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Quality of Service

Acceptance Testing for Cellular Networks

Quality of Service Acceptance Testing for Cellular Networks

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Contents

Introduction

Only a few years ago – when mobile telephony was just starting to come of age as a business, a licence to set up a cellular network was often treated as tantamount to a licence to print money. The theory was simple: with the only competition coming from old analogue networks operated by national telecom monopolies, new operators could afford to overspend in the early stages of setting up their network. The rewards would more than compensate for any initial over-investment. It's no surprise that the period was referred to by some as the "GSM gold rush."

Since then, the situation has changed considerably. Several years of worldwide liberalisation and deregulation of the telecommunications sector have created a highly competitive environment which forces companies to be much more careful about how they use their initial investment budget.

The norm in European countries now is two established GSM 900 operators, with licensing underway for an additional DCS 1800 network. In the US, as well as two layers of AMPS at 800 MHz, the PCS bidding yielded six new regional competitors within the 1900 MHz band, resulting in thousands of individual licences. Even countries like China and the former Soviet republics, which traditionally have a very centralised telecommunications policy, are now issuing regional or city-wide licences for at least two competitors.

This world-wide licensing policy has in turn created a new type of operating company, which combines a local industrial concern with access to sites or civil engineering and a financial backer, such as a bank or insurance company. Technical and operational know-how is gained either by having a telecommunications company as an additional share-holder, or – and this is increasingly common – by buying consultancy, engineering and operational support from outside.

This White Paper outlines the risks faced by such "turnkey" purchases and the various ways in which new operators can seek to minimise them. It develops the thesis that Quality of Service (QoS) is the key to success in this new market and sets out precisely what is meant by QoS. It then explains the best way for network operators to specify functionality of the system and their QoS requirements, how they can order QoS from infrastructure suppliers instead of base stations, and how they can test whether the QoS delivered meets their actual specifications and requirements.

Buying a Turnkey Cellular Network

To be profitable in this period of liberalisation and deregulation, a newly licensed network operator must come with new strategies as well as being fully prepared to manage the following two primary challenges.

- To quickly launch the new cellular services in order to deliver a fast pay back and good return on investment.
- To achieve the planned QoS within the designated service areas.

Unfortunately, the scheduled period for deployment does not allow sufficient time for setting up and training of a local engineering staff to handle the initial cellular and transmission planning, installation, commissioning and follow-on operation. Therefore, ordering a 'whole network' – as a turnkey project – including the network planning service from a large infrastructure provider can be a very attractive solution.

The 'own-staff' which in the beginning is limited, can dedicate their efforts on service aspects such as development of a marketing strategy and new services roll-out plan. And, of critical importance, they will be able to concentrate on developing detailed QoS specifications and requirements for different parts of the service area.

Risks and Opportunities

Outsourcing – the purchasing of a turnkey network – is an excellent option with many advantages for the modern operator. It allows fast implementation, an important element when considering return on investment.

There are, however, risks in that infrastructure suppliers can exploit the lack of technical know-how on the operator's side and plan more base stations than really required in order to increase the contract volume.

An uncritical, *better-one-base-station-more* strategy, is often preferred by the supplier in place of conducting a complete alternative study. Such a 'creative study' consists of a careful and cost/quality sensitive checking of alternative base station (or repeater) configurations during the planning process. This endeavour places more responsibility on the supplier and increases his planning effort – arising primarily from the need for additional site verification measurements and engaging a larger site acquisition team. It may also be necessary for the infrastructure supplier to acquire more sophisticated provisioning tools as well as obtaining access to supplemental terrain data bases.

The creative alternative approach, although tedious, can yield infrastructure savings of at least 10% – without the operator sacrificing coverage or interference degradation. The savings is realised by avoiding placement of unnecessary base stations. And, this is only possible by evaluating cost/quality trade-offs, and applying creative planning which should include consideration of new cellular architectures such as overlay/underlay, microcells, and the tuning potential of network parameters during operation.

On the suppliers' side, most planning engineers are oriented to the customer, aware about advanced network planning methods and try to achive a cost efficient network design. Time pressure, limited resources, cost of terrain data and surveys, and sometimes the demand for short term sales volume might generate a conflict with cost/quality sensitive planning. However the mobile communications world is changing and infrastructure suppliers are moving to adapt to the demand for better QoS planning.

