



Soldier as a Sensor – putting the user at the core

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Abstract

The concept of "Soldier as a Sensor" has been discussed in defence circles for decades. However, the reality is that **most soldiers are currently not even digitally connected**, much less functioning as sensors. In 2024 most soldiers arrive at work with a smartphone and then deploy with the equivalent of an analogue telephone.

Defence is still hardware constrained, like the tech sector was 30 years ago. Unlike other sectors defence is yet to make the change and become software-enabled. Further, defence must learn from the commercial sector and **accept "mixed-fleets" of hardware and software** and stop chasing the fantasy that "one-size fits all" such as all soldiers having the same radio, all drones needing to support a single common interface or that a single battle management application works from fire team to Corps level.

In many sectors **software is the competitive advantage**, yet defence has largely been unable to benefit. Instead of the outdated approach of setting up-front requirements, defence needs to focus on **iteratively putting working software in the hands of users**. Taking a user-centric approach that puts the soldier at the core is crucial to ensure that technological advancements enable battle winning capability without increasing risk of failure by adding to the soldiers' burden or adding complexity for complexity's sake.

In our daily lives, we use smartphones and a vast array of apps (software) for technically complex tasks. In contrast, defence uses exquisite equipment, needing extensive training to get basic outcomes. The need for the change could not be more obvious. **Defence needs to be data driven, user centric and digitally enabled.**

This paper:

- Explores the imperative for change within defence, identifying specific needs and proposing solutions.
- Offers a rapid route towards a connected and efficient software-enabled defence infrastructure.
- Illuminates the path through global case studies and comparisons with non-defence sectors.

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The Need for Change

30 years ago, when the author graduated, internet access and websites were rare. Smart phones didn't exist and businesses didn't use email. The dominant IT companies were the likes of Sun Microsystems, DIGITAL and Silicon Graphics. Apple was in a period of decline, PowerPoint for Windows was new and Google didn't exist. Hardware was king and software was an add-on.

Those dominant IT players have now gone and instead we have a whole ecosystem of internet enabled software applications in our pocket. The biggest Taxi firm in the world has no cars, the biggest accommodation provider owns no real estate and the largest media outlets create no content. Software is now the enabler and hardware is commoditised. Except in Defence.

The base level fielded comms for an average UK soldier is the Personal Role Radio (PRR). This was introduced 22 years ago and is voice only. It's like having a Nokia 3310 in the smartphone era. Except the Nokia was more capable than the PRR with text messaging and encrypted voice communicationsⁱ.



*Personal Role Radio (PRR)
in-service since 2002*



*Nokia 3310 mobile phone
common in 2002*

Over 10 years ago, Cosworth Motor Sports were in the UK Defence industry and delivered a fieldable wearable soldier system "Man Worn Power and Data" to MODⁱⁱ. Following this "success" Cosworth withdrew from the UK defence market as procurement was too slow and it was too hard to do business. This innovative, non-traditional supplier left the UK defence sector, like many others have before and after, depriving soldiers access to better solutions.

Currently the British Army lacks digital enablement below battlegroupⁱⁱⁱ for dismounted soldiers, there is only analogue voice. "*The MORPHEUS Evolve to Open (EvO) contract was signed in 2017 in order to transition from the closed architecture of the in-service Bowman system to an open-architecture system*"^{iv} EvO was due to deliver in 2020 and enter service by 2025, but was cancelled in 2023^v, setting the Bowman capability back years and leaving the Army with a closed system controlled by the prime-vendor for the foreseeable future. As such, in 2024 soldiers arrive at work with a Smartphone and then deploy with the equivalent of an analogue telephone.

We cannot close the sensor-decider-effector chain or even consider AI in the dismounted, close combat context until we make the change that the tech industry had to; become software-enabled not hardware-constrained.

To show it is possible to make the change, there is an example of what is possible in a similar "traditional" sector. Space was dominated by large players with the cost per kilo in orbit on the Space Shuttle at \$54,500^{vi}. SpaceX dropped that to \$1,500 per kg in 2018 with Falcon Heavy^{vii}. The number of Satellites in orbit 5 years ago was under 5,000^{viii}, today it is nearly 10,000^x with SpaceX's Starlink accounting for around 60%^x of those in orbit. SpaceX have approached space like an agile software company with the objective of significantly disrupting the market and the established monopolies. Starlink are not like a traditional hardware focused supplier and the difference is stark.



