T A M P E R E
P O L Y T E C H N I C

FINAL THESIS REPORT

MOBILE PHONE TESTING IN 2G AND 3G NETWORKS

Jaana Forsblom

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Author(s):	Jaana Forsblom
Degree Programme(s):	Business Information Systems
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Supervisor:	Paula Hietala	**Pages:** 32

ABSTRACT

Final thesis is made for a company, which is mainly concentrated on testing. This thesis is made as an introduction material to new employees who are starting to work in testing company for the first time.

Meaning of this thesis is to give common knowledge about the testing of mobile devices. This final thesis is written on basic level because different testing methods concentrate to different aspects. The thesis doesn't concentrate on networks and also different testing tools are left out. The goal of this work is to clarify new terms that will come along while working with new devices and tell more about the possible features of S60 phones.

The final thesis is written based on writers own experience and the goal is to introduce things that the new employee might concider to be complicated in the beginning. The basic services in the network are explained, these are for example streaming, video telephony and push to talk.

Also some network related functions are introduced so that the reader could get knowledge about some basic features of the networks even though the networks itseld are not handled in this thesis. This helps the reader to recognize the network implementations and not to think them as mobile phone malfunctioning.

This work introduces the basic terms and possible functions. This will not give a full guidance to the subject but opens up the newcomer's eyes. The work is expandable when the services on the network keep on developing. At this stage only the current services are introduced.

TAMPEREEN
ammattikorkeakoulu

Tekijä(t):	Jaana Forsblom
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TIIVISTELMÄ

Työ tehdään opasmateriaaliksi yritykselle, joka on keskittynyt pääasiassa testaukseen. Oppaan tarkoituksena on antaa perustietoa mobiililaitteiden testauksesta. Se on kirjoitettu perustasolla, sillä eri testausmetodit keskittyvät eri asioihin. Tämän työn päätavoitteena on selventää uusia käsitteitä, joita uusien laitteiden kanssa työskenteleminen tuo eteen ja selventää S60-puhelinten mahdollisia ominaisuuksia. Työssä ei käsitellä puhelinverkkoja eikä erilaisia testaustyökaluja, koska jokaisella testauksen alalla on omat työkalunsa.

Työ on kirjoitettu omien kokemusteni pohjalta ja siinä on esitelty asioita, joita uusi työntekijä saattaa pitää hankalina alkuvaiheessa. Työssä selitetään peruspalvelut, joiden käytön verkot mahdollistavat. Näitä ovat muun muassa streaming, videopuhelut ja push to talk.

Työssä käsitellään verkon asettamia rajoituksia sekä verkossa tapahtuvia tapahtumia, jotka näkyvät käyttäjälle. Nämä osiot on lisätty työhön, jotta uusi mahdollinen testaaja ei pitäisi kyseisiä ominaisuuksia puhelimen vikoina vaan tunnistaisi ne oikeissa tilanteissa verkon ominaisuuksiksi.

Työ esittelee perustermit ja mahdolliset toiminnot, jotka saattavat olla tarpeen. Tutkintotyö ei ole kattava opas testaamisesta mutta peruskäsitteet tulevat käyttäjälle/lukijalle tutuiksi. Työ on laajennettavissa sitä mukaan kun verkkopalvelut kehittyvät, mutta tässä vaiheessa työtä vain nykyiset palvelut on esitelty.

Avainsanat:	testaus	verkkopalvelut	GSM	UMTS	matkapuhelimet

1 Introduction

The meaning of this work is to give common knowledge about the testing of mobile devices in different networks. This is written in common level because different testing methods concentrate to different aspects. This final thesis is made to open up the newcomer's eyes to subject that the new employee has not handled before. This is done so new people who are recruited to the company will have some sort of short introduction to the subject before they rush to the fields of testing. This should also introduce common concepts to the new employees so they will have some sort of knowledge about the possible features of today's mobile phones and used networks.

In this paper the writer tries to avoid mentioning the network implementations itself or the testing tools available and concentrate on issues mentioned before. When mobile device is mentioned in this paper it is always S60 product (S60 is a phone built on Series 60 platform). When the writer mentions network it is not any certain operators network. This is because the situation of different available services varies constantly, and the resent situation should be checked from the operators themselves. The reader of this thesis should know the terms 2G, 3G and series 60 platform. There is list of abbreviations in the appendix.

2 History of telecommunications

Common telecommunication systems can be roughly divided to three generations. The first generation can be considered as analogue cell systems where e.g. NMT (Nordic mobile telephone) belongs to. NMT-450 was taken to commercial use in 1981 and the more developed version of it NMT-900 was taken into use in 1986 in the Nordic countries as well as in Holland and Switzerland. Many other analogue systems were developed and used at the time but they were not compatible with each other.

GSM system (Global system for mobile communications) and other digital cell systems can be considered as the second generation (2G). The history of GSM started in 1982 when new European 900 MHz bandwidth telecommunication system was started to develop. The GSM became very popular system. New features such as SMS (Short Message Service) sending and receiving and the visibility of the caller number made the system known and widely used. After the GSM became more popular the operators have systematically ramped down the NMT systems.

