

**Implications of Exponential Technological
Change on Air Force Strategy Through 2035**

Center for Strategy and Technology

Academic Year 09

We Produce the Future

Purpose

This briefing is not asking for money, proposing new systems or attacking the way things have been done to date . . .

It's sole purpose is to introduce a way of thinking about the future that will result in changing attitudes, priorities and expectations . . .



Center for Strategy & Technology

Air University

What we do

Assess strategic impact of rapidly accelerating technological change

Blue Horizons Program

A CSAF directed study on future strategy and technology to inform the debate on AF future thinking and investment



Sponsors

- A8
- AFRL

Researchers

- Air War College
- Air Command and Staff

Research Support

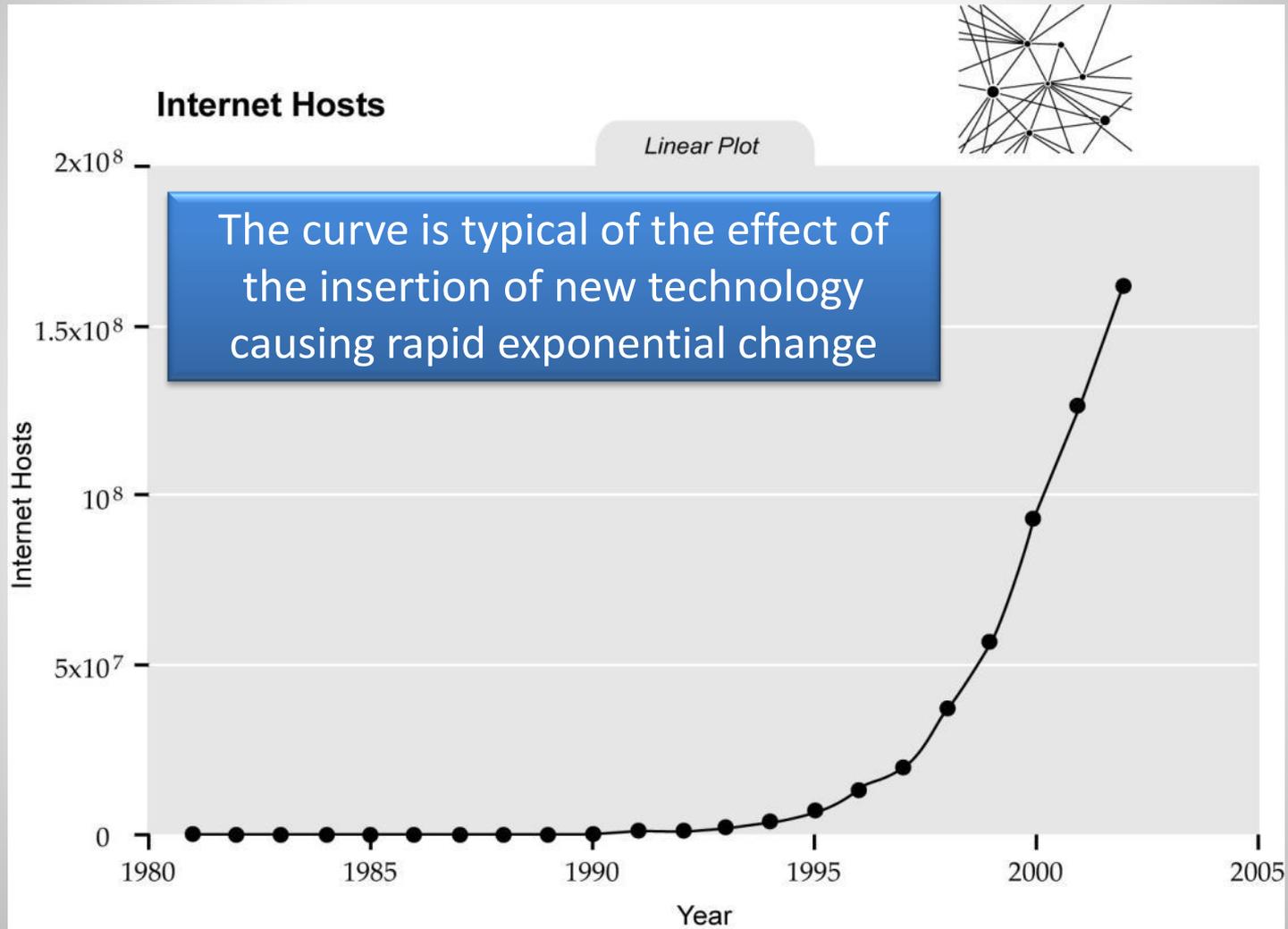
- AFRL
- Sandia National Lab
- Los Alamos National Lab



An introspective briefing ***built by Airmen for Airmen***



The J Curve and Rapid Exponential Change



Harsh Realities

Why the Air Staff squelches these kinds of briefings

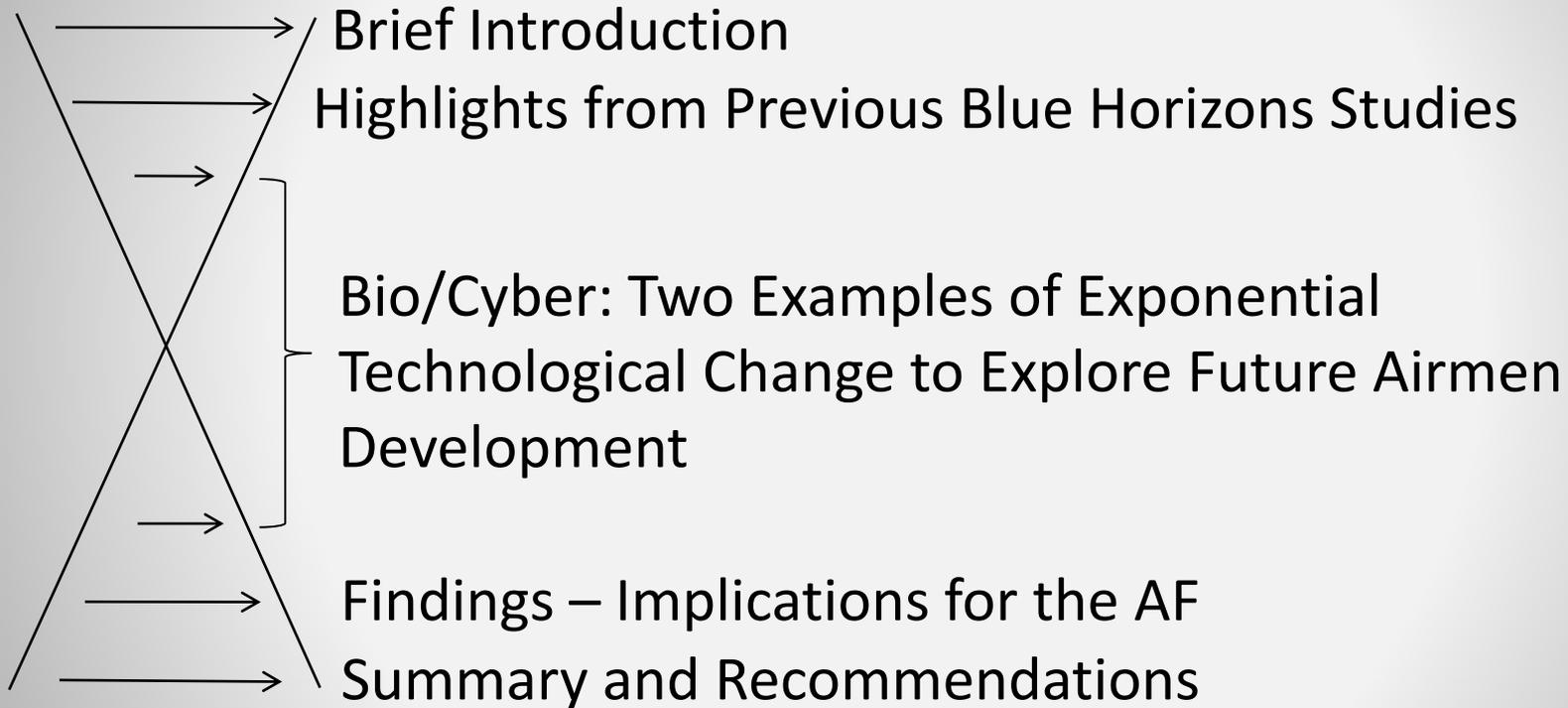
- “We’re at war – talk to us after the fight”
- “It’s all about the money – not enough for today...”
- “This is Next-War-itis writ large – need a grip on today”
- “This briefing is all Star Wars”

