Title	**ONP Final Project Report Template**
Versions	**v.04 [FINAL]**

Dorset Open Networks Ecosystem	
List of partners (as at project closure)	**Dorset Council** **X-Net (Services) Ltd.** **ARM Ltd.** **Keysight Technology UK Ltd.** **Telint Ltd.** **University of Strathclyde** **Neutral Networks**
Total funding amount	GFA authorised **~£3.615M**. Current (claim 5) estimate is a total funding of **£2,809,396**
Locations	Dorset, Fleet, ARM USA, Manchester, Glasgow

Executive Summary

The Dorset Open Networks Ecosystem (DONE) project undertook R&D across two strands of Open Radio Access Network (ORAN) enablement - RAN intelligent controller (RIC) applications plus processors and RAN/Radio Frequency (RF) hardware.

The aim of the project was to further define the blueprint for rural connectivity by advancing development of open and interoperable radio access networks. The project examined the use of technology alternatives to standard network equipment and what power consumption savings this could yield. This may help to make the roll out of telecommunications infrastructure in rural and hard to reach areas cheaper, faster and more environmentally friendly. The project's innovative research and development (R&D) was driven by real-world requirements from operators, X-Net (Services) and the Ministry of Defence.

This work underlined the project's commitment to regional growth, and its contribution to growing high-tech skills and job opportunities in areas of under-investment, like Dorset, which has led to lower-than-average productivity. It also grew the UK's skills base in telecoms and cyber security, with a specific niche in national security, law enforcement and defence use-cases.

The project built a strong consortium of internationally well-respected partners that intend to continue working together on similar R&D projects into the future.

The DONE project was established to understand and validate real-world interoperability of ORAN equipment, in the context of exploring ways to introduce solutions built upon Arm (rather than Intel) architectures, and understanding the opportunities and risks posed by the RIC to security capabilities and activities in telecoms networks today. By developing a lab-to-live test environment, with cutting-edge testing and RAN digital twin technology, we have established and integrated a RIC testing capability for RIC app developers, as well as testing interoperability of radios and other ORAN equipment.

Deployment Summary

Illuminate (CipherForge) explored integration with a range of different RIC platforms throughout the project, to understand the opportunities to develop “write once, run everywhere” RIC applications for security applications in Open RAN networks.

By evaluating open-source implementations, exploring ORAN Alliance standards, and developing against the project’s RIC, this work has produced detailed technical reports on real-world interoperability and barriers posed to x/r-app deployment at-scale, including feature and interface availability, as well as API consistency.

The project conducted exploratory studies into the electrical energy consumption of x86 & Arm commercially available off-the-shelf processing hardware DU components. Idle (or low) processor utilisation represents a disproportionate amount of electrical consumption and accordingly reducing idle consumption would reduce the operational cost of rural site deployments. This demonstrated that idle consumption could be reduced by ~50%. To compare the difference in x86 vs Arm processing efficiency a 10 MHz wide N77 TDD cell was configured on both x86 and Arm. Mobile test device(s) were then connected in a repeatable manner to each system. This initially measured a mobile device being connected but with no traffic to measure for periods of low utilisation such as nighttime. This was followed by the mobile device streaming internet video, which consumes batches of traffic as content is downloaded and buffered locally. Finally, the cell was saturated with mobile devices maximising the link. For each of these scenarios the electrical power consumption of the processing unit and the processor utilisation was measured and recorded. This process was then repeated for a 50 MHz cell. These measurements showed that for each scenario the Intel processor consumed more energy than the Arm processor. This experiment also revealed that the electrical consumption of both processors while under moderate load did not vary significantly compared with idle. As a result, idle or low utilization consumes a significant amount of energy for both technologies. However, through a combination of a larger section of processors and lower overall consumption an Arm implementation could reduce the overall energy consumption by 70%. This work also highlighted that modelling indicates that off-grid self-powered rural mobile mast sites would be technologically possible and financially advantageous for particularly challenging environments. Additional work was undertaken in the deployment of O-RAN radio equipment in a Wireless Internet Service Providers network environment and profiling of the power consumption of both a small cell and a tier 1 vendor's radio units.

