Bharti Airtel Limited's Response to TRAI's Consultation Paper on "Duration of alert for the called party"

At the outset, we would like to thank the Authority for providing us the opportunity to submit our response to the Consultation paper on the issue of "Duration of alert for the called party."

The issue has recently gained prominence due to unilateral reduction in Originating Exchange Timer by one operator to an abysmally low value of 20 seconds, which has further resulted into a substantial drop in Answer-to-Seizure Ratio (ASR) and degradation in customer experience. This has also led to the gaming of IUC by artificially skewing the call traffic symmetry between two networks, causing a huge loss to other operators.

Further, due to this Originating Exchange Timer being less than Terminating Exchange Timer, the Called party was being deprived of the facility of Call Forwarding feature in case of No Reply and Voice mail. This also resulted in gaming the IUC payouts by converting these outgoing calls to incoming calls, which is ultimately causing a huge loss of revenue to Airtel.

Despite our repeated requests since last 7-8 weeks, neither has the said operator been directed to restore the timer to its original value nor any general direction has been issued to all operators to set the timer at a unform value.

Therefore, we also had to reduce the Orininating Exchange Timer to 25 seconds in our network. While, we realize that this may cause inconvenience to customer, however, in absence of any direction from TRAI and to prevent further loss of IUC, we are not left with no other option than to reduce the timer in our network as well.

We believe that the called customer has a right to be allowed enough time to be able to attend to a phone call and that such time should be kept considering all category of customers. Till recently, $T_{RINGING\_TERMINATION}$ was set at 45 seconds in network and had been working fine. We look forward to TRAI's directions which duely considers customer convenience and the ringing timer values are restored back to the prior values for all the operators.

In this context, please find our detailed submissions on the issues raised in the Consultation Paper:

Q1 Can the arbitrary value of $T_{RINGING}$ impacts consumer experience? Please give your views with detailed justifications.

Bharti Airtel's Response:

The call ringing timer value set by the service provider of the calling party is known as the Originating Exchange Timer ($T_{RINGING\_ORIGINATION}$) and the call ringing timer value set by the service provider of the called party is know as Terminating Exchange Timer ($T_{RINGING\_TERMINATION}$). Setting these timers would determine the time period for the connection to be forced release if an answer signal is not received.

Generally, in case of no answer by the called party, the terminating exchange disconnects the call. The value of $T_{RINGING\_TERMINATION}$ is commonly set around 45 seconds which implies that if the call is not answered by the called party, the said call will be disconnected/ force released by the terminating exchange or the call will be forwarded to a designated number or voice mail in case of no reply if the same has been set by the customer.

Further, the $T_{RINGING\_ORIGINATION}$ is recommended to be set at a higher value of approx. 1.5-3 min (as per TEC/ ITU specifications) than $T_{RINGING\_TERMINATION}$ which is set at around 45 seconds so that the call is disconnected by the terminating exchange only. The $T_{RINGING\_ORIGINATION}$ is only triggered in case the terminating exchange does not return any signal to the originating exchange.

An arbitrary value of $T_{RINGING}$ whether originating or terminating can significantly impact the consumer experience. A lower value $T_{RINGING}$ usually results in early release of the calls when the called parties intend to answer.

Further, lower value of $T_{RINGING}$ will result in :

a) <u>Degradation of Consumer Experience</u>: The Consumer experience will degrade if the $T_{RINGING}$ is very low. It will lead to:
   - Increase in the number of Missed Calls on the Terminating Network
   - Not providing sufficient time to the Receiving Party to answer the call. For example, the Receiving Party may be busy, driving or simply on another call at that point of time.
   - Called party also having to call back the Calling party on seeing the missed call, creating major inconvenience for both the Calling and Called parties.

b) <u>Called party being deprived of the following alternatives:</u> If $T_{RINGING\_ORIGINATION}$ is lower as compared to $T_{RINGING\_TERMINATION}$, called party is deprived of the following alternatives:
   - Call Forwarding on No Reply
   - Voicemail

To summarize, a lower value of $T_{RINGING}$ whether originating or terminating will result in higher incidence of missed calls in cases where the called party is not able to answer, increase in call attempts to reach out to the called party and the called party calling back to the calling party on seeing the missed calls, thereby, adversely impacting the consumer experience as well as Network QoS. Further, if originating operator sets $T_{RINGING\_ORIGINATION}$ lower as compared to $T_{RINGING\_TERMINATION}$ set by the terminating operator**,** than it will result in the Called party customer being deprived of the alternatives such as Call Forwarding on No Reply and Voicemail.

