

**Biosecurity:
A Multi-Dimensional Challenge of
Escalating Complexity and Urgency**

Dr. George Poste

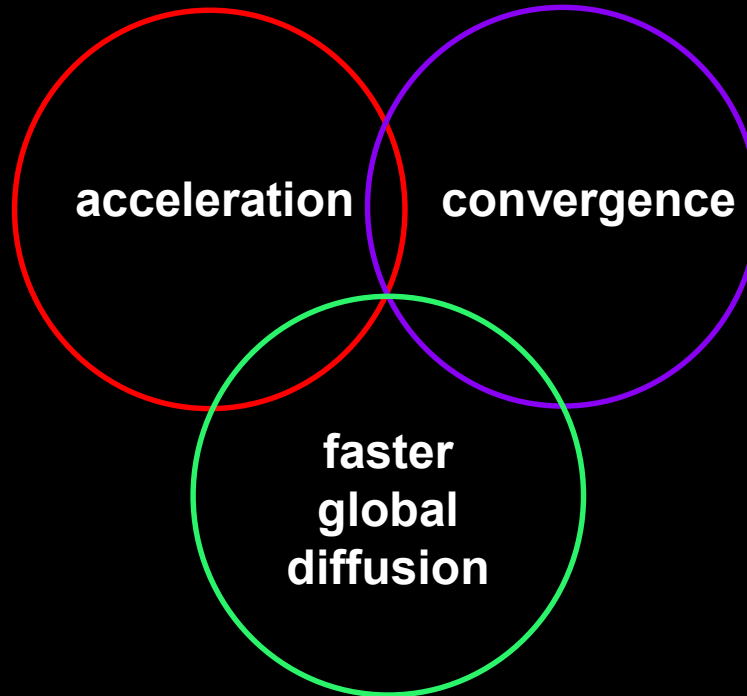
Chief Scientist, Complex Adaptive Systems Initiative
and Regents Professor of Health Innovation