Keysight Technologies deployed a suite of test and validation tools to aid O-RAN interoperability. Firstly, the RICTest platform was employed to validate the capabilities of the Accelleran RIC through the creation of a dynamic xApp to turn on and off capacity responsively. Secondly, the Keysight UE simulator was able to establish a bug which would cause the DU to crash if sufficient PDU sessions were left open. This bug can now be fixed so any future developments would not be vulnerable to such an attack from a malicious actor. Thirdly, the Keysight RUSim was connected to an Open-Source CU + DU (SRS) to demonstrate cross vendor interoperability. This was subsequently repeated connecting the DUSim to SRS CU.

Results and Benefits Achieved

The aims of our work packages were broadly to examine the use of technology alternatives to standard network equipment and to explore possible power consumption savings. We investigated the use of RIC technology for dynamically controlling ORAN ecosystems and the development and proliferation of x/apps and r/apps to achieve this. Work was split into work packages and run by different partners responsible for RIC testing, digital twin integration, FWA power consumption trials and security.

Work package 1 was established as the governance stream for the project and was led by Dorset Council. It also took responsibility for delivering the ARM server and ORAN stack procurement and delivering what was the original work package 3 scope. This was eventually subcontracted to Illuminate. We successfully satisfied the broad aims of the project stated in the GFA by undertaking R&D across two strands of ORAN enablement - RIC applications plus processors and RAN/Radio Frequency (RF) hardware. We successfully further defined the blueprint for rural connectivity by advancing development of ORANs. We proved that the use of technology alternatives to standard network equipment can yield power consumption savings. Further detail on our success is provided below.

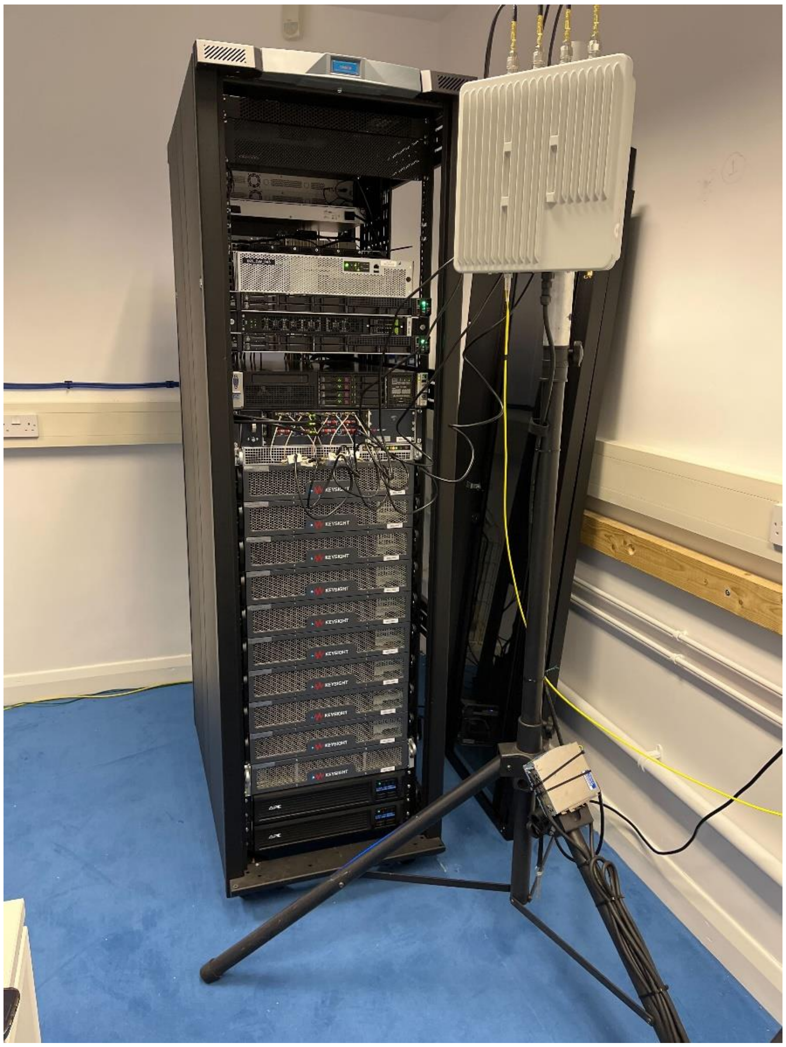
Illuminate (ILT) developed RIC capabilities to explore extraction of information through the E2 interface to enable detection of threats in an ORAN network and understand the ability for useful performance information to be accessed from within the RIC. ILT is interested in exploring how this may be productized, in the event of widespread ORAN deployment, alongside RIC app uptake. If the right information can be exposed and accessed through the RIC interface in an interoperable way, and the right security model is used for deployment of RIC (i.e. as an integrity-verified area of the network), ILT believes there are opportunities to improve mobility analytics. These present benefits for the UK through enhanced understanding of how ORAN and RIC interfaces and standards can be used to augment existing network security capabilities. ILT learnings around the real-world application of standards and interoperability for ORAN RIC are included in their more detailed project reports.