The major questions, then, for the new operator are the following:

- How can we establish a cost/quality sensitive and creative network planning process?
- How do we link the result of this planning process to purchasing and accepting a network?

The next sections discuss the options open to the new operator searching for best answers to the above questions.

Establishing a Cost/Quality Sensitive and Creative Planning Process

For the network operator who has chosen the 'turnkey solution', there are two options available. Each different, but offering the possibility to build a supplier/buyer relationship around the creative planning process. The first option is classical and calls for hiring a reputable engineering company.

The more aggressive second option is based on issuing exact QoS specifications which implicitly directs the infrastructure supplier into conducting a creative planning process with the necessary cost/quality sensitive analysis in order to conform to contractual terms.

The independent engineering company

The first alternative is to contract with an independent engineering service company. In general, this provides a good network design at reasonable cost. The network planning team and the infrastructure supplier have shared responsibility for the goal that the network meets the quality of service requirements. However, if it turns out after network deployment that the network has failed to meet the requirements it is difficult to identify the responsible party.

Specify QoS requirements to infrastructure supplier

This is a demanding option that practically guarantees from the start that a creative planning process will be carried out by the infrastructure supplier. Here the operator issues a Request For Quotation (RFQ) that contains specifications of the designated service areas, required QoS by zone and the projected traffic capacity. The quality of service would be expressed in terms of percentages of successful call set-ups, successful call holds for a certain duration and an acceptable speech quality during, for example, 95% of the call duration.

The RFQ would *not* contain a specification for the number of base stations nor their configuration. The bidder is asked to comply to the QoS requirements. If it turns out during acceptance testing that specifications were not met, then corrective action, including, if necessary, additional infrastructure, must be supplied at no additional costs.

During preparation of the offer the infrastructure supplier has to create a preliminary network design and QoS prediction by use of computer planning tools and measurement equipment based on sites proposed by the operator. The resulting number and configuration of base stations determines the value of the offer. In order to win the contract an infrastructure supplier has to calculate the minimum base station configuration which still delivers the specified QoS. This approach helps to create the competitive spirit necessary to encourage suppliers to conduct cost/quality sensitive studies and to apply a creative network planning process.

This method, however, requires that the operator has a certain amount of information available for preliminary network design at the time the RFQ is issued. If for example sites are not known, all suppliers will use safety margins and the advantage of open competition is lost.

The Value of Quality of Service (QoS)

The ultimate criterion for the QoS provided by a cellular network operator is the satisfaction of the mobile phone user. He is sensitive about how often the mobile phone is on ‘network search’ instead of showing the availability of his home network. A long waiting time or failure to set up a call is more annoying and the only consolation the customer receives is automatic redialing capability. But, really frustrating is a dropped call after having spent periods of tolerating poor speech quality where most of the conversation consisted of repeating broken sentences. Listening effort in *both* directions of the conversation is the single most important factor for sustained subscriber satisfaction.

Defining a realistic quality goal

The perfect network with more than 99% successful calls at all locations and all usage situations is not yet state-of-the-art in mobile communications. Accordingly, what is happening in the marketplace, is that a new operator will try to offer better quality than his competitors under the precondition that the same or lower tariffs can be achieved.

Figure 1 shows schematically how network cost depends on certain quality criteria such as call success rate. It turns out that the cost per additional percent in call success rate increases steeply as the 100% mark is approached.

