DECT Standardization

One of the latest developments in DECT has been the Generic Access Profile, which ensures full inter-operability among equipment from different manufacturers.

Peter Olanders
Telia Research AB
Malmö, Sweden

DECT is the acronym of Digital European Cordless Telecommunications. It is a standard developed within European Telecommunications Standardization Institute (ETSI), *i.e.* it is a standard intended to be used throughout Europe. The standard is focused on the radio interface, and there is no specification of a background network (as, for example, GSM). The standard describes a cordless telecommunication system going far beyond its predecessors in services, quality and applicability. These predecessors included CT0 generally used in the United States; CT1, an enhanced analog CT used in Europe; and CT2, a digital CT developed in Europe.

DECT will offer a wide range of services in areas as:

- Business use
- Public Access
- Residential use
- Local Loop Replacement

As DECT is developed by interested parties throughout Europe, we expect that it will be marketed by many independent European companies, and that DECT will therefore enable a fast penetration of the market.

The DECT standards can be divided into the *Basic* standards and the Application standards. The Basic standards are the *Common Interface* (ETS 300 175) and the *Approval Test Specification* (I-ETS 300 176) which were finally approved in ETSI 1992. The Application standards are so far the DECT/global system for mobile communications (GSM) Interworking Profile, GSM Interworking Profile, the DECT/integrated services digital networks (ISDN) Interworking Profile, the DECT Authentication Module, the Generic Access Profile, the Data Profile, etc. Apart from these standards there have also been developed the extremely important Type Approval documents TBR 6, 10 and 11.

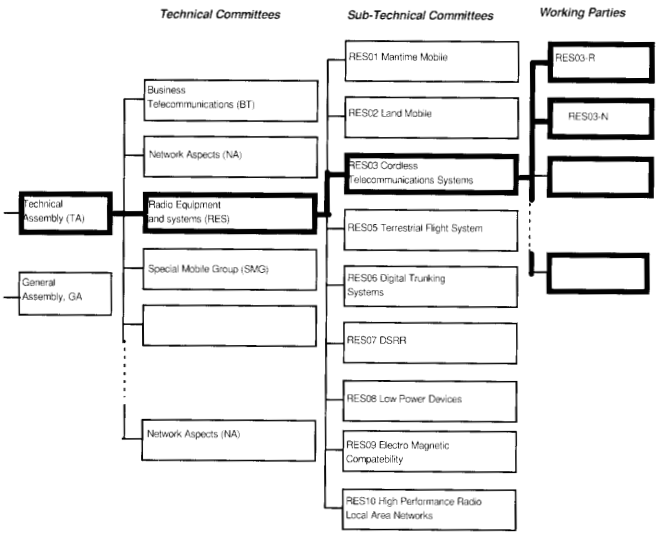

Figure 1. The European Telephone Standards Institute (ETSI) Organization.

The development of DECT within ETSI

The standardization of DECT already started in Conférence des Administrations Européenes des Postes et Telecommunications (CEPT) and European Association of Telecom Manufacturers (ECTEL), the bodies for operators/administration and manufacturers respectively, and was transferred to ETSI when it was created in 1987. The actual transfer was completed in 1989 when the main structure of RES-03 was set, and the work started within ETSI.

It is now the task for RES-03, a sub-technical committee (STC) in ETSI, to standardize DECT. The STC has also other assignments, for example, to develop ETSI standards for CT1 and CT2. RES-03 is thereby responsible for all cordless communications recognized by ETSI!

It is worthwhile to discuss the ETSI organization. In Figure 1 the organizational structure is shown. A Technical Committee is responsible for standards in an area, for example, RES is responsible for Radio Equipment, SMG for Mobile Telecommunications, etc. A STC has a responsibility limited to specific standards, and within a STC there are usually working parties assigned for parts of the standards.

