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Analysis and Optimization of International A2P SMS Traffic Using an SMS Gateway Platform

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Abstract

Messaging services represent an essential communication medium even in today's telecommunications. Short Message Service (SMS) traffic can be classified into Person-to-Person (P2P) and Application-to-Person (A2P) messaging, where A2P SMS enables automated message delivery from applications and organizations to end users. This study presents the design and implementation of an experimental framework for the simulation, management, and analysis of international A2P SMS traffic. The proposed environment integrates an SMS Gateway platform with MATLAB, Microsoft SQL Server, and an SMS Agent to reproduce the main processing stages of an A2P SMS management system. The framework enables the generation of international SMS traffic, database-based traffic management and the evaluation of filtering mechanisms for mobile number validation and message content analysis. The experimental evaluation shows that the proposed framework is capable to analyze A2P SMS traffic behavior and assess the impact of optimization mechanisms on message processing. The obtained results highlight the importance of traffic validation and filtering approaches in improving the efficiency and the reliability of processes, on A2P SMS management systems.

Keywords

A2P SMS, SMS Gateway, SMPP, SMS Filtering, Mobile Number Validation, Message Content Analysis, Traffic Validation

1. Introduction

Mobile phone text messaging is a modern telecommunication technology that has significantly transformed human communication worldwide [1]. Among the various messaging technologies, the Short Message Service (SMS) remains one of the most widely used services provided by mobile communication networks. SMS enables the transmission of short text messages of up to 160 characters from a sending user of mobile phone to a receiving user of mobile phone [2]. During the past two decades, the role of mobile devices has evolved, extending beyond traditional voice communication and text messaging to support a broad range of applications, such as: social networking, entertainment, e-commerce and web-based services. Despite this trend, messaging remains a near-ubiquitous method of mobile communication, enabling person-to-person (P2P) communications and business-to-person, also known as application-to-person (A2P), communications. This type of communication, is widely used for authentication codes, financial notifications, service alerts and other business-related applications [3].

The increasing adoption of digital services has contributed to the growth of international A2P SMS traffic. Due to the large number of messages processed and the diversity of destination networks, efficient traffic management has become an important requirement for messaging platforms and telecommunication service providers [3]. Challenges such as invalid destination numbers, unwanted content and inefficient message processing may affect delivery performance and increase operational costs.

A2P SMS systems commonly rely on communication protocols such as the Short Message Peer-to-Peer (SMPP) protocol to exchange messages between applications and SMS infrastructures. SMPP provides a standardized mechanism for submitting and receiving SMS messages and is widely used in SMS gateway environments [4]. In addition, filtering mechanisms are required to improve traffic quality by identifying invalid messages and preventing unwanted SMS content from being processed. Various approaches to SMS spam detection and content filtering have been reported in the literature, including content-based analysis methods [5]-[7].

This paper presents the design and implementation of an experimental environment for the simulation, management, and analysis of international A2P SMS traffic. The proposed framework integrates an SMS Gateway platform with MATLAB, Microsoft SQL Server, and an SMS Agent to reproduce the main stages of A2P SMS processing. The developed system enables traffic generation, database-based message management, and evaluation of filtering mechanisms based on destination number validation and message content analysis.

2. Related Work

A2P SMS is now a key part of mobile communications. It supports authentication, notifications, marketing, and business apps. Isa *et al.* [5] looked at the regulatory issues in A2P SMS. They showed how content aggregators affect the link between platforms and mobile operators. They also noted that A2P growth creates new challenges in service management and regulation.

Beside regulations, SMS spam is a major problem for users and operators. Abdulhamid *et al.* [6] reviewed various SMS spam filtering techniques and datasets.

They compared existing methods and showed that standard filters struggle with new types of spam. To fix this, Kawade and Oza [7] built a Python machine learning model for content filtering. Their model achieved high accuracy in detecting spam. However, it only classifies text messages and does not run inside a full A2P gateway system.

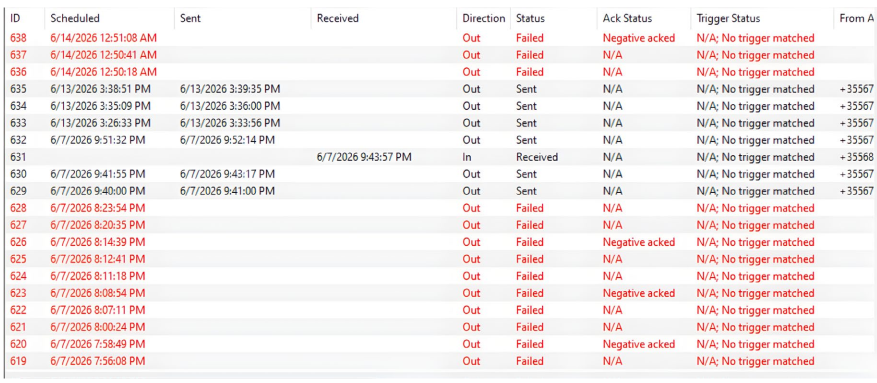
Past studies offer good insights into regulations or spam algorithms separately, but very few focus on building a complete test system. Most papers do not show how traffic generation, gateway processing, database management, and filtering work together. This study presents an experimental framework to simulate, manage, and analyze international A2P SMS traffic.

3. Experimental Environment

An experimental environment was developed to support the practical implementation of this study. The generation, processing, and transmission of A2P SMS traffic are tested using the simulations. The environment was designed to closely resemble the operating conditions of real-world SMS communication systems by integrating software platforms with physical devices. The experimental setup consists of an SMS Gateway platform, an Android SMS Agent, MATLAB, and Microsoft SQL Server, which operate together to implement the proposed experimental scenarios.

3.1. SMPP Simulator

The SMPP Simulator is designed for testing and simulating communication based on the SMPP protocol, one of the most widely used protocols for the exchange of A2P SMS traffic.



