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1. **PARTE I**

| **1. Antecedentes Personales** |
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| Nombre estudiante | **Samuel Garrido, Matías Aniñir, Angelo López** |
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| Rut | **20.386.453-1, 21.402.551-5, 20.611.720-6** |
| Carrera | **Ingeniería informática** |
| Sede | **San Andrés de Concepción** |

| **2. Descripción Proyecto APT** |
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| Nombre del proyecto | GeoBus |
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| Área (s) de desempeño(s) | Software Development |
| Competencias | * Offer IT solution proposals by comprehensively analyzing processes according to the organization’s requirements. * Develop a software solution using techniques that allow for the systematization of the development and maintenance process, ensuring the achievement of objectives. * Build data models to support the organization’s requirements based on a defined and scalable design over time. |

| **3. Fundamentación Proyecto APT** |
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| Relevancia del proyecto APT | The project aims to address the uncertainty faced by rural transport users in the Ñuble and Biobío Regions, particularly along the Trehuaco – Coelemu – (Ranguelmo/Guarilihue) – Rafael – Concepción corridor.  Currently, passengers do not know whether the bus has already passed, is delayed, or is about to arrive due to the lack of real-time information. This affects their daily planning and can result in wasted time.  We chose this topic because we are frequent users of this service and have experienced firsthand the difficulties caused by the absence of accurate data on bus routes. The issue is highly relevant to the professional field of our degree, as it combines the development of technological solutions with the analysis and management of geospatial information—key competencies in software development and data engineering applied to transportation.  The situation is concentrated in highly rural areas of Ñuble (Trehuaco: 6,124 inhabitants – [Chile National Congress Library](https://www.bcn.cl/siit/reportescomunales/comunas_v.html?anno=2025&idcom=16207); Coelemu: 15,895 inhabitants – [Chile National Congress Library](https://www.bcn.cl/siit/reportescomunales/comunas_v.html?anno=2025&idcom=16203)) and Biobío, with intermediate localities such as Ranguelmo, Guarilihue Bajo, and Rafael (~2,320 inhabitants). The potentially impacted population amounts to around 24,000 people, with a direct target “market” estimated at 1,893 – 3,156 frequent and occasional users who commute to Concepción for study, work, healthcare, or other tasks.  The main age group corresponds to young and adult individuals of studying or working age (15–64 years). University students are particularly noteworthy: between ~200 and ~500 active students from the corridor regularly travel to higher education institutions in Concepción, with peaks during enrollment and semester start periods. Implementing this system would allow them to plan departures, receive delay notifications, reduce waiting times, and optimize their time use.  For users, the platform would eliminate much of the uncertainty associated with rural transport, reducing waiting times and improving the travel experience. For Maga Bus, the system would serve as a business intelligence (BI) tool to monitor punctuality, optimize bus frequency, and improve perceived service quality, strengthening its positioning as an innovative operator in the regional market. |
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| Descripción del Proyecto APT | The objective of the project is to develop a technological solution that provides Maga Bus rural transport users with real-time information on bus locations, reducing uncertainty and improving the planning of their daily trips. To achieve this, the design and development of a mobile application is proposed, which will display on a map the exact position of each bus through the use of the driver’s cell phone GPS. The app will integrate a map API and connect directly with the devices, allowing passengers to view the buses’ location and updated routes. In addition, smart notifications will be included so that users receive alerts about a bus’s proximity or possible delays.  The initial focus will be on developing a functional MVP to test the feasibility of the solution and evaluate its impact on the user experience. Subsequently, validation will be sought with Maga Bus to ensure that the system meets both passenger needs and the organization’s requirements. |
| Pertinencia del proyecto con el perfil de egreso | The project is related to the graduate profile as it requires the application of core competencies of the degree program, such as: the development of technological solutions and the integration of information technologies, which are put into practice when designing the mobile app and connecting it with GPS devices and map APIs. IT project management is necessary to plan and coordinate the development stages, while teamwork skills and the ability to generate innovative ideas are reflected in the creation of a collaborative solution that addresses a real need of rural transport users. |
| Relación con los intereses profesionales | The project is linked to professional interests in software development, particularly in creating technological solutions with social impact that contribute to improving people’s quality of life. The proposal of an application for rural transportation reflects the motivation to apply computer science as a tool to address real-world problems in the environment.  Likewise, this APT Project supports professional development, as it allows the application of technical knowledge in a real context, collaborative work, and the ability to face challenges inherent to the development of innovative software. In this way, it strengthens the professional profile with a focus on technological innovation and commitment to the community. |
| Factibilidad de desarrollo del Proyecto APT | The project is feasible to develop within 10 weeks during the semester, provided that a functional Minimum Viable Product (MVP) is defined. Although the available time is limited due to part of the team being engaged in professional internships, progress is achievable through rigorous task planning and collaborative work during the available days.  The required materials include a GPS-enabled device (e.g., a mobile phone) and the use of map APIs. Enabling factors include prior knowledge of the technologies, availability of free tools, and the team’s experience. The main anticipated difficulties are time availability, potential costs associated with paid technologies (e.g., certain APIs or services), and possible refusal or low collaboration from the bus company. These gaps can be mitigated through strict schedule management and MVP prioritization, the adoption of free or open-source alternatives whenever possible, and the execution of simulated trips or independent field data collection by the team. |

