

APPLICATION OF AIRPOWER IN URBAN WARFARE

BY MAJ KWAN KUM WAH

INTRODUCTION

Since the end of the Cold War, military forces in the world have been involved in a number of operations (peacekeeping, humanitarian relief, and non-combatant evacuations) that have taken place in urban settings. Peace operations in Somalia, what started as a humanitarian mission degraded into urban guerrilla warfare, especially the deaths of 18 U.S. servicemen and the wounding of almost 100 others on October 3, 1993, profoundly influenced the American public's perceptions of modern urban combat in the developing world. Besides the US, other countries like Russian military operations in urban areas of Chechnya (with focus on the fighting in Grozny) between 1994 and 1996, Israeli experiences operating in urbanized southern Lebanon during Operation Peace for Galilee in 1982, and British military experiences in Northern Ireland from 1969 to 1996, with special emphasis on the period 1969 to 1976 when the British Army had the lead in security operations, found themselves involved in this setting. While given the technological advancement in the information age, many felt that fighting in urban environment may require unique operational aspect, training, clear ROEs and some key technologies that can help resolve unknowns unknowns to knowns unknowns. To illustrate better, Somalia also was a painful reminder that the technological and operational dominance the United States experienced on the conventional battlefield during Desert Storm did not necessarily carry over into urban peacekeeping. For infantrymen in particular, the fierce fighting of "Bloody Sunday"—the most intense light infantry engagements since the Vietnam War—brought home the relevance of urban combat, its nastiness, and the need to develop concepts and tactics better suited to this

unique environment. So how much can airpower influence the future urban battlespace given her unique characteristic of speed, range, lethality, ubiquity and now persistency?

Traditionally mainly ground forces have prosecuted urban operations, but I believe that airpower can potentially play a decisive. Airpower's potential is significant and in understanding this, first we must examine why the consideration of urban warfare is so important. We must examine the nature and characteristic of the urban environment to ascertain what characteristics drive airpower to be the key component. It also aims to highlight how urban terrain restricts ground mobility and employment of ground forces at the tactical level. Such analysis will lead us to contemplate why airpower is not being employed besides Close Air Support (CAS)? Finally using some of Israeli operations in Lebanon, I will draw the necessary key features of airpower to substantiate why airpower can play a decisive role in the successful prosecution of urban warfare.

WHY URBAN OPERATIONS?

If urban operations are so costly and complicated then why fight in this environment? In the SAF context, Fighting in the Buildup Area (FIBUA) is the only doctrinal guide for operations in the urban terrain. This may lead us to believe that urban warfare should be avoided when possible. We acknowledge the fact that it is a risky, time consuming and costly affairs. So then why is the Army focusing so much on urban warfare? The answer lies in unprecedented demographic changes in the strategic environment due to population growth and urbanization around Asia.

URBANIZATION TRENDS

Of the many profound changes which have swept Asia during the last half-century none have been so profound and far-reaching as the doubling of the proportion of population living in urban areas. In 1950, 231 million Asians lived in urban areas and by 2000 they had increased five times to 1.22 billion while their proportions of the total population increased from 17.1 to 34.9 percent (United Nations 2001a). Moreover, in the next two decades Asia will pass the threshold of having more than half their population living in urban areas (United Nations 2002 – Table 1). By the year 2030, three-fifths of the Asia's population--five billion people--will live in urban areas.

Source: United Nations 2002

	1950			2000			2030	
	No. (⁰⁰⁰)	%	% Growth 1950-2000	No. (⁰⁰⁰)	%	% Growth 1950-2030	No. (⁰⁰⁰)	%
China	69,528	12.5	556.3	456,340	35.8	93.6	883,421	59.5
India	61,695	17.3	352.3	279,045	27.7	106.3	575,684	40.9
Indonesia	9,863	12.4	781.5	86,943	41.0	107.1	180,019	63.7
Pakistan	6,949	17.5	572.9	46,757	33.1	184.9	133,226	48.9
Bangladesh	1,774	4.2	1,836.5	34,354	25.0	186.9	98,554	44.3
Japan	42,065	50.3	137.9	100,089	78.8	2.7	102,819	84.8

Table 1 shows Asia largest countries: Urban population, number and percentage estimate, 1950, 2000 and projections, 2030.

