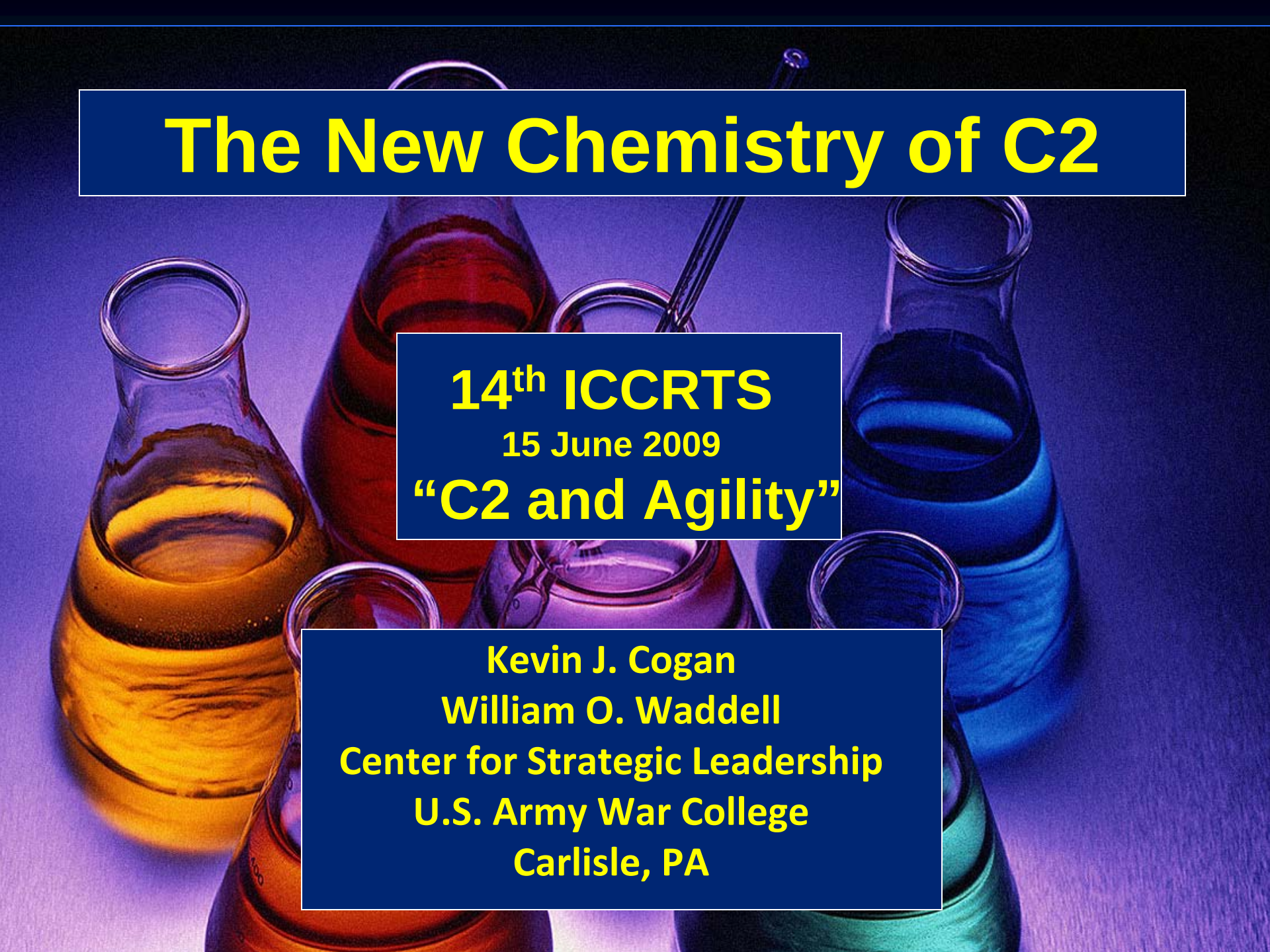


The New Chemistry of C2

14th ICCRTS
15 June 2009
"C2 and Agility"

Kevin J. Cogan
William O. Waddell
Center for Strategic Leadership
U.S. Army War College
Carlisle, PA

Language as an Art

"Language serves not only to express thought but to make possible thoughts which could not exist without it"

--Bertrand Russell
Nobel Laureate

But spoken language also poses barriers between cultures

The Language of C2

C – Command or Control

C2 – Command and Control } multiple definitions

C3 -- Command, Control, and Communications (Consultation)

C4 – Command, Control, Communications, Computers

C4ISR – C4 with Intelligence, Surveillance, Reconnaissance

C5 - C4 + COMPLEXITY ??

C6 - C5 + CHAOS ??

C7 - C6 + CENTER of Gravity ??

Language as a Science

Science uses language that is

- Universal
- Immutable
- Unambiguous

Examples:

$P = mv^2$ $E = mc^2$

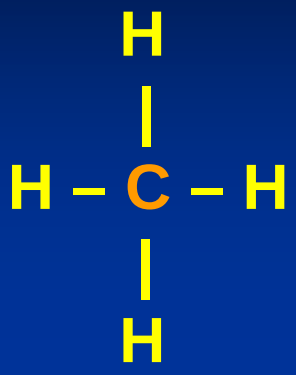
H_2O CO_2 $NaCl$ H_2SO_4

New Chemistry of C2

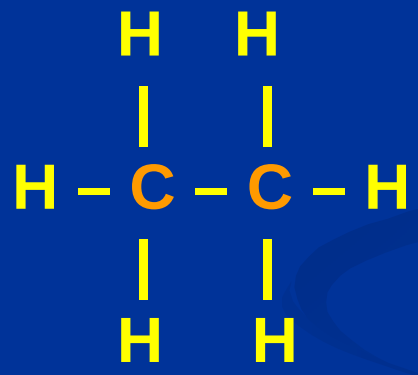
We can replace the **C** in military language with the **C** of **Carbon** chemistry to create a way to envision adaptation and agility for military organizations.

Examples of Simple Structures

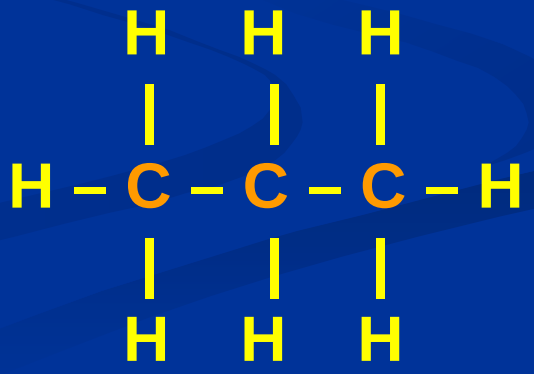
Methane



Ethane



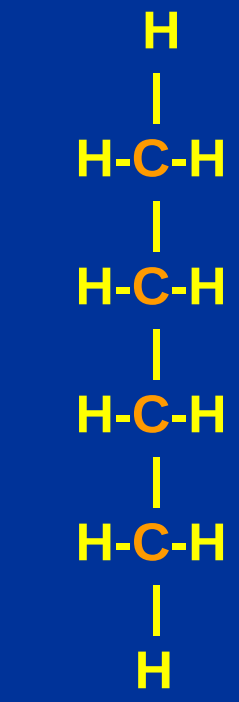
Propane



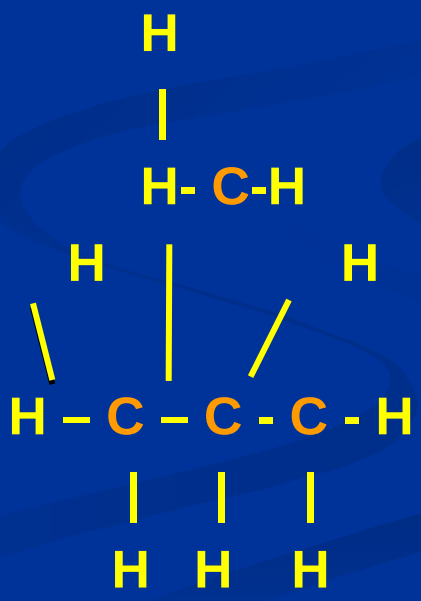
Chemical Isomers

Allow for rearranging the organization of elements without changing the chemical composition or weight of the compound

