

# **Advanced Technologies for Collective Defence within NATO**

Dr Robert Pearson, Cobham plc



*Ultra-wideband antenna technology*

**EW Europe**

7<sup>th</sup> June 2017

# Our World : Yesterday, Today and the Future

Our view of the world is determined by experience, how we act depends on what we see when we're young, what we learn and what we believe is possible



Today, more-so than ever, we need to work together in the international community to control and disrupt terrorist, hybrid and state adversaries that threaten global security

# Russia's Rearmament and its Achilles Heel

To many in Russia, Putin represents the counterweight to the US and its allies in Europe

Munich Security Conference Feb 2016: "I never said that a new Cold War has started. Rather, the actions of the NATO military alliance are pushing us toward the emergence of a new Cold War". Dmitry Medvedev

Russia has put priority on military reform and power projection; sanctions don't seem to be dampening an increase in spending, at the expense of wider investment.

Stronger and more capable armed forces are preconditions for Russia to re-emerge as a **regional great power with global reach** - including land forces build up on the border of the Baltics and an increase in airstrikes over Syria.

Achilles Heel: in 2014, dependence on imports - c.90% in electronics and optronics



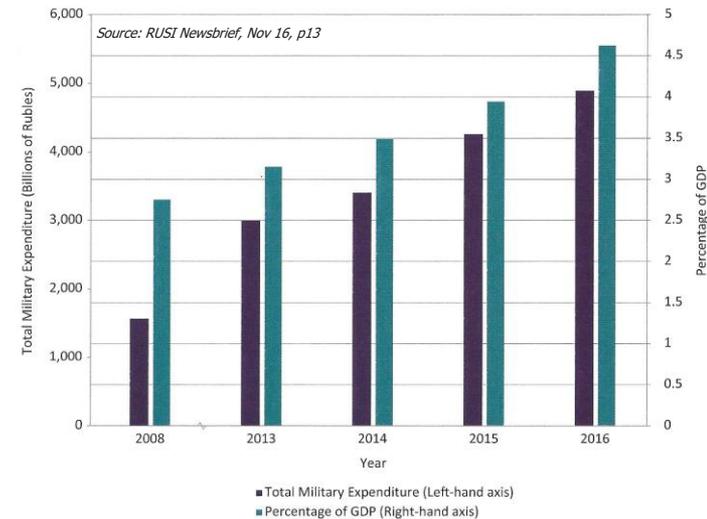
NATO concern about the Baltics



Armata Tank production slowed: just 70 tanks by 2020



Krasukha-4: EW system



Nominal Russian Military Expenditure in Rubles (Bn) as % of GDP

# Rise in EW: A Global Issues

Europe, Middle East and South East Asia

- Significant **humanitarian crisis in Syria** and concerns about the deployment of **Russian EW systems**.
- **Nov 2016: 300,000 NATO troops on high alert** over tensions in the **Baltics**.
- **South China Seas:** China is seeking to assert Sovereignty taking control of territories: raising tensions and impacting close allies, including Philippines and Japan. They call their objective: “**winning a local war in high-tech conditions**”.
- Potential difficulty for Allied aircraft-carriers to operate within the first island chain (thus pushing them out beyond the combat range of their tactical aircraft).
- Allied Unmanned aerial vehicles (UAVs) required for persistent surveillance, with both navy and the air force needed to meet **ISR requirements**.



Significant issues over control of the EM spectrum in Syria



China: Seeking to assert sovereignty in S China Seas

**Warsaw Summit – July 2016:** “NATO's essential mission is unchanged: to ensure that the Alliance remains an unparalleled community of freedom, peace, security, and shared values, including individual liberty, human rights, democracy, and the rule of law. We are united in our commitment to the Washington Treaty, the purposes and principles of the Charter of the United Nations (UN), and the vital transatlantic bond. To protect and defend our indivisible security and our common values, the Alliance must and will continue fulfilling effectively all three core tasks as set out in the Strategic Concept (*Collective Defence, Crisis Management and Cooperative Security*).”

**NATO Heads of State Meeting 25<sup>th</sup> May 2017** - two major items on the agenda:  
Stepping up NATO's role in the fight against terrorism and fairer burden sharing.

Increase number of NATO troops to train, advise & assist in Afghanistan to counter ISIS.

“A New Terrorism Intelligence Cell – improving intelligence sharing on foreign fighters will be established”.

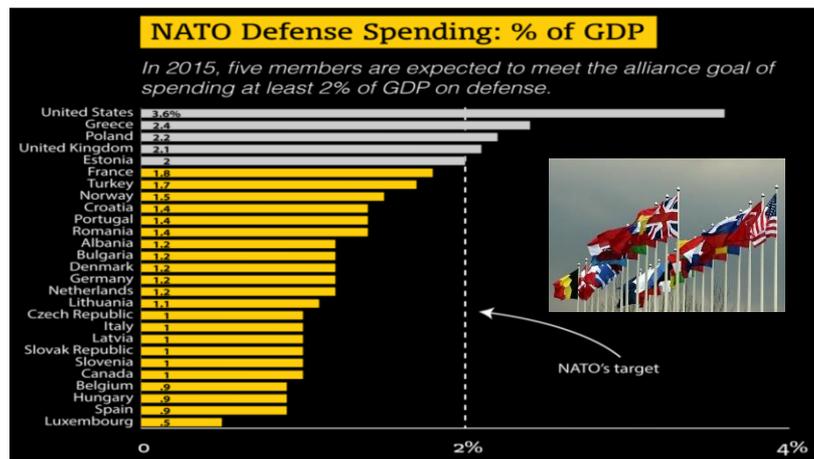


Sec. General Jens Stoltenberg, May 2017

# NATO Nations – balancing investment will take time

June 2017 Montenegro – has become the 29<sup>th</sup> Member of NATO

**"If America wants more balanced burden-sharing and enhanced European contributions to tackle our joint security challenges, Washington should support and incentivize European efforts to do more together and invest in crucial capabilities that can be used by the Alliance, instead of insisting that individual NATO allies simply spend more no matter on what."**\*



Courtesy: NATO

EU armies use 6x more weapons systems than US – but only a fraction of fire power. "European NATO allies can and should benefit from economies of scale and should systematically begin to invest in joint procurement. A more balanced transatlantic burden sharing will only be realized by EU pooling & sharing of military capabilities."\*