As the statistics have shown in Table 1, growing trends of over population and urbanization in Asia, may potentially lead to greater discrepancies in moral, religion or

racial harmony that eventually turn into insurgent attacks or terrorism. In this case, drawing military into the urban environment.

STRATEGIC VALUE

Another reason why city continues to be of strategic values to politician is that history has demonstrated the fall of any major cities in war has typically been associated with final defeat. Thus, it is no surprise that battles for cities have been central to both civil and international conflicts from the Peloponnesian War to Bosnia. They also have been very common: Urban battles number in the thousands.¹ Progress in wars has often been measured with respect to these cities. For example, during World War II (WWII), U.S. newspapers and newsreels routinely ran headlines such as “Allies Capture Caen” or “Allies 30 miles from Paris.” Although rivers and national borders were also used as milestones, both national leaders and the public as the true measure of success viewed the capture of key cities. In short, unlike any other terrain feature on a map, cities have symbolic and practical significance. Due to this power-centric nature of cities, it will likely the main target for any offences, like most of US military interventions have often focused on them, including Mazar-i-Sharif, Afghanistan; Panama City, Panama; Port-au-Prince, Haiti; and Kuwait City.² As the culturally symbolic centers of economic and political power grow in size, number, and strategic importance, so will they more likely

¹ A short list of twentieth-century urban battles includes Madrid (1936–1937), Stalingrad (1942), Bastogne (1944), Caen (1944), Berlin (1945), Manila (1945), Seoul (1950), Budapest (1956), Algiers (1957), Prague (1968), Hue (1968), Saigon (1968 and 1975), Jerusalem (1948 and 1967), Port Suez (1973), Khorramshar (1980), Beirut (1982), Panama City (1989), Kabul (1989–1991), Khafji (1991), Mogadishu (1993), and Grozny.

be embroiled in accompanying urban fighting?

CHARACTERISTICS OF URBAN ENVIRONMENT AND IT'S OPERATIONAL IMPACT TO GROUND OPERATIONS

“Know the Weather, Know the Terrain, and Your Victories Will be Limitless”

*Sun Zi, Terrain.*³

As advised by Sun Zi, weather and terrain affects both the adversary and yourself. In this case the terrain is fixed and weather can be deliberated to a certain extent (choosing the right time to attack). So the terrain favors those who understand it well. Those who can capitalize on this knowledge tends to gain the advantage. For example, in Chechnya where the Chechen rebels was fighting against the Russians. Although the Russians outnumbered them by at least 2:1 in terms of soldiers, weapons, experience and technological advancement, but yet the Russian lost the battle because the Chechen was able to use the terrain to their advantage. Following a quote from a Chechen fighter in Grozny, Ramzan Maltsegov, “We were very happy they [Russian] came into the city, because we cannot fight them in the open”.⁴ Maltsegov fully understood that in urban terrain, the defender has a much better opportunity to dictate the fight by creating an environment of chaos and disarray for the attackers on ground. The effects of chaos can

² Dr. Daniel Marston, *“Force Structure for High-and Low-Intensity Warfare: The Anglo-American Experience and Lessons for the Future”*, [Online] Available http://www.cia.gov/nic/PDF_GIF_2020_Support/2004_05_25_papers/force_structure.doc, 13 Apr 2005

³ Prof Wee Chou-How Op. Cit. pg 304, Chap10, Line 10.57.

⁴ MAJ Charles A Preysler, *Going Down Town: The Need for Precision MOUT* (Fort Leavenworth, Kans.:School of Advanced Military Studies, US Army Command and General Staff College, 1995), pg 14.

be achieved in terms of attrition, delay, discrimination between combatants versus non-combatants, proportionality of weapons effects and negative media coverage.⁵

The urban environment consist of three main characteristics namely physical terrain, population density and man-made structures. In order to capitalize the urban terrain, we need to have a better understanding of these characteristics and the associated complications faced by our ground forces in urban battle.

