Analysis of LTE Network Optimization

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Abstract

This paper analyzes the key technologies of network optimization through the typical cases of actual LTE network engineering optimization, analyzes the causes of common problems in the network, finds out the factors that affect the network quality through parameter collection and data analysis, and makes the network reach the best operating state through technical means and parameter adjustment, finally meeting the needs of the customer market.

Keywords

Network Optimization; Communication Technology; Mobile Network.

1. Introduction

At present, China Mobile's 2G and 3G networks are built in large scale in the three major communication operators. So far, the total number of mobile users is 1.36 billion, and the number of Internet users is about 1.1 billion, and the data continues to increase. Mobile has established TD-LTE test network in multiple locations. However, the problems caused by the increase of this test point are becoming increasingly prominent, and the mutual interference between systems is becoming more and more serious. Therefore, the network optimization work is becoming increasingly arduous.

2. LTE Network Optimization Technology

Through the data analysis of the collected and executed traffic, as well as the overall test of the on-site software and hardware, find out the reasons that affect the network communication. Finally, through the modification of parameters, or the adjustment of the network structure, and the adoption of some technologies, maximize the use of existing architecture resources to maximize their use.

3. LTE Wireless Network Parameters

As with other network standards, besides user perception, parameters and indicators are also important factors to reflect network quality. Common parameters are:

(1) Network identification parameters. Identifier is a parameter used to identify users, cells, etc. in the network, mainly including: TAC: tracking area code; EARFCN: LTE system frequency point number; PCI: Physical cell ID.

(2) LTE network optimization parameters. RSRP/RSRQ/RSSI are three parameters used to determine the signal strength and signal quality in LTE. In addition, TM mode multi antenna technology is one of the key technologies of LTE. Different antennas have different coverage effects at the same location, so flexible use of antennas can greatly improve the optimization speed.

(3) LTE network switching parameters. While the planning of each cell is balanced, the handover between cell signals of the same frequency and different frequencies also needs to be focused.

(4) LTE network reselection class parameter In LTE reselection, due to different network frequency bands, LTE reselection is divided into the same frequency and different frequency switching.

4. LTE Network Optimization Content

LTE optimization mainly includes PCI optimization, interference troubleshooting, coverage optimization, neighbor optimization and system parameter optimization.

(1)PCI optimization: PCI interference is prone to two common problems, such as easy dropped calls and slow download speed. In addition, three principles should be followed: for example, multiplexed PCI should be used to separate at least 4 layers of cells and be at least 5 times larger than the spacing, and the same PCI cannot exist in the same cell; The frequency positions of adjacent areas shall be staggered as much as possible.

(2)Interference troubleshooting: according to different interference sources, it is divided into internal and external interference, including GPS deviation, equipment stealth fault and antenna feeder system fault. Three kinds of external interference, such as stray interference, blocking and intermodulation interference.

③Override optimization: Common network coverage problems are caused by excessive coverage, insufficient coverage or uneven coverage, which in turn lead to access success rate, higher discard rate, lower handover success rate and lower download rate. The reasons for the wireless coverage problems are various, including the engineering quality of the antenna feeder system, antenna selection, the rationality of setting relevant parameters, and equipment failure. The coverage optimization measures include checking the antenna feeder installation, adjusting the antenna direction and tilt angle, adjusting the beam shaping factor of the antenna sector, troubleshooting the equipment, checking the neighborhood relationship and adjusting the reference power.

(4)Neighbor cell optimization: It aims to increase the coverage, reduce the drop rate and improve the handover success rate. It also affects the timeliness of measurement, and it is very important to correctly and reasonably configure adjacent areas. In the optimization process, the adjacent areas shall be checked and adjusted according to the geographical location, wireless environment, KPI indicators and test conditions.

(5)System parameter optimization: At present, LTE optimization and adjustment mainly include power parameters, PCI parameters, switching parameters, interference avoidance algorithm parameters, antenna technical parameters, etc.

