

Spatial Information Management and Workflow at IGM GDB ("Latitud Sur Project" - 1:25.000 Cartographic Production)

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Key words: Cartography Production, Workflow Process, Mapping, Spatial Information Management.

SUMMARY

The Military Geographic Institute of Chile, constitutes the official authority, on a permanent basis and representing the State, in all matters relating to geography, surveying and mapping Chilean territory. In that sense, has been involved in a project called "*Latitud Sur*" that should create a new base Cartography at 1:25.000 scale for Chilean development and defense.

The project works capturing cartographic information from satellite imagery and digital elevation models in order to map the whole national territory. To fulfill this objective the Cartographic & Informatics (Geospatial Database) Departments, has generated a procedure to manage a database with geographic data derived from nationwide mapping capture process following the methodology proposed by the MGCP (Multinational Geospatial Co-production Program) and workflow tracking through a ESRI Workflow Manager application.

In response to these new needs, has been implemented a cartographic information capture system in Windows environment on a platform Arcgis 10.0 with high-performance equipment for users and administration purposes.

Workflow done by Capture operator: The user, in arcgis10 environment, connects to workflow manager where locates the task sent by the Supervisor and then runs the Edit Capture procedure, then opens the Capture program called Summit Evolution from the project integrating elevation models to do their daily capture.

Workflow done by supervisor: The Supervisor connects to Workflow Manager in order to complete administrative fields of the task, mark the AOI place to capture and then sends it to the operator to capture their daily work.

Conclusions

The work procedure adopted for the capture and management of spatial information has allowed to organize workflows in an automatic and organized way, and thus begin capturing of the national territory with very good results in its initial phase from the north of

the country using high-performance equipment and software, as well as a procedure aligned to the highest international standards of cartographic production.

SUMMARY (Spanish)

El Instituto Geográfico Militar de Chile constituye el organismo oficial, de manera permanente y en representación del Estado, en todos los asuntos relativos a la geografía, la topografía y la cartografía del territorio chileno. En ese sentido, ha estado involucrado en un proyecto llamado " Latitud Sur " que debe crear una nueva base Cartográfica a escala 1:25.000 para el desarrollo de Chile y la defensa.

El proyecto consiste en la captura de información cartográfica desde imágenes de satélite y modelos digitales de elevación con el fin de mapear la totalidad del territorio nacional. Para cumplir este objetivo, el Departamento Cartográfico y la Base de Datos Geoespacial del IGM han generado un procedimiento para administrar una base de datos con los datos geográficos que se derivan de todo el país en el proceso de captura siguiendo la metodología propuesta por el MGCP (Programa Multinacional de Coproducción Geoespacial) y el flujo de trabajo de seguimiento a través de una aplicación de Workflow Manager de ESRI.

En respuesta a estas nuevas necesidades, se ha implementado un sistema de captura de información cartográfica en el entorno de Windows en una plataforma ArcGIS 10.0 con equipos de alto rendimiento para los usuarios y los fines de administración.

El Flujo de trabajo realizado por el operador de captura: El usuario, en entorno Arcgis10, se conecta al Workflow Manager, donde localiza la tarea enviada por el Supervisor y luego ejecuta el procedimiento de edición y de captura, a continuación, abre el programa de captura de llamada Summit Evolution, integrando los modelos de elevación para hacer su captura diaria.

El Flujo de trabajo realizado por el supervisor: El Supervisor se conecta a Workflow Manager para completar campos administrativos de la tarea, selecciona el Área de Interés (AOI) para capturar y luego lo envía al operador para que proceda a capturar su trabajo diario.

Conclusiones

El procedimiento de trabajo adoptado para la captura y gestión de la información espacial ha permitido organizar los flujos de trabajo de forma automática y organizada, y así comenzar la captura del territorio nacional con muy buenos resultados en su fase inicial en la zona norte del país, debido al uso de equipos y software de alto rendimiento, así como un procedimiento alineado con los más altos estándares internacionales de producción cartográfica.

