

PROCEEDINGS OF SPIE

***Evolutionary and Bio-Inspired  
Computation: Theory and  
Applications III***

**Teresa H. O'Donnell  
Misty Blowers  
Kevin L. Priddy**  
*Editors*

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- 4 Advanced Approaches for Image and Audio Processing  
**Michael Peterson**, University of Alaska Anchorage (United States)

- 5 Space Situational Awareness  
**Adrian Stoica**, Jet Propulsion Laboratory (United States)
- 6 Design and Optimization of Systems and Components  
**Hugh Southall**, Air Force Research Laboratory (United States)
- 7 Advanced Sensors and Sensing Systems  
**Olga Mendoza-Schrock**, Air Force Research Laboratory (United States)



## Introduction

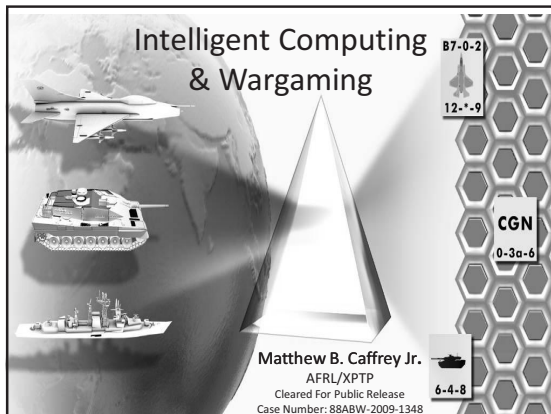
The “Evolutionary and Bio-Inspired Computation: Theory and Applications” conference was back by popular demand, settling into its third year at the Defense, Security, and Sensing 2009 symposium. Several interesting presentations were made by some of the brightest luminaries in the computational intelligence and defense communities, covering such topics as knowledge discovery and understanding, advanced approaches for image and audio processing, space situational awareness, and design and optimization of systems and components. We were especially happy to announce the merger of Kevin Priddy's conference on Advanced Sensors and Sensing Systems to our own. In addition, this year's conference had two engaging keynote discussions, one by Dr. Leonid Perlovsky, titled “Modeling evolution of the mind and cultures,” and another by Matthew B. Caffrey on “Intelligent computing: the key to meeting the most important challenge to defense and service campaign-level wargaming.”

As always, any conference is only as good as the planners, authors, presenters and attendees make it. In that respect, we have yet to see a better mix of all the ingredients. For those of you who attended, we hope you came away a little more enlightened than when you arrived. We sincerely hope you appreciate the papers that follow, and that they serve to foster further research into, and application of, evolutionary and bio-inspired computation. We look forward to seeing you next year at “Evolutionary and Bio-Inspired Computation: Theory and Applications IV,” to be held at the SPIE Defense, Security, and Sensing Symposium from 5-9 April, 2010 in Orlando (Kissimmee), Florida.

**Teresa H. O'Donnell**  
**Misty Blowers**  
**Kevin L. Priddy**



Intelligent computing and wargaming  
Matthew B. Caffrey, Jr., Air Force Research Lab.



Intelligent Computing: the key to meeting the most important challenges to defense and service campaign-level wargaming

**Disclaimer**


The views expressed in this briefing are those of the speaker and do not necessarily represent those of the Air Force Research Laboratory or the United States Air Force.

**Why Listen to Me**

- DoD Civil Servant – previous positions
  - Professor of Wargaming & Campaign Planning, Air Command and Staff College
  - Research Associate, School of Advanced Airpower Studies
- Col USAFR (ret.) - USAFR Assignments
  - Senior Reservist, AF Research Lab's Info Directorate
  - Chief Wargaming, HAF/XOOC (Checkmate)
- Author/Speaker
  - Co-author Gulf War Fact Book
  - Many articles, chapters, hundreds of talks


**Eisenhower's Strategic Dilemma**

"We can lose the Cold War in an afternoon, but we can only win it over decades. Hence we must spend enough on defense to avoid losing it in an afternoon yet little enough so we will win in the long term."