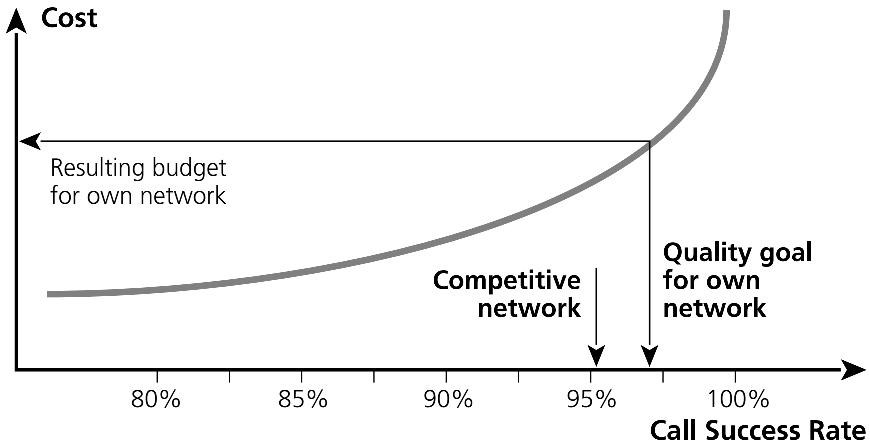


Figure 1:
Cost /Quality sensitive trade-off

One parameter commonly used by network planning engineers is the so-called 'coverage probability'. The calculation shown in Table A shows how a coverage calculation can be applied in a realistic cost vs. quality example. The argument considers the statistical fading characteristics of electromagnetic wave propagation in the real world to predict the field strength that the terminating end of a communication link will receive when it exceeds its threshold value or a given reference sensitivity.

System data:	BTS	MS (2W)
TX power	43 dBm	33 dBm
Combiner loss	- 4 dB	0 dB
Cable loss	- 2 dB	0 dB
Antenna gain	10 dBi	0 dBi
Effective isotropic radiated power	47 dBm	33 dBm
Ref. sensitivity	- 104 dBm	- 102 dBm
Diversity gain	- 2 dB	0 dB
Tower mount ampl.	- 2 dB	0 dB
Cable loss	+ 2 dB	0 dB
Antenna gain	- 10 dBi	0 dBi
Min. received power	- 116 dBm	- 102 dBm

Propagation characteristics:

Urban environment:

- distance dependence: according to Hata model (GSM rep. 03.30)
- morpho structure correction factor = 4 dB
- fading model: lognormal with standard deviation = 7 dB
- flat terrain

BTS antenna pattern: Omnidirectional, 10 dBi gain

BTS antenna height = 30 m

MS antenna height = 1.5 m

Frequency = 900 MHz

Table A:
Coverage Calculation example:
Urban GSM cell

The listed GSM system parameters and resulting cell areas in Table B can be used to support the concept graphically illustrated in Figure 1. One can assume that a competitors' network provides on the average a 95% coverage probability at outdoor locations over the service area (better at base station site and, declining at the cells periphery). For typical European flat urban environments and standard GSM system data a cell area of 39.4 km^2 can be achieved. This will serve as a reference in the following discussion.

Coverage probability over area	Cell radius [km]	Cell area [km^2]	Usage situation
0.50	8.77	242	outdoor
0.70	6.45	131	outdoor
0.80	5.42	92	outdoor
0.85	4.87	74.5	outdoor
0.90	4.28	57.5	outdoor
0.95	3.54	39.4	outdoor
0.97	3.14	31.0	outdoor
0.98	2.88	26.1	outdoor
0.99	2.51	19.8	outdoor
0.995	2.22	15.5	outdoor
0.999	1.72	9.3	outdoor
0.90	1.60	8.0	indoor (+15 dB loss)
0.90	0.60	1.1	indoor (+30 dB loss)

Table B:
Typical cell area vs. coverage probability and usage

If the marketing decision is to design a new network with 97% average coverage probability, the resulting tolerable cell area would decrease to 31.0 km^2. And, this in turn would increase the number of cells by a factor ρ = 39.4 / 31.0 = 1.3 in comparison to a 95% average coverage design goal. If it is decided to include indoor locations in the proximity of windows (approximately 15 dB penetration loss) with 90% coverage, the cell area would shrink to 8.0 km^2 and the number of cells increases by a factor of ρ = 39.4 / 8.0 = 4.9! The factor ρ, of course, is not directly proportional to the network cost because the number of transceivers per BTS may be reduced when increasing the number of BTSs. Interference and blocking along with other QoS parameters such as the effects of heterogeneous topography, land usage and population density have not been taken into consideration in this example. Nevertheless, the tremendous sensitivity of network cost on the QoS requirement is an obvious and very important issue.

The aim of this example is to demonstrate that "coverage" can be bought from infrastructure suppliers in a range of varying tolerances; and, that very slight differences in quality are worth significant percentages of the total price.

It is important to be aware of the relationship between quality and cost: a 95% coverage probability, for example, might not be noticed even though a 97% figure was specified. Note, that the value of the quality difference between 95% and 97% coverage represents about 15% of the total value of a network. If this was the actual case – and taking a typical start-up network value of US$ 20 million – would mean that an operator would have, in effect, overpaid the infrastructure supplier US$ 3 million.