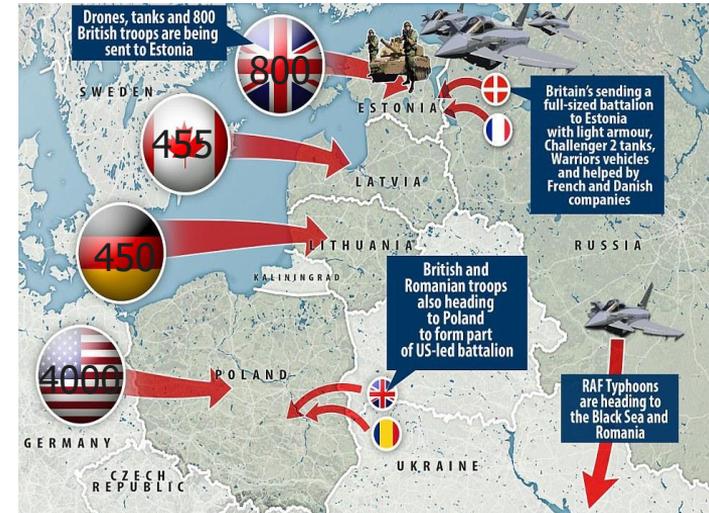


Courtesy: NATO

Munich Security Conference in Feb 2017, Merkel reaffirmed her commitment to the declaration adopted at the Wales Summit in 2014. At that summit, NATO member states agreed "to aim to move towards the 2% guideline within a decade with a view to meeting their NATO Capability Targets and filling NATO's capability shortfalls."

# Evolution: Collective Defence at the Heart of NATO Policy

- **Sept 2014: NATO Wales Summit, Allied leaders approve a Readiness Action Plan** to enable **swift and firm response to new security challenges** - in and near Europe and to threats emanating from the Middle East and North Africa.
- **Feb 2015: NATO defence ministers decide that quick-reaction *Very High Readiness Joint Task Force of 20,000 troops*** would include a land component of 5,000 are ground troops with appropriate air, maritime and Special Operations Forces units available. France, Germany, Italy, Poland, Spain, Turkey and UK agreed to assume lead roles on a rotational basis.
- **June 2015: c40,000 personnel for the NATO Response Force: air, maritime and SOF** and sped up political and military decision-making, including authority for NATO's Supreme Allied Commander Europe to prepare as soon as a political decision.
- **September 2015: NATO Force Integration Units** inaugurated in Bulgaria, Estonia, Latvia, Lithuania, Poland & Romania (**collective defence & exercise co-ordination**)
- **July 2016: NATO Warsaw Summit, Allies welcomed the implementation of the Readiness Action Plan** and agreed to further strengthen the Alliance's deterrence and defence posture - broad range of options to respond to threats from wherever they arise to protect Alliance territory, population, airspace and sea lines of communication.
- **Jan 2017: final two NATO Force Integration Units** in Hungary and Slovakia inaugurated.



Courtesy: Daily Mail

Since May 2014, NATO has increased the number of fighter jets on air-policing patrols over the Baltic States, and deployed fighter jets to Romania and Poland.

- What is Collective Defence?

- Collective defence means that an attack against one Ally is considered as an attack against all Allies.
- The principle of collective defence is enshrined in Article 5 of the Washington Treaty.
- NATO invoked Article 5 for the first time in its history after the 9/11 terrorist attacks against the United States.
- NATO has taken collective defence measures on several occasions, for instance in response to the situation in Syria and in the wake of the Russia-Ukraine crisis.
- NATO has standing forces on active duty that contribute to the Alliance's collective defence efforts on a permanent basis.

*"A worried man with a worried mind  
No one in front of me and nothing behind"..."  
People are crazy and times are strange  
I'm locked in tight, I'm out of range  
I used to care, but things have changed"*

Lyrics: Things Have Changed - Bob Dylan



March 2017: 120 British troops arrive at Amari Airbase in Estonia

British troops began a long-term deployment to Estonia, as Germany's intelligence chief warned Russia had doubled its military presence on its Western border.

NATO deployment designed to deter Russia from attempting a repeat of its invasions of Crimea and Eastern Ukraine in the Baltic.

# NATO Exercise: "Kevadtorm" Spring Storm, May 2017

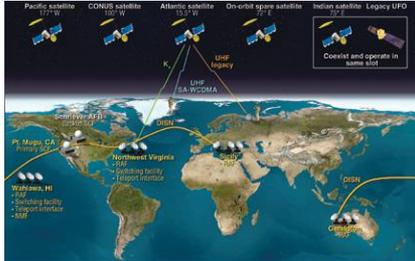
## Supporting NATO: Air, Land and Sea

- One of the nation's biggest military exercises, it's held annually at the Estonian Defence Forces' central training ground.
- This year, it involved around 6,000 troops from 10 allied countries.
- British troops are taking a leading role in the NATO mission in the country, which aims to protect and reassure member states in the region.



Courtesy: NATO

Amari Airbase, Estonia



Vital Role of Interoperable Comms (e.g. MUOS and Link 16)



Courtesy: NATO

6 NATO ships arrive in Tallinn



Courtesy: NATO

800 British Troops supported Spring Storm



Courtesy: NATO

## Collective Defence is at the Heart of NATO Policy

# Land: IEDs - Global Scourge: UN Resolution 70/46

## Impact on Civilians, Military, Peacekeepers and Infrastructure

**Summary:** Improvised Explosive Devices (IEDs) kill thousands every year, inflict grievous physical injuries, cause dire psychological harm and spread fear and disruption across affected communities. Their impact on the security and stability of affected States is profound: IED attacks not only hinder the political, social and economic development of a country, they also block life-saving humanitarian aid. **In recent years, IEDs have become the primary weapon for non-state armed groups across many conflicts. IED incidents have occurred in 66 countries and territories in the last three years, including in Africa, the Americas, Asia, and Europe.** Eight countries saw over 1,000 civilian casualties of IEDs. The threat of IED attacks is a global problem. Cheap and relatively easy to construct, IEDs can be made anywhere from a wide range of materials – from everyday tools to commercial explosives used in construction and mining. The lack of proper stockpile security of military and commercial explosives – making them susceptible to diversion into illicit hands – also presents a significant security risk.

**Civilians:** In the last few years more than 4,300 'improvised explosive device events' have resulted in an estimated **65,400 casualties – in 2014 alone**, over three-quarters of casualties were civilian. IEDs now kill 10 times more civilians than landmines do in Afghanistan. Over the last decade, 367 humanitarian workers have been killed and injured by IEDs. **The percentage of IED attacks occurring in populated areas has risen to 62%.**

**Military:** Cheap and easy to construct, IEDs allow lightly armed and barely trained militants to engage far better equipped security forces. They help tip the balance in an asymmetric conflict by enabling insurgents to inflict casualties without exposing themselves. The unpredictable, combat-avoiding nature of IED attacks can effectively sap the morale of security forces. **IEDs significantly limit the mobility of troops as time-consuming sweeps for concealed devices need to be conducted. Forces are weighed down with equipment** – metal detectors, electronic counter-measure systems, and robots.

