Telenor's Engagement in EU-Research Projects – A Historical Survey

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After having coordinated Telenor's engagement in EU-research for almost two decades, I felt that the time was ripe for a historical review of this important collaborative research from its start in the mid 1980s until early 2010. During this period of 23 years Telenor has participated in about 100 EU projects, of which 96 are mentioned in this report.

I try to convey, in broader terms, the reasoning behind Telenor's engagements as a response to the ever active and dominating role played by the EU Commission, rather than to give extensive descriptions of all our projects. Needless to say, the review is flavored by my own recollection of the events, so are the projects dwelt upon.

Our records from the first two framework programs (RACE I & RACE II) are unfortunately incomplete. The material in chapters 2.1 and 2.2 is thus collected from various sources (including my memory), and there is no guarantee that some projects may not have slipped through.

As the title indicates, the focus of this report is on EU projects. However, both Eureka and Eurescom, as means for collaborative research in Europe, deserve to be mentioned. This is done in chapters 3 and 4 respectively. Both Eureka, being industry driven, and Eurescom, being Telco owned, offered projects that in many ways complemented the ones from EU. This is still the case for Eureka, whereas Eurescom today only invites for Studies, ie. small projects of about three months' duration.

1 Background

The research in Telenor (at the time a state owned monopoly called Televerket) was established in 1967 and organized as a separate entity called TF (Televerkets Forskningsinstitutt). The acronym TF, albeit with changing meaning, stayed with the entity until 1995 when the name was changed to Telenor R&D. Although the name later changed a couple of times, we will in this review just stick to the two acronyms TF and Telenor R&D for the years before and after 1995 respectively.

Until 1988, when TF got access to the EU research programs, the *standardization arena* was the main source of R&D interaction with other international telecom players (like operators, vendors, and academia). Televerket represented the government in standardization organizations. And since standardization took place in a three level hierarchy, Nordic (NT), European (CEPT) and Global (ITU), there were numerous work groups and committees to attend. Technical Department in Televerket was traditionally the main participant in these bodies, and by piggybacking on them, TF could little by little build up an international contact network.

Collaboration amongst the Nordic countries was another, and important source of network building. Here TF was heavily involved in various projects and discussions. Worth mentioning are: Specification and piloting of systems for data communications (X21&X25), mobile communications (NMT) and satellite broadcast (Nordsat, Tele-X). Although not large in manpower, these projects gave rise to systems that were international forerunners and fundamental for Telenor's later commercial success on the international arena.

2 EU's Research Programs

During the second half of the 1980s new possibilities opened for TF when EU launched its second framework program for research[1)] called RACE (Research and Development in Advanced Telecommunications in Europe). This initiative became of great importance for TF and opened the researchers' access to networks of peers all over Europe; people actively working with R&D-related questions. Thus RACE gave the first possibility for full scale European research collaboration.

The acronym RACE is actually used both in the second and third framework programs. RACE is therefore said to have two phases; RACE I (1988-1992) and RACE II (1992-1994). (The first framework program was unknown to us and ran for just one and a half year in 1985–86. In retrospect it has by some been called RACE 0.)

1) *Actually, the framework programs (FP) in EU cover a number of thematic areas. In this document, however, any reference to an FP is to be understood as the ICT part of that framework program.*

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From its start in the mid 1980s, EU has launched seven framework programs, each of typically four years' duration. As mentioned above, RACE I was the second framework program and RACE II the third. The fourth was called ACTS (Advanced Communications Technology and Services) and the fifth was IST (Information Society Technologies). The notation IST is also used for the two succeeding framework programs, which are however more frequently named just FP6 and FP7 respectively.

The thematic progression of the first framework programs was very intuitive and logical: From Technology (FP2) to User (FP5). The starting point was broadband communication, then called B-ISDN, and with RACE I the Commission wanted to contribute to a substantial technology push. The idea of the next framework program, RACE II, was to utilize results from RACE I to develop complete *systems*. An example here is ATM (Asynchronous Transfer Mode), which was defined and partly developed in RACE I, whereas a complete switch was established and tested in RACE II. On basis of the technology and systems developed in the previous programs, the fourth framework program, ACTS, focused on services, including tests and piloting. Finally, with FP5 the thematic cycle was completed by focusing on the users (the European Citizen).

After completing the mentioned cycle, technology to user, the Commission's strategy people devoted lots of thinking on what to do next. In 2000, during the EU Council in Lisbon, they presented their new vision, the so called ERA (European Research Area). The objective was "… to ensure European leadership in generic and applied technologies by increasing innovation and competitiveness in European business and industry …". To that end FP6 was equipped with some new *instruments* (EU-terminology, meaning new types of projects). Amongst these were Integrated Projects, IP, which are large projects covering a much wider spectrum of issues than the older ones called STREP (Specific Targeted Research Projects). The idea behind the IPs was to bring projects above 'critical mass' for later commercialization. Another new instrument was Network of Excellence (NoE). The idea behind NoE was to bring together competence centers throughout Europe within specific thematic areas by providing them with a (small) EU funding. This funding was not meant to support the work itself but rather contribute to the cost of active collaborations, eg. travelling, meetings etc. Reference is made to chapter 2.5 where these new instruments are discussed in more detail.

2.1 EU's Second Framework Program — RACE I (1988–1992)

The very idea behind RACE was to pave the way for Integrated Broadband Communication (IBC) in Europe. To that end RACE was focusing on technological challenges. The vision was, optimistically, an optical network to end users with a 600 Mbit/s symmetrical two-way capacity. The ambition was to spend 13,000 person-years, with a budget of 4.5 billion NOK (EU spending) during the five year period 1988-1992.

1988 was still years before the EEA treaty, and Norway did not really qualify as a *formal* partner in the framework program. We were nevertheless invited to participate on project basis, subject to paying our own expenses and having at least two EU members with us in the consortium. In Norway TF was appointed National Coordinator for RACE and, in fact contributed financially to other Norwegian participations as well. In its first call Norway offered 105 person-years to RACE, of which 85 were approved. Of the latter, TF itself contributed with 13.

The projects in RACE I were initially grouped into three areas, each addressing a particular industry segment:

- Networks: Development and Implementations (Telcos)
- Broadband technologies (Vendors)
- Piloting (Telcos and Users)

TF participated in all of these three areas.

Being new to European collaboration, TF approached the first call for proposals in RACE I with a humble attitude. Most of the potential partners we met in project discussions were new to us, and initially, we had no ambition whatsoever to take on a leading role. This slight inferior feeling was however soon to evaporate.