How to Specify QoS Requirements for a Cellular Network

In the past, many new cellular operators have been in the situation that they have either specified QoS requirements in rather weak terms, leaving ambiguities in the interpretation, or they did not have access to suitable tools to verify whether QoS requirements were actually met. Being in this position can have substantial commercial consequences especially when the QoS requirement is the base for a turn-key contract.

The following is a proposal on how QoS requirements for turnkey network purchases should be defined. The approach leaves no ambiguities or room for misinterpretation by either the operator or infrastructure supplier.

QoS requirement map

Defining the quality of service for the supplier to deliver is based on a QoS requirement map which allows the operator to delineate for each location of the license area the specific QoS desired (see Figure 2). An accompanying legend (Table C) explains the QoS requirements in detail.

The traffic density map

A mandatory supplement to the QoS requirement map is the traffic density map – based on population, employment, vehicle traffic, or social-economic and other demographic data. This map is submitted along with the QoS specification to the infrastructure supplier in order for him to determine the traffic capacity of the network and to develop a frequency plan with tolerable interference limits. Modern network planning tools are able to use traffic density maps and integrate these data during the planning process.

All degrading effects are covered by the QoS requirement

QoS as specified within the QoS requirement map is understood in a way that all degrading effects are subject to consideration regardless of whether they are generated by lack of field strength coverage, co-channel interference, adjacent channel interference, radio multipath delays, blocking due to lack of radio channels, lines or switch capacity, echo, or any other causes.

Because QoS takes the end user’s perspective, no *degrading effect may be excluded* from the requirement and from the test. Of the tools available on the market to network engineers only one is able to provide the information required to carry out QoS acceptance testing: The *QVoice Cellular Network Quality Testing and Analysis System* developed in Switzerland by Ascom Infrasys. QVoice is a unique tool and can detect all the consequences of the above mentioned degrading effects as far they relate to QoS.

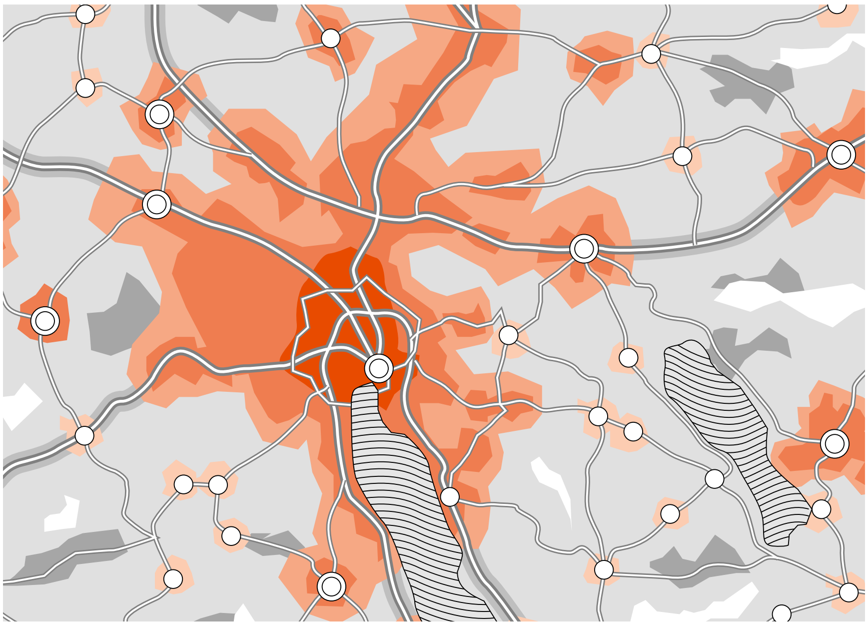


Figure 2:
The QoS requirement map allows mapping of each location of the license area to a QoS requirement

QoS req. class	Usage situation	Call success rate	Type of mobile
rural	outdoor	80 %	2 W handheld
suburban	incar, 50 km/h	80 %	2 W handheld
urban	indoor (15 dB)*	90 %	2 W handheld
metropolitan	indoor (20 dB)*	95 %	2 W handheld
water	outdoor	95 %	2 W handheld
main road	incar, 100 km/h	95 %	2 W car install.
small city	indoor (15 dB)*	75 %	2 W handheld
no service area	not defined	0 %	not defined
others	*free def.*	*free def.*	*free def.*

Table C:
Map legend

*Note: The indoor coverage includes outdoor coverage since it is the more critical condition. For future network dual mode GSM/DECT network architectures where pico-cells with small DECT base stations are installed within buildings, indoor and outdoor requirements might be specified separately.

