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## Table of Contents



## Copyright Notice

# Synoptic 4D coastal monitoring system
# Report on Bathymetry Nexus radar deployments

## Introduction

Please see associated technical note for more detail on the radar systems being deployed.

Several systems comprise the Liverpool Bay coastal monitoring radar network. These radar locations are seen in the figure below:


**Stations deployed and active:**

- Liverpool Port (Langton Lock)
- Crosby beach, Hall Road pumping station

**Stations in planning stage**

- New Brighton radar (lifeguard station promenade)

Coverage is illustrated in relation to the Data Nexus model grids and the satellite swath paths. The radars cover the immediate foreshore area and the approach channels to the Port of Liverpool.

In this project we provide radar-derived imagery of wave fields approaching. The instruments have a maximum range of 6km, but due to the project power decay with range, results at very long ranges are typically degraded unless weather conditions are optimal for sea surface monitoring (windy with visible waves).

## Background and use cases of Liverpool Bay radar network

The radar systems in Liverpool Bay are primarily designed to provide the Northwest Regional Monitoring Programme with a wealth of data upon which to base critical coastal defence decision making and flood risk management intervention designs. Without a large body of data, decisions must

be made on temporally and spatially sparse survey datasets that do not provide a clear picture of how the dynamic coastal zone is evolving.

This is vital in the case of managing not only coastal defence and erosion, but also navigation through the Port of Liverpool entrance channel. Currently monitoring this is an extremely expensive manual task carried out by crewed survey vessels operated by the port. While the accuracy required to validate safe navigation levels cannot currently be given by remote sensing, we can help to survey the wider area and reduce the number of survey vessel missions required to maintain a good understanding of the dynamic channel zone.

