The Next Generation Enterprise Geospatial Data Capture

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Key words: Cartography, GNSS/GPS, Low-cost technology Photogrammetry, Remote sensing

SUMMARY

Ordnance Survey has been mapping Great Britain for more than 200 years. Our large-scale data stands at the core of the geospatial data commitment to the nation. With changing data needs and a society accustomed to information at their fingertips, it is essential Ordnance Survey provides up-to-date data to public partners and commercial customers.

To support the increased and ever-changing demand for rich geospatial content it is essential Ordnance Survey has the infrastructure to effectively and efficiently manage the core data capture and maintenance programmes.

Leveraging the technical advancements in web applications, Ordnance Survey have developed a production solution to support data maintenance that can expand data themes to continually improve the data on offer.

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1. LARGE SCALE DATA PLATFORM

At the centre of Ordnance Survey (OS) data capture and maintenance is the three year cyclic revision programme. All 243,241 square kilometres of Great Britain are surveyed over the course of the programme, with more than 80,000kms being flown and updated annually. A combination of external suppliers based in India, UK based Field survey teams and a small office of remote sensing surveyors, contribute to the 20,000 daily updates made in the production system.

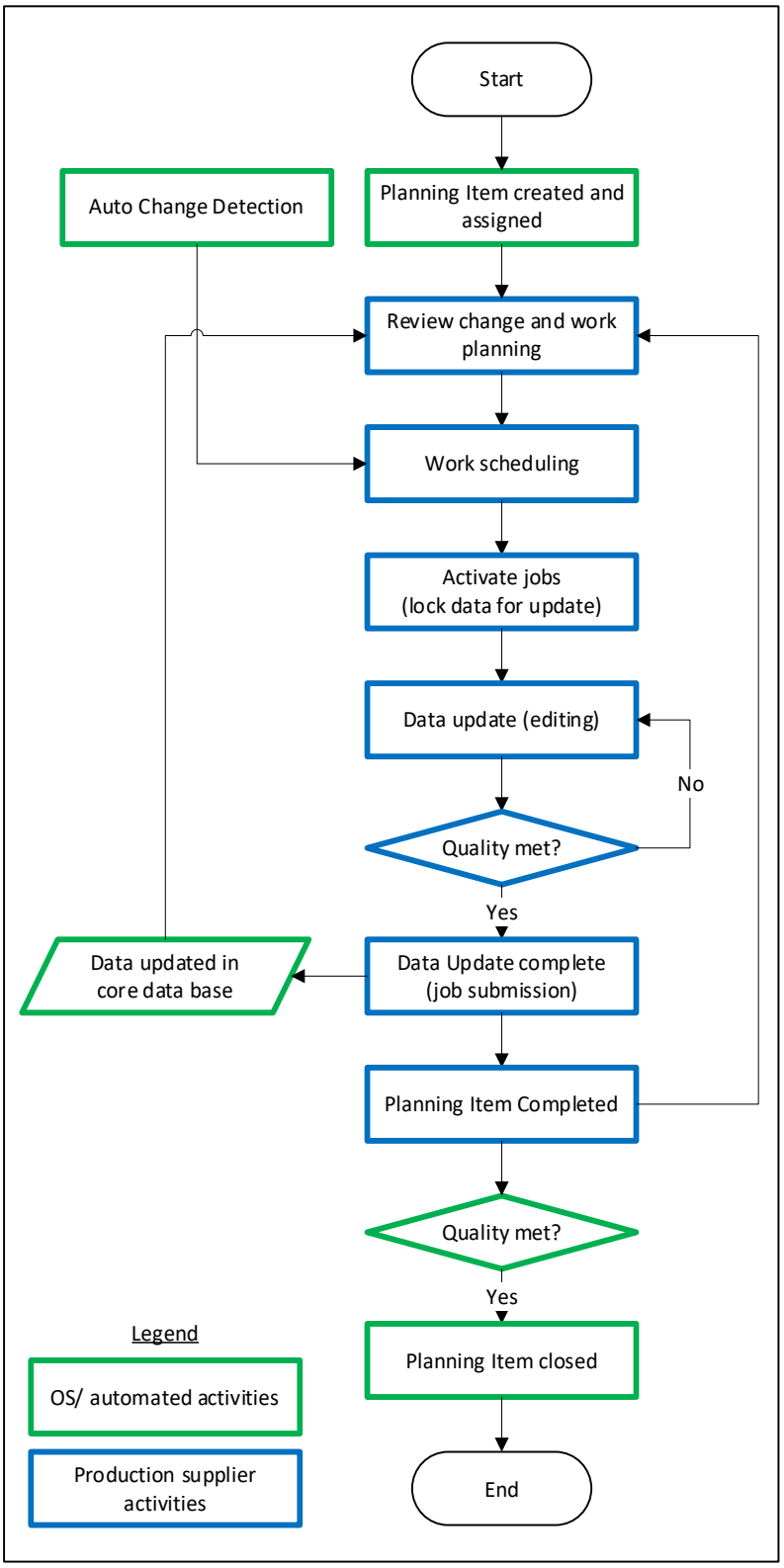
OS now has an extensive new data capture contract with the UK government which will require the capture and maintenance of additional data themes in stricter timescales. The solution to ensure the consistent delivery of this core customer requirement was to develop a new large-scale capture and maintenance platform, known as the Geo-Spatial Production Platform (GSPP).

