Reclaiming Rapid Cognition

Improving Decision-making in Command and Control Agencies by Understanding and Enabling Rapid Cognition

Presentation 206

Captain Elizabeth A. Cassleman, USMC

From Operation Enduring Freedom

- Austere, Mobile Environment

To Operation Iraqi Freedom

- Stationary, Data Heavy Environment

Effects of Technology

- Battlefield Picture in Real Time
- Can see individual units
- Faster Communications
- Demand for constant updates
- Demand for immediate response to senior’s requests

Overall Effect

- Micro-management
- Second-guessing subordinates
- Demand for explanations
- Disables Rapid Cognition Decision-Making

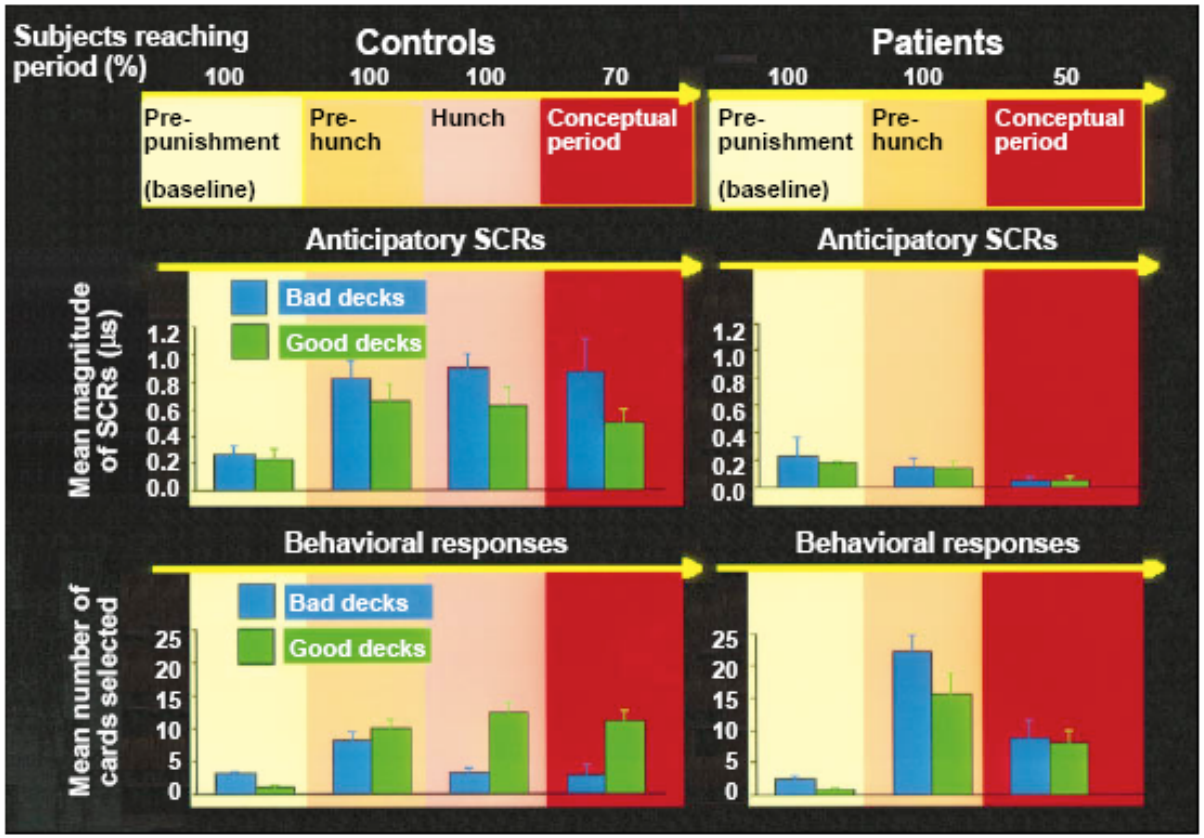
Reclaiming Rapid Cognition Overview

- What is Rapid Cognition?
- Training Rapid Cognition Decision-Makers
- Getting Back to Basics—Enabling the Executors
- Why it Matters What Our Architecture Looks Like
- Leadership as a Network Property

What is Rapid Cognition?

“I see only one move ahead, but it is the correct one.”-Jose Raul Capablanca, Chess Grandmaster

Deciding Advantageously Before Knowing the Advantageous Strategy (1997)



Deciding Advantageously Before Knowing the Advantageous Strategy (1997)

- Rigged Decks
- From cards 10-20, after few losses, anticipatory SCRs
- By card 50, subjects had hunch
- By card 80 subjects could verbalize strategy
- Subjects began to choose advantageously before they realized which strategy worked best

Decision-Making Cycle

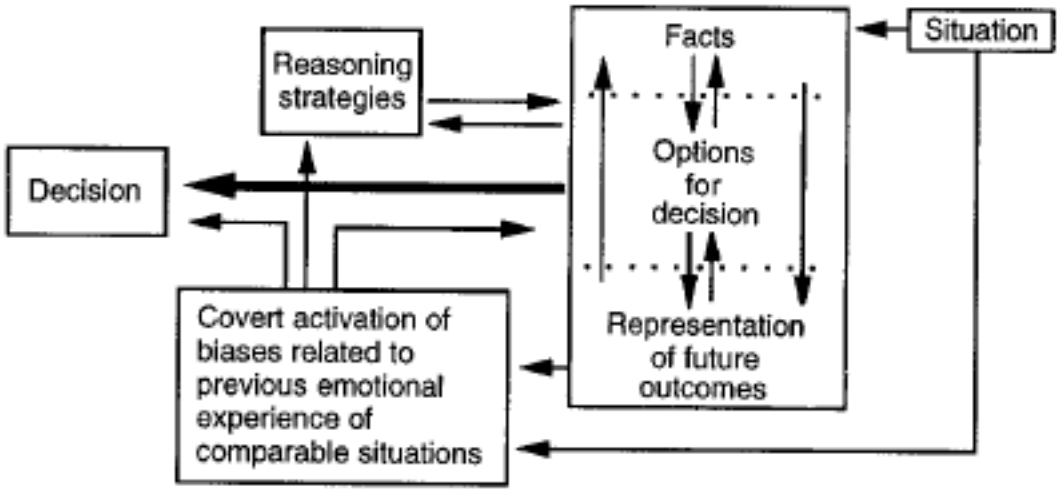


Fig. 2. Diagram of the proposed steps involved in decision-making.

Rapid Cognition

- Takes place in unconscious
- Is a rational process
- Works at a faster rate than conscious thought
- Found in high-stress, quick reaction professions

Training Rapid Cognition Decision-Makers

“Yet this belief in the importance of innate talent, strongest perhaps among the experts themselves and their trainers, is strangely lacking in hard evidence to substantiate it . . . The preponderance of psychological evidence indicates that experts are made, not born.” –Philip E. Ross

Training the Components

- Knowledge Bank
  - Academic knowledge
- Experiential Knowledge
  - Allows the organization of knowledge
- Simulation Training
  - Identifies problems
  - Overcomes stress reactions

Experts don't know significantly more, they just access it more efficiently

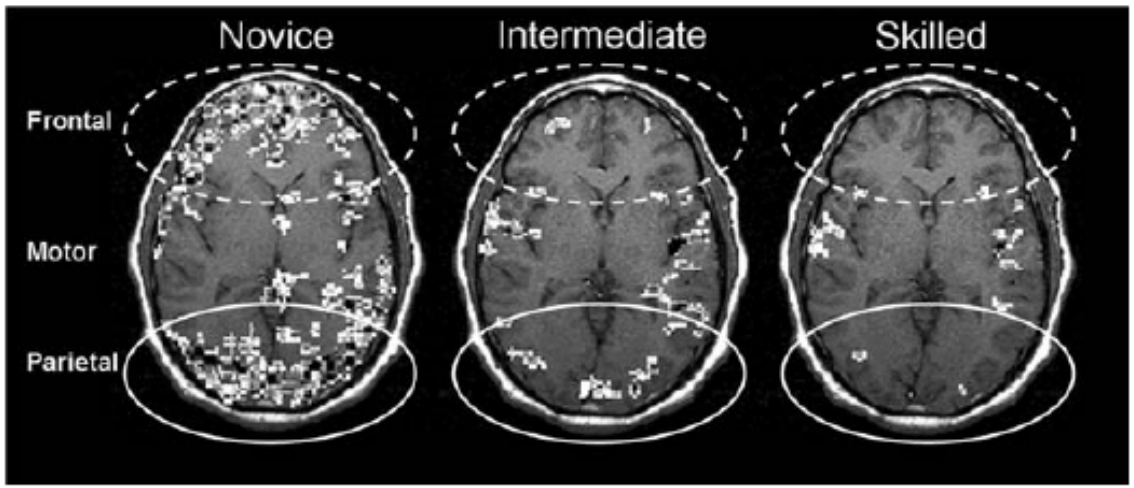


Figure 37.1. Activation of the brain, as a function of practice, in three periods of learning a motor tracking task. This is a maximum projection image, with white areas showing the activation of any cortical area either above or below the illustrated brain slice. The image is an axial (aerial) view of the head, where the top of the image corresponds to the front (nose) of the head and the bottom corresponds to the back of the head. The frontal areas (dashed ellipse) and parietal attention control areas (solid ellipse) show dramatic reductions in activation. The motor areas (middle of images) shares fairly preserved activation.

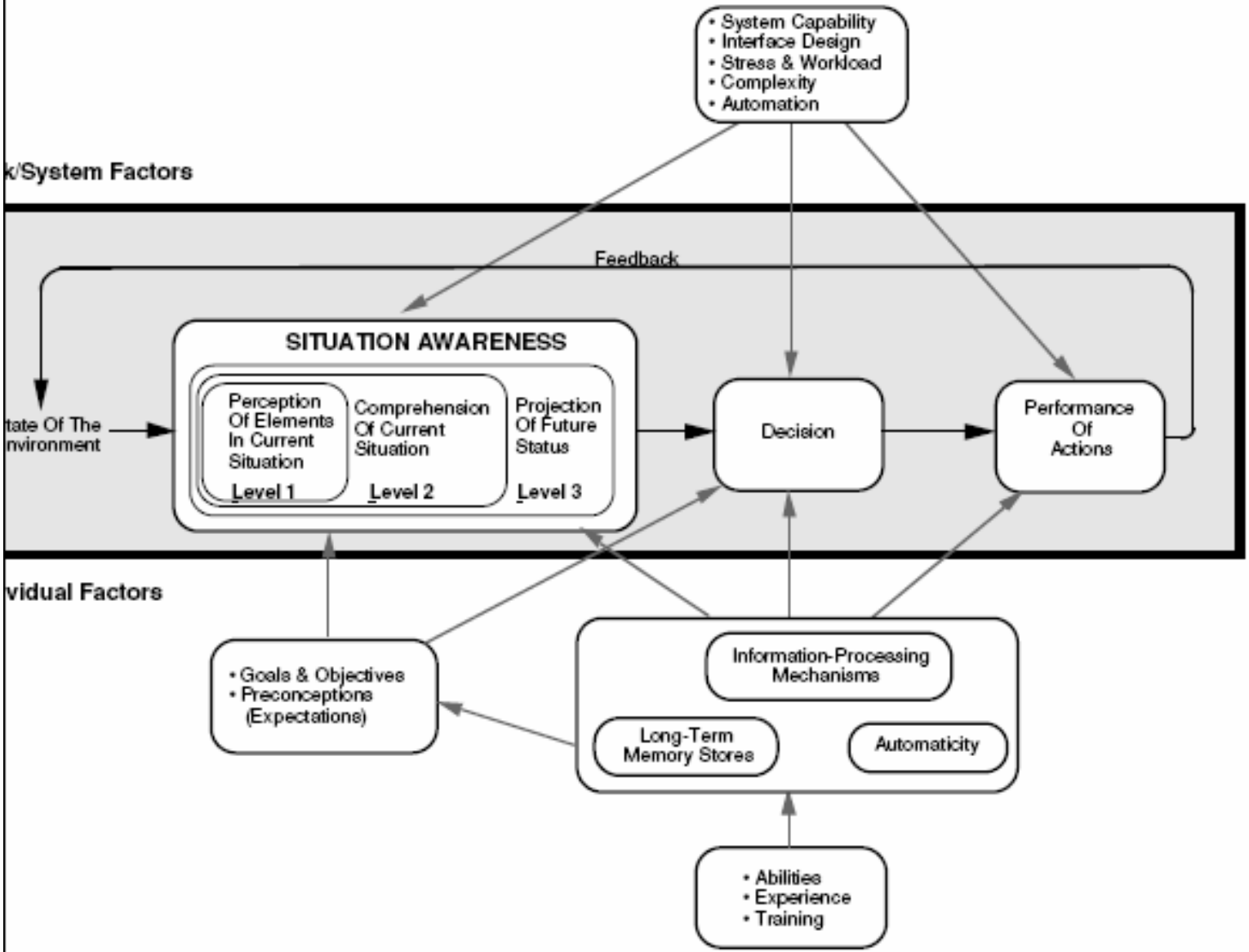


Figure 36.1. Model of Situation Awareness in Dynamic Decision Making (Endsley, 1995)