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1. INTRODUCTION

1.1 Military Geographic Institute of Chile (IGM)

The Military Geographic Institute of Chile (IGM) was founded in the year 1922. Since that date it has been the 'official body', representing the State of Chile, responsible for establishing basic geographic information covering Chilean Territory.

Since its creation the IGM has created various types of cartographic information covering the whole country, this being at various scales and 99 % of which is in digital format. The standard, topographic cartography at 1:50,000 scale is the basis for the development of other cartographic coverages at smaller scales (1:250,000 and 1:500,000). Moreover, urban digital cartography has also been developed (1:1,000 to 1:5,000) for a significant number of the cities in Chilean territory.

Currently the IGM is working on various projects in order to optimize the digital cartographic information by means of a process of checking and verifying the data contained in the cartography and storage at the Geo databases, in order to prepare it appropriately, both for processes related to its use in Geographic Information Systems and for publication and printing.

In addition to its efforts to create an adequate geodesic and cartographic set of information, the IGM is constantly cooperating with various initiatives both at national and international levels, by means of its contribution to basic geospatial data. At a national level there is adequate cooperation with other organisations possessing similar characteristics, such as the Hydrographic and Oceanographic Service of the Navy, the Aerophotogrammetric Service of the Air Force and the Center for Natural Resources Research.

The role of the IGM extends beyond that initially mentioned here; it represents the State in international scientific organizations related to the geosciences (PAIGH, IGU, IUGG, ICA, ISPRS), it is an active member of the SNIT (Chilean NSDI), it is a member of the INN-SNIT project for national geographic standardization, it performs MGCP cartographic projects overseen by the NGA of the USA, it participates actively in the inter-operability project of the Armed Forces and finally, within its organizational structure, it has a dedicated research and development technical unit.



1.2 “Latitud Sur Project”: National Digital Cartographic Coverage at 1:25,000 scale

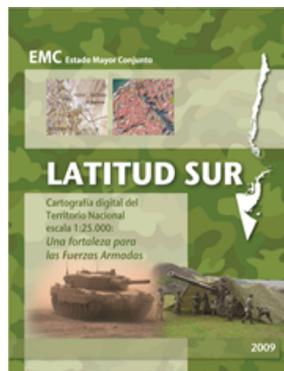


Figure N° 01
Latitud Sur Project

The “Latitud Sur Project” concerns the creation of a new cartographic coverage at 1:25,000 scale of the whole of Chile with the exception of its Antarctic territory. This project was approved in August 2010 by the National Defence Ministry and is being performed by the Military Geographic Institute (IGM) in its capacity as an official organization of the state.

This new portrayal of the country is being set up over six years, starting in the north of Chile and working southwards until reaching the far south of the territory.

The geographic setting in which the Armed Forces act both in preparation and in war has various features that impose conditions on the tasks, on the structure and on the use of the Armed Forces while at the same time it determines the capabilities that the resources available, the use of the facilities and the equipment should have.

The establishment of this cartographic coverage involves using emerging technologies which consist of using hardware and software for mapping, including ARCGIS, the use of ortho-images from high resolution obtained by remote sensing and digital terrain models, all of this referenced to a single reference system known as SIRGAS. This provides a new map coverage of greater detail, accuracy and updated currency.

Considering the geographic information systems and also the command and control systems of the Armed Forces that should enable spatial analysis and support for command of military operations, this new cartographic base includes accurate and updated basic information that will allow efficiency and effectiveness to be maximized in the management of geo-spatial information, running military tasks, the use of weapons systems, fire control and simulation systems.



Figure N° 02
Orthoimages

All of this information will be able to be shared between the various branches of the Armed Forces, which will then relate the basic information to the thematic material of their own that relates to and complements the mapping data, thus contributing to optimizing the management of the information of the Armed Forces and their systems.