PHYSICAL TERRAIN

Urban terrain can be divided into four major dimensions. Airspace and surface areas make up the natural environment of urban area. In addition, urban areas consist of man-made super-surface and sub-surface areas (Figure 1). This categorization of urban terrain is necessary so as to allow a better understanding of the effects aimed at the attacking ground forces.

⁵ Ibid.

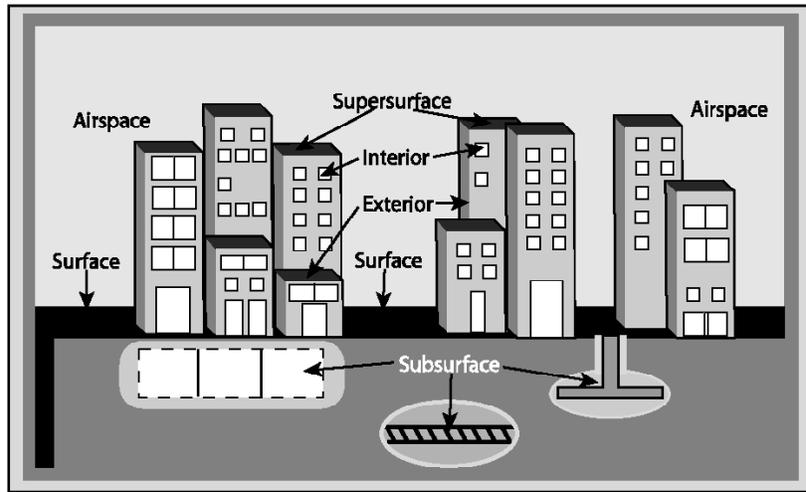


Figure 1. Urban Terrain

Airspace Above Surface

Aircraft or employment of aerial munitions will use this area above surface. However, as a defender, the aim is to deny attackers from using this dimension by setting up a point defense. Attackers aircraft will be vulnerable to portable surface-to-air missile systems and anti-aircraft guns.

Land Surface Dimension

The second dimension consists of roads, alleys, fields, and parks and any other exterior features of the cities, which influence mobility. The defenders may set bobby-traps, changing street signs to confuse attackers, re-routing traffic, set up mines to cause disruption and other trip lines that will greatly influence ground movement. For example in Grozny, the Russians amour convoy was lost after separated from the supporting

infantry, which became an easy target for the Chechen irregulars armed with anti-tank guided missile (ATGM) and rocket-propelled grenades (RPG).⁶

Super-Surface Dimension

This dimension consists of rooftops and upper floors of buildings, towers or other structures that provide a vantage point for the defender. By occupying this area, the defender has the advantage of high ground where he can deploy snipers, early warning and tactical advantage. This high point also restricts attackers usage of their superior weapons such as tanks may not be able to target high rooftop, artillery may not be able to perform their function due to the high tilt angle requirements.

Sub-Surface Dimension

Lastly the forth dimension is sub-surface, this dimension is often than not addressed as it is the most difficult task to handle. It consists of sewers, under-ground subways and tunnels. Adversaries may use this dimension to escape or re-supply their troops without exposing themselves. So to control this dimension requires an in-depth understanding of the under-ground system together with the blueprints of buildings around the area of operations. This is one area where airpower has limited influence due to accessibility.

⁶ Alan Vick, John Stillion, David R. Frelinger, Joel S. Kvitky, Benjamin S. Lambeth, Jeff Marquis, Matthew C. Waxman, *"Aerospace Operations in Urban Environments: Exploring New Concepts"*, RAND Publication 2000, MR1187 Chap 2, pg. 31.

POPULATION DENSITY

The density of non-combatants further complicates the urban environment and has its own demographic characteristics, such as ethnicity, race, daily movements in and around the city, and a host of other considerations tied to the nature and behavior of the populace. History has shown that local populace backing the defenders will complicate the attackers in mainly in many ways, mainly identification and collateral damage.

