## The Technological Context of Cybersecurity

Governance of Emerging Technologies 2016 May 25, 2016 Brad Allenby President's Professor of Civil, Environmental, and Sustainable Engineering Lincoln Professor of Engineering and Ethics



ARIZONA STATE UNIVERSITY



**Center for Earth Systems Engineering and Management** 

## What is Cyber Anyway?

• . . . cyberspace [is] the global domain within the information environment consisting of the interdependent network of information technology infrastructures and resident data, including the Internet, telecommunications networks, computer systems, and embedded processors and controllers. Cyberspace consists of many different and often overlapping networks, as well as the nodes (any device or logical location with an Internet protocol address or other analogous identifier) on those networks, and the system data (such as routing tables) that support them.... Cyberspace can be described in terms of three layers: physical network, logical network, and cyber-persona [people and institutions on the network].



US Joint Chiefs of Staff, Joint Publication 3-12 (R), *Cyberspace Operations*, 5 February 2013: "This publication provides joint doctrine for the planning, preparation, execution, and assessment of joint cyberspace operations across the range of military operations."

## A New Domain?

• The oceans became a separate military domain when, ca. 1900, Alfred Thayer Mahan in, e.g., The Influence of Sea Power upon History, 1660-1783, created an influential strategic framework for war on the oceans; and Julian S. Corbett in, e.g., Some Principles of Maritime Strategy created an overarching strategic framework for how naval warfare and operations integrated into overall military and strategic operations. In essence, they took centuries of commentary regarding military operations on land ranging from Sun Tzu to Clausewitz and Jomini, and modified it to apply to a new domain, the ocean.

• Despite efforts to apply this model to cyber, it fails. Why?



## Cyber versus the Mahan/Corbett Model

- Operationally, immediate responses to cyber-challenges, such as Chinese data acquisition and Russian Hybrid Warfare using postmodern narrative structure, are required. And the domain framework enables that. But . . .
- The complexity of cyber cannot be decoupled from accelerating volume and velocity of information, and . . .
- Cyber is not a domain; it is an on-going evolution of cognitive capability beyond the human.



# The Age of Big Data: Info Volume and Velocity

- Eric Schmidt, CEO Google: Every 2 days we create as much information as we did up to 2003
- 250 days of Google processing of Web information equivalent to all words ever spoken by humanity
- Facebook 12 years old; Twitter 10; Siri 5
- Watson wins Jeopardy, 2011; AlphaGo wins Go series against world champion Lee Sedol, 2016



#### **Computing Performance**



Note that human and cat brain estimates apply to both the left and right y-axes.

Prepared by Carolyn Mattick. Adapted from Ananthanarayanan, Esser, Simon, & Modha (2009), Bennett (2008), EconomicExpert.com (n.d.), Moravec (1998), Polsson (2009), and TOP500.Org (n.d.).



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### **Big Data Stories**

 Quill<sup>™</sup> from Narrative Science – "Data-Driven Communication at Machine Scale" – an "advanced natural language generation (Advanced NLG) platform for the enterprise that goes beyond reporting the numbers—it creates perfectly written narratives to convey meaning for any intended audience." "Data visualizations are often complex, requiring expert-level analysis and explanation. Quill immediately adds value to data by identifying the most relevant information and relaying it through professional, conversational language. The result? Intelligent narratives that efficiently communicate the insights buried in Big Data that people can comprehend, act on and trust."



#### What Quill Actually Means

- It represents an extension of cognition onto technohuman networks (e.g., it creates a model by rejecting some data, and keeping some, based on a set of rules designed for internal coherence).
- Like a brain, it combines bottom up active data management with top down algorithmic direction
- It creates narratives, coupling its chosen model to human cognition using non-rational pathways predicated on human cognitive patterns.



#### It Isn't About Cyber; It's About Cognition

- Telepathy chips and "mindplexes":
  - Create structures of selfhood consisting of integrated human brains at many different levels of complexity (tech basis: telepathic brain chips, now in research stage).
  - Big Data state: cloud mindplexes with independent learning power, coupled to multiunit functionality (aka individuals).
  - Dystopia: pop-up adverts in the brain
  - And . . . Who owns the data? Who owns the software, especially when it's integrated tech/human individuals? You got copyright on that?



#### **Elements of Cognition**

- Cognition is contextual process: can be conscious, unconscious, "human," "artificial," or completely alien.
- Perception, attention, awareness
- Differentiation between, and synthesis of, stimuli
- Memory
- Judgment, reasoning, planning, problem-solving
- Emotion
- Information to feed into cognitive processes



#### Human Cognition

- We are wired to be low bandwidth most functioning is done subconsciously, and brain probably consumes maximum energy possible without causing tissue damage:
  - Brain is 2% of body, but consumes 20% of energy
  - Newborns: brains consume 65% of energy
  - 80% of genes code for brain and its functions
  - At least 100 billion neurons in typical human brain
  - At least 300 trillion synapses



#### Human Cognition

- Limited bandwidth and time constraints lead to evolutionary heuristics, so human cognition is a kludge – hence behavioral economics and evolutionary psychology
- At the margins, especially with complexity, it fails. Why shouldn't it? It's metabolically expensive, and you don't need it on the veldt.
- Evolution has pushed Cartesian cognition about as far as it can go.



## Cyber is Cognitive Telescope on New Worlds

- Big data and analytics allows people to perceive complexity they otherwise could not.
- Primary examples:
  - Genomic data and coupling to environmental and disease states
  - De-extinction and genetic engineering
  - Climate change and biodiversity shifts
  - Patterns of behavior spun off by terrorists
  - Integrated swarm robots and humans on battlefields



#### Cyber Infrastructure: Moore's Law Across the Entire Technological Frontier

- Neuromorphic chips memory and computation simultaneous and distributed across chip, rather than sequential, with substantial energy and time savings
- Quantum computing
- "deep learning" hierarchical networks, mimicking human wiring (e.g., vision system, with processing at many different levels)
- AI from expert systems that degrade rapidly outside bounded design expertise to General AI
- Real world cognition from Cartesian to techno-human networks



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## Cyber Isn't Another Domain: It's the Dawn of AI (Alien Intelligence)

- Cyber systems are not just better ways of doing human cognition; they are a significant evolution of cognition beyond the human
- Beyond human cognition not just in scale and complexity, but in fundamental structure: AI, for example, won't have the evolutionary kludges that human intelligence requires
- Techno-human cognitive systems are not Artificial Intelligence, but Alien Intelligence – and cyber security is the tip of the Al iceberg.



### The Dawn of Alien Intelligence

- The framing of human versus artificial intelligence is obsolete; we are evolving into a world where cognition occurs in techno-human systems at levels of complexity and functionality inaccessible to human cognition, although we can intend and perceive the results (e.g., NSA and EU detection of terrorist patterns).
- Merging of intelligences regardless of substrate?



## Welcome To the Age of Alien Intelligence

- The challenge of cybersecurity is that the individual human as the primary operative cognitive structure of the world is obsolete.
- You may have agency, but because you cannot possibly have the relevant data, you – the Cartesian individual mind - are evolutionarily dead.
- The person that controls the narrative controls reality that's the US Presidential race, and that's Crimea, and that's cybersecurity.
- The cyber world is multiple realities, and the winner is the one with the fastest and most potent narrative



## Life in a Scifi Novel

- We are creating techno-human mind from the ground up, from inside.
- The unaided human mind is incapable of directly perceiving, much less understanding, the techno-human cognitive systems that we are creating.
- It is the first chapter of a scifi novel, and evolving cognition, not cyber as a domain of conflict, is the real theme.