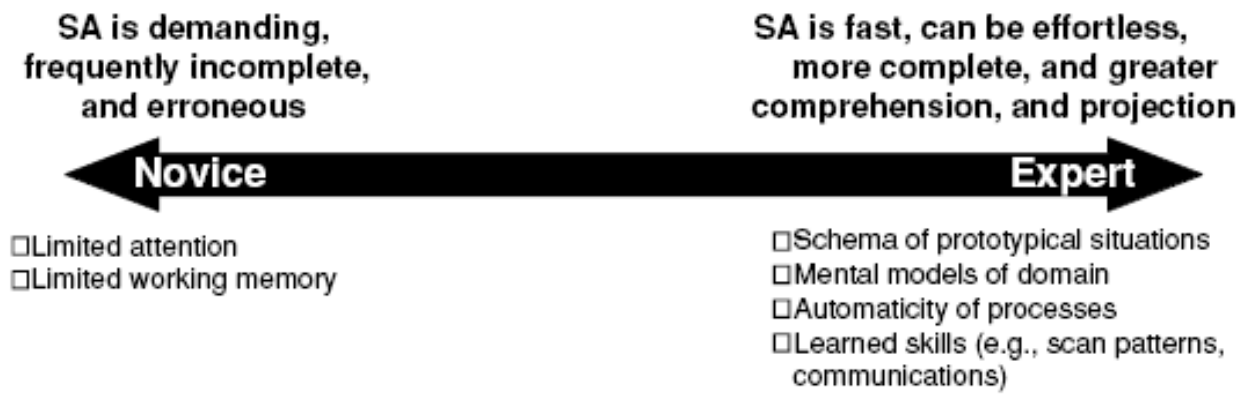


Figure 36.2. Factors effecting SA in Novices and Experts in a Domain

Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)

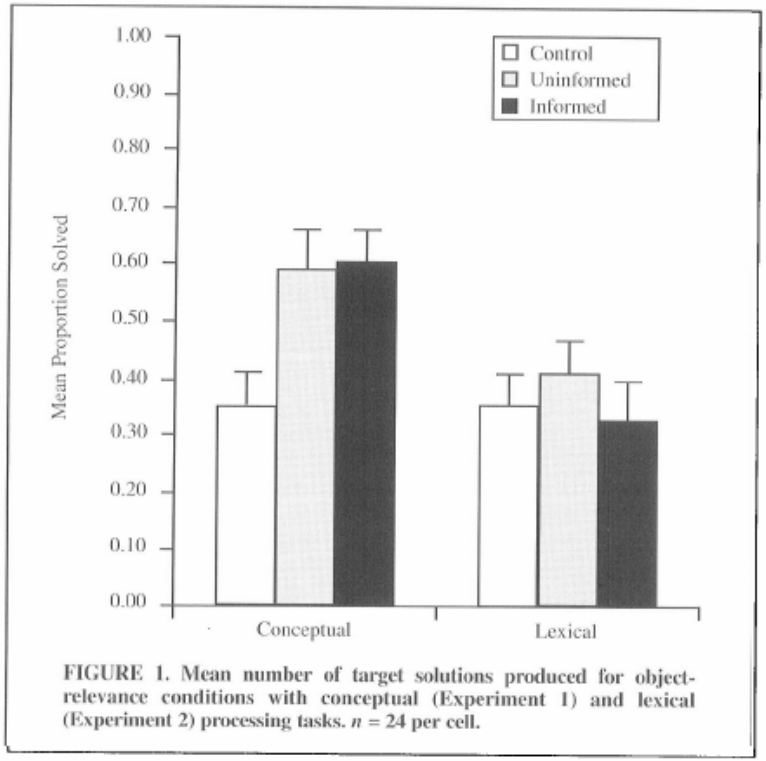


FIGURE 1. Mean number of target solutions produced for object-relevance conditions with conceptual (Experiment 1) and lexical (Experiment 2) processing tasks. $n = 24$ per cell.

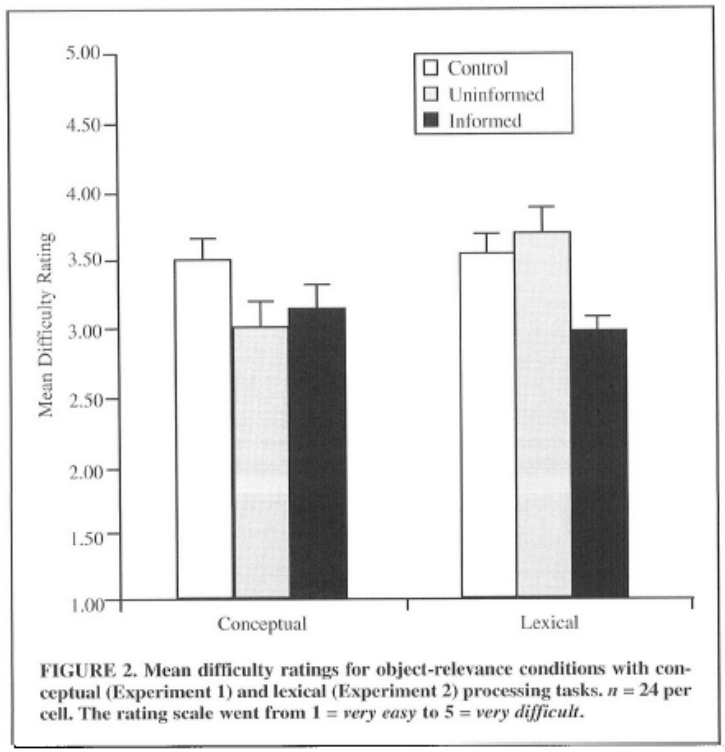


FIGURE 2. Mean difficulty ratings for object-relevance conditions with conceptual (Experiment 1) and lexical (Experiment 2) processing tasks. $n = 24$ per cell. The rating scale went from 1 = *very easy* to 5 = *very difficult*.

Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)

1. Object: apple
Detective Jones arrived at the hospital to find that Al Franks, who had been in a coma, died moments ago while under police custody. Officer Bob Clark, who was assigned to guard the door, swore that no one had entered the room since a nurse last checked in on him some two hours earlier. Aside from an autopsy, Jones ordered that the hospital room be combed for clues. The only unusual thing found was a waste can containing crumpled pieces of paper, a tongue depressor, a half-eaten apple, and an empty cigarette pack. Other than that, everything seemed normal. After the search, Jones suggested to Officer Clark that he was lying, and that someone had indeed been in the room in the last half hour. What caused Jones to draw such a conclusion?

Answer: The half eaten apple was still white, indicating recency of being bitten.

2. Object: camera
During a world fair a group of scientists were exhibiting their advances in genetic engineering. There were cross-breeds of various bulls, cows, and other domestic farm animals. Featured on the exhibit were several over-sized prize turkeys. One afternoon during the show, a woman walked up to the exhibit, shot the turkeys, and then ran out of the building. Although she was known to a number of people, nobody made any attempt to stop her. Why?

Answer: The woman shot the turkeys with a camera. She was a journalist with a deadline.

3. Object: chess set (in folded box)
Professor Charles was giving a lecture on "The Life of the Aristocracy in the 19th Century." "It was during a large festive gathering of nobility," began Charles, "when a fairly common occurrence took place. The Queen suddenly attacked and killed the King. The crowd watched the entire scene and then casually continued their party." In what situation in the 19th century would a crowd be so casual about the Queen killing the King?

Answer: This would happen in a game of chess.

Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)

4. Object: Bicycle brand playing cards (in the original box)
A man is found inside a room dead, lying among 53 Bicycles. The only other objects in the room are a table and some chairs. What might have happened to cause this scene?

Answer: The man was playing cards with Bicycle brand playing cards, was caught with an extra card, and was killed by his opponent.

- Insight Problems
- Cannot be solved by comprehensive analysis
- Successfully primed subjects to get correct answers by showing them objects that later came up in the problems

Priming Problem Solving With Conceptual Processing of Relevant Objects (2004)

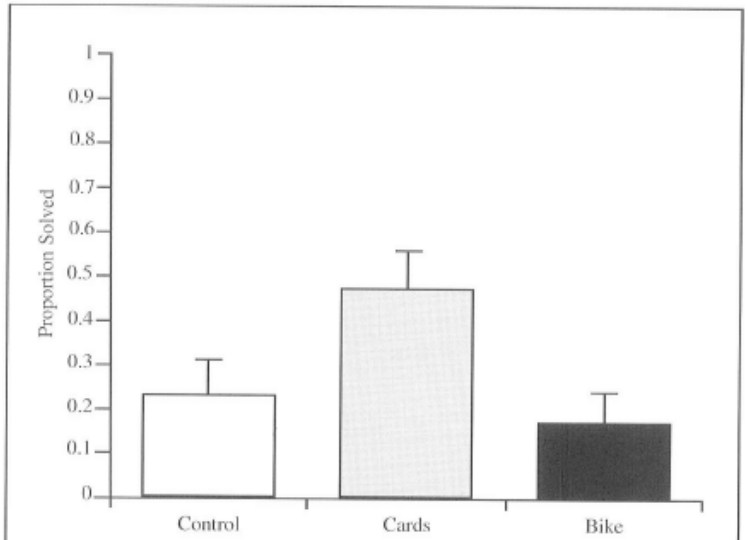


FIGURE 4. Mean proportion correct for the Bicycle problem for control, cards, and bike objects conditions in Experiment 3. n = 30 per condition.

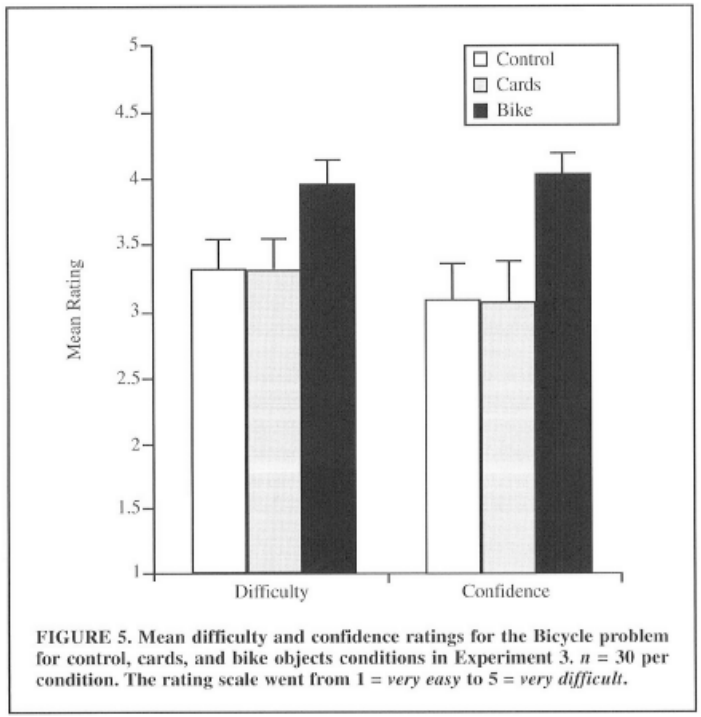


FIGURE 5. Mean difficulty and confidence ratings for the Bicycle problem for control, cards, and bike objects conditions in Experiment 3. n = 30 per condition. The rating scale went from 1 = *very easy* to 5 = *very difficult*.

