Project Alpha: A Modest Contribution to Defense Transformation

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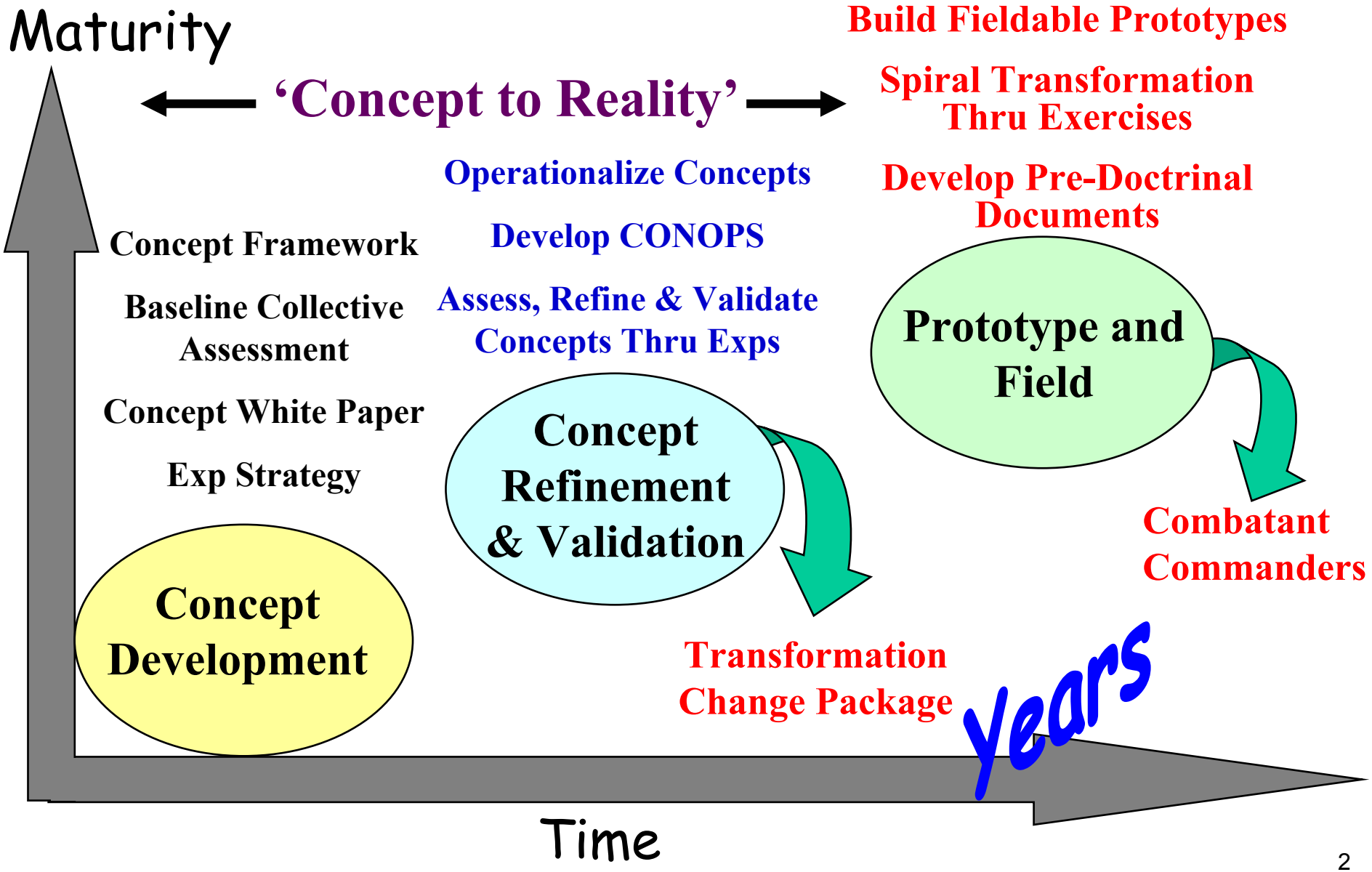
Joint Experimentation CD&E Process



Project Alpha's Mission

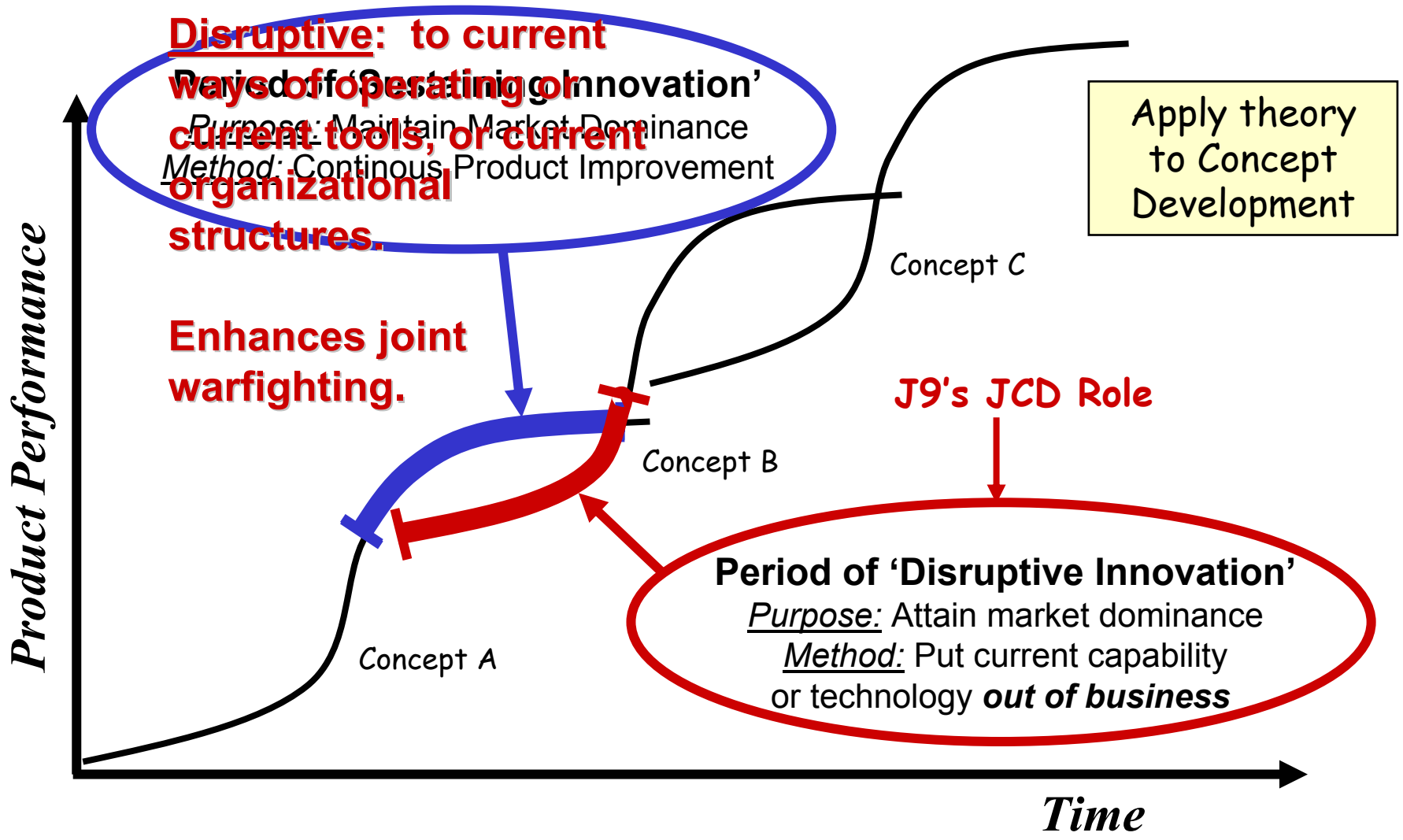
Mission: "***Accelerate joint force transformation and the mission of JFCOM by rapidly advancing good ideas across DoD***"