Even though the GSM works practically on every habitat continent its coverage is not worldwide. UMTS networks are called the new third generation systems, which are planned to have worldwide coverage. It is meant to have multimedia possibilities in addition to traditional speech and data transfer. (Penttinen 1999:11)

The data transfer capability has been improved from the GSM capabilities. This provides higher bit rate services, which will enable e.g. video sending and receiving in the network. This function is available on WCDMA (Wideband Code Division Multiple Access), which is the main 3G interface in the world. WCDMA is deployed in Europe, Japan and Korea in the same frequency band (around 2 GHz) (Holma & Toskala 2001:xiii).

Third generation systems are developed specially for multimedia communication such as high quality image and video. These features together with the continuing development of 2G systems will increase the opportunities for manufacturers, operators, content providers, content users and applications using the networks.

The expectations towards the new 3G networks have been really optimistic and the commercial networks were supposed to be open in Japan during 2001 and in Europe at the beginning of 2002 (Holma & Toskala 2001:5). This optimistic plan did not succeed and for instance in Finland both main Finnish operators Sonera and Elisa launched their own 3G networks during autumn 2004.

There are many candidates for 3G and the most popular of them are CDMA2000 (in USA) and WCDMA (in Europe, Japan and Korea). (Bahl 2003:16.) Next chapter concentrates more to this issue.

3 History of WCDMA

WCDMA (Wideband Code Division Multiple Access) did not come up from one source. The basic process of selecting the best technology was conducted in several regions. In the following chapters there is a brief overlook about this issue.

3.1 Europe

At the end of 1995 the European research programme ACTS (Advanced Communication Technologies and Services) was launched to support the mobile communications research and development. Within this programme the FRAMES (Future Radio Wideband Multiple Access System) project was set up to define a proposal for UMTS radio access system. The main industrial partners for this project were Nokia, Siemens, Ericsson, France Télécom and CSEM/Pro Telecom with participants also from several European universities.

The proposals were sent to ETSI (European Telecommunication Standards Institute) as candidates for UMTS and five groups were formed:
- Wideband CDMA (WCDMA)
- Wideband TDMA (WTDMA)
- TDMA/CDMA (Wideband TDMA/CDMA)
- OFDMA
- ODMA

All of the proposed candidates were basically able to fulfil the UMTS requirements but the selection was made between WCDMA and TDMA/CDMA which were the main candidates. The selection between these two technologies was made in January 1998. WCDMA was selected as a standard for the UTRA (UMTS Terrestrial Radio Access) on paired frequency bands (FDD) and WTDMA/CDMA for operation on unpaired spectrum allocation (TDD). (Holma & Toskala 2000:39-45)

3.2 Japan

In Japan the ARIB (the Association for Radio Industries and Businesses) was the decision maker between WCDMA, WTDMA and OFDMA. WCDMA technology in Japan was very similar to the one, which was considered in Europe. The selection in 1997 was WCDMA (with FDD and TDD modes of operation) and it influenced also to the ETSI selection process in Europe, which was not yet completed by that time. (Holma & Toskala 2000:39-45)

These days UMTS WCDMA is the used network in Japan and it is maintained by the Japanese operators NTT DoCoMo and J-Phone. In 2001 these operators covered 75.7% of Japanese subscriber base (Halonen, Romero & Melero 2002:517).

3.3 United States

In the United States there were many second generation technologies such as GSM-1900, US-TDMA, US-CDMA (IS-95) and they all started to develop their own suggestion towards the third generation system. It now seems that cdma-2000 was the most successful candidate. It was partly based on IS-95 technology. (Holma & Toskala 2001:44-45.)

In the following table (table 1) this all is put together for better understanding.

Table 1: The conclusion about evolution paths associated to the 2G technology. (Halonen, Romero & Melero 2002:518.)

2G standard	3G standard	Evolution
GSM	GSM/EDGE/WCDMA	UMTS
PDC (Japan)	WCDMA	UMTS
US-TDMA (IS-136)	TDMA/GSM/EDGE/WCDMA	UMTS
cdmaOne (IS-95)	cdma2000 or GSM/EDGE/WCDMA	cdma2000 or UMTS

3.4 3GPP is created

As similar technologies were standardised around the world it came evident that it would be a huge and more or less impossible challenge to get the networks to work together. Because of this all the people involved tried to create a single forum for WCDMA standardisation. This created the 3rd Generation Partnership Project (3GPP). This new organization included ARIB (Japan), ETSI (Europe), TTA (Korea), TTC (Japan) and T1P1 (USA).

A bit later also CWTS (the China Wireless Telecommunication Standard Group) joined to the 3GPP and contributed technology from their own network to the knowledge of 3GPP. (Holma & Toskala 2001:45-46)

After that also USA noticed that they need to unify their network system and develop their own cdma2000 system more. 3GPP2 (3G Partnership Project number 2) was created for this specification. (Korhonen 2003:11)

As it can be noticed the development of 3G has been quite complex. The development is gradually continuing forward. This may take a while but the near future will tell how 3G is going to be used globally. Hopefully these efforts mentioned before have helped to create more unified mobile system.

4 Network related functions in mobile phones/testing the functions

4.1 Messaging

4.1.1 SMS

SMS service was introduced to the public during year 1992. These days SMS messages have become part of essential telecommunication possibilities for end-users. People send more and more text messages because it is a simple way of communication. The user can have a quick response even during important meeting or while traveling.

When testing SMS functionalities the tester must concentrate on issues like
- are the messages received in the exactly the same format as they where during sending (e.g. no letters missing)
- are all parts of the messages received if the message is sent in multiple parts (also known as concatenated messages).

