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Signal Processing for Military Communications – Challenges and Opportunities

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Strategic Context



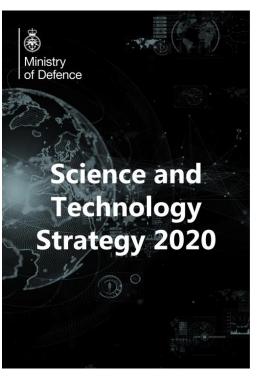


- The landscape has changed: new science, new technology, new partners, new challenges
- Science and technology is a domain of international competition and conflict
- We need the resilience that only science and technology can provide: Covid-19, climate change, conflicts
- Gov looking to science and technology as an engine of economic growth post-Brexit, post-Covid
- Ambition to do better and be better Gov reform includes better science and technology skills

MOD S&T Strategy 2020

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- S&T ambition of the Integrated Review is informed by MOD CSA's S&T Strategy 2020
 - <u>https://www.gov.uk/government/publications/mod-science-and-technology-strategy-2020</u>
- This identifies five key challenge areas:
 - Pervasive, full spectrum, multi domain Intelligence, Surveillance and Reconnaissance (ISR)
 - Multi-domain Command & Control, Communications and Computers (C4)
 - Secure and sustain advantage in the subthreshold
 - Asymmetric hard power
 - Freedom of Access and Manoeuvre (FOAM)
- Sets a focus on 'Generation After Next' capability for CSA funded research



Comms & Nets Programme Overview

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Through S&T, MOD has advanced options to enable **resilience**, **reach** and **autonomous interoperability** in its communications and networks in order to **enable Multi-Domain Integration** and deliver against the **Defence Multi-Domain C4 challenge**

- Produce a vision and roadmap for C5I S&T integration
- Demonstrate C5I concepts
- Develop and prototype resilient bearers and waveforms
- Develop and prototype architectures for resilient networks and data services
- Develop and prototype Non-Satellite Future Beyond Line Of Sight Communications technologies
- Primary focus on "Generation After Next"





Context – Threats to Communications and Networks

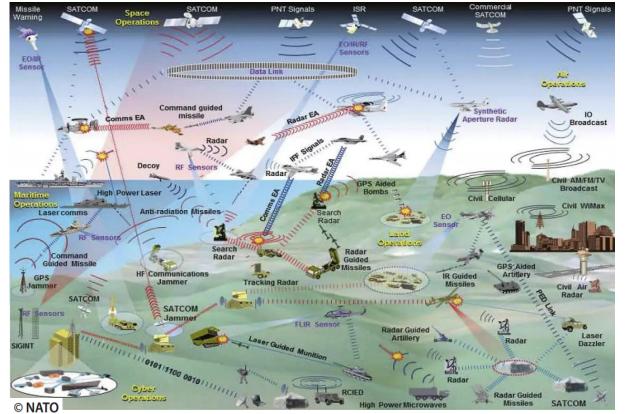


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Aspiration for Multi-Domain C4





 The network is the shared resource that enables and constrains all of these

- In terms of performance
- In terms of resilience
- The network is the arbiter of capability for any given mission or task

The Multi-Domain C4 Challenge



A modern military deployment is a highly complex and highly dynamic system of systems. C4 is the connecting tissue within and between those systems.



Our adversaries have identified and targeted our C4 capability as a key Centre of Gravity. They have made significant investments in capability and demonstrated intent at all levels of conflict and through proxies.



Our current approach is stove piped and brittle. We lack freedom of manoeuvre in the EME and run the risk of potentially destructive interference with friendly or neutral systems.

We are in an arms race for C4.

S&T is critical to establish and maintain advantage.

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An Example of Threat - Russian Cyber and EW

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Russian Cyber and EW Capability Development

'Starting a war without controlling the Electromagnetic Spectrum is tantamount to defeat' - Col. Anatoly Tsyganok

- Military reforms were initiated in 2008 to modernise the Russian Armed Forces.
- Significant and continuous investment in Cyber and Electronic Warfare capability development:
 - · An asymmetric response designed to counter sophisticated NATO capabilities.
 - These capabilities are now tightly integrated within the Russian Armed Forces.
- Cyber and EW are well suited to sub-threshold/greyzone operations:
 - Disinformation
 - Deception
 - Destabilisation
 - Disruption
 - Deniability
- Multiple distributed Cyber and EW operations can be conducted simultaneously and have an impact across the warfighting domains.
- Russian EW forces even have a dedicated professional holiday celebrated on 15th April.