**Peacekeepers:** To a number of UN peacekeeping missions, **IEDs are the largest single threat.** The contingents of many countries that make up the bulk of UN peacekeeping missions use unarmoured pick-up trucks that are highly vulnerable to IEDs. **It restricts their ability to patrol rural areas and allows insurgents to establish and maintain control over territory.**

**Infrastructure:** **Oil and gas pipelines** – a key source of revenue for many States – are particularly vulnerable. Insurgents looking to put pressure on governments **also target mobile telephone networks, railway lines, bridges, electricity grids**, cultural heritage, and tourist resorts. Such actions sow terror, disrupt commerce and tax revenue, break down communications, destroy identity-defining artefacts, **undermine confidence in authorities**

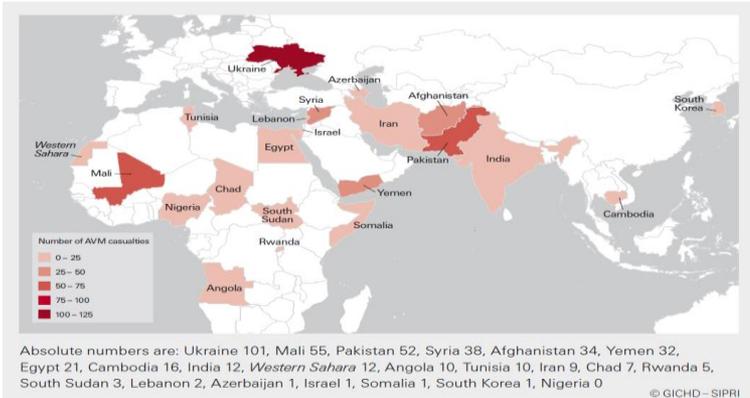


- **Attack the Network**
  - Electronic Surveillance: detect & take down networks
- **Impact on UN peacekeepers and civilians:**
  - Effective Force Protection and comms are vital to counter
- **Freedom of Manoeuvre:**
  - ECM with Effective Comms
  - Defeat the Device: networked sensors & GNSS

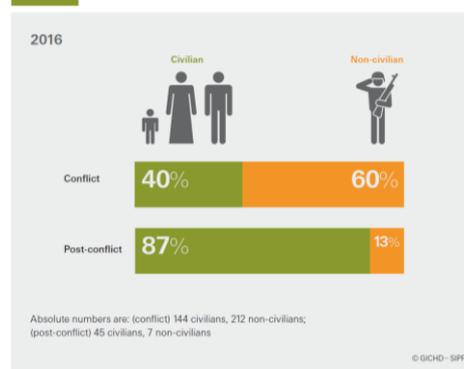
# Land: Anti-Vehicle Mines (AVM) and IEDs

- The Geneva International Centre for Humanitarian Demining (GICHD) published a report in April 2017, in collaboration with the Stockholm International Peace Research Institute (SIPRI) detailing incidences involving vehicles.
- Afghanistan, Cambodia, Mali, Pakistan, and Ukraine were the five states with the most recorded AVM incidents in 2016. All states, besides Afghanistan, featured among the top five states with the most incidents in the previous year.
- In post-conflict situations, 87 per cent of casualties were civilians.

**FIGURE 2** HEAT MAP OF ALL STATES AND TERRITORIES WITH RECORDED INCIDENTS IN 2016<sup>11</sup>



**FIGURE 5** CASUALTY DEMOGRAPHICS IN CONFLICT VS POST-CONFLICT SETTINGS



United Nations End User  
Guide on IEDs

# Sea: Russia and Maritime Security

Russia's strategic priority to re-establish offensively oriented navy for operations in North Atlantic

## Russia:

- Strategic priority to re-establish an **offensively oriented navy** for operations in the North Atlantic. : Russia is shaping its navy to support these aims - revamping the Northern Fleet, including a new Arctic Command.
- Seeks to secure access to warm-water ports in the Black Sea and the Mediterranean = logistic support for naval forces deployed to the Atlantic. Strengthening its sea-based antiballistic missile systems and investing in strategic-level anti-surface warfare capability.
- Developing **high-end strategic capabilities that could potentially disrupt operations and project force in the Atlantic Ocean, as well as deny Allied maritime operations** in the waters between Greenland, Iceland, UK and Norway.

## NATO:

- Needs to harness expertise from in cyber, EW and intelligence. Improved Situational Awareness and information sharing are vital to maintain knowledge about Russia's intentions and capabilities.
- 1<sup>st</sup> June 2017: Operation Sea Guardian is a NATO Maritime Security Operation – led by a French Commander for the first time. Situational awareness, counter terrorism and capacity building – co-ordinated by the NATO Maritime Command in Northwood.
- Technology in Action: 9 P-8 Poseidon maritime patrol aircraft to be procured by the UK.



Courtesy RUSI



Courtesy: NATO

Courtesy NATO

# Sea: Increasing Role of Maritime Security in the North Atlantic **COBHAM**

## Strategic Role of Naval Assets and rise of Hybrid Warfare



Cobham's interferometer-based array technology greatly enhances the SEWIP Block II program's detection and reporting accuracy against modern threat systems and improves overall shipboard combat effectiveness

WE NEED  
TO CONTINUE TO  
**SHARE**  
**TECHNOLOGY**  
**WITHIN NATO**  
TO ENSURE WE'RE  
ALL PREPARED

*"The most powerful (non nuclear) warhead can't hurt even the flimsiest ship if its **targeting system is deceived into hitting empty water** instead... such electronics can be easily added to existing ships".*

Capt. Doug Small, US Navy\*



UK - Type 26 Global Combat Ship (GCS)

Multi-mission warship capable of joint and multinational operations across the full spectrum warfare

*To provide assurance at sea, NATO deploys a number of multinational maritime forces such as a Standing NATO Mine Counter-Measures Group patrolling the Baltic Sea and the Eastern Mediterranean, and an enlarged Standing NATO Maritime Group conducting maritime assurance measures in addition to counter-terrorism patrols.*