Yet why it is critical to the Air Force

- Historic niche for the AF – see the future, innovate and capture the next technology wave
- Today's reality – an unsustainable “boots on the ground” strategy
- Tomorrow’s reality – radical change spawned by technology revolutions



Overview



A8 Taskings for Blue Horizons

2007: Blue Horizons I

- Validate technology increasing at exponential rate
- Detail ramifications of exponential technological change through 2025

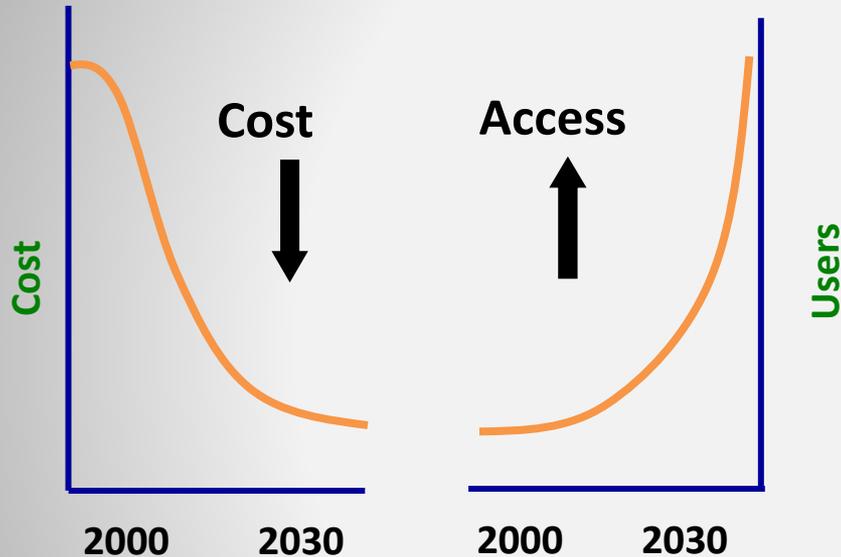
2008: Blue Horizons II

- Based on BH I – created 4 alternate futures for 2030
- Prioritized concepts and enabling technologies for AF investment

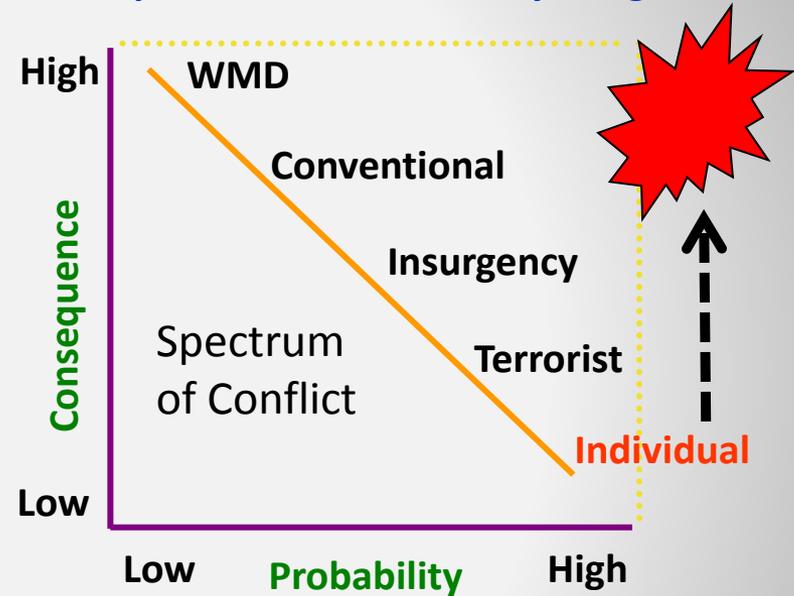


Blue Horizons I (2007)

Cost of tech decreases – availability increases



Most probable becomes very dangerous



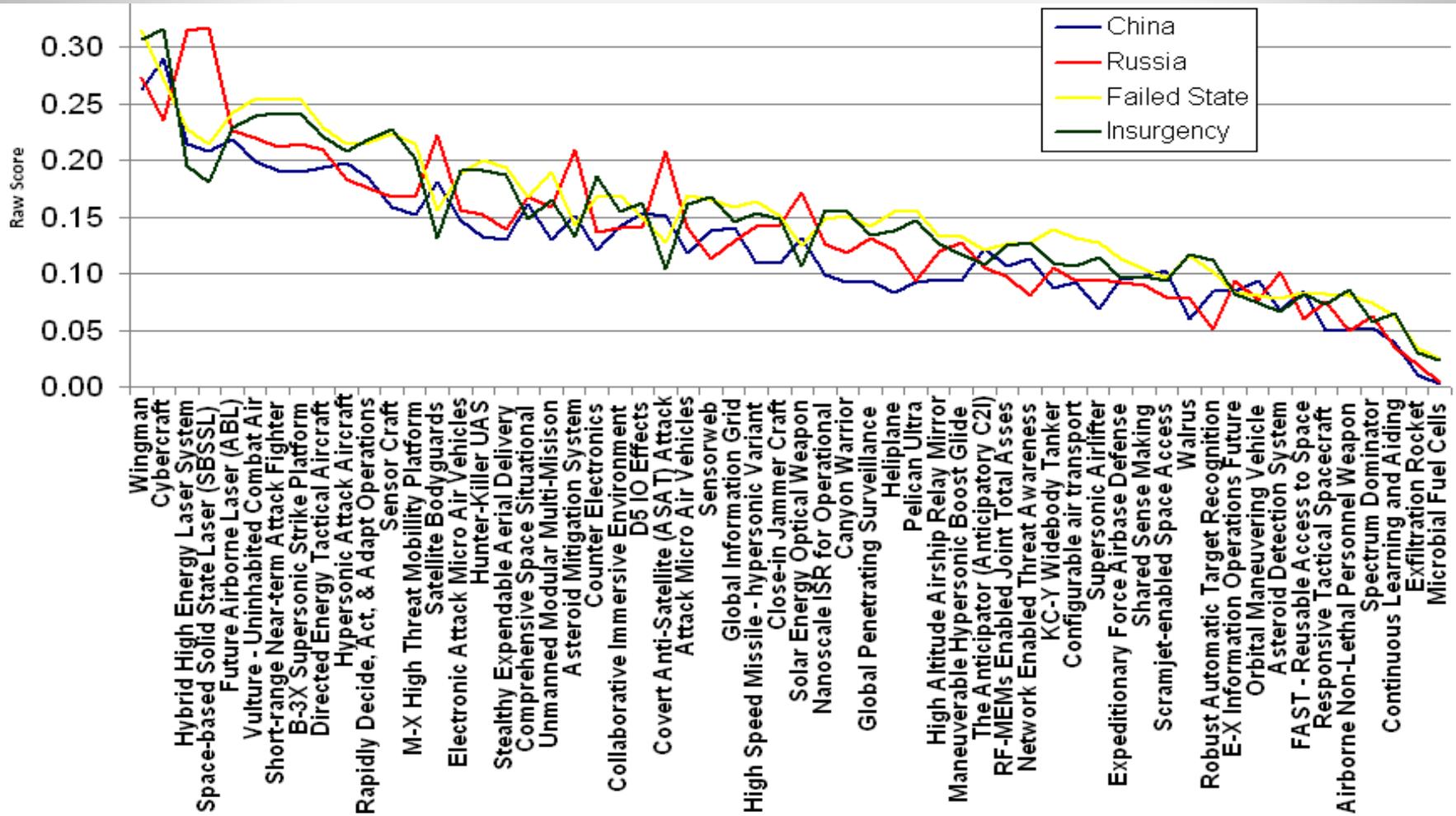
Demonstrated the proliferation of high tech systems from the nation to the group to the individual



