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Transforming Naval Wargaming: A Framework for Operational-Level Wargaming

CNA:
Peter P. Perla, Michael C. Markowitz,
Christopher A. Weuve
Naval War College:
Stephen Downes-Martin,
Michael Martin, CDR, USN
Paul V. Vebber, CDR, USNR

CNA

4825 Mark Center Drive • Alexandria, Virginia 22311-1850

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Peter P. Perla

Dr. Peter P. Perla
Director, Interactive Research Production
Office of the President

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Summary: Transforming Naval Wargaming

To transform the way we fight wars we must first transform the way we think about war. One of the major elements affecting the way we think about war is wargaming. The War Gaming Department (WGD) of the U.S. Naval War College (NWC) asked the Center for Naval Analyses (CNA) to work with them to develop some new ideas about transforming Navy wargaming as part of the Navy's ongoing efforts to transform U.S. military thinking and practice in response to the perceived changes in the global military-political-technical environment at the start of the 21st Century.

The words *wargame* and *wargaming* (and their separated-at-birth synonyms war game and war gaming) have a variety of definitions, many of which are vague and virtually useless to serious scientific discourse. (If we can use the same term to describe both the bustling physical activity of thousands of real troops and vehicles maneuvering across hundreds of square miles and also the largely intellectual activity of two players crouched over a paper map and cardboard playing pieces, then we contend that term loses its utility for many of the discussions important to this effort.) Instead of taking such a broad view of wargames (the thing) and wargaming (what you do with that thing), we focus our attention on "real wargames," distinguishing them from analytical models, computer simulations without players (CSWP, pronounced "cazwhip"), and field exercises. Real wargames focus on human beings making decisions and dealing with the consequences of those decisions, but not on the action of actual forces.

If we accept the notion of the three domains of real war[1]—physical, informational, and cognitive—then the wargame designer must

1. Alberts, David S., et al. *Understanding Information Age Warfare*. Washington, DC: Department of Defense, Command and Control Research Program (CCRP), 2001

somehow condense that real universe into the game universe. He does this by combining the six dimensions of wargaming—time, space, forces, effects, information, and command—to form three interconnected topologies—operational, informational, and command. These topologies are the interfaces and engine through which the players enter and transform the universe of the game. The measure of the game's realism is how well the relationships the players have with the game topologies reflect the relationships real-world commanders have with the real domains. Ultimately, the goal of any "science of wargame design" is to delineate these connections, develop the foundation for understanding the problems by articulating definitions and postulates, and then using those axioms to propose and prove theorems about the connections between war and wargame, and about ways of making coherent connections from reality to wargame, using the dimensions of wargaming to do it.

What we discuss in this paper is an approach to thinking in scientific ways about the underlying concepts and structures that a wargame uses to represent and manipulate these six key dimensions to create the topologies of the game. Together, these topologies and their interworkings form what we call the *game system.* Just as there are many types of vehicles for travel on land, sea, air, or space, there are many types of game systems we can use to reach our objectives. Just as all physical vehicles must conform to some fundamental physical principles, so too all wargame systems must deal with fundamental objects, forces, and interactions. We propose a particular way of categorizing and thinking about those fundamental principles as a starting point for developing further what we may call a science of wargame design.

Wargaming and transformation

In many ways, the Naval War College's style of conducting wargames looks very like a condensed representation of staff operations. Sometimes dozens of players work together around a single table or in a couple of conference rooms; sometimes hundreds of players work together across several rooms, using an elaborate network to communicate. In all cases, however, as Robert “Barney” Rubel has articulated in a number of ways, despite the fact that much of wargaming is a simulation, the players experience real command and control processes (even if not always using real command systems).[2]

The intellectual arguments of the leading proponents of information warfare focus on the nexus of information and C3 (command, control, and communications).[3] Combined with new fighting techniques that enable precision delivery of munitions, they see this increased power of C3 as the engine driving us toward the future of warfare. Wargaming, with its inherent emphasis on decisionmaking, is an ideal tool for learning about and understanding the resulting transformation in warfare. To use the tool effectively, however, requires us to reconsider both the old and the new techniques of wargaming.

When stripped of their flashy externalities, both war and wargaming are quintessentially human activities. But with both, the externalities can play a significant role in the experience. Computer wargaming is dominated and shaped by the aesthetics and structure of cinema. Dramatic storytelling, reinforced by powerful image and sound, imposes the creator's view of the story on the passive spectator. Board wargaming is dominated and shaped by the aesthetics and structure of information graphics: the concise and efficient visual display of data, interactions, and processes. As is the case with the printed words of a novel, however, the physical components of a board wargame provide only the skeleton of the game, which the readers (or players) must flesh out and bring to life using their own imagination. The real wargame takes place in the mind of the player; the real challenge to any game system is to provide enough of a framework for the players to tell themselves the story of the game without turning them into

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2. Rubel, Robert C., CAPT, USN, "War-Gaming Network-Centric Warfare," *Naval War College Review*, Spring 2001, Vol. LIV, No. 2. http://www.nwc.navy.mil/press/Review/2001/Spring/art5-sp1.htm

3. See, for example, Garstka, John J. "Network Centric Warfare: An Overview of Emerging Theory," *Phalanx: The Bulletin of Military Operations Research*, Dec 2000, Vol. 33, No. 4. http://www.mors.org/publications/phalanx/dec00/feature.htm

passive observers. This emphasis on humanity over technology permeates the history of effective wargaming and the basic philosophy of wargaming at Newport.[4]

A scientific foundation for wargame design?

If the human basis of wargaming argues for considering it primarily an art form, our research nevertheless leads us to propose the beginnings of a scientific basis for wargame design. We begin this exploration by extracting from several sources an underlying set of postulates about warfare at the operational level. We use these postulates and additional research and analysis to develop ideas about how to build wargames to condense important dynamics of warfare at that level into the topologies of a wargame design.

Military operations are prone to inefficiencies, accidents, and uncertainties that stem from the fact that conducting such operations generates *friction*, *destruction*, and *disruption*. Together, these fundamental forces of warfare conspire and interact to increase the *entropy* of the military system, best described as a level of energy or activity that is inherent in the system but unavailable at any particular time to enable the system to carry out its missions. This entropy is a major source of the uncertainty that military command systems exist, in part, to overcome. For each force that generates entropy, command systems apply countervailing forces: to friction, direction; to destruction, leadership; to disruption, information. Unfortunately, the very application of the countervailing forces in one dimension can and usually does increase the entropy-inducing forces in other dimensions. Thus, the essence of good command is to develop and maintain a balance among the forces and countervailing forces that minimizes entropy, or at the very least ensures that the entropy affecting the friendly system is controlled enough to overwhelm the enemy and the enemy's ability to manage its own entropy.

4. See Perla, Peter P. *The Art of Wargaming*. Annapolis: Naval Institute Press, 1990.

To be useful in studying the operational-level of war, wargames must better reflect these fundamental dynamics in the real-world context of the domains of conflict (physical, informational, cognitive); the essential relationships permeating those domains (awareness, prediction, understanding and influence); and the driving effects of time. Our proposed framework addresses these key issues.

The way ahead

We do not claim to have all the answers, but only to have established a jumping-off point for additional research in game design. We recommend that:

- The Naval War College develop these principles into a comprehensive approach for wargaming information warfare, including the design of distillation games to help conduct game-based research into topics like the relative effectiveness of command structures under different operational conditions.
- The Navy establish a program of research to continue developing the scientific foundation for wargame design.
- The Naval War College further develop the principles embodied in the *Road to Baghdad* game to create new games to explore broader warfighting scenarios for the future, particularly those involving more extensive use of naval and amphibious operations.
- The Navy support research and development to link the nascent science of wargame design with the new science of agent-based analysis to develop a new and powerful approach to studying and understanding complex problems associated with the integration of human beings and complex systems.

The promise is there. We need only take the games seriously enough to explore the possibilities.

Transforming naval wargaming: the task before us

To transform wargaming we must first return to its roots. We must remind ourselves what sets wargaming apart from other techniques and what makes wargaming most effective at what it does best.

Over the long history of wargaming at the Naval War College, the playing of wargames was inseparable from discussion—sometimes heated discussion—of the "rules of the game," the data and relationships defined for a scenario, and the underlying mechanics that brought the data and the decisions of the players to life. Much of the shared understanding about potential future situations arose from that discussion before the game was even played.[5]

Today, Naval War College wargaming at the operational level is generally done with a large staff in the context of a command-post exercise. Personnel brought in to play the game are, in effect, told to "do the job you usually do today" as part of an effort to explore future concepts. Such advice can obviously become a source of confusion when players are organized in fashions different from the way they are currently, and must use different processes and new technologies to perform their functions. It can be difficult, indeed, to go beyond applying the new processes and technologies to do today's jobs differently all the way to conceptualizing how those new processes and technologies may transform the nature of tomorrow's job.

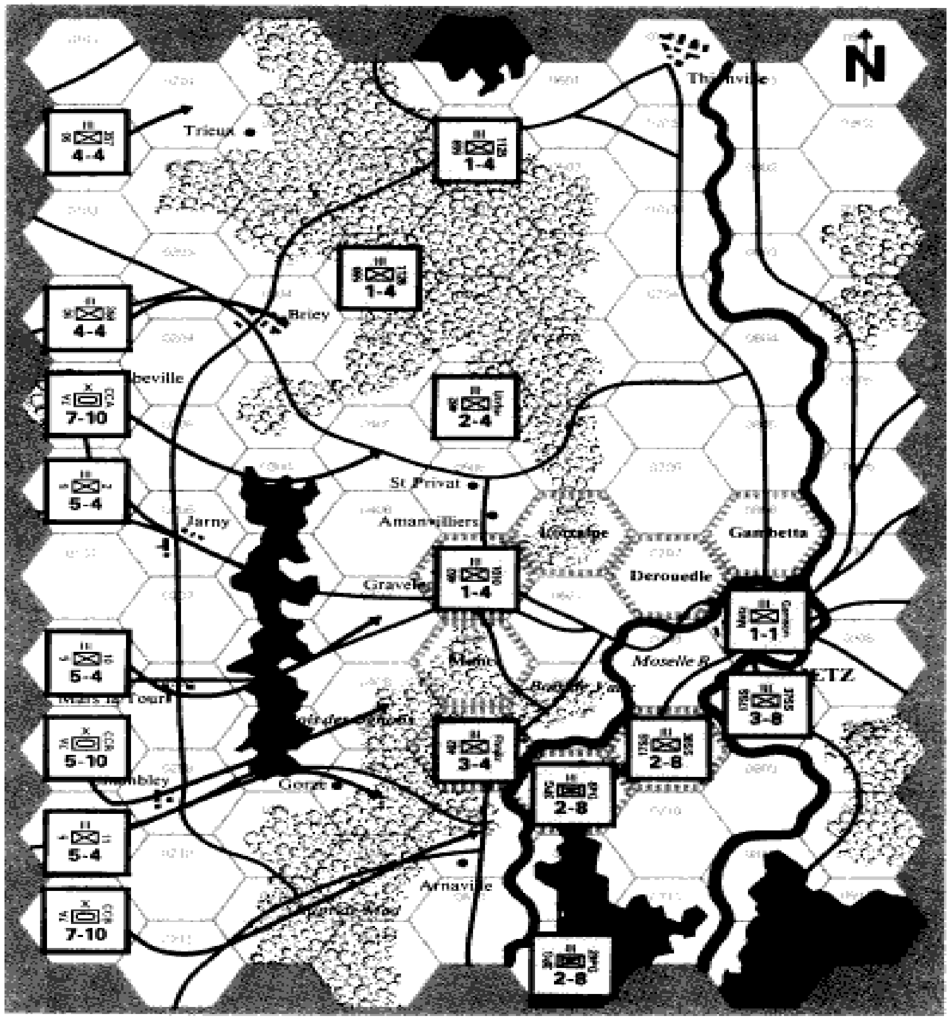
The primary alternative to the large-scale CPX-style game is a seminar game in which a group of experts is presented a situation to analyze and discuss. This sort of discussion can be valuable at the brainstorming stage of concept development. Unfortunately, the framework of such a seminar game is seldom rigorous enough, or well enough defined, to facilitate thinking concepts through deeply enough to contrast them with one another, much less to allow them to compete with one another.

5. See Perla, 1990 for a discussion of the history of NWC wargaming, particularly that done between the world wars of the early 20th century.

Nevertheless, discussion of rules, data, and procedures still occurs at the NWC, not only in preparation for games, but during and after play as well. Players argue that results of combat assessments (BDA-battle damage assessment) are either not appropriate or conflict with their assumptions and preconceived notions about what should happen. Because of the admixture of free-form umpiring and black-box computer models, however, too often today such discussions occur with little structured context. The participants frequently find it difficult to penetrate the secrets of the game to reach the source of the insights the game seeks to impart. Debate without data or context is seldom fruitful.

It was, in part, to provide a basis for developing that context and constructing that data that the NWC asked CNA to undertake this research. Our work has evolved from a broad-front attack on a set of vague goals into a more focused attempt to explore the potential for developing a scientific foundation for wargame design at the operational level. By trying to devise a more scientific and rigorous basis for defining, understanding, and designing wargames, we believe we can better apply their inherent power to exploring and understanding the evolutionary processes affecting warfare today. We can explore some new ways of applying fundamental concepts to reflect those evolving dynamics. Those dynamics affect all of the six key dimensions that a game must use to represent reality: time, space, forces, effects, information, and command. Clearly the last two dimensions are most directly relevant to the ideas of the proponents of a network-centric warfare revolution.

In many ways, that revolution points to a command, control, and information system that may be considered, oddly enough, an operational realization of techniques of information display and mechanisms for control similar to those that form the basis of modern board wargaming and, ultimately, many modern computer wargames as well. One mind, the commander, sees all, controls all with ease, and readily perceives the available options and possible outcomes of his choices.



As a tangible example of the basic technology and techniques of modern board wargaming, consider the game *Drive on Metz*, designed by James F. Dunnigan and included in his book *The Complete Wargames Handbook* [6] as an example of, and part of a tutorial about, designing board wargames. The figure shows the major components of the game, its mapboard, and playing pieces (traditionally known as "counters").

The board began with a standard map of the area. To make the scale of the map clear and regularize the movement and placement of the

6. Dunnigan, James F. *The Complete Wargames Handbook: How to Play, Design and Find Them.* New York: Morrow, 1980.

counters, an hexagonal grid of fixed width (in this case, the width of one hexagon, or hex, is 4 km) was superimposed on the base map and the terrain features modified to fit the grid. Terrain types for the hexes include clear, forest, rough, town, and fortified, with linear features such as roads and rivers added over and above basic terrain.

The counters represent the major combat formations involved in the operation. In this case, the units represent regimental-size units. Each unit is rated for its combat ability (the leftmost number at the bottom of the counter) and its movement ability. The effects of terrain on movement and combat are embodied in the Terrain Effects Chart. Different types of terrain cost moving units different numbers of "movement points" to enter and will have specific effects on combat.

Terrain effects chart

Terrain	*Example Hex Number*	*Effect on movement [MP's to enter]*	*Effect on combat [Leftward column-shifts on CRT]*
Clear	0406	2	None
Forest	0404	4	2
Rough	0306	3	1
Town	0206	Same as other terrain in hex	2
Fortified	0507	Same as other Terrain in hex	3
Road	0405	1	None
River	0804	Must be adjacent at start of movement, uses all MP's to cross	3 [Only if all attackers are attacking across]

Units may engage in combat from adjacent hexes. The combat strength of the attacking units is divided by that of the defending units to determine the "odds ratio." To resolve the combat, players roll a die and look the result up in the Combat Results Table.

Combat results table

Die Roll	Differential [attacker's strength minus defender's strength]							
	-1+	0	+1	+2,+3	+4,+5	+6,+7	+8,+9	+10+
1	-	DR	DR	DR	DR2	DR2	DR2	DR2
2	-	-	DR	DR	DR	DR2	DR2	DR2
3	AR	-	-	DR	DR	DR	DR2	DR2
4	AR	AR	AR	-	DR	DR	DR	DR2
5	AR	AR	AR	AR	-	DR	DR	DR
6	AR	AR	AR	AR	AR	-	DR	DR

- : No result, DR: defender retreat one hex, AR: attacker retreat one hex, DR2: defender retreat two hexes.

In a classic board wargame such as *Drive on Metz*, the players have perfect knowledge of the terrain, and of the location, strength and capabilities of friendly and enemy forces. Even more crucially, the players know (or at least have access to) the complete rules of the game governing movement, combat, logistics, and "how to win." Within these constraints, the players can move their forces in any desired way, knowing that all forces will do exactly what they are ordered to do. The players also know how the laws of probability interact with the game's combat results system, and so can accurately assess the risk of alternative courses of action. The players receive immediate and accurate feedback on the results of combat. The structured sequence of alternating turns allows the players to formulate and execute new plans instantly, without the need to observe, understand, and react to simultaneous enemy counter-moves.

Historically, of course, commanders in real war have achieved none of these ideals of access to complete and accurate information and total control over forces. If the vision of network-centric warfare is achieved, however, that reality might well change. Self-synchronization, the Global Information Grid (GIG), and real-time video, voice, and data links hold out the tantalizing promise of a degree of control at the operational level of conflict approaching that of the teenaged wargamer maneuvering his regiments in a game of *Drive on Metz*—if not really warfare by remote control, something very close to it, when looked at from the perspective of the operational commander.

Our focus in the remainder of this paper is on that level of warfare, the operational. The U.S. Department of Defense defines the operational level of war in the following way.[7]

> *operational level of war* - The level of war at which campaigns and major operations are planned, conducted, and sustained to accomplish strategic objectives within theaters or areas of operations. Activities at this level link tactics and strategy by establishing operational objectives needed to accomplish the strategic objectives, sequencing events to achieve the operational objectives, initiating actions, and applying resources to bring about and sustain these events. These activities imply a broader dimension of time or space than do tactics; they ensure the logistic and administrative support of tactical forces, and provide the means by which tactical successes are exploited to achieve strategic objectives.

Not the most precise or intuitive definition, but one that makes it clear that this *operational level of war* falls somewhere in the murky area between the more readily grasped notions of tactics (how forces actually fight the enemy physically) and strategy (the overall plan for achieving victory in the war). The same dictionary also defines the general concept of *operations,* in these terms.

> *operation* - 1. A military action or the carrying out of a strategic, operational, tactical, service, training, or administrative military mission. 2. The process of carrying on combat, including movement, supply, attack, defense, and maneuvers needed to gain the objectives of any battle or campaign.

This definition is still a little vague for the practical requirements of structuring a wargame to reflect the key elements of warfare at the operational level. Nevertheless, it indicates some of the key aspects of warfare at this level that a game must somehow address: movement, supply, attack, defense, maneuvers. The game must enable its players to address each of these aspects of war, among many others. And if the game is to be useful for research, training, or educational purposes,

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7. *Joint Publication 1-02, The Department of Defense Dictionary of Military and Associated Terms,* U.S. Department of Defense, 12 April 2001 (as amended through 9 June 2004).

playing the operational wargame must draw on the same (or a very similar) skill set as real warfare at this level. The DoD dictionary defines this skill set in terms of *operational art*.

> *operational art* - The employment of military forces to attain strategic and/or operational objectives through the design, organization, integration, and conduct of strategies, campaigns, major operations, and battles. Operational art translates the joint force commander's strategy into operational design and, ultimately, tactical action, by integrating the key activities at all levels of war.

So, if we set ourselves the goal of defining an underlying theory for designing operational-level wargames, we must address the factors and dynamics involved in translating strategy into plans and plans into action, integrating tactics and strategy in ways appropriate to the span of interest and control of the real-life command and staff levels the players of the game will represent.

The rest of the paper proposes an approach to meeting this goal. We begin by describing the basic concepts that form the foundation for our thinking. We then translate those concepts into a framework for building wargame models of operational warfare. To demonstrate the applicability of the concepts and framework, we present an example of a working game based on them. We conclude by proposing some fruitful directions for future development.

Concepts and postulates for operational-level design

We begin our efforts to transform wargaming by proposing a set of interrelated concepts we will use to design a reasonable and useful boardgame representation of joint military operations in the current and near-future environment. We propose an underlying foundation to represent time, space, forces, and effects in relatively simple ways, but also in ways that allow the interactions of those four elements with the two remaining ones, information and command, to be represented with all the richness necessary to explore and understand them.

Much of our thinking and modeling focus directly on information and command. In some cases, we consider command from two aspects: direction and leadership. By direction, we mean telling people what to do; by leadership, we mean inspiring them to overcome obstacles—"Follow me!" remains the essence of leadership. Our approach involves defining some *topologies*—of command, information, and operations—and the link between those topologies, in terms of a representation of the information and direction that flows between them. Our fundamental model is based on concepts of friction, uncertainty, and entropy. We relate those concepts to information and direction, and propose an approach to represent their effects on the remaining dimensions.

Our ideas spring from many sources. We base our discussion of the concept of friction and its connections to elements of chance from the granddaddy of Western military theorists, Carl von Clausewitz.[8] Beginning with Clausewitz's concept of friction, Mark Herman proposed the concept of *entropy-based warfare* to explore the interactions

8. Clausewitz, Carl von. *On War.* Edited and translated by Michael Howard and Peter Paret. Princeton: Princeton University Press, 1976.

of friction, disruption, and lethality, and characterized their activity as the production of *entropy*.[9]

We take a slightly different perspective. We see disruption less as a cause of entropy than as a reflection, in the physical operation of the system, of the effects generated by the interplay of friction and uncertainty as they produce entropy. Destruction (equivalent to Herman's notion of lethality) and deception (equivalent, perhaps, to Herman's concept of disruption) are the means with which opponents attempt to create or increase both the friction and the entropy in their enemy's system over and above its inherent levels of each. Lethality, by increasing the physical risk of actions, can potentially slow down enemy activity (increasing friction) because the opponent takes precautions against those physical risks. Deception, by increasing the opponent's uncertainty (or by disconnecting his assessments from reality), can potentially make the opponent's actions less relevant, or even counterproductive, to the situation in which he finds himself.

Entropy, as defined above, is reflected in the actual operations of forces in the uncertainty or *fog of war* that plagues all such operations. Martin van Creveld discusses how command systems exist to deal precisely with that uncertainty.[10] Just as in physics friction can be considered the cause of the difference between the actual motion of an object and its ideal motion, uncertainty reflects the differences between planned actions and actual performance on the battlefield. In other words, it is the reflection—or perhaps better, the shadow—of entropy on planning and execution.

In light of the current emphasis on network-centric operations, it makes sense to consider command systems in terms of networks. As Paul Vebber, CDR, USNR, first proposed in an unpublished paper for

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9. Herman, Mark. *Entropy-Based Warfare: A Unified Theory for Modeling the Revolution in Military Affairs.* Booz-Allen Hamilton technical report, July 1997; also a slightly revised version published as "Entropy-Based Warfare: Modeling the Revolution in Military Affairs," *Joint Force Quarterly*, Autumn-Winter 1998-1999, pp. 85 - 90.

10. Van Creveld, Martin. *Command in War.* Cambridge, Massachusetts: Harvard University Press, 1985.

the NWC,[11] such networks must deal with the interactions of the physical, informational, and cognitive domains of warfare described by DoD's Command and Control Research Program.[12]

We integrate these ideas into a framework we use to define a specific game system that we propose as an example of transforming wargaming by applying a more scientific approach toward designing wargames—particularly at the Naval War College. As a proof of concept and practical application, we apply this game system to build a working game that allows us to play out the course of Operation Iraqi Freedom and to explore alternative courses of that operation that might have happened. This game demonstrates the ability of the game system derived from these principles to capture at least some of the principal dynamics of an actual information-age (or at least a proto-information-age) conflict.

In the end, however, the approach and its fundamental ideas are more important than their application to any particular game. In an attempt to open the door for further development, we conclude with a detailed discussion of potential research to build on our concepts and techniques to advance the state of the art of wargame design.

Clausewitz: friction and chance

In his seminal work, *On War*, 19th-century military philosopher Carl von Clausewitz argues that, "Everything in war is very simple, but the simplest thing is difficult. The difficulties accumulate and end by producing a kind of friction that is inconceivable unless one has experienced war." [13] If wargames are one method of providing their players with a "synthetic experience" of war,[14] then they must explicitly address the need to recreate or at least simulate both this essential friction and its varied causes and effects.

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11. Vebber, Paul, CDR, USNR, *Wargaming Networks at the Operational Level*, unpublished paper, May 2004
12. Alberts, 2001
13. Clausewitz, p. 119
14. See Perla, 1990

To Clausewitz, “Action in war is like movement in a resistant element. Just as the simplest and most natural of movements, walking, cannot easily be performed in water, so in war it is difficult for normal efforts to achieve even moderate results.” This difficulty is created by the inherent frictions of war, and “[t]his tremendous friction, which cannot, as in mechanics, be reduced to a few points, is everywhere in contact with chance, and brings about effects that cannot be measured, just because they are largely due to chance.” The problem stems from the fact that “Countless minor incidents—the kind you can never really foresee—combine to lower the general level of performance, so that one always falls far short of the intended goal.” To overcome the effects of this friction demands the exertion of enormous will-power on the part of the commander. “Iron will-power can overcome this friction; it pulverizes every obstacle, but of course it wears down the machine as well.” [15]

Based on these ideas, we propose some postulates for incorporating friction into wargame design. The game system should:

1. Include both explicit and implicit mechanisms through which friction exerts significant influence on the effects produced by forces based on its interference in their ability to act over time and across space.

2. Reflect “average” or “normal” degrees of friction in the definition of the baseline capabilities of forces and systems.

3. Implement the actual effects of friction on particular actions, situations, or forces through chance mechanisms with effects unknown to the players ahead of time.

4. Enable players (as commanders) to exert effort to overcome or mitigate the effects of friction.

5. Impose on players who exert command effort to overcome friction both immediate and accumulating costs in terms of the ability of their force to act.

15. Clausewitz, pp. 119 and 120

Herman: Entropy-Based Warfare

In the late 1990s, Mark Herman, a noted designer of commercial hobby wargames and an associate in the defense practice at the Booz-Allen Hamilton consulting firm, proposed a concept he titled *Entropy-Based Warfare*. He first described his ideas in a 1997 Booz-Allen technical paper, and later published them in an article for *Joint Force Quarterly*.[16] Reacting to the Cold-War era's campaign models, heavily based as they were on weapons-oriented attrition calculations as the measure of merit for assessing operational concepts in a continental war, EBW, as it came to be called, took a different tack.

Herman based his approach on “the historical view that warfare can be directed against the cohesion of units or states rather than their components.… In this paradigm, the goal of a force is to disorder an enemy while maintaining its own cohesion.” To describe this notion of disorder, Herman chose as his metric a physics concept: entropy. He defined entropy in this context as “the steady degradation of a system” and proposed it as “the mechanism that measures enemy disorganization and ineffectiveness.”[17] In other words, instead of rating a unit's capability on the basis of firepower scores or other numerical measures of its equipment and platform strength, an “entropy level” can serve as the “collective expression of current unit cohesion and capability … As organizational entropy rises its capability decreases. A unit with no entropy can realize its full physical potential.” [18]

Although Herman's published work does not provide us with the details of his own method for calculating and changing the entropy level over time, he does describe the three factors that contribute to it: friction, disruption, and lethality.