The initiative to make a new standard may come from different sources, but must be introduced in a TC. The TC then assigns the task to a STC, in some cases creating a new STC for the work. The STC develops a working program for the task, which must be approved by the TC and then by TA. The STC then divides the work among the existing working parties, and new parties created if necessary.

When the development work has started within the STC the standard is discussed and iterated in the STC until it is ready for approval. At that stage it must be approved by the STC, and then by the TC. This first approval is for Public Inquiry, a process whereby all members of ETSI are invited to comment on the standard. The STC must then handle and respond to all comments received. Usually corrections are made in the standard as a consequence of the Public Inquiry. Thereafter the standard must be approved by the STC and the TC again, this time for 'National Voting' (or more correctly: Formal Voting) a procedure by which the members vote for or against the standard on a national basis. The minimum time from first STC approval to passed National Voting is about a year.

The Main DECT Applications

As declared in the introduction, when the services and facilities of DECT were decided it was agreed that DECT should have multiple applications. The main applications were:

- Business
- Public Access
- Residential

to which also

- Cordless Local Loop

could be added.

Business use

Cordless equipment in business environment offers users new services with mobility. As DECT is fully ISDN compatible, it may even provide users new services. DECT equipment may be used with a PABX, as well as a stand alone system (for example, as a key-system).

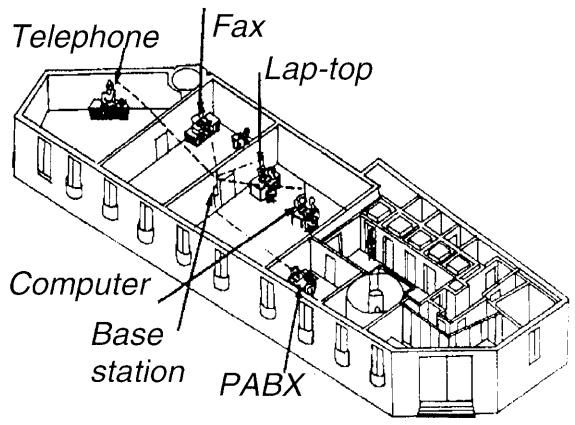

Figure 2. A cordless office?

From the start DECT was designed for this application, with structure and features aimed for office use. DECT should therefore handle speech and high density data without any problems. The first application that comes to mind is the cordless phone, a handheld to be used *everywhere*. However, it is interesting to note that one of the first DECT products on the market for business use is for data transmission only.

Public Access

A Telepoint is usually considered to be a confined area in which it is possible to make calls, for instance, a telephone booth with radio connection. In DECT there is no need for these kinds of constraints. A DECT Telepoint may as well cover quite large areas, and it is possible to have incoming calls. In other words, DECT is designed to handle both handover and roaming.

DECT Telepoints may be found not only in streets, but also in semi-public environments airports, airplanes, shops, etc. where an intermediate operator takes care of the access. An interesting case is the *Telepoint* provided by a GSM operator. Another interesting case is the *Data Telepoint*, wherein the user of a lap-top may be interested in connecting his home-based computer-server.

In this context one may also note that owners of shops, gas stations, supermarkets and so forth may very easily establish themselves as DECT operators. If they have a DECT system installed for their own use, it may be opened for their customers' use as well. In such cases the customers are then using the DECT system as an access to the public network. Only a few functions need be added to the PABX behind the DECT system, as DECT standard already includes signaling for authentication, charging, and so forth.

Residential use

The residential use of cordless equipment is well-known, with CT0 and CT1 equipment, being used extensively throughout Europe.

Cordless Local Loop

Replacement of the Local Loop has been discussed intensively during the last years as a consequence of the *liberalization* and the free competition also in the Local Loop. DECT has been considered one of the most interesting means of 'replacing' the local loop, and several trials have been started (SFR/France, Denmark, Borgå / Finland, Sweden, the CEC funded DECT / VAL, etc.).