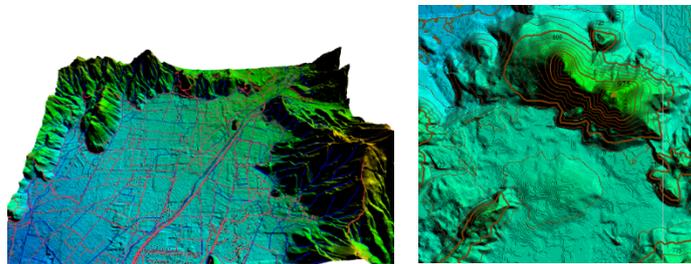


Figure N° 03
Digital Terrain Models Latitud Sur

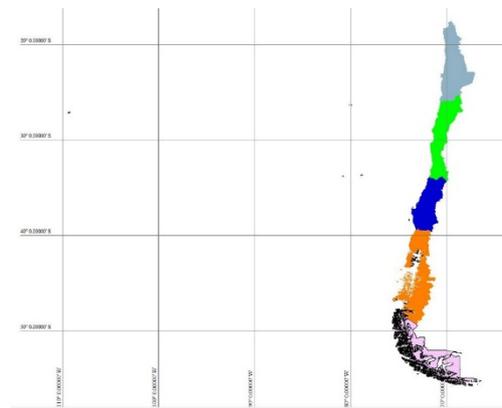
2. PROJECT DEVELOPMENT

2.1 Overview

2.1.1 Project Schedule

This new mapping cover begins production from North to South of the country, with its forward and term dates:

Implementation	Year 2012
Production start:	Year 2013
Zone XV – I y II	April Year 2014
Zone III – IV – V y Metrop.	April Year 2015
Zone VI – VII – VIII y IX	April Year 2016
Zone XIV – X – XI	April Year 2017
Zone XII	April Year 2018



The generation of this cartography involves a big challenge for IGM, since it is a new and innovative process, which involves the use of orthoimages and digital surface models. From its beginnings a data model and an orderly, rigid and sequential workflow must be used to fulfill production and help to control it. Also, International standards should be used to ensure compatibility of information and standardized quality control processes.

Both the process and the products are innovations, as they are the first to be introduced into the country and satisfy a latent need.

2.1.2 Terms and Definitions

- Feature: Phenomenon of abstraction of the real world [ISO 19101]. Normative term not translated into Spanish by agreement of the Geomatics Technical Committee of the Chilean National Standards Institute (INN), which brings together the various meanings; commonly used examples are element, object, entity, etc..
- Interoperability: ability to communicate, execute programs, or transfer data among various functional units, without the user having knowledge about the unique characteristics of those units [ISO 19119]
- Model: abstraction of some aspects of reality [ISO 19109]
- Quality: totality of the characteristics of a product that have to do with its ability to satisfy stated needs. [ISO 19101]
- Metadata: Data about data [ISO 19115]
- ESRI Shape File Format: geospatial data vector format for software GIS.

2.1.3 Interoperability

Interoperability, in very simplified terms, through its first component called syntactic interoperability, allows the transfer of information between systems (network protocols, interfaces, etc.) and through its second component, semantic interoperability, enables one to know the meaning or sense of the information transferred.

That is why the IGM has decided that this new generation of cartographic coverage with a level of detail, currency and accuracy superior to that available now, should create geographic information provided in addition to its implied characteristics, that is, the properties that give form to the geo-technological present and future stages.

It is therefore concluded that generating interoperable geographic data is globally synonymous with conceptualizing the project under the umbrella of the standards on which interoperability is based, particularly in its semantic component. That is why, based on the reasons stated, also on research, study, test runs and trial and error, this mapping project adopts the current model from the NGA survey data originating in the U.S. Topographic Data Store (TDS) at their local level, according to the scale of the project.

Unlike its predecessor, the Vector Smart Map Products (Vmap, also from the NGA, designed to store maps transformed from paper to digital format and governed by proprietary standards mapping), TDS is designed for creating data from its origin and grounded in international standards from ISO / TC 211, OGC and W3C. Nevertheless, these models have a few similarities, first; both ranges have segmented scales and moreover retains the original TDS identifier code (FACC) of features. Additionally, the adoption of this model due to its derivation from the National Geospatial Intelligence System for NSG (Figure 04) ensures that the requirements of Armed Forces at all levels for military operations will be satisfied.

