

# Technology Convergence and National Security

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**To Be Determined**

T.B.D.

# Outline

- Part 1: National Security
- Part 2: Technology Convergence
- Part 3: An example

# Part 1: National Security

# What is national security?



Global

## War

- Conventional engage.
- Nuclear deterrence
- Military containment

## Environmental

- Resource conflicts
- Sustainable dev.
- Ecomigration

Destructive

Constructive

## Homeland

- Terrorism
- Crime

## Human need

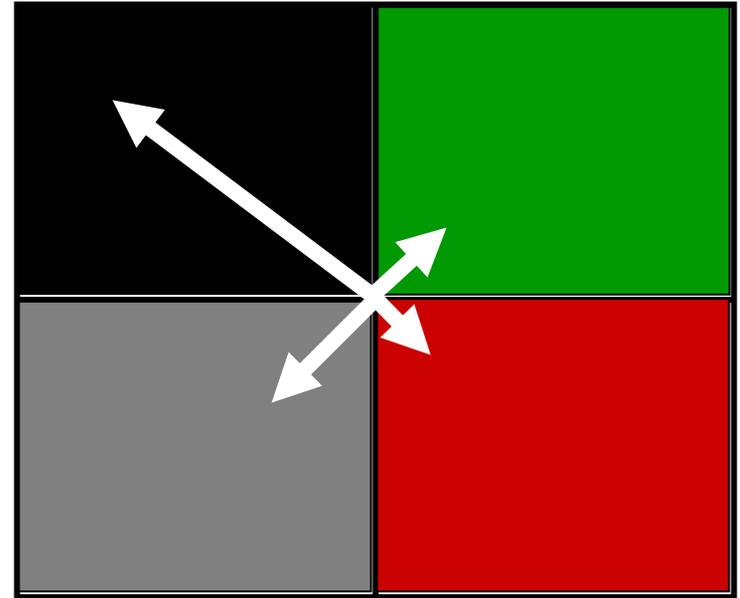
- Prosperity
- Health care
- Education



Local

# Basic thesis

- Breakdown in Red and Green leads to conflict in Grey and Black
- Prevention is more efficient
- Do we have the right balance of effort?

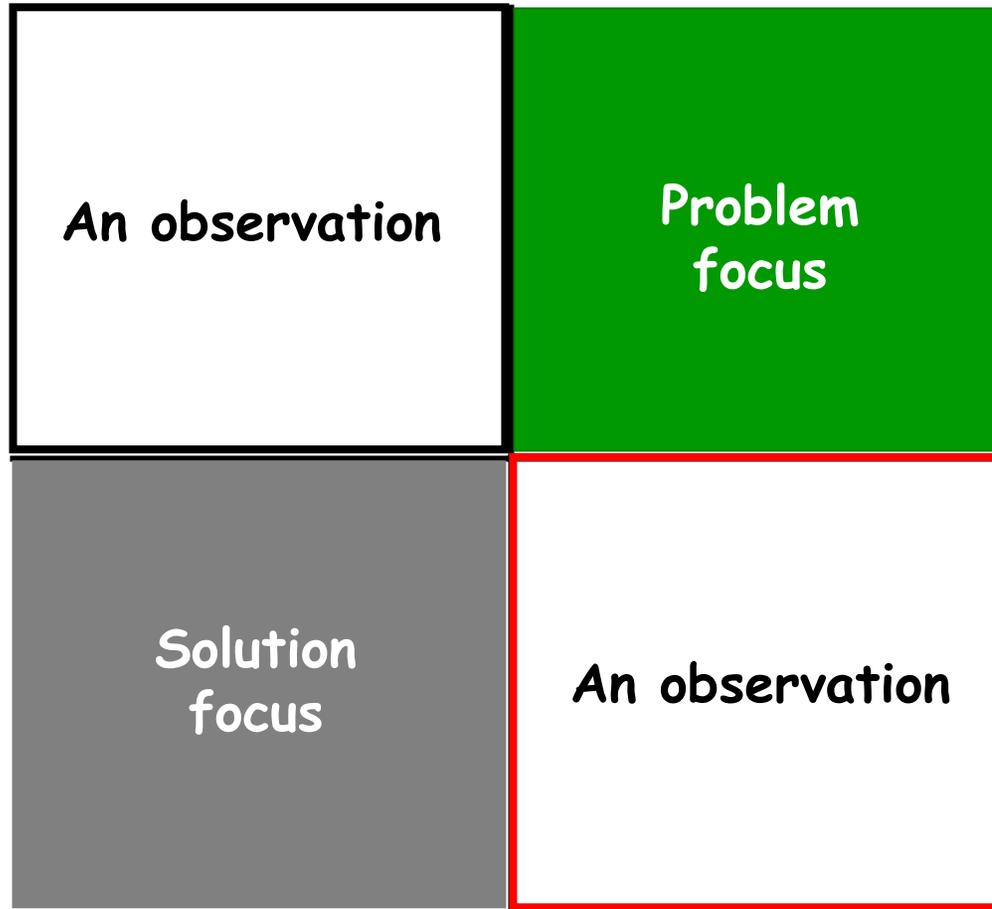


Current relative effort

# Basic algorithm

- Describe the problem in full dimension
- Understand the threat
- Work back from the future
- Formulate a systems solution
- Choose the leverage point
- Apply technology if appropriate

# A sampling of the space



# Red: Some perspective

## Deaths worldwide, 1900-2000

Warfare	37m
Government action	170m
Smallpox	>300m
Infectious disease	few billion
All causes	~10B

# Black: Historical cycles

Era	Crisis	Period	Peak	Yrs. since previous
Late Medieval	Wars of Roses	1459-1487	1485	
Reformation	Armada Crisis	1569-1594	1588	103
New World	Glorious Revolution	1675-1704	1689	101
Revolutionary	American Revolution	1773-1794	1781	92
Civil War	Civil War	1860-1865	1863	82
Great Power	Depression & WWII	1929-1946	1944	81
Millennial	Millennial	2005-2026?	2024?	80?

# Green: The Malthus challenge

2000: 6B people, \$30T economic output

2025: 8B people, \$60T economic output

2100: Expect ~2X as many people,  
Expect ~5X per capita consumption

*Implies an order of magnitude greater  
environmental stress on the planet*

# One perspective

“The political and strategic impact of surging populations, spreading disease, deforestation and soil erosion, water depletion, air pollution, and, possibly, rising sea levels ... will prompt mass migrations and, in turn, incite group conflicts ... and **become the core foreign policy challenge from which most others will ultimately emanate**”

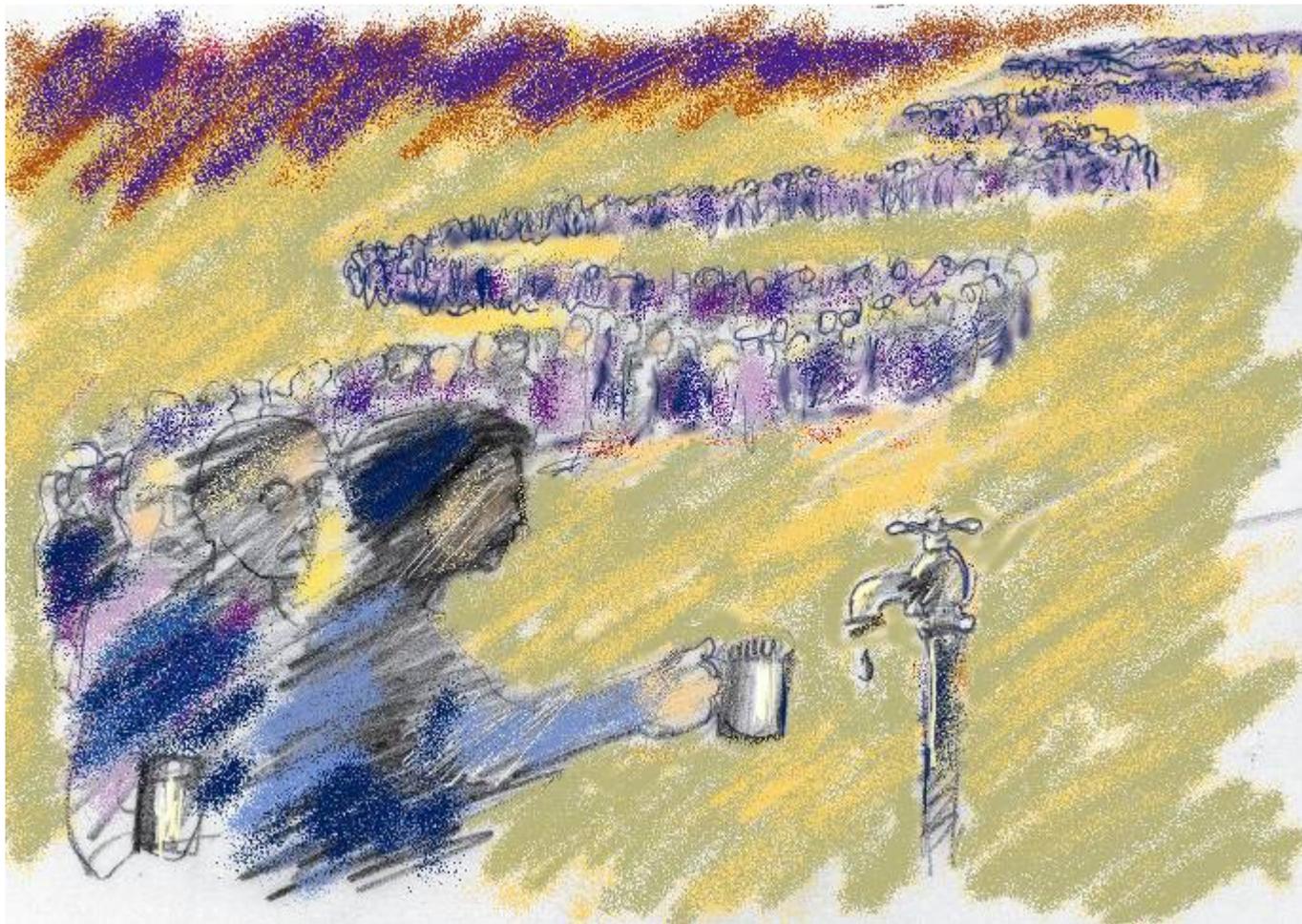
“It is time to understand “the environment” for what it is: ***the national security issue of the early twenty first century.***”