Blue Horizons II (2008)

- HQ USAF/A8 tasking:

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



Blue Horizons I and II Bottom Line



Exponential Technological Change is

Real

Inevitable

Driving Proliferation

Result of Synergies in Nano/Bio/Cyber

Privately Led...Governments Shape Margins

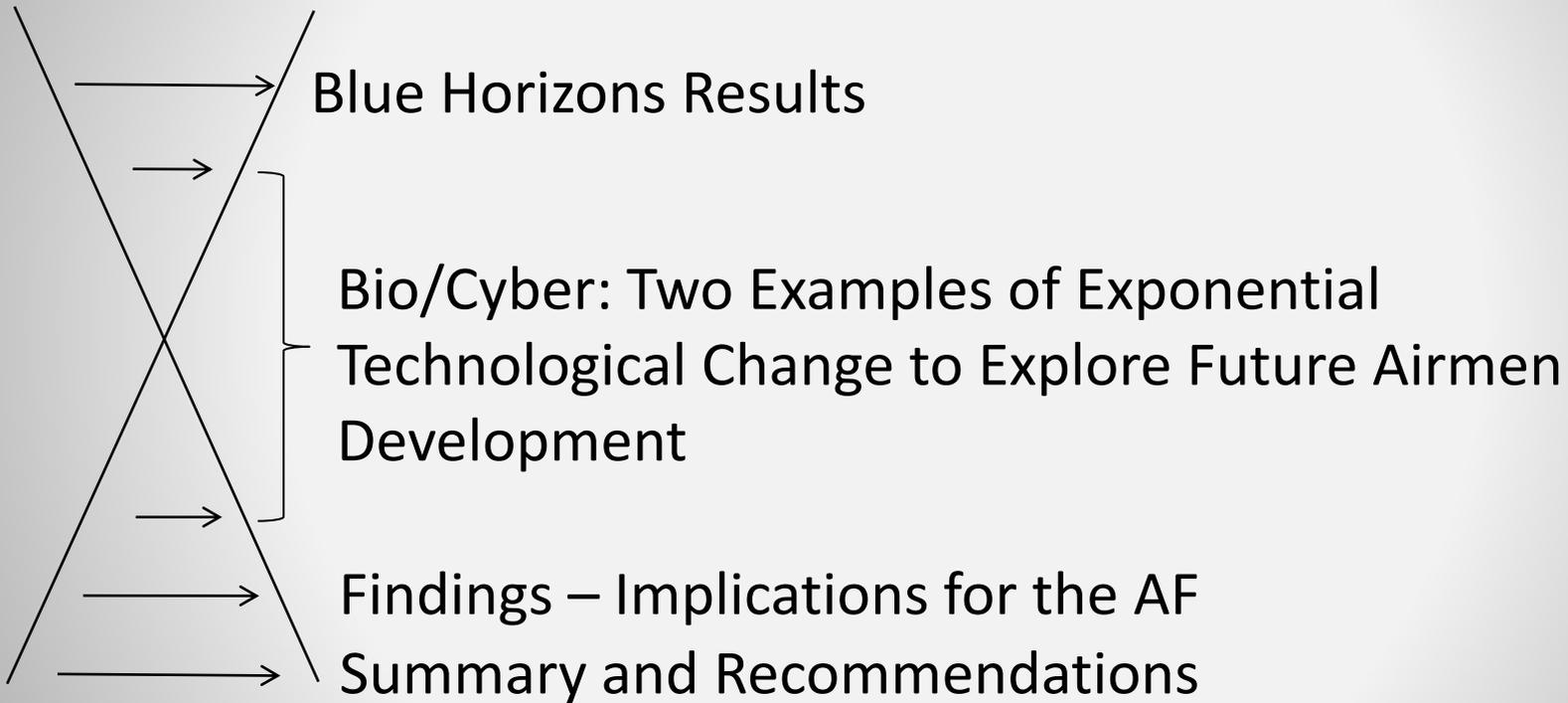


Purpose of Blue Horizons III

- Given *“head nods”* all around in response to Blue Horizons I and II, Blue Horizons III asked:
 - What changes in Air Force culture and organization are needed to address disruptive technology?
 - How will Exponential Technological Change affect employment in the air, space and cyber domains?
 - What changes in Airmen development are needed to deal with the world of 2035?



Exponential Tech Change - Bio



The New Battlespace

- Future enemies
 - ***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***



The implications of these changes will shift the foundations of today's Air Force structure