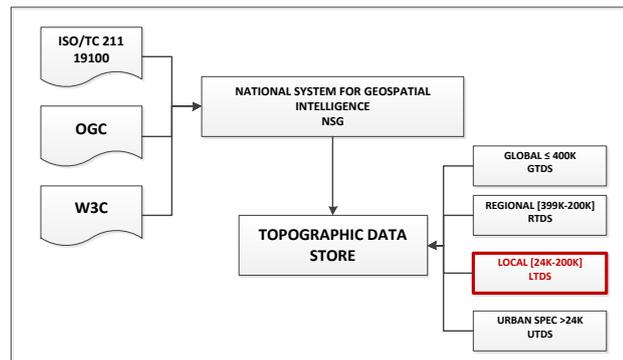


Figure N° 04
Origin of Data Model for Latitud Sur Project

2.2 Technical Characteristics

2.2.1 Overview

This mapping project is established largely on the guidelines of ISO 19100 family standards for Geographic Information / Geomatics, mainly ISO 19131 : "Data product specifications" whose purpose is to help creators of geographic information to structure a governing document that establishes, among other aspects, what types of geographic phenomena are covered by the dataset, how they will be organized, catalogued and portrayed, the sources of extraction, expected levels of quality, work methods, as well as how they will be released to users, also the semantics, meaning and characteristics of the final data. That is, "how the product is expected to be". Once created, the product must be analysed in terms of "how it really is", as per ISO 19115: "Metadata". In this context, and in order that the resulting product be, ideally, equal to the planned ISO 19131, the guidelines involving the interaction of peers are used.

2.2.2 Data Model

The "Latitud Sur Project" adopted the Topographic Data Store (TDS), which corresponds to a model of topographic data specifications governed by structural and semantic content built on ISO / TC 211, OGC standards and W3D, including individual specifications from the U.S. DoD. It is a granular pattern, segmented into four levels of

representation and scales each inherited from the content specifications of the general model, which will compete at their level of abstraction.

The graphic expression of this conceptualization, is shown in the following figure and the LTDS level is highlighted in magenta, adopted for modeling, structure and capturing the 1:25,000 topographic features used by the ‘Latitud Sur’ project at the IGM.

