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The Use of LADM Primitives and Structured Indexing to Support Automated Registration Using Submitted Applications

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Key words: LADM, Automated registration, Indexing, Titles, Deeds, Applications, State, Change.

SUMMARY

The Land Administration Domain Model (LADM (ISO TC/211, 2012)) is a conceptual model which supports the modelling of social relations with land articulated through *rights*. There are three principal concepts within LADM: the party (*the who*) that has a rights relationship (*the what*) with a plot of land (*the where*). As an abstraction the party-right-land model makes it easy to conceptualise the *state* of real rights (all *real rights* are *rights in land*). It is simple to model who owns a piece of land and, using a spatial index, determine who holds rights which encumber all, or part, of the same land. When the land identifier (index) is used as a proxy for a party it is also easy to identify what rights benefit the owned land based on a party index. As such it is also reasonably obvious that a party-right-land model is closely related to a Title.

A deed registerable in a Land Register is a legal instrument that represents a real rights *state change*. A deed describes real right transactions that result in the *creation, variation or discharge* of party-right-land relationships. Henssen (1995, p. 7) describes four general principles that underpin transactions within Land Registers. Critical for automated transactions is the *specificity principle*: the principle that the transactional party-right-land components must be unambiguously identified.

Party verification and designation during registration allows us to uniquely identify *the who*. The formalised sub-set of registerable rights (*numerus clausus*) makes it easy to identify *the what*. *The where* is the *cadastral unit* that uniquely identifies each owned *plot of land* and the associated spatial representation in the cadastral map. The *specificity principle* means that the Registrar can unambiguously identify the party-right-land relationship which is to change either explicitly or by reference to the corresponding deed in the deed chain. Zevenbergen & Ploeger (2019, p. 4); Palmer (1996, p. 63) both argue for the explicit inclusion of parcel-based (cadastral) registers to improve the rigour of Deeds based registration systems.

Once the party-right-land relationship has been unambiguously identified then the nature of the transactional change can be articulated. Owners can vary their ownership in terms of a party, right or land dimension. A *party variation* allows an owner to transfer (sell) all or part of their property. All such transfers are *in personam* - the variation specifically identifies the third party grantee who benefits from the rights transfer. A *rights variation* allows an owner to alienate rights (such as access) which can then be transferred to third parties. A *land variation* allows an owner to split their ownership in to multiple spatial parts some of which

can then be transferred to third parties. In this manner a deed represents a party-right-land *state change*.

This paper considers automation of registration based on LADM primitives. To automate registration the deed should be delivered in such a manner that enables the *state change* articulated in a deed to be digitally enacted on the register without human intervention. It will initially consider the nature of deeds as conveyancing transactions and how these deeds are submitted as an *application* to the Registrar to change the *state* of records in the Land Register. The *application* is validated by the Registrar to ensure that it is suitable for registration (the validation process will not be discussed in this paper). If not rejected then the submitted deed is registerable. Key to the approach is how an application can be used to frame both the legal instrument (the deed) and the database update that allows the deed to be registered in the Land Register. The registration process takes the *state change* articulated in the deed and either records or registers the change as appropriate. This requires the extraction of the *key registrable content* in the deed. In this example the extraction problem is solved by articulating the *key registrable content* in the application and using the application to create the deed and register the state change. This means that the application becomes the vehicle that creates the deed, as well as the vehicle that delivers the deed to the Registrar. By necessity the semantics surrounding registration will become highly formalised to provide complete and flexible registration capability. If implemented, this approach may require a change to any supporting real property registration legislation. In this paper we will demonstrate this process and provide an exemplar during a live presentation.

This paper represents significant thinking that has occurred over a number of years. I would like to thank a number of colleagues at Registers of Scotland and Ordnance Survey for their guidance, support and patience over this period. This includes: Laura Alderson, Hillary Brownlie, Drew Clancey, Michael Hill, Jon Hodge, Alan Howie, Chris Kerr, Alasdair MacCormick, Chris McDermot, Duncan Moss, Chris Muir, Iain Porter, Alastair Reid, Keith Robertson, & Dave Stow.

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1. INTRODUCTION

The Land Administration Domain Model (LADM (ISO TC/211, 2012)) is a conceptual model which supports the modelling of social relations with land articulated through rights. There are three principal concepts within LADM: the party (the who) that has a rights relationship (the what) with a plot of land (the where).

As an abstraction the party-right-land model makes it easy to conceptualise the state of real rights (all real rights are rights in land). It is simple to model who owns a piece of land and who else has rights, such as access, over all, or part, of the same land. A party-ownership right-land triple is a cadastral unit which describes which party owns land. A cadastral unit-right-land triple is a praedial relationship which describes what beneficial rights a cadastral unit holds over other land (representing, for example, an easement). The relationship a party-right-land triple has with a cadastral unit defines the rights which encumber owned land. By defining the ownership, the rights which benefit ownership and the rights which encumber the owned land, it is obvious that a party-right-land model can be used to model Title. When framed in a Register of Title the title is, as defined by Dale & McLaughlin (1999, p. 17): "demonstrable proof of ownership."