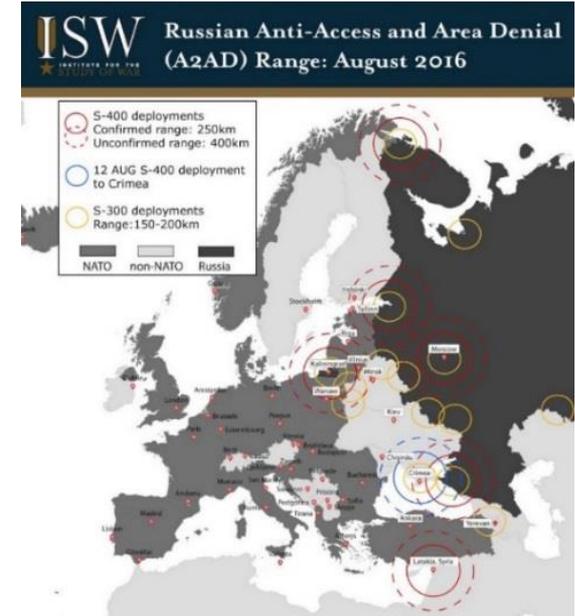
# Air: Disruption of ISIS in Syria

Jammers not only disrupts radar, but comms and the ability to organise



Cobham provide RF transmitters for electronic jammers aboard the Navy EA-18G jet aircraft that are designed to spoof and blind enemy low-frequency radar systems

May 2016: USS Harry S Truman in the Gulf - EA-18G Growler.  
Mission disruption of ISIS



Russian Anti-Access and Area Denial A2AD in Europe and Syria

# Air: Stealth, Counter Stealth and EW

Now you see it – Now you don't

- Counter Stealth - VHF radars:
  - Larger RCS at low frequencies – aircraft/features resonate
  - Bistatic and Multistatic Radar techniques
  - Cueing higher band radars
- Counter-Counter Stealth – the role of EW:
  - Suppression of Enemy Air Defences (SEAD)
  - AESA-based offensive electronic attack jamming pod (DoD from 2021). Increased power, increased flexibility and more capacity to jam more radars at one time.
  - Assist in protection of B-2, F35 and future Long Range Strike-Bomber



F35: Cobham supplies microelectronic components and integrated microelectronic assemblies for radar & EW



Courtesy, Bill Sweetman/AWST

Counter Stealth (Left): JY-27A, Skywatch, ECREE/CETC  
(Right): VHF Radar - 55Zh6UE Nebo-U, designed by NNIIRT

# Air: Increasing Importance of Air-to-Air Refuelling

## Refuelling: resilience and new roles

- At the Heads of State meeting in May 2017: NATO pledged to increase air-to-air refuelling
- **Air-to-air refuelling** (AAR) stands as one of the key enabling technologies of modern air supremacy. From **projecting military power** to delivering humanitarian aid, the ability of advanced air forces to operate far beyond their national boundaries provides an **unparalleled force enhancer**.
- Looking beyond their main purpose, they need to be multi-functional and he sees tomorrow's tankers doubling-up as **flying sensor suites and data relay hubs** in an increasingly networked battlespace.
- To support overseas deployments anywhere in the world at short notice AAR is only becoming more important. The vast ranges predicted for future operations in contested airspaces risked turning AAR into a new strategic vulnerability and making airborne tankers into prized targets.
- Future tankers will potentially need to provide in-theatre support to the receiver aircraft, meaning that they will have to be stealthy to avoid detection as well as having comprehensive defensive aids.
- In addition, intelligence, surveillance and reconnaissance (ISR) capabilities may be added e.g. **signals intelligence or airborne ground surveillance** – without affecting the aircraft's primary role.
- Proliferation of UAVs will mean that their refuelling will become commonplace like refuelling of manned aircraft is today.



Cobham is the world Leader  
in Air-to-Air Refuelling

# Air: The Role of Training - be prepared

Electronic Warfare training is vital for NATO

- Electronic attack is a real and evolving threat to military forces worldwide
- Important to deliver radar and communications jamming training through to false target generation
- Combine military know-how with leading edge technologies, to provide highly effective and genuine simulations of real-life encounters
- Innovative approaches needed provide full spectrum effects to optimise training efficiency and effectiveness, including new more capable wideband antenna systems
- Training is increasingly important - NATO (JEWCS)



Cobham: Dassault Falcon 20 aircraft: high technology electronic attack and threat simulation systems - experienced crews

# Hybrid Warfare: Fiddling whilst Rome Burns?

Increasingly complex and controversial tactics



Palmyra, Syria - Mariinsky Orchestra



Admiral Michael Rogers, NSA

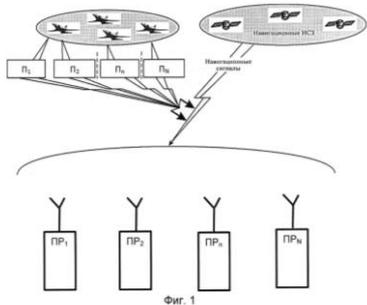
Hybrid warfare involves a broad range of traditional and non-traditional instruments to achieve goals. The nature of the challenge as part of an integrated campaign designed to achieve surprise, seize the initiative and gain psychological as well as physical advantages utilising diplomatic means, sophisticated and rapid information, electronic and cyber operations, covert and occasionally overt military and intelligence action as well as economic pressure.

- May 2017: Admiral Michael Rogers:
  - *“We had become aware of Russian activity”... “US cyber specialists are helping German and British officials defend their upcoming elections from Moscow’s meddling”.*
- Hybrid Warfare is also an increasing concern in the North Atlantic: collective defence, seamless connectivity and tactics to counter, including an increased proportion of private sector support to CNI protection, coastguard and other agencies

# Hybrid Warfare: Russia to install 250,000 cell phone towers to create a GPS/GNSS jamming network

**PATENT TITLE:** System for radio suppression of hostile GNSS navigation user equipment, compatible with local GNSS navigation user equipment

**EFFECT:** improved compatibility of local GNSS navigation user equipment with local jamming transmitters of GNSS navigation user equipment without reducing effectiveness of radio suppression of hostile GNSS navigation user equipment



РОССИЙСКАЯ ФЕДЕРАЦИЯ (19) **RU** (11) **2 539 563** (13) **C1**

(51) МПК **G01S 7/58** (2006.01)  
**H04B 1/10** (2006.01)

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Адрес для переписки: 394028, г. Воронеж, ул. Базовая, 6, ОАО НВП "ПРОТЕК"

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(54) СИСТЕМА РАДИОПОДАВЛЕНИЯ НАВИГАЦИОННОЙ АППАРАТУРЫ ПОТРЕБИТЕЛЕЙ ГНСС ПРОТИВНИКА, СОВМЕСТИМАЯ С ОТЕЧЕСТВЕННОЙ АППАРАТУРОЙ ПОТРЕБИТЕЛЕЙ ГНСС

(57) Реферат: Изобретение относится к технике радиоэлектронной борьбы (РЭБ) и может быть использовано для радиоподавления навигационной аппаратуры потребителей глобальной навигационной спутниковой системы (НАП ГНСС) противника. Система радиоподавления НАП ГНСС противника, совместная с отечественной аппаратурой потребителей ГНСС, состоит из нескольких передатчиков преднамеренных помех с известной, но скрытой от противника структурой излучаемого помехового сигнала, предназначенного для радиоподавления НАП ГНСС противника и отечественной НАП ГНСС, содержащей между прямой антенной и отечественной НАП ГНСС блок компенсаторов с последовательно установленными компенсаторами. Каждый компенсатор состоит из генератора копии помехового сигнала, излучаемого поставщиком помех, корректора, решающего устройства, управляемого элементом задержки, управляемого аттенуатора, вычитающего устройства и имеет вход, на который поступает выходное напряжение прямой антенны или предшествующего компенсатора, и выход, с которого выходное напряжение поступает на вход последующего компенсатора или отечественной НАП ГНСС. Внутренний компенсатор выходное напряжение поступает на первый вход вычитающего устройства и на первый вход корректора, а на второй вход - копия компенсируемого сигнала, сформированная генератором копии помехового сигнала, излучаемого поставщиком помех.