Project Alpha = "***Good Idea Transfer Agent***"

- **Challenges:**
  - **Identify good ideas**
  - **Add value by merging and synthesizing with other ideas and providing a joint operational context**
  - **Rapidly transfer to potential users or stakeholders**

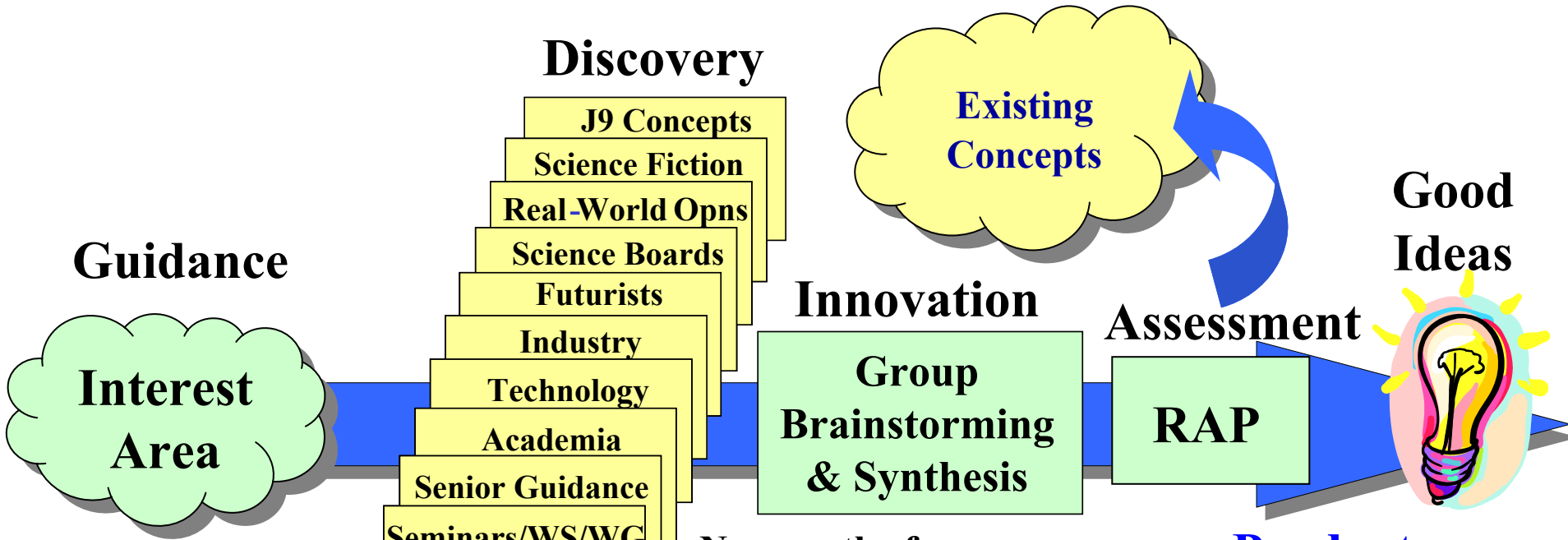
Innovation

[Reference: The Innovator's Dilemma by Clayton M. Christensen]



Focus Area Cycle

4 Phases: Discovery, Innovation, Assessment, Reporting



- 4 person PA team with SERA augmentee
- Team armed with knowledge of JFL concepts

- Narrow the focus
- Due diligence
- Provide joint operational context
- Feed ideas to current JFL concept teams
- Identify and collaborate with potential users/stakeholders

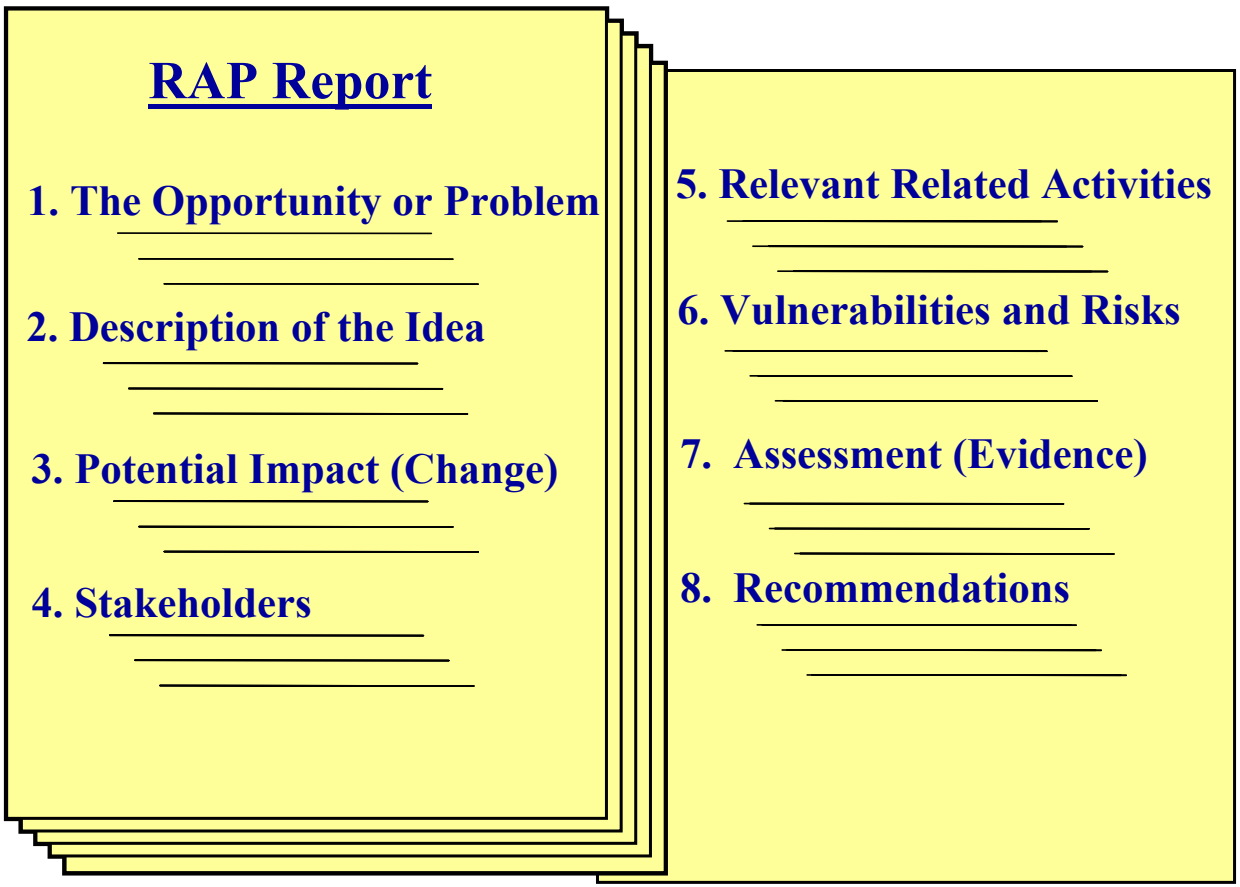
Products

- RAP Report
- Intellectual Prototypes
- Articles (Plant the seeds)