ID	Scheduled	Sent	Received	Direction	Status	Ack Status	Trigger Status	From A
638	6/14/2026 12:51:08 AM			Out	Failed	Negative acked	N/A; No trigger matched	
637	6/14/2026 12:50:41 AM			Out	Failed	N/A	N/A; No trigger matched	
636	6/14/2026 12:50:18 AM			Out	Failed	N/A	N/A; No trigger matched	
635	6/13/2026 3:38:51 PM	6/13/2026 3:39:35 PM		Out	Sent	N/A	N/A; No trigger matched	+35567
634	6/13/2026 3:35:09 PM	6/13/2026 3:36:00 PM		Out	Sent	N/A	N/A; No trigger matched	+35567
633	6/13/2026 3:26:33 PM	6/13/2026 3:33:56 PM		Out	Sent	N/A	N/A; No trigger matched	+35567
632	6/7/2026 9:51:32 PM	6/7/2026 9:52:14 PM		Out	Sent	N/A	N/A; No trigger matched	+35567
631			6/7/2026 9:43:57 PM	In	Received	N/A	N/A; No trigger matched	+35568
630	6/7/2026 9:41:55 PM	6/7/2026 9:43:17 PM		Out	Sent	N/A	N/A; No trigger matched	+35567
629	6/7/2026 9:40:00 PM	6/7/2026 9:41:00 PM		Out	Sent	N/A	N/A; No trigger matched	+35567
628	6/7/2026 8:23:54 PM			Out	Failed	N/A	N/A; No trigger matched	
627	6/7/2026 8:20:35 PM			Out	Failed	N/A	N/A; No trigger matched	
626	6/7/2026 8:14:39 PM			Out	Failed	Negative acked	N/A; No trigger matched	
625	6/7/2026 8:12:41 PM			Out	Failed	N/A	N/A; No trigger matched	
624	6/7/2026 8:11:18 PM			Out	Failed	N/A	N/A; No trigger matched	
623	6/7/2026 8:08:54 PM			Out	Failed	Negative acked	N/A; No trigger matched	
622	6/7/2026 8:07:11 PM			Out	Failed	N/A	N/A; No trigger matched	
621	6/7/2026 8:00:24 PM			Out	Failed	N/A	N/A; No trigger matched	
620	6/7/2026 7:58:49 PM			Out	Failed	Negative acked	N/A; No trigger matched	
619	6/7/2026 7:56:08 PM			Out	Failed	N/A	N/A; No trigger matched	

Figure 1. Main interface of the SMPP simulator.

In this study, the SMPP Simulator was used to generate and manage SMS traffic within a controlled testing environment. It enables the simulation of message transmission processes and the implementation of experimental scenarios for analyzing A2P SMS traffic. One of the main reasons for selecting this platform is its flexibility in configuring testing environments, allowing the creation of the conditions required to investigate SMS traffic management and optimization processes.

To support the integration of SMS communication with different systems, the simulator provides message exchange between applications and external services, enabling the implementation of various traffic simulation and testing scenarios. Figure 1 presents the main interface of the SMPP Simulator, through which the experimental environment was configured and managed.

3.2. SMS Agent for Android

The Android SMS Agent is the component used in the first experimental scenario, where real SMS message transmission is performed. In this configuration, communication between the computer and the Android smartphone is established through a Wi-Fi network, while the smartphone is used to transmit SMS messages through the mobile network, as illustrated in Figure 2.

The Android SMS Agent enables the smartphone to connect to the host computer and act as an interface for sending and receiving SMS messages. Messages generated by the experimental system are transferred directly to the smartphone and are subsequently transmitted through the mobile network.

The application also supports Unicode encoding and multipart SMS messages and it is suitable for a wide range of SMS communication scenarios. It is compatible with Android version 7.0 or later and can be easily integrated with the host system, providing a simple and reliable solution for evaluating real SMS message transmission within the proposed experimental environment.

Figure 2. Android SMS Agent used for real SMS message transmission.

4. Scenario 1: Real SMS Message Transmission Using an Android SMS Agent

For the implementation of the first experimental scenario, a testing environment was established to enable the real transmission and reception of SMS messages. The primary objective was to verify the operation of the SMS Gateway platform under conditions that closely resemble a real-world deployment.

In this environment, an Android SMS Agent application was installed on an Android smartphone. On the other hand, an SMPP Simulator was executed on a PC running the Windows operating system. Both devices were connected to the same local Wi-Fi network, enabling communication between the SMS Gateway platform and the mobile device.

A valid SIM card was used to the smartphone to enable the transmission of SMS messages over the cellular network. After the Android SMS Agent application was installed and activated, the system generated the required connection parameters, which were subsequently used to configure the SMPP Simulator.

4.1. Establishing the Connection between the SMPP Simulator and the Android Device

After installing the Android SMS Agent application on the Android device the connection with the SMPP Simulator was configured. Initially, the application was launched, displaying the device's IP address and the communication port used for data exchange.

As next step, a new SMS Gateway connection was created in the SMPP Simulator by entering the connection parameters provided by the Android application. After configuring the corresponding IP address and communication port, the system established a connection between the computer and the mobile device.

In order to verify the configuration, the "Test Connection" function was executed and the successful communication between the SMS Gateway platform and the Android device was confirmed. Finally, the telephone number associated with the respective SIM card was specified, completing the configuration of the communication channel. Figure 3 illustrates the active status of the established communication channel in the SMPP Simulator, together with the "Test Connection" function used to verify that the channel is operating correctly.

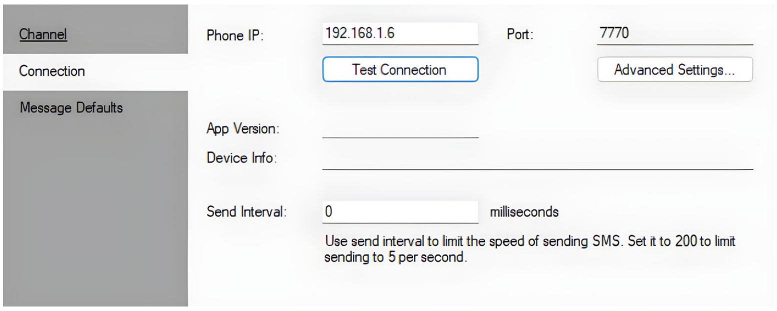


Figure 3. Verification of the communication channel between the SMPP Simulator and the Android device.

4.2. Transmission and Reception of Test SMS Messages

To verify the operation of the proposed system under realistic conditions, a series of test SMS messages were exchanged between the SMPP Simulator and the Android device. The messages were transmitted to four different mobile numbers: two registered in Albania and two in Germany. The two German numbers, which were located outside Albania during the testing period, enabled the verification of SMS delivery under international roaming conditions, as illustrated in Figure 4(a).

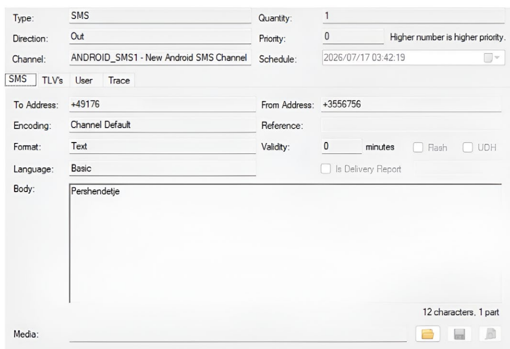
The test messages included not only the plain text but also special characters and Albanian letters in order to verify the system's support for Unicode encoding as shown in Figure 4(b). This capability is particularly important for A2P SMS communications, where messages frequently contain multilingual text and special symbols.