16. Herman, 1997 and 1999

17. Herman, 1999, p. 86

18. Herman, 1999, p. 87

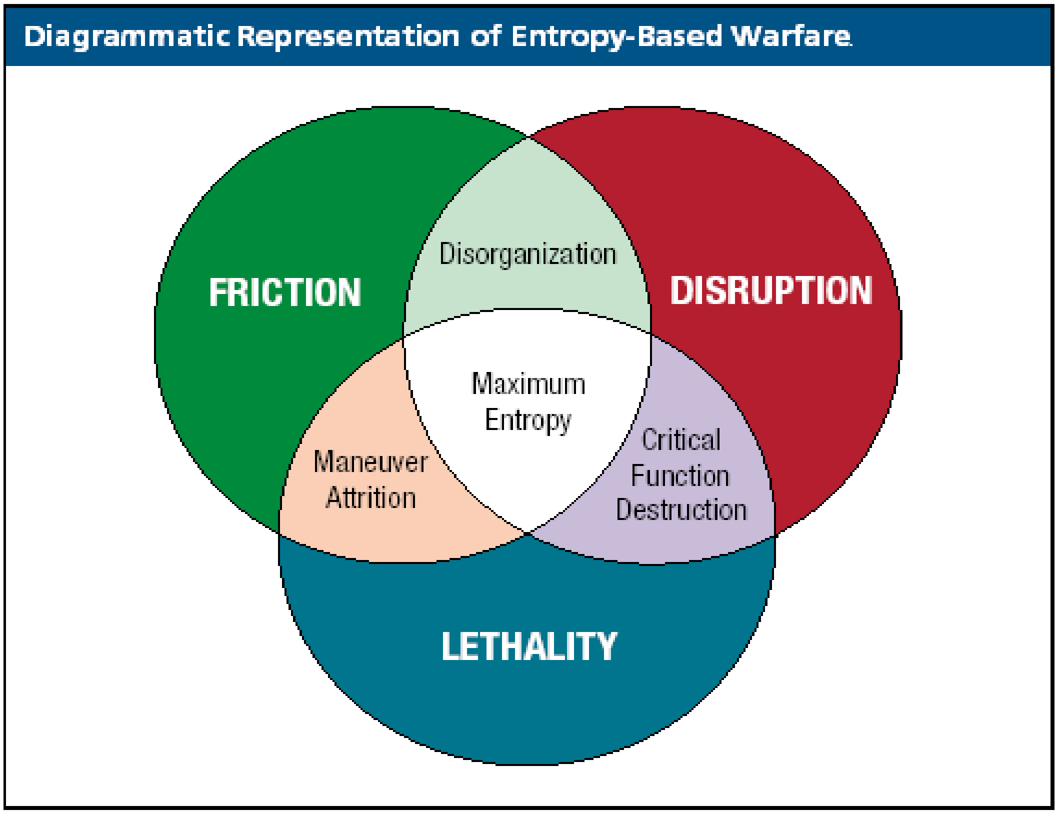

Figure taken from Herman, 1999, p. 87

In model terms, "Friction comprises those activities the unit performs that increase its entropy level. Disruption includes those activities an enemy conducts to expand the unit entropy level. Lethality is the firepower that a unit has to directly reduce an enemy through physical contact." [19]

If two or more factors converge, the effects on a unit's entropy level become more severe. A direct attack on a critical C3 node is an example of the combination of lethality and disruption. Interdiction of a unit forced to maneuver in response to a threat is an example of the intersection of lethality and friction. Computer network attack or

19. Herman, 1999, p. 87

other information-warfare techniques applied to disrupt the movement orders and logistical support for arriving reinforcements could be an example of the combination of disruption and friction. Overlaying such an effort with direct attack using multiple-launch rocket systems against roads jammed with confused traffic is an example of the three-way intersection, the spot no unit wants to find itself in.

Indeed, information warfare is a major element of the so-called revolution in military affairs, one that the paper addresses at length. "In this new form of warfare, networked computers and databases are manipulated to create a real-time picture of the battlefield that links all echelons through the commander's intent. Force interactions generate effects synchronized in time to inflict high-order consequences on an enemy. These effects are captured by the entropy-based warfare paradigm." [20]

Herman contrasts the "RMA force" with its outmoded "platform-based" opponent. The RMA force is based on

> an interconnected architecture [that] will utilize advanced information assets to understand, locate, and target vital enemy capabilities. Through application of advanced long range munitions and information warfare techniques, an enemy force can be dismembered by coalescing military strength on precisely coordinated timelines from spatially dispersed locations. The platform-based force will find itself disconnected, unsupported, and unable to mass platforms … [it] is defeated before it can effectively respond because it masses force much more slowly than its munitions-based counterpart.[21]

Time has explicitly entered the mix of model elements. Speed of acquiring, processing, disseminating, and acting upon the highly precise information available to the RMA force is the source of its dominance over its more ponderous enemy. This is the speed promised by network-centric operations. To achieve such dominance in speed of action, the RMA force is "enabled by information-driven computer

20. Herman, 1999, p. 89

21. Herman, 1999, p. 88

networks that confer information superiority, which stresses precision strike, dominant maneuver, information warfare, and space conflict. … When effects are coalesced in time, well within the ability of the enemy to react, the capacity to concentrate lethality against enemy critical functions can cause sudden surges in entropy. Vital functions lost to precision strike are often those that could otherwise reimpose order on units." [22]

But the technologies and techniques that give the RMA force its tremendous advantages when things go right can also lead to disaster when they go wrong. If the information network should suffer significant degradation for any period of time, "information superiority, maneuver agility, and precision strike capabilities should suffer similar impacts. This loss of cohesion and the corollary rise in entropy could see the RMA force incapacitated while it sustains only low attrition." [23]

Herman concludes his argument by contrasting EBW with attrition-based models. "Where attrition-based models primarily emphasize quantity, the entropy-based model creates a more balanced view by emphasizing the physical impacts of attrition and asymmetrical effects of attrition, friction, and disruption on the unit or society." This broader approach holds the promise of applying equally well to different regions of the conflict spectrum. "Guerilla, mobile, and conventional war utilize lethality, friction, and disruption with different emphases that rely on strategic factors, relative strength, and character of the forces. When conflict is depicted in terms of friction, disruption, and lethality, the common threads that link various types of warfare become more visible and illuminate where the revolution in military affairs may be going." [24]

Many of the ideas contained in the concepts of EBW can be seen reflected in some of the published games that Herman has designed. Not surprisingly, then, many of the immediate implications of

22. Herman, 1999, p. 89

23. Herman, 1999, p. 90

24. Herman, 1999, p. 90

adopting these ideas in a game system will be apparent to the game designer. Some of them include:

1. The effective capability of units should be derived by applying a measure of their current entropy state to their baseline physical capability.
2. The system should include effects of friction based on activity of friendly units.
3. Players should be able to affect the entropy levels of their opponent's system by making both physical attacks (lethality) and information-based attacks (disruption).
4. Units that suffer high levels of entropy should be subject to temporary and even permanent elimination from play.
5. All these effects should be applicable at multiple levels, from subunits to entire societies.
6. To model information warfare and network-centric operations, the system must reflect the significant advantages in timely action that a force with information superiority has over its opponent, particularly how "Small differences in synchronization can measurably affect performance." [25]
7. This must be balanced by some mechanisms to reflect the "fragility" of such an RMA force when it suffers relatively minor physical damage to critical network nodes.
8. Time, and the ability of the contending forces to use it effectively, must be a critical parameter in the game system.

Van Creveld: command and uncertainty

Clausewitz has argued that the will of the commander can overcome (at least to some extent) the deleterious effects of friction. Even in Clausewitz's own time, however, that will was seldom exerted directly by the commander on his forces. Instead, it was transmitted, filtered,

25. Herman, 1999, p. 90

and in rare cases even amplified by the workings of a command system—whether that command system was embodied by a few carefully chosen aides riding around the battlefield or the layered organization of Napoleon's *Grand Armée*. Herman expands on the Clausewitzian concept of friction by broadening the analysis to incorporate other deleterious effects of warfare on human organizations. These elements of disruption and destruction (a better word in this context, perhaps, than lethality) interact and magnify each other and friction to produce entropy. Herman defined entropy in terms of a steady degradation of a system. In the context of military operations, a more persuasive definition may be one given in the dictionary: entropy is "a measure of the unavailable energy in a closed thermodynamic system …"[26] This notion of "unavailable energy" resonates well with the concept as applied to military forces.

If friction, disruption, and destruction produce entropy, and entropy is a measure of how much of a force's combat power (or energy) is unavailable for effective application in warfare, then finding a way to reduce or overcome entropy and the forces that generate it is the essence of military success. In his book *Command in War,* Martin van Creveld addressed the issue of the development and application of command systems to deal with the problems of warfare.[27] He describes command as

> a function that has to be exercised, more or less continuously, if the army is to exist and to operate... The need for command arises from, and varies with, the size, complexity, and differentiations of an army...once a force of any size is subdivided into several subunits, however, the problem of assigning a specific mission to each, and of ensuring proper coordination among all, becomes much more difficult...The role of command, in other words, increases with the sophistication of the forces. [28]

In essence, command is the means to mitigate entropy.

26. *Webster's Seventh New Collegiate Dictionary.* Springfield, 1963.

27. Van Creveld, 1985

28. Van Creveld, 1985, pp. 5 - 6

Conveniently for the purposes of game designers, van Creveld also characterizes both the responsibilities of command and what command actually does. Its responsibilities include, first, “looking after itself,” along with “function-related” responsibilities, like arranging and coordinating “everything an army needs to exist—its food supply, its sanitary service, its system of military justice, and so on.” It also has “output-related responsibilities,” which are those that enable “the army to carry out its proper mission, which is to inflict the maximum amount of death and destruction on the enemy in the shortest possible period of time and at a minimum loss to itself.” He includes the functions of gathering intelligence, making plans, and monitoring operations among these output-related responsibilities.

As far as what a command system does, the situation is a bit murkier because of the difficulties inherent in trying to separate its many activities into neat bins. For purposes of study and analysis, however, he accepts the challenge of articulating an “ideal command system.” Such an ideal system

- Should be able to “gather information accurately, continuously, comprehensively, selectively, and fast”
- Should employ reliable means to “distinguish the true from the false, the relevant from the irrelevant, the material from the immaterial”
- Should create “clear, detailed, and comprehensive” displays of its information
- Should analyze the information and transform it into an estimate of the situation based on a “mental matrix, individual or collective,... [that] correspond[s] to the actual world rather than one that existed twenty-five years previously or not at all”
- Should select objectives that are “both desirable and feasible, two requirements that are not always compatible”
- Should present to the commander and staff alternative courses of action that are “real, not subterfuges presented as a matter of form. (As Moltke remarked to his aides, the enemy always seemed to have three alternatives available to him and he usually chose the fourth.)”

- Should "adhere firmly" to decisions that are made, "but not under any and every circumstance"

- Should issue "clear and unambiguous orders" that "tell subordinates everything they should know, but nothing more"

- Should monitor execution of operations closely enough to "secure reliable execution, but not so close as to undermine the authority and choke the initiative (or even, as sometimes happens, the very ability to act) of subordinate commanders at all levels."

Van Creveld divides the means through which a command system carries out these functions into "three categories: organizations, such as staffs or councils of war; procedures, such as the way in which reports are distributed inside a headquarters; and technical means, ranging from the standard to the radio." He argues persuasively that "the history of command in war consists essentially of an endless quest for certainty—certainty about the state and intentions of the enemy's forces; certainty about the manifold factors that together constitute the environment in which the war is fought,...and, last but definitely not least, certainty about the state, intentions, and activities of one's own forces."[29] Key elements in this quest include a system of regular reports to provide updates about important information. Because such reports tend to become distorted as they make their way through the system, van Creveld argues that, "To guard against this danger and to keep subordinates on their toes, a commander needs to have in addition a kind of directed telescope—the metaphor is an apt one—that he can direct, at will, at any part of the enemy's forces, the terrain, or his own army in order to bring in information that is not only less structured than that passed on by the normal channels but also tailored to meet his momentary (and specific) needs." [30]

This quest for certainty is at the heart of the developments in command systems from the earliest times to today's ideals of the Global Information Grid. Van Creveld proposes that, "Certainty itself is best

29. Van Creveld, 1985, p. 264

30. Van Creveld, 1985, p. 75

understood as the product of two factors, the amount of information available for decisionmaking and the nature of the task to be performed...Everything else being equal, a larger and more complex task will demand more information to carry it out. Conversely, when information is insufficient (or when it is not available on time, or when it is superabundant, or when it is wrong, all of which can be expressed in quantitative terms), a fall in the level of performance will automatically ensue." The development of command systems reflects their constant "race between the demand for information and the ability of command systems to meet it." [31]

For the wargaming theorist or game designer, van Creveld provides useful guidance about dealing with command systems. "Uncertainty being the central fact that all command systems have to cope with, the role of uncertainty in determining the structure of command should be—and in most cases is—decisive."[32] But it is not only the task the command system is called on to perform that determines the information required to carry it out; "equally important is the structure of the organization itself. The more numerous and differentiated the departments into which the organization is divided, the larger the number of command echelons superimposed upon each other, the higher the decision thresholds, and the more specialized its individual members, then the greater the amount of information processing that has to go on inside the organization."

There are two, logically exhaustive, ways for a command system to deal with situations that require more information than it has available, or to improve its performance overall. It can either increase its "capacity for information processing or … restructure the organization in such a way as to enable it to operate with a reduced capacity. The former approach will lead to the multiplication of communication channels (vertical, horizontal, or both) and to increase the size and complexity of the central directing organ; the latter, either to a drastic simplification of the organization so as to enable it to operate with less information (the Greek phalanx, and Frederick the Great's robots) or else to the division of the task into various parts and to the

31. Van Creveld, 1985, p. 265

32. Van Creveld, 1985, p. 268

establishment of forces capable of dealing with each of these parts separately on a semi-independent basis” [33] (Napoleon's *corps d'armée*).

Tellingly, however, he also argues that

> the two basic ways of coping with uncertainty, centralization and decentralization … are not so much opposed to each other as perversely interlocking. In war, given any one state of technological development, to raise decision thresholds and reduce the initiative and self-containment of subordinate units is to limit the latter's ability to cope on their own and thus increase the immediate risk with which they are faced; in other words, greater certainty at the top (more reserves, superior control) is only bought at the expense of less certainty at the bottom. … Properly understood, the two ways of coping with uncertainty … consist … of a distribution of uncertainty among the various ranks of the hierarchy. Under the first method the security of the parts is supposed to be assured by the certainty of the whole; under the second, it is the other way around.[34]

Any command system must make this choice of how to distribute uncertainty, either implicitly or explicitly, if it is to function at all. But it is not some “technological determinism that governs the method to be selected for coping with uncertainty. At various periods in history …different military organizations … approached the problem from radically different angles and with radically different results. There was nothing in the nature of any single technology … to dictate which of the two solutions should be adopted.” [35]

Van Creveld's historical review and his analysis of it led him to a conclusion that may be surprising to some in light of current emphasis (dare we wonder if it's really over-emphasis?) on advanced technology and the “information revolution.”

> Far from determining the essence of command, then, communications and information processing technology merely constitutes one part of the general environment in which

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33. Van Creveld, 1985, p. 269

34. Van Creveld, 1985, p. 274

35. Van Creveld, 1985, p. 275

> command operates. To allow that part to dictate the structure and functioning of command systems, as is sometimes done, is not merely to become the slave of technology but also to lose sight of what command is all about. Furthermore, since any technology is by definition subject to limitations, historical advances in command have often resulted less from any technological superiority that one side had over the other than from the ability to recognize those limitations and to discover ways—improvements in training, doctrine, and organization—of going around them. Instead of confining one's actions to what available technology can do, the point of the exercise is precisely to understand what it cannot do and then proceed to do it nevertheless.[36]

Based on these ideas, we propose some postulates for incorporating command and its ability to deal with uncertainty into wargame design. The game system should:

1. Reflect the interrelationships and interactions among the command system's information processing and organizational structures associated with the distribution of uncertainty among the various elements of the structure

2. Employ mechanisms to represent the regular flow of information through the system's organizations and procedures, using available technology

3. Provide the players with an ability to apply a directed telescope to gather additional or different information about the enemy, environment, or friendly forces and activity

4. Offer payoffs and limitations that reflect the tradeoffs required between centralized and decentralized aspects of command organizations and processes

5. Include the effects of uncertainty and the efforts to overcome it in mechanisms provided for the players to

- Gather, interpret, display, and analyze information

- Select objectives consistent with the mission

36. Van Creveld, 1985, p. 275

- Define and assess alternative courses of action that forces can pursue
- Give direction to subordinates about actions to take
- Monitor execution of directives.

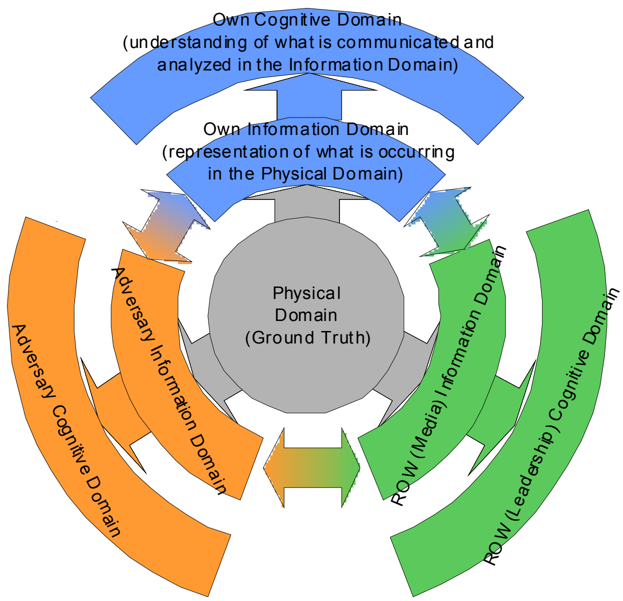
Vebber: wargaming network effects[37]

If we are to represent the way command deals with entropy in warfare, we must be able to represent the way command systems function in themselves. We must also represent how command interacts with other elements of war, such as the operational environment, friendly and enemy forces, and the full range of information (and disinformation) about each that swirls around everyone and everything involved in warfare.

Recent works on network-centric warfare, or information-age warfare, or so-called fourth-generation warfare, have identified three domains of interaction in warfare—the physical, the informational, and the cognitive.[38] These domains represent, respectively, the actual reality that exists; the ways that physical reality can be sensed, analyzed, and reported; and the perception of the physical reality, as communicated by sensing and understood through analysis, in the minds of the participants—most importantly the respective decision-makers. The physical domain is reality, or ground truth, but the participants in the conflict have their own information domain based on their sensing and analysis of the physical domain. Most modern conflicts have at least three participants—a minimum of two adversaries and the rest of the world (or ROW), which observes and analyzes the actions of the adversaries, usually by means of reports from local, or international information media. What goes on in each of these information domains affects the others. Similarly, all participants understand and interpret the information available to them within their own cognitive domains, again interacting with each of the others.

37. Much of this section is derived from Vebber, 2004

38. See, for example, Alberts, 2001.



Each of the principals in the conflict (to keep things simple for now, we will assume there are only two) senses what is going on in the physical domain through a variety of sensors and sources to which they are linked by some sort of communications pathway. This process of sensing and communication produces data that the participants refine into information by embedding the data into the context of the decision-maker in their information domain. The end result of the process produces perceptions about the physical domain and the relationships that exist there—which we define as knowledge—in each decision-maker's cognitive domain. For our purposes we consider knowledge to exist exclusively in the cognitive domain. So, when cognitive domains interact, they do so through the information domain, as information is derived from knowledge and shared with others. Information that is rooted in historical or shared knowledge can be misinterpreted or simply not comprehended and so can be knowledge in the cognitive domain of the originator, but may be transferred imperfectly to others. Data and information are things that can be exchanged; knowledge itself cannot.

This transition from "physical reality" to "sensed data" to "information" to "knowledge" is the basis for defining some key relationships. We define *awareness* to be the degree of agreement between ground truth in the physical domain and the perception of that reality in the cognitive domain, based on knowledge developed from the information domain. A high level of awareness indicates the perception is close to the reality; low awareness indicates that the decision-maker has not integrated important elements of the physical reality into his cognitive domain. This can result from poor sensing (the transition from the physical domain to the information domain) or poor synthesis of relationships (the transition from the information domain to the cognitive domain).

Similarly, we define *prediction* as the ability to project the next state of the information domain from the trends in the current one. It is akin to "dead reckoning" from the present state of the information domain to the next, between opportunities to sample the physical domain. When the rate of sensing the physical domain for data is small compared to the rate of change in the physical domain state, then prediction is not as important because the decision-maker receives updates from the physical domain often. When the sensing rate is relatively long, however, prediction must account for the wider range of changes in the physical before new sensor data become available.

The third key relationship is *understanding*. Understanding goes beyond prediction by incorporating an estimate of how the adversary might respond to the situation, not simply projecting the future based on current trends. Understanding includes the processes of producing and evaluating alternatives. The degree to which awareness and knowledge coincide with physical reality will allow the decision-maker to make good or poor predictions of what changes will occur in the physical domain in the near future. Looking at the conflict systems as a series of "states," if you understand the physical domain state at time *t* then you can make a good estimate of the physical domain state at time $t + 1$. Because sensing and developing information into knowledge takes time, you need good understanding to predict the interim states accurately to avoid "losing the bubble" about the situation by the time the next update arrives.

The final key relationship we define here is *influence*. Influence is the degree to which one decision-maker's cognitive domain changes the cognitive domains of other decision-makers by weight of the relative power positions of those decision-makers within the command system. In any system with multiple decision-makers, those with high degrees of influence will have their information and awareness accepted by others based on influence alone—not necessarily on the basis of relative quality—more often than those with low influence. Note, however, that in a relationship similar to that between information and knowledge, awareness can be shared, but understanding cannot.

Based on these ideas, we propose some key postulates about how to integrate the operational, command, and information topologies into a coherent representation of warfare at the operational level.

1. Command systems are networks of nodes and links
2. Command systems sit at the nexus of the physical, informational, and cognitive domains of warfare
3. Data and information from these domains flow through the nodes and links of the network to enable the decision-makers in the system to build awareness, make predictions, and improve their understanding of the situation they are in and to influence the awareness, predictions, and understanding of others in the system
4. The products of these command processes are decisions that direct the taking of action on the part of the component units and forces under their authority
5. In addition, command systems may produce and manipulate information related to those actions that it communicates to the commanded units in order to increase the likelihood of success for the actions those units are ordered to undertake

6. The speed, accuracy, and quality of direction and information produced by the command system are the major determinants of the ability of the overall force to minimize its entropy.

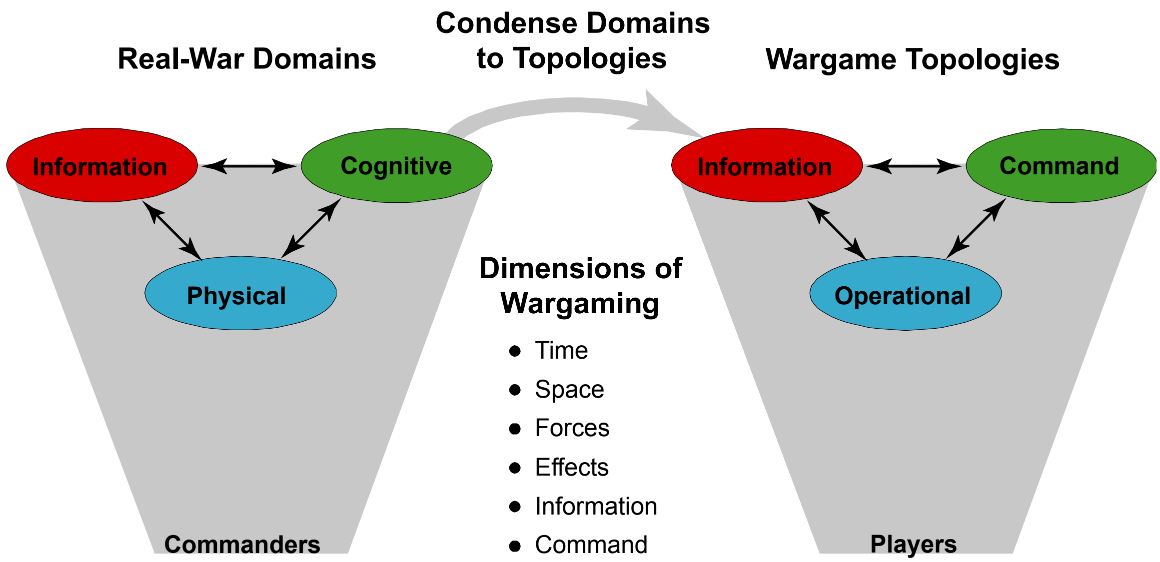
The framework connecting war and wargame

If we accept the construct that there are three domains of warfare, the physical, informational, and cognitive, how can we relate it to the dimensions of wargaming, which we defined earlier as time, space, forces, effects, information, and command? To answer this question is the fundamental task of the wargame designer.

From war to wargame

The real world, and so real war, is effectively infinite in its complexity when considered from the perspective of human mortality. Efforts to model that complexity by recreating it artificially in all its glory using advanced computer techniques are misguided. The closer the model mimics reality in details, the more difficult populating the model with data and analyzing the model's output become. Essentially, the model becomes as difficult to use and interpret as reality.

The wargamer's approach is different from that of the true believer in the power of *simulation über alles*. The wargame designer must condense the nearly infinite complexity of the real world into a small number of variables and parameters, based on the six dimensions of wargaming, and represent as best he can the real world and its complexities using this reduced set. Our conception of the task of game design is based on the notion of condensing the infinite dimensionality of the domains of warfare into a finite system of linked topologies, defined and constrained by the six dimensions of wargaming.



To do this, we define three *wargame topologies*: the *operational* topology, the *information* topology, and the *command* topology. Consider each of these topologies as specific simplified condensations of the complex real-world interconnections among the physical, informational, and cognitive domains of war, mediated through and by the six dimensions of wargames.

The operational topology is where we condense from reality into wargame space the activity of forces in the physical domain, as directed and informed by the cognitive and informational domains. The information topology is where we condense the flow of data and information to and from the physical domain into and through the informational and cognitive domains. The command topology is a bit more difficult to describe. Because the cognitive domain is such a central part of the process of command, it is important that our condensation of reality find a way to integrate the actual cognitive activity of the human players of the game with a representation of the real-world cognitive domain relevant to the commanders, staff, and other humans that are represented collectively in the game system itself.