n-Butane

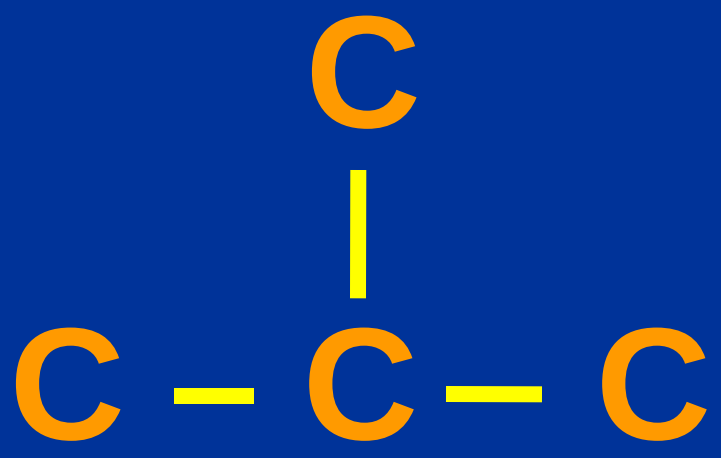


Isobutane

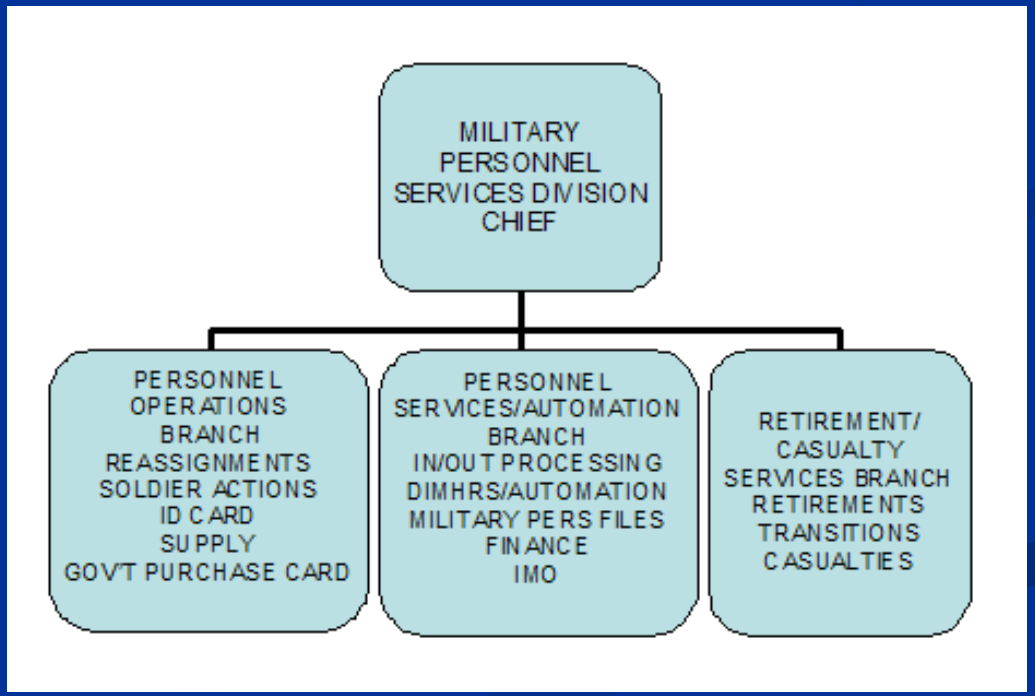


Typical Hierarchical Structure

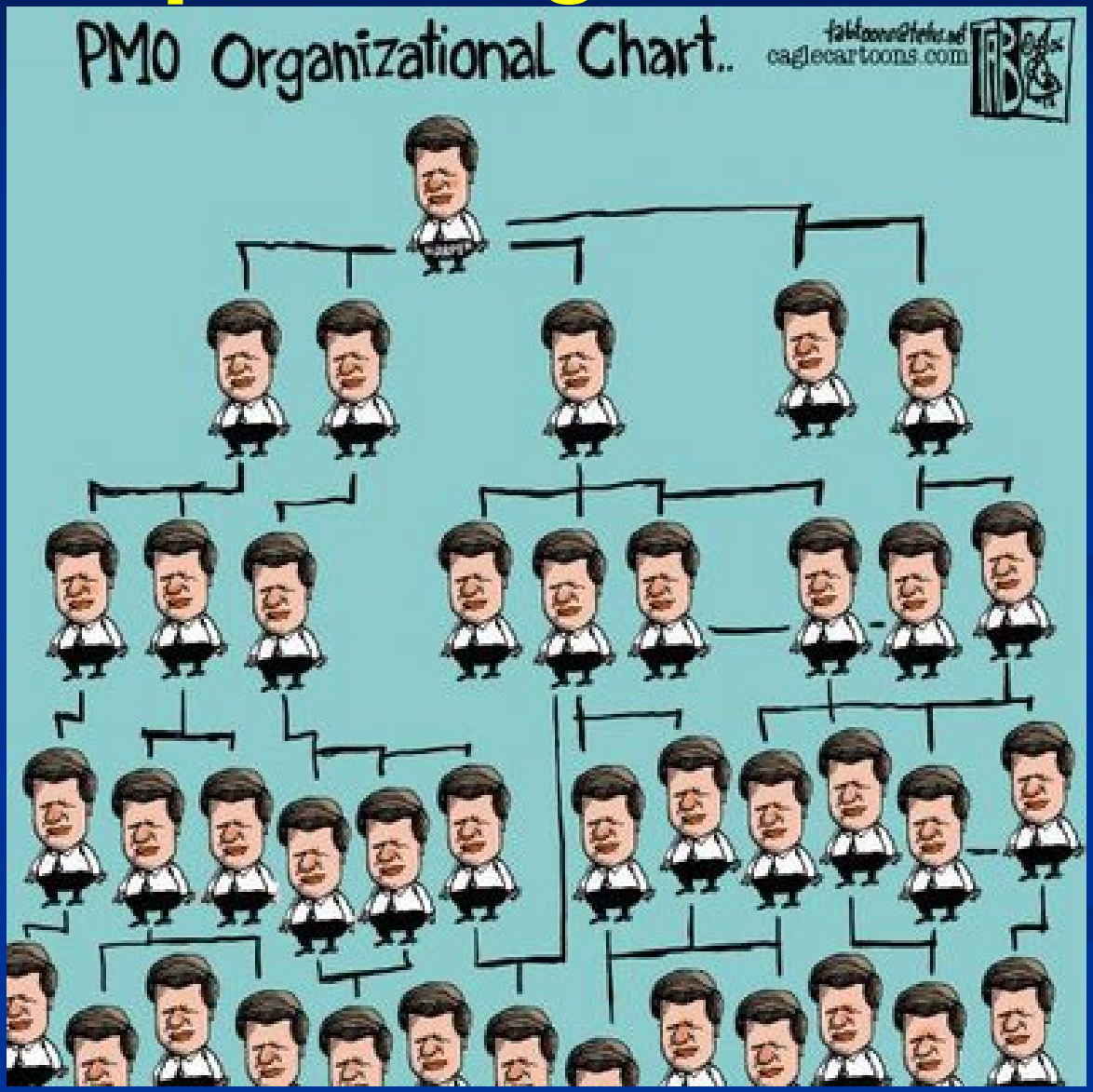
Isobutane



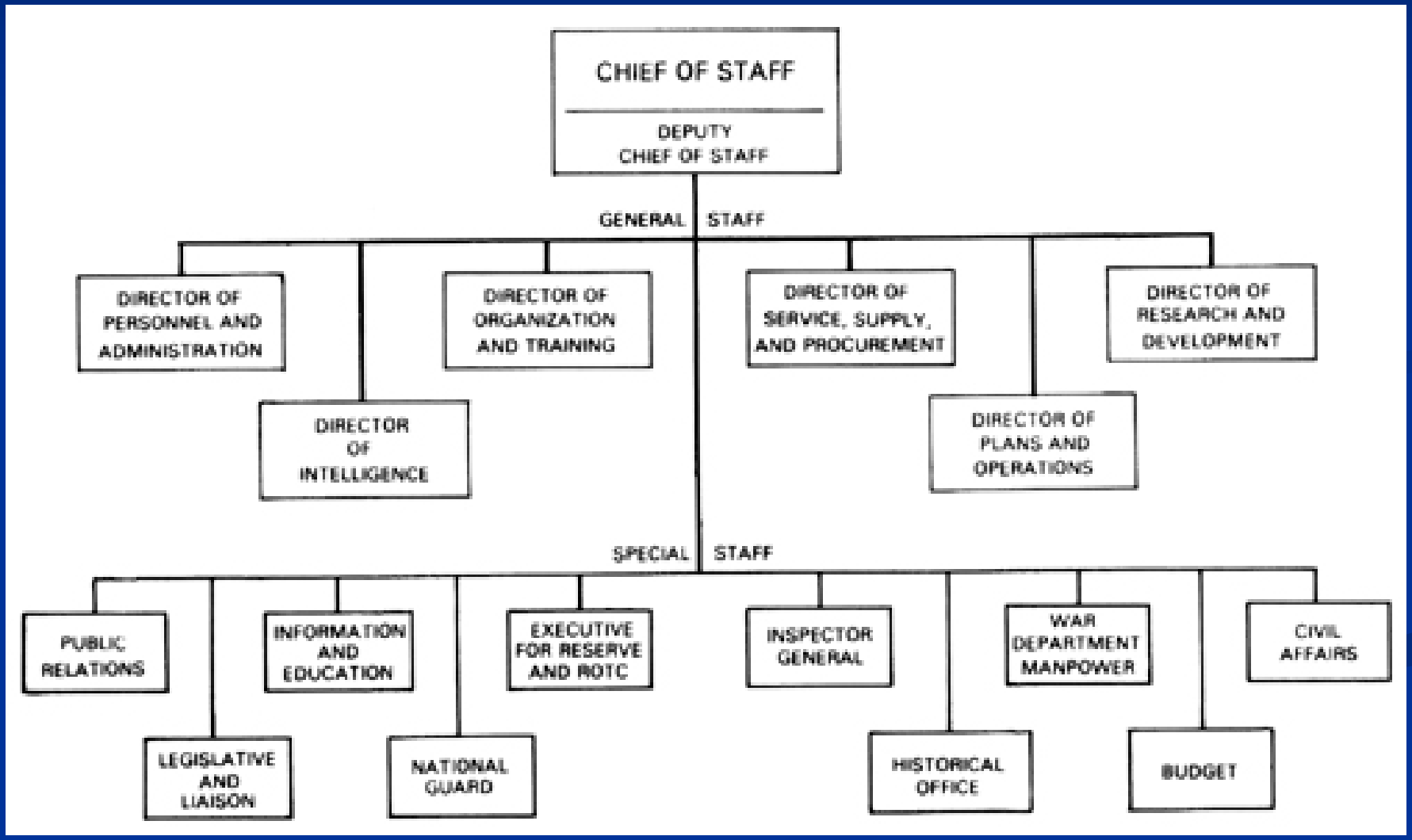
Army War College
Military Personnel Division



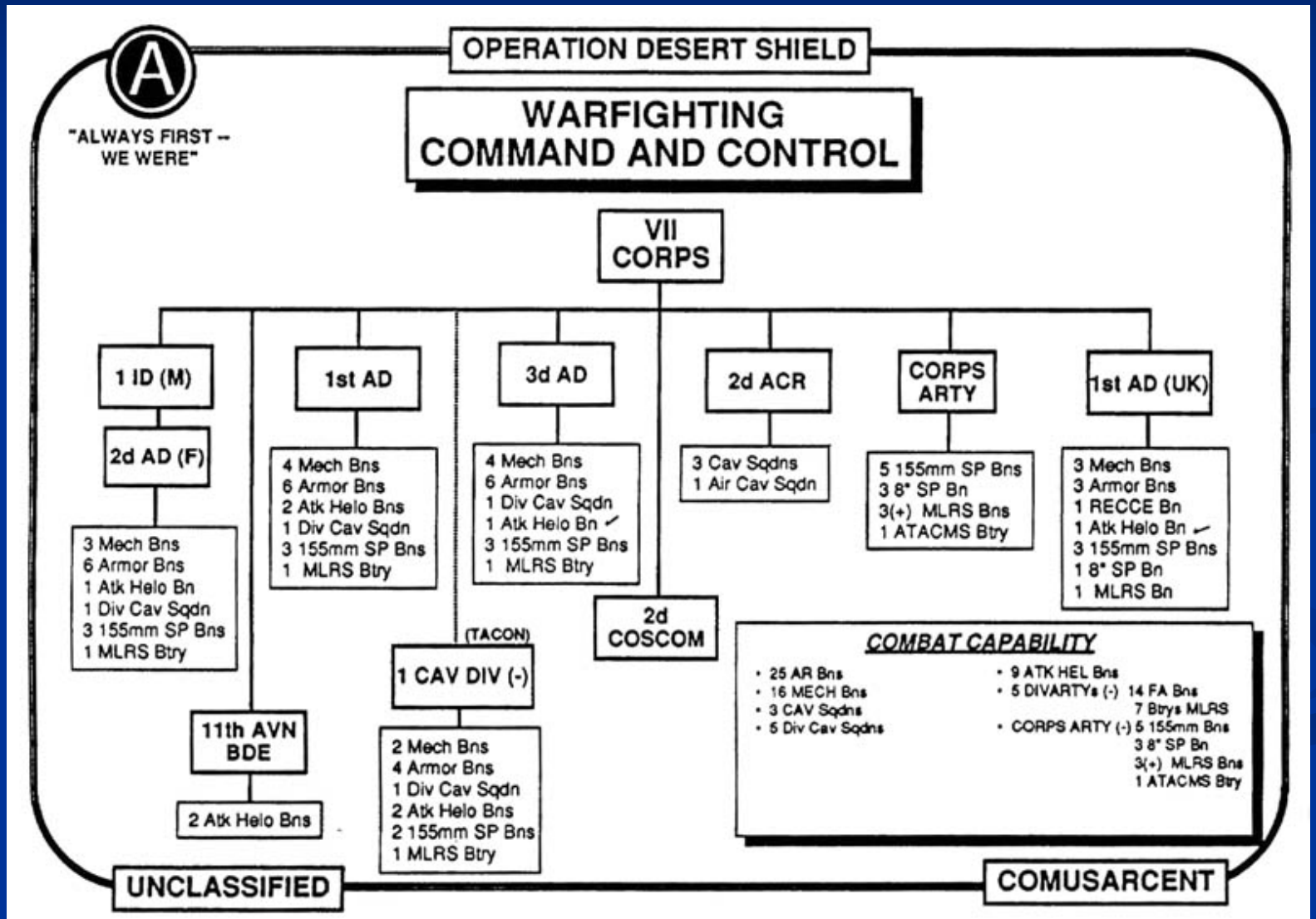
Complex Organizations



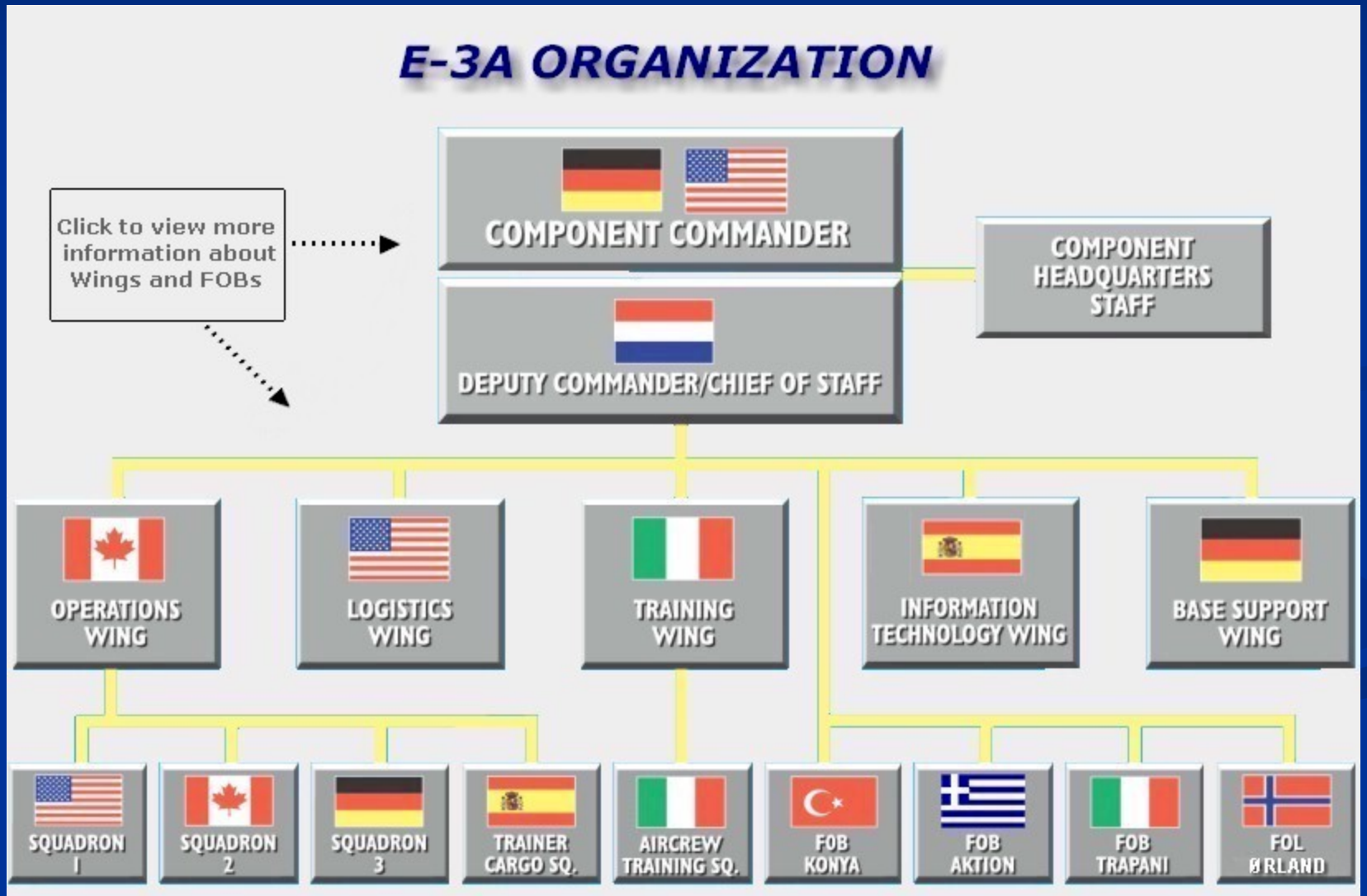
U.S. Army - 1946


CHIEF OF STAFF
DEPUTY CHIEF OF STAFF
GENERAL STAFF
DIRECTOR OF PERSONNEL AND ADMINISTRATION
DIRECTOR OF ORGANIZATION AND TRAINING
DIRECTOR OF SERVICE, SUPPLY, AND PROCUREMENT
DIRECTOR OF RESEARCH AND DEVELOPMENT
DIRECTOR OF INTELLIGENCE
DIRECTOR OF PLANS AND OPERATIONS
SPECIAL STAFF
PUBLIC RELATIONS
INFORMATION AND EDUCATION
EXECUTIVE FOR RESERVE AND ROTC
INSPECTOR GENERAL
WAR DEPARTMENT MANPOWER
CIVIL AFFAIRS
LEGISLATIVE AND LIAISON
NATIONAL GUARD
HISTORICAL OFFICE
BUDGET

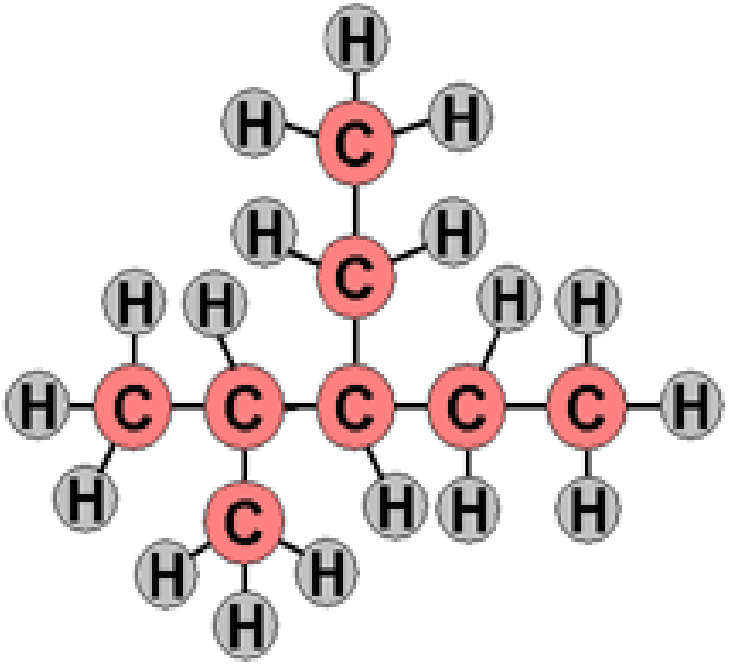
Operation Desert Shield



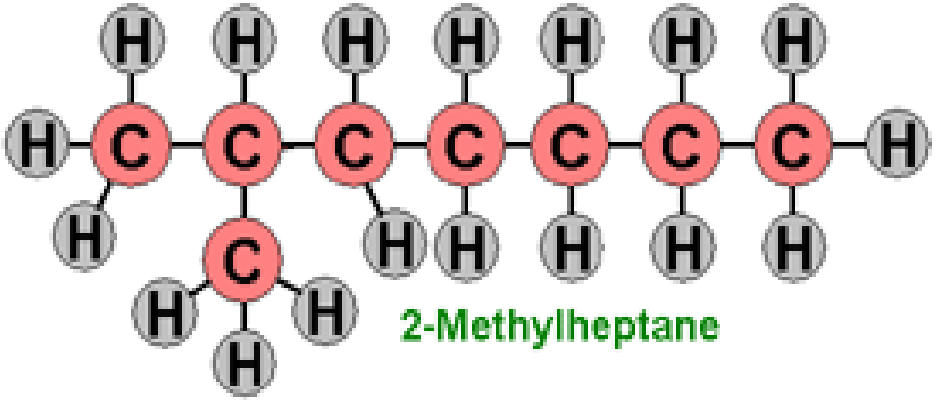
NATO Early Warning and Control Force – E-3A Component



