İnsansız Hava Araçları
(Haberleşme ve Telemetri Çözümleri)

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İnsansız Hava Araçları

- İnsansız hava araçları, zor ve tehlikeli bölgelere ulaşabilme ve yüksek çözünürlüklü görüntü sağlayabilme kapasiteleri
- Kamera, algılayıcı dedektör, havacılık ve otomatik pilot navigasyon teknolojilerindeki gelişmeler, insansız hava aracı maliyetlerini giderek daha da karşılanabilir bir hale getiriyor.
- Yüksek tekonoloji cihazlarla donatılmış dikey olarak havalanan ve iniş yapan helikopterler şimdiden iş dünyasının hizmetinde, şirketlere milyonlarca dolar kâr getirmeye başladı.
- Arazide yürütülen iş süreçleri sırasında, kuş bakışı incelemelerde riskler önceden belirlenerek firmalara milyon dolarlık tasarruf sağlayabilmektedir.
- İnsansız hava araçlarının çektiği fotoğraflarla elde edilen veriler, ariziyi ya da inşaat alanındaki gelişmeleri incelemede ve alanın üç boyutlu haritalarının üretilmesinde kullanılıyor.
- İnsansız hava araçlarında meydana gelen gelişmeler, üretilen yeni aparatlar ve artan kablosuz bağlantı hızları sayesinde belgesel ve amatör film yapımcılarının havadan çekimler yapabilmeleri artık çok daha kolay bir hal aldı. Kuş bakışı görüntü sağlayabildikleri için hem amatör hem de profesyonel fotoğrafçılar için de faydalı bir araçlar.

İnsansız Hava Sistemleri

İnsansız hava uçakları uzunca bir süredir askeriye ile özdeşleştirilmiş durumda, fakat sivil hayatta da giderek kendilerine yer bulmaya başladılar.

- İnsansız hava araçları gökyüzünde artık daha sık görünür oldular.
- Tarımda ekinleri gözetlemeye,
- Kendi kendine hareket edebilen insansız hava araçlarıyla kırsal bölgelerde malzeme taşımak. Kırsal alanlara ilaç ve lojistik ulaştırılmakta
- Gelecekte genişbant teknolojileri için üs
- Facebook ve Google taşımacılık için etkin bir şekilde çabalıyor.
- İnsanlar internetten bu sofistike sistemleri ucuza alabiliyorlar.
- Güvenlik ve mahremiyet gibi sebepler göz ardı ediliyor.
- Sporcular performanslarını izlemek ve güzergahlarını yayınlamak için
- Emlakçılar arazilerini, ofislerini dairelerini pazarlamak için
- Güvenliğin sağlanmasında insansız helikopterler ve polislerin işbirliği
- İnsansız hava araçları özellikle acil durumlarda olay yeri görüntülemede kullanılabilir.

Unmanned Aircraft Systems (UAS)

The system comprises a number of sub-systems which include the aircraft (often referred to as a UAV or unmanned air vehicle), its payloads, the control station(s) (and, often, other remote stations), aircraft launch and recovery systems where applicable, support systems, communication systems, transport systems, etc.

It must also be considered as part of a local or global air transport/aviation environment with its rules, regulations and disciplines.

An unmanned aircraft is an aircraft with its aircrew removed and replaced by a computer system and a radio-link.

- The control station (CS) which houses or container for the system operators, the interfaces between the operators and the rest of the system;
- The aircraft carrying the payload which may be of many types
- The system of communication between the CS which transmits control inputs to the aircraft and returns payload and other data from the aircraft to the CS (this is usually achieved by radio transmission);
- The support equipment which may include maintenance and transport items.

Why Unmanned Aircraft?

- An old military adage (which also applies to civilian use) links the use of UAVs to roles which are dull, dirty or dangerous (DDD). There is much truth in that but it does not go far enough. To DDD add covert, diplomatic, research and environmentally critical roles. In addition, the economics of operation are often to the advantage of the UAV.
- Military and civilian applications such as extended surveillance can be a dulling experience for aircrew, with many hours spent on watch without relief, and can lead to a loss of concentration and therefore loss of mission effectiveness. The UAV, with high resolution colour video, low light level TV, thermal imaging cameras or radar scanning, can be more effective as well as cheaper to operate in such roles. The ground-based operators can be readily relieved in a shift-work pattern.
- Dirty Roles; Again, applicable to both civilian and military applications, monitoring the environment for nuclear or chemical contamination puts aircrew unnecessarily at risk. Subsequent detoxification of the aircraft is easier in the case of the UAV.Crop-spraying with toxic chemicals is another dirty role which now is conducted very successfully by UAV.
- Dangerous Roles; Power-line inspection and forest fire control are examples of applications in the civilian field for which experience sadly has shown that manned aircraft crew can be in significant danger. UAV can carry out such tasks more readily and without risk to personnel. Operating in extreme weather conditions is often necessary in both military and civilian fields. Operators will be reluctant to risk personnel and the operation, though necessary, may not be carried out. Such reluctance is less likely to apply with a UAV.
- Covert Roles; In both military and civilian policing operations there are roles where it is imperative not to alert the ‘enemy’ (other armed forces or criminals) to the fact that they have been detected. Again, the lower detectable signatures of the UAV make this type of role more readily achievable.
- Research Roles
- Environmentally Critical Roles
- Economic Reasons

İnsansız Hava Araçları Potansiyel Kullanım Alanları





Sınır güvenliği

Arkeoloji

Yangın Söndürme

Sel

Tarım ilaclama, gözetleme

Madencilik

Çiftçilik

Fotoğrafçılık

Emlak

Haberleşme

Endüstiriyel Malzeme

Kirlilik

Fırtına

Atık Malzeme

Değerleri İzleme

Orgize güvenlik

Liman Güvenliği

İnşaat

Kargo

Radyo ve televizyon yayın, İnternet

Arama Kurtarma

Acil durum müdahele

Boru hattı güvenliği

Film çekimleri

Kalabalık Kontrol

Meteoroloji, erken uyarı

Vahşi Yaşam Kontrol

Orman

Enerji hatları gözetleme

Hasar Tespitleri








Çevrenin korunmasına katkı sağlamak için

- İnsansız hava araçları, petrol rafinerilerindeki yanma olaylarını, petrol tankerlerini, yüksek gerilim hatlarını ve boru hatlarını incelemek için kullanılıyor.
- Endüstri çağı, beraberinde atık problemini de beraberinde getirdi. Atıklar, elektronik atıklar, zehirli atıklar derken aslında atıklarla yaşam alanlarımızı çevreler hale geldik. Özellikle zehirli atıkların yaydığı gazlar bulunduğu bölgede ve rüzgarlarla uzak bölgelerde ciddi sorunlara yol açabiliyor. Kirlenen nehirleri, dereleri bu yolla izlemek ve hangi tesislerin bu kirliliğin kaynağı olduğunu yüksekten bakarak görmek mümkün.
- Ormanlardaki ağaçları kesenler, izinsiz balık avlayanlar gibi farklı tehlikeler için de kullanılabilir.
- Nesli tükenen hayvanları izlemek için
- NASA, The Airborne Tropical Tropopause Experiment (ATTREX) olarak adlandırdığı bu projedeki araç 30 saat kadar havada kalabiliyor. NASA'nın amacı, yanına yaklaşılamayan güçteki fırtınalar hakkında, fırtınanın üstünden bakarak özellikle hortumların yapısına dair bilgi toplamak.

Afet durumlarında hayat kurtarmak için

- Deprem sonrasında, ulaşımın zorlukla sağlandığı sokaklara insansız hava aracı göndermek hangi binanın daha fazla hasar aldığı, aşağıda yardım isteyen kimse bulunup bulunmadığı, hatta takılacak özel kameralar ve algılayıcılar ile yıkıntı altında canlı olup olmadığını dahi tespit etmek mümkün.
- Afet derken bunu yalnızca depremle sınırlamamak gerekiyor. Dünyanın dört bir yanında depremden, sele, heyelandan yangına çok sayıda felaket yaşanıyor. Bu bölgelerde kullanılacak insansız hava araçları pek çok yaşamın kurtarılmasını destek verecektir.

Applications of UAS -Civilian uses

- Aerial photography; Film, video, still, etc.
- Agriculture; Crop monitoring and spraying; herd monitoring and driving
- Coastguard; Search and rescue, coastline and sea-lane monitoring
- Conservation; Pollution and land monitoring
- Customs and Excise; Surveillance for illegal imports
- Electricity companies; Powerline inspection
- Fire Services and Forestry; Fire detection, incident control
- Fisheries; Fisheries protection
- Gas and oil supply companies Land survey and pipeline security
- Information services News information and pictures, feature pictures, e.g. wildlife
- Lifeboat Institutions Incident investigation, guidance and control
- Local Authorities Survey, disaster control
- Meteorological services Sampling and analysis of atmosphere for forecasting, etc.
- Traffic agencies Monitoring and control of road traffic
- Oil companies Pipeline security
- Ordnance Survey Aerial photography for mapping
- Police Authorities Search for missing persons, security and incident surveillance
- Rivers Authorities Water course and level monitoring, flood and pollution control
- Survey organisations Geographical, geological and archaeological survey
- Water Boards Reservoir and pipeline monitoring

Applications of UAS – Military Roles

Navy

- Shadowing enemy fleets
- Decoying missiles by the emission of artificial signatures
- Electronic intelligence
- Relaying radio signals
- Protection of ports from offshore attack
- Placement and monitoring of sonar buoys and possibly other forms of anti-submarine warfare

Army

- Reconnaissance
- Surveillance of enemy activity
- Monitoring of nuclear, biological or chemical (NBC) contamination
- Electronic intelligence
- Target designation and monitoring
- Location and destruction of land mines

Air Forces

- Long-range, high-altitude surveillance
- Radar system jamming and destruction
- Electronic intelligence
- Airfield base security
- Airfield damage assessment
- Elimination of unexploded bombs

Riskler

- Yakın aralıklı yüksek binaların arasında dolaşarak trafiği gözleyen bir insansız hava aracı, yanlış kumanda edilmesi ya da otomatik pilotta gidiyorsa sensörlerinden birinin arızalanması durumunda bir gökdelenin 20. katından içeri girerek zarar da verebilir.
- Geleceğin muhtemel konvansiyonel savaşları için oldukça yetersiz olan mevcut İHA'lar, belirli bir seviyenin üstünde savunma gücüne sahip ülkeler tarafından kolayca etkisiz hale getirilmektedir. Halihazırda en gelişmiş sistemlerden biri olan ABD Hava Kuvvetlerine ait RQ-170 Sentinel İHA'sının 2011 yılında GPS aldatmasıyla İran tarafından ele geçirilmesi bu kapsamda verilebilecek ilk örneklerdendir.
- ABD Hava Kuvvetlerine ait RQ-4 Global Hawk İHA'larından iki adedinin Çin hava sahasında uçarken Çin hava savunma unsurları tarafından düşürülmesi ise bir diğer önemli örnektir.

Güvenlik Riskleri

- Kötü niyetli kişiler bir insansız uçağı ele geçirip bir binaya çarptırabilir.
- Uçağı çalıp patlayıcılarla doldurup sonra bir hedefe yönlendirebilirler.
- En kaygı verici olan, çok yetenekli birinin orduya ait saldırı amaçlı uçakları ele geçirmesi.
- Almanya'nın Rheinmetall Defence şirketi, aynı anda iki insansız hava aracını yaklaşık 2 km den vurabilen lazer sistemi geliştirdi.
- Lazer sistemi, ilk olarak radar ile insansız hava araçlarının bulunduğu bölgeyi tespit ediyor, ardından optik sistem aracılığıyla takibe başlıyor.
- Rheinmetall'ın gerçekleştirdiği testte 15 mm kalınlığındaki çelik kirişleri kesmeyi başaran lazer, birçok insansız hava aracının zırhını delebilcek özelliğe sahip olduğunu gösterdi.
- ABD savunma sanayisinin önde gelen şirketlerinden Raytheon, 50 kW gücünde uçak savar silahı geliştirdi. Hedefe lazer güdüm ateşleyen bir silahın ilk detayları açıklandı.

