Center for Strategy and Technology at Air University

We make a difference…

one idea at a time

Blue Horizons II

Academic Year 2008

Today's Vision – Tomorrow's Capabilities

Mission

- Research the strategic implications of emerging technologies on future warfare
- Educate senior officers on:
  - Impact of emerging technologies on USAF operational concepts and future strategy
  - Importance and structure of national and AF laboratory system
- Publish findings to influence joint thinking, investment

Air, Space and Cyber-minded futures research exploring the feedback loop between technology and strategy…to shape USAF investment

History

- Grew from Air Force 2025 studies in 1996
  - DARPA funded
  - AFOSR involved in AF Future Council Steering committee…dissolved about 1998
- Transitioned to standing technology study in 1998
  - Funded through AFRL
- Emphasis on strategy and technology shifted ahead of 2006 QDR
  - Today, HAF/A8 and AFRL funded

A flexible organization to support the USAF mission

Research

- Research conducted under “Blue Horizons” rubric
  - Elective course at AWC and ACSC
  - Mentor approx 49 students papers per year
  - Participation is voluntary and open to all but…
    - Invitations are targeted to specific students
    - Class size is limited and selective to ensure diversity
- Center provides funding and research guidance
  - Includes group orientation trips to labs; individual research trips to access experts across the country

Program targets students with promising career potential to match study requirements and maximize its out-year impact

Publications

- Publish annual study results and summary briefing
  - Publications target:
    - JCS
    - Headquarters, USAF
    - Labs/industry
    - Academic/scientific community
  - Briefing targets:
    - CSAF
    - Senior Air Staff Leaders
    - Labs
    - Futures conferences
- Publish 5-8 student occasional papers per year

Expand influence through targeted publication and briefings

Faculty

- Col John Geis, PhD – director (technology)
- Col (ret) Ted Hailes – deputy director (futures)
- Col Chris Kinnan (SAASS, Air Staff, space)
- Col Harry Foster (SAASS, Air Staff, AOC, fighter, bomber)
- Mr Larry Schoof (Sandia National Labs) – Chief Scientist
- Vacant– AFRL representative to Air University
- Leverage adjunct faculty from ACSC and Air War College, when required

Small faculty, mixed expertise

Blue Horizons (BH) II
2008 Final Report

We make a difference…

one idea at a time

Today's Vision – Tomorrow's Capabilities

Overview

- Premise of Study
- A-8 Tasking and Background
- Operational Analysis
- Summary of Underlying Technologies
- 2008 Findings and Conclusions

Premise

PROBLEM: Accelerating technological change interacting with a shifting strategic landscape is producing massive, dynamic change

EFFECT: Acts as a catalyst creating a ***very disturbing disruptive threat*** to the US and a serious challenge to the USAF's future dominance

Dynamic change is the coming norm…surprise is inevitable

The New Battlespace

All this to say future enemies will be ***motivated*** by resources, fear, and hate; ***empowered*** through education; and ***enabled*** through technology and globalization to directly challenge the US

The ***enemy*** will be different -- the targets they present will be more ***difficult*** to find, ***harder*** to hit, more widely ***distributed***, and more ***dangerous***

A-8 Tasking

Center for Strategy and Technology
Air University, Maxwell Air Force Base, Alabama

Today's Vision – Tomorrow's Capabilities

A8 Tasking for Blue Horizons II (2008)

Specified Task

"…develop a prioritized list of concepts and their key enabling technologies that the U.S. Air Force will need to maintain the dominant air, space and cyber forces in the future"

Implied Task: ***Determine how we can leverage a targeted investment today to position the USAF to address a broad set of possible challenges in 2030***

The Researchers

Student Participants

- Line Officers – top 12% of peer group
- Faculty selected for quality and diversity
- All volunteers – accepting higher workload for year

Student Preparation

Technology

- In-depth reading program
- TDY to AFRL (WPAFB & ABQ)
- 40 hrs class on Technology

Regional Studies

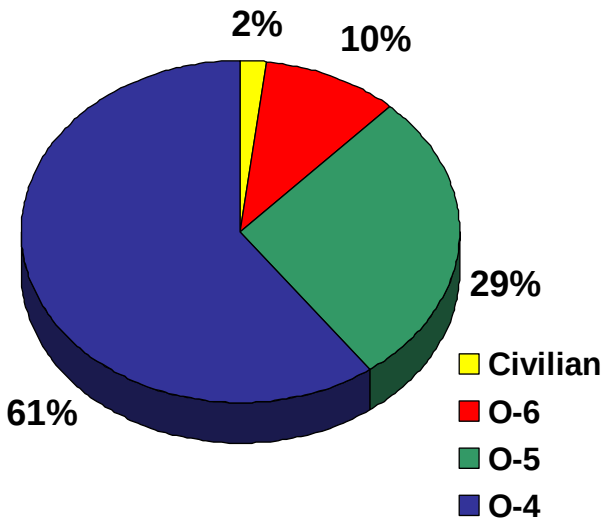
- 45 class hours on ISS
- TDY to CIA, DIA, State
- TDY to region (ex. Russia & China)

Research Methodology

- 4 alternate futures for 2030
  - Jihadist Insurgency
  - Failed State
  - Peer China
  - Resurgent Russia
- 58 AFRL, A8, AU future concepts
- Quantitative operations analysis of all 58 concepts conducted against all four alternative futures assisted by

The Researchers

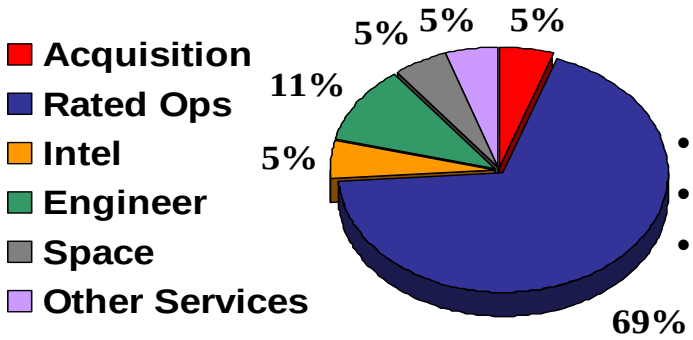
PARTICIPANTS



49 students & 7 faculty

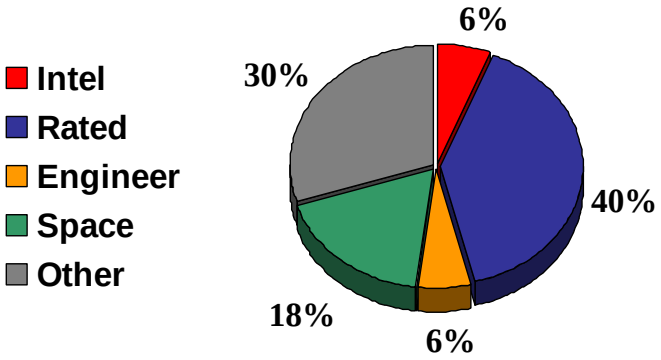
SERVICE EXPERIENCE

Air War College



Tasks:
- Alternate futures
- Operations analysis
- S&T analysis

Air Command and Staff College



Tasks:
- Futures Technology
- CONOPS
- Forecasts

…a blue-suit, operational view of future technology

Assumptions

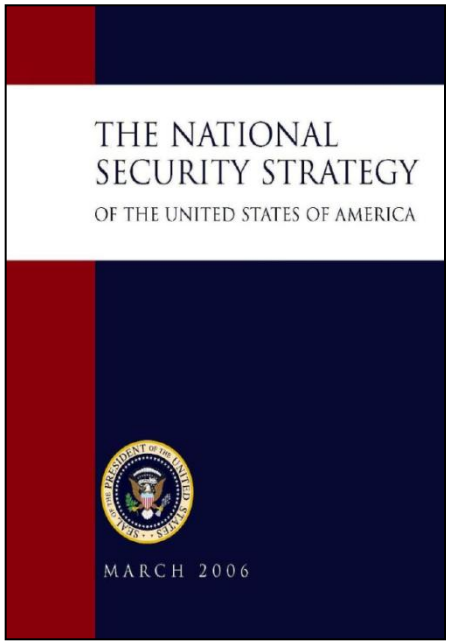
- Exponential S&T growth continues into the future
- Alternate futures provide the best tool to understand future challenges – provides:
  - Context for USAF 2030 – from peace enforcement to insurgency to peer conflict
  - Logical extrapolations based on extensive research but not intended to be predictive
- Air Force core missions remain in the domains of air, space, and cyberspace

Alternate futures provide a glimpse of likely stressors that could challenge US power

Study Limitations

- We do not specifically address new high explosives or nuclear weapons technology
- Nanotechnology, biotechnology and materials science may be under-represented
  - These technologies are scored in parts of the study
  - However, they may enable more concepts than is indicated in the AFRL data set used
- We will research these further in Blue Horizons III

2030 Alternate Futures:
Rooted in National and AF Guidance



"The United States must: Strengthen alliances to defeat global terrorism and work to prevent attacks against us and our friends…(and)…work with others to diffuse regional conflicts…"

Alternate Futures: Failed State and Jihadist Insurgency

"Our strategy seeks to encourage China to make the right choices for its people, while we hedge against other possibilities."