4.1.2 MMS

MMS messaging service enables the possibility to send sound, video and pictures on multimedia messages. MMS usage is increasing due to increasing amount of camera phones on the market. The amount of content which the user can send is limited by the operator. For instance the maximum size for Sonera and Elisa is 100 Kb/message and for Vodafone this limit is 300 Kb in most countries.

4.2 Dial up

Dial up enables the user to use a mobile phone as a gateway to the data services. It enables for example browsing on users computer or data transfer.

When testing dial up connection the tester has to test the connection over bluetooth (BT) and USB cable. They are both commonly used and no regression should occur on these connections itself.

While traveling abroad the dial up connection may not be so simple to create as it is in Finland. This is because of the different kind of network configuration but the problem is usually solved with AT-command. AT-

command tells to the phone which access point to use. On Windows 2000 environment (`Control panel` -> `Phone and Modem Options` -> `Modems` -> select *your modem* -> `Properties`), and then open the `Advanced` tab.

Insert into this: `AT+CGDCONT=1,"IP","your.ap.name"`, where *your.ap.name* is the name of your AP (Access Point) that the tester needs to connect to.

While testing dial up connection tester makes other actions at the same time (send/make/receive phone calls, messages etc.) and makes sure that if the connection is suspended it is also resumed after it is possible.

4.3 Streaming

Streaming means basically downloading content from the server to the phone. The content is not downloaded to phone's memory but instead it is pushed directly to the screen. Streaming content is usually either voice (e.g. radio program) or video (e.g. music video). Streaming can be used in both 2G and 3G networks but the quality of 2G streaming is low due to the poorer data transfer capability in 2G networks.

To be able to use streaming the end-user has to set correct access point according to the following operator dependent procedure. This may seem like very minor thing to point out but this is usually the thing that the new testers always forgets and it takes time to find out the reason why the streaming is not working. The only reason for this malfunction is usually the missing access point in the RealPlayer settings. When the user is trying to stream via the browser and the there is no access point defined in RealPlayer settings, the phone informs about the missing access point. The user tries to change the access point from the browser and doesn't understand to check the situation in RealPlayer.

First the end-user has to go to the main menu in the phone. And select "Media"-folder.

After that "RealPlayer" folder should be selected.
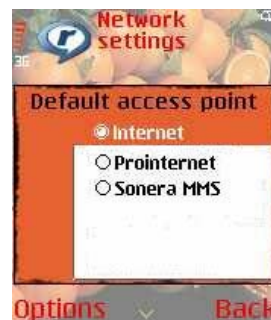
RealPlayer opens.

Now the user should
press options->settings

And next the user should
go to network settings
and select the correct
access point to be used in
streaming.

In this case the example
is made with Sonera SIM
card so the correct access
point is "Internet".

4.4 Phone calls

When testing phone calls tester should use a reference phone in addition to
test phone. Reference phone can mean another similar manufacturers phone
or a phone from own company, which is already being sold. The test is
passed if the test phone works at least as well as the reference phone. Good
test cases are MO (Mobile originated) and MT (Mobile Terminated) success
call rates. As many phone calls have to succeed with tested phone as with
reference phone.

It is also important to test simultaneous tasks at the same time as ongoing
call is active.

4.5 Video Telephony & Video Sharing

Video Telephony

Video call enables the user to see the other party on the phone during the phone call. There are couple of preconditions that have to be fulfilled before video telephony can be made:

- The phone has to be in 3G network (both a- and b-party).
- The phones have to be video telephony compliant (e.g. Nokia 6630, 6680 or N90).
- The used operator must support 3G video calls.

At the moment the main Finnish operators don't support Video Telephony except Saunalahti (Lehto 2005). This is a bit odd because Saunalahti uses Elisa's network. At this point we could ask why Elisa doesn't support this functionality for its own subscribers?

Video Sharing

Video Sharing has the same preconditions as Video Telephony. Video Sharing enables the end-user to share live video (or previously recorded clip) to the b-party. There aren't many operators that are supporting this functionality but Italian operator TIM (Telecom Italian Mobile) is the first one to launch this possibility to the end-users (TIM and…2005).

4.6 Push To Talk

Push to talk over Cellular (PoC) introduces a new real-time direct one-to-one and one-to-many voice communication service in the cellular network.

First the tester creates a connection with one user (or a group). Then if the user pushes the call button his/her voice is transferred to another parties. And if the tester is not pushing the transmission button he/she can hear what the others say. It is basically old-fashioned walkie-talkie in your own mobile phone.

It is not yet commonly supported by the operators and testing might be a bit difficult. The functionality is supported by many Nokia phones but operators haven't started to support it yet. T-mobile from Germany supports it on S40 phones but not yet on S60 phone according to their web pages (Mit welchen… 2005). This functionality works over GPRS so it works on both 2G and 3G networks.

4.7 Roaming

Roaming is a term, which means the situation when a user travels abroad and uses the home operator's SIM card in foreign country. Even though telecommunication networks are available worldwide the user cannot use the visited network without roaming agreement between the operators. User has to check the current roaming agreements from operators own web pages. Even though 3G networks are starting to be widely available there still aren't so many roaming agreements between 3G as between GSM networks.