ABD'de Adalet Bakanlığının baz istasyonu işlevindeki casus uçaklarla ülkenin büyük bölümündeki cep telefonlarını izlediği iddia edildi.

- Wall Street Journal gazetesinin haberine göre, 2007'de kullanılmaya başlanan programda ülkedeki en az 5 metropoldeki havalimanında konuşlanan Cessna uçaklarıyla casusluk faaliyetleri yürütülüyor.
- Program kapsamında uçaklara monte edilen ve baz istasyonu işlevi gören cihazların (dirtboxes), uçuş yapılan bölgedeki tüm cep telefonlarının sinyallerini toplayarak telefonlardaki bütün verileri ve bulunduğu yer bilgilerini elde ettiği belirtildi.
- Cep telefonlarının otomatik olarak en güçlü sinyali gönderen baz istasyonuna bağlanması nedeniyle de uçaktaki cihazdan gönderilen sinyalleri, telefonların en güçlü ve en yakın sinyalmiş gibi algılayarak hemen bağlandıkları kaydedildi.
- Adalet Bakanlığı yetkilileri, programı yalanlamazken, sadece suçluların takibi amacıyla kullanıldığı savunulan sistemle bölgedeki tüm telefonların verilerinin toplanabildiği belirtiliyor.
- Daha önce de ABD Ulusal Güvenlik Ajansı'nın (NSA) eski Sistem Analisti Edward Snowden, NSA'nın dünya genelindeki dinleme ve izleme faaliyetlerini ortaya çıkarmış ve bu faaliyetler büyük tepki çekmişti.

Categories of Systems Based upon Air Vehicle Types

- **HALE – High altitude long endurance**. Over 15 000 m altitude and 24+ hour endurance. They carry out extremely long-range (trans-global) reconnaissance and surveillance and increasingly are being armed. They are usually operated by Air Forces from fixed bases.
- **MALE – Medium altitude long endurance**. 5000–15 000 m altitude and 24 hour endurance. Their roles are similar to the HALE systems but generally operate at somewhat shorter ranges, but still in excess of 500 km. and from fixed bases.
- TUAV – Medium Range or **Tactical UAV** with range of order between 100 and 300 km. These air vehicles are smaller and operated within simpler systems than are HALE or MALE and are operated also by land and naval forces.
- Close-Range UAV used by mobile army battle groups, for other military/naval operations and for diverse civilian purposes. They usually operate at ranges of up to about 100 km and have probably the most prolific of uses in both fields, including roles as diverse as reconnaissance, target designation, NBC monitoring, airfield security, ship-to-shore surveillance, power-line inspection, crop-spraying and traffic monitoring, etc.
- **MUAV or Mini UAV** – relates to UAV of below a certain mass (yet to be defined) probably below 20 kg, but not as small as the MAV, capable of being hand-launched and operating at ranges of up to about 30 km. These are, again, used by mobile battle groups and particularly for diverse civilian purposes.
- **Micro UAV or MAV.** The MAV was originally defined as a UAV having a wing-span no greater than 150 mm. This has now been somewhat relaxed but the MAV is principally required for operations in urban environments, particularly within buildings. It is required to fly slowly, and preferably to hover and to ‘perch’ – i.e. to be able to stop and to sit on a wall or post. To meet this challenge, research is being conducted into some less conventional configurations such as flapping wing aircraft. MAV are generally expected to be launched by hand and therefore winged versions have very low wing loadings which must make them very vulnerable to atmospheric turbulence. All types are likely to have problems in precipitation.
- **NAV – Nano Air Vehicles**. These are proposed to be of the size of sycamore seeds and used in swarms for purposes such as radar confusion or conceivably, if camera, propulsion and control sub-systems can be made small enough, for ultra-short range surveillance.

Remotely piloted helicopter (RPH)

- RPH, remotely piloted helicopter or VTUAV, vertical take-off UAV. If an air vehicle is capable of vertical take-off it will usually be capable also of a vertical landing, and what can be sometimes of even greater operational importance, hover flight during a mission. Rotary wing aircraft are also less susceptible to air turbulence compared with fixed-wing aircraft of low wing-loading.

- UCAV and UCAR. Development is also proceeding towards specialist armed fixed-wing UAV which may launch weapons or even take part in air-to-air combat. These are given the initials UCAV for unmanned combat air vehicle. Armed rotorcraft are also in development and these are known as UCAR for Unmanned Combat Rotorcraft.

System Composition

- Control Station (CS)
- The Payload
- The Air Vehicle
- Navigation Systems
- Launch, Recovery and Retrieval Equipment
- Communications
- Interfaces
- Support Equipment

  It ranges from operating and maintenance manuals, through tools and spares to special test equipment and power supplies.
- Transportation
- System Environmental Capability

Navigation Systems

- the aircraft had to carry a sophisticated, complex, expensive and heavy inertial navigation system (INS), or a less sophisticated INS at lower cost, etc., but which required a frequent positional update from the CS via the communications link. This was achieved by radio tracking or by the recognition of geographical features. Nowadays, the availability of a global positioning system (GPS) which accesses positional information from a system of earth-satellites, has eased this problem.
- The accuracy is further improved by the use of differential GPS (DGPS)

a risk of the GPS system being blocked, other means of navigation are possible fall-back options. These methods include:

- Radar tracking. Here the aircraft is fitted with a transponder which responds to a radar scanner emitting from the CS, so that the aircraft position is seen on the CS radar display in bearing and range.
- Radio tracking. Here the radio signal carrying data from the aircraft to the CS is tracked in bearing from the CS, whilst its range is determined from the time taken for a coded signal to travel between the aircraft and the CS.
- Direct reckoning. Here, with the computer-integration of velocity vectors and time elapsed, the aircraft position may be calculated. If the mission is over land and the aircraft carries a TV camera surveying the ground, its position can be confirmed by relating visible geographical features with their known position on a map.

Launch, Recovery and Retrieval Equipment

- Launch equipment. This will be required for those air vehicles which do not have a vertical flight capability, nor have access to a runway of suitable surface and length. This usually takes the form of a ramp along which the aircraft is accelerated on a trolley, propelled by a system of rubber bungees, by compressed air or by rocket, until the aircraft has reached an airspeed at which it can sustain airborne flight.
- Recovery equipment. This also will usually be required for aircraft without a vertical flight capability, unless they can be brought down onto terrain which will allow a wheeled or skid-borne run-on landing. It usually takes the form of a parachute, installed within the aircraft, and which is deployed at a suitable altitude over the landing zone. In addition, a means of absorbing the impact energy is needed, usually comprising airbags or replaceable frangible material. An alternative form of recovery equipment, sometimes used, is a large net or, alternatively, a carousel apparatus into which the aircraft is flown and caught.
- Retrieval equipment. Unless the aircraft is lightweight enough to be man-portable, a means is required of transporting the aircraft back to its launcher.

Communications

- Uplink (i.e. from the CS to the aircraft), Downlink (i.e. from the aircraft to the CS)

The specifications for communications performance will include two fundamental parameters:

- ‘data rate’ which is the amount of data transferred per second by a communications channel and is measured in bytes per second (Bps), and
- ‘bandwidth’ which is the difference between the highest and lowest frequencies of a communications channel, i.e. the width of its allocated band of frequencies and is measured in MHz or GHz as appropriate.

Communication Media

- Laser
- Fiber – Optics
- Radio

Radio Frequency Band Designations

The international forum for worldwide agreement on the use of the radio spectrum and satellite orbits is the World Radio communication Conference (WRC).

There are at least three systems in use to designate frequency bands.

- The International Telecommunication Union (ITU) designations, cover the wide
- spectrum from extremely low frequencies from 3Hz up to the microwave bands.
- The Institute of Electrical and Electronics Engineering (IEEE) designations were the original band ranges developed in World War 2, but do not cover the lower radio ranges below HF.
- The NATO and EU Designations are the more recent series, but do not cover the VHF and HF radio frequencies.

IEEE		EU, NATO, US ECM.	
BAND	FREQUENCY RANGE	BAND	FREQUENCY RANGE
HF	3 to 30MHz	A	0 to 0.25GHz
VHF	30 to 3MHz	B	0.25 to 0.5GHZ
UHF	0.3 to 1.0GHz	C	0.5 to 1.0GHz
L	1 to 2GHz	D	1 to 2GHz
S	2 to 4GHz	E	2 to 3GHz
C	4 to 8GHz	F	3 to 4GHz
X	8 to 12GHz	G	4 to 6GHz
K_U	12 to 18GHz	H	6 to 8GHz
K	18 to 26GHz	I	8 to 10GHz
K_A	26 to 40GHz	J	10 to 20GHz
V	40 to 75GHz	K	20 to 40GHz
W	75 to 111GHz	L	40 to 60GHz
		M	60 to 100GHz

Radio frequency band designation

Tarihsel Gelişim Süreçleri

Genesis of Unmanned Aircraft Systems (UAS)

- The modern Remote Piloted Vehicle (RPV) era began in late 1959, three and a half years after the United States began over flying Russia in the high altitude U-2 aircraft
- The US promised to stop manned missions
- Before satellite reconnaissance was available
- Began development of unmanned reconnaissance assets

Modern Timeline

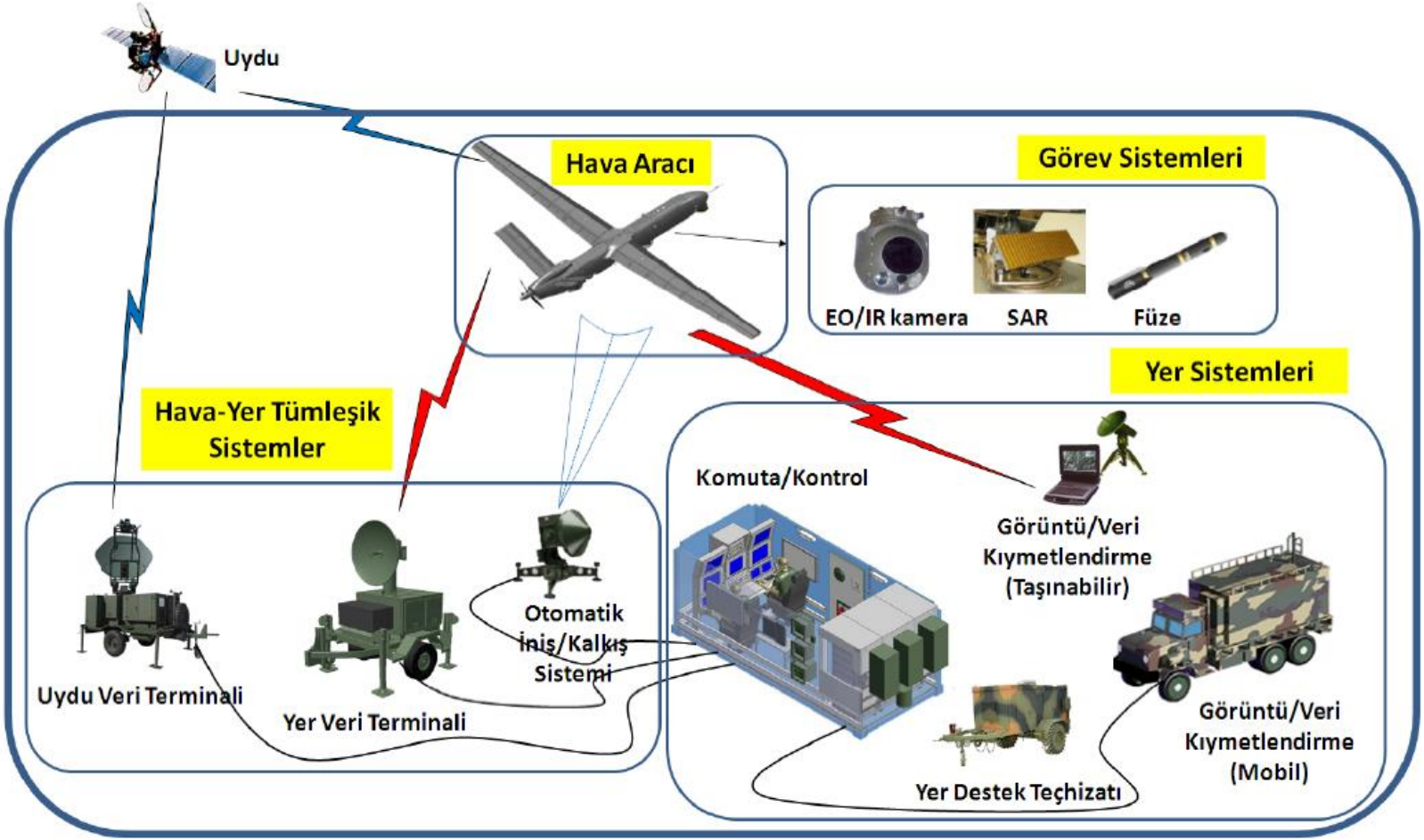
- 1960-80’s - Remote Piloted Vehicle (RPV)
  - Pilot in the loop, had near-real time control of aircraft and flight surfaces
- 1990’s - Unmanned Aerial Vehicle (UAV)
  - Pilot on the loop, beginning of automation, pilot can take over if necessary
- Beginning in 2005 - Unmanned Aircraft System (UAS)
  - Most flight profiles pre-programmed, pilot can modify or take over in emergencies

