

# **The Potential for Warfare in Space: Australia's Response**

**by**

**Group Captain Darren May**

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Both civil society and militaries around the world are becoming critically dependent upon space capabilities. While space capabilities provide significant benefits to modern society and are a key enabler of modern warfare, such dependency also constitutes a vulnerability. Warfare in space has the potential to render large parts of the space domain unusable, with significant secondary effects in the other physical domains.

In this Air Power Seminar, Group Captain May will discuss the factors influencing the potential for warfare in space and the steps that Australia is taking in response to this increasing threat.

## **Group Captain Darren May**

Group Captain Darren May entered the Royal Australian Air Force in 1982 through the Engineer Cadet scheme. On completion of his engineering degree, he was commissioned as an Electronic Engineering Officer at the rank of Flying Officer.

From 1986 to 1995, GPCAPT May occupied various positions where he managed the operation and maintenance of ground telecommunications equipment and information systems supporting RAAF operations, including Air Traffic Control and Air Defence.

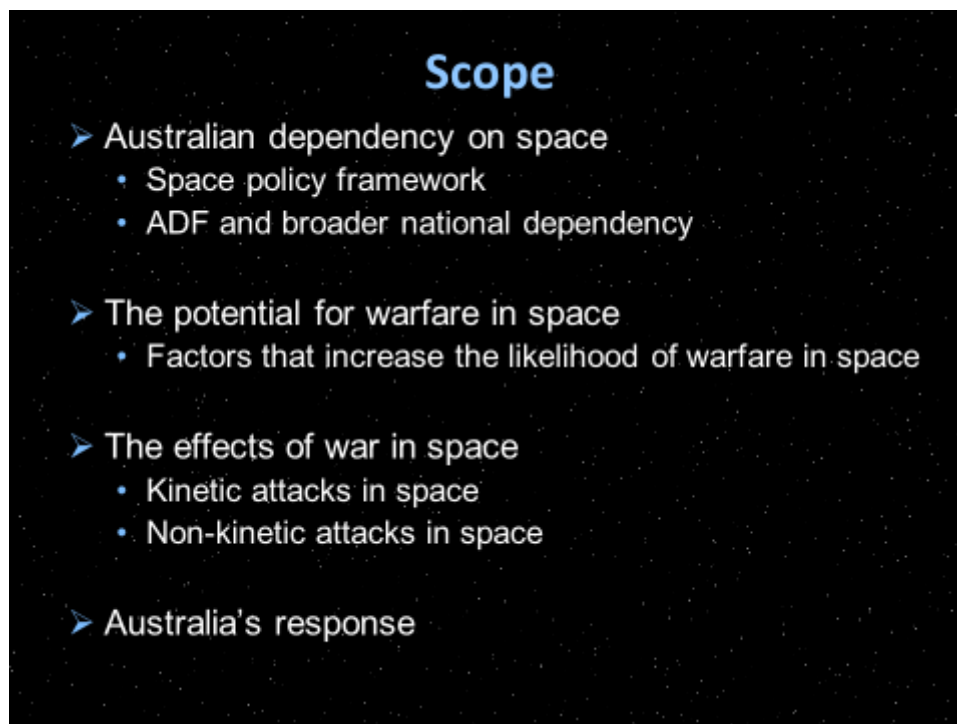
In 1996, GPCAPT May completed a Master's Degree in Aerospace Engineering and was subsequently posted to Aerospace Development Branch in Defence Headquarters, Canberra, where he developed requirements for future ADF space and unmanned aerial system (UAS) capabilities. Following an 18-month posting to his home state of Western Australia, he was promoted to Wing Commander and posted to the Defence Materiel Organisation where he managed the acquisition of space-based and UAS surveillance systems from 2001-2004.

In 2005, GPCAPT May attended the Australian Command and Staff College and subsequently graduated with a Graduate Diploma in Management (Defence Studies). From 2006 to 2008, he was posted to Air Force Headquarters, where he managed strategic capability planning for Air Force Communications and Information Systems. From 2009 to 2010, GPCAPT May commanded the RAAF's No 462 Squadron, providing Information Operations capabilities to the RAAF and wider ADF.

GPCAPT May was promoted to Group Captain in January 2011 and posted to the Defence Chief Information Officer Group where he served as Director of Business Relationship Management until end of 2014. In January 2015 he took up his current position as Director Defence Space Coordinating Office in Air Force Headquarters.