Arizona State University george.poste@asu.edu www.casi.asu.edu

Pressing Threats II
New and Emerging Bioweapons

Drivers of Technological Change

- automation
- large scale data and analytics
- entrepreneurial innovation

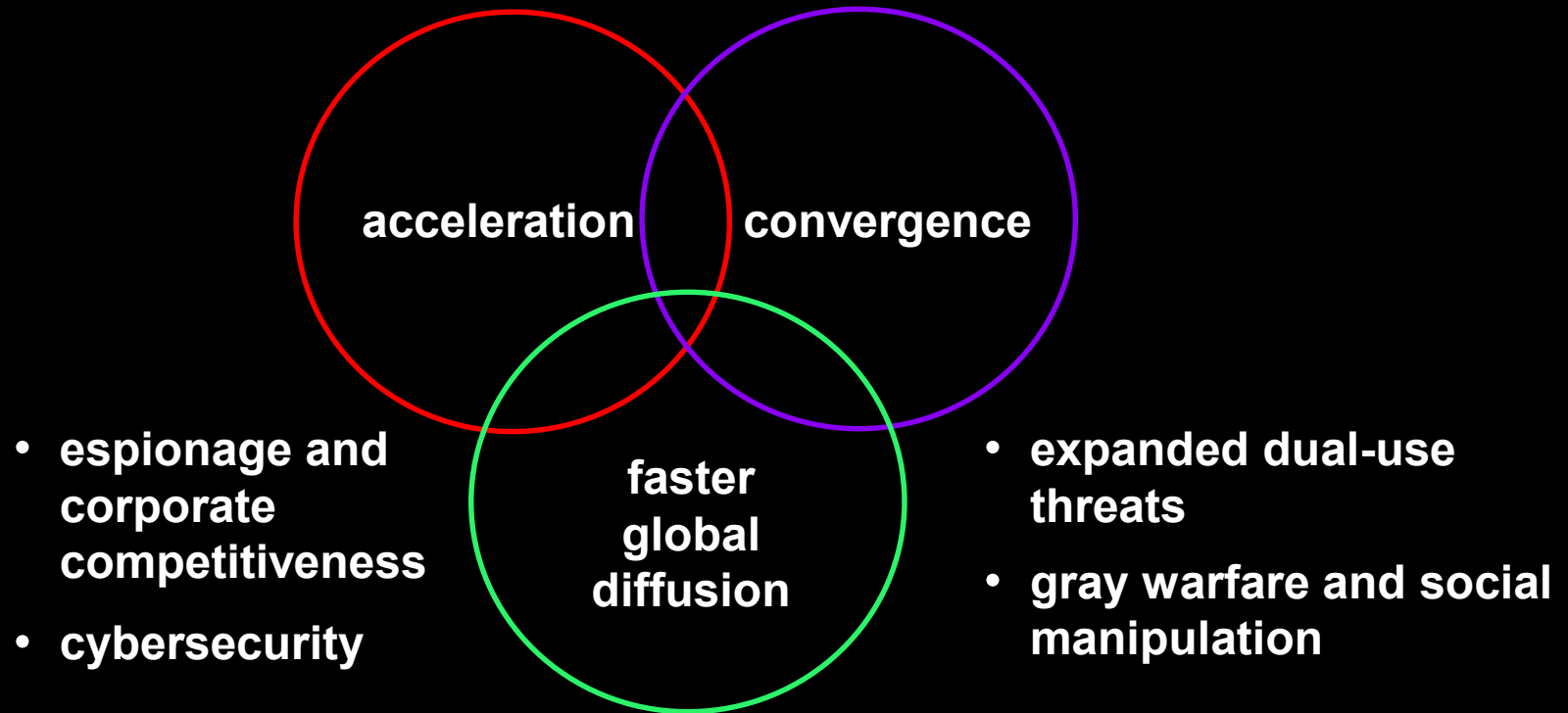


- biology, medicine, engineering and computing
- new cross-sector corporate alliances

- industrial and military competitiveness

- trade policies
- supply chains

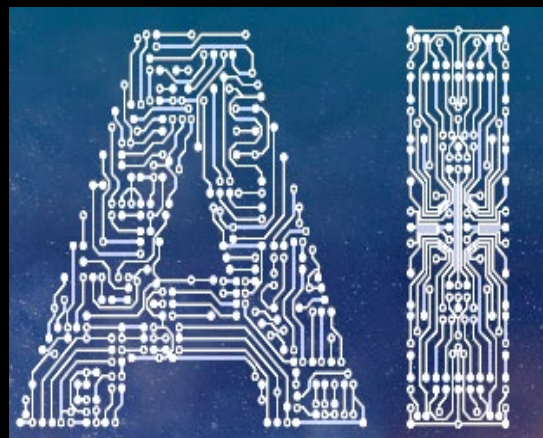
Drivers of Technological Change



National Leadership in Advanced Technologies: The Quest for Corporate and Military Superiority



- biotechnology
- genomics
- synthetic biology



- artificial intelligence
- quantum computing

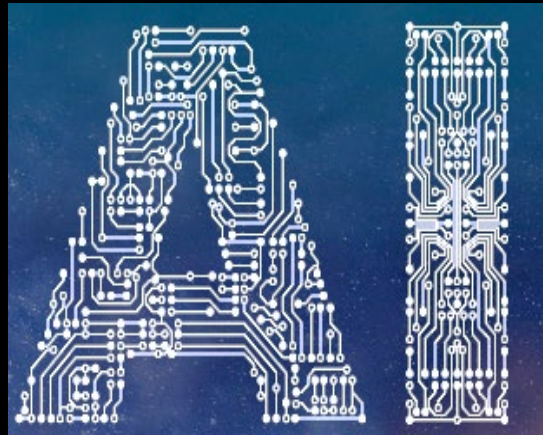


- control of low earth orbits
 - commercial
 - military

National Leadership in Advanced Technologies: The Quest for Corporate and Military Superiority



‘bio’

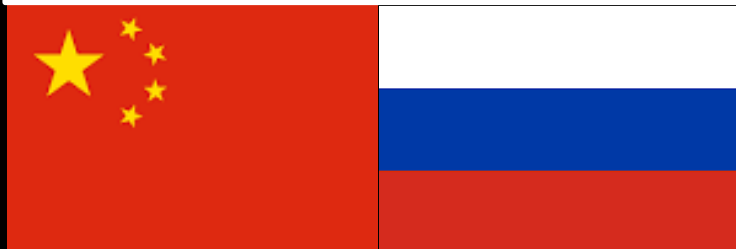


‘cyber’



‘space’

A New Cold War Begins?