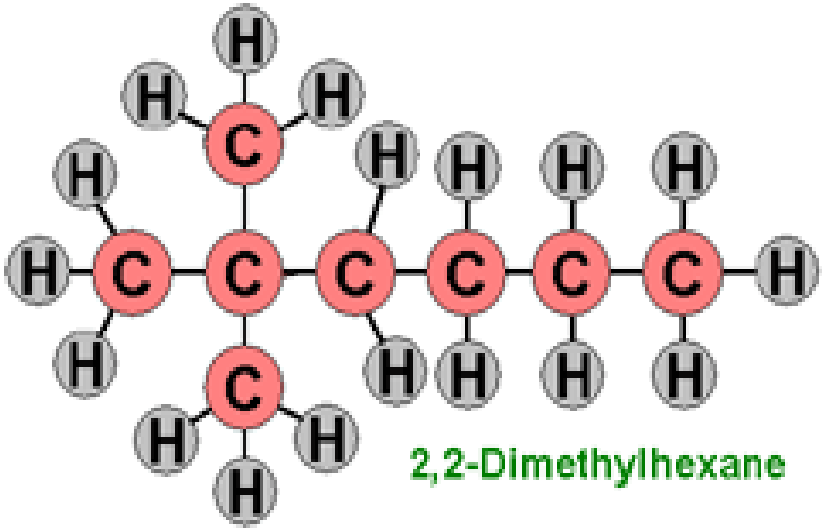
Complex Isomers



2-Methyl, 3-Ethylpentane

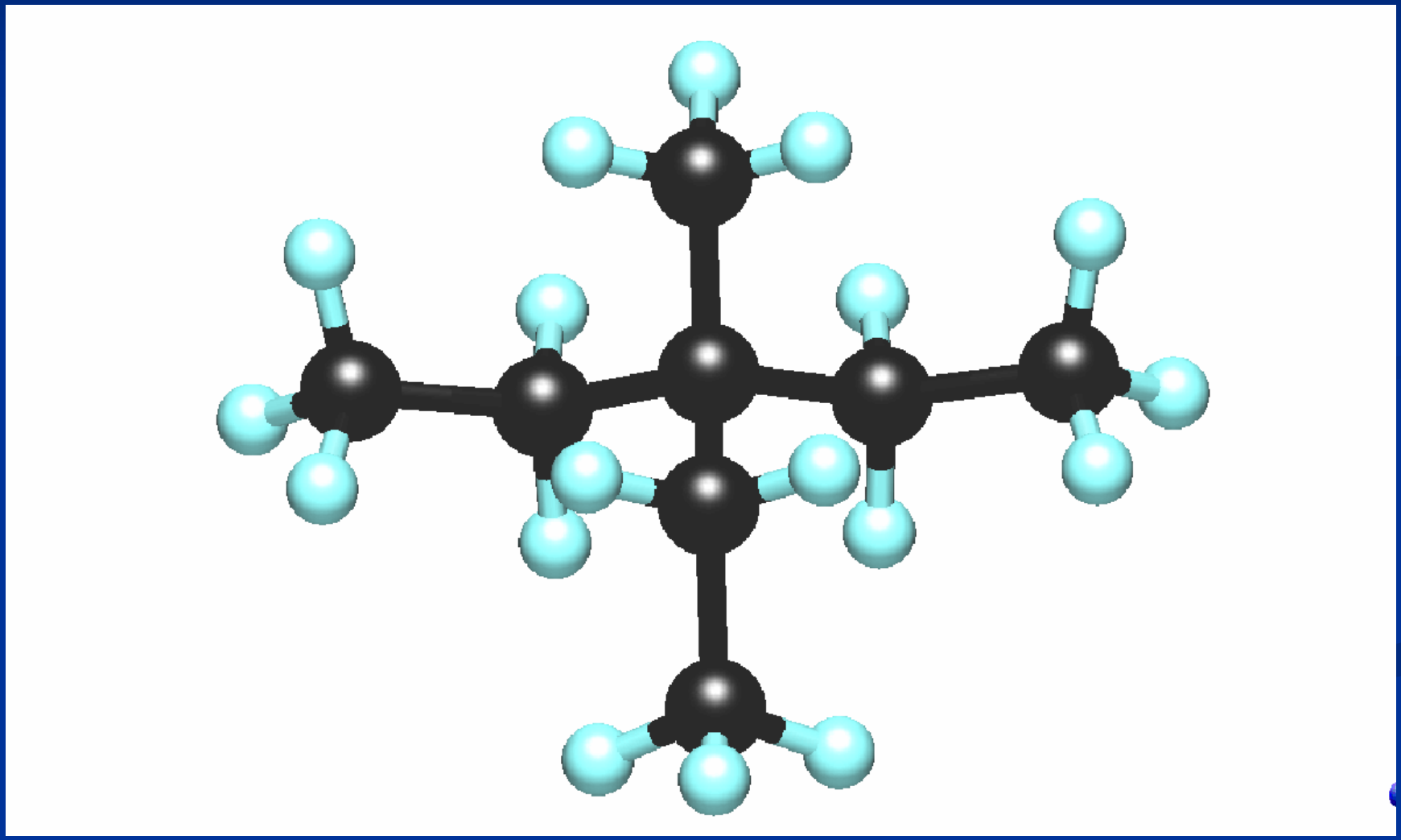


2-Methylheptane

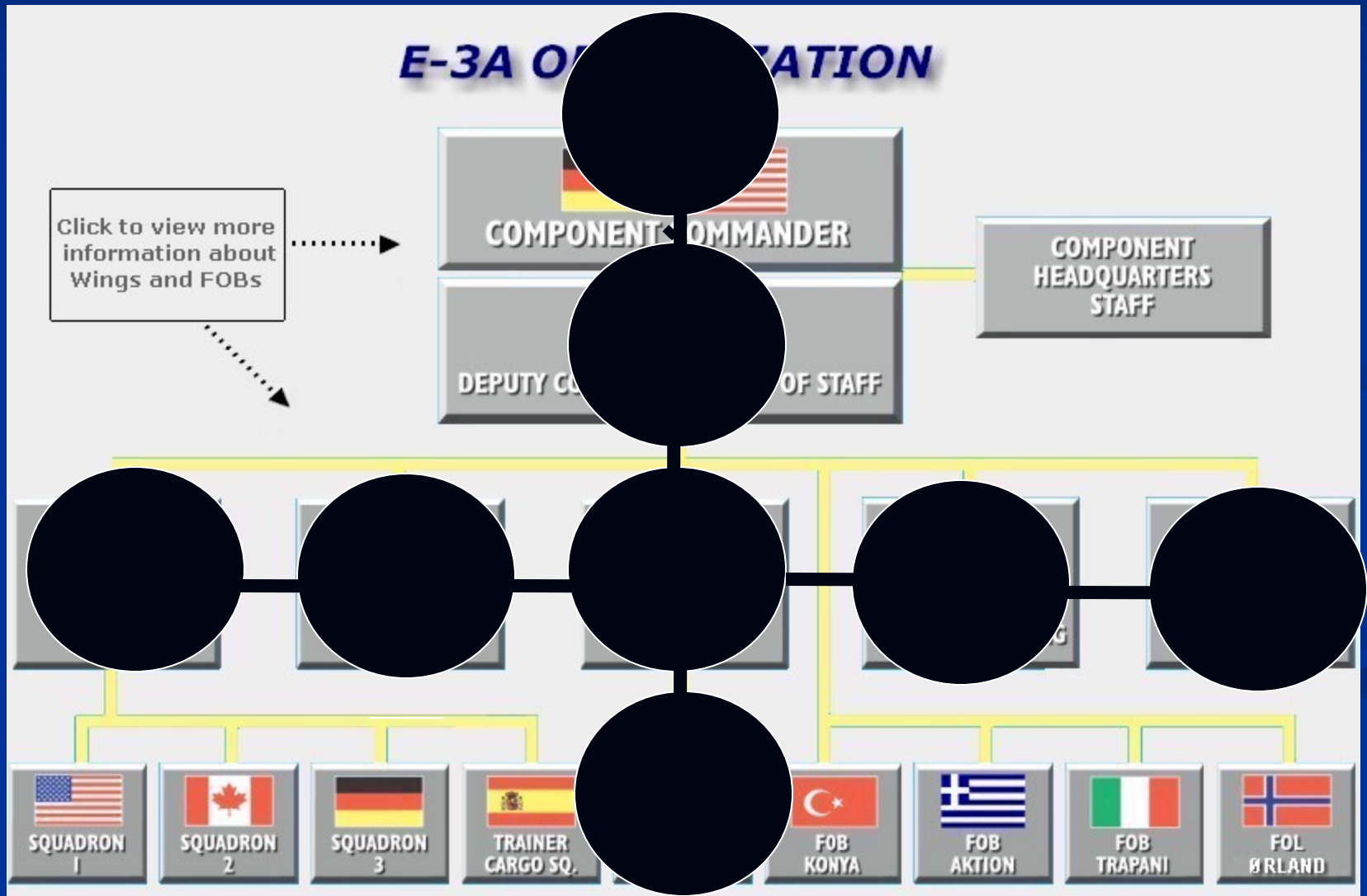


2,2-Dimethylhexane

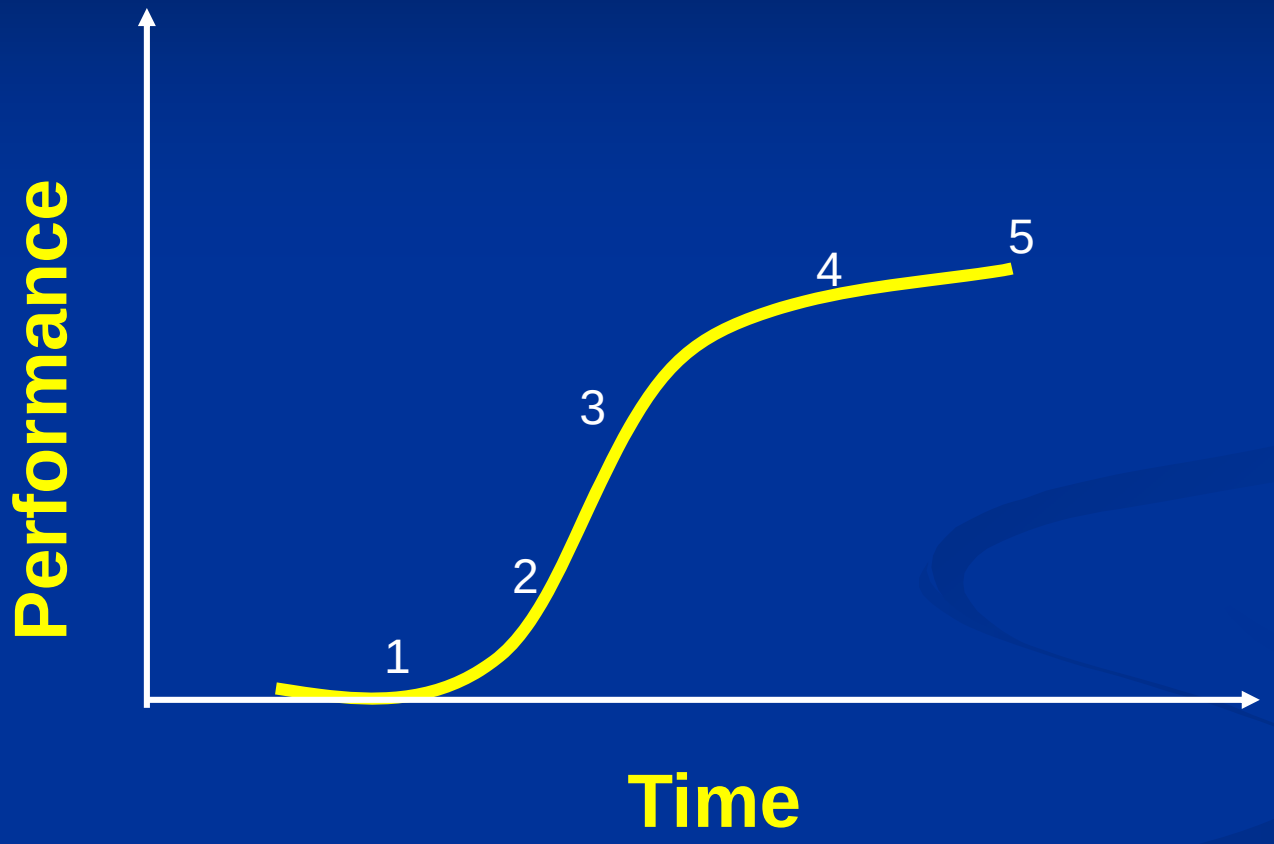
3-Methyl, 3-Ethylpentane



NATO Early Warning and Control Force – E-3A Component

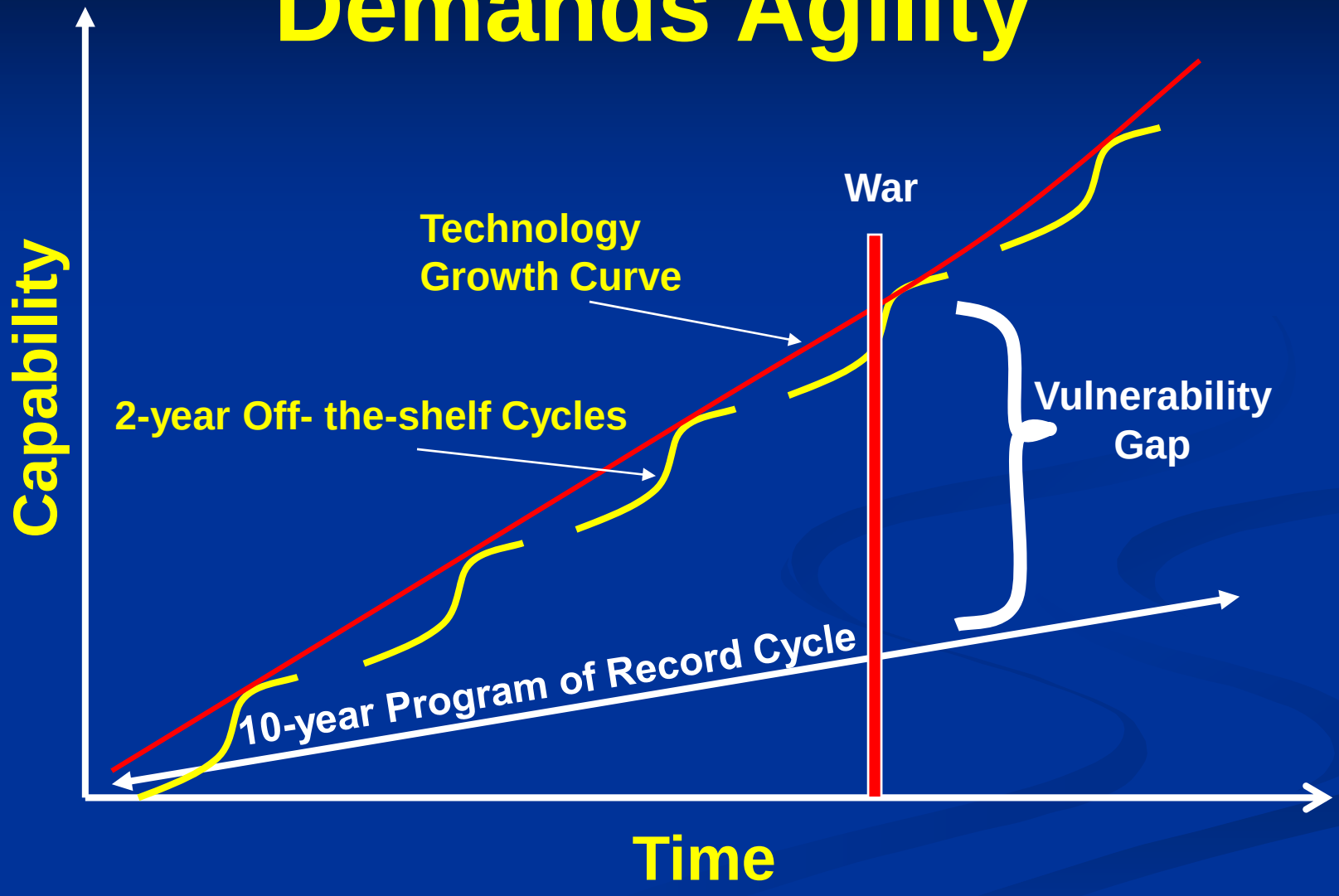


The S-Curve denotes a paradigm shift



Phases of technology innovations: (1) rupture, (2) early development, (3) expansion, (4) maturation, and (5) saturation

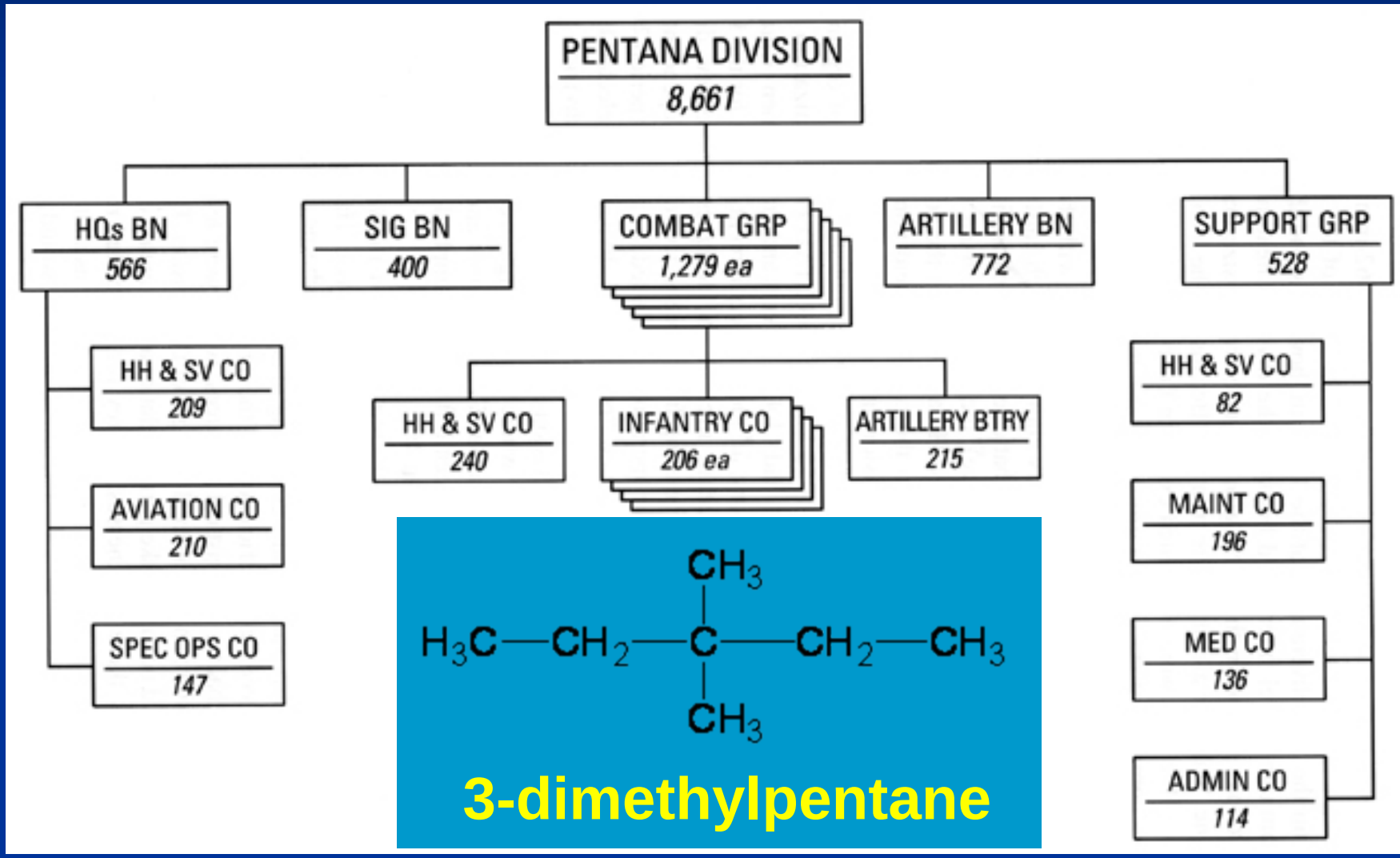
Vulnerability Gap Demands Agility



Vulnerability Gap Dangers

- The enemy cycle times take advantage of “commercial off-the-shelf” cycles (2 years)
- The U.S. manages programs of record with 10-year cycle times