4.8 Data transfer

Data transfer capabilities vary depending of the network coverage and the load on the network. You cannot say the exact speed of data transfer because it varies every time. Estimated amounts are presented in figure 3.

speed

UMTS
<2Mb/s

EGPRS
E-HSCSD
<384kb/s

GPRS
<170kb/s

HSCSD
<57.6kb/s
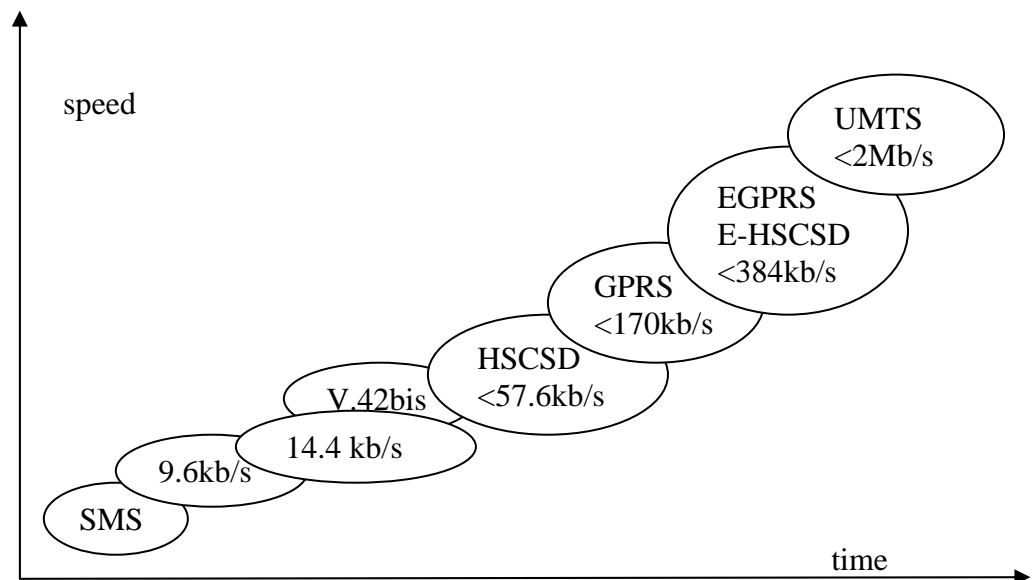
V.42bis
14.4 kb/s

9.6kb/s

SMS

time

Figure 3: Development of data transfer towards the WCDMA network. (Penttinen 1999:281.)

When tester makes a test case he/she cannot usually say the exact data transfer capability. The easiest way to see the difference is to try the streaming functionality in 2G and 3G networks. If the tester tries to stream the same music video it is nicely played in 3G network. The sound and image are clear. If the tester tries the same video in 2G network the image is pixelated and the sound is either not heard at all or it may be played with pauses. The pauses and pixelation are visible because it takes more time to download the content to the mobile device. The phone tries to show the content faster than the network can transfer.

4.9 Other things to notice

Idle state

> Idle state is a state, which is quite commonly referred on test specifications. To be able to understand test specifications there are couple of concepts the tester should know.
>
> According to Vijay G. Garg (2001:170) idle state is a "basic" state where the phone can:
> - receive messages and orders from the base station
> - receive an incoming call
> - initiate a registration process
> - initiate a call
> - initiate a message transmission

Testing in operators own network

> When testing abroad it is important to test with all local operators SIM cards. This way the phone manufacturer can be sure that the phone works as it should and there are no major faults in the phone or in the operators network. In the early days of testing (the new 3G network) network faults do exist.
>
> Before the testers are sent to test operators own network they should check all available information before hand. Like what are the needed settings (SMS, MMS, email, browser, dial up and streaming) and what are the limitations set by the operator (e.g. possible MMS sizes on sending and receiving). This helps the actual work when all needed information is available and the tester doesn't need to look for it in strange environment even perhaps without good internet access.

Internet (browsing)

> When testing browsing main things to check are to
> - Check that the operators own web pages are rendered correctly
> - Check that the pages are rendered correctly with both small screen and original screen options
> - Check that the pages are downloaded correctly also while moving e.g. around with a car.

5 Handovers in dual mode

WCDMA (Wideband Code Division Multiple Access) works in parallel with GSM network in different frequency band. Handovers between these two networks are needed to maintain the service on the users mobile phone. The handover between these two networks is called Inter Radio Access Technology handover (IRAT HO). Because WCDMA doesn't have full coverage IRAT HO is important to ensure seamless service between WCDMA and GSM network. (Zhang 2004:849.)

The mobile phone has to measure the quality of both uplink (UL) and downlink (DL) to be able to perform IRAT HO. WCDMA connection might drop due to bad uplink or downlink quality. To avoid this the mobile phone has to measure these values constantly and switch to GSM mode early enough so that the connection doesn't brake. (Zhang 2004:849.)