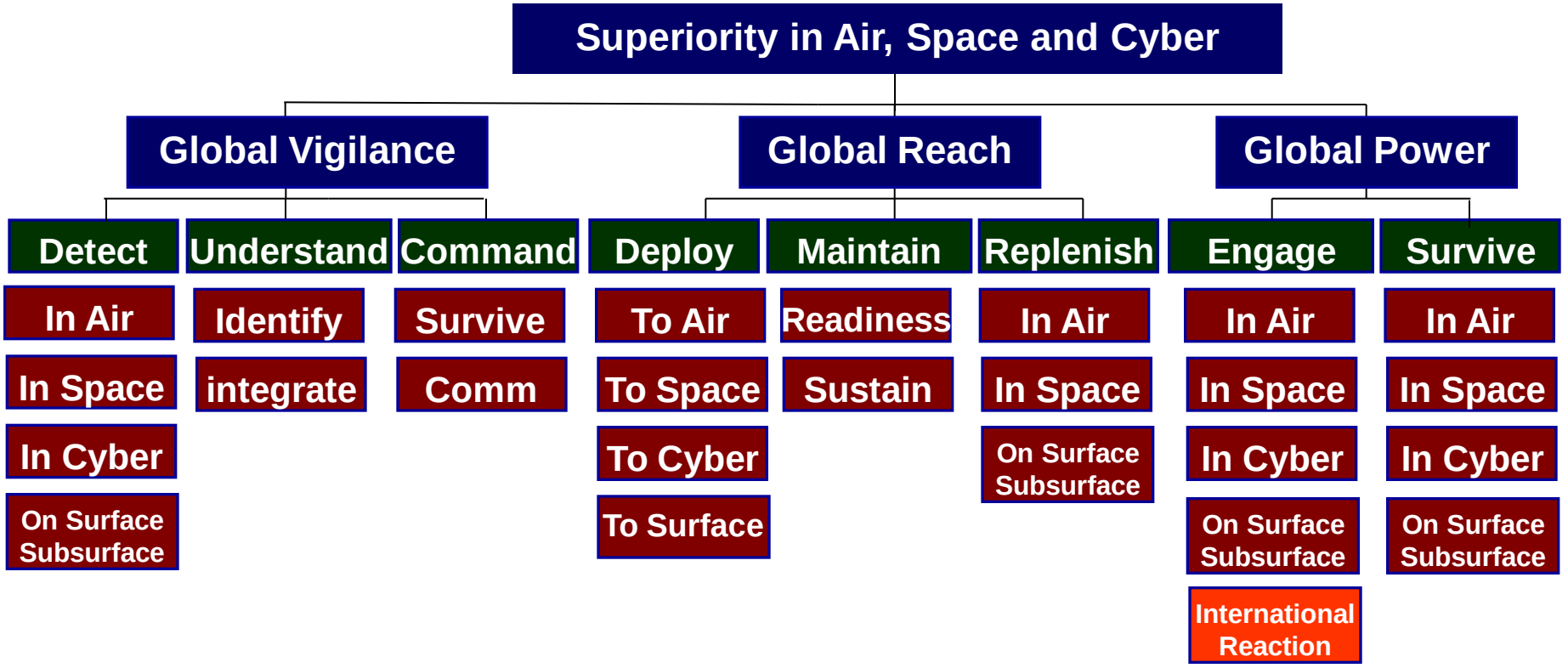
Alternate Future: Peer China

"Russia has great influence not only in Europe and its own immediate neighborhood, but also in many other regions of vital interest to us…(but) recent trends point to a diminishing commitment to democratic freedom and institutions."

Alternate Future: Resurgent Russia

BH 2030 Research Methodology Quantitative Analysis

- Model equation: $V(\mathbf{x}) = \sum_{i=1}^{n} w_i v_i(\mathbf{x}_i)$
- Concepts scored across all four alternate futures using the following value model:



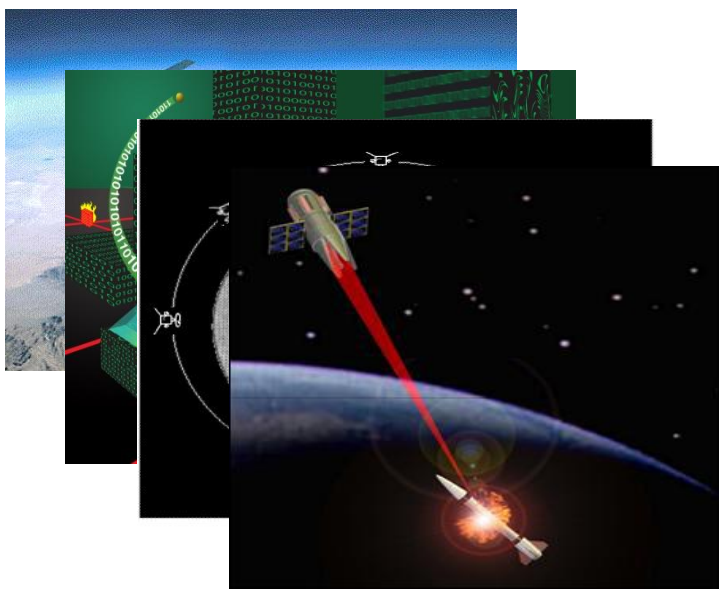
Blue Horizons
2008 Operational Analysis

Center for Strategy and Technology
Air University, Maxwell Air Force Base, Alabama