The Cordless Local Loop has similarities with the Telepoint application, but could also be said to have about the same network architecture as that of the business application. In this case the cable from the 'curb' to the individual household is replaced by a radio connection. This is initially a tool for the network operator, who may gain efficiency due to the more flexible structure and the 'concentrator in the air' effect. As a next logical step (but this does not suggest that it necessarily be introduced later) mobility also may be added.

The Cordless Local Loop and the Neighborhood Access (sometimes called Neighborhood Telepoint) are similar, both aimed at replacing the last pieces of cabling to the subscriber. The *pure* CLL replaces only the cable, and the user does not directly benefit from the arrangement, whereas the NA provides mobility in a confined area (which could be the block, or part of suburb, etc.). The physical implementation of these applications are quite different: with CLL directional antennas and so forth can be used extensively whereas NA requires higher average field strength, and consequently more base stations (or repeaters).

It is interesting to note the fact that the operator of these DECT systems could be a community in a residential district, the owner of a block of flats, etc. In such a way they may establish themselves as access operators! In 1993 RES-03 developed on request a separate ETSI report on Radio in the Local Loop, describing the major technologies for radio access in the local loop.

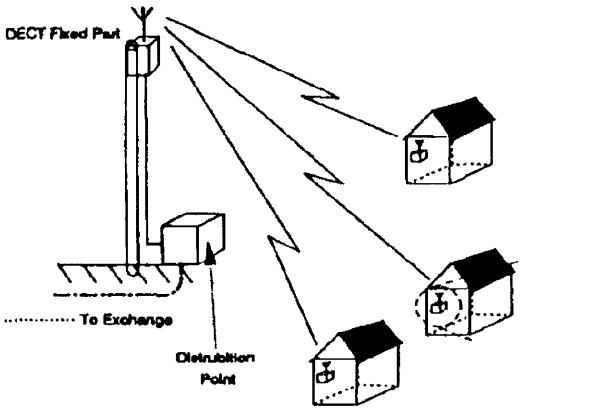

Figure 3. DECT in the Local Loop.

The DECT standards

Today, the set of DECT standards is rather extensive. It is comprised of Basic standards, Application standards, Test Specifications and the Type Approval standards (refer to the Type Approval regime below).

The Basic DECT standards

The Common Interface standard (ETS 300 175) specifies the different features and procedures of DECT, and how they are implemented. The standard is divided into 9 different parts:

1 Overview
2 Physical Layer
3 Medium Access Control Layer
4 Data Link Control Layer
5 Network Layer
6 Identities and Addressing
7 Security Features
8 Speech Coding and Transmission
9 Public Access Profile.

The standard thus contain the most essential elements for the DECT system, including the first public access profile (PAP). It does, however, not include any description of a backbone fixed network, in contradiction to, for example, the cellular systems. DECT is thereby a system that must be connected to a network, which could be most of the networks available today and those in the future (PSTN, ISDN, GSM, ...).

Standard	Status
DECT Common Interface	June 1992
DECT Approval Test Specification	June 1992
DECT Authentication Module	-> FV
DECT/GSM IWP; Access & Mapp	Nov 94
DECT/GSM IWP; 'stage 1/2'	-> PE
DECT/GSM IWP; Fixed Intercon	mid 95
DECT / ISDN IWP, End System	PE
DECT/ISDN IWP, Intermediate Sys	end 95
Generic Access Profile (GAP)	-> FV
DECT Data Profile	PE / FV
PAP Test Specification	1993
GAP Test Specification	PE
DAM Test Specification	1995
DECT Test Case Library	PE
DECT/GSM IWP Test Spec	1995
DECT/ISDN IWP Test Spec	1995
DECT Data Profile, Test Spec	1995
TBR 6	June 93
TBR 10	June 93
TBR 11	early 94
TBR for GAP	PE
TBR for DECT/GSM	1995
TBR for DECT/ISDN	no start

Table 1. The DECT Standards, Status 1995.