WCDMA and GSM standards support handovers to both directions. These handovers are used for coverage or load balancing reasons. This behaviour is explained in the following picture (figure 4). If the user is in the urban area he/she can use the 3G network so the data transfer capability increases and more network services are available. When the user moves to the rural area the handover must happen in order to maintain the coverage and because of this the data transfer capability decreases and e.g. Video Telephony is no longer available.
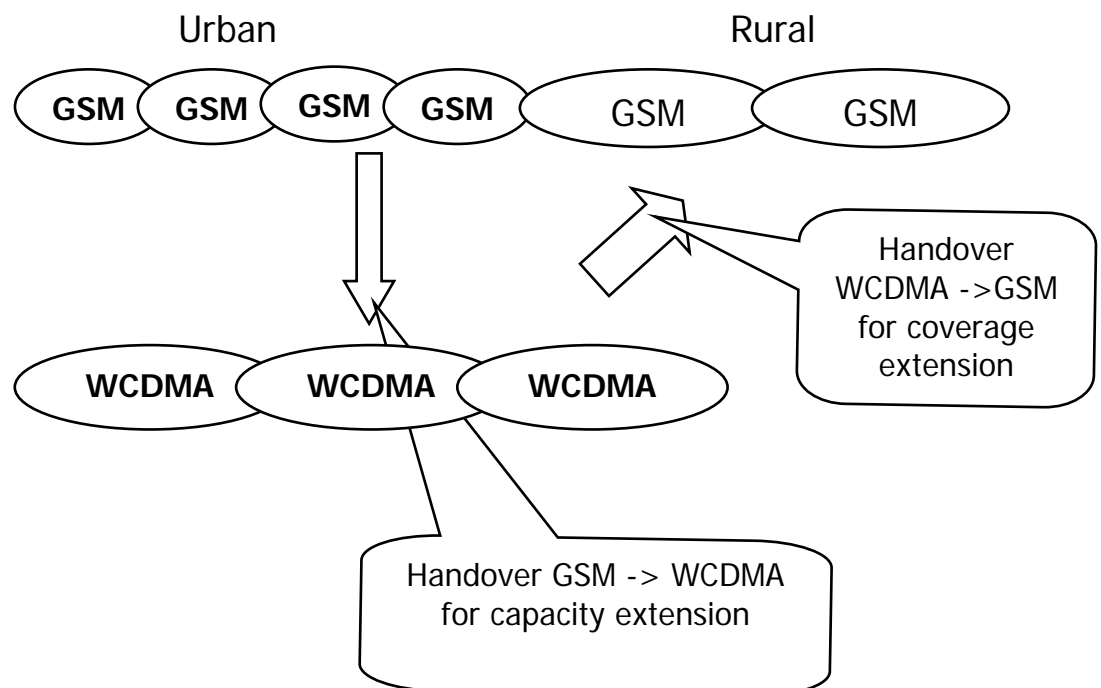
Figure 4: Handover between networks (Holma & Toskala 2000:205)

6 Network limitations

6.1 Load control

The networks are not always properly planned and this may be visible to the user on several ways. When the networks are being planned the network planner cannot always predict the usage of them and when the load is bigger than expected problems occur. This kind of load control problems can be seen for instance in the centre of the city where the greatest subscriber amount is witnessed. Possible defects seen by the end user/tester:

- Network indicator shows good coverage but when user tries to call error note is shown: "network busy". This error note is shown to the user if the network is busy with the current load of users.

- Someone is trying to call to the end-user but no indication about that is shown to him/her. The phone call is directed to his/hers voicemail. This happens if the network is busy with the current load of users.

There are some situations where the end result is not so visible to the end user but the network makes actions in order to reduce the load.

- Handover to another WCDMA carriers. Not visible to end-user in any way.
- Handover to GSM. This action causes only increased delay of packet data services. Speech calls are being maintained.
- Decrease bit rates of real-time users
- Drop calls in a controlled fashion. This action is taken only if the load on the network is still high after the actions mentioned before. (Holma & Toskala 2000:214.)

6.2 Network differences when testing in 2G/3G

6.2.1 PDP context

In some networks it is possible to have only one PDP (Packet Data Protocol address) context at a time in 3G network. This means that the user can have only one active connection at the time. This was more common in early stages of 3G development but these days it is working much better than earlier. This used to complicate the usage of common actions like browsing and usage of email because every time the users used different access point they had to close the previous connection.

Number of PDP connections is not limited in 2G networks so it seemed that 3G has gone "backwards" in the areas where the network allows only one PDP connection at the time. This problem is going to improve and it should be corrected to most of the networks during year 2005.

6.2.2 Examples

In the following few paragraphs there are examples about test functions that are not so commonly seen. It helps to understand a new functionality when the tester can actually visualize the situation. It helps also in the future because after reading this next paragraph the tester has an expectation about the test result. If the tester has never seen anything similar it might be difficult to act as it is explained on test specification.
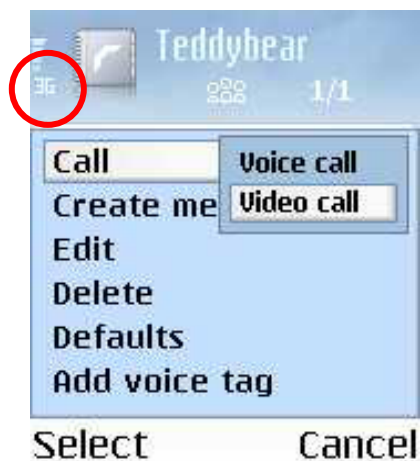
6.2.2.1 Video Telephony

If preconditions stated in par. 4.5 are fulfilled the end user can try to initiate a Video Call. There is an example about this on following pages where Piglet and Teddy bear are calling to each other.
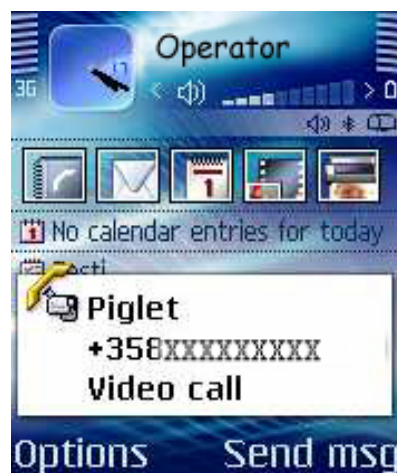
IN 3G:

A-party: Piglet
- finds a contact from the phonebook
- chooses "call video call " from options to attempt a video call

Both parties are in 3G and their operator supports Video Telephony

B-party: Teddy bear
-    notices that Piglet is trying to call a video call for him

- Teddy bear answers to a call, which Piglet started

Piglet who started the call sees Teddy bear on big screen and his own picture on little screen. This way he knows what is being transmitted to the other party.

