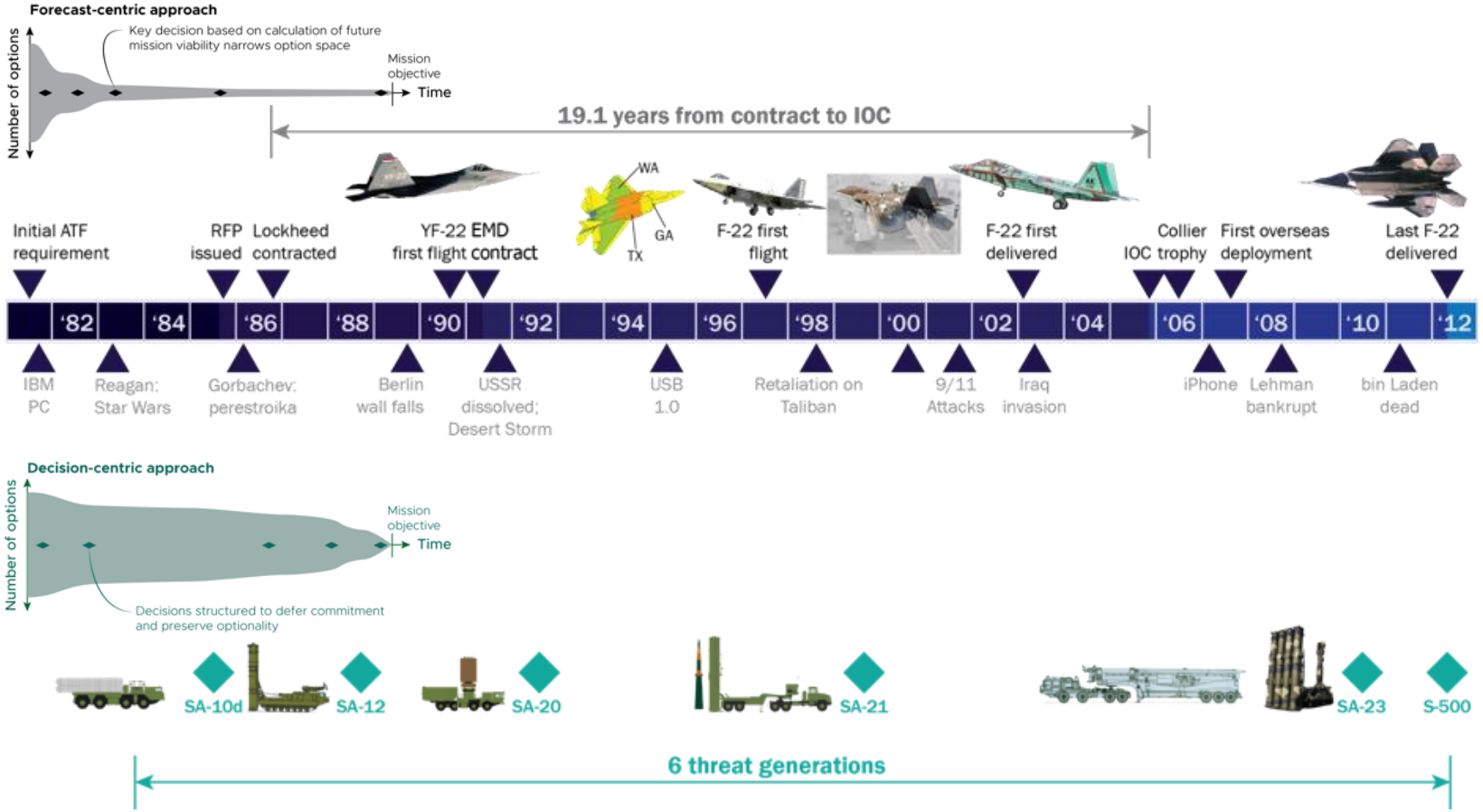


Depends on:
Low incremental cost of re-combination of kill chain elements

C2 tools + disaggregated force speed blue decisions and degrade enemy orientation



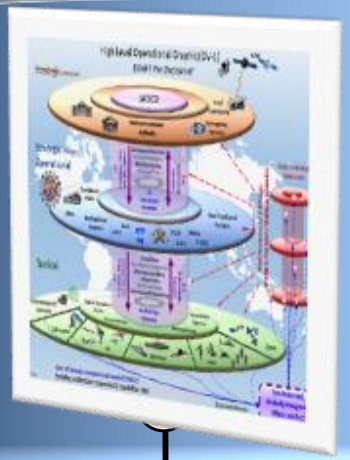
Adaptability also benefit in terms of acquisition