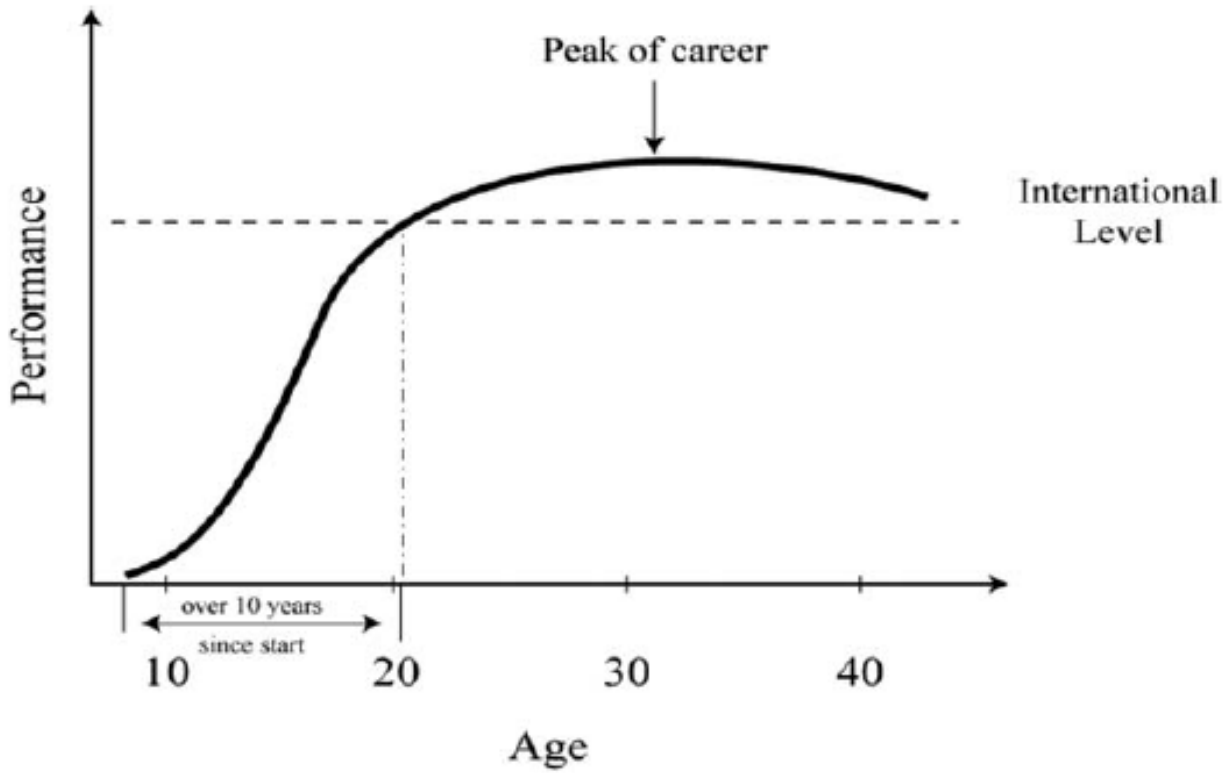


Figure 38.3. An illustration of the gradual increases in expert performance as a function of age, in domains such as chess. The international level, which is attained after more than around ten years of involvement in the domain, is indicated by the horizontal dashed line. (From "Expertise," by K. A. Ericsson and Andreas C. Lehmann, 1999, *Encyclopedia of Creativity*. Copyright by Academic Press.)

Getting Back to Basics—Enabling the Executors

"You've got to let people work out the situation, work out what's happening. The danger in calling is that they'll tell you anything to get you off their backs, and if you act on that and take it at face value, you could make a mistake. Plus, you are diverting them. Now they are looking upward instead of downward. You're preventing them from resolving the situation." –Paul VanRiper

Thinking Too Much: Introspection Can Reduce the Quality of Preferences and Decisions (1991)

Table 1
Study 1: Mean Liking Ratings for the Five Jams

Condition	Jam 1	Jam 2	Jam 3	Jam 4	Jam 5
Control					
M	6.52	7.64	6.12	2.72	4.68
SD	2.22	1.66	2.05	2.26	2.66
Reasons					
M	4.54	6.25	5.42	2.88	4.92
SD	2.00	2.38	2.70	2.13	2.89
t	3.27	2.38	1.03	−.25	−.30
p	.002	.02	.31	.81	.77

Note. The jams are listed in order of their rankings by the *Consumer Reports* experts; Jam 1 was the highest ranked jam, Jam 2 was the second highest, and so on. The liking ratings were made on 9-point scales that ranged from *disliked* (1) to *liked* (9).

- Novices differed from expert jam ratings when asked to explain why they liked the jam they liked

Thinking Too Much: Introspection Can Reduce the Quality of Preferences and Decisions (1991)

- Introspecting about decisions to take psych courses caused students to weight information in a less than optimal way and to make less optimal choices.

Table 4
Courses Preregistered for and Actually Taken

Variable	Condition		
	Control	Reasons	Rate all
Preregistration			
Highly rated courses	.41	.15	.21
Poorly rated courses	.04	.10	.01
Actual enrollment			
Highly rated courses	.37	.21	.24
Poorly rated courses	.03	.08	.03

Note. Subjects were assigned a 1 if they registered for or actually took a course and a 0 if they did not register or take a course.

TABLE I Comparison of the Experiential and Rational Systems (From Epstein et al., 1996)

Experiential System	Rational System
1. Holistic	1. Analytic
2. Automatic, effortless	2. Intentional, effortful
3. Affective: pleasure-pain oriented (what feels good)	3. Logical: reason oriented (what is rational)
4. Associationistic connections	4. Logical connections
5. Behavior mediated by "vibes" from Past events	5. Behavior mediated by conscious appraisal of events
6. Encodes reality in concrete images, metaphors, and narratives	6. Encodes reality in abstract symbols, words, and numbers
7. More rapid processing: oriented toward immediate action	7. Slower processing: oriented toward delayed action
8. Slower and more resistant to change: change with repetitive or intense experience	8. Changes more rapidly and easily: changes with strength of argument and new evidence
9. More crudely differentiated: broad generalization gradient; stereotypical thinking	9. More highly differentiated
10. More crudely integrated: dissociative, emotional complexes; context-specific processing	10. More highly integrated: context-general Principles
11. Experienced passively and preconsciously: we are seized by our emotions	11. Experienced actively and consciously: we are in control of our thoughts
12. Self-evidently valid: "experiencing is believing"	12. Requires justification via logic and evidence

TABLE II Characteristics of Analysis and Intuition (From Dunwoody et al., 2000)

Analysis	Intuition
High insight into judgment process, and hence, publicly retraceable	Low insight into judgment process, and hence, difficult to retrace and defend
Low confidence in outcome, high confidence in method	High confidence in outcome, low confidence in method
Cues are objectively evaluated	Cues are perceptually evaluated
Slow rate of processing	Fast rate of processing
Errors few, but large when they occur	Errors normally distributed
High cognitive consistency	Low cognitive consistency

TABLE III Task Characteristics That Induce Analysis and Intuition (From Dunwoody et al., 2000)

Analysis-inducing Task Characteristics	Intuition-inducing Task Characteristics
Less than five cues	More than five cues
Successively presented cues	Simultaneously presented cues
Low cue redundancy	High cue redundancy
Unequal weighting of cues in ecology	Equal weighting of cues in ecology
Cues objectively measured	Cues perceptually measured
Nonlinear cue functions	Linear cue functions
Organizing formula available	No organizing formula available
Task outcome available	Task outcome unavailable

Rapid Cognition

- Uses a different part of the brain than Comprehensive Analysis
- Can be “switched off” by asking for an explanation
- Fragile Process

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The Verbal Overshadowing Effect: Why Descriptions Impair Face Recognition (1997)

Table 1
Recognition and Recognition Weighted by Confidence Scores for Experiment 1

	Percentage Correct Recognition	Recognition × Confidence Scores	*SE*
Self-paced test			
Control	80	4.95	.39
Verbal	65	4.20	.51
Speeded test			
Control	70	4.30	.38
Verbal	35	3.20	.37
Two-choice			
Control	65	4.25	.51
Verbal	55	3.85	.49
Ignore			
Verbal	45	3.30	.45

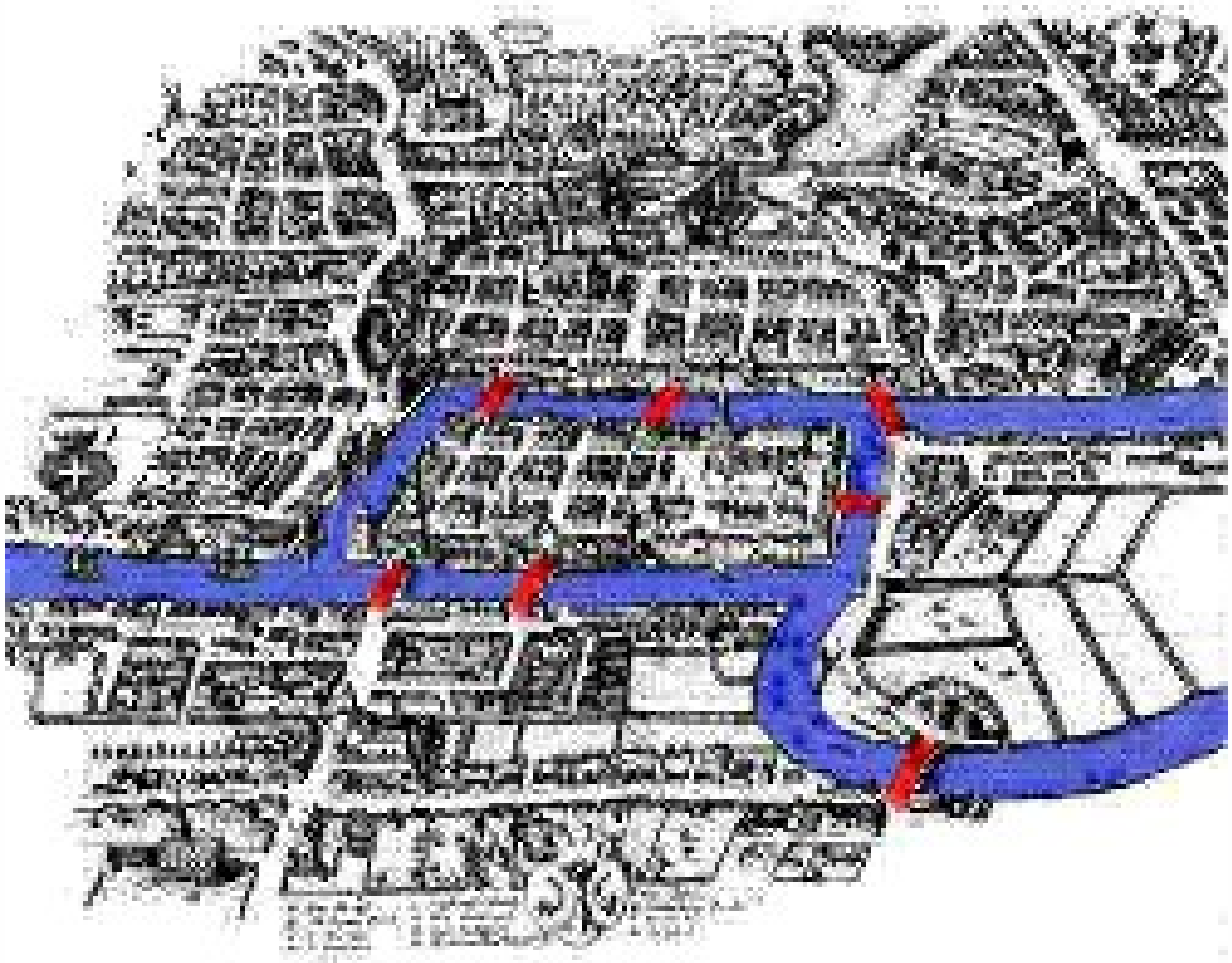
Table 2
Recognition and Recognition Weighted by Confidence Scores for Experiment 2

	Percentage Correct Recognition	Recognition × Confidence Scores	*SE*
Control	65	4.38	.35
Describe parent	53	3.63	.34
Verbal			
Self-paced	53	3.72	.33
Ignore	38	3.23	.30
Provide			
Self-paced	45	3.48	.31
Ignore	63	4.15	.30

Why It Matters What Our Architecture Looks Like

"Networks have properties hidden in their construction, that limit or enhance our ability to do things with them." –Albert-Laszlo Barabasi