Further, an arbitrary value for $T_{RINGING}$ may create a chain reaction wherein each access service provider will further reduce the value of $T_{RINGING\_ORIGINATION}$ in comparison to other

access service providers. Such a scenario would be contrary to the interest of the subscribers and would impact the overall network performance in terms of decreased Answer-to-Seizure Ratio (ASR).

If different operators start setting different values for $T_{RINGING}$, it would create a massive shift in MoU-Incoming & MoU-Outgoing, thereby artificially skewing the call traffic symmetry between two networks.

Hence, we are of the opinion that low $T_{RINGING}$ (at both originating as well as terminating ends) directly impacts the customer experience, therefore, standardizing the $T_{RINGING}$ value at both originating and terminating ends is paramount at this stage and $T_{RINGING\_ORIGINATION}$ should be higher as compared to $T_{RINGING\_TERMINATION}$.

Q2   How to discover the appropriate values of $T_{RINGING}$ from customer's perspective? What may be the guidelines to be followed when configuring specific values of relevant timers in the originating and terminating networks to achieve TRinging? Please give your views with detailed justifications.

Bharti Airtel's Response:

In this regard, we would like to reinstate Clause 27.3 of the License, which states that interconnection between the networks of different licensees for carrying traffic shall be as per national standards of CCS No. 7 as amended by TEC from time to time:

> *"27.3 Interconnection between the networks of different Licensees for carrying circuit switched traffic shall be as per **national standards of CCS No.7 as amended from time to time by Telecom Engineering Centre (TEC)** and also subject to technical feasibility and technical integrity of the Networks and shall be within the overall framework of interconnection regulations/ directions/ orders issued by the TRAI/ Licensor from time to time…"*

A perusal of TEC's National CCS 7 Standards for MTP and ISUP (SD/CCS-02/03.Jan2000) with respect to release of connection (*by originating network*) on failure to receive an answer message would show that the standards/prescribed for the release timer should be in the range of **1.5-3 minutes**. However, these standards only allow this period to be reduced to 1 minute, in case of administration with the ability to discriminate call answers. Further, TEC has based its standards on ITU-T recommendation Q.764 and Q.118. (*Annexure – I shows the clear linkages between TEC's National CCS7 Standards for MTP and ISUP (SD/CCS-02/03.Jan2000) and ITU-T standards Q.764 & Q.118*)

The appropriate value of ringing timer should depend on the analysis of the impact of ringing duration on the percentage of subscribers. For instance, in case of Airtel the $T_{RINGING\_TERMINATION}$ is set at 45 seconds. In such a scenario, the normal Answer to Seizure Ratio for the network is around 50% thereby implying that out of 100 call attempts 50 calls are answered in 45 seconds. Sample analysis carried out from traces of approximately 28 million

calls by Airtel wherein terminating timer has been set at 45 seconds have led to the following findings:

Ringing Duration (seconds)	% age of calls Answered as per the analysis	% Drop in Network Incoming ASR with present 50% ASR at 45 seconds	No. of calls answered out of every 100 calls till the outer range of ringing duration	No. of calls converted to missed calls till the outer range of ringing duration	% of calls converted to missed calls till the outer range of ringing duration
Between 0-19	83.50%	16.40%	41.8	8.2	16.40%
Between 20-29	6.60%	9.80%	45.1	4.9	9.80%
Between 30-39	4.60%	5.20%	47.7	2.6	5.20%
Between 40-45	5.20%	0%	50.0	0.0	0%

Based on the above analysis, it is evident that a reduction in $T_{RINGING}$ from 45 second to 20 seconds will result in a drop of ASR by 16.4% and consequent 16.4% missed calls which otherwise would have been answered in case $T_{RINGING}$ was 45 seconds.

We believe that the called customer has a right to be allowed enough time to be able to attend to a phone call and that such time should be kept considering all category of customers. Till recently, $T_{RINGING\_TERMINATION}$ was set at 45 seconds in network and had been working fine, we recommend that the same shoule be continued.

In view of the findings above, we are of the opinion that $T_{RINGING\_TERMINATION}$ timer be set to 45 seconds. This will significantly improve the customer experience by ensuring the completion of approximately 16.5% more calls in comparison to the 20-second timer value for $T_{RINGING\_ORIGINATION}$ set by one of the operators.