A deed registerable in a Land Register is a legal instrument that represents a real rights state change. As stated by Zevenbergen & Ploeger (2019, p. 5): (a deed) "indicates that the parties have created a legal fact with the intention of having a certain legal consequence, and decided to have it registered." This means that, as stated by Simpson (1976, pp. 14-15): "a deed in itself does not prove title; it is merely a record of an isolated transaction." A deed describes real right transactions that result in the creation, variation or discharge of a party-right-land triple. In order to undertake state change the party-right-land triple which is to be changed must be unambiguously referenced. Party, right, land and deed indexing provides an unambiguous way to directly reference each element of the party-right-land triple. Henssen (1995, p. 7) refers to the unambiguous referencing of registered elements as the specificity principle. Once the party-right-land triple which is to change is identified, then the nature of the party, right or land change (or changes) must be articulated. In this manner a deed describes the creation, variation or discharge of a party-right-land triple which in turn creates a state change on a land register.

As such party-right-land triples can be used to represent both state and state change. Such structuring is critical to automation. Automation can simply be the digital emulation of a manual process. However, while streamlined, such approaches can be brittle and do not provide resilience to change. A more resilient approach is to build a logic based framework that can evolve when the legislation or registration infrastructure changes. As a standard, the

LADM provides a mechanism to articulate state and state change in a structured, logical and predictable manner. This provides the ability to build the underlying logic, syntax and grammar that represents the language of registration.

This paper will describe an approach to automated registration. It will initially consider the nature of deeds as conveyancing transactions and how these deeds are delivered as an application to change a Land Register. Key to the approach is how an application can be used to frame both the legal instrument (the deed) and the database update that allows the deed to be registered in the Land Register. It is quite a high level description as there is significant underlying detail which can not be represented in a single paper. The reader is referred to other papers published at this workshop where supporting terms and concepts have been articulated (editors: please reference later).

2. CONVEYANCING AND TRANSACTIONS

General conveyancing practice tends to be based on legal instruments: *in personam* contracts between a granting party (normally a right holder) and a grantee (benefitting) party. By alienating '*use and service*' rights and granting them to third parties, owners can develop nuanced governance and transformation strategies associated with land. Rights granted in this manner could be considered as the equivalent of *sticks* in the *bundle of sticks* model (see Baron, 2013; Simpson, 1976, p. 7; Merrill & Smith, 2011, p. 10).

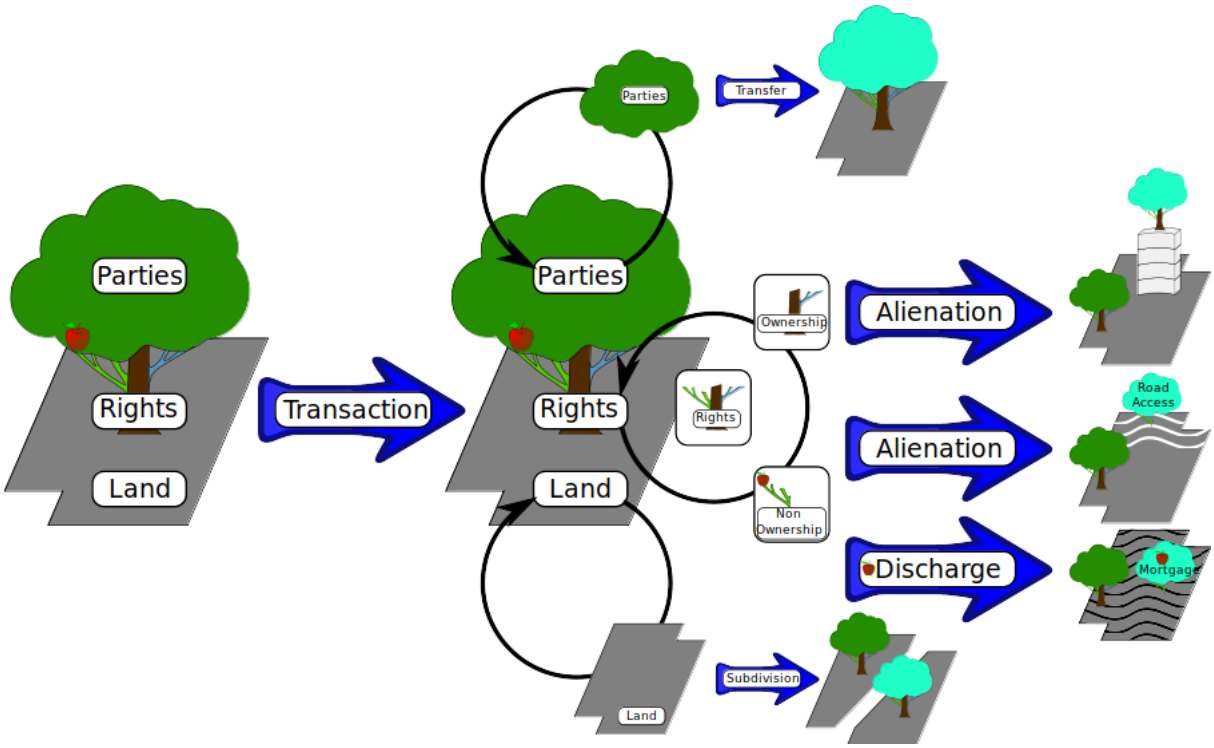

Figure 1. How in personam transactions can change Party, Rights and Land relationships (Beck, 2021). Similar thinking is seen in Figure 1 of Bennett et al. (2021) and Figure 4.8 of Zevenbergen (2002)

As described in Figure **Error! Reference source not found.** owners can vary their ownership in terms of a party, right or land dimension.