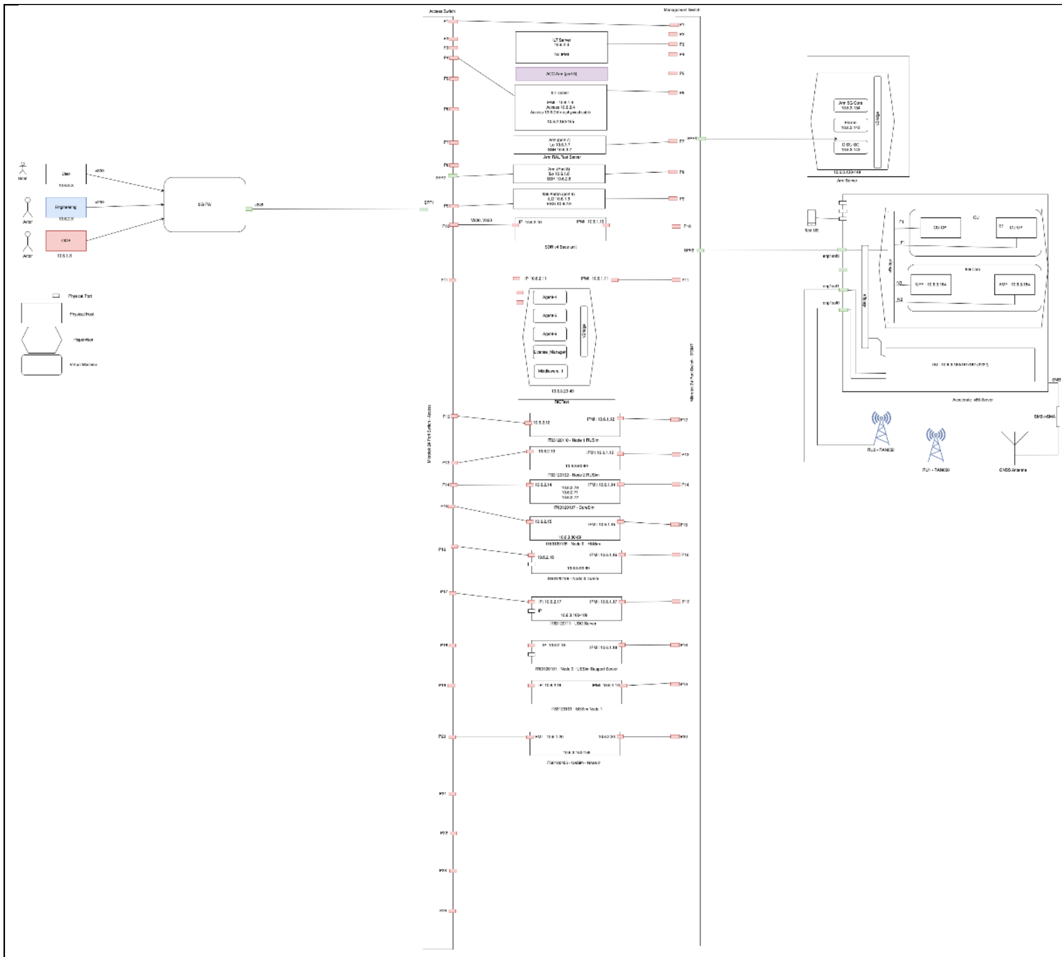
Through work package 1 the project also developed an Arm implementation of a DU, CU and near-real time RIC capable of running a third-party vendor RU and interconnecting with an Arm based 5G Core.