Mosaic Warfare is the 2nd and 3rd wave of an evolution started with JADC2

Wave 1

Manually engineer solutions



JADC2

Wave 2

Operator defined architectures as part of mission planning

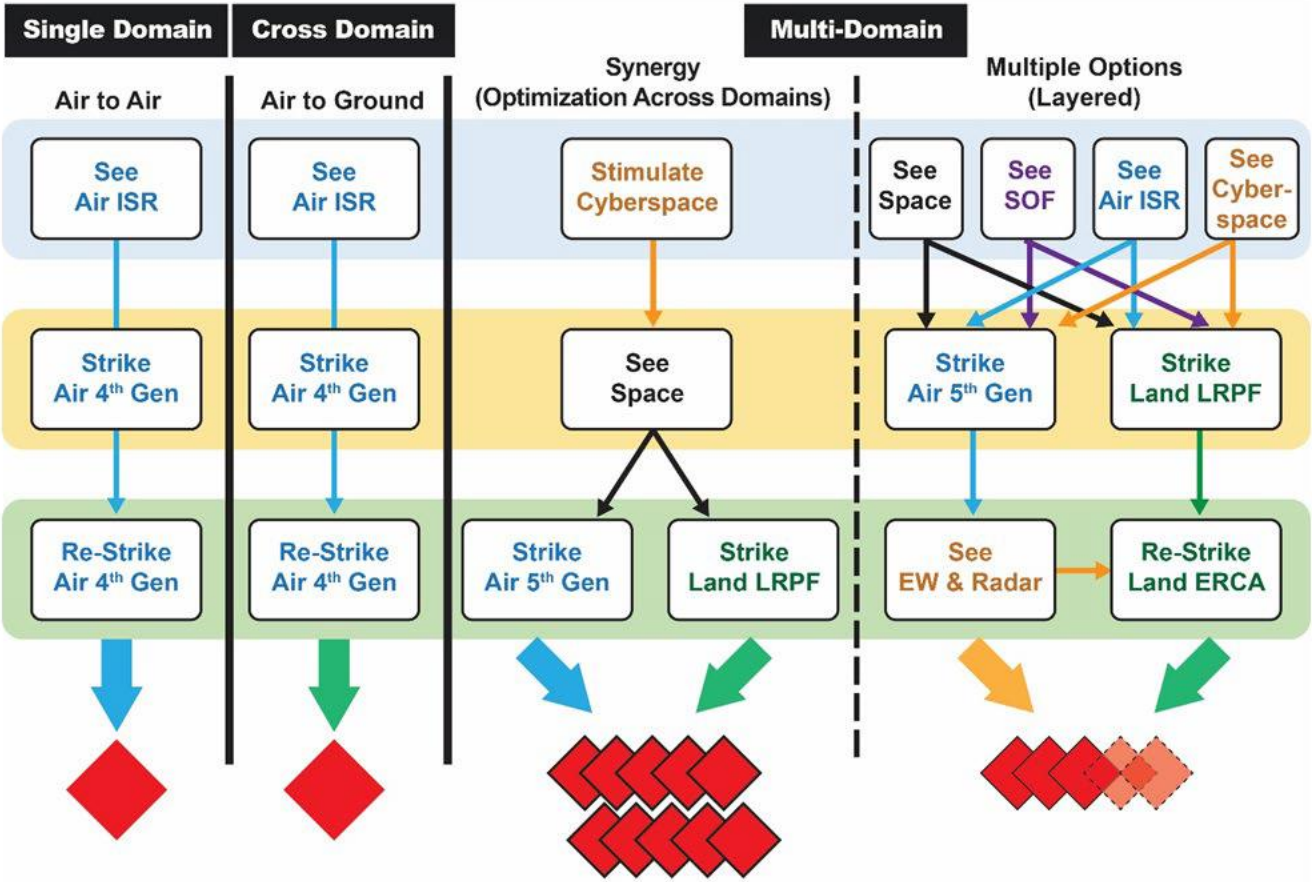
Mosaic Warfare (operationally)