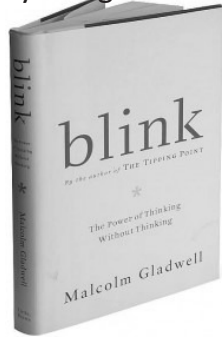


**Today's Strategic Dilemma**

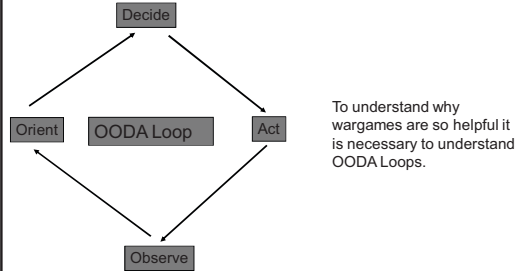
We must spend enough on our current wars to prevent our enemies from gaining safe havens from which to mount a new attack on the US, yet we must spend little enough that our economy and the world economy will recover - making it more difficult for terrorists to recruit.



## Why Wargames Work

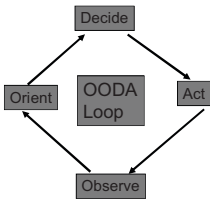


## Why Wargames Work



To understand why wargames are so helpful it is necessary to understand OODA Loops.

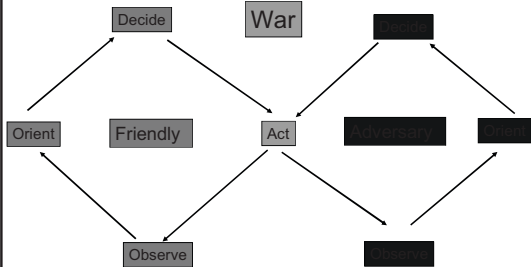
## Why Wargames Work



Boyd predicted, and experience confirms, with experience OODA Loops get tighter and decisions get more effective

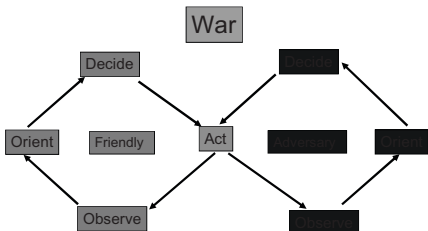
Does this give us an advantage in war?

## Why Wargames Work



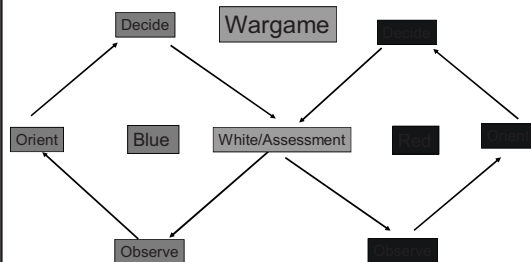
Not necessarily.  
As we go through our OODA Loop...

## Why Wargames Work

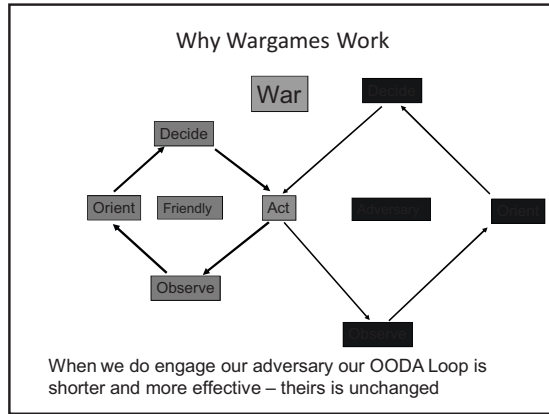
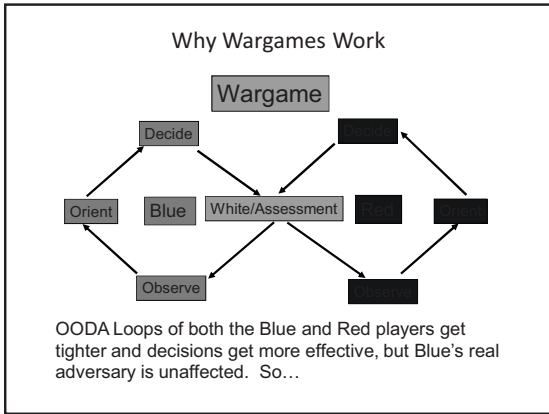


...Our Adversaries go through their OODA Loop, their OODA Loops get tighter and decisions get more effective just as ours do