WP 2 Responsible for installing, integrating and hosting the equipment from the various partners at the Dorset Innovation Park (DIP). Despite some procurement delays this was achieved, and X-Net continues to host an ARM based ORAN stack with RIC integration at the DIP as well as a digital twin platform from Keysight for testing and validating ORAN components and apps.

- Constructed a lab-to-live O-RAN testing environment with remote connectivity to a range of O-RAN assets and testing facilities.
- Observed a 2.6x decrease in heat generation for comparable server workloads on Arm compared to Intel resulting in more space and energy efficient data centre configurations.
- Deployed both internal and external O-RAN radios alongside existing 3GPP radios all connected to the same core network for 3GPP - ORAN interoperability testing and enabled advanced traffic analysis.
- Deployed two parallel and interoperable Arm and x86 based O-RAN stacks – DU, CU and Core network.

- Deployed two RIC variants, one connected to physical E2 nodes, and one connected to RICTest. This enabled simultaneous development from the xApp and the E2 service model tracks.





WP 4:

- Detailed Arm vs Intel energy consumption comparison for rural mobile mast sites showed energy consumption is ~50% reduced for like-for-like computation.
- Computational unit energy consumption reduced by 75% when appropriately specified and employing Arm processors.
- Detailed understanding of how low-utilisation sites disproportionately consume energy.
- Prediction that a single-sector rural mobile mast could be operated year-round using a 5.8kW solar array with a 8.4 KWh battery available for ~£7,500 or a ~£13,000 wind system or a combination.
- Understanding that rural Wireless Internet Service Providers would require power autonomy for 72-hours, whereas mobile network operators which benefit from overlapping coverage are more willing to deploy teams with backup generators.
- Increased the TRL level from 4 to 6 by demonstrating the capabilities of Arm based 5G processing units.

WP 5:

- 6 publicly available new quarterly open-source releases developed as part of the project[1]
- 2.8% performance hit between Google Highway cross platform and native implementations. This demonstrates a small performance hit compared to the potential ~50% energy savings generated without the issues of maintaining two codebases.
- Achieved the predicted TRL increase from 2 to 3, and steps initiated to develop the library into an open-source reference implementation.
- Observed a 50% performance improvement for Turbo encoding/decoding.
- Addition of several core matrix multiplication functions.
- ~10-20% improvement in batch matrix multiplication vector functions.
- 38% improvement in computation of Singular Value Decomposition 32x4 32-bit floating-point complex matrix for singular values, and 20% improvement for singular values and singular vectors.
- Library is platform and performance agnostic meaning that DU software can be developed and run on high-performance servers or power efficient single board computers. Giving a 'horses for courses' approach rather than overkill 'one size fits all'
- These easily accessible and agnostic performance improvements lower the barrier to entry for new vendors to implement performant and efficient DU implementations.