5. LTE Network Optimization Cases

5.1. Problem Description:

The VOLTE is disconnected due to the missing configuration of adjacent cells. During the network test of the operator of National Highway C, the main service cell occupies A -- LD at the problem section_2. When the test vehicle runs from west to east, the signal of the main service cell attenuates to less than - 100dBm and cannot be switched normally until the cross frequency handover is started, as shown in Figure 1:

ISSN: 1813-4890

Time	Messages			Q II Type		- # 洋田信息	And Street or other	Χ. ΤΕ ΠΕΙ	plink Statistics	<u>.</u>			
09:52:29:027 09:52:29:027 09:52:29:042 09:52:29:042 09:52:29:042 09:52:29:042 09:52:29:214 09:52:29:214 09:52:29:214 09:52:29:214 09:52:29:276 09:52:29:557	UECapabilityEl UECapabilityEl UECapabilityEl RRCConnectic RRCConnectic RRCConnectic RRCConnectic RRCConnectic RRCConnectic RRCConnectic SysInfoTpot Masterinformat Raging	formation onReconfigu onReconfigu onRelease St onRequest onRequest onSetupCon	nplete	DL_ UL_ DL_ DL_ DL_ EPS UL_ DL_ DL_ UL_ BCC	DCCF DCCF DCCF DCCF DCCF CCCF CCCF DCCF H_SC H_BC		106) 0.0) RSRQ	EL(F)		(1) 安(1) 安(1) 安(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)		新州 E120.644516, N31.3 市区新 1	28049 L(F)_1 (F)_2 (F)_2
09 52 29 582 19 52 29 947 09 52 30 212 09 52 30 399 89 52 30 493 09 52 30 524 09 52 30 540 *	Event A3 Event A3 Event A3 Event A3 Event A4 Handover start Prach: Msg1 (F Prach: Msg2 (F	RA)		-106, -94 -106, -93 -106, -93 -107, -93 -107, -76 Cell: 38400 Handover	- 322		83.7		- ₩01 ~ 6		7_2		X
Name		EARFCN	PC1	RSRP	RS ^	Serving Cell Info	Value	L1 Info	Value	Throughput			
娄江大道与 园区万宝商 市区新苏友	国区新苏苑LD_3 5娄门路东LD_3 5业广场TL(F)_1 乾L(F)_3	37900 38400 38400	382 422 77 322 8	-106.9 -95 -104 -77 -85	-2- -11 -1(-1(TAC SCell ID SCell PCI SCell Name SCell Distance(km)	20781 84981252 382 英门L(D)_2 0.676	RRC State TM Mode CRS RSRP CRS SINR CRS RSRQ	Connect 3 -186.9 -3,7 -21.8	Layer FTP PDCP RLC MAC	UL(kb/s) 36.9 38.3 45.0	DL(kb/s) 1.9 2.3 2.9	
风区五宁美	新作情而后。	38400	377	38	11-	EARFCN	37900	Pathloss	124	PHY	160.4	9.5	

Figure 1. Screenshot of LTE Cell Handover Exception Test

5.2. Cause Analysis

When testing the VOLTE from west to east, the callee cannot switch normally, and the A3 event is always sent, as shown in Figure 2, which causes the caller and the callee to drop the call.