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Defence can't wait another decade for exquisite systems. The change is overdue and defence must become a software first organisation making use of existing hardware and off the shelf software wherever possible and do the minimal level of tailoring required to ensure usability.

User Centred Design

Another major change in the tech industry is “User Centred Design”, an iterative design process in which designers focus on the users and their needs to create highly usable and accessible products for them. The approach makes products the users actually need, when they need them, and avoids wasting time and money on features that no-one will ever use. Netflix epitomises this approach, focusing on ease of use and user experience over everything else.

Defence typically defines systems “top down” and then pushes the requirements onto users - the total opposite of a User Centered approach. This is most noticeable with dismantled soldiers. A good example is many of the in-service radio systems, which are technically brilliant but unusable without weeks of training. Contrast this with a smartphone, which is a significantly more capable device requiring no training and has no user manual.

As an example, a group of users that 2iC were working with had a highly configurable real-time video dissemination system. However, it was possible for a trained user, using the interface buttons on the device, to configure the radio in such a way that it stopped working altogether and required being returned to the factory. The user said all they really needed were three simple buttons; longest range, highest bandwidth and something in the middle. Instead, they have to work with an over complex and easy to break system.

Soldier Centric Design starts with the individual and builds solutions for them. This focuses resources on solutions for real issues, not perceived needs, and reduces training burden by making solutions intuitive for the actual user.

There is no single solution – cross cutting capabilities are needed

To achieve operational effectiveness, defence end users need real-time access to the right information at the right time, sourced from across the entire battle space, potentially utilising every soldier, sensor, and system available. They require the flexibility to purchase best-of-breed platforms, sensors and effectors from a broad, ever-changing, supplier base and then integrate these within days, not years.

ATAK is a software only solution and shows the value software can have. Its adoption is down to three simple attributes; it is easily accessible, it runs on off the shelf Android devices and the software works over a range of existing IP enabled comms bearers. However, ATAK is just one cog in the system of systems. There are other battle management applications, such as SitaWare, and other platforms, such as drones to consider. Then all this needs to work when operating with partners.

Digital enablement is needed down to the individual dismantled soldier but soldiers also need to integrate with the wider battlespace. To put the soldier at the core and design around the individual warfighter requires making it easy and quick to integrate them into the wider battlespace using the existing range of communication bearers. Also, it must be possible to quickly integrate any sensors and effectors on or near the soldier to maximise their effectiveness without adding burden. However all of these have different interfaces, APIs and architectures.

Service-based solutions are commonly used in commercial sectors to achieve this rapid and seamless integration. For example, Amazon connects millions of customers across various devices and networks with millions of sellers using different inventory systems, distribution centres, and couriers.

However, the tools used by companies like Amazon are designed for enterprise and cloud environments and rely on powerful servers and reliable high-bandwidth networks, which are rarely



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available in the battlespace. These enterprise solutions fail in military environments where connectivity is unreliable, bandwidth is limited, and infrastructure is mobile.

The Lean Services Architecture, invented by 2iC then tested and openly published by the MOD was designed for use on an individual soldier and between soldiers. It addresses the battlespace challenges of ever-shifting participants, wearable and mobile computers, and intermittent, low-bandwidth connections.

Traditionally, Defence organisations prefer a single solution to avoid mixed fleets, but this one-size-fits-all approach is not feasible for the dismounted soldier. Invariably, any organisation will have a wide range of systems, devices, sensors and effectors along with a range of communication bearers, it will be an ever-evolving mixed fleet. Some will be legacy defence equipment, some will be off the shelf technologies and some will be custom developed. Much could be commodity, like modern small drones and laptops.

The mixed fleet challenge faced by defence is analogous to those in the smartphone industry. In daily life we routinely use phones from different manufacturers (Apple, Samsung or Google), different versions (iPhone 13, 13 Max, 14 Pro, etc) and different “payloads” (Applications such as WhatsApp, X, Safari, etc) over various networks (different 4G & 5G providers, WiFi etc). This mixed fleet operates seamlessly and allows users to send images around the world in seconds, talk to friends in other countries or accurately share our location with colleagues. This is made possible through the open software-oriented approach rather than the traditional stovepiped hardware-focused approach taken by Defence organisations.

For defence organisations to attempt to standardise on a single protocol or single architecture for everything will only add delay and will ultimately fail, as exemplified by the obsolescence of the Blackberry in the smartphone market. For defence to embrace mixed-fleets, it needs to move away from the flawed hardware notion of economy of scale (buying lots of the same thing makes it cheaper) and instead iteratively introduce low-overhead open standards, such as the Lean Services Architecture, that can quickly and easily be extended.