- War erupts prior to fielding best technology available
- Potentially, the enemy can field better technology at a given point in time

PENTANA Division - 1954



The Learning Organization

"An organization's ability to learn, and translate that learning into action rapidly, is the ultimate competitive advantage."

-- Jack Welch

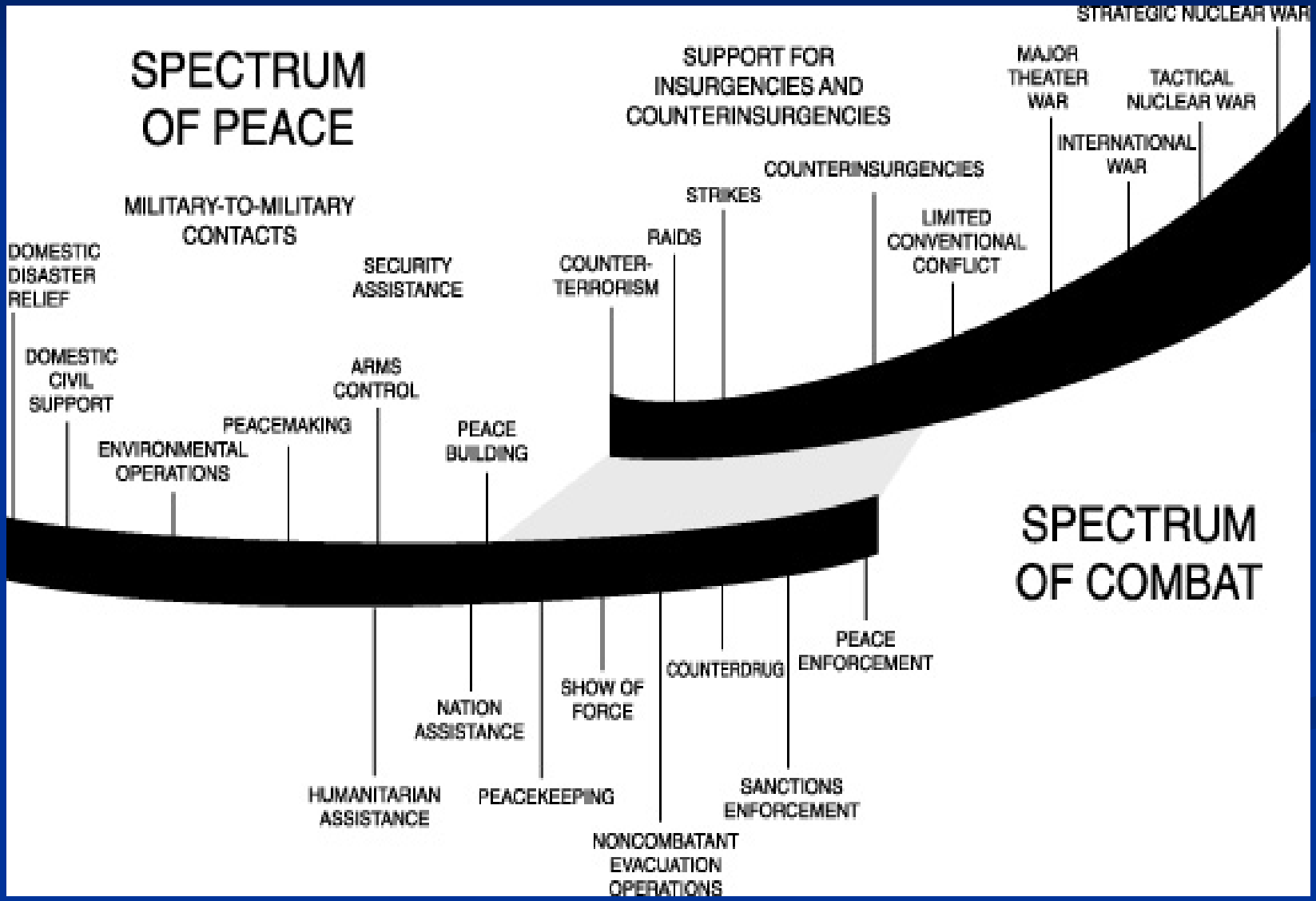
former General Electric CEO

Need for Agile Organizations

Adaptability: the capability to rearrange components to meet a different set of demands or exist in a different environment with different properties.

Agility: the measure of how quickly the organization can adapt to its new environment.

The Spectrum of Conflict



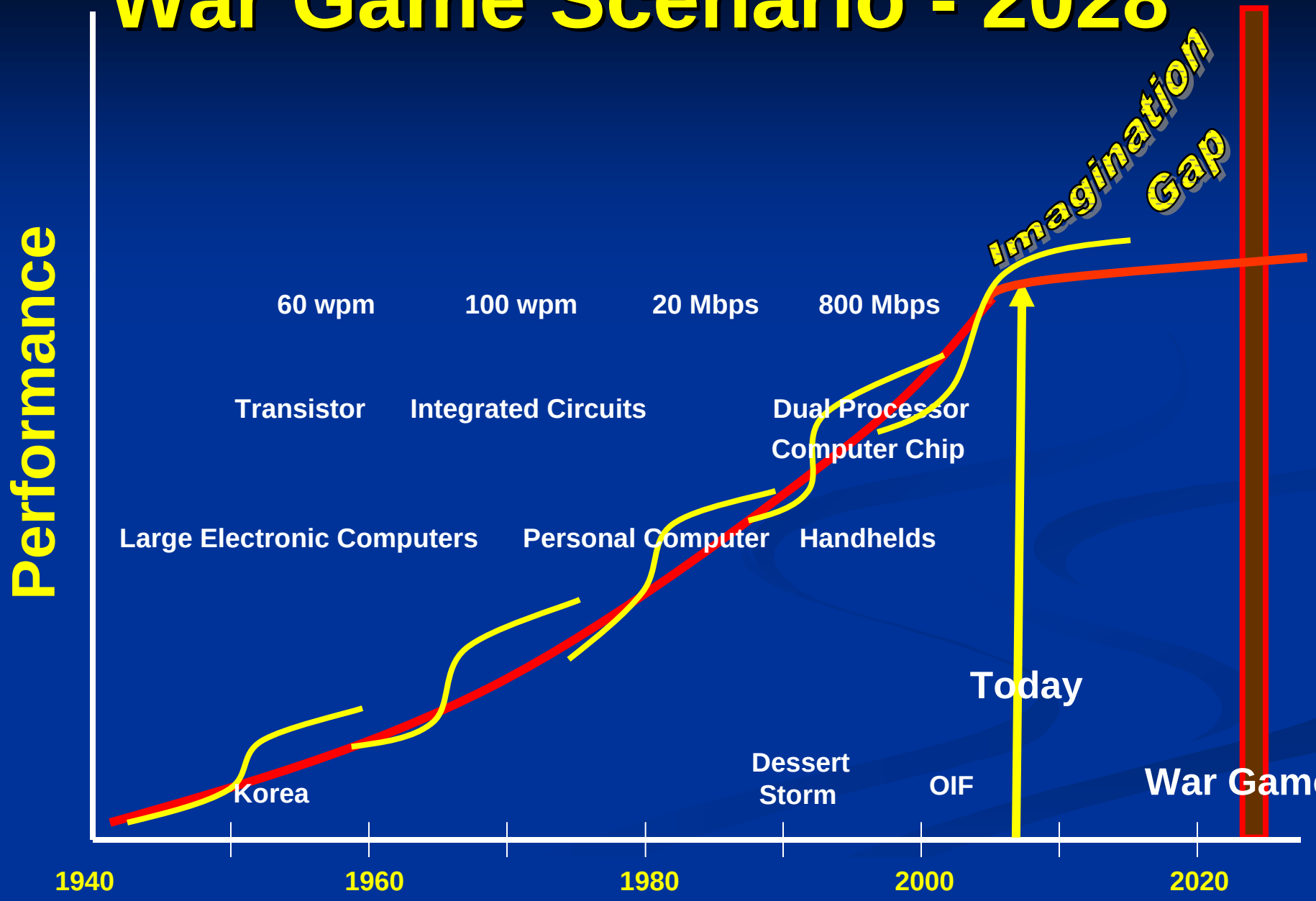
We Must Meet This Challenge

"The best way to predict the future is to invent it."

