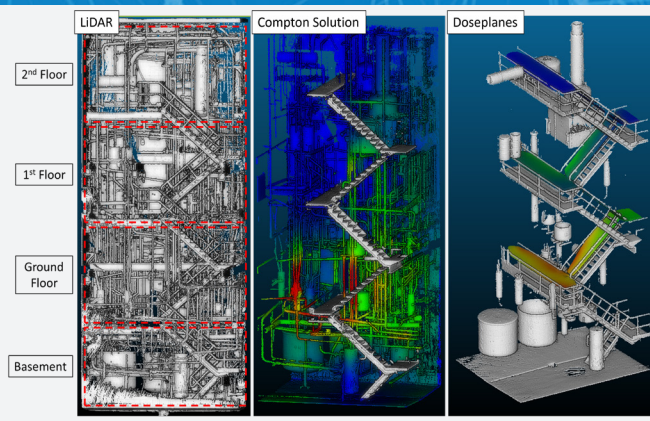
RAJANT

CASE STUDY

Createc Map Radioactive Power Plant Site Using Boston Dynamics Spot and Rajant BreadCrumb®



The Dounreay nuclear site on the north side of Scotland, operational in the UK for reactor research and development from 1955 to 1994, is now part of the nation's largest nuclear clean-up and demolition project. It was where some of Britian's leading scientists and engineers experimented with Plutonium, Uranium, and other nuclear metals to give them advanced knowledge to generate electricity from nuclear energy. Dounreay is now a construction, demolition, and waste management site, all designed to leave the site in a safe condition for future generations. The experimental nature of many of its redundant facilities means the clean-up and demolition require innovative approaches and great care.

The Challenge

A multi-floor nuclear material processing cell at Dounreay remained sealed for over 25 years in a non-operational state. A lack of information on the contamination and dose rates within the cell presented an obstacle to the nuclear decommissioning process, requiring a comprehensive understanding of the cell's condition before any work could commence.

Although estimated to be around singular mSv/hr, the exact radiation levels could not be confirmed. This necessitated that remotely operated robotic surveys be done before human operators could safely enter.

Moreover, restricted access between levels, narrow walkways, and inadequate lighting posed additional challenges. Sole access to levels beyond the ground floor relied on staircases within the cell, not easily traversed by most ground-based robots.

Thick concrete walls and a large amount of metal structures within the cell made wireless radio communications within the cell difficult. This posed a severe challenge to remotely operating robots using conventional radio communications.

The Solution

Createc has developed the N-Visage Explore (NV-X) system for real-time radiation mapping. It is modular and compact and can be mounted onto any ground robot or handheld instrument of appropriate size. NV-X utilizes a sensitive gamma radiation camera

Customer Description

- Located in Scotland's Highland area, Dounreay is a nuclear site owned by the Nuclear Decommissioning Authority (NDA), overseeing the multi-decade process to turn into a brownfield site.

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 technology deployments in challenging industrial environments.
- **Boston Dynamics -** Global leader in developing and deploying highly mobile robots capable of tackling industry's toughest challenges, enabling automation in unstructured or hard-to-traverse spaces.

Solution Components

Kinetic Mesh Components:

ES1 BreadCrumb and BCICommander

Other Equipment:

Boston Dynamic's Spot, Createc N-Visage Explore (NV-X), OSE Ltd. Robot PoE Switch, Createc Smart PoE Powerbanks

to produce high-quality 3D radiometric survey data.

While NV-X is intended to be modular, it has been closely integrated with the Boston Dynamics “robot dog” Spot. Spot is a quadruped capable of navigating rugged terrain. This allows operators to deploy the NV-X into complex environments with a wide range of obstacles, such as debris and stairways.

Createc successfully deployed two Spots into the cell at Dounreay - one with a manipulator arm and PTZ camera and one with the NV-X payload. Both robots were equipped with custom lighting units and contamination control suits to provide lighting in the unlit cell while preventing the robots from ingesting contamination that would prevent them from being released from the Dounreay site.

Integral to Spot’s onboard equipment was Rajant Kinetic Mesh® BreadCrumb radios for BVLOS (Beyond Visual Line-of-Site) robotics operations, enabling Spot to enter the hazardous environment while keeping the human operator of Spot physically removed from the danger.

The Rajant ES1 was chosen due to its dual radio setup, a wide variety of available high-gain antennas, and small form factor. The ES1 BreadCrumbs were interfaced with Spot using a Robot PoE Switch designed and manufactured by a Createc spin-out company - OSE Ltd. The Switch provides power regulation from Spot’s payload power bus (48-72V), networking with Spot via a four-port Ethernet switch, power to the Rajant ES1 via passive PoE, and a PoE+ port for additional sensors, such as the Fluke SV600 (not used in this deployment).

An ad-hoc Rajant Kinetic Mesh was set up by utilizing another OSE product, the Smart PoE Powerbank, which was designed for this application to power and network to Rajant nodes. Rajant ES1s were mounted to the Smart PoE Powerbanks, and Spot was used to carry them into place. The Powerbanks have onboard computers, which allow them to report back to the user the battery state as well as additional sensor data. The Powerbanks powered the Rajant ES1 for up to four days or until the job was complete. This strategy allowed the network to be adjusted for best throughput within the cell without putting human operators at risk. BCICommander was used to monitor the health of the Rajant network.

> “By doing the initial groundwork, Spot has shown us the hazards that might affect workers who are tasked with the decommissioning. We will use the data to ensure that we mitigate those hazards and keep our people safe. This work also has the potential to save money on our decommissioning investigation.”
>
> **— Bernie Jones,**
> Dounreay Project Manager

Rajant Kinetic Mesh was the networking of choice, and indeed all of Createc’s robotic BVLOS work due to its meshing capability. Nuclear environments feature significant shielding and obstructions, requiring mesh communications. Rajant Kinetic Mesh’s low latency and high bandwidth enable robotic deployments in these environments with little effort from human operators.

The modular nature of NV-X allows it to be used with a wide variety of 3D mapping sensors for data capture. Createc has partnered with Leica Geosystems to employ the Leica BLKARC, which can produce high-fidelity geospatial surveys as 3D point clouds. NV-X uses these point clouds in an online survey and post-processing format.

The Results

The Spot with manipulator arm deployed Rajant BreadCrumbs on custom power banks designed to run for the four-day deployment. This Spot then conducted swab sample return missions, inspected objects with the PTZ camera, and finally retrieved the Rajant Kinetic Mesh radios at the end of the deployment. The Spot with NV-X conducted 3D laser scans and multiple radiometric survey missions throughout the four floors of the cell. These were all combined into a single model of the cell in post-processing. The NVisage radiation mapping algorithms produced a 3D reconstruction of the radiation sources and dose planes for the cell, which have proven very valuable aid for decommissioning planning.

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