- Robert Kaplan,  
The Atlantic Monthly

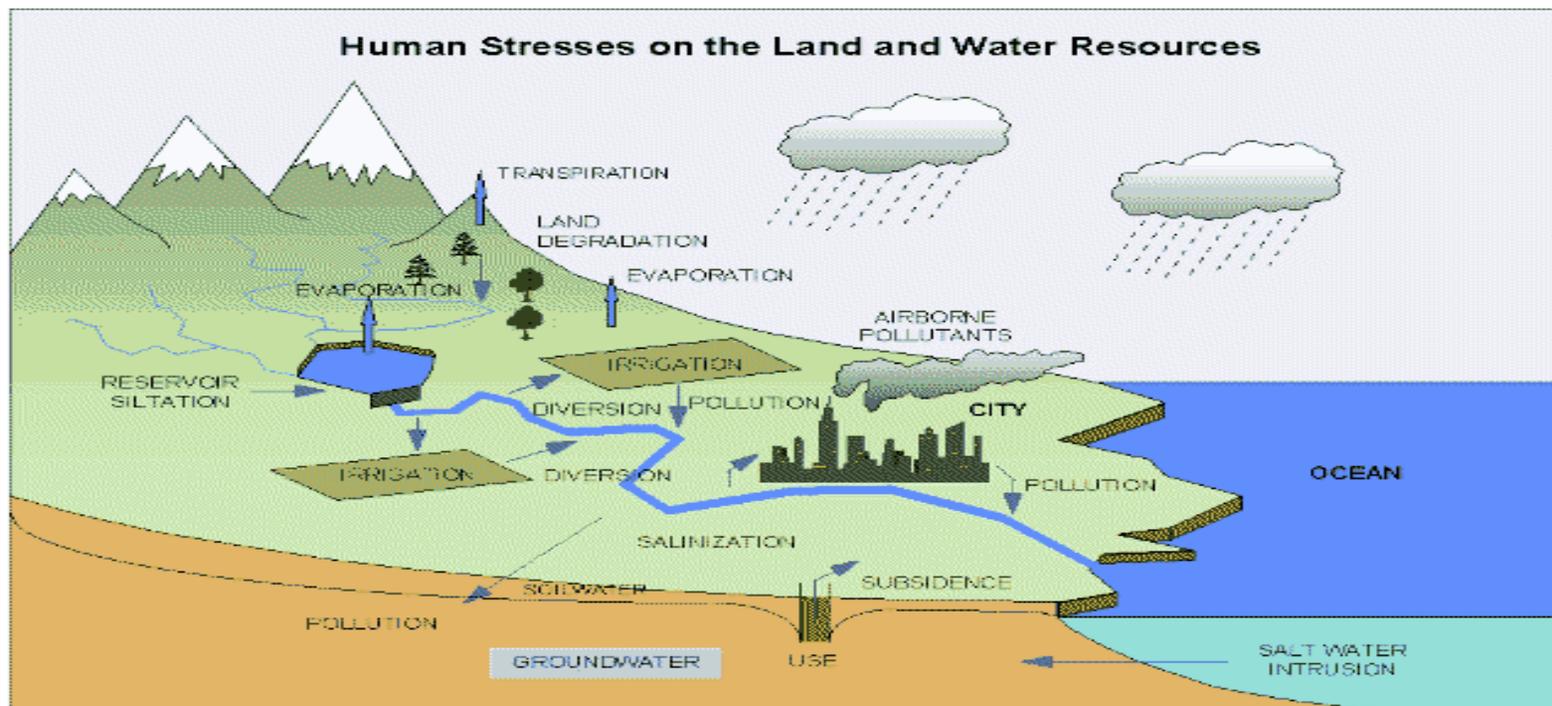
# The national security connection

- Green links to NS directly through
  - Impact on our health, safety & prosperity
    - e.g. ozone and fishery depletion
  - Conflict over resources
    - e.g. with China over green house gas emissions or the pollution plume approaching the West Coast
  - Strategic linkage
    - e.g. defense agreements and deployments to protect access to oil resources in Middle East
- And indirectly through
  - Ecomigration leading to conflict
    - e.g. India/Bangladesh
  - Destabilization of critical regions
    - e.g. Turkey/Syria

# For example: The freshwater shortage ...



# ... is acute globally



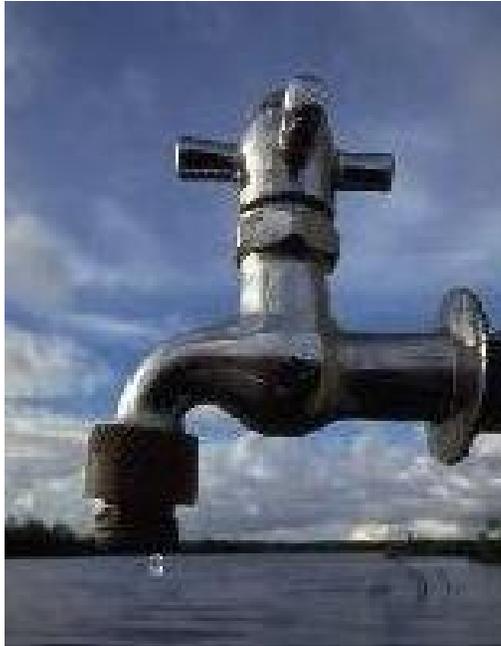
$3.4 \times 10^{12} \text{ m}^3$  captured

----- =  $340 \text{ m}^3/\text{person}$

$10 \times 10^9$  people

WHO: <1700 Stress; <1000 Shortage; <500 Crisis

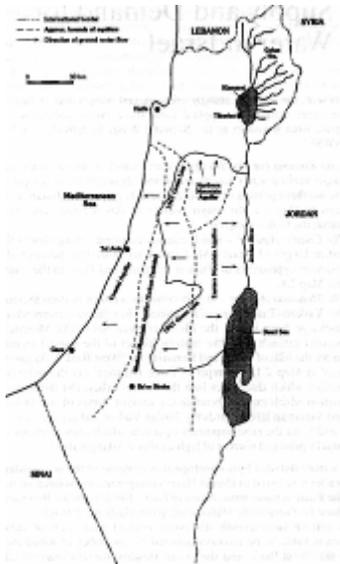
# Which means ...



- 80 Countries with 40% of the world population suffer from water shortage
- 1 billion people drink unsafe water each day
- A child dies every eight seconds from contaminated drinking water
- Countries with the highest population growth rates have inadequate resources
- Increased regional tensions and ecomigration

# Two case studies

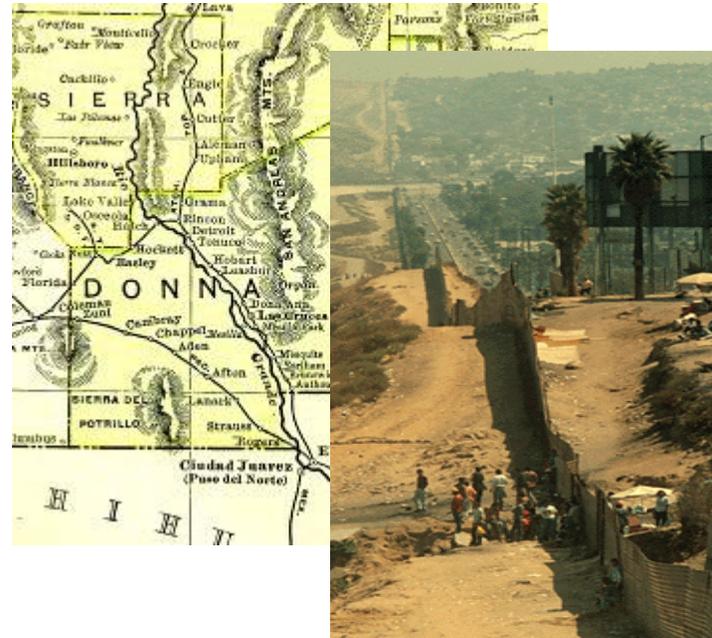
## Middle East



Water avail. (m <sup>3</sup> /cap)	1990	2025
Israel	470	310
Jordan	260	80
Saudi Arabia	160	50