The Dual-Use Dilemma

- advances in science and technology with simultaneous potential for beneficent and maleficent applications
- omnipresent in the history of technical progress and weapons development
- every technology that can confer military superiority is always developed
 - metallurgy: swords, spears, stirrup, armor
 - ordinance: bullets, bombs
 - aviation: planes, missiles, drones
 - electronics: GPS, guidance systems
 - computing: cyberwarfare
 - nuclear
 - robotics and autonomous systems
 - space exploration

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‘BIO’ joins the club!

Advances in the Biosciences and the Expanded Dual-Use Dilemma

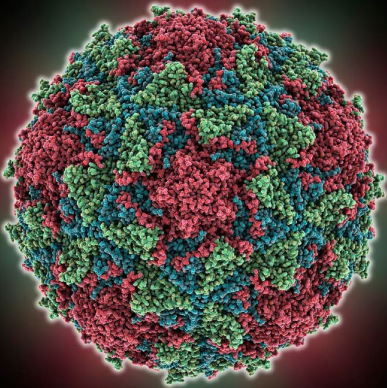
genomics (and multiOmics)

- mapping the functional properties of living organisms (phenotype) at the molecular level based on encoded genetic information (genotype)
- understanding the molecular signaling information networks (biocircuits) that control specific biological functions
 - cells, tissues, organs, whole organisms

synthetic biology

- new technologies to alter the properties of existing organisms
- design of biological functions/organisms for which there is no known evolutionary precedent
- powerful new tools for genome modification
 - read, write, edit

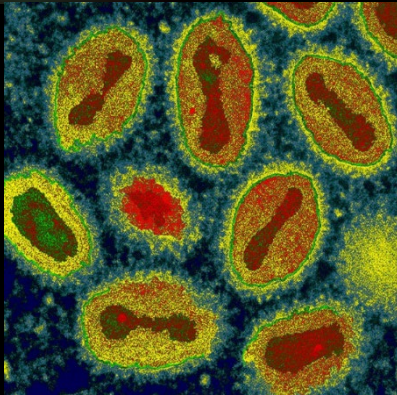
Dual-Use Technologies: De Novo Synthesis of Pathogens



Science (2002) 297, 1016

Chemical Synthesis of Poliovirus cDNA: Generation of Infectious Virus in the Absence of Natural Template

Jerónimo Cello, Aniko V. Paul, Eckard Wimmer*

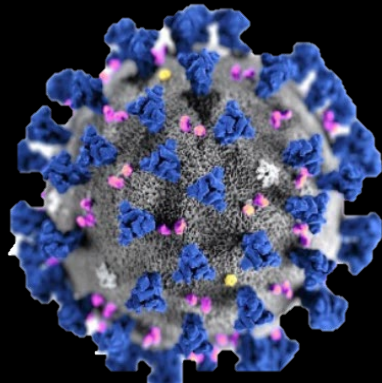


PLOS ONE <https://doi.org/10.1371/journal.pone.0188453>
January 19, 2018

Construction of an infectious horsepox virus vaccine from chemically synthesized DNA fragments

Ryan S. Noyce¹, Seth Lederman², David H. Evans^{1*}

¹ Department of Medical Microbiology & Immunology and Li Ka Shing Institute of Virology, University of Alberta, Edmonton, Alberta, Canada, ² Tonix Pharmaceuticals, Inc., New York, New York, United States of America