The accompanying Approval Test Specification (I-ETS 300 176) describes how the main features of DECT should be tested, with an emphasis on the physical layer (i.e. radio characteristics) and speech quality. There is no detailed description in the Approval Test Specification on how the intermediate layers (MAC, DLC and NWK) and the PAP should be tested. Test Specifications for these have been or will be developed separately. The lack of a backbone (fixed) network implies that DECT must be adopted to other networks. Some of this adoption is described in the *Profiles:*

The DECT Application Standards

If DECT basic standards comprise the heart of DECT then the Application standards are the limbs. It is the Application standards which describe how DECT can be used in various applications.

The *Profile* application standards (as, for example, DECT/GSM) are described below. The DECT Authentication Module is the DECT smart card, corresponding to the GSM SIM. These smart cards are

in fact aligned today, they have the same physical size and interface, as well as the same principal logical structure. The DAM is now designed to be a multi-functionality card, that is, one DAM could contain more than one identity, and so forth. A DECT portable may, but need not necessarily, use a DAM card, with the authentication implemented in the portable.

The DECT Test Specifications

The final test of a standard, as well as the test of products complying to this standard, is the Testing. Without Test Specifications there is really no need for any formal standards, since there would be no method agreed upon to ensure that the product complies to the standard.

The Approval Test Specification was the first attempt to produce a Test Specification for DECT. It covers the DECT Common Interface standard (Physical Layer and Speech). This standard is currently being revised, as the standard could as well be aligned according to the regulatory documents (see below).

This *end-to-end*, approach is a consequence of the philosophy within ETSI some years ago: To keep the standardization as *thin* as possible, only ensuring end-to-end performance.

When the PAP Test Specification (ETS 300 323) was developed, it became apparent that in some cases it is also necessary to get information from the intermediate layers (this was, however, not needed for the PAP Test Specification). Within the CTS-3/DECT project (partly funded by the CEC) have the first test cases for the intermediate layers been developed, these are now going to be converted into the DECT Test Case Library. The DECT TCL in fact will form a Test Specification for the MAC, DLC and NWK layers of the DECT Common Interface (ETS 300 175).

The Type Approval Standards

The regulatory aspect of the Test Specifications is introduced in the Type Approval procedure. Type approval also serves other purposes, such as to control the use of radio spectrum and to ensure that *no harm* is caused either to the user or the networks. In Europe this is described for telecommunications in some *EEC. Directives*, wherein the *essential requirements* are most important.

ETSI standards are made for Europe and equipment complying to ETSI standards is intended for the complete European market. With an open market with free trade and circulation of goods it is impractical, even impossible, to require type testing in each country.

Therefore it has been decided that a piece of equipment need be type approved in one country only. This type approval then remains valid throughout Europe. Also, the type approval processes must be specified. The documentation for this is called Common Technical Regulations (CTRs). The CTRs are outside ETSI's mandate, but ETSI is developing the technical part of the CTRs, called Technical Basis for Regulation (TBRs). The bodies handling the regulatory aspects in Europe are Approvals Committee for Terminal Equipment (ACTE) (EC countries) and Technical Recommendations Applications Committee (TRAC) (EC + European Free Trade Association (EFTA)).

The Profile Approach

In OSI terms a profile is defined as: "A *profile* is a combination of one or more base standards, and where applicable, the identified chosen classes, subsets, options and parameters of those base standards, necessary for accomplishing a *particular* function (for such purposes as *inter-operability*)."

The DECT profiles describe both the services and how these services are implemented.

Public Access Profile (PAP)

Due to its importance the PAP was developed simultaneous with the Basic Standard and was then incorporated with the other parts in the DECT Common Interface. While therefore formally a part of the Basic standard, in reality it is an application standard. The standard describes the features and procedures for Public Access (the application as such is described above).