By the mid-eighties TF had a strong traffic group, had worked with various aspects of broadband communications, and had for a long time been advocating the use of SDL as a formal description language. Hence, TF entered the first three RACE projects with very competent people:

- R1022 ATD (Asynchronous Time Division)
- R1023 BEST (Description language for B-ISDN)
- R1044 RIC (IBC Development and Implementation Strategies)

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The participation in R1022 (ATD) gave a tremendous inspirational kick for our traffic people. In contrast to their earlier experience, consisting of analyzing and sometimes improving (read: patching up) the traffic-throughput in *existing* networks, they could now start from scratch and themselves contribute to the specification of the relevant traffic mechanisms. In the project our people were in particular preoccupied with studying traffic behavior and developing methods for resource allocations in an ATD network. They also took part in the specification of an ATD switching machine, later to be known as an ATM switch. Alcatel was the prime contractor for the project.

R1044 RIC was the largest project in RACE, aiming at specifying the architecture of the emerging B-ISDN. Our initial participation here was concentrated around the user-network interface. In R1023 BEST guidelines were produced for how to formally describe the functional specifications for B-ISDN. This resulted in SDL (CCITT Specification and Description Language) and LOTOS (Language of temporal ordering of Specifications) to become the central languages.

It was with an increased degree of confidence that TF approached RACE's second call for proposals. This time TF succeeded in entering four more projects:

- R1053 TERRACE (Strategy for TMN in B-ISDN)
- R 1083 PARASOL (Traffic generator and analyzer)
- R1087 ESP (Exploitation and Service Project)
- R1086 TELEMED (Telecommunications + Medicine)

Of these, PARASOL turned into a 'thriller'. Since ATM was a completely new way of transmitting data through a network, tools were needed for generating *realistic* (ATM) traffic and to study its behavior through various network elements, in particular through the switching machine. The goal of PARASOL was thus to develop a generator/analyzer equipment. In that respect, the two Norwegian participants in the project, Telenor and ELAB (the latter to become SINTEF Tele & Data), were very active and contributed with substantial input to the resulting prototype. The end result looked very promising, and the Norwegian partners, as agreed by the rest of the project group, took the initiative for industrialization of the product. The German company Wandel & Golterman showed interest, and, in fact, more or less 'headhunted' one of the Norwegian participants. However, after a year or so, they figured that there might not be a large enough market for such an instrument and dropped the whole industrialization. SINTEF subsequently picked up the loose ends and made a new attempt for commercialization, but finally gave up. The prototype was unfortunately never commercialized.

To complete the picture, TF was involved in four more projects during RACE:

- R1081 BUNI (Hardware interface for the broadband T reference point)
- R1043 MOBILES (UMTS, MBS)
- R1046 SPECS (Specification and Programming Environment for Communications Software)
- R1093 ROSA (RACE Open Services Architecture)

R1043 Mobiles [1] and R1046 Specs were examples, mentioned above, of projects with national funding from TF but without active TF-engagement in the projects (at least not initially). However, TF decided later on (1990) to join R1043 actively since it was addressing some of the fundamental questions concerning the future direction of mobile communications, like UMTS and MBS (Mobile Broadband Services). (The latter was intended for broadband services with limited radio range.) It is interesting to note, though, that the planning for the 3rd generation mobile, both at TF and in EU, was well on the track years before the launch of the 2nd generation (GSM)!

2.2 EU's Third Framework Program – RACE II (1992–1994)

As mentioned above, RACE II, which started in 1992, set forward to take the results from RACE I and put them into systems and test pilots. A typical example was the continuation of R1022 ATD into R2061 *EXPLOIT*, the latter belonging to RACE II. TF took an active part in EXPLOIT, which had basically the same partners as R1022. The objective was to perform experiments with real traffic over an ATM switch. This gave the possibility of validating and refining the theoretical models worked out in R1022. The pilot itself was physically located in Basel, Switzerland.

It is fair to say that ATM was a baby of RACE, a baby that matured to become the de facto standard for B-ISDN. As such, ATM was by many considered as the main achievement of RACE. However, one should not forget that RACE also contributed substantially to a few other aspects of telecom, like mobile communications, TMN and Multimedia services, to mention but a few.

In mobile communications the RACE I project R1043 [1] considered two lines of evolution; UMTS and MBS. RACE II followed up both with pilots for technology demonstrations. TF decided to join the MBS project, R2067 *Mobile Broadband System*, which was a true broadband system with 32 Mbit/s

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bandwidth. The radio transmission was in the millimeter range (ie. in the 60 GHz band), which is a band with very high attenuation. The idea was to utilize this (high attenuation) to create radio cells with little radio spill-over, and thus render possible an effective reuse of radio frequencies giving high capacity cells. MBS was not meant to replace UMTS but rather complement it in areas of high density traffic. So far, MBS has not been a commercial success, but many of the ideas are later to be found in wireless LANs.

TF did not participate in any of the UMTS pilots in RACE II. Worth mentioning, though, is the two UMTS pilots ATDMA and CODIT that, for the radio interface, tried out time division (TDMA) and code division multiple access (CDMA) respectively. Traces of both these solutions are still to be found in commercial 3G systems of today!

The list below shows the RACE II projects with TF participation, followed by a short description of those projects that were not mentioned above:

- R2061 EXPLOIT [2] (Exploitation of an ATM Technology for Broadband Experiments and Applications)
- R2067 MBS (Mobile Broadband System)
- R2041 PRISM (Principles, Methods and Case Studies for Designing Telecom Management Systems)
- R2060 CIO (Coordination, Implementation and Operation of Multimedia Services)
- R2087 TITAN (Tool for Introduction Strategies and Techno-economic Evaluation of Access Network)

PRISM was a very large project (20 partners) making a substantial contribution to TMN.

CIO [3] set forward to specify and implement advanced multimedia services.

TITAN [4][5] was initiated by the RACE I project R1044, which was in need of tools for making cost analysis of fiber versus copper in access networks. The resulting RACE II project, TITAN, developed a methodology for techno-economic calculations including risk assessments for any kind of technologies (fiber, copper or radio). Telecom operators were thus able to establish guidelines for the introduction of new technologies in access networks, depending on traffic density, time of deployment etc. TITAN turned out to be the first of a series of several techno-economic projects throughout the framework programs, se chapter 2.4.

2.3 EU's Fourth Framework Program — ACTS (1994-1998)

ACTS (Advanced Communications Technology and Services) [6][7] was established on 27 July 1994 with a total budget of €670m. ACTS represented the ICT-part of the 4th framework program in EU and belonged to the field: *Information and Communication Technologies*. This field was allotted by far the largest budget in the framework program, more than 30% of the total amount. There were actually three research programs under this field:

- ACTS (telecom)
- Telematics (telematics services)
- Information Technologies (computer technology)

All of these programs were potentially of interest for TF, and we were in fact represented in the management committees in two of them (ACTS and Telematics). But as it turned out, the only project participation by TF happened to be in ACTS.