The ability to positively identify the threats when the local populace is willing to support their operations is inherently very complicated. Somalia is a good example of what started initially as humanitarian operations quickly turned into urban battle. Rebels who shot down the helicopters were not easily identifiable and thus caused a major impact on the rescue mission.

While the undesirable effect of collateral damage restricts the choice of weapon. Generally, heavier weaponry that supports urban operations can be counterproductive because any attempts to hit targets in a city creates collateral damage over a wide area surrounding the target. Collateral damage will like reduces accessibility, visibility and recognition by blocking roads as well as by creating infantry position among the rubble.

MAN-MADE STRUCTURES

Urban areas will contain varying degree of physical infrastructure. This infrastructure will consist of buildings in varying size and height, networks hospitals and schools. The density of these structures will restrict mobility and visibility. Historically, when ground forces enter cities, the streets and buildings, the insufficient space often restricts their deployment and maneuver as a large unit. The traditionally platoon, company size may not be relevant and thus forcing these smaller units to operate autonomously. The consequence of this fragmentation is loss of command and control (C²) by commanders. The resultant of this is the loss of combat effectiveness as unit and higher probability of fratricide.

Another fundamental feature of the urban environment is that buildings limits line of sight. The consequence of this is the reduction of surface weaponry effective ranges. These ranges may be too short to safely operate any heavier weaponry and thus confining the combat to just hand-held or hand thrown infantry weapons. This may also invalidate the use of traditional fire support system such as the artillery and armor. Another phenomenon of line of sight is the reduction in communication capability. Most GPS tracker or mobile phones may not work effectively inside buildings and thus favor combatant using ambush technique.

The density of the buildings will also promote close-in combat that is not desirable to all ground forces. When this happens the consequence is the expectation of higher casualty rates. For a country like Singapore that mainly consist of mainly conscript army, this

high casualty rate may not render public support during high period of tension (POT) or during troubled peace.

Lastly due to most buildings are build with thick walls, it may require penetrating weapons which minimum explosive content to prevent excessive rumble. This may not be available to the smaller ground forces.

A summary of how the characteristic of urban environment can affect ground operations (Figure 3).

Dimension	Characteristic	Significance to Ground Forces
<ul style="list-style-type: none"> • Physical Terrain <ul style="list-style-type: none"> – Airspace – Surface – Super-surface – Sub-surface 	<ul style="list-style-type: none"> • Airspace • Roads, alleys • Rooftops, upper floors of buildings, towers, vantage points • Sewers, underground subways 	<ul style="list-style-type: none"> • Deny freedom of movement and mobility • Offer defender vantage point (high ground) • Freedom in Vehicular movement • Use for re-supply or route of escape
<ul style="list-style-type: none"> • Population Density 	<ul style="list-style-type: none"> • Demographic characteristic • Ethnicity • Race • Religion • Daily movements 	<ul style="list-style-type: none"> • Sanctuary for rebels to hide or stock weapons • Deny / complicate positive identifications • May cause high collateral damages • Restricts choice of weapons • Reduce visibility • High civilian casualty
<ul style="list-style-type: none"> • Man-made Structures 	<ul style="list-style-type: none"> • Buildings • Networks • Hospitals • Schools • Religious buildings 	<ul style="list-style-type: none"> • High casualty rate • Force large units to split into smaller operating groups • Loss or reduction in command and control • Loss of combat effectiveness • Promotes close-in combat • Questions traditional fire-support systems • Reduce line-of sight communications • Require penetrating weaponry to penetrate building thick walls

Figure 3.

The above table highlighted some very critical issues that threaten the employment of ground forces. Of significant is the employment of smaller operating group, they possess limited fire-support and can be easily cut-off or annihilated by the enemy forces. Firepower is also limited to hand-held which invites close-in combat. Leadership and C² are driven to the lowest level, making operational coordination difficult. There is a potential the ground forces will suffer high casualty rates amongst the civilians and own forces thus creating an unfavorable condition to rally public or political support. Accumulation of these disadvantages questions the employment of ground forces in the urban environment.

WHY AIRPOWER IS THE CHOICE OF WEAPON?