It is further submitted that the value of $T_{RINGING\_ORIGINATION}$ should be greater than $T_{RINGING\_TERMINATION}$ to enable optimum utilization of services such as Call Forwarding on No Reply, Voicemail, etc.

We would also like to highlight that the recent reduction in $T_{RINGING\_ORIGINATION}$ to 20 seconds by one of the service providers has resulted in:

- 17% of calls from that operators' network remaining unanswered at Airtel's network.
- Significant dip in Incoming ASR at Airtel's Network
- Higher outgoing MOUs from Airtel's network to the said operator due to conversion of incoming calls to outgoing calls i.e. artificially skewing the call traffic symmetry between the two networks
- Impact on IUC payouts to the said operator

As per our analysis, reduction in $T_{RINGING\_ORIGINATION}$ to 20 seconds by the operator w.e.f. 6th July 2019 has resulted in significant variation in the incoming to outgoing call ratio between Airtel and the said operator. The ratio which was **62.6:37.4** (Other TSPs I/c : O/g) before 6th July 2019, has turned **59.7:40.2.** An overall change of approx. **5.7% [(62.6-37.4)% – (59.7-40.2)%]** consequent to reduction in $T_{RINGING\_ORIGINATION}$ w.e.f. 6th July, 2019. This has not only caused a huge inconvenience to the customers, but has also resulted in major financial loss of approx. **25-30 Crores per month** to Airtel due to an additional **132 million MOUs/day** getting terminated at other TSPs' network from Airtel's network.

In view of the above, we recommend the $T_{RINGING\_TERMINATION}$ timer to be set at 40 seconds and value of $T_{RINGING\_ORIGINATION}$ should be set higher than $T_{RINGING\_TERMINATION}$.

Q3 **Is there a requirement to configure values of timers related to ringing in a uniform manner across the networks or is there also a requirement to maintain additional time margins for the timer in the originating network with respect to the typical values of timer configured in the terminating networks? Please suggest typical values for TRinging along with supporting data and explain with detailed justifications.**

Bharti Airtel's Response:

Originating Exchange Timer ($T_{RINGING\_ORIGINATION}$) should always be higher than the Terminating Exchange Timer ($T_{RINGING\_TERMINATION}$) with standardized values for all access service providers. If the terminating network sets the timer value more than or equal to the origination network, it will lead to failure of services such as Call forwarding on No Answer or Voicemail as the Terminating exchange will not be able to forward the call or send it to voicemail owing to the lack of adequate ring time. Hence, we reiterate that both $T_{RINGING\_ORIGINATION}$ and $T_{RINGING\_TERMINATION}$ should be standardized.

Further, we would also recommend to have the following values for ring timers as the standard:

- $T_{RINGING\_TERMINATION}$ ~ 45 seconds
- $T_{RINGING\_ORIGINATION}$ ~ 75 seconds (30 seconds more than $T_{RINGING\_TERMINATION}$)

The additional 30 seconds between $T_{RINGING\_ORIGINATION}$ and $T_{RINGING\_TERMINATION}$ will help in Call forwarding on No answer to the terminating user.

Q4 **Whether customers need to be offered options to change or modify the duration of ringing time particularly for them? If yes what should be the typical range of values within which one can set the values and what should be the granularity to make such a change? To modify values, What procedure is suggested to be followed by the customer to make such changes? Please give your views with detailed justifications.**

Bharti Airtel's Response:

In case of an originating call, the duration till which the calling party intends to wait for the called party to answer the call is under its direct control. This means that the calling party can terminate the call simply by pressing the disconnection button on their mobile or landline. Therefore, there is no justification/need for the calling party to change or modify the duration of ringing time particularly for them.

No operator should be allowed to assume the behaviour of the customer or to play on behalf of originating customer and disconnect the call. Disconnection of calls should be in control of the calling customer as far as originating operator is concerned. Originating customer can always take the decision of when to disconnect the call and therefore no timer value is required to the originating customer. But to optimally use the resources and reduce the impact on customer experience, we suggest the Originating Exchange timer be set to 70 Seconds.

Further, we also do not recommend setting user-based terminating timer for Indian consumer base as features like Voicemail are not widely used in the country. It is further submitted that in all the international instances, the operators are facilitating setting the terminating exchange timer to the called subscriber and it is not disconnection triggered by originating operator.