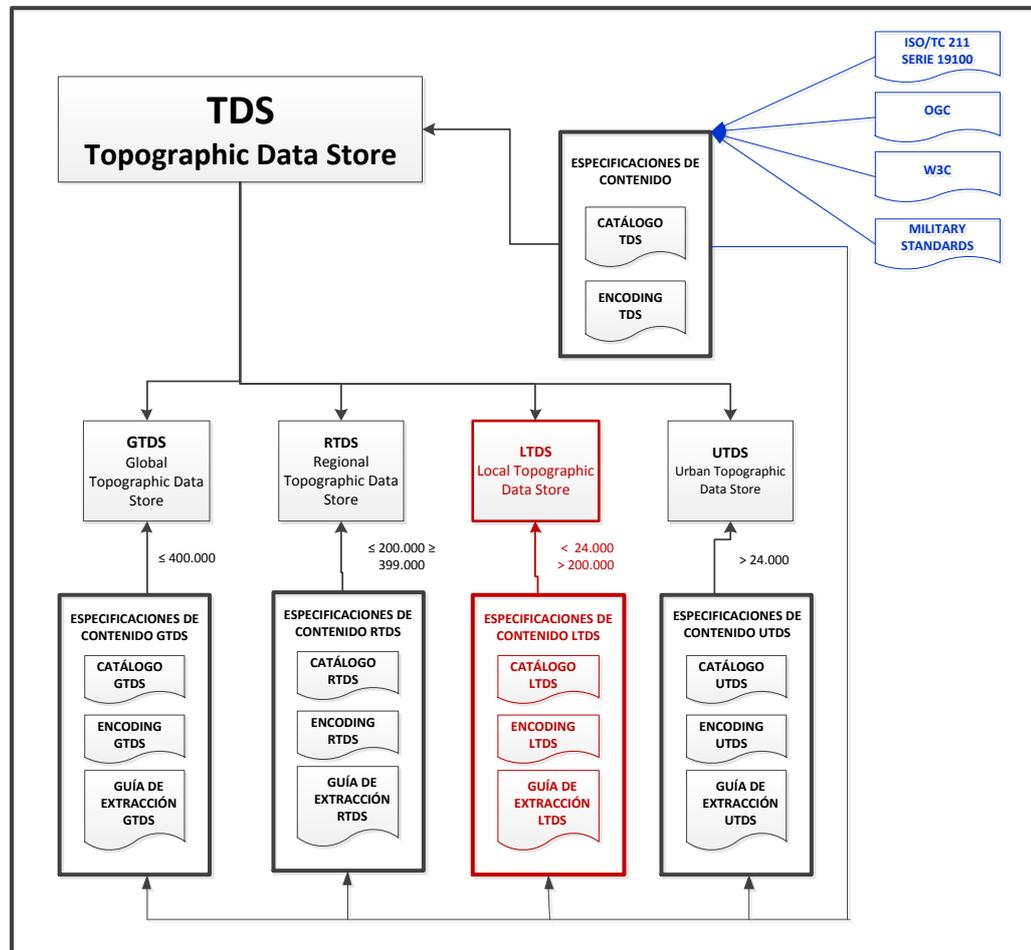


Figure N° 05
Topographic Data Store (TDS)

First, the catalog features, whose structure follows the guidelines of the standard ”ISO 19110:2005, Geographic Information - Methodology for Feature Cataloging”, are consistent with it, by defining features, types, operations, attributes and associations.

The second document, ”Encoding or Coding”, addresses the issue of the exchange of topographic data and in this context three physical formats are set for this: Format ESRI Shape file, Geographic Markup Language (GML, ISO 19136 and OGC) and Keyhole Markup Language (KML: OGC).

It should be noted that each of the four levels has an additional document within their individual specifications content: "Extraction Guide" (EG). This normative document provides guidelines that guide the process of capturing or extracting topographic features mentioned in each level, so as to support the collection of digital data for population of the corresponding database.

No modification or adaptation has been performed on the documents "LTDS Catalogue" and "LTDS Extraction Guide" that would affect the goal of creating interoperable data, implicitly involving the facility and providing technology for automatic migration to possible improved versions of the data Model. What one works on does not affect the model itself, which facilitates the work of the technical staff who perform the tasks, adding Spanish language translations of important issues. A commonly used example of this is shown in the following Figure:

	Table Root Name	DFDD-like Code	NAS AlphaCode	Español	Point	Curve	Surface
149	MILITARY						
150	AIRCRAFT_REVETMENT	GB050	AircraftRevetment	Barrera de Protección de Aeronaves	C		
151	DRAGONS_TEETH	AL060	DragonsTeeth	Dientes de Dragón	C		S
152	ENGINEERED_EARTHWORK	AH025	EngineeredEarthwork	Trinchera	C		S
153	CASTLE_COMPLEX	AL376	CastleComplex	Complejo Fortificado	P		S
154	CASTLE	AL376	Castle	Castillo	P		S
155	FIRING_RANGE	FA015	FiringRange	Campo de Tiro	P		S
156	FORTIFIED_BUILDING	AH055	FortifiedBuilding	Edificio Fortificado	P		S
157	MILITARY_INSTALLATION	SU001	MilitaryInstallation	Instalación Militar	P		S
158	MISSILE_SITE	AL120	MissileSite	Lugar de misiles	P		S
159	SURFACE_BUNKER	AM060	SurfaceBunker	Bunker en Superficie	P		S
160	TRAINING_SITE	FA165	TrainingSite	Sitio de Entrenamiento	P		S
161	UNDERGROUND_BUNKER	AH060	UndergroundBunker	Bunker bajo tierra	P		S
162	CANTONMENT_AREA	SU004	CantonmentArea	Area de cuarteles militares			S
163	CASTLE_COMPLEX	AL376	CastleComplex	Complejo Fortificado	P		S
164	CASTLE	AL376	Castle	Castillo	P		S
165	DRAGONS_TEETH	AL060	DragonsTeeth	Dientes de Dragón	C		S
166	ENGINEERED_EARTHWORK	AH025	EngineeredEarthwork	Trinchera	C		S
167	FIRING_RANGE	FA015	FiringRange	Campo de Tiro	P		S
168	FORTIFIED_BUILDING	AH055	FortifiedBuilding	Edificio Fortificado	P		S
169	MILITARY_INSTALLATION	SU001	MilitaryInstallation	Instalación Militar	P		S
170	MINFIELD	AL065	Minefield	Campo Minado			S
171	MISSILE_SITE	AL120	MissileSite	Lugar de misiles	P		S
172	SURFACE_BUNKER	AM060	SurfaceBunker	Bunker en Superficie	P		S
173	TEST_SITE	FA100	TestSite	Sitio de Pruebas			S
174	TRAINING_SITE	FA165	TrainingSite	Sitio de Entrenamiento	P		S
175	UNDERGROUND_BUNKER	AH060	UndergroundBunker	Bunker bajo tierra	P		S