After the transmission command was executed, the messages were forwarded from the PC to the Android device through the Wi-Fi network. The Android device processed the messages and transmitted them over the cellular network using the installed SIM card. For international message delivery, the SIM card must have roaming services enabled. This process represents a simplified implementation of an A2P SMS communication system, in which messages are generated by an application and subsequently delivered to end users through the infrastructure of mobile network operators.

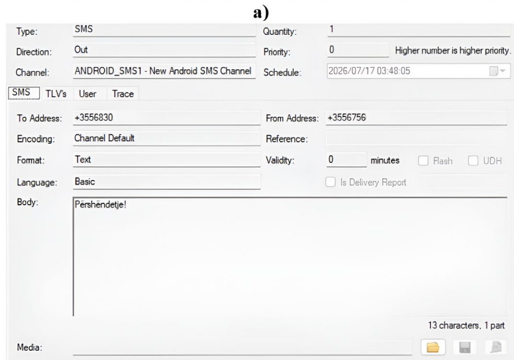
During the experiments, the SMS Gateway platform also provided the capability to send a limited number of real SMS messages, without additional cost, enabling practical validation of the proposed approach without requiring a dedicated commercial SMS infrastructure.

In addition to outgoing message transmission, inbound SMS communication was also evaluated. An SMS message sent to the phone number associated with the Android SMS Agent was successfully received and automatically recorded by the SMPP Simulator. This confirmed the correct operation of bidirectional communication for both outgoing and incoming SMS messages, as illustrated in Figure 4(c). Figure 5 shows the successful delivery of SMS messages to the end user and the successful reception of messages sent by the end user to the SMS Gateway platform.

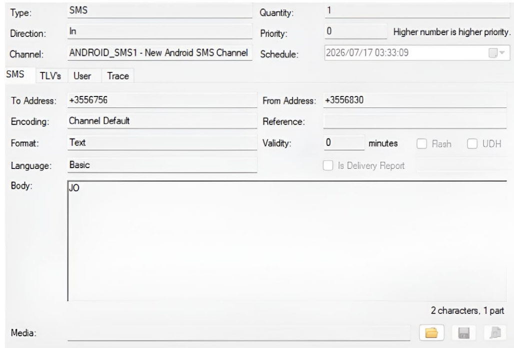
The results of this experimental scenario demonstrate the successful communication, between the SMPP Simulator and the Android device. This scenario provides the foundation for the second experimental phase, which focuses on the simulation and analysis of international A2P SMS traffic on a larger scale.



a)



b)



c)

Figure 4. (a) Transmission of an SMS message to a German mobile number. (b) Transmission of an SMS message containing the Albanian special character "ë" to an Albanian mobile number. (c) Reception of an SMS message from an Albanian mobile number.

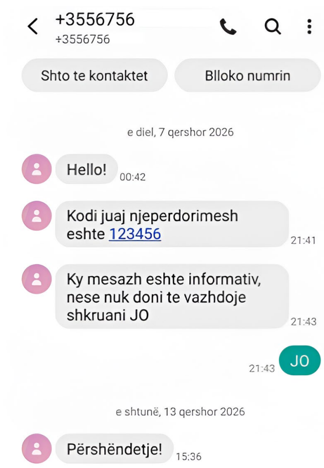


Figure 5. Verification of SMS communication between the SMS Gateway platform and the end user.

5. Scenario 2: Large-Scale Simulation of A2P SMS Traffic

The second experimental scenario was designed to simulate A2P SMS traffic on a larger scale. Unlike the first scenario, which focused on the real transmission of a limited number of SMS messages, in this experiment, a significantly larger traffic volume was generated in order to facilitate the study of message management, filtering, and processing mechanisms.

The experimental environment was implemented using MATLAB for the automatic generation of 1000 SMS messages and mobile phone numbers, Microsoft SQL Server for data storage and management, and an SMS Gateway platform for simulating SMS traffic processing. The interaction among these components enabled the creation of a testing environment that represents the workflow of an A2P SMS system, from message generation and database storage to message processing by the SMS Gateway platform. The objective of this scenario was not the actual transmission of SMS messages, over cellular networks, but rather the simulation of the core processes involved in A2P SMS traffic management and the implementation of message filtering mechanisms. The overall architecture of the experimental system used in this scenario is presented in Figure 6.

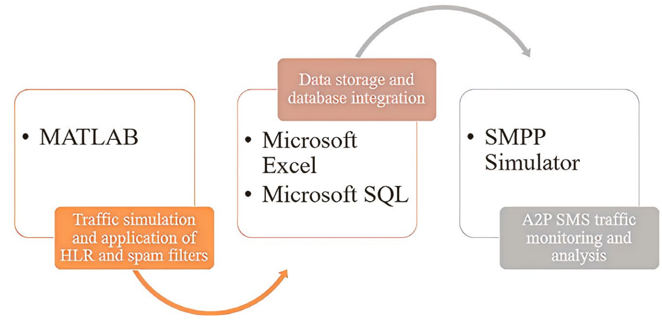


Figure 6. Overall architecture of the second experimental scenario.

5.1. Development of the MATLAB Model

MATLAB is a high-level programming and numerical computing environment widely used for engineering and scientific problem solving. It combines programming capabilities with an extensive collection of built-in functions that support data processing, mathematical computation, and algorithm development, enabling efficient implementation of engineering applications [8]. In this study, MATLAB was employed to generate a synthetic dataset representing international A2P SMS traffic. The generated dataset provided a controlled and reproducible environment for evaluating the performance of the proposed SMS Gateway platform.

Table 1. Mobile network operators and numbering prefixes used in the simulation.

Country	International Prefix	Mobile Network Operator
Albania	+35569	Cellular operator X
Albania	+35568	Cellular operator Y
Italy	+3933	Cellular operator Z
Italy	+3934	Cellular operator W
Germany	+49151	Cellular operator Q
Germany	+49152	Cellular operator R
United Kingdom	+4474	Cellular operator S
United Kingdom	+4477	Cellular operator T
France	+336	Cellular operator U
Türkiye	+9053	Cellular operator V

MATLAB was used to generate the test traffic by automatically creating SMS messages and mobile phone numbers. The dataset contains 1000 records, each representing an SMS message together with its corresponding destination information. Mobile phone numbers were generated using the international dialing prefixes of several countries to simulate international A2P SMS traffic. The simulation included Albania (+355), Italy (+39), Germany (+49), the United Kingdom (+44), France (+33), and Türkiye (+90). Multiple mobile network operators from each country were considered in order to create a more realistic traffic distribution. The operators and numbering prefixes used in the simulation are presented in Table 1.