And Teddy bear can see the same situation vice versa.

The video call can continue as long as both parties are in the 3G area. The picture is transmitted as video so all the movements and back ground noise is also transmitted to the receiving party.

IN 2G:

Because Video Telephony is not supported in 2G the user cannot make a call.

Instead user gets an error message where he/she is advised to use another type of contact.

This same error message is also shown to the end-user if user tries to make a Video call while he/she is out of 3G coverage (even though the used operator would support it otherwise).

6.2.2.2 Video Sharing

At first the same rules apply as in Video telephony
- user has to be in 3G network
- the operator has to support this functionality (and they have to provide a server which enables this)
- in addition there are differences between phone models. Testers have to check from their phones manufacturer if the needed Video Sharing files are already installed to the phone or do they have to install themselves.

When user starts Video Sharing (VS) he/she has to start a normal phone call at first. Then if the needed VS files are already installed to the phone both parties have to wait for a while so that both phones register to the SIP server. After the pointy arrows are being established beneath the operator strength bar (also on the b-parties phone) the user can start sharing.

When the arrows are on – open the camera and the phone asks instantly if the user wishes to share a video.
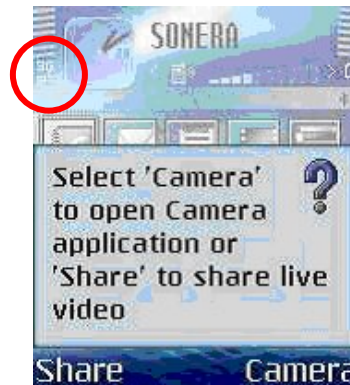
After this the user has to choose "Share" and gets an opportunity to add an address to an address box.

Now the invitation to accept the shared video is sent.

And the other party accepts it.

After this both parties can see the shared file. In this case it is a part of television program. A-party wants to explain it to the other and this is the easiest way. The program is currently on the television and the B-party is not near television. This way the A-party can explain the happenings of the currently ongoing running contest to the B-party.

6.3 Test cases

When reading test cases the tester should read them carefully. There are always preconditions that should be fulfilled when running the test cases. Some tests are done only in GSM network, some only in WCDMA network and some test cases need to be done during handovers to different cell or network. This is always told on test cases.

Usually it depends about the test case in what situation they should be tested. There are some cases where the tester cannot test in 2G and these are usually the cases where the service needs 3G network to work (like Video Telephony.) Usually the test cases are run in all of these networks and the method may vary a bit but basic functionalities have to work.

If the test case says that the cell or network should change during the test it usually means that the tests are made mobile. Usually this means that the tests are done in moving vehicle.

7 Problems with today's WCDMA networks

The networks aren't yet as stabile as they should. At the same time when new 3G phones are being developed and tested, there are new problems found when there is bigger load on the network. This has been seen also on network planning. 3G networks work entirely different way than other mobile technologies. 3G network needs five to ten times as much base stations compared to normal 2G and 2.5G networks and in addition they have to plan the right "link budget" to ensure the service for every user (Kyas 2003:22). Otherwise some network problems can be seen by the user (e.g. when the network is too busy the user can not make calls).

There are also some interoperability problems between different networks in the same country. It is possible that the operator is using different kind of techniques in different cities. This has been under study also between different operators because they have to be able to work together. Interoperability is one of the reasons why seven leading network vendors (Nortel Networks, Siemens, Nortel, Alcatel, Ericsson, Motorola and Nokia) formed the NVIOT Forum (Network Vendor Interoperability Test Forum), which agreed to run regular test cases together to find out uncovered differences in their network implementations (Kyas 2003:22). This among other things has helped the operators to improve their networks and keep their network interoperability up-to-date.

Even though the network has been tested it is important that it is tested also with real devices in a real environment. On the other hand when phones are tested there is not much of a possibility to test them on test network and the only possibility to run high scale testing is to do it on real environment. This way when both technologies are new and uncommon both developing areas are getting benefit of each other.

Yet the phones have the ability to use brand new techniques all the operators do not support them. One example is video Telephony. Even though phone supports it there are only couple of operators in the world that are supporting this functionality. If the public doesn't have knowledge about these features and they don't expect these features from the operators the operators are not going to add these features to their network implementation. This is because it is too expensive for the operators if they don't have subscribers for their services. There has to be demand before the service becomes beneficial for the operator.

