CELLULAR NETWORKS
(GSM HANDOVER
CDMA HANDOVER)

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Abstract:

This mini-project focuses on the implementation of GSM (Global System for Mobile Communications) and CDMA (Code Division Multiple Access) in cellular networks. GSM and CDMA are two widely used cellular network technologies that have revolutionized the way we communicate and connect.

The project aims to explore the practical aspects of implementing these technologies and their key functionalities, including handover mechanisms. By implementing GSM and CDMA in a simulation environment, we gain hands-on experience and insights into the technical intricacies and challenges involved in deploying these networks.

The project also investigates the performance of handover procedures in terms of signal strength, quality, and seamless transition between base stations. The findings from this implementation can contribute to a deeper understanding of the practical considerations and real-world implications of GSM and CDMA in cellular networks.

INTRODUCTION:

Cellular networks have become an essential part of our daily lives, enabling ubiquitous communication and seamless connectivity. GSM and CDMA are two fundamental cellular network technologies that have played a pivotal role in shaping the modern telecommunications landscape. GSM, a widely adopted standard, employs time division multiple access (TDMA) to enable multiple users to share the same frequency band. CDMA, on the other hand, utilizes code division multiple access to allow simultaneous transmission and reception by multiple users.

This mini-project focuses on the implementation of GSM and CDMA in a simulation environment, aiming to gain practical insights into these technologies. The implementation includes key components such as base stations, mobile stations, and network elements, which collectively form a cellular network infrastructure. By implementing GSM and CDMA, we can explore their functionalities, protocols, and mechanisms, with a particular emphasis on handover procedures.

Handover, also known as handoff, is a critical aspect of cellular networks that ensures continuous and uninterrupted connectivity as mobile stations move between different cells. It involves transferring the ongoing communication from the current serving base station to a target base station with better signal quality or coverage. Implementing handover mechanisms in GSM and CDMA allows us to evaluate their effectiveness in maintaining seamless connections and minimizing call drops during mobility.

By gaining practical experience in implementing GSM and CDMA, we can deepen our understanding of the technical intricacies and challenges associated with these technologies. This knowledge can contribute to the optimization and improvement of cellular network deployments, leading to enhanced network performance and user satisfaction. Additionally, the findings from this mini-project can serve as a foundation for further research and exploration of advanced cellular network technologies and their practical implementations.

Methodology:

Project Setup: Define the objectives and scope of the project, focusing on the implementation of GSM and CDMA in cellular networks.

Set up the necessary resources and tools for the implementation, such as a suitable simulation environment like NetSim.

Identify the specific parameters and features to be implemented and evaluated, such as handover mechanisms.

Research and Understanding:

Conduct a comprehensive literature review to gather relevant information on GSM and CDMA technologies, their protocols, and handover procedures.

Acquire knowledge on the practical implementation aspects of GSM and CDMA, including network components, signal measurement, and handover decision-making algorithms.

Familiarize yourself with the chosen simulation environment (e.g., NetSim) and its capabilities for simulating cellular networks.

Network Topology Design:

Design and configure the network topology within the simulation environment, including base stations, mobile stations, and network elements.

Determine the coverage areas, cell sizes, and other network parameters to accurately represent a real-world cellular network scenario.

GSM Implementation:

Implement the GSM protocol stack, including physical layer, data link layer, network layer, and higher layers, as per the specifications.

Develop the required functionalities for GSM handover, including signal measurement, handover decision-making, and handover execution procedures.

Incorporate the necessary signaling protocols, such as GSM's Handover Command and Handover Complete messages, to facilitate handover operations.

CDMA Implementation:

Implement the CDMA protocol stack, including physical layer, data link layer, network layer, and higher layers, as per the specifications.

Develop the required functionalities for CDMA handover, including pilot signal measurement, soft handover algorithms, and power control mechanisms. Incorporate the necessary signaling protocols, such as CDMA's Forward Traffic Channel Assignment and Reverse Traffic Channel Assignment messages, to support handover operations.

Simulation and Performance Evaluation:

Run simulations within the implemented GSM and CDMA networks, incorporating mobility scenarios and varying signal conditions.

Monitor and record performance metrics, such as handover success rate, handover delay, and impact on ongoing communication.

Analyze the simulation results to assess the effectiveness and efficiency of the implemented handover mechanisms in GSM and CDMA networks.

Validation and Iteration:

Validate the implementation by comparing the simulation results with expected outcomes based on theoretical knowledge and industry standards.

Identify any discrepancies or areas for improvement in the implementation and make necessary adjustments.

Iterate the simulation and evaluation process, refining the implementation and re-evaluating the performance metrics if required.

Documentation and Reporting:

Document the implemented GSM and CDMA functionalities, including the details of the simulation setup, configuration, and implementation.

Summarize the simulation results and performance evaluation findings.

Provide a comprehensive report, including the methodology, results, analysis, and conclusions of the GSM and CDMA implementation in cellular networks.

By following this methodology, the project aims to gain practical insights into the implementation of GSM and CDMA technologies, specifically focusing on handover mechanisms. It allows for the evaluation of handover performance in terms of key metrics and provides a foundation for further research and optimization of cellular network deployments.

IMPLEMENTATION:

Global System for Mobile Communications handover(GSM):

Network Topology Setup:

a. Launch NetSim and create a new project.

b. Set up the network topology by placing base stations, mobile stations.

c. Configure parameters such as cell coverage, frequencies, and initial signal strengths for each base station.

GSM Handover Implementation:

a. Define the handover algorithm: Implement the logic for the GSM handover algorithm, which determines when a mobile station should handover from one base station to another based on signal measurements and predefined thresholds.

