[dstl] The Science Inside

Precision Time at DSTL

Matthew Aldous

International Timing and Sync Forum

8th November 2022

#ITSF2022

Ministry of Defence

The Science Inside UK Defence and Security

[dstl] The Science Inside

4,456 staff across 4 sites

£432m spend with industry

£876m turnover

“intelligent customer” capability

Working with….

[dstl] The Science Inside

Industry

BAE SYSTEMS

Rolls-Royce

MBDA MISSILE SYSTEMS

QINETIQ

THALES

TATA STEEL

LOCKHEED MARTIN

LEONARDO

ROKE

GENERAL DYNAMICS

AIRBUS

ATLAS ELEKTRONIK UK

Working with….

[dstl] The Science Inside

Academia

University of Southampton
University of Birmingham
University of Michigan
University of Nottingham
University of Bristol
The University of Edinburgh
Loughborough University
Heriot-Watt University
The University Of Sheffield.
The University of Manchester
Johns Hopkins University
University of Liverpool
UCL
University of Exeter
Cranfield University

Generating military force results from the synchronisation of several activities toward a common end…

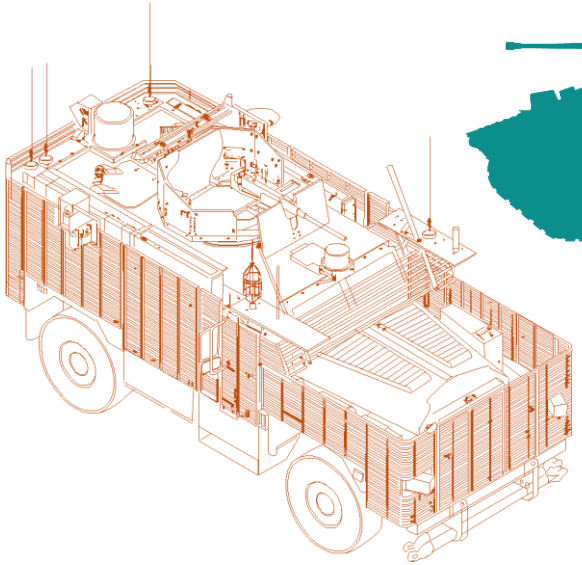
Major General Kenneth L. Privratsky US Army (Retd), “Logistics in the Falklands War” (2014)

…It is not easy.

Major General Kenneth L. Privratsky US Army (Retd), “Logistics in the Falklands War” (2014)

Why do we care?

- Consider armour
  - What are you protecting?
    - People
    - Hardware
    - Something else
  - Against what?
    - Range
    - Repetition rate
    - Targeting effectiveness
    - …
- What would be the consequences of defeat?

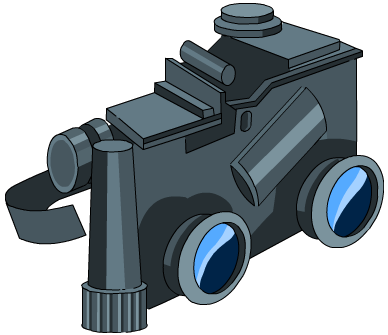


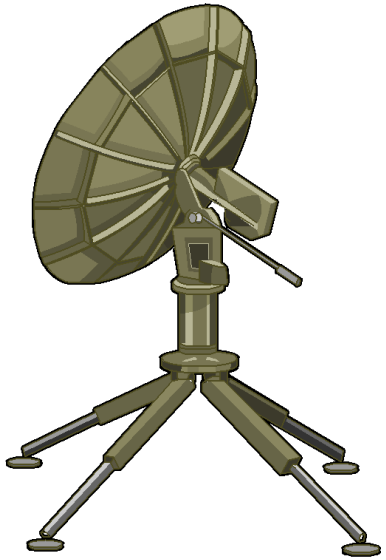
Why do we care?

- What are the equivalent questions with respect to time and synchronisation?
- Requirements and constraints can be sensitive and life-or-death
- System-of-systems response to degradation or loss of timing hard to assess

Why do we care?

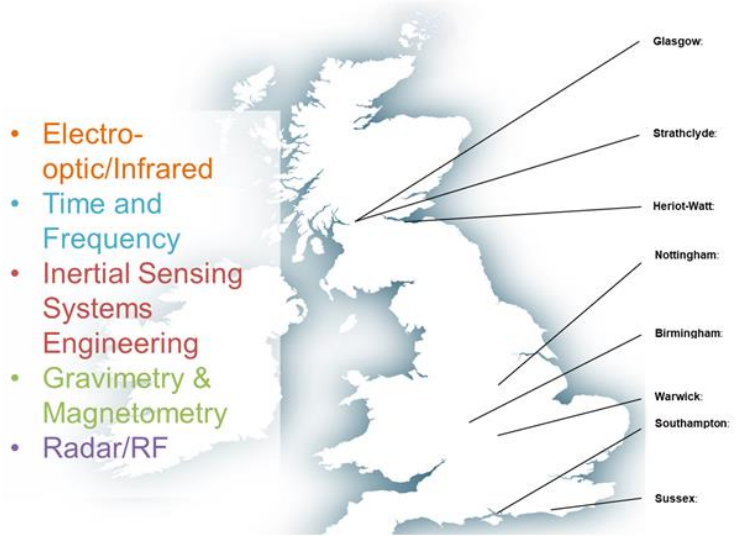
- Consider timing
  - What are you synchronising?
    - Activity
    - Comms
    - Something else
  - With what parameters?
    - Tolerance
    - Holdover
    - Integrity
    - …
- What would be the consequences of defeat?