Wave 3

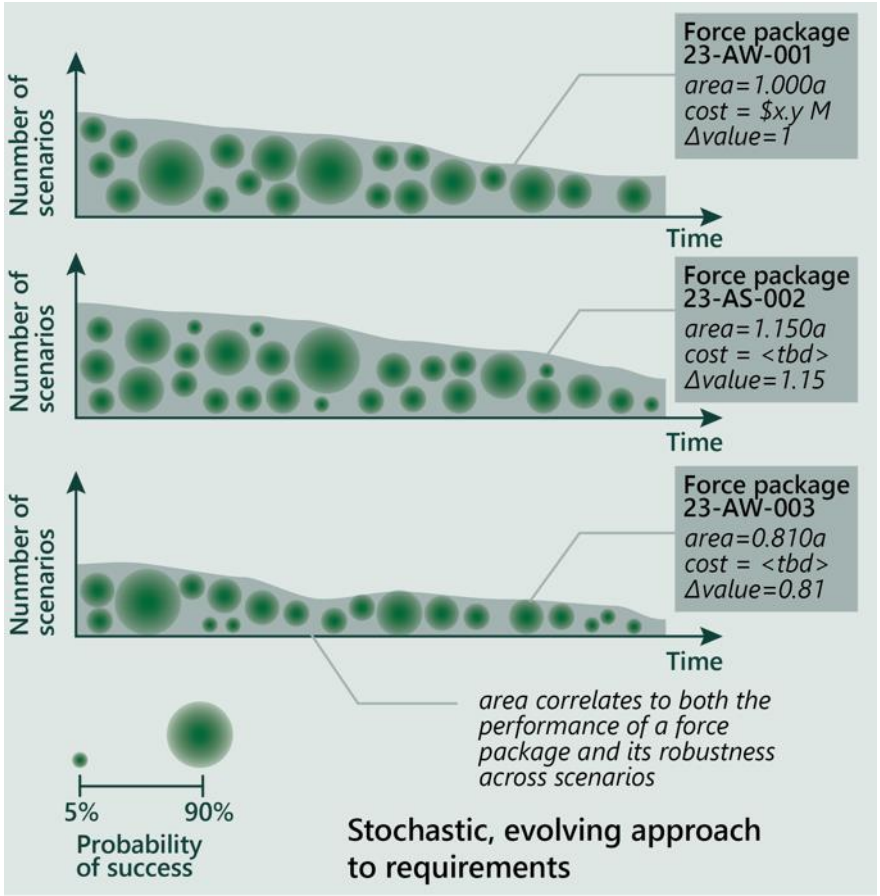
Adapted acquisition focus

Mosaic Warfare (reqmts/acquisition)

Army MDO concept shares Mosaic's goal of recomposition, adaptability & complexity