Internationally, setting the user based terminating timer is provisioned for managing the voicemail services based on the customer preference. Customers have been given the option of setting the timer values based on either the number of rings or seconds. AT&T provide the user with terminating timer value of upto 36 seconds & Vodafone UK provides upto 30 seconds and Optus Australia provides the timer value of upto 30 seconds in various multiple increments starting from 5/6 seconds. The practices adopted by international operators cannot be justified for use by the Indian subscribers as the voice mail service is not widely used. For services like call forwarding as well, the operator defined terminating timer suffices the requirement.

Q5 **How to discover the appropriate values of percentage of calls that can be force released by the network i.e. value of CREL, which may be acceptable in general from customer's perspective? How this value affects with the changes in value of the TRinging? Please suggest typical values for CREL along with supporting data and explain with detailed justifications.**

Bharti Airtel's Response:

Please refer to our response to question no.2

Q6 **How the impact on the utilization of different types of telecommunication resources such as radio spectrum, point of interconnect etc. may be assessed due to the change in the values of timers, related to duration of ringing, configured at originating network or at terminating network? Please provide details of computation**

methodology to make such assessment along with supporting data to justify the suggested value of TRinging.

Bharti Airtel's Response:

As per our calculations, the Impact on Spectrum Capacity would be as below:

S No	Increase in Ringing timer from	Impact on Spectrum capacity assuming 100% voice on LTE (as in case of 4G only operator)	Impact on Spectrum capacity assuming 35% voice on LTE & remaining on 2G/3G
1	25 sec to 30 sec	0.13%	0.14%
2	30 sec to 35 sec	0.10%	0.11%
3	35 sec to 40 sec	0.08%	0.08%
4	25 sec to 40 sec (cumulative impact)	0.31%	0.35%

These calculations are based on the VoLTE, 3G and 2G network design parameters in which 1 MoU is approx. 1 Mb. A detailed calculation and assumption of the same is enclosed herein as Annexure - II.

Without prejudice to our submissions above and in the IUC consultation and litigations, we would like to bring to the notice of the Authority that in 2017, during the consultation paper on MTC and its subsequent presentation, the said operator, which has reduced its originating ringing timer, submitted that the network is primarily data network with around 2% of network resources used for voice services.

- In a January 2019 press release, the said operator declared the average data consumption per user per month to be 10.8 GB and average voice consumption as 794 minutes per user per month.

- With a usage of 1 MB per 4 minutes i.e. best effort network instead of a managed network (as claimed by that operator during IUC consultation), the total usage of resources on the said operators' network for Voice can be calculated as 1.76% [198.5MB/(10.8GB+198.5MB)], which is quite close to the operator's own estimates.

- While we don't agree with that operator's submission and calculation methodology presented during MTC/IUC consultation wherein it had treated VoLTE as a best effort service instead of a managed service, we take their own assumptions forward that an increase in timer will result in a increase by a mearge amount on overall network capacity including spectrum as per below:

S No	Increase in Ringing timer from	Increase in Voice Capacity Utilization (as per our estimates in Annexure – II) (A)	Impact on Spectrum capacity B = (1.76% X A)
1	25 sec to 30 sec	0.5%	0.009%
2	30 sec to 35 sec	0.4%	0.007%
3	35 sec to 40 sec	0.3%	0.005%
4	25 sec to 40 sec (cumulative impact)		0.021%

It is further brought to the notice of the Authority that if the timer values have such a significant impact on network and spectrum resources utilization, the said operator should have resorted to reduction in incoming terminating timer as well in its network. **As on date, a subscriber calling the operator's network gets disconnected after 55-60 seconds. If resource utilization was such a critical aspect for reduction in the originating ringing timer, the same logic should be applied to the terminating ringing timer, which hasn't been altered at all by that operator.**

In view of the same, it is evident that reduction in the originating ringing timer has little to no impact on the network/ spectrum resources and the advantages of having a higher outgoing originating timer outweigh savings, if any, on network resources.

Q7 Whether networks can be adaptive by utilizing Artificial Intelligence (AI) and Machine Learning (ML) techniques to discover appropriate value of ringing duration specific to a subscriber or class of subscriber? Whether networks can also differentiate commercial calls from normal calls from the perspective of ringing duration? Please provide inputs and give your views with detailed justifications.