In addition to generating mobile phone numbers, MATLAB was also used to create different SMS message contents. To represent various types of A2P SMS traffic, the messages were classified into three main categories: One-Time Password (OTP) messages, informational messages, and promotional messages. Representative examples of the generated messages are presented in Table 2.

Table 2. Categories of messages used in simulations.

Category	Example Message
OTP	Your OTP code is 123456
Informational	Bank transfer completed
Informational	Welcome to our service
Informational	Package delivered successfully
Promotional	Special casino offers today
Promotional	Online casino jackpot
Promotional	Bet and win now

5.2. Dataset Development

The data generated in MATLAB were organized into a structured dataset, containing the information required for each SMS message. The dataset was generated automatically using pseudo-random selection procedures to simulate international A2P SMS traffic under controlled experimental conditions. Organizing the data into a unified structure was essential to support their storage, management, and processing during the subsequent stages of the experiment.

For each of the 1000 records, a country and its corresponding mobile network operator were randomly selected from the predefined configuration, while the SMS message content was randomly selected from a predefined set of transactional and promotional messages. Based on the selected country, a destination mobile number was generated according to the implemented numbering rules before the message was exported to the dataset.

For each SMS message, the dataset stores information related to the communication type, destination country, destination mobile network operator, recipient mobile number, message content and processing status. This structure facilitates traffic management and enables each message to be monitored throughout the simulation process.

The dataset, created in Microsoft Excel format, contains a total of 1000 records that are distributed among the countries included in the study. The distribution of messages by destination country is presented in Table 3. The Excel format also provides a convenient means of validating and managing the data before importing them into Microsoft SQL Server. The dataset fields are summarized in Table 4. These fields contain the essential information required for the simulation and processing of A2P SMS traffic. The adopted structure enables the identification of the destination, the corresponding mobile network operator, the message type, and the monitoring of the message processing status throughout the simulation.

Table 3. Distribution of SMS messages by destination country.

Country	Number of Messages
Albania	199
France	92
Germany	180
Italy	208
Türkiye	112
United Kingdom	209
Total	**1000**

Table 4. The structure of dataset used in simulations.

Field	**Description**
Type	Communication type; in this study the value SMS is used
Destination	Destination mobile phone number
Country	Destination country
Operator	Mobile network operator associated with the destination number
Subject	SMS message content
Status	Message processing status within the system

5.3. Integration with Microsoft SQL Server

Microsoft SQL Server is a relational database management system (RDBMS) that provides mechanisms for storing, organizing and processing structured data. The SQL Server Database Engine supports efficient query processing, transaction management and reliable data storage making it suitable for applications that require centralized data management and integration with external software components [9]. In this study, Microsoft SQL Server was employed as the central repository for the synthetic A2P SMS traffic generated in MATLAB. The database enabled efficient organization of the generated records and served as the communication layer between MATLAB and the SMS Gateway platform during traffic processing.

To support the storage and management of the generated data, the dataset created in MATLAB was imported into Microsoft SQL Server. The database was used to organize the traffic in a centralized repository and to provide a communication interface between the database and the SMS Gateway platform.

A database table (generated in MATLAB) that has all records was created by using SQL Server. The table preserves the same structure as the Excel dataset, by enabling efficient data organization and facilitating integration with the other components of the experimental system.

The import process was carried out using the data import tools provided by SQL Server, which enabled the transfer of data from the Excel dataset to the database without information loss. After the import process was completed, the stored records were verified to ensure that all data had been imported correctly and were ready for processing by the SMS Gateway platform. Only messages that successfully passed the structural number validation and message content filtering mechanisms were imported into Microsoft SQL Server. These messages were assigned the status "Accepted for processing", indicating that they had successfully completed the internal validation stage before gateway processing. A portion of the resulting SQL Server table is shown in **Figure 7**.

Results | Messages

	ID	Type	Destination	Country	Operator	Subject	Status
1	59	SMS	355691234XXX	Albania	Operator X	Your OTP code is 123456	Accepted
2	60	SMS	355684934XXX	Albania	Operator Y	Bank transfer completed	Accepted
3	61	SMS	90530329XXX	Turkey	Operator V	Your OTP code is 123456	Accepted
4	62	SMS	4915198XXX	Germany	Operator Q	Bank transfer completed	Accepted
5	63	SMS	3933520XXX	Italy	Operator Z	Bank transfer completed	Accepted
6	64	SMS	3367855XXX	France	Operator U	Welcome to our service	Accepted
7	65	SMS	90531985XXX	Turkey	Operator V	Your OTP code is 123456	Accepted
8	66	SMS	49151208XXX	Germany	Operator Q	Bank transfer completed	Accepted
9	67	SMS	39344930XXX	Italy	Operator W	Package delivered successfully	Accepted
10	68	SMS	447401985XXX	UK	Operator S	Your OTP code is 123456	Accepted
11	69	SMS	33676897XXX	France	Operator U	Welcome to our service	Accepted

Figure 7. SQL server table containing the generated SMS dataset.

5.4. Simulation of A2P SMS Traffic

To enable communication between the Microsoft SQL Server database and the SMS Gateway platform, a Database Integration Channel was used. This component acts as an interface between the database and the message processing system, allowing SMS records to be automatically retrieved from the database and imported into the processing platform.

The configuration process first defines the SQL Server connection parameters, including: the server address, database name and authentication credentials. After the connection was established, an SQL query was configured to retrieve SMS messages from the dedicated database table. The database fields were then mapped to the corresponding fields of the SMS Gateway platform, ensuring that the information stored in the dataset columns was correctly associated with the parameters required for SMS message processing. **Figure 8** illustrates the main steps involved in configuring and validating the database integration channel.

After the configuration was completed, the platform automatically retrieved SMS messages from the database and placed them into the message processing queue. This mechanism simulates the workflow of real A2P SMS systems, where traffic is received from external applications or databases and prepared for processing before being transmitted through the infrastructure of mobile network operators.