T.T.N. Thao et al. (2020) Nature 582, 561

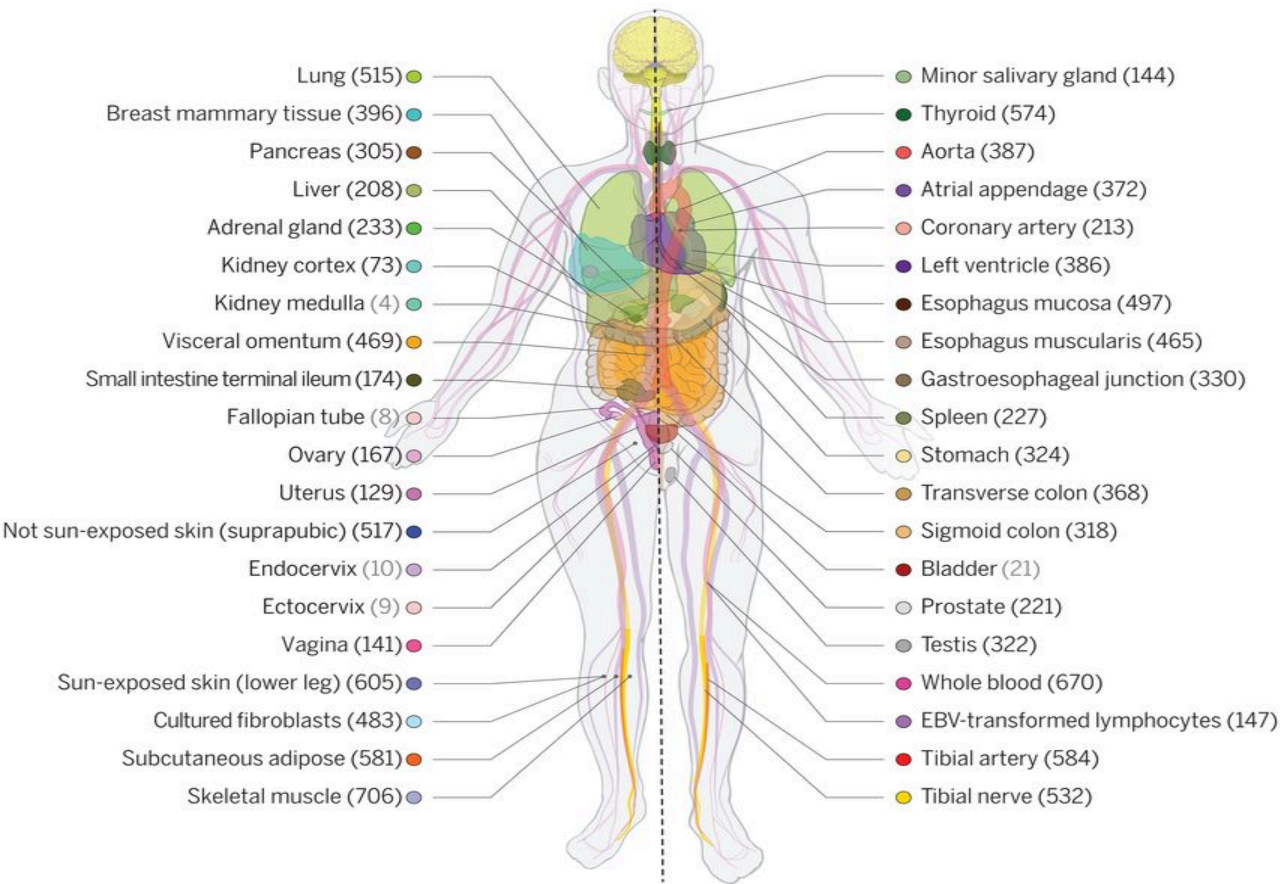
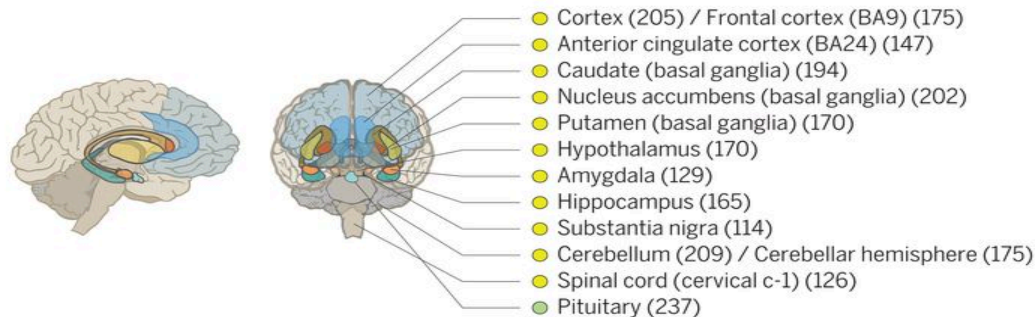
Rapid reconstruction of SARS-CoV-2 using a synthetic genomics platform