The call success rate

Since the QoS requirement refers to a call success rate, it is necessary to define this term as follows:

Call success rate: equals the number of successful calls / Number of call attempts

Criterion	Condition
network status	home network available after an idle time T_i (in GSM Phase 1 if C1 criterion fulfilled)
call attempt	leads to a connect status with the selected conversation partner
call set up duration	shorter than time τ
call stability	call is uninterrupted over pre-selected call duration time T_c
call quality downlink	at least speech quality level Q for a fraction $\geq \eta$ of the call duration
call quality uplink	at least speech quality level Q for a fraction $\geq \eta$ of the call duration

Table D:
Definition of a successful call

The parameters τ, T, and Q are subject to free definition within reasonable ranges.
The following is a typical example:

τ = 8 seconds
T_i = 30 seconds
T_C = 120 seconds
Q = Ascom (QVoice) speech quality class on a scale of 5 categories "excellent", "good", "fair", "poor", "bad"
η = 95 %

In each case or location specification, individual variables of the QoS requirement classes and successful call definitions may be elaborated. An operator may for example, include desired performance of data and fax transmission in the set of QoS requirements.

Ascom QVoice system has been the tool of choice for many cellular operators. QVoice is able to simulate the subjective speech quality perception of the human being by use of a neural network. Using a stationary and a mobile part, speech samples are transmitted in uplink and downlink directions. Integrated speech quality classes – ranging from 1 to 5 – may be defined to represent the overall quality perception within the duration of a call. Using QVoice simplifies QoS Acceptance Testing.

How to Accept a Turnkey Cellular Network

We have seen that QoS acceptance testing is of paramount commercial importance for a network operator. This procedure is also being rapidly recognised among operators and suppliers as the best way to determine QoS conditions, a few percent better call success rate could mean Millions of dollars.

The cellular network quality experts at Ascom are dedicated to the task of supporting new network operators in specifying their QoS requirements as well as to provide the most appropriate test and analysis equipment for a fair and unambiguous acceptance testing.

The QoS Acceptance Test proposal consist of six steps

Step 1: Specification of QoS requirements

QoS requirements are defined in this White Paper. If necessary, maps of different scales down to the city level should be prepared. Usage situations must be clearly described; and strategic locations like railway stations, airports, shopping malls or hotel lobbies specified individually. Both parties have to agree on the QoS requirement specification document.

Step 2: Care of prerequisites and test conditions

The following conditions should apply before starting the QoS Acceptance Test:

- Functional tests of infrastructure completed successfully
- No 3rd party interference within allocated bandwidth
- Close coupling and spurious emissions at shared sites is prohibited

Step 3: Specification of test procedure

The specification of the test procedure is the task of the operator and the supplier is notified accordingly. QVoice experts are prepared to give support if necessary. Test specifications would include but are not limited to the following menu.

- Selection of test routes through representative parts of the service area
- Total test duration
  (depending on desired statistical significance – See Table E)
- Definition of measurement program
  - mobile terminated or originated calls
  - conversation and idle times T_C and T_i
  - half duplex / uplink / downlink

- Simulate situation of usage
  - include indoor measurements or simulate using defined attenuation
- Optional: Simulate network load
  - at launch time, the co-channel interference situation of the network may be simulated by setting up parallel calls with standard mobile phones or by use of load generators

Table E:
How many call attempts

Assuming that 95% call success rate is required and the statistical tolerance shall be 0.5%. By applying the following formulas the number of required call attempts is calculated as a function of call success rate and statistical tolerance:

$N_f = (1 - CSR)^2 / \Sigma^2$

$N_C = N_f / (1 - CSR) = (1 - CSR) / \Sigma^2$

N_f number of unsuccessful call

N_C number of call attempts

CSR required call success rate (1 – CSR) shall be << 1

Σ statistical tolerance based on one standard deviation)

For CSR = 0.95 and $\Sigma = 0.005$ a number of $N_C = 2000$ call attempts has to be done. Such a large number of calls cannot be performed and evaluated in an objective way without automatic test equipment.