Bharti Airtel's Response:

Based on the outcome of standardization of $T_{RINGING}$ values at both terminating and originating ends, we can explore solutions such as Artificial Intelligence (AI) and Machine Learning (ML) in future if the customer experience is not improved and issue is still not resolved.

Q8 Any other issue which is relevant to this subject?

Bharti Airtel's Response:

No Comments.

A. License Condition:

- Clause 27.3 of the license states that interconnection between the networks of different licensees for carrying traffic shall be as per national standards of CCS No. 7 as amended by TEC from time to time:

    *"27.3 Interconnection between the networks of different Licensees for carrying circuit switched traffic shall be as per **national standards of CCS No.7 as amended from time to time by Telecom Engineering Centre (TEC)** and also subject to technical feasibility and technical integrity of the Networks and shall be within the overall framework of interconnection regulations/ directions/ orders issued by the TRAI/ Licensor from time to time. For inter-networking between circuit switched and IP based network, the Licensee shall install Media Gateway Switch. Further, the Licensor may direct the LICENSEE to adopt any other technical standards issued by TEC on interconnection related issues.*

B. National Standards of CCS No. 7 BY Telecom Engineering Centre (TEC):

- National CCS7 Standards for MTP and ISUP has been published by TEC vide document no. SD/CCS-02/03.Jan2000.
- In the said document, the condition connection release in case an answer signal is not received is defined in **'Abnormal conditions' – Other failure conditions**
- Clause 5.4.1 of the TEC Standards state as below:

    (g) The facilities listed in Table 27 of this document for 'Abnormal conditions' shall be provided as per clause 2.9 of ITU-T Recommendation Q.764.

- Table 27 of the TEC standards refer to **Clause 2.9.8 of ITU-T Rec. Q.764** for further details:

Facility	Clause of ITU-T Rec.Q.764
Dual seizure: Method-2 shall be used.	2.9.1
Transmission alarm handling for digital inter-exchange circuits.	2.9.2
Reset of circuits and circuit groups	2.9.3
Failure in the blocking/unblocking sequence	2.9.4
Receipt of unreasonable signalling information messages	2.9.5
Failure to receive a "release complete" message – Timer T1 and T5	2.9.6
Failure to receive a response to an information request message	2.9.7
Other failure conditions	2.9.8

C. ITU-T Recommendations Q.764:

- Reference invited to sub-clause 3 under 2.9.8 as mentioned in ITU standards which state as below[1]:

  "2.9.8.3 Abnormal release conditions

  If the conditions for normal release as covered in 2.3 are not fulfilled, release will take place under the following conditions:

  a) Outgoing international or national controlling exchange The exchange shall:

  – release all equipment and the connection on failure to meet the conditions for normal release of address and routing information before 20-30 seconds after sending the latest address message;

  *– **release all equipment and release the connection on failure to receive an answer message within time T9 specified in ITU-T Q.118 [10] after the receipt of the address complete message.** The call is released in the backward direction with cause value #19 (no answer from user; user alerted).*

- Clause 2.9.8.3 refers to time T9 specified in **ITU-T Q.118** as stated below:

Table A.1/Q.764 – Timers in the ISDN user part *(continued)*

Symbol	Time-out value	Cause for initiation	Normal termination	At expiry	Reference
T9	Interval specified in ITU-T Q.118 [10]	When national controlling or outgoing international exchange receives ACM.	At the receipt of answer.	Release connection send back release message.	2.1.4 2.1.7 2.9.8.3

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[1] https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Q.764-199912-I!!PDF-E&type=items

D. ITU-T Recommendations Q.118:

- A perusal of ITU-T recommendations Q.118 clearly indicates that in case an answer signal is not received by an outgoing exchange within a period of 1.5-3 minutes, the connection can be released. Further, it only allows for this period to be reduced to 1 min in case the administration with the ability to discriminate call answers.

> *1 Answer signal not received by an outgoing exchange after receiving a number-received signal or number-received information (Systems No. 4 and R2) or after receiving an address complete signal (Systems No. 6 and No. 7) or after transmitting the ST signal (System No. 5)*
>
> *It is recommended that arrangements should be made, either in the national network of the outgoing country or at the outgoing international exchange,* ***for the connection to be released if an answer signal is not received within a delay period of 1.5 to 3 minutes*** *as soon as it is known, or can be assumed, that the called subscriber's line has been reached. In addition, Administrations* ***with ability to discriminate call answers may adopt a shorter interval which may be as low as 1 minute***. *However, this will require bilateral agreement.*

From above, it is clearly established that a licensee is mandated via National Standards on CCS7 and the connection should not be released if an answer signal is not received within a delay period of **1.5-3 min**. Further, it only allows for this period to be reduced to 1 min in case the administration with the ability to discriminate call answers.