1. Party based transaction primitive: the transfer of all or a proportion of the ownership to a third party(s).
   - All such transfers are *in personam* - the legal instrument which describes the variation specifically identifies the third party grantee who benefits from the rights transfer.
2. Rights based transaction primitive: where rights can be separated from the body of ownership and granted to third parties.
   - ownership: alienation of sub-ownership rights (e.g. strata).
     - these rights can be reincorporated in to the body of the parent land when both the parent ownership and sub-ownership are owned by the same party.
   - non-ownership: alienation of non-ownership rights (e.g. lease, security (mortgage), easement, etc.).
     - the alienated rights are equivalent to sticks in the 'bundle of sticks' model of land.
     - non-ownership rights can be discharged by the new rights holder.
     - right holding parties may have limited powers associated with these rights.
3. Land based transaction primitive: a subdivision of a cadastral unit to create two parcels of owned land or the merging of multiple parcels of owned land to create a single cadastral unit.

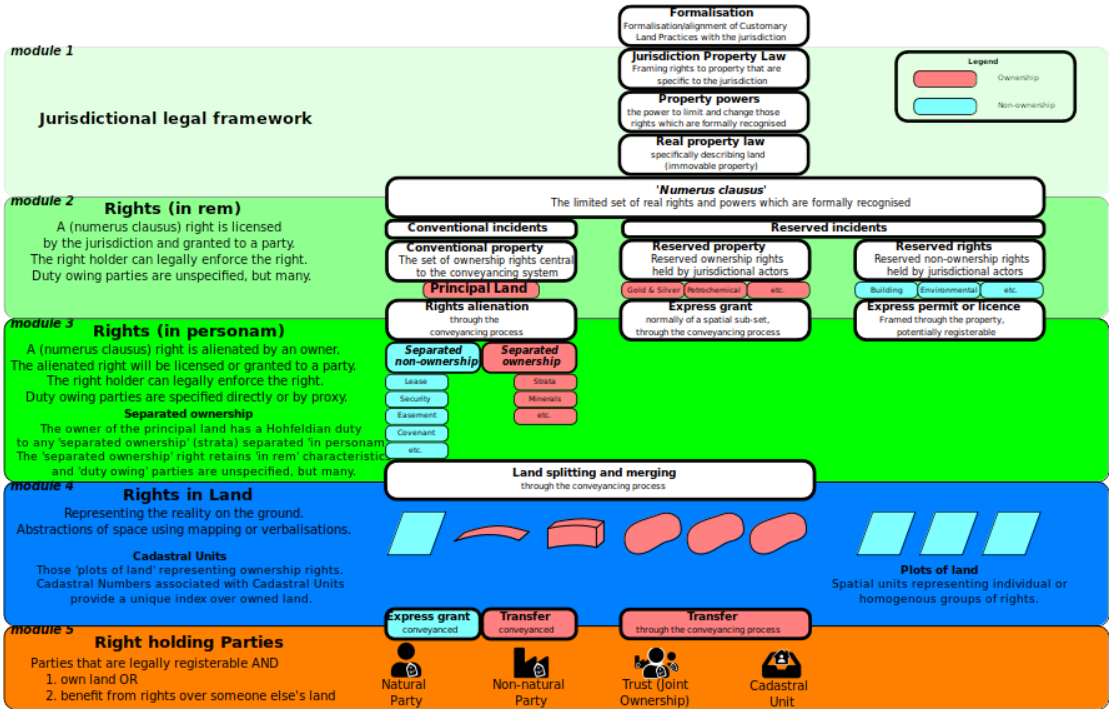

Figure 2. The modular arrangement of rights relationships (Beck, 2021). Conveyancing activities are described in modules 3-5 where respectively right, land and party variations occur

The nature of these transactions are summarised in Figure **Error! Reference source not found.**. Module 3 shows how owners of conventional property can use their powers to alienate the legally permissible '*use and service*' rights (as defined in *numerus clausus*) that are inherently associated with their land and grant them (*in personam*) to third parties. Where *real rights in land* are legally separated (alienated) from the **owned land**: the separated real rights can represent *ownership* or *non-ownership* rights. Module 4 shows how right holders can use their powers divide or merge rights in land. Module 5 describes the range of different parties which can have a relationship with a right in land.

Deeds are used to formally describe *state change* for a Land Register. Deeds (see Figure **Error! Reference source not found.** and Figure **Error! Reference source not found.**) can be drafted that represent the changes described above. Each deed has a global identifier (GUID) that allows it to be unambiguously identified. The language in the deeds is highly formalised representing implicit structuring and rule based logic. The granter is normally the party who holds the real right that forms the basis of the transaction. The granter must have the associated power to undertake the transaction. For example, apart from *emminent domain*, the holder of an ownership right is normally the only person who can transfer ownership. This represents the concept of nemo dat: '*you can not sell what you do not own*'. The grantee is the party who will benefit from the transaction. Under certain circumstances right holders have powers to discharge the right they hold (most commonly seen with security rights as seen in Figure **Error! Reference source not found.**). With a discharge there is no grantee. However, ownership rights can not be discharged (land can not be destroyed): although it may be possible for land to be disowned within a jurisdiction. The granter and grantee are both managed in the party index. The land is the cadastral unit: the identifier is managed in the land index. The right is the thing which is being changed or managed and is indexed in the formalised sub-set of registerable rights (*numerus clausus*). These are the generic elements which help identify the party-right-land triple and define the nature of the ensuing transaction.