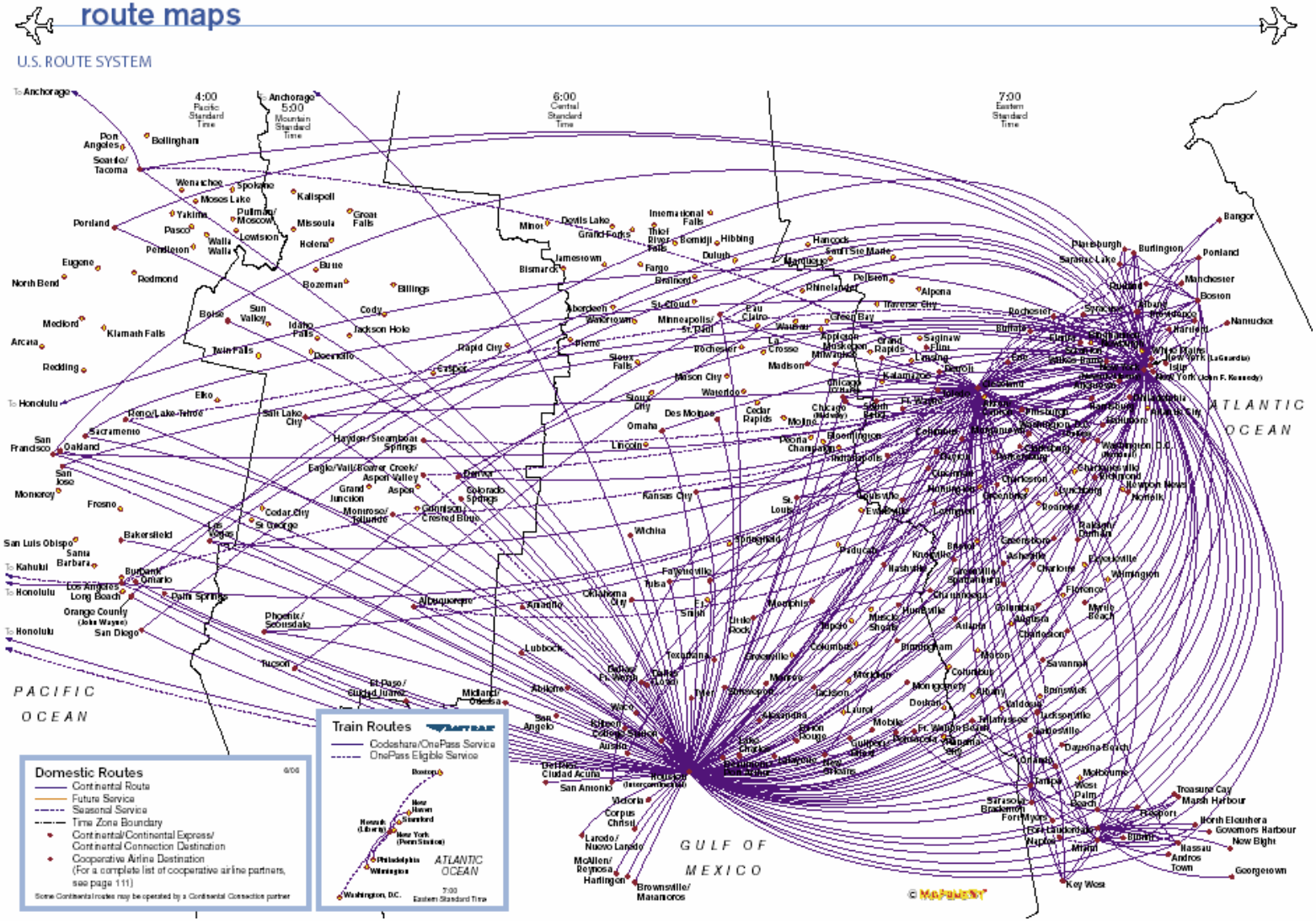
Koenisburg Bridge Problem

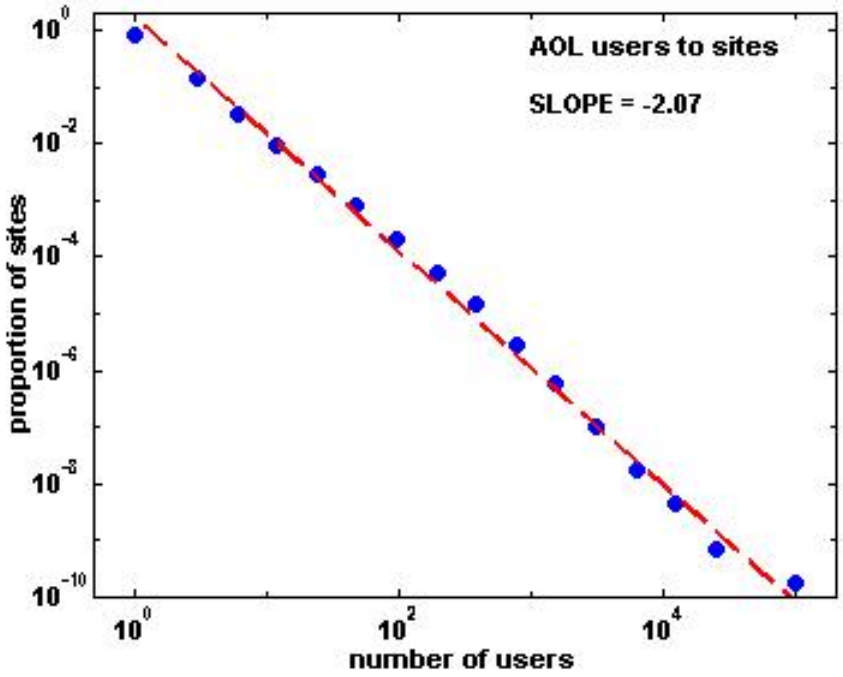


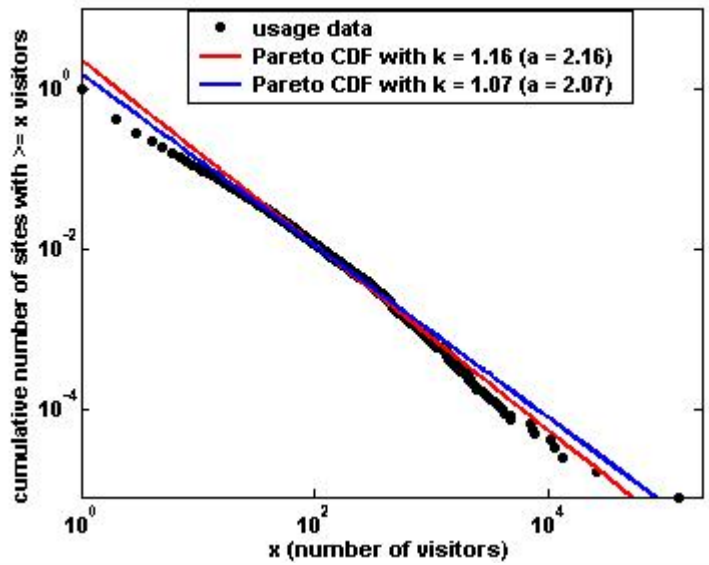
Genesis of Graph Theory

- There was a definitive answer: No
- There was a formula to support it: No unbroken non-repetitive path will exist between the nodes when there are an odd number of links
- Networks have Properties

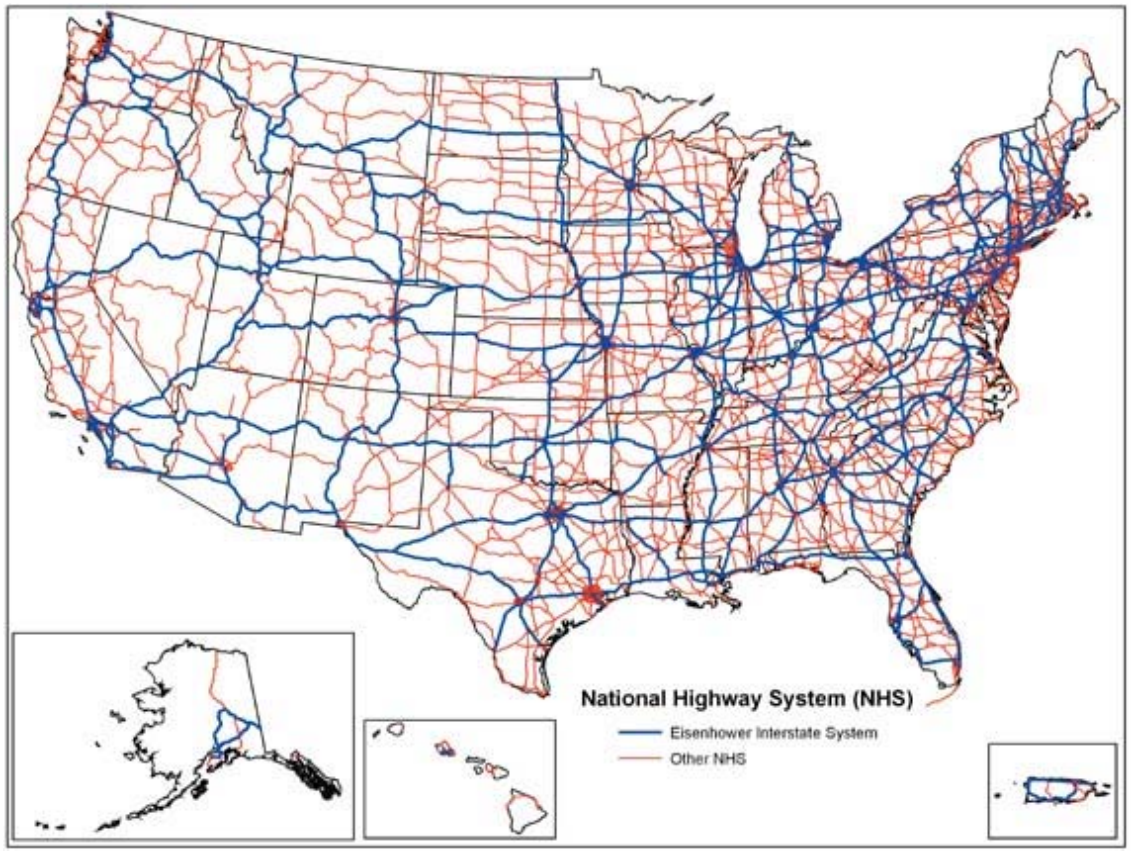
Scale-Free

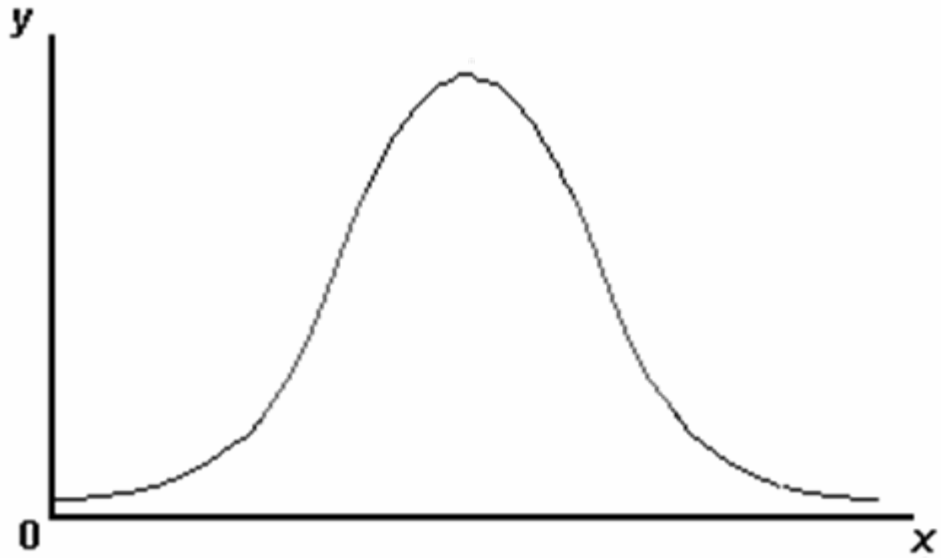

route maps
U.S. ROUTE SYSTEM
4:00 Pacific Standard Time
5:00 Mountain Standard Time
6:00 Central Standard Time
7:00 Eastern Standard Time
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
Domestic Routes
Continental Route
Future Service
Seasonal Service
Time Zone Boundary
Continental/Continental Express/ Continental Connection Destination
Cooperative Airline Destination
(For a complete list of cooperative airline partners, see page 111)
Some Continental routes may be operated by a Continental Connection partner
Train Routes
Codeshare/OnePass Service
OnePass Eligible Service
Washington, D.C.
Eastern Standard Time