UAS is a “System”

Unmanned Aircraft
US Army Sky Warrior

Transportable
Ground Control Station

Predator “Cockpit”


Uydu
Hava Aracı
Görev Sistemleri
EO/IR kamera
SAR
Füze
Yer Sistemleri
Hava-Yer Tümleşik Sistemler
Komuta/Kontrol
Görüntü/Veri Kıymetlendirme (Taşınabilir)
Uydu Veri Terminali
Yer Veri Terminali
Otomatik İniş/Kalkış Sistemi
Görüntü/Veri Kıymetlendirme (Mobil)
Yer Destek Teçhizatı

UAS Manned Aircraft

- Remotely piloted vehicles will never fully replace manned aircraft
- They can perform an increasingly sophisticated array of missions due to their small size and decreased radar, acoustical, and infrared signatures.
- To wholly replace man would be expensive and technically risky.
- UAS should be only considered for certain types of missions for which it can be a cost effective (dirty, dull and dangerous)
- The absence of an aircrew means that a great deal of space and weight can be saved.
- With a continuing trend of miniaturization in electronics and other components, the RPV can be made much smaller and cheaper
- Size largely determined by the size of the payload,
- Could be a sophisticated electronics package or weapons system

UAV classification

- Target and decoy - providing ground and aerial gunnery a target that simulates an enemy aircraft or missile
- Reconnaissance - providing battlefield intelligence
- Combat - providing attack capability for high-risk missions
- Logistics - UAVs specifically designed for cargo and logistics operation
- Research and development - used to further develop UAV technologies to be integrated into field deployed UAV aircraft
- Civil and Commercial UAVs - UAVs specifically designed for civil and commercial applications

Casus Uçaklar

- Tek bir tuşa basarak keşif yapma olanağı sağlayan mini insansız hava araçları kullanacak. Daha kapsamlı istihbarat almakı amaçlanıyor.
- Füzeleri ve top mermilerini havada durdurup imha edebilen gelişkin bir füzesavar savunma sistemi. Atılan roketlerin engellenmesinde bu sistemin büyük rolü olacak.

Taranis

- Taranis" isimli uçak, İngiltere'nin çokuluslu savunma şirketi BAE Systems'ın da en tuhaf görünen hava aracı.
- Çatışma bölgelerinde uzun menzilli atışlar yapabilecek insansız savaş uçakları
- Düşük radar kapasitesi ve kızılötesi ışınlarla nesneleri tespit etme özelliklerine sahip olacak şekilde tasarlanan Taranis'in gelişmiş bir egzoz sitemi var. Motorlarının ısısıyla çıkabilecek izlerin takip edilmemesi ve vurulmaması için farklı bir teknolojiye sahip.

Elde Taşınabilir İnsansız Hava Araçları

- Norveç merkezli Prox Dynamics AS'ın geliştirmiş olduğu Black Hornet Nano,
- Kendi küçük ama önemi büyük olan bu insansız hava araçlarıyla tehlikeli koşullardaki muhtemel kayıpların önüne geçilmesi planlanıyor.
- Black Hornet Nano yapı olarak mini helikopterlere benzese de, ağır hava koşullarına ve sert rüzgarlara daha dayanıklı olarak imal edilmiş.
- Minik İHA tam şarjlı durumda 30 dakika boyunca maksimum hızı olan 35 km/sa ile uçarak almış olduğu bilgileri askerleri merkezlere ulaştırmakta.
- Operatör, İHA'yı uçurmak için kontrol ünitesini kullanabileceği gibi direkt olarak sisteme yüklediği GPS koordinatları ile cihazın kendi kendisini uçurmasını sağlayabilir.

Quadrotor helikopter

- İHA lar iki sınıfa ayrılır: İlki uzaktan kumanda edilerek uçan diğeri ise kendiliğinden belli bir uçuş planı üzerinden otomatik olarak hareket edebilen uçaklardır.
- Keşif amaçlı üretilen İHA lar günümüzde birçok saldırı görevinde de kullanılmaktadır.
- İHA'lar aynı zamanda yangın söndürmek amaçlı olarak da kullanılmaktadır. Bu araçlar genellikle normal savaş uçakları için zor, kirli ve tehlikeli görevlerde kullanılır.
- Quadrotor helikopter, quadrocopter, quadrotor ve quadracopter isimleri verilen quadcopter, dört motor tarafından kaldırılan ve yürütülen bir multicopterdir. Sabit kanatlı hava araçlarının aksine quadcopterler kaldırma kuvvetini dönen kirişlerden elde ettiği için rotorcraft sınıfına girer. Helikopterlerin aksine, quadkopterler genellikle simetrik olarak yerleştirilmiş pervaneler kullanır. Bunlar kollektif olarak ayarlanır ancak helikopterdeki gibi “cyclic” değildir. Cihazın kontrolü motorların dönüş hızını değiştirerek, yani tork yükünü ve itme/kaldırma karakteristiklerinde farklılık yaratarak sağlanır.
- Bu araçlar elektronik kontrol sistemleri ve elektronik sensörlerle stabilize olur. Küçük tasarımları ve çevik manevra kabiliyeti sayesinde hem kapalı hem açık alanda uçurulabilirler.

Drone

- Savunma ve havacılık sektörüne yönelik araştırmalar yapan Teal Group'un yaptığı bir araştırma, çok değil, 10 yıl sonra insansız hava araçları "uygulama pazarının" 11.5 milyar dolarlık bir büyüklüğe ulaşacağını gösteriyor. Bu teknolojinin gelişimi için yapılan harcamalar ise 6.4 milyar doları bulmuş durumda. Yine aynı tarihlerde drone ekonomisinin askeri ve sivil toplam 100 milyar doları aşacağı öngörülüyor.

Türkiye

- Türk hükûmeti, TUSAŞ-Türk Havacılık ve Uzay Sanayi (TAİ) ile 2016-2018 yılları arasında teslim edilecek yer kontrol istasyonlarıyla birlikte 10 adet ANKA insansız hava aracı üretimi için bir sözleşme imzaladı.
- Kale ve Baykar- geçen günlerde, taktik insansız hava aracı Bayraktar'ı test etti. Şirketler, ilk üç testin tatmin edici olduğunu ve Bayraktar'ın üç saat boyunca 18,750 feet (5,700 metre) yükseklikte uçtuğunu açıkladı.
- Vestel Savunma Sanayi A.Ş. de 2005 yılından beri toplamda 30 milyon dolarlık bir yatırımla taktik insansız hava aracı Karayel'in geliştirilmesi için çalışıyor. Şirket, yakında altı adet Karayel'in, üç adet yer kontrol istasyonu ve ilgili destek sistemlerinin teslim edilmeye başlanacağını bildirdi. Uçağın 21,500 feet (6,500 metre) yüksekliğe çıktığı önceden test edilmişti.

Raven

Mission

The RQ-11 Raven Small Unmanned Aircraft System is a small man-portable UAS that performs reconnaissance, surveillance, and target acquisition missions for Air Force Special Operations Command Battlefield Airmen and Air Force security forces.

Features

The Raven back-packable UAS features two air vehicles or AVs, a ground control unit, remote video terminal, transit cases and support equipment. Two specially trained Airmen operate the Raven AV. The AV can be controlled manually or can autonomously navigate a preplanned route.

The Raven includes a color electro-optical camera and an infrared camera for night operations. The air vehicle is hand-launched, weighs less than 5 pounds, has a range of 10-15 kilometers and an endurance of up to 80 minutes.

Background

The Raven system has proven itself in combat supporting U.S. operations in Iraq and Afghanistan, and other areas of conflict. The Raven is now used by all of the military services. Air Force security forces are currently purchasing the Raven UAS to replace its aging Desert Hawk UAS.

General Characteristics
Primary Function: Situational awareness and direct target information
Contractor: Aerovironment, Inc.
Power Plant: Electric Motor, rechargeable lithium ion batteries
Wingspan: 4.5 feet (1.37 meters)
Weight: 4.2 lbs (1.9 kilograms)
Weight (ground control unit): 17 lbs (7.7 kilograms)
Speed: 30-60 mph (26-52 knots)
Range: 8-12 km (4.9-7.45 miles)
Endurance: 60-90 minutes
Operating Altitude: 150-500 feet air ground level (45-152 meters)
System Cost: approximately $173,000 (2004 dollars)
Payload: High resolution, day/night camera and thermal imager
Date deployed: 2004
Inventory: Classified

Shadow

- The Shadow 200 is a small, lightweight, tactical UAV system. The system is comprised of air vehicles, modular mission payloads, ground control stations, launch and recovery equipment.
- The air vehicle is intended to provide coverage of a brigade area of interest for up to four hours, at 50 kilometers from the launch and recovery site.
- The maximum range is 125 kilometers (limited by data link capability), and operations are generally conducted from 8,000 to 10,000 feet above ground level during the day and 6,000 to 8,000 feet above ground level at night.
- The air vehicle uses a pneumatic launcher and is recovered by a tactical automatic landing system without pilot intervention on the runway. The air vehicle is stopped using an arresting hook and cable system.

Performance:
Speed 194.5km/h (105kt)
Flight Ceiling 4,572m (15,000ft)
Endurance 5 to 7 hours
Mission Radius 200km
Climb Rate 300m to 450m a minute
Take-Off Distance (Launcher) 10m
Maximum Dash Speed 219km/h (118kt)
Cruise Speed 167km/h (90kt)
Loiter Speed 111km/h (60kt)
Datalinks:
X band, C band, UHF
Standard Datalink Range 50km
Optional Datalink Range 200km

MQ-1 Predator

- **Mission**
  The MQ-1 Predator is a medium-altitude, long-endurance, unmanned aircraft system
- The MQ-1's primary mission is interdiction and conducting armed reconnaissance against critical, perishable targets

Features

- The basic crew for the Predator is one pilot and two sensor operators. They fly the aircraft from inside the ground control station via a line-of-sight data link or a satellite data link for beyond line-of-sight flight
- The aircraft is equipped with a color nose camera (generally used by the pilot for flight control), a day variable-aperture TV camera, a variable-aperture infrared camera (for low light/night), and other sensors as the mission requires. The cameras produce full-motion video.
- The MQ-1 Predator carries the Multi-spectral Targeting System which integrates electro-optical, infrared, laser designator and laser illuminator into a single sensor package. The aircraft can employ two laser-guided AGM-114 Hellfire anti-tank missiles

General Characteristics
Wingspan: 48.7 feet (14.8 meters)
Length: 27 feet (8.22 meters)
Height: 6.9 feet (2.1 meters)
Weight: 1,130 pounds (512 kilograms) empty
Maximum takeoff weight: 2,250 pounds (1,020 kilograms)
Fuel Capacity: 665 pounds (100 gallons)
Payload: 450 pounds (204 kilograms)
Speed: Cruise speed around 84 mph (70 knots), up to 135 mph
Range: up to 400 nautical miles (454 miles)
Ceiling: up to 25,000 feet (7,620 meters)
Armament: two laser-guided AGM-114 Hellfire missiles