One can hardly mention ACTS without also mentioning the concept of National Host (NH) since they were closely interrelated. The idea of NH came from the Commission and can be traced back to the very objective of ACTS of having focus on *demonstrators*. In the initial phase of ACTS the Commission sent an invitation to all EU/EEA countries to provide infrastructure and projects facilities for the ACTS projects to come. The rationale was that by offering such an infrastructure, the respective countries would *qualify* to run corresponding ACTS projects, sort of a 'tender situation' for ACTS projects. In practice, this tender idea was never launched, but one or more NH was nevertheless created in every participating country, all running some projects. In addition to being interconnected by commercial services, like ISDN and Internet, an experimental network called James, based on ATM was provided for by EU. In Norway NH was run by Telenor and national partners were invited in by using Supernett. The latter was a high capacity network between universities and some demanding users, provided for by Telenor.

Although the main focus of ACTS was demonstrators and pilots, there were a few exceptions, like photonics, where more fundamental research was necessary. The Commission thus invited for project proposal within the seven following work areas, also called domains:

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1	Interactive Digital Multimedia Services	€162m
2	Photonic Technologies	€104m
3	High-speed Networking	€75m
4	Mobility and Personal Computer Networks	€115m
5	Intelligence in Networks and Service Engineering	€100m
6	Quality, Security and Safety of Comm. Services and Systems	€43m
7	Horizontal Actions	€31m

The figures to the right represent the tentative distribution of the funding amongst the various domains.

As seen in the list of work areas above, there is a domain called Horizontal Actions. The projects belonging to this domain were projects of common interest for all domains. It could be research driven projects like 'techno-economic methodology' as well as information driven projects aimed at informing the external world. TF participated in projects within both these categories.

The first projects in ACTS started to run in the second half of 1995 at which time TF had changed name to Telenor R&D. This time our researchers indulged in projects with a lot of confidence, and in fact were asked to take on the project leader role in four of them (Optimum, Tera, Crabs and ITUNet). During the four year period of ACTS, Telenor R&D participated in 25 projects. Below is shown how these were distributed over the seven domains:

Interactive Digital Multimedia Services

Momusys	Mobile Multimedia Systems
Custom TV	Customized TV
Crabs	Cellular Radio Access for Broadband Services
Maestro	Maintenance System based on Telepresence for Remote Operators
Vis-à-Vis	Fitness for Purpose of Video telephony in Face-to-Face situations

Photonic Technologies

Open	Optical Pan-European Network
Bliss	Broadband Light wave Sources and Systems
Mephisto	Management of Photonic Systems and Networks
Actual	Application and Control of Widely Tunable Lasers

High Speed Networking

Asiccom	ATM Switch for Integrated Comm. Computation and Monitoring
Ca$hman	Charging and Accounting Schemes in Multi Service ATM
Expert	Platform for Engineering Research and Trials
James	Provision of European Networking Facilities
Nice	National Host Interconnection Experiment
Reform	Resource Failure and Restoration Management in ATM-based IBCN
Diana	Demonstration of IP and ATM Networking for real time Applications
ITUNet	International Trial with User and Networks from European Test beds

Mobility and Personal Communications

Sinus	Satellite Integration into Networks for UMTS
Sumo	Service Ubiquity in Mobile and Wireless Realm
Samba	System for Advanced Mobile Broadband Applications

Communications Management

Retina	An Industrial-Quality TINA-Compliant Real-time DPE

Horizontal Actions

Optimum	Optimized Network Architecture for Multimedia Services
Tera	Techno-Economic Results from ACTS
Infowin	Multimedia Information for National Hosts
Infobridge	The Bridge from ACTS to the outside world

Below follow some comments to the various domains:

2.3.1 Interactive Digital Multimedia Services

By the start-up of ACTS, TF had already for years been working on coding of video signals and was one of the pioneers behind the MPEG-2 & -4 standardization. Hence, when Momusys [8] and Custom TV were planned, both dealing with various aspects of MPEG, it was natural for Telenor R&D to join them both:

- *Momusys* [8] contributed substantially with software programs for the testing of MPEG-4 and developed a terminal that was tested in a field trial.

- *Custom TV* used the inherent properties of MPEG to develop a user-friendly screen customization and an interactive program-selection in a multimedia broadcast environment. The project demonstrated an evolutionary path from MPEG-2 to MPEG-4 and MPEG-7.

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Telenor R&D became project leader for Crabs [9][10], one of the largest projects in ACTS. It was a project of 1017 MM, divided among nine partners and three associated partners. Crabs, together with Optimum (see Horizontal Actions) were the first EU projects led by Telenor R&D:

- *Crabs*' [9][10] main objective was to develop and demonstrate a cellular wireless system to provide broadband interactive multimedia services, eg. digital television. The system operated in 40 GHz band and field trials took place in several European countries; Czech Republic, Greece, Italy, UK and Norway.

R&D participated in two more projects within this domain: *Vis-à-vis* and *Maestro*. The former examined video telephony for communications in companion with face-to-face communication, and the latter used virtual reality techniques in learning situations, in particular applied to maintenance, installation and repair situations.

2.3.2 Photonic Technologies

Telenor R&D participated in four projects within this domain. Two of them, Bliss and Actual, did advanced optical research, ref. the introductory remark concerning photonics research. Of the other two projects, Open [11] aimed at Pan-European pilots of high-capacity optical fiber links, and Mephisto focused on TMN applied to an optical core network. More specifically:

- *Open* [11]: Feasibility study of overlay network between major European cities with 4x4 cross connect and extensive use of WDM. There were two field trials; Norway-Denmark and Paris-Brussels.

- *Bliss:* Brought advanced key components for optical network to full maturity. A 4x2.5 Gbit/s WDM long haul transmission system was demonstrated. Optical receiver chips for the access network were developed, where PON and an ATM ring were tested. The latter was based on the ALINE concept of Siemens/Telenor.

- *Mephisto:* Network management of an advanced all-optical core network. Exploited WDM for transmission and routing and developed a generic information model for O&M of optical networks.

- *Actual:* Developed a methodology for control and management of widely tunable lasers for WDM networks. The lasers were capable of handling 128 channels with 0.4 nm channel spacing. NTT, Japan, participated in the project.

2.3.2 High Speed Networking

Telenor R&D participated in eight projects in this domain. Two of the projects, *James* and *Nice*, were closely connected to the National Host concept. Although James' objective was to test and evaluate ATM-based broadband services, ie. doing research in its own merit, it had the additional important function of providing ATM infrastructure to National Host sites. In that respect, James was a very important *horizontal* project in ACTS. Nice had a similar function, to assist the National Host to provide common international broadband applications over an ATM infrastructure. Nice concentrated mainly on teleconferences and distributed meetings.

Below are a few comments to the rest of the projects in this domain:

- *Asiccom:* ATM Gigabit switch on a single-chip, architecture for an effective support of a broad range of services, implementation of a Gigabit ATM test bed.