Changing Role of Man and Machine



Man is the machine



Man's "value added" is shifting: physical to cognitive to ethical



Man controlling the machine



Man employing the machine



Man observing the machine



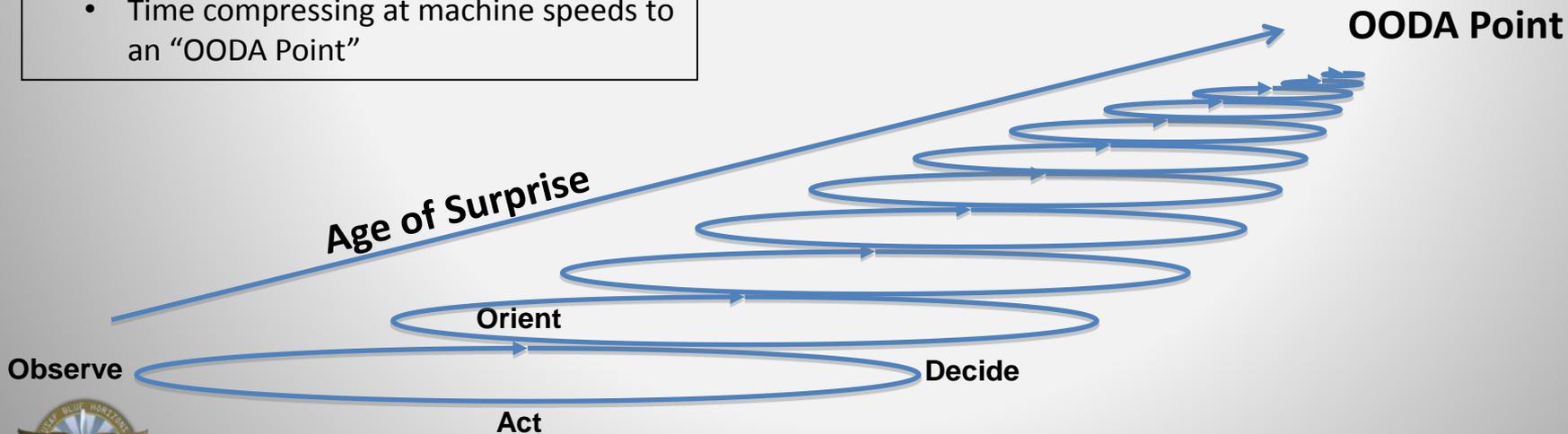
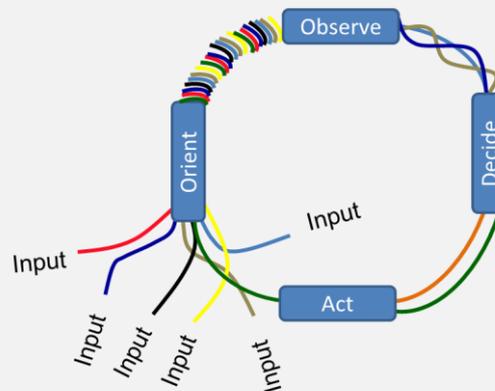
Impact: Human Driven Out of the Loop



Exponential Technological Change forces humans out of the decision loop

- OODA Loop recognizes
 - Number of inputs
 - Time
- Old news: OODA getting smaller

- New news in the Age of Surprise
 - Increasing number of inputs
 - Time compressing at machine speeds to an "OODA Point"



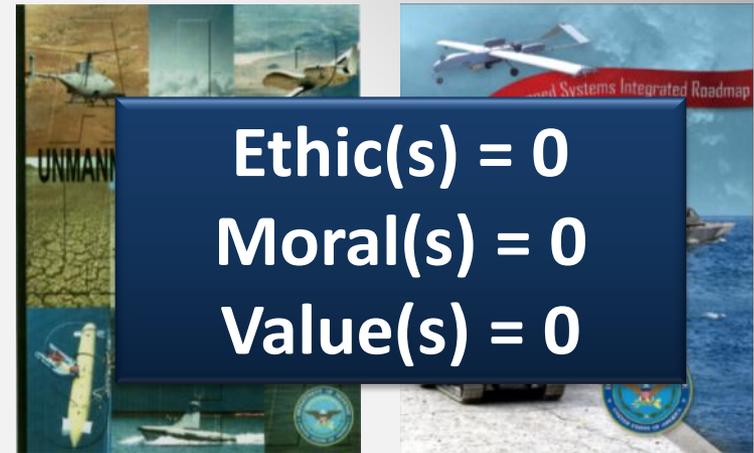
The Man in the Loop Dilemma

Policy Assumption

- Man will stay in the control loop
- Result: No Ethical Dilemma

Reality

- Constant and persistent drive to increase autonomous capability
- Belief that brilliant machines will avoid human error generated by fear, emotion, agenda, speed or facts



In fact, Exponential Technological Change is outpacing the ethical programming of unmanned technology



Approaches to Keep Man in the Loop

Artificial Intelligence

- Machine to machine
- Autonomous action

Intelligence Augmentation

- Pharmacology
- Bio enhancement
- Human-Machine connectivity

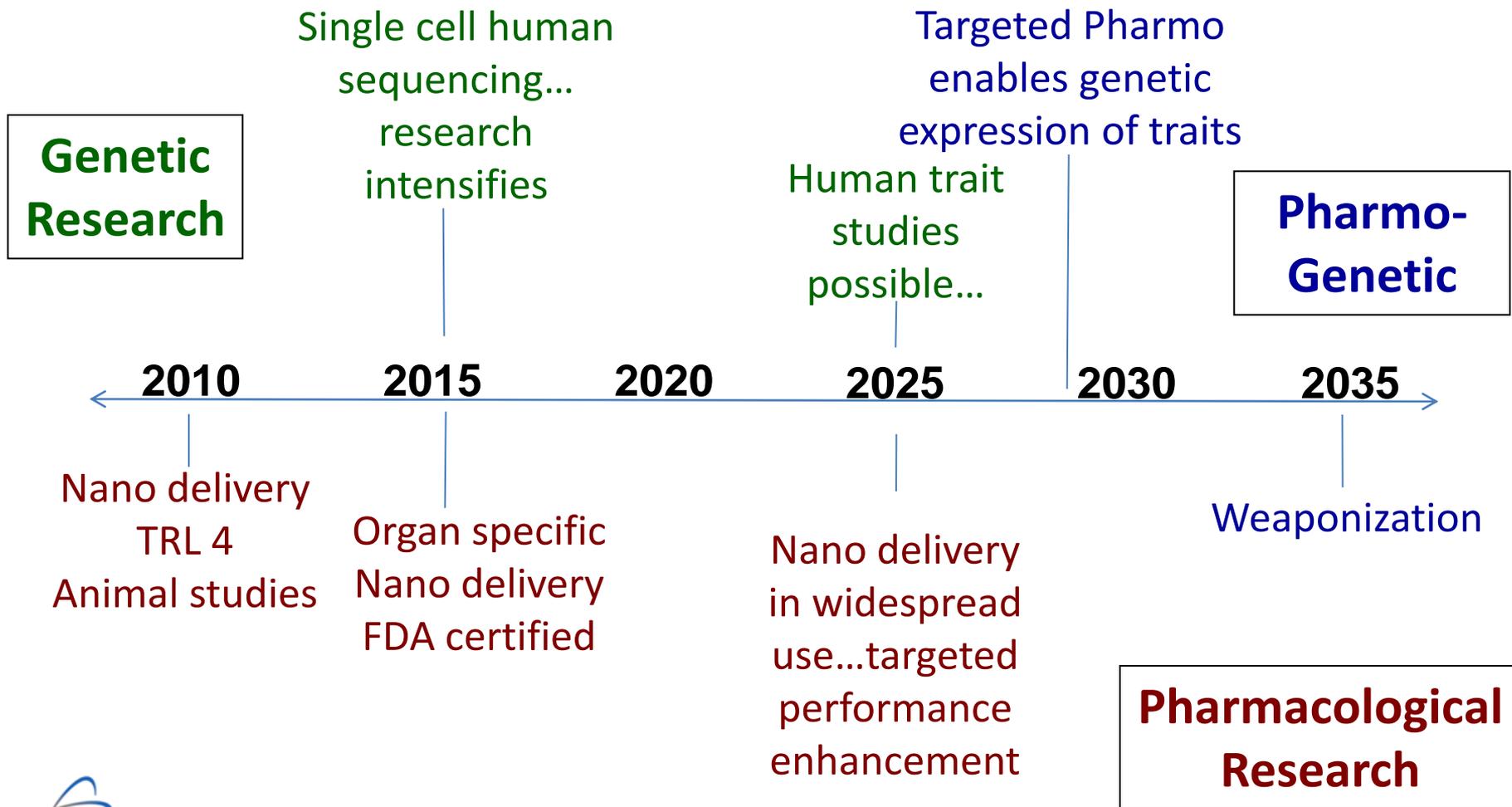
Education & Training

- Adjust requirements
- Foster agility
- Select/promote right players

Genomics Neuroscience Human Factors Education Training
Computer Science Psychology Pharmacology