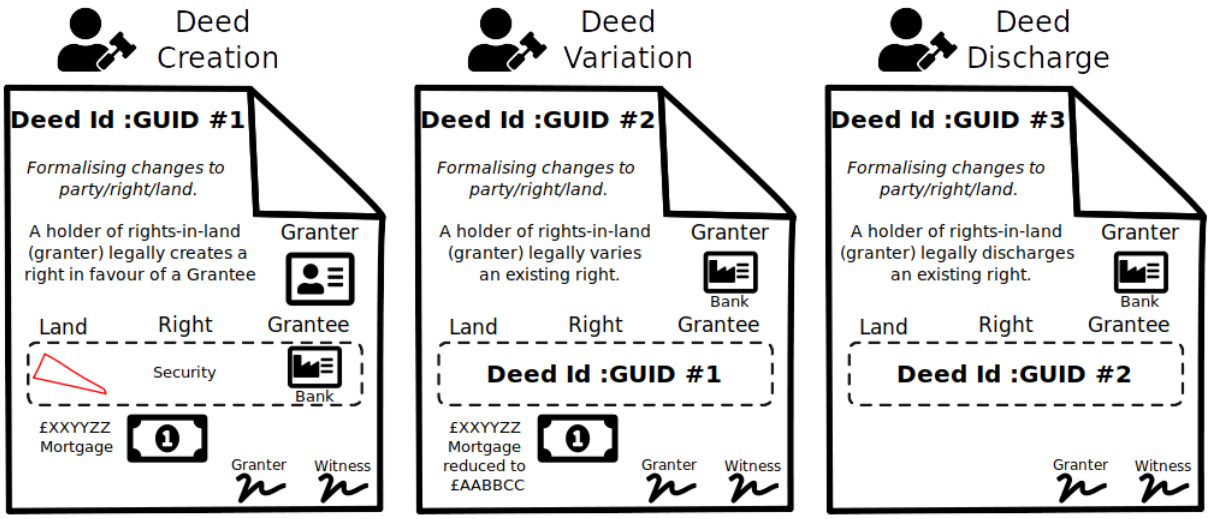

Figure 3. Legal Instruments are jurisdication dependent (normally a Deed or Contract) and used to legally instruct Registrars to make changes to the register that create, vary or discharge rights (Beck, 2022)

The transformational deeds described in Figure **Error! Reference source not found.** fall in to three patterns:

1. Transfer of Party Part (TOPP)
2. Transfer of Right Part (TORP)
3. Transfer of Land Part (TOLP)

The *part* component is indicative of the fact that the right holder is not required to transfer all of their interest. In a TOPP the part refers to the fraction of ownership which is to be transferred. There is a special case of TOPP called Transfer of Party Whole (TOPW), where the granting party transfers **all** of their interest. In a TORP the *right* refers to the right which will be alienated from the owned land and the part refers to the spatial extent of the right (which must be within the three dimensional spatial bounds of the parent cadastral unit). There is a special case of TORP called Transfer of Right Whole (TORW), where the spatial extent of the alienated right is coincident with the spatial extent of the parent cadastral unit. Sub-ownership and non-ownership rights can be alienated in this manner. The ownership and non-ownership rights will have a spatial extent (either expressed as geometry or verbally (grounded in respect of the cadastral unit from which the right was separated)). Owners of a parent cadastral unit have a duty to allow these right holders to enjoy their right. The right holders have a claim over the parent cadastral unit framed through the spatial extent of their right. In a TOLP a cadastral unit can be subdivided with the part representing the cookie cutter subdivision. Conceptually, a Transfer of Land Whole (TOLW) is impossible as it would create a land right with no spatial dimension. However, a TOLW can be used as a conceit to re-index cadastral units. Although this may have unintended consequences across the indexes and would require associated rules to ensure all relationships are properly maintained.

As can be seen there are implicit rules within this framework. For example, TOPP, TORP, and TOLP all use cadastral units as input: this is primarily due to the fact that transformational change requires cadastral units. In general the powers associated with an alienated non-ownership right are limited. In most scenarios the only thing a non-ownership right holder can do is discharge their right (this would be by reference to the GUID of the originating deed supported by a validation check to ensure that the granter of the discharge and the right holder are the same party (see Figure **Error! Reference source not found.**)). However, the point of a Land Register is to formally register *real rights in land*, to provide evidence of these rights and where necessary to support the enforcement of the right holders registered right. In this capacity the Land Register is important in ensuring that non-ownership rights can be enforced in the jurisdiction. The obvious exception to this is how some jurisdictions manage leasehold rights - which are treated much like ownership.

The deeds shown in Figure **Error! Reference source not found.** are transactional primitives: they represent atomic (single activity) actions which occur on a Land Register. These primitives can be chained together to create registration patterns. For example, when land is subdivided (split) using a *Land based transaction primitive* it is common for one of the cadastral units to be transferred (sold) to a new party using the *Party based transaction primitive*. By chaining the functionality of the *Land based* and *Party based* transaction primitive together a deed can be created that compounds the two transactional activities.