WP 6:

- Test equipment has already demonstrated its value by discovering crash behaviour in the O-RAN stack which required manual intervention.
- Integrated Keysight RICTest with the Accelleran RIC to enable repeatability.
- Development of the latest v5 and v6 iterations of KPM and RC E2 Service models.
- Keysight implemented support for Energy Saving use-case and extended existing O1 functionality to be operable via the E2 interface as well.

[1] https://gitlab.arm.com/networking/ral/-/releases

- Significant learning on understanding, deploying and utilising tools for simplifying O-RAN interoperability.

One of the challenges with emerging and rapidly developing technology is the need for vendors to differentiate their product. Another common issue is integrating with another system without full control. As a result, vendors are incentivized to innovate their own product lines over developing a diverse eco-system. This in turn creates numerous mismatches and compatibility issues when trying to integrate equipment from different developers and these problems and inconsistencies all need fixing before operation can commence. Providing a common base model for vendors to implement would both reduce developing from scratch and reduce the number of interoperability mismatches. The standardization and repeatability of tests additionally reduces variance and complexity. Easily accessible specific version compatibility is a challenge within the industry. Vendors are reluctant to share this information, and as a result the scale and scope of the integration problem

We targeted each of these issues. Firstly, through Arm's work in developing a DU library this could become an industry recognised launchpad for vendors to share compatibility. Secondly, throughout the project we have early and often sought out exact version compatibility numbers to get a head start on the integration challenge. Finally, through the Keysight and X-Net lab-to-live workstream we have developed the knowledge and skills to conduct repeatability testing and simplification and have started to look at automated testing.

One example of where inconsistency within the standards have emerged is within the Energy Saving xApp use case. Certain manufacturers employ the O1 interface from the SMO to control turn on/off operations of radio unit during periods of low utilisation. Others employ the E2 interface from the near-real time RIC. The benefit of the former is that the network as a whole would have increased visibility, whereas the benefit of the latter would be being able to re-use an existing connection to extend functionality easily. These differences result in incompatibility issues.

The ARM RAL wouldn't have developed at such phenomenal pace without DSIT funding. This will have a significant impact on the development of ORAN equipment and solutions. Their work with Google Highway is important because, with further development, manufacturers will no longer need to maintain two code bases for ARM and x86 architecture, instead using a middleware service to translate the differences in the operating code.

Security
The DONE project was established to investigate a series of security-related use-cases and opportunities in ORAN, and adjacent areas. For example, in attempting to reduce reliance on "single source" DU acceleration from incumbent vendors, presenting a "single point of failure" in the UK RAN. In addition, by exploring access to RAN and RIC-originated information, and the levels of standardisation for routes of access to this information, the DONE project has laid the groundwork for a range of security monitoring use-cases like rogue base station detection, and mobility analytics. One key observation was around the limited level of implementation of ORAN security features in the RIC – we found in testing that these were often not implemented to the extent set out by standards. For Open RAN RIC apps to become a viable approach to these activities, standard (and implemented) service models and data will need to be exposed, with appropriate access controls and security around them, and this access will need to be enforced by a security layer in the RIC that is separate from the app itself. Likewise, implementation of conflict mitigation in the RIC will be essential to at-scale adoption of RIC apps. We believe that generally, the challenges in ORAN will continue to be similar to those seen in traditional RAN – challenges around software supply chain security and secure software development lifecycle will remain. We also believe that there may be challenges around identifying and agreeing the security posture of the RIC (and how it is deployed), since certain deployment scenarios may result in the RIC holding access to sensitive user identifiers.