So why is airpower not chosen as the weapon of choice? In my view, airpower is the instrument of choice. Airpower can be domineering in 3 out of the 4 dimensions, airspace above, land surface and super-surface while airpower is unlikely to be used in the sub-surface dimension. In the dimension of airspace, airpower can provide wide area surveillance, uninterrupted C² and near to real-time targeting similar to Time Sensitive Targeting for fleeting target like snipers or ambush. Correspondingly, for land-surface dimension, airpower is able to enforce a “sanitized” area where no external resupply can take place. Importantly, airpower can provide continuous surveillance where data can be used for trend analysis. This analysis will subsequently provide information / intelligence to commander for better decision-making. Lastly, airpower can deny the use of super-surface by performing TST.

As for reducing combat casualty, airpower with her lethality and range, can significantly contribute in this area. Targeting is no longer restricted to only fighter platform but best platform for the job as seen in OEF where UAV was employed for the first time to target fleeting targets. When UAV or UCAV is used extensively for dull, dirty and dangerous missions⁷, we can extrapolate the reduction in combat casualties also.

Lastly, collateral damage can be detriment to political and population support in the conduct of warfare since “CNN” effects can be used to undermine military efforts. Where airpower can contribute most is the selection of “smarter smart bombs” with sub-munitions aimed to reduce collateral damage such as LOCAAS system by Lockheed Martin.

In summary three key concepts of airpower can be used to achieve successful urban operations (Figure 4).

⁷ Peter Van Blyenburgh, “UAVs-Where Do We Stand”, Military Technology, no.4, March1990:30.

Airpower Capability	Eliminating Urban Ops Constraints
<ul style="list-style-type: none"> • Dominate From the Air (DFA) <ul style="list-style-type: none"> – C4ISR – Airborne Command Post – Unmanned Warfare 	<ul style="list-style-type: none"> • Restore Command and Controls • Enable Greater Situational Awareness • Reduce Casualty rates • Ensure constant pressure over target area • Enable 24/7 monitoring • Able to predict and dictate the battle due to the ability to monitor trends, changes in routines and external influence
<ul style="list-style-type: none"> • Lethality <ul style="list-style-type: none"> – Precision Warfare – Penetration Bombs – Non-lethal Weapons 	<ul style="list-style-type: none"> • Pin point targeting • Minimize collateral damages • Penetrate think walls • Non-lethal to Create same effects without the destruction • Enable stand-off delivery and deny close in combat
<ul style="list-style-type: none"> • Mobility <ul style="list-style-type: none"> – Speed – Simultaneous – TST Operations 	<ul style="list-style-type: none"> • Targeting fleeting opportunity • Eliminate snipers and ambush

Figure 4.

Dominating from the Air

The precursor to dominating from the air is the attainment of air dominance. Once it is achieved, then the ability to dominate from the air would mean the freedom to monitor and to provide a continuously situational picture for air or surface. Currently with the C4ISR (command, control, communications, computers, intelligence, surveillance and reconnaissance), commanders can stay airborne to orchestrate the battle. The advantage of having a **continuous comprehensive surveillance** is to **enhance situational awareness (SA)**.

Comprehensive wide area surveillance also facilitates data collection for further trend analysis. Daily movements in and around the urban environment, traffic patterns can be monitored. Any significant changes in traffic patterns or people activities may signal an

impending activity.

The advent of high endurance, high altitude unmanned aerial vehicle (UAV) such as the Global Hawk, enable airpower to be pervasive and permanence over the area of operations. As evident in Ops Enduring Freedom (OEF), unmanned warfare was proven to be a key component and a force to be reckoning in future application of airpower. In this war, we saw for the first time an UAV (Predator) being employed as the sensor and the shooter, defying the traditional problem of **shortening the sensor-to-shooter cycle**. If developed further, this will be a solution to **deny** the enemy use of **super-surface** dimension where sniper attacks often take place.