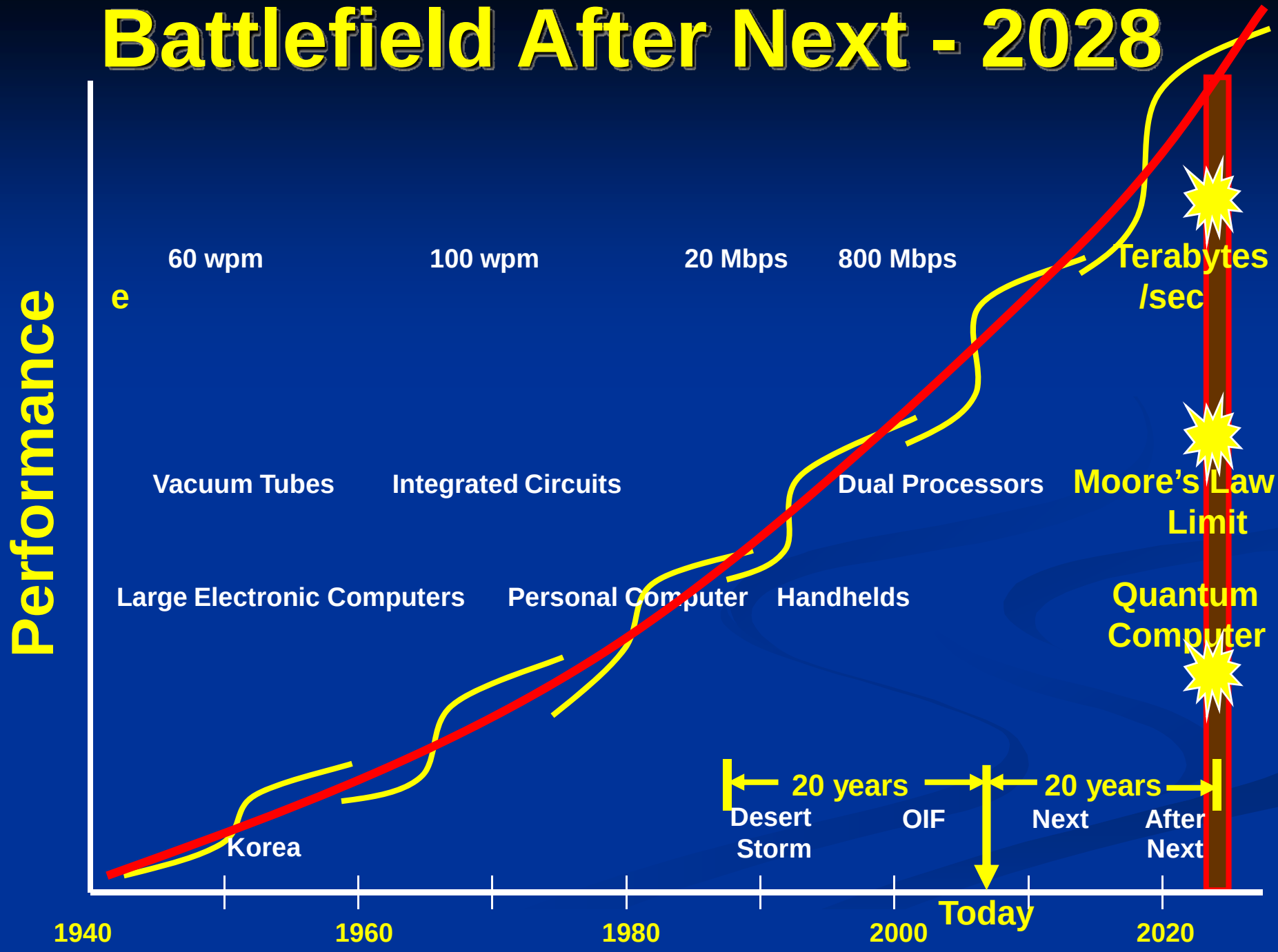
-- Alan Kay

American Computer Scientist

War Game Scenario - 2028



Battlefield After Next - 2028



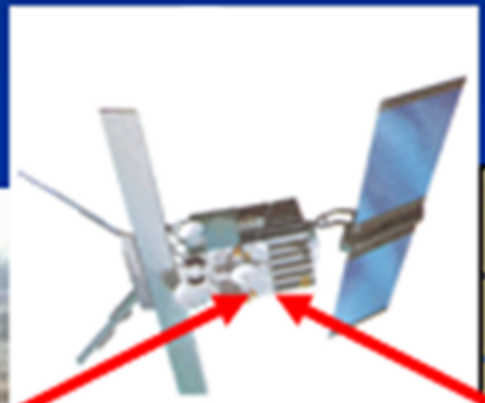
COL John Boyd's OODA Loop

Communications Spanning the Globe

The OODA Loop is Shrinking

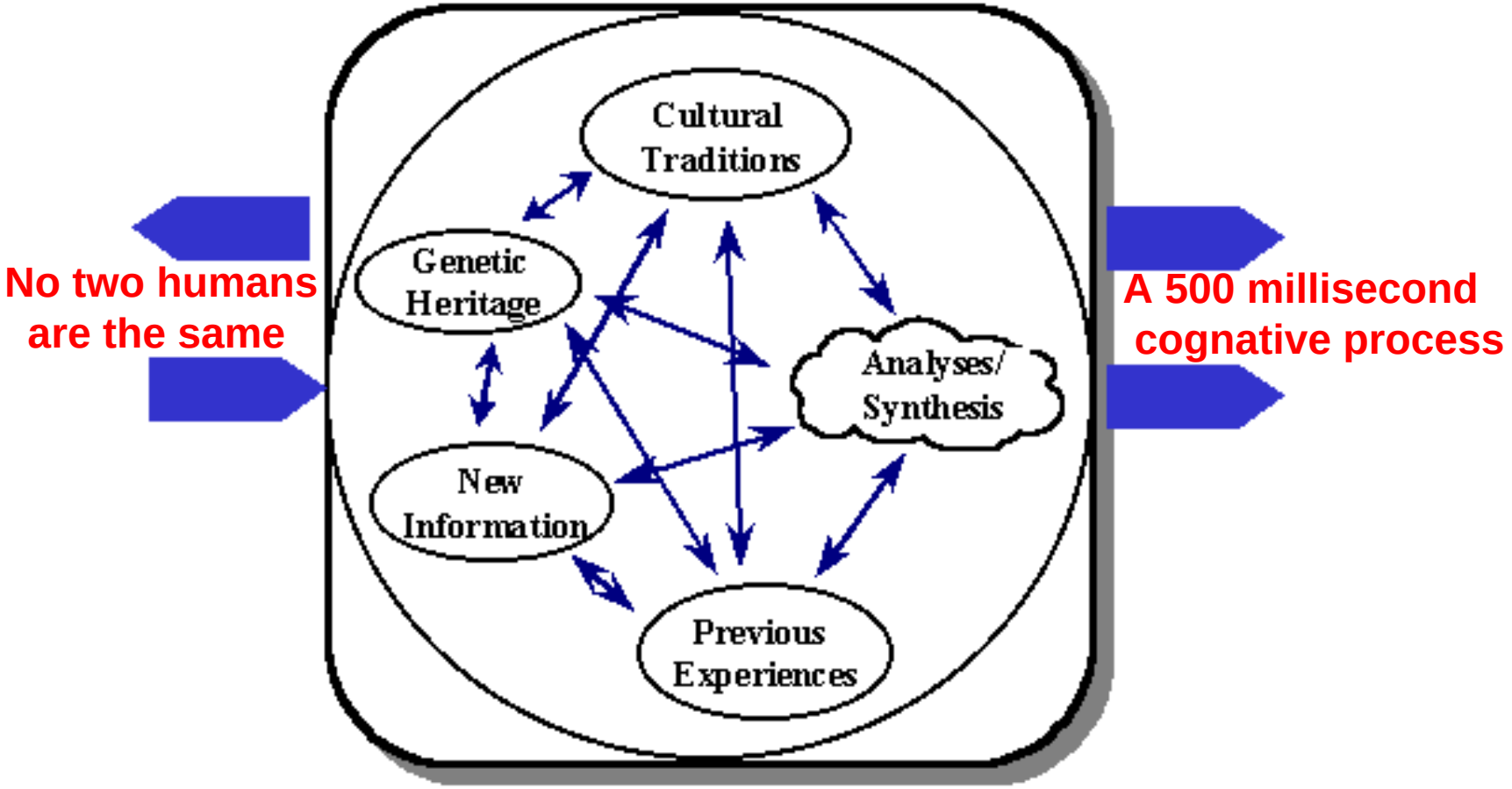
The below 10 minute cycle represents a 97% reduction in the OODA Loop in a 5-year period

Nellis AFB, NV



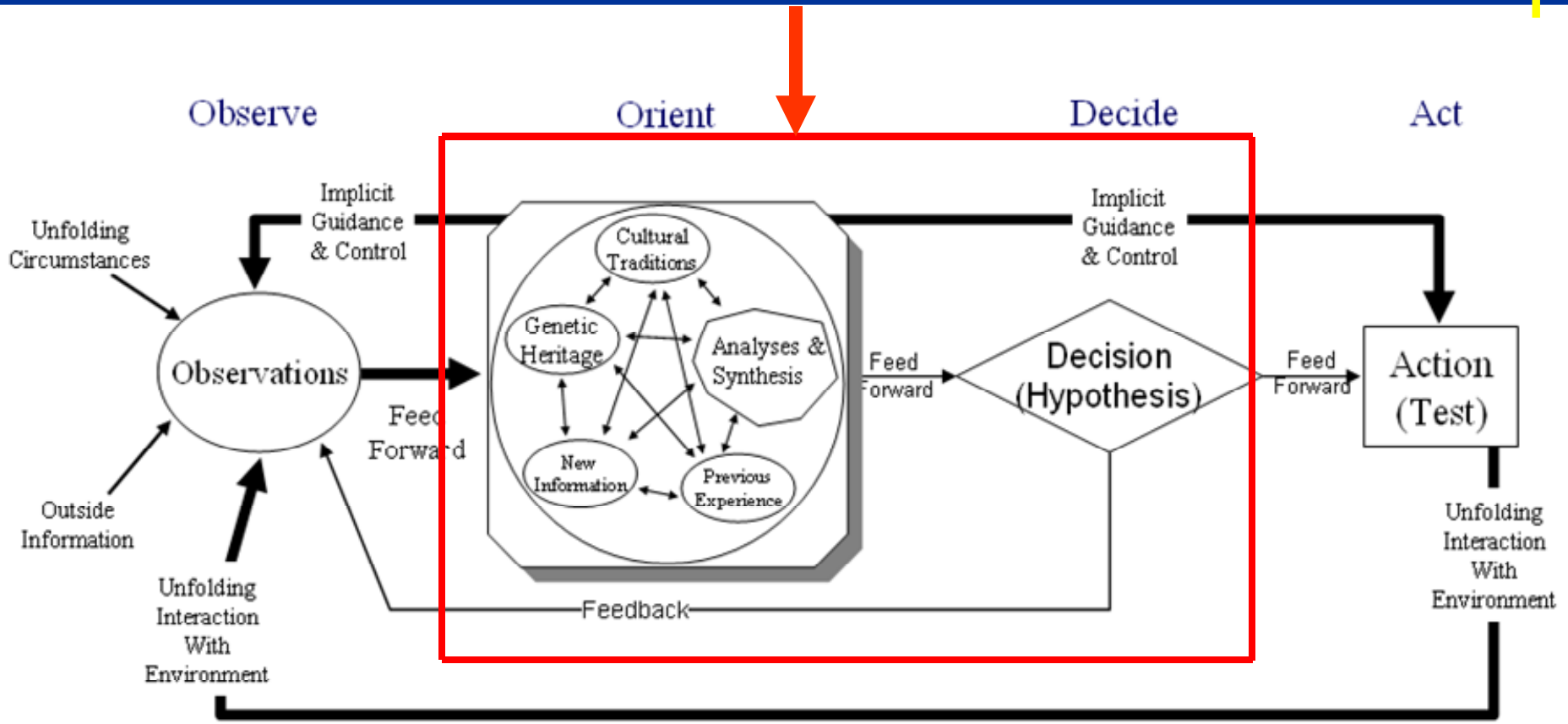
Iraq

Orientation



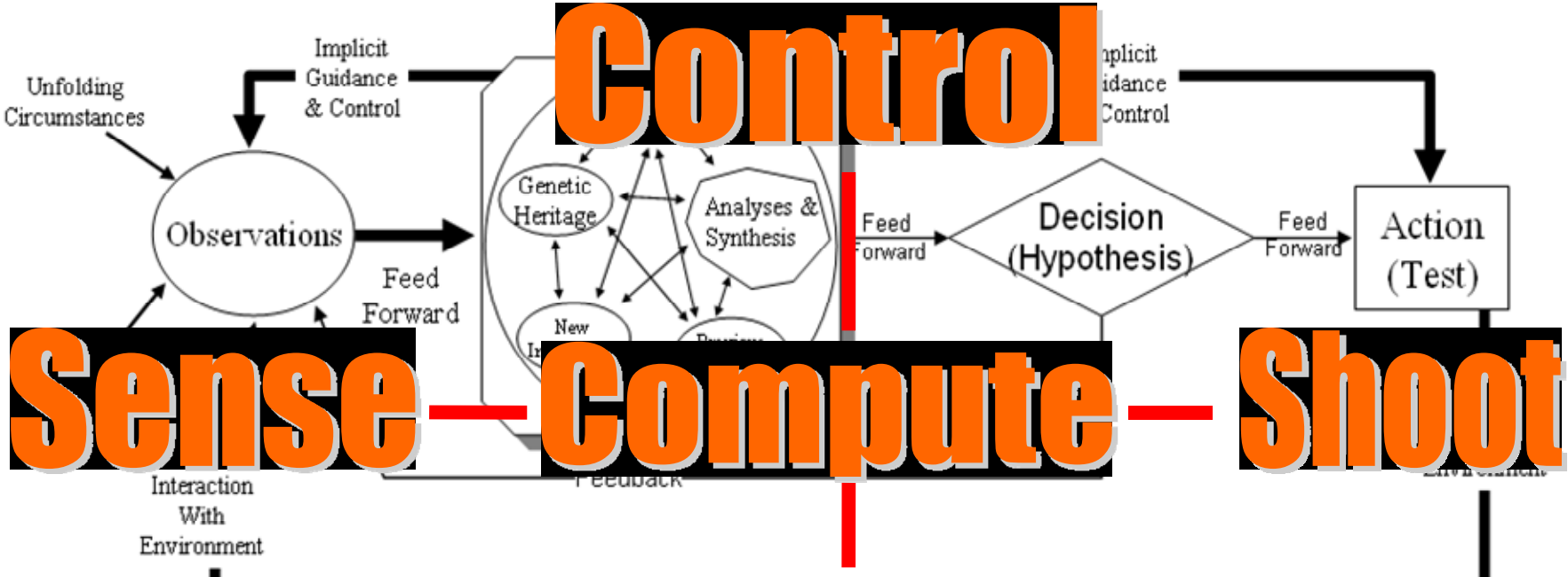
… an interactive process of many-sided implicit cross-referencing projections, empathies, correlations and rejections