## Why Wargames Work



Wargames allow their users to improve their decisions and their decision makers without a similar improvement taking place in the enemy



### Solution Found?

No

- Need: Warfare is evolving, wargaming needs to evolve to remain effective
- Opportunity: Advances in computing can enable that evolution and more

### The Evolution of Warfare & Wargaming

- First Generation of War
  - Dawn of civ through medieval
  - Unlimited –people vs. people
- First Generation of Wargame
  - Abstract
  - Develop Strategists
  - down board thinking

### The Evolution of Warfare & Wargaming

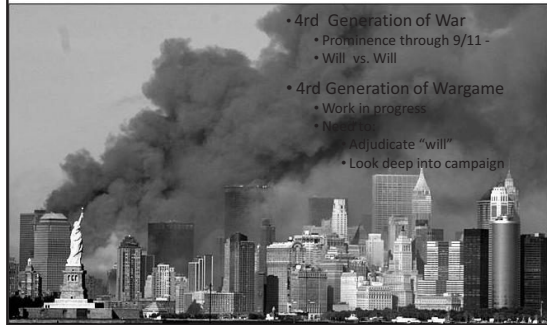
- 2<sup>nd</sup> Generation of War
  - Post 30 Years War -
  - Limited –State vs. State
- 2<sup>nd</sup> Generation of Wargame
  - 1811/1824
  - Professional Development
  - Decision Support

## The Evolution of Warfare & Wargaming



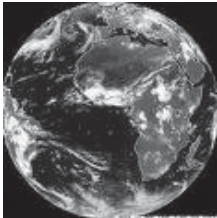
- 3rd Generation of War
  - World Wars -
  - Economy vs. Economy
- 3rd Generation of Wargame
  - Work in progress
  - Need to:
    - Adjudicate effects on and of economy
    - Look deep into campaign

## The Evolution of Warfare & Wargaming



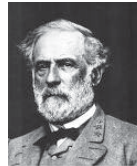
- 4rd Generation of War
  - Prominence through 9/11 -
  - Will vs. Will
- 4rd Generation of Wargame
  - Work in progress
  - Need to:
    - Adjudicate "will"
    - Look deep into campaign

## The Evolution of Warfare & Wargaming



- 5rd Generation of War
  - Full Spectrum Warfare
  - DIME+ vs. DIME+
- 5rd Generation of Wargame
  - Work needed
  - Need to:
    - Adjudicate all effects
    - Look deep into decades

## Why Full Spectrum Warfare

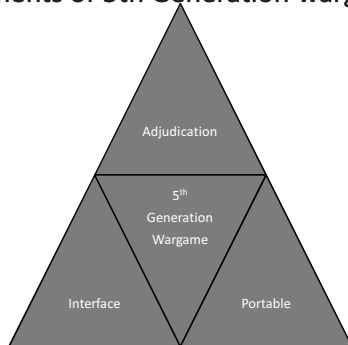


*"Grant will move to the North Anna because that is his best move and Grant will make his best move."*