Dual-Use Technologies and Expansion of the Biothreat Spectrum

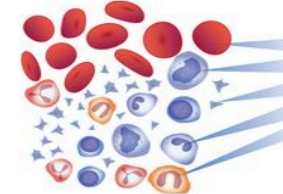
**deliberate engineering of microorganisms for
biowarfare/ bioterrorism**

- **evade detection and circumvent therapeutic countermeasures**
- **new virulence features to alter target organs attacked**
- **induce high levels of chronic disease and unsustainable economic burden to healthcare systems**
- **expand the spectrum of vulnerable host species (animals, crops, ecosystem disruption)**

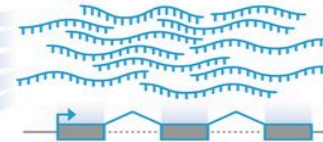
Mapping Genetic Control Circuits in Human Organs and Cells : New Dual-Risk Challenges



Cell type composition in tissues

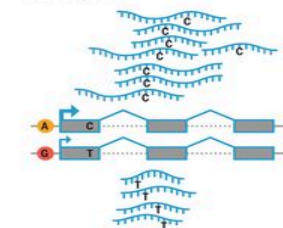


Gene expression and splicing



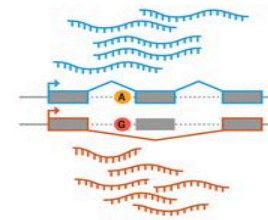
Expression quantitative trait loci (eQTLs)

cis-eQTLs

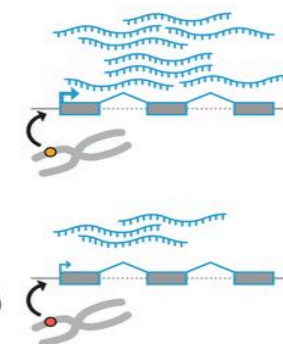


Splicing quantitative trait loci (sQTLs)

