Replace your ageing sound recorder with a PDA — fitted out with a broadcast-quality software package

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For the past two decades, the PDA has gone through a fast and turbulent period of development. It started off in 1984 as a small handheld computer for storing addresses and phone numbers, taking notes and keeping track of daily appointments. Nowadays there are extensive operating systems and features available for PDAs. With their processing capacity and storage space constantly expanding, the modern PDA offers a lot of possibilities for the broadcasting world.

Transforming a PDA or Smartphone into a high-quality portable MPEG recorder is the next logical step to take. The use of a PDA with built-in wireless communication can provide an "all-in-one" solution, resulting in more creative broadcasting and a more efficient way of working. It can also be shown that the use of this PDA technology for newsgathering can bring down the broadcasting costs and increase the amount of material which makes it to air.

Do you remember the ***Nagra*** tape recorder which served well for more then 40 years ... and the ***DAT*** recorder, introduced around 1985 and still being used 20 years later? Well both devices have now disappeared completely. Sony delivered the last DAT recorders in December 2005 and is no longer producing them. They only sold a hundred devices a month worldwide and therefore it was no longer profitable. Even their successors – such as the ***Minidisc recorder*** (1992) and the ***PCMCIA recorder*** – are vanishing slowly. Time is overtaking these earlier technical developments and applications.

Undoubtedly time is also essential in newsgathering and radio broadcasting. Formerly, journalists had to go back to base in order to edit and broadcast their interviews or news reports – not only a time-consuming job, but also hard work after a full day on the road! Using a ***PDA*** or ***Smartphone***, these days are now over. Imagine only needing one device to record audio, edit your recordings, take pictures or videos and send the captured material wirelessly back to the studio. The device fits in your pocket, while special broadcast-quality software makes it easy to use. Even members of the public with minimal training can record audio for broadcasting and get it on-air within minutes. Think about the possibilities for user-generated content.

A PDA fitted out with Luci broadcast-quality software

Technica Del Arte, from Maastricht in the Netherlands, has developed such a specialist broadcast-quality software package for the PDA, called Luci®. Using a Pocket PC or Smartphone equipped with this software, journalists all over the world are able to edit and transmit wherever they are and whenever they want. Avoiding hours of travelling, it allows them to take audio clips from interviews, record links and create a radio package which can then be sent back to the studio in just a few minutes. Even text, photographs and video can be added.

Once ready for broadcast, the material is simply sent back to the radio station via Wi-Fi hotspots, or over the mobile phone network via GPRS, UMTS or, in the near future, HSDPA. For the programme producer back at the radio station, it is also very simple: it is an easy drag & drop to load the sent file into the playout system. There is also an application available that transforms the PDA into a high-quality live internet broadcasting communication channel.

From now on, newsgathering will be simple, swift and mobile.

The Luci software has been developed, tested and improved "in the field" in close cooperation with professional journalists and technicians at radio stations including BBC Radio Lincolnshire in the UK and L1 Radio-TV in the Netherlands. It aims to bring the best quality, user-friendliness and reliability. Recordings can be made using standard formats, including metadata, that are suitable for transmission right away.

Advantages of the PDA platform

The advantages of using a PDA for broadcasting are numerous. The inclusion of a data communication capability is a big advantage, compared to conventional portable-recording kit. At best, the latter has a built in ISDN codec, whereas PDAs are equipped with a wireless connection to the internet as standard, making it far easier to publish audio, metadata and external files such as photos or video, to radio stations or websites. Technically, the authors believe that Luci software is far ahead of its competitors like Pocketrec from the USA. Pocketrec is not able to work with MP2 files and has a complicated way of transmitting. Moreover the price of Pocketrec is almost 5 times higher then Luci.

The present internet generation is accustomed to text, audio and video media and wants to be kept well abreast of the latest news. The audio-visual media are ahead of the print media in this respect. Radio and television are much faster in breaking the news and meet the vast growing demands of the public. Swift newsgathering is required and major broadcasters worldwide do have a tendency to collect more multiple regional news and information bulletins in addition to their national and international programmes. Most of the output is immediately published on the internet after broadcasting, so the public is able to obtain the news from anywhere, any time, wherever they are.

Reporters who are using a PDA are able to report from remote areas, add text and pictures and transmit this in the shortest possible time, practically from any location. In the Netherlands Vodafone, KPN and T-Mobile offer more than 1800 Wi-Fi hotspots and the coverage of UMTS and HSDPA is growing. Reporters need little time to air. Files can be published by FTP to the uplinking station. Automated processes, using watch folders, make it possible to publish these items automatically via the playout system or the internet news site of the radio station, if required, together with text files, audio quotes, pictures and video as a teaser for sequel reports.