It should be noted that, in this experimental scenario, the SMS messages were not actually transmitted over cellular networks because the experimental environment was not connected to a commercial SMPP provider or a Short Message Service Center (SMSC). As shown in Figure 9, all submitted messages are reported with a Failed status because the experimental environment was not connected to a commercial SMPP provider or SMSC. Therefore, the gateway status reflects only the outcome of the transmission attempt and is independent of the internal "Accepted for Processing" status assigned during the filtering stage. Nevertheless, the implemented configuration accurately simulates the processing workflow of A2P SMS traffic up to the stage at which messages are forwarded to an SMPP gateway.

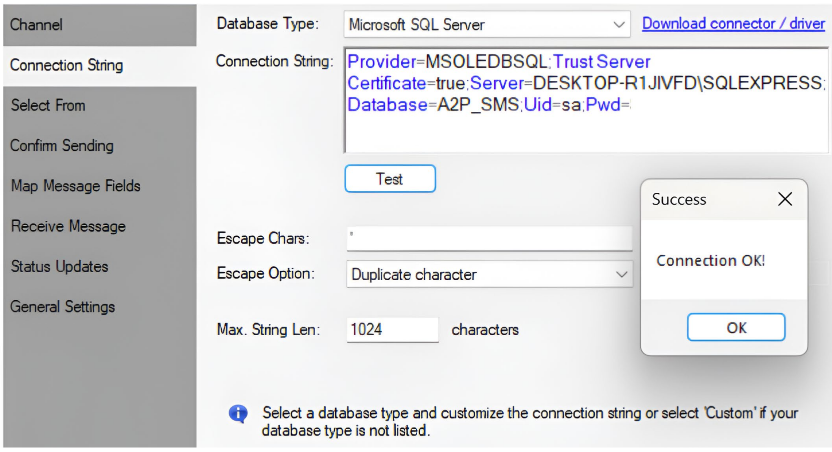
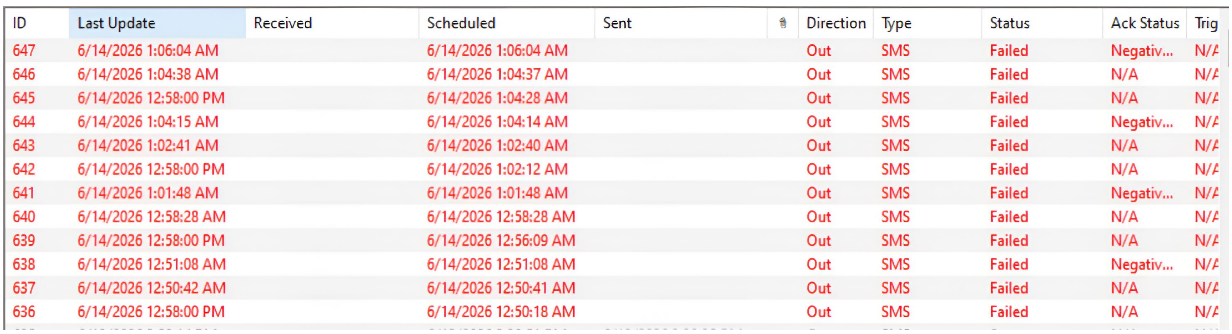


Figure 8. Configuration and validation of the database integration channel.



ID	Last Update	Received	Scheduled	Sent		Direction	Type	Status	Ack Status	Trig
647	6/14/2026 1:06:04 AM		6/14/2026 1:06:04 AM			Out	SMS	Failed	Negativ...	N/A
646	6/14/2026 1:04:38 AM		6/14/2026 1:04:37 AM			Out	SMS	Failed	N/A	N/A
645	6/14/2026 12:58:00 PM		6/14/2026 1:04:28 AM			Out	SMS	Failed	N/A	N/A
644	6/14/2026 1:04:15 AM		6/14/2026 1:04:14 AM			Out	SMS	Failed	Negativ...	N/A
643	6/14/2026 1:02:41 AM		6/14/2026 1:02:40 AM			Out	SMS	Failed	N/A	N/A
642	6/14/2026 12:58:00 PM		6/14/2026 1:02:12 AM			Out	SMS	Failed	N/A	N/A
641	6/14/2026 1:01:48 AM		6/14/2026 1:01:48 AM			Out	SMS	Failed	Negativ...	N/A
640	6/14/2026 12:58:28 AM		6/14/2026 12:58:28 AM			Out	SMS	Failed	N/A	N/A
639	6/14/2026 12:58:00 PM		6/14/2026 12:56:09 AM			Out	SMS	Failed	N/A	N/A
638	6/14/2026 12:51:08 AM		6/14/2026 12:51:08 AM			Out	SMS	Failed	Negativ...	N/A
637	6/14/2026 12:50:42 AM		6/14/2026 12:50:41 AM			Out	SMS	Failed	N/A	N/A
636	6/14/2026 12:58:00 PM		6/14/2026 12:50:18 AM			Out	SMS	Failed	N/A	N/A

Figure 9. Messages marked as Failed due to the absence of an SMPP provider.

6. Implementation of Filtering Mechanisms in the Second Experimental Scenario

In addition, to simulating A2P SMS traffic the second experimental scenario incorporates filtering mechanisms designed to validate SMS messages and destination mobile numbers before they are processed by the SMS Gateway platform. Such mechanisms are commonly employed in operational A2P SMS systems to reduce unnecessary traffic, improve service quality, and minimize the costs associated with processing messages addressed to invalid destinations or containing undesirable content.

Two filtering mechanisms were implemented in this study. The first validates mobile phone numbers by examining their numbering prefixes and overall structure, while the second analyzes message content to identify messages exhibiting spam-related characteristics. Both mechanisms were implemented in MATLAB and executed before the data were imported into Microsoft SQL Server and subsequently processed by the SMS Gateway platform.

6.1. Structural Number Validation Mechanism

In modern telecommunication systems, Home Location Register (HLR) lookup services are commonly used to verify the validity of mobile phone numbers and identify their associated mobile network operators. Since access to operational HLR services requires specialized telecommunications infrastructure, this study implements a structural number validation mechanism based on destination number format, international dialing prefixes, and numbering rules rather than a real HLR lookup service. The objective of this mechanism is to identify destination numbers whose structure does not conform to the numbering rules defined for the corresponding country and mobile network operator. The validation mechanism is applied to every destination number generated during the simulation, regardless of the destination country. The validation process is based on three criteria: the international country code, the operator prefix, and the total number of digits.

For Albanian destinations the validation mechanism verifies that the number contains exactly twelve digits, including the international country code. For the remaining simulated countries, the mechanism verifies that the generated destination number contains between ten and fifteen digits after the corresponding international dialing prefix has been applied.