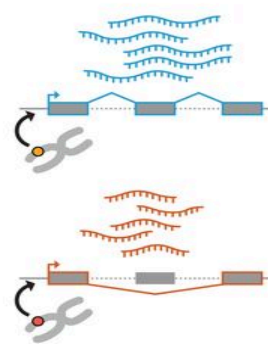
cis-sQTLs



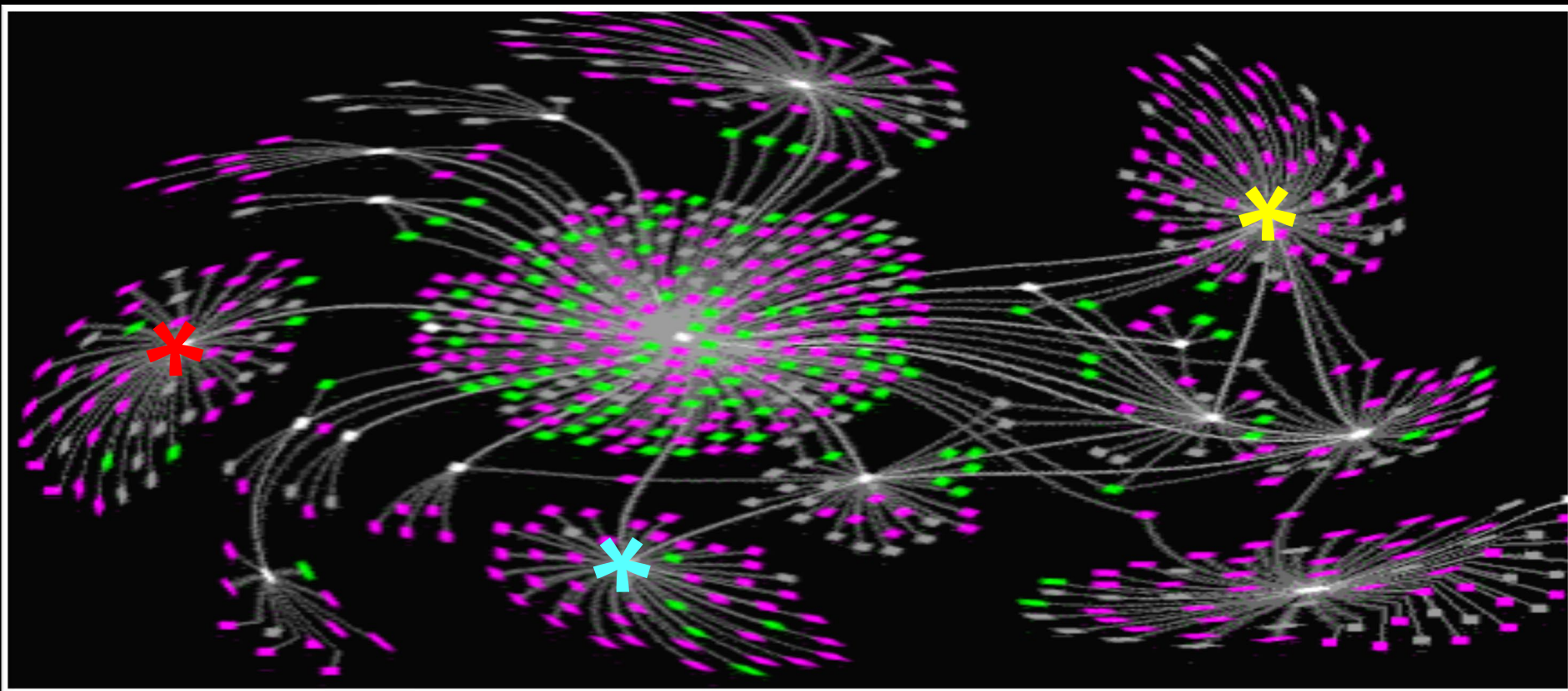
trans-eQTLs



trans-sQTLs



Synthetic Biology and Dual –Use Research : Thinking ‘Beyond Bugs’



- precision medicine: mapping molecular networks
 - (circuit diagrams) of every cell type in the body and the circuit disruptions that cause disease
- roadmap for next-generation CBW agents to target specific molecular circuits (✱, ✱, ✱)

Dual-Use Technologies and Expansion of the Biothreat Spectrum

'beyond bugs'

- **new biothreats that do not involve microorganisms**
- **potential to target any lifeform or biological functions based on knowledge of the underlying molecular control systems**
 - **“biocircuit modulators”**
- **although viruses could theoretically be designed to attack specific biocircuits the more likely scenario will be to design chemical molecules to hit the circuit of interest**

Next Generation Chemical Threat Agents: 'Inspired by Biology'

- **design of next-generation chemical weapons targeted to specific biocircuits**
- **acute versus chronic effects**
- **altered immune functions**
 - **activation: autoimmune disease**
 - **immunosuppression: vulnerability to multiple infections**
- **neuromodulation**
 - **trigger fear, panic, hallucinations, aberrant memories**
 - **reduce thresholds for violence, addictive behavior**

China's Export of Fentanyl and Derivatives: A New Biosecurity Threat



Testimony

Evolution of the U.S. Overdose Crisis

Understanding China's Role in the Production and Supply of Synthetic Opioids

Bryce Pardo

CT-497

Testimony presented before the House Foreign Affairs Subcommittee on Africa, Global Health, Global Human Rights, and International Organizations on September 6, 2018.



Next Generation Chemical Threat Agents: 'Inspired by Biology'

- **extravagant diversity of biological circuits involved in human physiology and the perturbations causing disease (acute and chronic)**
 - **millions of potential targets**
- **major obstacle to robust defense planning for threat assessment, monitoring and mitigation**
- **'all hazards' biopreparedness for diverse microbial threats is challenging but protection against biocircuit modulation presents a quantally more complex problem**
- **solutions not easily identifiable**
 - **higher level of complexity than any previous dual-use dilemma in national security**