The platform architecture supports optimised transformational business processes, a simplified data model and efficient data capture methods. GSPP leverages primarily Azure cloud and ESRI ArcGIS enterprise technologies. Users operating from OS and supplier offices use online web applications to undertake job planning, data capture and quality control activities. Connected working removes redundant or dis-jointed data extracts, data transfers and dependency on thick clients. Browser based editing facilitates simple version updates without the need for software set up on user machines and on-the-fly validation of the data ensures data is correct at the point of capture. Hosting on the cloud also provides the flexibility in infrastructure, high availability and scalability based on operational requirements.

2. Production Flowline

The platform was designed to integrate with the production flowline, supporting key activities and yet providing flexibility depending upon the production tasks. By understanding the flowline as a whole, we can breakdown the component steps and highlight the technical benefits GSPP is providing.

The flowline presented here is for the National Cyclic Revision programme, the multi-year programme of core data update across Great Britain.



It all begins with the annual flying programme, responsible for providing the imagery used in the national update. The country is then divided into areas for allocation to a supplier.

The suppliers use the online planning tools in the Job Planning Application (JPA) to view and access the detailed data in that area to identify change and sub-divide into smaller segments or "jobs". Each job is reviewed and scheduled, ensuring data does not conflict with other jobs. These are then activated, locking the data so only one user can make updates at one time.

Data is captured to the core data specification with the capability to carry out inline quality assurance. Using the same tools and data as the editor, quality checks can ensure Acceptable Quality Levels (AQLs) are met.

When jobs are completed the updated data is submitted back to the core database and the updates will be reflected in the JPA. A quality assessment for each allocated area is completed by Ordnance Survey before closure.

2.1.1 Imagery

Mono imagery is used at the start of the process to identify any changes from the underlying data. Providing imagery to review at this stage focuses production on areas where change has occurred, ensuring jobs are only created in areas that need update. The JPA presents a mono view of the most recent imagery for all of Great Britain to support this activity.

