Title	*SWaP+C Final Project Report*
Versions	*V.01*

NAME OF PROJECT	*ONE SWaP+C*
List of partners	*CSA Catapult; Space Forge; British Telecom*
Total funding amount	*£854k DSIT grant funded*
Locations	*Newport, Cardiff, Ipswich*

Executive Summary

Overall, the project aims to help pave the way for advanced wireless communication systems, delivering faster and more efficient connectivity while supporting the UK's economic growth and national security.

The Project will develop high-frequency and energy-efficient ultra wide band gap Power Amplifiers (PA) for massive Multiple-Input Multiple-Output (MIMO) systems. The key focus is on producing and using alternative ultra wide band gap materials alongside RF GaN (Gallium Nitride) to create state of the art, efficient power amplifiers.

The Project aligns with the UK's strategic goals of creating a sovereign supply chain for wireless infrastructure components and ensuring the security and resilience of the country's telecommunications network. By developing advanced power amplifier technologies and enhancing energy efficiency in radio units, the Project aims to lower operational costs and provide globally competitive mobile services.

The Project offers a range of benefits for the UK telecoms industry and supply chain -
(a) Improved network performance, faster and more reliable wireless networks, and an overall enhanced user experience.
(b) Energy efficiency & reduced power consumption.
(c) Total cost of ownership savings.
(d) Strategic, secure, sovereign supply chain.
(e) Global competitiveness.

Deployment Summary

CSAC conducted simulation and assembly process optimisation allowing Space Forge to develop and produce their optimised heat-spreader material.
This assembly was then tested and characterized by BT (supported by NPL).

The detailed simulation work was very successful, giving an indicative possible ~10% efficiency improvements through optimised material choice and assembly stack configuration.

The samples built were based on a suitable RF MIMIC (Monolithic Microwave Integrated Circuit) recommended by the voice of the customer. This was to closely replicate the end goal of efficiency gains realised in the UK RF / 5G infrastructure.

Results and Benefits Achieved

Results and key findings,
Initial simulation work supported by evidence in the deliverable reports – showed clear possible efficiency benefits from the implementation of an optimised heat spreader.

The work completed has allowed the UK to support specifically UK supply chain with the project partners all being in the UK.

The impact of this extra efficiency can also be used in many technology areas, such as: Power, EV 5G etc. This would fully support 'green' UK jobs along with further future growth in this novel technology.

Space Forge, BT and CSAC can work collaboratively with other UK supply chain partners to follow on and push the introduction of this technology.

Security

Security was addressed in physical, personnel, and cyber security aspects and implement appropriate and comprehensive risk mitigation strategies during the 5G SWaP+C project to protect valuable information and assets.

This was achieved through:

Regulatory Compliance
Failure to comply with data protection and privacy regulations could lead to legal consequences.
The CSA Catapult stayed informed and up to date with relevant regulations and implement any necessary safeguards.

Cyber Security, Data Breach, Malware & Cyber Attacks

Unauthorized access to project data could lead to intellectual property theft or compromise. Vulnerabilities in the project's network infrastructure could also be exploited.

Sensitive data was kept in private folders on the Teams application, with permissions only given to specific employees. Two Factor Authentication was in place to increase security on the network, with regular cybersecurity audits and monitoring of network traffic.

One of the cyber security programs used within the CSA Catapult is Keeper.
Its Security Audit program provides password security strength reporting.
Antivirus software was and is installed on all applicable equipment and regularly updated.

The CSA Catapult uses Keeper BreachWatch. This is a powerful, secure add-on feature that monitors the internet and dark web for breached accounts matching records stored within the Catapult's Keeper Vault. BreachWatch delivers the most in-depth monitoring available to the public with a database of over a billion records while upholding Keeper's state-of-the-art, zero-knowledge security architecture.

BreachWatch alerts the CSAC so that the IT department can take immediate action to protect against hackers. Once activated, BreachWatch continuously monitors for compromised credentials and notifies if any records were at risk.
To ensure all CSA Catapult personnel receive regular comprehensive training on cyber security and best practices, the company has partnered with CybSafe.

CybSafe lowers human cyber risk. It's the award-winning, cloud-based software built on the understanding that traditional security awareness and training (SA&T) doesn't influence security behaviours. CybSafe educates, nudges, and supports people, providing both measurable change and measurable value.

High level summary of project costs

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The baseline was agreed at £854k funding.
Through the development the project required reforecasting 8 times in total.
Final funding Claim was revised total of £833k (-2.5%)

In hindsight, extra funds and extra project time would have helped to derisk the project , especially for a development project like this.

