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# Dominant Battlespace Knowledge

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# DBK WITH AUTONOMOUS WEAPONS

**Michael Soveriegn**

DBK alone is meaningless. Military relevance comes from the ability to hit what you can see. To do this it is necessary to analyze the synergy of DBK and a new class of autonomous weapons in a canonical scenario -- what might have occurred if Saddam Hussein's lunge in October 1994 had not stopped short of the Kuwait border. Although DBK can deter, the assumption in this case is that it did not; the issue is whether DBK mated to autonomous weapons can let the United States win in a timely manner, without major deployment or without having to buy new platforms. Autonomous weapons -- sensor-fuzed weapons (SFW), brilliant anti-tank submunition (BAT) and wide-area munitions (WAM) -- are those needing far less human guidance than earlier weapons and promising a high Pk if placed within range.

## Prior Studies

Most prior studies suggest that armored thrusts can be stopped from the air alone using autonomous weapons. Examples include RAND's "The New Calculus" and "The Use of Long-Range Bombers to Counter Armored Invasions" and similar studies by Jasper Welch, Major General, USAF (Ret). A more recent study by OSD (S&R) examines the kill rate from onhand U.S. forces (plus those that can arrive over the next few weeks) in a scenario similar to *Vigilant Warrior*; they concluded that despite high kill ratios, most of the vehicles would reach Kuwait. A McDonnell- Douglas study showed similar results but a lower kill rate. Recent studies by JCS and the Navy suggest that more than one kill per sortie can be obtained even from today's unguided cluster munitions (v. the .01 rate in the Gulf but that mixes all sorts of sorties together).

Recent work by Dr. Raymond Macedonia suggests that sensor- fuzed weapons (SFW) can generate powerful results if wide area mines are placed in attack corridors; attackers are forced to slow down for mine-clearing (and risk being hit from the air) or take large casualties from the mines themselves. Advanced WAMs could be used to help target more mines or guide SFWs. Commanders with DBK could deploy thin lines of WAMs and use the feedback to call in more SFW or ATACM-based WAMs -- even under bad visual conditions that might frustrate DBK.

## Study Parameters

The results of the study are predicated on a careful definition of DBK and a reasonable characterization of autonomous weapons.

DBK is the upper limit of what intelligence systems 10 years hence can be expected to do. It entails the precise location of enemy units and their general status, but not the status and location of each platform. The location of mobile units can be known intermittently but they do move over time. Not all this data will be known instantly by all units, nor is it equally available from difficult environments or in the face of countermeasures. There

would remain a gap between DBK and actual targeting that may require additional local information, man-in-the-loop, or very intelligent weapons with terminal guidance capability.

The benefits of DBK are that it:

- Removes uncertainty as to whether an attack is underway
- Gives the location, composition, and status of the attacking units
- Ensures sufficient knowledge on friendly units.

During the Gulf War, the United States came close to achieving DBK at the outset of the air war. This knowledge, however, took a long time to acquire and degraded as soon as air actions raised uncertainties about the results. While DBK was not achieved for the ground war, JSTARS helped provide a real-time ground picture for the first time.

DBK does not mean that all U.S. units would be in *continuous* possession of sufficient targeting information; *that* would require perfect C3, great mobility, and survivability. Direct-fire weapons, whether ground or air based, require more than DBK; they also need delicate and time-consuming reconnaissance, surveillance, targeting and maneuver actions, plus fast expenditure rates and therefore heavy logistics to produce sufficient kills.

First-generation PGMs (e.g., laser-guided bombs) reduced the logistics requirements of combat but still required precise target information; they also put the designator and the platform at risk. Autonomous weapons, though, can be targeted with less precise information and in some cases (e.g., stand-off delivery) do not even put the launch platform at risk. DBK is needed to generate taskings, but the timing of mission scheduling is no longer so critical because moving targets can be localized again.

## Autonomous Weapons

Autonomous weapons can select their own aimpoints and are available in quantity. Even though redundant kills reduce efficiency, overall kill rates can be high.

- **BAT** is a 20-kg, self-guided (acoustic and IR) antitank round with a large acquisition area that permits a high Pk even when launched from medium altitude or from stand-off (e.g., MLRS, ATACMS, Tomahawk, or JSOW). Now in early testing, it is expected to cost less than $100,000 per but is unlikely to appear in large numbers before 2000 absent a more relaxed procurement cycle.
- **SFW** is a smaller, self-guided IR hit-to-kill round with a smaller acquisition range designed for counter-battery applications, MLRS and ATACMS delivery, or low- and medium- altitude air drop. It is low-rate acquisition with a $20,000 price tag.