Figure N° 06
Extract from LTDS_Catalogue and column name features in Spanish

The following Figure outlines the themes of the features of version 4.0 LTDS clusters.

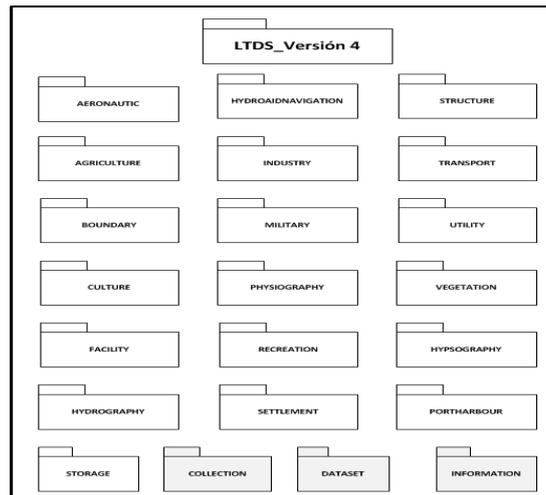


Figure N° 07
Thematic grouping of the features of LTDS version 4.0

2.2.3 Source Data

A study of technical and economic feasibility was carried out for the Latitud Sur Project and the following data as a source of raw material source was defined: orthomosaics (aerial or satellite) of panchromatic high spatial resolution (highly detailed) images and Digital Elevation Models.

2.2.3.1 Geodetic mapping parameters:

Technically the DF must meet specifications consistent with the particular parameters of the project, which relate to:

- Horizontal Reference System: SIRGAS-GRS80 ellipsoid
- Vertical Reference System: EGM2008
- Coordinate System: Geographic
- Format DF: National Imagery Transmission Format Standard version 2.1 (NITF v 2.1)

2.2.3.2 Digital Technical Specifications for Orthomosaics:

- Spatial Resolution: $\leq 1\text{m}$
- Spectral Resolución: $0,4\mu\text{m}$ a $1\mu\text{m}$ Panchrotic
- Radiometric Resolution: ≥ 8 bits
- Horizontal Accuracy ≤ 6.5 m. CE90
- Age of capturing images based ≤ 6 months, before the date of publication of the procurement

2.2.3.3 Technical Specifications of Digital Surface Models:

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- Spatial Resolution < 12.5 m. CE90
- Vertical Spatial Resolution 12.5 m. LE90
- Vertical measurement unit: meter
- Age of altimetry data capture ≤ 9 months, before the date of publication of the procurement

2.2.4 Data Quality

The concept of Quality of geographic data in the context of the ISO 19100 family is primarily addressed through three of these standards and complements other ISO standards that have to do with quality in other areas.