Guided Autonomy (4 months)

RAP Report

Build an "intellectual prototype" and provide a compelling case in support of the idea; make actionable recommendations for advancing the idea



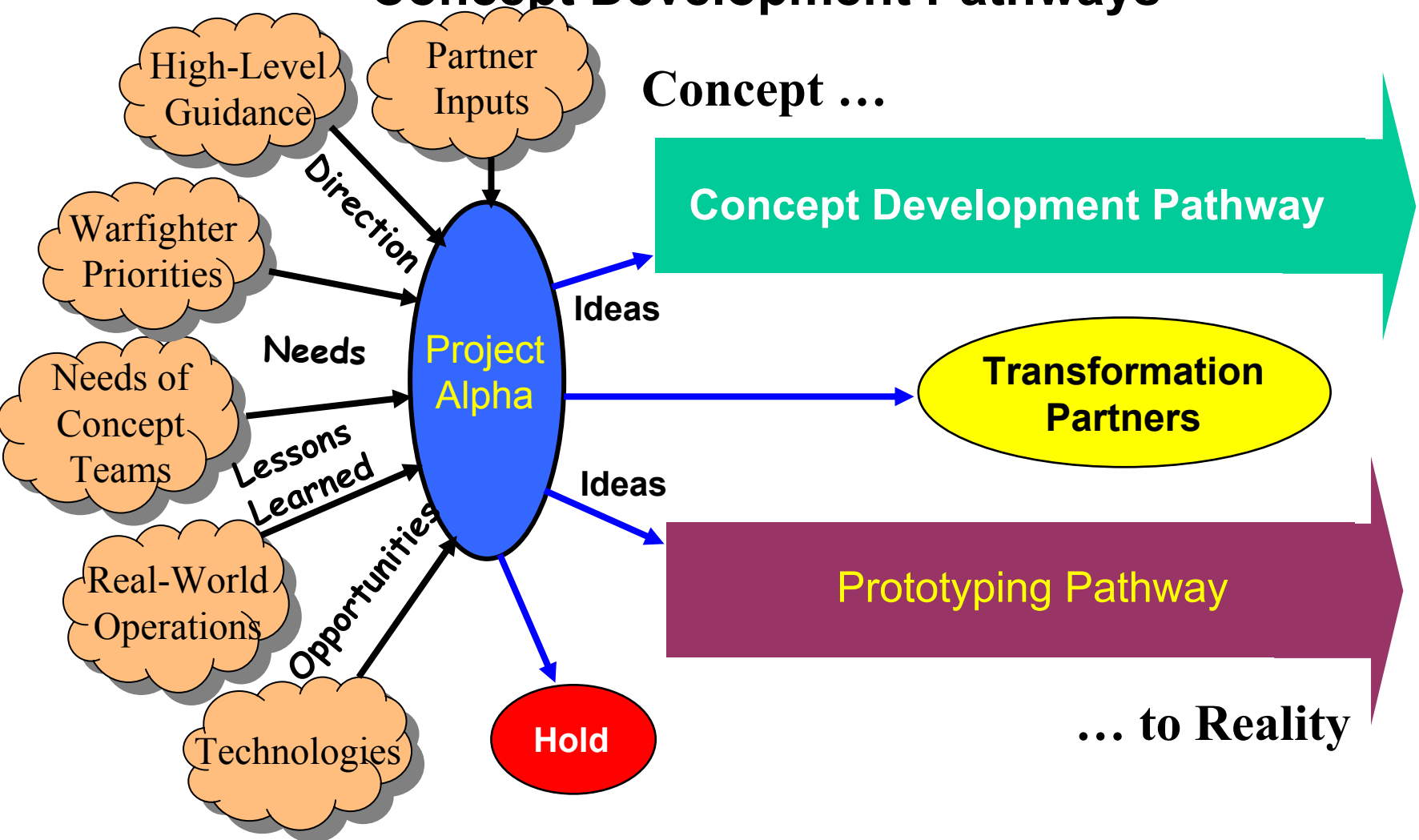
- **Report is short (~15 pages), hard hitting**
- **Makes specific recommendations**
- **Provides the evidence**
- **The objective is the engagement of potential stakeholders and users in exploring and maturing the ideas**
- **Stakeholder/partner collaboration occurs before RAP is written**

What is Done for Assessment?

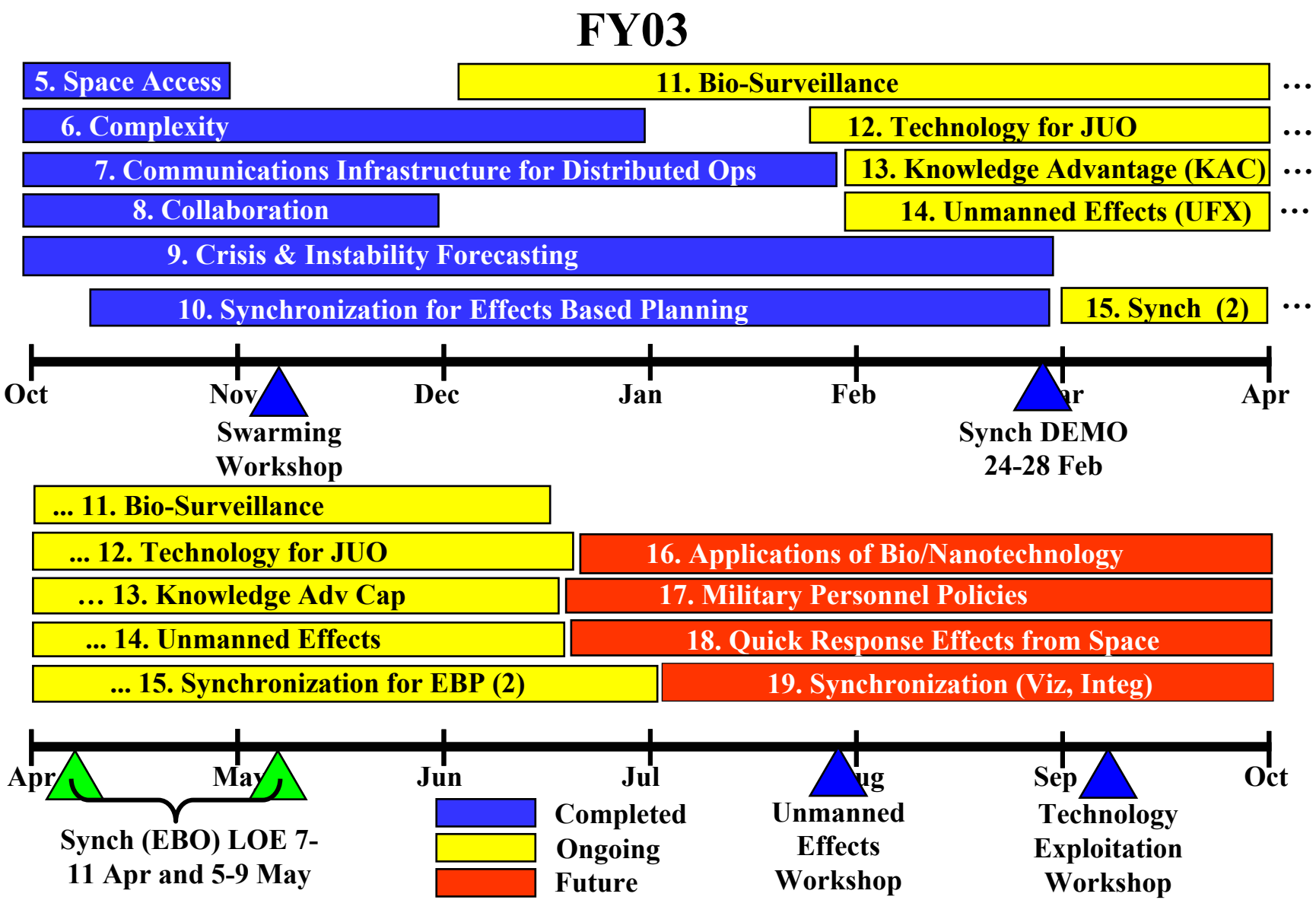
- **Of necessity (due to time and resource constraints) the assessments will not be as rigorous as those for CD&E**
- **Our objective is to put together a case supporting the idea that is compelling enough to convince others to consider the idea**
  - **We are not trying to prove anything; just whet the appetites of potential users, stakeholders or decision makers**
- **Types of assessments (examples discussed later):**
  - **Live field experiment**
  - **Constructive / virtual simulation**
  - **Analysis / optimization**
  - **Workshops**
  - **Endorsements from people with clout**
  - **Data mining / research the literature; put together a case based on work others have already done**