The 500 Millisecond Human in the Loop



It Might Not Be Fast Enough

OBSERVE ORIENT DECIDE ACT



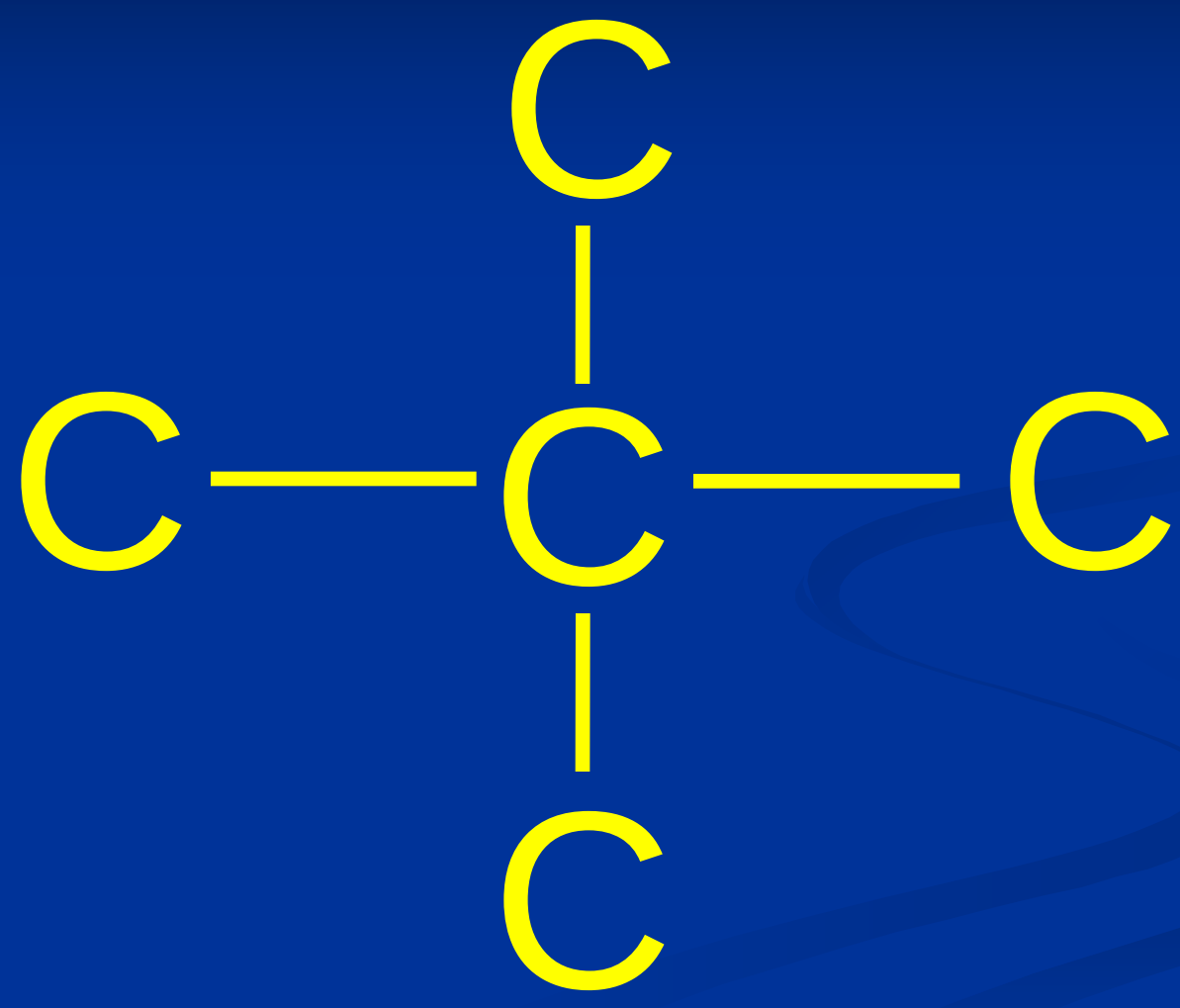
Control

Sense – Compute – Shoot

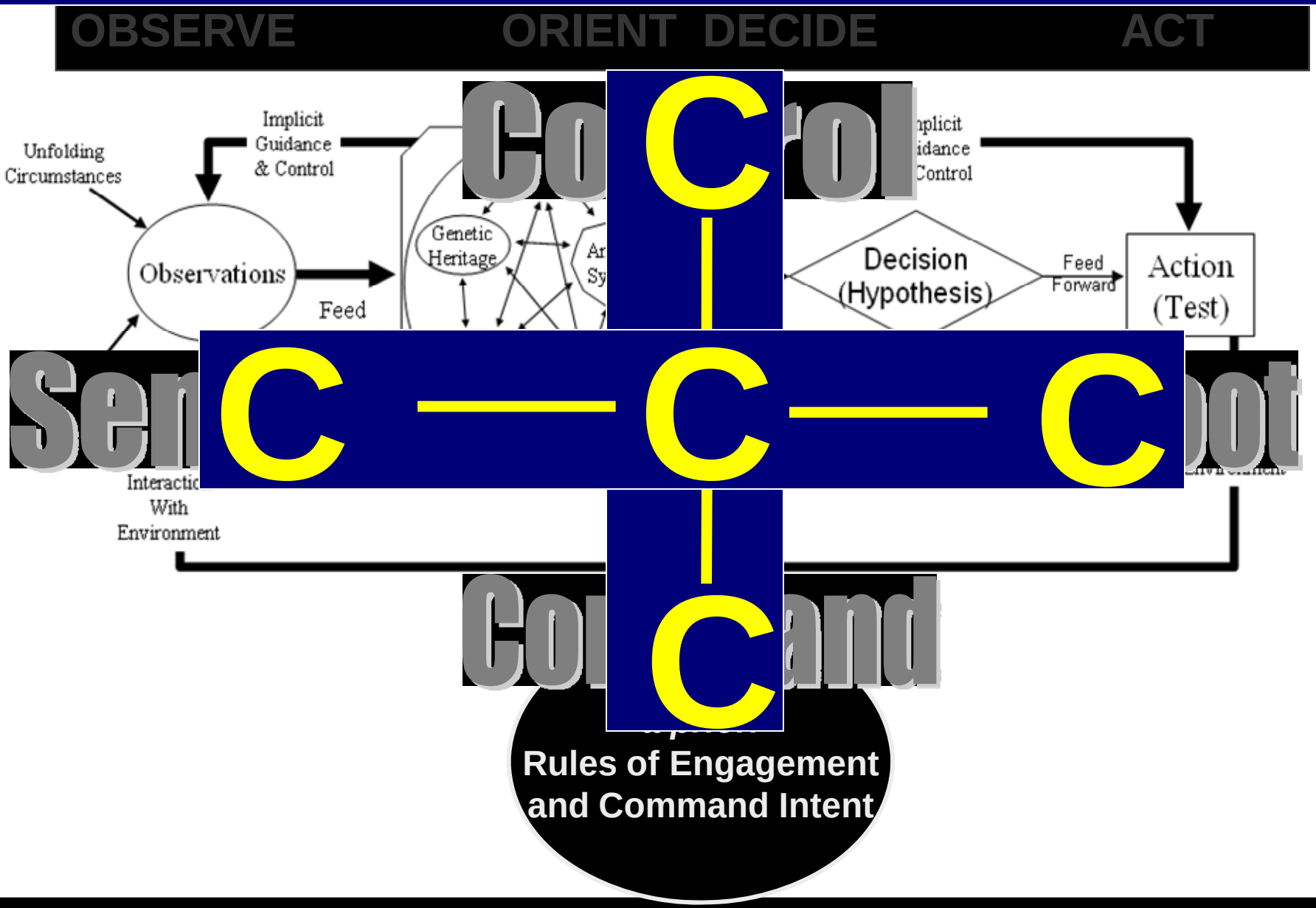
Command

a priori
Rules of Engagement and Command Intent

Neopentane Configuration

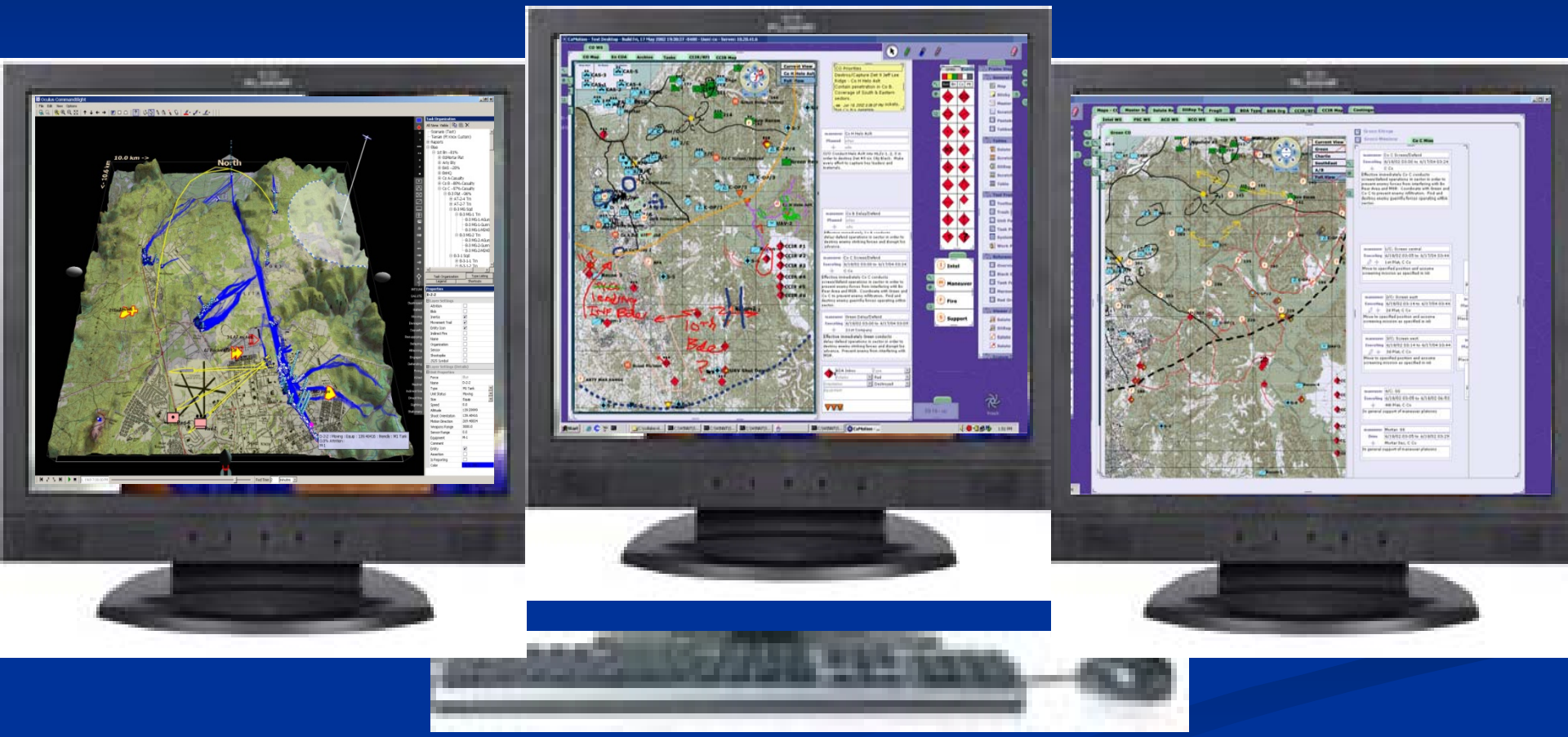


An OODA Loop After Next



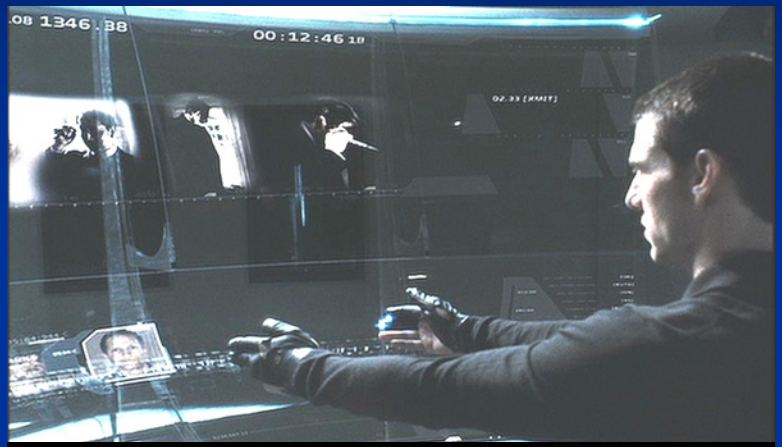
Evolving Tactical C2

Command Post of the Future Deployed Now in Iraq



Command Post of the Future after Next

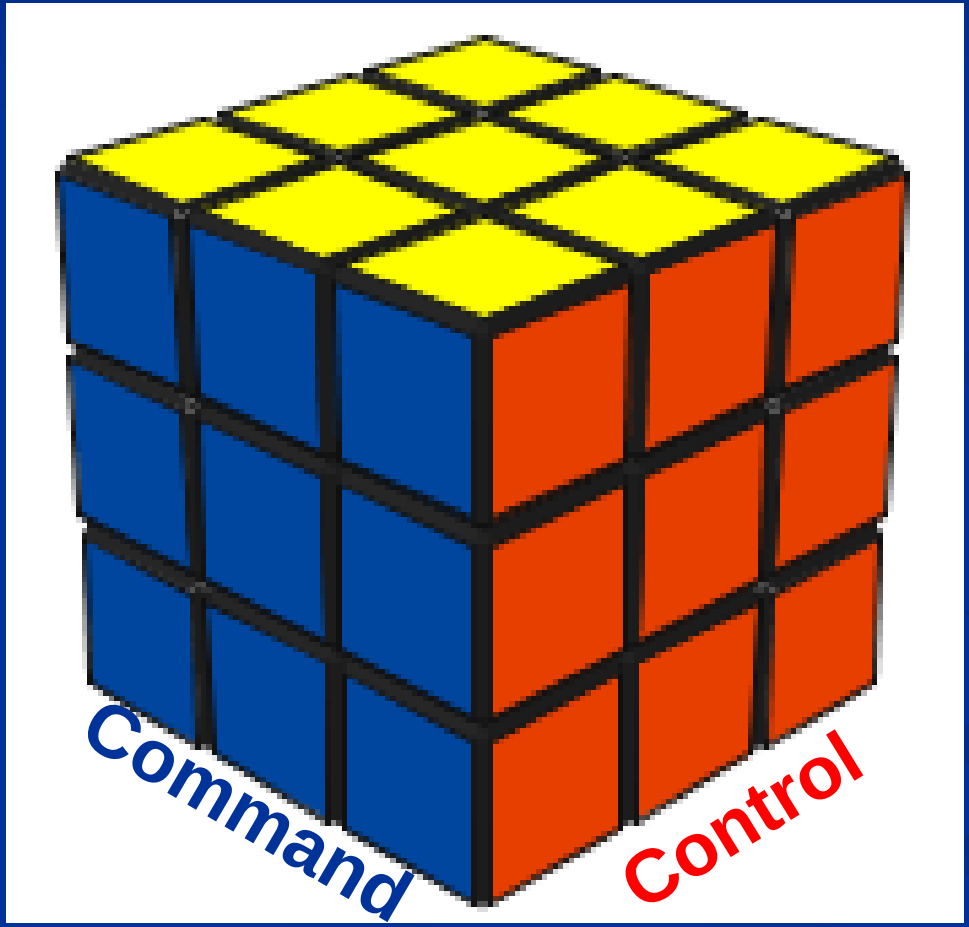
We Are Imagining This Future Now



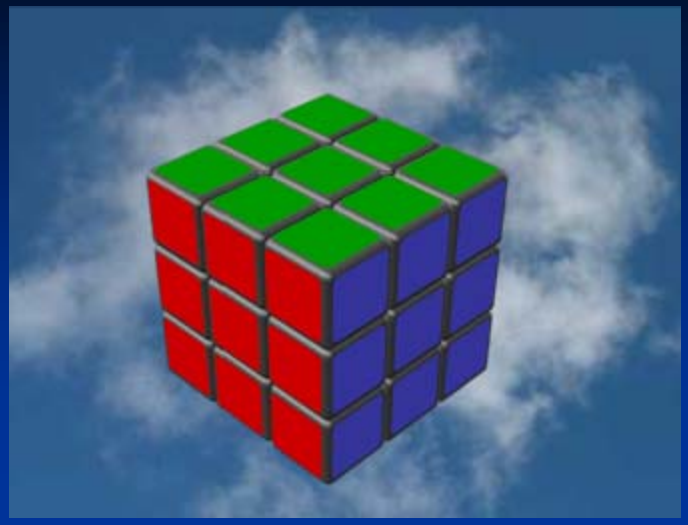
Is Automated C2 Possible ??