Thus, the operational topology condenses the real world to the game-world relationships among forces, operating areas or environments, and tasks; the command topology reflects the structure and workings of the command systems relative to that operational framework; the information topology reflects the structure and dynamics of flows among the physical domain, the informational domain, and the cognitive domain.

The topologies of the wargame define the interface between the players and the game, as well as between the game and the real world. They are thus the key link that players experience between the play of the game and real-world experience. The players must, therefore, relate to the topologies of the game in ways that are analogous to the way real humans relate to the domains of real war. And the most important of those relationships are the ones we defined earlier: awareness, prediction, understanding, and influence. It is the degree of agreement between the relationships of the real world and the relationships of the game world that are the true measure of the so-called *realism* of the wargame.

The goal of the wargame designer is to employ the six dimensions of wargaming to condense the domains of real warfare into the topologies of the game, so that the players can relate to the game through those topologies in a manner as closely as possible to the way real combatants relate to the domains of real war.

Although we cannot yet fully articulate precisely how to do this—even assuming such a thing were possible—we can illustrate at least some of the thought processes involved by describing in detail an underlying theoretical construct for thinking about the task. We then supplement the theoretical discussion by describing in some detail a specific practical example of how we designed a wargame to represent the 2003 war with Iraq, Operation Iraqi Freedom. Truth in advertising demands that we admit that our example of a wargame design did not flow completely from the theoretical framework we propose here, but it was closely intertwined with, and influenced, the development of that framework.

Theoretical view of gaming the operational level of war

The discussion of the preceding section applies generally to all types and levels of wargaming. In what follows, we will focus specifically on wargaming at the operational level of war.

Traditionally, the U.S. military's understanding of the term *operational art* has focused on the use of maneuver to apply combat power in the physical domain. But successful application of operational art originates in understanding and exploiting the information and cognitive domains. Superiority in those domains allows your command system to exploit a disparity in its ability to produce coherent information and direction relative to that of its opponents. This disparity enables you to surprise and disrupt an opponent’s systems and operations and so decrease his ability to make informed decisions and act upon them. In other words, it enables you to increase your opponent's entropy, possibly to disabling or even disarming (literally) levels.

To represent the functioning of operational art based on these ideas, our wargame’s topologies must involve a set of mechanisms that reflect the key elements of operational-level warfare as we described earlier. The usual wargame designer’s bag of tricks includes many widely accepted methods for determining the effect of raw combat power on losses, advance rates, and achieving objectives. But there are few methods in general use designed to represent the effects of a disparity in information and command.

So we begin by developing a framework for representing the effects of information and command on operational-level warfare. This framework will comprise representations not only of the physical connectedness of the command networks, but also of the nature—and to the extent required, the details—of information and direction flowing to and from the command system's decision-makers. We then connect information and command to the dynamics of operations.

These dynamics inherently involve the notion of change over time. The representation of time, then, must be a key component of our framework. Time is the engine that propels the players through their game experience through the interfaces of the three topologies. It is also the most elusive and slippery component of all. Because the whole concept of information-age warfare revolves around the notion of the self-evident benefits of gaining a time advantage over the opponent in operations, gaming information-age warfare requires that we find some way to represent the mechanisms for creating—and the effects of exploiting—such an advantage in the game system. The trick, of course, is to find a technique that accomplishes this without requiring us to play the game itself in real-time, with all the supporting infrastructure such a game would demand.

We present theoretical descriptions of the topologies of wargaming as abstractions or schematic representations of general architectures rather than specific structural details. They form part of the theoretical framework that a wargame designer can use as the foundation and starting point for developing specific applications of the theory to represent a specific approach to condensing reality into a wargame dealing with a specific subject. The resulting diagrammatic views of the three topologies are merely one way of thinking about them. In a very real sense, they embody some fundamental assumptions, beliefs, or constructs based on our underlying mental model of warfare and its domains and relationships. It is our intention in articulating them and the underlying model they spring from to be as general—and as generalizable—as possible. But it is important to emphasize that other theoretical constructs may be proposed to reflect different interpretations of which characteristics of the major real-world domains are most important to condensing the real world into the game world.

Command topology

In our conception, command is all about decisionmaking. Commanders make decisions in the cognitive domain based on knowledge, awareness, and understanding and affected by the influence of others in the system. There are two fundamental components of decisionmaking: determining that a decision must be made (a decision point is at hand), and making the decision. Decision points arise from the interactions in the physical domain coupled with the commander's ability to estimate the effect of those interactions on plans for future events (prediction). As long as “the plan is working,” then most often the key decision points will be those planned around branches and sequels within the plan itself. If the commander's assessment of the state of the physical domain begins to diverge from what he anticipated in the plan, however, then decisions may be necessary to change the course of ongoing operations or of operations planned for the future. In our context, a decision point occurs when something happens in the flow among the physical, information, and cognitive domains to trigger a decision-maker's need to evaluate whether to respond to a situation. On the other hand, the lack of data, knowledge, awareness, or understanding may result in a decision point's being missed.

In real warfare, commanders, staff, and troops make decisions constantly about myriad things, and those decisions interact in complex and frequently indeterminate ways. In a wargame, the vast majority of those real-life decisions are abstracted away, or washed out, through the workings of the game system. It is to be hoped that the game's design retains the most important or telling of the decisions in the hands of the human decision-makers playing the game. Nevertheless, the nature of the beast demands that the game system itself condense the form and substance of many of those decisions relative to their real-world complexities, and provide surrogates for the decisions made by persons and organizations not physically played by other humans in the game. This is the function of the command topology.

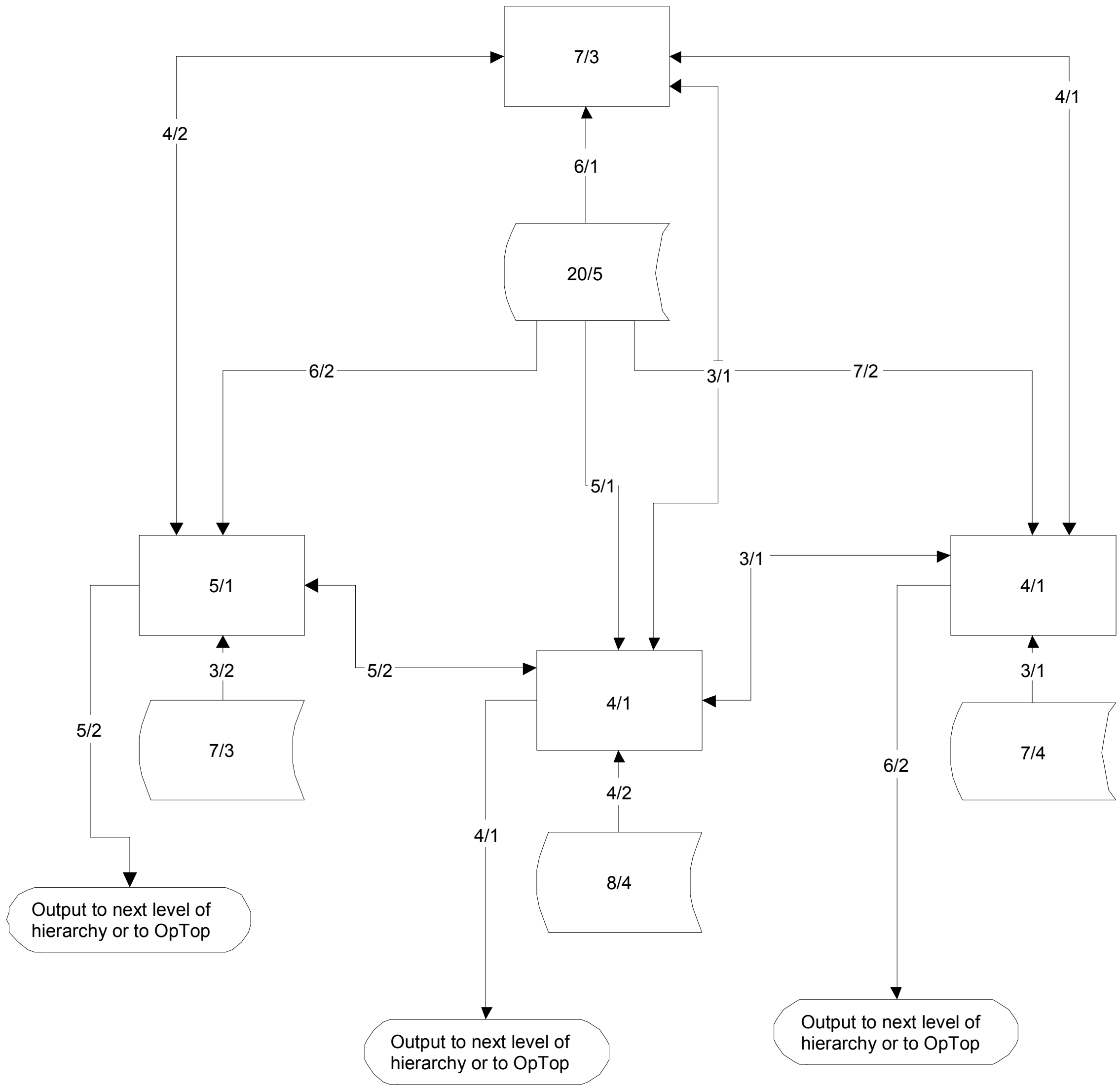
Without loss of generality, we can represent any command system as a network of decision-makers who make decisions regarding when, where, how, and with what to take action. Thus, you can think of the organizational structure of any command system in terms of a set of *nodes*, of which we can define two categories. C2 nodes represent individuals or groups who make decisions about the activities of the commanded forces. Information-storage nodes represent the databases and administrative processes that inform or assist in implementing the decisions. These nodes are tied to one another through *links* representing channels of communication and contact, and through which the processes of the system flow.

Within the network of nodes and links, we define two different classes of *content* that flows through the system: directives and information. Directives having a planning and coordination aspect to them;

information is not merely raw data but consists of processed and contextualized relationships as well as “knowledge” derived from the raw data. Feedback is a specific class of information that arises from the operational and information topologies and facilitates issuing new directives.

We also incorporate into the framework the notion that information can be linked to a directive. This linked information represents the effort the command system makes to ensure that the directive is more effective, and that the executing units will thus have a greater chance of achieving success when they carry it out (which will occur in the operational topology). In general, we also assume that some amount of feedback is required to facilitate linking information to a new directive. You can make decisions in a vacuum, but it is very hard to attach relevant information to a directive created in this fashion

As an example, the figureon the next page illustrates a command topology as a network diagram. Rectangular boxes are C2 nodes. Curved-ended rectangles are storage nodes. Directional links connect the nodes. Boxes and links are labeled with numerical values that represent several parameters that we can use to characterize how and how well the system works to process information and pass information and directives to the operating forces..



Command nodes have a staff-point value (leftmost number) that represents the size and efficiency of the staff of that node. They also have a relevancy rating that represents in some sense the level of command the C2 node inhabits. High staff ratings indicate that a node is capable of producing more work. A natural way to think about the staff points is that actions taken in the game require the system to "spend" available points to take certain actions. For example, staff points could be used in the game to process information, create directives, link information to directives, decrease the entropy loss of a link (more on that later), move information or directives from node to node, and coordinate actions in the operational topology when an interaction occurs there. High relevancy ratings, on the other hand, indicate the relative quantity of information that might be relevant to the tasks the node is responsible for. This is typically related to the level of command that node inhabits. Nodes operating at a relatively high level of command typically make use of a wider variety of information than lower-level nodes.

Storage nodes have a capacity rating (leftmost number) and an entropy rating. The storage rating is the total number of "information points" that storage node can hold. The entropy rating is used to increase the cost or difficulty of obtaining useful information from the storage node. (We describe an example of this effect later.)

Links have directionality (shown by the arrowheads) and numerical values that represent throughput and entropy. Throughput is the number of "information points" that can flow through that link in a unit of time. (Directives also flow across these links, but we would typically allow the directives to move freely when attached to information.) Entropy is the number of information points lost when a package of them passes through the link in the direction the arrow is pointing. Double-headed arrows mean entropy cost is paid regardless of the direction the information flows. C2 nodes are typically linked with bi-directional arrows. Storage nodes are linked to C2 nodes with the arrow pointing to the C2 node to indicate that the entropy cost is paid only when accessing the stored data, not when storing the data in the first place. (The information loses its value over time.) Usually, the link between two storage nodes would have no arrowhead and there would be no entropy cost to move information through a pure storage network.

If the entropy cost for moving information across a link is greater than 1, additional staff points can be spent to reduce the entropy cost to a minimum of 1. (Only a link whose entropy cost is 0 can ever provide a free ride.) On the other hand, the cost (really the loss) for moving information across a link may become higher than the printed value of the link when moving information from a storage node. This is when the entropy rating of the storage node comes into play.

In this system, you would divide the number of information points in the storage node by the entropy value of that node to determine the added cost in lost information points for transmission from the storage node to any other node linked to it. For example, consider the bottom center storage node in the diagram, the one rated 8/4. If fully stocked with 8 pieces of information, any attempt to move information from that node would cost an additional 8/4 = 2 pieces of information lost in transmission. Moving the full 8 information points stored in the node across that 4/2-rated link would thus normally cost a total of 4 of the points, resulting in an effective transmission of only half the information available in the link.

To mitigate this entropy, however, we allow the system to expend staff points to offset some of the entropy costs by representing the ability of the staff to “maintain the picture” of the relevancy and context of the information in the database. Normally, if we were to attempt to move 4 information points from the storage node, the operation would result in the loss of 4/4 = 1 point from the effect of the node and an additional 2 points from the effect of the link, and we would be able to transmit only 1 point total. By spending 2 staff points, however, we could negate the cost of two of the entropy points and succeed in transmitting 3 out of the 4 points we originally tried to move.

The fundamental model in this construct treats information as quanta that move around the system and may decay through the transmission process between nodes. The relevancy rating of a command node reflects the idea that information is not always used up in the knowledge management process—but that a lot of staff activity is associated with understanding the relevancy of information to any given task. Although the information is not destroyed, it does take time to create the relevancy link to a new task, which we measure here in terms of staff points. By expending staff points up to the limit of the C2 node's relevancy rating, the system can duplicate that number of information points when moving information from one node to another. (In essence, these points are cloned and then moved, allowing copies of the information to remain in the originating node.)

Now that we have built this edifice of nodes and links and points and flows, what does it actually let us do? How do the players interact with the resulting command topology to play the game in ways that are analogous to how real commanders command real wars? What can the players use the command topology to do? Some of the answers to that question are:

- Process information obtained from the information topology.
- Move information within the command topology.
- Create directives for action in the operational or information topologies.
- Develop mission orders by linking directives and relevant information in a C2 node.
- Move mission orders within the command topology.
- Issue mission orders to the forces (or other entities) that inhabit the other topologies.
- Coordinate action in the operational and information topologies (including the possibility of providing direct leadership for specific actions).

This construct, while perhaps somewhat complicated in game terms, is infinitely simple when compared to the command systems of the real world. By arranging the nodes and links, assigning their ratings, defining the rules and costs to perform actions, and establishing the context and the sequence in which those actions can be performed, we can create a command topology to represent important characteristics of most types of command organizations.

Practically speaking, to implement such a system we must define the rules through which the players interface with the command topology to achieve frequently competing ends: facilitating ease of play, and representing a battle rhythm analogous to the real world. Accomplishing this for a specific game environment may require us to incorporate additional detail within the nodes. Alternatively, we could devise specific dynamics of play to define a temporal relationship between the command topology and the operational and information topologies that is not 1:1.

Information topology

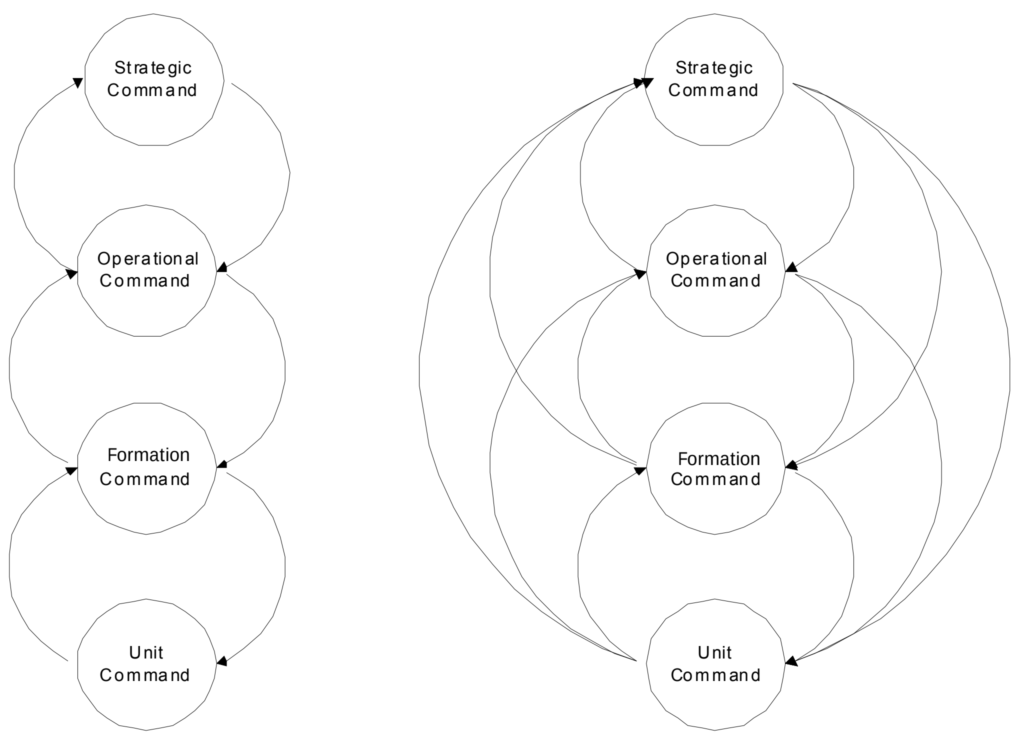
The command topology defines the set of knobs and levers and switches the players of the game can use to change the nature of the game's universe. The information topology delineates the boundaries of what the players can learn about that universe and defines the windows through which the players may observe its workings.

Generally speaking, command decisions lead to actions by subordinate units. Actions may be performing an assigned task (including the task "do nothing"), changing an assigned task, changing a planned task, or adding a new task, either to a current operation or to a planned operation. A series of related tasks designed to achieve a common goal are frequently termed an operation—a potential source of some confusion in the current context. At the operational level of command, the important decisions are based on how confident you are in what you think you know about the environments in which your forces are operating, the forces (on both sides) that occupy those environments, and the effect the situation may have on your chances of successfully completing the operation. Once you start worrying too much about the particulars of that information, you start down the slippery slope into tactics, the realm best left to the commanded units to deal with.

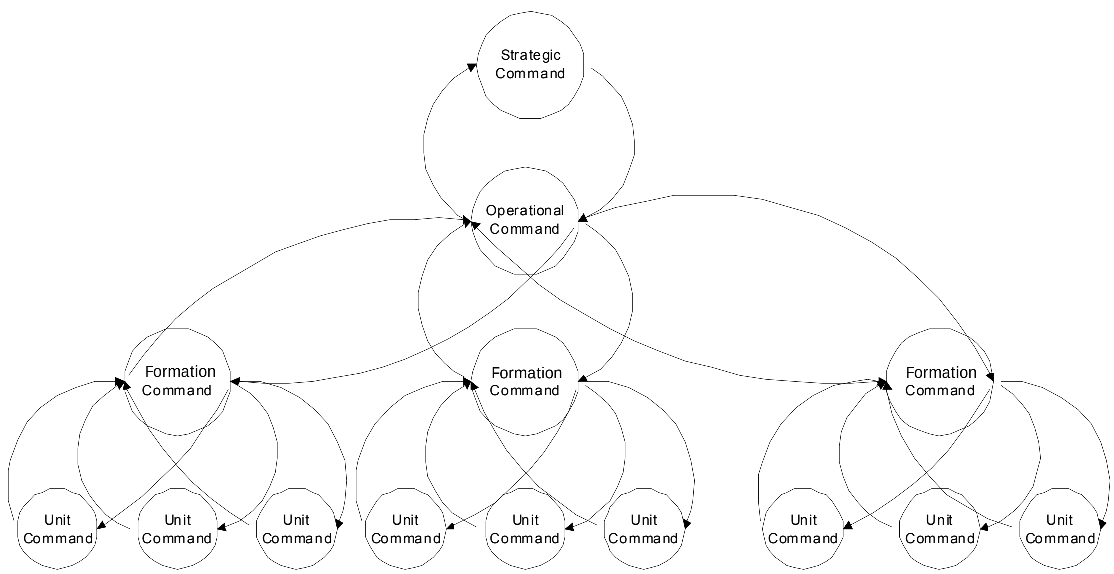
But how do we distinguish between these various layers of command and their associated networks? It is far too easy to get hung up on subtleties of language and interpretation here. Let us agree that if we assign the players of the game to represent the *operational echelon*, then we can define three additional layers. The *strategic echelon* imposes its goals and intent on the operational echelon represented by the principal players. The *formation* and *unit echelons* carry out the direction of the operational echelon in order to achieve the strategic goals and intent. The unit echelon is the echelon of primary interaction with the enemy and the environment in the physical domain. (More often, this echelon is referred to as the tactical echelon. However, the word "tactical" has too many overtones to avoid interminable misunderstandings.) The *formation echelon* is the conduit through which information flows from the units to the operational echelon, and direction and supporting information flows from the operational echelon to the units.

The information topology is where we represent the interconnections of the various echelons and their command and information networks. These networks and the information that they process and deliver to the various echelon commanders play a major role in determining the results of physical interactions (which we represent in the operational topology). The principles of information-age warfare predict that the unit commanders who best understand the battlespace, their adversary, and the plans and intentions of their superiors will enjoy at least a temporary and frequently a meaningful advantage in combat power.

The existing physical networks constrain the possible information networks. If the communications pipes do not exist to connect the unit echelon directly to the operational echelon, then information must go stepwise through the formation echelon—taking time and adding potential for error, but also adding the possibility of refinement and filtering as well. Examples of a "traditional" and a "fully networked" set of connections are shown below:



The situation is actually quite a bit more complicated as there are usually multiple formation commands under the operational command and multiple unit commands under each formation. This results in a rather complicated situation, even for the "simple" traditionally networked organization, as shown below:



Of course, the existence of information and command networks is constrained by the corresponding need for physical networks. Although the existence of some sort of physical network, whether fiber-optic cable or bicycle messenger, is the essential prerequisite, the specific technologies of the physical networks become most important when you decide how vulnerable to information warfare the networks are, or how much information they can exchange over time.

In game terms, the type, quantity, timeliness, accuracy, relevance, and completeness of information made available to the players, and the means through which they can acquire it, is the central question the design of the informational topology must address. As game designers, we pride ourselves on what we like to think is our intuitive grasp of how to deal with this question. Articulating a set of fundamental principles and procedures for doing so is not so easy. Here we can only provide a first, rough, stab at it.

We can characterize our main ideas about how the designer can think about information in the following contrasts:

- Content vs. container
- Look it up vs. watch it work
- Database vs. model.

In general, human players make decisions based on the content of information, the facts and ideas that enter the player's cognitive domain. In terms of the game mechanics and system, however, information content may be less important (indeed, meaningless) as long as some sort of container for the information is tracked. For example, the discussion of the command topology above spoke of directives and information points, which could simply be abstract representations of packets (or containers) of information that the game system moves around to enable activity.

Players can acquire information about the state of the game in two basic ways. They can seek out (look up) the information, for example in data tables or the printed combat factors of boardgame playing pieces. Or they can watch the outcomes of interactions to try to discern the underlying causes of events in the game even when they cannot access the raw information.

The information itself can reside in two fundamental places in the information topology and game system. Facts and figures can be stored in databases of one form or another. Relationships, on the other hand, are embodied in models of one form or another, from simple look-up tables like the classic boardgame's combat results table, to complex mathematical formulas used in computer games for resolving the outcomes of combat. Databases reflect the state of the game universe; models change the state of the game universe.

To sort through the complexities of what information is needed in the game, what form it should take, where it should be stored, and how it should affect the evolution of the game, the designer can consider the answers to several key questions.

- Is the information necessary or useful to the player or relevant only to the game system itself?
- Why does the player need or want the information?
- What will the player do with the information if he gets it?
- If needed by the game system, is the content of the information important or is the fact that some information is available and transmitted through the system sufficient to perform the necessary functions?

Another way to think about the information is in terms of several broad characteristics of the information itself. Is the information:

- Fixed or variable?
- Known or unknown (by the players or by the elements of the command or operational topologies beyond the players themselves)?
- Knowable or unknowable?
- Inherent (in situations or entities) or emergent?

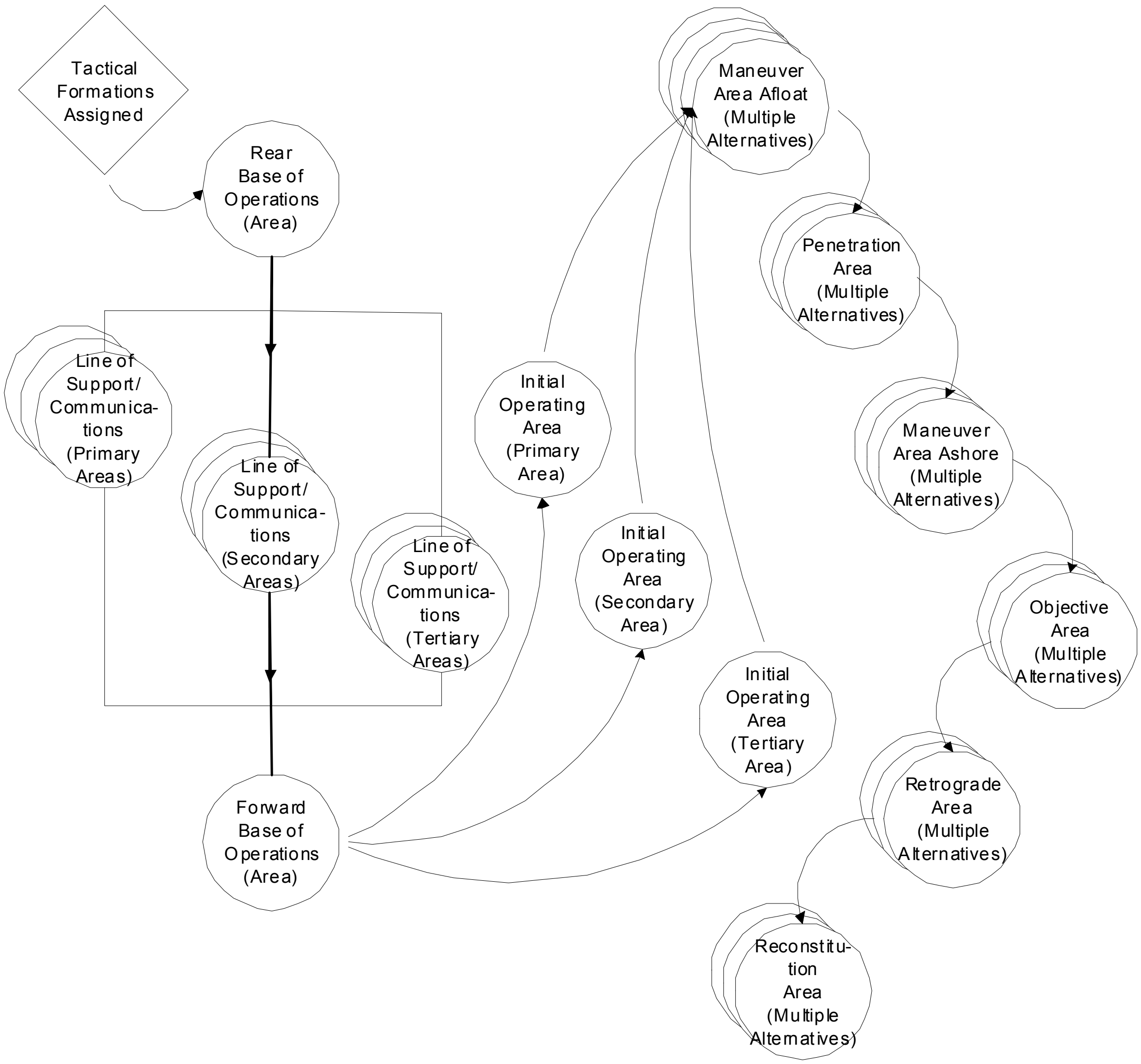
All of these considerations, and probably others, must go into the design of the information topology and its component parts. The design of the information topology has significant effects on the ability of the game to help create the analog of the cognitive domain of the real world in the minds of the game's players. It is the conduit through which the players perceive and make sense of the operational topology and impose their will on that topology, as mediated by the command topology.