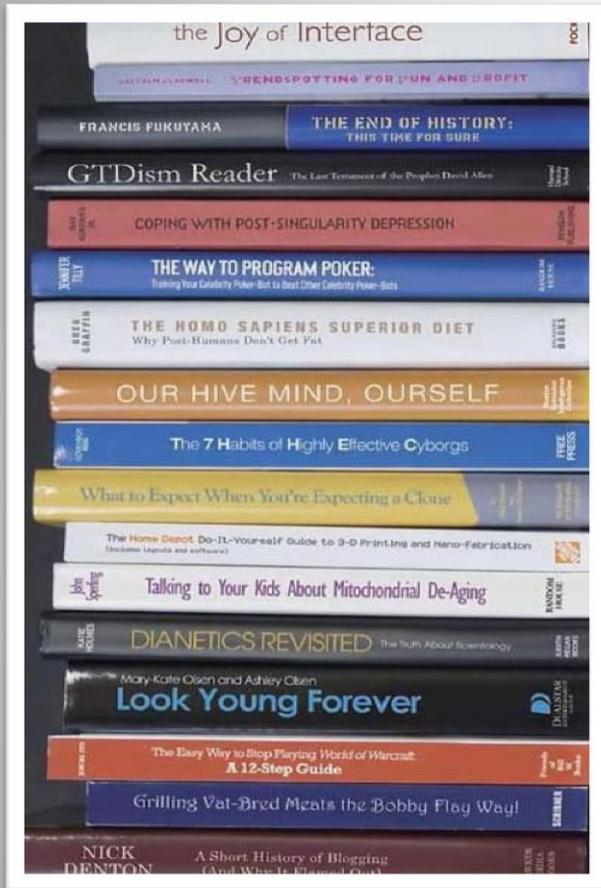
Pharmo-Genetic Enhancement Timeline



Education and Training

We can not know the future but we *can*:

- Create a *“Man for all Seasons”* through creative educational techniques
- Instill a *philosophical* and *psychological* capacity to expect and accept surprise caused by rapid technological change
- Foster and encourage flexible *agile thinking*
- Generate a drive for *innovation* with attendant acceptance of *risk*
- Provide virtual reality training to prepare mind for surprise



TRAIN for certainty – *EDUCATE* for uncertainty



Take Aways

Keeping Man in the Loop

Air Force future leader:



- Selected based on demonstrated proclivity for success in a chaotic environment, genetics and way of thinking
- Educated to instill a *philosophical* and *psychological* capacity to expect and accept surprise
- Cognitively enhanced through Pharmo-genetic technology
- Trained in a virtual reality environment . . . conditioned to think clearly and rapidly . . . brings ethics into machine dominated world



Surprise #1

Rosetta Stone

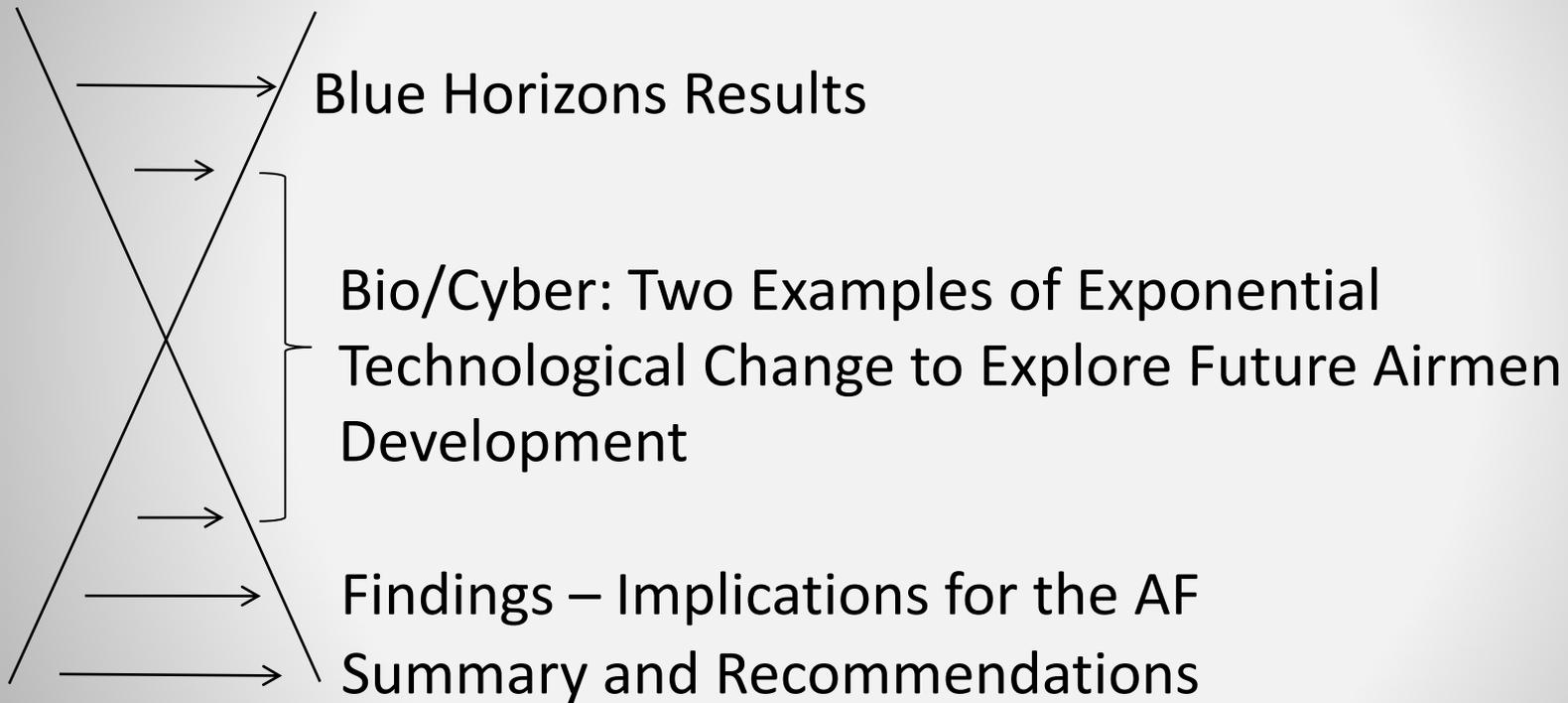
- We have decoded the human genome, but lack a gene-to-function Rosetta Stone
 - Lack computational power, algorithms . . . ethics block research
 - Don't have full set of behavioral traits or understand how the psyche affects cognition
 - Not being extensively researched in national labs
 - Requires intensive intelligence monitoring on private sector research
 - Deserves military R&D effort
 - **Potentially, next 'Manhattan Project'**
- Pharmaceutical industry focused on nearer term applications . . . may require prodding in this direction



The first group to break the gene-to-function code may have an insurmountable advantage



Exponential Tech Change - Cyber



Trajectory of Cyber Development

1980

- TV
- Telephones
- Computers

2010

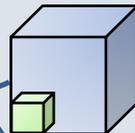
- PDA
- Computers
- Internet
- “Cyber Attack and Defense”

2035

- Transparency
- World net

Knowledge and things combine in “one machine”– results in era of transparency

Connections/computing result in proliferation of knowledge



Establishing Connections



Cyber in 2035

- Not better . . . radically different
 - Driven by innovation . . . not governments
 - Transparency changes the game
 - “Dominance” not possible



Beyond Big Brother: Transparency in 2035

Cyber vector: “One Machine”

- World interconnectedness creates “One Machine”
- One Machine constantly
 - Redesigns itself moment to moment
 - Develops new architectures daily
 - Never fails (nodes may fail but not the “Machine”)
 - Innovates – surprise the result



Beyond Big Brother: Transparency in 2035

Human vector: Drives reliance on Cyber

- Society, industry, government, military: Ever greater dependency on autonomous machines
- Constant: All recorded, catalogued, tracked



Beyond Big Brother: Transparency in 2035

Transparency: Integrates knowledge and things

- Hoarding knowledge difficult to unlikely
- Nations lose asymmetric advantage
- Knowledge shifts from nation to group to individual



Transparency provides answers to questions like:
Who are the 25,000 most influential people in the world and
how many of them are within 10NM of my location?