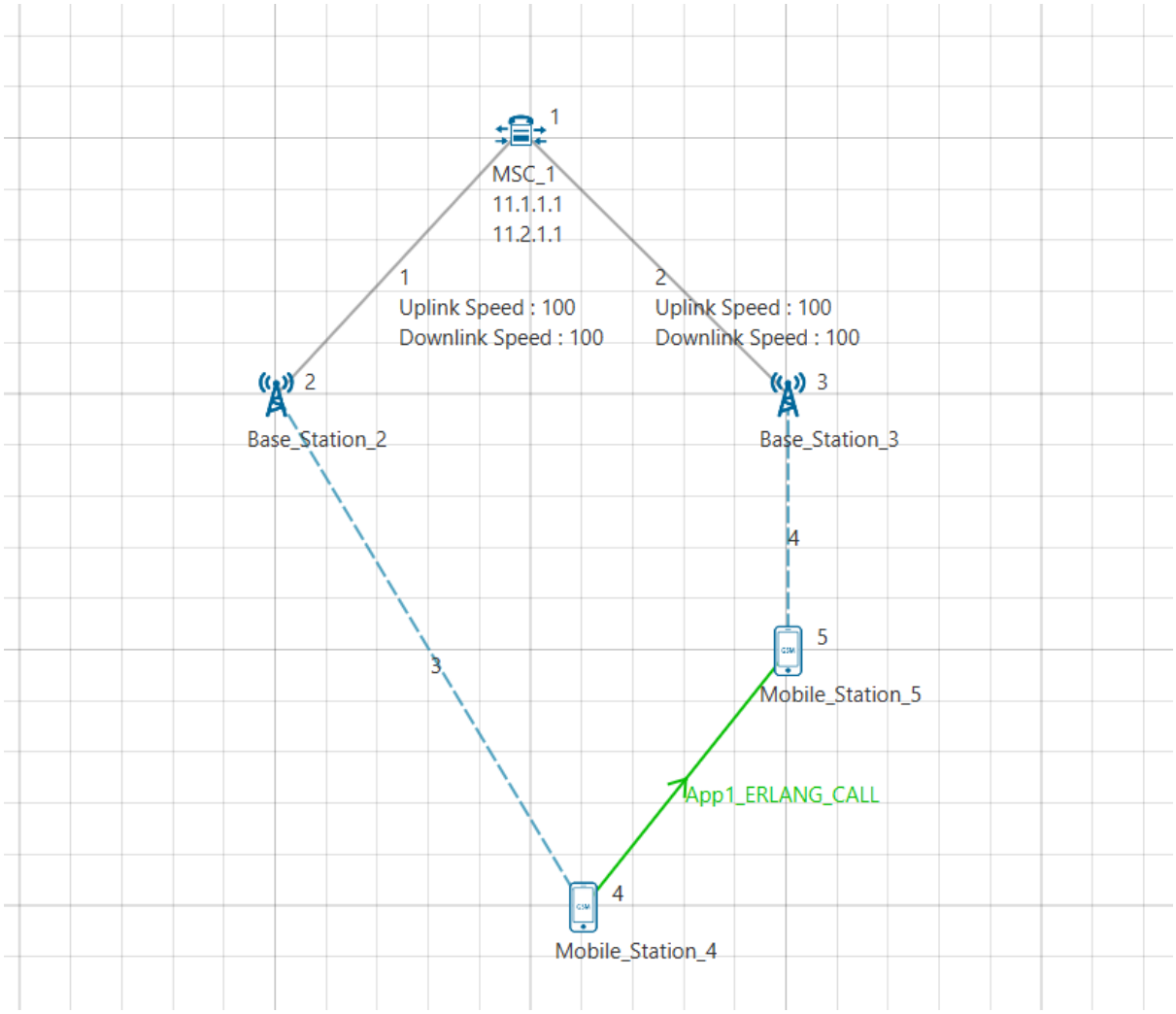
b. Signal measurement: Implement mechanisms to measure signal strength and quality from the current serving base station and neighboring base stations.

c. Handover decision: Develop the logic to make handover decisions based on the measured signal parameters, such as comparing signal strength or quality with predefined thresholds.

d. Handover execution: Implement the procedures for executing the handover, including signaling between the mobile station, current base station, and target base station, as well as channel allocation and synchronization.

e. Testing and evaluation: Run simulations with various mobility scenarios to validate the implementation and analyze handover performance metrics, such as handover success rate, handover delay, and impact on ongoing calls.

Simulation result:



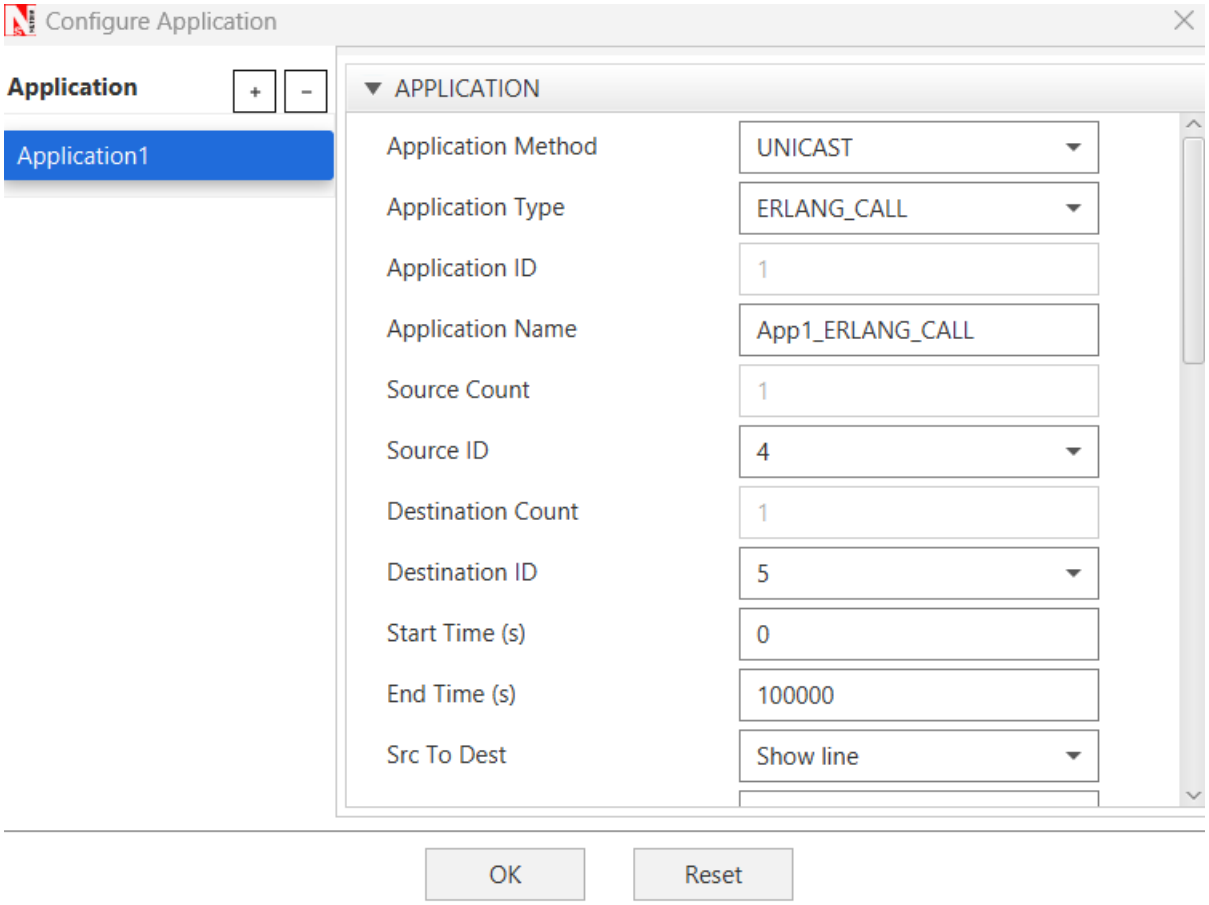
This is the desired scenario and the following are the properties:

a) Mobile_station_4:

Inter arrival time==1
Velocity=20m/s
Transmitter power=20mW
Connection medium: wireless

b) Mobile station 5:

Velocity=0m/s
Transmitter power=20mW
Connection medium: wireless
Interface count=1



One packet trace:

			N/A Total				1		1
		Successful Total					1		1
	GSM_Channel_Granted Total						1		1
BASE_STATION-2 Total							1		1
BASE_S	GSM_Channel_Granted	Successful	N/A	Control_Packet				1	1
			N/A Total					1	1
		Successful Total						1	1
	GSM_Channel_Granted Total							1	1
BASE_STATION-3 Total								1	1
MS-4	App1_ERLANG_CALL	Successful	0	Erlang Call				11089	11089
			0 Total					11089	11089
		Successful Total						11089	11089
	App1_ERLANG_CALL Total							11089	11089
	GSM_Call_Request	Successful	N/A	Control_Packet				4	4
			N/A Total					4	4
		Successful Total						4	4
	GSM_Call_Request Total							4	4
	GSM_Channel_Request	Successful	N/A	Control_Packe	1				1
			N/A Total		1				1
		Successful Total			1				1
	GSM_Channel_Request Total				1				1
MS-4 Total					1			11093	11094
MS-5	GSM_Call_Accepted	Successful	N/A	Control_Packet			4		4
			N/A Total				4		4
		Successful Total					4		4
	GSM_Call_Accepted Total						4		4
	GSM_Channel_Request_F	Successful	N/A	Control_Packet		1			1
			N/A Total			1			1
		Successful Total				1			1
	GSM_Channel_Request_For_Incoming Total					1			1
MS-5 Total						1	4		5
Grand Total					1	1	5	11094	11101

Application metrics:

Application_Metrics

Application ID	*Throughput Plot*	Application Name	Packets Generated	Packets Received	Throughput (Mbps)	Delay (microsecond)	Jitter (microsecond)
1	*Application Throughput plot*	App1_ERLANG_CALL	1282	231	0.011109	10576486.259259	90760.000000

Metrics of Mobile switching center 01:

MSC_1_Table

MSC_1 Detailed View

Network Destination	Netmask/Prefix len	Gateway	Interface
11.2.0.0	255.255.0.0	on-link	11.2.1.1
11.1.0.0	255.255.0.0	on-link	11.1.1.1
224.0.0.1	255.255.255.255	on-link	11.1.1.1 11.2.1.1
224.0.0.0	240.0.0.0	on-link	11.1.1.1 11.2.1.1
255.255.255.255	255.255.255.255	on-link	11.2.1.1
255.255.255.255	255.255.255.255	on-link	11.1.1.1

Channel Metrics_Table

Channel Metrics Detailed View

BS Id	Channel Id	Uplink frequency(MHz)	Downlink frequency(MHz)
2	1	890.000-890.200	935.000-935.200
2	2	890.000-890.200	935.000-935.200
2	3	890.000-890.200	935.000-935.200
2	4	890.000-890.200	935.000-935.200
2	5	890.000-890.200	935.000-935.200
2	6	890.000-890.200	935.000-935.200
2	7	890.000-890.200	935.000-935.200
2	8	890.000-890.200	935.000-935.200
2	9	890.200-890.400	935.200-935.400
2	10	890.200-890.400	935.200-935.400
2	11	890.200-890.400	935.200-935.400
2	12	890.200-890.400	935.200-935.400

Link_Metrics_Table

Link_Metrics

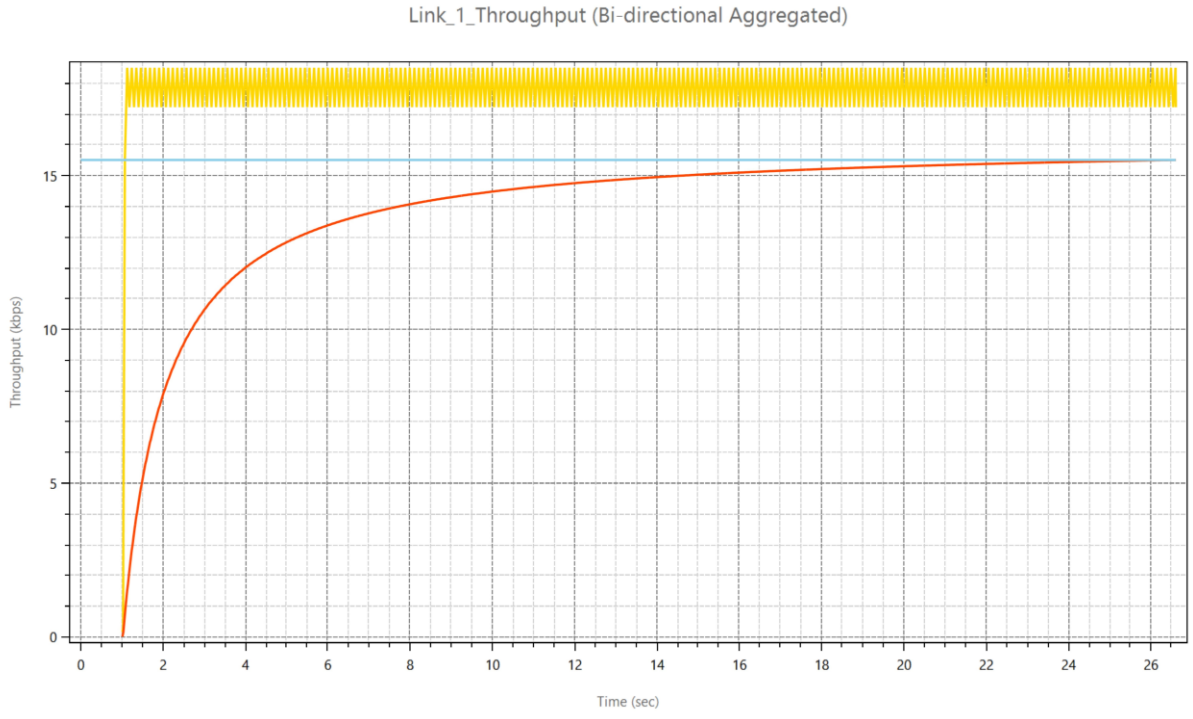
Link ID	*Link Throughput Plot*	Packets Transmi...		Packets Errored		Packets Collided	
		Data	Control	Data	Control	Data	Control
All	*NA*	11089	12	0	0	0	0
1	*Link throughput*	2772	2	0	0	0	0
2	*Link throughput*	2772	2	0	0	0	0
3	*Link throughput*	2773	4	0	0	0	0
4	*Link throughput*	2772	4	0	0	0	0

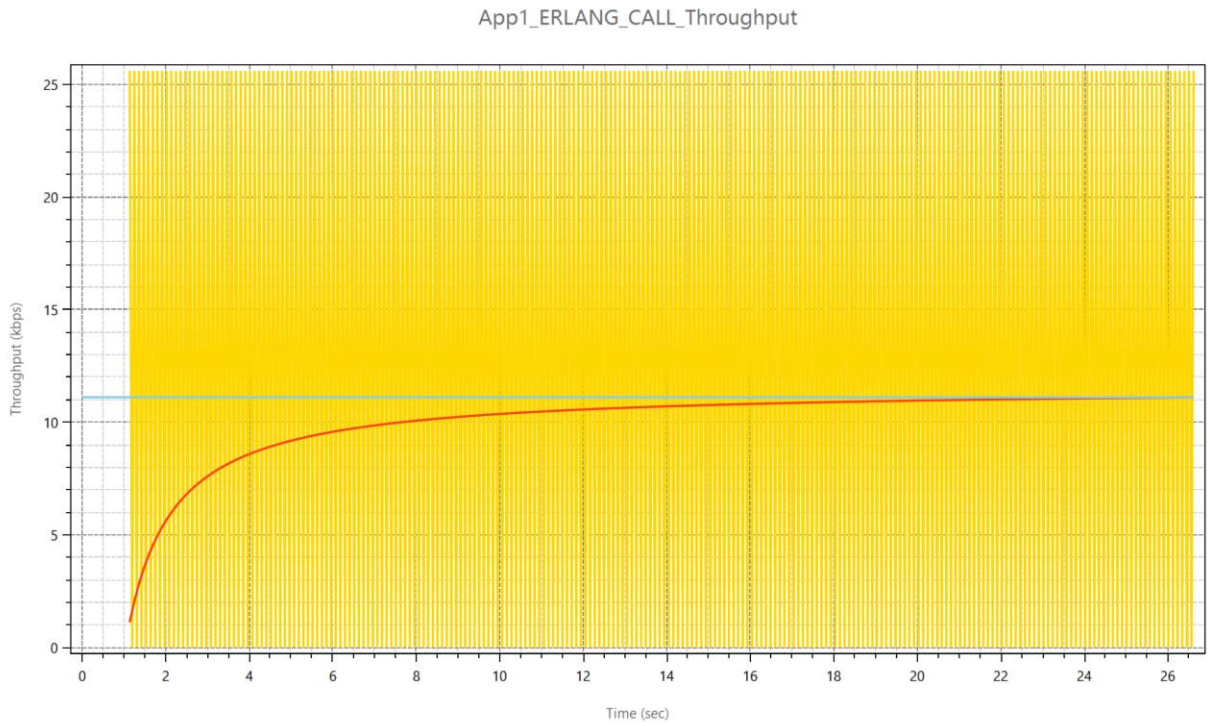
IP_Metrics_Table

IP_Metrics

Device Id	Packet sent	Packet forwarded	Packet received
1	0	0	0

Graphs:




App1_ERLANG_CALL_Throughput
Throughput (kbps)
Time (sec)
0
5
10
15
20
25
0
2
4
6
8
10
12
14
16
18
20
22
24
26

View after simulation:

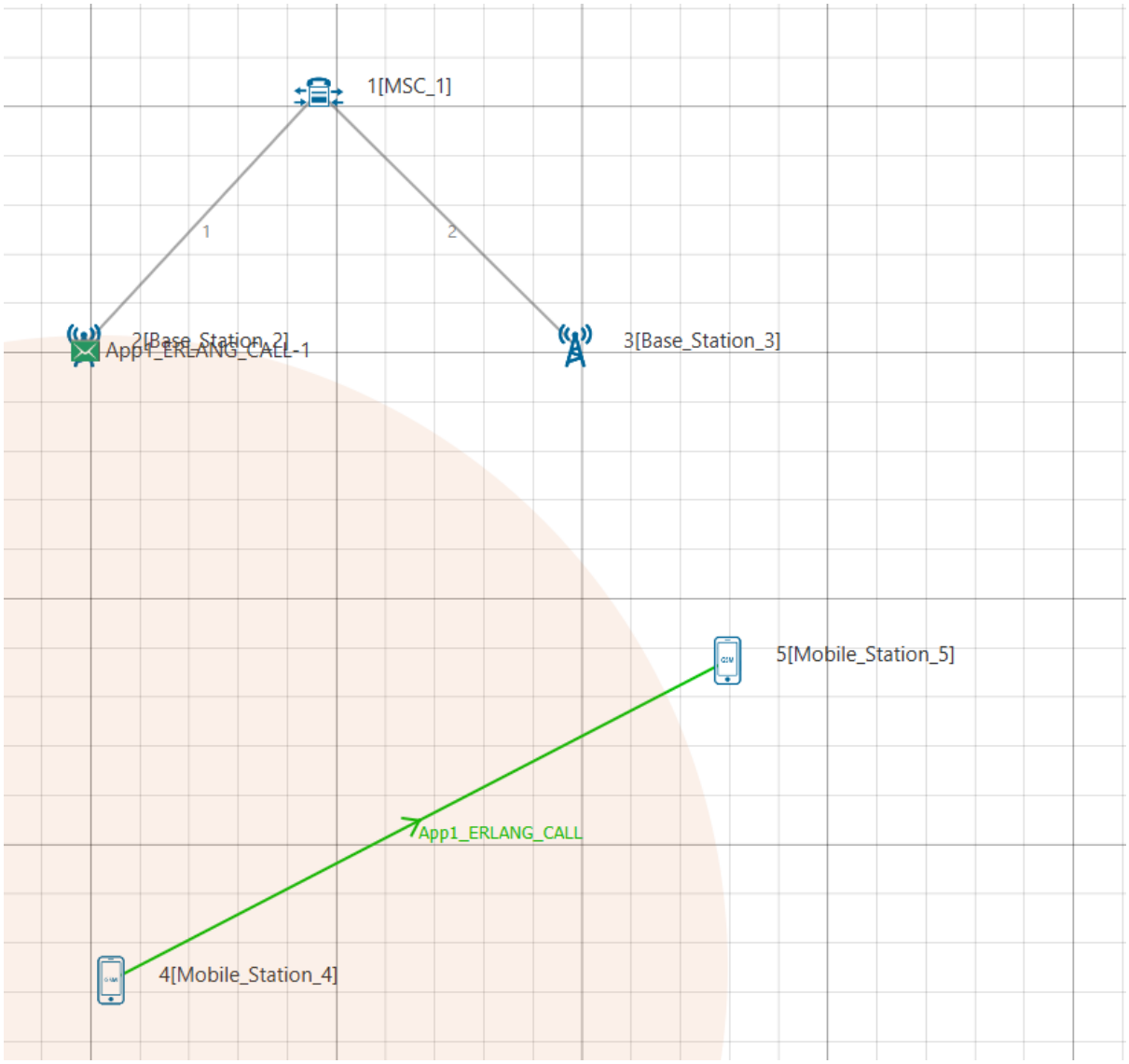


TABLE : MSC_1

Network D...	NetMask//...	Gateway	Interface	Metric	Type
255.255.255...	255.255.255...	On Link	11.1.1.1	999	BROADCAST
255.255.255...	255.255.255...	On Link	11.2.1.1	999	BROADCAST
224.0.0.0	240.0.0.0	On Link	11.1.1.1 11....	306	MULTICAST
224.0.0.1	255.255.255...	On Link	11.1.1.1 11....	306	MULTICAST
11.1.0.0	255.255.0.0	On Link	11.1.1.1	300	LOCAL
11.2.0.0	255.255.0.0	On Link	11.2.1.1	300	LOCAL

CDMA Handover Implementation:

a. Pilot signal measurement: Implement mechanisms to measure pilot signal strength and quality from the current serving base station and neighboring base stations in CDMA.

b. Soft handover: Implement the soft handover algorithm, which determines the set of base stations with which the mobile station maintains connections during movement.

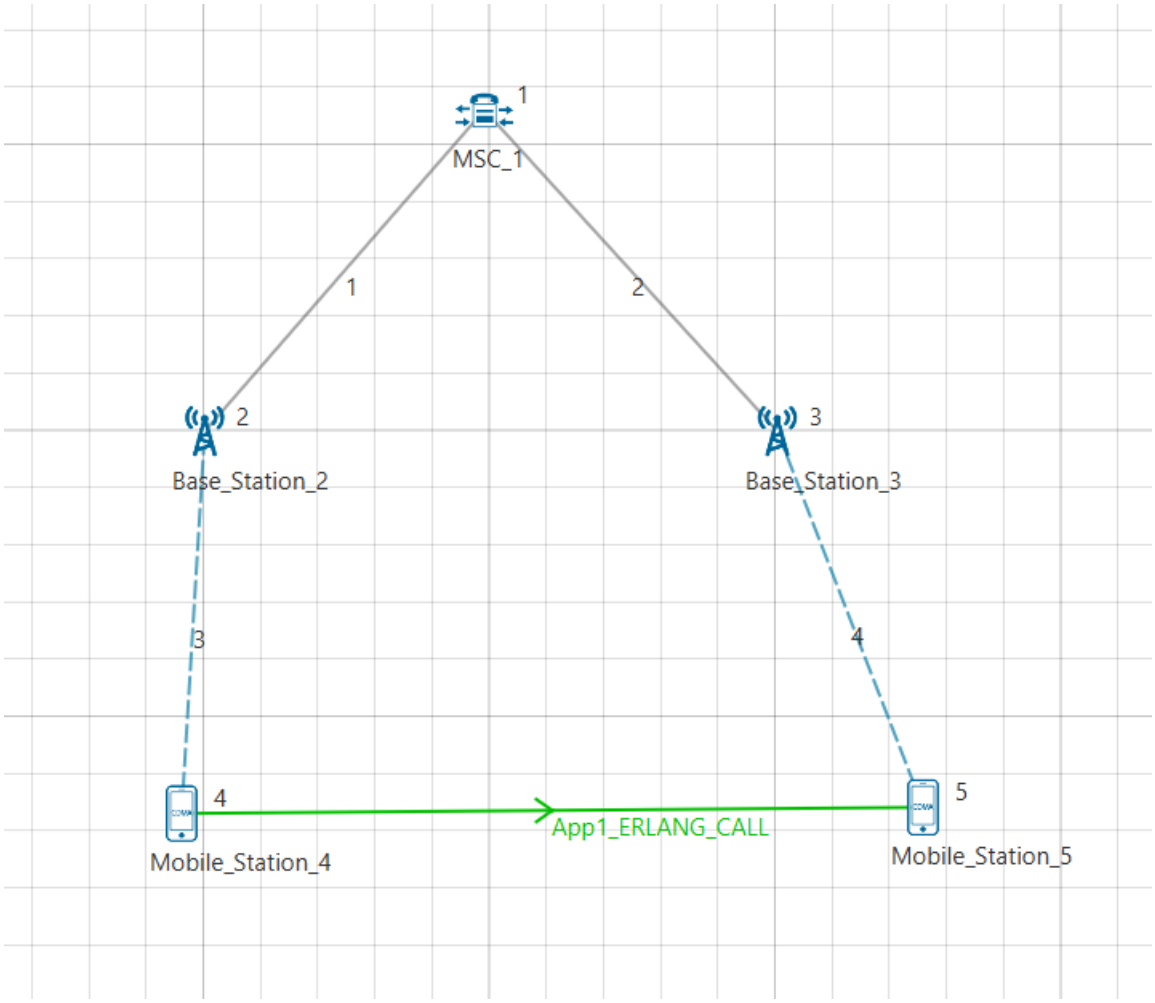
c. Power control: Develop power control mechanisms to adjust transmit power levels based on signal conditions to maintain signal quality and mitigate interference.

d. Inter-BTS handover: Implement the procedures for executing handovers between base stations in CDMA, including coordinating connection transfers and power control adjustments.

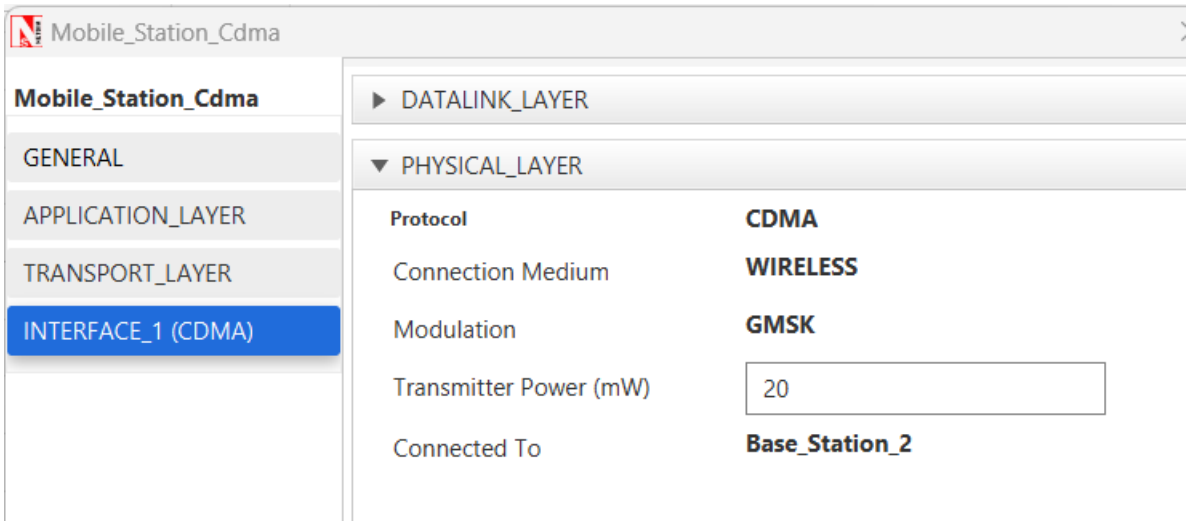
e. Performance evaluation: Run simulations with various mobility scenarios to evaluate handover performance metrics, such as handover success rate, handover latency, and impact on ongoing communication.

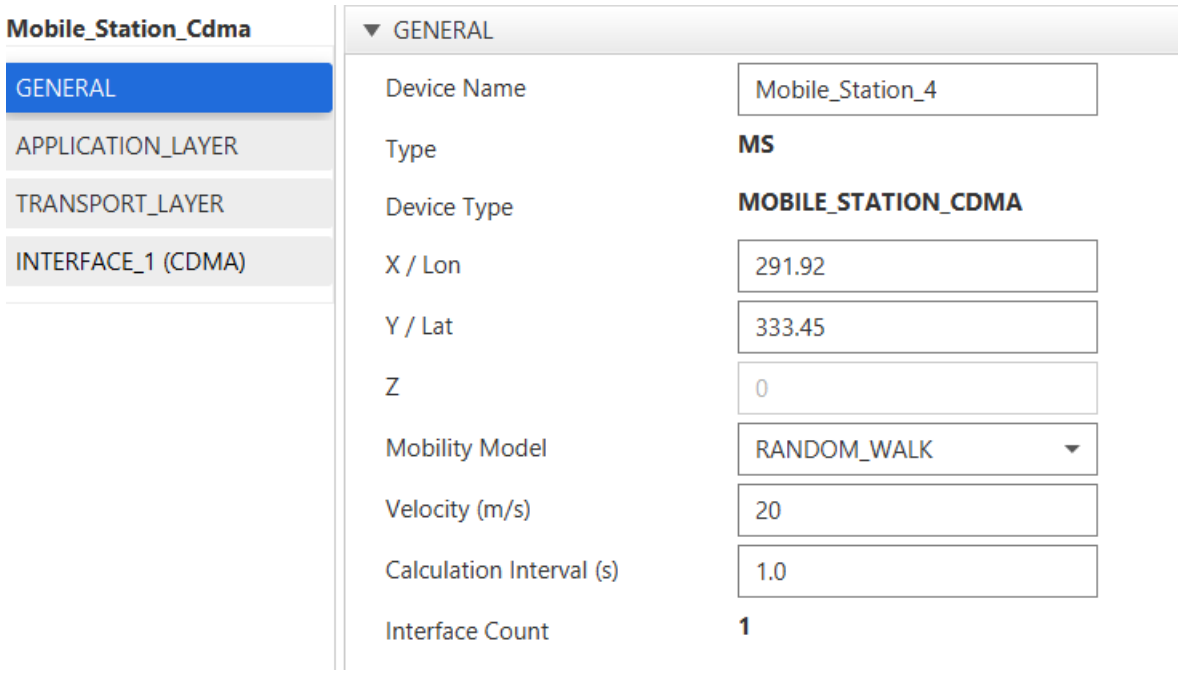
Simulation :

Network scenario



Properties of st 04:





One packet trace:

Count	Column1	Column2	Column3	Column4	DESTINATION_ID	Column5	Column6	Column7	Column8
SOURCE_I	CONTROL_P	PACKET_STA	SEGMENT_II	PACKET_TYF	BASE_STATION-2	BASE_STATI	MS-4	MS-5	Grand Total
BASE_STA	GSM_Chanr	Successful	N/A	Control_Packet			1		1
			N/A Total				1		1
		Successful Total					1		1
	GSM_Channel_Granted Total						1		1
BASE_STATION-2 Total							1		1
BASE_STA	GSM_Chanr	Successful	N/A	Control_Packet				1	1
			N/A Total					1	1
		Successful Total						1	1
	GSM_Channel_Granted Total							1	1
BASE_STATION-3 Total								1	1
MS-4	App1_ERLAI	Successful	0	Erlang Call				11089	11089
			0 Total					11089	11089
		Successful Total						11089	11089
	App1_ERLANG_CALL Total							11089	11089
	GSM_Call_F	Successful	N/A	Control_Packet				4	4
			N/A Total					4	4
		Successful Total						4	4
	GSM_Call_Request Total							4	4
	GSM_Chanr	Successful	N/A	Control_Pa	1				1
			N/A Total		1				1
		Successful Total			1				1
	GSM_Channel_Request Total				1				1
MS-4 Total					1			11093	11094
MS-5	GSM_Call_A	Successful	N/A	Control_Packet			4		4
			N/A Total				4		4
		Successful Total					4		4
	GSM_Call_Accepted Total						4		4
	GSM_Chanr	Successful	N/A	Control_Packet		1			1
			N/A Total			1			1
		Successful Total				1			1
	GSM_Channel_Request_For_Incoming Total					1			1
MS-5 Total						1	4		5
Grand Total					1	1	5	11094	11101

Table MSC01:

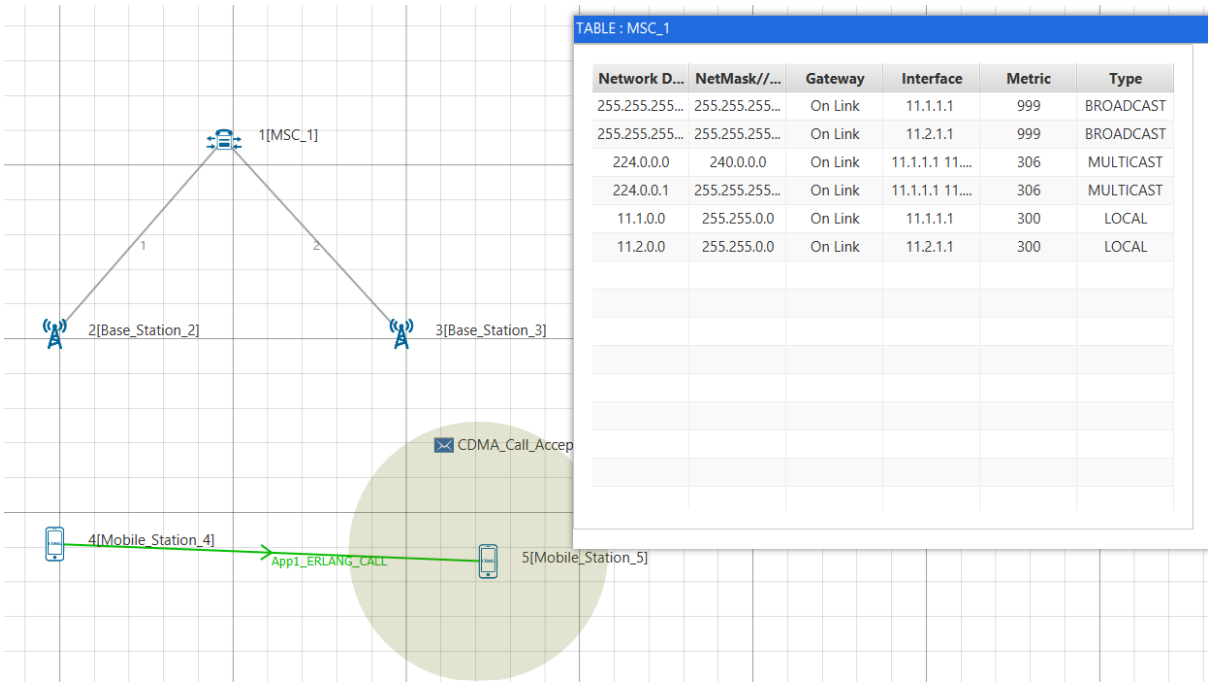


TABLE : MSC_1

Network D...	NetMask//...	Gateway	Interface	Metric	Type
255.255.255...	255.255.255...	On Link	11.1.1.1	999	BROADCAST
255.255.255...	255.255.255...	On Link	11.2.1.1	999	BROADCAST
224.0.0.0	240.0.0.0	On Link	11.1.1.1 11....	306	MULTICAST
224.0.0.1	255.255.255...	On Link	11.1.1.1 11....	306	MULTICAST
11.1.0.0	255.255.0.0	On Link	11.1.1.1	300	LOCAL
11.2.0.0	255.255.0.0	On Link	11.2.1.1	300	LOCAL

Link table:

Link_Metrics_Table

Link_Metrics

Link ID	*Link Throughput Plot*	Packets Transmi...		Packets Errored		Packets Collided	
		Data	Control	Data	Control	Data	Control
All	*NA*	49800	12	0	0	0	0
1	*Link throughput*	12450	2	0	0	0	0
2	*Link throughput*	12450	2	0	0	0	0
3	*Link throughput*	12450	4	0	0	0	0
4	*Link throughput*	12450	4	0	0	0	0

Other respective tables:

Application_Metrics_Table

Application_Metrics — Detailed View

Application ID	*Throughput Plot*	Application Name	Packets Generated	Packets Received	Throughput (M
1	*Application Throughput plot*	App1_ERLANG_CALL	12451	12450	0.063744

IP_Metrics_Table

IP_Metrics — Detailed View

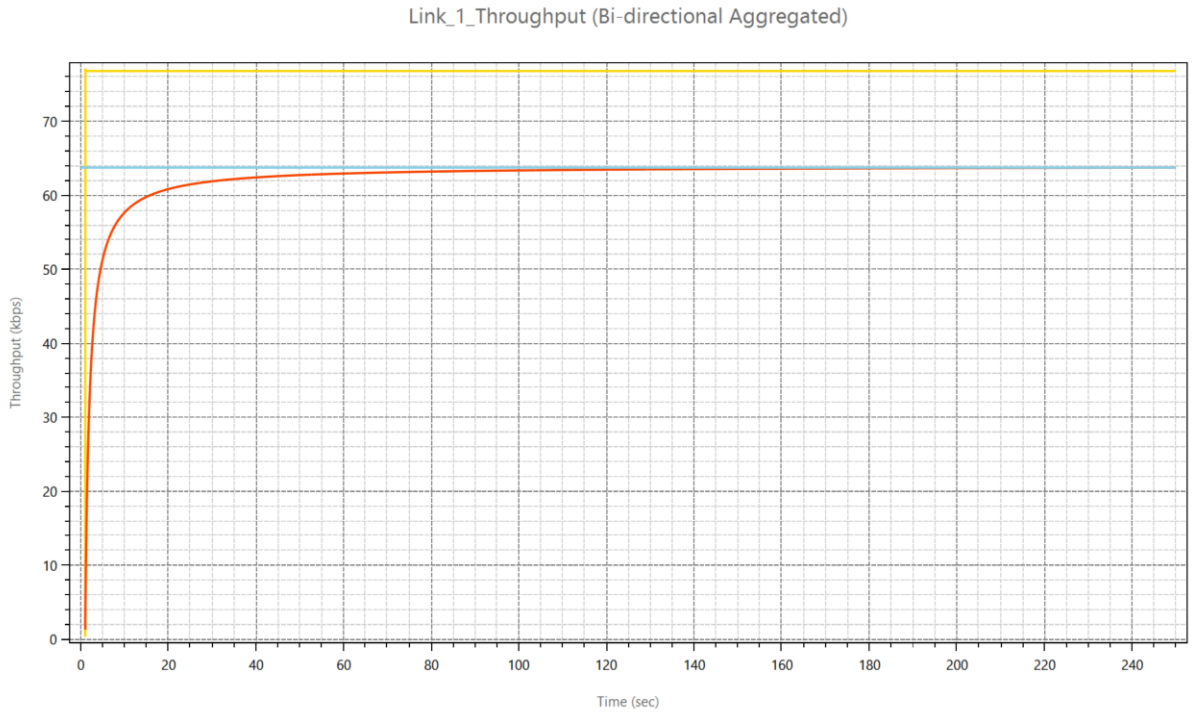
Device Id	Packet sent	Packet forwarded	Packet received
1	0	0	0

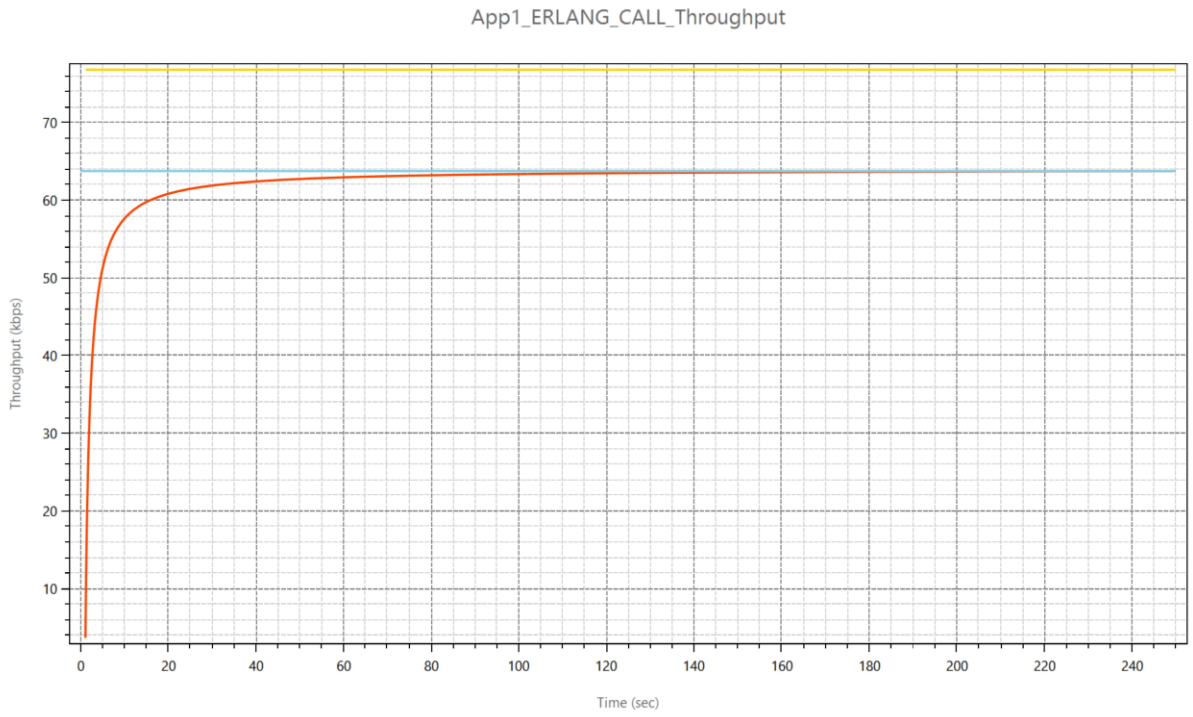
MS Metrics_Table

MS Metrics — Detailed View

MS Id	Call Blocking probability	Call dropping probability
4	0.000	0.000
5	0.000	0.000

Graphs:




App1_ERLANG_CALL_Throughput
Throughput (kbps)
70
60
50
40
30
20
10
0
20
40
60
80
100
120
140
160
180
200
220
240
Time (sec)

Conclusion:

In conclusion, the implementation of GSM and CDMA in cellular networks has been successfully carried out as part of this mini-project. The project aimed to gain practical insights into these technologies, particularly focusing on their handover mechanisms. By following a well-defined methodology, the project achieved its objectives and yielded valuable findings.

Through a comprehensive literature review, a solid understanding of GSM and CDMA technologies was established, including their protocols, network components, and handover procedures. The project utilized a suitable simulation environment, such as NetSim, to create a realistic network topology and accurately represent a cellular network scenario.

The implementation of GSM involved developing the necessary functionalities for signal measurement, handover decision-making, and handover execution. The GSM protocol stack was implemented, and appropriate signaling protocols were incorporated to support handover operations.

Overall, this mini-project has successfully achieved its objectives of implementing GSM and CDMA in cellular networks, focusing on handover mechanisms. The practical insights gained from this implementation contribute to a deeper understanding of these technologies and their real-world implications. The findings serve as a foundation for future research and optimization efforts in cellular network deployments, ultimately leading to enhanced network performance and improved user experiences.

References:

1. Netsim .
2. Stallings, W. (2013). Wireless Communications and Networks. Pearson Education.
3. Molisch, A. F. (2011). Wireless Communications (2nd Edition). John Wiley & Sons.