Operational topology

Wargames traditionally represent the operational topology in terms of maps showing the geographic territory over which a campaign unfolds. They typically represent the forces that operate over that territory during the campaign in some sort of symbolic manner. In boardgames, such as the example described at the beginning of this paper, the symbols are printed on physical playing pieces; in computer games, they are usually represented by electronic counterparts to such pieces, on-screen icons. The players move these pieces from one physical location on the map to another. The characteristics of the pieces reflect the capabilities of the real forces they symbolize. These characteristics, defined and employed in the information topology, will affect or determine the course and outcome of any interactions that take place in the operational topology.

Although the vast majority of operational games use a map of the type we normally associate with the word (a scaled representation of actual terrain), they will also adapt the characteristics and form of the map to perform game-related functions more easily and efficiently than a standard operational graphic might (though, to be sure, operational graphics can and have been used as the basis for wargames). Typical conventions include the use of a hexagonal grid overlaid on the actual terrain to regularize and regulate the positioning and movement of forces. The map then represents an almost separable element of the operational topology, the physical topography of the battle space, if you will, while the pieces and their activities as reflected by the way the players employ them on the map embody most of the remaining elements of the operational topology.

We can generalize this practice of representing the battle space of the campaign by considering such maps as simply a form of network diagram showing relationships of adjacency and distance, as well as more complex characteristics such as terrain and access. We can also more closely couple the topographical representation with a representation of the activity of the forces by considering non-traditional approaches to representing the operational topology. An example of one way to do this is shown in the diagram on the following page.



Each node in the diagram consists of an area (an element of the topography or the more general environment) in which operations may occur. One or more tactical formations may act within these areas to perform tasks at any particular time. Each area thus defines a physical *sub-domain*, if you will, of the true state of the world in that area. Corresponding information and cognitive domains derive from these physical domains and drive the link between the operational topology and the information and command topologies of the game.

Opposing forces interact physically within the physical domain. This is the battlespace where each of the participants in the conflict attempts to interact with the other at the unit level. Units, the basic particle of force, are controlled and directed by the players as mediated through the formation echelon, from one to several layers of command below the operational level of interest to us. This is the traditional domain of interaction in wargames. Each adversary attempts to maneuver to a position of advantage from which he strives to inflict lopsided attrition against the opponent or, in the ideal of effects-based operations, cause the opponent to surrender with a limited (or no) actual combat, perhaps by increasing his entropy to disarming levels.

Interaction at this level involves opposing forces that occupy the same area and are assigned tasks that cause them to interact. The command networks and the information and direction that flow through the networks to and from the commanders at the operational and the formation echelons can be major determinants of the results of those physical interactions. All of those threads from the command and operational topologies ultimately feed into the databases and models of the information topology to produce the information that the players receive about the course and outcome of the actions taken by the units and formations.

Timing is everything

And that brings us to the final crucial component of our framework: time. And where better to start than with a few pithy quotes from two experts on time: Napoleon Bonaparte and Albert Einstein.

> "Strategy is the art of making use of time and space. I am less concerned about the latter than the former. Space we can recover, lost time never."
>
> – Napoleon Bonaparte

> "When a man sits with a pretty girl for an hour, it seems like a minute. But let him sit on a hot stove for a minute and it's longer than any hour. That's relativity."
>
> – Albert Einstein[39]

Einstein goes on to explain his whimsical observation in more rigorous terms. "As the observer's reference frame is crucial to the observer's perception of the flow of time, the state of mind of the observer may be an additional factor in that perception."

Surprisingly, perhaps, Einstein's observation has, in fact, made its way into the design of a commercial wargame. *Piquet* is a set of rules for playing games with miniature toy soldiers.[40] It originated as rules to replay Napoleonic battles but has expanded to cover not only different periods of warfare but also has been applied to the operational level of war as well. In his attempts to explain (and, indeed, to justify) his unique perspective on the design of the game, *Piquet*'s designer writes, "one other unique aspect of *Piquet*'s 'turns' is that they are of an undetermined and variable length. Some are made up of many phases and initiatives and some are made up of just a few (or none). When related to real battles this very effectively models 'lulls in the battle', 'sudden rushes', and other battle descriptions. It also speaks to Einstein's observation stated above that equal time isn't always equal."

A source of the difficulty game designers seem to have in dealing effectively with time in wargames is the tendency to treat time as something that lives outside the topologies of the game, a fourth topology if you will, similar to the way we think of time in the real world as a fourth dimension of space-time. But treating time this way in our games may unnecessarily limit our ability to enable the players

39. Although this "quote" of Einstein's is repeated frequently in many sources, there appears to be no documentary citation available. For the best, and most entertaining of the stories associated with it, see Mirsky, Steve, "Einstein's Hot Time: Great theoreticians know that hypothesis must be confirmed with experiment," *Scientific American,* September, 2002. Available on-line at http://www.sciam.com/article.cfm?articleID=0001AA08-864C-1D49-90FB809EC5880000

40. Jones, Robert. *Piquet Master Rules for Wargaming.* Highlands Ranch, Colorado: Piquet, Inc., 1996. See http://www.piquet.com/

to interact with the game's topologies in ways analogous to their actions in the real world because, paradoxically, by trying to treat time uniformly and sequentially in the game we disassociate it from the way real commanders *experience* time in the real world.

Traditionally, board wargames control the activity of the play by imposing fixed time intervals in which players may conduct their actions. These time steps are typically called *turns*. These turns chop up time into discrete, and usually equal-length, chunks, representing, for example, a 12-hour span of time. The game system then scales the activities of the forces and players to represent somehow an average capacity for activity based on that time span. The problem, of course, is that the essence of the promise of network warfare is to speed up the ability of friendly forces to formulate, communicate, and carry out plans and operations. The old model of fixed-length game turns is an artificiality with little utility in this environment.

Many computer wargames adopted the same convention of the game turn to regulate play. The game turn concept allows players to tackle the problem of the game in identifiable chunks, giving them an improved capacity to make themselves aware of their situation, predict likely state changes, and understand the advantages and disadvantages of possible courses of action open to themselves and their opponent (in most cases, a virtual opponent provided by some form of computer program). Recently, computer games have used a “continuous time” mechanism to change the nature of the player's ability to interact with the game. Instead of allowing the player to collect information about the state of the game as a whole, ponder the implications of that state for his existing plans, and develop and implement new plans in turn-by-turn chunks, the computer imposed some sort of continuously moving “game clock” on the player's decisions. Instead of updating the physical domain only after the player had taken his turn, the computer now updates that domain continuously. While the player observes and gives orders to his forces in one part of the battlefield, the situation elsewhere is changing without his being able to observe or affect it. Perhaps surprisingly, at first blush, this approach is equally artificial. The end result is often a ludicrous spectacle of the player riding around the battlefield trying to react at the unit level to every changing situation confronting the forces at his command.

The lure of the continuous-time approach is that

> It appears to be more faithful to reality and is more likely to produce the kind of dynamic interactions that occur in real operations. The price lies in potential distortions, especially in the planning process, when the game-time to real-time ratio (or game rate) is not one-to-one. If game time is speeded up as is the usual case in operational or strategic games, so that one minute of real time represents several minutes of game time, players may find that realistic planning of operations takes too long in game terms and is replaced by seat-of-the-pants or reactive decision making. At the other extreme, if the game clock is slowed down, as is most likely in tactical-level games, so that the players may study the situation more carefully before acting, a false impression of the effects of time pressure may easily result.[41]

In our efforts to condense the real domains of warfare into the topologies of the wargame, we should care less about the operation of clocks than about the battle rhythm of human decision-makers. The precise clock time at which each event occurs, though important to determining effects in the operational domain is of less importance overall than representing correctly the flow of information and events into the cognitive domain of the players, and the effects of that flow on the four key relationships (awareness, understanding, prediction, and influence) between the players and the game.

The complicating factor, of course, is that time does have an undeniably real physical effect on the operational topology. Forces can move only so fast. Planning cycles take so long to complete. (Can you spell ATO?)[42] I may make contingency plans, but I can respond to a contingency only after it occurs.

The trick for the game designer is to find a way to combine the tick of the clock and its inexorable effects on physical actions and

41. Perla, 1990, p. 223

42. ATO is the acronym for Air Tasking Order. The ATO is the principal mechanism devised by the U.S. Air Force to schedule daily air operations in accordance with an overall plan of campaign. It is mythical in its reputation for following a rigid, usually three-day, planning cycle.

interactions with the more subjective experiences of time in the player's cognition. This linking of physical and cognitive domains in the real world reflects, perhaps, the heart of the experience of real command.

At some level, as Paddy Griffith has articulated it in his book of rules for miniature wargames, generalship is all about managing your time.[43] If this is so, then representing time and its effects and modes of experience cannot be a mere afterthought or choice of convenience in designing a wargame. Instead, it is possibly the most crucial and central decision the designer must make. If, indeed, the future of warfare—whether you call it network-centric, information-based, hyperwar or any other of the popular buzzwords in current fashion—will revolve around creating and exploiting advantages in information, communications, and coordination to achieve the information dominance characterized by faster OODA loops, then treating time as a constant for all sides or even all formations of the same side seems fundamentally inconsistent with painting an experientially as well as physically faithful representation of real operations.

How can we create such a faithful representation? Unfortunately, we are better at asking the question than providing the answer. Yet. We do know that we cannot do it using the same old techniques that have so far proven of limited success in doing it.

There have been some attempts at introducing new, or at least non-traditional, ways of looking at time in wargames. The *Piquet* miniatures rules mentioned earlier are one example. These rules use cards of various types to introduce some unpredictability and chaos into the party by replacing virtually all traditional elements of the fixed game-turn sequence of play with uncertainty and asymmetry. Other games, particularly operational and strategic games designed by Mark Herman, regulate the potential and pace of operations using cards in a different manner, within a structure of much longer fixed-length game turns. In our *Road to Baghdad* game, we have tried a third approach.

43. Griffith, Paddy. *Napoleonic Wargaming for Fun*. London: Ward Lock, 1980

A different view of time: the *Road to Baghdad* game

As an example of how the framework we sketched out in the preceding section can be applied to create a game dealing with a specific operation, we have designed a board game to represent Operation Iraqi Freedom. The rules and other components that embody the design for this game, which we call *Road to Baghdad,* are provided in appendix A.

Our thinking on the important issue of better reflecting the experience of time in a wargame is just beginning to develop. Our overall approach in developing a new idea of dealing with time in *Road to Baghdad* is to take conventional concepts of game design and turn them on their heads. In this case, rather than fixing the time step and scaling the activity of the units to that time step, we fixed the ability of the units to conduct basic activities like moving or fighting, but varied the time it takes them to carry out those activities.

The underlying notion is that unpredictable delay, Clausewitz's friction or Herman's entropy, causes units at the lowest level to function in unexpected, and sometimes unpredictable, ways. Higher-level commanders and staffs work to overcome the uncertainties and unpredictability using their C3I systems and procedures to plan and prepare operations and to react rapidly to changing circumstances in an attempt to counter and reduce the effects of entropy. At the lower levels, individual units work to self-synchronize their activities where possible to overcome the same entropy. Over time, however, the overall system's entropy will increase and may ultimately reach levels that bring the entire system to a state of extreme lethargy, or even grind it to a halt. After an "operational pause" to recover and refit, the force may once again conduct operations at a normal level of efficiency.

To represent these effects in a boardgame system, the *Road to Baghdad* introduces the notion of "clock ticks" of varying lengths. During each such tick, some or all units may be able to perform their usual activities. Shorter ticks mean that the units are performing quickly and efficiently. Longer ticks mean that entropy is reducing the effectiveness and efficiency of the units, causing them to take longer to carry out the same sorts of activities.

The simplest approach to implementing this idea is to use only two possible time spans—short and long, or fast or slow—to define two classes of moves with fixed activity levels available in each. For example, suppose that the short (or fast) turn represents 6 hours and the long (or slow) turn represents 12 hours of activity. The fast turn represents efficient activity, well-planned and well-supported actions that follow the predicted course. The slow turn represents the effects of unexpected or unpredictable factors that create extraordinary entropy and slow the efficiency of execution. This new approach to sequencing turns and exposing the players to a different experience of time in the game is clearly only a baby step in the direction we are proposing. But it is one worth developing and exploring.

The end of the beginning

Although this paper is the final report of the Transforming Naval Wargaming project, it is, in a real sense, only the beginning of an attempt to break new ground in meeting the promise of the project's title. One thing that this research effort has demonstrated is that accepting the conventional wisdom that considers the discipline of wargame design as a slowly evolving art form, or craft, wholly dependent on the talent, genius, or inspiration of its practitioners to produce useful and productive wargames, is neither wise nor necessary. At the start, we game designers were skeptical that any form of scientific approach—beyond the almost pseudo-scientific appellation of “social science”—must be doomed to founder on the very humanity of the practitioners of the art and the players of the games.

No longer. We have taken only one tiny, tentative step in the direction of building a scientific foundation for wargame design at the operational level of war. This paper has presented some basic definitions and proposed some fundamental postulates. It has articulated a view of wargame design as a process of mapping the physical, cognitive, and informational domains of real warfare to the operational, command, and information topologies of a wargame. And it has identified the representation of time and its challenging mixture of objective and subjective effects on human activity and cognition as a primary element to understanding what makes a game go.

A science of wargame design?

Can we make this foundation more rigorous? Can we build an edifice of wargame-design science based on something more than the accumulated wisdom (and errors) of the masters of the designer's craft? We now are ready to answer those questions, boldly, “Yes!" It will not be easy, but we are convinced that it may well be possible. It is certainly worth the effort.

Why? Because to continue as we have been dooms us to the repetitive cycles of wargaming fashion. It places our fate at the mercy of the whims of the genius or the blandishments of the charlatan; wargaming has been blessed with both, though too often more of the latter than the former. We exist under the threat of an unfortunate equation of the work of the game designer with that of the computer programmer. As computing power increases and the high-priests of technology claim (with more and more justification) that they can "model" anything you might want in their black-box simulations, the lack of a rigorous, scientific foundation for understanding, evaluating, and applying their wares judiciously leaves us distressingly vulnerable to the wargaming equivalent of quack doctors peddling promises of quick fixes for all the thorny operational problems that plague us.

To move beyond the difficult to discern differences between the products of genius and the elixirs of snake oil, we need the kind of firm foundation in science that drove physicians from the hopeful practice of bleeding the patient to the effective practice of scientifically based medicine.

Moving onward

To continue the start we have made here, we suggest first of all that you try out our *Road to Baghdad* game. Not because it is a finished product, but because it is not. It is merely a first step, an admittedly tentative departure from the norm. We hope that it can, nevertheless, inspire or irritate you enough to take bolder and broader steps of your own.

We have proposed some basic ideas for creating a framework for operational wargaming and given an example of how it can be applied. Using this framework, other game designers can create new wargames that will allow small teams (let's say two to six players per side) to explore operational-level military concepts, particularly those associated with network-centric warfare, by allowing the disparate concepts to compete with each other in easily replayed situations. Key to implementing this framework is to develop a representation of the functions and effects of command networks below the level of the players by replacing the organizations, processes, and technologies actually used in an operational situation by the elements of the game system that can represent their behavior and key outputs based on the mechanisms of the game system, assumptions inherent in the scenario, and inputs from the players.

Our framework provides a conceptual basis for modeling and running a game at the operational level. Our application of these concepts in the *Road to Baghdad* game are embodied not in the mind of individual umpires or in computer code, but in simple mechanical processes and straightforward tables of data and procedures for applying them. These rules help to insulate players from getting sucked down into the tactical domain of widgets, radar equations, and third-order effects. They provide that structured context within which players are freed to develop their own understanding about what does and does not transfer from the game experience to reality.

On the other hand, the framework should not be rigidly constructed or applied. It should guide players about what interactions they should expect to see in the game, and about what the range of potential results of such interactions may look like. It should not, however, straightjacket the players into accepting either the range of interactions or their possible results as given. The beauty of the boardgame approach we have taken here (whether applied literally as a paper-based game or adapted to a computer-moderated environment) is that everything is open to the players for them to understand, manipulate, or replace with their own judgment easily and quickly.

The overarching purpose of our conceptual framework and practical example is to present the players and game directors with a workable system to govern the occurrence and nature of interactions and advance the play of the game by resolving those interactions. These resolution systems are in no way designed to predict actual combat outcomes in any meaningful sense of the word. Instead, their purpose and design is to provide a basis for discussion and evolution of thinking about concepts of operations, organizations, and decisionmaking strategies. It is our intention and sincere hope that the framework and the specific systems that implement it will evolve based on the learning and thinking that occurs during each use of the game, as the players themselves increase their understanding of what the likely interactions are and how they may occur and influence each other.

For our part, we seek to follow up our initial foray into creating a science of wargaming and explore two complementary paths. The first is the theoretical one. We have touched on some ideas from old and new thinkers about war and about wargames. We have proposed some ideas we boldly term postulates based on their explorations. Can we now gather these postulates together into a rigorous system of thought? Can we (dare we say it, even think it, in our most private thoughts?) develop and prove "theorems" about wargame design based on such postulates? Let's at least make the attempt.

The second path is the more practical and immediately applicable. Let's design some games. *Road to Baghdad* is at best what the computer industry would term an alpha-level product. We had intended all along to try to use the game to "replay" the actual course of Operation Iraqi Freedom, as some sort of demonstration of the "validity" of the game, measured at least by its ability to reflect the real operation. We found that our resources were too limited to carry out this goal within the bounds of the current study. By conducting further playtesting and development, not only can we carry out this program of comparison, but also we expect to improve the existing ideas and develop new ones as the game evolves in response to our experience and our increasing understanding.

In addition—as our work with the *SCUDHunt* game has convinced us—the development and use of distillation games can open up interesting and fruitful avenues for research.[44] Can we adapt this nascent theory to guide us in the design of distillation games (or even of abstract games) that would allow us to build tight connections and understandable relations from the real domains of warfare to the game topologies? If so, can we find ways to use such games to conduct game-based research of topics like the relative effectiveness of different command structures under different operational conditions?

44. Perla, Peter P. et al. *Game-Based Experimentation for Research in Command and Control and Shared Situational Awareness.* CNA Research Memorandum D0006277.A1/Final, May 2002.

Finally, we can see some scope for marrying our new thinking about games and game design to the new sciences associated with agent-based techniques. *SCUDHunt* once again provides us some evidence that marrying these two concepts holds promise for future research.[45] Can we link the techniques of gaming and agent-based analysis in new and more rigorous ways to allow us to feed off their strengths and develop a new and powerful approach to studying and understanding complex problems associated with the integration of human beings and complex systems?

When integrated in agent-driven wargames, human players and agents complement each other in important ways. Human-played games can help focus us on interesting phenomena, and multiagent simulations can help us explore those phenomena more thoroughly. In addition, we can embody variations of specific behaviors observed in human-played games in multiple agents. We can then use those agents to explore broader games involving large numbers of independent decision-makers that share a common value system—precisely the problem confronting us with representing extensive and diffuse terror networks. Games played by the relatively small numbers of human players will not act the same way, nor is it possible to use human players to explore systematically the large space of possible rules and behaviors. The promise is there. We need only take the games seriously enough to explore the possibilities.

Prospective projects

To that end, we recommend that the Naval War College initiate a program of research to develop further the scientific theory of wargame design, and apply the learning based on that effort to revolutionize the practice of wargaming at the operational level. In particular, we recommend that:

45. Perla, Peter P. et al. *Using Gaming and Agent Technology To Explore Joint Command and Control Issues.* CNA Research Memorandum D0007164.A1/Final, October 2002.

- The Naval War College develop the principles presented in this paper into a comprehensive approach for wargaming information warfare.
- The Navy establish a program of research to continue developing the scientific foundation for wargame design.
- The Naval War College apply the principles presented here to the design of distillation games to help conduct game-based research into topics like the relative effectiveness of command structures under different operational conditions.
- The Naval War College further develop the techniques embodied in the *Road to Baghdad* game to create new games to explore broader warfighting scenarios for the future, particularly those involving more extensive use of naval and amphibious operations.
- The Navy support research and development to link the nascent science of wargame design with the new science of agent-based analysis to develop a new and powerful approach to studying and understanding complex problems associated with the integration of human beings and complex systems.

Specific projects that the Navy should consider for future research include the following.

Apply social network analysis to wargaming information operations

Background

Future scenarios faced by 5th Fleet in CENTCOM and 7th Fleet in PACOM will require an understanding of information operations and the effects of networks on the operational level of war. Although the Navy has long experience with designing wargames that incorporate the effects of kinetic weapons, there is a significant shortfall in its understanding about how best to represent the effects of information operations, specifically "who knows what, when did they know it, and with whom did they communicate."

Recommended research

The War Gaming Department should investigate the application of social network theory and agent-driven wargaming to the construction and dynamic adaptation of command and control structures during wargames by examining how staffs organize tasks and information flows between themselves. The WGD should gather social-network data during the play of NWC wargames to understand how intra-staff networks evolve during a game and to develop working hypotheses for detailed experimentation. Such research would also help the WGD construct future command and control structures and procedures. For example, by understanding how a networked staff structures itself and uses its assets to accomplish its assigned tasks, it may become possible to optimize dynamically network assets such as bandwidth available to the distributed staffs and decision-makers as a function of the type and characteristics of the mission and task.

Benefit

Understanding how staffs self-organize will provide insights into command and control structures, dynamic adaptation, and procedures necessary to investigate information operations in the challenging warfighting scenarios faced by 5th Fleet and 7th Fleet.

Wargame antisubmarine warfare (ASW) for 7th Fleet

Background

The 7th Fleet is facing a serious and credible threat from submarines, mines, and theater ballistic missiles (TBM). With 7th Fleet support, the War Gaming Department has for several years been researching detailed approaches to dealing with the threat. Conclusions to date indicate that it is necessary to truly understand the tactical-level details of a specific operational environment in order to understand the operational-level issues. In many cases, commonly held opinions about how to best proceed at the operational level are simply contradicted by detailed tactical-level analysis.

Recommended research

The War Gaming Department should develop in detail a set of conceptual models of ASW based on current research, implement the models in forms useful for gaming, and develop some initial practical applications of the gaming approach and model to conduct initial assessment of the utility and practicality of the approach.

Benefit

The War Gaming Department should use the resulting conceptual models to explore combat interactions and novel command decision-making concepts at the operational level of warfare within specific scenarios faced by 7th Fleet. Such a practical application will demonstrate the results of the research to operational commanders and will facilitate the NWC's using the models for precise and quick assessments in fleet games.

Develop work-flow models of innovative concepts

Background

Wargaming innovative concepts and processes that are relevant to the Fleet usually requires that staffs from those Fleets play the game. However, 5th and 7th Fleet are extraordinarily busy. Therefore, when using staffs from these Fleets, it is necessary to make sure that the innovative concepts have been refined as much as possible before the wargame so that these staffs do not spend the time they commit to the game discovering flaws and making recommendations that should have been discovered in the laboratory. Furthermore, because a game necessarily addresses only a limited number of possible trajectories through the space of possible events and outcomes, it is necessary to address the possibility that the game play missed combinations of events that would prove important in a real conflict.

Recommended research

The War Gaming Department should develop formal process models and workflow simulations of innovative concepts proposed for wargaming. Where feasible, the process models should be embodied in computer models written using the industry-standard and DoD-mandated IDEF0 language. The WGD can use these models to define and design innovative concepts in terms of the activities, resources used by the activities, inputs and outputs of the activities, and guidance to or constraints on the activities. The work-flow simulations would be dynamic models—designed using the process models—that track work product through the process that uses the concepts in terms of time and volume and track the potential work load of the staff employing the process derived from the innovative concept.

Benefit

An IDEF0 model of proposed innovative concepts provides a strict documentation of a well-defined process that is unambiguous, promoting clear communication between Fleet staffs and laboratory scientists and facilitating efficient modification of the process before and after engaging in the expense of a full war game. A dynamic work-flow simulation provides insights into problems like bottlenecks, work-load imbalances, and information-flow delays that can be fixed and tested before engaging in the expense of a full wargame. Additionally, by running the work-flow simulation in Monte Carlo mode, you can explore a huge number of paths through the process to seek out unanticipated problems that may not surface in a standard wargame using small numbers of staff for limited periods of time.

Further develop the foundations of wargaming theory

Background

The professional military wargaming organizations of the DoD are staffed with military officers who are usually assigned to their positions on a two-year rotation. To become an expert in something as complex as the design, execution, analysis, and reporting of wargames to support clients with complex military problems takes longer than two years. Therefore, DoD wargaming organizations face a continual problem of training new staff and losing skills. Despite this, DoD wargaming organizations have an excellent record based on past performance of delivering high-quality product. However, as warfighting becomes more complicated, the pace of change on the battlefield speeds up, and billets are left unfilled in order to maintain OPTEMPO overseas, the struggle to maintain corporate memory will become a losing battle. DoD wargaming faces a near-term train wreck in its ability to train staff in wargaming methodology, deliver innovative high-value games, increase the number of games played in a year, and retain necessary skills as staff members rotate out.