Impact on Spectrum Capacity while increasing outgoing ringing timer from 25s to 30s

Assumptions Considered

Assumptions	Value
% Call ringing beyond 30 Seconds	10%
% Call ringing beyond 25 Seconds	14%
Average Call mean holding time	1.5 Minutes
LTE Voice capacity at 100% voice usage per 5 MHz carrier	150 Erlangs
3G Voice capacity at 100% voice usage per 5 MHz carrier	100 Erlangs
2G Voice capacity at 100% voice usage per 5 MHz carrier	50 Erlangs
ASR ratio for calls between 25 s to 30 s ringing	20%

Network Capacity Reference

Technology	Carrier BW (MHz)	Site Voice Capacity (Erlangs)	MOU (Minutes)	Mean Holding Time (Minutes)	Total Voice Capacity (No. of Calls)	Equivalent MOU in 30s Ringing Time (Minutes)	Equivalent MOU in 25s Ringing Time (Minutes)
FDD	5	150	9000	1.5	6000	0.5	0.42
2G	5	50	3000	1.5	2000	0.5	0.42
3G	5	100	6000	1.5	4000	0.5	0.42

Delta Capacity used in 25 Second & 30 Second Ringing time

0.5% additional capacity used by increasing Call ringing time from 25 seconds to 30 seconds

Technology	% Missed Calls		Total Missed Call MoU (30sec)	Total Missed Call MoU (25sec)	%Capacity used for ringing		
	30 Sec	25 Sec			Ringing timeout of 30sec	Ringing timeout of 25sec	Delta 25 to 30 sec
LTE	13.2%	14%	396	350	4.4%	3.9%	0.5%
2G	13.2%	14%	132	117	4.4%	3.9%	0.5%
3G	13.2%	14%	264	233	4.4%	3.9%	0.5%

Impact on Spectrum Capacity

Technology	% Spectrum used for Voice		% Spectrum impact		% Spectrum on 2G, 3G & 4G		%Spectrum Impact (Weighted)	
	100% of Voice traffic on LTE	35% Voice traffic on LTE	100% Voice on LTE	35% Voice on LTE	100% Voice on LTE	35% Voice on LTE	100% Voice on LTE	35% Voice on LTE
LTE	25%	8.8%	0.13%	0.04%	100%	78.0%	0.13%	0.03%
2G		100%	0.00%	0.51%	0%	11.0%	0.00%	0.06%
3G		90%	0.00%	0.46%	0%	11.0%	0.00%	0.05%
							0.13%	**0.14%**

- **0.13**% impact on spectrum capacity by increasing ringing time from 25 to 30 second assuming 100% voice on LTE network
- **0.14**% impact on spectrum capacity by increasing ringing time from 25 to 30 second assuming 35% voice on LTE & rest on 2G/3G

Impact on Spectrum Capacity while increasing outgoing ringing timer from 30s to 35s

Assumptions Considered

Assumptions	Value
% Call ringing beyond 35 Seconds	7%
% Call ringing beyond 30 Seconds	10%
Average Call mean holding time	1.5 Minutes
LTE Voice capacity at 100% voice usage per 5 MHz carrier	150 Erlangs
3G Voice capacity at 100% voice usage per 5 MHz carrier	100 Erlangs
2G Voice capacity at 100% voice usage per 5 MHz carrier	50 Erlangs
ASR ratio for calls between 30 s to 35 s ringing	15%

Network Capacity Reference

Techno logy	Carrier BW (MHz)	Site Voice Capacity (Erlangs)	MOU (Minutes)	Mean Holding Time (Minutes)	Total Voice Capacity (No. of Calls)	Equivalent MOU in 35s Ringing Time (Minutes)	Equivalent MOU in 30s Ringing Time (Minutes)
FDD	5	150	9000	1.5	6000	0.58	0.50
2G	5	50	3000	1.5	2000	0.58	0.50
3G	5	100	6000	1.5	4000	0.58	0.50