- *Ca$man:* Charging and accounting schemes for ATM networks, developed appropriate pricing models and their effective implementation in hardware and software. Extensive use of National Host for validation.

- *Expert:* Extension of two test beds in RACE II (Basel and Eichelsham), enhanced these with testing of new features, in particular end-to-end QoS.

- *Reform:* Specified, designed and developed a system with necessary functions for ensuring network performance and availability.

- *Diana:* Specifications of a generic network infrastructure involving ATM and next generation IP.

- *ITUNet* [12]: Led by Telenor. Experimenting with broadband services to residential users using xDSL. Offered an innovative network solution based upon inverse multiplexing of ATM over VDSL using twisted pair access.

2.3.4 Mobility and Personal Communications

As in RACE, two types of mobile platforms were considered in ACTS; UMTS and MBS. After a while the latter was often denoted MBS/WLAN because most of the ideas originating from MBS were taken over by WLAN.

It is fair to say that the UMTS work in ACTS was decisive for the progression of UMTS standardization in ETSI, especially the radio interface (UTRA). The subsequent decision by the EU Commission to launch

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the 3G mobile came just a year or so after the termination of ACTS.

The original MBS approach was successfully tested in ACTS but has not led to any immediate commercial success (like UMTS). Focus was rather directed towards WLAN as a consequence of the proliferation of portable and laptop computers during the 1990s.

Telenor R&D participated in three projects in this domain; Sinus [13], Samba, and Sumo:

- *Sinus* [13]: Validation of UMTS for different satellite interfaces as well as interworking with terrestrial components. Looked also into the economic and technical feasibility of providing UMTS over satellite.

- *Samba:* MBS-project developed a trial platform consisting of a few base and mobile stations operating in the 40 GHz band. Each mobile station offered a transparent ATM bearer service up to 34 Mbit/s.

- *Suma:* Successor of Sinus, demonstrated service support and network control for the satellite segment of UMTS. Considered also the interoperability between terrestrial UMTS and various satellite systems, like LEO, MEO and GEO.

2.3.5 Quality, Security and Safety of Comm. Services and Systems

This domain focused on i) how inherent intelligence in the network may be employed to provide flexibility and open competition in the provision of services, and ii) means for managing and administrating end-to-end communication systems which span many independent network operators and service providers.

Telenor participated in one project, Retina, in this domain:

- *Retina:* Developed and demonstrated a TINA compliant Distributed Processing Environment based on Corba. It was demonstrated through the Norwegian and Italian National Hosts.

2.3.6 Horizontal Actions

This domain was established for projects of common interest to the ACTS program as a whole. Two such projects, James and Nice, have already been mentioned, but they had some additional qualities that caused them to be placed in domain 3; High Speed Networking.

Telenor participated in four projects in this domain; Optimum, Tera, Infowin and Infobridge. The first two, dealing with techno-economics, were successors to each other; the same applied for the last two, dealing with information to the outside world. Telenor had a central role in all four and in fact acted as project leader in the first two.

- *Optimum* [4][5][14][15][16][17]: Techno-economic project. Established guidelines for the introduction of different technologies in the access network (optics, copper, radio). Cost forecast for various technologies and risk evaluations was included.

- *Tera* [14][17][18]: Continuation of Optimum. Consolidating of deployment guidelines and their dissemination. Performed techno-economics of various ACTS projects.

- *Infowin* [19]: ACTS' information window. Provided added value to the information flow between ACTS projects and the outside world.

- *Infobridge:* A continuation of Infowin. Provided information by developing an Infospace, publication of regular news service, publishing CD-ROM etc.

The yearly project evaluations, performed by a panel of experts on behalf of the EU Commission, showed good results for most of the ACTS projects in which we participated. From the evaluation in January 1998, the Open project got top score on all evaluation points with Momusys and Expert very close behind.

As a closing remark, it may be of interest to quote what the present author wrote in *Telektronikk* in 1998:

> "The experience gained though the ACTS collaboration had an important bearing on the professional work and competence of Telenor R&D. The results and knowledge thus obtained have been acquired in an extremely cost-effective way. Projects in the 50-100 MNOK-range are not easily financed on a national level.
>
> It is also interesting to follow the ease with which our researchers are now taking part in the international research community. We are, together with our Nordic colleagues highly appreciated as partners in the various EU projects and are from time to time getting more offers than we can accept."

Before leaving the 4th Framework Program, I would like to mention that Telenor R&D participated in four more EU projects in parallel to, but not being part of ACTS. They are:

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- Speechdata Speech databases for creation of voice driven tele-services
- Metamorp Measurement test and calibration of advanced mobile radio channel test equipment
- Discover Developing Industrial Competence through virtual Environment
- Presence Enhancing Activity and Presence of Elderly People in local Communities

2.4 EU's Fifth Framework Program – IST (1998–2002)

The ICT part of FP5 is called 'User-friendly information society' with the acronym IST (Information Society Technologies). The program contains four key actions (numbered in roman letters i-iv). In addition, there are four more work areas of 'horizontal' character, giving a total of eight work areas:

i. Systems and services for the citizen
ii. New methods of work and electronic commerce
iii. Multimedia content and tools
iv. Essential technologies and infrastructure
v. Cross program themes
vi. Future and emerging technologies (FET)
vii. Research networking
viii. IST support activities

Each work area in the list above contains several subareas. Every specific call (for submission of proposal) was accompanied by a selection of subareas, among which the proposal had to be addressed. The selection of subareas differed from call to call.

Item vi. (FET) is a bit special and could as well be considered a key action in itself. The idea, though, was to open for more speculative, futuristic projects than would normally be accepted within the key actions. The concept of having a dedicated work area for 'ideas of tomorrow' has prevailed for all subsequent framework programs. The *Bison* project (see list below) is an interesting example of a FET project. The project sets out to solve problems arising in Adhoc, P2P and Virtual networks with the help of the theory for Complex Adaptive Systems (CAS) through enabling the construction of robust and self-organizing information systems.

As mentioned earlier, the IST program put the user in focus (which is also clear from the very name of the program). Hence, all the project proposals, even the most technical ones, needed to explain how their project would benefit the European Citizen. Most of the projects thus had a reference to one or more of the subareas under key action i. However, in most of the cases the content of the projects was more heavily addressing one of the other key actions, under which they also have been cataloged. In the case of Telenor, we see from the list below that only one project, IPPA, has actually been placed under key action i.

Telenor R&D participated in 23 projects in IST, covering all but one key action (key action iii.). We were project leader of two projects (Coras and Embrace) and were instrumental in two more Norwegian led projects (Odin, headed by Fylkesmannen i Sogn og Fjordane, and eye-to-eye, headed by SINTEF). By then (1998) Telenor R&D had obtained a good reputation within the European research communities, was a popular partner to bring into consortia and had gained a lot of confidence in discussing with peers all over Europe.