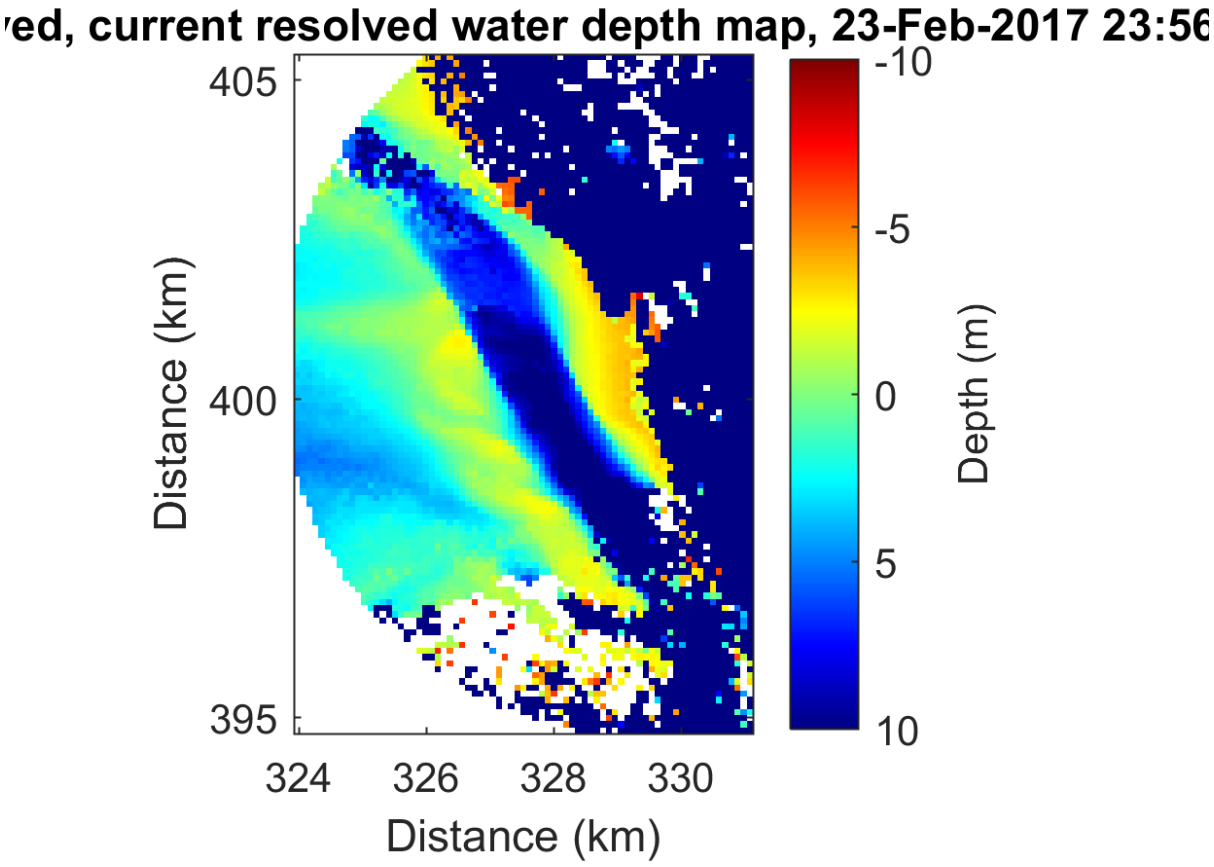



*Figure 1: Example radar depth map from Queen's navigation channel*

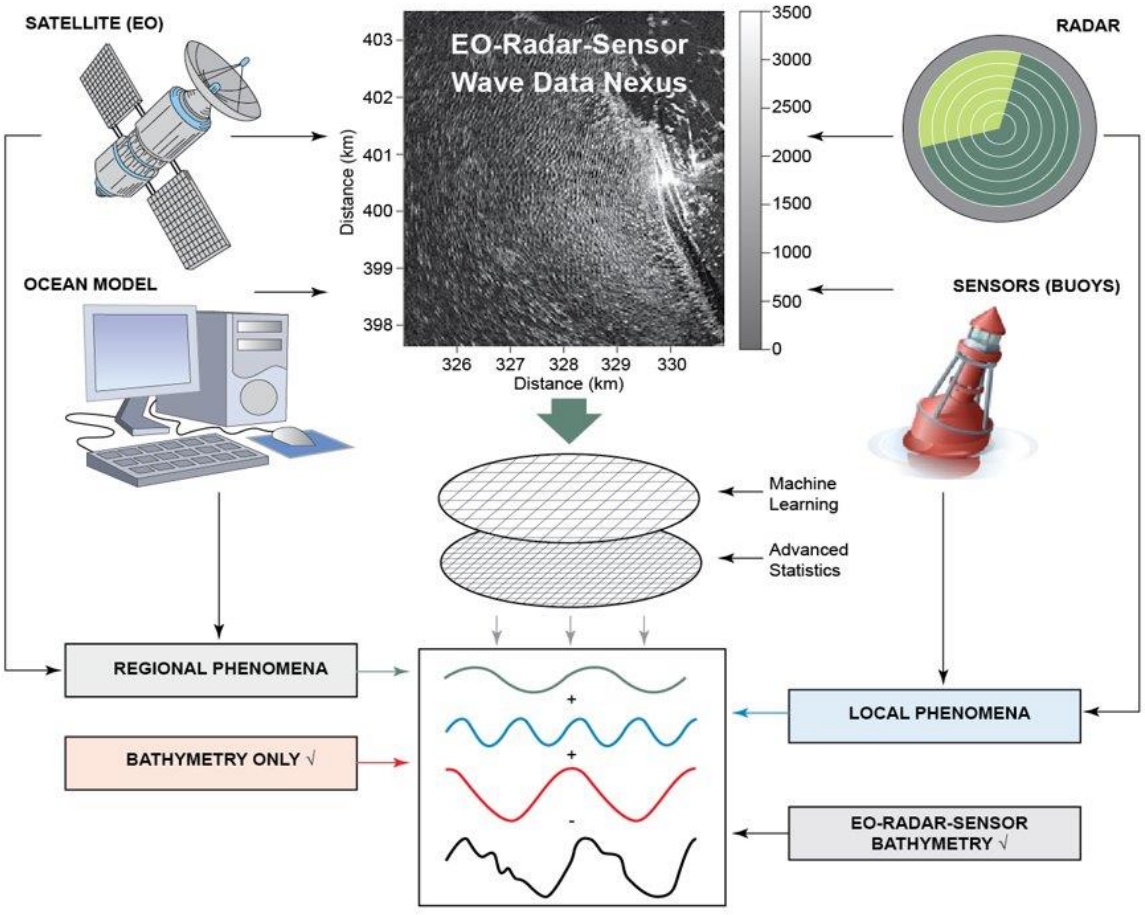
The elevation and depth maps produced by the radar can also help to identify areas of rapid change and direct more focused survey campaigns to trouble areas that may require rapid intervention to maintain navigational safety. When combined with the satellite, wave model and instrument data, the utility of each individual technology will be dramatically increased.

## Integration into the Data Nexus

The radar network is intended to cover the nearshore/intertidal zone in the Data Nexus region of interest, this area is typically incredibly difficult to monitoring with traditional survey techniques and is often not reflected well by modelling because of the dynamic nature of the surrounding bathymetry and how that affects the waves coming from offshore.

Multiple data sources (radar, satellite, survey, models, buoys) operating within the Nexus region will allow the system to determine the data most suitable to use for a given space and time within the domain. Advanced statistical analysis and Machine Learning performed on the bank of data will analyse the wave velocity patterns to determine bathymetry. This will allow a rapid update rate on the state of the physical environment over a temporal and spatial scale that is not possible with any one given observation methodology.