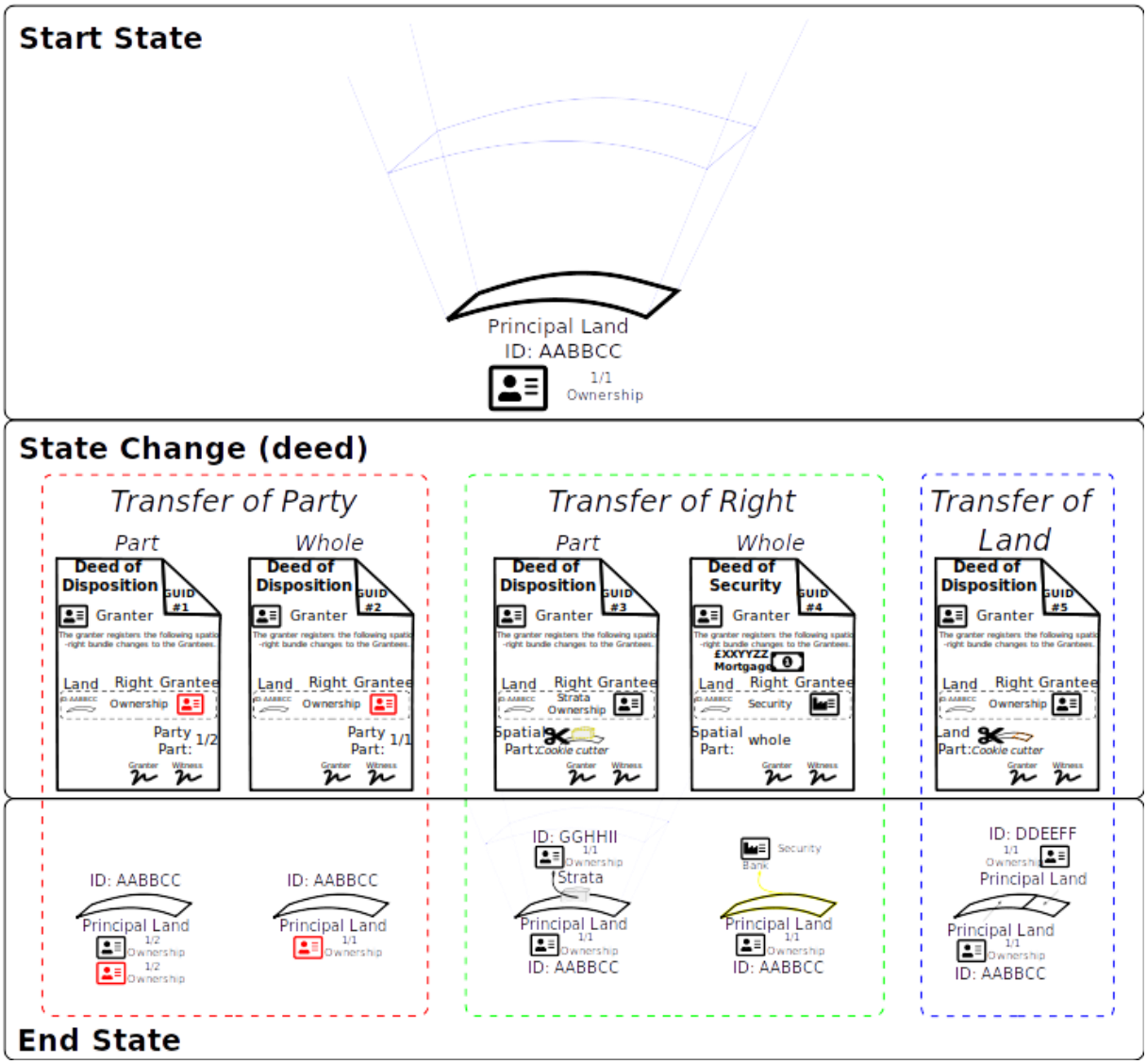

Figure 4. Transfer of Party, Right or Land - A parent cadastral unit is transformed in either a Party (TOPP), Right (TORP), or Land (TOLP) dimension (Beck, 2022). There is a special case of TOPP called Transfer of Party Whole (TOPW), where the granting party transfers all of their interest. There is a special case of TORP called Transfer of Right Whole (TORW), where the spatial extent of the alienated right is coincident with the spatial extent of the parent cadastral unit

A deed as a legal instrument is highly formalised and has a long history. While the data and concepts described above allows us to abstract the nature of a deed in a sparse manner as a party-right-land change, the reality is that each jurisdiction will expect to see a deed expressed in highly formalised legal language. In addition the deed may need 'wet' signing, witnessing, stamping and a seal. Each element demonstrates the authenticity of a party or of the deed itself. These are intrinsically analogue activities, however, many jurisdictions are developing digital facsimiles of these analogue requirements (see, for example, Reid & Gretton (2017, pp. 329-338).

This section demonstrates there is a need to model the functional and transactional relationships between the party, right, and land elements in a jurisdiction. These are articulated in the registration legislation and refined in the operating procedures of the Registrar. We are building a supporting *first order logic* OWL ontology that explicitly grounds the terms, articulates the relationships between terms and supports automated reasoning and inference.

At this point a deed has been created. It represents a personal contract between the granter and the grantee. However, in most jurisdictions this is not the end of the journey. In order for the grantee to be legally granted a real right in land either the deed needs recording in a Register of Deeds or the implications of the deed need registering (referred to as *Title by registration*) in a Title Register.