Another advantage is the reliability and the high time-saving service level of the PDA manufacturers, for these are mass-market products. Replacement equipment and accessories, such as virtual keyboards and 12-volt cables, can be bought on any street corner so to speak. Manufacturers who

produce only broadcast hardware can never reach that kind of penetration level. Also, value for money is important. For €1,000 a complete reporter set can be specified and purchased, including software, mic pre-amplifier, headphones, high-quality audio card and cables. The Dutch broadcaster L1 Radio-TV is at the moment using an E-TEN smartphone which has a remarkably good audio chip, so the need for an external audio card is not even necessary. That brings the cost for the equipment down to just €600.

Output

The audio files are recorded with a BWF header – depending on the newsroom system the reporter is using or what is preferred – in MPEG-1 Layer II format, or linear. Bitrates can vary up to 256 kbit/s. The files are saved in high-capacity memory cards such as SD. A memory-card of 1GB can record about 17 hours of audio at a bitrate of 128 kbit/s. Also, simple non-destructive accurate editing can be done by non-technical reporters. Programme-makers, technicians or web (radio) masters can define the technical setup and the general behaviour of the software beforehand, so reporters are not bothered with the actual settings such as preferred publishing (FTP uploading or email), input EQ and metadata specifications.

Experience has shown that uploading via GPRS – by Bluetooth connection to a GPRS mobile – allows an upload speed factor of around 7, at a bitrate of 64 kbit/s. This means that one minute of audio will take about 7 minutes of upload time. With UMTS, this speed factor drops to just 2. However, using Wi-Fi is considerably faster: an item of 2 minutes duration can be transmitted in about 20 secs, depending on the number of users and the available bandwidth.

Batteries

If you are concerned about battery life ... all PDAs benefit from the latest advances in battery technologies. Most are equipped with Lithium Ion (Li-Ion) batteries. Li-Ion has quickly become the emerging standard for portable power supplies in consumer devices. Li-Ion batteries produce the same energy as NiMH batteries but weigh approximately 35% less. This is crucial as the battery makes up a significant portion of the device's weight. Another reason Li-Ion batteries have become so popular is that they do not suffer from the memory effect that afflicts NiCad batteries. Also, on the recharging front, NiCad batteries should be fully discharged before recharging, whereas Li-Ion batteries can be recharged if not fully used and whenever needed. Continuous recording times of 8 hours are more the rule than the exception with the current range of PDAs.

Metadata

By using a well thought-out metadata model, it is even possible to automate the publication of recorded footage on several channels or websites. By adding the destination in the BWF header, the media asset system at the broadcaster's base can strip the header and distribute the content

Abbreviations

DAT	Digital Audio Tape
EQ	EQualization
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HQ	High Quality
HSDPA	High-Speed Downlink Packet Access
IP	Internet Protocol
ISDN	Integrated Services Digital Network
LAN	Local Area Network
PCMCIA	Personal Computer Memory Card International Association
PDA	Personal Digital Assistant
RAM	Random-Access Memory
UMTS	Universal Mobile Telecommunication System

based on the metadata rule that has been provided. That means that publication can be done from any location without the need of any manual intervention.

Trials with L1 Radio-TV

L1 initiated a unique trial in the Netherlands with the collaboration of Fraunhofer and Vodafone NL. The goal was to test the transport of live HQ audio via (IP) UMTS networks using Fraunhofer's AAC LD codec for PDAs and Vodafone's UMTS network in the Netherlands. The Fraunhofer codec was implemented into the Luci live software by Technica Del Arte. The IP connection was made with a Mayah Centauri IP codec at the studios of L1. The test proved that the idea was realistic. Live broadcasting was done by using the Fujitsu-Siemens Pocket Loox T 830 Smartphone with UMTS, GSM and Wireless LAN.

Broadcast interview using a Luci-equipped smartphone

The biggest concern of the trial was the overall delay. The goal was to achieve a delay of under 400 ms. This would mean that the equipment could still be used in a live two-way situation with conversations between studio and the remote location. That goal was achieved. L1 used the connection for a live report of a soccer game. The Luci Live software is also available for the PC, turning a standard PC into an IP codec.

Trials with BBC Radio Lincolnshire

For more than a year now, BBC Radio Lincolnshire has been running a pilot project for the BBC in the use of Pocket PC phones and Luci. One of the aims is to assess whether this could be the standard reporter's toolkit for the future.