DECT/ISDN Interworking Profile

The aim of the DECT/ISDN profile is to provide ISDN services with DECT. As full ISDN requires rather high capacity. Two different reference configurations have been defined within the DECT/ISDN Interworking Profile:

- DECT end system
- DECT intermediate system

In the end system the ISDN is terminated in the DECT Fixed System (DFS), the DFS and the DPS may be seen as a ISDN Terminal Equipment (TE1). The DFS may be connected to a S, S/T or a P-interface, as illustrated in Figure 4.

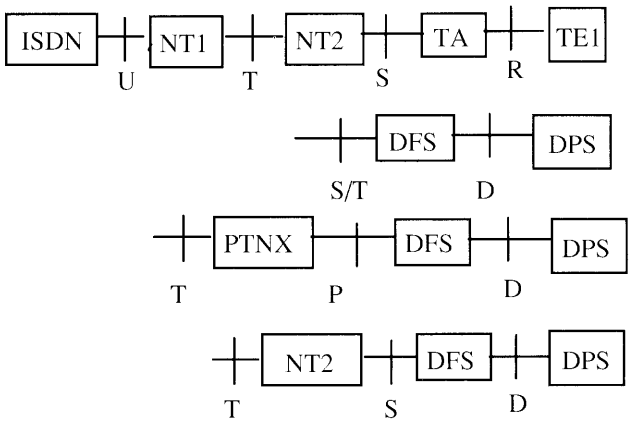

Figure 4. End System configurations.

In the intermediate system ISDN is terminated in the DECT portable. It is fully ISDN transparent, the (ISDN) S interface is even regenerated in the portable part.

Both configurations have the following services specified:

- 3.1 kHz telephony, *i.e.* standard telephony
- 7 kHz telephony, *i.e.* high quality audio
- Video telephony,
- voice band based data, *e.g.* group III fax
- digital data transmission as X.25 over ISDN
- Telematic services as group IV faxes, telex,

The DECT/ISDN profile is compatible with the PAP in such a way that a PAP portable can be used together with an DECT/ISDN fixed part, and an ISDN portable can be used with a PAP fixed part.

DECT / GSM Interworking Profile (GIP)

The DECT/GSM Profile describes how DECT may be connected to the *fixed* network of GSM (GSM PLMN) and necessary air interface functions. The interworking between these two systems offers advantages for both users and operators: The users may benefit from the mobility functions of GSM, giving a *wide-area* mobility with DECT, or access to GSM features with the high quality DECT offers (as, for example, speech). The operator, on the other hand, will reach new customers (DECT users) as well as a new part of the frequency spectrum, wherein DECT provides a very high capacity.

It is interesting to note that with the DECT/GSM profile a link between two mobile systems has been established. This is a very interesting way of combining two different systems/standards.

In the work to align the DECT/GSM IWP to the GSM phase 2, it has been necessary to extend the scope of the IWP. As a consequence the originally developed standard (prETS 300 370) will be focused on the DECT Access and Mapping GSM functions to the DECT Access. A complete description of services (that is, CCITT stage 1) and network architecture (CCITT stage 2) will form a separate standard. A third standard in the IWP will be the description on the interconnection between the fixed DECT part and the fixed GSM network (many GSM messages will terminate in the DECT fixed part).

Generic Access Profile (GAP)

The Generic Access Profile is a rather late invention. It stems from the discussions in ETSI on general mobility where it became apparent that the mobility functions in some networks could be utilized in DECT. The idea could be said to be a generalization of parts of the GSM profile.

We have discussed to what extent inter-operability should be guaranteed: the basic DECT standards offers one level of inter-operability, the PAP an other. With the GAP we have specified a well-defined level of inter-operability.

Data Interworking Profile

One of the first DECT products launched on the market is a system for data transmission without any voice services. This system is designed to work as a wireless LAN, giving medium data transmission rates (up to 0.5-1 Mbit/s). The equipment is obviously intended to be used in offices and so forth, locations where there may be an interest in having cordless telephones at the same time. To have two independent systems would be inefficient and a waste of radio spectrum. With the Data profile cordless portables (phones) can be mixed in the same system as cordless data terminals, even if the equipment stems from different manufacturers.