RU 2539563 Patent

# Hybrid Warfare: Drone and Counter Drone

- “Counter Drone is the new Counter IED”
  - Counter-UAS the no. 1 force protection priority
  - Operational priority – various tactics (eyes on and IEDs)
- Al-Qaeda fighters in Syria recently showed off their drones in a propaganda film (pictured) and now evidence has emerged of them being used by ISIS in Iraq
- Iran develops a 'suicide drone' capable of delivering explosives and skimming maritime attack:
  - Reportedly designed to fly as low as 60cm above the water at a speed of around 160mph but can reach an altitude of 900m
  - It has apparently been developed primarily for maritime surveillance and not designed to be armed with missiles
- Drones have also been used in Ukraine:
  - EOD specialists of the Armed Forces of Ukraine have neutralized 28,700 mines and IEDs



U.S. Special Operations Forces members inspect a drone used by ISIS in Mosul on Jan. 25. (Muhammad Hamed/Reuters) *Courtesy Washington Post*

US Special Operations Forces (Mosul, Iraq)



ISIS Video: drones being used in Iraq

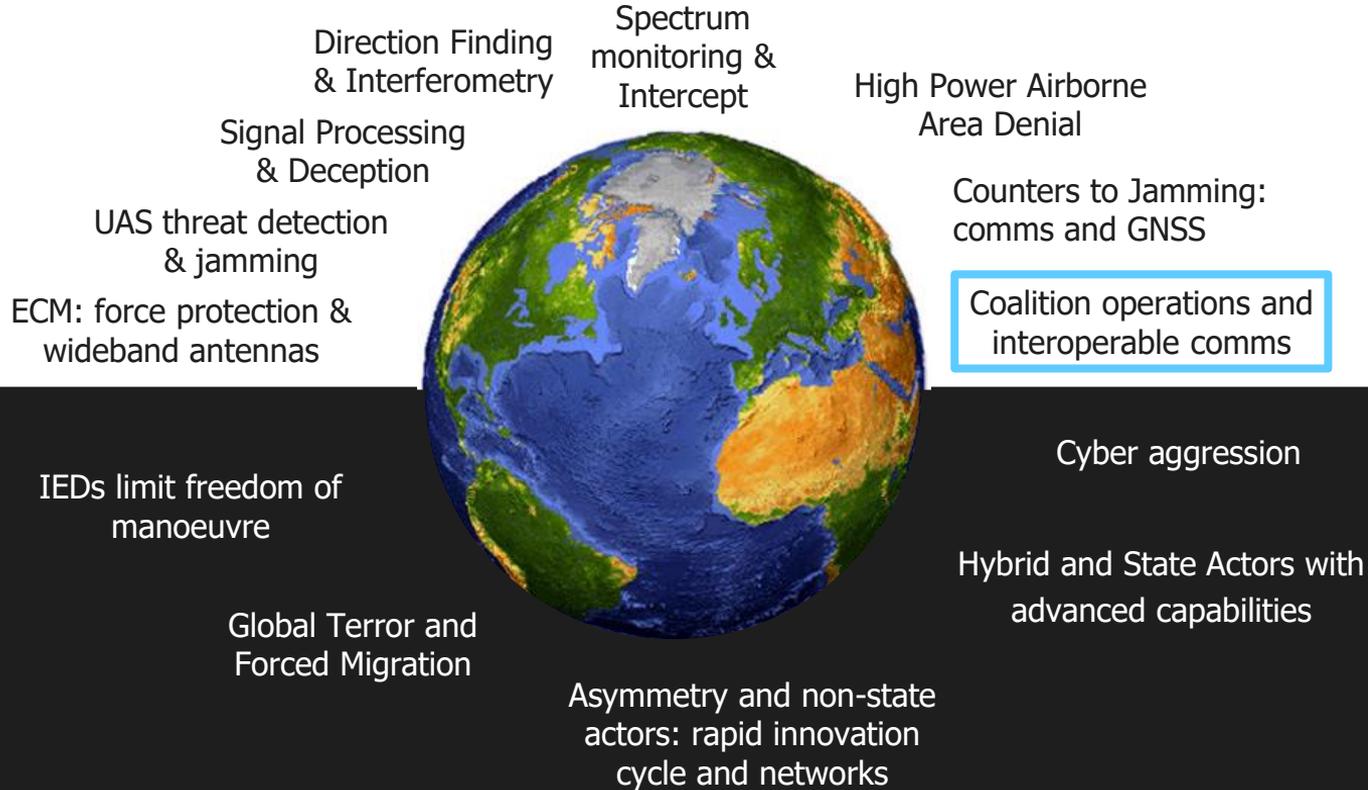


*Courtesy: The Counter IED Report*

Ukraine: UAV adapted to carry an RGO grenade

# Electronic Warfare: Black and White

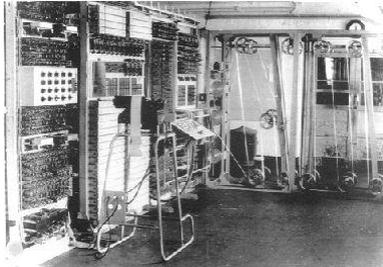
As boundaries become blurred complexity increases





"The development of the classic JTIDS concept is most closely identified with Gordon Welchman, a transplanted Englishman whose remarkable career included World War II service with the team at Bletchley Park that cracked the German high command code. His early exposure to the Ultra Secret led to a lifelong fascination with military communications and a number of important contributions during his many years at Mitre. Welchman's study of the North African campaign convinced him that one of the keys to Rommel's victories had been the flexible system of tactical communications that allowed the Desert Fox to command from any point on the battlefield...the presence of radios in all German tanks allowed Rommel and his subordinate commanders to have great connectivity but also gave junior officers the wide latitude for independent action characteristic of decentralized operations". Ken Allard, *Command, Control, and the Common Defense*, NDU - 1996