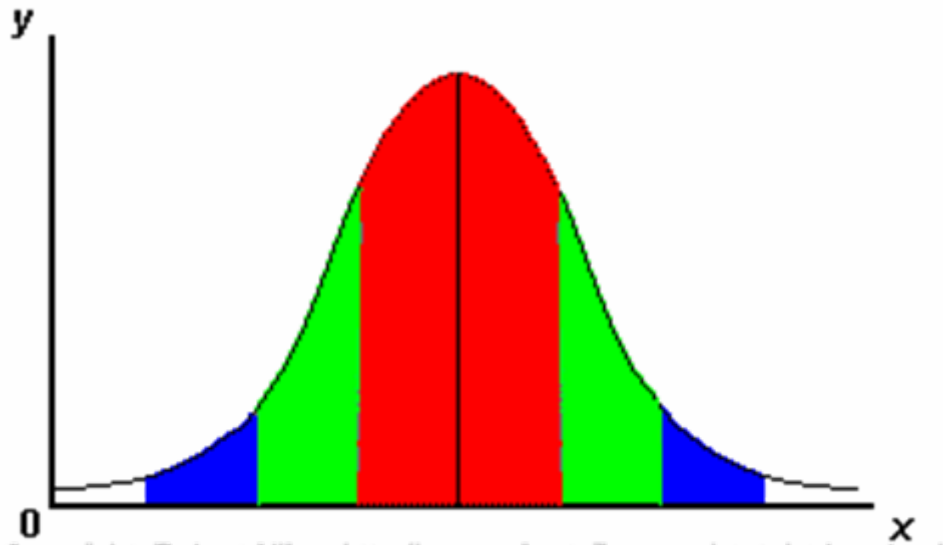

AOL users to sites
SLOPE = -2.07
proportion of sites
number of users
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
10^{0}
10^{2}
10^{4}

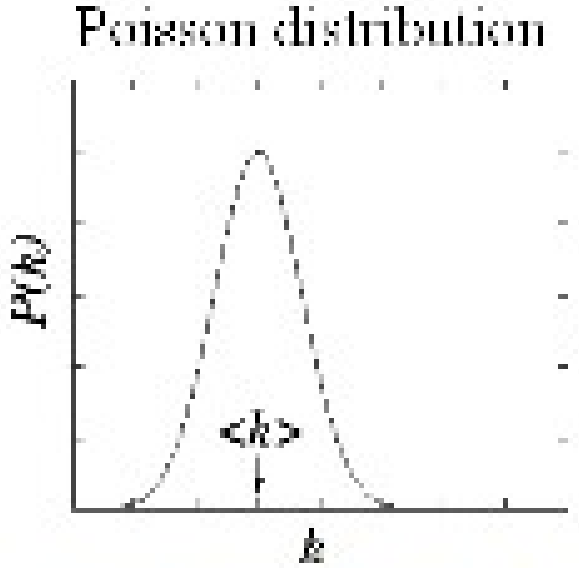

usage data
Pareto CDF with k = 1.16 (a = 2.16)
Pareto CDF with k = 1.07 (a = 2.07)
cumulative number of sites with >= x visitors
x (number of visitors)
10^{0}
10^{-2}
10^{-4}
10^{0}
10^{2}
10^{4}

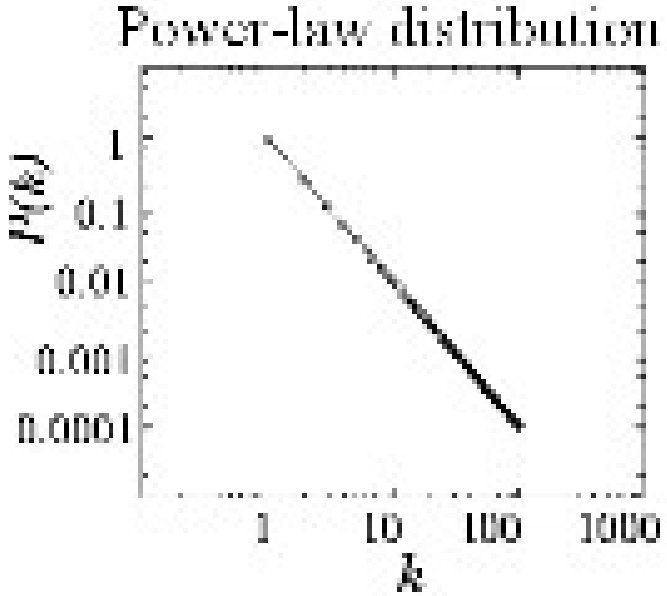
Distributed



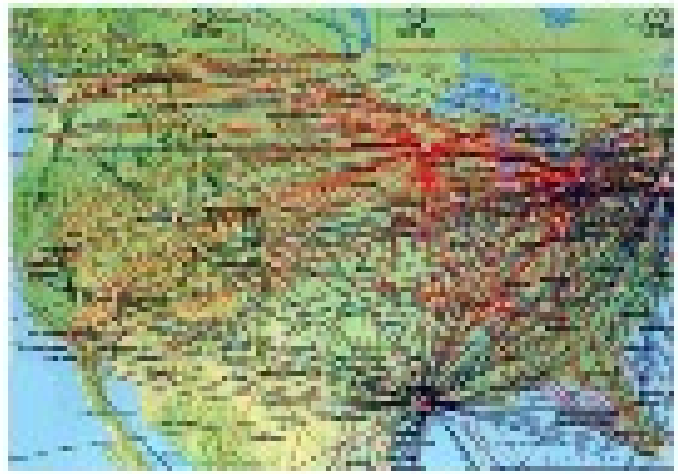








Exponential Network



Scale-free Network

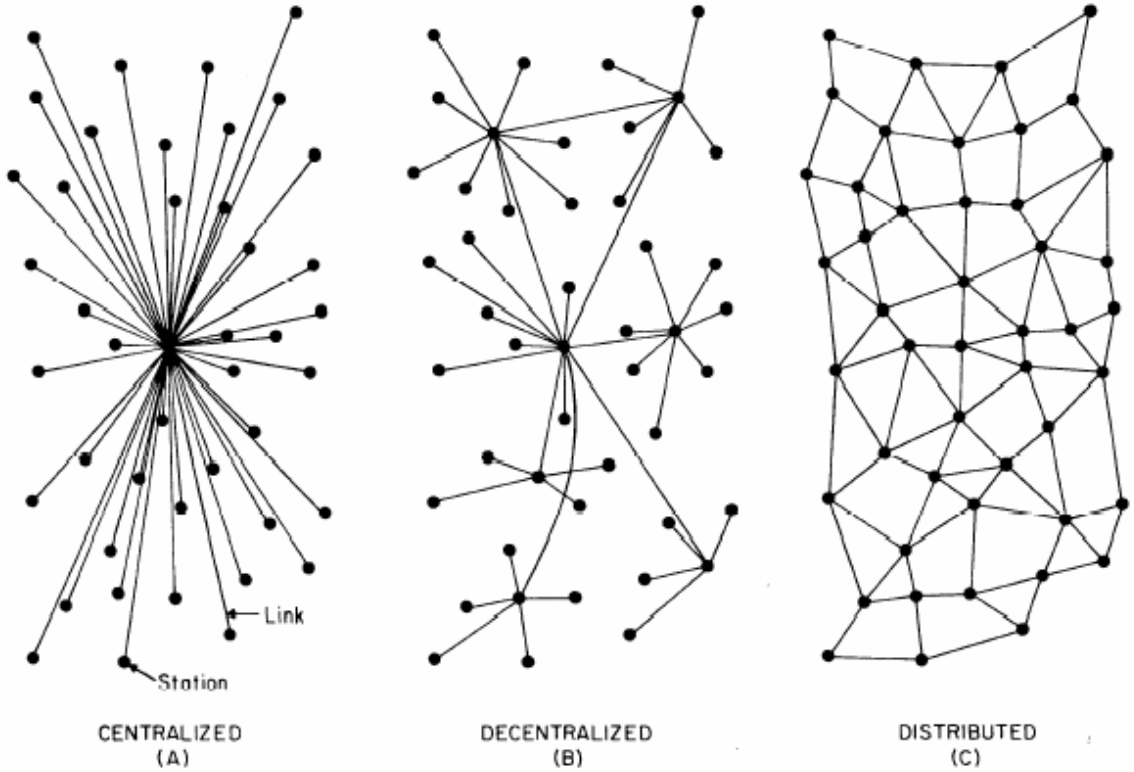
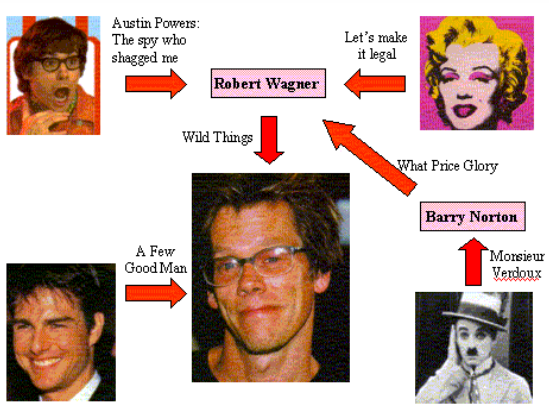
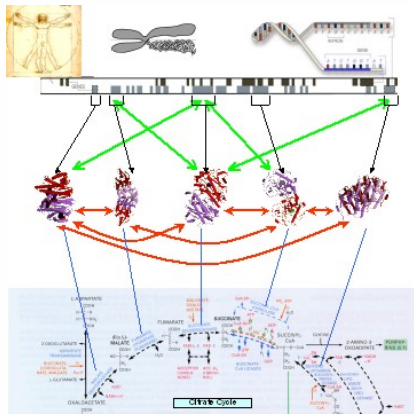
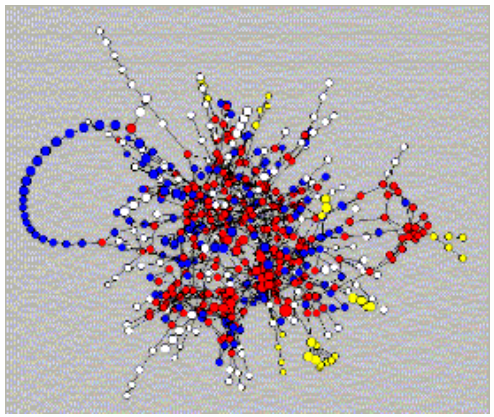


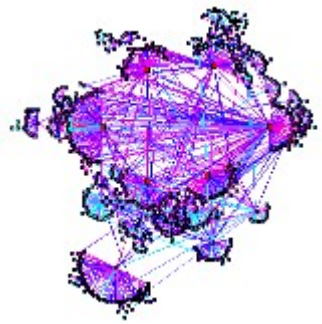
FIG. 1 — Centralized, Decentralized and Distributed Networks

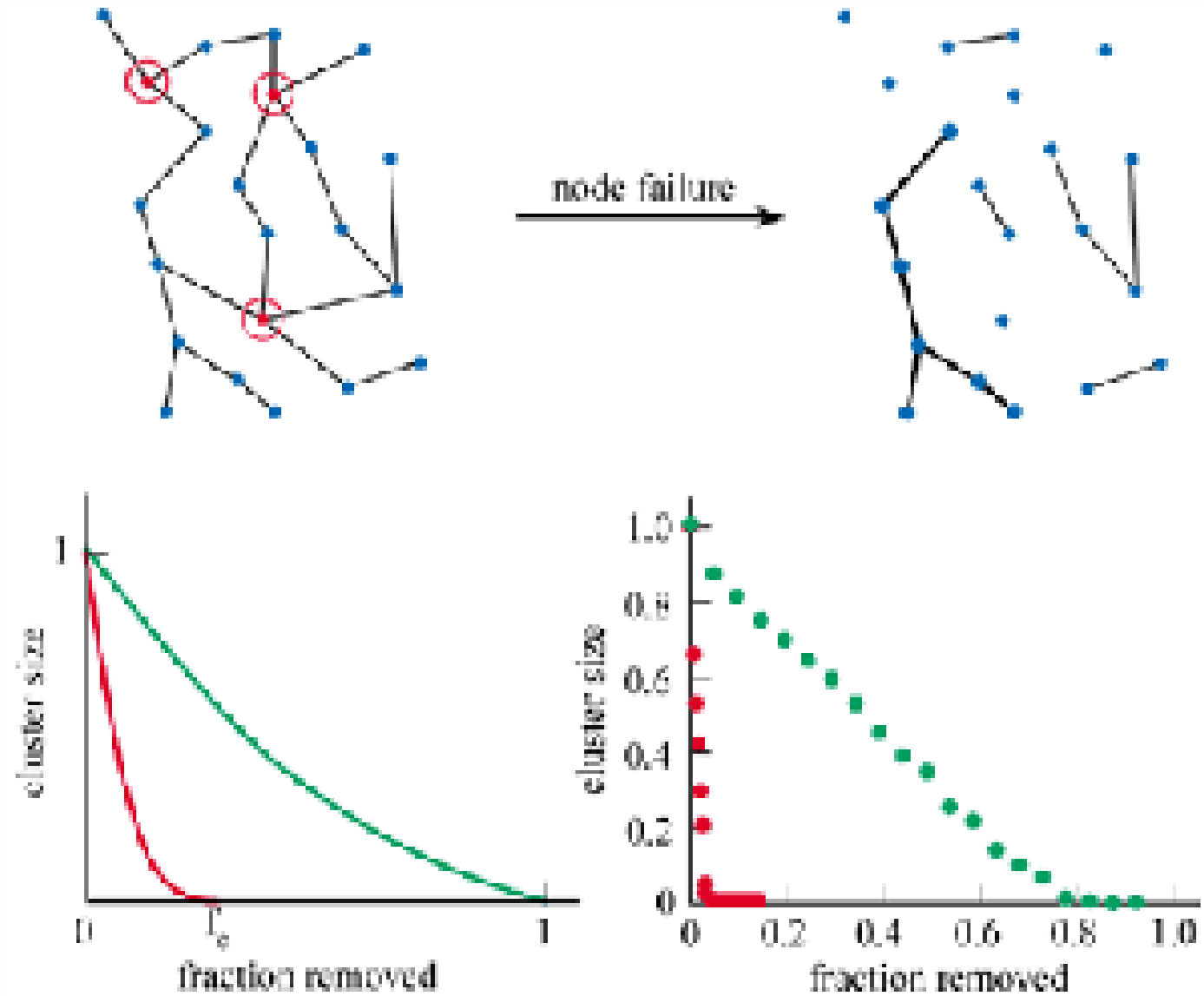
All Scale-Free have similar topologies, regardless of the character of the network










node failure
1
cluster size
0
f_c
1
fraction removed
1.0
0.8
0.6
0.4
0.2
0
cluster size
0
0.2
0.4
0.6
0.8
1.0
fraction removed