Russian EW Emblem Source: Министерство обороны РФ, commons.Wikimedia.org





Communications Research Challenges

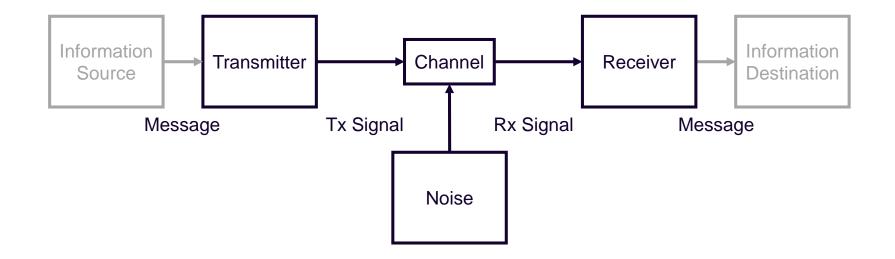


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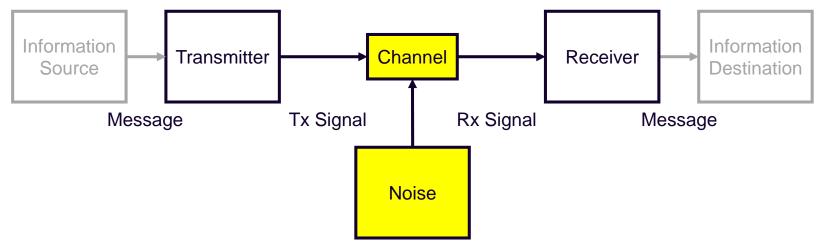
Communications





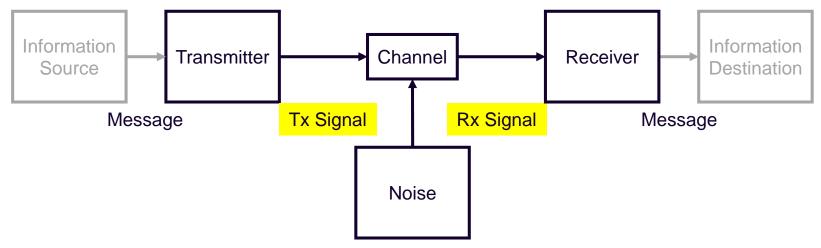
Channel and Noise





- Understanding the channel (and potential channels) to identify threats, challenges and opportunities
- Drive forward general 'state of the art' and address specific challenges (e.g. LOS Radio, Optical, Through Water, Beyond Line of Sight ...)
- Channel performance prediction as a commodity service
- Understanding the physics of the environment

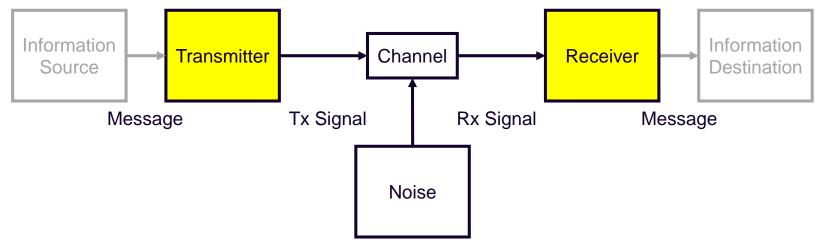




- Increase breadth and depth of waveform development beyond RF 'sweet-spot'
- Seeking lost dB's, increased resilience and reduced signature in all channel types
- Develop (and further develop) options for non-satcom BLOS
- Extend optimisations performance / resilience trades at operational time

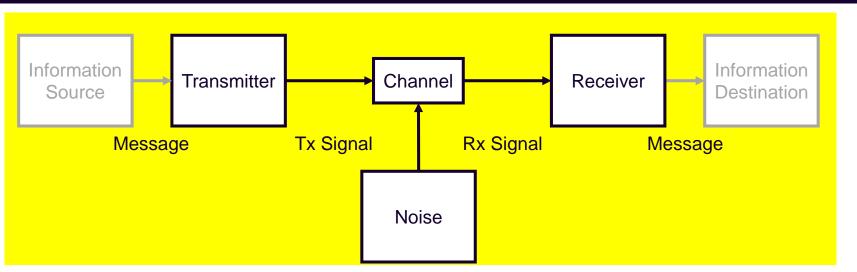
Transmitters and Receivers





- Intelligent bearer concept building on previous work
- Develop options for adaptable and agile system communications nodes
- Develop concepts and prototypes showing 'electronic freedom of manoeuvre' including smart antenna concepts
- Develop concepts and prototypes for convergence of LOS and BLOS, UK OFFICIAL RF and non-RF comms as well as other EMA