- **WAM** is a 16-kg mine capable of launch an SFW to about 100 meters. It can be remotely controlled; an improved version may be networked as a sensor field. It is designed for ground, artillery, or air delivery (an anti-helicopter variant is being developed). It is projected to emerge from engineering development in 1996 and cost $25,000 per.

Order of Battle

Using the Iraqi feint as a base, the following target set is assumed:

- 4,000 armored vehicles
- 200 high altitude SAM sites
- 100 C3 sites
- 20 long-range radar sites
- 20 airfields
- 200 SCUD support sites
- 80 infrastructure nodes

U.S. forces consist of:

- 30 aircraft (F-15 and F-16) on hand because of the continued Southern Watch operations.
- An aircraft carrier with 50 attack aircraft is nearby.
- 100 long-range bombers from CONUS and Diego Garcia armed with sensor-fuzed munitions dispersed from wind-adjusted tactical munitions dispensers (WATMDs).
- 18 Apache helicopters (with Hellfire) out of Kuwait.
- 24 A-10s (with Maverick, rockets, and 30mm) out of Kuwait.
- Two reinforced brigades (to implant WAM) supported by MLRS and ATACMS (with SFW) as well as tube artillery with laser-guided projectiles (includes Allied ground forces).
- Another 100 aircraft within 5 days.

Other assumptions include:

- Air superiority is not an issue except near Iraqi air defense units; it is assumed that air attacks are launched from medium altitude to keep attrition low.

- There is enough strategic warning to permit loading up on weapons (which are otherwise too sensitive to keep in the Middle East on a permanent basis).

- No countermeasures were factored in even though anything that is a great advantage for one side will become a potential target for the other. In practice, the instruments of DBK will be attacked, dispersion will be used to frustrate autonomous weapons, and information warfare will be used to introduce delay into the sensor-to-shooter cycle.

**TABLE 1. Various Weapons, Operational Load-Out, and Effective**

Mobility Kills per Sortie

| Number | Platform | Loadout | Kills/Sortie | Kills/Day |
|---|---|---|---|---|
| 10 | F/A-18 | 2 JSOW w/3 BAT each | 2(3) | 40 |
| 20 | F/A-18 | 2 JSOW w/6 SFW each | 3(6) | 120 |
| 10 | F/A-18 | 2 JSOW w/8 BAT each | 6(8) | 120 |
| 10 | F-14 | 2 JSOW w/3 BAT each | 2(3) | 40 |
| 20 | F-16 | 2 WCTMD w/32 SFW | 3(32) | 120 |
| 10 | F-15E | 2 WCTMD w/32 SFW | 8(32) | 160 |
| 20 | A-10 | Hfire & 2 Maverick | 4(16) | 160 |
| 50 | ATACMS | 12 BAT | 3(6) | 150 |
| 50 | ATACMS | 24 SFW | 4(12) | 200 |
| 100 | MLRS | 6 SFW | 1.5(3) | 150 |
| 10 | B-2 | 16 TMD w/40 SFW | 32(320) | 80 |
| 90 | B-1 | 16 WCTMD w/32 SFW | 25(256) | 562 |
| 100 | Tomahawk | 16 BAT | 4(8) | 400 |
| 18 | AH-64 | Hellfire | 4(16) | 216 |

Table 1 contains the various weapons, operational load-out, and effective *mobility* kills per sortie (assuming a Pk of 50 percent). Sortie rates over the first 10 days are three a day for helicopters, two a day for fixed- wing aircraft in theater, once every 2 days for

bombers out of Diego Garcia, once every 4 days for CONUS-based bombers. Launch rates for ATACMS and MLRS are 200 a day total. The figure in parenthesis is nominal kills per sortie, the difference reflecting wastage due to multiple submunitions targeted on an aimpoint. See the appendix for a more detailed discussion of the difference.

The basic results, shown in the right-most column, indicate that a modestly size air attack force, if not otherwise diverted, could kill half the targets (2618) in the first day of combat. These rates (four kills per sortie, 2,600 per day) far exceed rates from *Desert Shield* thanks to DBK, autonomous weapons, and the fact that armor, when it moves, is out in the open. No kills were calculated for WAM but they play a large role in slowing down the attack so that sufficient attrition can be effected before Kuwait (and thus cover) is reached.

## Implications and Limitations

Implications fall into five areas: DBK itself, munitions, C3/training, geo-location, and survivability.