Global Hawk

Mission

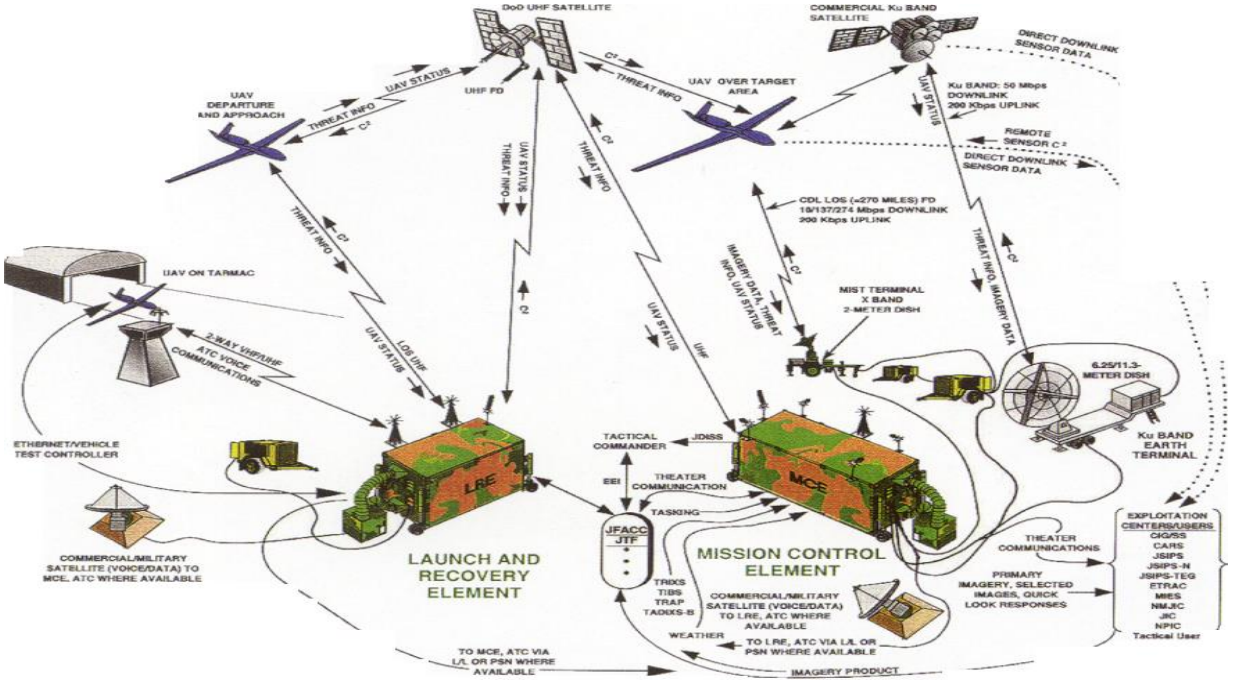
- The RQ-4 Global Hawk is a high-altitude, long-endurance unmanned aircraft system with an integrated sensor suite that provides intelligence, surveillance and reconnaissance, or ISR, capability worldwide
- Global Hawk's mission is to provide a broad spectrum of ISR collection capability to support joint combatant forces in worldwide peacetime, contingency and wartime operations
- The Global Hawk complements manned and space reconnaissance systems by providing near-real-time coverage using imagery intelligence (IMINT) sensors.

Features

- The Global Hawk system consists of the RQ-4 aircraft, mission control element, or MCE, launch and recovery element, or LRE, sensors, communication links, support element and trained personnel
- The IMINT sensors include synthetic aperture radar, electro-optical and medium-wave infrared sensors.
- The system offers a wide variety of employment options
- The long range and endurance of this system allow tremendous flexibility in meeting mission requirements.

General Characteristics
Primary function: High-altitude, long-endurance intelligence, surveillance and reconnaissance
Contractor: Northrop Grumman (Prime), Raytheon, L3 Comm
Power Plant: Rolls Royce-North American AE 3007H turbofan
Thrust: 7,600 pounds
Wingspan: (RQ-4A) 116 feet (35.3 meters); (RQ-4B) 130.9 feet (39.8 meters)
Length: (RQ-4A) 44 feet (13.4 meters); RQ-4B, 47.6 feet (14.5 meters)
Height: RQ-4A 15.2 (4.6 meters); RQ-4B, 15.3 feet (4.7 meters)
Speed: RQ-4A, 340 knots (391 mph); RQ-4B, 310 knots (357 mph)
Range: RQ-4A, 9,500 nautical miles; RQ-4B, 8,700 nautical miles
Ceiling: 60,000 feet (18,288 meters)

GLOBAL HAWK
SPECTRUM REQUIREMENTS



Some Possible Global Hawk Frequency Bands

- 112.7 - 117.9 MHz
- 118 - 136 MHz
- 225 - 400 MHz
- 1030 - 1090 MHz
- 1217 - 1235 MHz (L2)
- 1530 - 1559 MHz
- 1565 - 1585 MHz (L1)
- 1626 – 1660.5 MHz
- 2.3 - 2.4 GHz
- 4.2 - 4.4 GHz
- 5.4 - 5.9 GHz
- 8.4 - 9.0 GHz
- 9.75 - 9.95 GHz
- 10.015 – 10.425 GHz
- 10.95 – 12.75 GHz
- 14.0 - 14.5 GHz

Agenda Item 1.3, WRC-2011

- AI 1.3 to consider spectrum requirements and possible regulatory actions, including allocations, in order to support the safe operation of unmanned aircraft systems (UAS), based on the results of ITU R studies, in accordance with Resolution 421 (WRC 07)

Resolution 421

resolves

- that WRC-11 consider, based on the results of ITU-R studies:
  - the spectrum requirements and possible regulatory actions, including additional allocations, to support the remote pilot in commanding and controlling the unmanned aircraft systems and in relaying the air traffic control communications, as mentioned in *considering c)*;
  - the spectrum requirements and possible regulatory actions, including additional allocations, to support the safe operation of unmanned aircraft systems not covered by *resolves* 1, as mentioned in *considering d)*,

UAV Communications

- **RF basics**
  - Data link types
  - Frequency bands
  - Antennae
  - Equations
- **Communications issues**
  - Architecture
  - Function
  - Coverage
  - Etc.
- **Sizing (air and ground)**
  - Range
  - Weight
  - Volume
  - Power

Data link types

- Simplex - One way point-to-point
- Half duplex - Two way, sequential Tx/Rx
- Full duplex - Two way, continuous Tx/Rx
- Modem - Device that sends data sent over analog link
- Omni directional - Theoretically a transmission in all directions (4π steradian or antenna gain $\equiv 0$) but generally means 360 degree azimuth coverage
- Directional - Transmitted energy focused in one direction (receive antennae usually also directional)
  - *The more focused the antennae, the higher the gain*
- Up links - used to control the UAV and sensors
- Down links - carry information from the UAV (location, status, etc) and the on-board sensors

Frequency bands

Civil Radio band designation

1-10 kHz	VLF (very low frequency)
10-100 kHz	LF (low frequency)
100-1000 kHz	MF (medium frequency)
1-10 MHz	HF (high frequency)
10-100 MHz	VHF (very high frequency)
100-1000 MHz	UHF (ultra high frequency)
1-10 GHz	SHF (super high frequency)
10-100 GHz	EHF(extremely high frequency)

US Military and Radar bands

1-2 GHz	L Band
2-4 GHz	S Band
4-8 GHz	C Band
8-12 GHz	X Band
12-18 GHz	Ku Band
18-27 GHz	K Band
27-40 GHz	Ka Band
40-75 GHz	V Band
75-110 GHz	W Band
110-300 GHz	mm Band
300-3000 GHz	μmm Band

NATO

D Band
E/F Band
G/H Band
I Band
J Band
K Band
K Band
L Band
M Band

Note - NATO designations cover <u>almost</u> the same frequency ranges

Satellite band designation

S Band	1700-3000 MHz
C Band	3700-4200 MHz
Ku1 Band	10.9-11.75 GHz
Ku2 Band	11.75-12.5 GHz
Ku3 Band	12.5-12.75 GHz
Ka Band	18.0-20.0 GHz

Safety communications

- Agenda item 1.3 of WRC-11
  - Objective: take decision on globally harmonized spectrum for the safe and seamless insertion of UAS in non-segregated airspaces
  - Current status (in line with ICAO position): to be accommodated under AMS(R)S (Aeronautical Mobile Satellite (en-Route) Service), initial focus on existing allocations
- Existing AMS(R)S bands:
  - L-band (1.6 GHz/1.5GHz)
  - 5GHz band (shared with MLS)

Payload communications

- Possible ITU services: AMSS (Aeronautical Mobile Satellite Service) and MSS (Mobile Satellite Service)
- Possible frequency bands: higher frequencies preferred (antenna size, available bandwidth):
  - Ku-band (14/11 GHz) ➔ High commercial use
  - Ka-band (30/20 GHz) ➔ Partly restricted for governmental/defense use (NATO countries)
  - X-band (8/7 GHz) ➔ Governmental/defense use (NATO countries)
  - Q/V band (40-50 GHz) ➔ Partly restricted for governmental/defense use (NATO countries)

- **Carrier frequency**

  - The center frequency around which a message is sent
  - The actual communication or message is represented by a modulation (e.g. FM) about the carrier

- **Bandwidth**

  - The amount (bandwidth) of frequency (nominally centered on a carrier frequency) used to transmit a message
  - Not all of it is used to communicate
    - *Some amount is needed for interference protection*
  - Sometimes expressed in bauds or bits per second but this is really the data rate

- **The physical orientation of an RF signal**
  - Typically determined by the design of the antenna
  - But influenced by ground reflection
- **Two types of polarization, linear and circular**
  - Linear polarity is further characterized as horizontal ("h-pole") or vertical ("v-pole")
    - *A simple vertical antenna will transmit a vertically polarized signal. The receiving antenna should also be vertical*
    - *V-pole tends to be absorbed by the earth and has poor ground reflection (∴tracking radars are V-pole).*
    - *H-pole has good ground reflection which extends the effective range (∴ used for acquisition radars)*
  - Circular polarity typically comes from a spiral antenna
    - *EHF SatCom transmissions are usually circular*
    - *Polarization can be either right or left hand circular*

- **Antenna gain - a measure of antenna performance**

  - Typically defined in dBi = 10*log10(P/Pi)
    - *where P/Pi = ability of an antenna to focus power vs. theoretical isotropic (4 π steradian) radiation*
    - *Example - an antenna that focuses 1 watt into a 3deg x 3 deg beam (aka "beam width") has a gain of*

      *10*Log10(1/3^2/1/360^2) = 41.6 dB*

  - For many reasons (e.g., bit error rates) high gain antennae (>20dBi) are required for high bandwidth data
    Example - 10.5 Kbps Inmarsat Arero-H Antenna

  - For small size and simplicity, low gain antenna (< 4 dBi) are used…….. for low bandwidth data
    Example - 600 bps Inmarsat Aero-L Antenna

Free space loss

- The loss in signal strength due to range (R)
  $= (\lambda/4\pi R)^2$
- Example : 10 GHz (λ=0.03m) at 250 Km = 160.4 dBi