> 95% of available water in use

## US/Mexico



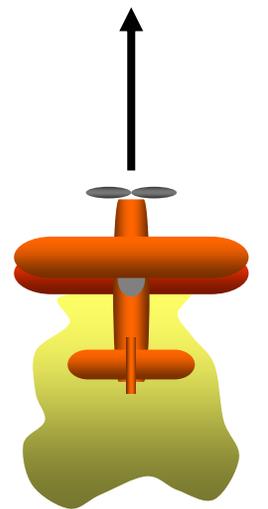
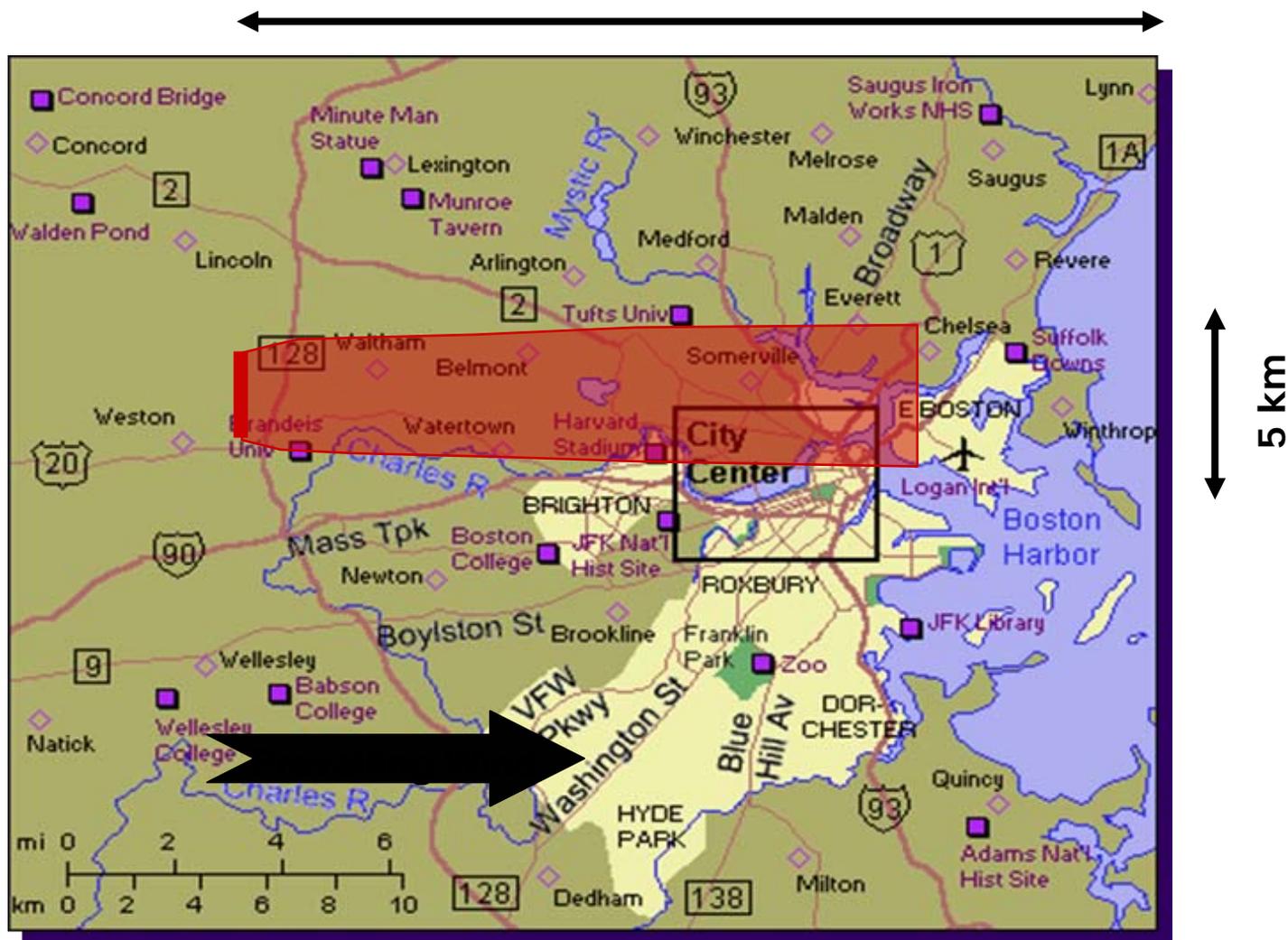
4.8M people living along border  
 900,000 ecomigrants/year  
 2250 km<sup>2</sup> of farmland are lost/year  
 Water table dropping 1-3 / year