**Group Captain May:** The debate about warfare in space has been around almost as long as the space race itself. Not long after the launch of Sputnik by the Soviet Union on 4 October 1957, research into the development of anti-satellite weapons had begun. The need for them was apparent to the military in Moscow and Washington once it was seen that space flight was a reality and that the Treasury in both capitals was willing to support this modern form of exploration.

Now, almost 60 years later, anti-satellite weapons are a reality and the military commander is at a point where he would be struck deaf, dumb and blind should his satellites be destroyed. And this is not only an issue for the military; as we shall see, broader society has also got to a point where space systems have become an everyday necessity for modern life and the effects of warfare in space will not necessarily discriminate between military and civil systems. In other words, our dependency on space systems is also a vulnerability not only for the military but also for the economy and our way of life in general.



Maintaining assured access to space systems is now a new focus for a modern military, and the ADF is no exception. Over the coming decades, we will see increasing investments among allied nations in technologies that contribute to making our space systems more resilient, including increased situational awareness of the space domain, the development of systems to protect satellites and improvements in our ability to reconstitute systems that have become disabled. The realisation that this needs to occur signals a new era in the military use

of space as, up until now, the space domain has been seen as somewhat of a sanctuary, having never really been subject to direct warfare. But the threat profile has now changed and space is transitioning from an environment that enables terrestrial warfare to one where it seems increasingly likely that war could be waged.

**Australia's satellite utilisation policy.** The policy was launched in April 2013 and is Australia's first ever space-related policy. It is designed to provide certainty and strategic direction for satellite technology users, which now includes almost everyone. The policy highlights satellite capabilities are now a fundamental part of Australia's economy, our environmental management and our communications infrastructure. It also recognises that space capabilities enhance services Australians depend on and seeks to protect and enhance our access to those capabilities through better domestic co-ordination and focused international engagement.

Other aspects of the satellite utilisation policy include:

- giving priority to Earth observations from space,
- contributing to international 'rules of the road' for space,
- building high quality Australian space expertise, and
- developing a plan to meet growth in Australia's satellite information needs.

**Defence strategic policy statement on space.** This policy statement sets out Australia's strategic interests in space and its key policy objectives. Strategic interests include the following.

- Access to space is a national strategic interest. Space is vital for Australia's day-to-day functions and affects all industries and sectors.
- Australia has very limited sovereign space-based capabilities. Defence relies on the US for access to high-end space capabilities. Defence also relies on other international partnerships and commercial arrangements.
- Australia occupies a unique geostrategic location as a southern hemisphere, near equator, US ally and 'Five Eyes' member. This provides opportunities to contribute to US space capabilities and international partnerships.
- Defence and our allies have more space experience than potential adversaries, which allows us to optimise the advantages of access to space and integrate space into military operations. However, this balance is changing. The risk of malicious activity through space against our strategic interests will increase out to 2035, with some countries now developing capabilities that target satellites in order to destroy them or degrade their capabilities.
- Given this emerging threat, Defence's dependence on space systems also constitutes a vulnerability.
- And finally, consistent with Government policy to strengthen international frameworks and norms that promote the rule of law and international security, Defence strongly supports the development of international norms and governance regarding the responsible use of space.

Defence's policy objectives are as follows.

- Defence should organise, train, sustain and equip so it can leverage the advantages provided by space systems.
- Defence must work in cooperation with other Government departments, Australian entities and key international partners to maximise the advantages we derive from space and to develop and promote international norms.
- Defence must be able to continue operations and win in a contested, degraded and operationally limited space environment. It is not sufficient that Defence operations simply survive in such an environment—Defence must have the capability to pursue its mission and prevail, either independently or as part of a coalition.
- And the final point—Defence must protect Australia’s access to space systems. This is vital given the key role space has in the functioning of Australian society and in supporting the conduct of military operations.

**ADF reliance on space.** The unique combination of perspective and persistence, not available in the other physical domains, enables space to drive radical changes to the way the ADF operates in all domains. The ADF has the following key space dependencies which are typical of a modern military.