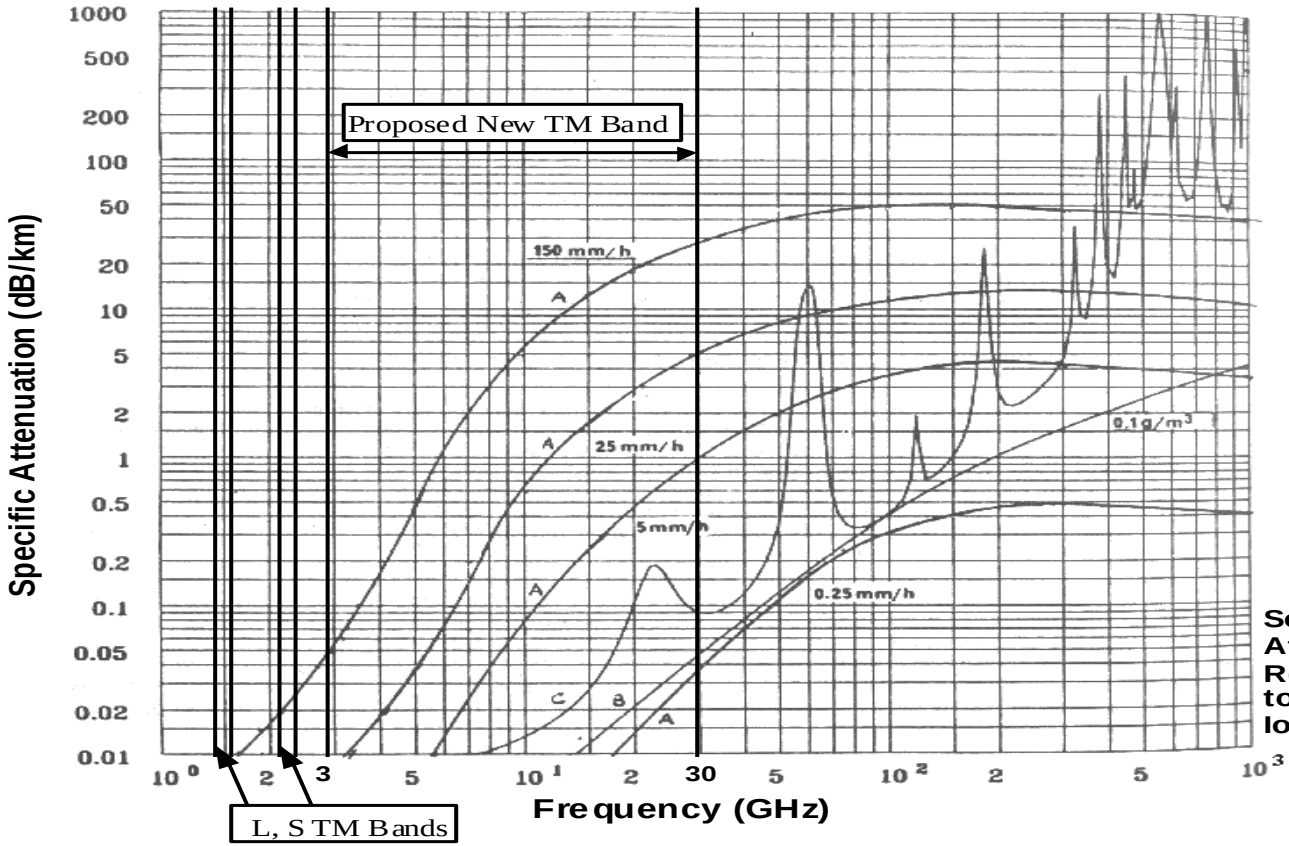
Atmospheric absorption

- Diatomic oxygen and water vapor absorb RF emissions
- Example : 0.01 radian path angle at 250 Km = 2.6 dB

Precipitation absorption

- Rain and snow absorb RF emissions
- Example : 80 Km light rain cell at 250 Km = 6.5 dB

Atmospheric Attenuation vs. Frequency



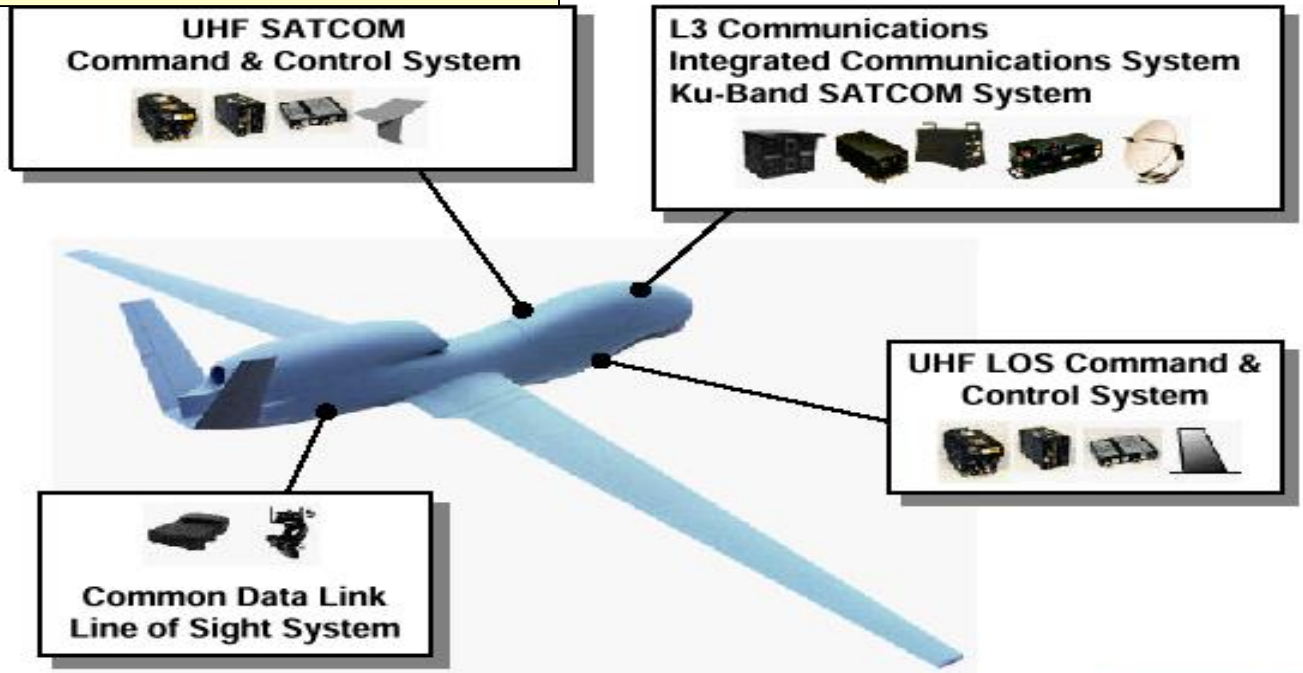
A: Rain
- Downpour (150 mm/hr)
- Heavy (25 mm/hr)
- Light (5 mm/hr)
- Drizzle (0.25 mm/hr)

B: Fog (0.1g/m^3)

C: Gaseous (H_2O + O_2)

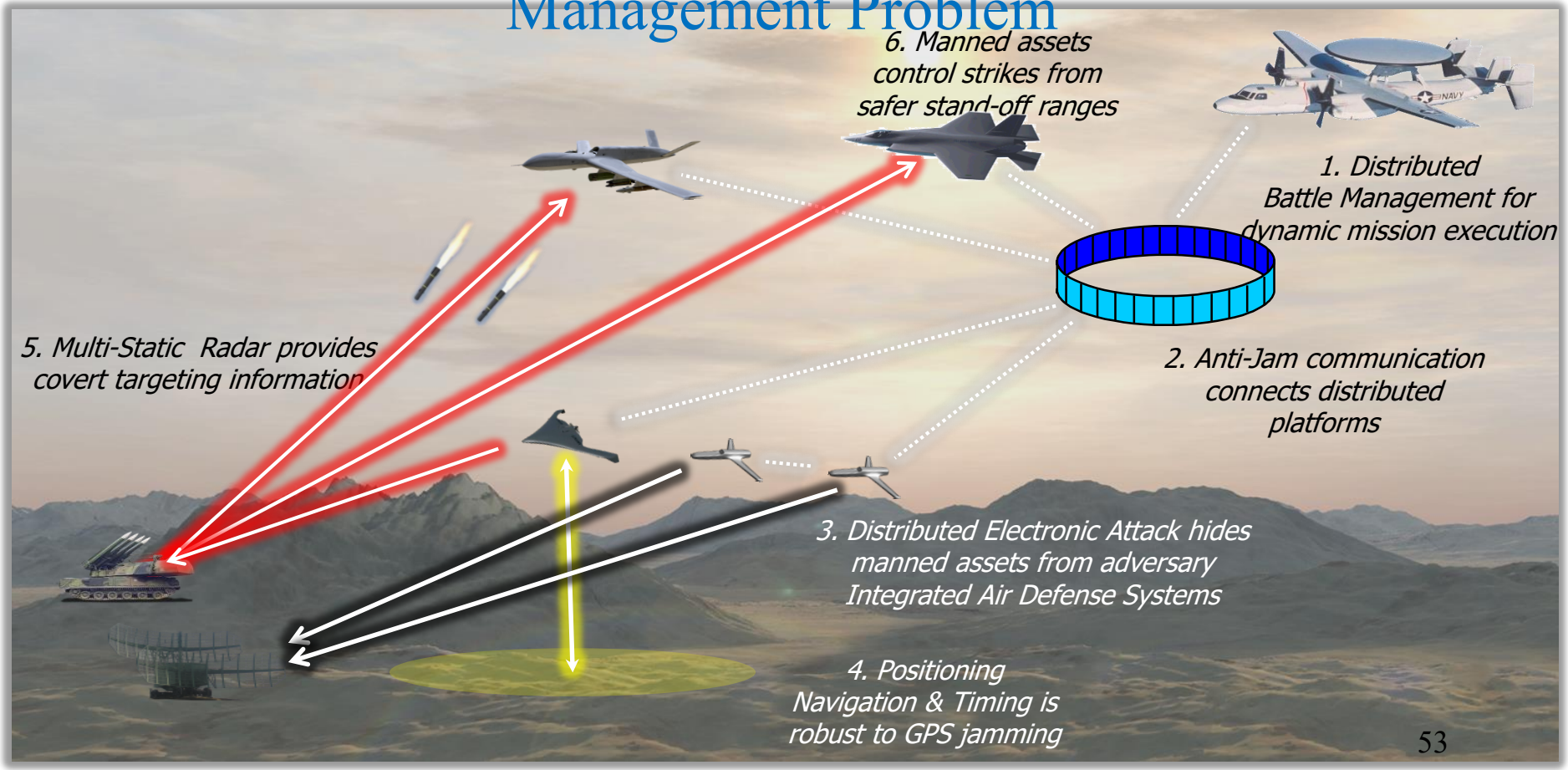
Source: Attenuation by Atmospheric Gases, Report 719-3, Reports of the CCIR, 19990, Annex to Vol. V: Propagation in Non-Ionized Media, Geneva, 1990, pg. 190.

ADT = Air "data terminal"