Project Alpha Role in Support of Pathways

Project Alpha contributes to both the Prototyping and the Concept Development Pathways



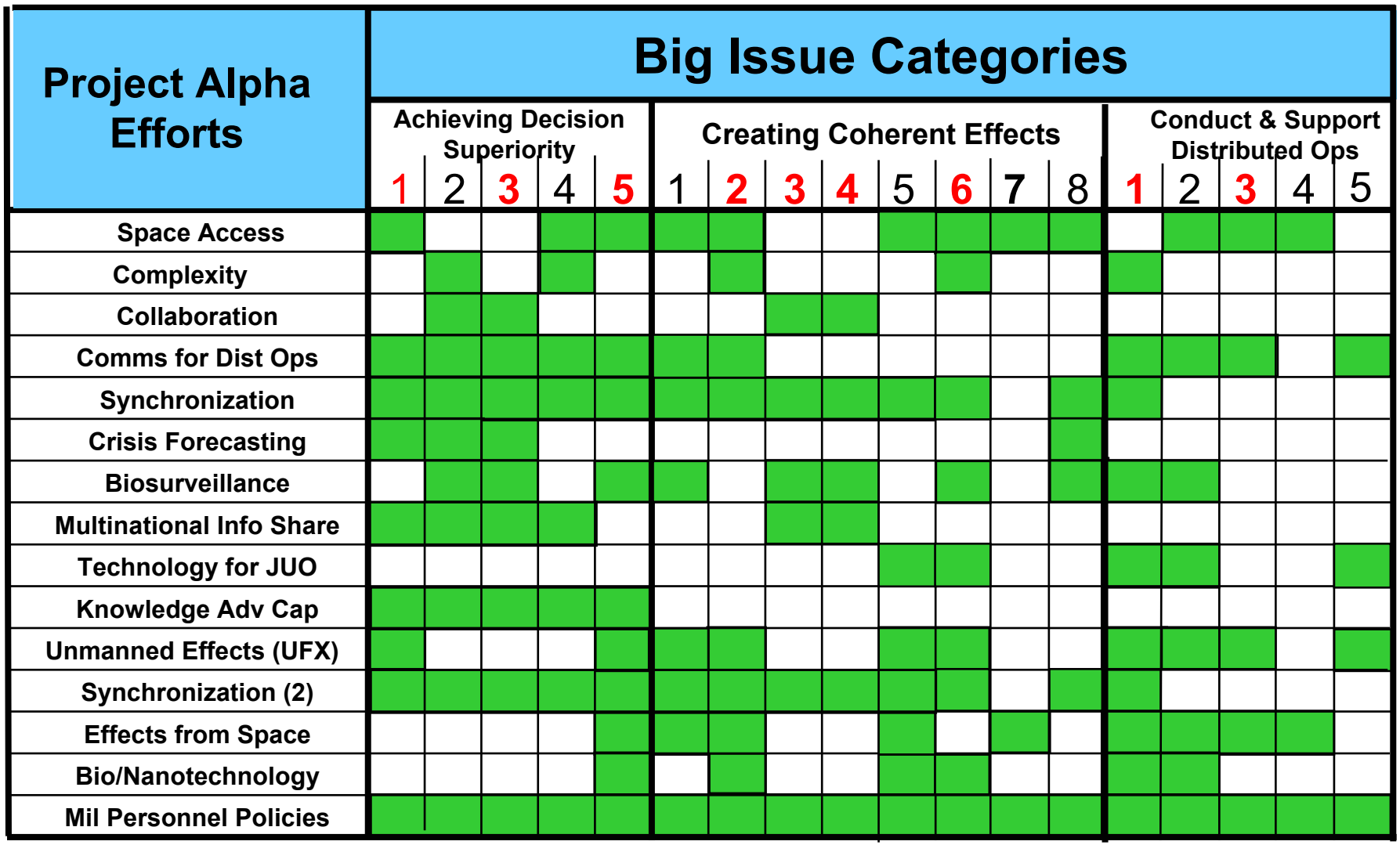
Project Alpha Schedule of FY03 Activities