Recommended research

The War Gaming Department should develop formal process models and workflow simulations of the processes involved in designing, executing, analyzing, and reporting on wargames. The process models should be used to define and design the processes in terms of the activities, resources used by the activities, inputs and outputs of the activities, and guidance to or constraints on the activities. The workflow simulations should be designed using the process models, and should track work product through the process in terms of time and volume, and should also track the potential work load of the participants at a game.

Benefit

A model of proposed wargaming processes provides a strict documentation of a well-defined process that is unambiguous, promoting clear communication between WGD staff and facilitating efficient modification of the process before and after engaging in the expense of a full war game. A dynamic work-flow simulation provides insights into problems that can be fixed and tested before actually beginning the game. Together, the two types of model capture knowledge about how and why games are designed for specific purposes, thus facilitating training of incoming WGD staff, capturing knowledge and experience from outgoing staff, and facilitating the design of novel wargaming techniques for new types of games.

Explore knowledge management within an adaptive C2 structure

Background

If adaptive information architectures are to be of use to Fleet staffs, then the system that manages information databases, access to those databases, and the business rules in force must also be adaptive to the changes in the C2 architecture. It is not good enough simply to provide staff members with access to new databases as the C2 architecture—and so their role—adapts. This is called "information management," and while necessary it is not sufficient for improving the effectiveness of C2 operations. What is missing and required is "knowledge management," a set of functions that includes but is not limited to providing assistance to staff member to help them to understand quickly the significance of the new types of information to which they have access.

Recommended research

The War Gaming Department should develop sets of proposed "business rules" for handling information within a dynamically adaptive C2 architecture. It should also design experiments for testing these rules within the current or future DoD systems. Further, the War Gaming Department should investigate the feasibility of using or adapting commercial systems (for example, the Microsoft Help System) to provide assistance to staffs in the use and meaning of information as their access to databases adapts.

Benefit

This research will provide design advice for knowledge management that can be incorporated into operational-level wargames proposed to the Fleet and joint commands, whether or not adaptive C2 is used. The results of the research will increase the willingness of Fleet operators to accept the use of adaptive C2 approaches by making those approaches easier to use during exploratory wargames (and possibly also during operational deployments).

Develop a wargaming system for information operations

Background

Future scenarios faced by 5th Fleet in CENTCOM and 7th Fleet in PACOM will require an understanding of information operations and the effects of networks on the operational level of war. There is a significant shortfall in our understanding of how better to represent information operations during wargames.

Recommended research

The War Gaming Department should develop an Information Warfare Wargame Construction Kit that focuses on managing information and information-processing assets (such as networks, bandwidth, connectivity routing) and on the effects of networks on the operational level of warfare. The focus should be on information, with an interface to a separate "traditional" wargame (one focused on representing kinetic effects) to ensure general applicability of the techniques. Initially, the

War Gaming Department should test the Information Warfare War Game using a distillation game. It should then expand the approach by adapting it to an expanded version of the *Road to Baghdad* operational-level wargame described in the appendix. Finally, the War Gaming Department should use the results of the research to provide design advice for operational-level war games proposed to the Fleet, joint commands, and others as appropriate.

Benefit

This research will provide design advice for wargames in which the players must make decisions about handling information and their information resources (such as bandwidth and processors) in order to achieve their desired operational effects. The players will have to "fight their networks" (in an analogous way to how they are currently expected to "fight their strike systems") when faced with opposing players who attempt to wage information operations against them. This will provide the Fleets with much more realistic wargames that deal with current and future threats.

Develop an agent-driven wargaming system

Background

Future scenarios faced by the Navy, particularly by 5th Fleet in CENTCOM and 7th Fleet in PACOM, will require representing concepts that are fundamentally different from those explored in past games. They will also require the development and analysis of multiple games in order to develop a broad understanding of the potential future scenarios. Undertaking multiple games is an extremely onerous task for staffs already at war or planning for war. On the other hand, single games provide only limited insight to the problems that the Navy may encounter in these uncertain futures. An approach that combines multiple and rapid simulation runs of the wargame with a small number of fully manned war games would be a useful adjunct to existing techniques.

Recommended research

The War Gaming Department should develop an agent-driven wargame engine designed to enable the gaming of novel concepts in future scenarios, based on CNA's agent-based approach developed by Andrew Ilachinski's work on the EINSTein model[46] and applied and extended in the *SCUDHunt* research.[47]

Benefit

This research will provide rapid testing of multiple concepts and courses of action in a scenario prior to fully manned gaming, thus providing wargame design assistance that will enable the wargame to make optimum use of valuable staff time. The research will also provide a system rapidly to test out ideas and approaches generated by the fully manned wargame.

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46. EINSTein is a pioneering attempt to simulate combat on a small to medium scale by using autonomous agents to model individual behaviors and personalities rather than specific weapons, synthesizing high-level behaviors, from the ground up, using low-level agent-to-agent interactions. EINSTein allows researchers to use an embedded genetic algorithm to "breed" whole combat forces that optimize some set of desirable characteristics. EINSTein has been used to explore the role of fractal statistics to describe real-world combat, as a test-bed for exploring squad and fireteam compositions in the U.S. Army and USMC, to play "What If?" scenarios in studies of asymmetric warfare, to explore reconnaissance and counterreconnaissance and the dynamics of battlefield survivability, and was instrumental in introducing complex-systems into the USMC's lexicon (with associated language changes appearing in the USMC official doctrinal publications). There are currently more than 500 registered users of EINSTein in academia, commercial, and research organizations, the U.S. Department of Defense, and other military operations research analysts worldwide. See http://www.cna.org/isaac/

47. Perla, Peter P. and Julia Loughran, "Using Gaming and Agent Technology to Explore C2," *Proceedings of the 8th International Command and Control Research and Technology Symposium (ICCRTS)*, 17 to 19 June 2003. Available through http://www.dodccrp.org/

Appendix A: *Road to Baghdad* Wargame

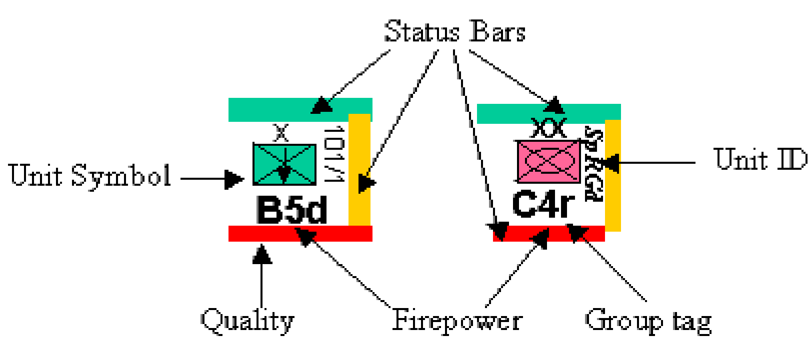
Road to Baghdad (*RtB*) is an operational-level two-player wargame based on OPERATION IRAQI FREEDOM, covering the period 19 March – 10 April 2003.

The game emphasizes interactions between off-map command and control systems and the flow of events on the map. The Command system generates, stores and transports “Operations” (represented as poker chips) which players “spend” to deploy, maneuver, and reconstitute their combat forces.

Game scale

Units are mostly brigades for the Coalition player and divisions for the Iraqi player. A game turn represents 12 – 24 hours of real time. Most units move from point to point on the map. Paths between cities, towns and “waypoints” range from a few km to 100 km.

Typical combat units



Playing pieces

Combat units

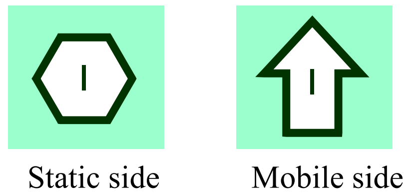
Combat units are colored wooden blocks with a blank side and a label side. Combat units are kept off the map, and represented on the map by numbered Force markers. The blank side is kept facing the enemy player, except during combat. The label side shows the following information:

- Standard military map symbol and identifier. Coalition units have a green symbol box, Kurdish units orange, Iraqi regular gray and Iraqi Guard pink.
- Uppercase letter that indicates the unit Quality rating (A= elite, B = regular, C = conscript D = armed mob).
- Number that indicates unit Firepower (Special Operations units have a bullet rather than a number, since they execute Missions rather than Combat).
- Lowercase letter ("tag") that shows the unit's Group. Units that belong to the same Group enjoy a synchronization advantage in Combat (minus 1 to the die roll).
- Status bars on the edge that indicate the unit's current condition (Green = fully capable, Yellow = reduced, Red = critical.) "Status" is a composite of fatigue, supply, and damage to people and equipment. A unit's Status may worsen as a result of combat or improve through reconstitution. The unit is rotated in 90-degree increments so that the current Status is always at the top.

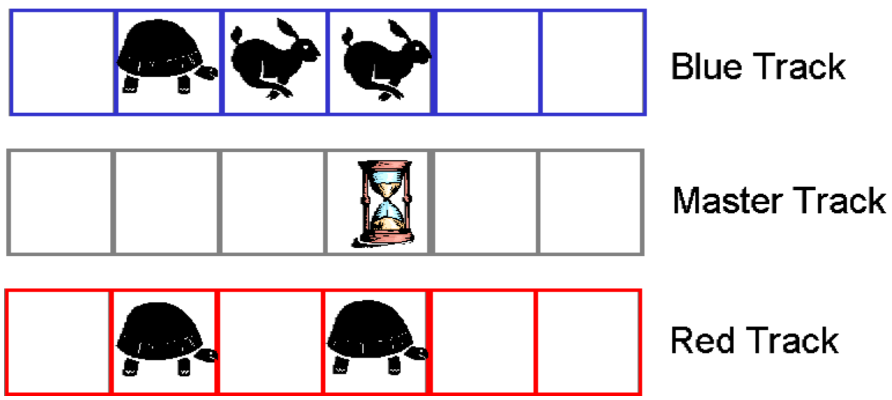
Force markers

Force markers are double-sided numbered counters that serve as on-map "containers" for Combat units. When the hexagon side is face-up, the Force is static and may not move. When the arrow side is face-up, the Force is mobile, and *must* move in the direction indicated by the arrow.

Force marker



Time track with clock markers



Clock markers

Clock Markers are drawn from a cup and place on the Time Track. The rabbit symbol indicates a Fast phase, the tortoise symbol indicates a Slow phase. An hourglass marker indicates the current clock "tick." The fast turn represents efficient activity, well-planned and well-supported actions that follow the predicted course. The slow turn represents the effects of unexpected or unpredictable factors that create extraordinary friction and slows the efficiency of execution.

Air strike (front and back)

System Strike

Kill Box Strike

Air strike markers

Two-sided Air Strike markers represent about 50 strike sorties. The blue side represents System Strikes, against enemy command and control. The tan side represents Kill Box Strikes against enemy Forces on the map.

Operations chits

Operations points (Ops) are an abstraction of command attention, network capacity, staff work, logistic support, information and other operational enablers. Ops are represented by poker chips and are used to overcome friction in a local area and allow units that would normally not be able to act during a move to carry out some limited actions. Ops may also be used to enable a unit to recover combat losses, to synchronize attacks of multiple formations, improve the effectiveness of units in combat, enable a fast unit to conduct an exploitation, to conceal the identity of units revealed through combat or other means, or to entrench a unit in a critical defensive position. Ops are placed, moved and expended on the Command Display.

Command cards

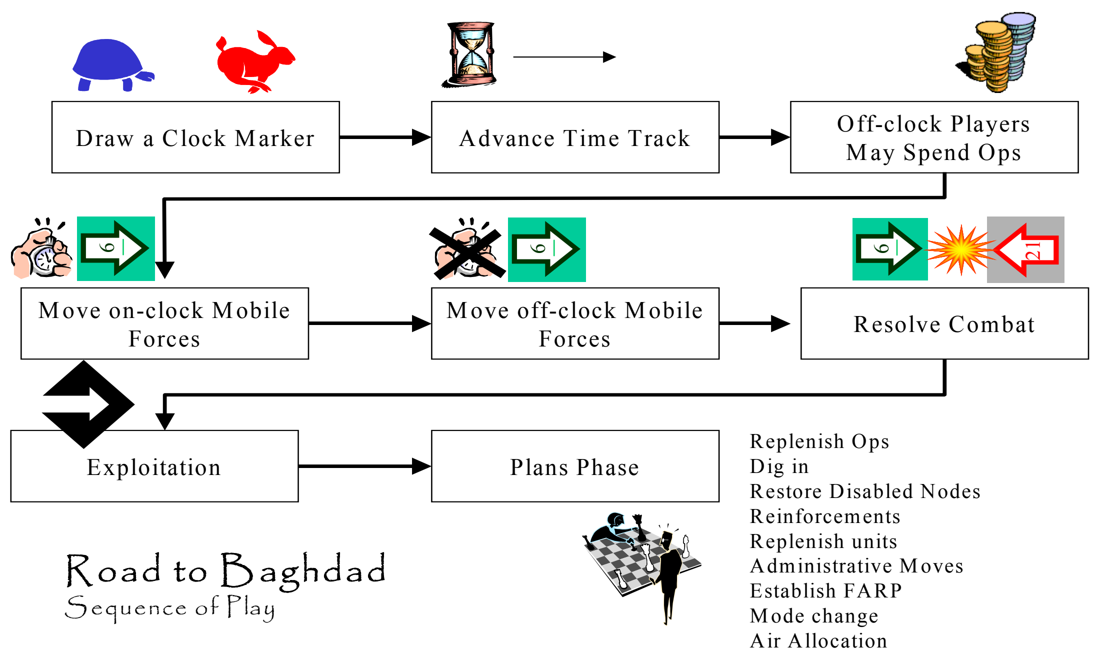
These cards represent Theater, Army, Corps and other command nodes. They are placed on the Command display.

Other game markers

Bomb Damage, Dug-in, Decoy, WMD. The counter set includes a variety of markers for future options that are not implemented in the Basic scenario.

Sequence of play

Sequence of play flow chart



Phase 1: Advance move and clock markers

If a player's clock marker is in the space corresponding to the current position of the clock (indicating that the player has just completed a move), that player determines whether his next move is long or short. (draw a marker from a container). Place the player's marker one space ahead for a fast phase or two spaces ahead for a slow phase. Once both players have placed their markers, if necessary, advance the clock marker one space (tick).

Phase 2: Operations decision

If either player's move marker is NOT in the space corresponding to the clock marker (i.e., off the clock), that player may choose to expend Ops to activate forces during that move. If both players are off the clock, the advantaged player chooses which player will first declare his decision about using Ops. Any player that chooses to use Ops for this purpose must immediately spend one Op from an eligible command node to exercise this privilege.

Phase 3: The on-clock player moves his pieces

All mobile pieces of an on-clock player (or both players if both are on-clock) must move to their designated destination, subject to the limitations imposed by road capacity.

Phase 4: The off-clock player may move activated pieces

If an off-the-clock player chose to activate pieces during the move by expending an Ops point in Phase 2, that player may now spend an Ops point to activate an eligible space to allow units in that space to move to their already designated destination (only). Place the Ops chit directly on the Force Marker to keep track of which Forces are activated. Remove the Ops chit after the Force completes its movement. If the space the unit moves from contains enemy units, at least one friendly unit must remain in the space for each enemy unit present there. Any and all mobile pieces in a space and eligible to be activated by the Ops point spent may move to their destination regardless of the number of such pieces in the starting space. More than one Ops point may be spent to activate different forces in the same space (for example, units from different armies might require the expenditure of an Ops point from their own army node).

Phase 5: Resolve combat

Combat takes place automatically in spaces that contain units of both sides. If the order of resolution of the different combats matters, the advantaged player chooses which battle to resolve first. After resolving that battle, he then chooses the next, and so on until all battles are resolved. The details of combat resolution will be explained later.

Units that actively participate in a battle are tipped forward to reveal their identity and capabilities. These units remain tipped forward in this way until allowed to conceal themselves again, by the expenditure of an Ops point or some other means. Combat may result in the damage or destruction of pieces, or in their retreat. If a space is cleared of enemy pieces as the result of combat, any friendly Forces in the space may immediately and freely reorient their destination arrows.

Phase 6: Exploitation phase

Either player may spend Ops points to move *concealed* fast units in mobile mode (only) to an adjacent space. This space must be the current destination of the unit. (Note that fast units that participated in combat—which typically means actually used their combat capability in the fight—are usually not eligible to exploit because they have been revealed; this is where the use of Ops points to re-conceal such units comes in handy, reflecting the concentration of resources at the *schwerpunkt* of the attack.) If both players wish to conduct such exploitation moves, the advantaged player chooses who will act first and players alternate choosing towns to activate to conduct such moves. Ops points must be spent on each move according to the same rules and limitations of a normal off-clock activation, with the exception that exploiting units may neither leave nor enter an enemy-occupied space.

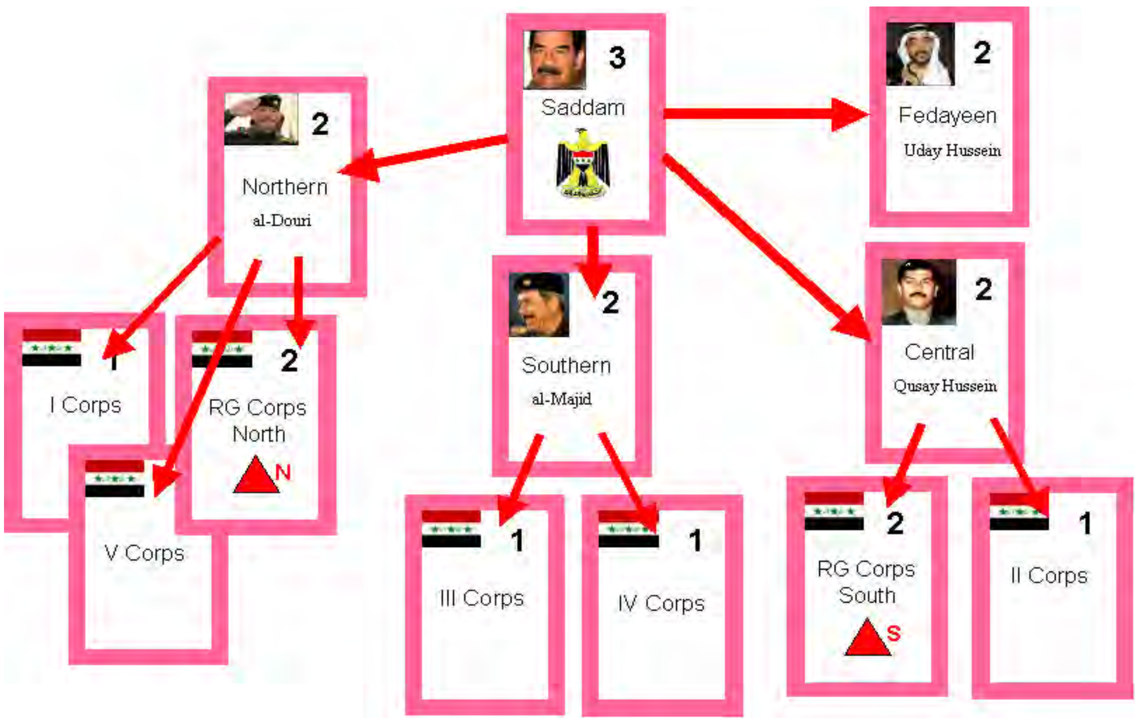
Phase 7: Plans phase

If both players are on-clock the advantaged player chooses who will act first and players alternate their actions. Each command node may replenish Ops, enter reinforcements, conduct administrative moves, change mode or destination of units, or other actions specified in the game or scenario.

Command

Each side in the game has a command and control network, represented by an arrangement of cards (the Command Display). The cards represent nodes in this network and the physical arrangement ("topology") of the cards represents the linkages of these nodes.

Iraqi command display



The number on each card represents its "storage" capacity for Ops. At the beginning of the game, each Node receives its full storage capacity. Each side has a top Theater-level node: Saddam for the Iraqi side and CENTCOM for the Coalition side.

Generating Ops

During the Plans phase, each Functional node in the Command Display generates one Op, and may move any number of Ops to a linked node that is Functional.

Functional nodes

A Theater-level node is "Functional" if it is face-up. Any other node is Functional if it is face-up and linked to a Functional higher-echelon node.

Broken link

A node may be turned face-down as a result of System Strike or Regime Collapse. Any stored Ops are destroyed. A face-down node may be restored during any subsequent Plans phase when a higher-echelon node spends an Op. A face-down Theater-level node may restore itself, but may not perform any other action during the phase.

Subordination

In general, a node may only spend Ops on units it directly or indirectly controls. Every Combat unit "belongs" to a Command node. For example, CENTAF may only spend Ops for Airstrikes, and V Corps may only spend Ops on units of the 3rd Infantry, 4th Infantry, 101st Airborne, 11th Aviation Bde and 82nd Airborne.

Get Saddam

[We suggest you consider this an optional rule]. System strikes on the Saddam node are resolved as follows: Shuffle the Saddam card with the three "decoy" nodes and arrange them face down. The Coalition player selects one randomly. If it is the Saddam card, Saddam is killed and replaced by Uday. Otherwise, no effect.

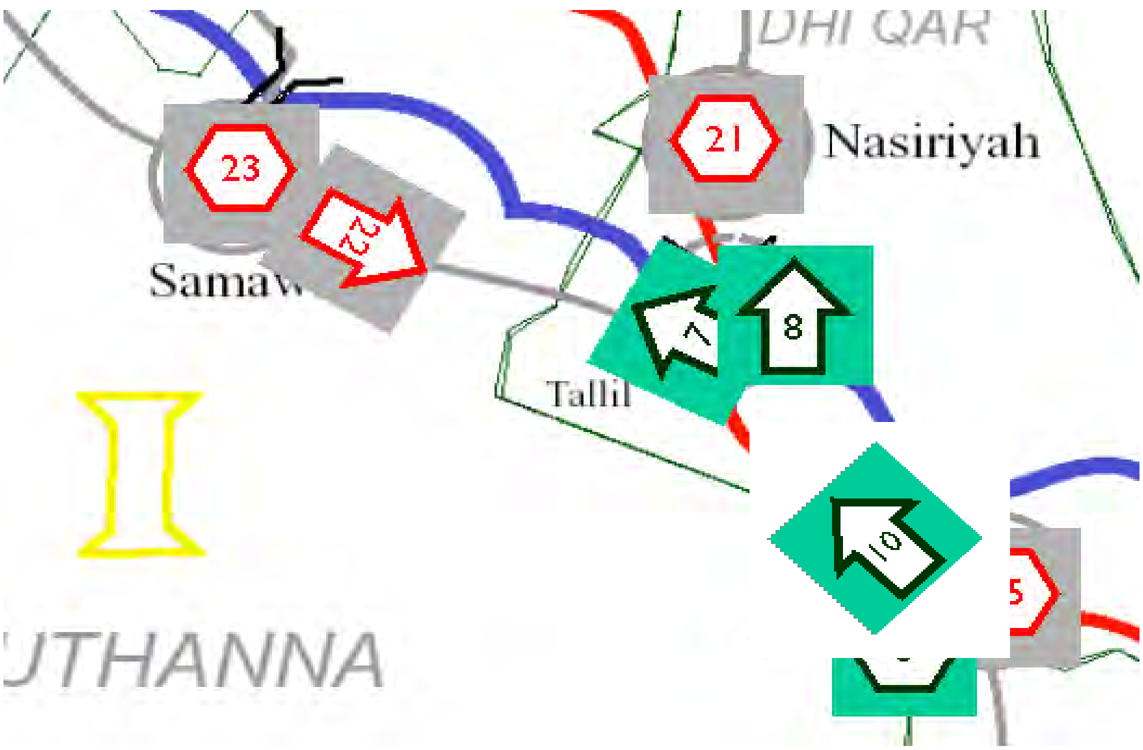
Movement

Forces in Mobile mode *must* move in the direction indicated by the arrow on the Force marker.

Unlike many wargames, there are no "stacking limits" in *RtB*. An unlimited number of combat units may be present in a space, but there are strict limits on the size of Forces that can use Ground movement along any particular Road segment during a phase.

If a force is larger than the road capacity, it must split off a Force, equal or less than the road capacity, that *can* move in the current phase. Any remainder *must* attempt to move in the next possible phase, unless redirected or placed in Static mode by spending an Op.

Note: There is no differentiation of movement allowances in *RtB*. All ground forces are motorized or mechanized. Moving one space takes one movement phase. Administrative movement (up to 5 spaces along roads clear of enemy forces) is an exception.



In the example shown above, Iraqi Force 22 and Coalition Force 7 are attempting to move down the same road in opposite directions. This is a meeting engagement, resolved "on the road." If Force 22 retreats as a result of combat, Force 7 may advance from Tallil to Samawah. If Force 7 retreats, then Force 22 may advance to Tallil. Force 8 must move into Nasiriyah. Force 10 must move from Jalibah to Tallil. Note that if Force 5 were not present, Force 10 could not move out of Jalibah, due to the presence of Iraqi Force 25.

Ground movement

Ground movement takes place along roads. Road capacity is measured in Combat units (Coalition brigades or Iraqi divisions). Fedayeen and Coalition SpecOps units count as "zero" for Ground Movement purposes. A Force of up to six combat units may move along a Primary Road *in each direction.* A Force of up to three combat units may move along a secondary road in only one direction.

Airmobile movement

All units of the 101st Airborne Division, the 82nd Airborne, 173rd Airborne, Attack helicopters and the UK 16th Airmobile Brigade may use Airmobile Movement. This takes at least two successive phases. In the first phase, LIFT markers are placed on the units that will move. These units must be in Static mode, but the placement of each LIFT marker counts as movement, and requires an Ops point. On any subsequent phase, units under a LIFT marker may move—off the road network—to any FARP in the same or an adjacent air zone, or they may establish a Landing Zone (LZ) anywhere in the same Air Zone or an Adjacent Air Zone. The LZ marker is placed in any convenient open terrain, adjacent to any space (town, city or waypoint). Units that begin a phase in an LZ may enter the adjacent space.

Forward arming and refueling points (FARP)

The Coalition player may establish up to three FARPs during the game. Only one FARP may be established per Plans phase. A FARP functions like a ready-made Landing Zone for Airmobile Movement. Establishment of a FARP expends two Ops.

Administrative movement

A Force that begins and ends its movement in spaces free of any enemy Force, and that does not enter or pass through a space containing an enemy Force may move up to five spaces. This costs 1 Op per Force. The Coalition player may only use Admin movement through spaces that have previously been occupied by Coalition Forces (i.e. through Iraqi territory that has been "liberated".)

The Map

Map scale is approximately 24 miles per inch. International and province boundaries (green or brown for Kurdish-controlled provinces) are provided for reference only and have no effect on movement or combat in the basic game.

Roads

Main roads (up to 6 units in *each* direction) are shown in red. Secondary roads (up to 3 units in *one* direction) are shown in gray.