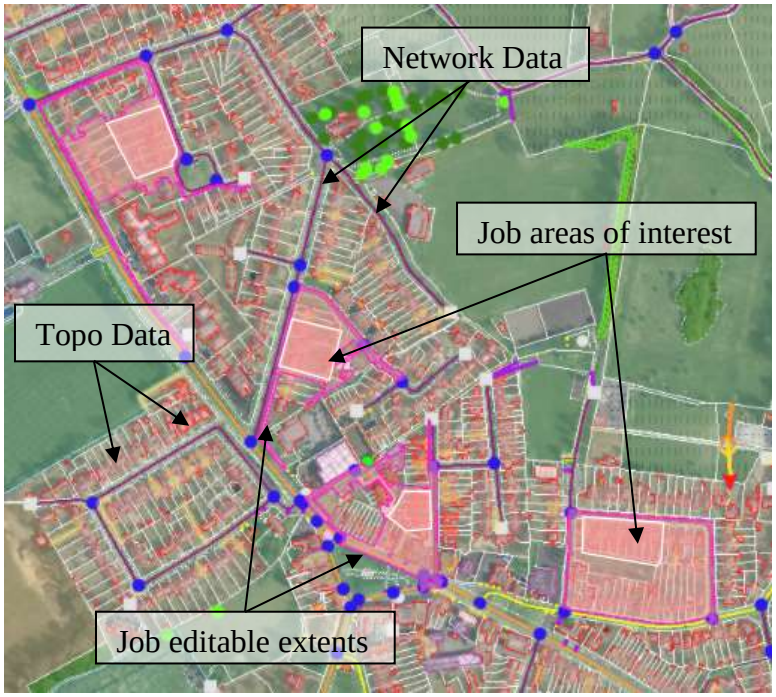
2.1.2 Automatic Change Detection

To add efficiencies to the identification of change in the production flowline, the Automatic Change Detection (ACD) process was developed by the Ordnance Survey internal research team using Trimble e-cognition software. This takes new imagery, height data, and existing vector data to identify categorized areas of change. These areas drive the creation of jobs, removing the need for a manual review of the imagery and job creation.

With significant success in rural areas and with imagery captured in optimal conditions the process has been refined to work with suitable geographic locations and imagery specifications. When the imagery is processed, change information is amalgamated into job areas of interest and loaded directly into the system. This reduces manual change identification and job creation activities for Job Planners and provides OS with early assurance that areas are up to date where no change was detected.

2.1.3 Smart Planning

As shown in the adjacent diagram, multiple data themes are visualised with imagery in the JPA to identify change and define the job editing extent. The data layers are updated hourly to ensure planning decisions are accurate.



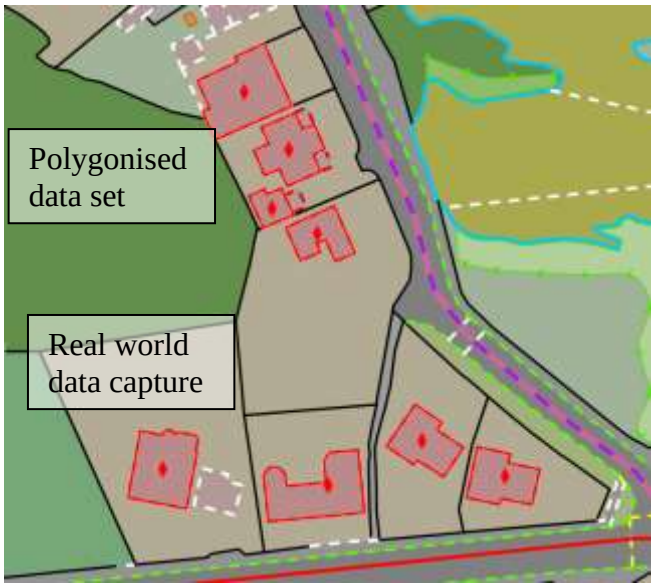
Identified areas of change can be visualised in a combination of ways. Job Planners can combine a selection of change into a single job or they can identify change individually using change detection markers. Markers can then be combined to create a single job.

All features needed for update are included in the job creation process as well as connecting features required for validation, so the editable extent (the full scale of each job) contains the data needed to validate updates made in the area of interest.