Operations in Virtual and Live Domains



Farmed Data Display

Socially Networked

Work together

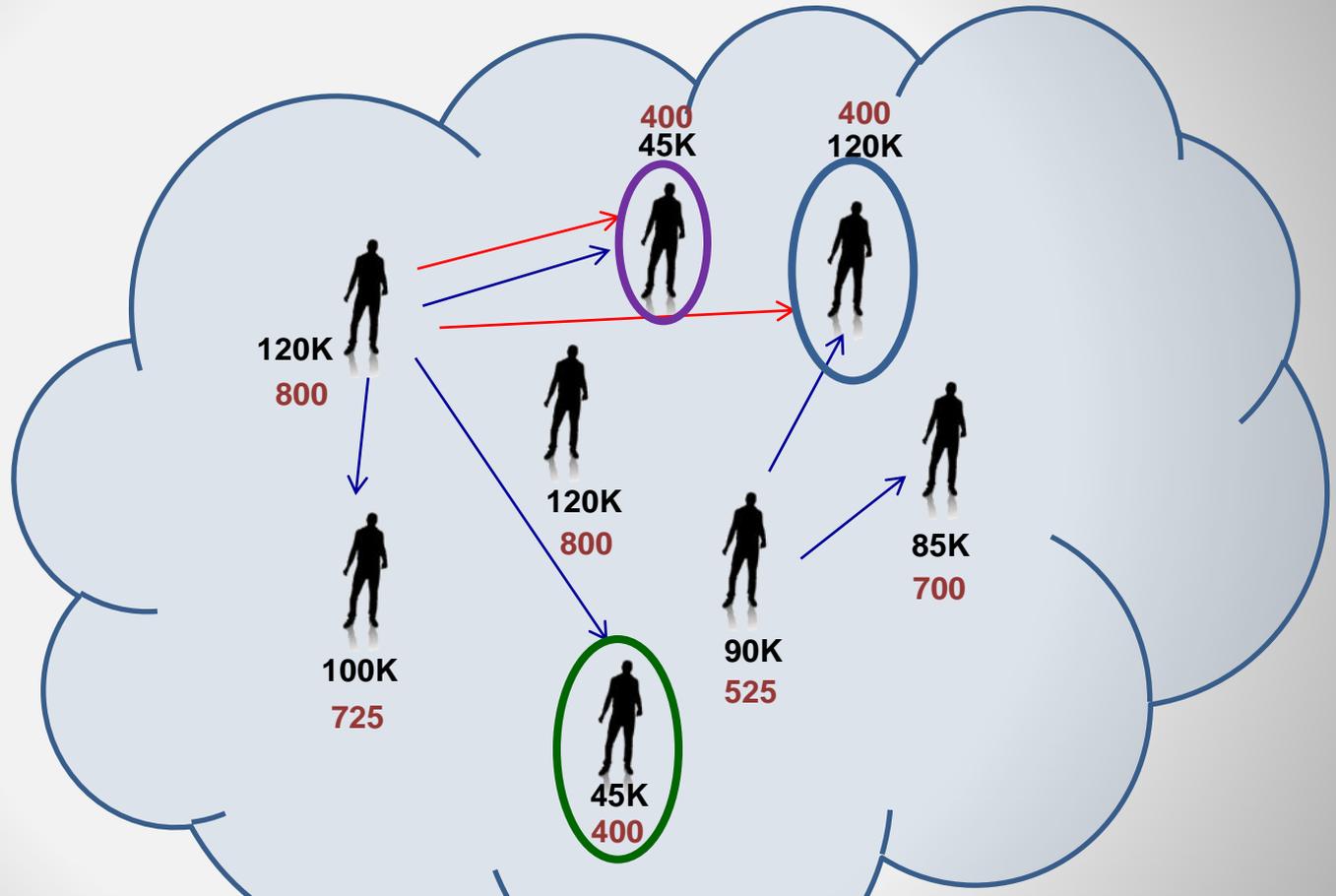
Income

Credit Score

Has Cancer

FBI Most Wanted

IRS Audit



And this is 2015 . . .

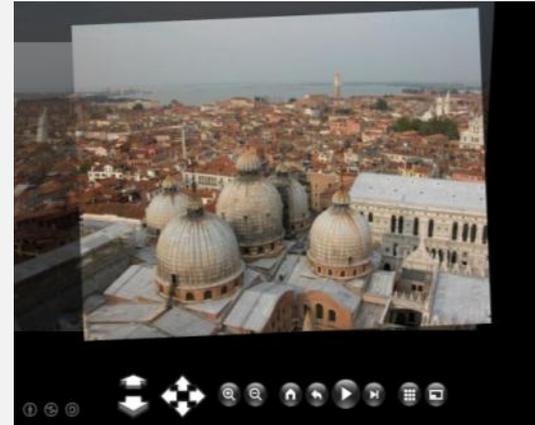


Reality in Combat

Angel fire from GEO



Photosynth

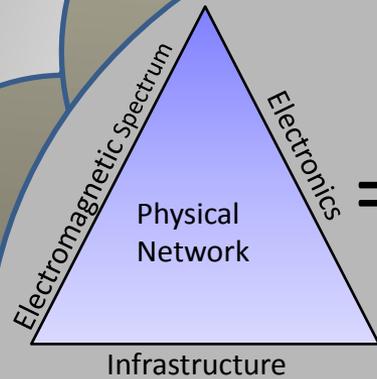


- Imagine what these two programs operational today. . . Will look like in 2035
- Historical records of all movement within a city for years
- Three dimensional exterior & Interior of buildings available to everyone in the cloud
- On-demand instantaneous integration of terrestrial, airborne, and space sensors (e.g., Angel Fire FMV from GEO)