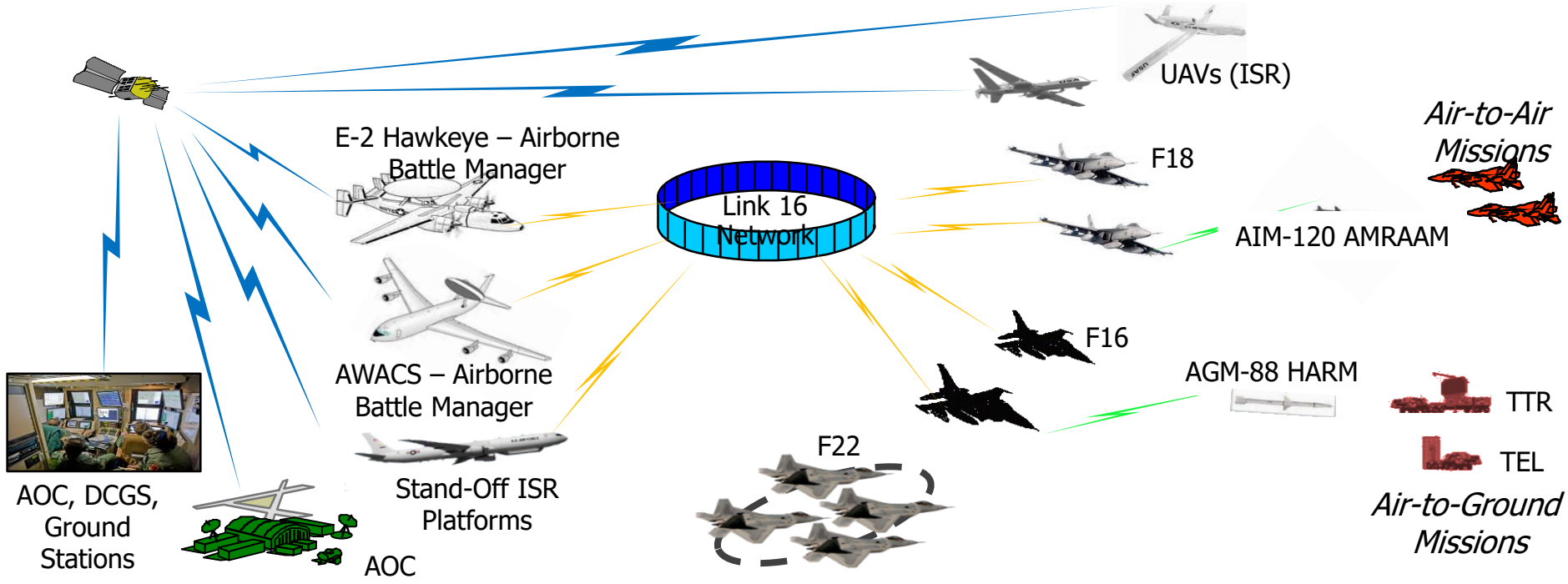


NORTHROP GRUMMAN

Systems of Systems Multiply the Complexity of the Management Problem



Robust Communications

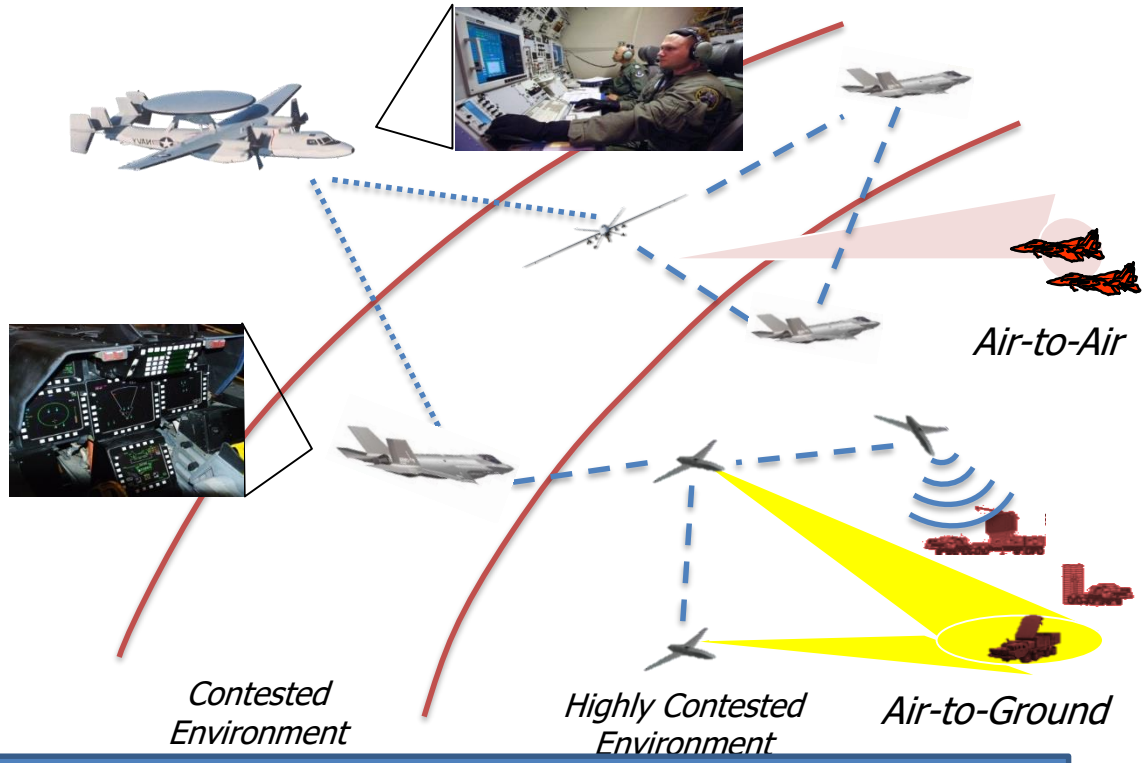


AWACS = Airborne Warning And Control System
AMRAAM = Advanced Medium Range Air-to-Air Missile
AOC = Air Operations Center
DCGS = Distributed Common Ground Station
HARM = High-speed Anti-Radiation Missile
ISR = Intelligence, Surveillance, and Reconnaissance
TEL = Transporter Erector Launcher
TTR = Target Tracking Radar
UAV = Unmanned Aerial Vehicle

Management to the Tactical Edge Enables

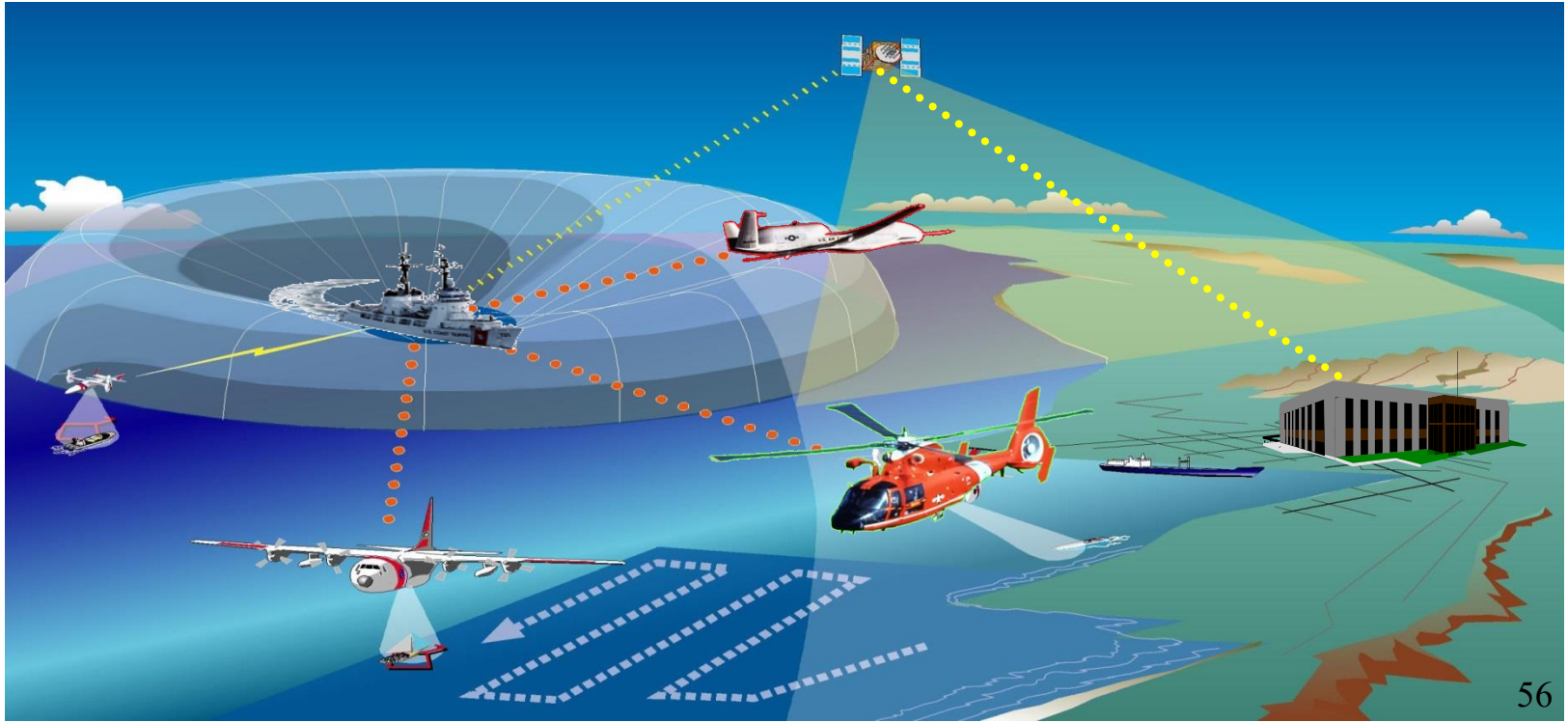
System of Systems (SoS)
- Architecture incorporating innovative technologies and legacy capabilities
- Disaggregated and fractionated capabilities

DBM Challenges
- Distributed Adaptive Planning and Control
- Distributed Situation Understanding
- Human-Machine Integration

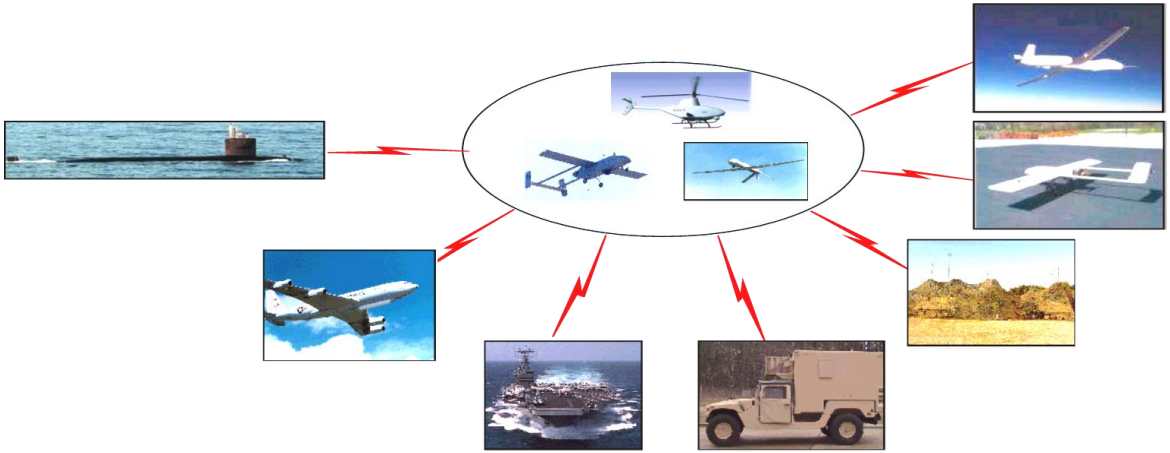


Management Algorithms and Software Needed to Help Pilots and Operators Manage Scale and Complexity with Limited Communications

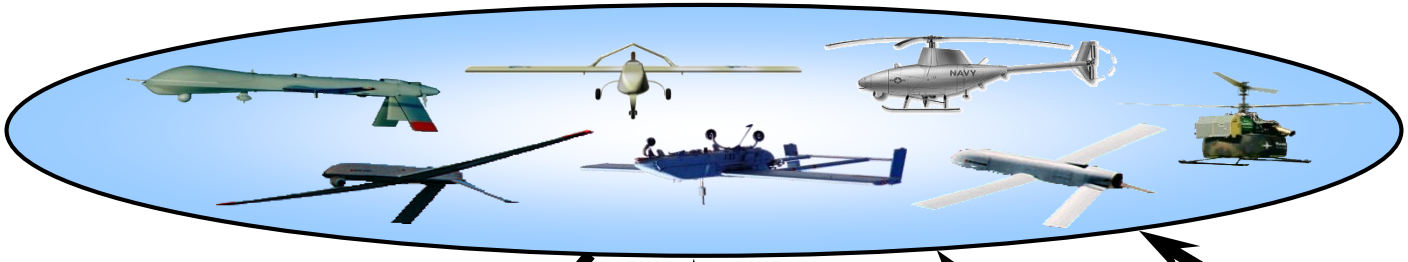
Improving interoperability among joint agencies through the use of tactical control systems & communications



TACTICAL CONTROL SYSTEM



TCS Defined Levels Of AV Command and Control



LEVEL I
- Secondary Product

LEVEL II
- Direct Data Receipt

LEVEL III
- Payload Control
- Direct Data Receipt

LEVEL IV
- Flight Control
- Payload Control
- Direct Data Receipt

LEVEL V
- Launch & Recovery
- Flight Control
- Payload Control
- Direct Data Receipt

Telemetrik ve Algılama

Signature

- Ses, Titreşim, Sismik
- Görsel
- Kızıl Ötesi Termal
- Radio/Radar
- Kimyasal, Renk, Gaz

Telemetry Inevitable in Global Missions

Platforms on balloon, sounding rocket and UAV required for In-situ-measurements & calibration of satellite and groundborne instruments