Cities, towns and waypoints

Cities are shown as gray squares. Towns are gray circles. Waypoints are dashed gray circles. Kurdish-controlled towns (Arbil, Zakhu, Sulaymaniyah) are brown circles. The shrine cities of Najaf and Karbala (indicated by a green crescent) may not be targeted by Airstrikes. Critical Objectives, indicated by a red star are important in determining Regime Collapse. **Note:** the three city squares of Baghdad are inter-connected by main roads.

Combat

Ground combat takes place between opposing forces in the same space.

Ground combat may be either optional or mandatory. Optional combat takes place when one side is Static and the other is Mobile. Mandatory combat takes place when opposing Mobile forces collide (a "meeting engagement").

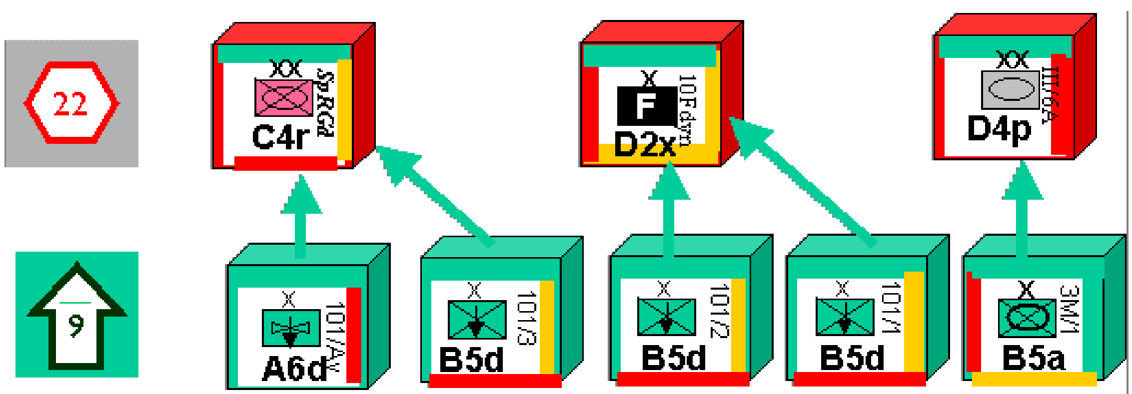
Combat is considered to be simultaneous between units of the same Quality. All “A” units fire first, followed by all “B” units, etc. If a unit is eliminated or forced to retreat before it fires, then it may not fire.

Combat is resolved by rolling 1d10 for each participating Combat unit. A die roll less than or equal to the unit’s Firepower inflicts a hit on an opposing unit. Combat die rolls against Iraqi units (only; a “home court advantage” if you will) are modified by terrain: add 1 in a town and 2 in a city. Add 1 if the targeted unit is dug-in. Subtract 2 for each Air Strike providing close support. Units at Yellow status add 1 to their die roll. Units at Red status may not fire.

Coordination

Units belonging to the same Group get a combat bonus (subtract 1 from the die roll for the second and all subsequent units of the same Group firing at the same target.)

Combat example.



In the example below, Force 9 (5 Coalition units) and Force 22 (3 Iraqi units) fight in a town. All “A” units fire first. **101/Av** fires on *SpRGd* and rolls 4, which is modified to 5 for the town. *SpRGd* takes a hit, rotates so that the yellow bar is at the top and retreats, forming a new Force. All “B” units fire next. **101/3** was allocated to fire on *SpRGd*, but cannot, since the target retreated first. **101/2** fires on

10Fdyn. The die roll is 7, modified to 8, which is a miss. Seven is added to the Coalition casualty total. **101**/1 now fires, rolling 2. The coordination bonus (subtract 1 for second unit of the same group engaging the same target) cancels the town defense, so the modified roll is a hit. *10Fdyn* rotates so the first yellow bar is at top, but does not have to retreat. 2 is added to the Coalition casualty total. Continuing with "B" units, **3M/1** fires on *III/6A*.Die roll is 9, modified to 10 for the town. Another miss, and 9 is added to the Coalition casualty count. Now "C" units fire, but the only "C" unit, *SpRgGd* has already retreated. "D" units now fire. The Iraqi player concentrates on the fragile **101/Av,** *III/6A* rolls a 5, for a miss, and *10Fdyn* rolls a 1, for a hit. **101/Av** is rotated, putting the red Status bar at top, and must retreat, forming a new Force.

Combat results

Combat results are applied differently depending on the side. For Iraqi units, each hit causes the affected unit to lose a Status level. Rotate the unit 90 degrees counter-clockwise. If this loss is a change of color (green to yellow, or yellow to red) then the unit **must** retreat. *Exception: units in a city are never forced to retreat.* For Coalition units, each hit causes the affected unit to lose a Status level and the unmodified die roll is added to the Coalition casualty total. A die roll of 10, however is recorded as zero.

If an Iraqi unit at Red Status suffers a hit, it is immediately destroyed and removed from play. Coalition units are never eliminated as a result of combat. If a Coalition unit at Red Status suffers a hit, it must retreat and twice the unmodified die roll is added to the Casualty count.

Setup

See the OB spreadsheet for start locations and reinforcement schedule.

Iraqi units set up in static mode, one Force per location. SAMs are placed in their Air Zone. Coalition units set up in Kuwait, in Mobile mode as follows:

- Udairi – Third Mechanized Infantry Division: 3M/1, 3M/2, 3M/3 in one Force (mobile)
- Al Salem – First Marine Division: Mar1, Mar5, Mar7 in one Force (mobile)
- Al Salem – First UK Armoured Division: 7Ar/UK, 16Aa/UK, M/Trw in one Force (mobile)
- Fao – 3Cdo/UK (static)
- Kuwait City – 11Av (static)

Coalition reinforcements enter at Kuwait City, except 173 Abn, which may airdrop at Bashur.

Airpower

The Coalition player has a variable number of Airstrike markers each turn.

The Iraqi player has a fixed number of SAM brigades assigned to Air Zones at the start of play.

Airstrike availability

Airstrikes are allocated three days in advance on the Air Tasking display. The number of Airstrike markers for any given day is 10 + 2d6 (min 12, max 22). At the start of play, the Coalition player determines availability and makes allocations for the first three days. At the beginning of each turn, the Coalition player repeats this process for another subsequent day.

Allocation

The Coalition player allocates Airstrikes by assigning markers to an Air Zone, with either the blue (System Strike) or brown (Kill Box) side facing up.

System strikes

Iraqi Command nodes are marked with the Air Zone in which they are located. To execute System Strikes, the Coalition player spends one Op per Airstrike marker and places the marker(s) on the targeted Node(s). All System strikes are placed before any are resolved. Roll 1d6 for each marker. The node is disrupted (turned face down) on a roll of 3 or less.

SAMs & kill box strikes

To execute Kill Box Strikes, the Coalition player spends one Op per Airstrike marker and places the marker(s) on the targeted Force or SAM. All Kill Box strikes are placed before any are resolved. Roll 1d6 for each targeted SAM. The SAM is killed on a roll of 1 and suppressed (turned face down) on a roll of 2 – 4. SAMs that are not killed or suppressed may fire at any Airstrikes in their Air Zone, rolling 1d6. An Airstrike is forced to abort on a SAM die roll of 2 or less.

Resolving kill box strikes

If a Force is targeted by a Kill Box strike, the Coalition player draws one BDA chit per strike, and (without looking at it) hands it to the Iraqi player, who places it with one unit in the affected Force according to the following priority schedule: Republican Guard armor, Republican Guard Mech, regular armor, regular mech, regular infantry, Fedayeen.

Close air support

Airstrikes allocated to Kill Box missions may also be used for Close Air Support (CAS). Place the Airstrike marker on any Iraqi Force that is participating in combat. Add +2 to the Coalition player's die roll. No more than one Airstrike may be used as CAS in any individual combat. Note that CAS is not allowed in Shrine cities (Najaf and Karbala).

Special operations

Coalition units marked with a bullet [•] rather than a firepower rating are Special Operations (SpecOps) units. They do not move on the road network or engage in normal Combat. SpecOps units do not have Status bars. They are inserted or extracted in Air Zones, where they can execute a variety of Missions. SpecOps have their own “Black” helicopters, and do not use Airmobile Lift or Landing Zones. All SpecOps units “belong” to the SOCCENT Command node. Each SpecOp insertion, extraction and mission expends one Op.

Special missions

- **Recon**: pick an enemy Force in the Air Zone and roll 1D6. On a roll of 1 – 5 the contents of the Force are revealed. On a roll of 6 the mission fails and must be Extracted.
- **Precision Targeting:** pick an enemy Force that is not in contact with friendly forces. On a 1d6 roll of 1 – 4 the Force is successfully targeted: each Kill Box airstrike draws two BDA chits rather than one. Any other result is No Effect.
- **PeshMerga support**: Place a SpecOp unit with one or more Kurdish brigades. The Quality rating of the Kurdish units is increased one level while the SpecOp remains with that Force.
- **SAM site Takedown**: Pick a SAM unit and roll 1d6. On a result of 1 – 3 the SAM is destroyed. On a roll of 6, the SpecOp suffers six casualties and must be extracted. Any other result is No Effect. [The “SCUD Hunt” can be represented by requiring the Coalition player to eliminate all SAMs in Air Zone III by a certain date.]
- **Interdiction**: Place the SpecOp unit on any road segment in the Air Zone. When an Iraqi Force attempts to pass along the road, roll 1d6. On a roll of 1 – 3, the move is aborted, and the Iraqi Force remains in place. On a roll of 6, the SpecOp suffers six casualties and must be extracted. Any other result is No Effect.
- **Capture Saddam**: Future addition to system.
- **Command Node Takedown:** Future addition to system.
- **Iraqi Counter-SOF:** Future addition to system.

Fedayeen

Fedayeen “brigades” have a Black unit symbol marked with a white F. They represent Ba’ath party loyalists, foreign fighters, and local militia. Five are present in the initial setup. The other five may be created during any Plans phase in any Iraqi town or city by expending one Op. No more than one Fedayeen unit may ever be present in a space. Fedayeen have the option of not retreating from a town when they suffer a combat result. Eliminated Fedayeen are eligible to be rebuilt on subsequent phases, even in enemy-occupied spaces.

How to win

Coalition victory: The Coalition player must occupy at least five Critical Objectives (causing Iraqi Regime Collapse) before the end of the 30th game turn, otherwise the Iraqi player wins a Symbolic Moral Victory. The presence or absence of Iraqi units is irrelevant in determining “Occupation” for purposes of this rule. When regime collapse occurs, all Iraqi regular unites (those with gray unit symbol boxes) are removed from the map. All five Iraqi regular corps HQ’s are removed from the command display (I, II, III, IV, V).

If the Coalition player suffers more than 500 casualties, the Iraqi player wins an Arab Media Virtual Victory, regardless of Regime Collapse.

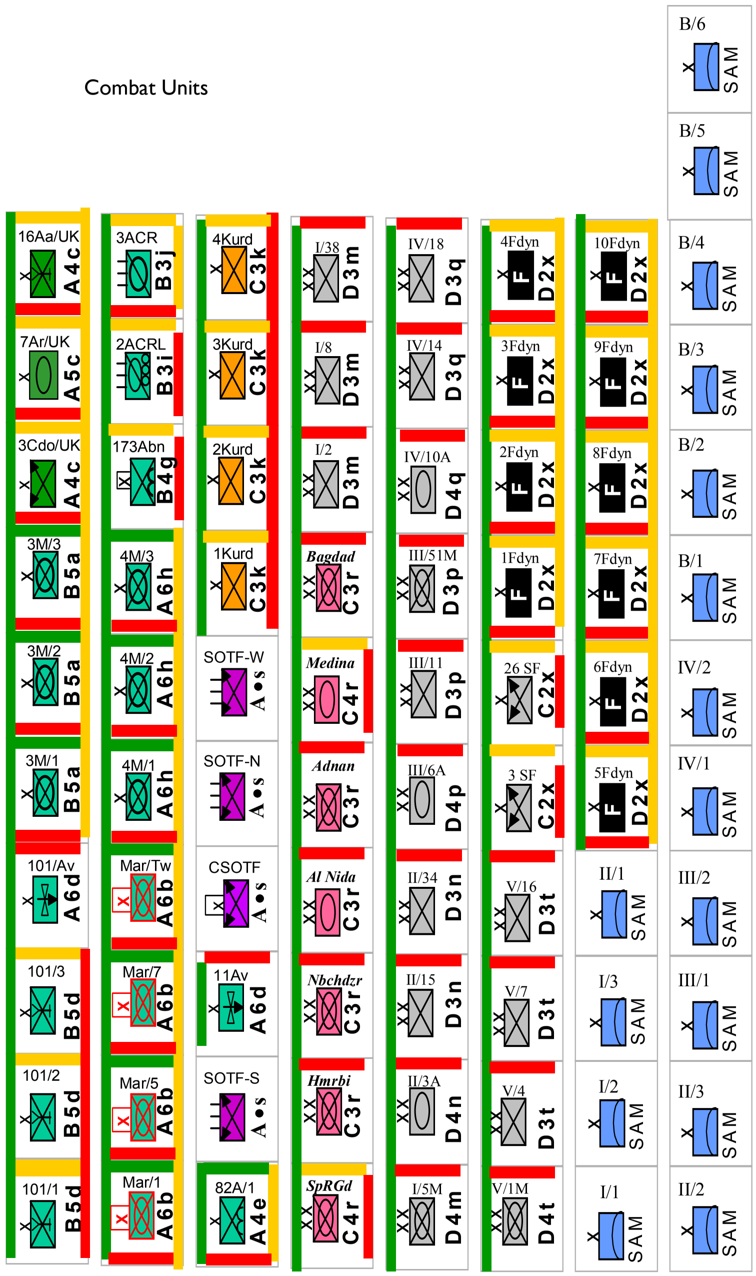
Explanation of game components

In addition to the rules above, a complete set of *RtB* components includes the items provided in the following pages:

- Counter sheets (six sheets): Artwork for the game pieces. The combat units (sheet 1) are labels that must be affixed to wooden blocks. 30 Green blocks are required for the Coalition forces and 36 Red blocks for the Iraqi forces. The 16 Iraqi SAMs on this sheet go on cardboard counters, not blocks. Force Markers and AirStrikes are double-sided counters. All other counters are single sided.
- Artwork for Command Node cards (2 sheets of Coalition and 2 sheets of Iraqi). These should be glued or printed on card stock, and cut apart. Card protectors (sold in hobby shops) are recommended; 15 blue for the Coalition and 15 red for Iraq.
- Artwork for the game map. We provide the map in sixteen 8.5x11" pages which you can tape together. You may also try to blow up the single-page reduced-size sheet.
- Setup sheet, a spreadsheet listing all combat units, with starting locations or earliest time of arrival.
- Graphics for the Sequence of Play, Red and Blue Force Holding boxes, Air Tasking display and Time Tracks (4 pages) .

In addition, to play the game you will need to provide a set of poker chips or other markers, some ten-sided and six sided dice, and blocks to paste the counter faces on. Blocks may be obtained from various game supply shops or publishers. See, for example, Columbia Games. http://www.columbiagames.com/cgi-bin/query/cfg/search.cfg?search=blocks&submit=Go

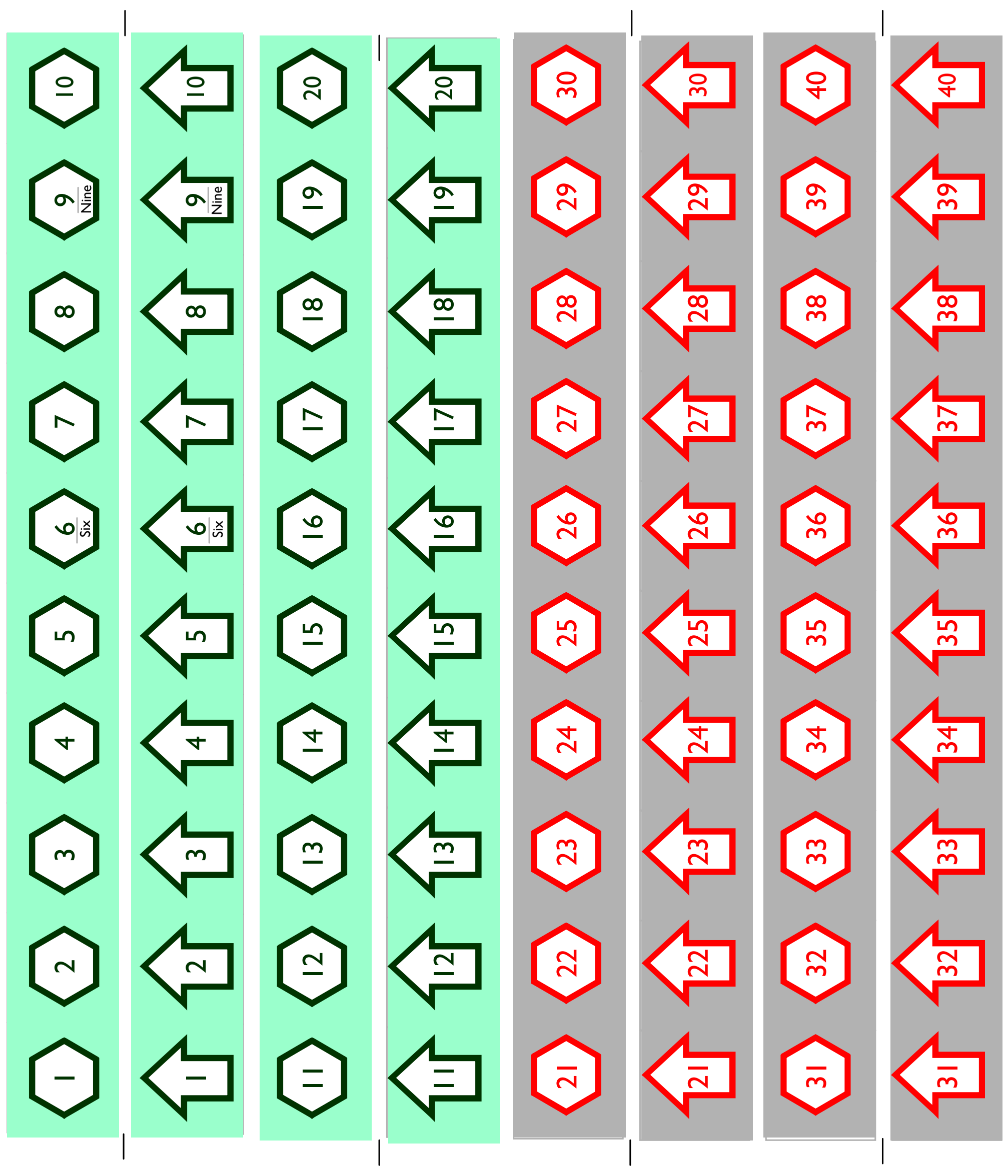
Combat Units



BDA Chits

ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step
ELIM 2 Step	ELIM 2 Step	ELIM 2 Step	ELIM 2 Step	ELIM 2 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step
No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect
No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect
ELIM 2 Step	ELIM 2 Step	ELIM 2 Step	ELIM 2 Step	ELIM 2 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step	ELIM 1 Step
No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect
No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect

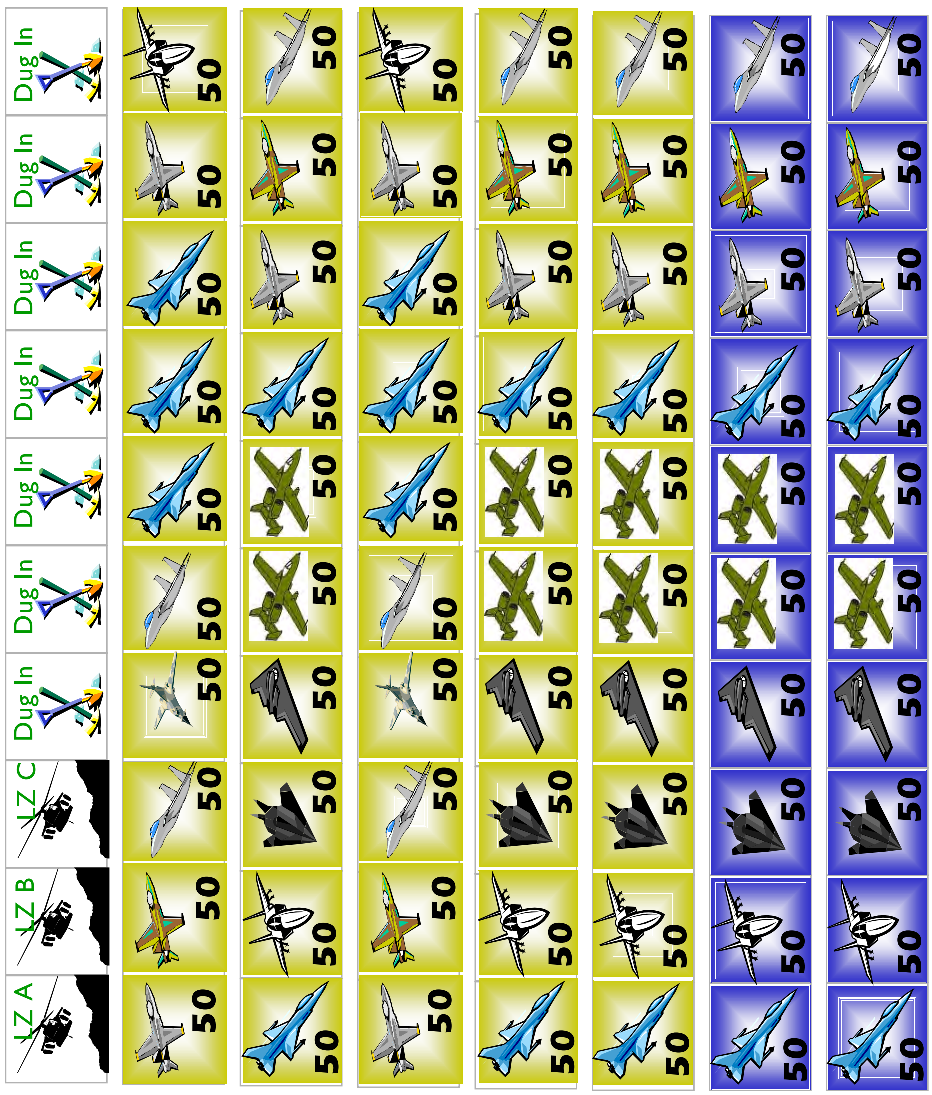
Force Markers



Clock Chits


50 50 50 50 50 50 50 50 50 50
50 50 50 50 50 50 50 50 50 50
Nuke
Chem
Bio
Bridge Out
Bridge Out
Bridge Out
Bridge Out
Bridge Out
Bridge Out
Bridge Out
FARP
FARP
FARP
FARP
SCUD
Pvt. Jessica
LIFT
LIFT
LIFT
50 50 50 50 50 50 50 50 50 50
50 50 50 50 50 50 50 50 50 50
decoy decoy decoy decoy decoy decoy decoy decoy decoy decoy
decoy decoy decoy decoy decoy decoy decoy decoy decoy decoy

Air and Misc Markers 2



4 **Central Command**	3 **Air Component Command (CENTAF)**	3 **Maritime Component Command (NAVCENT)**	3 **Land Component Command (ARCENT)**
	2 **Special Operations Command Central SOCCENT**	3 **V Corps**	3 **I Marine Expeditionary Force**