To illustrate the change needed below are recent case studies which demonstrate how user centred design and off the shelf software has worked effectively to rapidly deliver capability.

Case Study - Hyper Enabled Assault Kit (HEAK)

The UK is not alone in needing to make the change to be software-enabled and user centred. US SOCOM dismounted operators needed to be able to get situation awareness and use tactical chat messaging without being heads-down looking at a chest-mounted screen. Further, they sought to achieve this with a low cost off the shelf Bluetooth smartwatch (which could be worn on the wrist and visible when weapon up) and integrated with their existing tactical radio and wider battlefield equipment.

The HEAK solution provides essential situational data directly on the wrist, enhancing soldiers' situational awareness and operational efficiency. Key features include eyes-up situational awareness (by glancing at their wrist instead of interacting with a chest-mounted device), rapid mission-configurable messaging, and secure tactical Bluetooth interactions.

Over a period of 8 months and a series of field trials with current operators a solution was developed and iterated that displayed blue forces picture and other situation data sourced from ATAK and displayed on a Samsung watch. This allowed the user to get a good situational awareness by quickly glancing at their wrist rather than pausing to look down and open their chest-mounted ATAK device.

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HEAK display on Samsung watch

As can be seen above, the solution integrated with other battlefield platforms, in this case a UAS, which automatically appeared on their display. This allowed the user to see that the UAS only 32m to their west was friendly and not a threat.

Another feature of HEAK was the ability for users to create “canned” short messages and deploy these over the air to the watch. This allowed the users to quickly send and read mission message specific messages from their watch without needing to open ATAK.

Initially the users had asked to control the device using rifle mounted buttons, but during trials the users did not like to use these and they were dropped from the solution. This reduced cost and complexity for a feature that was not going to be used.

This case study demonstrated the value of User Centric Design, using COTS hardware and software and integrating with existing military equipment. It is a baseline for further development including using the watch for physiological monitoring and using motion to report weapon firing. The approved use of tactical Bluetooth opens up a large range of wireless sensors, such as laser range finders. As it's already integrated into the wider battlespace, it can truly deliver soldier as a sensor.

For more information see [Overview](#)^{xi} and [Video](#)^{xii}

Case Study - Digital Combat Helmet System (DHCS)

DHCS is an Australian Army programme to position the individual soldier as a component of a wider integrated battlespace which provides a networked capability across military platforms and systems. DHCS delivers the ability for the combatant to share data seamlessly across the battlespace (soldier as a sensor).

Using a prototype digital helmet from Gentex data was displayed in Augmented Reality (AR) using the ballistic visor. The presentation of situational awareness and targeting information was presented using familiar iconography for rapid understanding and response.

However, excessive or intrusive information can overload cognitive resources, and performance will suffer. DHCS integrates sensors that provide physiological data that can assist in monitoring the performance of soldiers. The primary sensor used was a Garmin watch. In combination with the University of Newcastle, principles were developed that can exploit this physiological data to mitigate cognitive load. In future, this physiological data can be used to automatically adapt the display to their cognitive capacity to increase individual performance at each moment in time.

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The project demonstrated integrating sensors on a soldier and sharing data to and from the wider battlespace including integration with Generic Vehicle Architecture (GVA) platforms and Synthetic training environments. All while reducing burden on the soldier.

While the initial algorithm for determining cognitive load is deterministic, when the technology and models mature this algorithm could be seamlessly swapped out for an AI without changing anything else in the system.

For more information see [Overview](#)^{xiii}.

Case Study - Project Quicksilver

The Army's project Quicksilver is delivering a Communication Information Systems capability for the Land Special Operations Forces (Land SOF). This delivery follows a comprehensive user centric discovery phase and development of a Concept of Communications for Land SOF.

Quicksilver is tasked with creating a **“repeatable model to operationally, technically, and commercially deliver modern digital solutions to deployed users at pace and scale”**^{xiv}. The author of this paper is the 2iC Programme Director for Quicksilver and 2iC are the C5ISR Solution Architect for the Land SOF, leading the digital integration.

Central to Quicksilver's implementation is the adoption of a User-Centric Design methodology. This approach, coupled with iterative development, involves moderated workshops with end-users to identify and prioritise unit-level challenges. These workshops lead to actionable solutions, refined through real-world testing in the Quicksilver 'Battle Lab'.