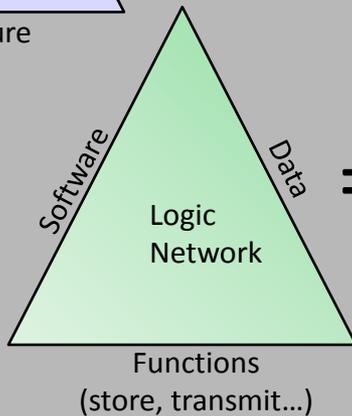


Surprise #2

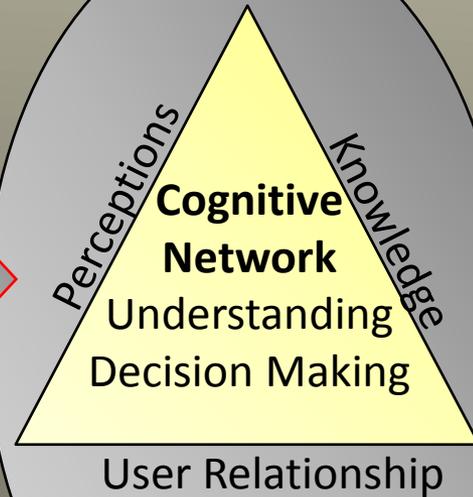
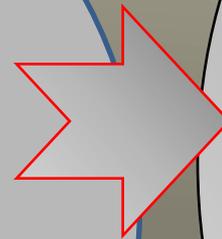
War in the Cloud



= Computer Networks



= Virtual Networks



Cognitive Network

Understanding
Decision Making



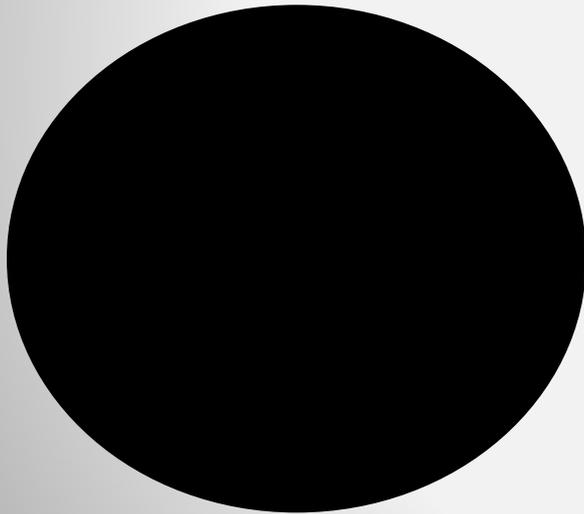
USAF Foundational Shifts

Rise of ISR in Cyberspace

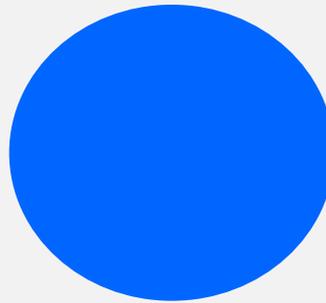
“Airpower is about targets and
targeting is about intelligence”

Contribution of Sensors to Situational Understanding

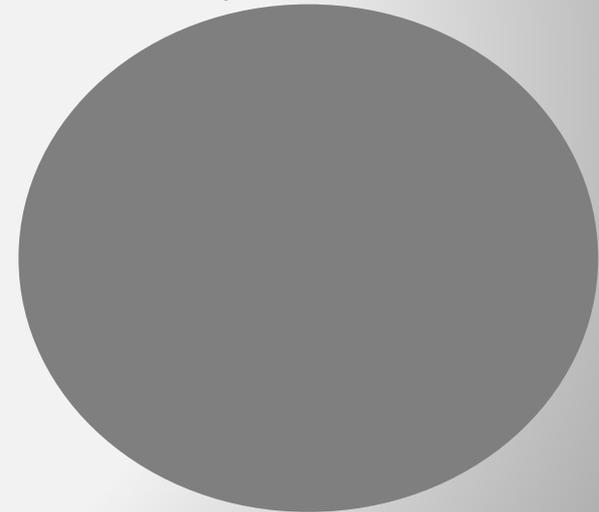
Space-based



2009 2035
Air-based



Cyber-based



Our Cyber thinking is stovepiped and our definitions narrow . . .
this is not a Cyber challenge . . . it's an Airman's problem



USAF Foundational Shifts

End of US Air, Space, Cyber Hegemony

Achieving domain superiority is a central operating tenet of air, space, and cyber power

Technological leveling and innovation will

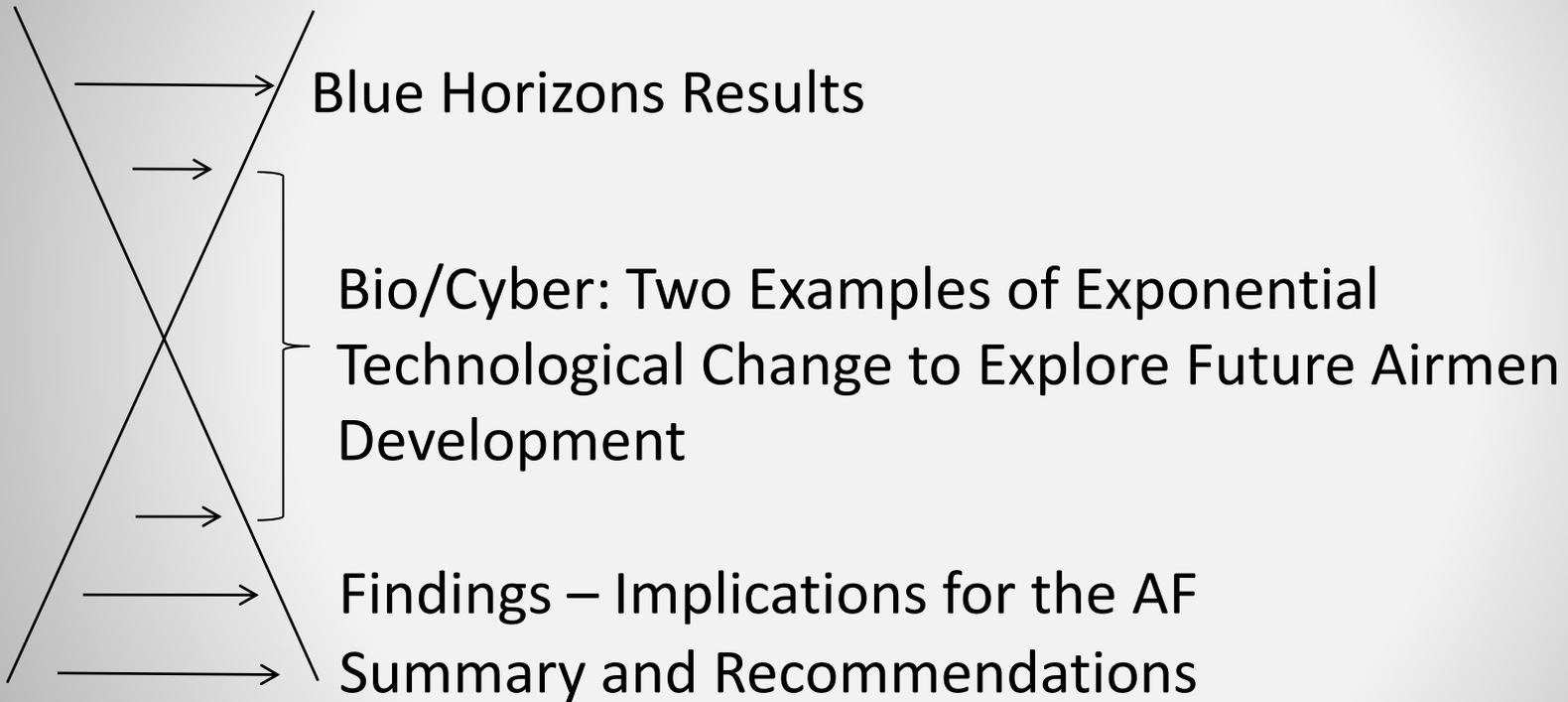
- *End the period of assured US domain dominance*
- *Revive historic thinking on degrees of domain control to enable operations, particularly in Cyber*
- *Reshape Airman's thinking to embrace less Centralized Control as battlefield automation increases and dominance ends*
- *Multiply physical and virtual defensive tasks in the face of ubiquitous precision and growth of transparency*



