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Modelling Units of Real Property Rights

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Abstract. The GI2000 initiative considered the requirements for a geographic information infrastructure in Europe. This was followed by the European Territorial Management Information Infrastructure project, ETeMII, which among others examined the issue of reference data. Reference data sets provide a spatial context and structure for everyone involved with geographic information. An analysis of the information provided through these efforts point to the relative importance of geographic information on real property and other socio-economic issues. - The research activity *Modelling Real Property Transactions* gained status as COST action G9 by March 2001. It is addressing the important reference data sets that regard the unit of real property and related information. - The present paper develops from the above efforts. It presents and motivates a structure of cadastral core packages, and relates this proposal to the outcome of standardization and modelling activities in the USA and Sweden.

1. Introduction

National mapping agencies have traditionally provided consumers with standard products. Now new technologies allow for providing users with components that are mixed as appropriate. This presupposes that the components are specified and prepared to support this approach. The ETeMII project consortium has provided a specification and structure of geographical data, which provide a spatial context and structure for everyone involved with geographic information (ETeMII, 2001). Consensus views from a number of ETeMII reports and information from workshops provided the basis for the following breakdown of reference data components, cf. Figure 1.

It is interesting to note the clear distinction between components that refer to objects visible in the terrain, and components that refer to objects defined and identified only in an administrative setting. This is worth mentioning, because a follow-up in the context of the INSPIRE project (Inspire, 2002) apparently disregards this distinction.

The ETeMII White Paper furthermore includes an annex that addresses available information on user requirements. Drawing on figures from this annex, namely an investigation on geographical information in Australia (ANZLIC, 1995), and combining them with the above structure of components, one arrives at the figures of Table 1 below.

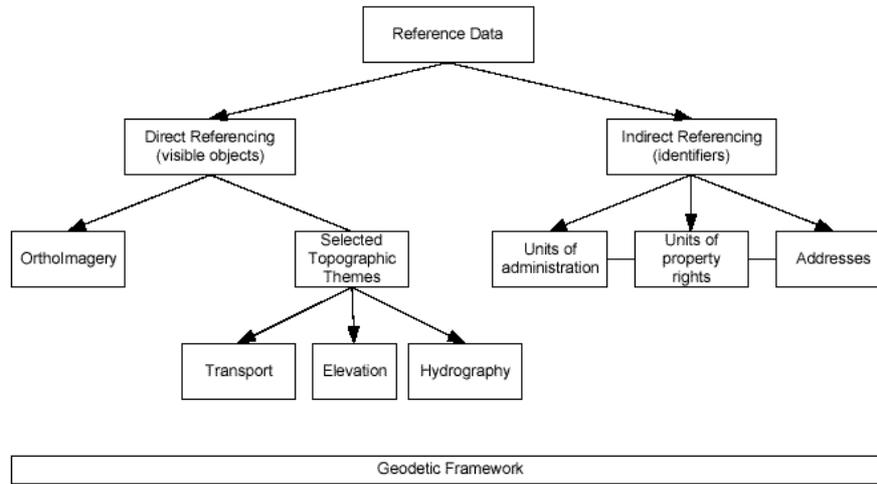


Fig. 1. Reference data components. ETeMII Reference Data White Paper, July 2001, page 9.

The figures indicate the relative sizes of cost of production of different geographical data sets for original use. The sources do not reveal the relation of the total (100%) to the turnover of the Australian mapping industry and, furthermore, do not indicate how geographical data (maps) for road and building construction are counted. The latter could amount to the same order of size as the Utilities. However, according to the information available, the component Units of Property Rights is attributed the largest weight (27 %), followed by components related to environment (Hydrography and Other environmental: 21).

Table 1. Geographical data groups and their relative economic weight (Per Cent of total)

Topographic objects: 33 %		Socio-economic units: 29%	
Transport	5	Administrative units	2
Relief and contours	7	Units of property rights	27
Hydrography	5	Addresses	?
Other environmental	16		
Utilities 19; Geodetic network, etc. 4; Maritime navigation 15;			

Source: ETeMII, 2001: 9ff and Annex C: 36, data from ANZLIC, 1995. Edited

The concern for environmental data is well reflected by the INSPIRE project, which is further motivated by the Water Framework Directive 2000/60/EC. The present paper addresses the socio-economic units, and specifically the units of property rights, which according to the economic weight are the most important.