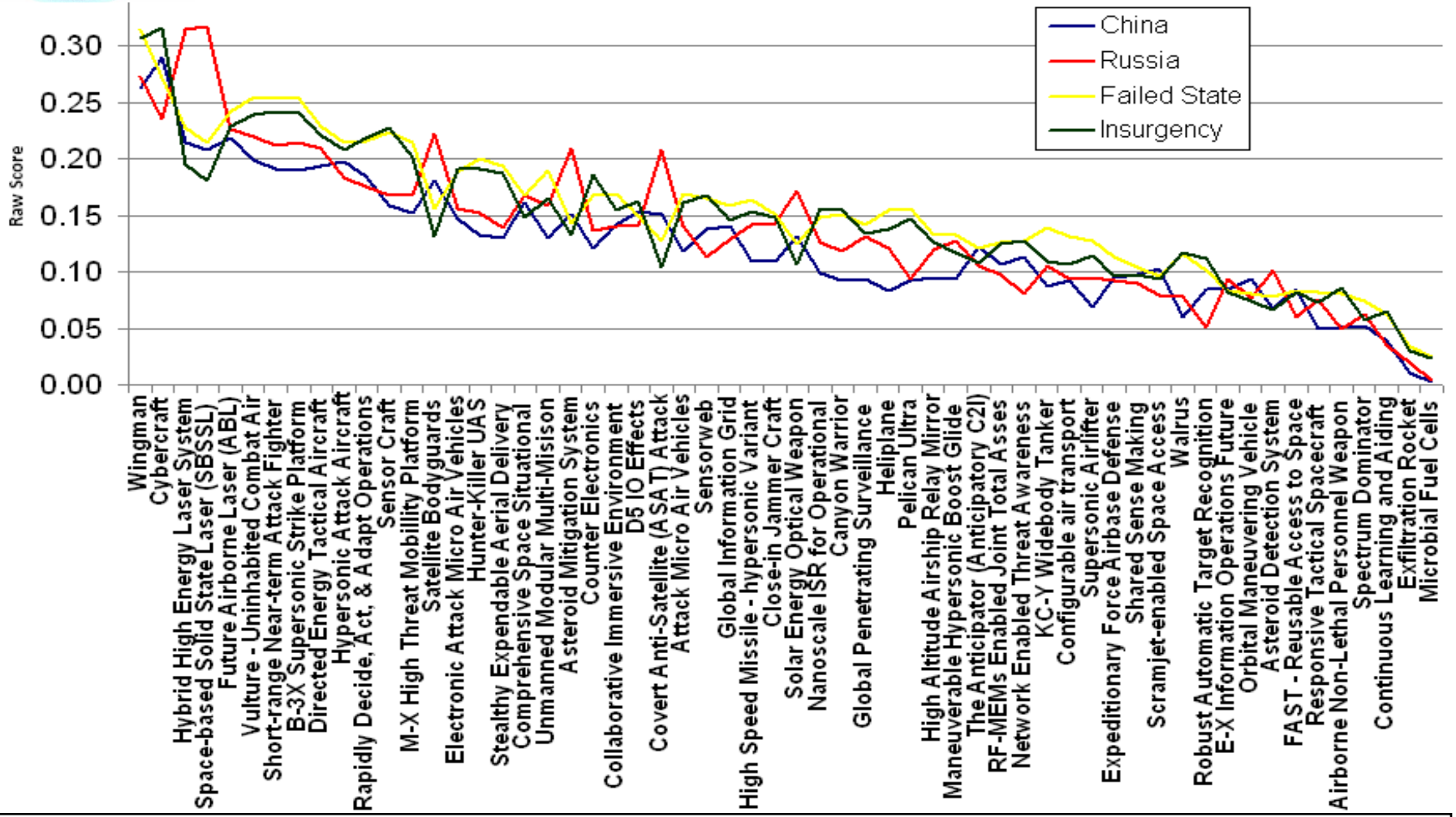
Today's Vision – Tomorrow's Capabilities

Summary of 58 Concepts

- Notional systems (in most cases) representing specific capabilities
- Some top concepts are worth exploring for production
- Concepts provide a vehicle for evaluating enabling technologies



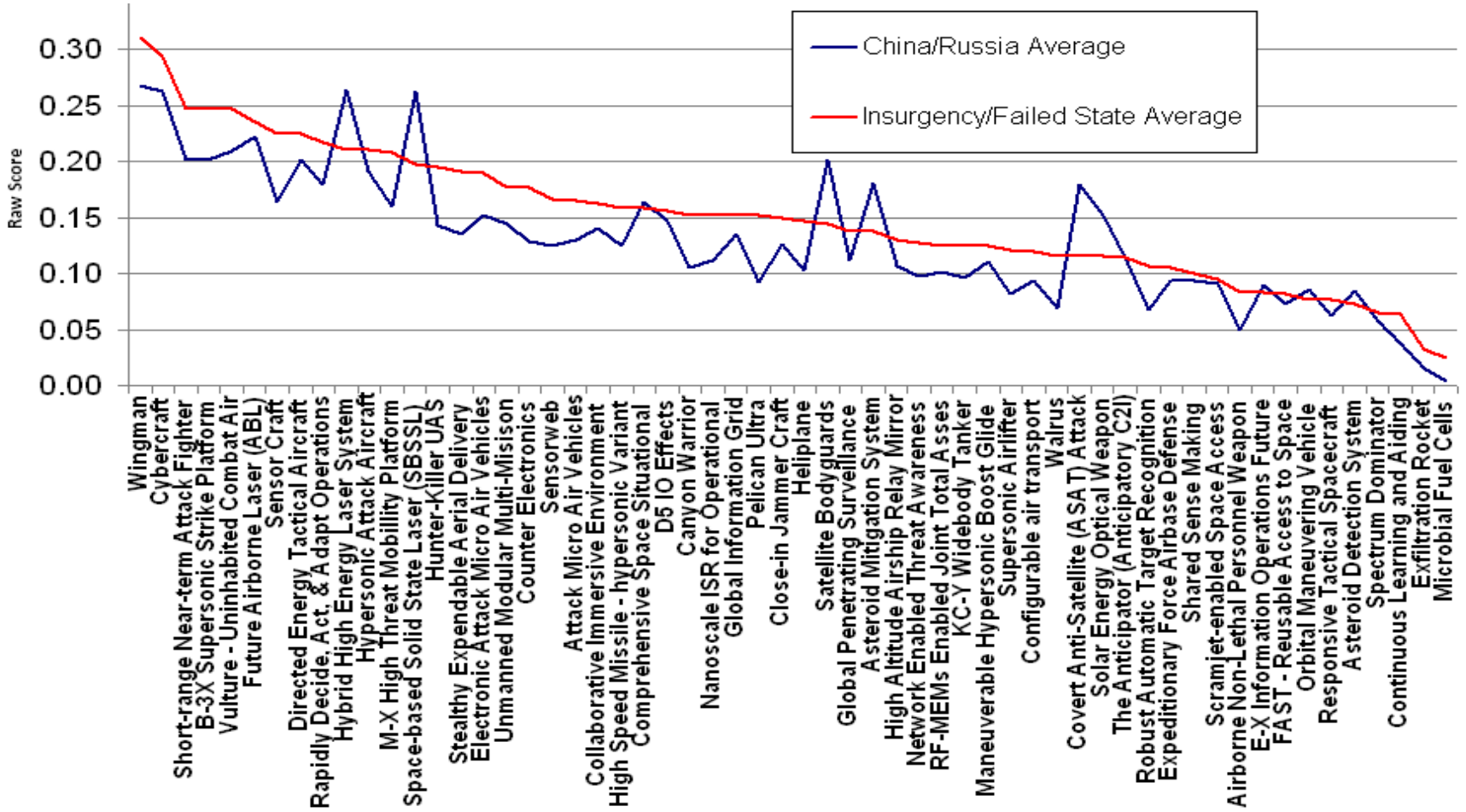
Rank Order of Concepts
Across All Alternate Futures