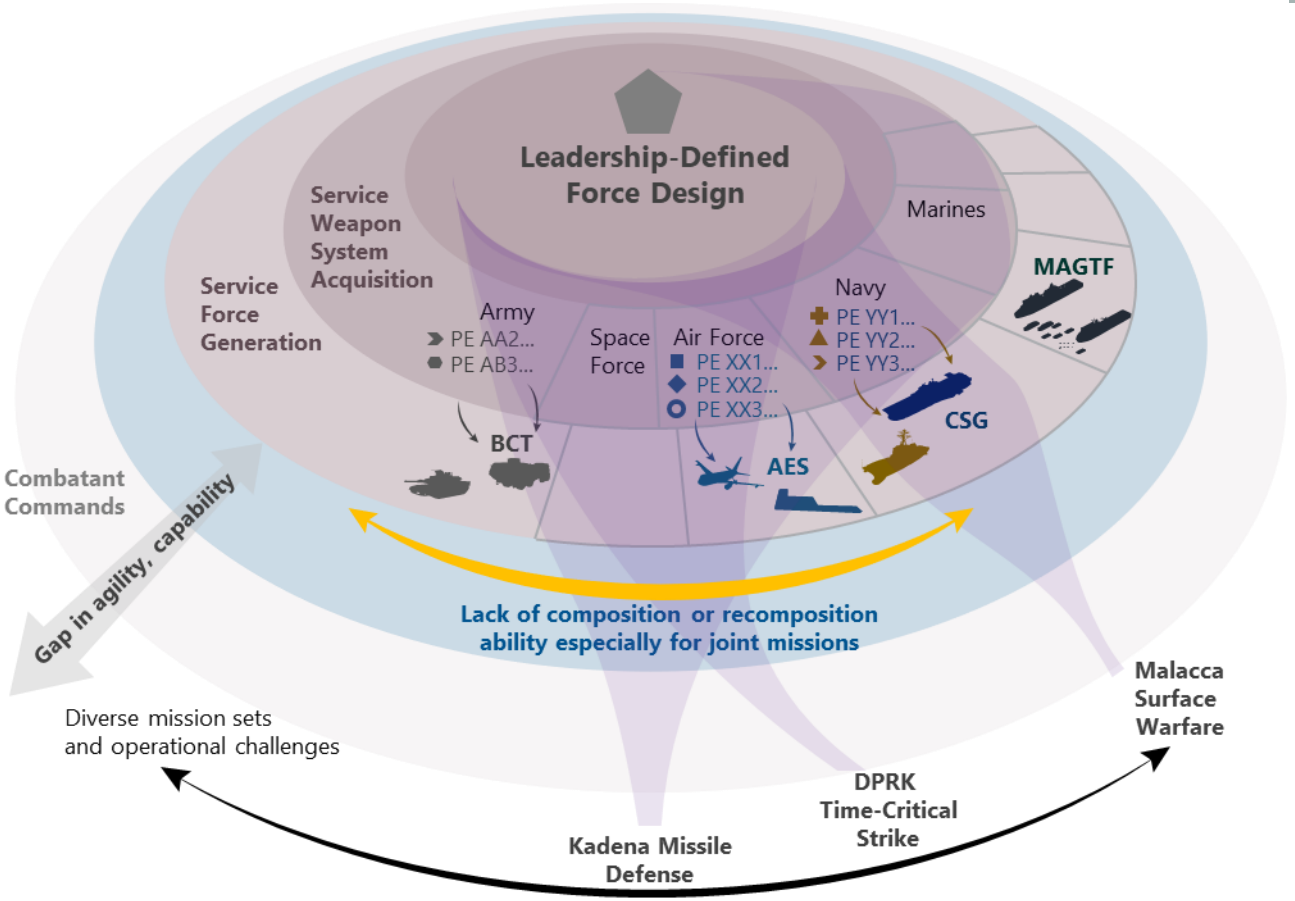


Recomposability implies new approaches to requirements and analysis

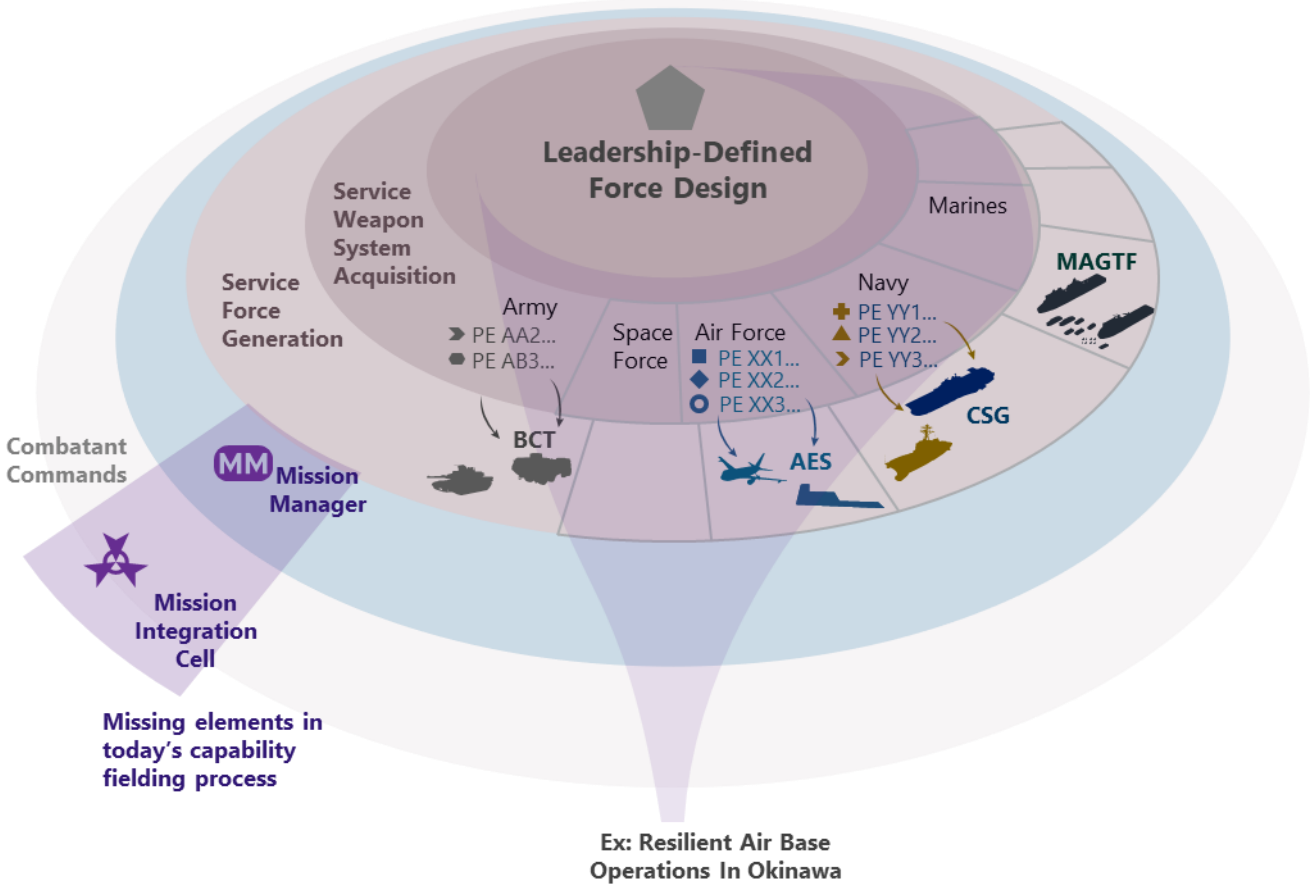


- **Performance of force packages, not individual systems, should be measured**
- **Force packages should be assessed a wide range of situations**