Lethality

The next advantage of employing airpower is her ability to employ variety of weapons, ranging from precision to non-precision, lethal to non-lethal but the most important feature is airpower can be delivered at a **standoff distance** precluding any **close-in combat**. Increasingly precision weapons are getting smarter and warhead trends are moving towards smaller firepower. With smarter and smaller warhead precision weapons can be very precise and destruction can be controlled to minimize collateral damage. The image of strategic bombings by the Germans onto London during WWII will be the thing of the past. Currently in the market are smart bombs like CBU97 (figure 5), which was war proven during Kosovo campaign can employed by either F16s or F15s at 600-20,000ft. When deployed, one canister of 40 BLU-108/B submunitions with infrared

sensors can precisely target many targets with infrared signature. Each submunitions has a self-destruct capability to prevent collateral damage. Other contender like Lockheed Martin Low Cost Autonomous Attack System (LOCAAS) may be another solution for operations in urban environment. Similar to CBU97, F16s or F15s can employ this weapon via a tactical missile dispenser (TMD). Each TMD with 16 LOCAAS can be deployed to the area for search and destroy mission.⁸

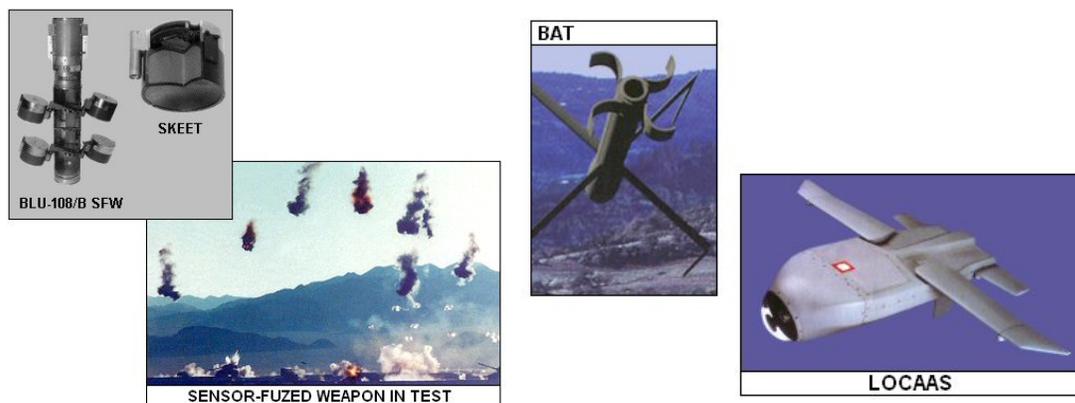


Figure 5 CBU97 and LOCAAS.

Although one may argue why ground forces cannot employ similar weapon type such as standoff precision artillery or long-range precision missile systems, the answer is within the **sensor-to-shooter cycle**. The time for any ground systems to complete the sensor-to-shooter cycle is often longer than airborne systems. Generally, ground based systems such as artillery or standoff land attack systems are often deployed at a safe distance from the area of ops. As such it will inevitably take a longer time for the ground-based system to complete the whole targeting cycle versus an airborne weapons waiting for targets to

⁸ Greg Goebel, "Modern Smart Munitions / Smart Shells", [Online] Available

appear. In my view, the success between targeting fleeting targets such as snipers or terrorist hiding in buildings and losing the golden opportunity lies within the sensor-to-shooter cycle. I believe airpower can shorten this cycle to near real-time and in the future where technology allows autonomous real-time targeting may materialize.

Mobility

When the land forces enters the urban environment the characteristic of the surface dimension will severely restricts their movement especially in deployment of armor vehicles or tanks. The consequence is ground forces become very defensive and reactive to the threats leash out at them from the super-surface dimension. In my view, airpower can solve this disadvantage by denying the enemy use of this dimension. Airpower with her speed and simultaneity can exploit the exclusive use of the airspace dimension to dictate the battle. Using the network centric environment (NCW) with smart precision weapons and persistency with unmanned platforms, airpower can deliver the deadly punch. This was evident in Israel war against terrorism in Southern Lebanon. In April 1996, Israel launched Ops Grapes of Wrath⁹ against the Lebanese with attack helicopters and fighters and no ground forces. The result was very different from their earlier Ops Peace for Galilee where the IDF lost **550 soldiers** as compared to **no combat fatality**¹⁰ after having flown **2,350 combat sorties**. Israel continues to head urban ops

<http://www.vectorsite.net/twbombb.html>, 16 Jul 2005.