Robert E. Lee

- Full Spectrum War Works
- Napoleon in Spain
  - The US in Vietnam

## Elements of 5th Generation wargame



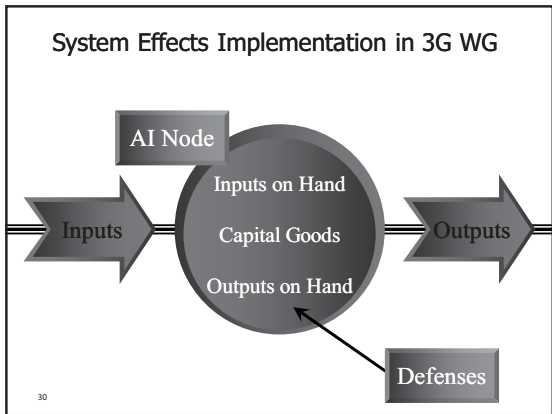
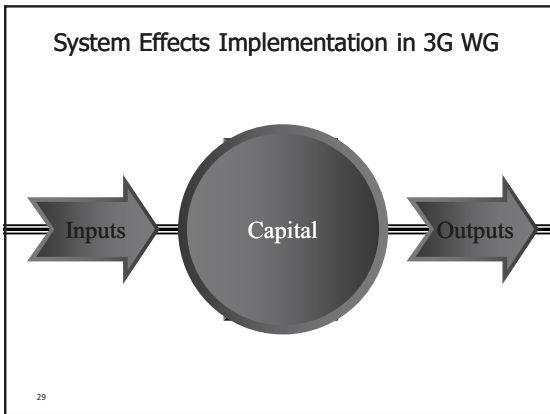
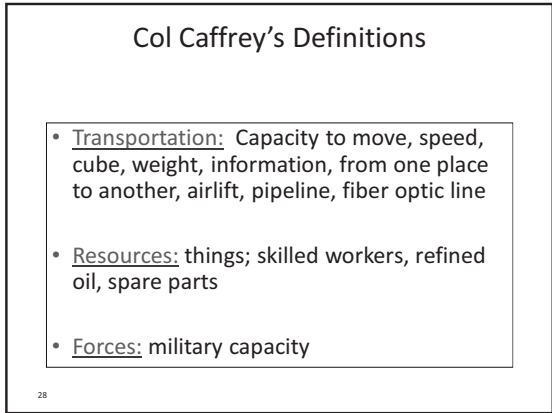
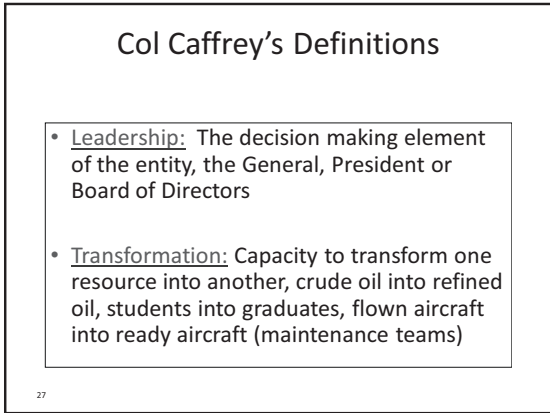
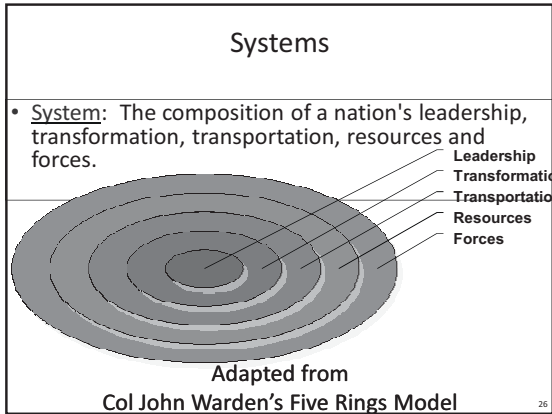
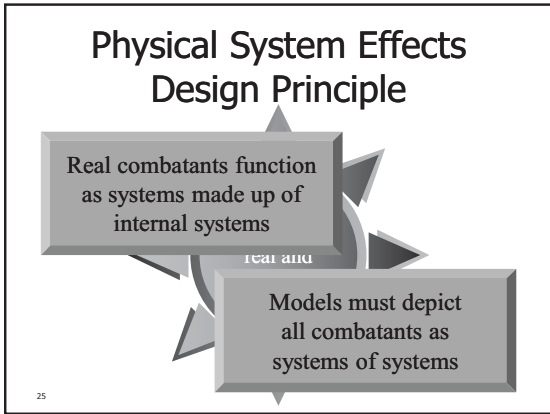
## Elements of 5th Generation Wargame Adjudication

