

Digital Submission Challenges and Opportunities with the Next Generation Parcel Fabric

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Whereas digital data is certainly more shareable and discoverable, the real value and return on investment is in the upfront self-validation of survey data prior to submission using identity, rules-based engines, data standards, and automation. This is expected to reduce the likelihood of errors and the associated back office examination time as all submissions will have been validated upfront before submitting to a web-based portal for retrieval. Surveyors are also expected to benefit from shorter examination times and the ability to access any pre-existing data (e.g. survey marks, traverse and radiation observations, title boundaries, easements, restrictions and administrative details) that may be used to start a new survey.

Digital submission is one of the many innovative functionalities supported as part of the next generation Parcel Fabric within ArcGIS. Through the use of web services and integrations with business partners such as AutoDesk, surveyors will be able to edit parcels in their native surveying software (AutoCAD), and leverage dedicated parcel functionality (via REST API) to evaluate their edits and visualize error features. This paper will provide a detailed review of the challenges and opportunities for realizing digital submission using web services and the new ArcGIS Parcel Fabric.

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Introduction

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International Experiences with Digital Submission

In most jurisdictions, cadastral surveyors create a survey plan based on a field survey and any pre-existing data from the cadaster as well as other survey plans in the area. The plan is then submitted to the registering authority. The registering authority checks and validates the spatial and textual data according to pre-defined rules for that geometric object. Once validated and accepted, the authority registers the plan and updates the cadastral database.

In recent years, several countries have adopted workflows towards the digital submission of cadastral survey plans. For example, Australia has developed national ePlan guidelines, including the standardization of terminology for each jurisdiction. Land XML is the non-proprietary data standard used to create, interchange and store the cadastral data.¹ LandXML is a specialized XML (eXtensible Mark-up Language) data file format containing cadastral plan and survey information that includes survey measurements, dimensions of parcels, interest in land, land parcel descriptions, administrative information, owners' corporation schedules, survey marks, traverses, radiations, connections to title, annotations, plan approval status and stakeholder signatures.

Two dimensional plans submitted in Land XML go through a semi-automated validation process, which checks for identification of created and affected parcels, adjoining parcels, accuracy of other supplied information and compliance to pre-defined plan format and numbering conventions. Automated validation rules address:

- The internal consistency of the plan, including dimensions and tolerances
- Compatibility with information already in the database (e.g. no overlap between two adjacent parcels) and that the surveyor preparing the plan is registered²

A manual validation process is used for items that require subjective assessment, including where natural boundaries are part of a parcel definition.

New Zealand and Singapore have also adopted the Land XML protocol for digital submission of survey plans. In some ways, New Zealand's process was streamlined through its Landonline system. This system allowed registered surveyors to extract digital data prior to undertaking their survey. Once the survey was complete it was then exported from the surveyor's software and uploaded into Landonline where the data is pre-validated and eventually submitted for formal approval.³

In Singapore, there is a Registered Surveyor's (RS) Portal and a Singapore Land Authority (SLA) Inspection and Approval module. The RS Portal is used in office by registered surveyors to pre-validate plan submissions, generate cadastral plans, and receive updates from the SLA. Once the plan passes through the RS Portal, no major errors are expected, and it is then passed on for

¹ Karki, S. et al. Development of validation rules to support digital lodgement of 3D cadastral plans. *Computers, Environment and Urban Systems* (2013), <http://dx.doi.org/10.1016/j.compenvurbsys.2012.10.007>

² Ibid.

³ Olfat, H. et al. Strategic Actions for Increasing the Submission of Digital Cadastral Data by the Surveying Industry Based on Lessons Learned from Victoria, Australia. *International Journal of Geo-Information* (2018).

inspection by SLA officers. The Chief Surveyor approves the plan once all has been determined to be in proper order.⁴

There are a number of drawbacks with these existing approaches to digital lodgment / e-submission. First, there are now more modern data formats than XML that are lighter and faster to parse. Such formats can scale up and be more easily viewed, including JSON and compression using Protocol Buffer by Google. Further, the use of XML requires moving from files to services, which requires translating data between formats and potentially losing information along the way.