⁹ Ze'ev Schiff and Ehud Ya'ari, Israel's Lebanon War, New York: Simon and Schuster, 1984, p. 301

¹⁰ Amnesty International, Israel/Lebanon: Unlawful Killings During Operation Grapes of Wrath, London, England, July 1996.

development as suicide bombers and terrorist attacks in their city are testing their armed forces daily.

By denying the enemy the use of airspace, land surface and super-surface dimension, airpower is able to influence the tactical fight to the operational focus where it favors own forces speed and simultaneity.

Additionally, airpower can also provide a medium to execute psychological operations (PsyOps). Air platform can transmit messages of impending air attacks to the rebels or the civilians. The aim is for the rebels to surrender or the civilian to flee the area of operations and if not to face the consequence of an air attack. This has been proven successful in many Israeli or Russian operations. Bottomline, airpower saves lives, firstly for the blue force by not committing or limited ground forces can actually alleviate high casualty rate that may internally affects morale and will to fight. Secondly, by applying airpower with the correct warhead and smart precision weapons can alleviate collateral damage and civilian casualties.

RELEVANCY TO THE SAF AND RSAF

As SAF surge ahead in this transformation to the third generation armed force, we must continue to place importance in developing a sound doctrine that caters to military operations in urban terrain (MOUT). Increasingly, developing countries around the

world is also transforming into more modern urban cities. Soon most countries will be urbanized and military forces can no longer evade fighting in cities.

So in order for SAF to succeed in urban operations, airpower must be considered more than a supporting arm of the Army. Besides CAS and BAI, Army doctrine on MOUT should include airpower as major component for success. The critical success factor that is required of airpower is dominate from the air, lethality and mobility. Under each success factor are the sub-components that enable SAF to perform well in this operation.

A comprehensive wide area surveillance using AEW or JSTAR is key in orchestrating the battle. A network centric force enables self-synchronization and shortens sensor-to-shooter cycle. RSAF should continue to invest in developing TST given the interconnectivity through Information Knowledge Based Command and Control (IKC2) architecture.

On the force structuring perspective, technology will continues to evolve and it will be imperative for our planners not to fall into this trap of letting technology drives doctrine. In my view it should be doctrine drives technology and in this circumstance, we really need to look into the area of unmanned warfare. As a small country with limited resources, manpower is our highest key to success and as evident in Chechnya and Lebanon, urban ops is inherently manpower intensive with high casualty rates. Therefore, unmanned warfare may allow SAF the options of targeting without risking valuable resources. The potential for RSAF to garner the benefits in this area is

substantial, given the lethality and persistency that some of these UAV can provide in the future. Hence UAV can help in reducing the risk of losing critical asset like the fighter platform. The significance of losing one pilot and one aircraft is greatly felt for a small country like Singapore.

In the same vein, with persistency the system can monitor and track traffic patterns, civilian movements. These data forms part of a trend analysis where any significant changes can signal an impending attacks. Correspondingly, SAF should continue to develop systems that allow trending and pattern recognition as threats in urban environment is far too complicated than conventional war.

Another critical area where SAF may choose to use airpower is PsyOps. Airpower can influence a large area and can be use as coercing tool, like Israel / Lebanon urban conflict, the IAF fighters often perform flyovers and sonic boom aimed at intimidating either the civilians or the rebels to surrender.¹¹ As information ops becomes an influential instrument in war partly due to the CNN effects, airpower can also be used to control or restrict information flow by jamming hand phone signals and preventing radio or TV broadcast.

Finally, airpower offers SAF an important tool in battling urban constraints. Given the significance of urban characteristics to ground forces, airpower can dominate and shape the outcome of the urban battle. It may be worthwhile for SAF to explore some of my thoughts.