Rubik's Cube

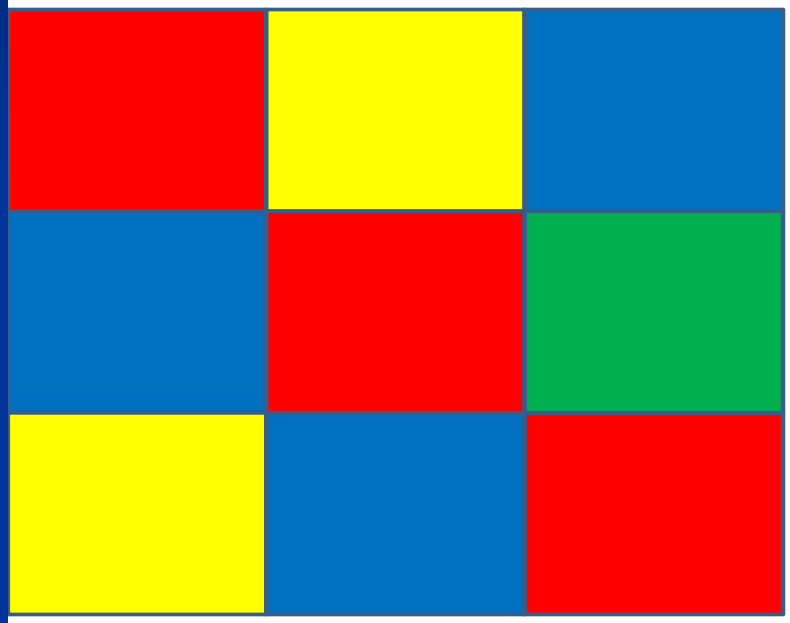
Communications



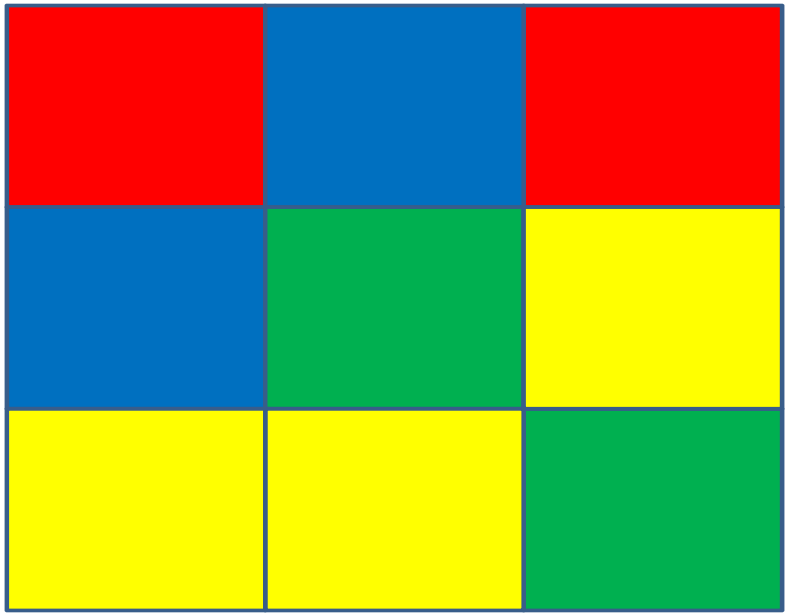
C3 Communications Architectures
(Homogeneous)



Two Versions of a C4 Organization

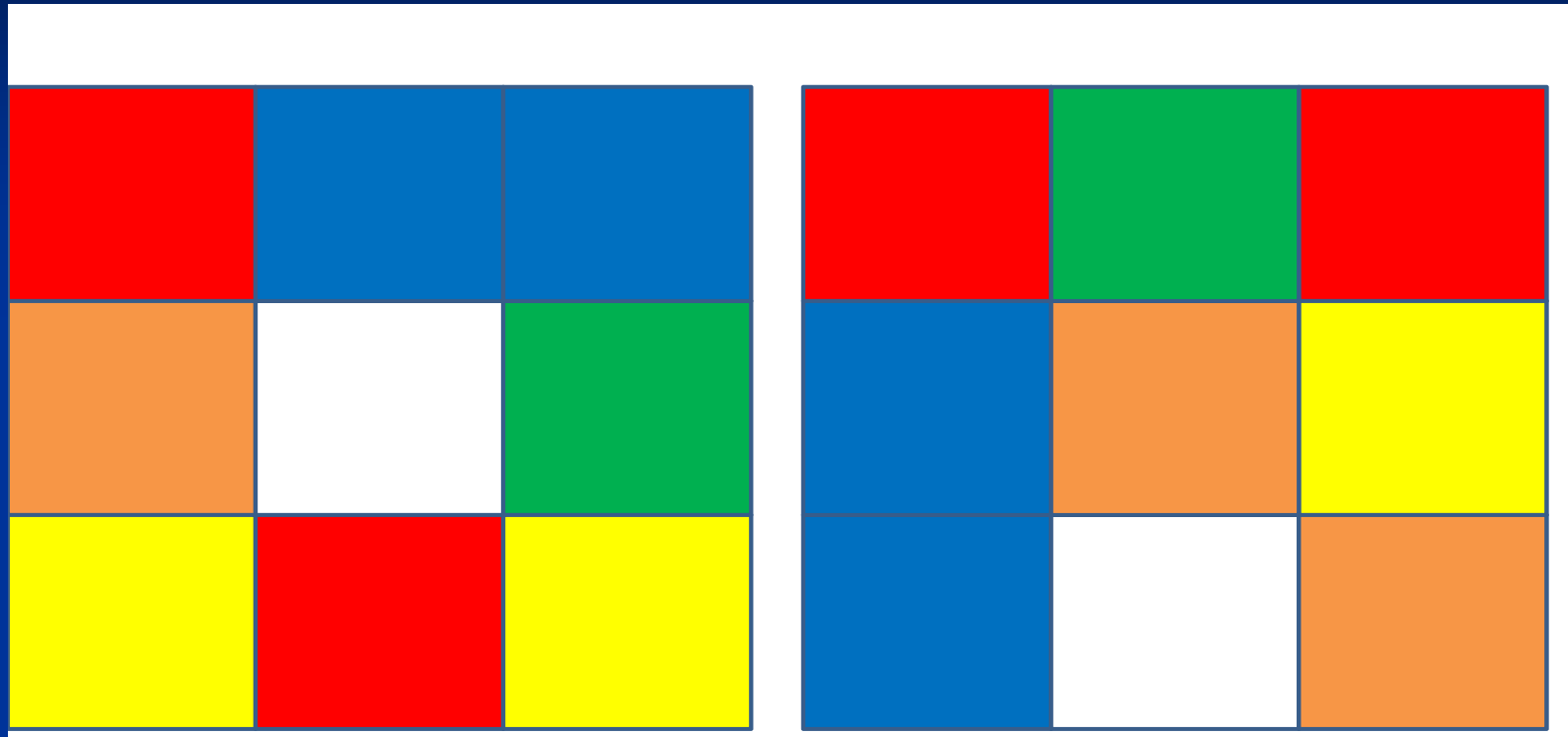


C4 organization, version 1



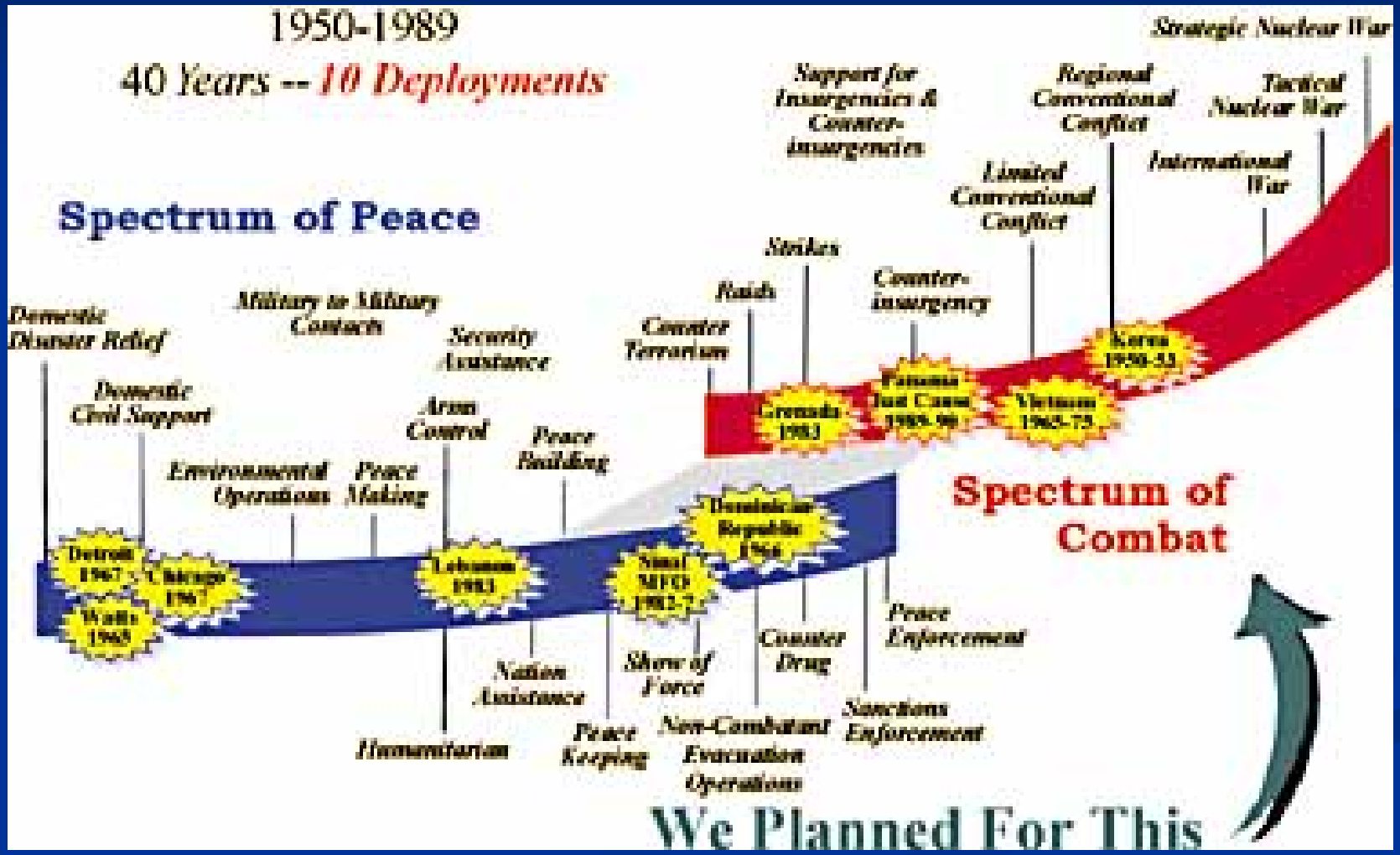
C4 organization, version 2

Two Versions of a C6 Organization

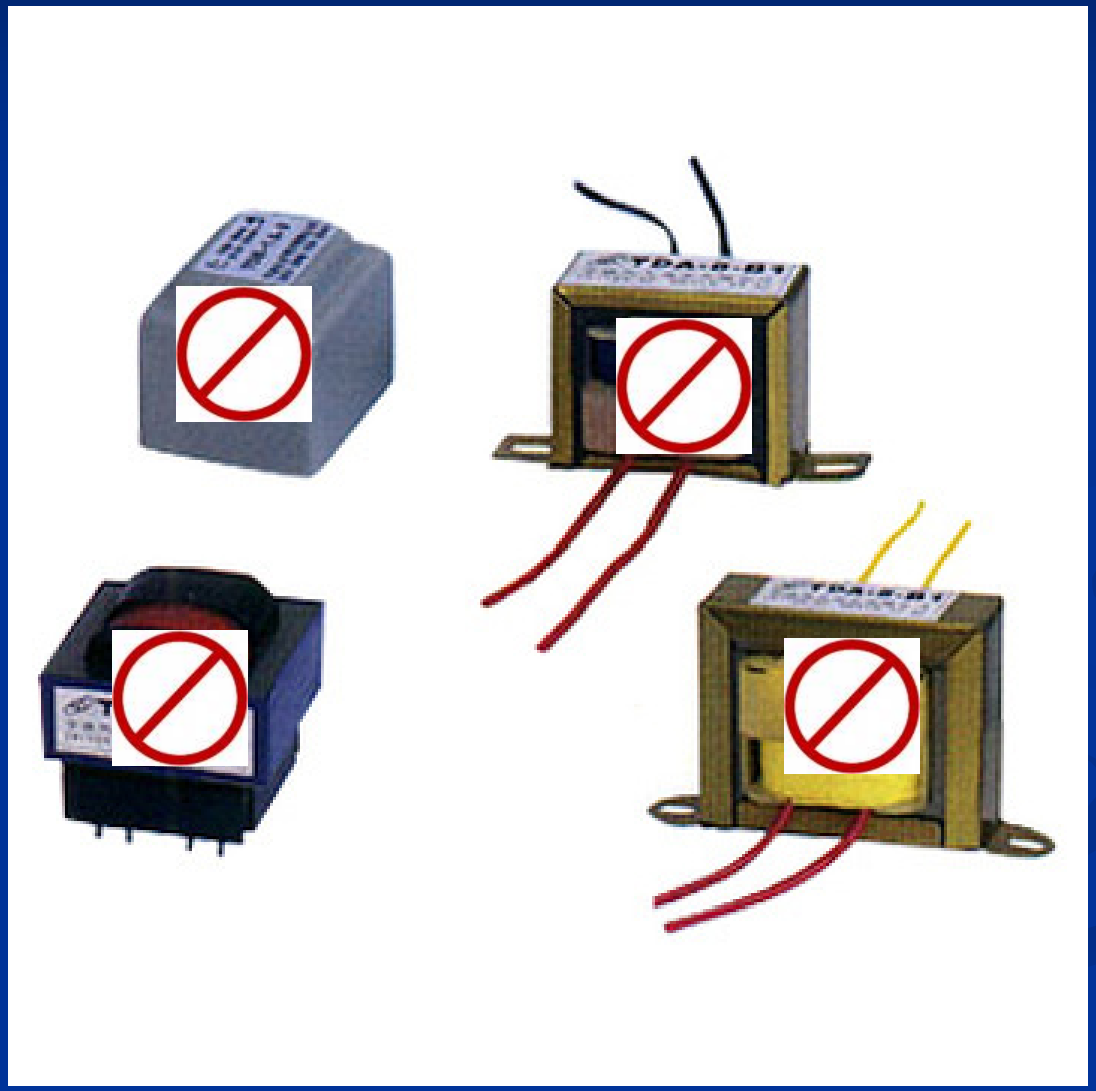


Two different configurations (isomers) of a C6 size organization (hexane)

Agility to Meet Conflict ?