- Satellite communications provides BLOS [beyond line of sight] support to command and control and the dissemination of ISR [intelligence, surveillance and reconnaissance] products.
- Position, navigation and timing (PNT)—primarily GPS—supports navigation, communications and targeting.
- Space-based intelligence, surveillance and reconnaissance (ISR) capabilities support decision superiority, operations planning and execution, and targeting.
- Space-based meteorology services support the planning and execution of ADF operations.

Over 90 per cent of DIIP [Defence Integrated Investment Program] projects have a space dependency.

**National dependence on space.** As with the ADF, Australian society more broadly has been able to leverage advances in space technology to conduct activities that would otherwise be either impossible or significantly less efficient. These are some of those industries.

- Navigation of aircraft, road transport, and shipping is primarily carried out with satellite based systems.
- Banking. ATM transactions, stock market transaction, money transfers all rely on the GPS timing signal. Australia’s entire economy is underpinned by reliable access to space capabilities, including precise timing and communication of transaction data.
- Communications. Satellites are used for global telecommunication (including long distance phone calls), television and radio broadcast, and internet access.
- Weather forecasting. Satellites are used for visible and infrared imaging, determining wind speed and direction, aerosol type and concentration in the atmosphere, CO2 concentration, humidity, sea surface temperature, sea surface height and ice thickness, to name a few. Some of this information is critical for agricultural and land management activities, transport, climate modelling and prediction etc.

- Search and rescue. Australia's search and rescue area of responsibility encompasses approximately twelve percent of Earth's surface. Satellites are used to detect emergency beacon signals and communicate them immediately to SAR agencies. Position and identifying information can be encoded into these signals. Without SAR satellite capability, detection of distress signals, and location and rescue of survivors would in many cases be extremely challenging.
- Land management. Remote-sensing satellites are used to determine vegetation type, soil moisture content, health of crops and waterways, presence of minerals etc. They are also used for disaster response and recovery. GPS is used for precision farming, often resulting in very substantial improvements in efficiency of resource use (water, fertiliser). GPS guided machinery can automatically perform agricultural work in place of human operators.

### **The Likelihood of Warfare in Space.**

While a range of UN international treaties exist that attempt to provide a legal framework to govern the peaceful use of outer space, the reality is that these do not go far enough; they are ambiguous and leave much open to interpretation. The upshot is that, despite the treaties and unlike other domains such as maritime and air, there is no robust global rules-based system governing behaviour in space. As a result, international law does not provide a clear and unambiguous obstacle to irresponsible behaviour in space, including extending warfare to the space domain. This lack of rules and norms, therefore, is one factor that increases the likelihood of warfare in space.

Lets take a quick look at the current space treaties that have been developed by the UN Committee on the Peaceful Uses of Outer Space.

Extant treaties do not totally exclude using space for non-peaceful purposes, including the 'weaponisation' of space using conventional types of weapons. Therefore, there is no clear obstacle provided here to pursuing warfare in space. Similarly, there appears to be no clear way forward internationally to try and resolve this. For example, the 2016 Defence White Paper [DWP] pessimistically (and realistically) notes that, 'Limiting the militarisation of space will also require the international community to work together to establish and manage a rules-based system—a prospect that does not seem likely in the immediate future.'

There have been attempts, such as the drafting of an International Code of Conduct on space, but that died a natural death before the UN even got into discussing the details—hence the DWP's pessimism.

The second factor that increases the likelihood of warfare in space is directly related to the significant dependency that nations, such as Australia, have on space for the conduct of military operations. The United States and its allies currently enjoy a technological edge over many potential adversaries, particularly with the use of advanced weapons systems with global reach and intelligence capabilities that derive their edge from space systems. How would we communicate BLOS effectively with remotely deployed units and UAVs without SATCOM? How would we get timely, global intelligence without the reach, perspective and persistence of space-based systems. How would we get some precision guided munitions on target without GPS? Without these space capabilities, commanders in many cases would be struck deaf, dumb and blind.

However, and here lies the asymmetry, many of these space systems were not designed with space warfare in mind. They were engineered to do their job of enabling terrestrial warfighting operations and they do this exceptionally well. In many cases, however, what they don't do well is provide resilience or self-protection. As a result, this has led many observers to conclude that the US military's current space architecture is its Achilles' heel. A potential adversary could exploit this vulnerability, recognising it as a critical point of weakness.