3. APPLICATIONS: DETERMINING IF A DEED IS REGISTERABLE

A Land Register must have the facility to change: to add, vary or extinguish registered rights. Change to a Land Register is normally triggered by an application: a vehicle which presents a deed to the Registrar. In Scotland, the *application record* is a formalised component of the register mandated in legislation (see section 15 and sections 21-26 of LRSA (2012)). Applications for deed registration are evaluated for suitability based on criteria described in the legislation (in Scotland these are referred to as the *application conditions* (Reid & Gretton, 2017, p. 127)). If the application does not match the criteria then the application, and its associated deed, is rejected. Otherwise the application, and its associated deed, is accepted for registration. This paper does not describe any validation process. However, such validation rules and logic are a pre-requisite for automation.

Applications tend to present a summary of the key information contained within a deed (see, for example, schedule 1 in LRRSR (2014)). The Registrar uses this summary information in conjunction with the deed to ascertain whether the deed is suitable for registration (using the rules described above). There may be an issue where the application and deed provide different information. A closer coupling of the two would create clear benefits. Subject to appropriate legislation, it is theoretically possible for the digital content in an application to be used to create both a legal instrument and to invoke the required database change against a register in a completely automated manner. This is the approach used and is discussed in more detail later in this paper.

4. REGISTERABLE DEEDS: INVOKING STATE CHANGE IN A LAND REGISTER

If an application is accepted then the associated deed is considered registerable. The Registrar will either:

- *record* the legal instrument (e.g. deed) contained in the application that describes the **fact** of the legal rights change (in a *Register of Deeds*). Title can be derived from the *Register of Deeds*.
- *register* the **impact** of the legal instrument (e.g. deed) contained in the application against a Title (*Title by registration*).

In a *Register of Deeds* approach, *legal change* data is required in order to publicly record the **fact** of the rights change. The **impact** of the legal change can be seen in a Title derivative or through a search of the deeds. Therefore, it can be argued, there is no need for a materialised *Register of Title*.

In a *Title by registration* approach, *legal change* data is required in order to register the **impact** of any rights change on the Title. However, once registered, the **fact** of the *legal change* is theoretically no longer needed as the Title should describe everything that would be in a *Register of Deeds* Therefore, it can be argued, there is no need to maintain a *Register of Deeds*.

The *registration process* represents how the Registrar implements the relationship between *state change* (e.g. deeds and applications) and *state* (e.g. products, such as derived searches and Title). The two elements of *State* and *State Change* are fundamental to every Land Register irrespective of the approach taken to registration.

5. A PROOF OF CONCEPT BASED ON SCOTS LAW

We have implemented an exemplar, theoretical proof of concept, that demonstrates how LADM primitives can be used to articulate *state change* which can be directly applied to alter the *state* of rights and rights relationships in a Land Register. The exemplar is based on the legislation in Scotland (LRSA, 2012). Reid & Gretton (2017, pp. s4.4) state that LRSA (2012) requires a *Register of Title*, a *Register of Deeds* and a *Register of Plots of Land*. This hybrid model provides some useful characteristics. The *Register of Plots of Land* creates a spatial index of owned land for the "*uniform system for identification of properties*" which Zevenbergen & Ploeger (2019, p. 3) state is a core requirement of a high quality deeds system. All owned land can be managed in the *Register of Plots of Land* and used as a reference index. The *Register of Title* articulates the parties who hold owned land. All other registerable rights are managed in the *Register of Deeds*. Spatial or party indexing is used to articulate the relationships between a cadastral units and rights held by third parties. This allows significant flexibility for the creation, variation and discharge of non-ownership real rights (see Figure 5). This is especially important for securities (mortgages) and for transactional management in a digital system.