- **New systems can be evaluated by incorporating them into force packages and assessing the impact on performance**
- **Systems/force packages that offer better performance across range of relevant scenarios are preferred**

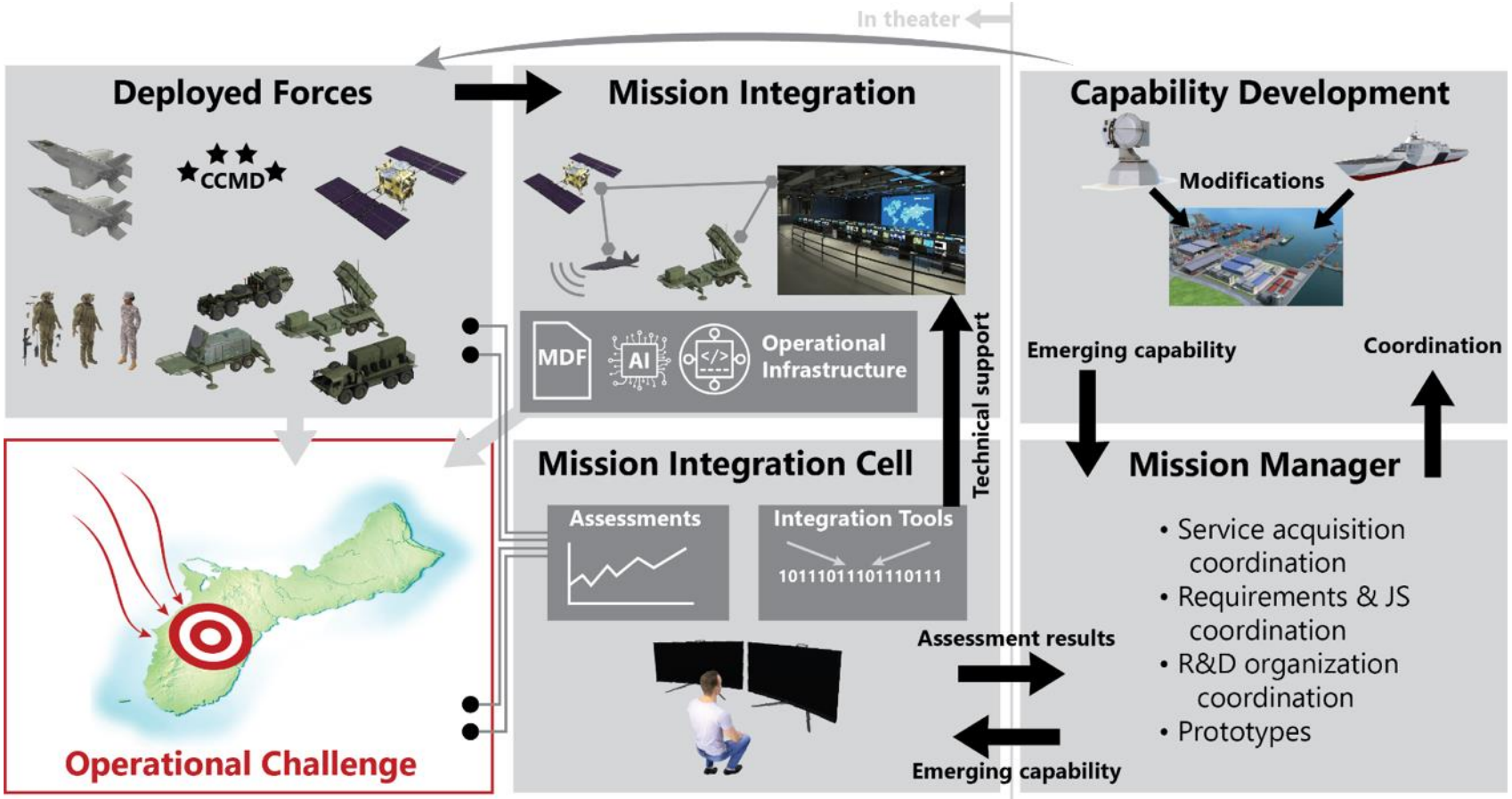
Organizational view highlights lack of joint integration in US force generation