Gordon Welchman: understanding of tactical comms systems & networks at Bletchley park -> 1967 study by MITRE led to JTIDS (Link 16)



**1943 Bletchley Park – Colossus:** scanned codes at 5,000 chars/sec, used an optical tape reader developed by **Dr Arnold Lynch** and the team at the Post Office in Dollis Hill, London

<http://www.dtic.mil/dtic/tr/fulltext/u2/a421917.pdf>

- 18<sup>th</sup> / 19<sup>th</sup> Century: age of enlightenment & Maxwell's Equations
- 1943: Bletchley park – computer decodes comms intercepts
- 1960 Corona "Discoverer" intel satellite accelerated by U2 loss
- 1962 Telstar-1 - first communications satellite was launched
- 1967 MITRE study on tactical comms by Welchman/Desmarines
- 1978 the first GPS satellite named Navstar was launched
- Radio took 40 years to reach 50m listeners, but by 2010 the number of texts in 1 day exceeded the global population
- By 2012: >4 billion You-Tube – a tool for sharing but also potential misuse
- Today electromagnetics : communicate, control, disrupt & intercept - key to security

# Land: A Coherent Response to the Issue of Land Mines & IEDs **COBHAM**

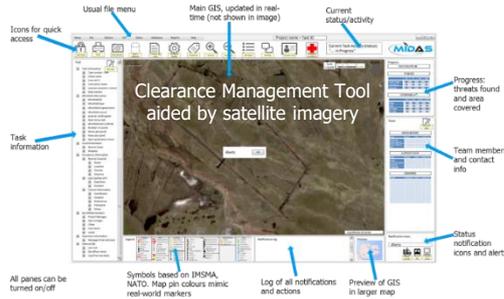
New technology: will requires resilient GNSS and protection afforded by ECM to support UN operations



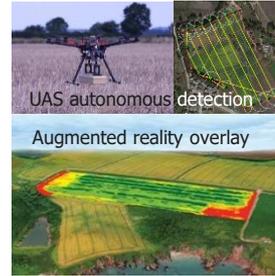
Equipment and Investment are vital



Today



Tomorrow



The Future



Post Conflict/UN: need control of the spectrum to conduction peacekeeping and clearance operations



- “Counter Drone is the new Counter IED”

- Counter-UAS the No. 1 force protection priority
- Operational priority – various tactics (eyes on and IEDs)
- Fiscal Year 2017 National Defense Authorization Act (Section 3112):
  - PROTECTION OF CERTAIN NUCLEAR FACILITIES AND ASSETS FROM UNMANNED AIRCRAFT
  - *“(A) Detect, identify, monitor, and track the unmanned aircraft system or unmanned aircraft, without prior consent, including by means of intercept or other access of a wire, oral, or electronic communication used to control the unmanned aircraft system or unmanned aircraft.*
  - *“(B) Warn the operator of the unmanned aircraft system or unmanned aircraft, including by passive or active, and direct or indirect physical, electronic, radio, and electromagnetic means.*
  - *“(C) Disrupt control of the unmanned aircraft system or unmanned aircraft, without prior consent, including by disabling the unmanned aircraft system or unmanned aircraft by intercepting, interfering, or causing interference with wire, oral, electronic, or radio communications used to control the unmanned aircraft system or unmanned aircraft.”*
- *UN Security Council Resolution 2341 (2017): “Recognizing a growing importance of ensuring reliability and resilience of critical infrastructure and its protection from terrorist attacks for national security, public safety and the economy of the concerned States as well as well-being and welfare of their population”*

Radar Antennas  
track the drones



Courtesy: Liteye

EO tracker and ECM system to  
counter drones



Blighter Counter Drone System Detection range: 8km/  
Minimum target size (RCS): 0.01 m<sup>2</sup>

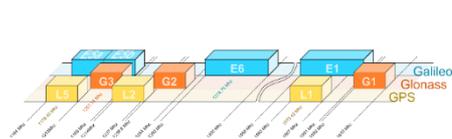
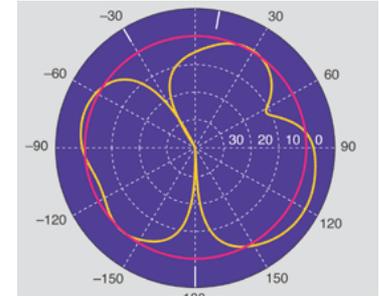


Courtesy: Openworks Engineering

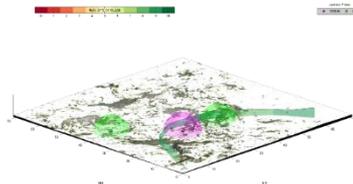


Skywall: casts a physical net

- More resilient Waveforms
- Anti-phase Interference Cancellation: to restore radio sensitivity
- Spatial Adaptation: wideband nulling and beam steering
- Combined techniques: wideband instantaneous cancellation, mitigate multiple threats and improved EW situational awareness
- SWAP reduction: Signal Processing and Meta-Materials Inspired Antennas



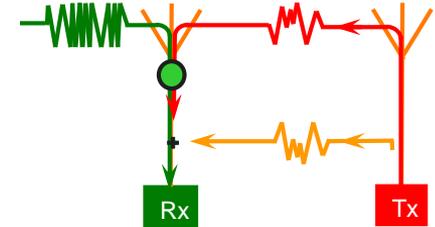
Multi-standard GNSS



Scenarios assessment to define vehicle aircraft routing



Meta-materials antenna and adaptive processing



Integrated Comms Environment (ICE) Technology

# Precision Integrated Navigation Environment (PINE)

GNSS systems are critical to position and timing for both military and civilian systems

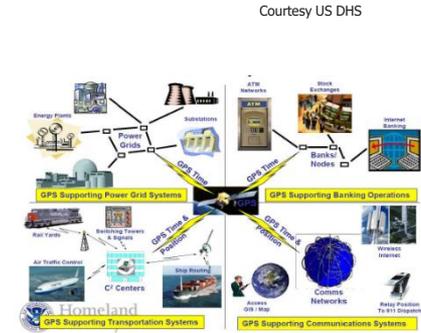
- GPS is critical for both time and position references
- Launch of new GNSS Galileo constellation should provide additional resilience for NATO allies
- Increasing need for Precision Integrated Navigation Environment (PINE) for a range of new applications
- Most current GNSS signals are so weak that a tiny transmitter can block the signal – new ways to augment are being evaluated
- GNSS services remain vulnerable to both unintentional and deliberate EW jamming