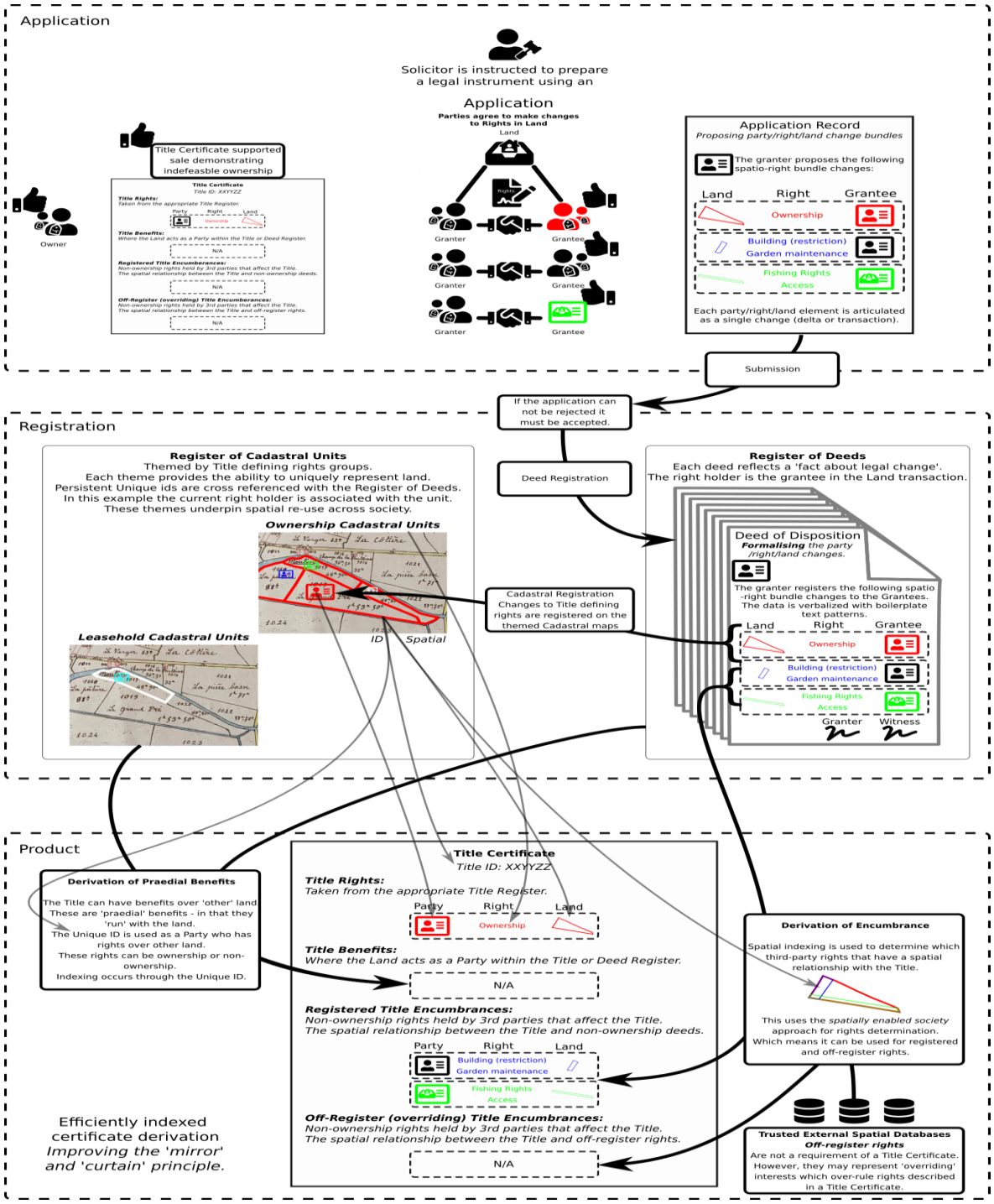

Figure 5. The transactional process that changes a Land Register (Beck, 2022). A solicitor or notary working with the right holder and benefiter drafts a deed to reflect the required changes to the real rights in land in the register. This is submitted to the registrar in an application. If the registrar accepts the application the deed and rights changes are recorded and registered based on the legal framework in the jurisdiction. The data is indexed to support the efficient derivation of products required by the jurisdiction (notably Title derivation)

The transactional process that changes a Land Register (Beck, 2022). A solicitor or notary working with the right holder and benefiter drafts a deed to reflect the required changes to the **real rights in land** in the register. This is submitted to the registrar in an application. If the registrar accepts the application the deed and rights changes are recorded and registered based on the legal framework in the jurisdiction. The data is indexed to support the efficient derivation of products required by the jurisdiction (notably Title derivation).

To automate registration the deed should be delivered in such a manner that enables the *state change* to be digitally enacted on the register without human intervention. This requires the articulation of the *key registrable content* in the deed. In this example the extraction problem is solved by articulating the *key registrable content* in the application and using the application to create the deed and register the state change. The formalised semantics of registration, described above, are required to create a deed and invoke change on the register. Deed creation patterns with associated boilerplate text are used to transform the *key registrable content* in to a formalised deed that is legally compliant. Associated database update patterns are used to both version and update the rights relationships in the Land Register.

The proof of concept is used to simulate a variety of different development scenarios from simple ownership of a detached house to flats with complex co-operative communal encumbrances. The framework allows automated registration and validity checking and the derivation of Title based around rights relationships.

It should be noted that such an approach is at present only theoretical. In order to be implemented there would need to be an associated change to the legislation that redefines the relationship between applications and deeds. This is a simple cost-benefit problem: do the social benefits of automated registration outweigh the legal and implementation costs? If so then the appropriate reform needs to be enacted. However the cost of the cultural and technical change may be more difficult to calculate.

6. USING INDEXING TO REPRESENT *STATE*

A Land Register must derive the current *registered state* (by a search output or derivation of a 'title' product) that demonstrates:

- Legal ownership (the party (*the who*) that benefits from the ownership right (*the what*) over a plot of land (*the where*)) and
  - what other *real rights in land* benefit that plot of land.
- What real rights in land encumber the owned land and who benefits from these rights.
  - what rights might lead to *adverse claims* against the owner (the lack thereof demonstrates indefeasability).

The proof of concept is no different, The creation of a Title product is a data storage, indexing, and retrieval problem which in modern registers is supported by (spatial) databases,

dedicated indexing and conceptual models (such as the Land Administration Domain Model (ISO TC/211, 2012).

In the proof of concept Title can be derived based on a seeding cadastral unit (see Figure 5). The cadastral unit is the principal right representing owned land. The legitimacy of ownership is demonstrated by ensuring the chain of deeds going back to a *good root of title* (while Scotland has an approach of deferred indefeasibility it is only deferred for a year or the last transaction (whichever is longer)). In the proof of concept the logic to demonstrate *good root of title* has yet to be implemented. There are a number of technological applications that can be used to support modelling and inferencing of these relationships (including graph modelling and first-order logic). Praedial (beneficial) rights (that come with the owned land) can be identified by party indexing: where the right holding party is the seeding cadastral unit. This can include other cadastral units which are *owned by proxy* by the seeding cadastral unit. The set of cadastral units is referred to as the *subjects*. Encumbering rights (rights held by third parties, over some or all of the subjects), potentially including overriding interests, can be identified by spatial indexing. The inference being that any registered right which has a spatial overlap relationship with the cadastral units in the subjects are encumbering the owner.