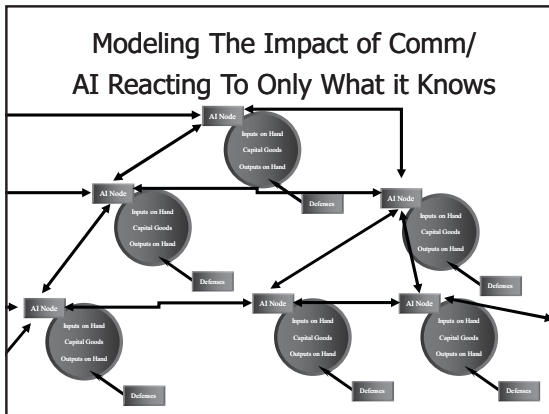
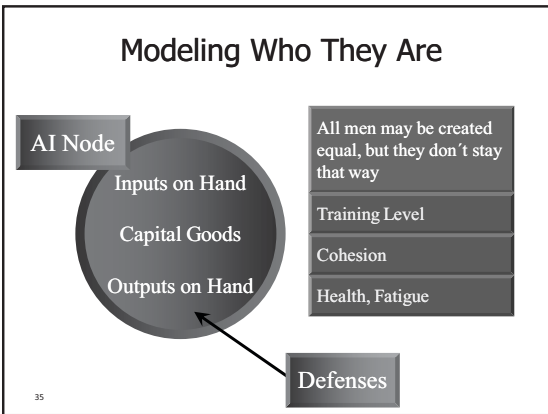
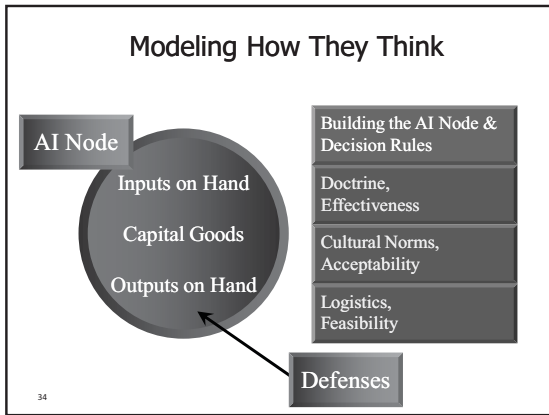
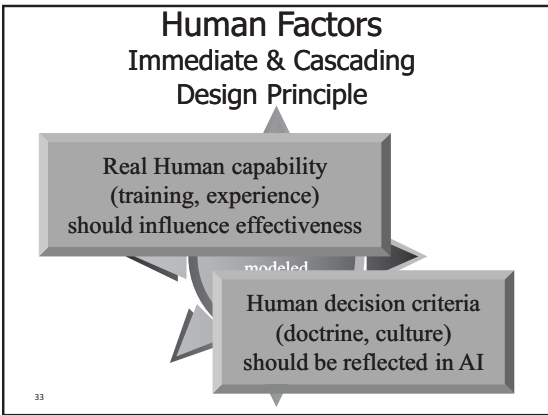
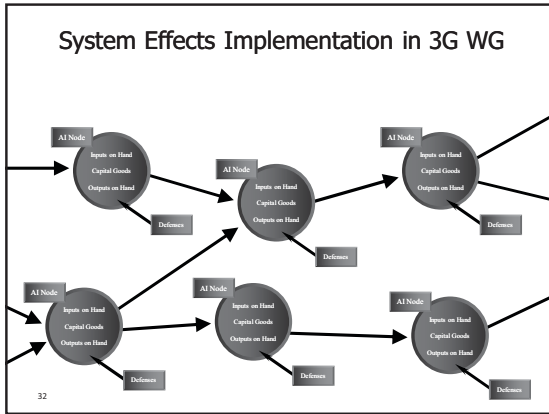
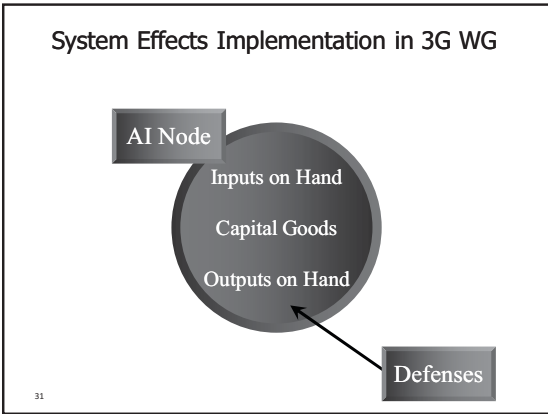
Retains the two sidedness of the 1st, the attrition of the 2nd and adds