BBC Radio Lincolnshire is one of 40 local radio stations run by the BBC in England. It provides a speech-based radio service to the rural county of Lincolnshire on England's east coast. The radio station is based in the city of Lincoln, but covers a large geographical area served by a poor road network. It can often take 90 minutes to drive to the more remote parts of the county even though they are less than 75 km away, so the ability to send material back to the studio quickly was one of the main advantages driving the project.

PDA implementation

For the initial implementation, the O2 XDAIIi unit was used. The requirement was for a device with the phone built-in as, in Lincolnshire, access to wireless broadband is limited (but now growing). Also, there was an obvious need to use the mobile phone network (GPRS) to publish a lot of the material, and to do this without users having to carry two separate devices around.

As well as Luci Edit software, "Spb Pocket Plus" menu software was used, for two reasons:

1) It provides an easily configurable front-end menu system, which will look the same regardless of which device it runs on.
2) It can be configured to keep total memory-use of a PDA to a minimum. This is an important way of ensuring the device is running in a robust way, and that valuable system RAM is not being used by other applications which do not need to be running.

Another good preventative measure is to install third-party software to reset the device automatically every day. Memory leakage in Windows Mobile itself is widely documented. An automatic daily reset prevents this from becoming a problem.

At the start of the Radio Lincolnshire project, standard reporters' mics were used with these units, with very good results. However, the quality of the built-in microphone of the XDAIIi was sufficiently good (with EQ applied) that this offered an acceptable quality for speech recordings. Using the built-in mic had other advantages in that reporters were more likely to carry their PDA with them at all times if they did not have to carry a microphone with them also.

The recorded material is published to the BBC's FTP server, from where it is an easy operation to drag it into an audio editor and hence into the playout system. This system will be automated soon, like L1 has done already, so audio will appear directly in an "inbox" in the playout system.

Who is using the PDA for recording?

Three areas were identified, where these units would be used:

- News reporters;
- Presenters and other production staff;
- Members of the public.

News reporters

In an instant, the news team was given the ability to record audio, edit it, and send it back for broadcast, in one self-contained unit. Their pattern of working has changed, to allow for more time out of the office, gathering stories. PDAs have removed the need to return to the office, making it a real possibility that reporters can spend the whole day "on the road", moving from one job to another.

Presenters and other production staff

All radio presenters were issued with PDAs. This meant that whenever they were out and about in the county, they had the ability to record audio. For some, it meant they could record the sounds of everyday life to add to their programme, and for others it meant the ability to record "off the cuff" interviews with people they met by chance.

Members of the public

BBC Radio Lincolnshire has a pool of 15 PDAs which are available for loan to members of the public as "citizen journalists". They can be used in many different ways. Among the contributions so far have been:

- Behind-the-scenes audio diaries and interviews from the RAF Red Arrows aerobatic display team (based near Lincoln) from around the world;
- Personal audio diaries of teenagers who care for seriously ill members of their family;
- A daily diary of two 4-year-old sisters on their first week of school;

- A student spending a month in India working with street children, reporting on her experiences in a weekly audio despatch.

These machines are set up to a “cut down” build, where most of the menu options are removed, and Luci is run in “Lite” mode, offering a very simple user interface.

The results

The introduction of PDAs running Luci has had a dramatic effect on BBC Radio Lincolnshire – so much so, that they are now being introduced across the BBC. Some of the benefits include:

- Getting news stories on-air first – for the first time, a reporter can record a short voice report for a news bulletin and it can be on-air within a couple of minutes. This has been very useful when covering court cases, for example.

- Getting photos for BBC News Online – now, every radio reporter can take photos when they cover a story, and send them back with their audio. The BBC News website can now use specific photos instead of stock shots as used before.

- More creative audio on-air – an example of this was when a whale was washed up on a Lincolnshire beach recently. A reporter was able to record audio, edit it into a radio package and send it back to the radio station with a photo – all from ½ km out to sea on the beach at Skegness!

- New opportunities – Two reporters visited Australia and recorded a one-hour documentary on the links between Lincolnshire and Australia. It was all recorded using Luci, edited, and then sent back via wireless broadband.

- More local stories covered – local audio content has risen by 50%! PDAs have freed up reporters from being confined to the office and have allowed them to cover more stories.

- Television reporters providing radio audio – when a breaking story happens and a local TV reporter is attending, they can record a radio interview before their TV interview and send this back for broadcast while doing their filming. The result – more resources freed up to cover more radio stories, and the profile of the regional TV programme raised by hearing the TV reporter on the radio.

It would be no exaggeration to say that PDA reporting has been the biggest change at Radio Lincolnshire since the introduction of digital playout systems.