Step 4: Specification of test procedure

Perform tests as described above. The presence of both parties is not necessary because QVoice reporting is automatic and unambiguous, all measured data is recorded.

- Set-up QVoice measurement programme
- Start QVoice measurement procedure using QVoice Mobile and QVoice Stationary
- Drive pre-selected routes / Visit pre-selected indoor locations
- Calling procedures and comprehensive data acquisition run automatically

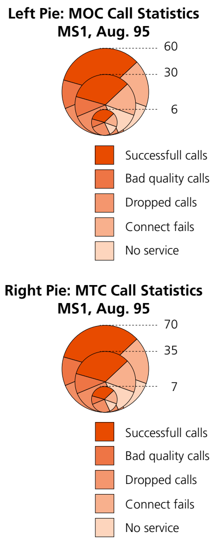
Step 5: Decision: passed / not passed

The QVoice System provides the following results for the acceptance decision:

- Call success rates according to the predefined and agreed requirements
- Call data like set-up times and quality values used to determine call success
- Mapping of call success rates individually for each QoS requirement class/area (see Figure 3)
- Cartographic presentations of statistics and local speech quality
- Conventional parameters like RxLevel or bit error rates

Step 6: Presentation of QoS Acceptance Test results

The decision of whether the QoS Acceptance Test passed successfully is based on a comparison of the QoS requirements and the QoS test results. However, the number of unsuccessful calls is a statistical variable which follows approximately a Poisson distribution. A statistical tolerance of one standard deviation should be granted.



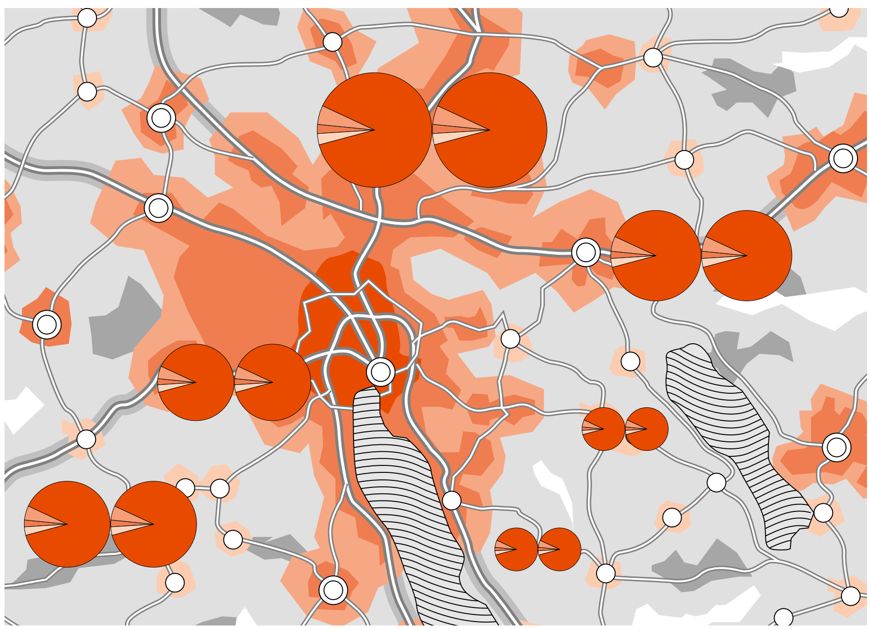


Figure 3:
QoS Test Results

Traffic Capacity and Interference

It should be considered that at launch time the cellular network serves only a few friendly users. Therefore, the transceivers installed in the base stations are for the most part inactive. With the exception of the frequency carrying the broadcast information, traffic channels are only activated upon demand. Therefore, blocking of calls due to lack of channels, processing capacity or quality degradation from co-channel interference will *not* be apparent at network launch time.

Traffic capacity and Erlang blocking

The number of traffic channels N_{TCH} in each base station is determined by the traffic forecast T within the base stations' service area and the required maximum allowed blocking probability P_{block} (typically between 1% and 5%). This function is shown as follows:

$$N_{TCH} = f_{ErlB} (T, P_{block})$$

In practice the Erlang B statistics are used in this analysis. In other queuing systems a similar mathematical approach is often taken using Erlang C values. The next step is to determine the number of transceivers N_{TRX} within the base station by considering the system specific multiplex schemes:

$$N_{TRX} = f_{system} (N_{TCH})$$

For example, in a GSM systems one transceiver can handle up to 8 full rate traffic channels, but time-slots for control channels have to be reserved as well (see table F).