Delta Capacity used in 30 Second & 35 Second Ringing time

0.4% additional capacity used by increasing Call ringing time from 30 seconds to 35 seconds

Technology	% Missed Calls		Total Missed Call MoU (35sec)	Total Missed Call MoU (30sec)	%Capacity used for ringing		
	35 Sec	30 Sec			Ringing timeout of 35sec	Ringing timeout of 30sec	Delta 30 to 35 sec
LTE	9.6%	10%	334	300	3.7%	3.3%	0.4%
2G	9.6%	10%	111	100	3.7%	3.3%	0.4%
3G	9.6%	10%	223	200	3.7%	3.3%	0.4%

Impact on Spectrum Capacity

Technol ogy	% Spectrum used for Voice		% Spectrum impact		% Spectrum on 2G, 3G & 4G		%Spectrum Impact (Weighted)	
	100% of Voice traffic on LTE	35% Voice traffic on LTE	100% Voice on LTE	35% Voice on LTE	100% Voice on LTE	35% Voice on LTE	100% Voice on LTE	35% Voice on LTE
LTE	25%	8.8%	0.10%	0.03%	100%	78.0%	0.10%	0.03%
2G		100%	0.00%	0.38%	0%	11.0%	0.00%	0.04%
3G		90%	0.00%	0.34%	0%	11.0%	0.00%	0.04%
							0.10%	**0.11%**

- **0.10%** impact on spectrum capacity by increasing ringing time from 30 to 35 second assuming 100% voice on LTE network

- **0.11%** impact on spectrum capacity by increasing ringing time from 30 to 35 second assuming 35% voice on LTE & rest on 2G/3G

Impact on Spectrum Capacity while increasing outgoing ringing timer from 35s to 40s

Assumptions Considered

Assumptions	Value
% Call ringing beyond 40 Seconds	5%
% Call ringing beyond 35 Seconds	7%
Average Call mean holding time	1.5 Minutes
LTE Voice capacity at 100% voice usage per 5 MHz carrier	150 Erlangs
3G Voice capacity at 100% voice usage per 5 MHz carrier	100 Erlangs
2G Voice capacity at 100% voice usage per 5 MHz carrier	50 Erlangs
ASR ratio for calls between 35 s to 40 s ringing	10%

Network Capacity Reference

Technology	Carrier BW (MHz)	Site Voice Capacity (Erlangs)	MOU (Minutes)	Mean Holding Time (Minutes)	Total Voice Capacity (No. of Calls)	Equivalent MOU in 40s Ringing Time (Minutes)	Equivalent MOU in 35s Ringing Time (Minutes)
FDD	5	150	9000	1.5	6000	0.67	0.58
2G	5	50	3000	1.5	2000	0.67	0.58
3G	5	100	6000	1.5	4000	0.67	0.58

Delta Capacity used in 35 Second & 40 Second Ringing time

0.3% additional capacity used by increasing Call ringing time from 35 seconds to 40 seconds

Technology	% Missed Calls		Total Missed Call MoU (40sec)	Total Missed Call MoU (35sec)	%Capacity used for ringing		
	40 Sec	35 Sec			Ringing timeout of 40sec	Ringing timeout of 35sec	Delta 35 to 40 sec
LTE	6.8%	7%	272	245	3.0%	2.7%	0.3%
2G	6.8%	7%	91	82	3.0%	2.7%	0.3%
3G	6.8%	7%	181	163	3.0%	2.7%	0.3%

Impact on Spectrum Capacity

Technology	% Spectrum used for Voice		% Spectrum impact		% Spectrum on 2G, 3G & 4G		%Spectrum Impact (Weighted)	
	100% of Voice traffic on LTE	35% Voice traffic on LTE	100% Voice on LTE	35% Voice on LTE	100% Voice on LTE	35% Voice on LTE	100% Voice on LTE	35% Voice on LTE
LTE	25%	8.8%	0.08%	0.03%	100%	78.0%	0.08%	0.02%
2G		100%	0.00%	0.30%	0%	11.0%	0.00%	0.03%
3G		90%	0.00%	0.27%	0%	11.0%	0.00%	0.03%
							0.08%	**0.08%**

- **0.08**% impact on spectrum capacity by increasing ringing time from 35 to 40 second assuming 100% voice on LTE network

- **0.08**% impact on spectrum capacity by increasing ringing time from 35 to 40 second assuming 35% voice on LTE & rest on 2G/3G