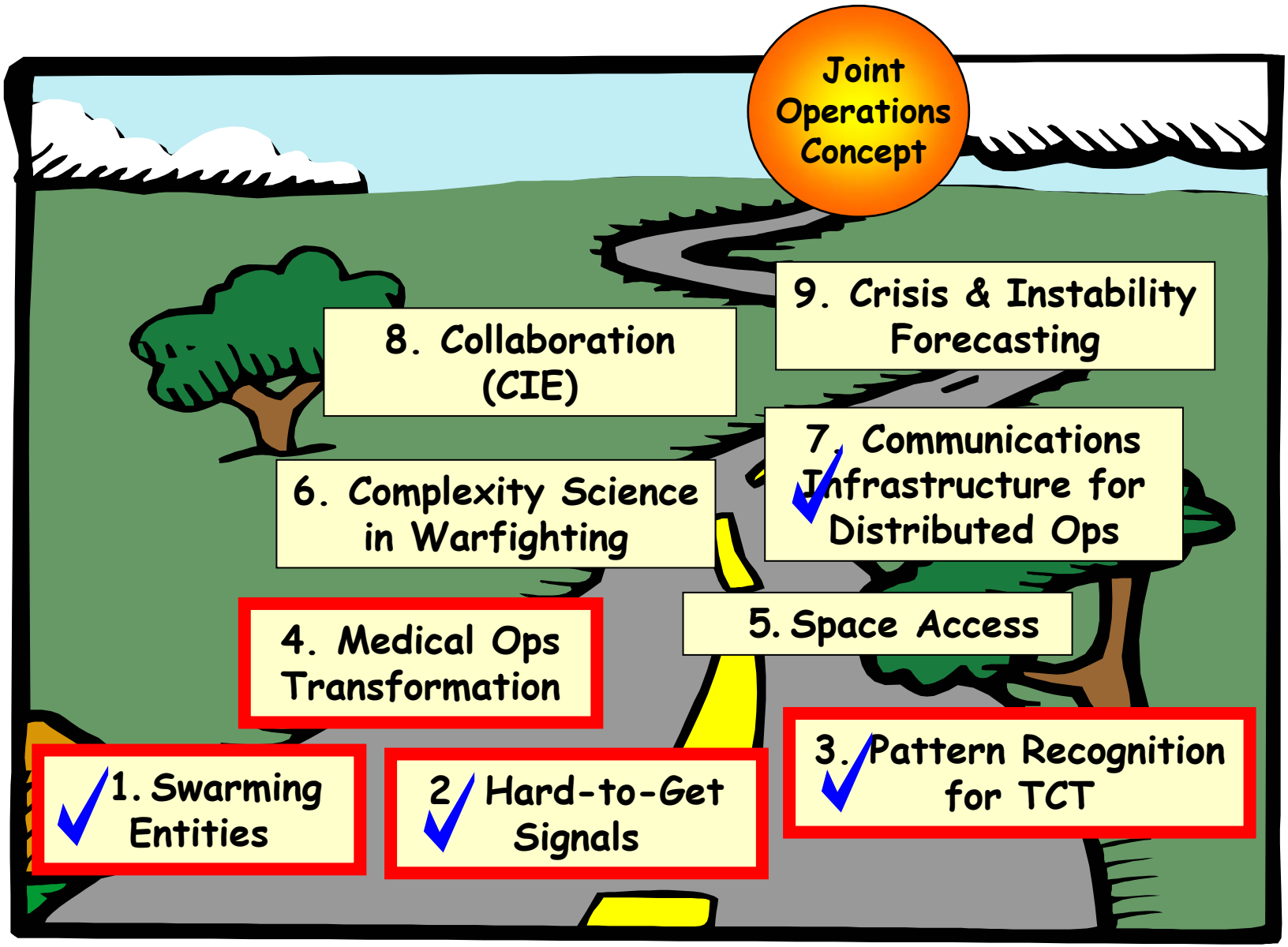
Big Issues (the right things to work)

Achieve Decision Superiority	Create Coherent Effects	Conduct & Support Distributed Ops
1. Achieve Info Superiority	1. Info Ops/Assure	1. Force Projection: Deploy/Employ/ Sustain
2. Decision Making in a CIE	2. Joint Maneuver and Strike	2. Force and Base Protection
3. Coalition & IA Info Sharing	3. Interagency Ops	3. Counter Anti-Access and Area Denial
4. Global Integrat'n	4. Multinational Ops	4. Low Density, High Demand Assets
5. Joint ISR	5. Precise Effects	5. Proper Decentralization
	6. Urban Ops	
	7. Deny Sanctuary	
	8. Transition Ops	
	9. ? Coercive Ops ?	

Support to Concept Development Pathway



Completed Exploration Activities



Compressive Receiver for Hard-to-Get Threats

Problem:

- Current (thru 2007) joint ISR capabilities have difficulty detecting, locating, and targeting threat emitters that are LPI/LPD. This includes future IADs and Coastal Defense Cruise Missile Systems
- Demonstrated in UV00 experiment exploring "Attack Operations against Critical Mobile Targets" concept; Blue forces did not fare well in a robust anti-access environment

Idea Description:

- Upgrade Rivet Joint (RJ) and other platforms with 4-GHz BW super wideband compressive receiver to enhance SEAD missions against short on-time emitters.
- Develop small payloads for near-in detection & geolocation of short-on-time and low-sidelobe emitters
- Integrate into networked ISR systems
- Improve air superiority and assured access

Method:

- Integrated compressive receiver technology into Rivet Joint as part of the Quickbolt ACTD
- Conducted live field test of the ability of the compressive receiver to detect, identify and locate threat emitters

Results:

- Excellent detection and identification of enemy emissions (100% accuracy)
- Testing was inadequate to address geolocation ability

Recommendations:

- ❑ DUSD AS&C allocate resources for further development of compressive receivers and support additional testing (geo-location) as part of Hairy Buffalo ACTD

Swarming Entities

Problem:

- When Blue forces with anticipated 2012 capabilities operated against a Red adversary with sophisticated IADS and double-digit SAMs; the Blue forces did not fare well in the robust anti-access environment
- In UV01, a constructive simulation, the loss exchange ratios were 2 Blue for every 1 Red.

Idea Description:

- Reduce Blue risk by using large numbers (50/100) of small affordable UAVs controlled autonomously by emulating the swarming behavior of bees and ants; human-on-the-loop vs HITL
- UAVs as sensors and UAVs as combination sensors and weapons (kamikaze-like); working in collaboration with each other as ants do using pheromones

Method:

- Partnered with Army SMDBL and Dr. Van Paranak of ERIM to model swarming behavior
- Designed constructive simulation (using EADTB) experiment to explore the contribution of the 'swarming UAVs' in the same scenario and force laydowns of UV01
- Calibrated EADTB to give the same results as UV01 in the 'baseline trials'

Results:

- Loss-exchange ratios improved approximately 10-fold from 1 to 2 to 5 to 1 (R/B)
- Swarming control algorithm provided excellent coverage of the area of interest

Recommendations:

- ❑ Extensive trade-space analysis and live demonstration of swarming UAVs
- ❑ Explore swarming apps to other unmanned entities (UUVs, UGVs, UCAVs, etc.)

Modeling Swarming UAVs

- **Ants have three types of 'pheromones' that they use to communicate with other ants: food, nest and threat (ants find minimal spanning tree path between nests and food sources over time)**
- **We modeled three types of 'digital pheromones' to control UAVs: target, density and threat**
- **'Density' signal prevents too many UAVs from congregating in same sector; when 3 UAVs are already in a sector a signal is sent saying "we got it covered"**
- **Sectors defined by HOSTs, emplaced on the battlefield**
- **UAVs communicate with HOSTs; HOSTs communicate with central command and control to call in other, more capable, sensors or weapon systems**

Pattern Recognition Agents for TCT

Problem:

- Human analysts have difficulty processing the massive amounts of sensor data that are being collected. They frequently fail to detect patterns in the data that suggest the locations of hide sites, reload facilities and forward operating bases
- Demonstrated in J9901 and AO00 experiment; poor prosecution of critical mobile targets (scuds and TELs)

Idea Description:

- Develop software algorithms that will process the sensor data looking for matches with known or anticipated movement and behavior patterns
- Pattern recognition agents (PRA) transform constant streams of battlespace data into useful information that will shorten target acquisition times and increase target prosecution

Method:

- Partnered with IDA to develop software agents that process radar data
- Constructive simulation. Ran data tapes from the J9901 simulation (JSAF and SLAMEM) through the PRA 'black box'
- PRA would signal when patterns were found that suggested the locations of hide sites, reload facilities and forward operating bases

Results:

- PRA predictions of TCT hidden locations were 73-98% correct (both types of errors)
- PRAs required little time to detect the patterns

Recommendations:

- ❑ Further refinement of PRAs to include different types of sensors and ID of targets
- ❑ Virtual simulation or live testing to determine contribution to prosecution of TCTs

Communications Infrastructure for Distributed Operations

Problem:

- Distributed operations is one of the "big three" areas for which J9 is focusing concept development activities.
- Vision of future joint operations that involve widely distributed, mobile forces, synchronizing activities, operating in a very rich collaborative information environment with a common relevant operational picture provided down to the tactical level.
- Heavy demands on the communications infrastructure. Can communications support this vision?