1. **PARTE II**

| **4. Objetivos** |
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| Objetivo general | Reduce the uncertainty of residents in rural communities regarding bus arrivals through a technological solution that integrates geolocation and real-time arrival time estimation. |
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| Objetivos específicos | * Ensure real-time visualization of buses on the map with updates no longer than 15 seconds in pilot tests. * Implement an ETA system with an average error margin of less than ±5 minutes in simulated routes. * Incorporate proximity notifications for the selected stop, verifying their correct activation in at least 95% of test cases. * Include a user authentication mechanism and trip logging that ensures the preservation of travel information in at least 90% of test sessions. |

| **5. Metodología** |
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| Descripción de la Metodología |
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| To address the development of the GeoBus project, the Traditional Waterfall methodology will be used, as it allows the work to be organized into sequential phases with defined deliverables and formal documentation, ensuring the achievement of the project’s proposed objectives within the established timeframe.  Since the development time is limited, this approach has been integrated with intermediate control points, which will serve to present product progress and validate partial results, reducing possible risks that may arise throughout the project and ensuring the final quality of the MVP.  **Stages and working methods**   1. **Requirements gathering**  * Collection of user and Maga Bus company needs through digital forms, news, and review of public information. * Identification of key functionalities: real-time visualization, ETA, smart notifications, and data persistence. * Deliverables: requirements document, initial acceptance criteria. * Control Point 1 (CP1): approval of scope and prioritized functionalities.  1. **Architecture and data model design**  * Definition of the database structure for users, buses, and routes. * Design of the application architecture and UML diagrams (components, use cases, process sequences, relational model). * Deliverables: data model, architecture document, navigable prototypes. * Control Point 2 (CP2): validation of architecture and data model.  1. **MVP development**  * Implementation of the mobile application using Angular/Ionic for the frontend. * Integration with Google Maps API to display buses’ real-time location. * Backend programming in Firebase Realtime Database to receive and process GPS data (driver’s cell phone, GPS, or simulator). * Implementation of proximity and delay alerts using Firebase Cloud Messaging or other notification libraries. * Configuration and compatibility testing on different mobile devices. * Deliverables: functional MVP version with map, initial ETA, and notification system. * Control Point 3 (CP3): verification of MVP functional coverage.  1. **Pilot testing and validation**  * Execution of tests in simulated routes and, potentially in coordination with Maga Bus (and/or another company operating the same route), in real scenarios. * Measurement of ETA accuracy, notification effectiveness, and system stability. * Deliverables: test plan, validation reports, documented results. * Control Point 4 (CP4): achievement of target metrics and pilot approval.  1. **Project closure**  * Preparation of the final report with results, evidence, and improvement projections. * Preparation of presentation for the project defense.   **Team roles and responsibilities**  Each team member will participate in all stages of the project, fostering comprehensive learning and co-responsibility. However, main responsibilities are defined by area to ensure technical continuity and proper management of each deliverable:   * **Samuel Garrido**: Main responsible for the data model and backend. In charge of designing the database and developing the API for receiving and processing GPS positions. * **Matías Aniñir**: Main responsible for the mobile frontend. In charge of implementing the application in Angular/Ionic, integrating the map, and developing the notification system. * **Angelo López**: Main responsible for coordination and documentation. In charge of planning and coordinating activities, maintaining formal documentation, and leading the preparation of the final report and presentation.   Although each member has a defined role, everyone will collaborate in analysis, design, development, testing, and documentation activities, ensuring active participation in all phases of the project. |