7. CONCLUSION

While in theory anyone can submit a deed of change to a Land Register, in practice such changes are mediated by lawyers and notaries in most jurisdictions. There are a number of good reasons for this mainly framed around the complexity of legislation, the validation requirements of a registerable deed and fraud. However, it does not need to be this way. While information on the Land Register may frame deed content, this is a passive rather than active relationship. The application model approach used in this paper provides new opportunities for future ways of working. This includes structured or guided application creation, where *active* content in the register is used to seed the change. This data is implicitly valid and lowers some of the verification overhead.

For example, by securely logging in to an LADM compliant Land Register an *owning party* (or their agent) can determine which cadastral units they own. By examining an individual cadastral unit in more detail the *owner* can see what rights benefit or encumber their owned land. Using this interface over the registered rights the owner could indicate that they want to initiate a rights transformation (such as described in Figure **Error! Reference source not found.** and Figure **Error! Reference source not found.**).

In such a guided application we already know *what* rights are registered, *where* they have affect, *who* they are held by and, where the right is *ownership*, what party-right-land triples encumber the owned land. We are able to unambiguously reference party-right-land triples directly within the guided interface based directly on authorative data held in the Land Register. This satisfies the specificity (originally *speciality*) principle (Henssen, 1995, p. 7)). Hence, when an owner (the granter) wants to sell their property to a third party (a grantee), the system already knows a significant amount of information about the transaction and can use

this to seed the application. The interface can request the details of the third party (which will then be securely verified). The system should also evaluate if there are any currently existing registered encumbrances, such as a security, which may need discharging in order for the transaction to be successfully completed. If this is the case then the system can broker the communication with the mortgage provider. Prior to submitting an application the granter can simulate the proposed application, or suite of applications (normally a house sale requires three changes: a security discharge, a transfer of ownership, and the granting of a new security for the new owner). The system will provide feedback on whether the application(s) will be accepted (or not) and describes the state of the register after the change has been applied. Rejections will be reduced as better quality submissions are received. By using LADM structuring and explicit rights logic the language of registration is made more transparent.

Irrespective of the actual dynamics of any application it is clear that in order for automation to occur there is need for highly structured data that supports a rights and registration logic. This paper has described a number of the structural elements required to support flexible and generic automation of registration processes. A digital proof of concept has been produced as a companion to this paper and presented at the workshop which demonstrates automated registration from simple through to complex cases. While clearly any approach to automation should be framed by the legal requirements of each jurisdiction there are generic modelling approaches that can support automation. While the work of Hjelmblom et al. (2019) and others is important in this regard, it is also important that more work is undertaken to model rights and rights relationships to ensure that automation can be used for all forms of application.

This approach is based on Scots law. Scots law is a hybrid model containing elements of both deeds and title registration. The approach outlined in this paper uses a Title materialisation to store cadastral units (and details of their owners) and the deeds element to store party-right-land triples relating to non-ownership rights. In its current form it requires both a deed register and title register to function. We agree with Zevenbergen & Ploeger (2019, p. 7) when they state that in reality most systems are neither purely deeds or Title based and lie on a spectrum between the two poles. As binary concepts, the terms Title and Deed register are poorly suited at representing the reality of this spectrum. We recognise that registers have a need to represent both *state* and *state change*, and would argue that a Registrars stance on indefeasibility and error correction is a more nuanced way to classify registration systems.

Registration automation has the potential to significantly disrupt the conveyancing sector. While there may always be a need for lawyers and notaries to be involved in complex transactions this requirement could be removed for simple transactions. There may be significant friction to such change by the conveyancing sector. In addition automation will lead to increased concerns around cybersecurity, identify theft and other fraud related issues. These issues will need to be effectively mitigated.

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BIOGRAPHICAL NOTES

Ordnance Survey is the national mapping agency for Britain, and a world-leading geospatial data and technology organisation. Accurate location data is used for smarter solutions to the world's most complex problems including resource management, urbanisation and population growth. As a trusted partner to government, business and citizens across Britain and the world, our expertise and technology helps customers in government, business and infrastructure deliver efficient services.
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Anthony BECK is a geospatial and analytics professional with a strong mix of technical, commercial, academic and policy skills. He has experience of delivering repeatable solutions using an inclusive and interdisciplinary approach, involving GI-Science, Knowledge Engineering, and Data Modelling. One of Anthony's key skills is demonstrating the link between concepts, data, policy and practice. Anthony is a Concept and Data architect. He is lead author on many academic journal publications that cover different domains: these include land administration, utilities, heritage, smart cities and addressing. He holds a PhD in heritage remote sensing applications and advises specialist, policy and standards bodies. He has won a number of industry awards including work on the integration of underground utility assets and the PAS128 utility standard. He was short-listed for the Institute of Civil Engineers entrepreneur of the year award. Anthony is fluent with ISO19152 (Land Administration Domain Model (LADM)) and is contributing to the ISO19152 version 2 revision. He is interested in approaches that improve registration automation and first-order logic modelling of the registration domain.

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