The development of anti-satellite, or ASAT, technologies is the third factor that increases the likelihood of warfare in space. In 2007, China demonstrated a direct-ascent, kinetic ASAT capability by destroying one of its own malfunctioning weather satellites. Then in 2008, the US demonstrated a similar capability by shooting down a de-orbiting satellite that posed a threat to the terrestrial environment.

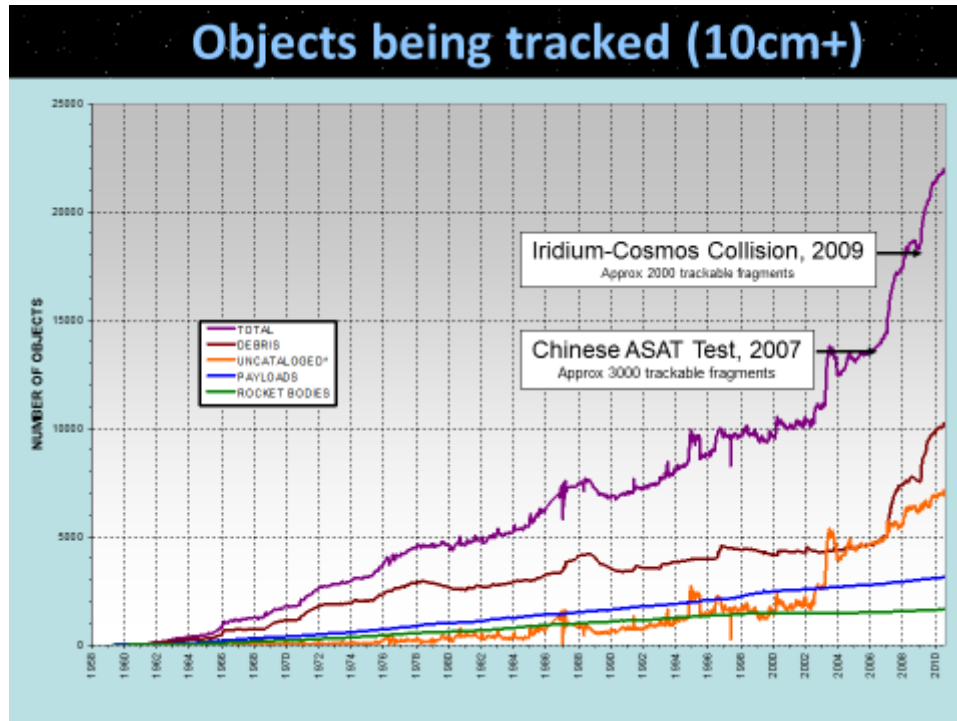
While direct-ascent, kinetic weapons are certainly effective, attacks are relatively easily detected, and therefore attributable. In addition, the destruction of a satellite leads to the creation of a significant amount of debris which can in turn threaten the aggressor's satellites as well. This is one reason why co-orbital ASAT technology is also being developed. Co-orbital ASATs, also known as 'hunter/killer satellites', are manoeuvred to within close range of a target satellite such that the target can be degraded or disabled in some way. Attacks by such ASATs are more difficult to attribute and could be plausibly denied by the attacker. In addition, there is no need to physically destroy the target satellite, thereby avoiding the creation of debris; the target satellite's critical systems need only to be disabled rendering the satellite inoperable.

Non-kinetic ASATs that are capable of degrading or disabling a satellite also exist. Examples include ground based RF [radio frequency] jammers that can degrade radar satellites, communications satellites and satellite communications uplinks for used for TT&C [telemetry, tracking, and control of the satellite], as well as directed energy systems either RF- or laser-based that can damage sensor optics and electronic systems on board satellites. High-altitude, nuclear blasts can also be used as a non-kinetic ASAT.

Having established that there is an increased likelihood for warfare in space due to a range of factors including deficiencies in international law, military dependency and the existence of ASAT weapons, let's now take a closer look at the effects of warfare in space.

## The Effects of Warfare in Space

The harsh physical environment is becoming increasingly congested, with millions of debris objects estimated to be in orbit, most of which are too small to be tracked. A great many of the objects that are too small to track have sufficient kinetic energy to destroy satellites.



The use of kinetic ASATs would create a large number of debris objects that would in turn pose a threat to other satellites. This may eventually lead to an exponentially increasing rate of collisions, known as the 'Kessler Effect', something similar to this was depicted in the movie *Gravity*.