8 Outlook

Even though the 3G network is just coming to the public use there are
already speculations about the future and the future 4G and 5G networks.
These speculations have started already before 3G networks where in public
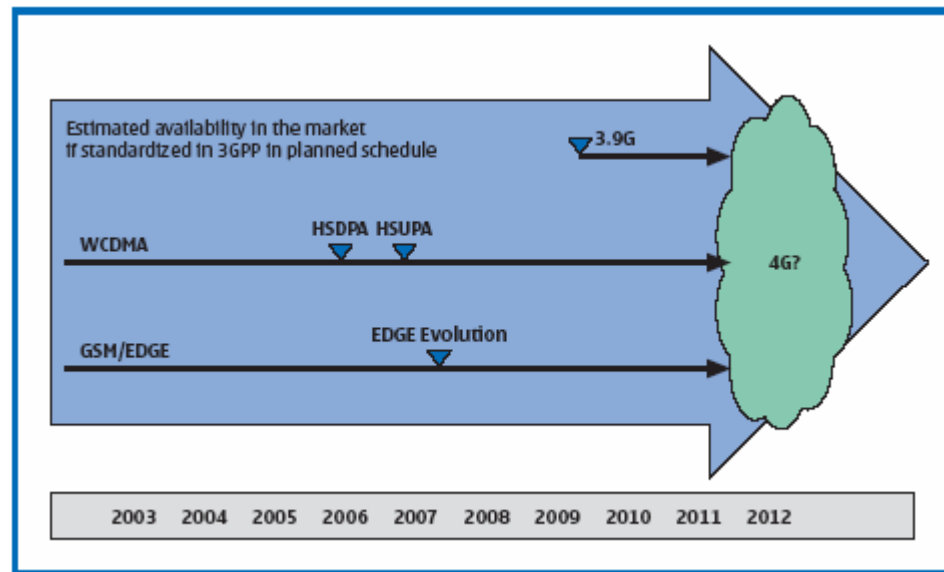use (see figure 5).

Figure 5: Radio evolution roadmap towards 3.9G and 4G (Radio Network
Evolution … 2005).

Here is another picture (figure 6) about the same issue. It is made already
2002 but the same aspect can be seen from it. The number of existing
technologies is constantly decreasing and the goal is to have a unique global
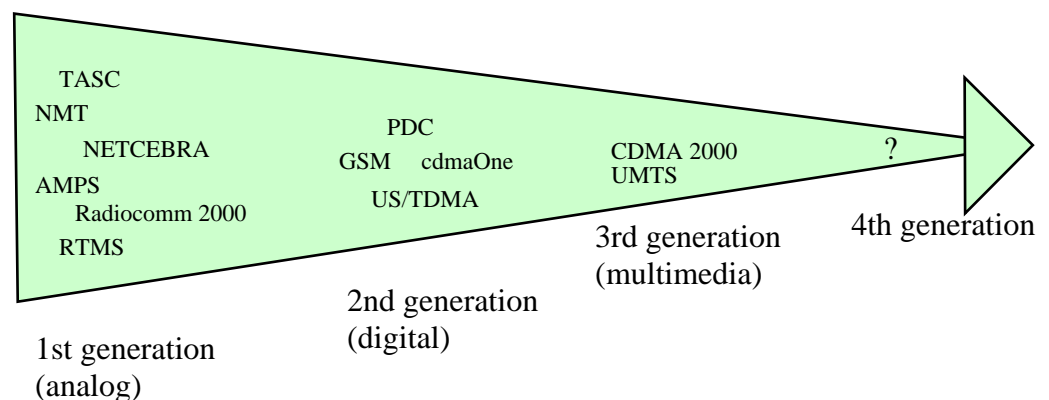radio technology in the near future.

Figure 6: Technology globalisation by Halonen, Romero & Melero (2002:
513).