*DBK*: Even if major military formations can be located, they cannot necessarily be targeted. Environmental constraints, sensor revisit time, the complexity of processing and fusion, and simple task overloading can result in significant delays before C3 systems get their information. Many sorties will be working with out-of-date information on mobile units. Even autonomous weapons require a degree of target localization that delays deny them. The status of targets is also hard to assess. Battle damage assessment was difficult in the Gulf War. The ability to fuze videotapes from guns, and laser-guided bombs should increase our ability to know what these weapons do, but autonomous weapons present new difficulties (no one is necessarily looking). If battle damage assessment is bad, autonomous weapons will not work as well. WAMs used to see which vehicles are moving may help BDA.

*Autonomous Weapons*: Although good munitions made the scenario work, the U.S. military traditionally holds off on buying high-end munitions preferring to wait until they get better or cheaper. This strategy may work for long wars but not short ones. This scenario needs between 10 and 20 thousand autonomous weapons to work. Delivery systems will cost more if they have to be stand- off (e.g., Tomahawk JSOW), but even so, they remain cheaper than new launch platforms.

*C3 and Training*: Sensor-to-shooter delays degrade DBK (a motivation for the other side's IW efforts). DBK is also degraded if tactical development and training do not keep up with new systems. Joint training and exercises are implied because of the global nature of DBK and the mix of forces that must be on scene to carry out this scenario.

*Geo-Location*: The conversion of DBK to targeting requires platforms be aware of their own location, speed, and acceleration in three dimensions. Thus the vulnerability of GPS matters.

*Survivability*: Attack forces, DBK equipments, and their supporting C3 infrastructure all must survive enemy attack to make the scenario work. The small U.S. forces could be suppressed, attacked, or diverted (e.g., to SCUD hunts) by unexpected enemy capabilities. Often a stand-down is necessary to fix problems.

## Appendix

Although the number of weapons on an aircraft is subject to physical limits (weight, attach points, etc.), maximum payloads are rarely achieved because of the tradeoff of weapons for fuel, inventory limits, and the possibility of having to drop a load for tactical reasons. The number of BAT submunitions, for example, is limited by the desire for flexibility depending, the model of aircraft, internal versus external carriage, and other factors.

A more careful analysis would consider the geometry of attack and the target set. Delivery means also matter -- e.g., whether a standoff launch can be achieved that surprises the enemy and therefore precludes the dispersion of targets. But tactics are hard to anticipate for any scenario.

The translation between nominal and effective kills per sortie must take many factors into account:

- The delivery of sensor-fuzed weapons from tactical munitions dispensers from medium altitude will probably waste most sub- munitions; they are unlikely to make contact unless targets are parked close together.

- BATs have a greater acquisition rate than SFWs, and their search behaviors can be adjusted; thus their kill rate is higher

- A night-flying B-2 can drop the same tactical munition dispenser of SFWs with many kills because its radar target mapping is accurate; with short warning time, targets are not likely to be dispersed.

- Stand off-weapons such as the SLAM (a Harpoon variant) and JSOW will provide a low wastage rate because they carry small numbers of sub-munitions and are individually targeted from so far off that they will result in similar surprise.

- TMDs and Tomahawks carry large numbers of sub-munitions are inherently subject to wastage rates as high as 90 percent if the submunition has a small acquisition area (e.g., SFW). With several minutes of free fall time, they are affected by wind and are therefore inaccurate. Wind-corrected TMD can be accurate from higher up if the target location is well known at launch time. Their guidance works off GPS and would best served fixed targets and those identified by radar target mapping.

- JDAM is a GPS-guided weapon comparable in punch to the Mk-82 series of bombs. When dropped from high altitudes, it can achieve surprise, but moving

targets may depart from their original location in the meantime (unless the bomb is updated in flight). Thus JDAMs are likely to be used against fixed targets (except from B-2s which can fly low at night). Both JDAM and WCTMDs can carpet bomb an area.

- MLRS and ATACMS can operate with low wastage of SFW against up-to-date locations of concentrated but surprised forces or against fixed targets. But under current conditions they would have a high wastage against moving armored columns.

# About the Authors

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# Dominant Battlespace Knowledge

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**A popular Government, without popular information or the means of acquiring it, is but a Prologue to a Farce or a Tragedy; or perhaps both. Knowledge will forever govern ignorance; And a people who mean to be their own Governors, must arm themselves with the power which knowledge gives.**

**JAMES MADISON to W. T. BARRY**

**August 4, 1822**

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