1

3rd Infantry Division

1

101st Airborne Division

1

1st Marine Division

1

1st UK Armoured Division

1

82nd Airborne Division

2

4th Infantry Division

2

CAOC Prince Sultan Saudi Arabia

1

8th Air Force Barksdale Louisiana

3

Saddam

B

2

RG Corps North

N

IV

2

RG Corps South

S

II

1

I Corps

IV

1

II Corps

II

1

III Corps

I

1

IV Corps

I

1

V Corps

IV

2

Northern

al-Douri

IV

2

Southern

al-Majid

I

2

Central

Qusay Hussein

B

2

Fedayeen

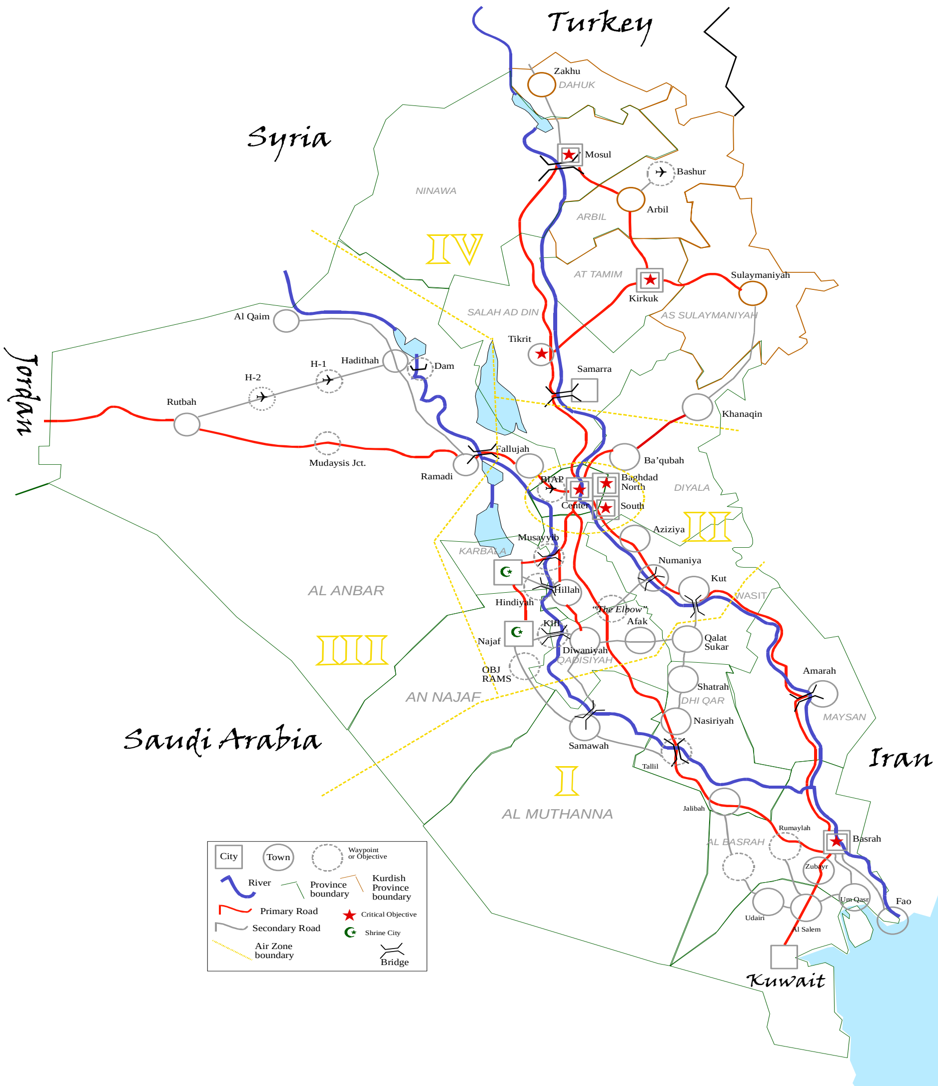
Uday Hussein

B

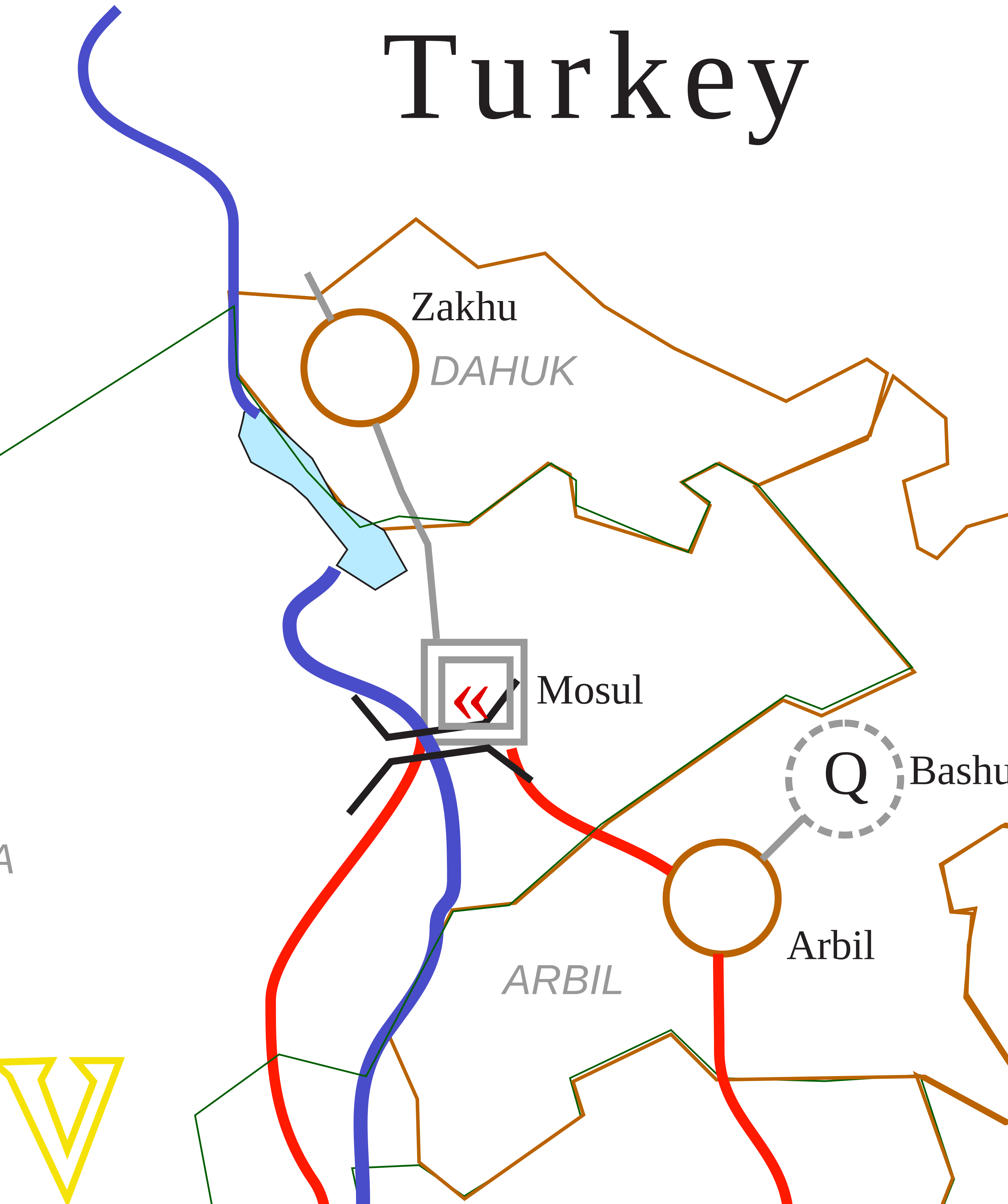
Safe House

Hide Site

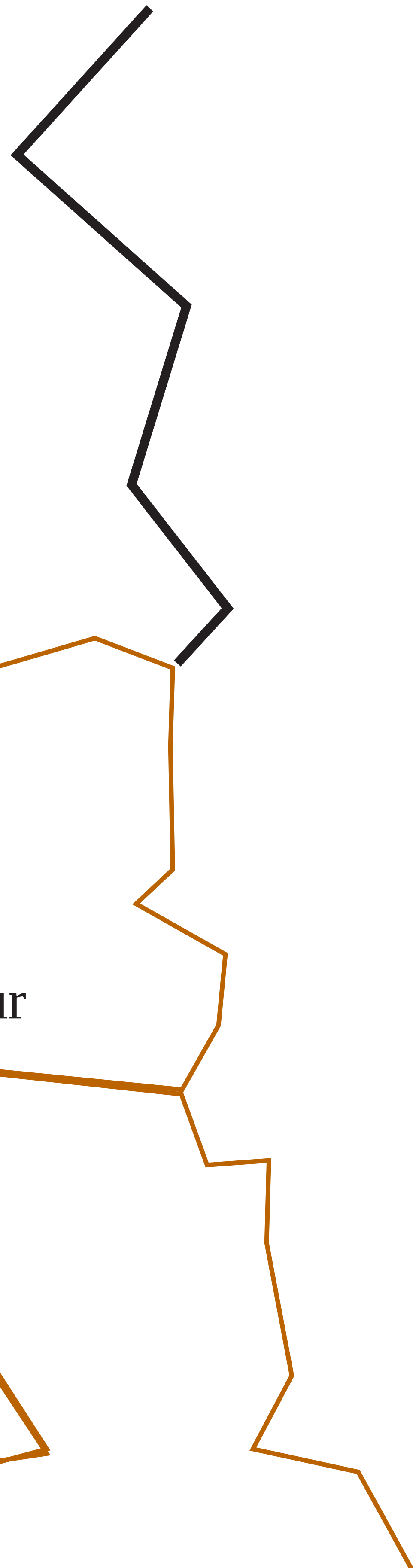
Cave


Turkey
Syria
Jordan
Saudi Arabia
Iran
Kuwait
Zakhu
DAHUK
Mosul
Bashur
NINAWA
Arbil
ARBIL
IV
AT TAMIM
Kirkuk
Sulaymaniyah
AS SULAYMANIYAH
SALAH AD DIN
Tikrit
Samarra
Al Qaim
Hadithah
Dam
H-1
H-2
Rutbah
Khanaqin
Mudaysis Jct.
Fallujah
Ramadi
Ba'qubah
BIAP
Baghdad
North
Center
South
DIYALA
Aziziya
III
KARBALA
Musayyib
Numaniya
Kut
WASIT
AL ANBAR
Hillah
Hindiyah
"The Elbow"
Afak
Najaf
Kifl
Diwaniyah
QADISIYAH
Qalat
Sukar
II
OBJ
RAMS
AN NAJAF
Amarah
Shatrah
DHI QAR
MAYSAN
Nasiriyah
Samawah
Tallil
I
AL MUTHANNA
Jalibah
Rumaylah
Basrah
AL BASRAH
Zubayr
Um Qasr
Fao
Udairi
Al Salem
City
Town
Waypoint
or Objective
River
Province
boundary
Kurdish
Province
boundary
Primary Road
Critical Objective
Secondary Road
Shrine City
Air Zone
boundary
Bridge

Syria
NINAWA



Turkey
Zakhu
DAHUK
Mosul
Q
Bashu
Arbil
ARBIL
A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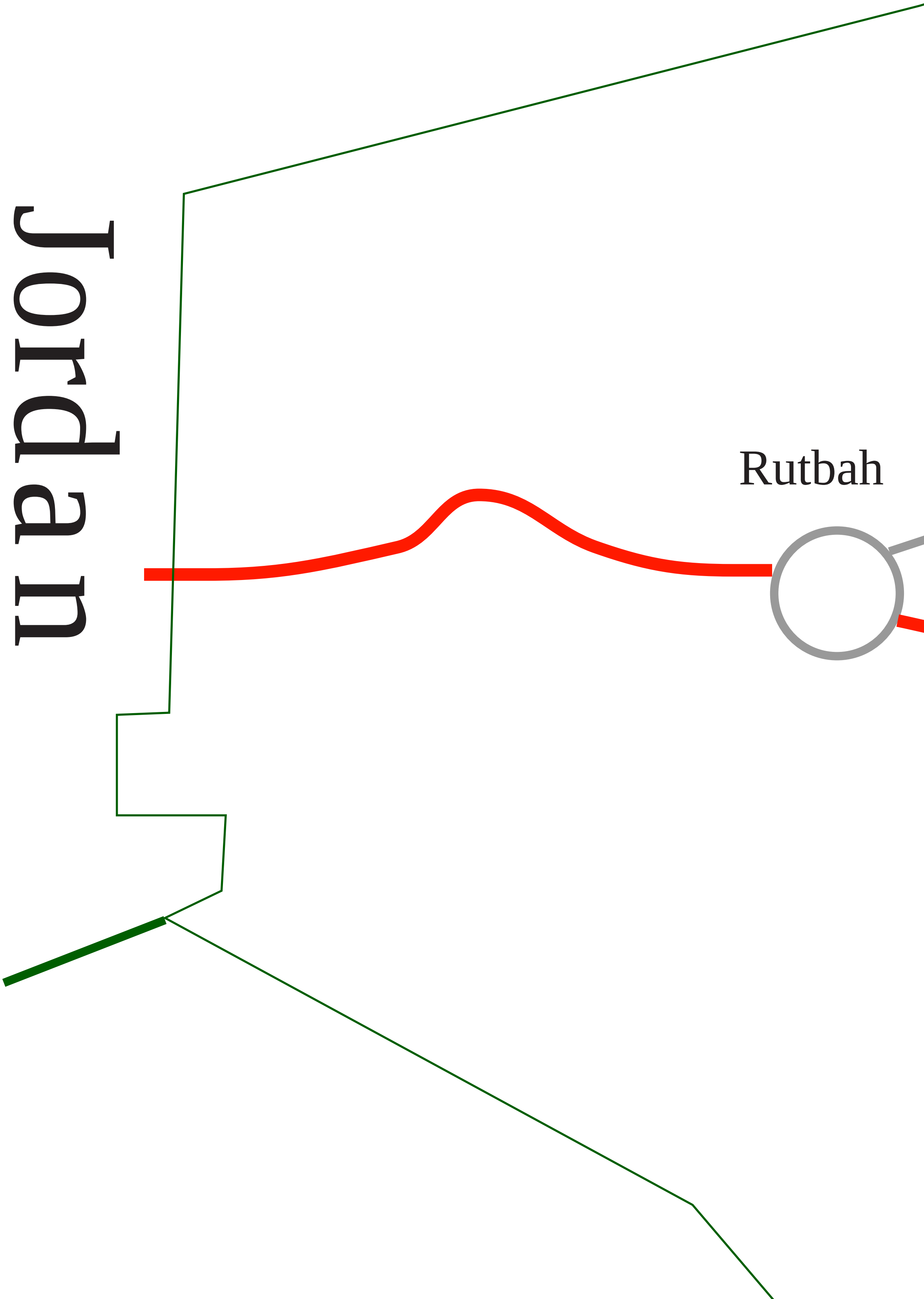
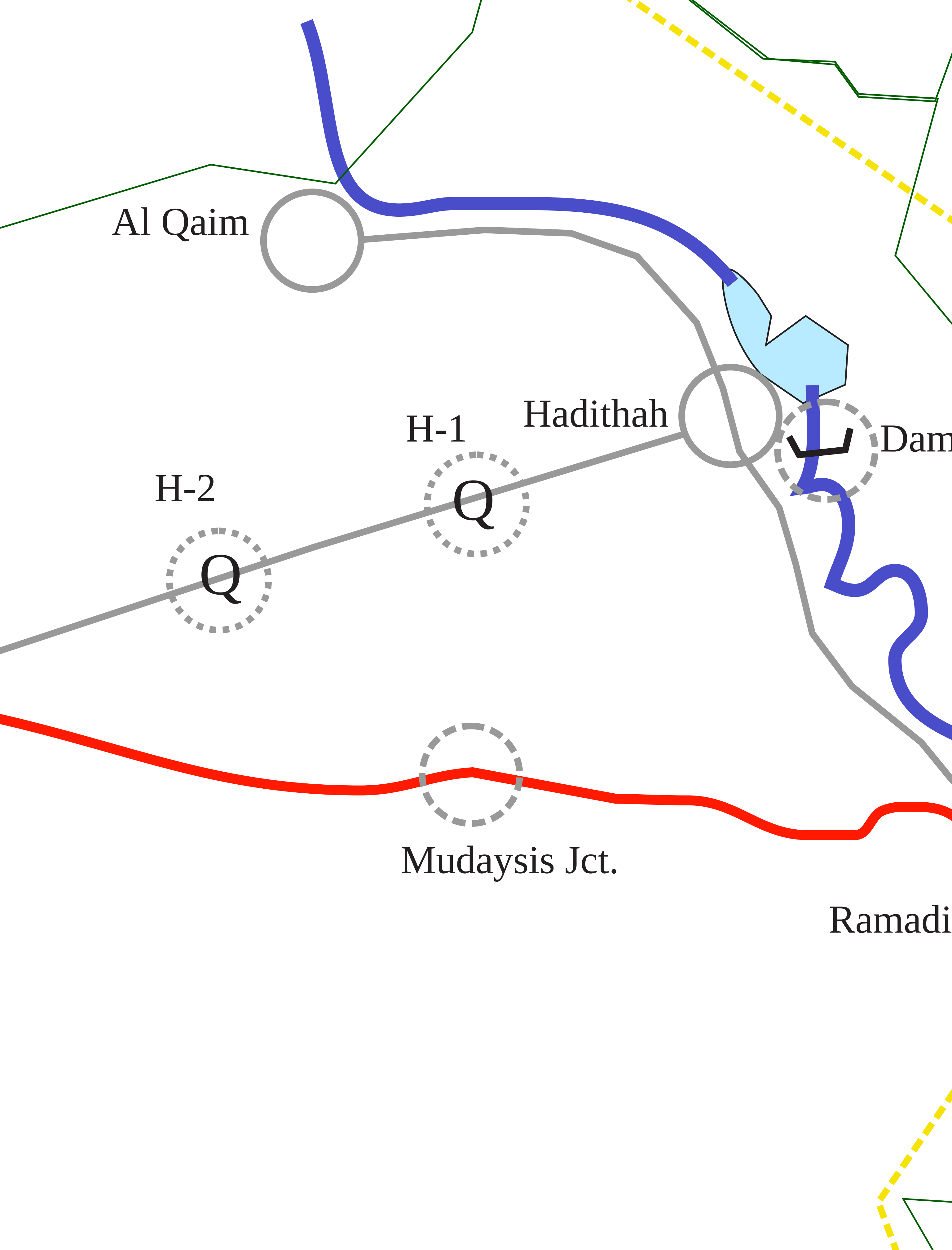
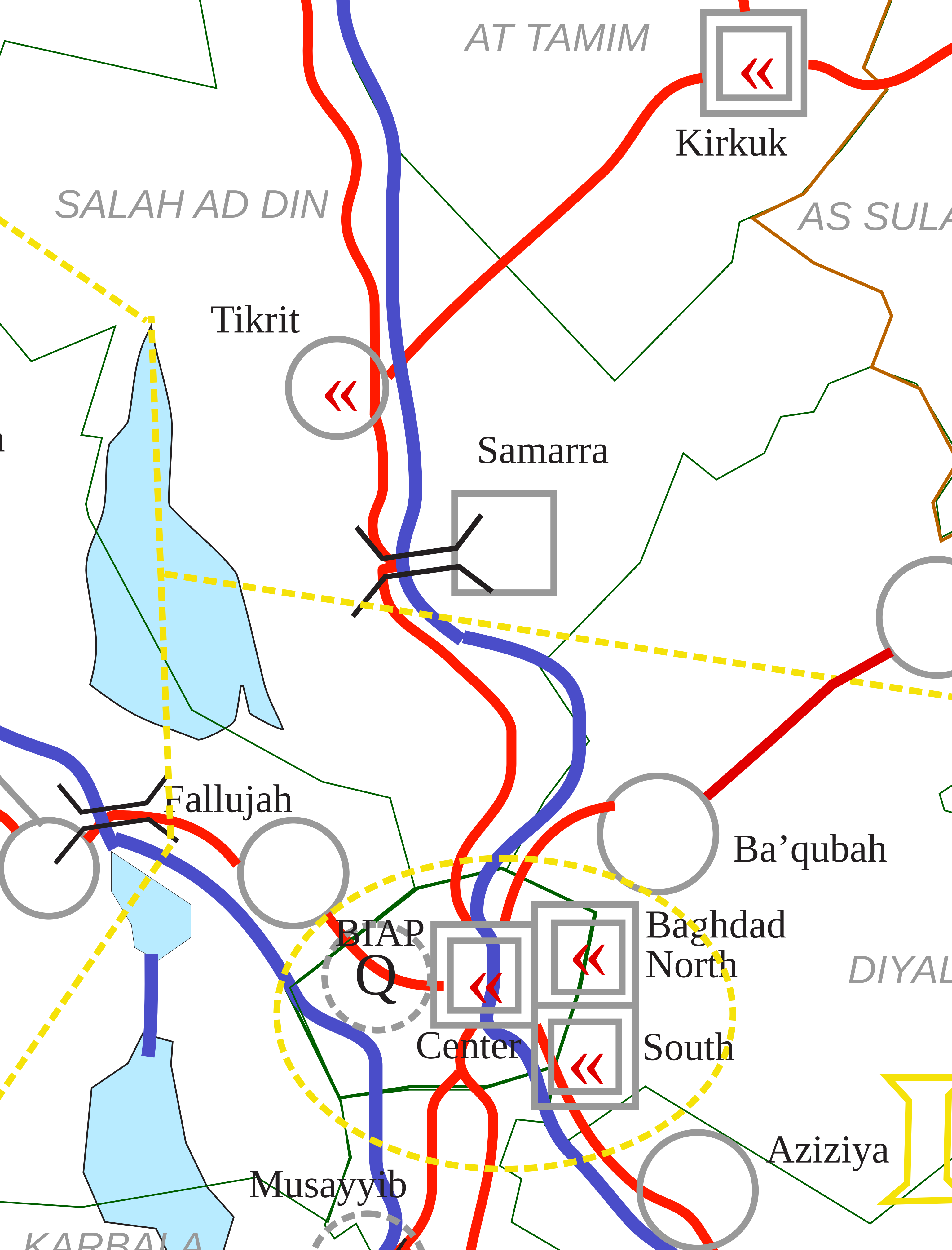
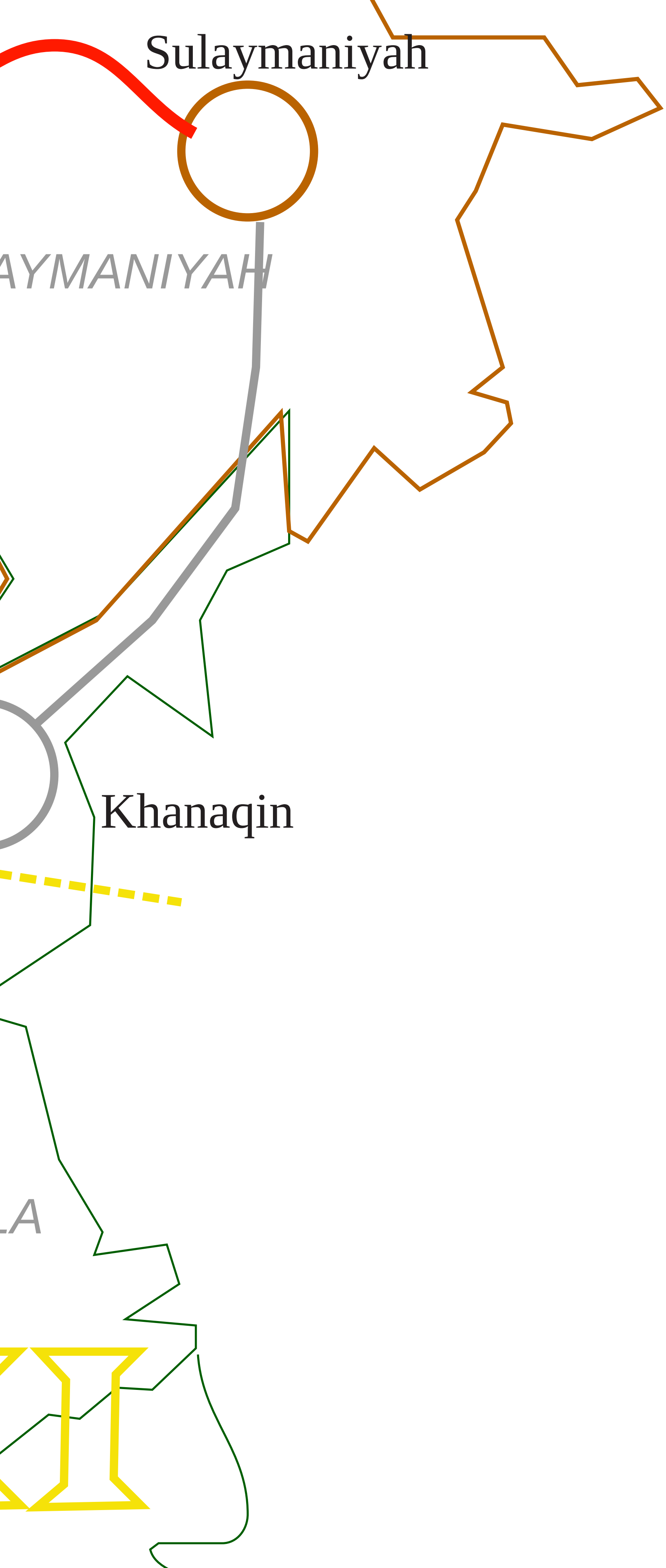
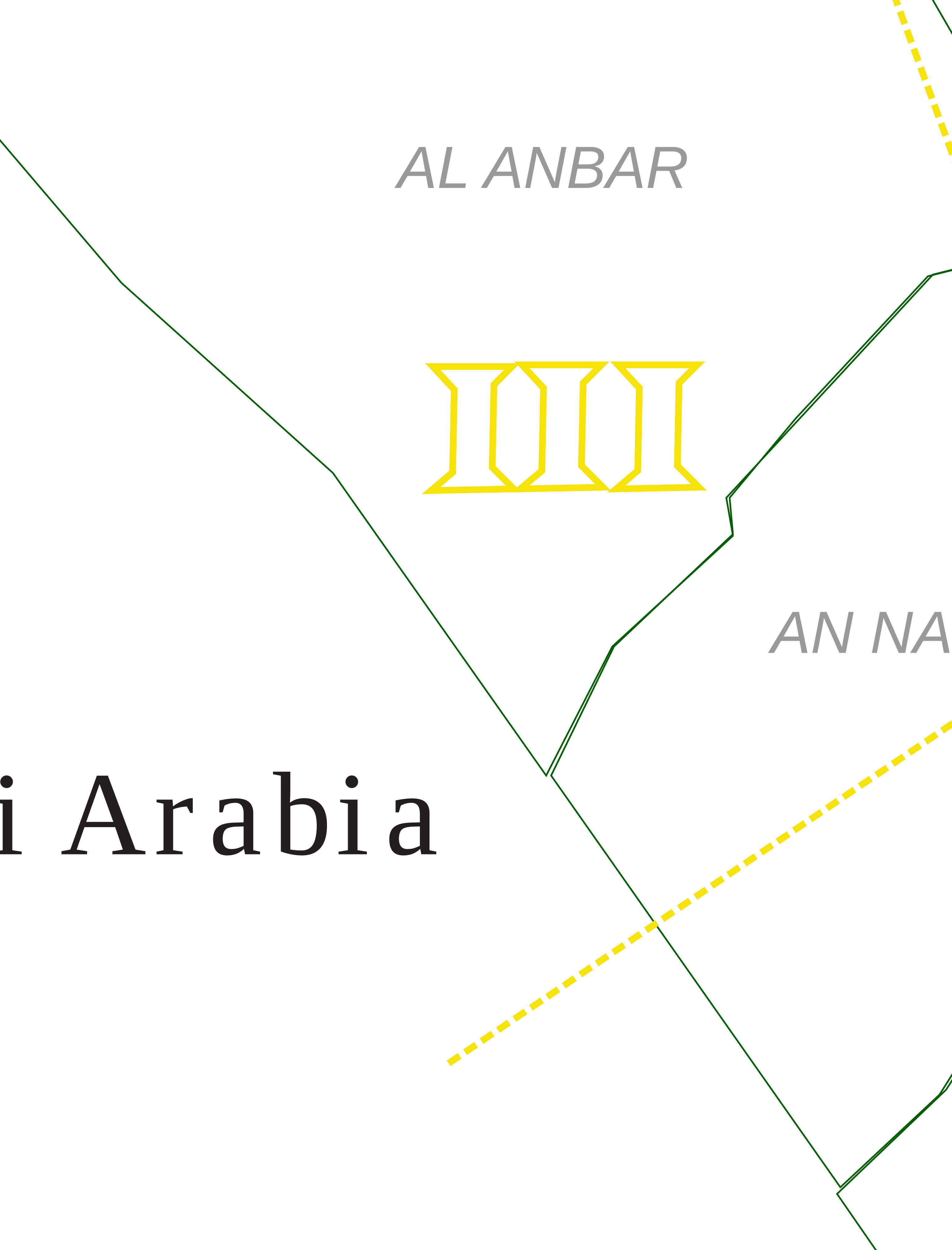