2.1.4 Managing Conflict

The connected editing experience provides many benefits but does present a significant challenge in ensuring data integrity. To ensure the data is updated without impacting the data model, only one user can update a feature at any one time. Throughout the planning stages Job Planning Application users must assess all the information to prepare an accurate and efficient production schedule. The complexity of this approach is supported by the regular update of data to the planner users, providing the detailed view needed to manage spatial impacts and schedule their own production.

2.1.5 Data Capture and on-the-fly Validation



OS have chosen the Esri UK product, Sweet, for the online edit client and have configured the editing system to work with rich data themes, to validate the data model and ensure quality.

The validation of data is at the point of capture. Within seconds of a potential update, editors are informed of correct or incorrect updates. This reduces validation at the end of a session that previously took an extended amount of time and could often render a whole edit session invalid if specific updates were against the defined rules governing the data.

The simplified symbology and capture tools ensure that the configuration is focused on the OS specific needs. The web based nature of the edit client will streamline the deployment of version updates, ensuring that new innovative capture tools are available to users without prolonged software update processes.

2.1.6 Companion Applications

Whilst Commercial off the Shelf (COTS) tools provide significant benefits for the long-term maintenance of the production solution, the level of detail for remote data capture and cartographic representation require bespoke capability. To meet this challenge, complimentary companion applications were developed to connect to the COTS software and provide specialist capture and maintenance capabilities.

The Sweet Photo Interpretation Capture Enhancement (SPICE) application accesses stereo imagery, Digital Surface Models (DSM) and Digital Terrain Models (DTM). It provides the ability to apply selected raster functions dynamically on mono imagery to aid the capture process. The user will also see relative height using a height difference service. This tool enables photogrammetric surveyors to inspect the height value of features such as overhangs and buildings where edges are not clear enough in imagery.

The Sweet Adjust Legacy Text (SALT) application manages the capture and maintenance of cartographic text, required for traditional data products. Cartographic text enables customers to visualise key information without the need for complex queries or analysis. The complex rules of cartographic representation, established over two hundred years of map making,

require precise rules to be embedded in the application such as specific fonts, text banking, rotation, descriptive and distinctive text to guarantee consistent representation across the data.

2.1.7 Quality Control

The accuracy and completeness of data is essential to Ordnance Survey's core remit as a National Mapping agency. Whilst all production suppliers are accredited under rigorous training and coaching processes before editing live data, ongoing assurance of quality remains a priority. To ensure this, two gates of quality checking were embedded in the flowline to facilitate inline checking throughout the production process. The first gate provides quality users with the same tools and information used in the capture process to assess the updates made and where required make corrections before the data is committed to the live database. The second gate enables checking of the assurance process itself, reviewing users to ensure consistent application of the capture specification.

3. DATA CAPTURE FROM MONO AND ENHANCED MONO VIEWS

Photogrammetric survey is at the heart of the production process. Desk based stereo capture has proven an efficient and accurate capture method yet providing stereo imagery via a web-based edit client was not technically feasible.

The technical challenge was to find a way to present the stereo information in a way that was supportable for online users yet still provide the detailed capture capability needed. OS took the innovative approach to develop a fusion of stereo and mono imagery, presenting the stereo image pairs that are captured in the flying programme in a mono view.

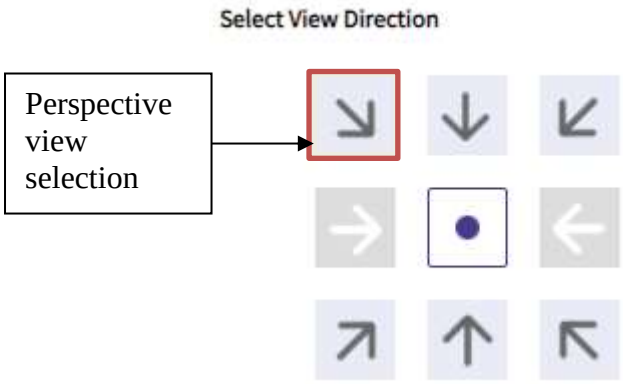
To deliver this functionality to the user, the SPICE companion application was developed. Imagery frame information, camera metadata, stereo imagery and a DTM and DSM were used to build mosaic datasets, providing dynamic perspective views to the capture users.