Term 4G is not defined yet and nobody knows what it is actually going to be. Here is one futuristic 4G vision about this subject. See figure 7: The old networks will remain and new ones are being created but they all work seamlessly. The future cell systems may work in the future with satellite networks as shown in the picture. All old networks will also remain and they create a multilayered network system.
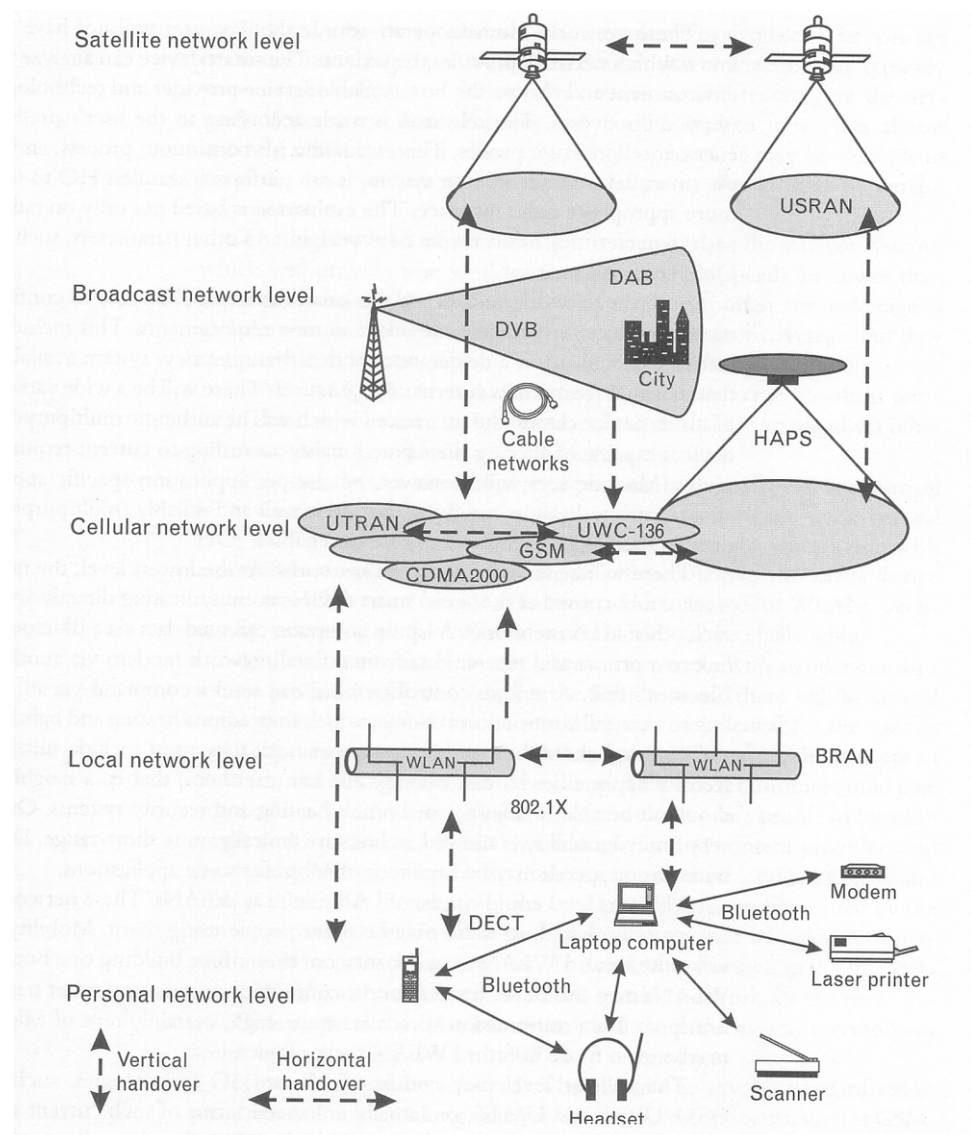

Figure 7: Future of networks? (Korhonen 2003:473)

There is a huge demand for new networks because developers want constantly to increase the data transfer capabilities. The new networks are not defined yet and only time will tell when they are going to be published. In Japan there are ongoing tests about one example of 4G network but it may still change from its current implementation because the networks are constantly developing. (1Gbps Packet…2005)

It doesn't actually matter what kind of network is going to be used in the future. Testing is important also in the future because there will be always new devices, new networks (or updates and changes) and new network functions. It is important to test the performance of new devices with the old networks and old phones. The change has to be seamless

9 Conclusion

The purpose of this thesis was to give common knowledge about mobile phone testing and network services available.

This thesis introduces all essential network related services to the reader. There are examples about network related functions and the main target was to concentrate on the most essential issue about every specific area. All the important issues according to writer's opinion have been collected to this paper so that the new tester would benefit from it by reading this paper.

The thesis concentrates a bit more on 3G testing because it is more complicated than 2G testing. This is because 3G has more functions to test.

This work is going to be used in company as an introduction material to new testers. This is not given to a new employee automatically, only if they want more information about the subject.

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Appendix

Appendix 1: Abbreviations

1G	First Generation Cellular Technology
2G	Second Generation Cellular Technology
2.5G	2.5 Generation Cellular Technology
3G	Third Generation Cellular Technology (a.k.a. UMTS and WCDMA/cdma2000)
3GPP	3rd Generation Partnership project (Refers to an organization which includes ETSI and ARIB)
AMR	Adaptive Multi-Rate (Speech codec)
AP	Access Point
ARIB	Association of Radio Industries and Businesses (Japanese telecommunication body)
CDMA	Code Division Multiple Access
DL	Downlink (refers to the direction from Base Station to Mobile Station)
EDGE	Enhanced Data Rates trough Global Evolution
ETSI	European Telecommunication Standards Institute
FDD	Duplex method where different frequency is used in UP and DL directions
GERAN	GSM EDGE Radio Access Network
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
MMS	Multimedia Messaging Service
MO	Mobile Originated
MT	Mobile Terminated
ODMA	Opportunity Driven Multiple Access
OFDMA	Orthogonal frequency division multiplexing
PDC	Personal Digital Cellular (most popular 2G cell system in Japan)
PDP	Packet Data Protocol address
QoS	Quality of Service
SIP	Session Initiation Protocol
S40	Cell phones build on S40 platform
S60	Cell phones build on S60 platform
SMS	Short Message Service
TDMA	Time Division Multiple Access
TDD	Duplex method where UL/DL transmitters take turns in sending
UL	Uplink (refers to the direction from Mobile Station to Base Station)
UMTS	Universal Mobile Telecommunications System/Telephone System (a.k.a. 3G)
US-TDMA	US-Time Division Multiple Access
UTRAN	Universal Terrestrial Radio Access System (refers to 3GPP specified, WCDMA based radio access technology)
Vodafone	operator that works at least in Spain, Hungary, UK, Germany and Italy
V.42bis	compression standard (which can increase e.g. the speed of the 9.6 kb/s)
WCDMA	Wideband CDMA (refers to CDMA system with wide transmission bandwidth 5MHz)
WTDMA	Wideband TDMA (refers CDMA system with narrow transmission bandwidth 1.6MHz)