The issue of socio-economic units is not new in GI research. For example, the GISDATA series includes volume 8 by A. Frank, J Raper, and J-P Cheylan on 'Life

and motion of Socio-economic Units'. Human geography may well explore quantifiable relations, but the research criteria in the following is not such relations, but whether it is possible to identify commonalities in the way humans define spatial, socio-economic units across jurisdictions and countries. Recently, standardization and modelling efforts in USA and Sweden have resulted in reports, which may serve as evidence for more theoretical investigations that follow below.

An introduction to the term *cadastral system* may be useful. A definition often used reads:

“A Cadastre is normally a parcel based and up-to date land information system containing a *record of interests* in land (*e.g. rights, restrictions and responsibilities*). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (*e.g. valuation and equitable taxation*), legal purposes (*conveyancing*), to assist in the management of land and land use (*e.g. for planning and other administrative purposes*), and enables sustainable development and environmental protection.” (FIG, 1995)

However, this definition rather reflects the situation in Anglo-American countries. In continental Europe, cadastre and legal land registers were born separately: “In many parts of Europe, the cadastre evolved as a support for land taxation, while the legal processes of land registration were dealt with separately by lawyers and the records entered in land books, for example the German *Grundbuch*. Dual systems therefore emerged” (UNECE, 1996: 4). Recent definitions show an agreement on the concept of a *cadastral system*, namely the combination of a cadastre - with its spatial focus - and a land register - with its legal focus, as developed in (Silva and Stubkjær, 2002: 408f).

The following section 2 presents and motivates a core set of ‘packages’ (in the UML sense). The core is developed in the context of the COST G9 research activities (Stubkjær, 2002). The development is made in dialogue with a ‘Core Cadastral Data Model’, which was presented by Peter van Oosterom and Christiaan Lemmen at the workshop “Towards a Cadastral Domain Model” in Delft, October 2002 (2002). A further development of their core data model appears in a paper to be presented at FIG Working Week 2003 (Lemmen, Oosterom, 2003). The present author has commented specifically on this paper in (Stubkjær, 2003), and therefore the present paper does not refer to this important line of research in the following.

Sections 3 and 4 compare the proposed structure with the mentioned standardization efforts in the USA and Sweden. The conclusion points to the fact that a consensus on the core packages of cadastral systems is emerging.

2. Presentation and motivation of cadastral core packages

The design objective of the following cadastral core packages (see Fig. 2 below) is to provide a basis for international comparisons of cadastral systems, as defined

above. Within the COST research activity *Modelling Real Property Transactions*, the international scope is Europe, but the core should possibly allow for interpretations in other cultures as well.

The basic ideas of the present proposal for a core is that

- change of real property rights is socially mediated, and
- cadastral systems are relevant for end users and society mainly during this change process.

In case of a change, e.g. the conveyance of title to a unit of real property, the buyer and the seller performs a prescribed sequence of activities to achieve the transfer. In the European setting, this ‘ritual’ is formalized through statute law, regulations, and professional codes of conduct. This explication of general norms into written clauses has the implication that the transfer process is fairly predictable, and that evidence pertaining to the change process can be stored in a set of GISs. It would be simplistic to state that the outcome of the change process could be stored in the GISs. Property rights is an *institution* that is “humanly devised constraints that shape human interaction” (North, 1990: 3). These constraints are basically carried in the minds of people, but rules, spatial plans, documents and database recordings provide evidence of the constraints. If needed, this evidence provides a basis for enforcement of the constraints, e.g. through court rulings or in extreme cases through police action.

The purpose or function (Zevenbergen, 2002: 89 f, 106) of a national *cadastral system* is here stated as follows:

- to assist the owner and other holders of rights in achieving a reorganization of either real property rights, or the geographical object of these rights, or both, while
- protecting the rights of third parties, and
- keeping official recordings consistent and cost effective.