WAY AHEAD – TECHNOLOGICAL ADVANCEMENT

In this 21st Century, we have witnessed a quantum leap in technological advancements especially on network systems, sensors, unmanned capabilities and non-lethal weapons. We have seen many of these advancements being demonstrated in the recent conflicts, namely in Ops Enduring Freedom (OEF) and Ops Iraqi Freedom (OIF), but there are areas where I believe technology can do more. I have identified two areas where technology can further enhance the application of airpower in the future. These areas are unmanned and sensors technology.

Unmanned Technology

As evident in OEF, unmanned platforms were used extensively to either provide surveillance or targeting. Their navigation and targeting systems is very dependant on the accuracy of Global Positioning System (GPS). However, ground based jammers can easily jammed the signals via cheap microwave device. This will cause rippling effects, as inaccurate target information will result in smart bomb missing their intended target. This is an area where politicians and/or ground commanders try desperately to avoid as the ramifications of a missed target in an urban terrain may further fuel hatred amongst the public on the on-going war. One solution suggested by RAND research paper¹² is vertical take-off or landing unmanned aerial vehicle VOL UAVs, these systems are air-breathing vehicles that can remain stationary or nearly stationary and provide long

¹¹ Ze'ev Schiff and Ehud Ya'ari, Op.Cit.

¹² Alan Vick et al. Op.Cit. Chap 5, p142.

endurance (several to many hours) sensor platforms. It can also be configured to act as a GPS pseudolites. Pseudolites are ground-based or airborne transmitters that supplement or replace GPS for navigational or targeting purposes.

Sensors Technology

Advances in sensor technology will provide quantum improvement in the effectiveness of airpower for time-critical missions. So far, sensor technology is still lacking in isolation and recognition of small or low signature threats such as muzzle flashes from snipers. Such technology is currently being experimented by Livermore Labs. "Lifeguard" Anti-Sniper IR System is a prototype system that uses infrared sensors to track the heat of a sniper's bullet back to point of origin. The system can be coupled with an automatic response that either shoots back along the bullet track to the point of origin or illuminates the sniper. The potential of this system is greatly enhanced if incorporated into the UAV, thus solving the elusive sniper threat. When fully developed, it will definitely reduce the ground casualty rate.

Many of these new technologies may eventually be made available to us but the question is how long. Meanwhile our defense industry may want to research and further develop in these two key areas because the likelihood of losing the GPS signal is high and the current problems of targeting small or low signature threats have not been solved.

CONCLUSION

As statistic shows in the above paragraph, the world population is growing substantially and urbanization has kept up with this trend. The increase in urbanization around the world couple with the strategic value of each city lead us to believe that we can no longer bypass fighting in urban terrain. Correspondingly, the SAF must prepare herself to conduct operations in the urban terrain when called upon in the future. This would mean having an additional arm to develop urban tactics, training and doctrines to answer to this potential scenario. While developing this capability, SAF planners must factor the potency of airpower and what airpower can provide to alleviate close-in combat, high casualty rates, uncoordinated small unit operations and lost of C² function.

All services must appreciate the complexities of urban warfare. Traditional way of having ground forces leading the attack may not be the only option given the constraints and limitations imposed by the fixed terrain. As evident in Grozny and Lebanon the eventual outcome of both conflict left us to believe that urban combat is very attrition based, defensive in nature and manpower intensive. Ground forces are restricted in many ways such as large vehicular movements or employment of large unit, super-surface becomes the vantage point for the enemy to target ground forces and the sub surface if not secured can escape haven for enemy.

Airpower as the weapon of choice, can it be done? Although many airpower critics have cited airpower alone cannot win war but are we missing the point? From an airman perspective, the ability to dominate from the air prevents the enemy use of land surface and super surface dimension. Given the limited space, the enemy will be forced to fight

the airspace above him which airpower can prevail. It may not be airpower alone to win this war but a culmination of air, ground and sea power orchestrated from the air domain that ultimately is the deciding factor. In my view, airpower can contribute more than just targeting in urban warfare; in the tactical sense airpower is potent but yet nimble and flexible enough to react to the unpredictability of urban operations. While operationally it can shape the battlefield to suit the commanders intent and lastly it can achieve the strategic objectives.

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