RAJANT

CASE STUDY

Createc Ltd. Establishes Resilience of Rajant ES1 BreadCrumb® in Highly Irradiated Environment

Jacob's Co-60 gamma irradiation facility

Managing and decommissioning nuclear plants presents a range of unique challenges, from the special hazards of radioactivity to the strict regulatory environment. Emerging techniques in robotics, sensing, and imaging have significant potential to save lifetime costs, improve safety, and accelerate clean up.

Comprehensive and controlled reputable testing of advanced technology is what The Harwell Science and Innovation Campus does. It is a 700-acre science and technology center in Oxfordshire, England. Over 6,000 people work there in over 240 public and private sector organizations, working across sectors including Space, Clean Energy, Life Sciences and Quantum Computing.

The Challenge

Createc Ltd. specializes in helping customers solve technical and human challenges together, vastly increasing the chances of success for nuclear innovators. Using robotics, such as the Boston Dynamics Spot equipped with advanced sensors, Createc provides services to nuclear decommissioning organizations across much of Europe, plus the UK, USA, and Japan. Critical to their ability to provide these services is the ultra-reliable network provided by Rajant.

As a Rajant partner, Createc believed Rajant Kinetic Mesh® could withstand the significant challenges of radiation and contamination. Createc arranged for testing at the Harwell Science and Innovation Campus, where controlled exposure to a Cobalt 60 (Co-60) source was available. Establishing whether key electronics and networks were capable of functioning while exposed to extremely high levels of Gamma radiation was paramount. The Rajant ES1 BreadCrumb was selected for the activities.

The Solution

Two Rajant ES1-2450R units were set up with one device located in the radiation cell and the other in the corridor outside of the cell. The device in the cell was exposed to the Co-60 source at varying dose rates throughout testing.

The measurement used for the Co-60 Gamma Radiation is Sieverts (Sv). For context – nuclear industry staff radiation exposure is kept As Low As Reasonably Practicable (ALARP). UK regulations do not allow workers to

Testing Location

- The Harwell Science and Innovation in Oxfordshire, England

The Partners

- **Rajant:** Pioneers of peer-to-peer radio communications enabling real-time voice, video, and data to connect machines, robots, and people together as part of a secure private mobile network.
- **Createc Ltd:** Global leaders in the research, development, and delivery of robotics, sensing, and radiometric solutions. Createc has a track record of world-first deployments and entrepreneurial success.

Kinetic Mesh Components: ES1-2450R

- 2.4 GHz and 5 GHz
- One ES1 being irradiated

Other Equipment

- Raspberry Pi with SD card
- 3D-printed handle to distribute power banks

exceed 20mSv/yr, with most sites limiting that to 10mSv/yr.

Harwell personnel used a highly sensitive Gamma Ray dosimeter, and identified positions relative to the Co-60 source at which varying doses rates per hour would be experienced. The starting point was 0.5 S v/h, increasing by 0.5 Sv/h to 5 Sv/hr at the closest point.

While not optimally positioned for RF signal propagation, the alignment of the ES1 for full exposure to the Gamma Rays across the body of the unit was more important than range considerations and antenna alignment. The Co60 source is a retractable source, rendering the environment safe between tests allowing repositioning of the ES1 for testing at the varying exposure levels.

Four tests were performed:

Test 1: Rajant's range-of-network performance in a 'nuclear concrete environment. Rajant A was positioned inside of the cell at the 0.5 Sv/hr position with Rajant B at various locations outside of the cell from 0 - 15 m with the cell door open and closed.

Test 2: Rajant's performance with Rajant B positioned at the cell door (closed) and Rajant A moving to regions of a slowly increasing dose rate from 0.5 - 5 Sv/hr. The source was exposed for 300 seconds using the automated source retraction system at Harwell. To load the network, iPerf3 was running for the duration of the exposure. To cover the time taken for the source to move into place and retract, iPerf3 ran for 360 seconds. No obvious issues were observed as the dose rate increased.

Test 3: This was exposure at 4Sv/hr to mimic a high-radiation application that Createc is undertaking for a customer. This was done at the max range as determined from Test 1 (10 m). Issues were noted as Rajant A was moved into the 1 Sv/hr position with the signal dropping between the 2 devices. This was likely due to the increased distance between the devices, as opposed to the increased dose rate. Due to the sensitivity of the 10 m position, Rajant B was moved back to the 5 m position, and the test was repeated. No issues were observed until Rajant A reached the 4 Sv/hr position, at which point the connection was lost. Again, this is most likely a geometry issue with the increased distance at Rajant A moved to higher dose rates. Moving Rajant B back to the cell door resulted in the connection being restored.

Test 4: This test tried to destructively test the device. Rajant A positioned at 10 Sv/hr and Rajant B at the cell door (closed). The source was exposed overnight and throughout the morning on the second day to test the performance of the network under extended exposure to high dose rates. In total, Rajant A was exposed to 214 Sv over the two days and was still working in a sensible manner undestroyed.

> "We regularly deploy the Rajant Kinetic Mesh network to enable our robotic operations in industrial settings. This testing conducted for Rajant proves the efficacy of a mobile robotic/sensor network for nuclear applications. We have already taken this learning and implemented an ad hoc network in a high radiation environment, allowing the site licensees to capture data which was previously impossible to access."
>
> **— Will Newsom**
> Energy MD, Createc Ltd.

Final confidence checks were performed again once the equipment returned to Createc to ensure the system was still working as expected. No obvious issues with the system were seen.

BC|Connector, BC|Commander, and BC|Enterprise were used throughout to track performance metrics for the Kinetic Mesh.

The Results

Createc's intent had been to find the limits of the Rajant ES1-2450R to high Gamma Ray radiation to assess whether Rajant Kinetic Mesh can be relied upon for remote operation of assets in its decommissioning and inspection activities. The exposure levels of the ES1 BreadCrumb far exceeded levels any human could withstand, and despite a full exposure of 214 Sv in the testing period – in excess of 21,000 times the annual limit for nuclear workers.

The results mean Createc can remotely operate in irradiated environments, accelerating the speed of activities and ensuring the safety of personnel tasked with inspection and decommissioning activities. Locations, where this will be vital, are the USA, Japan, and Europe.

Rajant network nodes have been relied upon for decades by organizations needing to operate networks reliably in harsh climatic and industrial environments. The nuclear industry becomes the next to be added to this list.