By ‘reorganisation’ is meant any change of property rights. For example, the purchase of a property is achieved by exchanging one kind of property, namely money, against another kind of property, namely real property. This involves also those, who have a right in the unit of real property concerned, e.g. mortgagees. Normally, it is thus a quite complicated puzzle to make sure that the wishes of the owner are implemented without infringing on the right of others. The same applies to changes of the size, shape, and location of units of real property: Changes involves the neighbors as well as possible holders of right of way, and have to take existing cadastral recordings into account. Here a complicated geographical puzzle has to be solved. These considerations have led to the diagram below of cadastral core packages (in the UML sense).

The core package is the Transaction, which is a superset of all the different kinds of procedures that are needed to perform changes in RealPropertyUnit or RealPropertyRights, or both. The package associates to the PropertyDatabase, which is queried and updated in the course of Transaction.

SpatialReferenceFrame locates RealPropertyUnit. SpatialReferenceFrame includes the object class of GeodeticDatum, which provides the basis for calculating coordinates of points on the Earth (cf. e.g. Groot & McLaughlin, 2000: 175 ff.). National mapping agencies provide the co-ordinates to benchmarks, which are stable and spatially well-defined subsets of the package TerrainObject. Furthermore, SpatialReferenceFrame includes the object class of PlaceNames, including postal codes, civic addresses, and areas defined by administrative boundaries (Groot & McLaughlin, 2000: 181).

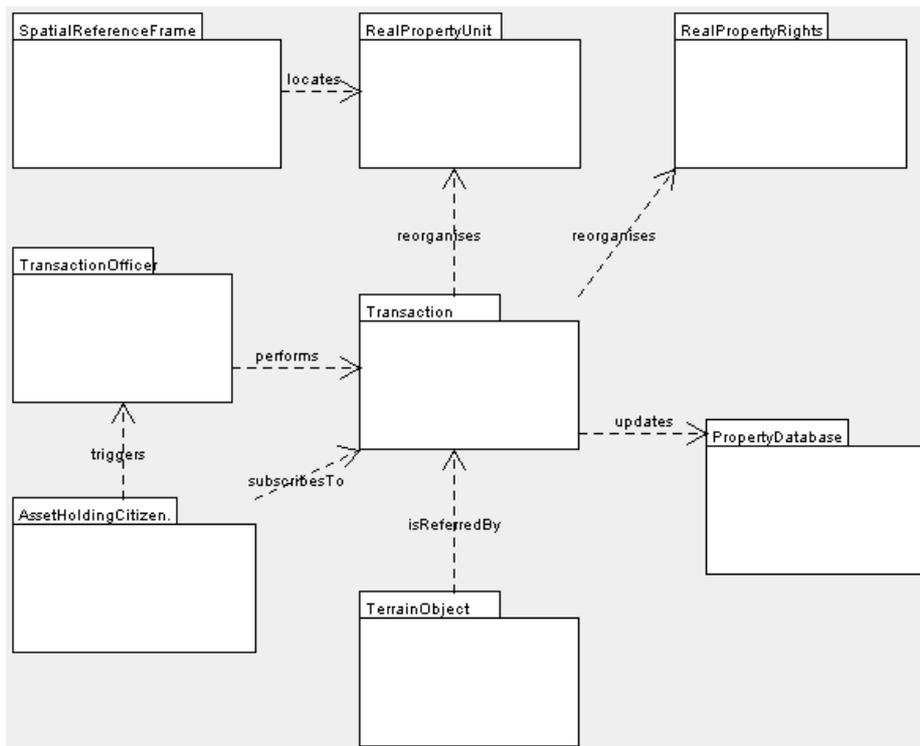


Fig. 2. Core packages of cadastral systems

It is important to recognize the importance of the non-numerical reference systems for the following reasons: The purpose of cadastral systems is to support the end user. Consequently, the system should draw as far as possible on the competencies of the end user, to make the system transparent and cheap. Research has identified a number of non-numerical spatial reference frames, which are available for the end user: The human body, landmarks, (road) networks, and enclosures (Couclelis, 1987; Gersmehl, 1996). An enclosure is an area that surrounds the object to be located. It might be a forest, but in the real property context the jurisdictions specify location of a RealPropertyUnit. In Europe, many variations take their historical point of departure in the bishopric- parish- township hierarchy. In the USA the Public Land Survey's hierarchy of origin - township- section- forty serves the same purpose.