A short journey into the unknown

PDAs were not really intended for use as high-quality audio recorders. Yes, they all come with pre-installed audio recording applications but, by default, these are set to record in the worst possible quality, sometimes called “radio-quality”. By this, they must mean radio quality from the thirties, judging from sample-rates and bit-depths! Just go to your regular modern PC, try to record audio and choose “radio-quality” ... you will get a 22 kHz and 8-bit (linear) recording. If our ears do not deceive us, this is not what we hear on modern day radio. . .

On a PDA there is, at first glance, a lot to prevent us from having good audio quality: there is no external microphone-input! Also, the presence of a good quality internal microphone is not guaranteed – after all, these things are mostly only used for taking audio notes or making GSM-quality phonecalls. High professional audio quality seems to be of no priority for PDA manufacturers.

However, looking closer there are two important features:

1) Every PDA has a standard audio-codec onboard, capable of 16-bit/44.1 kHz recording at the minimum.

2) Most PDAs have a version of Windows CE onboard, which is like Linux or Windows for PC (yes, for 99% of the applications). Windows CE is an open, documented OS for software application writers, not some java-like higher language where an application can have no control other than what is dictated by the manufacturer.

"Open" means you can actually control almost all audio features of the PDA's audio codec exactly the same way as on a PC. Some PDAs can even record at 48 kHz, but this is not documented.

Another rarely-documented feature which contradicted our findings at first glance was ... almost all PDAs with GSM onboard do have the ability to connect an external microphone! If you can connect a wired headset to it, you can also plug an external microphone into the headset input. Just find the right plug, build some electronics for impedance matching and you are ready to use any (non phantom-powered) external microphone. If you want to use phantom-powered microphones, there is even a solution for that, which is explained below.

Measurements

Journalists can now use an external (mic) input and record at professional audio sample rates and bit-depths. *Fig. 1*, in conjunction with the table below, shows the measured audio dynamic range of four types of PDA, measured with a Shure Beta58 connected to the headset input.

The results are not bad at all for doing day-to-day electronic newsgathering.

As one can suspect from the noise-floor of some PDAs, there are strange things going on with the frequency response at the input. *Fig. 2* shows the frequency response (in yellow) of 3 devices:

- Upper: Toshiba E800
- Middle: O2 XDAII
- Lower: E-Ten M600

Trace colour / PDA	Dynamic range, A-weighted (dB)	At Mic sensitivity (dBμ at full scale)
Yellow / Toshiba E800	84	–40
Red / O2 XDAII	76	–32
Cyan / Fujitsu-Siemens PocketLoox T830	66	–33
Green / E-Ten X500	73	–34

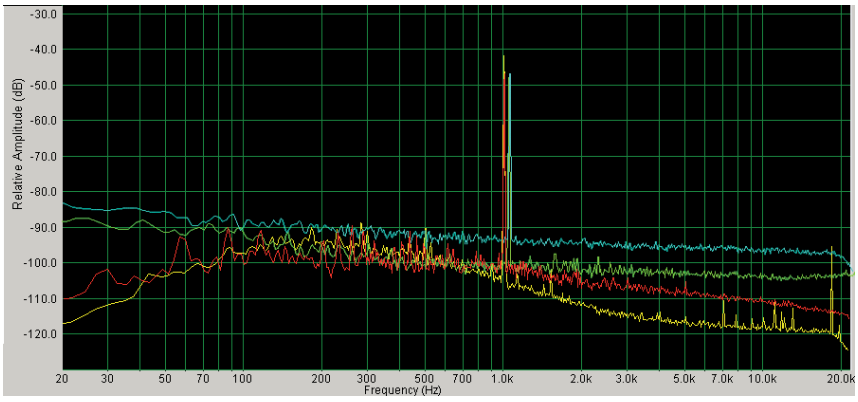

Figure 1
Measured audio dynamic range of several PDAs

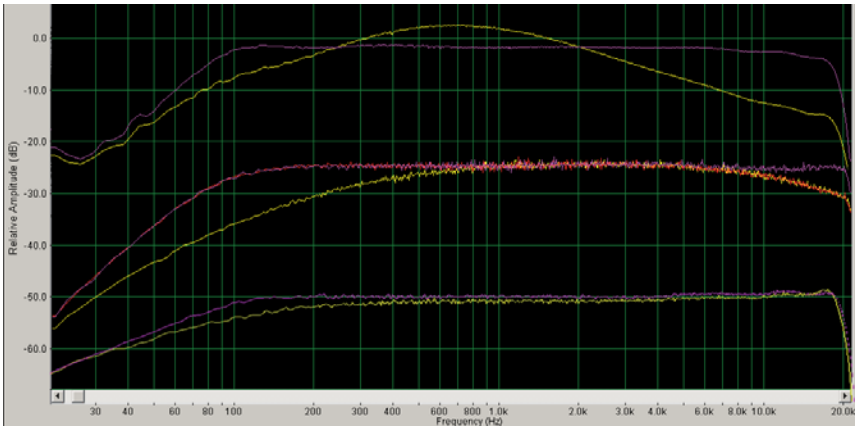

Figure 2
Frequency response of three PDAs

As you can see, there is some considerable filtering in, for instance, the E800 – probably done for the purpose of speech-recording. The purple lines are the frequency responses after applying a digital EQ.