# TRX	1	2	3	4
# physical. time-slots	8	16	24	32
# control. channels	1	2	2	3
# FR traffic channels	7	14	22	29
Traffic cap. (2% block.)	2.9 Erl	8.2 Erl	14.9 Erl	21.0 Erl

Table F: Example of base station traffic capacity (GSM)

Using available time-slots for traffic instead of control may cause congestion in short message services, call set up procedures and location updating. Therefore, a balance between traffic and signalling capacity has to be provided.

Another issue is the need to package traffic capacity in units of 8 physical time-slots. If a base station has to serve a traffic of 10 Erl then 3 transceivers (TRX) have to be installed to achieve a maximum of 2% blocking probability. In this case P_{block} = 0.05% is achieved due to over-capacity. On the other hand the selection of 2 TRXs for serving 10 Erl yields P_{block} = 6%. Accordingly, the blocking probability has to be considered on a per-cell base since only a small reduction in capacity increases the blocking probability significantly.

Network suppliers often claim the total traffic capacity of a network by summing up the traffic capacities of individual base stations. And, they do not always consider, when doing capacity planning, that traffic is not distributed among the base stations in a way that they all operate just at the wanted maximum blocking probability P_{block_want} (meaning that the traffic load is conforming perfectly to the traffic capacity given Table in F). However, violating this balance and not increasing the number of transceivers will inevitably create peaks of bad blocking probability. The end result is a network average P_{block_av} worse than P_{block_want}.

QVoice in combination with Load & Performance Measurements within the network infrastructure, such as ETSI GSM rec. 12.04, is the recommended tool to measure blocking probability and the QoS degradation from the subscribers' point of view. Test results are usually observed over a long-term time period and use the suppliers' OMC or similar applications that run on the network management data base. The QVoice Presentation application is also based on a relational data base making it a central part of the Network Management Support System. In addition to results reported by the switches, QVoice measurements give the subscribers' perception when unsuccessful random accesses or blocking, upon attempts to capture SDCCH or TCH dedicated channels.

Co-channel interference from channel reuse

When planning the frequencies for a cellular network the number of channels within the allocated spectrum have to be considered as a scarce commodity and sometimes extremely expensive as recently observed in the American auctions. Using each channel only one time is by far insufficient to satisfy the anticipated traffic demand within the service area. Therefore, frequencies are reused within base stations which have sufficient mutual isolation. That means that within a fraction of η of the service area from base station A, the field strength received from base station B on the same frequency is below the carrier-to-interference-threshold, and vice versa. η should be equal to or greater than 95%. And $P_{int} = 1 - \eta$ can be interpreted as the probability that a call attempt failed due to co-channel interference.

Logically as P_{int} increases channel usage increases. At launch time, co-channel interference is never an issue. However, if the network was planned with small reuse cluster sizes because the number of base station sites, for example, was limited – then the interference probability would become more and more critical with increasing number of subscribers and resulting growth in traffic – (see explanation accompanying Table G). If no additional bandwidth can be allocated, *the operator might be forced by quality degradation due to interference to install new base stations even if the existing base stations have not yet reached capacity limits*.

Therefore, QVoice experts recommend to carry out a second and even a third QoS Acceptance Test after the subscriber base has reached 50% and 100% respectively of the installed capacity. Additionally, at launch time, the network can be artificially loaded by setting up a number of calls with standard mobile stations which are spread throughout the field. The number of simultaneous calls would correspond to the network capacity measured in Erlang. Alternatively, load testers might be applied. For example in a IS-95 CDMA system, the artificial load can be realized in a very effective way by simple noise generation at the base station receiver and by putting dummy calls on the downlink, which is done by the base station itself.

Frequency planning has to consider cost vs. quality issues as well. Reducing the interference probability P_{int} is possible by reusing the same frequencies at base stations in larger distances. This means that more base stations in between have to operate and to share the other frequencies of the allocated spectrum. Therefore, the number of frequencies per base station decreases. In regions with high traffic density the number of base stations can be determined by the traffic demand rather than coverage requirements and therefore costs for sites and infrastructure are born for the benefit of interference protection.