The PropertyDatabase models the national information systems: The cadastral recordings in alphanumerical and graphical form, and the recordings at the courts. Furthermore, the package includes object classes of the information that makes up a case: The completed forms, standard documents, and necessary notes used for the Transaction.

Cadastral systems are made by and for humans, but it is still a rather open question, how these humans are best modelled. A general design criterion is that the model catches the invariant aspects, here of human behavior. The institution of property rights imposes certain *roles* on people: owner, user, mortgagor, etc., and consequently these roles must constitute object classes. However, the notion HolderOfRealPropertyRight is not comprehensive enough, because a buyer of a property unit would not be included. Hence, the term AssetHoldingCitizen was chosen, as it refers to all people holding assets, whether money or real property rights. Transactions are triggered by those AssetHoldingCitizens, who are entitled to do so. All holding RealPropertyRight in the RealPropertyUnit must subscribe to the Transactions before they can take place.

The term AssetHoldingCitizen refers to citizen, rather than to person, for the following reasons. An important divide exists between the people, who have an interest in the Transaction, and those who contribute to the Transaction on behalf of society. The role of the latter is defined by the institution of a society of law and order (German: *Rechtsgesellschaft*). This calls for a short development of the relation between real property rights and society.

General ontologies, e.g. the Cyc ontology, model ownership through a predicate owns(Agent, SomethingExisting) (Stubkjær, 2001: 174 f).

Similarly, in the literature on cadastral and land registration systems, the standard structure is owner-right-parcel (Henssen, 1995; Zevenbergen, 2002: 103 f). However, this relationship does not hold in a situation of change, and cadastral systems are devised precisely to handle changes, and not the rather permanent, everyday situation. In a situation of change, the institution of property right in a sense alienates the property right from the owner, because a unilateral action might compromise the property rights of other parties. For this reason, in every society the reorganization of real property rights is socially mediated; it is performed as an elaborated ritual. In societies of law and order, the 'ritual' is formalised into Transaction, which relates owner and other holders of right with their RealPropertyRight.

Returning to the issue of how to model persons in the cadastral core, it is now established why persons perform roles on behalf of society. In some countries, cadastral systems are mainly governmental. In other, professionals and other occupations also perform key tasks. As these key tasks are performed on behalf of society, the non-governmental roles mostly will be regulated through licenses and similar instruments. TransactionOfficer is proposed as the general term for the persons, who perform these governmental and non-governmental tasks.

TerrainObject is a package of the object classes that makes the rights 'real', that is: related to the surface of the Earth. The object classes model the visible and discernible features, which can be identified by software from imagery. Generally, cadastral parcels cannot be identified this way, because the discontinuities of the terrain do not provide sufficient evidence to establish parcel boundaries, let alone parcel identification. Consequently, human involvement, namely in terms of Transaction, is needed to establish parcels and other classes of RealPropertyUnit from TerrainObject.

The above mentioned eight packages constitutes the core of cadastral systems. They are depicted in the diagram in the way that the most palpable are located at the bottom, and the more abstract at the top. The purpose of cadastral systems was stated as follows:

- to assist the owner and other holders of rights in achieving a reorganisation of either real property rights, or the geographical object of these rights, or both, while
- protecting the rights of third parties, and
- keeping official recordings consistent and cost effective

The proposed core corresponds fairly well to the stated purpose. The core packages are more specific as to official, societal involvement (TransactionOfficer), and to geographic localisation (SpatialReferenceFrame). This is due to the fact that the purpose is described in the terms of the end user, while the packages have to account for what makes the system work.

3. The US Cadastral Data Content Standard

The Subcommittee on Cadastral Data of the (US) Federal Geographic Data Committee issued as of October 2002 a Cadastral Data Content Standard for the National Spatial Data Infrastructure, version 1.2. The standard is a document of about 100 pages, the main part of which consists of entity and attribute definitions.

The about 35 entities are depicted in Entity-Relationship diagrams, which for better readability are separated into four parts. The four parts are not named or otherwise characterized by the standard. The indications of main content is thus an interpretation of the present author:

- part 1: Description of name hierarchy (state - origin - township - range - divisions) and geodetic reference
- part 2: Description of parcel records and boundary details
- part 3: Parcel, Rights and Interests, Restrictions, and Transactions, respectively, as well as "intersecting entity"(s) that describe, e.g. "the relationships between Rights and Interests, and an instrument of Transaction", and
- part 4: Agent, and its specialization into Individual, Organization, Public Agency, TransactionAgent (any participant or party identified in a land record document or instrument), as well as Restriction (imposed by Agent), and GeopoliticalArea (or in other terms: jurisdiction) of Agent.