Below is the complete list of projects with Telenor participation in FP5:

Systems and services for the citizen

IPPA	Innovative Portable Pilot Assistance

New methods of work and electronic commerce

Youngster	Young People creating Active Service On Context-aware Terminals [20]
Sane	Sustainable Accommodation in the New Economy

Essential technologies and infrastructure

David	Data and Voice Integration over DWDM
Stolas	Switching Technologies for Optically Labeled Signals
M3I	Market Managed Multi-Service Internet
Song	Portals of Next Generation
Embrace	Efficient millimeter broadband radio access for convergence and evolution
Flows	Flexible Convergence of Wireless Standards and Services
Sambits	System for Advanced Multimedia Broadcast and Information Technology Service
Mega	Multisensory Expressive Gesture Applications
Savant	Synchronized and scalable AV content Across Networks
Moda-tel	Model Driven Architectures for Telecom system development and operation

Cross program themes

Coras	A Platform for Risk Analysis of Security Critical Systems

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Odin	Geographic distributed information tools and services for the mobile info services
Eye-to-eye	Fitness-for-Purpose of Person-Person Communication Technologies
Tonic	Techno-economics of IP optimized networks and services
e-living	Life in a Digital Europe
Tu Amo	The Ultimate Entertainment Advanced Mobile Open Services Platform

Future and emerging technologies

Bison	Synthetic pathways to bio-inspired information processing
Astra	Awareness Services and systems – towards Theory and Realization

Research networking

Torrent	Technology for a Realistic End User Access Network Test bed
CBSEnet	Component Based Innovation Network

The list above shows how projects with Telenor participation are matched into the work areas defined by the Commission. This structuring, together with the full name of the projects gives a picture of our research work within the IST program. However, we cannot easily see how Telenor R&D's collaborative research has evolved throughout the work programs, ie. how one project has led to another in a chain. Networks of peers created during start-up of one project will naturally continue to discuss further developments or new topics based on their original idea. Hence, in the list above there is a mix of newcomers and projects with some former history. For the latter, we mention the following:

Tonic [21] belongs to a chain of techno-economic projects where Telenor has been very active. The chain started with the Titan project in RACE II, continued through Optimum and Tera under ACTS, and finally Tonic under ITS. The evolution of the projects was; general *methodology* in RACE II, *guidelines* for technology introduction in ACTS, and finally *business models* for new broadband and IP service scenarios in IST.

Embrace belongs to a chain of cellular broadband wireless systems starting with Crabs in ACTS, Embrace in IST and, as we shall see, continuing with Broadwan into FP6. The main idea behind the projects is to obtain an *integrated* system for broadcast services together with two-way (broadband) traffic and to develop a low cost wireless system. As an enhancement to the experience from Crabs, Embrace focused on improved return link in the access system. The system was working in the 40.5 – 42.5 GHz band but could easily be adopted for operation in other millimeter bands. Many of the ideas from Embrace are to be found in WiMax-systems of today, albeit with the latter working in a different frequency band.

Sambits belongs to a chain starting with Momusys and Custom TV in ACTS. They all dealt with the MPEG standards in which Telenor R&D had a strong pre-history (income from patents pertaining to MPEG has accumulated to 50 mill NOK by 2010!). Sambits developed a multimedia studio system and demonstrated integrated Internet and DVB Broadcast services using consumer-type terminal demonstrator. That gave the consumer a personalized and easy access to multimedia applications like E-commerce, training, information and broadcast retrieval. The technological basis for the system was MPEG-2/-4/-7.

Without going into detail a couple of other chains can be mentioned:

- Vis-à-vis in ACTS and eye-to-eye in ITS for human awareness/fitness.

- Bliss/Open in ACTS and David/Stolas [22][23] in IST for optical high speed communications.

Before leaving FP5 we have to mention the Coras project with Telenor as project leader. In 1999 Telenor R&D had a large group working on security and risk analysis. They initiated the Coras project, which aimed at developing a framework for precise, unambiguous, and efficient risk analysis of security critical systems. The background, or challenge, was to implement security in our operative systems that met business needs in a cost effective way. The project was in close cooperation with the Corporate Group of Security in Telenor which also contributed financially. Midway in the project, Coras ran into managerial difficulties because the project leader left Telenor. For the first (and only) time in our EU history we had to go out and hire a professional project manager[2)]. With the new manager in charge (Tony Price, UK), Coras was completed in time and with all objectives met.

2.5 EU's Sixth Framework Program – FP6 (2003–2006)

The initial vision of the EU commission, dating back to the eighties, to let the framework programs evolve from 'technology to user', was completed with FP5.

2) *In this case 'manager' is used rather than 'project leader' since the job was to take care of the reporting and all other formal fulfillment towards the EU Commission, rather than to run the scientific part of the project.*

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A new, revised vision for subsequent framework programs was presented at the EU Council in Lisbon in 2000. Central to the new vision was a concept called ERA (European Research Area). The reasoning behind ERA was the observation that Europe, in spite of the steadily increasing European research effort through the framework programs, was still dropping behind USA technology wise. Hence, the Commission wanted to remedy this situation and launched ERA, which contains several measures for catching up on USA.

The Commission recognized several shortcomings of European research, of which three were pinpointed for special attention:

- Lack of funding
- Lack of stimuli for doing research and for the ability to utilize its results
- Very fragmented research

FP6 was to be the most important tool for dealing with these shortcomings, and to that end some new instruments[3)] were introduced.

- Integrated projects (IP)
- Network of Excellence (NoE)
- Article 169

The idea behind *IP* was to enable larger and more complete projects within a certain area than had been possible before (hence, satisfying the first bullet point in the shortcomings list above). By this measure, the projects would get enough resources to bring it above 'critical mass' and thus deliver results over a broad self-content area. An example was Next Generation Mobile that initially was discussed heavily. Would it be possible for the European stakeholders to come together and bring forward this new concept through one IP? The answer turned out to be no. The Commission soon realized that such a project would after all require far too much resources (> € 100m), with the consequence that many other good project proposals had to be turned down. Typical budgets for the IPs were thus decided to be in the € 10m range rather than in the € 100m. The effort of bringing forward next generation mobile resulted in the end in five independent IPs, covering System, Network, Platform, Terminal, and Radio.

Network of excellence was introduced to overcome the fragmented research situation in Europe (third bullet in the list of shortcomings above). The idea was to encourage research collaborations across geographical as well as professional boundaries by contributing with some 'collaboration money'. That is, funding for expenses, like travelling, meetings etc, but not for doing the very research itself. The NoE-concept looked a bit like the ongoing intergovernmental COST program (European Cooperation in Science and Technology), but the rigid legal consortia agreement, that by now seems to accompany each NoE has made them more introvert. This limits the openness of the research results and one can thus question whether NoE has been a success in the sense of reducing the fragmented research situation in Europe.