Project Highlights

Mid Project (July 2024) Face to Face review at Space Forge Facility in Cardiff.

~Full Team support from all project partners along with full DSIT support – made a great technical review along with a sense of 'team' allowed engineers to optimise working opportunities and to progress development in the best way.

Project Conclusions

Findings from this project included some amazing initial simulation work, that was correlated to best in class global research papers on the topic of heat spreader optimisation and bolding methodologies.

The work undertaken was well thought through as an achievable target – however from project kick off, there was clear agreement that this project did come with fairly high technical risks. Unfortunately, even though the consortium team followed due diligence, it was slightly frustrating to run out of time and funds, just as the research and samples build were being finalised. We did have a hard stop date though.

Following "end of project" – we had a great opportunity to have a discussion regarding the larger funding route and policies in the UK.

The project was very worthwhile completing, as the development that was completed, allowed very useful feedback to Space Forge to optimise local processes.
The learnings from this project will stand all partners in good stead for the next phase to allow this development to come to completion.

Next Steps

The UK has the opportunity to seize an early-mover advantage in this vital and sustainable hardware technology for global telecom markets by securing intellectual property and essential know-how, with power amplifiers based on diamond spreaders may be more power efficient in the longer term or could help drive a reduced cell site count for MNOs which would lead to a reduced network infrastructure operating cost. Eventual adoption of the technology by equipment vendors for their massive MIMO solutions is another sustainability angle to note.

This DSIT funded project has provided invaluable information to Space Forge, allowing optimisation of the plasma production process.

This optimised process has included the realisation that specialist metalisation of the manufactured diamond heatspreader is required due to limitations in directly growing the diamond on the GaN device.

The output of this project would ideally have an extension to fulfil the project brief and push for the following:

Testing of the several types of diamond heat spreader to compare existing commercial material with the latest optimised material available locally in the UK from Space Forge.
Project partners are looking at alternative funding sources to allow this process to run to completion.
This includes Space Forge also pushing and trialing production in micro gravity in orbit.

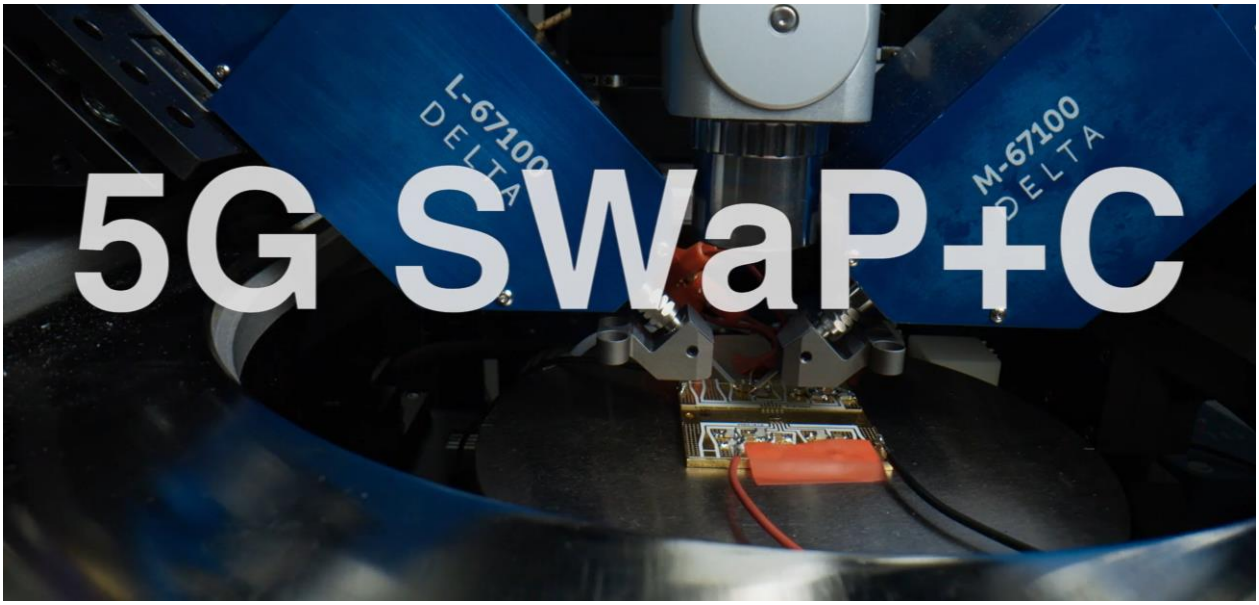
Media Library

Link to the main professional video is here. This resource has been very instrumental in several roadshows – to help promote this work globally.
Shorter version: https://vimeo.com/1036777803?share=copy
Social version: https://vimeo.com/1036697619?share=copy
(Password is available on request)