Idea Description:

- Distributed operations require comprehensive connectivity -- robust, adaptive communications in a hostile environment.
- A first-order analysis is necessary to understand the full implications of distributed operations on communications.
- Will today's capabilities suffice?

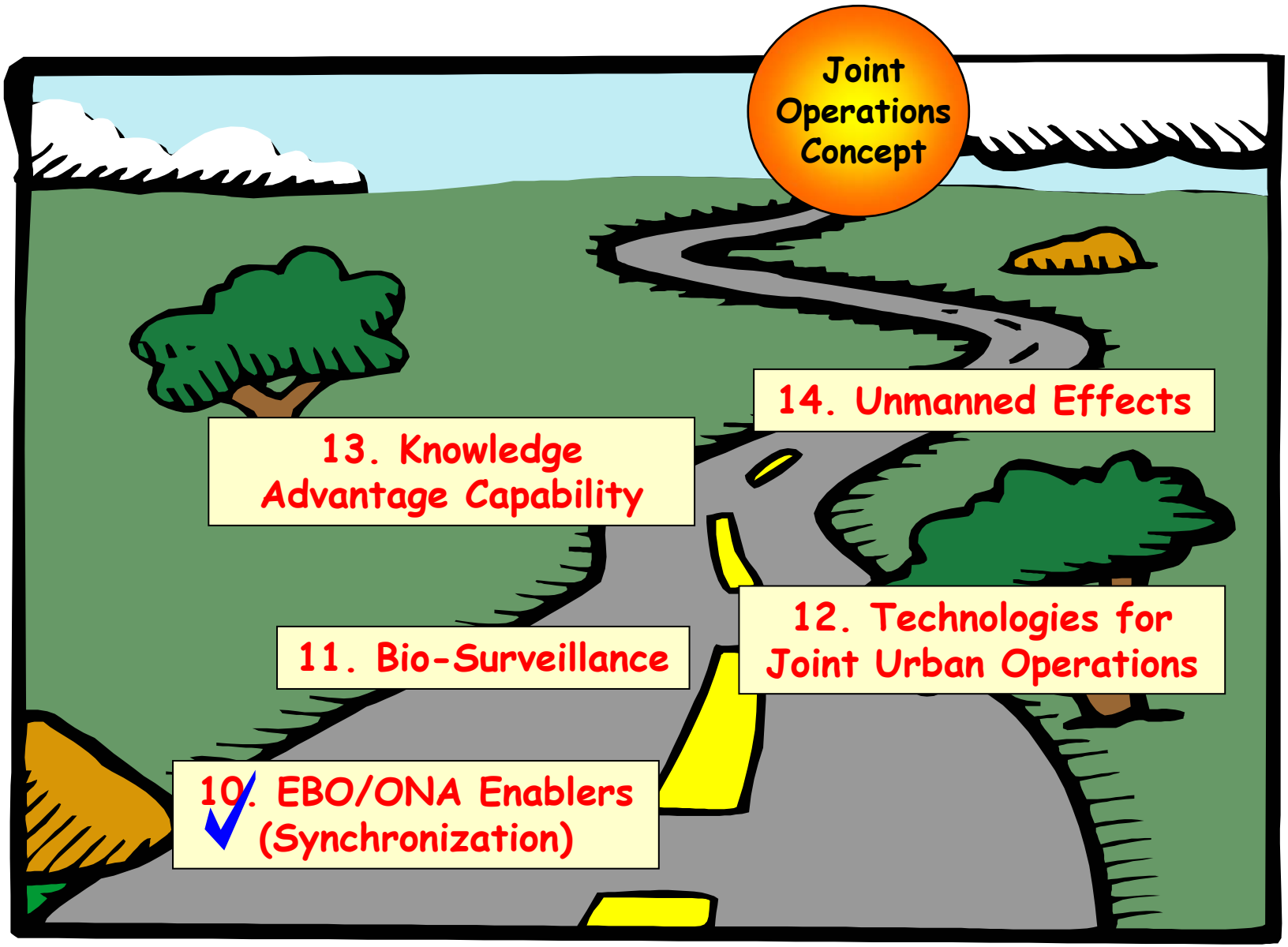
Method:

- Considered various scenarios and force configurations desired to help "size" the communications requirements. Settled on Stryker Brigade for ground forces.
- Linear Programming analysis focused on the fundamental issue of connectivity within and across subscriber clusters (units, cells, centers, and headquarters). Assumed robust, adaptive, mostly wireless, with dynamic mobile subscribers.

Results:

- Analysis considered frequency allocation, radiated power, battery life, and organizational lines of communications.
- Communications requirements cannot be met with today's capabilities, but they can be met if the future capabilities expected for the Joint Tactical Radio System (JTRS) and other programmed communications capabilities are realized.

On-Going Exploration Activities



Synchronization, Adaptation, Coordination and Assessment (SACA) Tool for EBO

Problem:

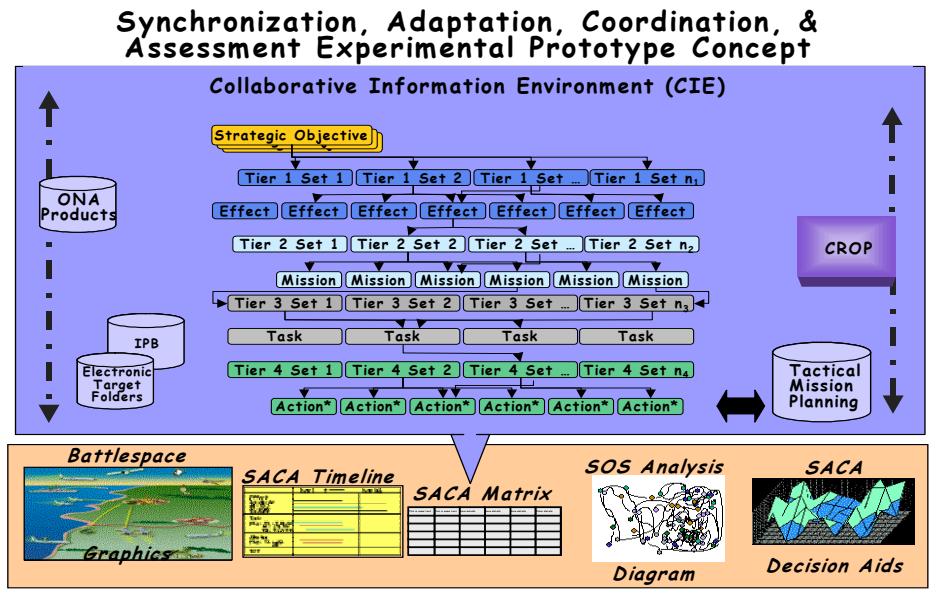
- The command and control concepts being developed by JEXP envision effects-based planning in a collaborative information environment (CIE) spanning multiple echelons and involving joint, coalition & IA
- Various experiments, including MC02, demonstrated the concepts are winners, but better decision support tools are needed to improve the ability to synchronize actions for coherent operations