High level summary of project costs
Initially the GFA total project value (TPV) was ~£7M. This consisted of a total expected grant claim of ~£3.615M and partner contributions totalling ~3.403M as follows:

GFA Cash Flow Profile Values

	£
Total Project Value	£7,019,111.43
Total Grant	£3,615,974.62
Total Partner Investment	£3,403,136.81

CR1 related to the removal of Illuminate and Vodafone from the project and added a new piece of work – the preparation of a report titled "MoD Dynamic Spectrum Sharing Options". As a consequence of CR1 the total project value, total estimated grant and partner investment values changed as follows:

CR1 Cash Flow Profile Values

	£	Change from GFA CFP
Total Project Value	£5,532,504.41	-£1,486,607.02
Total Grant	£2,915,935.35	-£700,039.27
Total Partner Investment	£2,616,569.06	-£786,567.75

CR2 authorised a number of further changes to project funding including the loss of any unspent FY1 allocated grant funding that had not been spent by 31/3/24 resulting in updated total project value, total estimated grant and partner investment values changed as follows:

CR2 Cash Flow Profile Values

	£	Change from GFA CFP
Total Project Value	£5,184,281.39	-£1,834,830.04
Total Grant	£2,813,656.54	-£802,318.08
Total Partner Investment	£2,370,624.85	-£1,032,511.96

CR3 related to the removal of Wildanet from the Project with some of the allocated grant for Wildanet being transferred to Dorset Council. This resulted in updated total project value, total estimated grant and partner investment values changed as follows:

CR3 Cash Flow Profile Values

	£	Change from GFA CFP
Total Project Value	£5,149,989.93	-£1,869,121.50
Total Grant	£2,813,627.35	-£802,347.27
Total Partner Investment	£2,336,362.58	-£1,066,774.23

Currently the most recently submitted CFP relates to our Q5 Claim submitted to DSIT on 27th Jan 25 which has not yet been approved. Our Q5 CFP included "actual" values for Q1 through Q5 inclusive and estimated values for Q6 (based on profile category underspend) as follows:

Claim 5 Cash Flow Profile Values

	£	Change from GFA CFP
Total Project Value	£5,142,936.93	-£1,876,174.50
Total Grant	£2,809,396.14	-£806,578.48
Total Partner Investment	£2,333,540.79	-£1,069,596.02

The values included for our final Q6 claim is based on the total grant amount balance for each partner for the year taking account of claims already made (including our recently submitted Q5 claim).

Discussions with partners indicate that the actual likely claim amounts will be somewhat lower and will likely result in an overall underspend of grant claim of somewhere around £100K – the exact level of the underspend will be confirmed once our Q6 claim is submitted.

DONE Project Grant Claim Summary by Claim Period:

Milestone Period	Q1	Q2	Q3	Q4	Q5	Q6	FY1	FY2	Total
Dorset Council	£48,235.48	£71,281.54	£51,048.59	£51,383.90	£389,937.12	£237,562.87	£119,517.02	£729,932.48	£849,449.50
ARM	£0.00	£182,000.71	£34,991.50	£73,932.33	£95,277.63	£102,726.47	£182,000.71	£306,927.93	£488,928.64
Illuminate	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Keysight	£6,845.53	£672,934.24	£9,881.94	£21,210.72	£20,587.66	£38,017.46	£679,779.77	£89,697.77	£769,477.54
Kimcell	£30,151.85	£42,349.16	£29,143.23	£14,707.69	£29,589.12	£34,534.73	£72,501.01	£107,974.77	£180,475.78
Neutral Networks	£10,853.58	£27,444.16	£21,341.91	£23,755.75	£22,675.96	£57,188.41	£38,297.74	£124,962.03	£163,259.77
Strathclyde Uni	£0.00	£23,183.78	£13,873.57	£13,728.66	£13,847.20	£14,223.18	£23,183.78	£55,672.61	£78,856.39
Telint	£37,339.87	£36,180.43	£35,325.28	£26,677.58	£23,765.54	£86,375.72	£73,520.30	£172,144.12	£245,664.41
Vodafone	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Wildanet	£6,672.09	£10,321.60	£0.00	£16,290.42	£0.00	£0.00	£16,993.68	£16,290.42	£33,284.10
Total	**£140,098.39**	**£1,065,695.63**	**£195,606.01**	**£241,687.06**	**£595,680.22**	**£570,628.84**	**£1,205,794.02**	**£1,603,602.13**	**£2,809,396.14**