Ranking of key concepts is relatively constant across alternate futures

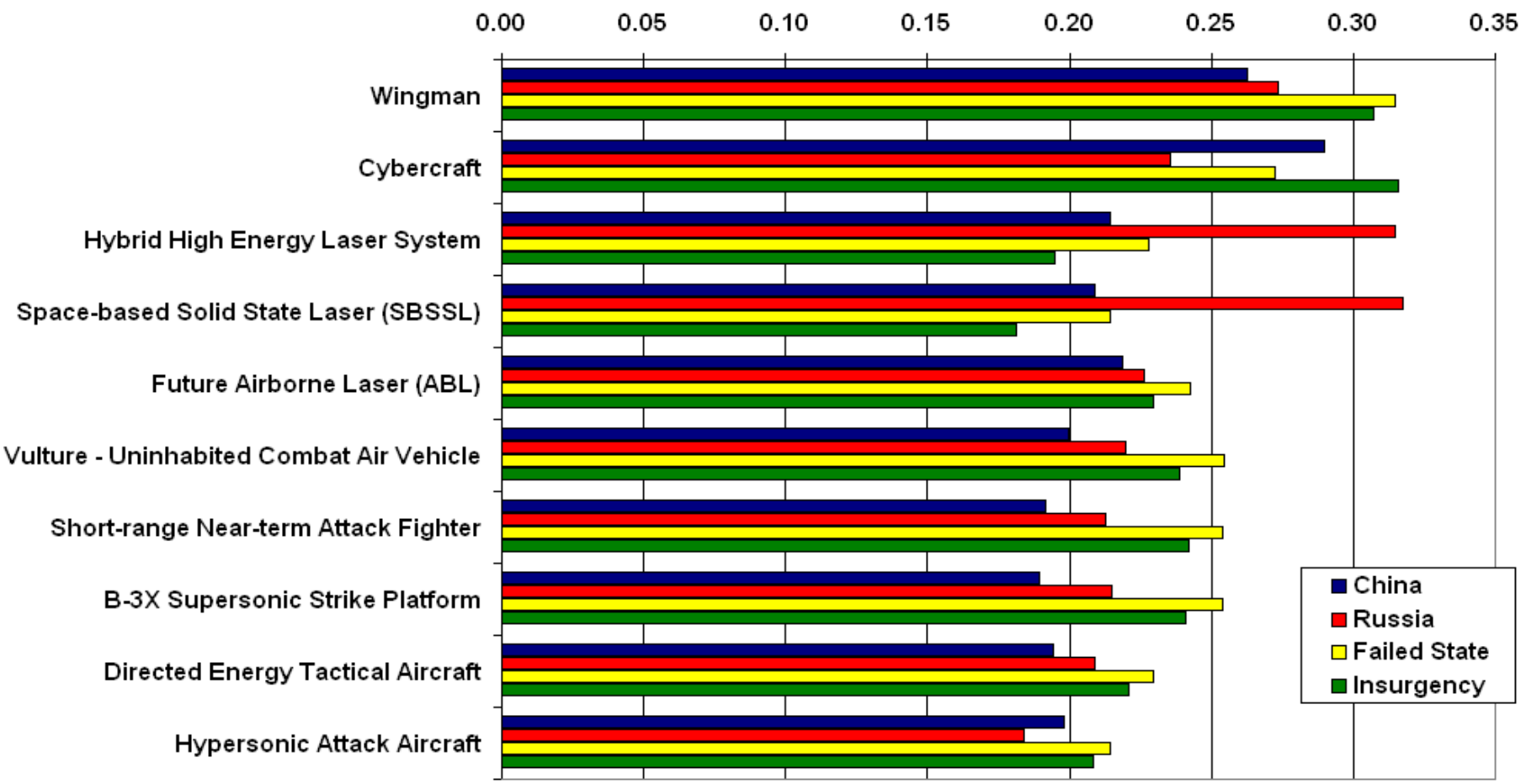
Rank Order of Concepts

China/Russia vs Insurgency/Failed State



Offensive Space Capability Differentiates Futures

Top 10 Concepts
Across All Alternate Futures



Top 10 Concepts encompass 83 of 172 Enabling Technologies

Top 10 Concepts
Across All Futures

Wingman

Cybercraft

Hybrid High Energy Laser System

Space-based Solid State Laser (SBSSL)

Future Airborne Laser (ABL)

Vulture - Uninhabited Combat Air Vehicle

Short-range Near-term Attack Fighter

B-3X Supersonic Strike Platform

Directed Energy Tactical Aircraft

Hypersonic Attack Aircraft

- *41 Enabling Technologies*
- *Integrated multi-spectral sensors for threat acquisition*
- *Flight systems incorporate self-diagnosis and repair*
- *Multiple technique jamming devices and arrays – arrays embedded in aircraft skin*
- *Able to control jamming swarms and coordinate other engagements through battle management system*

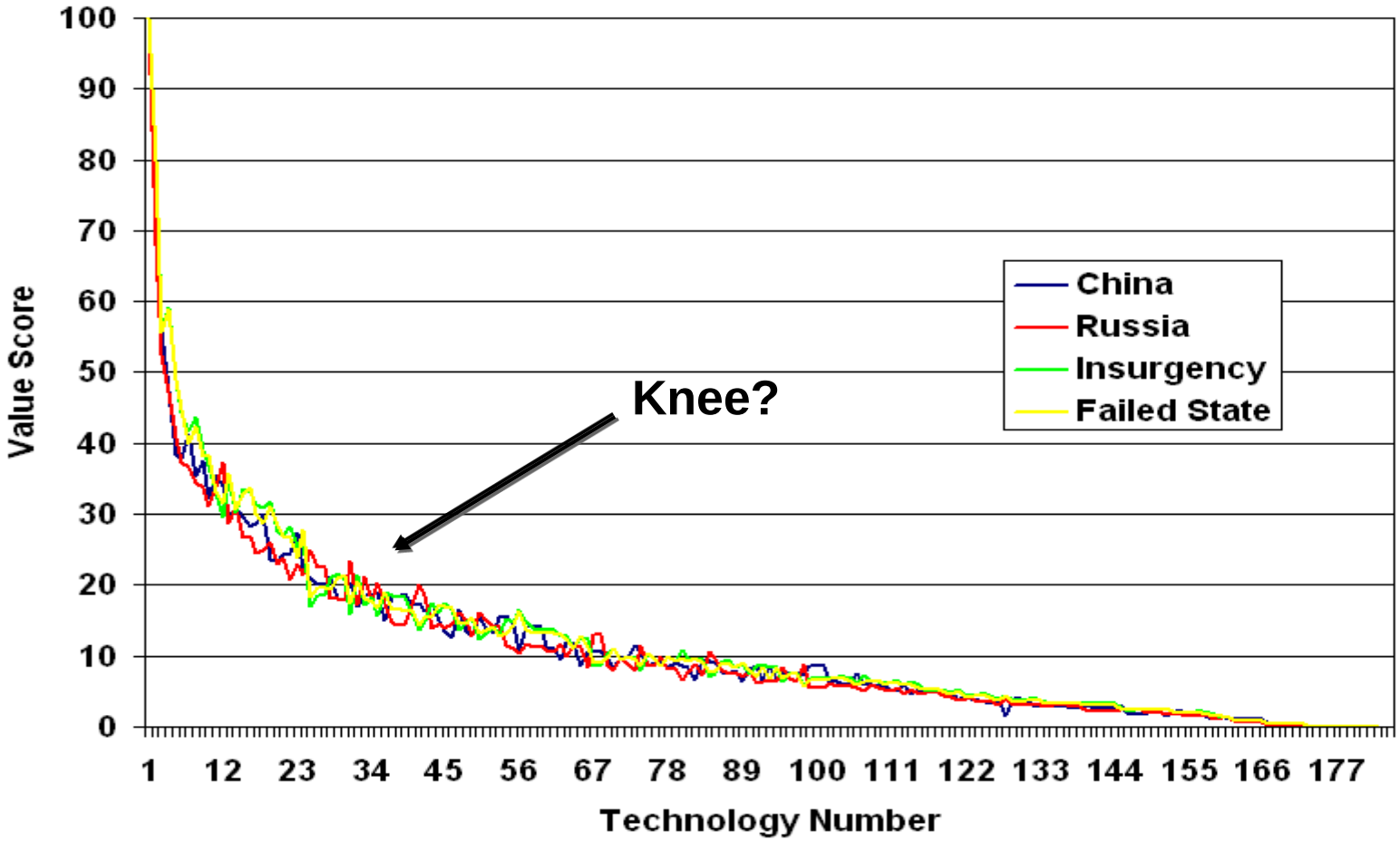
Blue Horizons Summary of Underlying Technologies

Center for Strategy and Technology
Air University, Maxwell Air Force Base, Alabama