Article 169 refers to an article in EU's legal framework that opens for cooperation with the national, publicly financed research programs. In the case of Norway this means coordination between EU and NFR-financed projects (was intended as a remedy for the second bullet in the shortcomings list above). Article 169 was not really much used (if at all) in FP6. However, the Technology Platform discussion in FP6 (see chapter 2.7) has resulted in so called JTI (Joint Technology Initiatives) for some of the platforms. The JTI is an example of combined EU and national funding. ARTEMIS (Advanced Research and Technology for Embedded Intelligence and Systems), with Telenor in the steering committee, was one of the first Technology platforms to be turned into a JTI. It was up and running in 2009.

The introduction of IP projects in FP6 initially created some confusion and turmoil. The rumor among the European research groupings had been that the IPs were going to be very, very large. Hence, many project consortia (for the proposed projects) counted more than 50 partners. When the projects were finally approved, the budgets turned out in many cases to be reduced to only half of what was proposed. This put the project coordinators in a difficult position, since the consortia would then be far too large for the budget. The coordinators thus had to go to the unpopular step of reducing their consortia, which meant throwing out partners. Telenor R&D found themselves in the situation of being thrown out in one of our approved projects.

Although this confused situation around the IP projects was sorted out during the subsequent calls, the above mentioned situation nevertheless started a discussion within Telenor R&D whether projects under the Eureka umbrella would be more suited for us than the IP projects in EU. An IP project is large and has a very broad scope, which gives a risk of a small

3) *Initially, the Commission used the word 'instruments' for the various efforts in achieving the ERA vision. However, for our purpose* instrument *should be read as* type of projects *run in FP6.*

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player like Telenor R&D being 'left in a corner'. The Eureka projects, on the other hand, are more industry-driven and count typically five to seven partners. This discussion has not given a unique answer; some of our projects are definitely most suited for EU, whereas for others Eureka might be the right address. We have anyhow directed some of our work towards Eureka and since 2003 participated in seven Eureka projects, mainly within the Celtic program. This will be dealt with in Chapter 3.

The IST part of FP6 had a total budget of €3.625bn distributed over the four year period 2003-2006. The annual funding increased from €835m in 2003 to €964m in 2006. There were four main thematic areas to address and like FP5 it was possible to address some specially designed actions of more generic/horizontal character (given in italics in the list below):

- Applied IST research addressing major societal and economic challenges
- Communication, computing and software technologies
- Components and micro systems
- Knowledge and interface technologies
- *Future and Emerging Technologies (FET)*
- *Research Networking test-beds*
- *General accompanying actions*

The first tender for project proposals ended very successfully for Telenor with a success rate of 46%. This was a new record for us; a yield of 20% - 25% would be more normal. Telenor R&D was coordinator for two projects; Broadwan and Oban.

Most of our projects ended up under 'Communication, computing and software technologies' (second bullet point in the list above). This in spite of several proposals also under Applied IDT research and Knowledge and interface technologies. The reason for this skewed distribution of successful proposals can be traced back to the contact networks that had been built up by our researchers. Since the first framework programs were very technology oriented, our researchers within our 'hard-core' sciences had managed over the years to build up networks of highly professional people. This has not (yet) been the case within the 'softer' scientific part of R&D, showing the importance of network building.

FP6 opened for extensions of ongoing projects. Such extensions, though, had to go through the normal procedure of project proposals. Often the extended project kept the same name as the first one, only distinguished by the roman numbers I and II. Counting the extensions as separate projects, Telenor R&D participated in a total of 22 projects in FP6, which is about the same as in FP4 and FP5.

In the list of Telenor projects below, the type of project is explicitly given to the left. The new project types, IP and NoE, have been described above. Strep stands for Specific Targeted Research Project and is basically the traditional project type (used to address specific parts of the technology or value chain). SSA stands for Specific Support Action, indicating the horizontal character of the projects.

Applied IST research addressing major societal and economic challenges

IP *Akogrimo*
Access to knowledge through the grid in a mobile world

Communication, computing and software technologies

IP *ePerSpace*
Towards the era of personal services at home and everywhere

IP *Ambient Network I & II*

IP *Daidalos I & II*
Designing Advanced network Interfaces for the Delivery and Administration of Location independent, Optimized personal Services

IP *Spice*
Service Platform for Innovative Communication Environment

IP *Broadwan*
Broadband services for everyone over fixed wireless access networks

Strep *Oban*
Open Broadband Access Network

IP *Nobel I & II*
Next generation optical network for Broadband in Europe

NoE *e-Photon/one I & II*
Optical Networks: towards bandwidth manageability and cost efficiency

NoE *Euro NGI & FGI*
Design and engineering of the future generation Internet – Towards convergent multi-service networks

IP *Modelware*
Modeling solution for software systems

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IP *ASG*
Adaptive services grid

Strep *Hidenets*
Highly dependable ip-based Networks and services

FET – Future and Emerging Technologies

IP *Delis*
Dynamically evolving, large scale information systems

SSA *Astra II*
Awareness Services and Systems – Towards theory and Realization

SSA *Sapir*
Search on Audio-visual content using peer-to-peer Information Retrieval

General Accompanying Actions

SSA *Socquit*
System for management of Quality of service in 3G networks

From the list of projects above we see that IP projects were the project type most attended by Telenor. At that time, ie. in FP6, this was really by chance, since the decision, IP or Strep, was made by the EU administration *after the proposals were approved*. Later, this was changed and the proposers themselves had to indicate what type of project they were proposing.

We also note that Telenor participated in NoEs within Design/performance of ip-networks and *Optical networks* respectively. Both were extended, bringing the NoE projects up to four.

In the previous chapter was mentioned that many of our projects came in chains, ie. one project built on the previous one. However, with FP6 most of our chains were broken. One chain, the one of techno-economics, went over to the Celtic program under Eureka (see chapter 3) and the only remaining one in FP6 is Broadwan. But both Astra II and Delis build on their respective FP5 projects and could thus be the start of a new chain.

Broadwan [24] is the last project in the chain of cellular broadband wireless systems and builds upon Crabs and Embrace from FP4 and FP5.
Coordinator: Telenor R&D

Delis builds upon Bison from FP5 and looks upon the structure, self organizing and tools for controlling ad-hoc and peer-to-peer networks.

Astra II follows the Astra project in FP5. The project deals with awareness systems, which is a class of computer mediated communication systems.

As mentioned earlier, the initial idea of having one large IP for Next Generation Mobile was discarded. The vendor group[4)] behind this idea decided instead to split the topic into sub-topics, like Network, System, Service-Platform etc. and formulated an IP for each of these. The projects Ambient Network and Daidalos were two such projects, approved in the first call. A drawback of this splitting was that each project would individually be subject to the approval process. Hence, there was no guarantee that all of them would be approved. And sure enough, one of the projects, Service Platform with Alcatel as co-ordinator, did not make it. This was however partly remedied by the Spice-project that was approved in a later call and picked up most of the original ideas.