Examples of important disciplines :

- Geophysics

  Atmosphere, Land , Sea, Ice Research
- Biology

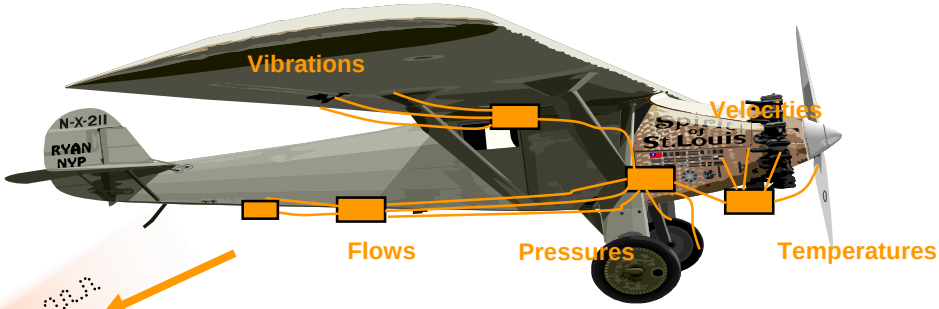
  Animal behaviour & wildlife research
- Remote Medical Supervision

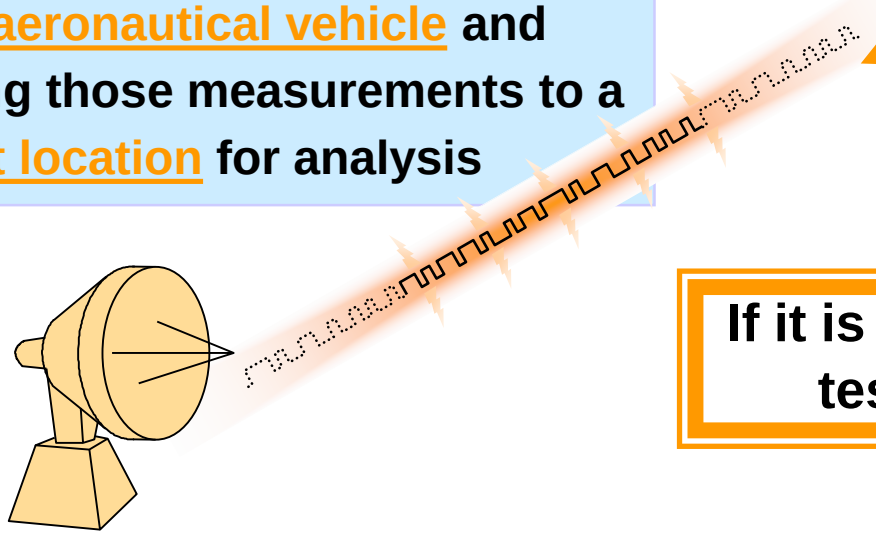
  patient monitoring e.g. at expeditions („bush telemetry“)

What is Telemetry?

- **Telemetry : The process of measuring at a distance.**

- **Aeronautical telemetry: The process of making measurements on an aeronautical vehicle and sending those measurements to a distant location for analysis**





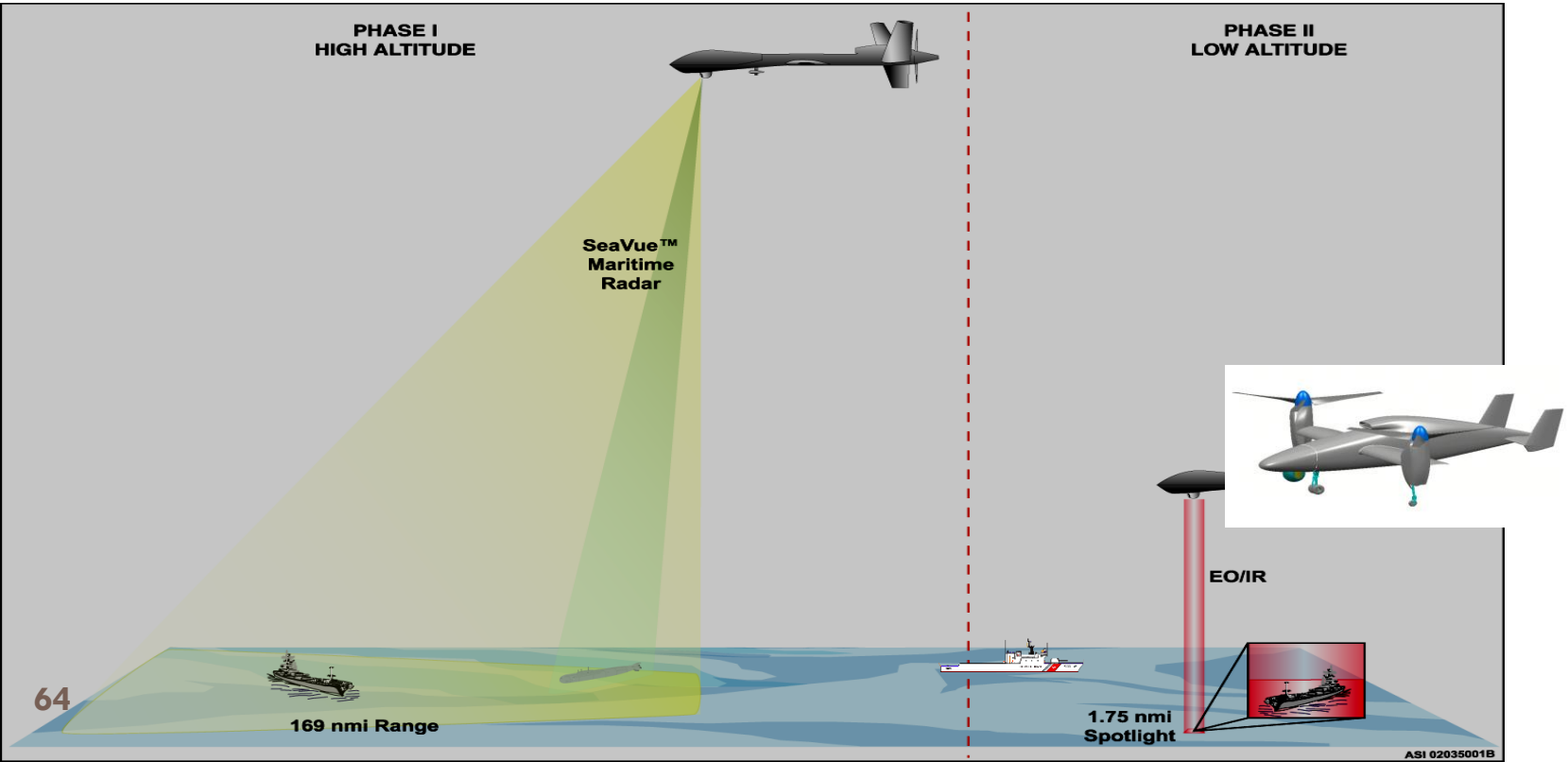
If it is ORANGE it is flight test measurement

TELEMETERING APPLICATIONS

- **The use of telemetry spectrum is common to many different nations and many purposes**
  - **National defense**
  - **Commercial aerospace industry**
  - **Space applications**
  - **Scientific research**

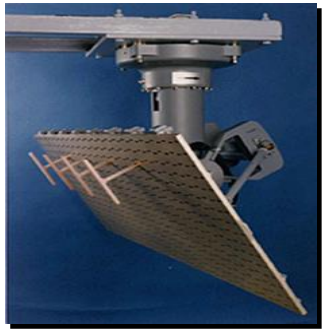
- **The primary telemetering applications represented by ICTS are**
  - **Range and range support systems**
    - **Land mobile**
    - **Sea ranges**
    - **Air ranges**
  - **Space-based telemetry systems**
  - **Meteorological telemetry**

Sensor combinations to extend shipboard detection capabilities while enhancing classification and identification



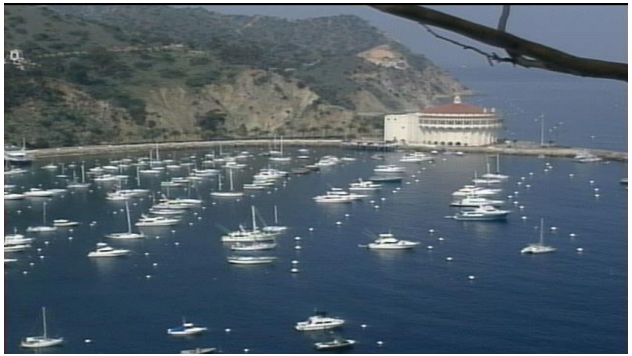
Why choose an airborne surveillance sensor?

- **Large area coverage**
- **Remote area coverage**
- **High-resolution imagery**
- **Long dwell times over areas of interest**
- **Readily available technology**
- **Flexibility in tasking**
- **Ability to operate in hostile environments**