SPACE FORGE
MAKING SPACE WORK FOR HUMANITY

CATAPULT
Compound Semiconductor Applications

BT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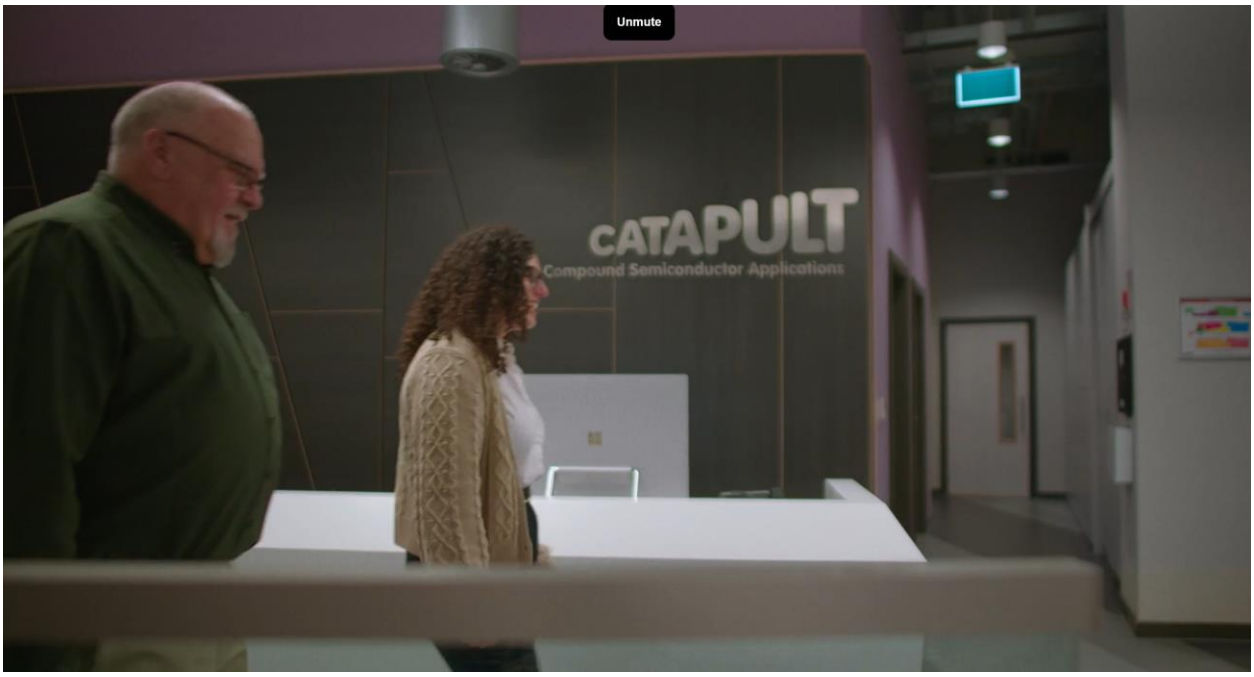
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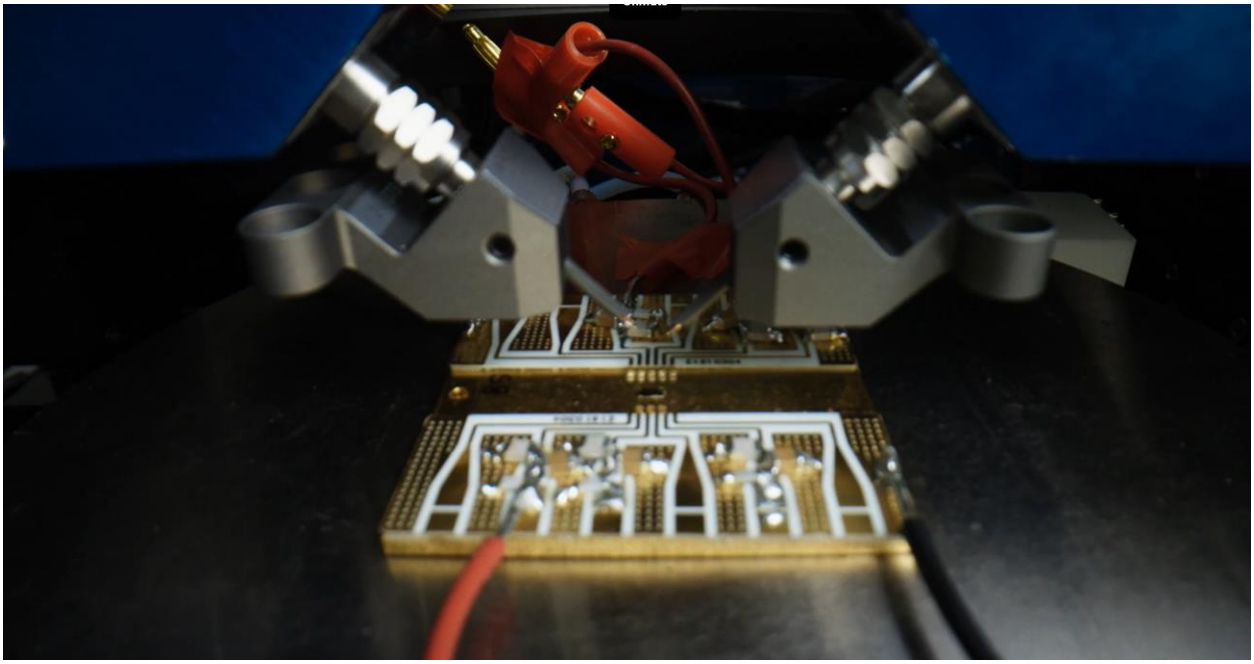