In the context of geographic information, if the quality of geographic data is known, anyone can tell if this is useful or not for the requirements of their needs and / or applications. The 19100 standards directly related to data quality and scope are shown in the figure below:

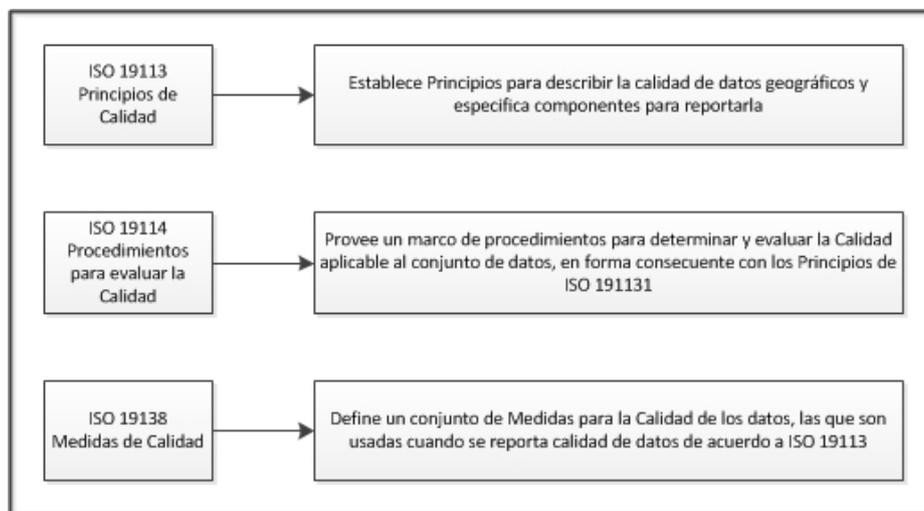


Figure N° 08
ISO 19100 standards relating to Quality Geographic Data

2.3 **Production Project.**

The production process is designed in the "Client / Server" concept, where the communication network is one in which all clients are connected to a server that centralizes the various resources and applications; and that makes material available to customers whenever they are requesting it.

This means that all the efforts being made to run the production processes, previously defined in a workflow, will concentrate and run in the server, so that task assignments as well as the requirements will be arranged around the clients. Some files are for public use, others are for restricted use, being read-only. Thus centralized control of

production will remain for data, progress, performance, bringing with it greater security to prevent local copies of copies that cause confusion and vulnerability. All clients apply templates, libraries and common procedures, complying with each stage of the production flow while controlled and recorded automatically.

The following Figure, outlines the client-server concept and is explained below:

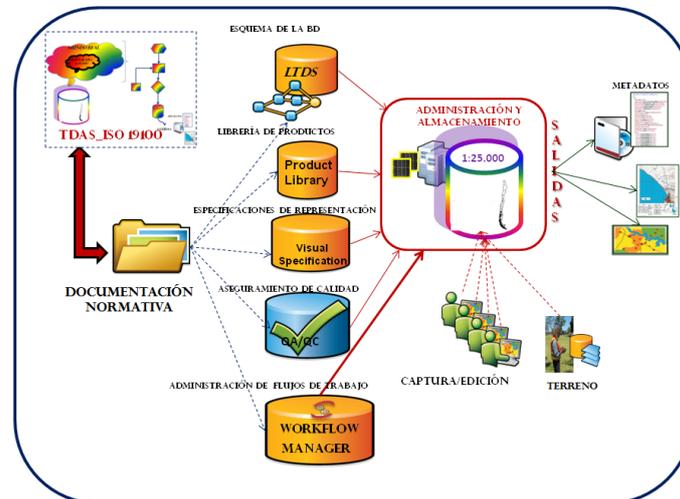


Figura N° 09
General Scheme

The platform of computer programs on which the project is developed consists mainly of ESRI Inc online software, also including Oracle added as a management platform and DatEm_SummitEvolution which engages ESRI allowing extraction of the third coordinate vectors in a stereoscopic environment.

The platform allows defined regulatory documentation at all levels: from the application model, catalogued Features Guide extraction, Toponymy, and specifications of graphic and digital outputs, rules for monitoring and control of the quality elements pre-defined in the semantic-model metadata generation and workflow, among others, are all loaded on the server, giving life to the client-server mode.

The 1:25,000 GDB is the repository that stores the topographical features of the country captured at 1:25,000 scale in the form of high-resolution vectors and its main purpose is to provide the Armed Forces and the country with information that accurately represents territory and meets the needs previously identified.

This repository also provides a common platform for multiple applications, providing interoperability among all sectors of national life and thus contributing to the consolidation of the Spatial Data Infrastructure of Chile.

3. CONCLUSIONS

The IGM is an organization with extensive experience in the earth sciences; that is why the organization performing this project ensures that the results will be those expected.

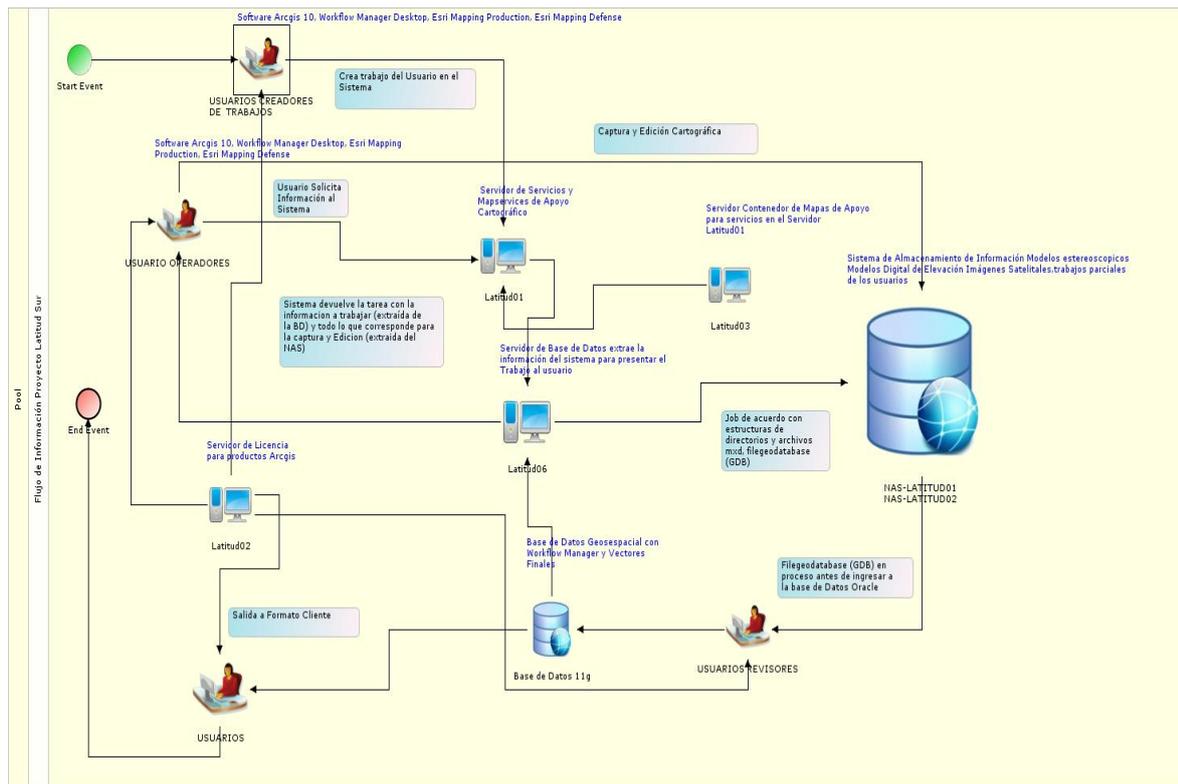
The Latitud Sur Project is a long-term activity and has been planned by skilled and professional staff, who have done their best to get good results.

The data model, extraction guides and data sources used by the project allows us to obtain an interoperable result and conform to the highest international standards.

The work procedure adopted for the capture and management of spatial information has allowed workflows to be organized in an automatic and systematic way, so as to begin capturing Chilean territory with very good results in its initial phase from the north of the country using high-performance equipment and software, as well as a procedure aligned to the highest international standards of cartographic production.

4. ANNEX

4.1 Workflow



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Acknowledgements

Special thanks are due to the members of the “Military Geographic Institute of Chile” and the “Cartographic Department” people who are working on the ‘Latitud Sur’ project, especially the technical coordinator, Cintia Andrade, who contributed direct and indirect information and time in helping me to prepare this work and developing the procedures of the project.

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