The Data profile will describe one way that data services implemented in DECT will be able to interoperate. The profile is thus a support for both customers and manufacturers.

The DECT Data profiles consists, as its name implies, of many standards. At the time when this is written four are in the approval process, and so are considered finalized. These four describe the use of DECT Data in pseudo-stationary use (as in an office) and with full mobility, for frame rely and data stream services. In the near future new standards will see the light of the day, as for bursty data, low power devices, telematic services and so on.

ETSI Reports on DECT

It must be admitted that it is rather difficult to start to read a technical standard, even if it describes the DECT system. In order to ease understanding and to guide readers several ETSI Technical Reports (ETRs) have been produced.

As mentioned above, RES-03 has also produced a separate ETR on radio access technologies for access to the local loop network. It is named Radio in the Local Loop, and was approved late 1993, published in 1994.

ETSI Technical Reports	ETR no	Status
DECT Reference Document	015	Published 1990?
A Guide to DECT features ... [capacity, transmission quality, simulations]	042	Published 1992
DECT Services and Facilities Document	043	Published 1992
DECT System Description Document	056	Published 1993
Wide Area Mobility Services with DECT via GSM	xxx	To be published
A higher guide to DECT standardization	xxx	To be published
DECT Data profile, an overview	xxx	To be published
On Conformance Testing of DECT	xxx	To be published

Table 2. Listing of ETSI Technical Reports.

DECT Products

Many manufacturers have already announced their interest in DECT. In fact, by the end of 1992 the very first DECT products were launched into the market. It is now possible to buy large DECT systems, intended for use together with a PBX, or small key systems, and single cells systems at very competitive prices (offered by firms which include Ericsson, Siemens, Alcatel, and Philips). One company, Olivetti, has used the DECT standard for their radio-based LAN systems, and which has been available for some years.

These are, of course, only the first DECT products, following the traditional concepts of "telephones." We must yet await the terminals integrating telephony, video and data. But such terminals are not far away: Consider a small computer like the Apple Newton, add a speech codec, a small video camera and the ensemble becomes a piece of DECT equipment, as for example through the use of a PCMCIA card, which is the new standard for PC (and other) cards.

Another interesting concept is embodied in the dual-mode terminal. Such a terminal could consist of a cellular part and a DECT part. Users would then use DECT at their premises, homes and so forth, and cellular (such as GSM) where there is no DECT coverage. It is interesting to note that such a combination would fulfill most of the service requirements of the third generation mobile system (universal mobile telecommunications system (UMTS) / future public land mobile telecommunications systems (FPLMTS)). Some European manufacturers already have declared that they will produce DECT/GSM dual mode equipment by the end of 1995.

Public operation of DECT

One of the basic DECT concepts was to use DECT in public areas, similar to a cellular system. Such public DECT system will require lower infra-structure costs than a cellular system, but will on the other hand not give any wide-area coverage. Thus, DECT as a public access will have some advantages and some disadvantages compared to cellular systems.

Similar concepts were used some years ago using CT-2 technology. There is, however, one important difference: CT-2 based systems had no possibility of receiving incoming calls, a restriction not shared by DECT.

A group for handling DECT operator issues was created in 1994 (DECT Operator Group). There is a considerable interest among European operators in using DECT in public environments; after only a few months following the start of the DECT Operators Group have more than 20 existing operators joined the group.

Peter Olanders, MSc, Dr Eng is currently head of Short Range Communications in Telia Research. As such he has the overall responsibility for projects in the area of Personal Communications in Telia Research.

Dr. Olanders is the chairman of RES-03, "Cordless Communications," which standardizes CT-1, CT-2 and DECT within ETSI. He is also recently initiated in DECT Operators Group, of which he is now chairman.