This facility enables the testing of new software, equipment, and operational patterns, facilitating rapid prototyping and iteration based on direct user feedback. The lab de-risks capability and through early user engagement gets soldiers ready allowing rapid progress from idea/problem to fielding.



Using a user centered approach, off-the-shelf software and by integrating with existing and future equipment procurements. Project Quicksilver serves as a blueprint for rapidly integrating advanced technological solutions into military operations. This ensures a more connected, efficient, and effective force, ready to face the challenges of tomorrow.



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Conclusion

There is a need and desire to use every soldier as a battlespace node and leverage soldier systems to close the sensor-decider-effector chain. This needs to happen without adding burden to the individual. The changes needed will be challenging and can't be achieved by traditional routes, as demonstrated across sectors with hardware companies being totally replaced by software companies. The most important change is to adopt a software first mindset and approach solutions from the soldier's (user) perspective.

Currently the soldier cannot be a sensor as their only connection to the battlespace is their voice. Defence cannot wait for the "perfect solution" nor can defence afford the defence specific solution. Defence must make use of existing equipment and purchase off the shelf whenever possible to avoid wasteful, complicated and slow "defence" solutions.

As current conflicts are proving, it is the tactical soldier, rather than the exquisite and expensive hardware capabilities that make the difference. Using software to supercharge the tactical soldier by integrating digital systems increases situational awareness and reduces cognitive load. This is proven to be a low-cost solution that delivers tactical overmatch. With CGS recent commitment to be software-first and 'double lethality in 3 years and treble it by 2030' it is vital to commence this essential change now.

2iC are a software company who's approach prioritises user experience, empowering the concept of the Soldier as a Sensor and delivering battle-winning capabilities. Established with decades of software expertise, 2iC has created and globally tested off the shelf software solutions. The 2iC software layer enhances and complements existing investments, providing the robust technical infrastructure in the battlespace that is commonly used outside of defence.

Across the 5EYES, 2iC is leveraging the MOD investment in the Lean Services Architecture, designed and proven for use on soldiers, between soldiers and across the battlespace. To learn more about how 2iC's open standard software enables this change or to be part of the fundamental change needed please get in touch with the author or any of the 2iC team.

About the Author

Graham Booth is the CEO of 2iC Ltd, a UK-based SME specialising in digital interoperability within the battlespace. With a degree in Mathematics, his career began as a software developer and he has worked across the software development industry for 30 years. His experience spans system design and architecture, project and delivery management, and commercial and general management.

Since founding 2iC, Graham has actively contributed to the UK LOSA Data (COIL) Technical Working Group and the UK Generic Soldier Architecture (GSA) Technical Working Group, including its Middleware subgroup. He has worked with both the Australian and New Zealand Defence Forces on GSA.

Graham led 2iC's work on US SOCOM's Hyper Enabled Assault Kit (HEAK) project, enhancing operator situational awareness through the technical delivery of tactical data to a Bluetooth smartwatch. Currently, Graham is 2iC's Program Director for Project QUICKSILVER, where 2iC are delivering the C5ISR Solution Architecture for the British Army Land Special Operations Forces.

Additionally, Graham is on the MoD's Defence Suppliers Forum (DSF) SME Working Group and chaired the SME Metrics and Transparency workstream. Graham is serving his 4th term as the elected chair of the TechUK ICT Trade body Defence and Security SME Forum, representing the SME tech industry to MOD and Government ministers.

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About 2iC Limited

2iC are global leaders in digital interoperability in the battlespace. 2iC's proven off the shelf software connects and controls systems and devices not originally designed to work together.

2iC was the original inventor of the Lean Services Architecture (LSA) and worked with the UK Ministry of Defence to thoroughly test and then published the Lean Services Architecture as an open standard. 2iC's software products all utilise the Lean Services Architecture to allow open digital interoperability.

Using open standards, 2iC software enables the rapid digital integration and coordination of diverse systems and devices which are typically unattended, uncrewed, wearable, or vehicle borne. 2iC software uses whatever communication bearers are available and is designed for use in the most digitally challenging environment, the modern battlespace. 2iC software improves operational effectiveness and directly addresses the core issues faced by defence organisations and their suppliers.

2iC are a sovereign UK Small Business (SME) with customers that include the UK Ministry of Defence, the United States Department of Defense, the Australian Department of Defence and the New Zealand Defence Force along with globally recognised Systems Integrators and Equipment Manufacturers. 2iC has significantly contributed to the development of digital interoperability standards in Defence and Healthcare.

Website: 2iCworld.com

LinkedIn: linkedin.com/company/2iCworld

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