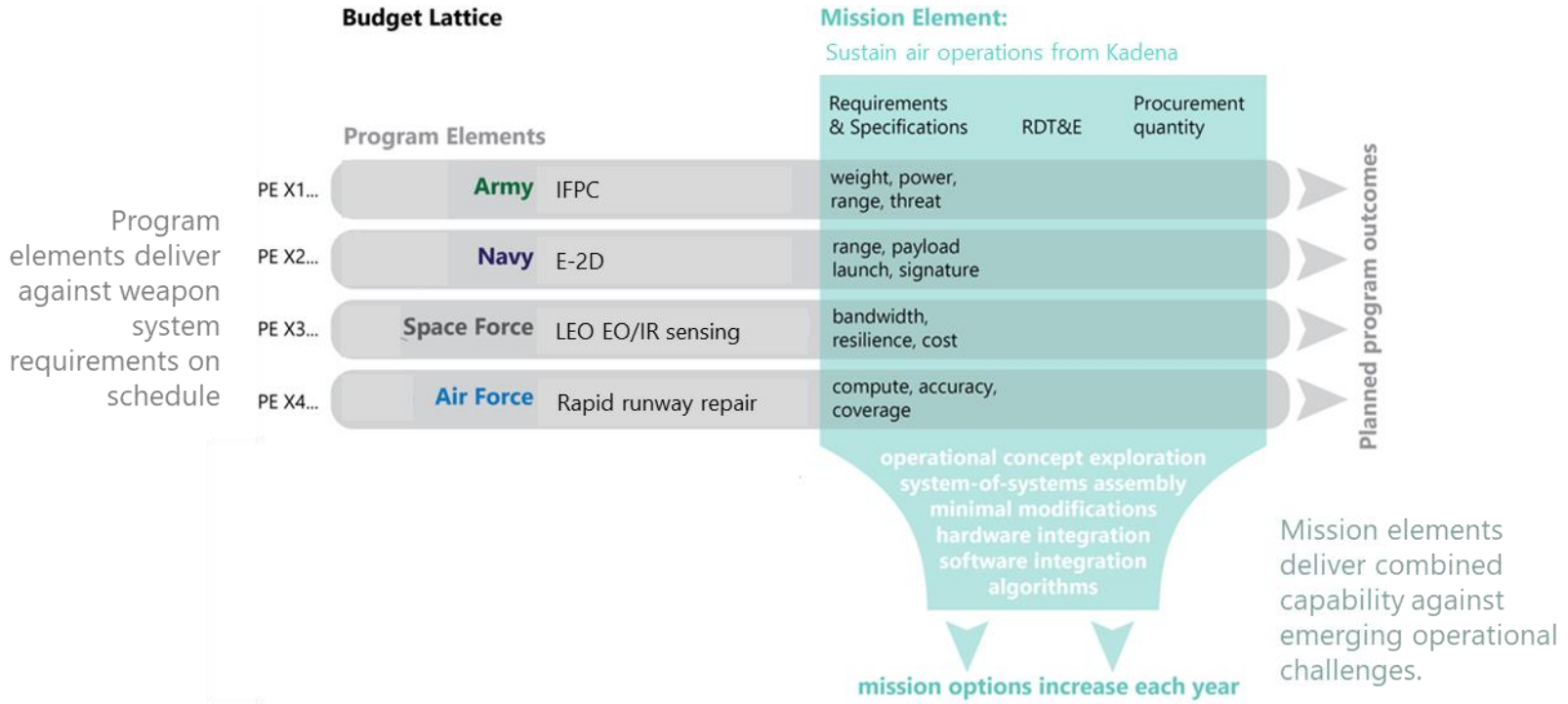
New organizations and processes needed for enable joint integration at tactical edge