By 2035, “dominance” is no longer possible . . . superiority is fleeting . . . defense increasing in importance



Findings



Findings

Acquisition

Education



R&D

AF Culture

Training

Operations

Challenge: *Compressing tech life cycle*

- We must move toward a one-year FYDP and a one-month POM, a one-week acquisition cycle with . . .
 - Continuous upgrades
 - Throw-away capabilities
 - “Any year” money
- Evolve to a World War II cycle for major systems



Findings



Challenge: R&D no longer driven by US government

- Unable to fully follow and report on state of technical innovation outside the United States
- Investment in basic research for military applications increasingly important
- Next **Manhattan Project**: Develop the “Rosetta Stone” for the human genome (gene to function)



Findings

Challenge: Prepare “strategic airmen”

- Develop Airman who:
 - Thrive on chaos and under continuous threat
 - View surprise as the norm
 - Excel under an avalanche of data
- Teach and test individual strategic thinking early and often throughout AF career
- Leverage virtual technologies to master strategic and cultural complexities



Findings



Challenge: Air Force in danger of losing strategic relevance

- Maintain offensive posture while increasing defensive capabilities
- It's a transparent world – AF must operate while hiding in plain sight
- Systems engineering – apply technology faster than anyone
- Cyber in 2035 will be radically different and it's a race . . . AF must excel



Findings



Challenge: Keeping the force at the leading edge

- Flexibility is no longer key to airpower . . . it is essential to Air Force survival
 - Mental Agility
 - Individual innovation
 - Rethink Risk: “Fail early, fail fast,” then win
- More doctrine can limit flexibility



Findings

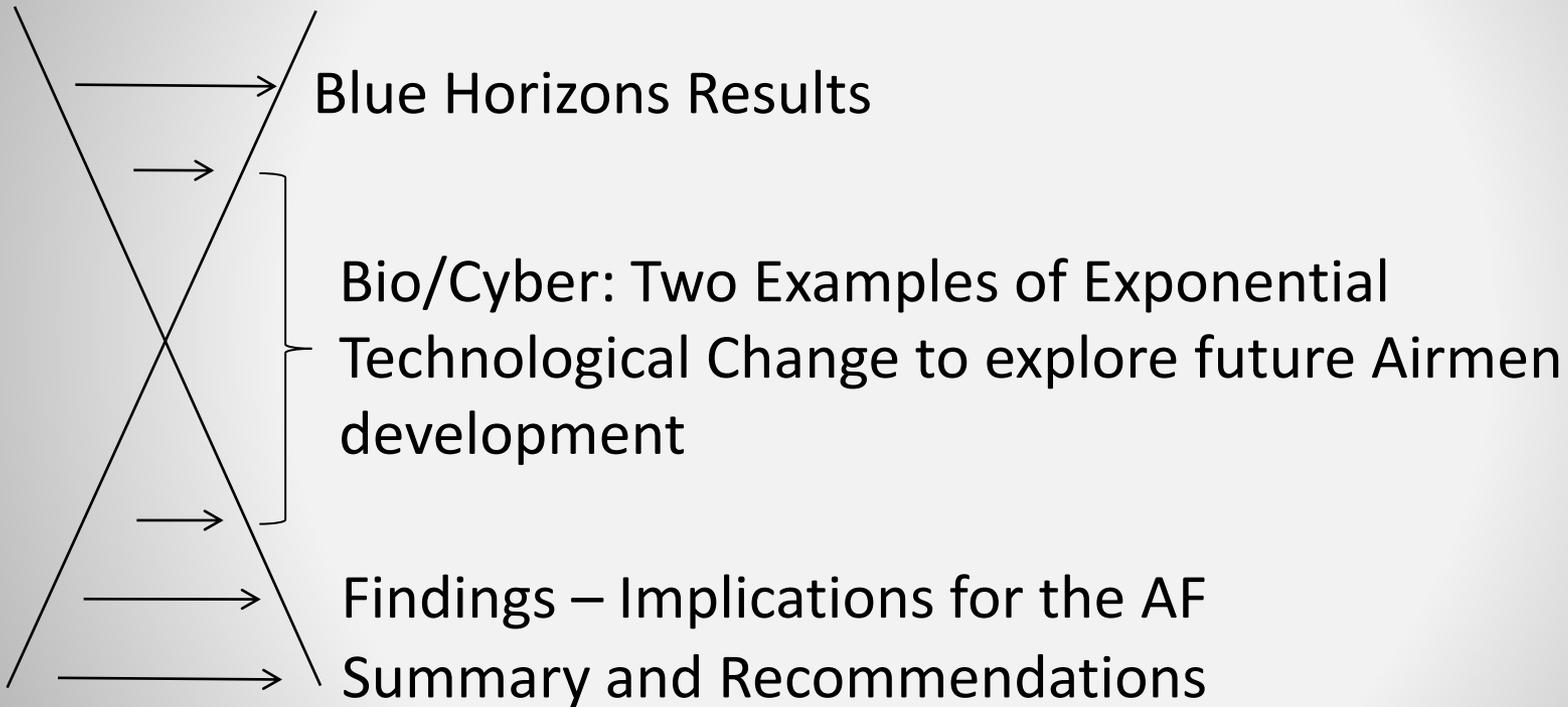
Challenge: *Leaders require more strategic breadth in The Age of Surprise*



- Traditional education approach falls short
 - History and current events adequate
 - Study of future political, economic and military disciplines lacking
 - Little technology or impact of exponential change covered
- Technology is the engine of AF power, but we lack commitment in personnel and resources to teach future studies



Summary and Recommendations



What This All Means

This briefing is not asking for money, proposing new systems or attacking the way things have been done to date . . .

It's sole purpose is to introduce a way of thinking about the future that will result in changing attitudes, priorities and expectations . . .

. . . which is far harder to do but much more important



A three-degree philosophical change in direction to future Air Force strategy is needed



Recommendations

- **Operations:** Define Cyber more broadly - not just about electrons - it also includes focused operations against cognitive-social networks
- **Acquisition:** AF in 2035 will fail with the current system . . . need rapid prototype, short operational life strategy
- **R&D:** Next Manhattan Project . . . develop the gene to function “Rosetta Stone” for the human genome
- **AF Culture:** Establish agile doctrinal process reflecting rapidly changing nature of threats
- **Training:** Invest in advanced tools and technologies to better prepare them for their role as strategic Airmen
- **Education:** Make future studies a keystone of AF education . . . produce officers who innovate and thrive on change



Backup



Areas for Additional Research

- Nano and Bio-technologies – surge in research is not reflected in AFRL, AF/A8, or AU concepts
- Etho-cognitive Artificial Intelligence
- Pharmo-genetics
- Alternative energy sources and solutions
- Organizing the AF for operations in 2035 and beyond
- Personal Loyalty or Competence? – finding, growing, and promoting future AF leaders



The Road Ahead

- Blue Horizons IV – Exponential technological change in the world of 2035
 - Deterring hostile nations, groups and individuals
 - Employing highly advanced disruptive technologies
 - New threats to national survival
- Publish results of Blue Horizons III
- Develop a research plan for Blue Horizons V