Next Generation Mobile projects (with Telenor participation):

Ambient Networks looked into network solutions for mobile and wireless systems beyond 3G. It was a large project with about 60 partners.
Coordinator: Ericsson.

Daidalos came out of the mentioned Next Generation Mobile-discussion as the, initially, only Telco-driven project. The project focused on personalized services and how these can be delivered seamlessly over network technologies beyond 3G.
Coordinator: Deutsche Telekom.

Spice addresses designing, developing and putting into operation efficient and innovative mobile service creation and execution platforms for networks beyond 3G. Coordinator: France Telecom

Before leaving FP6, two more projects, *ePerSpace* and *Oban* need menioning:

ePerSpace was a project originally proposed by Telenor and addresses the Home Platform arena. However, France Telecom showed a great interest in the project and insisted on having the project lead. Since FT had far more resources to offer than Telenor, it was agreed that FT took over the leadership.

4) *There were discussions between vendors and Telcos concerning 4G mobile. At the initial stage the vendors insisted on being in charge of the projects. This changed in the favor of the Telcos later on in FP6.*

But Telenor insisted on acting as a sort of CTO for the project. The project was an interesting one, but it is fair to say that it was run with some internal friction. The project was not approved for extension.

Oban [25] looked into an open access network, built on the existing 'privately owned' wireless LANs and the users' access lines. The ideas came from Telenor, who was also the project coordinator.

2.6 EU's Seventh Framework Program – FP7 (2007–2013)

The ICT part of FP7 was given a budget of €9bn. Seemingly this is a large increase from FP6 (€3.6bn), but note that FP7 runs over seven years rather than four for the previous programs. Still, though, the increase from FP6 is rather large, indicating EU's wish to catch up on USA.

FP7 uses the same instruments that were introduced in FP6. And by now article 169 is fully in use with two Technology Platforms, Eniac[5)] and Artemis, financed through the JTI. The changes from FP6 are not many, and lie basically in the legal framework that governs the relation between the Commission and the project consortia. There are now seven themes, called challenges in FP7:

1 Pervasive and Trusted Network and Service Infrastructure
2 Cognitive Systems, Interactions, Robotics
3 Components, systems, engineering
4 Digital Libraries and Content
5 Towards sustainable and personalized healthcare
6 ICT for Mobility, Environmental Sustainability and Energy Efficiency
7 ICT for Independent Living and Inclusion

In addition comes, as usual, Future and Emerging Technologies (FET).

In the writing of this review (February 2010) when we are about midway into FP7, Telenor is participating in the following six projects, all belonging to challenge 1; Pervasive and Trusted Network and Service Infrastructure:

NoE *Bone*
Building the future optical Network in Europe

Strep *Sendora*
Sensor Network for dynamic and opportunistic radio access

Strep *Inem4u*
Interactive networked experiences in multimedia for you

IP *Etics*
Economics and technologies for inter-carrier services

IP *QosMos*
QoS driven mobile cognitive systems

IP *Sensei*
Integrating the physical with the digital world of the network of the future

Bone is a Network of Excellence and builds on the ePhoton/One projects (see FP6). Bone looks further into the future, aiming at a high capacity, flexible, reconfigurable and self-healing optical network. Coordinator: Interdisciplinary Institute for Broadband Technology, Belgium

Sendora looks into sensor networks and how these can be used in handling licensed and unlicensed users in the same area. Coordinator: Thales

The goal of *Inem4u* is to find solutions for the interoperability between multimedia islands, like mobile, IPTV and broadcast, all designed for different types of users. Coordinator: Stichting Telematica Instituut, The Netherlands

Etics aims at creating a new ecosystem of innovative QoS-enabled interconnection models between Network Service Providers, allowing for a fair distribution of revenue shares among all the actors of the service delivery value-chain. Coordinator: Lucent

QosMos aims at developing a Cognitive Radio framework to enable mobile broadband systems to improve utilization of licensed and/or unlicensed band. The technical focus is on opportunistic use of spectrum combined with managed QoS and seamless mobility. Coordinator: BT

Sensei sets out to create an open, business driven architecture for future networks with Ambient Intelligence. The problem of scalability for an increasing number of objects is devoted special attention. Coordinator: Commissariat a l'energie atomique, France.

2.7 Technology Platforms

Before leaving the EU projects, the concept of European Technology Platform (ETP) needs to be dwelt

5) *European Nanoelectronics Initiative Advisory Council*

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upon. The discussion of ETP goes (at least) back to 2005 when the Commission formally proposed the concept. The idea was to provide a framework for stakeholders to come together to define R&D priorities, timeframes and action plans on a number of strategically important issues. 'Stakeholders' in this context are all organizations involved in EU research, like industry, academia, public authorities etc., and also including people from the EU Commission. ETPs were to be led by industry, which should give an assurance that the priority chosen was in line with the industry's own priorities. The term 'Technology platform' is thus to be thought of as a program or strategy for a certain topic, and has nothing to do with platforms as we know them in telecommunications.

There are 36 ETPs in all; the following nine have been established within IST:

1 eMobility	**Mobility and Wireless Communication Technology**
2 Artemis	**Embedded Systems**
3 Eniac	European Nanoelectronics Initiative Advisory Council
4 ISI	**Integral Satcom Initiatives**
5 NEM	**European initiative on Networked and Electronic Media**
6 NESSI	Networked European Software and Service Initiatives
7 EUROP	The European Robotics Platform
8 Photonics21	The Photonics Technology Platform
9 EPoSS	Micro- and Nanosystems Unit

The platforms in bold face have, or have had Telenor participation; in eMobility and Artemis we even participated in the steering committees. At the moment, though, we are only active in eMobility.

In every framework program there is an underlying Workprogram that contains all necessary information for the proposers of new projects. Amongst this information are the topics to be addressed in the respective calls. The first use of the ETPs was as an input to the strategic topics in FP7, an input that can directly be traced in the Workprogram.

The ETPs have built up strong organizations with steering committees and General Assembly counting typically more than one hundred people. The question has thus been, what to do with the platforms after they have delivered their input to FP7? Some felt that the ETPs had done their mission and should be closed down, whereas others wanted to build upon them for further research collaboration.

Whatever arguments, pro or contra, to closing down the ETP, it is a fact that they still all exist, more than five years after they were created and three years after they gave their first input to FP7. And there are at least two strong arguments for keeping them; i) the participants in an ETP constitute a strong fundament for selecting consortium partners for new project proposals (within the theme of the ETP), or put differently; it must be hard to stay outside this club. ii) the ETPs try to get JTI funding for their respective themes. JTI stands for *Joint Technology Initiatives* and is an instrument for providing long term funding for selected topics. It is based on a combined funding from EU and national public and private funding, ie. by use of Article 169, see chapter 2.5.