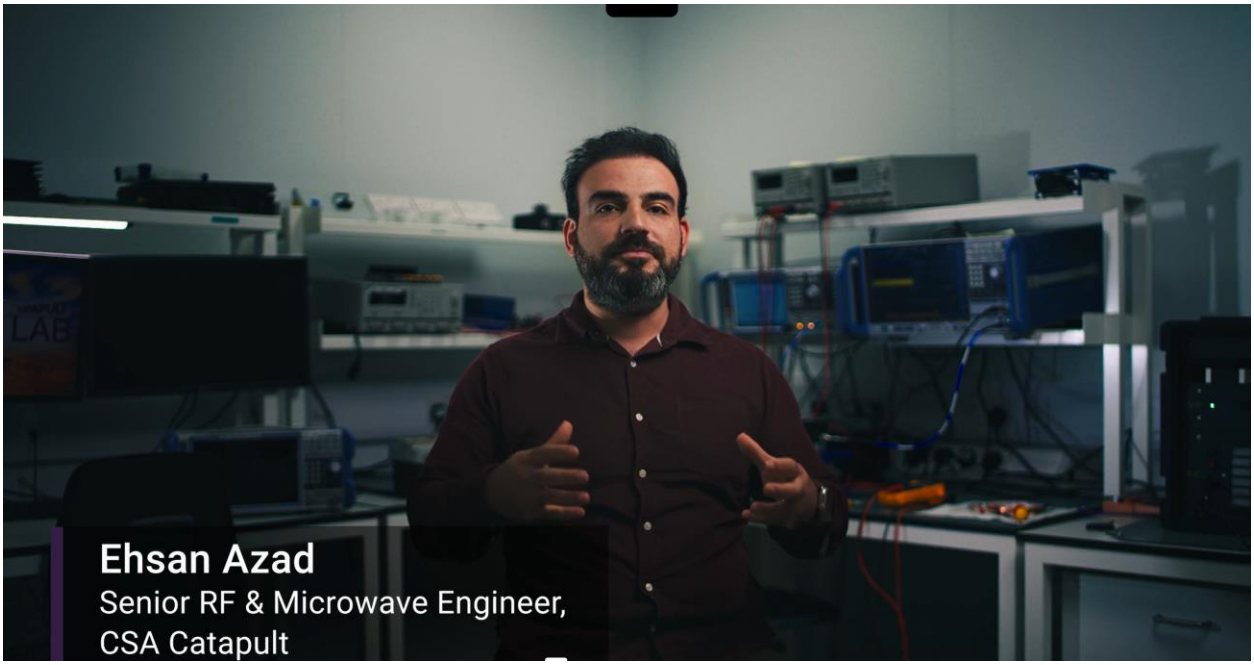
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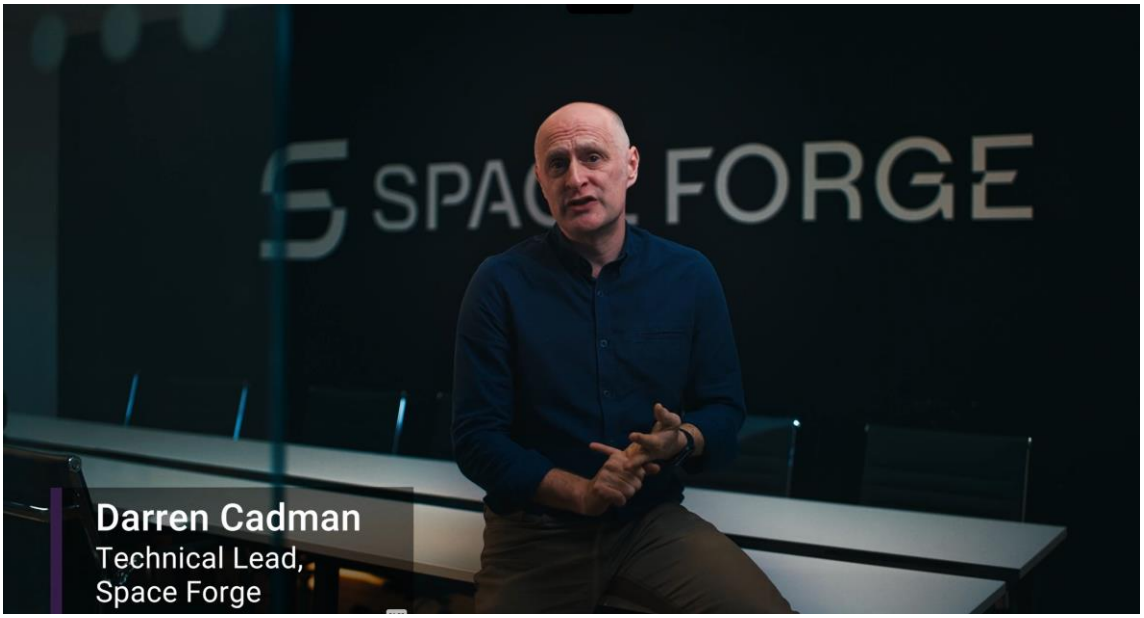