Mission Integration Cells address top CCDR operational challenges; pilot in 2022 NDAA



Integrating forces in theater requires funding for missions; pilot in 2022 NDAA



Discussion

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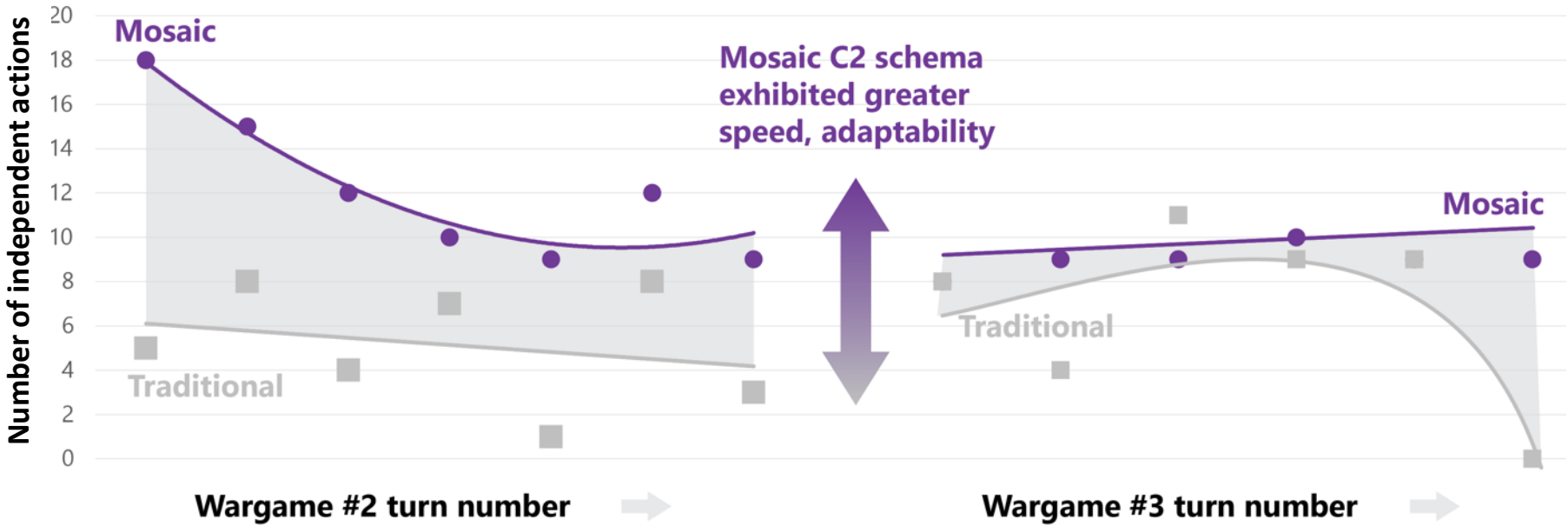
Mosaic Warfare wargames revealed optionality improves pace of operations

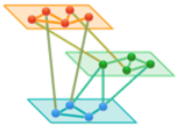


Implementation of Mosaic Warfare

- **DoD service concepts (MDO, EABO, DMO, etc.) reflect characteristics of Mosaic Warfare**
  - Emphasis on decision-making and information
  - Reliance on creating dilemmas for opponents
- **Joint Warfighting Concept incorporates elements of Mosaic Warfare**
- **Distributed force design being pursued by each military service**
  - Rebalancing in Navy and Air Force toward lager number of smaller ships and aircraft
  - Marine Force Design 2030
  - Distributed Army units
- **C3 and institutional reforms are the most important changes to implement Mosaic Warfare**