It is recommended that jurisdictions move away from file formats that do not scale, require specialized software to open and translate, and pose risks of losing data during the translation to web services.

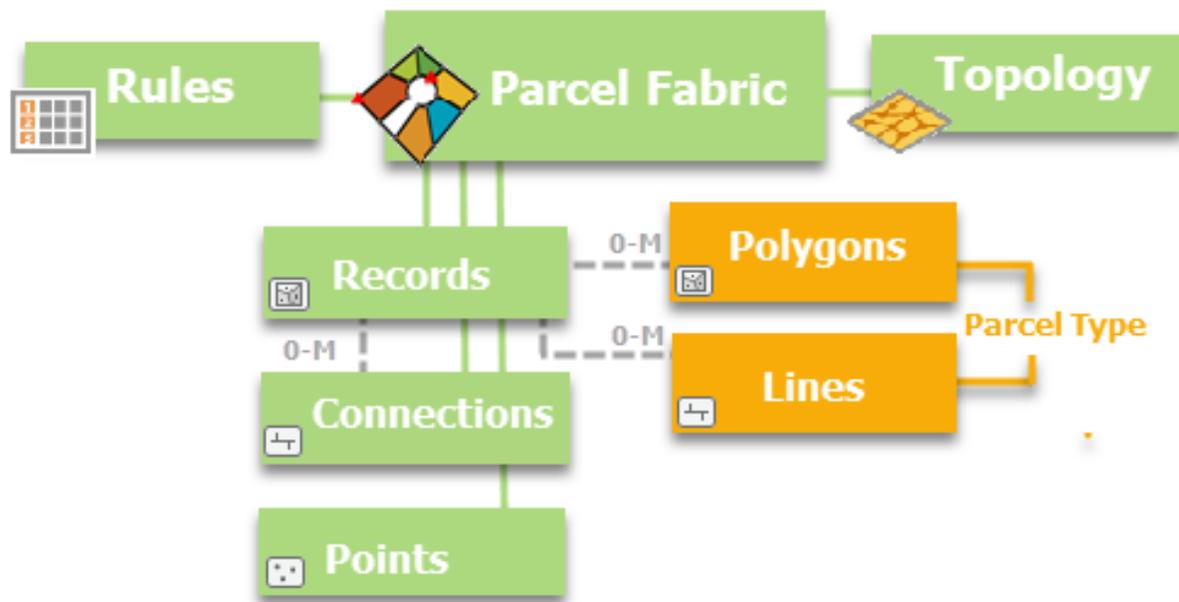
What is the Parcel Fabric?

Esri's parcel fabric provides a comprehensive framework for managing, editing, and sharing parcel data in ArcGIS Enterprise. In a multiuser environment, the parcel fabric can be edited and maintained using a services-based architecture. A services-based architecture allows you to share the parcel fabric across all platforms (desktop, mobile, and web) and different workflows can be enabled on different clients in the field and in the office.

Currently, the parcel fabric is edited in ArcGIS Desktop using ArcGIS Pro. Editing on web and mobile clients will be supported in future releases of ArcGIS Pro.

A parcel fabric stores a dataset of connected parcels or parcel network. Parcels are composed of polygon features, line features, and point features. Parcel polygons are defined by lines that store COGO dimensions from the recorded, legal document. Parcels are added to the parcel fabric as parcel types. A parcel type is comprised of a polygon and line feature class and is defined by your organization.

⁴ Ibid.



When a parcel fabric is created, a geodatabase topology is also created. The parcel fabric uses a set of predefined geodatabase topology rules and parcel rules to define parcels and model their behavior. Geodatabase topology rules define the spatial relationships between parcel features, and parcel rules define behavior that is specific to parcel features. All these rules are configurable, defined by the organization, and require zero custom code.

The parcel fabric topology is validated against the predefined set of geodatabase topology rules and parcel rules. You can define additional topology rules and attribute rules to enforce data quality standards in your organization.

Administrators can define different behaviors for parcel types by applying different topology rules and attribute rules to the parcel types and their subtypes. For example, overlapping parcels can be configured as an error for certain parcel types but allowed for other parcel types or subtypes (e.g. rights of way). The [parcel fabric topology](#) can be validated against these rules to assess data quality. Rule errors are visualized on the map as error features. Further, the ArcGIS attribute rules framework allows one to validate attribution and compare it against geometry. It also creates error features when rules are violated.