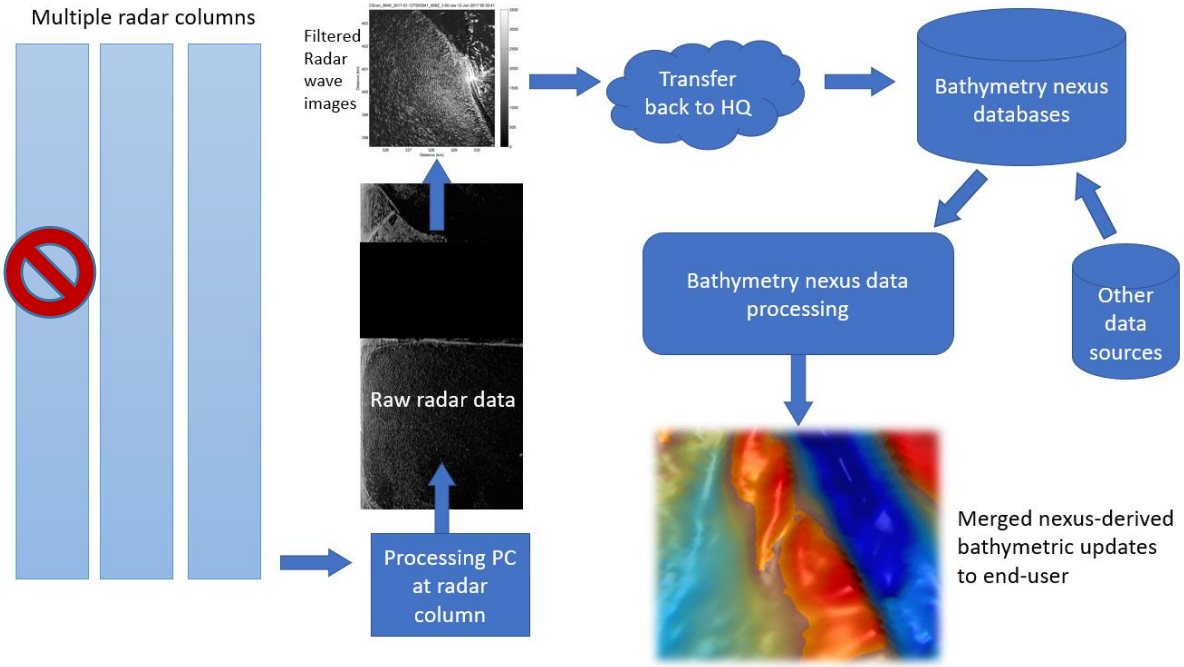
The diagram below illustrates at a conceptual level how the radar systems fit into the Data Nexus along with models and data analysis to produce a comprehensive map of depth estimates over a large area.



## Radar data and end-user data delivery

The diagram below shows how each radar column produces raw images, processes that data at site, cleans and filters out artefacts. The cleaned data are sent back to HQ and streamed into the Nexus databases where further sorting and cataloguing occurs. Other data sources involved in the project are also fed to the Data Nexus and temporally synchronised with each other.
These datasets are then passed to the Nexus processing cluster, where they are processed and compiled into a series of data products that will be delivered to the end user. The temporal rate of update is yet to be finalized and will likely be variable depending on the weather conditions observed and data sources available at any given time period.

In relation to Deliverable D.2 in the bathymetry nexus project plan several elements remain to be completed – most crucially the North Wirral Radar platform which has been delayed in planning approval stage (indicated by the red cross below). Currently production of raw radar imagery on site is automatic, however the process of transferring the data from HQ to the bathymetry nexus database is manual and batched currently. This task will be automated once the locations of the bathymetry nexus databases have been confirmed.




The processing stage involves many steps, some of which are yet to be fully developed. However, at a high level the process involves take wave statistics from all data sources, calculating the wave direction and velocity profiles over a wide area in a synchronised manner, and estimating bathymetric change from those data. This process differs in methodology and scale to that of the radar-derived bathymetry alone and aims to expand the utility of all sensors in the network to be greater than the sum of their parts.

## Conclusion

Radar data from the Crosby Station has been used to perform initial testing of the data analysis techniques and validation of data sources. Once the techniques for processing and data merger are validated and the North Wirral radar station at New Brighton comes online, the delivery of data to end users detailing the navigation channel approach bathymetry into the Port of Liverpool will be shared with project end-users.

Once the feasibility and utility of this ambitious project has been demonstrated Marlan will be leading the commercialisation process to extend the bathymetry nexus to port and coastal areas with a requirement for up to data, wide area bathymetric monitoring.

Interested persons are welcome to contact us:

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