Need Units Not Like These Transformers



But Like These Transformers

Agile Response to Meet the Requirement

… and These Transformers

DARPA Wants a Shapeshifter

By Sharon Weinberger, Wired, March 27, 2007

The folks at DARPA are … trying to entice high school students to explore topics in computer science that would be fun, and help the Pentagon. One of the ideas students liked: physical objects that can morph into different shapes. ***Objects that could morph into weapons? Who wouldn't love that?***

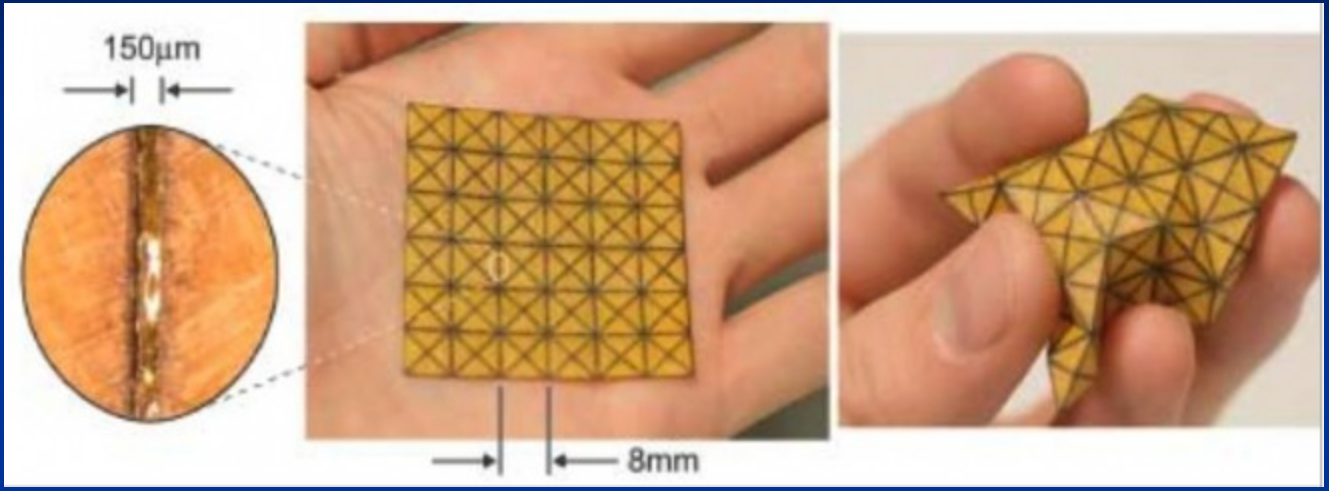
"A simple example is an antenna that would change its shape based on the communication system to which it is connected. The computer science challenges are to identify the algorithms that would allow each element of the object to do its job as the object changes, while staying well coordinated with the other elements and functioning as an ensemble."

DARPA Director Tony Tether
Report to Congress, March 2007

DARPA Programmable Matter

“a universal Rubik’s Cube”

Noah Shachtman | Wired.com 8 June 2009



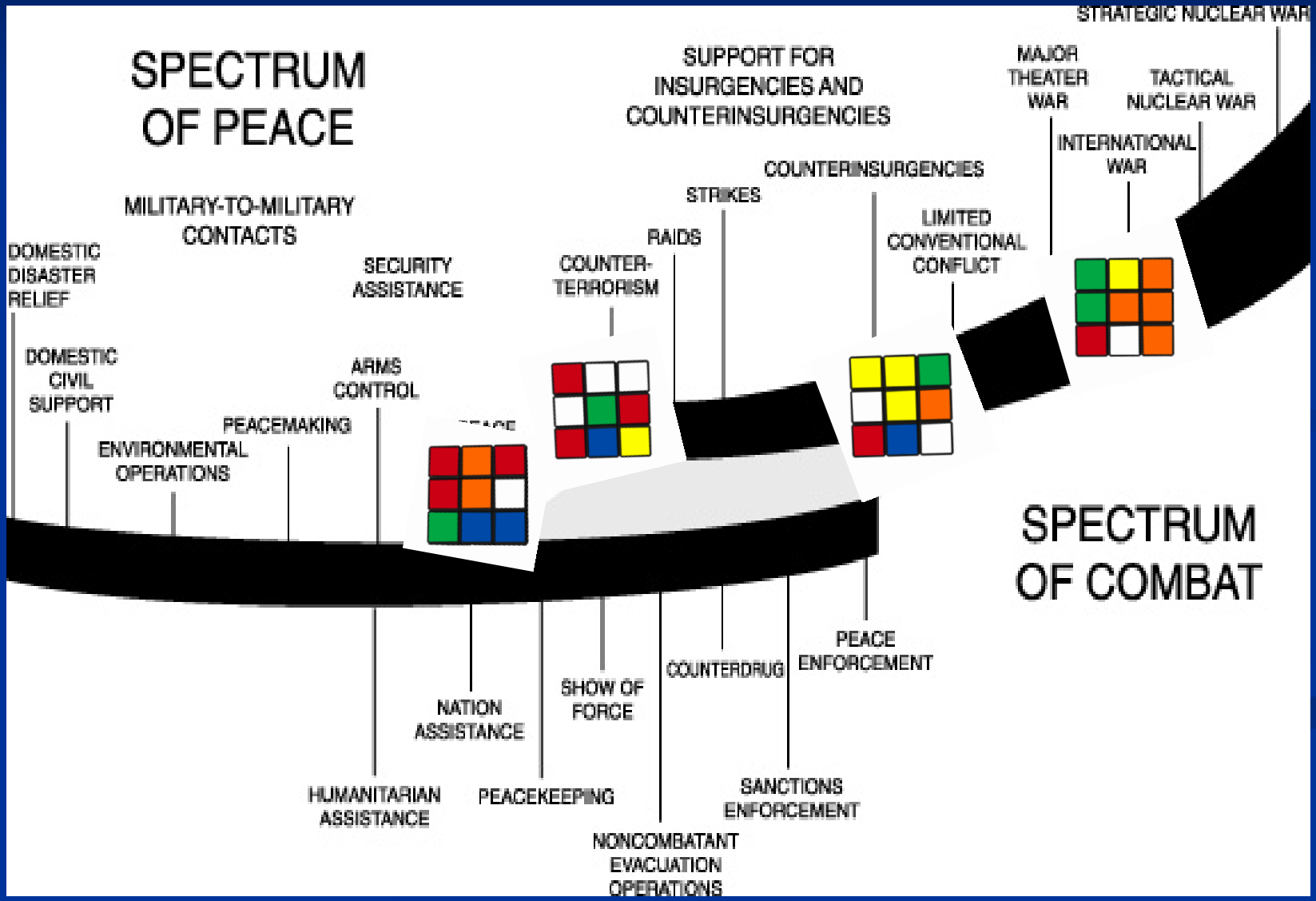
One possible direction for the technology is programming adaptability into the material itself. The Programmable Matter program is a first step. Adaptability, for example, could produce electronics that can cope with heat and dust in the desert and then shift to resist humidity and moisture in a jungle environment.

DARPA ChemBots

During military operations it can be important to gain covert access to denied or hostile space. Unmanned platforms such as mechanical robots are of limited effectiveness if the only available points of entry are small openings. The goal of the Chemical Robots (ChemBots) Program is to create a new class of soft, flexible, mesoscale **mobile objects that can identify and maneuver through openings smaller than their dimensions and perform various tasks**.

This program creates a **convergence between materials chemistry and robotics** through the application of any one of a number of approaches, including gel-solid phase transitions, electro- and magneto-rheological materials, geometric transitions, and reversible chemical and/or particle association and dissociation. With ChemBots, our warfighters can gain access to denied spaces and perform tasks safely, covertly, and efficiently.

Future Spectrum of Conflict



The natural extension here is to create military organizations that are programmable and able to morph into units of action that adapt to the mission spectrum with the agility of chemical science …

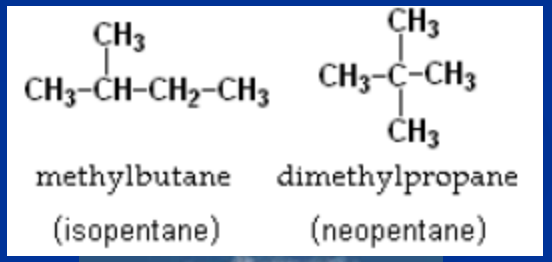
The New Chemistry of C2

Conclusion

Chemistry is a Universal Language

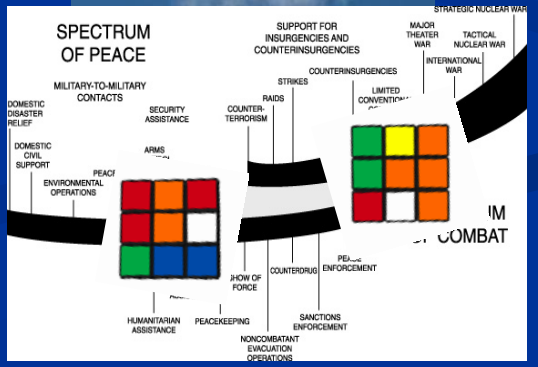
H_2SO_4

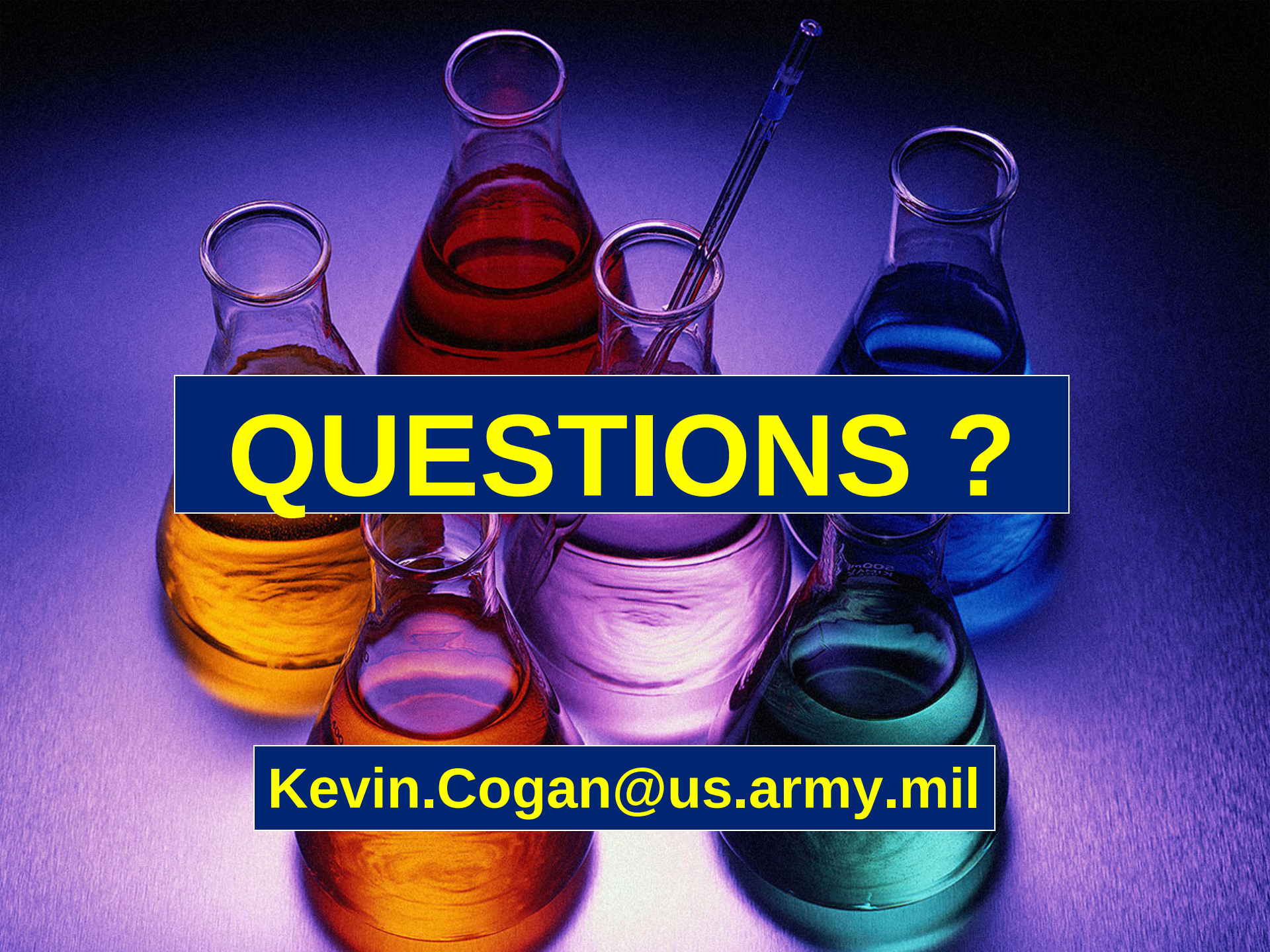
Organizations Can Look Like Isomers



The Rubik's Cube Denotes Adaptability

Agility across the Spectrum of Conflict Requires Isomeric Organizations




QUESTIONS ?
Kevin.Cogan@us.army.mil