Editing in the Parcel Fabric

[Branch versioning](#) enables enhanced editor tracking, in which every edit is tracked by date and time including which users delete features in a version. This allows the organization to review the

data as it was at any given point in time (e.g. 4D cadaster). In addition, edits can be validated against parcel rules, topology rules, and attributes.

When the topology is enabled, the parcel fabric tracks where data has been modified to optimize the validation to only validate these areas.

The following edits and updates will cause the topology to become out of date and require validation:

- Appending data to the parcel fabric.
- Editing parcel features (create, modify, and delete).

Validating the parcel fabric is an edit operation. You should not edit the parcel fabric in the default version, as edits are automatically saved and cannot be undone.

After validation, rule errors are displayed in the Error Inspector pane. Rule errors are violations of parcel rules and geodatabase topology rules.

Digital Submission Challenges and Opportunities with the Parcel Fabric

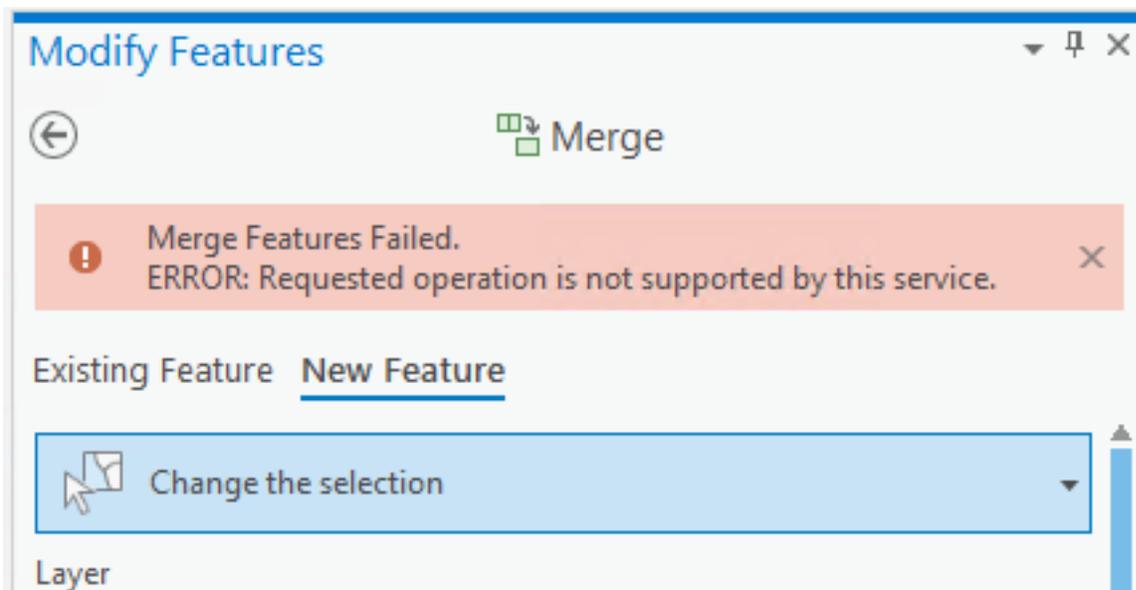
Beginning with ArcGIS Pro 2.5, Esri will support a REST API. An API is an application programming interface that is created on a server and includes a set of rules that allow programs to talk to each other. REST, on the other hand, is a software architecture that supports interoperability between computer systems on the internet using web services. A RESTful API breaks down a transaction (e.g. updating of a land record) to create a series of smaller parts (e.g. merge, split). Each part addresses an underlying aspect of the transaction.

With ArcGIS Pro 2.5, users will be able to execute record driven workflows by accessing the REST endpoints of the different parcel management tools (e.g. merge, split). For example, with Merge, users can enter the record information and parent parcels and the merge can happen through the REST call without ever having to open ArcGIS Pro. The list of exposed REST API operations will continue to grow to offer additional capabilities like Least Squares Adjustment and Align to Features to enable submitters to align their work to legacy parcel data.