Practical Uses

- Command and Control Systems are generally Scale Free
- C2 have hubs-defining trait
- Are the bottleneck for information and decisions
- Are actually fractals

Leadership as a Network Property

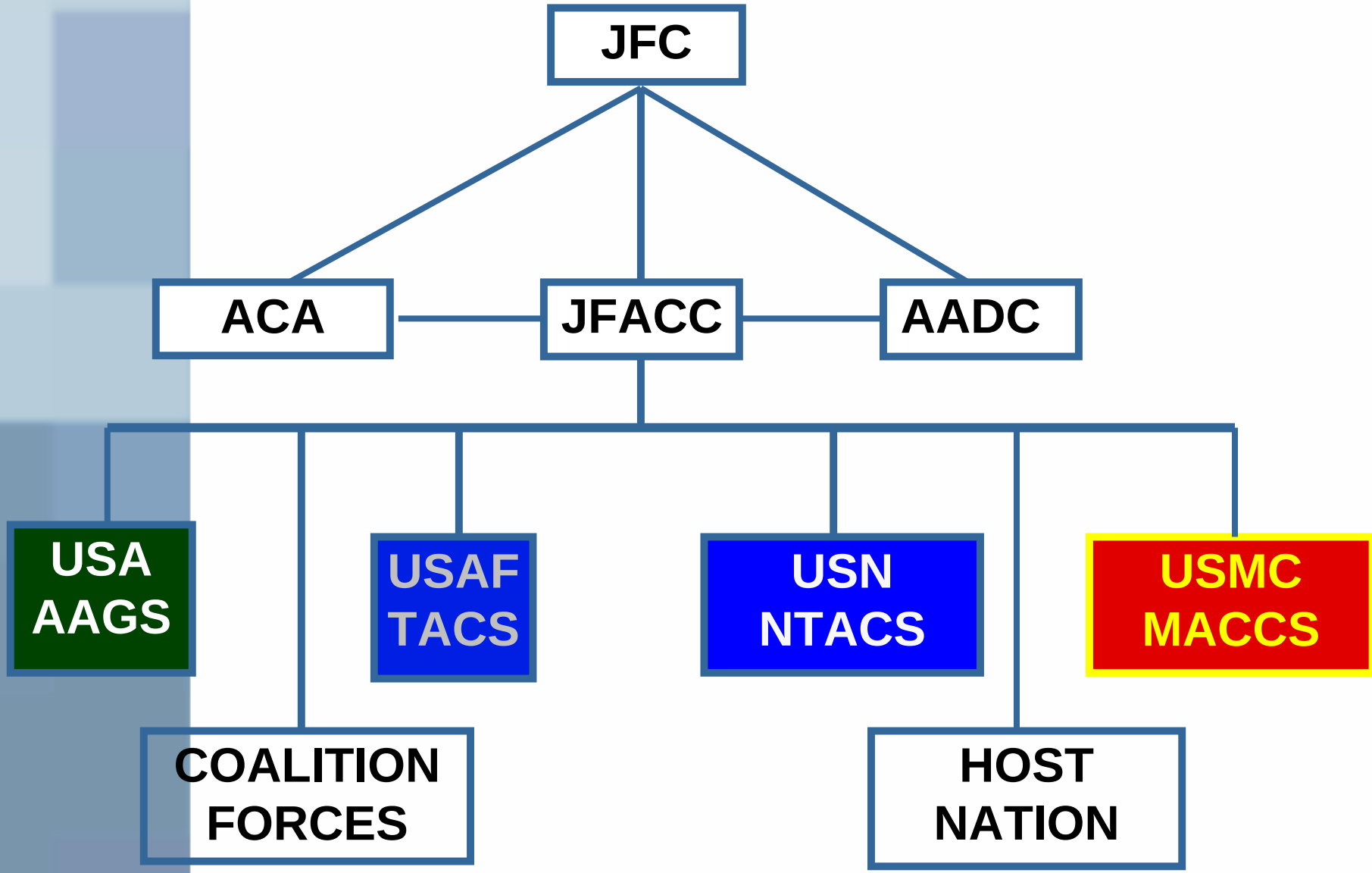
“This is not to say that individual qualities are not important, but rather that sustainable and replicable qualities of leadership treated here as a network property, made possible by the combination of the social network and the individuals themselves.”- Dr. John H. Clippinger

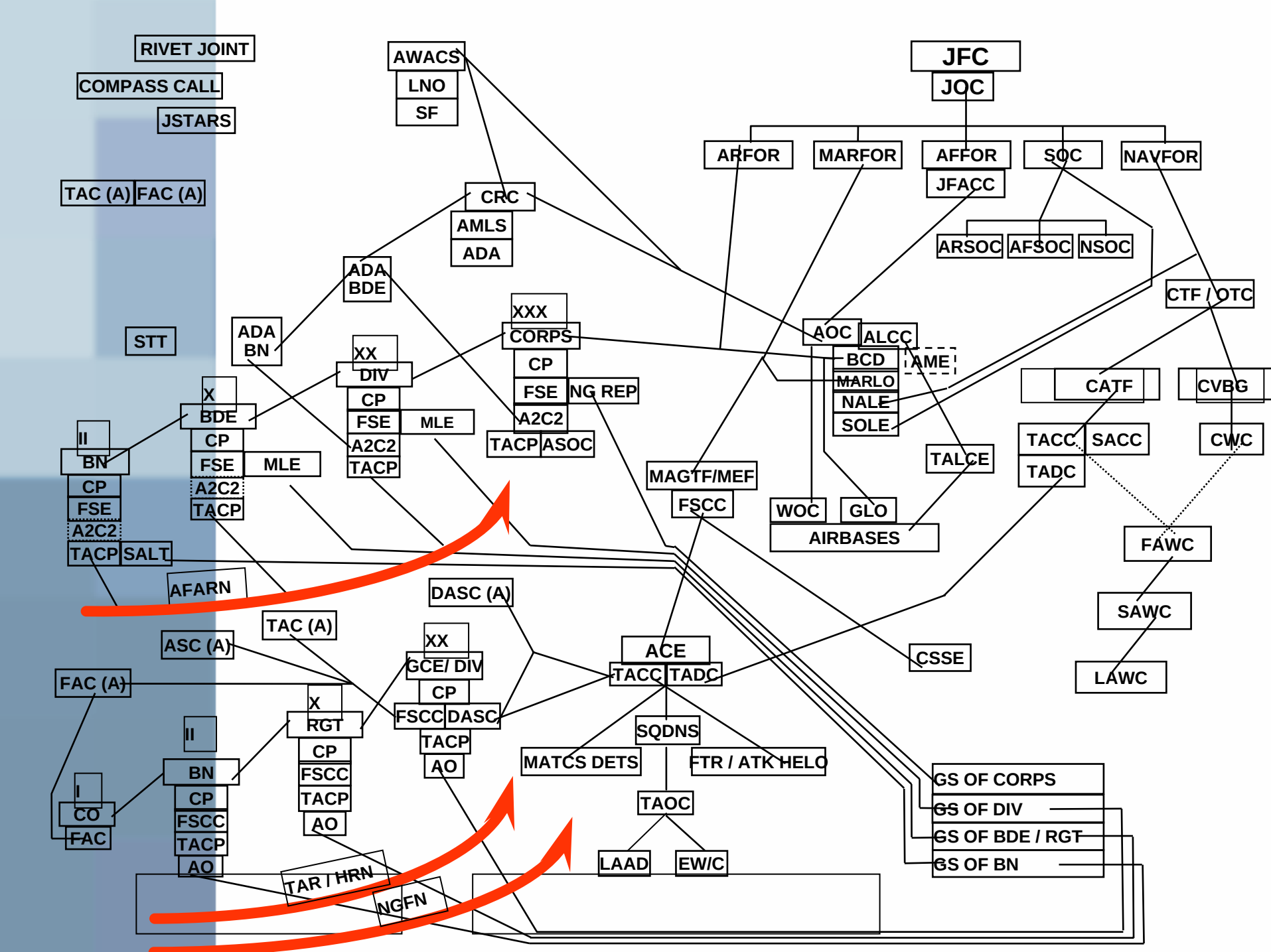
Leadership

- Sustainable and replicable
- Supported by architecture
- Cognitive Continuum Theory
  - Neither type of decision-making is “wrong”
  - Free to choose most appropriate type of decision-making

Practical Example

- MACCS -Marine Aviation Command and Control System
- TACC -Tactical Air Command Center (Senior Agency)
- DASC -Direct Air Support Center
- TAOC -Tactical Air Operations Center
- FSCC -Fire Support Coordination Center
- ASLT -Air Support Liaison Team


JFC
ACA
JFACC
AADC
USA AAGS
USAF TACS
USN NTACS
USMC MACCS
COALITION FORCES
HOST NATION


RIVET JOINT
COMPASS CALL
JSTARS
TAC (A)
FAC (A)
AWACS
LNO
SF
CRC
AMLS
ADA
JFC
JOC
ARFOR
MARFOR
AFFOR
JFACC
SOC
NAVFOR
ARSOC
AFSOC
NSOC
CTF / OTC
ADA
BDE
ADA
BN
STT
XXX
CORPS
CP
FSE
NG REP
A2C2
TACP
ASOC
XX
DIV
CP
FSE
MLE
A2C2
TACP
X
BDE
CP
FSE
MLE
A2C2
TACP
II
BN
CP
FSE
A2C2
TACP
SALT
AOC
ALCC
BCD
AME
MARLO
NALE
SOLE
CATF
CVBG
TACC
SACC
TADC
CWC
TALCE
MAGTF/MEF
FSCC
WOC
GLO
AIRBASES
FAWC
SAWC
LAWC
CSSE
AFARN
DASC (A)
TAC (A)
ASC (A)
FAC (A)
XX
GCE/ DIV
CP
FSCC
DASC
TACP
AO
ACE
TACC
TADC
SQDNS
MATCS DETS
FTR / ATK HELO
TAOC
LAAD
EW/C
X
RGT
CP
FSCC
TACP
AO
II
BN
CP
FSCC
TACP
AO
I
CO
FAC
TAR / HRN
NGFN
GS OF CORPS
GS OF DIV
GS OF BDE / RGT
GS OF BN