The entities included in the US cadastral standard can be related to the core that was proposed in section 2 above, and in several respects support the content and structure of the core. The discussion starts with Agent and moves upwards through the parts.

The US Standard distinguishes between public and private organizations, and furthermore introduces a TransactionAgent. It is not spelled out, but from the context it seems that TransactionAgent includes only the users of the cadastral system, not the officials, who perform the recording, issue certificates, etc. It seems justified that the core distinguishes between the class of these users, and the class of officials. To make this more explicit, the above proposal denotes the class of users: AssetHoldingCitizen. It seems that this agrees with the TransactionAgent of the US standard.

The entity Restriction is not easy to relate to Danish legal doctrine. A Restriction "captures information related to administrative, judicial, or other limitations or permissions for the use and enjoyment of land by the land right holder. These are not transferred rights, although succeeding owners may agree to the same restriction on a Parcel." If Danish building authorities would record their building permits in the cadastre, and other local authorities would do likewise, then the situation might motivate the entity Restriction. However, they do not. What comes closest is that the Agricultural Act (Danish: Landbrugsloven) puts a restriction on agricultural holdings, which is noted in the cadastre and also at the courts. Also, formally agreed, detailed spatial plans (Danish: lokalplaner) are recorded as easement, but such restrictions are definitely transferred to any new owner. It is thus difficult to see the motivation of the entity Restriction, as independent from RightsAndInterests in general, unless the entity/ class should denote statutorily imposed and owner-independent restrictions on the use of the unit.

RightsAndInterests are "benefits or enjoyments in real property that can be conveyed, passed, or otherwise allocated to another for economic remuneration. ..." and this fits well with the RealPropertyRights of the proposal.

The fact that Transactions are part of the US Standard fully agrees with the position taken in the proposal. The presence of the intersecting entities ParcelTransaction and RightTransaction points to the main dual domains of the core: the geographical domain, defining the objects to which the rights of the legal domain refer.

As regards part 2 on Parcel details, it should be noted that no provision appears for defining property units made of several parcels. This would be needed in the European setting.

Finally, part 1 points to two ways of spatial reference of a Parcel: One is the hierarchy of place names, the other is the class of geodetic reference frames. Again, general agreement can be established.

Summarizing, no substantial contradictions or lacunas exist between the proposed core and the US Cadastral Data Content Standard. The major discrepancy regards the way in which real property rights are specialized.

4. The Swedish Property Information Modelling Project

The Swedish National Land Survey, Lantmäteriet, issued in 2001 a project work on the modelling of real property information (Lantmäteriet, 2002). The purpose was to provide the basis for more effective business operations, including a better integration between the property database and the digital map, and generally more standardized recording of information. Design criteria included that the models be specified in UML and compatible with the models developed for topographical data. The modelling was performed in dialogue with representatives of several representatives inside and outside the National Land Survey. The Swedish Centre of Terminology (TNC, Solna) reviewed the outcome of the modelling effort. Besides internal use, the modelling effort also contributed to ESRI's ArcCadastré with a view of establishing an international model. The modelling effort is still ongoing; below is summarised outcome as of 2002.

The object classes are partitioned into 6 packages: Three of those, namely RealPropertyUnit, RealPropertyRights, and JointPropertyUnit, are subtypes of a Case (Swedish: Redovisningsenhet). The three packages also have the same relations to the package AdministrativeSubdivision (e.g. the hierarchical structure of county, municipality, township, etc). The sixth package is ChangeProcess. It is not related to the other packages in the uppermost view of the packages. Packages on History (of instances of RealPropertyUnit), and on Quality are mentioned, but will not be commented here.