DONE Project Grant Claim Summary by Category:
The above total claim can be summarised by spend category profile for the project based on our Claim 5 submission as follows:

Claim 5 CFP	
Full Project	
Dorset Council Breakdown by Category	
Labour	£245,782.13
Overheads	£49,156.43
Materials	£340,796.60
Cap Use	£0.00
Sub Contract	£199,075.98
T&S	£8,888.36
Other	£5,750.00
Total	**£849,449.50**

Claim 5 CFP	
Full Project	
ARM Breakdown by Category	
Labour	£145,853.20
Overheads	£29,170.64
Materials	£0.00
Cap Use	£0.00
Sub Contract	£313,904.80
T&S	£0.00
Other	£0.00
Total	**£488,928.64**

Claim 5 CFP	
Full Project	
Keysight Breakdown by Category	
Labour	£89,240.11
Overheads	£17,848.02
Materials	£660,662.00
Cap Use	£0.00
Sub Contract	£0.00
T&S	£1,727.40
Other	£0.00
Total	**£769,477.54**

Claim 5 CFP	
Full Project	
X-Net (was Kimcell) Breakdown by Category	
Labour	£12,864.00
Overheads	£2,572.80
Materials	£17,210.00
Cap Use	£1,400.00
Sub Contract	£121,848.98
T&S	£2,330.00
Other	£22,250.00
Total	**£180,475.78**

Claim 5 CFP	
Full Project	
Neutral Networks Breakdown by Category	
Labour	£134,023.93
Overheads	£26,804.78
Materials	£745.50
Cap Use	£0.00
Sub Contract	£0.00
T&S	£1,685.56
Other	£0.00
Total	**£163,259.77**

Claim 5 CFP	
Full Project	
Strathclyde Uni Breakdown by Category	
Labour	£25,300.58
Overheads	£47,643.25
Materials	£0.00
Cap Use	£0.00
Sub Contract	£0.00
T&S	£5,912.57
Other	£0.00
Total	**£78,856.39**

Claim 5 CFP	
Full Project	
Telint Breakdown by Category	
Labour	£200,250.38
Overheads	£40,050.07
Materials	£0.00
Cap Use	£0.00
Sub Contract	£0.00
T&S	£5,363.96
Other	£0.00
Total	**£245,664.41**

Claim 5 CFP	
Full Project	
Wildanet Breakdown by Category	
Labour	£7,223.35
Overheads	£1,444.67
Materials	£0.00
Cap Use	£24,435.63
Sub Contract	£0.00
T&S	£180.45
Other	£0.00
Total	**£33,284.10**

Project Highlights

As well as the project's many technical achievements and learnings, it has left a lasting legacy at the Dorset Innovation Park in the shape of a fully functional ORAN lab. This includes an outdoor testing facility for 3GPP + ORAN 5G technologies. Our intention next year is to fine-tune this facility so that it can test ORAN equipment and applications for the wider telco community, vendors and manufacturers and there is already Interest from external organisations to undertake such 5G testing. We have been fortunate to have big players in our consortium and it is our intention that they continue to be involved in this lab for the long-term.

Regarding dissemination, we have run several events during the project's life. As one of our partners was chair of the UKTIN expert working group for security, we organised an event at the DIP on Security attended by DSIT and secured GSMA and ETSI Director Level speakers.

We also ran a successful two-day event at the end of the project which was attended by local councilors, MPs and DSIT representatives and featured keynotes on topics such as rural connectivity, innovation and skills as well as demonstrations of the ORAN lab at the DIP. This broad event also reflected on the work that Dorset is leading in other areas of technical innovation which is funded by government as well as big industry players including Qualcomm.