Today's Vision – Tomorrow's Capabilities

Evaluating Technology Scores

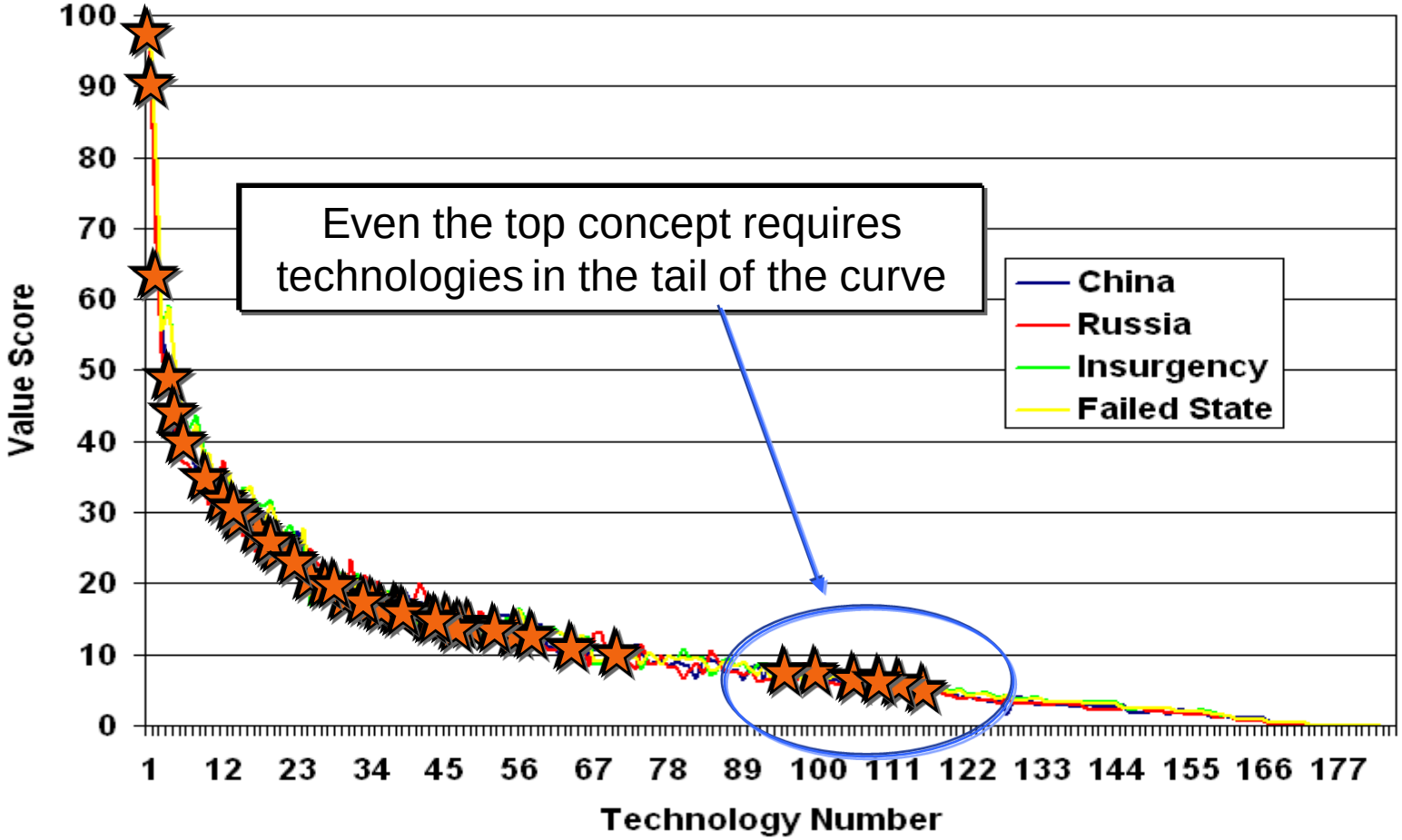
172 Technologies Across All Futures



While there appears to be a "knee" in the curve…

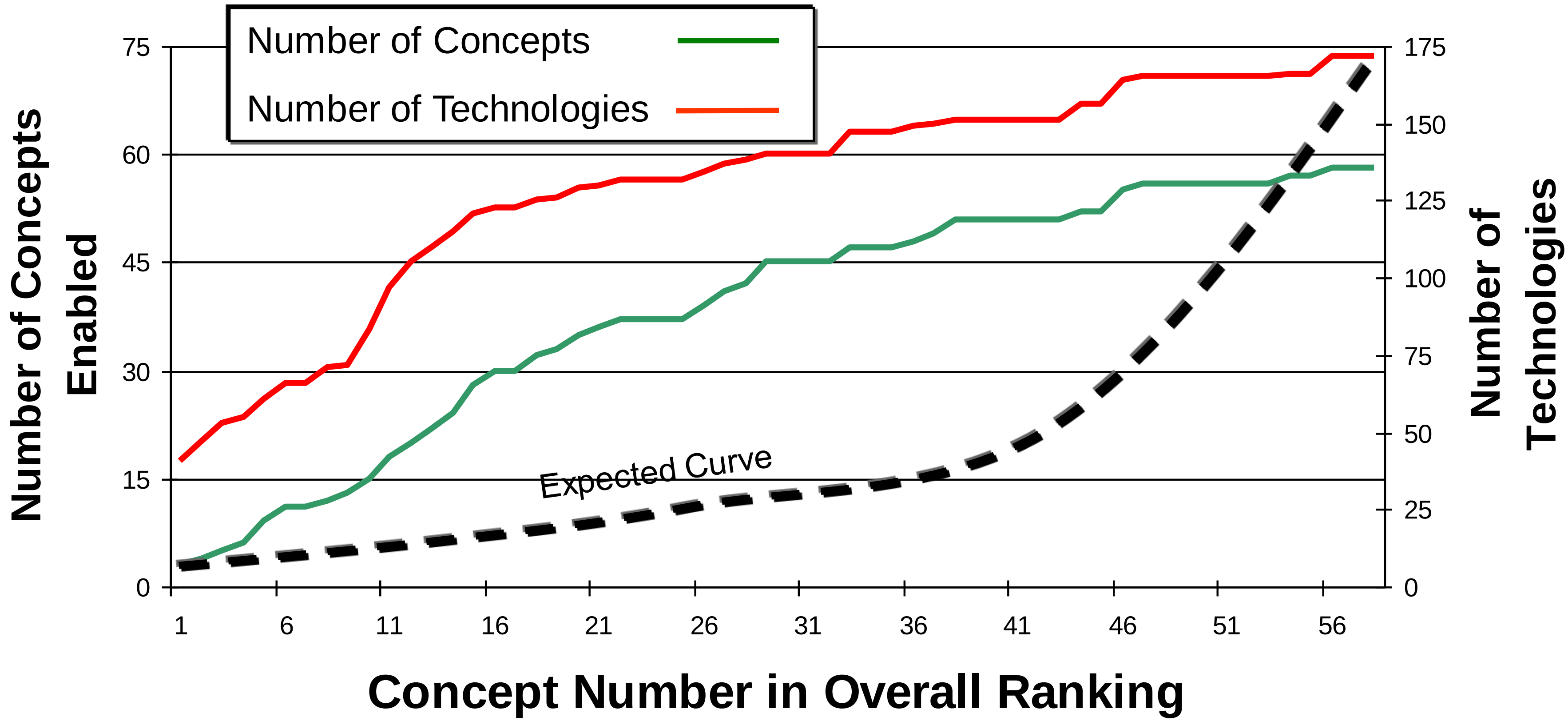
Evaluating Technology Scores

Wingman's 41 Enabling Technologies



57 of 58 Concepts Require Technologies in the Tail of the Curve

Number of Technologies and Concepts Enabled By Rank Order



Implied Task: ***Determine how we can leverage a targeted investment to address a broad set of possible challenges in 2030***