For example, Albanian mobile numbers use the country code 355. Within the simulation, operator identification is performed using the numbering prefixes defined in the dataset. Numbers beginning with 35569 are classified as belonging to cellular operator X, whereas numbers beginning with 35567 or 35568 are classified as belonging to cellular operator Y. In addition to prefix validation the mechanism verifies the overall length of the number. During dataset generation, destination numbers from all simulated countries were processed using a common validation procedure. However, to evaluate the proposed structural validation mechanism, some Albanian destination numbers were intentionally generated with incorrect lengths. Numbers that do not satisfy the implemented validation rules, are classified as invalid and excluded from further processing. This validation mechanism eliminates incorrectly formatted destination numbers before they enter the simulated A2P SMS traffic. So we have a cleaner dataset that more closely reflects the operating conditions of real-world A2P SMS systems.

Figure 10 illustrates the structural number validation process implemented in the proposed framework.

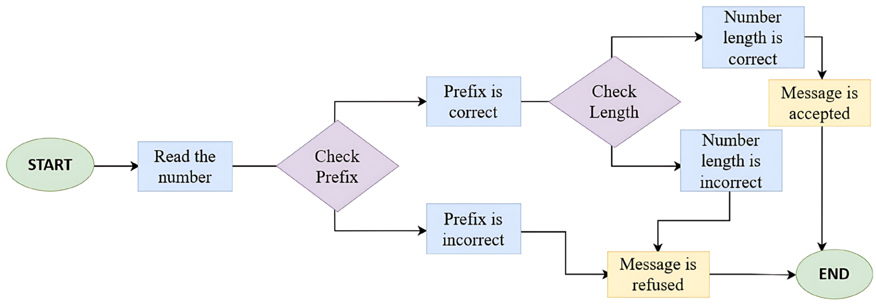


Figure 10. Mobile phone number validation algorithm.

6.2. Spam Filtering Mechanism in the Second Experimental Scenario

In addition to validating mobile phone numbers, the second experimental scenario incorporates a filtering mechanism for identifying SMS messages containing undesirable content. In operational environments, mobile network operators and A2P SMS service providers employ various filtering techniques to detect messages that may be classified as spam or that violate network policies.

In this study, spam detection was implemented through content analysis of SMS messages as illustrated in Figure 11. For each message, the system checks for the presence of a predefined set of keywords. The keyword list includes terms commonly associated with promotional content related to betting and gambling services, such as *casino*, *bet*, *jackpot*, *gambling*, and *roulette*.

During the analysis the content of each SMS message is compared against the predefined keyword list. If at least one of these keywords is detected, the message is classified as spam and excluded from subsequent processing stages. Otherwise, the message is considered valid and continues through the normal simulation workflow.

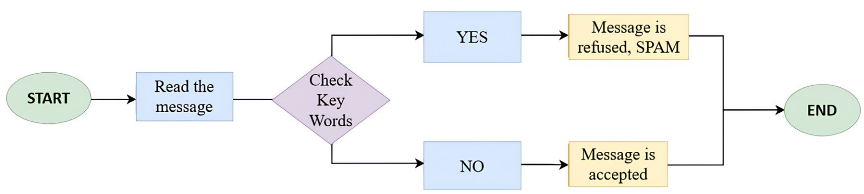


Figure 11. SMS message validation (spam filtering) algorithm.

7. Analysis of the Traffic Generated in MATLAB for the Second Experimental Scenario

The traffic analysis is based on a dataset consisting of 1000 records generated in MATLAB and used in the second experimental scenario. This dataset represents a simulation of international A2P SMS traffic, which was subsequently processed and filtered within the experimental environment implemented using Microsoft

SQL Server and an SMS Gateway platform.

The processing results show that of the 1000 generated SMS messages 568 were accepted for processing, while the remaining 432 messages were rejected during the filtering stage by the structural number validation and message content filtering mechanisms, as illustrated in **Figure 12**. Consequently, only 568 messages were accepted for gateway processing, corresponding to a simulated traffic reduction of 43.2%. This reduction demonstrates the effectiveness of the proposed filtering mechanisms in preventing unnecessary messages from entering the subsequent gateway processing stage.

In case the status is "Accepted for Processing" it indicates that a message successfully passed the implemented filtering mechanisms and entered the gateway processing stage. It does not represent successful end-to-end SMS delivery, since the experimental environment was not connected to a commercial SMPP provider or SMSC.

These results are related to the effectiveness of the proposed structural number validation and to the mechanism of message content filtering. In case the filters are not applied all generated messages would have proceeded to the gateway processing stage, including messages with invalid destination numbers or undesirable content. By preventing 432 messages from entering subsequent processing, the proposed approach reduced unnecessary traffic and improved the efficiency of the simulated gateway workflow. Although the experimental framework does not measure processing time or throughput, the reduction in the number of processed messages illustrates the practical benefit of early-stage filtering for A2P SMS traffic management.

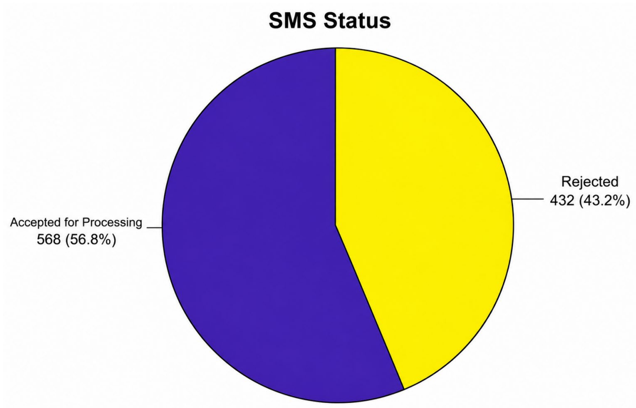


Figure 12. Distribution of Accepted and Rejected SMS messages.

7.1. Traffic Analysis by Destination Country

The SMS traffic generated in MATLAB, was distributed across six destination countries: Albania, Italy, Germany, France, the United Kingdom, and Türkiye. Each record in the dataset contains a Country field identifying the corresponding destination.

To analyze the geographical distribution of the generated traffic, a MATLAB program was used to group the records according to their destination country. The resulting distribution is presented in Figure 13.

The results indicate that the generated traffic is relatively well balanced among the countries included in the simulation. The United Kingdom and Italy account for the highest number of SMS messages, with 209 and 208 messages, respectively, while France has the lowest number, with 92 messages.

The distribution as above is significant in the context of the present study, because it enables the evaluation of system performance for different destination countries and for different mobile network operators. In operational A2P SMS systems, international traffic is rarely uniformly distributed; therefore, this simulation provides a more realistic representation of actual operating conditions. Furthermore, the adopted traffic distribution facilitates the evaluation of the implemented filtering and processing mechanisms under varying traffic conditions, reflecting how real A2P SMS platforms simultaneously manage traffic originating from multiple countries.