# Gray: Clear and Present



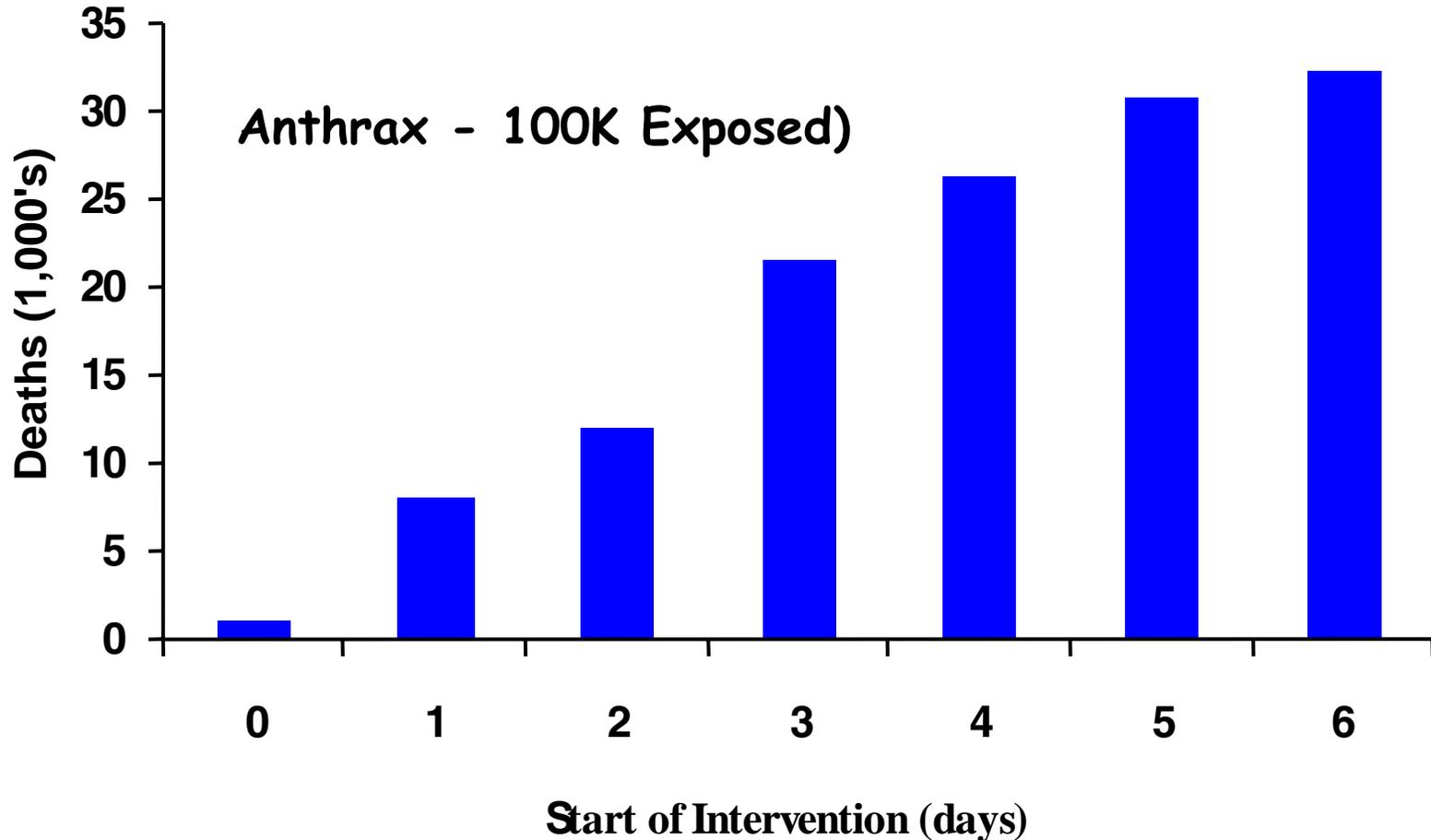
# Effective bio-attack appears feasible

20 km

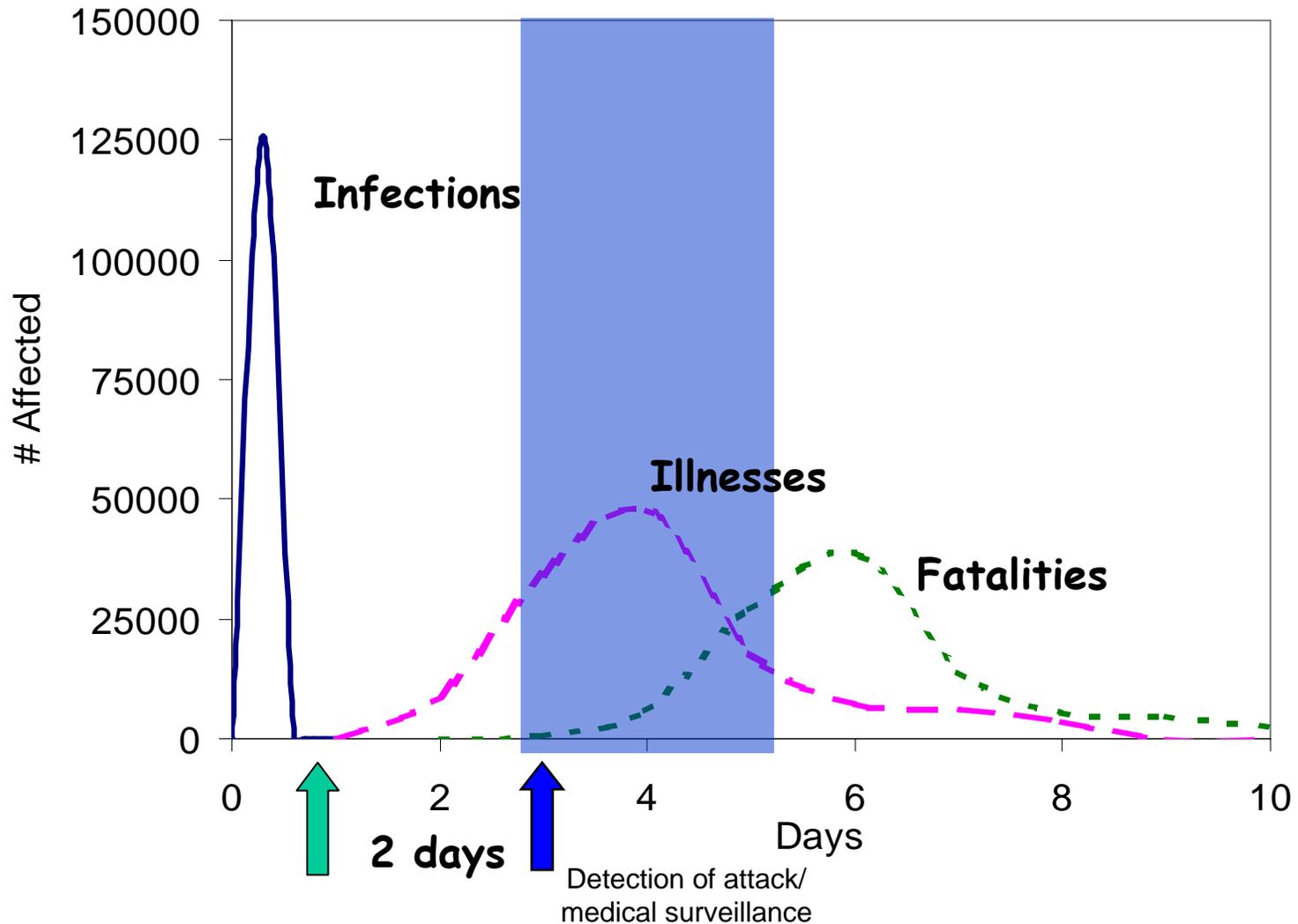


“Bio-ICBM”

# Early action is key



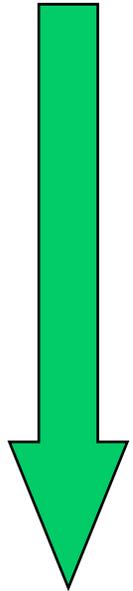
# ... but difficult



# Note

- Our competence is predominantly in the physical sciences
- The new threats depend strongly on
  - Informational awareness
  - Biology
  - Ecology
  - Individual psychology
  - Small group behavior
  - Social, political and cultural dynamics

Decreasing  
familiarity

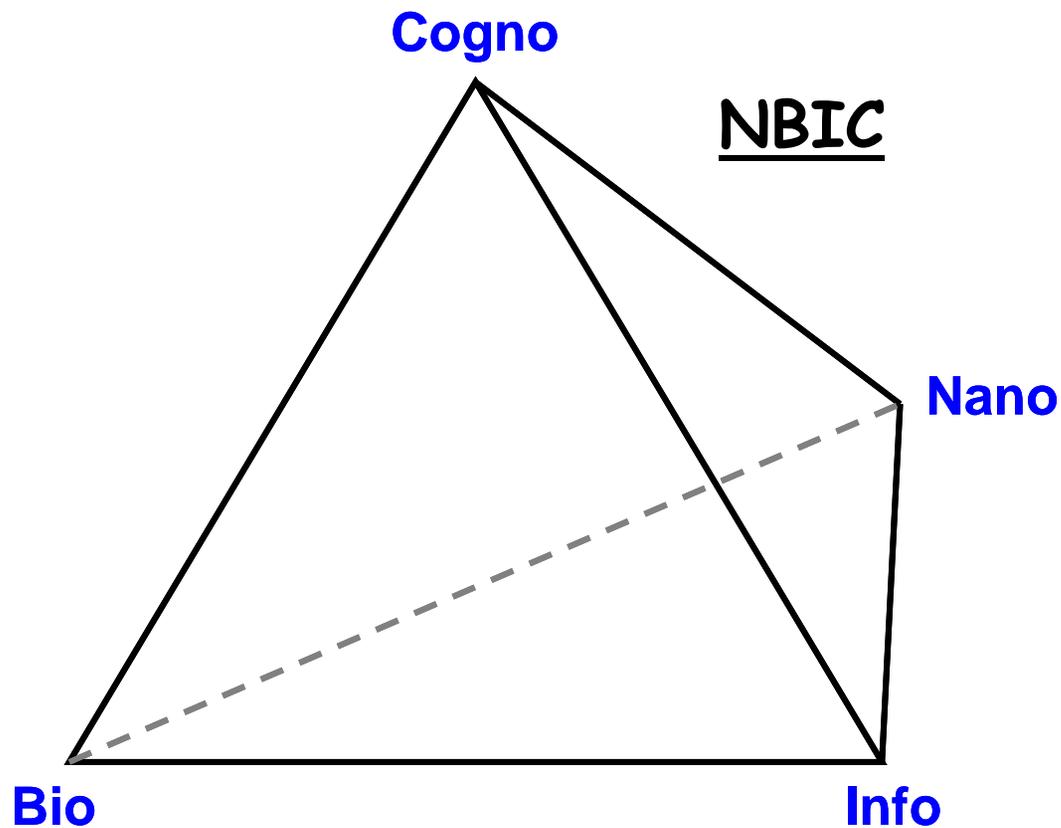


# Part 2: Technology Convergence

# What is convergence?

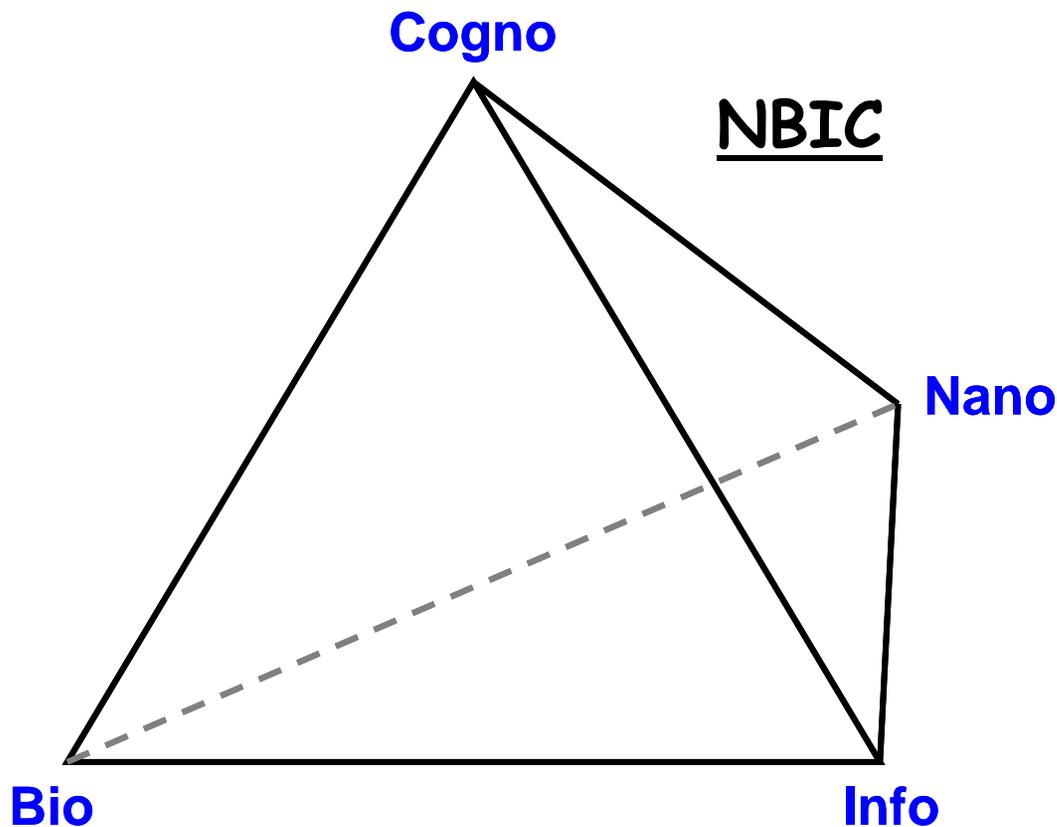
Generation index	Technological Event
-10,000	Tool use
-500	Drawing
-400	Agriculture, writing
-40	Universities
-24	Printing
-16	Modern scientific method, accurate clocks
-10	Industry
-5	Telephone
-4	Radio
-3	Television
-2	Digital computers
-1	Space age, microbiology
-.5	Internet, nanoscience
0	?

# One answer



# One answer

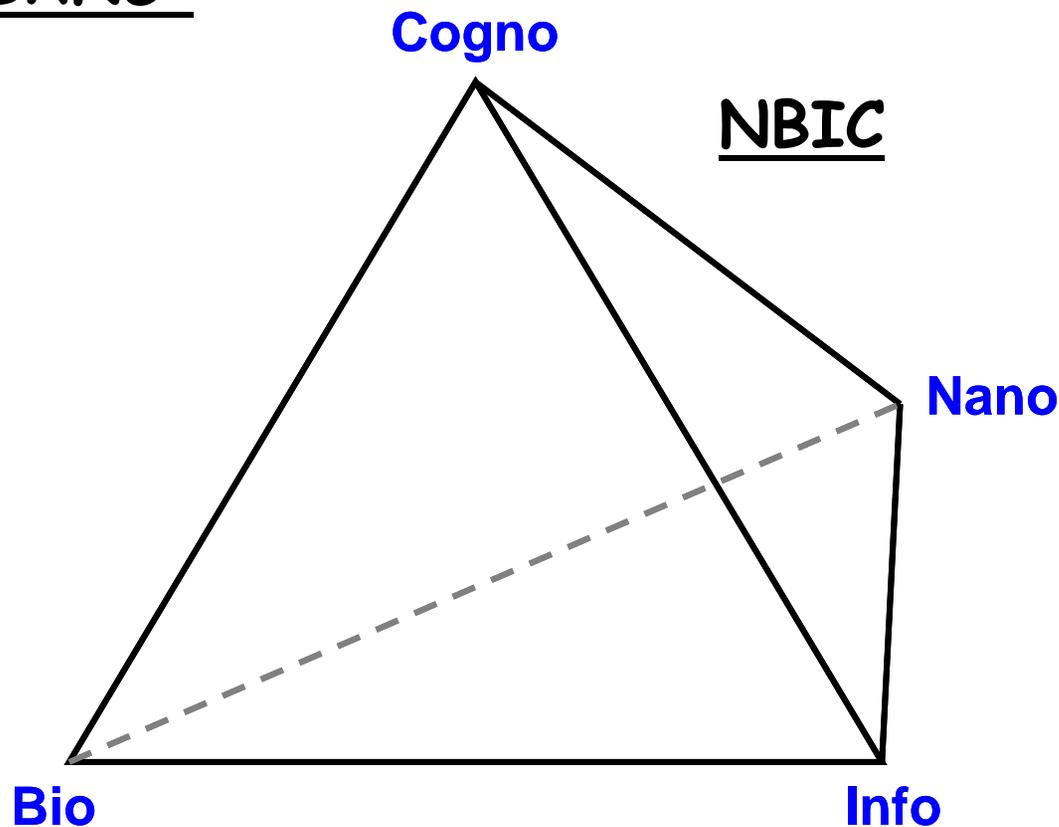
- Bits
- Atoms
- Neurons
- Genes



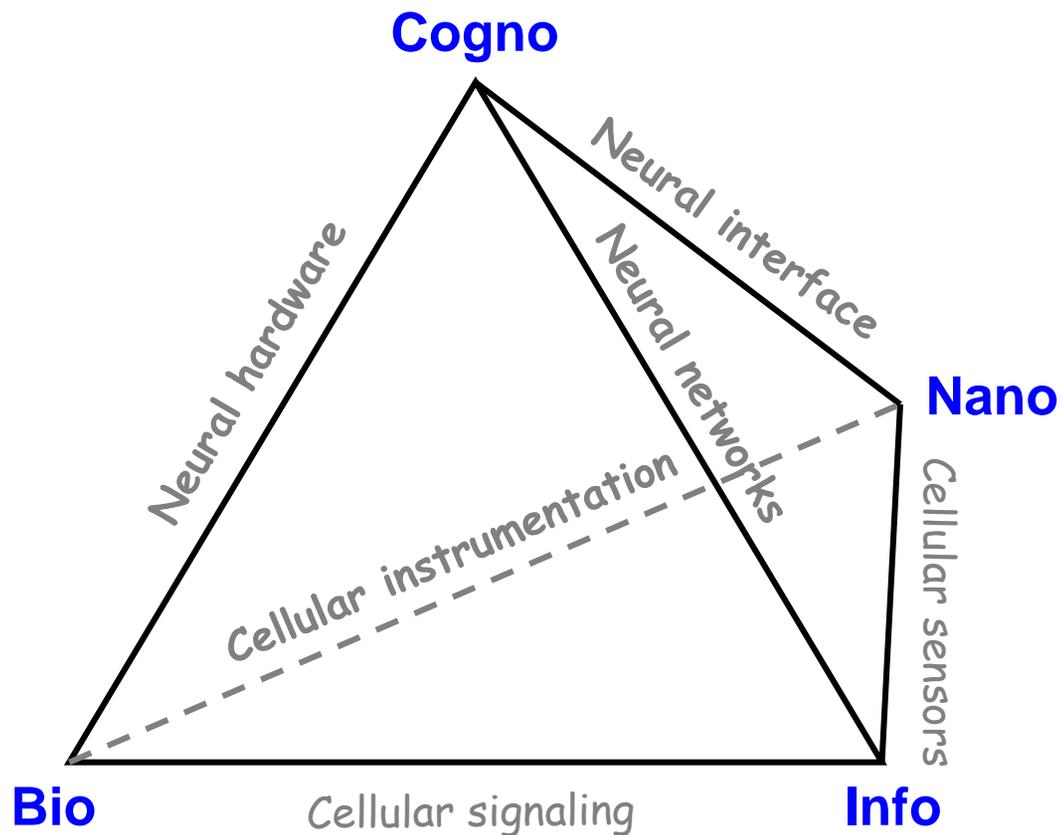
# One answer

## The little "BANG"

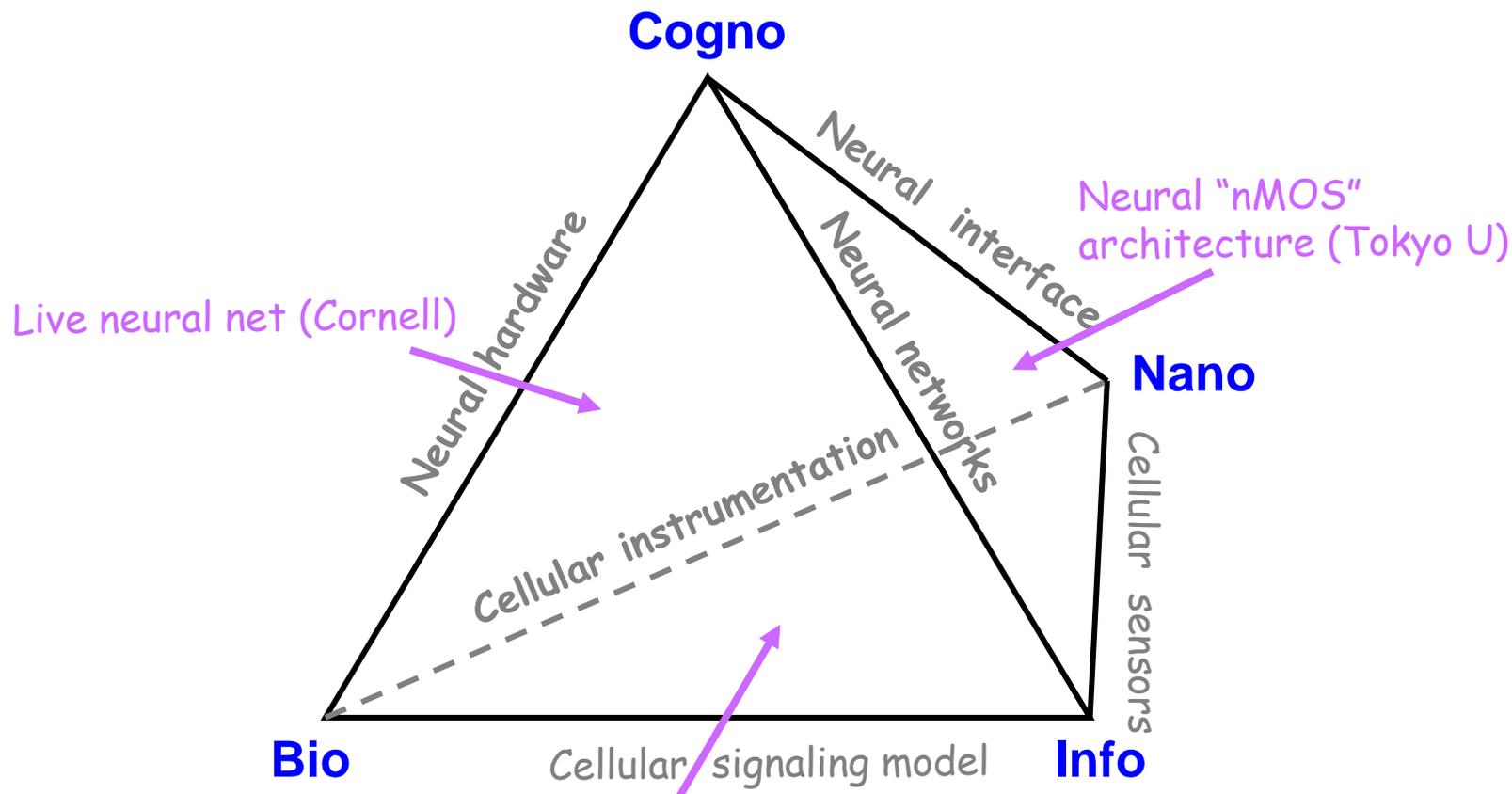
- Bits
- Atoms
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# Edge examples



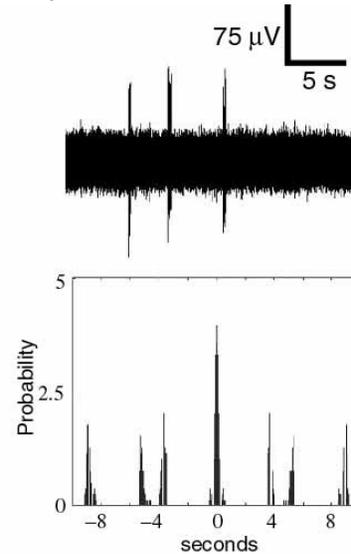
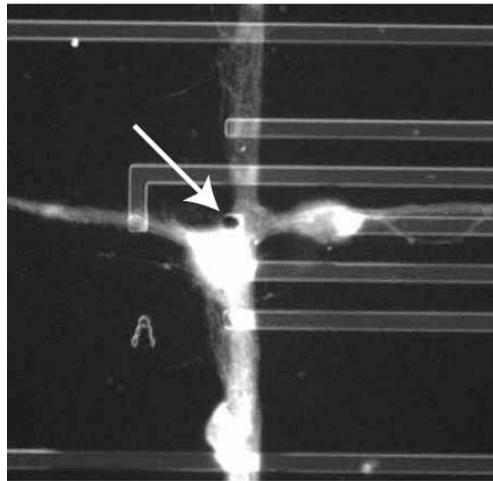
# Plane examples



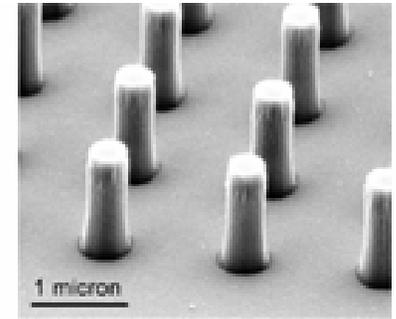
- Neuron "tunnel" (SNL)
- "Digital" antibodies ... viral sized logic chips (HP)
- Tissue based and in-vivo sensors
  - nanotube monitors in brain blood vessels (NYU)
  - optical nanosensors for chemical analysis within cells (U Mich.)
- DNA regulated nano assembly of circuit devices (U Minn.)