Physical System Effects

Human Factors

Treatment of Time





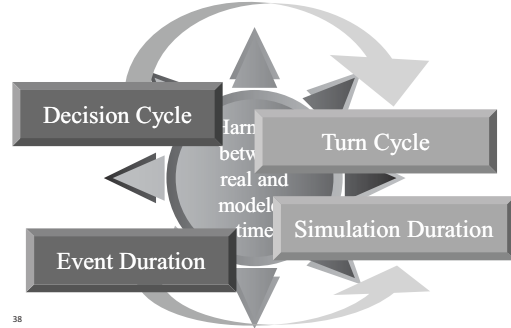


## Treatment of Time

Specifically the Explicit Modeling of Decision Loops at all Levels

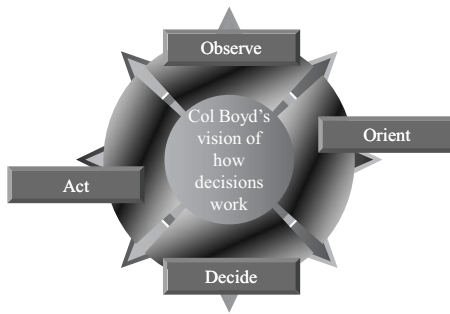
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## Design Principle



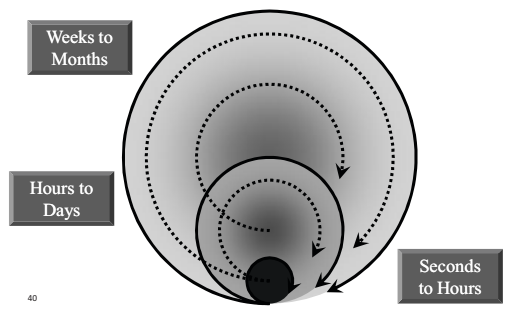
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## Boyd's Decision Loop



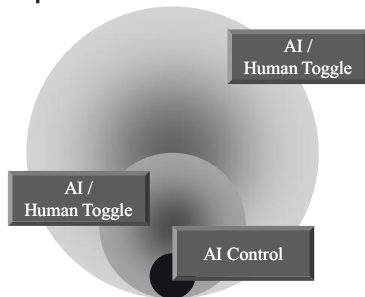
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## Nested Decision Loops



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## Nested Decision Loops Implementation in 5G WG



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## Elements of 5th Generation Wargame Interface

- Much faster spin up
  - Built in instruction/tutorials
  - Intuitive interface
  - On-line help
- Much faster setup
  - Low resolution data on all Earth physical geography, infrastructure, and forces resident
  - Intuitive, powerful: map, scenario, platform, AI editor
- Faster to comprehend outputs
  - Output designed to speed comprehension
  - Detail of data adjustable for need

## Elements of 5th Generation Wargame Portability

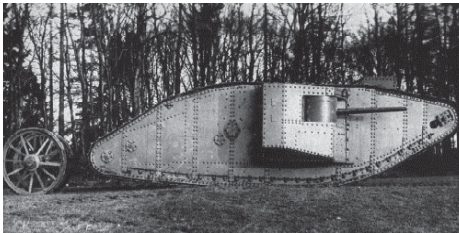
- Expeditionary
  - Run on standard easy to deploy notebook computer
  - Built in reachback capability
- Distributed
  - Run on standard easy to deploy notebook computer
  - Built in multiplayer capability

## How Hard Will it be to Create a 5th Generation Wargame?

- Many components already exist
- Integration may be biggest challenge

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## Armor in WWI May be a Good Analogy



## Tank - More Integration Than Invention

- WWI Incredibly Hard on Allies
- Technology for the tank was not new
  - Hydraulic recoil on cannon – France 1870s
  - Internal combustion engine – Germany + 1880s
  - Caterpillar tread – USA 1880s
  - Armor plate – ancient
- Yet it took until late in the war for these technologies to start saving lives

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## 5th Generation Wargame As Much Integration as Invention

- More comprehensive adjudication
  - Physical effects – infrastructure analysis, Homeland Defense
  - Human factors – work done on insurgency/counter insurgency
  - Campaign/decade length runs – high speed computing/ computer game AI - The power of Edison and Einstein working together -
- Faster insights –
  - Much faster spin up – computer game interfaces
  - Much faster setup – computer game mod trends
  - Faster to comprehend outputs computer gaming meets info science
- Expeditionary/Distributed
  - Deploy forward/reach back – increasingly powerful laptops, ever more robust internet

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## Conclusion

In part through 5<sup>th</sup> Generation Wargaming

- The wars we must fight will be faster with a lower cost in blood and treasure
- The peace we build will help turn former adversaries into willing allies, important trading partners and popular vacation destinations
- The future we build will be one in which government of the people, for the people and by the people shall inherit the earth.