Communications System Issues

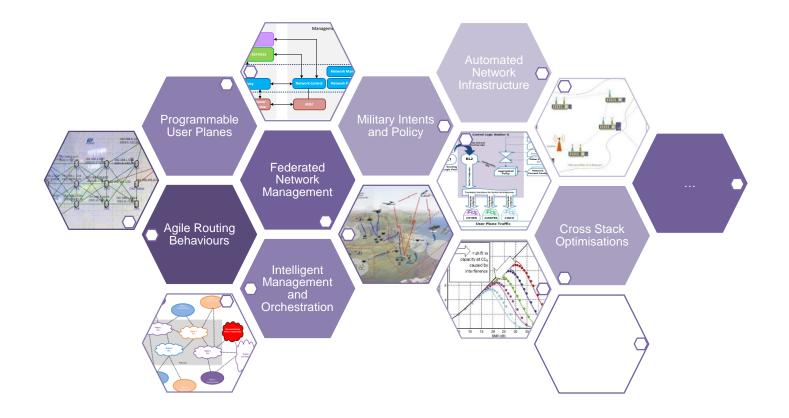


- How to optimise across the stack from the channel upwards
- How to plan and manage intelligent, diverse communication systems
- Prototyping and demonstration drawing from all communications tasks to derisk viable system options

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Networking Challenges





Data & Information services...

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Data & Information services in scope of future programme

Responsive, efficient, discovery & dissemination of data/information

Data is important part of this planned programme

In general, <u>not</u> about extracting new insights from the data

It is about optimising individual & collective exchanges

Interaction with layers above & below also important



Some Challenges...



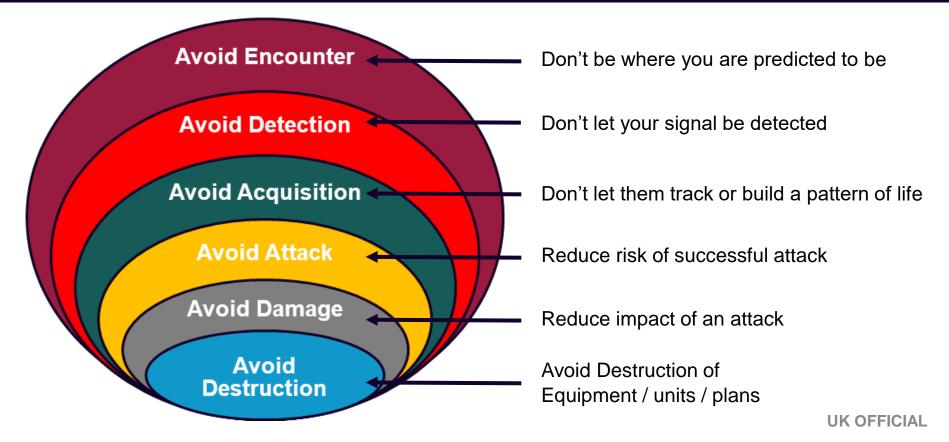
Instant unplanned Interoperability	Degrades (and recovers) Gracefully	Adaptable, reconfigurable, reusable
Variety as a constant	Openness	Design for unknown future
Assured & secure	Smarter, not more	Detail on a grand scale



Bringing it together



A Framework for Survivable Communications



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Concepts & Roadmap





Addresses:

- Adaptability
 - The extent to which a system can be changed to face new challenges
 - Foundational to any ability to evolve or introduce new capability
- Diversity
 - The range of options to effect change against a given challenge
 - Adaptability is a pre-requisite to increase diversity
 - Agility
 - The rate at which change can be effected against a given challenge
 - Adaptability and diversity are pre-requisites to increase agility



Getting Involved



Programme Features



Invest to stimulate UK capability growth in academia and industry

High degree of supplier delivery (>£100m over 5 years)

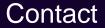
Generate UK IPR, innovation and invention

Significant collaboration required to deliver

Communications & Networks) Seek gearing from UKRI, Industry PV and Civil/Gov't investment

Build on existing frameworks and partnerships – including UDRC Phase 4

Develop S&T pipeline for experimentation, integration and demonstration





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