In ArcGIS Pro 2.5 / Enterprise 10.8, Esri exposes the parcel capabilities per published map. That means an administrator can restrict the parcel editing operations for certain groups of users at the published map level. For example, an administrator may want to restrict a cadastral map technician's ability to edit a parcel's history and can disallow that operation by that user on that published map.



To support digital lodgment / e-submission with the ArcGIS Pro Parcel Fabric, an Administrator assigns a named user type to the surveyor creating the plan. The administrator can also designate the operations permitted by that user in the version of the parcel map published. If the surveyor attempts to perform a function they don't have privileges to they receive an error function such as the below. Additionally, the administrator can also restrict a submitter to only pull changes from the master or default version of the data (reconcile) and not be able to push their own changes (Post) – a capability that is reserved to the cadastral organization.



The parcel map version exposed to the surveyor community can include cadastral plan and survey information that includes existing survey measurements, dimensions of parcels, interest in land, administrative information, survey control, and other data included in the attribute table.

The surveyor will log into ArcGIS using his/her named user identity. The identity (or named user credential) assigned associates the surveyor working with the cadaster office with ArcGIS

privileges. The surveyor can then log into an Esri supported app or Portal on any Esri supported device to access maps, apps, data and analysis that they have been given privileged to.

Through the ArcGIS for AutoCAD free plug-in, the surveyor can work with a DWG template and work in their native AutoCAD environment while connecting to a parcel fabric service layer. Although the editing is being made in AutoCAD they are technically editing a parcel fabric feature service. The surveyor can also access dedicated parcel editing functionality exposed through web services (REST API), allowing them to evaluate their edits at any time and get error features (e.g. undershoots, overshoots). Once validated and complete, the surveyor can submit their version limiting the back-office work for the cadastral office. Since each version is edited in isolation, each submitter can only see his/her own edits and if the digital submission is rejected the version can be deleted.

Today, this digital submission workflow faces some challenges. It is only possible if the ArcGIS for AutoCAD plugin:

- Supports user identity
- Supports branch versioning (user works on a version they have no permission to post and reconcile)
- Integrates parcel functionality that works against the Parcel Fabric's REST API

Assuming this capability is built into the ArcGIS for AutoCAD plugin, this proposed digital lodgment / e-submission will provide the following benefits:

- Access to real-time digital survey data, including existing survey measurements, dimensions of parcels, interest in land, survey control, etc.
- Simplified synchronization of content between AutoCAD and ArcGIS for surveyors preparing plans.
- Surveyor access to parcel fabric functionalities to check and validate plans prior to submission.
- Reduced the likelihood of errors and the associated back office examination time

Conclusion:

Digital lodgment / e-submission of survey plans offers many benefits to both the cadaster office and surveying community. Whereas digital data is certainly more shareable and discoverable, the real value and return on investment is in the upfront self-validation of survey data prior to submission using identity, rules-based engines, data standards, and automation. This is expected to reduce the likelihood of errors and the associated back office examination time as all submissions will have been validated upfront before submitting to a web-based portal for retrieval. Surveyors are also expected to benefit from shorter examination times and the ability to

access any pre-existing data (e.g. survey marks, traverse and radiation observations, title boundaries, easements, restrictions and administrative details) that may be used to start a new survey.

With the new ArcGIS Pro Parcel Fabric, Esri aims to provide world class parcel management functionalities, including digital submission of plans. As of the current release of ArcGIS Pro 2.5, we can deliver many of the capabilities required to support digital submission, however, certain challenges remain. These include integration of named user identity within the ArcGIS for AutoCAD plugin, support for branch versioning and incorporation of parcel functionality that works against the Parcel Fabric's REST API. Although challenges exist today, the software development roadmap for the Parcel Fabric intends to address these in upcoming releases.

Capabilities on the near-term (e.g. next 1-2 years) roadmap include integration of new business rules to assist with geo-design and validation against planning layers, 3D digital lodgment from BIM, field-to-fabric workflows and validation from field devices, and empowering thin clients (e.g. web) that serve as dedicated apps leveraging the REST API.