Behind the scenes, imagery optimisation and cloud cost optimisation was achieved by converting the imagery into Meta Raster Format (MRF) which is a cloud augmented format. This conversion and building of the mosaic datasets were achieved using open-source Geospatial Data Abstraction Libraries (GDAL) and Esri raster management tools.

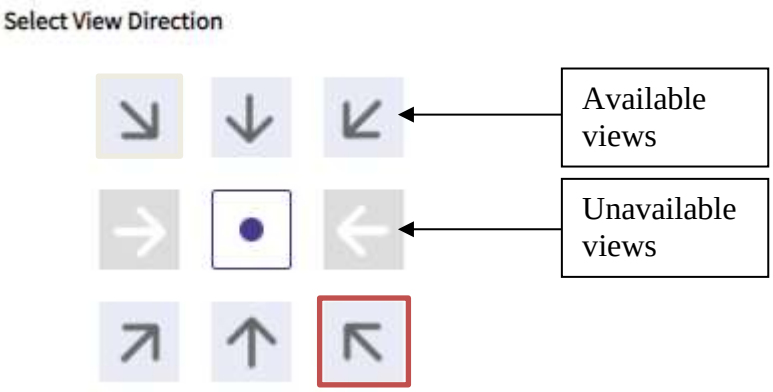
This mosaic of Enhanced Mono imagery facilitates photogrammetric surveyors with views from multiple angles (perspective views) to interpret features and accurately capture their location and provide detailed data attribution.

3.1 Perspective views

The Enhanced Mono views are presented via the SPICE companion application with up to eight perspective views of the same area. The companion application is paired to the editor with cursor tracking and pan and zoom functions.

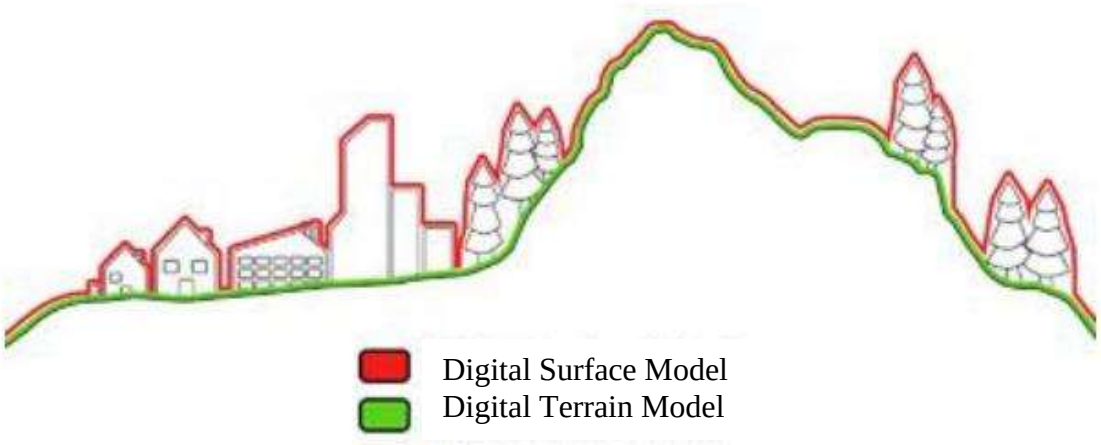


The imagery processing ensures only the best view is presented for each angle. If there is no view of a suitable quality to be had, the views are un-selectable. Embedding this level of intelligence in the SPICE application reduces non-value add activities for the editor.



3.2 Height Information

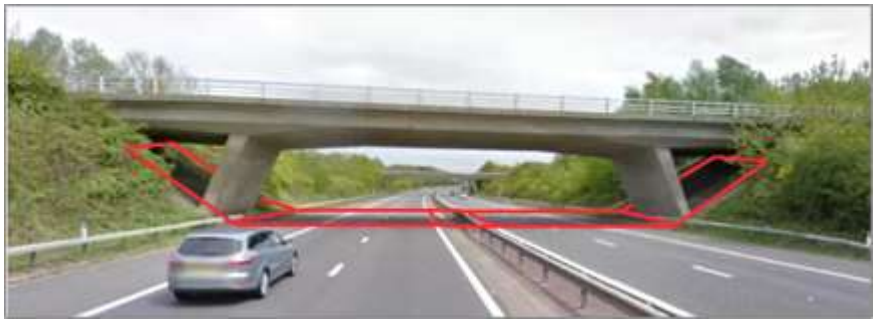
Along with a detailed view of the terrain, stereo imagery also provided height information for use in the capture process. With the stereo image presentation in the Enhanced Mono view, the height information had to be presented differently too, so a height tool was developed within SPICE.



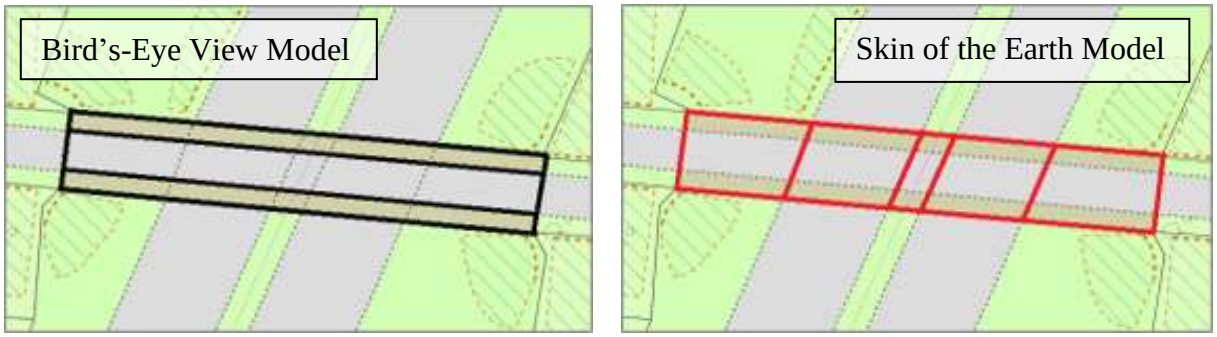
Using the Digital Terrain Model and Digital Surface Model, calculations are made for the difference between the two. This provides a representative feature height that is used in capture interpretation. When the height tool is activated the cursor provides the hight in metres (m) as the cursor is moved over features, the number adjusts dynamically to display the correct figure.

4. DATA MODELLING FOR THE FUTURE

Re-imagining a real-world representative data model is one of the key features of the transformational architecture of this platform. A data model that is simplified and optimized for data capture operations and real-world representation will provide the template for future additions and updates.



The model will transition from a bird's-eye view to a "Skin of the Earth" dataset with no gaps and multiple level attributions.