This image depicts the locations of all debris objects greater than 1 cm in size, as of 2009, using a statistical debris distribution model. This debris has the potential to collide with a satellite and, depending on its size, it could damage or destroy it. Object sizes greater than 1 cm are particularly significant because at LEO [low earth orbit] velocities of around 27 000 kph, they are capable of penetrating the walls of a satellite. At LEO velocities, a piece of debris has more kinetic energy than an equal mass of high explosives. To give another example to help you visualise the effect, a 1 cm fragment in LEO colliding with a satellite is comparable to being hit by a small motor vehicle travelling at 100 kph.

Let's now take a look at some non-kinetic effects starting with what a high-altitude, nuclear blast can do. A single high-altitude, exoatmospheric nuclear blast could indiscriminately wipe out large numbers of satellites due to non-kinetic effects which could linger for months. For example, the Starfish Prime was a high-altitude, nuclear test conducted by the US in 1962. The test used a 1.4 MT [megaton] bomb detonated at an altitude of 400 km. The resultant EMP [electromagnetic pulse] and radiation disabled about a third of the satellites in orbit at the time. The radiation that was generated formed man-made radiation belts that followed the earth's magnetic field that eventually damaged the solar arrays and electronics on the affected satellites.

## **Non-Kinetic Effects and Other Factors**

Other non-kinetic effects include laser dazzling, RF jamming and cyber attacks. Lasers can temporarily blind imaging satellites (or even permanently blind them if they are powerful enough), communications and radar satellites can be jammed, and cyber attacks can have a variety of effects. These are means by which conflict can extend to space without the indiscriminate catastrophic effects of more destructive actions.

Unlike laser dazzling and jamming, cyber attacks can be more difficult to detect and difficult to conclusively attribute to the responsible actor. The anonymity and plausible deniability potentially afforded by cyber attack can help an adversary avoid the political complications resulting from entanglement and dual civil/military use—let me further explain.

Commercial space capabilities, including but not limited to space-based imagery and communications, are becoming increasingly advanced, prolific and lucrative. As a result, commercial space services are now routinely being relied upon by militaries around the world, including Australia and the US, to supplement capability provided by military payloads. Therefore, if an adversary wishes to deny the ADF use of space systems through jamming, laser dazzling, cyber attack or other means, it would necessitate also denying the civilian population the use of those same capabilities. The impact of such activities cannot be contained to the military; the effects would be felt more broadly across society.

In addition to militaries making use of civilian space capabilities, nations are increasingly partnering together on combined military space projects, such as the Wideband Global SATCOM (WGS) system that includes seven partner nations (US, Australia, Canada, Netherlands, Luxembourg, Denmark, and NZ). Such partnerships create an effect known as ‘entanglement’, whereby an adversary is unable to target a specific nation’s space capabilities without also interfering with other nations’ capabilities. Entanglement therefore complicates the political calculations of an adversary that might attack in space.

Given the potential for warfare in space and our dependence on space systems that would be adversely affected by such warfare, let’s now take a look at what the Australian and allied response has been to this emerging threat.

### **Australia’s Response**

As outlined earlier in the context of our Defence space policy, maintaining assured access to space is of vital importance to Australia. The Defence White Paper states that our most basic strategic Defence interest is a secure, resilient Australia, and that this includes protecting Australia from non-geographic threats such as anti-satellite weapons.

One way to contribute to assuring access to space is to maintain our commitment to a rules-based global order that also extends to space. We encourage the responsible use of space through the creation of international transparency and confidence-building measures, including the development of guidelines that help establish norms of international behaviour.

The next area where we are contributing to assured access to space is through our efforts to improve space situational awareness (SAA). Space situational awareness, which encompasses, among other things, understanding what objects are in space, where they are, what their capabilities are, and what events are occurring in space, underpins all activities that contribute to assured access to space.



In recent times, Australia has entered into MoU [memorandum of understanding] arrangements with the US to improve our SSA and several initiatives will come to fruition in the next five years or so.

### **C-Band Radar**



The first initiative is the installation of a C-Band space surveillance radar at North West Cape in WA, as shown here in this slide. The radar will track objects out to the lower end of MEO and then feed this information back into the US Space Surveillance Network. The capability will be jointly operated by the USAF and the RAAF, with the RAAF conducting remote operations from 1RSU in South Australia. The capability is scheduled to become operational by the end of 2016.