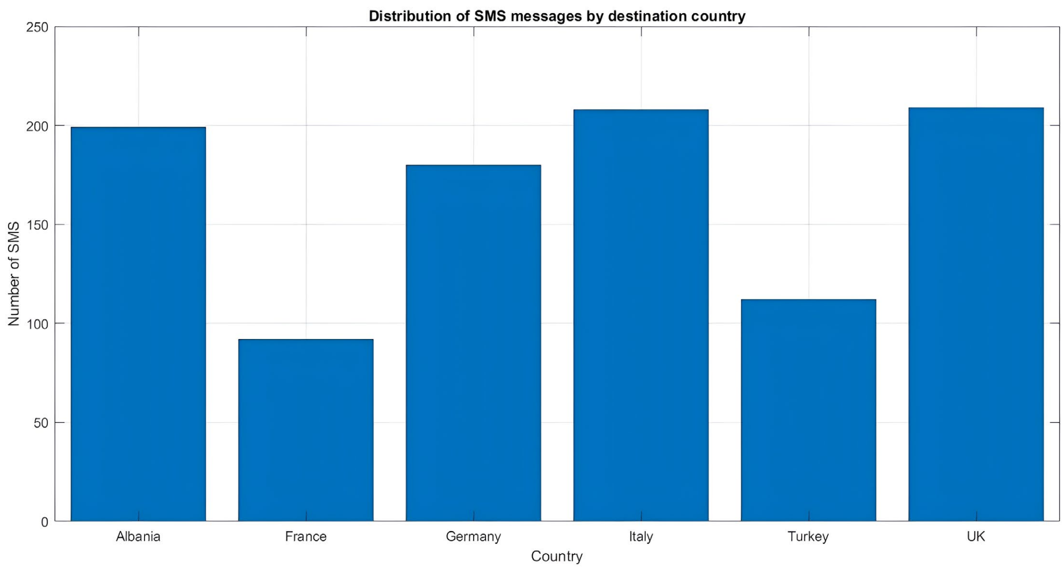


Figure 13. Distribution of SMS messages by destination country.

7.2. Evaluation of the Structural Number Validation Mechanism

During dataset generation, the international dialing codes and mobile network operator prefixes were created according to the numbering rules defined for each country included in the simulation. Consequently, the primary validation criterion focused on the length of the destination mobile number. In the case of Albania, a mobile number was considered valid only if it contained twelve digits, including the international country code 355.

Although the structural number validation mechanism was applied to destination numbers from all simulated countries, destination numbers with incorrect lengths were intentionally introduced only for a subset of Albanian records to evaluate the proposed validation mechanism. As a result, all records rejected by this mechanism correspond to Albanian destination numbers.

The analysis of the dataset identified several records whose mobile number length did not satisfy this requirement. These numbers were detected by the validation mechanism and classified as invalid, before entering the subsequent processing stages. Table 5 presents the records identified by the simulated Structural Number validation mechanism, showing destination numbers containing either fewer or more digits than the standard Albanian mobile number format.

The results demonstrate that the validation mechanism successfully identified and eliminated destination numbers that have incorrect structures. Even if the number of rejected records is relatively small, compared with the total traffic volume, their presence highlights the importance of performing the preliminary validation before SMS messages enter the processing workflow.

The use of this validation filter prevents the processing of invalid destinations, thereby reducing unnecessary system workload and avoiding the consumption of resources for messages that cannot be successfully delivered. In operational telecommunication systems similar validation mechanisms are widely employed to improve traffic quality and optimize the operational costs that are associated with SMS delivery.

Figure 14 illustrates the distribution of rejected messages according to the filtering mechanism. As can be observed, only a small proportion of the rejected messages resulted from mobile number validation, whereas the majority were rejected by the spam filtering mechanism.

Table 5. Mobile numbers rejected by the simulated structural number validation mechanism.

Type	Destination	Country	Operator	Subject	Status
SMS	3556957631xxx	Albania	Cellular Operator X	Welcome to our service	Rejected
SMS	35569218640xxx	Albania	Cellular Operator X	Welcome to our service	Rejected
SMS	35568872xxx	Albania	Cellular Operator Y	Welcome to our service	Rejected
SMS	3556894453xxx	Albania	Cellular Operator Y	Welcome to our service	Rejected
SMS	35569246xxx	Albania	Cellular Operator X	Package delivered successfully	Rejected
SMS	35569587xxx	Albania	Cellular Operator X	Package delivered successfully	Rejected
SMS	35569674xxx	Albania	Cellular Operator X	Welcome to our service	Rejected
SMS	35568316xxx	Albania	Cellular Operator Y	Package delivered successfully	Rejected
SMS	3556948755xxx	Albania	Cellular Operator X	Your OTP code is 123456	Rejected
SMS	35569479xxx	Albania	Cellular Operator X	Package delivered successfully	Rejected
SMS	3556888254xxx	Albania	Cellular Operator Y	Your OTP code is 123456	Rejected
SMS	35567062xxx	Albania	Cellular Operator Y	Bank transfer completed	Rejected
SMS	3556748550xxx	Albania	Cellular Operator Y	Your OTP code is 123456	Rejected
SMS	3556973629xxx	Albania	Cellular Operator X	Bank transfer completed	Rejected

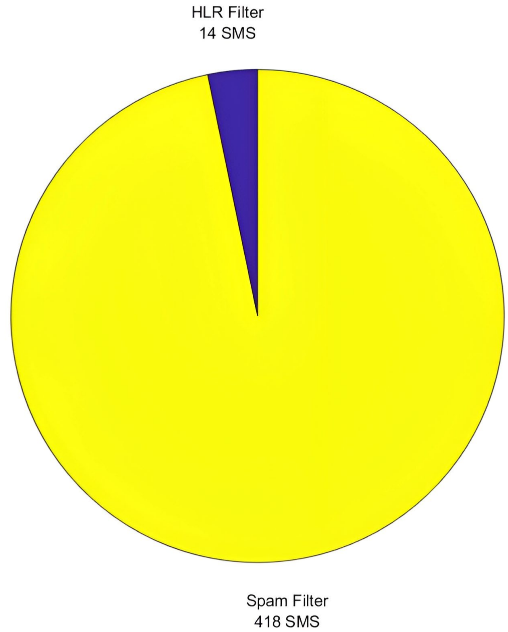


Figure 14. Distribution of rejected SMS messages by the simulated Structural Number validation mechanism and the spam filtering mechanism.