| **6. Evidencias** |
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| **Evidence Type (Progress or Final)** | **Evidence Name** | **Description** | **Justification** |
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| **Progress** | **Cronograma GeoBus.xlsx** | Preliminary Gantt chart of the project | Allows planning and controlling project times and activities. |
| **Progress** | **Data Model** | Application data model | Defines the structure and integrity of the information for development. |
| **Progress** | **MVP** | Minimum Viable Product of the project | Validates the feasibility of the application and its usefulness with a first functional version. |

| **7. Plan de Trabajo** |
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| **Plan de Trabajo Proyecto APT** | | | | | | |
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| **Competency or Units of Competency** | **Activity/Task Name** | **Activity/Task Description** | **Resources** | **Activity Duration** | **Responsible** | **Observations** |
| Manage IT projects in teams / Offer IT solution proposals | Project Definition | Define project scope, review feasibility, and draft the APT project definition in the official document according to institutional guidelines. | Course guide, institutional document, collaborative teamwork | 2 weeks | Whole team | Initial mandatory activity according to the guideline. May require minor adjustments after instructor review. |
| Offer IT solution proposals by analyzing processes | Requirements Gathering | Collect needs regarding routes, notifications, and app usage. | Digital forms, news, public reports | 1 week | Whole team | Possible difficulty: availability of users, company, and related documents. Enabler: experience as frequent users (expert judgment). |
| Build scalable data models | Data Architecture Design | Define database structure for users, buses, and routes. | Modeling tools | 1–2 weeks | Samuel Garrido | Requires group consensus. |
| Develop a software solution applying systematic techniques | Development of the Mobile App MVP | Program the initial interface in Angular/Ionic, integrating maps and basic connection to the driver’s GPS. | Angular, Ionic, Google Maps API, GPS-enabled cell phones | 6 weeks | Whole team | Limitation: available time. Enabler: prior knowledge of frameworks. |
| Develop software solutions ensuring maintenance and quality | Integration of Smart Notifications | Implement proximity and delay alerts, testing user cases. | Firebase / Firebase Cloud Messaging and/or notification libraries | 2 weeks | Matías Aniñir | Requires extensive testing. Possible difficulty: compatibility with different devices. |
| Manage IT projects in teams | Pilot Testing and Validation | Carry out tests in simulated routes and with real users to validate time accuracy and system stability. | Installed application, buses on route, control sheets | 2 weeks | Whole team | Difficulty: coordinating bus availability with the company. Enabler: team members’ frequent travel on these routes. |
| Integrate information technologies and document | Final Report and Presentation Preparation | Draft report with results, evidence, and improvement projections. PPT. | Business report template, test records | 2 weeks | Angelo López | Possible difficulty: time close to delivery. Enabler: division of writing among team members. |

| **8. Carta Gantt** |
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| **Actividad** | **Fase 1** | | | | **Fase 2** | | | | | | | | | | | | **Fase 3** | | | |
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| **S 1** | **S 2** | **S 3** | **S 4** | **S 5** | **S 6** | **S 7** | **S 8** | **S 9** | **S 10** | **S 11** | **S 12** | **S 13** | **S 14** | **S 15** | **S 16** | | **S 17** | **S 18** |
| Project Definition |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| Requirements Gathering |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| Data Architecture Design |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| Development of the Mobile App MVP |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| Integration of Smart Notifications |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| Pilot Testing and Validation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| Final Report and Presentation Preparation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |