

# ANALYSIS OF CONGESTION OF MOBILE NETWORK IN OFFA

## ABSTRACT

The study of congestion of mobile network in Offa is necessary as congestion remains a major challenge to telecommunication service provision both to service providers and the subscribers as well, even in developed country. Offa is a renowned city in Kwara State, Nigeria. Cellular wireless systems such as GSM suffer from congestion resulting in overall system degradation and poor service delivery. Obviously, subscribers are susceptible to quite network providers who fail to meet up with the services required of them. In this research, areas on the GSM network where congestion occurred were analyzed including the various causes of congestion on GSM network. This research work also brought to bear recommendation that necessitate the need for service providers to create a mutual benefit between the service providers and subscribers.

The tool used for data collection was a Five Point Likert attitude scale questionnaire. The Data collected for this study were analyzed using frequency counts, simple percentage (%) and mean score (x)

**Keywords:** Congestion, Mobile Network, GSM, Control Channel, Intra and Inter Congestion

## INTRODUCTION

In the global trend today the newest phone communication technology is the cellular telephone, which is known as the cell phone or simply mobile phone. A mobile phone is invented to give the user full liberty of movement. It is worth noting that in this regard, the number of mobile users keeps increasing daily and yearly at a reasonable progression. Therefore, the importance of mobile phones soar-up with the improvement in services render, reduction in service cost, and the range of services available. According to Mehrotra, 1997, mobile or simply cellular systems started in the United States with the release of the advanced mobile phone service (AMPS) system in 1983. Asia, Latin America, and Oceanic countries adopted the AMPS standard and started creating the largest potential market in the world for mobile phone.

Considering the early invented technology of mobile phone in the early 1980s, most mobile telephone systems were analog rather than digital (Kuboye B.M. et al, 2009). However, as recently witness in the country one can affirm that mobile technology has graduated in expedition from analog to digital. Digital system has a lot of benefits compare to analog type which include but not

39 limited to ease of signaling, lower levels of distortion and interference,  
40 integration of transmission and switching, and increased propensity to meet  
41 capacity demands. Nowadays the Global System for Mobile communications  
42 (GSM) adopted digital systems rather than the obsolete analog systems and uses  
43 digital data, which accommodates more subscribers even beyond one would  
44 imagine. Along the line, the GSM mobile telephone offers lots of advantages  
45 which include high quality voice communications and low bandwidth data  
46 connections for fax, short message service (SMS) and full dial-up connection to  
47 the Internet.

48 Also, many people are engrossed to GSM due to its unique mobility features.  
49 Thus, it has turned to a means of living for many people across the globe as they  
50 are getting involved in mobile phone-related ventures. In a nutshell, a network  
51 is a collection of computers, servers, mainframes, network devices, peripherals,  
52 or other devices connected to one another to allow the sharing of data  
53 (Computer Hope, 2017). The Mobile depots are now becoming complex  
54 entrenched systems, with rigorous real time necessities for signaling and voice  
55 processing (Scourias, 1997). Furthermore, the marketing strategies of the GSM  
56 network providers and competition to get many subscribers have lured lots of  
57 subscribers to mobile network communication, even though their infrastructures  
58 cannot sustain them. Some mobile network providers also complain that they  
59 pay an outrageous and huge sum of money to acquire licenses for operation in  
60 Nigeria, consequently the need for them to get as many subscribers as they can  
61 so as to recover their money. These and many more have led to congestion on  
62 the Nigerian GSM telecommunication systems. Congestion occurs when  
63 bandwidth is insufficient and network data traffic exceeds capacity”  
64 (Techopedia, 2017). Also, congestion is the unobtainability of the network to  
65 the subscriber at the time of making a call (Ani and Ogbuabor, 2015). Network  
66 congestion in data networking and queuing theory is the reduced quality of  
67 service that occurs when a network node is carrying more data than it can  
68 handle (Wikipedia, 2017). Thus, during network dimensioning process, there  
69 are some essential tasks to be well-thought-out. Switches need to be  
70 dimensioned in agreement with the projected desired capacity, taking for  
71 example, average conversation time, the need for signaling, projected number of  
72 handovers, location updates, short message distribution etc. (Ani and Ogbuabor,  
73 2015).

74 According to Kuboye B.M. et al, 2009, the following are areas of congestion in  
75 the GSM network: Common Control Channels (CCCH) - it consists of Random  
76 Access Channel (RACH), Paging Channels (PCH), and Access Grant Channel.  
77 As a matter of fact, on Common Control Channels congestion occur under three  
78 conditions, which are: Random Access Channel Congestion (RACHC), Paging  
79 Channel Congestion (PCHC) and Grant Channel Congestion (AGCHC). Thus,

80 when any of these three control channels is being congested, there cannot be  
81 any call launch between the sender and receiver. This failure is called a “Call  
82 Launch or Establishment Failure” (BoulMalf and Akhtar, 2003; Kuboye B.M. et  
83 al, 2009). Dedicated Control Channel Congestion (DCHC) also occurs when  
84 there is failure to allocate Stand-alone Dedicated Control Channel (SDCCH) to  
85 provide validation to mobile station, location updating and assignments to  
86 traffic channels during idle periods (Mehrotra, 1997). When making a call or  
87 replying to paging message for the sharing of an SDCCH for validation, if there  
88 is no vacant SDCCH to use at that time, then the call will be terminated abruptly  
89 (Boulmaif and Akhtar, 2003; Kuboye B.M. et al, 2009). Traffic channels  
90 congestion (TCHC), in this case Traffic channels (TCH) is used to transfer  
91 voice, data, and control information and when there is no vacant TCH, the voice  
92 communication on the GSM network cannot be authenticated (Kuboye B.M. et  
93 al, 2009). Pulse Code Modulation Congestion (PCMC): Pulse Code Modulation  
94 (PCM) is the link required to connect together the Base station (BS) and  
95 Mobile-switching center (MSC). Meanwhile, each PCM can carry between 1  
96 and 32 calls. When PCM is not vacant to carry the call signals between the BS  
97 and MSC, then we have Pulse Code Modulation Congestion (PCMC). This type  
98 of congestion can either occur within the network or between networks (Hartel  
99 et al., 1999; Kuboye B.M. et al, 2009).

100 One of the significances of this study is that it would use a market structure  
101 conduct performance context to evaluate the network congestion in Offa, Kwara  
102 State. It will also assist network providers to proffer salient solutions to those  
103 causes of congestion in the area under study and the entire country as a whole.  
104 Moreover, it will be a valuable tool for scholars, institutions and individual that  
105 wants to research into the congestion of network in a named city. It will as well  
106 serve as a point of reference for further studies. This research work evaluates the  
107 congestion of mobile network in Offa, Kwara State, Nigeria, in order to analyze  
108 the various causes of network congestion and to examine the factors that cause  
109 increase in the number of subscribers in the area under study. However, the  
110 study only covers analysis of congestion of mobile network in Offa, Kwara  
111 State. It specifically analyzes the location of congestion areas on GSM network  
112 in the city under study.

### 113 **LIMITATIONS OF THE STUDY:**

114 The limitations of this study therefore includes, the short duration given by the  
115 institution authority to cover this research work which does not allow for an in-  
116 depth coverage of all issue associated with the topic under study, and gathering  
117 of useful correlated information. Self-reliant information required in order to  
118 highlight and analyze some statement are not readily available, such as, the

119 actual number of subscriber per network provider in the area under study. Also,  
120 funding is additional excruciating limitation to an in-depth study of this topic.

121 **THE ENVISAGED CAUSES OF CONGESTION OF MOBILE**  
122 **NETWORK IN OFFA ARE STATED BELOW:**

123 **Inadequacy of Base Stations:**

124 Study shows that there is no adequate base stations in Offa presently, compare  
125 to the sizable number of subscribers that are patronizing each of the network  
126 operators. The numbers of subscribers to different networks providers has  
127 increased drastically because of the landslide reduction in the price of their  
128 network SIM card recently experienced in the area. However, the base stations  
129 do not had a matching increase as one will expect. The present ratio probably is  
130 about 8,000 subscribers to one base station.

131 **Inadequacy of the needed Channels:**

132 One will definitely expect to experience inadequate channels to support the  
133 subscribers and the service rolled out by the different operators in such area,  
134 since there are not enough base stations. Meanwhile, the channels usually  
135 determine the total number of subscribers that can be allowed to use a base  
136 station concurrently at any point in time (NCC, 2005). This track remains the  
137 same because any time a base station is added to their network; a high-level of  
138 promotion will be provided in order to lure more consumers.

139 **Competition for Subscribers among the Operators:**

140 Observation shows that the ulterior motive of GSM Providers in Nigeria, of  
141 which Offa is not exempted, is the profits they will effectually make from the  
142 subscriber base and not the overall quality of service they want to offer. Most of  
143 them falsify information and make fallacious advertisements all with the intent  
144 of luring customers to their network, whereas they lack basic infrastructure to  
145 satisfy subscribers' demands.

146 **Inadequacy of End-to-End System:**

147 Most Mobile Network operators in Nigeria are still relying on radio waves to  
148 convey speech and data from base stations to mobile switching centers. Usually,  
149 as far as microwave region is concern, radio wave signals are subject to certain  
150 interference that may emanate from other electromagnetic waves generating  
151 systems such as radio and television. It is possible that interference of such  
152 could cause call setup failure, call drop, or other impairment.

153 **Absence of Good Quality Phones:**

154 According to Electronic Design, 2008, common to any radio link  
155 telecommunication system; it is the radio link between mobile phone and base  
156 station that will be the weakest part of the communication system. However,  
157 provided conditions are not favorable, or the user transits into a tunnel during a  
158 call, there will be loss of connection.

159 Mobile Phone with better quality and higher frequency wave intensity will  
160 make a call more steady and shrink interference from another caller. This is  
161 supported by the parameter of the power control that links power between the  
162 terminal and base station. It is highly very necessary to maintain efficient power  
163 control so as to hold interference at a lowest.

164 **Inadequacy of Good Communication Terms between Different Networks:**  
165 Another colossal reason why there is poor inter-network communication is the  
166 incapability to reach a decision on the sharing ratio of the income between the  
167 network providers. Owing totally to this, the statistics of lines that are open for  
168 interconnectivity are lesser compared to the aggregate number of lines.

169 Also, condition such as congestion on the linking networks when a subscriber  
170 from a network A is calling from a network that is less congested to Network B,  
171 which is occupied to capacity; considering situation of such, the call will not  
172 definitely pass through the network.

173 **Marketing Strategies and Pricing Schemes:** The pricing schemes put in place  
174 by individual network providers also affect traffic behavior since this  
175 consequently increased the number of subscribers on the network.

#### 176 **FACTORS THAT FAVOR INCREASES IN THE SUBSCRIBERS IN** 177 **OFFA, KWARA STATE**

178 Study shows that the following factors drastically contribute towards increase in  
179 the subscriber base of each network in Offa, Kwara State.

180 **The Ease of Communication Offered by Mobile Phones:** Sizable number of  
181 people in Offa cheered the usage of GSM because it has solved the challenge of  
182 fading or attenuation during calls. Moreover, mobile phones are light and can be  
183 easily carried about from one place to another. In this regard, the noise and  
184 distortions caused by wired telephone are a bit eradicated.

185 **Elimination of Wired Connection:** The graduation from wired connection to  
186 wireless one allowed communication to be established in as much as the  
187 individual subscriber is within the cell area of his/her operator.

188 **Voice Quality Service:** Observation also shows that the quality of voice service  
189 experienced in Offa is far better than the analog wired service as a result of the

190 fact that it is not as vulnerable to distortion and interference as that of wired  
191 telephones.

192 **The Additional Data Service:** The additional data services available on GSM,  
193 such as SMS, browsing make communication easier for people and offer a  
194 wider array of options for network subscriber in Offa.

195 **The competitive reduction in the tariff:** There are competitions among  
196 network providers in Offa and the service rate for service remains the same,  
197 even with that of international service also remains the same, without increased  
198 tariff charges.

199 **The Low Acquisition Rate:** It is noted that the actual amount of money  
200 required for procuring a network line and phone is considerably lower than the  
201 one user(s) have to pay to have a wired NITEL telephone. Hence, this really  
202 attracted many new communication network GSM subscribers in the area.

## 203 **COMPLAINTS BY THE SUBSCRIBERS THAT ARE EVIDENT IN** 204 **OFFA**

205 Study shows that complaints from subscribers in Nigeria which that of Offa is  
206 not an exception include “If I try calling during the day, I often get the same  
207 message - ‘Network Busy’ or ‘Error in Network’ - even if the mobile phone at  
208 the other end is not being used” (Jonnes, 2005). However, research exposed the  
209 following messages as being regularly declared or displayed to the users by the  
210 GSM operators in Offa.

### 211 **From Etisalat Platform:**

212 “Error in connection”  
213 “The number you are calling is not available now”

### 214 **From MTEL Platform:**

215 “Number not responding”  
216 “Network temporary busy”

### 217 **From MTN Platform:**

218 “Error in connection”  
219 “Network busy”  
220 “The number you are calling is unavailable”  
221 “No network”

### 222 **From AIRTEL Platform:**

223 “Error in connection”  
224 “Network busy”

225 **From Globalcom Platform:**

- 226 "Network busy"  
227 "The number you have dialed is not on the Globalcom Network"  
228 "Error in connection"  
229 "No answer"  
230 "Number busy"  
231 "Not reachable at the moment; please try again later"

232 The above messages show the lack of support of our network operators to their  
233 individual subscribers. Those messages were observed to have been  
234 programmed into their equipment and it is guessed that they are selected  
235 probably randomly and declared to the users.

236 **AN OVER VIEW OF OFFA, KWARA STATE, NIGERIA:**

237 **Offa is an ancient town and at the same time, the Headquarters of Offa Local**  
238 **Government Area of Kwara State, Nigeria.** It is the second largest town in the  
239 state, and it is located in central Nigeria with geographic coordinates of 8°9N  
240 4°43E.

241 The city of Offa was founded by Olalomi Olofa-gangan; a crown prince from  
242 Oyo, and a direct descendant of king Oranmiyan in Ile-Ife, around 1395.  
243 Olalomi was a renowned hunter reputed for his skill as an archer. Offa is known  
244 as the traditional headquarters of Ibolu dialect of the Yoruba speaking people of  
245 Kwara and Osun States. Offa Local Government Area in its entirety has 5  
246 wards, namely; Essa, Ojomu, Balogun, Shawo and Igbo-Idun. Offa is the home  
247 of the legendary Moremi, the one who was said to be responsible for the defeat  
248 of the frequent marauders who stormed Ife, an ancient town and cradle of  
249 Yoruba race.

250 The new Olofa of Offa, a renowned king is Oba Alhaji Mufutau Mohammed  
251 Gbadamosi Okikiola Esuwoye II. The prominent knighted chiefs of Offa  
252 include Esa, Ojomu, Sawo and Balogun. The popular eulogy of Offa is "Ijakadi  
253 Loro Offa", a Yoruba phrase meaning "wrestling is our game". The city's  
254 mascot is the peacock bird which is one of the most prominent exotic avian  
255 species in the region.

256 The provincial figure for the population of Offa Local Government Area by the  
257 National population Commission (FRN official Gazette no24 of May, 2007  
258 Government Notice) is 89,674 comprising of 46,266 males and 43,428 females.  
259 Going by reputation, Offa is known as the home of sweet potatoes.

260 Education is the main industry of Offa people. Tertiary institutions in the town  
261 include the Federal Polytechnic, Kwara State College of Health Technology and

262 Nigeria Navy School of Health Science, School of Basic Studies, and National  
263 teachers Institute. Two private Universities are also springing up from Offa city.

## 264 **RESEARCH QUESTIONS**

265 The study would examine the following questions:

- 266 i. What have been the causes of network congestion in Offa?
- 267 ii. What do you think are the factors responsible for increase in the  
268 subscribers in Offa?

## 269 **FORMULATION OF HYPOTHESES**

270 Based on the objective of this study, following hypotheses were formulated.

271 **HA**= Alternative Hypothesis

272 **HN** = Null Hypothesis

### 273 **Hypothesis One**

274 HA: In Offa, there is network congestion

275 HN: In Offa, there is no network congestion

### 276 **Hypothesis Two**

277 HA: There is ease of communication offered by mobile phones to people in  
278 Offa.

279 HN: There is no ease of communication offered by mobile phones to people in  
280 Offa.

### 281 **Hypothesis Three**

282 HA: There is no enough Base Stations in Offa

283 HN: There is enough Base Stations in Offa

### 284 **Hypothesis Four**

285 HA: The available network channels are not sufficient

286 HN: The available network channels are sufficient

### 287 **Hypothesis Five**

288 HA: There is competition for subscribers among the network operators:

289 HN: There is no competition for subscribers among the network operators:



290 **Hypothesis Six**

291 HA: There is no enough End-to-End System

292 HN: There is enough End-to-End System

293 **Hypothesis Seven**

294 HA: There are no good communication terms between different networks in  
295 Offa.

296 HN: There are good communication terms between different networks in Offa.

297 **Hypothesis Eight**

298 HA: The elimination of wired connection has increased the number of  
299 subscribers per network

300 HN: The elimination of wired connection has not increased the number of  
301 subscribers per network

302 **Hypothesis Nine**

303 HA: The voice Quality Service rendered by network providers has increased  
304 subscriptions.

305 HN: The voice Quality Service rendered by network providers has not  
306 increased subscriptions.

307 **Hypothesis Ten**

308 HA: The competitive reduction in the tariff plan of each network provider  
309 contributed to increase in subscriptions experienced recently.

310 HN: The competitive reduction in the tariff plan of each network provider has  
311 not contributed to increase in subscriptions experienced recently

312

313 **RESEARCH METHODOLOGY**

314 This research work involves the study of wireless network communications  
315 including analog and digital system. Special attention was given to GSM as a  
316 digital communication system. A careful study of congestion in GSM was done.  
317 The points where congestion occurred on the GSM network were identified  
318 through observation of GSM stations such as MTN, Globacom, Airtel Etisalat  
319 and Mtel; and through the administering of questionnaires. During the survey of  
320 this study, the survey research design was adopted in collecting data. The tool  
321 used for data collection was a Five Point Likert attitude scale questionnaire. The  
322 Data collected for this study were analyzed using frequency counts, simple  
323 percentage (%) and mean score (x). However, a mean score of three (3) and  
324 above was used as a basis for successful outcome and regarded as an accepted  
325 mean to test research question, while a mean score of 2.99 and below was used

326 as a basis for unsuccessful outcome and regarded as rejection to test the research  
 327 question.

328 **PRESENTATION AND ANALYSIS OF DATA**

329 For the sake of this study, questionnaires were distributed. The total number of  
 330 questionnaires randomly distributed to respondents across five network  
 331 providers in Offa was 1000, using the simple random sampling method. The  
 332 network providers that the questionnaires cut across are MTEL, MTN,  
 333 GLOBACOM, ETISALAT and AIRTEL. The questionnaires were ensured to  
 334 be evenly distributed among the five network providers. Out of the 1000  
 335 questionnaires distributed, 960 were filled and returned which represent 96.0%  
 336 while 40 questionnaires were not returned, and represent 4.0% of the total  
 337 administered questionnaires. However, the total working figure for this study is  
 338 960.

339 The total population for this study consists of educational institutions like  
 340 Federal Polytechnic Offa, Offa, Kwara State, satellite campuses; and members  
 341 of the general public in Offa.

342 The outcomes of data collected are as tabulated below:

343 **TABLE 2: Respondents' Response to Questionnaire**

Variables	SA	A	SD	D	U	Total	Mean (X)
In Offa, there is network congestion	250 26.0%	582 60.6%	62 6.5%	48 5.0%	18 1.9%	3878 100%	4.04
There is ease of communication offered by mobile phones to people in Offa	191 20.0%	658 68.5%	10 1.0%	101 10.5%	-	3819 100%	3.98
There is enough base stations in Offa	-	485 50.5%	-	293 30.5%	182 19.0%	2708 100%	2.82
The available network channels are not sufficient	170 17.7%	652 67.9%	70 7.3%	18 1.9%	50 5.2%	3754 100%	3.91
There is competition for subscribers among the network operators	357 37.2%	562 58.5%	-	25 2.6%	16 1.7%	4099 100%	4.27
There is enough End-to-End System	-	487 50.7%	-	262 27.3%	211 22.0%	2683 100%	2.79
There are good communication terms between different networks in Offa.	72 7.5%	155 16.1%	468 48.8%	169 17.6%	96 10.0%	2818 100%	2.94

The elimination of wired connection has increase the number of subscribers per network	196 20.4%	502 52.3%	140 14.6%	119 12.4%	3 0.3%	3649 100%	3.80
The voice Quality Service rendered by network providers has increased subscriptions.	203 21.1%	590 61.5%	156 16.3%	11 1.1%	-	3865 100%	4.03
The competitive reduction in the tariff plan of each network provider contributed to increase in subscriptions experienced recently	177 18.4%	596 62.1%	118 12.3%	49 5.1%	20 2.1%	3741 100%	3.90

344

345 From the above table 2, “SA” stands for Strongly Agree, “A” stands for Agree,  
346 “SD” stands for Strongly Disagree, “D” stands for Disagree and “U” stands for  
347 Undecided.

### 348 SUMMARY OF FINDINGS

349 Technically, congestion within network is referred to as intra- congestion, while  
350 congestion between different networks is referred to as inter- congestion.

351 The incomplete calls are referred to as call-drop or call-break within networks.  
352 Call-drop means the two parties in dialogue were unable to end-up their  
353 discussion. This means that the call was brusquely terminated. However, study  
354 shows that:

- 355 1. In Offa, there is network congestion.
- 356 2. There is ease of communication offered by mobile phones to people in  
357 Offa.
- 358 3. There are no enough base stations in Offa;
- 359 4. The available network channels are not sufficient.
- 360 5. There is competition for subscribers among the network operators
- 361 6. There is no enough End-to-End System
- 362 7. There are no good communication terms between different networks in  
363 Offa
- 364 8. The elimination of wired connection has increase the number of  
365 subscribers per network.
- 366 9. The voice Quality Service rendered by network providers has increased  
367 subscriptions.

368 10. The competitive reduction in the tariff plan of each network provider  
369 contributed to increase in subscriptions experienced recently.

## 370 **CONCLUSION**

371 Base on this research work, congestion is a menace that has devastated GSM  
372 network in Offa, Kwara State, Nigeria. Scholars have been trying their best to  
373 ensure that it is brought under control. Mobile Service Switching Center (MSC),  
374 Base Station Controller and base station site in order to minimize congestion is  
375 needed in Offa. The bench mark created by the international telecommunication  
376 union has not been achieved even in the developed nations, a reason being that  
377 service providers are bent on making fabulous gains instead of satisfying their  
378 customers. Sequel to this, GSM service provider in the country should ensure  
379 they stop pursuing excess money at the detriment of their subscribers. This will  
380 go a long way to stabilize good communication system in the area under study  
381 and by extension to the entire country

## 382 **RECOMMENDATION**

383 It is necessary that network providers have reliable goals for the attainment of  
384 good quality and high performance network in Offa, Kwara State, Nigeria.  
385 There is need for integrated network architecture design that will show how the  
386 different services will be implemented as well as what equipment will be  
387 needed at each point. Also, a preliminary roll out plan should be included. There  
388 should be provision of more Mobile Service Switching Center (MSC), Base  
389 Station Controller and base station site in order to minimize congestion.  
390 Logistics such as detailed network planning, computer aided design system and  
391 tools are to be made available for coverage prediction, interference analysis,  
392 frequency planning, microwave link planning and documentation.

393 Furthermore, there is need for government to be moderate in the area of tax  
394 levying network providers in the country in order to enjoy congestion free and  
395 good communication system across the country. On this note, the Nigerian  
396 government should involve stakeholders, such as, Nigerian Labour Congress  
397 and Civil Society Organization officials in matters of importance regarding  
398 policy making, design, development and implementation in all areas of  
399 governance, most especially, the policy of taxation on foreign investors such as  
400 network providers.

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