## Space Surveillance Telescope



The second initiative is to relocate an advanced space surveillance telescope [SST] from the US and operate it at the North West Cape, not far from the C-Band radar. This slide shows the SST at its current location in New Mexico. The telescope is optimised to detect and track objects in the geostationary belt and, like the C-Band radar, will feed this information into the US SSN [space surveillance network] and be jointly operated by the USAF and the RAAF. Construction of the SST facility at North West Cape is due to commence later this year and the telescope should become operational towards the end of this decade.

Both the C-Band radar and the SST will provide coverage across a geographic region that is becoming increasingly active for space launches and the operation of geostationary satellites.

In addition to these two approved capabilities, Defence is planning to invest \$1-2 billion over the next 15 years to further enhance space situational awareness capabilities that contribute to assuring access to space both nationally and for our coalition partners.

Our next focus area is to participate in initiatives that enhance Defence cooperation with other countries. The primary way we are going about this is through our participation in the Combined Space Operations initiative.

### **Combined Space Operations (CSpO)**

The CSpO initiative is an MoU-level arrangement between the 'Five Eyes' nations. The primary aims of this partnership are to strengthen deterrence, improve mission assurance and to optimise the use of resources. A key philosophy behind the CSpO initiative is that the whole is greater than the sum of the parts—together we are stronger. It cuts to the heart of the entanglement effect I mentioned earlier and strengthens our ability to deter a potential adversary that now has to contend with five nations instead of one when considering hostile action against our collective space capability.

The other element of CSpO involves the optimisation of resources through the sharing of national capabilities and information with participating partners. Current significant focus areas for Australia include SSA collaboration, a key part of that being the C-Band and SST initiatives mentioned earlier, information sharing and coordinated operations between national space operations centres, looking at ways to enhance interoperability through development of common C2 [command and control] and information exchange architectures, and finally, looking at ways to increase the resilience of our collective space architecture.

### **Increased Resilience**

Key ways to increase resilience include:

- investment in technologies that provide an increased level of protection to jamming, including through protected communications and more resilient GPS receivers,
- exploring ways in which the space segment can be disaggregated by spreading space-based systems over a greater number of satellites, rather than aggregating capabilities onto a single satellite—spread out the targets, less chance of losing it all in one hit, and
- developing methods to more rapidly reconstitute space-based systems that have been damaged or destroyed through faster turnaround launch systems and the launch of numbers of shorter-life smaller satellites to temporarily plug holes in capability.

In addition, the ADF needs to prepare for operations in a contested, degraded and operationally-limited [CDO] environment. This includes investing in alternate terrestrial technologies, such as advanced high-frequency radio systems, and terrestrial navigation and timing systems that can provide the ADF with the ability to fight on and survive in the event that the space architecture does fail. The ADF also needs to train to fight on in a CDO environment and this includes the injection of CDO serials into major exercises.

In summary, Australia's response to the threat of war in space is a four pronged approach, consistent with our newly published space policy. It involves a combination of political and military cooperation and capability-based initiatives to achieve the primary aim of maintaining assured access to space.

### **Summary**

That brings us to the end of my presentation. In closing, I would like to highlight some of the key takeaways.

The bottom line is that space provides unique advantages to the ADF and its allies, but these advantages encourage an over-reliance on space that could be a major vulnerability if not properly addressed. In this, the military is not alone. Developed societies rely heavily on space-related capabilities that are easily disrupted and cannot be easily replaced. The benefits and vulnerability of space, combined with unclear international norms for its use and the proliferation of ASAT capabilities, makes warfare in space plausible and, arguably, increasingly likely. Such warfare could have disastrous consequences for most nations.

Australia is focussing its space-related efforts on assuring its access to the space domain. We are promoting the responsible use of space, contributing to enhanced space situational awareness and engaging with allied nations in cooperative Defence space agreements. However, we are also hedging against this approach failing to prevent warfare in space by

examining ways to improve the resilience of space systems, developing contingency capability options and training to operate in a space-denied or -degraded environment.

While we still have some way to go, the threat is recognised and we are taking measures to mitigate it.

Note: Words in square brackets [ ] were added during editing for clarity.