Idea Description:

- Develop an exploratory synchronization, adaptation, coordination and assessment (SACA) decision support tool that solves a multiple objective, constrained optimization problem to generate COAs that are robust and that synchronize or harmonize military actions with the actions of multinational and interagency partners

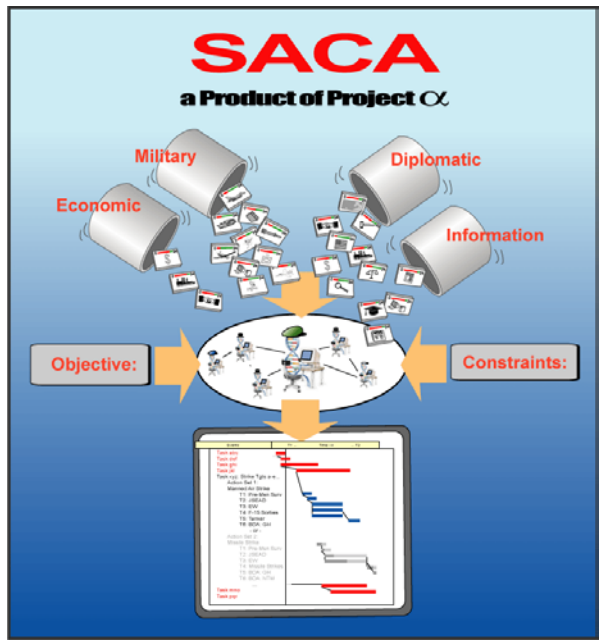
Method:

- Built a prototype tool for effects-based planning using genetic algorithm for 'optimization'
- Demonstrations/virtual simulation LOE. Provided the SACA tool to Blue Cell team that exercised the tool in developing COAs; effects-based planning in a CIE with ONA
- Army Research Lab scientists observed to suggest ways to improve visualization of plans



What Does SACA Do?

- **Key enabler for effects-based planning and assessment**
- **Frees humans for decision making; uses computer to track and manipulate data and do calculations – "TurboPlan"**
  - **Uses genetic algorithm to solve a constrained, multiple-objective, optimization problem to produce multiple synchronized COAs each of which is Pareto optimal***



* A solution to a multiple objective decision problem is ***Pareto optimal*** if the solution is feasible (meets all identified constraints) and is such that one objective can be improved only by making at least one of the other objectives worse.

What Does SACA Do? … continued

- **Produces robust COAs by favoring COAs with slack (enhanced adaptability)**
- **Synchronizer can hold "executing" activities constant, integrate modified activities, add new activities, and then rapidly (in seconds) resynch to produce adaptive options**
- **Leverages rich data across the CIE; uses integrated accounting tools to accumulate status; automates alerts**
- **Provides visualization of options and status**
- **Constraints considered: TPFDD, munitions, platforms, forces, ISR assets, weather, ongoing activities, rules of engagement, and objectives**

t Examples

Explore alternatives for reliable and affordable access to earth orbit. Options in[illegible] Vehicle, (2) [illegible] Gun,

Mostly examined human factors issues that are critical to the success of collaboration (trust, information sharing, reward system, culture, ROE, etc.)

Concept of a distributed functionally aligned dynamic system of analysis centers to provide knowledge advantage to Blue forces. National center to provide 'rolodex' functions.

Explore a largely robotic force integrated on the battlefield; controlled autonomously

- [illegible]riment
- [illegible]simulation
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- [illegible] Endorsement / data mining
- Space[illegible] Data mining
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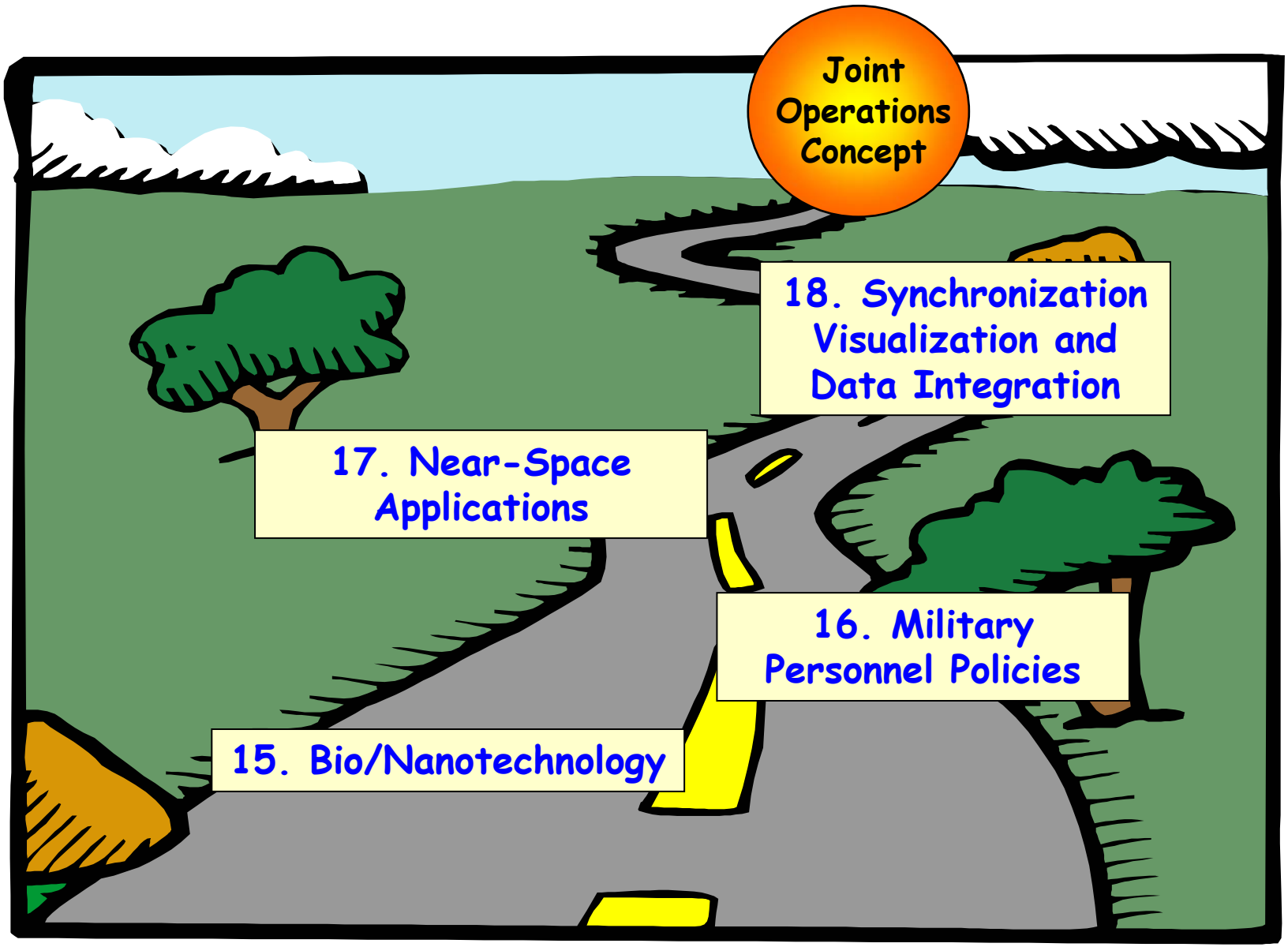
- [illegible]enetic algorithm / virtual simulation / [illegible]
- [illegible]ing -- Data mining
- [illegible]bility – Endorsement / data mining
- Biosu[illegible]ance – Data mining
- Unmanned Effects – Workshop / endorsement / data mining

Next Set of Exploration Activities



Candidate Future Focus Areas

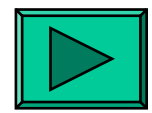
- **Combat ID; Friendly Fire**
- **Information Warfare System**
- **Anticipating Enemy Intentions**
- **Force Sustainability**
- **Force Conveyance**
- **Alternative Energy Sources**
- **M&S for Future Warfighting**
- **Enhanced Commander Situational Awareness**
- **Military Personnel Policies (PME, Training, etc.)**
- **Special Weapons (to include LCDW, non-lethal)**
- **Knowledge Management System for EBO**
- **Ecological Warfare**
- **Shaping the Battlespace for JUO**
- **Space Operations**

Project Alpha Engagement Activities

- Swarming Entities -- ASD(C3I), Navy UUV Program, APL, U. Michigan (ERIM)
- SACA Tools – DARPA, AF AC2ISRC, TEBO 'ACTD', Professional Societies (MORS, AIAA, CCRP), LANL, ARL, Army CECOM, Army BCBL, GTRI
- Unmanned Effects – DARPA, APL, GTRI, MIT, Carnegie Mellon, Army TRADOC, U. Michigan
- Knowledge Advantage Capability -- DARPA
- Bio-Surveillance – DTRA, APL, JFCOM Command Surgeon
- Technologies for JUO – IDA JAWP, JFCOM JUO, DARPA
- Crisis and Instability Forecasting – Army CAA, NDU
- SERA Engagement
  - National Labs: Oak Ridge, Los Alamos, Sandia, Pacific Northwest
  - UARCs: Applied Physics Lab, Georgia Tech Research Inst.
  - Service Labs: Army Research Lab, AFRL, NRL

What Have We Learned?

- Our model (four people for four months -- discovery, innovation, assessment and reporting) is "about right"
- There are lots of good ideas out there; getting them to first base is often the most difficult step
- The more successful we are, the more difficult it is for Project Alpha to "disengage" – the engagement process is an important part of our job; our work is not completed with the publication of our RAP report!
- Reaching out to other organizations (especially to acquire scientific expertise) is the right thing to do



- Engaging/partnering with potential stakeholders and users early (before RAP is written) is a good idea
- It is important that we balance efforts between "low-hanging fruit", good ideas for evolutionary changes and make a few "big bets" with potential for revolutionary change

How Well are We Doing?

- **Progress:**
  - **15 Focus Areas Started**
  - **9 RAPs Completed**
  - **SACA Demos and LOE**
- **External Impact Achieved with Focus Areas**
  - **Hard-to-Get Signals -- Hairy Buffalo ACTD**
  - **Pattern Recognition -- AF TCT Toolkit; STRATCOM**
  - **Swarming -- ASD(C3I) (Swarming W/S, Funding to DSC and APL)**
  - **Space Access -- NSSA Roadmap**
  - **SACA Tools -- SJFHQ, ONA, EBO, CIE, TEBO ACTD**
  - **Unmanned Effects -- DARPA**
- **Working the Right Things**
  - **Significant relevance to 3 "Big Issues" and the 18 subissues**
  - **Address 100% of issues/subissues**
  - **Influencing several concepts (ONA, EBO, JISR, CIE, IAC, MN Ops, Log CROP, SJFHQ, Dist Ops)**
  - **Contributing to prototyping pathway**

"Look and you will find it - what is unsought will go undetected."

- Sophocles

Questions?

"The real voyage of discovery consists not in seeking new landscapes but in seeing with new eyes."

- Marcel Proust

Partnership Activities -- Focus Area View

- Swarming -- ASD(C3I), NRL, Navy UUV, APL, AFRL, Sandia, Univ of Michigan (ERIM)
- Pattern Recognition for TCT -- IDA
- Hard-to-Get Signals -- Aerospace, OSD(AC&S), Hairy Buffalo ACTD
- Space Access -- APL, NRO, NSSA, Spacecom
- Medical Ops Transformation -- JFCOM Command Surgeon, DTRA
- Collaboration -- ARL
- Communications Infrastructure for Distributed Ops -- GTRI, APL
- Technologies for JUO -- IDA JAWP, USMC, SOCOM
- Biosurveillance -- APL, DTRA, JFCOM Command Surgeon; Battelle
- Synchronization for EBO -- LANL
- Crisis and Instability Forecasting -- Center for Army Analysis; NDU
- Unmanned Effects -- APL

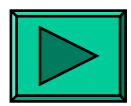
SERA: Partnering for Success

Leverage the Best Scientists America has to Offer!

* Science and Engineering Research Affiliates

SERA Program Affiliates

University Affiliated Research Centers	Military Services	Department of Energy
Defense Advanced Research Projects Agency (DARPA)	*Air Force Research Laboratory*	*Oak Ridge National Lab*
Georgia Tech Research Institute	*Army Research Laboratory*	*Sandia National Laboratory*
Johns Hopkins University Applied Physics Laboratory	*Naval Research Laboratory*	*Los Alamos National Laboratory*
Applied Research Laboratory Pennsylvania State		*Lawrence Livermore National Laboratory*
MIT Institute for Soldier Nanotechnologies		*Lawrence Berkeley National Laboratory*
Applied Research Laboratories; U. Texas		*Argonne National Laboratory*
USC Institute for Creative Technologies		*Ames National Laboratory*
Space Dynamics Laboratory Utah State University		*Pacific Northwest National Laboratory*
Applied Physics Laboratory University of Washington		*Brookhaven National Lab*



Partnership Activities

- **Dept of the Army – CAA: Partnering to enable ONA with CAA developed Crisis and Instability Forecasting Tool**
- **Marine Corps Concept Developments: Information agreement to provide AO as associate member; exchange ideas with MC Future Concepts Team**
- **Defense Threat Reduction Agency (DTRA) (Biosurveillance)**
- **IDA (Tech Exploitation Workshop) and IDA JAWP (JUO)**
- **SOCOM Future Concepts Working Group: Share ideas and focus areas**
- **DARPA: Project Alpha lead for establishing working relationship between J9 concepts and DARPA; Project Alpha liaison at DARPA**
- **JFCOM: Interest and involvement by JI&I, Legal Office, Command Surgeon, JBC, Science Advisor**
- **Science and Engineering Research Affiliates: Involving the nation's best scientists in each Project Alpha Discovery and Innovation cycle**
  - **National Labs, UARCs, Service Labs**
- **NRO Liaison Rep; National Space Systems Architect**
- **Industry (Boeing, Raytheon, Lockheed, General Dynamics, Northrup)**
- **Academia -- Naval PG School, U. Michigan, Johns Hopkins, Ga Tech**