09:52:29:214	+ Service Request	EPS M	EARFCN PCI RSRP	RSRQ	EARFCN PCI	RSRP	RSRQ	09:51:15.441	UPDATE	SIP
09:52:34.331	↑ Service Request	EPS M	37900 422 -90.3	-6.5	37900 382	-107.2	-23.2	09:51:15.457	UPDATE 200	SIP
09:52:39.432	Service Request	EPS MM	37900 77 -101	-15	37900 422	-95	-10	09:51:15.472	1 INVITE 180	SIP
09:52:39.525	Service Reject	EPS MM	37900 382 -106	-19	37900 77	-104	-16	09:51:18.031	1 INVITE 200	SIP
09:52:39.681	1 BYE	SIP			38400 322	-77	-6	09:51:18.421	ACK	SIP
09:52:40.493	1 Attach Request	EPS MM			38400 8	-85	-16	09:52:42:597	4 BYE	SIP
09:52:40.633	Identity Request	EPS MM			38400 377	-86	-16	4		
09: <u>52:40.633</u>	1 Identity Response	EPS MI			38098 345	118	-11	Q Call dropped		😽 🚡 🙆 «
•								09:52:29.947	Event A3	-106, -93
Q Call drop	ped 0/1	💆 🗿 🔍 *						09:52:30.212	EventA3	-106, -93
09:52:29.853	Paging received		EARFCN DL	37900	37900			09:52:30.399	Event A3	-107, -93
09:52:34.112	RRC release		PCI	422	382			09:52:30.493	EventA4	-107, -76
09:52:34.112	Service setup failure		RRC State	Connect	Conne			09:52:30.493	Handover start	Cell: 38400 - 32
9:52:34.331	Prach: Msg1 (RA)	Connection Re	CRS RSRP	-90.3	-107.2	.1		09:52:30.524	Prach: Msg1 (RA)	Handover
9:52:34.331	Prach: Msg2 (RAR)		CRS SINR	11.5	5.8			09:52:30.540	Prach: Msg2 (RAR)	
09:52:34.346	Prach: Msg3 (UE ID)				3			09:52:30.540	Random access success	
09:52:34.346	Prach: Msg4		TM Mode	2	Contraction of the second	-		09:52:30.540	Prach: Msg3 (UE ID)	
09:52:34.346	Random access success		CQI Average	11.6	11.1			09:52:30.540	Handover success	37900-382 -> 3
09:52:34.377	RRC setup success	0.094s	DL PHY Thrput(kb/s)	13.9	9.5			09:52:30.587	Read Systen Info	Sib1
09:52:37.217	RRC Timer Fired	CSG Asf	DL MCS	2	0			09:52:30.587	measCfg	+13, 14, 15, 16,
09:52:39.260	RRC release		PDSCH Rb/s	388	404			09:52:30.649	Handover laterncy info	0.088
9:52:39.260	Service setup failure		UL PHY Thr'put(kb/s)	57.5	160.4			09:52:30.696	Read Systen Info	Sib3
09:52:39.479	Prach: Msg1 (RA)	Connection Re	UL MCS	18	12			09:52:30.867	Read Systen Info	Sib5
09:52:39.479	Prach: Msg2 (RAR)		PUSCH Rb/s	306	1648			09:52:30.899	Read Systen Info	Sib6
09:52:39.479	Prach: Msg3 (UE ID)		DL RTP Packet Loss(%)	81	58			09:52:31.273	EventA1	-85
09:52:39.525	Prach: Msg4		RTP Packet E2E Delay(ms	s)(09:52:31.273	EventA1	-85
09:52:39.525	Random access success		UE GPS Time Status					09:52:31.289	EventA1	-85
09:52:39.525	RRC setup success	0.094s	Vocoder Type	AMR WB	AMR V	VB		09:52:32.115	Read Systen Info	Sib1
09:52:39.525	Service setup failure							09:52:42 597	RTP audio interrupt(DL)	13542ms
9:52:39.525	RRC release	*						09:52:42.597	Call dropped	signal losed tin
(10	•			P 5 P 66 7 P 55		a variable-	×		

Figure 2. Screenshot of A3 Event Signaling Always Reported

The call drop during the VOLTE voice test is caused by the failure of the calling and receiving terminals to switch normally on the 4G network and dragging. Can judge A-L (D)_ 2 Unable to switch to B-LD normally_ 3. After querying the network management data, there is no adjacent cell relationship between the two cells.

5.3. Optimization Results

After optimization, the switching of this section is normal, and the problem section in the VOLTE test does not have call drop, and the calling and receiving terminals can switch normally, as shown in Figure 3 and Figure 4.