7.3. Analysis of SMS Message Content Filtering

After the mobile number validation stage, the dataset underwent SMS message content filtering. The objective of this phase was to identify messages containing keywords defined by the spam filtering mechanism and to exclude them from subsequent processing.

The filtering process was based on content analysis and the identification of terms associated with the casino and gambling categories. This section focuses on the results of the filtering process and its impact on the generated A2P SMS traffic.

Figure 15 illustrates the distribution of messages identified as spam according to their destination country. The results show that spam messages are distributed across all countries included in the simulation rather than being concentrated in a single destination. This distribution reflects the methodology used to generate the dataset in MATLAB, where SMS messages were randomly assigned to the selected countries and mobile network operators.

It should be highlighted that the number of spam messages reported for each destination country does not necessarily reflect the characteristics for a real-world traffic. For example, although the simulation shows a higher number of such messages for the United Kingdom, this does not imply that this destination generates more spam traffic in practice. The observed distribution is solely a consequence of the dataset generation methodology and should not be interpreted as representing actual market statistics.

Furthermore, messages related to casino and gambling services are not treated uniformly across all countries and mobile networks. In practice, the acceptance or restriction of this type of traffic depends on national legislation, mobile network operator policies and the regulatory framework governing electronic communications. For the purposes of this study, all messages containing the keywords, defined by the spam filtering mechanism, were considered undesirable traffic and classified as spam, regardless of their destination country. The results demonstrate that the filtering mechanism successfully identified messages containing undesirable content and prevented them from entering the subsequent processing stages. Consequently, the implemented approach reduced unnecessary traffic and made the behavior of the experimental environment more consistent with the practices employed in modern A2P SMS traffic management systems.

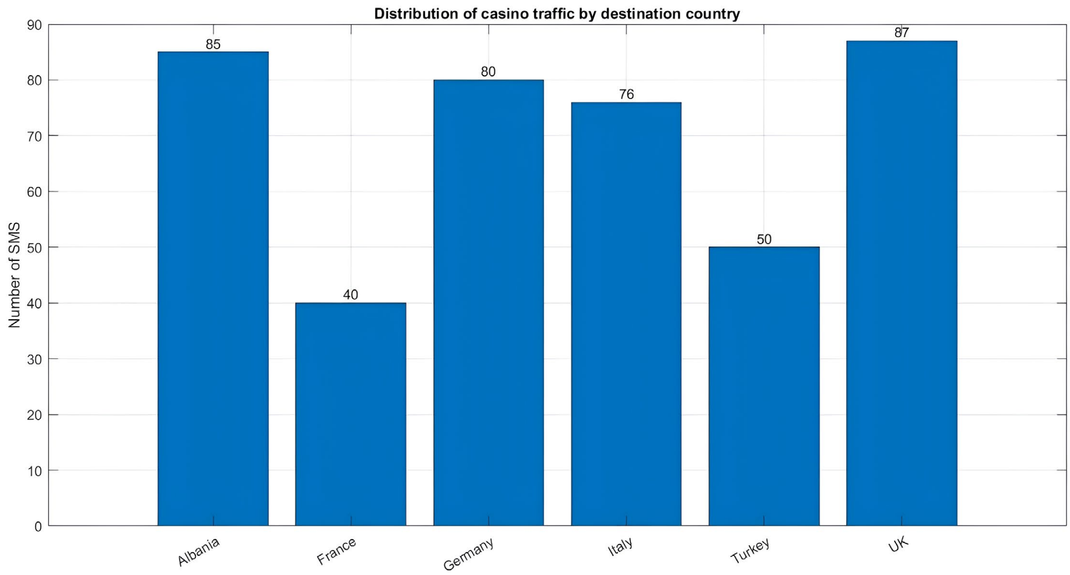


Figure 15. Distribution of casino-related SMS messages by destination country.

8. Study Limitations and Recommendations for Future Works

This study combines a practical implementation of real SMS message transmission with a simulation environment for the analysis of A2P SMS traffic. Based on these two complementary approaches, several limitations should be considered when interpreting the obtained results.

One of the primary limitations is that mobile number validation in the second experimental scenario was not performed using a real HLR Lookup service. Instead validation was limited to checking the structural correctness of destination numbers. As a result, an important verification mechanism commonly employed in operational telecommunication systems was not available.

Similarly SMS message filtering was implemented using a basic keyword-based approach. In operational environments, considerably more sophisticated filtering mechanisms are employed, including contextual content analysis, machine learning techniques and behavioral analysis for spam detection.

It should also be noted that the dataset generated in MATLAB is entirely synthetic and does not represent actual traffic collected from mobile network operators. So, the results obtained in the second experimental scenario should be interpreted as experimental findings and not as measurements taken from a real operational system.

Conversely, the first experimental scenario provides practical validation using real SMS message transmission; however, it is limited to a relatively small number of messages and therefore does not support large-scale traffic analysis.

Overall, the main limitation of this work lies in the balance between small-scale practical experimentation and large-scale simulation, without full integration with operational telecommunication infrastructure such as a commercial SMSC or a real HLR service.

Despite these limitations the combination of the two experimental scenarios provides a comprehensive view of A2P SMS system behavior by integrating practical experimentation with large-scale traffic simulation.

Future work may extend this research by incorporating real HLR Lookup services, integration with a commercial SMSC or SMPP provider and more advanced mechanisms for traffic monitoring, message tracking and performance analysis. Such enhancements would allow the proposed framework to more closely reflect real operational A2P SMS environments.

9. Conclusions

This paper presented an experimental framework for the analysis of international A2P SMS traffic by integrating an SMS Gateway platform with MATLAB, Microsoft SQL Server and an Android SMS Agent. This setup combines real SMS transmission with large-scale traffic simulation. It creates a practical environment to study message generation, database management, and traffic filtering.

Test results showed that the system handles A2P SMS traffic effectively. In the first scenario, real SMS messages were successfully sent and received using an Android phone. In the second scenario, 1000 simulated international messages were generated and processed. The filters quickly blocked invalid phone numbers and spam keywords, cutting down unnecessary traffic before processing.

Although the proposed framework does not include a commercial SMS infrastructure or a real HLR lookup service, it provides a flexible and reproducible platform for evaluating different approaches to A2P SMS traffic management. Future works may analyse the integrating of a real HLR services, commercial SMPP connectivity, and more advanced filtering techniques to further improve the realism and functionality of the experimental environment.

Author Contributions

All authors contributed collectively to the conception and design of the study, data collection, analysis and interpretation of the results, and writing and revision of the manuscript. All authors read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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