There is no silver bullet – the future requires a robust S&T investment strategy

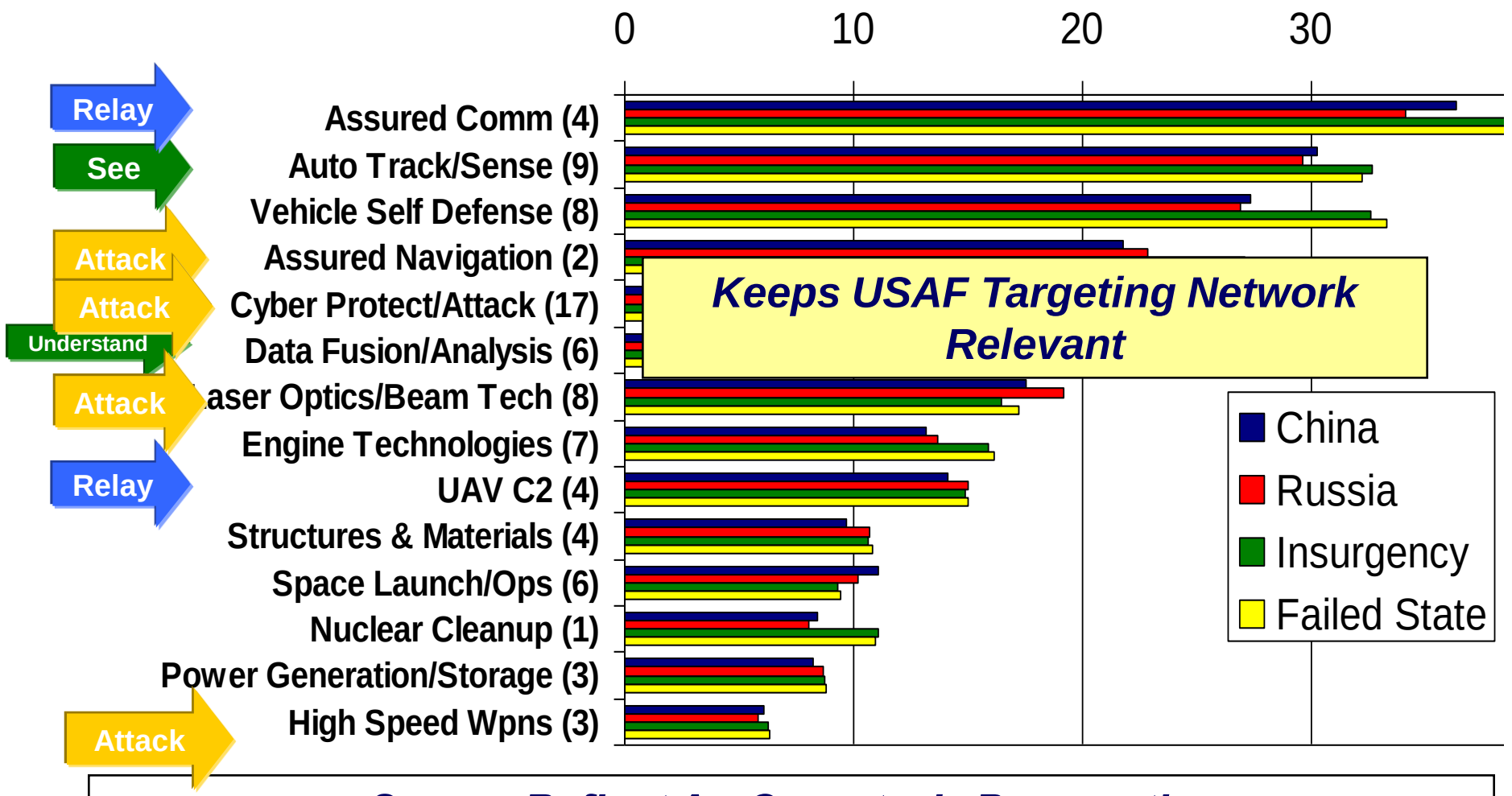
Top Technologies

Prioritized Technology Categories

Enabling Technology Category	# Technologies
Assured Communications	4
Auto Track/Sense	9
Vehicle Self Defense	8
Assured Navigation	12
Cyber Protect/Attack	17
Data Fusion/Analysis	6
Laser Optics/Beam Technologies	8
Engine Technologies	7
UAV C2	4
Structures & Materials	4
Space Launch/Ops/Forecast	6
Nuclear Cleanup (supports UAV)	1
Power Generation/Storage	3
High Speed Weapons	3