GNSS reception is vulnerable to land and air borne jammers



Cobham resilient GNSS testing



Global dependency on GNSS is colossal



Courtesy: Naval-Technology

Maritime Resilience: unmanned landing trials using Airbus Deckfinder

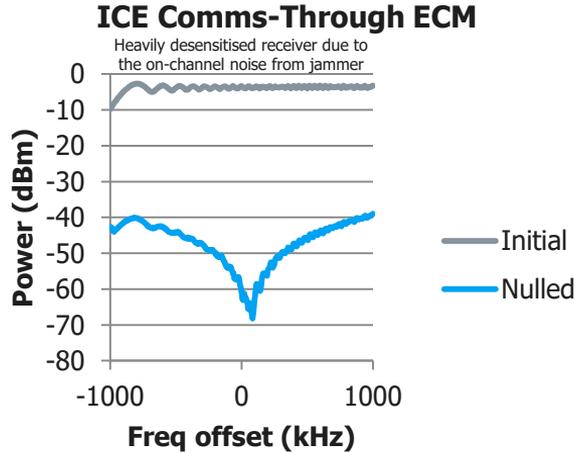
- RF interference arises when there are multiple transmitters/ receivers operating in close proximity (often multiple antennas mounted on the same platform with limited separation).
- This problem can affect airborne, land and maritime platforms.



- Antenna separation and the use of filters alone is not sufficient to mitigate the interference problem, particularly with the proliferation of software defined radios and associated communications equipment.

# Communications Through ECM: Spectral Resilience **COBHAM**

Managing Comms without degrading EW System Performance



ICE 7701 Communications Through ECM System with an Allen-Vanguard EQUINOX™ jammer

ICE can generate notches of the order of 60dB in the 30 – 512 MHz frequency range to restore communications in a jamming environment.

# Antennas – A Vital Part of EW Systems

We can learn from history – but some things never change – demands on antennas to do more

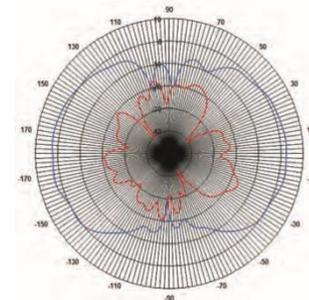
- A declassified US government report on the early days of Signals Intelligence, said that the ideal antenna system would have the following characteristics:
  - A continuous and fixed broad area coverage
  - Very broad electronic spectrum coverage
  - Very high efficiency
  - Inherent capability for giving directional information
  - In practice it is necessary to compromise in order to gain a workable system
- Today requirements are similar: advanced technologies = optimum performance:
  - Bi-conical elements for ground-plane independent omni-directional coverage
  - Cavity-backed Spirals: receive only for instantaneous detection and arrays for DF
  - Reflector-backed Spirals: high power area denial: 5-10dBi gain, compact and rugged



# How EW Antennas Work

## Omni Directional Antennas: Bicone, Truncated Bicone & Discone

- **Pure Bicone:** 30:1 bandwidth e.g. 300MHz - 10GHz
- **Truncated Bicone:** 4:1 bandwidth e.g. 700MHz - 2.5GHz  
Both - excellent patterns: peak gain at horizon
- **Discone:** half-height bicone with ground-plane patterns away from horizon
- All designs can handle >100W
- All designs are size dependent:
  - Lowest frequency = half wavelength



Bicone Antennas



1.6 – 3.0GHz



2-18GHz 0.8-6GHz

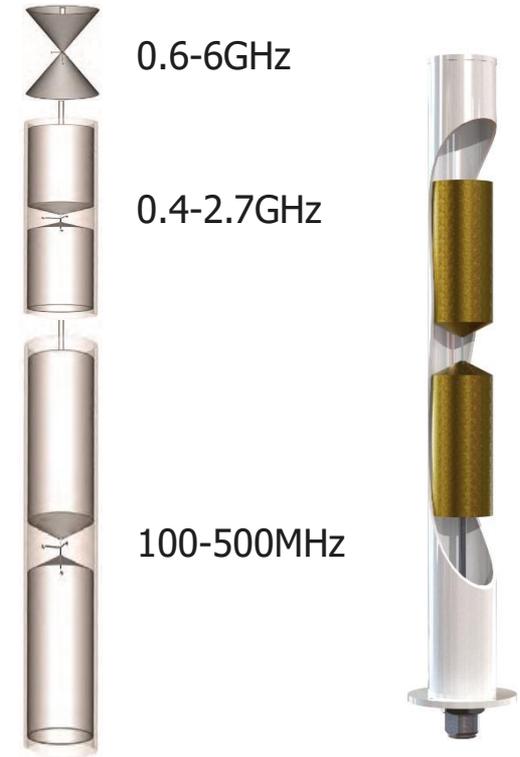


1-6GHz

# How EW Antennas Work

## Multi-stack Bicone Antennas: Overlapping spectrum coverage

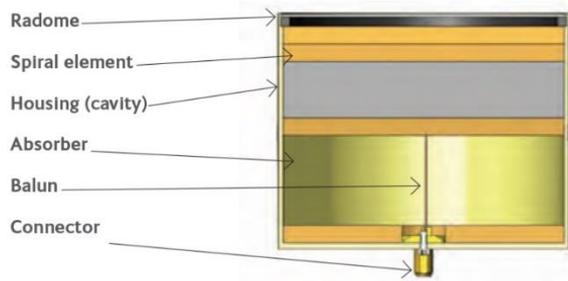
- Multi-stacked Omnis – Single Housing/Multi-band:
  - Novel feedthrough technology allows collocation to save space and provide optimum performance
  - Overlapped bands but high isolation
  - 200W per band simultaneously
  - Triple stacked design: 0.6-6 GHz
  - Alternative depends on size/bands: e.g. 0.1-6 GHz



# How EW Antennas Work

## Spiral Antennas for spectrum monitoring and Direction Finding/Interferometers

- Cavity-back spiral antennas:



- Receive only
- Used for DF
- Very monotonic patterns
- Phase and amplitude matched sets



*Courtesy: NATO*

NATO Alliance Ground Surveillance (AGS):  
5 Global Hawk UAVs



Cobham: partnership with General  
Atomics will provide whole life support  
for UK & Australian Certified Predator B

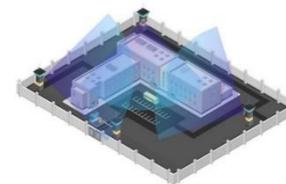
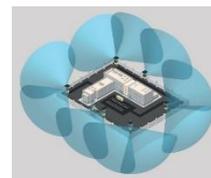


Wideband antennas are key to direction finding systems including as part of interferometer arrays: increasing DF accuracy