Traditionally, the maximum group of base stations all using different frequencies is called a reuse cluster. The number of base stations is the reuse cluster size RCS. Having an allocated spectrum of B frequencies the average number of frequencies per base station is NBTS = B / RCS. Studies about performance within GSM yield the following orientation:

Interference Probability vs. Traffic and Reuse Cluster Size

RCS	P_{int} (launch)	P_{int} (full traffic)
6.5 – 9.0	< 1 %	= 10.0 %
7.0 – 9.5	< 1 %	= 7.5 %
8.5 – 11.0	< 1 %	= 5.0 %
12.0 – 16.0	< 1 %	= 2.5 %

Of course, the actual figures in a given network depend on topography, network design, use of DTX, power control, frequency hopping, channel load etc..

Table G:
Cost vs. quality in frequency planning

Network Optimisation and Troubleshooting

In the event that a QoS Acceptance Test fails or ends with unexpected malfunctions, the QVoice Cellular Network Quality Testing and Analysis System helps in identifying and resolving problem areas. QVoice not only surveys network quality but provides by powerful analysis – using the same measurement data – deep insight into the physical characteristics of the radio link as well as the signalling and radio link control processes. This information can be condensed and presented on a two screen workstation giving multiple network views. Figure 4 shows examples of charts, tables and mapping graphics any of which can be enlarged on the second screen. Views are synchronised via a common "watchpoint" even between monitors.

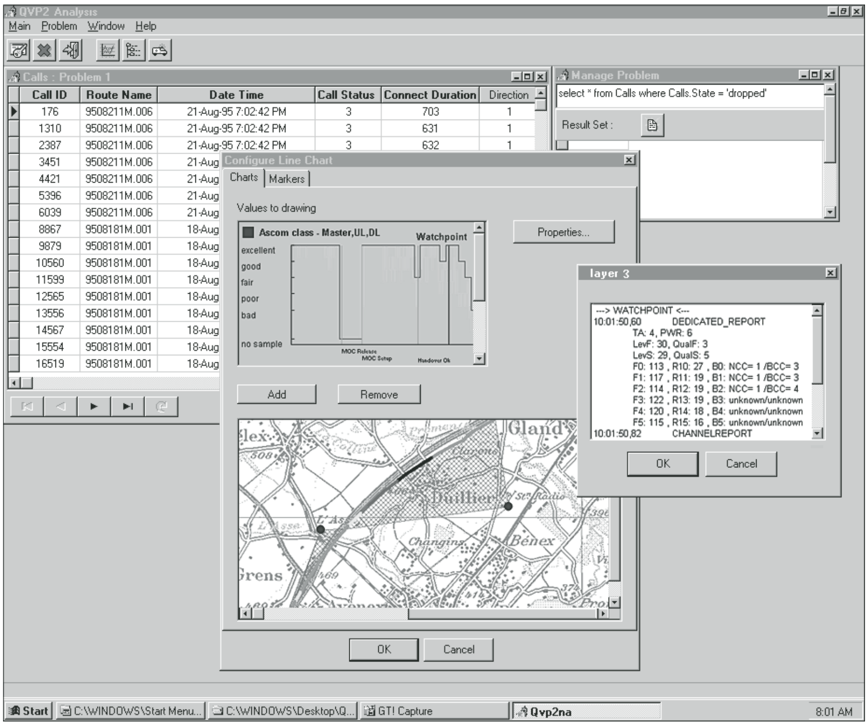


Figure 4:
QVoice presentation and analysis platform used for network optimisation

Physical characteristics like field strength level of serving and neighbouring cells (RxLev), along with bit error rates (RxQual) and indications for multipath propagation with long delays can be captured and displayed with QVoice. This information can then be used to reach conclusions about lack of coverage, or co-channel, adjacent channel and intersymbol interference effects. QVoice also provides information on radio link control processes such as cell selection, re-selection and location updating in idle mode, or serving cell indication, handover, power control and radio link time-out in call mode. This information assists operators in calculating correct settings of logical parameters and in determining optimum orientation of BTS antennas. And, for more system related trouble shooting, Layer 3 signalling messages according to GSM rec. 04.08 are decoded.

For acceptance testing QVoice provides an unbiased and equitable measure because results are objective and reproducible, and not subject to manipulation. It is for these reasons it is rapidly becoming the de facto standard for QoS Acceptance Testing.

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