It seems the earlier devices like the E800 and XDA suffered from considerable EQ-ing going on while the newer devices are reasonably flat. If you compensate this with a digital EQ, the dynamic range will decrease at the lows and highs ... but there is more than enough left to work with.

The phase, of course, will make all sorts of jumps, but that is something for the purists to worry about.

And what about the internal microphone?

Now, it would be fantastic if a PDA had a good enough internal microphone to do your basic work with. What is important is the "sound" and noise level. Noise levels are mostly dictated by electronics, so there you will not find any problem in comparison with using the external input. On the other hand, "sound" is commonly dictated by how well the very small hole for the microphone in the casing is shaped.

In general, there is enough dynamic range to do some decent digital EQ-ing. At BBC Lincolnshire and L1, they use the internal microphone of the O2XDAIIi and E-Ten M600 for all their reports. You would be astounded to hear the resulting audio quality!

Of course, you then have no choice of directionality – the internal microphones are always omni-directional by their nature. But you have the choice of using other types of microphones, which is important.

There are even more choices you can make:

- have you ever heard of a professional Compact Flash (CF) stereo audio card with phantom power and professional mic amps?
- have you ever heard of a Compact Flash SP/DIF input, capable of 192 kHz sample rate?

Yes, these cards are available for PDAs that have a CF interface on board. PDAs with compact flash however mostly do not have GSM onboard, but they always do have Wi-Fi and Bluetooth. The latter can then be used to connect to a mobile phone and upload your bits and pieces if you are not near a Wi-Fi hotspot.

So, to conclude this short journey into the unknown:

- There is now a choice, actually lots of choices, in getting high-quality audio recorded on a PDA.

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For more information, demos and specifications of the Luci Software applications, please see **www.luci.eu**.

Joost Bloemen studied information technology at the HTS in Heerlen, The Netherlands. After completing his studies in 1983, he worked for OMT a one-man business for a variety of clients and on his own products such as the hard disk recorder for the ATARI ST Computer, which made him one of the pioneers in this field. In 1994 he founded Technica Del Arte, a solution-based firm of consultant engineers with over 10 years experience in the development of professional audio technologies and products such as DSP, C++, and digital and analogue technologies.

As well as initiating and developing new products within the hard- and software fields, Technica Del Arte regularly undertakes commissions from, and partnerships with, clients for large-scale, innovative audio projects. At IBC 2004, Technica Del Arte launched the first application of Luci, the interview software for the Pocket PC with MP2 compression. At IBC 2006, Technica Del Arte and BBC Radio Lincolnshire where nominated and were finalists for the IBC 2006 Innovation Award in Content Creation.

Andy Roche graduated from Plymouth Polytechnic (now the University of Plymouth) with a BSc (Hons) in Computing and Informatics in 1988. He worked as a computer analyst/programmer on PC-based systems for several UK companies, including the brewer Whitbread, before training as a journalist in 1994 and obtaining an NCTBJ Postgraduate Diploma in Broadcast Journalism at Highbury College, Portsmouth.

Mr Roche spent 2 years as a news reporter for BBC Radio Humberside, before taking a management role at the BBC's local radio station in Oxford. Then, in 2001, he moved to BBC Radio Lincolnshire to run the BBC's community learning bus project. In 2006, he managed the project to introduce Pocket PC Phones with Luci recording and editing software, to all staff at BBC Radio Lincolnshire. He is now involved in supporting the introduction of these devices to other BBC local radio stations, and finding new creative ways of using these devices on-air.

Lucas Vroemen has worked in the broadcasting industry since 1988 and was previously a recording engineer and producer in the music industry. In 1997, he became CIO at L1 Radio-TV, a public regional broadcasting company in Holland, where he is responsible for not only the IT, telecommunications, audio and video infrastructure, but also innovation policy and future developments.

Because of its innovativeness, L1 was elected as Media Company of the Year (2005) in The Netherlands, and has initiated several innovative R&D projects such as (i) software developments for journalists, (ii) XML integration modules for media asset management systems and (iii) a trial to investigate the possibility of transferring live studio-quality audio via UMTS networks using a Smartphone.