Current MACCS

TACP

TACP

TACP

TACP

ASLT

ASLT

ASLT

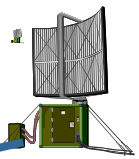
REG AO

MMT

Airboss

DIV AO

DASC



TAOC

Joint C2

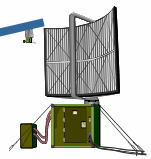
TACC

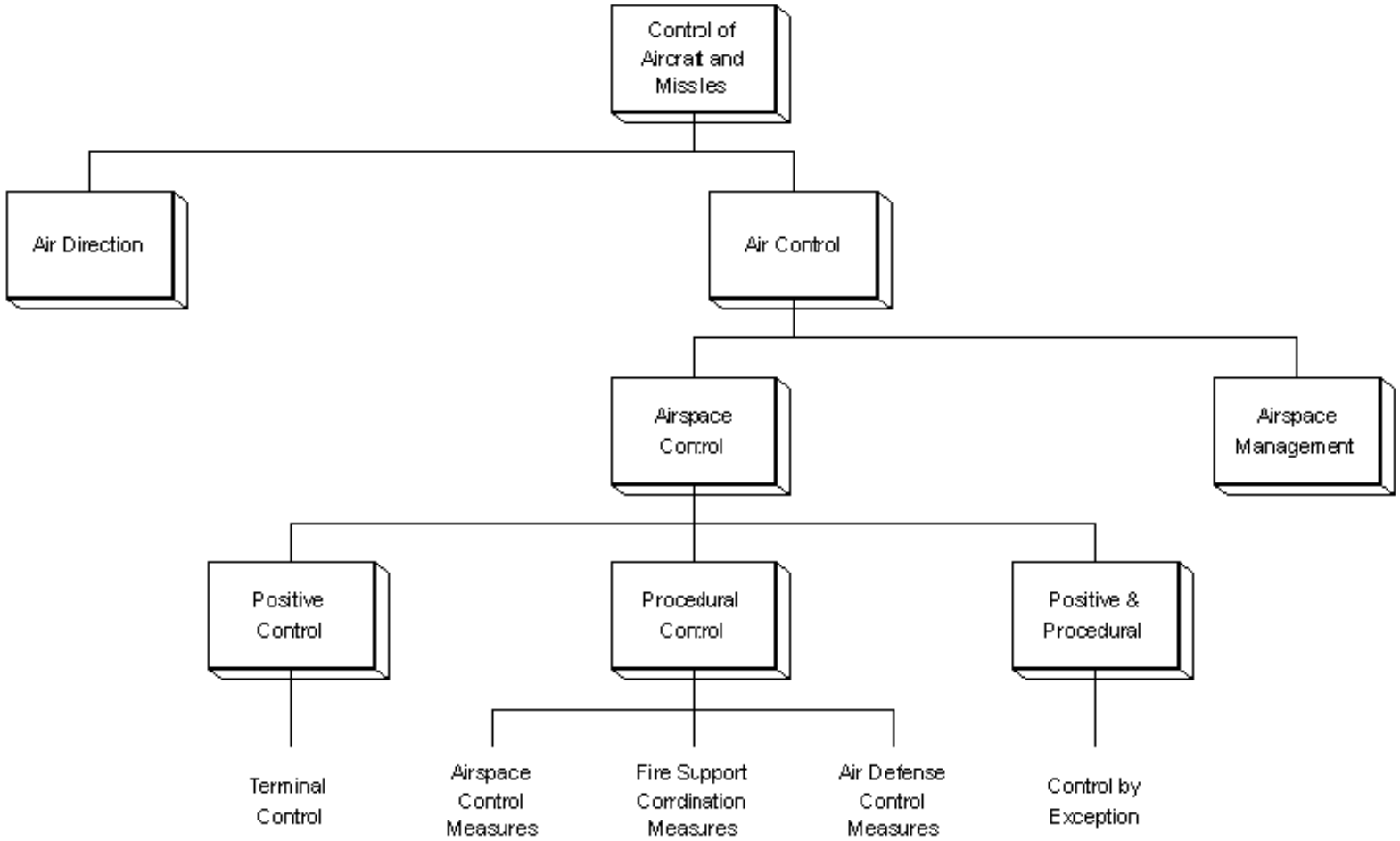
ATC

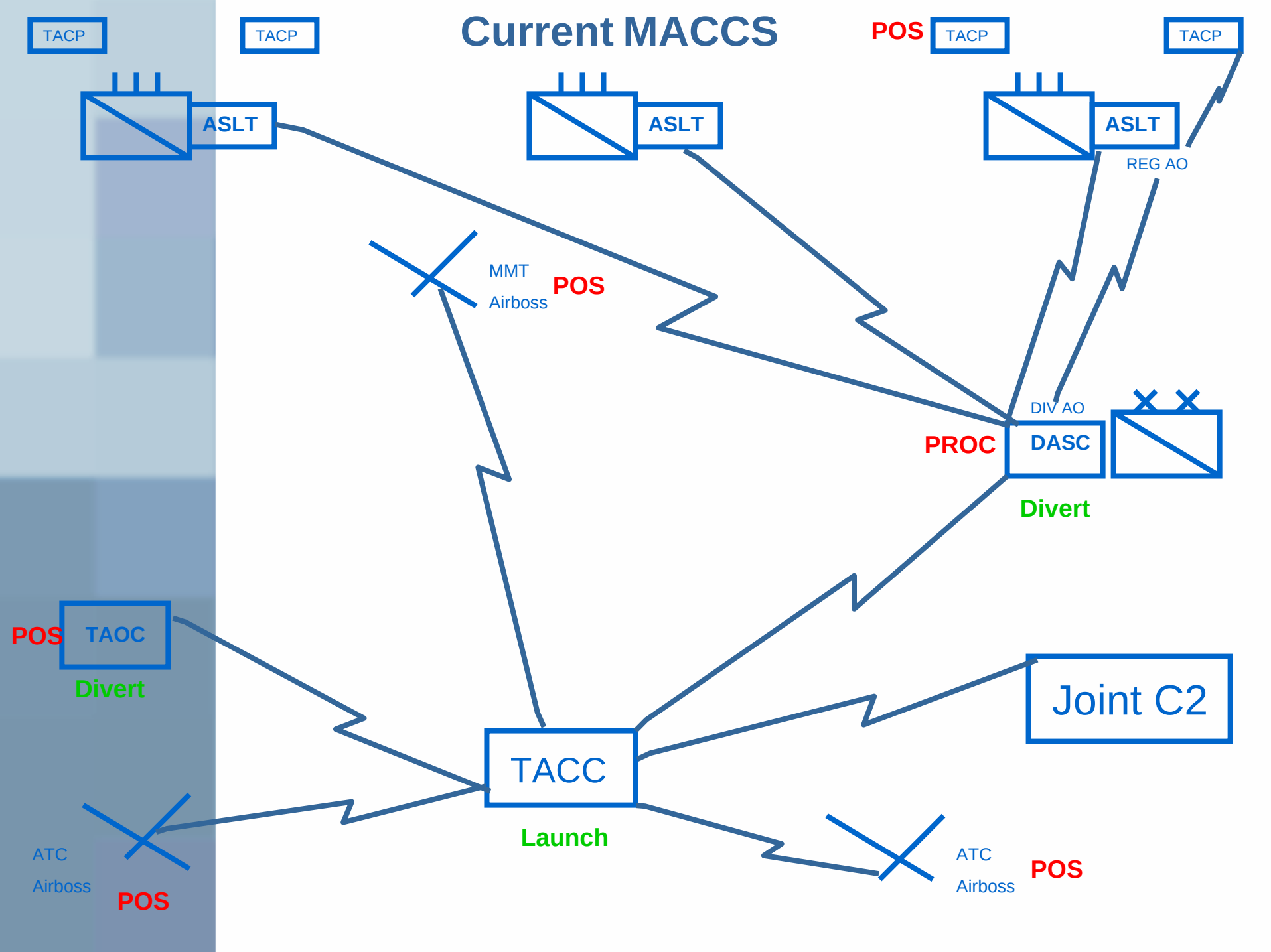
Airboss

ATC

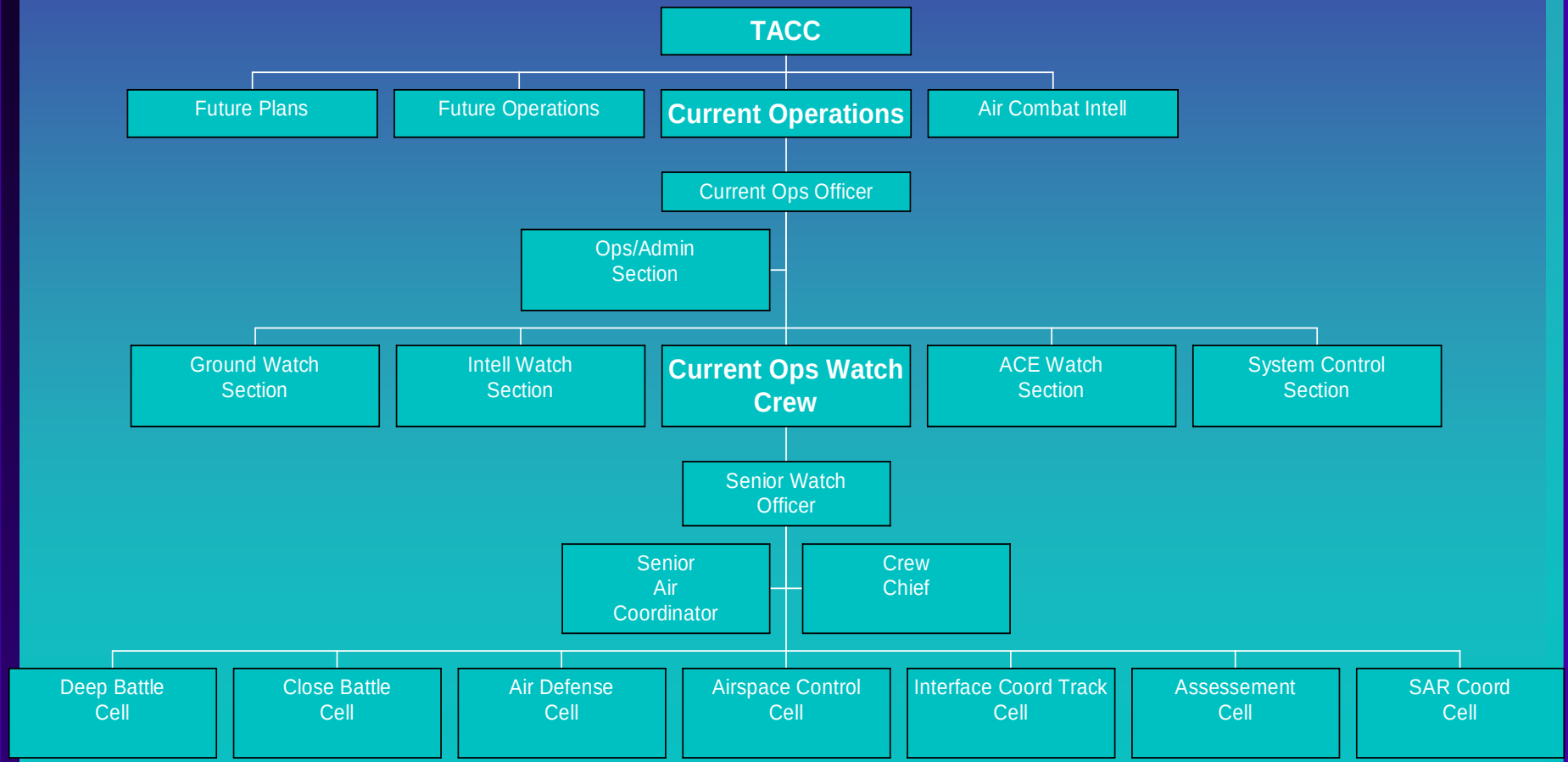
Airboss



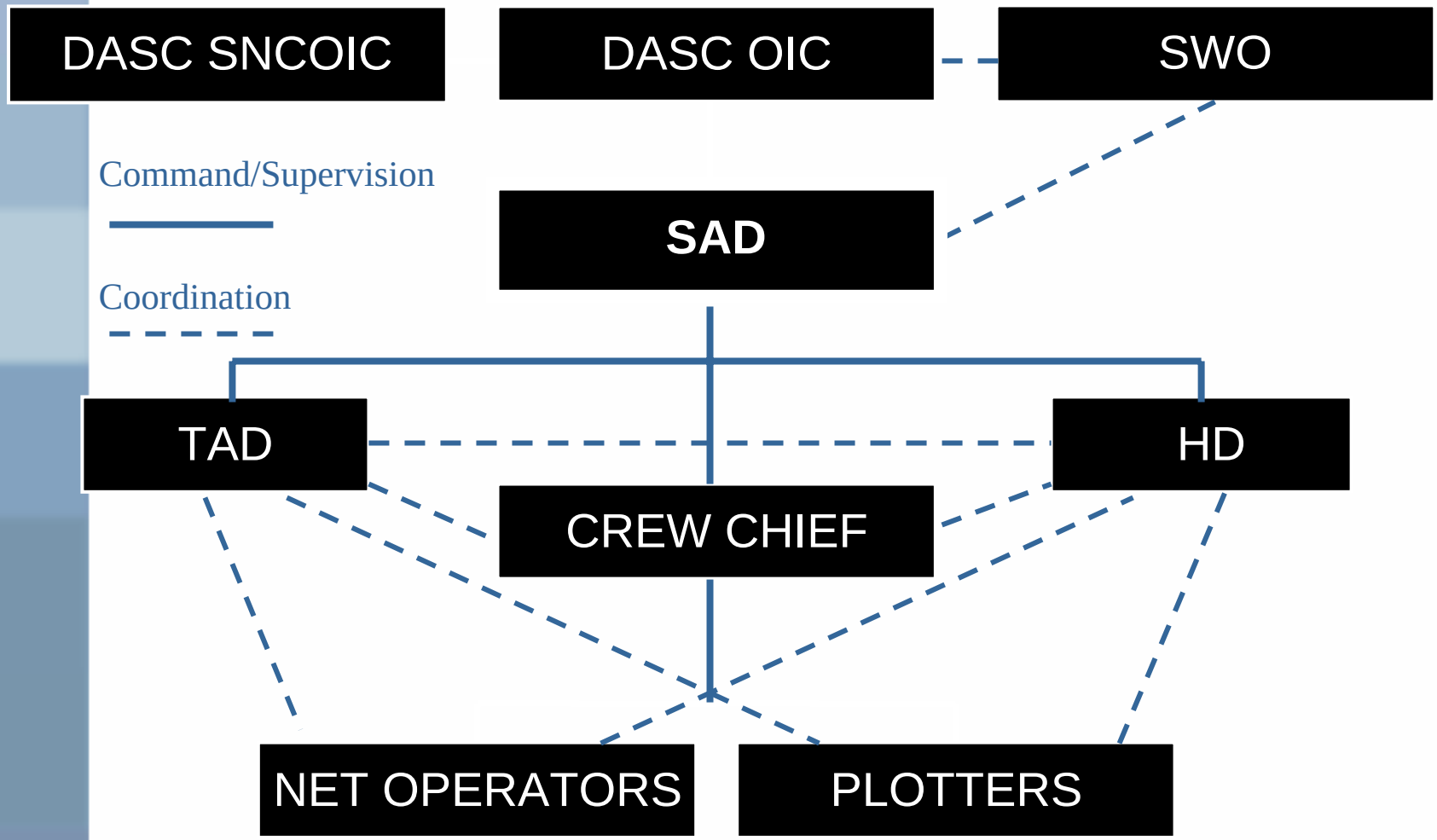

Control of Aircraft and Missiles
Air Direction
Air Control
Airspace Control
Airspace Management
Positive Control
Procedural Control
Positive & Procedural
Terminal Control
Airspace Control Measures
Fire Support Coordination Measures
Air Defense Control Measures
Control by Exception

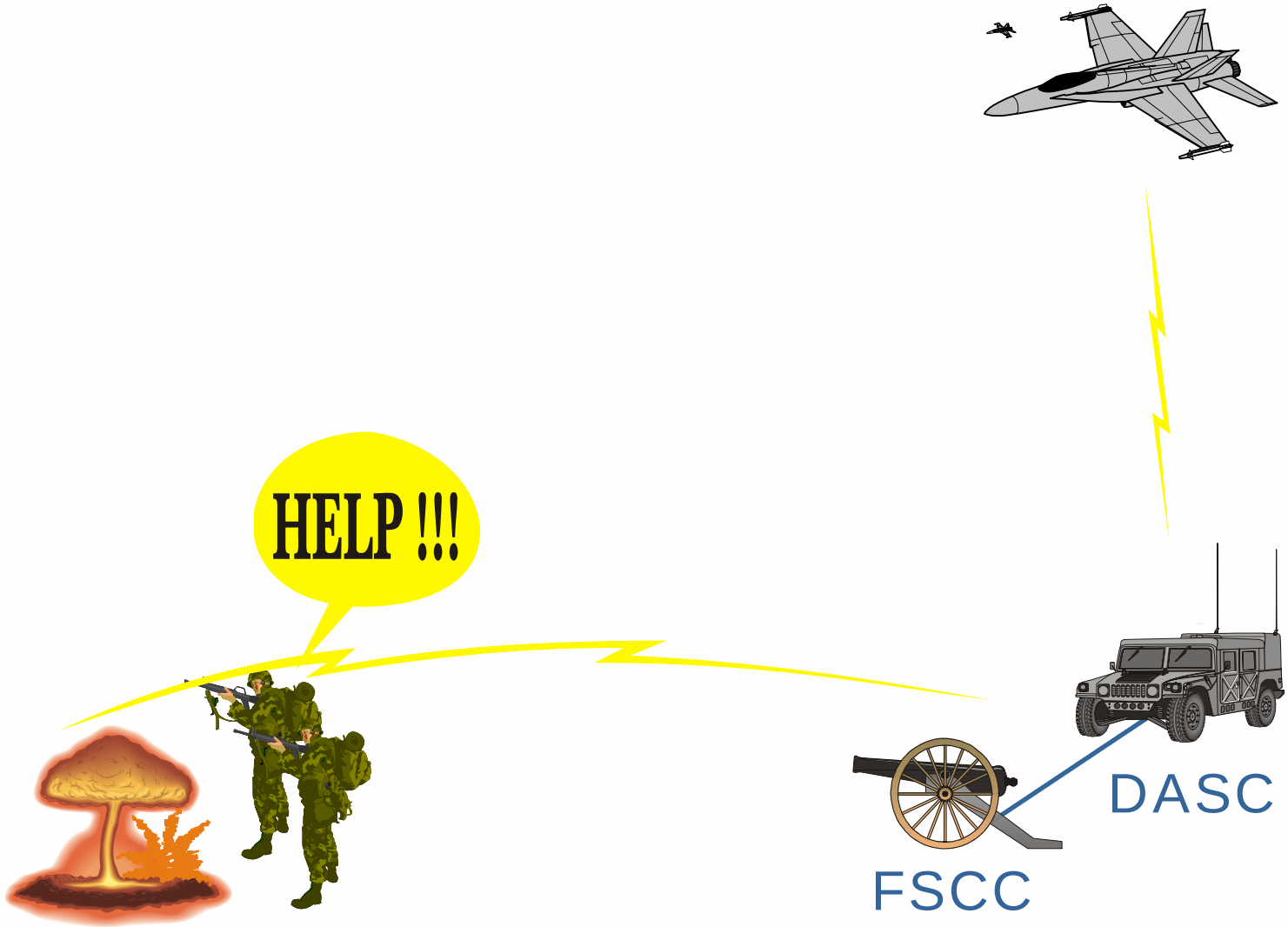

Current MACCS
TACP
TACP
POS
TACP
TACP
ASLT
ASLT
ASLT
REG AO
MMT
Airboss
POS
DIV AO
PROC
DASC
Divert
POS
TAOC
Divert
Joint C2
TACC
Launch
ATC
Airboss
POS
ATC
Airboss
POS

TACC ORGANIZATION

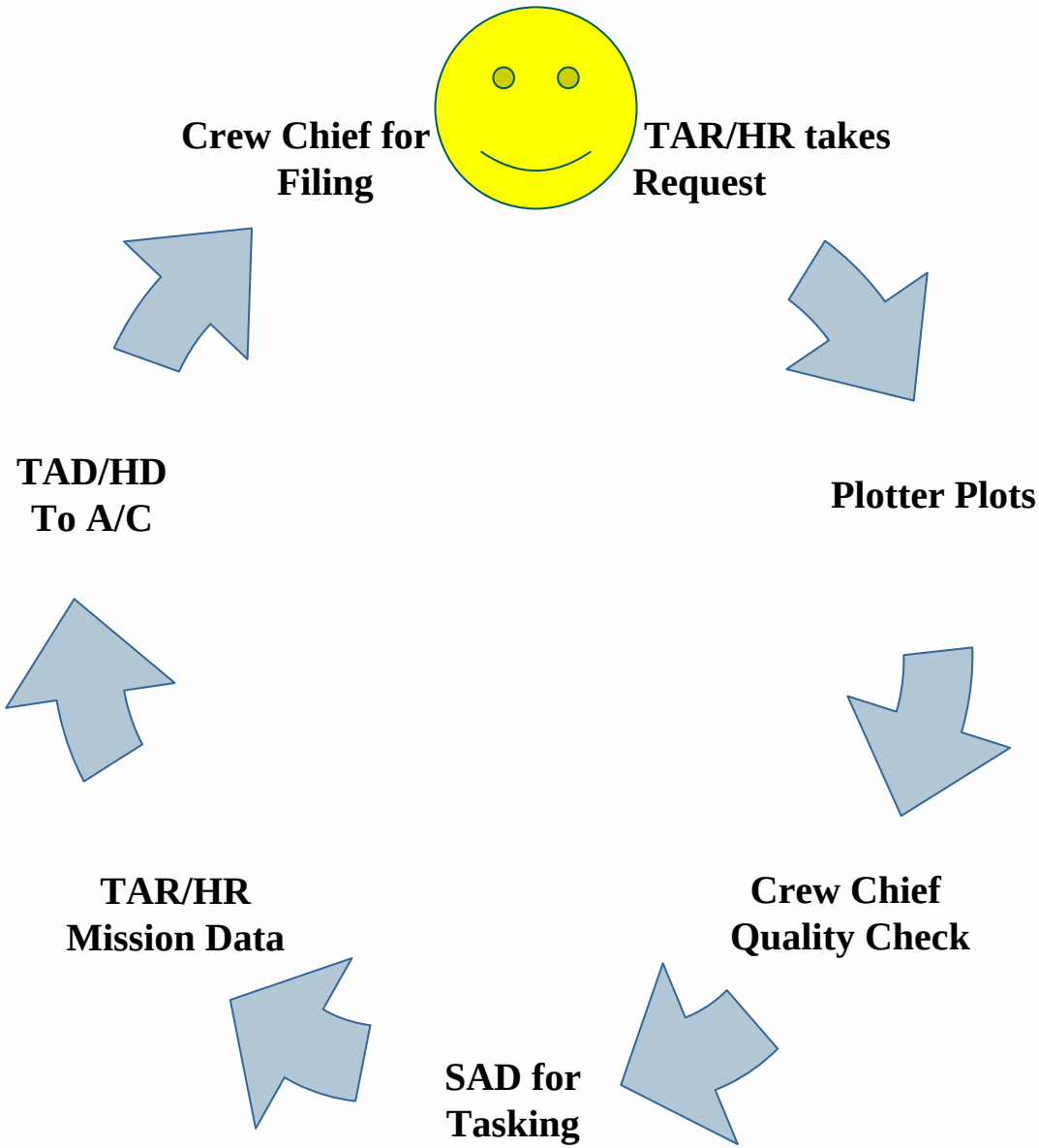


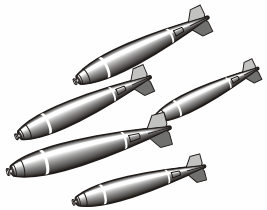
DASC Organization

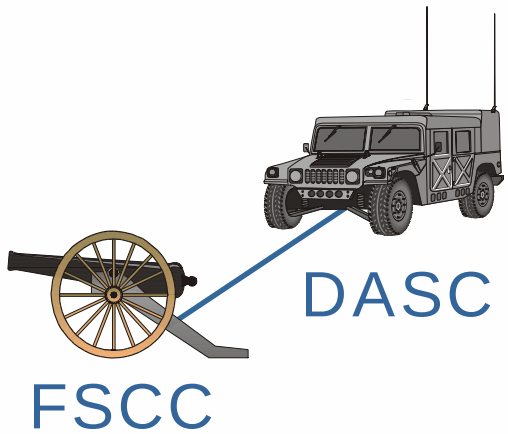



HELP !!!
DASC
FSCC

Request Process Internal Procedures






DASC
FSCC

- It is a profoundly erroneous truism, repeated by all copybooks and by eminent people when they are making speeches, that we should cultivate the habit of thinking about what we are doing. The precise opposite is the case. Civilization advances by extending the numbers of important operations which we can perform without thinking about them. Operations of thought are like cavalry charges in battle--they are strictly limited in number, they require fresh horses, and must only be made at decisive moments.

- *- Alfred North Whitehead*

- When making a decision of minor importance, I have always found it advantageous to consider all the pros and cons. In vital matters, however, such as the choice of a mate or a profession, the decision should come from the unconscious, from somewhere within ourselves. In the important decisions of personal life, we should be governed, I think, by the deep inner needs of our nature."

- *- Sigmund Freud*