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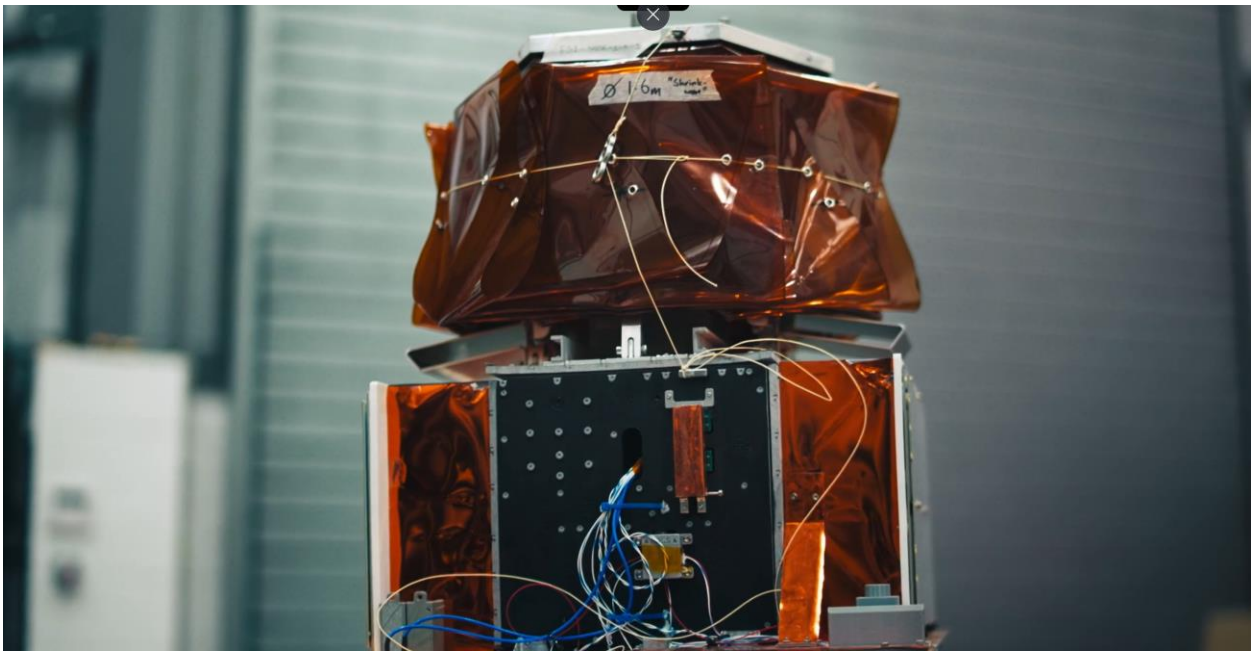
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