Top Technologies

Enabling Technology by Category

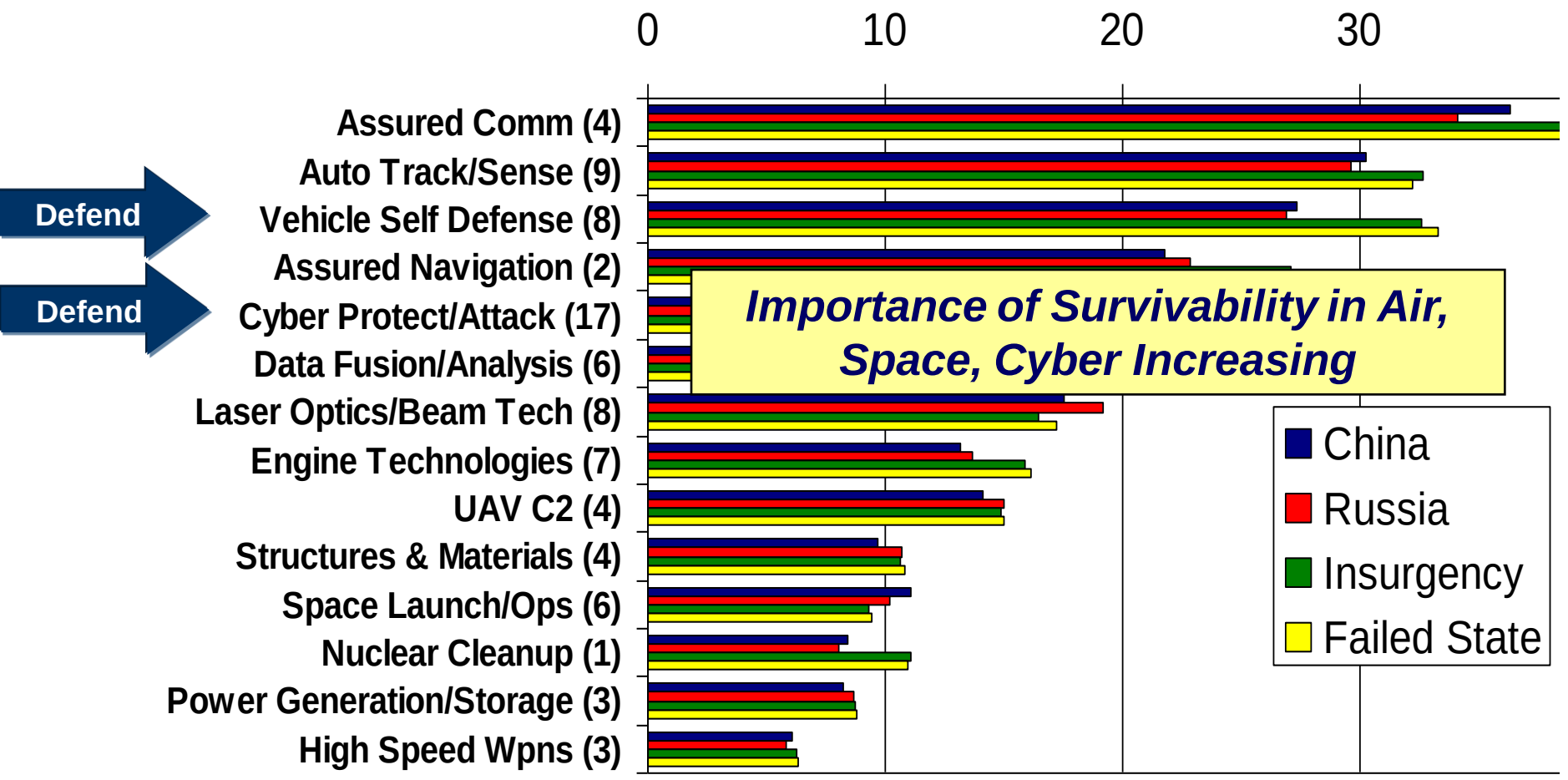


Scores Reflect An Operator's Perspective

Today's Vision – Tomorrow's Capabilities

Top Technologies

Enabling Technology by Category

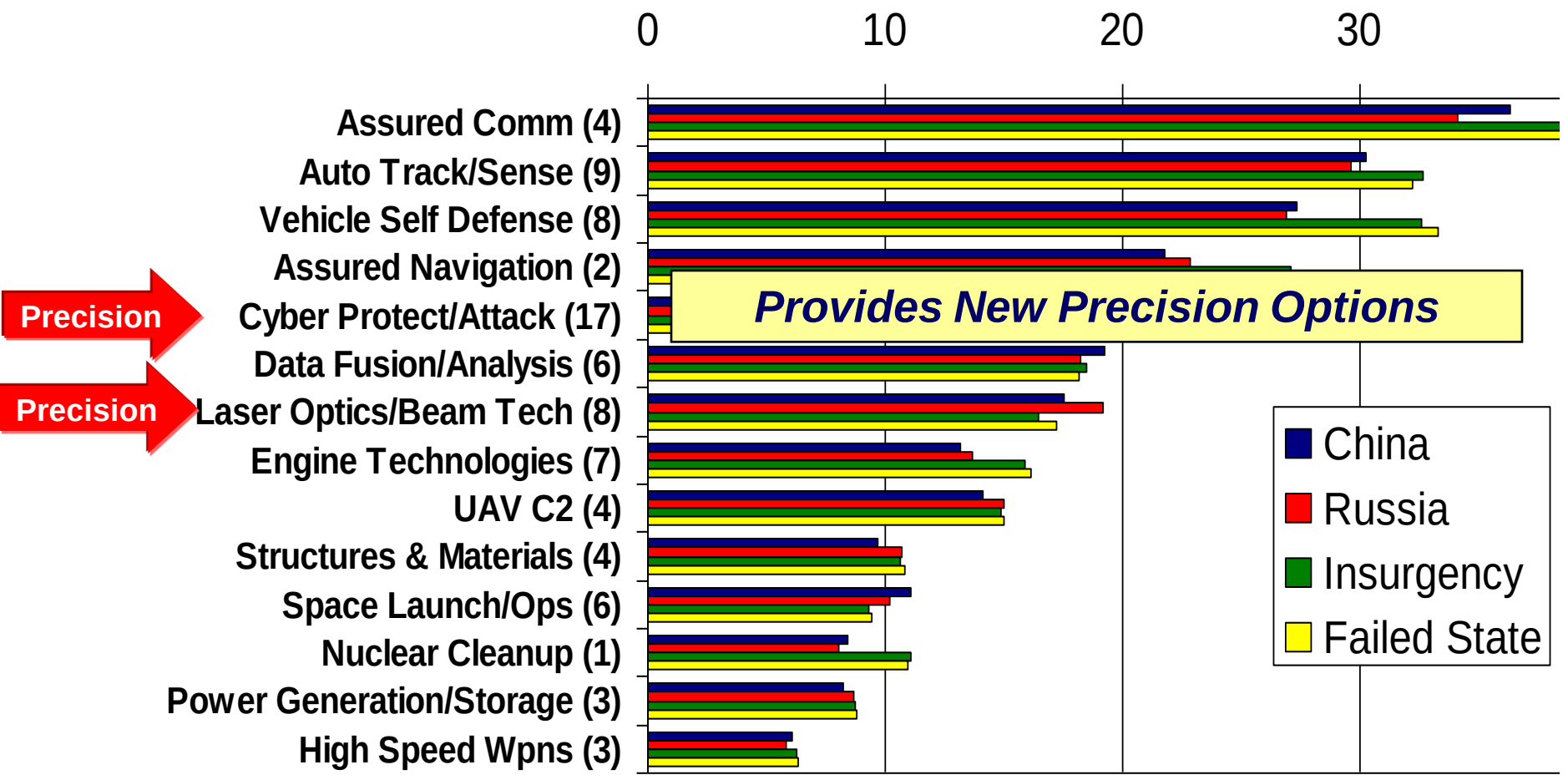


Scores Reflect An Operator's Perspective

Today's Vision – Tomorrow's Capabilities

Top Technologies

Enabling Technology by Category

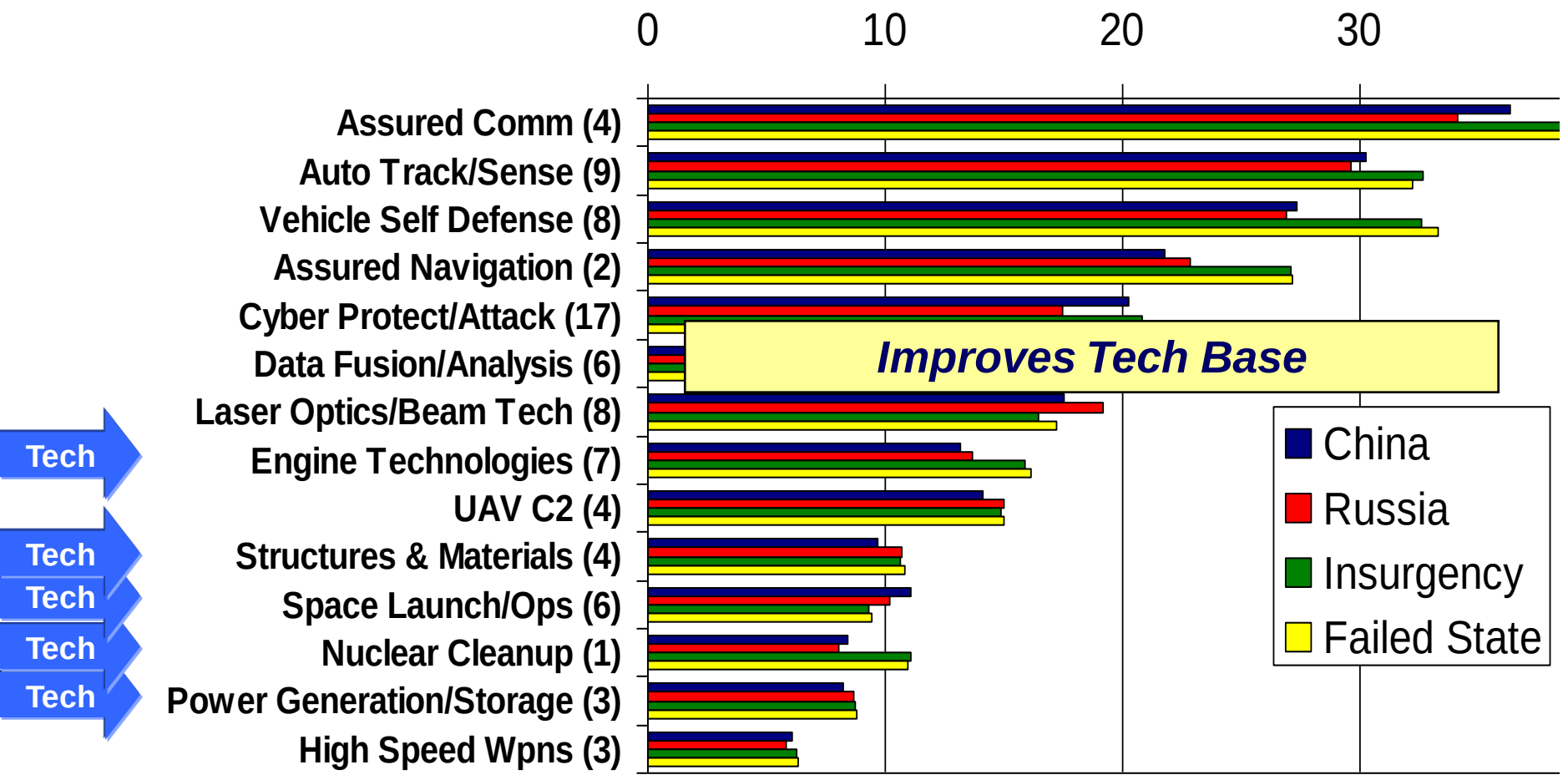


Scores Reflect An Operator's Perspective

Today's Vision – Tomorrow's Capabilities

Top Technologies

Enabling Technology by Category



Scores Reflect An Operator's Perspective

Today's Vision – Tomorrow's Capabilities

Additional 2008 Findings and Conclusions

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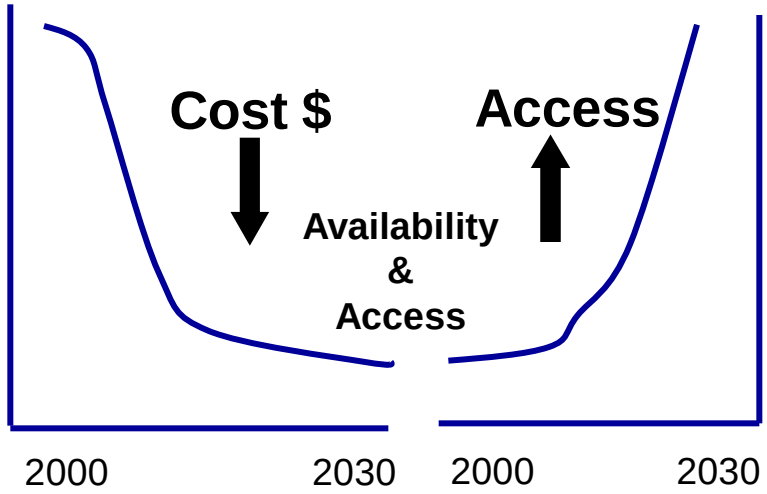
Air University, Maxwell Air Force Base, Alabama