Mosaic C3 and institutional reforms can be viewed through five lenses

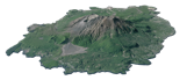
- **Stack view:** Technologies to enable communications, command, and control (C3) functions



- **Network view**: Concepts necessary to align communications with command and control (C2) in contested environments

- **Problem solving view**: AI methodologies needed to formulate and assess courses of action in C2 decision aids

- **Time view**: Processes to improve and sustain optionality over a confrontation or competition

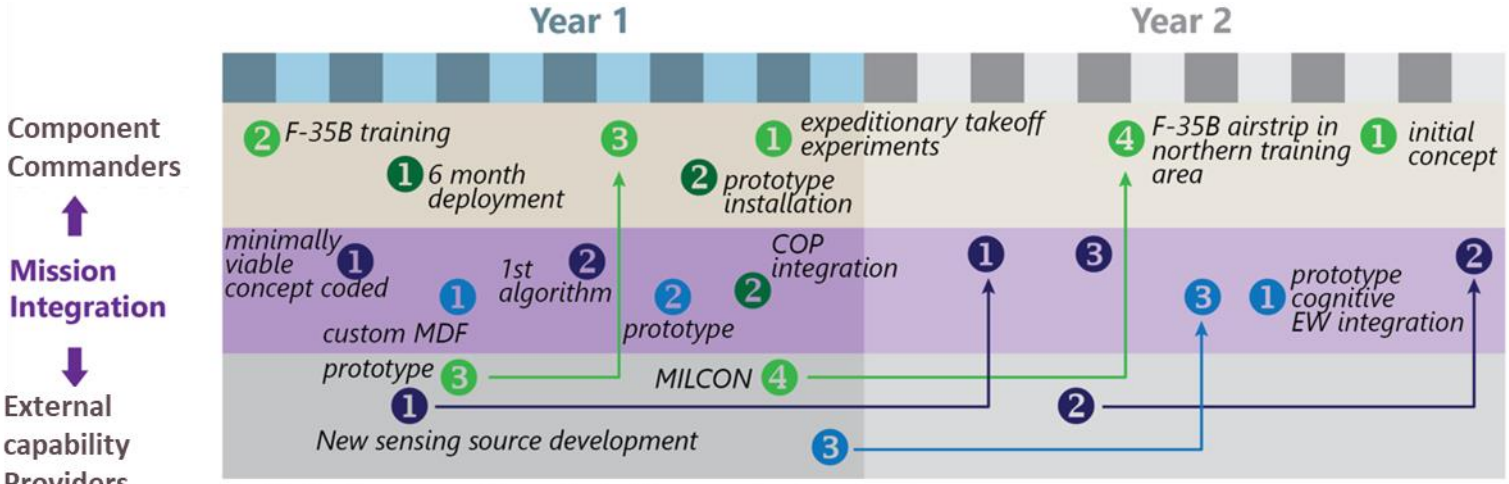


- **Organizational view**: Implications of new C3 technologies and force design for DoD requirements and budgeting

Stack view highlights DoD's efforts on communications technologies for Mosaic

Interoperability Stack Layer	Typical Interoperability Equipment	Managed Interoperability (Solution 101)	Intelligent Interoperability (Solution 201)
Application Use the bits for the mission	API	Published application programming interface (APIs)	Meta-API focused on needed information (e.g., GraphQL)
Information What do the bits mean?	Message	Open Standards (UCI)	Cross-standard, ad-hoc interoperability (STITCHES)
Network Where to send the bits	Router	Gateway / BACN Multiple networks with a router bridge	Adaptive software-defined routing (e.g., DYNAMO)
Physical How to send the bits	Radio	Software-defined radio cards (one card per waveform)	Software-defined signal processing (GNU radio) (per processing block)

Mission Managers support MICs by overseeing actions over next 1-2 years



Activity by operational challenge strategy category

Improve I&W	Degrade targeting	Defend better	Operate through
1 Common operating picture and targeting support	1 Custom electronic warfare algorithms	1 Additional Patriot batteries	1 USAF basing shell game (agile combat employment)
2 Indication and warning development	2 Specialized decoys	2 Hypervelocity weapon system prototype	2 USMC expeditionary operations of F-35B
3 Nonkinetic early engagement options	3 Software-defined electronic warfare hardware		3 Rapid runway repair
			4 Improvised airstrips