ISSN: 1813-4890

Time	Messages		Q 11	Type *	UE1_LTE SysInfo	LTE Downlink	Statistics 📋 LTE U	plink Statistics	5			
13:25:23:507	& RRCConnectionRe	lease			-₩ 洋细信息		83			33	5km/h E120.643990), N31387854 🖉
13:25:23.710	Paging			PCCH	UE1			N	-	(F)_2		
13:25:25.114	🕹 Paging			PCCH	Read Systen Info Time: 13:25:28.951		119 CUL C	/_1				
					Latitude: 31.32785		相之 员口 ()) 3				杰汀-
13:25:28:951	SysInfoType1			BCCH_SC	Lontitude: 120.64399			(- 1	• •		市区新市 L(F)_1
3:25:29.076	🕹 Sysinfo			BCCH_SC	EARFCN: 37900						-	娄江 加
3 25 29 092	SIBType2			BCH	PCI: 422						市民市市工	F)_2
3:25:29.092	SIBType3			BCH	q-RxLevMin: -64 (-128dt	im)			娄门东 (图)_1		- +
13 25 29 092	SysinfoType1			BCCH_SC					2013	(F) 2 X	at the second	gin
13:25:29.107	4 MasterInformation	Block		BCCH_BC					A 104			工业园区局
13:25:29.138				BCCH_SC						1		TICKNER
	🕹 SIBType5			всн	1			1)1	国区万宝内 图	(N)L(E)_1		工业园
1 10.00.00 464	Contaña III			north fr			1000	(1) 2	在1月1			
	50				-		-	V'-4	AL LUN			
Time	Events		🏥 Q, Extra				÷		东、 ELF_2		洋江	
13:25:23.522	RRC release			1	年功LF_1		/			-	1	
3 25 23 600	RRC Timer Fired		CONN	Rel		And And	XLF_2		3	东港时村_1	171	
3 25 28 951	Read System Info		Sib1		「1 运场 地图图图 🚺	ER UEI_CR.	Loss of an			-		G
3 25 29 076	I Cell reselect		Target	CI: 422	-					1		
13:25:29.092	Read System Info		Sib3						March		AL 1.	
13:25:29.092	Read Systen Info		Sib1		mary his man	the effect of			Martin	to i die		A And A Martin
13:25:29.154	Read Systen Info		Sib5							and the second	11 11	
13:25:41.993	Call attempt					100.7						
<u>e</u>	(m)				2 2000					💏 RI	RØ 🔮	
Name			CI RSR	-RS	Serving Cell Info	Value	L1 Info	Value	Throughput			
娄门L(D)_2	37	900 3	82 -100	7 -2(TAC	20781	RRC State	Idle	Layer	UL(kb/s)	DL(kb/s)	
	国区新苏苑LD_3 37	900 4	22 -93	-10	SCell ID	84981252	TM Mode	2	FTP		0.000	
					SCell PCI	382	CRS RSRP	-100.7	PDCP	0.0	0.0	
×					SCell Name	娄门L(D)_2	CRS SINR	4	RLC	0.0	0.0	
					SCell Distance(km)	0.623	CRS RSRQ	-20.2	MAC	0.0	0.0	
					EARFCN	37900	Pathloss	24.6	PHY	0.0	0.0	
					EANI ON							