Today's Vision – Tomorrow's Capabilities

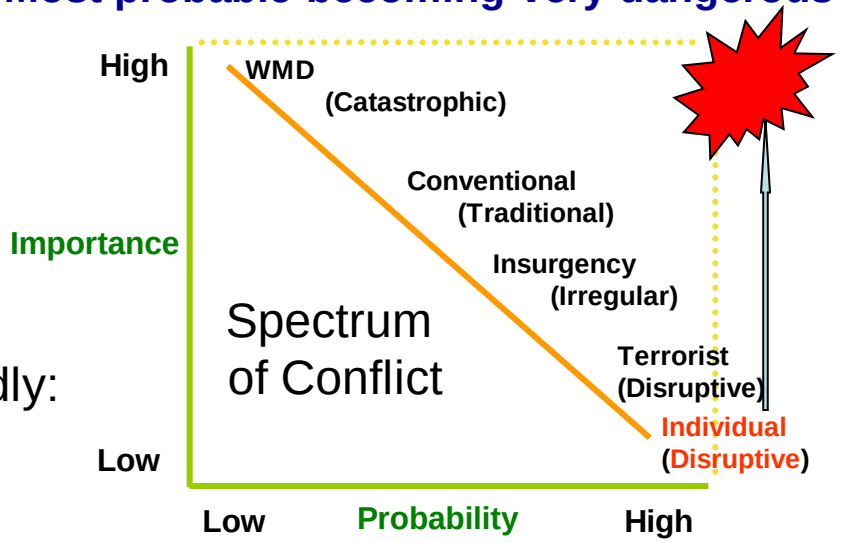
The Study Reveals

- Impact of exponential change in S&T
  - Individual accrues power of the state

Cost of tech decreases – availability increases



Most probable becoming very dangerous

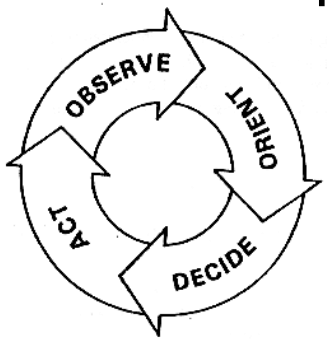


Bottom Line

- Strategic environment for S&T changing rapidly:
- Globalization levels playing field
- Reduced cost of access
- Empowered non-traditional actors

The Study Reveals

- "OODA-loop" shrinks toward an "OODA-point"
  - 2008 – Human commands throughout
  - 2030 – Machines will execute human intent at machine speeds.



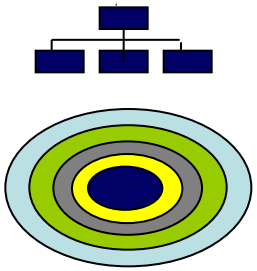
  - Human remains in the loop, but in new role
    - Will reigns supreme
    - Programs, builds, integrates, repairs, and analyzes
  - Time between observation and action in tactical engagements will be measured in fractions of seconds
  - Decisions, based on human intent, will be made by machines at machine speeds

Contest of Human Wills . . . Machine Controls Engagement

The Study Reveals

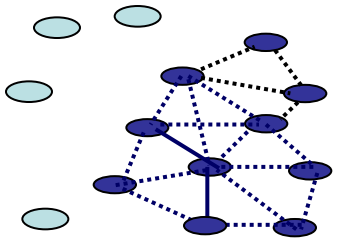
Old Targets

Hit the substation!



New Targets

Hit the black car?



- Targets more difficult to find:
  - Mobile
  - Distributed/Dispersed
  - Fleeting
  - Buried
  - Nested
  - Urban
- USAF must:
  - Find, attribute and respond
  - Strike quickly and precisely
  - Move beyond explosives
  - Kill what you need to and nothing else

The Study Reveals

- Increased role for unmanned systems
  - Five of top 10 systems are unmanned or CONUS-based
- Increased importance of the cyberspace domain
  - Need to be able to navigate, explore, defend, and attribute attack in this domain (e.g., Cybercraft)
- Increased need for rapid attack capability
  - Only one of top 10 systems attacks at speeds below Mach 1
- Increased need for survivability – threats proliferate
  - Many of top-ranked technologies are related to defense against directed energy (lasers and HPM) or cyberspace attacks
  - Defensive systems are critical to maintain freedom of action
  - Must be able to defend, reconstitute AND operate while degraded

The Study Reveals

- Rank ordering of concepts and technologies does NOT vary significantly between state-on-state and irregular warfare
  - Virtually identical results across all four alternate futures in:
    - Air and surface attack
    - Directed energy
    - Communications, cyberspace, and sensing
    - Attribution
    - Data fusion technologies
  - Offensive and defensive space systems and technologies are more crucial in state-on-state warfare than in other types of conflict

Surprise Results

Expected	Actual result
▪ A small list of key technologies would enable a large percentage of future concepts/systems	▪ Underlying technologies cross concept boundaries - ubiquitous
▪ Preferred systems and underlying technologies would vary with the type of warfare	▪ Capabilities required for major state-on-state conflict are mostly the same as those required for counter-insurgent and irregular warfare

Harsh Realities

- Bureaucracy and innovation are incompatible
  - Hierarchy needs to become a more net like structure

- "Bubba Einstein" will have disruptive power

- "OODA-Loop" shrinks toward an "OODA-Point"
  - Surprise is the norm
  - Decreases value of leaders gifted in crisis management; increases value of leaders who can anticipate crises and mitigate effect

- Classical military PME curricula does not prepare leaders for the worlds of 2030

- Recapitalization must include capabilities for the worlds of 2030

Study Recommendations

- Pursue concepts with increased range and persistence
- Increase UAV investments – 5 of top 10 concepts are UAVs
- Develop counters to directed energy – DE threatens all
- Increase emphasis on defensive capabilities because:
  - Technological proliferation is closing the capability gap between the US and its adversaries – individuals and states
  - Adversary systems threaten USAF freedom of action -- greatest impact is in cyber and space
- Improve speed and effectiveness of acquisition process
  - Old issue…but speed of technological development is accelerating
  - Near-action essential to keep pace with adversaries
- Treat cyberspace as a geographic territory in which wars will be fought

Study Recommendations

- Futures wargames need to incorporate super-empowered individuals whose access to disruptive technologies can ‘change the game’

- Invest S&T across a broad range of technologies
  - Each concept examined contains multiple technologies that span a myriad of different disciplines
  - Robust investment across all of them is the only way to hedge against an uncertain future and retain “sovereign options”
  - …But, some technologies will be developed by other governmental agencies and commercial enterprises
  - The AF needs to build networks to leverage these technological advances

Areas for Additional Research

- Nature of deterrence in a world with sub-state actors (groups and individuals)
- Building concepts to greater level of detail
  - Discerning 2nd and 3rd order effects on battlefield
- Nano and Bio-technologies
  - Sudden surge in research of these areas is not yet reflected in AFRL, A8, or AU concepts
- Alternative Energy Sources and Solutions
  - Microbial fuel cells scored 58th of 58 concepts, yet fuel costs are eating O&M budget AF-wide

The Road Ahead

- Executive Summary published this year; alternative futures monographs will be published as editing is concluded
- Blue Horizons III Study (2009) will address and envision future concepts
  - Study will work to expand depth of understanding and address threat environment of the four alternative futures
- Technology mapping to concepts will be re-examined
  - AFRL will assist. Cross-directorate efforts to be expanded
- Blue Horizons IV (2010) will address the implications of these technologies on deterrence

Questions?

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