# Neuromorphic-nano engineering

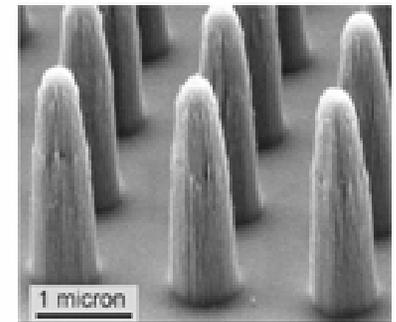
Craighead Group, Cornell University



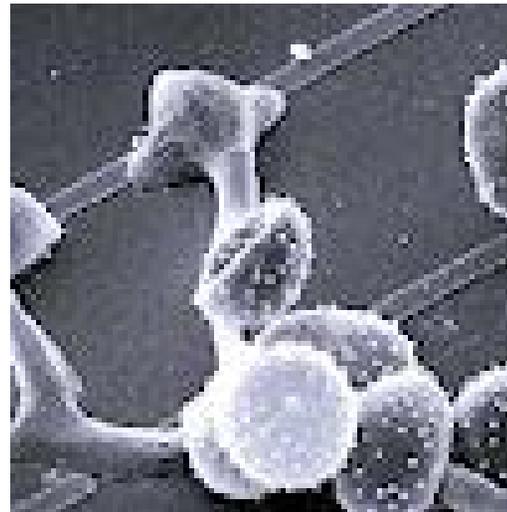
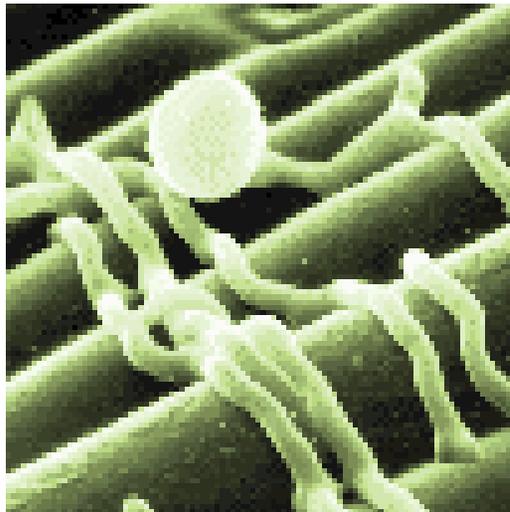
Series A