# Novel All Metal Antennas

High Power Handling – Wide and Multiband Technologies

- Conventional PCB based spiral technology offers compact form factor, but poor power handling



Critical National Infrastructure

- High Power /High Efficiency All Metal Spiral:
  - 150W power handling
  - Very compact compared to horn antennas



All Metal Technologies Can Handle Increased Power Demanded for Area Denial

- Novel Multi-band Omni-directional Antennas:
  - Allows tailoring of elevation coverage



FPA7-0.6-6.0R/2294



FPA-0.7-2.7R/2319



FPA7-1.7-6.0R/2293



FPA7-2.0-6.0R-HP/2231

60° cone 6-10dBiC coverage CP = effective denial

# The Future



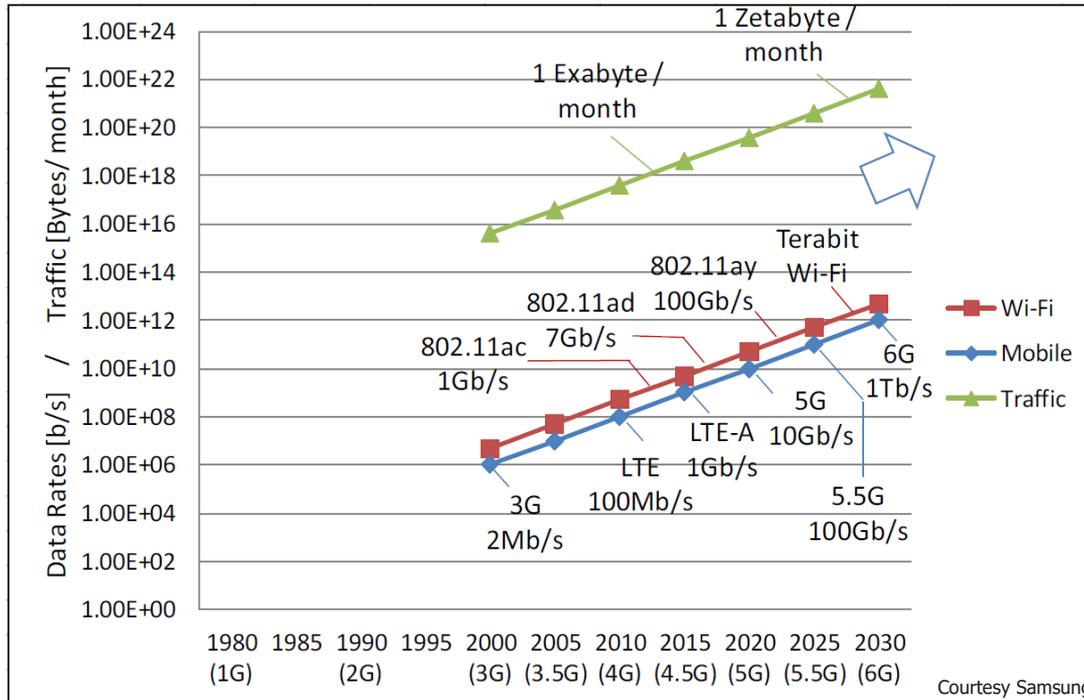
*Ultra-wideband antenna technology*

**EW Europe**

7<sup>th</sup> June 2017

# Growth in Traffic – Towards Zeta-byte Networks

The impact on the future of EW could be significant



Mega-constellations will offer > Terabyte data capacity by the end of the decade

5G will intelligently understand the demands in real time, dynamically and allocating network resources to deliver connectivity.

Increasingly signals be routed autonomously machine-to-machine terrestrially & by satellite



Courtesy OneWeb

A **zettabyte** (or zettabyte) is a measure of storage capacity and is 2 to the 70th power bytes, also expressed as  $10^{21}$  or 1 **sextillion** bytes

# Electronic Warfare in the Age of Autonomy

M2M – Internet of Things, Autonomy and AI



**COBHAM**

- **Global Connectivity:** high bandwidth / multiband antennas: meta-materials (3-D tailored material) re-configurable to enhance bandwidth
- **Commercial Phased Arrays:** multiple beams adaptively connects to satellites + 5/6G networks cancelling interference = Integrated Communications Environment (ICE)
- **Artificial intelligence:** key enabler for adaptive connectivity & intelligent comms networks that connect Internet of Things (IoT)
- **Autonomy:** including threat swarms, but also technology to counter such as UAS mounted EW, radar and autonomous air-to-air refuelling
- **Commercial Technologies:** connectivity grows exponentially, increasing the spectrum congestion: more inherent resilience in COTS, encryption and anti-jam capability of cognitive commercial systems increases
- **Cyber and Digital Trust**
- **EC3M: Electronic-Commercial-Counter-Counter-Measures Race**



Dual Polarised phased array, 3.3lb UAV Phased Array  
Ka-band equivalent would be ~ 3500 elements



AI: 19x19 Go board configurations than atoms in the Universe. No. of games =  $10^{(5.3 \times 10^{170})}$ : DeepMind Alpha-GO beat the champion



# Technology is Not Enough on its Own

Electronic Warfare is increasingly key to countering aggression

- Increasing scope and range of Electromagnetic threats across the spectrum
- Asymmetric tactics deny freedom of manoeuvre / area denial – new threats emerging (small UAS)
- Increased connectivity critical for effective coalition operations – comms, location, timing
- Multinational operations: NATO and UN - force protection and projection
- Advanced Comm & Nav systems (e.g. SDR, MUOS, GPS) rely on timing for synchronisation
- Vulnerability of GPS & GNSS to jamming to both low cost devices and advanced systems
- Those who are disaffected/warped ideologies – both at home and returning from conflict zones



Ultimately it is political decisions made with *information* provided by *technology* that is key

- **Industrial Strategy:**

- Investing in science, research and innovation
- Developing skills
- Upgrading infrastructure
- Supporting businesses to start and grow
- Encouraging trade and inward investment
- Improved productivity
- Delivering affordable energy and clean growth

- *Extract from a letter on Industrial Strategy: "There must be no faltering in the drive to nurture in the British people by all possible means the virtues of skills and inventiveness – these are the true characteristics of a virile nation in a technological age".*

*Winston Churchill, c1942*



# What of the Future?

How do we exploit all of the “Information” among the every growing noise and chatter

To understand the future we often benefit from looking at the past: some things never change, including our politicians.

*Quote from Winston Churchill:*

*"True genius resides in the capacity for evaluation of uncertain, hazardous, and conflicting information."*



Churchill has returned to the Oval Office



# The Final Frontier

EW in Space - will this be the next Wild West?



Cobham: The Most Important Thing We Build Is Trust

Cobham supplied vital components for the ISS, Mars Exploration Rover and European Space Agency's Deep Space Network