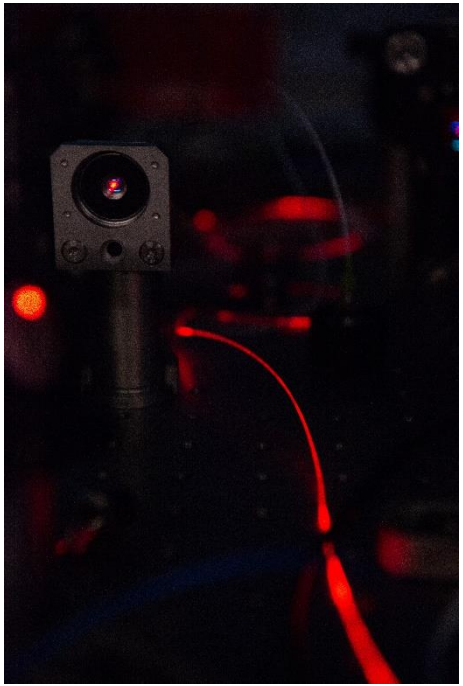
What are we doing?

- Extra-mural research
  - PhD students
    - 26 studentships at 8 institutions
    - 4 directly applicable to future T&F
  - Industrial partners
    - 10 projects at 8 organisations
    - 7 directly applicable to future T&F



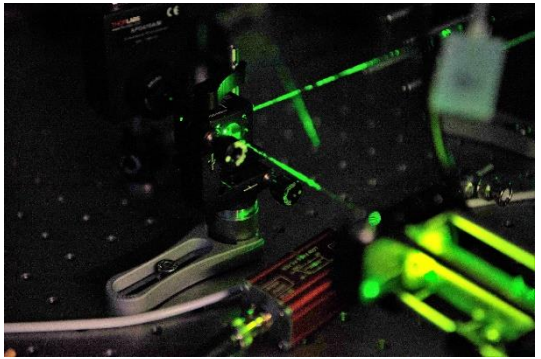
What are we doing?

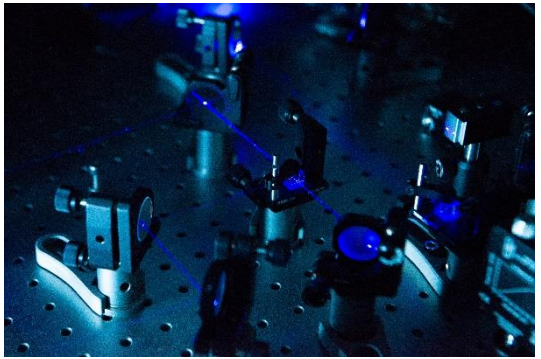
- Intra-mural research
  - Building generation-after-next clock systems
  - Assessing desirability and viability
  - Disseminating time to and from platforms



What are we doing?

- Optical clock development
  - Iodine vapour
    - Low size, weight and power
    - Good performance
    - Benchtop demonstrator at TRL 3-4
    - Compact trials system under development
  - Strontium optical lattice
    - High size, weight and power
    - “Metrology-grade” performance
    - Benchtop demonstrator at TRL 3-4





What are we doing?

- Participation at RIMPAC 22
  - Direct collaboration with four other nations
  - Demonstration of UK sovereign atomic clock
  - Collection of data in platform environment

USCGC Midgett conducts refueling at sea [Image 3 of 3], by PO3 Taylor Bacon

Joint Base Pearl Harbor-Hickam [Image 7 of 7], by Member: 1242095, identified by DVIDS

Public domain images obtained from https://www.dvidshub.net/

What are we doing?

Limited capability in platform environment

Technology requires further development to meet platform requirements

m ESL	Min	Max	Rate /min	Humidity	Min	Max	Rate /min	Frequency	Acceleration Power Spectral Density	U	Degree	Degree /sec	Field	Max	Rate/s
	(Celsius)			(% R.H.)	(kPa)			(Hz)	(g^2/Hz)	(g)	Degree		(Hz)	G	G/s
8	[illegible]	[illegible]	[illegible]	0-100	20	[illegible]	300	[illegible]	[illegible]	[illegible]	360	[illegible]	[illegible]	10000	[illegible]
7	50	90	[illegible]	0-85	30	[illegible]	200	[illegible]	[illegible]	[illegible]	300	[illegible]	18G	5000	800	[illegible]	500
6	-40	80	[illegible]	0-70	40	[illegible]	100	[illegible]	[illegible]	[illegible]	240	[illegible]	6G	1000	600	[illegible]	100
5	-30	70	10	15-90	50	100	50	500	[illegible]	100	190	100	1G	500	400	[illegible]	50
4	-20	60	5	[illegible]	[illegible]	140	10	250	[illegible]	50	140	50	100M	200	200	[illegible]	25
3	-10	50	1	30-95	70	120	5	100	[illegible]	30	90	10	70M	100	100	[illegible]	10
2	1	40	0.1	30-70	80	120	1	50	0.00238	10	30	1	[illegible]	50	50	5	[illegible]
1	10	30	0.01	30-50	90	110	0.1	10	0.00113	5	15	0.1	500k	10	[illegible]	1	1
0	18	22	0	35-45	100	101	0	5	0.0001	1	1	0	10k	1	1	0.5	0.5

Engineering Severity Level Matrix

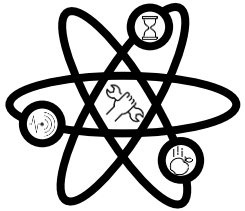
Become a partner

- Recently completed focused call on reducing reliance on GNSS
- Assessed using Engineering Severity Level (ESL) tool
- DASA Open funding route
  - Whole systems
  - Subcomponent technologies
  - Concepts and algorithms

Thank you

If you still have questions…

…come and talk to us at the conference



…contact us at QuantumSensing@dstl.gov.uk

[dstl] The Science Inside

Discover more