Jordan
Rutbah

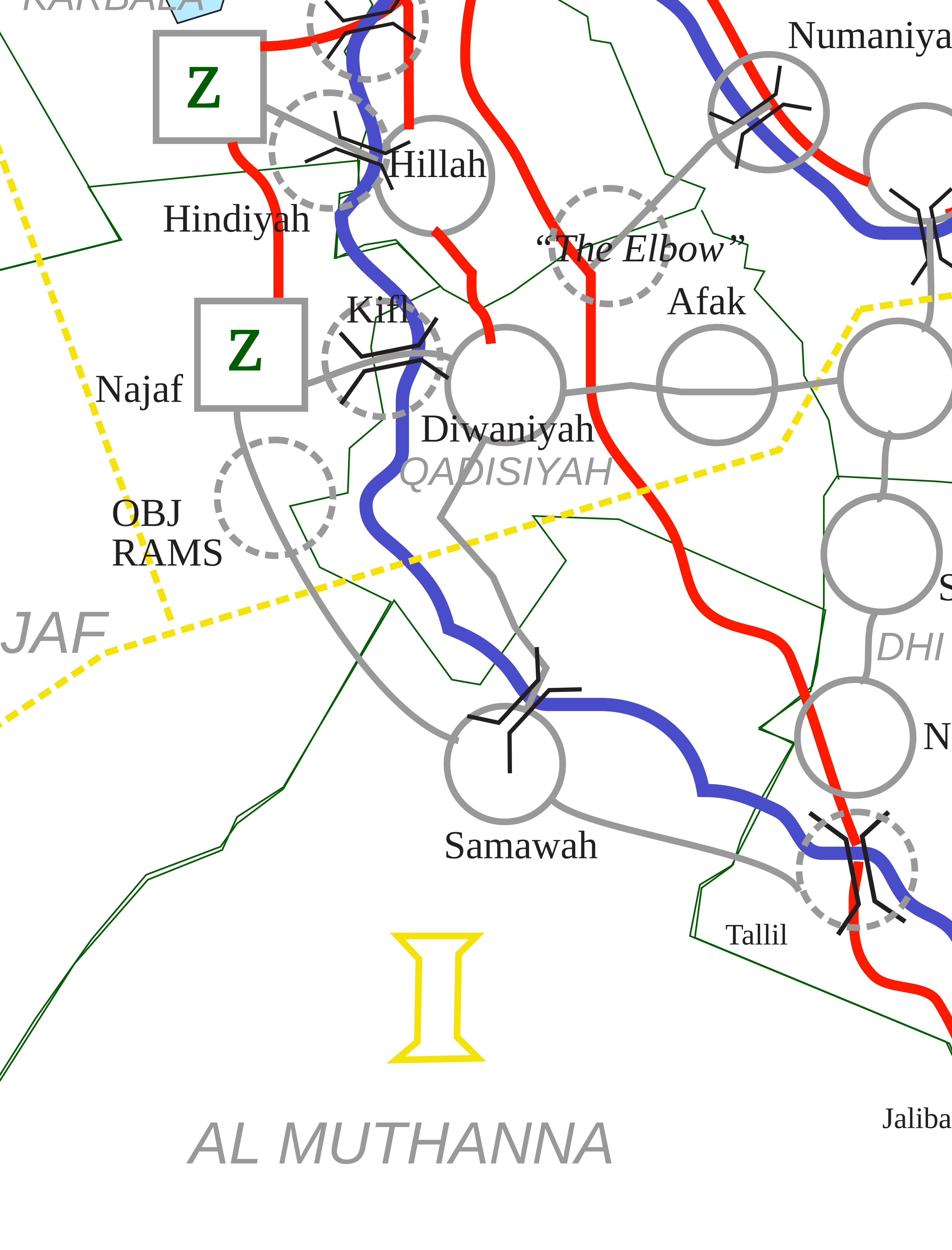

Al Qaim
Haditha
H-1
H-2
Q
Q
Dam
Mudaysis Jct.
Ramadi


AT TAMIM
Kirkuk
SALAH AD DIN
AS SULA
Tikrit
Samarra
Fallujah
Ba’qubah
BIAP
Q
Baghdad
North
Center
South
DIYAL
Aziziya
Musayyib
KARBALA

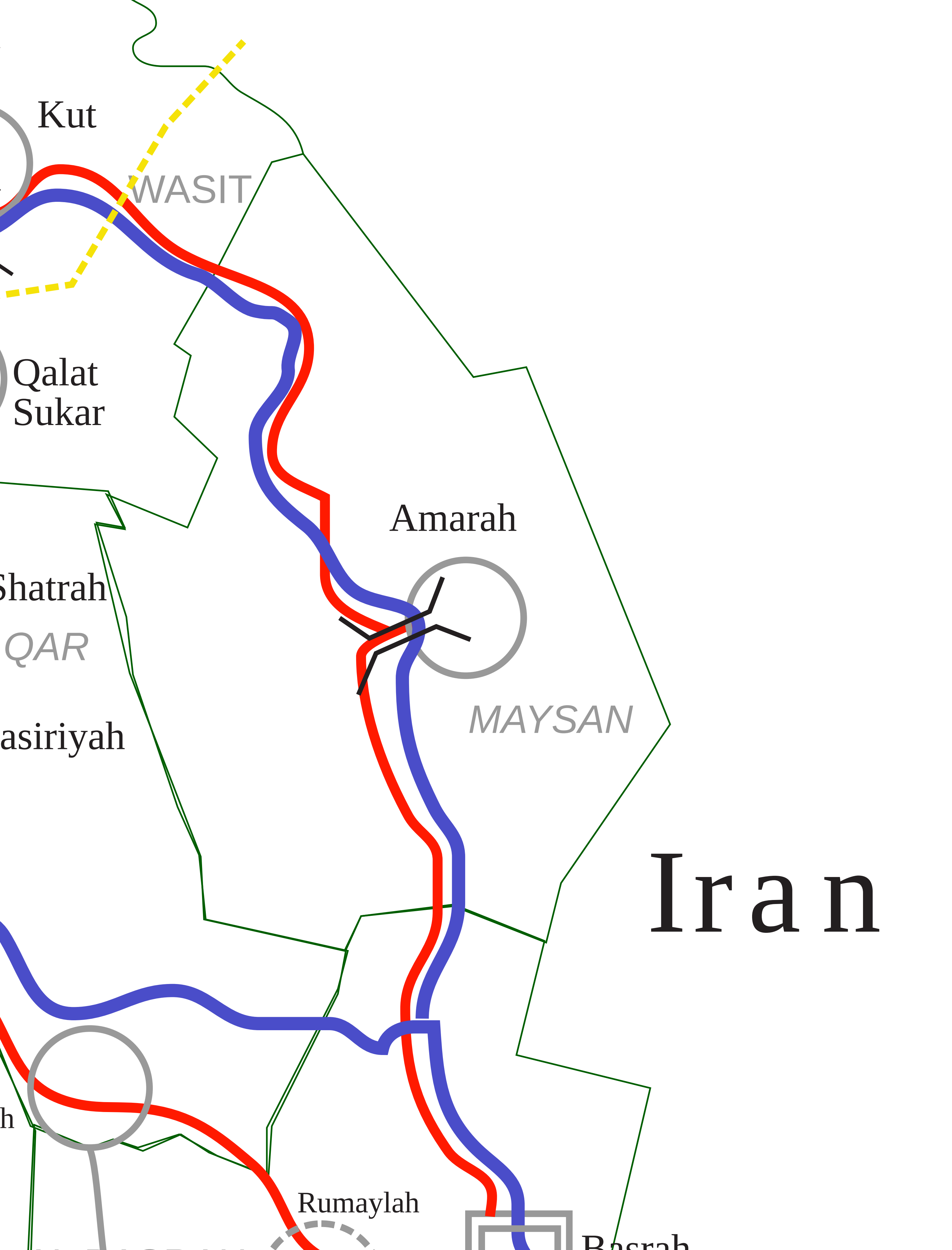

Sulaymaniyah
AYMANIYAH
Khanaqin
LA

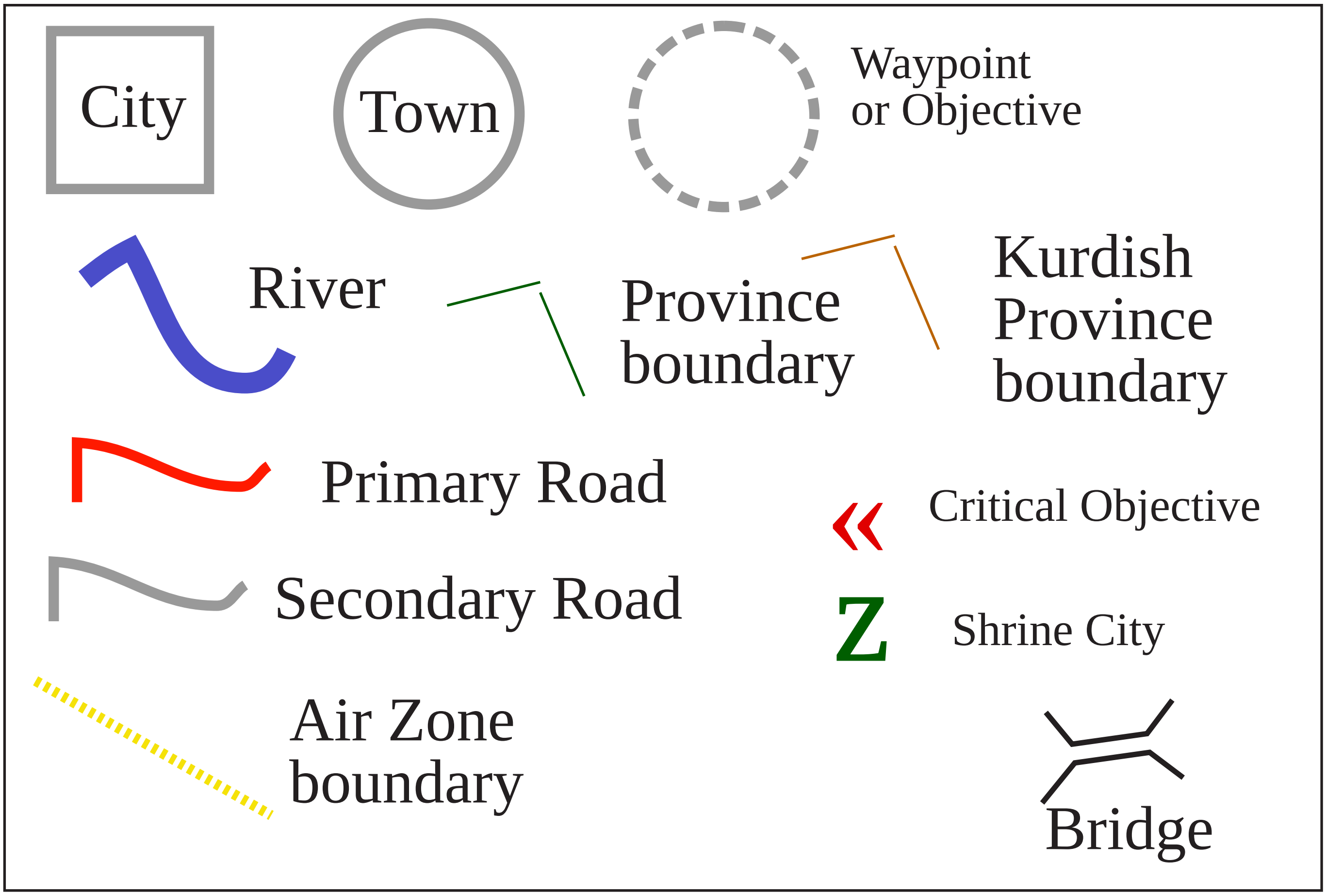
Saudi

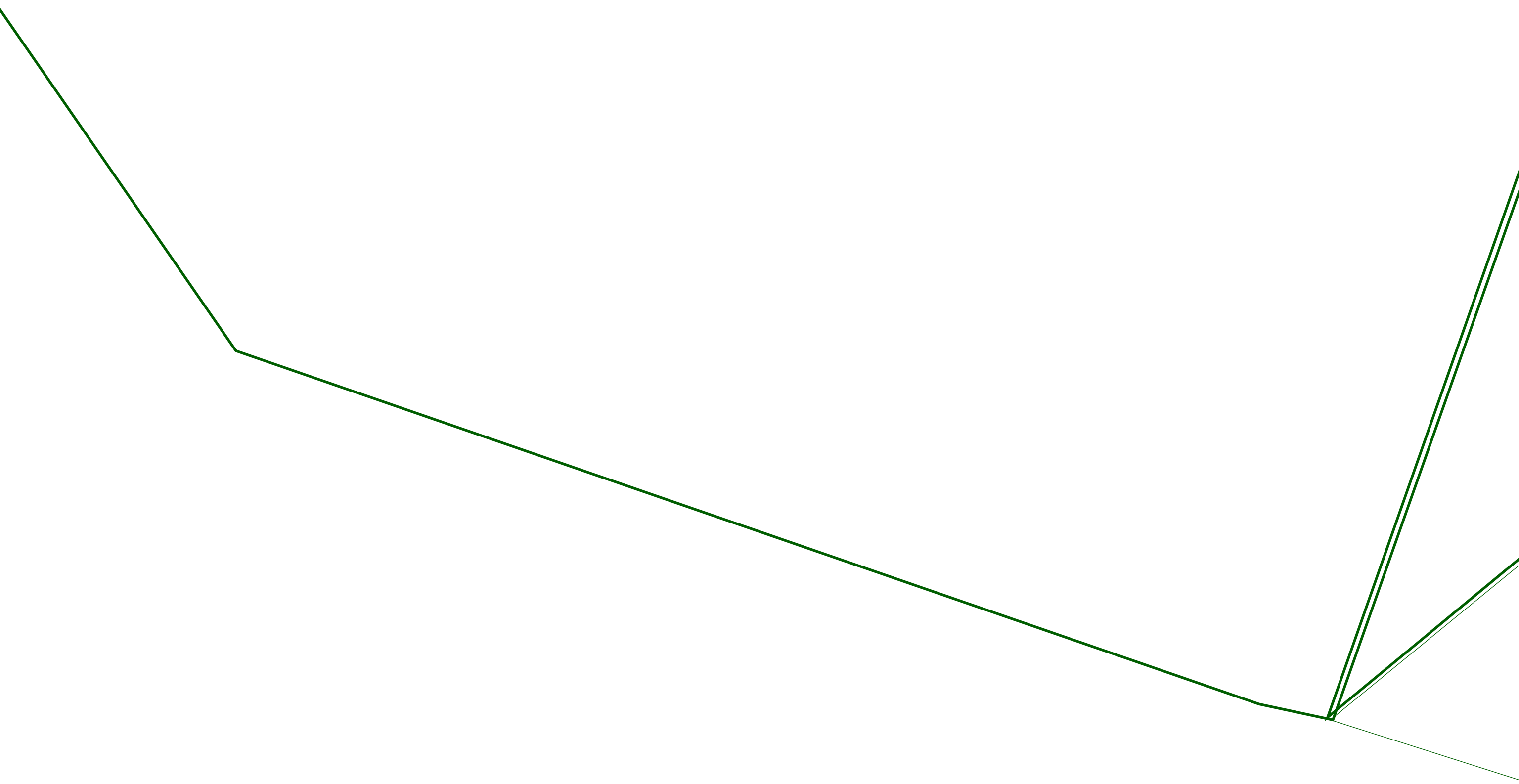

AL ANBAR
AN NA
i Arabia

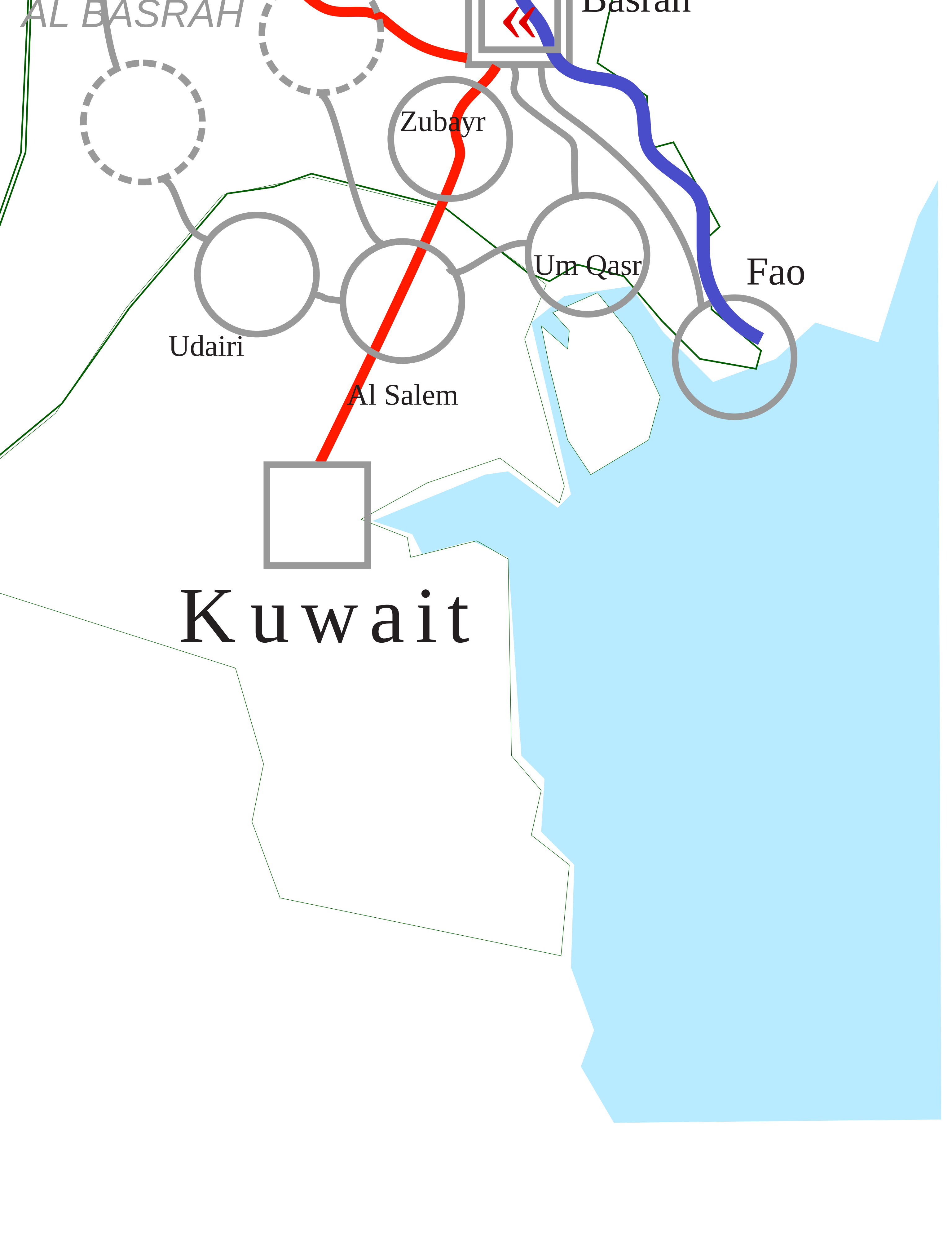


KARBALA
Numaniya
Z
Hillah
Hindiyah
"The Elbow"
Afak
Kifl
Z
Najaf
Diwaniyah
QADISIYAH
OBJ
RAMS
JAF
DHI
Samawah
N
S
Tallil
Jaliba
AL MUTHANNA


Kut
WASIT
Qalat
Sukar
Amarah
Shatrah
QAR
MAYSAN
asiriyah
Iran
h
Rumaylah
Basrah

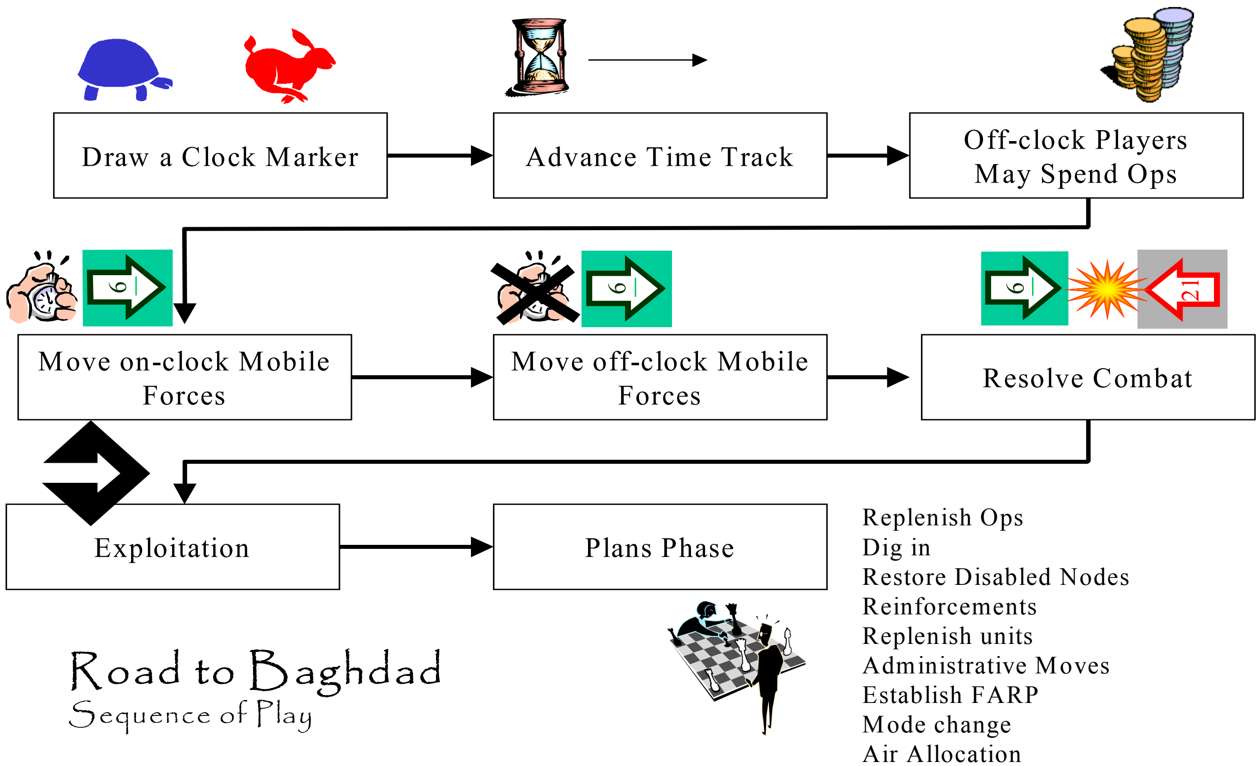

City
Town
Waypoint
or Objective
River
Province
boundary
Kurdish
Province
boundary
Primary Road
Critical Objective
Secondary Road
Shrine City
Air Zone
boundary
Bridge





AL BASRAH
Basrah
Zubayr
Udairi
Um Qasr
Fao
Al Salem
Kuwait

Unit	ID	Class	Strength	tag	endurance	Start Loc
3 MID 1st Bde	1/3	B	5	a	GGYR	Udairi
3 MID 2nd Bde	2/3	B	5	a	GGYR	Udairi
3 MID 3rd Bde	3/3	B	5	a	GGYR	Udairi
I MEF 1 RCT	Mar1	A	6	b	GGYR	Al Salem
I MEF 5 RCT	Mar5	A	6	b	GGYR	Al Salem
I MEF 7 RCT	Mar7	A	6	b	GGYR	Al Salem
I MEF TF Tarawa	M/Trw	A	6	b	GGYR	Al Salem
UK 7th Armour Bde	7Ar/UK	A	5	c	GYYR	Al Salem
UK 16th Aaslt Bde	16	A	4	c	GYYR	Al Salem
UK 3 Cdo Bde	3	A	4	c	GYYR	Fao
101 Abn 1st Bde	101/1	B	4	d	GYR	21-Mar
101 Abn 2nd Bde	101/2	B	4	d	GYR	21-Mar
101 Abn 3rd Bde	101/3	B	4	d	GYR	21-Mar
101 Abn Avn Bde	101	A	6	d	GR	21-Mar
82nd Abn 1 Bde	82/1	A	4	e	GGYR	26-Mar
11 Avn Bde	11 Av	A	6	f	GR	Kuwait
173 Abn Bde	173	B	4	g	GYR	26-Mar
"CSOTF"	SpecOp	A	•	s		off map
SOTF-N	SpecOp	A	•	s		off map
SOTF-W	SpecOp	A	•	s		off map
SOTF-S	SpecOp	A	•	s		off map
4 MID 1st Bde	4/1	A	6	h	GGYR	4-Apr
4 MID 2nd Bde	4/2	A	6	h	GGYR	4-Apr
4 MID 3rd Bde	4/3	A	6	h	GGYR	4-Apr
2nd Arm Cav Rgt (L)	2ACR	B	3	j	GYR	6-Apr
3rd Arm Cav Rgt	3ACR	B	4	j	GYYR	6-Apr
1 Kurdish "Bde"	1Kurd	C	3	k	GYR	Zakhu
2 Kurdish "Bde"	2Kurd	C	3	k	GYR	Arbil
3 Kurdish "Bde"	3Kurd	C	4	k	GYR	Sulaymaniya
4 Kurdish "Bde"	4Kurd	C	5	k	GYR	Sulaymaniya
Spec Rep Guard Div	SpRGd	C	4	r	GYR	Baghdad Center
Hammurabi RG Div	Hmrbi	C	3	r	GR	BIAP
Nebuchadnezar RG	Nbchzr	C	3	r	GR	Kirkuk
Medina RG Div	Medna	C	4	r	GYR	Baghdad South
Adnan RG Div	Adnn	C	3	r	GR	Tikrit
Alnida RG Div	Alnda	C	3	r	GR	Baghdad North
Bagdad RG Div	Bgdd	C	3	r	GR	Kut
2nd Inf Div	I/2	D	3	m	GR	Kirkuk
8th Inf Div	I/8	D	3	m	GR	Kirkuk
38th Inf Div	I/38	D	3	m	GR	Kirkuk
5th Mech Div	I/5M	D	4	m	GR	Kirkuk
3rd Arm Div	II/3A	D	4	n	GR	Ramadi


Draw a Clock Marker
Advance Time Track
Off-clock Players May Spend Ops
Move on-clock Mobile Forces
Move off-clock Mobile Forces
Resolve Combat
Exploitation
Plans Phase
Replenish Ops
Dig in
Restore Disabled Nodes
Reinforcements
Replenish units
Administrative Moves
Establish FARP
Mode change
Air Allocation
Road to Baghdad
Sequence of Play

Road to Baghdad

Su	M	Tu	W	Th	F	Sa
			Begin 19-Mar-03			

Air Tasking Track

Day 1	I	II	III	IV	B	S
Day 2	I	II	III	IV	B	S
Day 3	I	II	III	IV	B	S

Time Tracks

19-Mar-03	Wednesday	1
20-Mar-03	Thursday	
21-Mar-03	Friday	
22-Mar-03	Saturday	
23-Mar-03	Sunday	
24-Mar-03	Monday	
25-Mar-03	Tuesday	
26-Mar-03	Wednesday	2
27-Mar-03	Thursday	
28-Mar-03	Friday	
29-Mar-03	Saturday	
30-Mar-03	Sunday	
31-Mar-03	Monday	
1-Apr-03	Tuesday	
2-Apr-03	Wednesday	3
3-Apr-03	Thursday	
4-Apr-03	Friday	
5-Apr-03	Saturday	
6-Apr-03	Sunday	
7-Apr-03	Monday	
8-Apr-03	Tuesday	
9-Apr-03	Wednesday	4
10-Apr-03	Thursday	

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20

Coalition Force Holding Boxes

21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36
37	38	39	40

Iraqi Force Holding Boxes

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