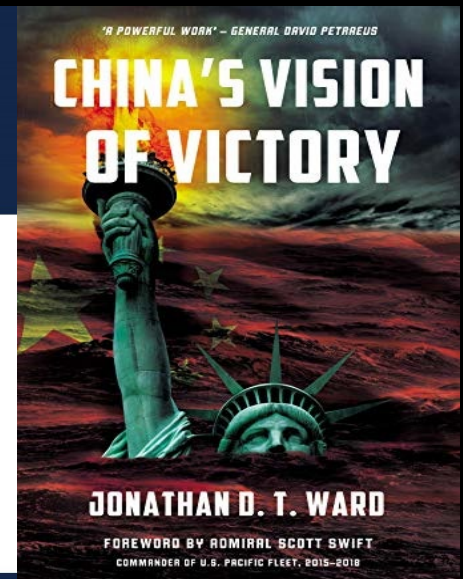
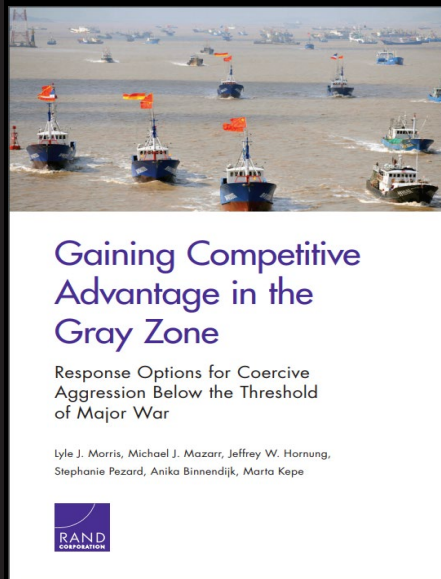
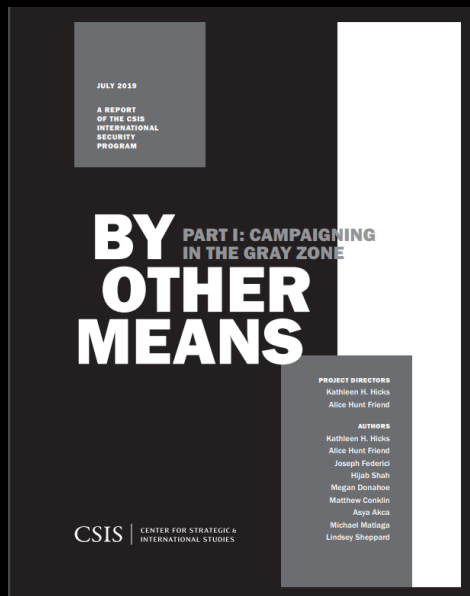
Dual-Use Technologies and Expansion of the Biothreat Spectrum

Gray Warfare

- **targeted psychological manipulation of cognition and beliefs**
- **undermine societal trust in political leadership and institutions**
- **promote social division, tension and civil unrest**
- **‘fake news’ and self-reinforcing ‘echo chamber’ propaganda**
- **parallel dimension to cyberwarfare but more subtle, insidious and longer-term impact**
 - **use of social media, gaming**