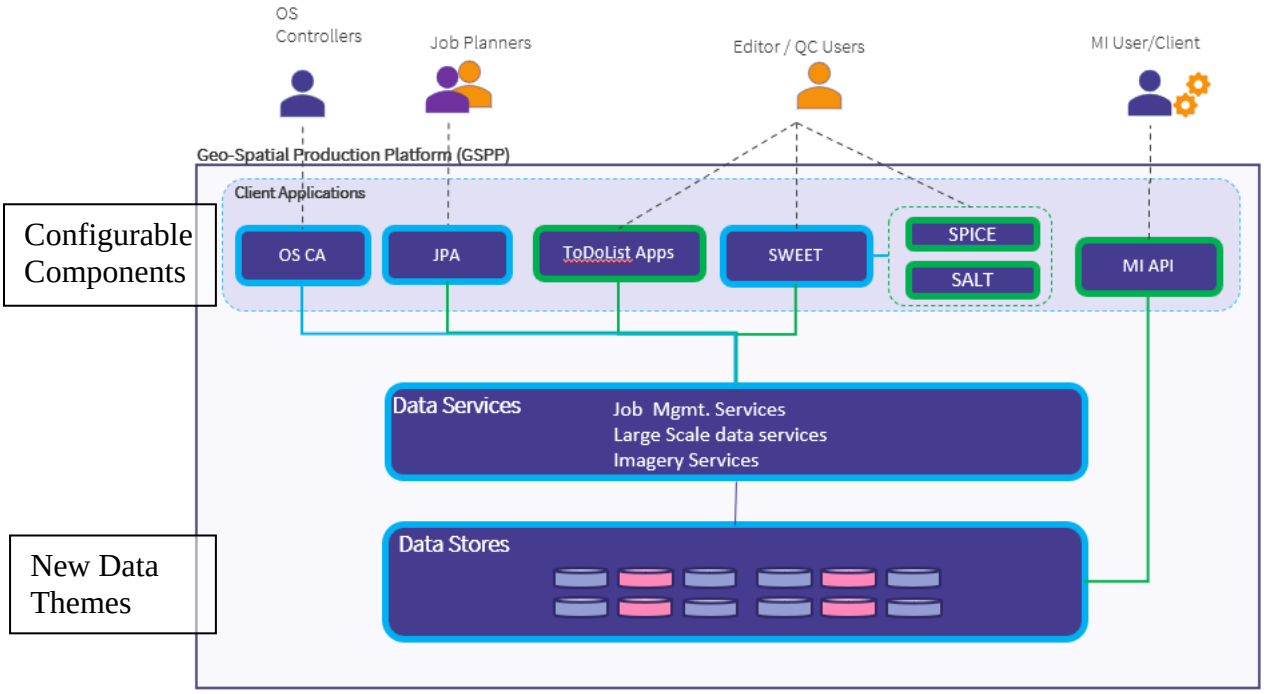


Elevated features not part of the skin of the earth such as a road or pavement on a bridge, will be captured with level information and obscured detail will be integrated into the ground level data. Data at the ground level can utilize the DTM and elevated features will be mapped to the DSM to enhance and generate 3D data in downstream systems.

The data model is designed to support re-usability for international customers and with the approach of multiple theme-based databases instead one single database. Topological and business rules-based data integrity within and across data layers is managed at the application level. This means that no data transfers and extractions are required, with the only exception being field surveyors who will need to extract a data package for remote capture.

5. Modular Architecture and Configurable Components

A modular architecture, which has been combined with a cloud platform, provides system flexibility. This is supplemented by configurable services and a high level of automation. Configurability over customization is one of the key principles followed in the design of this platform. Most of the components in this platform can be re-configured to respond to new requirements or change requests. Similarly, this modularity and configurability allows it to be used in other new geographies.



5.1 New Data Themes

Distributed databases and scaling out the data model will make it easier to add new themes to the platform. The addition of new layers can be achieved with little down time to production and roll out becomes even less disruptive with a high level of automation. This capability is fundamental to the changing needs of customers of spatial data management.

6. THE NEXT STEP

The Geo-Spatial Production Platform is an evolving production system, the first release has seen the Ordnance Survey's overseas supply chain transition onto the system. This innovative

new method for photogrammetric capture and simplified data model is fundamental to the future of national data capture, but what is next on the development roadmap?

Transition of Ordnance Survey's internal production flowlines is next on the agenda, including significant development of remote data capture capability. An online capture suite in an offline environment, field surveying tools and integration with GNSS/GPS equipment will certainly provide challenges but ones that can be overcome with innovation, ingenuity, and imagination.

REFERENCES

BIOGRAPHICAL NOTES

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