One particular technical standout was the work that ARM did with Google Highway. In porting the RAL to Google Highway, they created a means of developing hardware and software that doesn't require the maintenance of two code bases – x86 and ARM. This is game-changing as it makes market entry so much easier and cheaper and doesn't prohibit manufacturers from developing for ARM *an*d x86 due to cost. In doing so we satisfied one of the key objectives of this programme in exploring vendor diversification and efficiency. This work was additionally complemented by the exploratory work conducted into measuring x86 vs Arm power consumption and demonstrated that an established Arm based telco ecosystem could notably reduce mast power consumption and reduce deployment and operational costs. This would be particularly beneficial to rural connectivity as traditionally these sites have not been commercially viable and require government intervention.

We also managed an Exeter University undergraduate placement. This saw our lucky student meeting DSIT Directors and getting their recommendations on the ways that making small GFA changes could influence big policy and funding changes at DSIT.

We were honored to be asked to speak at Connected Britain 2024 and delivered keynote presentations on the importance of skills and student participation in Government research projects. The project also featured in talks about Council involvement in innovation projects and how local authorities can do things better, as well as panel sessions around rural connectivity.

Project Conclusions

As the Open Network Ecosystem projects developed in parallel with rapid ORAN standards development, we observed a number of important issues. Standards versions vary greatly between E2 Service Models and components lacking stability and make it challenging to understand where problems are occurring.

As the technology and market requirements varied rapidly from the initial bid proposal to the award, this meant that the beneficial focus of the project had changed.

ILT see a clear requirement for support in driving outputs and outcomes of these projects into standards, now that there has been sufficient time to develop informed insights into the challenges that likely need to be addressed to enable real-world interoperable x/r-app ecosystems to flourish. Given the risks and likelihood of ORAN adoption at scale, there are challenges for smaller companies to make intensive commercial investment into this area, given the interoperability and “real world” deployment barriers faced.

- Integrated Keysight RICTest with the Accelleran RIC
- Development an automated Energy Savings xApp to control simulated cells over the E2 interface.
- Conducted performance testing using the Keysight UE simulator to load test the Accelleran DU and CU components.
- Improved understanding of the challenges of the interoperability changes of discrete O-RAN components.
- WP4 power consumption findings

Next Steps

Taking advantage of the learnings, expertise and industry links developed within this project and its predecessors, Dorset Council aims to develop a non-commercial special purpose vehicle (SPV) for innovative and proactive research in line with industry and HMG objectives (see business sustainability plan for further information). It is our intention to further exploit the knowledge gained and equipment procured during the life of the DONE project to create an ORAN research and development facility at Dorset Innovation Park for the sole purpose of developing and evaluating ORAN components and apps. This may evolve over time to be a commercial facility that can generate revenue for Dorset Council as well as other partners involved in its creation, and bring much needed technology jobs to the Innovation Park.

Next Steps – ILT:

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- Similarly, ILT are keen to explore means through which the RIC and ORAN can reduce the cost of security monitoring, and how to cost-effectively influence and participate in relevant technical standards development to support this.

Dorset Council:

- Planning to exploit O-RAN's modular architecture and diversified RAN component base to develop a rural Fixed Wireless Access (FWA) demonstrator and increase rail connectivity through a proof-of-concept, demonstrating use of dynamic spectrum authorisation to gain access to MoD spectrum. This would be executed using other funding available to the Council which we are currently exploring and bidding for.

Arm:

- Develop a cross platform Open Source DU Reference model. This would simplify the development of DU software components for DU vendors.

Keysight

- Keysight plans to leverage these insights gained to further enhance our O-RAN solutions, aiming to provide improved test and measurement environments for the UK O-RAN ecosystem in key research areas of energy efficiency

Media Library
The DONE Project - Dorset Council Digital Dorset: Company Page Admin | LinkedIn Final reports and outputs

DONE Project partners and contributors to this report

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