Figure 3. Screenshot of normal display switching after parameter modification

Time	Messages	۹ :	Туре ^	UE1_LTE	E NCells	UE1_GSM NCELLs		UE2_LTE NCe	ls U	2_GSM NCELLs		Time	Messages	Q 🔡 Type
13:22:11.611	INVITE 200		SIP	EARFCN	PCI RSF	RP RSRQ		EARFCN PCI	RSRF	RSRQ		13:25:27.766	1 MeasurementReport	UL_DC
13:22:11.658	ACK		SIP	37900	382 -10	0.7 -20.2		37900 382	-99.5	-12.5		13:25:28.031	1 MeasurementReport	UL DC
13:25:11.838	1 BYE		SIP	37900	422 -93	-10		37900 422	-92	-7		13:25:28.202	1 MeasurementReport	UL_DC
13:25:12.228	BYE 200		SIP					37900 381	-108	-15		13:25:28.436	1 MeasurementReport	UL DC
13:25:12.290	Deactivate EPS Bearer Context F	Request	EPS SI					38098 345	121	-11		13:25:28.670	1 MeasurementReport	UL_DC
13:25:12.306	Deactivate EPS Bearer Context A		EPS SI					38098 206	127	-16		13:25:28 920	1 MeasurementReport	UL_DC.
13:25:41.977	1 INVITE	and by	SIP									13:25:29.263	1 MeasurementReport	UL DC
13:25:41.993	Service Request		EPS MI +									13:25:29.840	MasterInformationBlock	BCCH
1	III	_	+									1	m	+
				EARFCN D	,	37900		37900						
Time	Events 🙌 🤇	Extra		PCI	1 0	382	÷.	382			n	Time	Events 👫 C	Extra
13:25:14.365	EventA1	-93		RRC State		Idle		Connec				13:25:30.074	Read Systen Info	Sib5
13:25:14.365	Event A2	-93										13:25:30.090	Prach: Msg4	
13:25:14.365	measCfg	+1		CRS RSRP	•	<mark>-100</mark> .7		-99.5				13:25:30.090	Random access success	
13:25:23.507	ERAB normal release			CRS SINR		-9.4						13:25:30.246	Prach: Msg1 (RA)	Connection Req.
13:25:23.522	RRC release			TM Mode		2		8				13:25:30.246	Prach: Msg2 (RAR)	
13:25:23.600	RRC Timer Fired	CONN	Rel	CQI Averag				8.1				13:25:30.246	Prach: Msg3 (UE ID)	
13:25:28.951	Read Systen Info	Sib1		DL PHY Th	r'put(kb/s)	0.0		0.0			111	13:25:30.246	Prach: Msg4	
13:25:29.076	I Cell reselect	Target I	PCI: 422	DL MCS								13:25:30.262	Random access success	
13:25:29.092	Read Systen Info	Sib3		PDSCH Rb	/s							13:25:30.262	RRC setup success	0.101s
13:25:29.092	Read Systen Info	Sib1		UL PHY Th	r'put(kb/s)	0.0		0.0				13:25:30.277	RRC release	
13:25:29.154	Read Systen Info	Sib5		UL MCS								13:25:30.277	TAU successs	0.130s
13:25:41.993	📽 Call attempt			PUSCH Rb	/s	0		0				13:25:30.277	RRC Timer Fired	CONN Rel
13:25:42.008	Prach: Msg1 (RA)	Conner	ction Re	DL RTP Pa	cket Loss(9	%)	1.29					13:25:31.603	Read Systen Info	Sib1
13:25:42.008	Prach: Msg2 (RAR)			RTP Packe	t E2E Dela	y(ms)(13:25:43.646	Paging received	
13:25:42.008	Prach: Msg3 (UE ID)		-	UE GPS Ti	me Status		-					13:25:43.678	Prach: Msg1 (RA)	Connection Req.
•	III		•	•			•				Ψ.	•		•
	UE1 Audio U	E2	Audio				-							
手机状态		dle				> -100.	7		2000					
		201 11		4 2200	0							🚧 R	CO 6 6	
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				- 00	W									

Figure 4. Normal screenshot of signaling after retest

6. Conclusion

Since the mobile LTE is an inter frequency network, the D-band signal is used to preferentially cover the roads in the current network. When there is a neighbor cell missed allocation, it will lead to dropped lines. The importance of network optimization lies in improving network coverage, connection rate, handover success rate between cells, reducing network congestion rate, and improving user perception and satisfaction.

ISSN: 1813-4890

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