Before commenting on the packages it should be noted, that the modelling effort so far does not address ordinary functions of the Land Registry, including the recording of title and mortgages. (It is later being addressed (Paasch, 2003)). Rather, the instances of object class RealPropertyRights regards statutorily imposed or negotiated easements, e.g. for pipes, cables, power lines, etc. These easements typically will be recorded on several RealPropertyUnits. The JointPropertyUnit typically regards a private (dust) road, which is used by two or more RealPropertyUnits. From the point of view of a foreigner, both pipes, etc. and roads constitute linear easements, and it might well be due to historical reasons only that they are recorded differently, and thus modelled as different object classes. However, national modelling has to fit to national law and practises.

The object class Case is associated with the different categories of cadastral cases: Subdivision, amalgamation, lot transfer (reallotment), boundary definition, etc. Furthermore, it is associated with filenumber and other details regarding the case, e.g. responsible office, and whether the case is active or not. Finally, it is associated with classes and subclasses that reflect the decision(s) made through the case.

The Case class in many respects corresponds to the class Transaction. One may consider whether changes in the property unit only should be termed Case, while changes with legal or economic implications should be termed Transaction. As the Swedish surveyor is entitled to do both, Transaction may be the better term. The English term Case has been chosen here to comply with the Swedish notion.

The rather elaborated structure of the package RealPropertyUnit has many traits in common with the Core Cadastral Model, version 1, although they are not identical. Common is, for example, the Core Model's PropertyRight part has a strong and problematical emphasis on Restriction, compared to title and mortgages. This could well be due to inspiration from the Swedish project. A difference is that the Swedish model includes the Person-Right-PropertyUnit structure without making it the very core, as the Dutch Core Model does.

The class of RealPropertyRights includes several categories of easements, as mentioned above, as well as different use rights, including site leasehold.

Interestingly, a whole package is devoted to AdministrativeSubdivision. This corresponds to the elaborated treatment of the PublicLandsSystem of the US Cadastral Standard. Like the US Standard, the Swedish model also associates the geographical hierarchy of place names to co-ordinate system, as well as to (paper) map sheet identification.

The ChangeProcess appears to include only few details. Mostly, they seem related to the Case package.

Summarizing, the Swedish modelling effort appears to fit to the administrative practise, which of course is a main criterion of modelling. However, in this way the Swedish administrative structure and allocation of tasks and competencies is modelled along with the more general structures of the domain. By comparing the modelling efforts across jurisdictions (countries) the influence of national traits can be reduced, and hopefully eliminated.

Compared with the proposed core packages, it is again possible to establish correspondence between the two modelling efforts. And again, the major discrepancy regards the way in which real property rights are specialized. The FIM project report provides details regarding the Case/ Transaction packages, which are not mentioned by other models. Many of these details have not been mentioned here, but await further specification of the proposed core of cadastral systems.

5. Conclusion

At the outset, the paper provided evidence of the relative economic importance of socio-economic, geographical data. The evidence has been available now for about 2 years, but apparently no other has (had interest in?) pointing to this fact.

The paper stated the research issue, whether it is possible to identify commonalities in the way humans define spatial, socio-economic units across jurisdictions and countries. Furthermore, it established the criteria that the modelling effort catches the invariant aspects of human behavior regarding the definition of spatial units of real property rights, and at the same time reflect practises in diverse countries and administrative units. As regards modelling language, the paper applied the UML in a rather unreflected way.

In section 2, eight packages and their interrelations were theoretically substantiated as a core of cadastral systems, as defined in section 1. In sections 3 and 4 the proposed core was compared with expert modelling efforts done in the USA and Sweden. It was possible to establish correspondance between the proposed core and the two modelling efforts. They both supported the relevance of the packages Transaction and SpatialReferenceFrame, respectively, which are so far not included in the Core Cadastral Domain Model of Lemmen and van Oosterom (2003).

The major discrepancy between the present and other modelling efforts regards the way in which real property rights are specialized. This appears as not critical, as the main emphasis was to identify and relate the package of the geographical unit of real property rights. Also, the distinction between end users (holders of assets) and officials is not made so explicit in other modeling efforts. The distinction is, however, motivated theoretically in section 2, and empirically by the UseCase modelling effort, which was performed in the context of the research activity *Modelling Real Property Transactions* (Stubkjær, 2002), but not detailed here.

Concluding, a deeper and theory-related understanding of the unit of real property rights, often called the cadastral parcel, has been achieved.

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