Series B

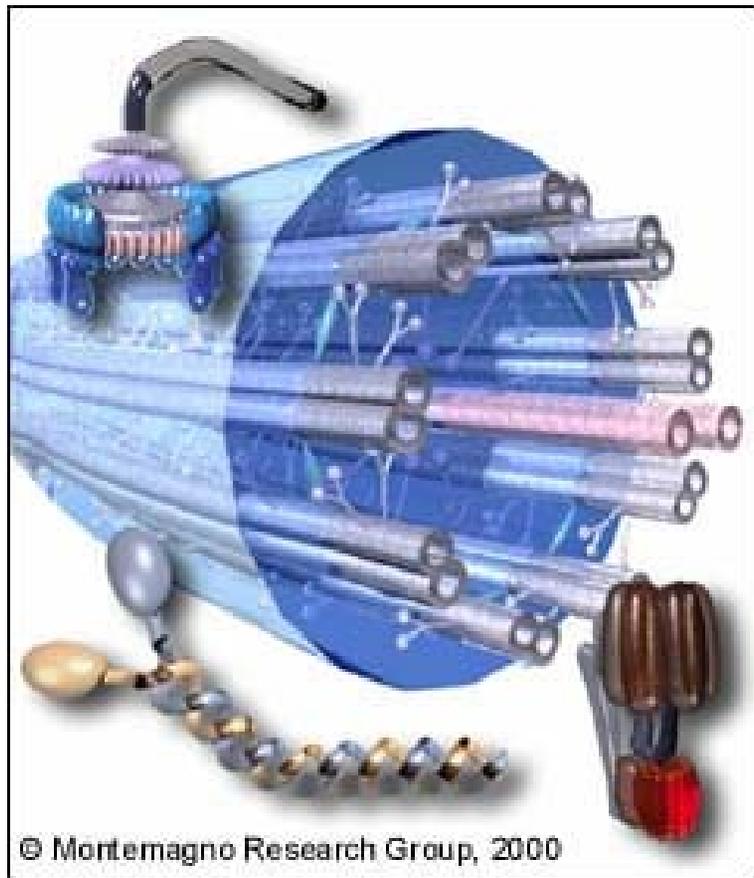


Scanning Electron  
Micrograph

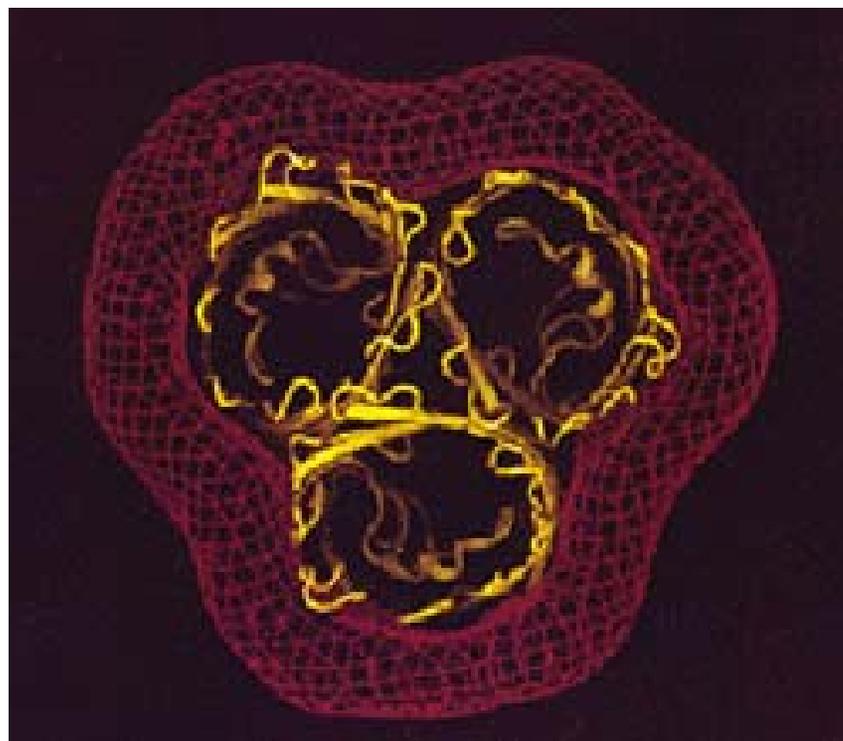


# Biomechanical-nano engineering

Montemagno Group, UCLA



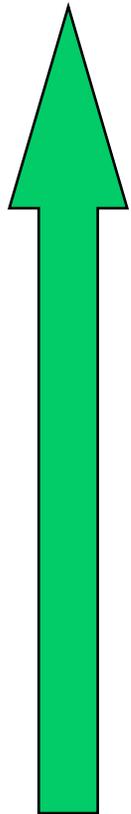
ATP-ADP motor



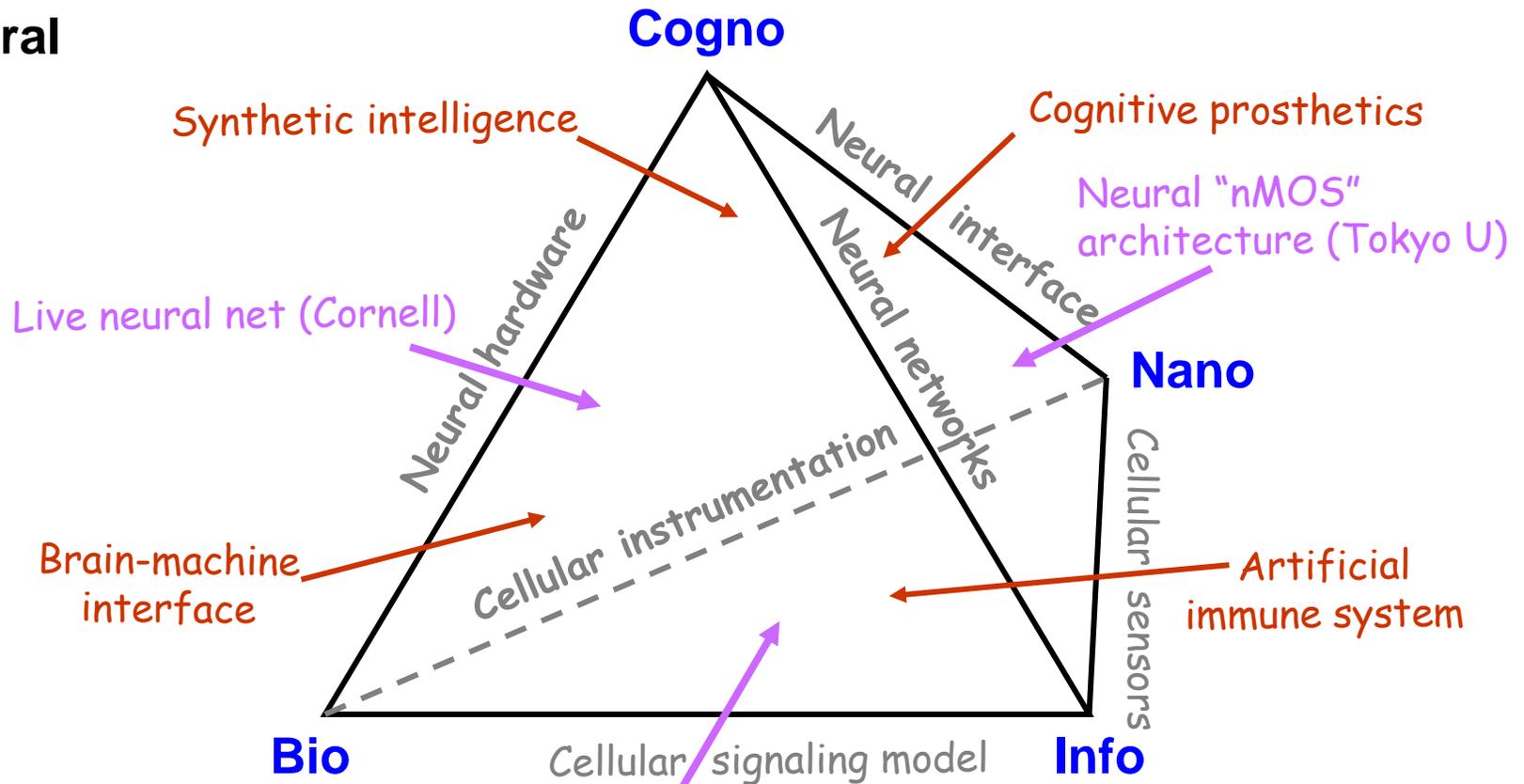
Voltage gated nano-valve

# The "cognohedron"

Behavioral



Physical



- Neuron "tunnel" (SNL)
- "Digital" antibodies ... viral sized logic chips (HP)
- Tissue based and in-vivo sensors
  - nanotube monitors in brain blood vessels (NYU)
  - optical nanosensors for chemical analysis within cells (U Mich.)
- DNA regulated nano assembly of circuit devices (U Minn.)

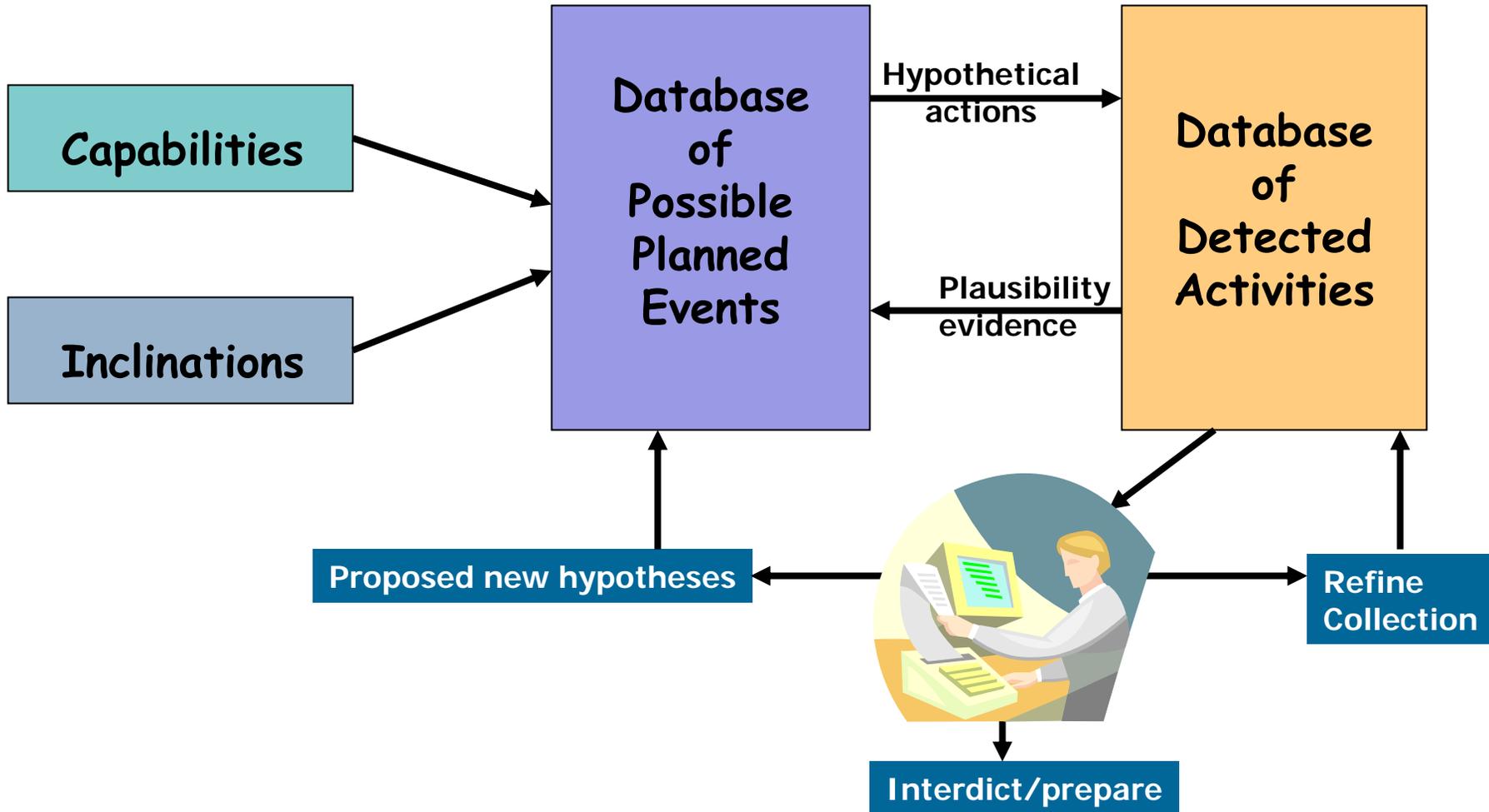
# Part 3: Terrorism detection as an example

# An assessment of the need

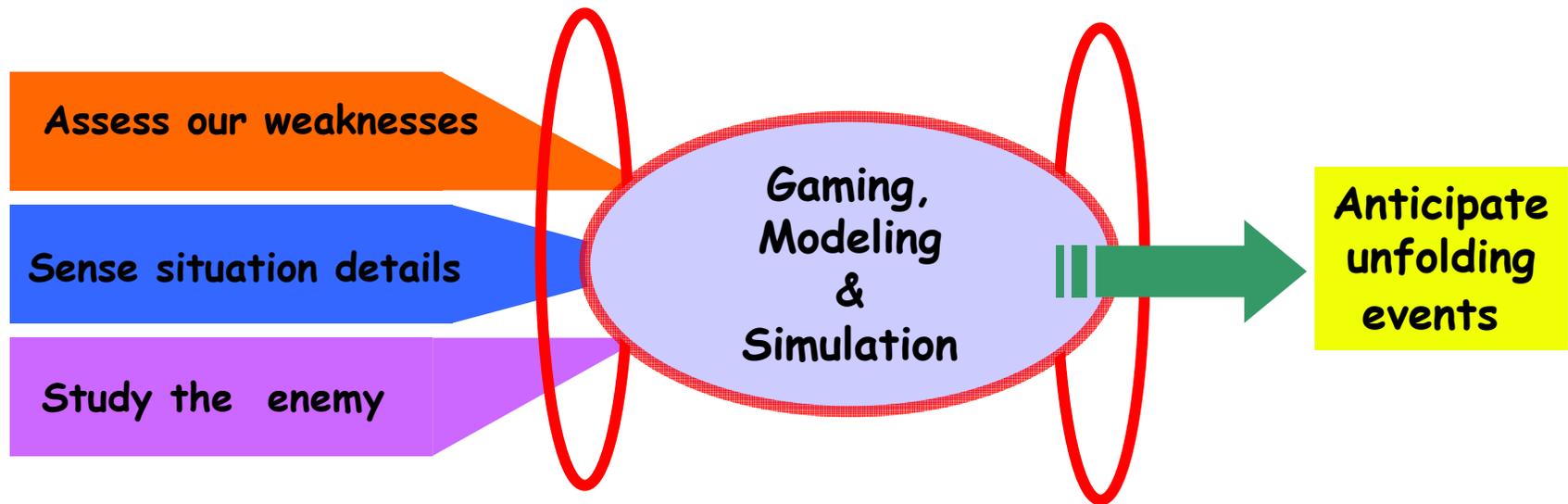
*“Nothing will be more important to the success of the campaign against terrorism than meaningfully improving the intelligence community’s capabilities and performance” -CSIS*

- Interpreters and analysts with language skills
- Better intelligence filtering and fusion
- Automated conversion of intelligence from paper to electronic form
- Greater use of open sources for intelligence
- More use of red teaming
- Greater investment in technology research and development
- More staff and resources to cover simultaneous threats
- ... etc.