Darker Shades of Gray: The Emerging Dimension of Hybrid Warfare

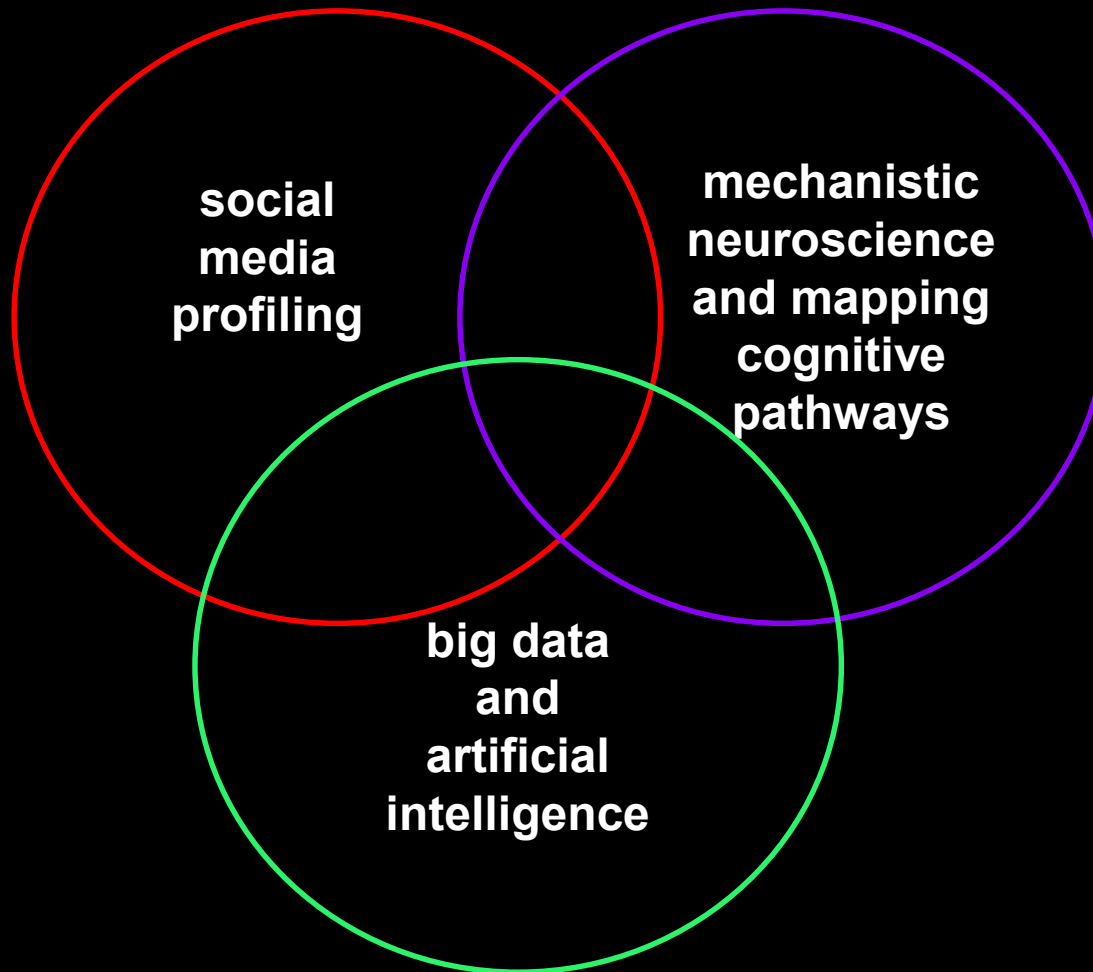
- lawfare: exploiting loopholes to seed confusion and dissent
- deception, disinformation and propaganda
- weaponized narratives (“fake news”)
- plausible deniability



Gray Zone Tweets and Biosecurity: Russian Trolls and Twitter Bots

- **purposeful social media disinformation campaigns**
- **weaponized disinformation in health communications**
 - **anti-vaccination campaigns**
 - **anti-GMO movements**
 - **exploit health disparities and racial tensions**
- **compromise health care computer systems and or other critical computing capabilities in bioincidents**
- **Russian FSB Novochock chemical attack on Sergei and Yulia Skripal in UK (3/4/2018)**
 - **Salisbury UK hospital computers hacked**
 - **thwarted hack of Organization for Prohibition of Chemical Weapons (The Hague) conducting forensic analysis of incident samples**

Targeted Neuromodulation – The Ultimate Technological Triad: From Commerce to Control



Dual-Use Technologies and the Expanding Biothreat Spectrum

- **rate of technology progress and risk expansion outpacing current national and international oversight mechanisms**
- **new classes of dual-use biothreats will arise from intensifying national competitiveness for commercial domination of advanced technologies**
 - **synthetic biology, neuroscience and AI (among others)**
- **CBW Convention and national export controls were designed to address far narrower, well-defined risks**

Week Seven

Planning for the Future

- **the present continued: navigating the post-COVID-19 world**
- **anticipated future technology trajectories and their impact**
- **guaranteed certainties**
 - **escalating technological complexity**
 - **intensified international competition for commercial and military dominance of advanced technologies**
 - **decision-making in the face of greater uncertainty**
 - **new governance challenges and more demanding legislative competencies**