Imaging Sensors

- **Film & Digital Cameras**



- **Low-light TV Cameras**

Imaging Sensors

- **Electro-optical/Infrared Imagers (EO/IR)**



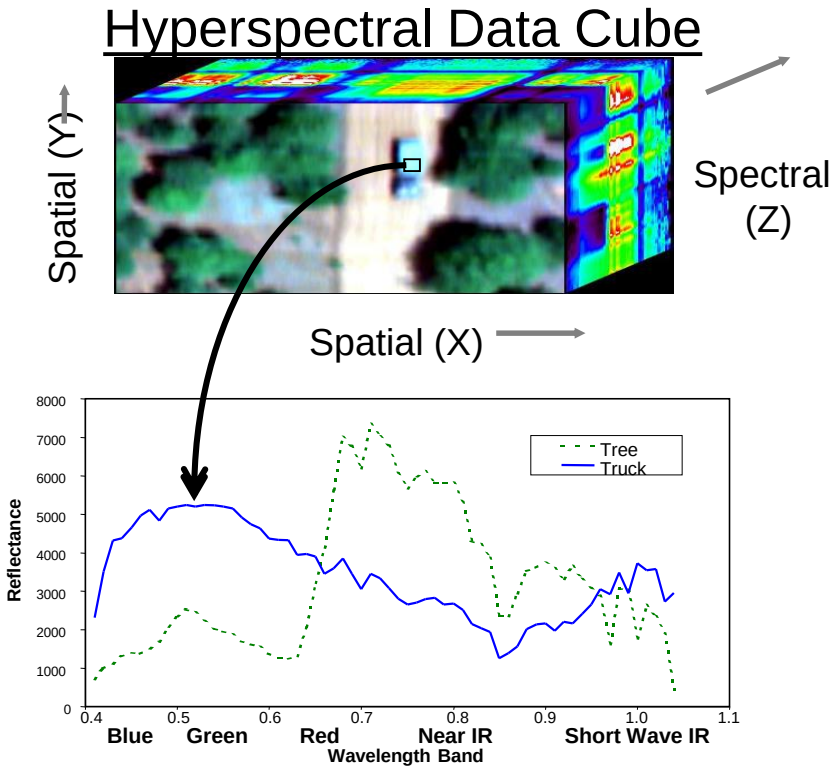

- **Multispectral Imagers**

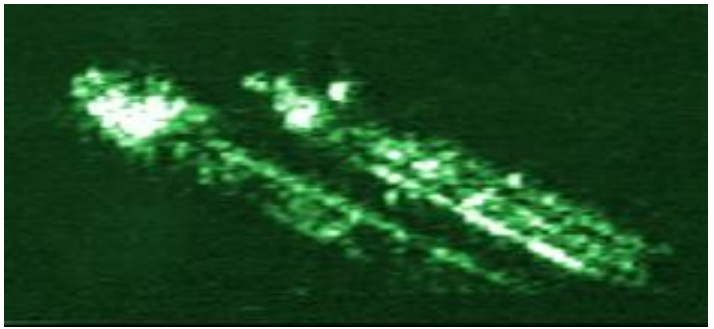
  Combine Low Light Images with FLIR



Imaging Sensors

- **Hyperspectral Imagers**

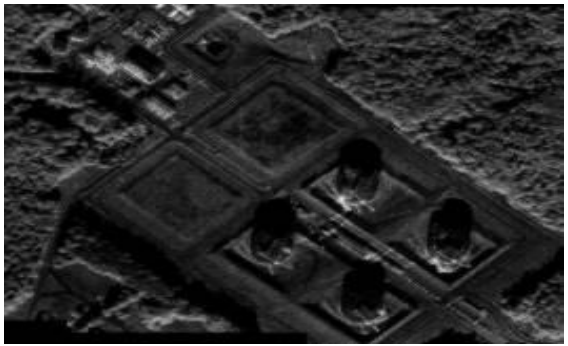




Imaging Sensors

- **Synthetic Aperture Radars (SAR)**

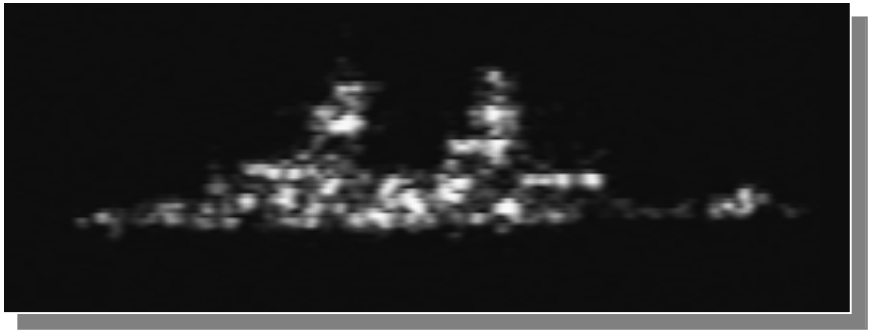
Visual Image



SAR Image

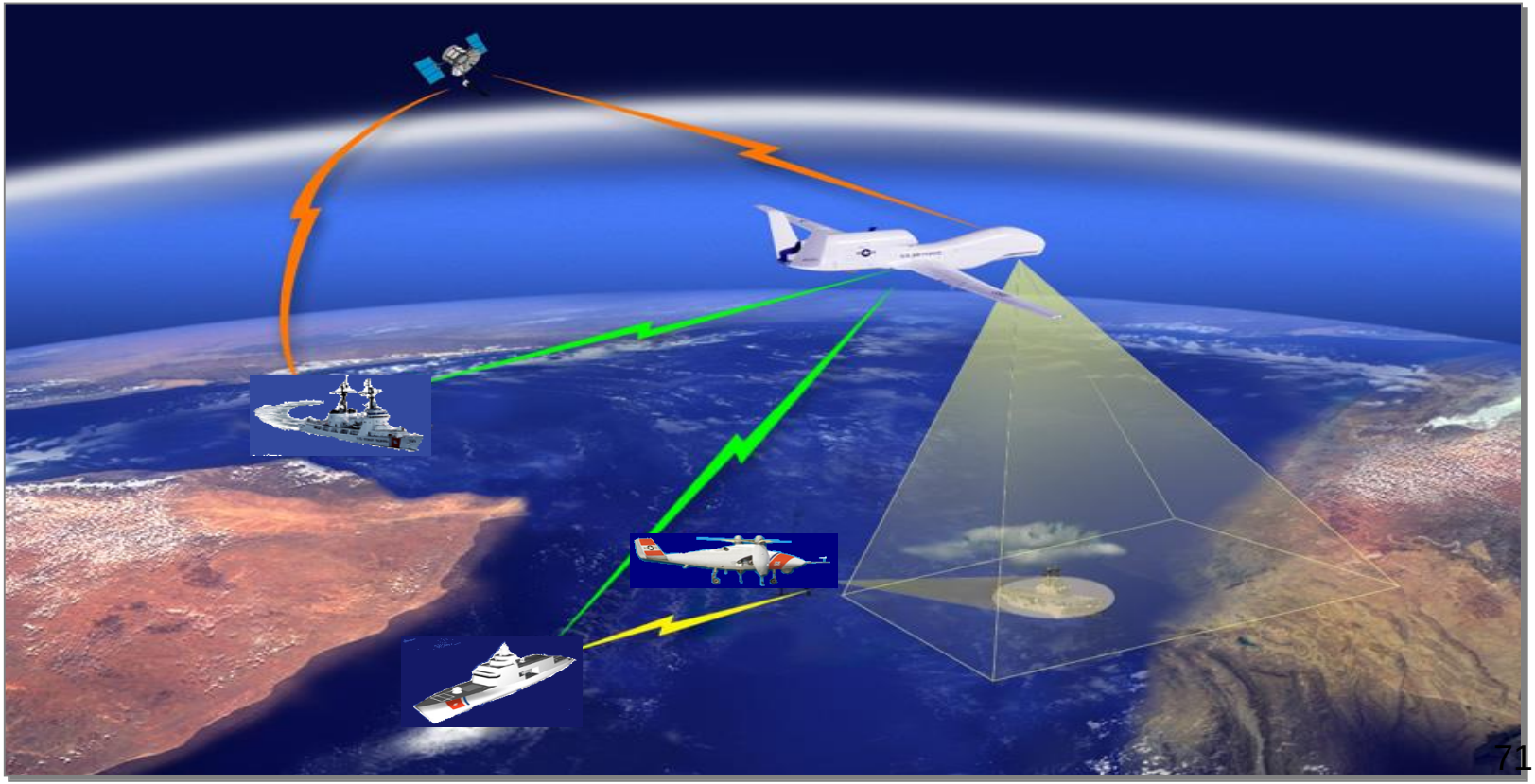
Imaging Sensors

- **Inverse Synthetic Aperture Radars (ISAR)**



- **LIDAR - In the far term, range-gated laser imaging radars (LIDARs) will complement traditional radars by providing the capability to build three-dimensional images in real time of suspected targets found by the latter.**

Telemetry Dissemination and its Role in Maritime Homeland Defense



Available Dissemination Capabilities

TCDL Antenna

Telemetry provides for Command &Control of UAV,

System Health Monitoring,

Single Payload Transmission @ 30fps.

UHF Antenna

Provides Command & Control of UAV,

System Health Monitoring @ 10fps.

IRIDIUM

Commercial Communication Satellite System

Command & Control of UAV, limited Payload.

KU Band

Over the Horizon Satellite Capability, cost effectiveness vs. availability.

Tehdit Algılama ve İmha Yetenekleri

UAV “Killer Bees”

Raytheon Corp.

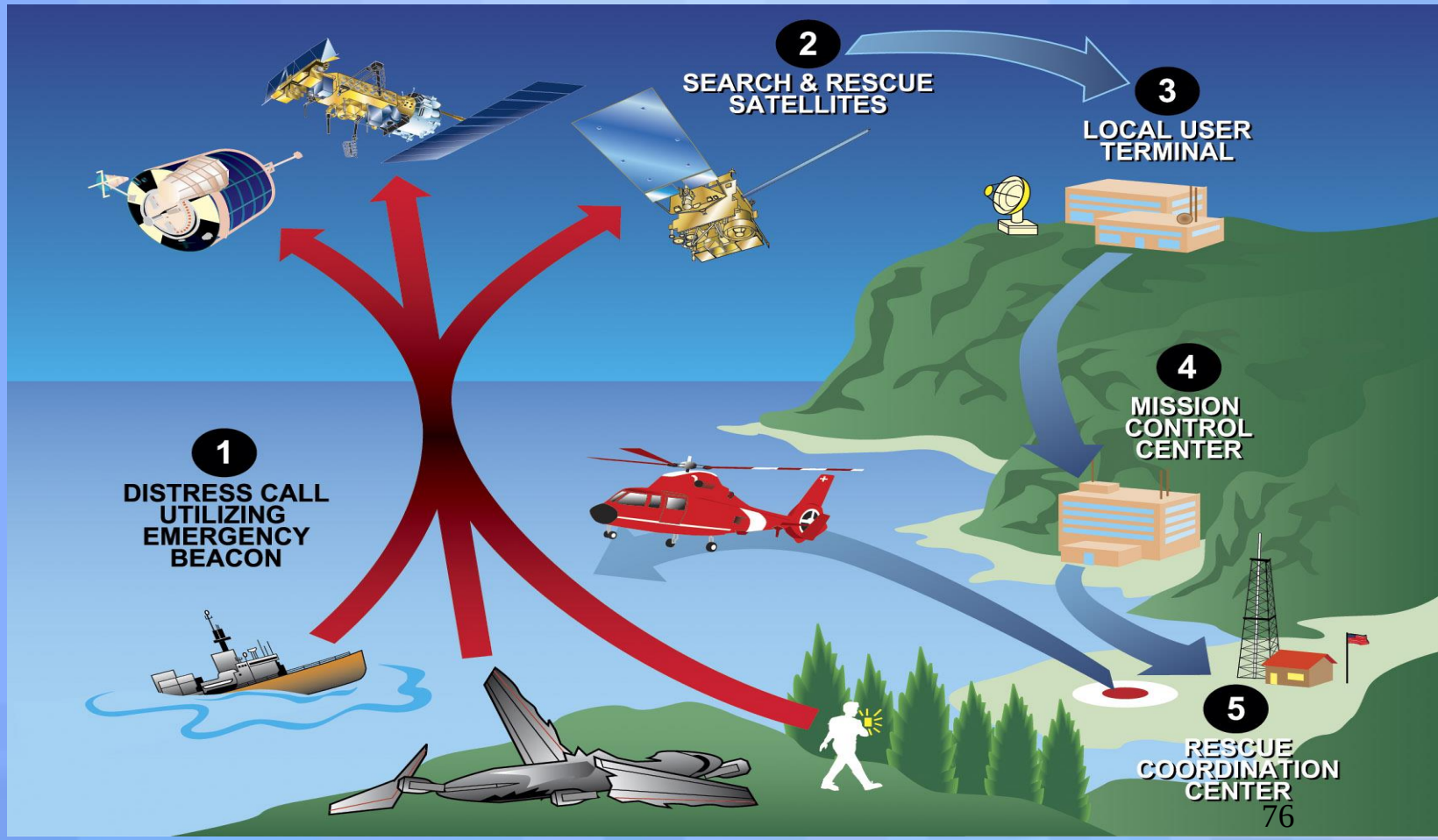
UAV “KillerBees”

“It has systems for land or sea launch, recovery and ground control……During the land-based test, KillerBee was recovered in a net mounted on a rapidly moving truck, demonstrating that the guidance system enables aircraft recovery from platforms moving at speeds similar to a naval vessel.

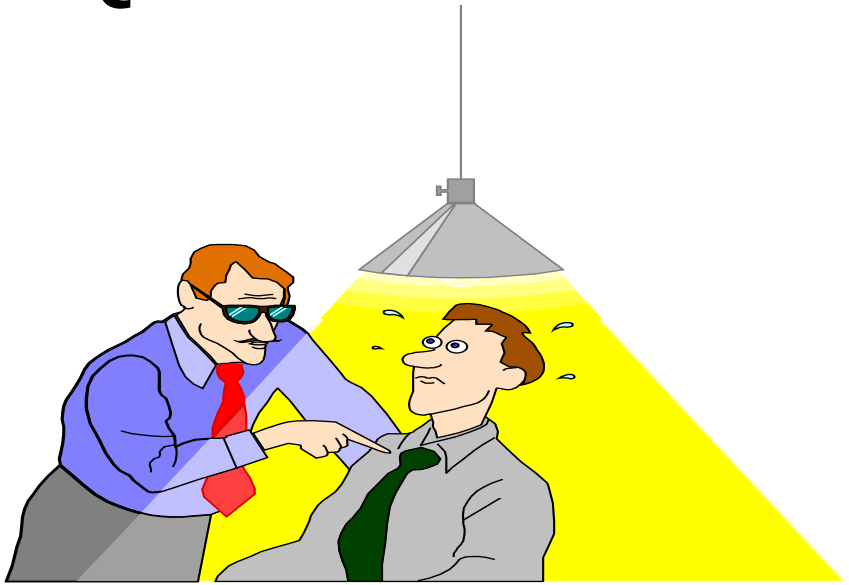
"…… represents a major upgrade to today's embedded airborne surveillance, reconnaissance and target acquisition capability.”

Raytheon Corp.

Search and Rescue



QUESTIONS?



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