# Terrorism detection architecture



# Understanding and anticipating the threat



The quest to avoid surprise will require optimal use of humans and machines

# Three types of terrorism gaming

## Hunter Games

- developing scenarios for intelligence analysis
- experimenting with tools for information extraction and analysis

## Policy Games

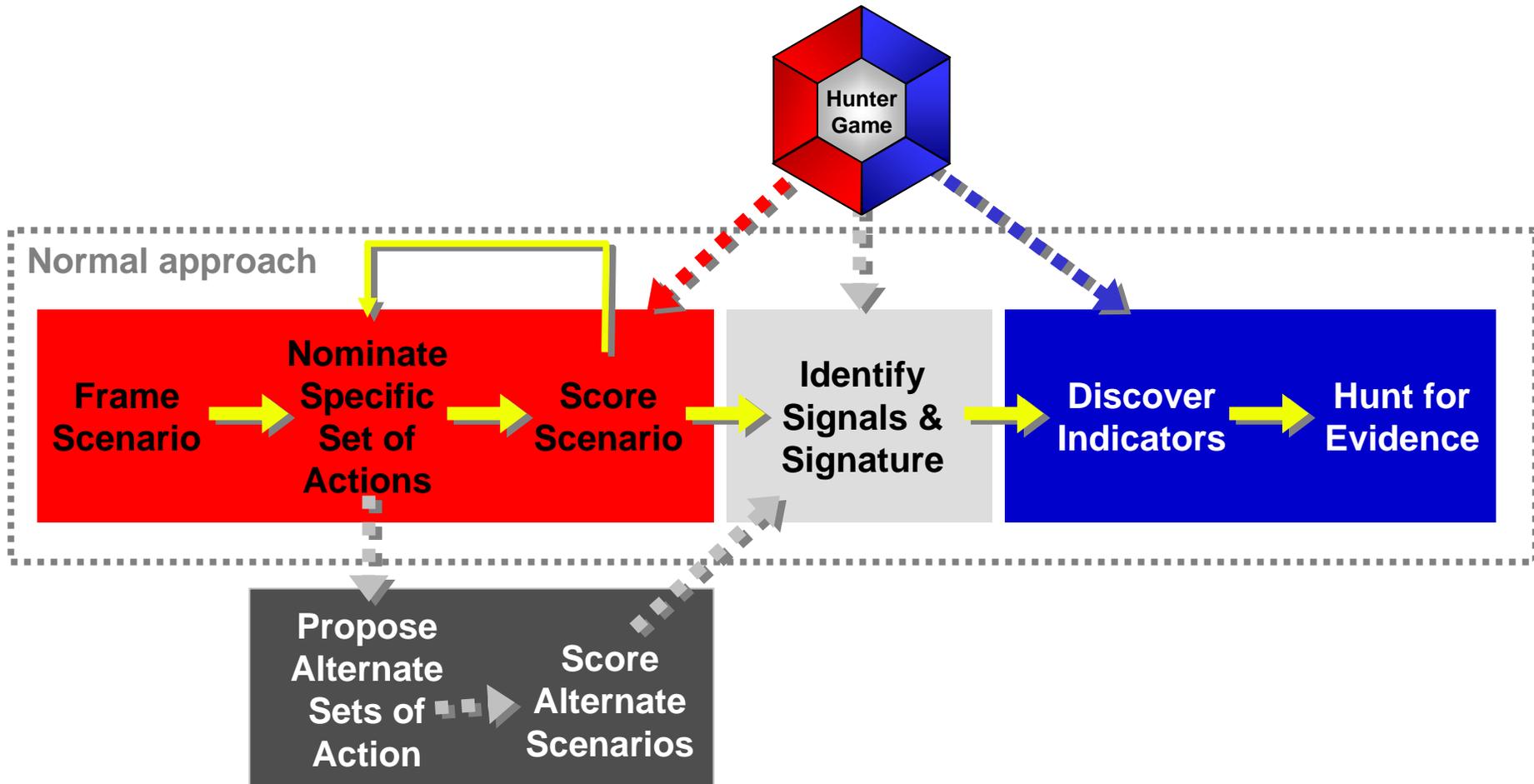
- exploring counterterrorism strategies
  - deterrence, disruption, dismantlement...
  - economic, political, military...
  - national and international law

## Responder Games

- providing realistic experience for defenders
- assisting response planning
- exploring future defensive tools

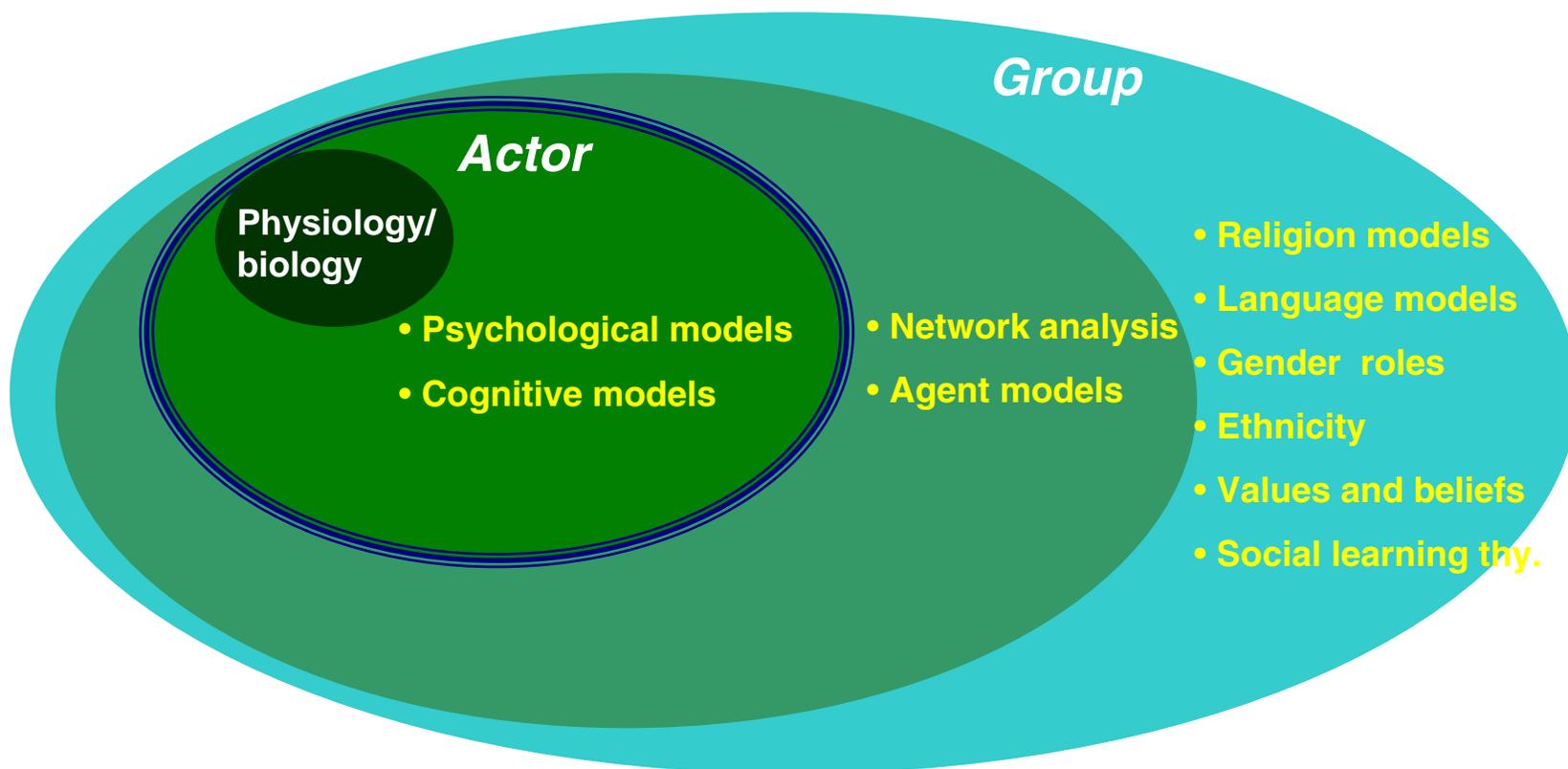


# Scenario-driven data mining



# Social prediction challenge

*How to model behavioral phenomena computationally?*



# Social/psychological simulation approach

- Underpin approach with social theoretic framework
  - ✓ Social Learning Theory
  - ✓ Terrorist Management Theory
- Develop computational formalism for modeling socio-psychological systems:
  - ✓ Agent-Based Modeling
  - ✓ Social Network Analysis
  - ✓ Cognitive Models
- Guide model development with data classification using neural networks
- Validate approach on data-rich analog: *street gangs*

# Summary thoughts

- Our concept and sense of national security will change dramatically over the next decade
- An emerging confluence of key technologies will prove vital in addressing the coming challenges
- Our community has a pivotal role to play in that confluence.
- We should think more broadly and creatively, and to understand better the “softer” sciences.

# Acknowledgements

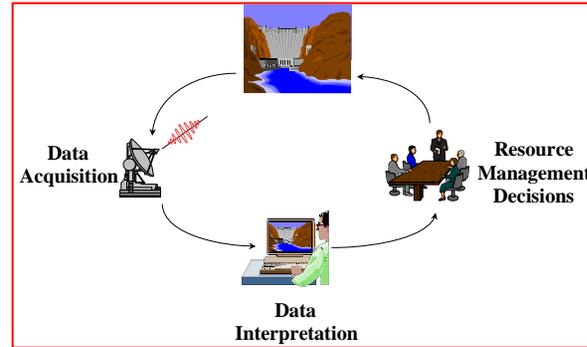
Reference/Credit
Threat space mapping - SNL Advanced Concepts Group/Gerry Yonas
Conflict deaths - <i>The Economist</i> ; Disease deaths- Al Zelicoff; total deaths - a simple exponential growth model
Population/Economic figures for 2000/2025 - <i>WorldWatch/Homer-Dixson</i>
Historical crisis chart (adapted) - <i>The Fourth Turning, Strauss &amp; Howe</i>
Threat illustrations - ACG/Ken Miller
Convergence in time - <i>NSF NBIC report</i>
The cognohedron/NIBC - ACG/Rob Leland
<i>The Big Down</i> , ETC Group - BANG name for NIBC
<i>To Prevail: An American Strategy for the Campaign Against Terrorism</i> ; Campbell and Flournoy, CSIS.
Terrorism detection architecture - ACG
Sensor element concept - ACG/Ron Pate
Behavior modeling paradigm - ACG/Ben Wu

# A system solution

## Stakeholder Collaboration



## Monitoring and Information System



## Evaporation Suppression



## Protected Agriculture



## Reuse technologies



## Alternate Development