3 Eureka Projects

As mentioned in chapter 2.5 Telenor felt a bit uncomfortable with some of the IP projects and started looking for alternatives. An interesting alternative was found in Eureka, by the Celtic-program. Celtic stands for: *Cooperation for a sustained European Leadership in Telecommunications* and had in 2003 just been created. The secretariat of Celtic is run by Eurescom, where Telenor is a member. This gave us an easy entrance to Celtic and we ended up also being a member of the Celtic Core Group.

We also discovered another program in Eureka of interest to us; ITEA – Information Technology for European Advancement. As seen in the list below Telenor has by now participated in both programs.

In addition to Celtic and ITEA, which are large programs (actually called *clusters* in Eureka terminology), it is also possible to make proposals directly to the Eureka secretariat and have the projects approved that way (ie. to get a Eureka label). The project Mobicome is an example of this possibility.

Telenor participation in Eureka:

Celtic

Ecosys	Techno-economics of integrated communication systems and services
ADPO	Personalized and Adaptive Portal Framework

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Fidelity	Federated Identity Management based on Liberty
March	Multilink Architecture for Multiplay services
Cinema[6)]	Competition and techno-economic modeling in convergent internet, telecom and broadcast markets

ITEA

Sumo	Service ubiquity in mobile and wireless realm
Wellcom	Deployment/management of services/ applications in a Distributed Home Environment

Eureka (stand alone project)

Mobicome	Mobile Fixed Convergence in Multi-access Environment

Eureka projects have certain advantages compared to EU projects; they are industry driven, do not involve too many partners (typically 5-7) and have more to-the-point industrial objectives. The Eureka system is also by itself far less bureaucratic than EU.

There is, however, one large drawback connected to Eureka projects. This has to do with the troublesome funding situation. The funding goes through the national public authorities (NFR in Norway) with their different funding regimes. Some countries, like Norway, allow for funding applications in parallel to the Eureka approval process, whereas others only accept application after a project has received a Eureka label. The latter procedure is very time consuming, in the worst cases it can take up to a year before the project is up and running!

A short description of the mentioned Eureka projects:

Ecosys belongs to the techno-economic chain of projects mentioned in chapter 2.4. The project adjusted the previous model for feasibility evaluations and investments decisions for mobile (3G) and convergent network. Coordinator: Nokia.

ADPO specified and developed architecture for service personalization based upon XML Web-application concept. That resulted in a framework for service creation. Coordinator: Telenor.

Fidelity developed an effective administration of user-identities based on Liberty Alliance specifications. This rendered it possible to offer Single-Sign-On (according to Federated Network Identity Concept). Coordinator: France Telecom.

March addressed key issues for ubiquitous broadband access with particular focus on service provision, effective for connecting all types of users, either fixed or on the move. Coordinator: Telenor

Cinema aimed at shedding light on new business opportunities for various actors in the converged telecommunication, media and content market. Coordinator: Nokia Siemens.

Sumo developed a seamless solution for mobile networks with bases in media distribution and service platform: All communication services *anywhere* and *anytime*. Coordinator: Alcatel.

Wellcom is a successor of Sumo, addressing issues related to the creation, delivery and management of advanced multimedia applications and services in the context of a distributed home environment and users' locations on the go. Coordinator: Alcatel

Mobicome's main goal was unified user subscription management and service continuity for an IP Multimedia System (IMS) deployed on a fixed mobile convergent multi access environment. The project developed solutions that enabled seamless access to different wireless technologies like UMTS, EDGE, Wireless LAN; etc. Coordinator: Telenor

4 Eurescom

Telenor is a shareholder in Eurescom GmbH (European Institute for Research and Strategic Studies in Telecommunications) [26], which is a Telco-owned institute situated in Heidelberg, Germany. Eurescom was founded in 1991 by the major telecommunications operators in Europe as a platform for collaborative R&D. The objective was to combine resources and create synergies among the operators.

During the first ten years the shareholders in Eurescom paid a relatively large annual membership fee, which was subsequently used for financing collaborative projects. The fee was according to the size of the shareholder, the largest being France Telecom, Deutsche Telecom, Telecom Italia and British Telecom. Telenor (or rather Televerket) was among the smaller shareholders and paid a fee of about 2 mill NOK.

6) *Cinema was later incorporated into March.*

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Thus the annual budget of Eurescom resulted in some yearly 20-25 projects and 5-10 strategic Studies; the projects were running over 1-2 years and the studies 3-5 months. Every year each shareholder was invited to propose new projects; typically 50-60 proposals were coming in. A group of experts made a screening and proposed the 20+ new ones to be run. Through this mechanism, there was a high degree of competition amongst the operators to get their respective projects through.

The above mentioned mechanism turned out to be very favorable to smaller operators. (Telenor received far more in return than we paid in membership fee.) The large operators therefore required some changes, and by a series of adjustments through the years 2001-2004, a new and slimmer Eurescom arose by 2005. There are no longer large membership fees to be paid, and the only projects to remain are the Studies, which are run on a voluntary basis.

It is fair to say that Eurescom, at least through the 1990s, played an equally important role for the collaborative research in Telenor as did the EU. In many ways Eurescom was complementing the EU projects, since the former always had the operator point of view. A more detailed discussion of Eurescom projects will however be out of scope for this document.

5 Concluding Remarks

By 2010 Telenor R&D has had more than 20 years of experience with the EU bureaucracy and knows fairly well how to maneuver in the system. This is an important asset in itself, an asset that has also helped other Norwegian partners in joining EU projects. Since the threshold for cracking the EU code is high, most newcomers to the EU research programs today have to hire specialized consultancy firms for making project proposals (unless they can rely on an experienced partner). This is a costly entrance for small companies.

Telenor R&D has benefited a lot from the EU, Eureka and Eurescom participation; in this respect two points are worth emphasizing:

- Any research organization needs to have a means for keeping the *competence* up to date and at an early stage be exposed to new thoughts and ideas. Through EU, Eureka and Eurescom projects Telenor has the privilege of being updated very early. It is hard to believe that any new research idea would miss being picked up by some of the mentioned research communities. It will then be a matter of days before it reaches Telenor; that is, as long as we are not talking about business confidentialities.

- One way of evaluating the quality and level of competence of a research organization is through *competition* with other peer organizations. In EU projects the competition is fierce. On average the success rate for EU projects is 16%. For Telenor, however, this rate has typically been 25% and has in fact been as high as 40% (first call in FP6)! This demonstrates Telenor's ability to join strong consortia, which can only be achieved through our own strength!

The research collaboration in EU, Eureka and Eurescom is always kept on a precompetitive level, and the final results can henceforth rarely be taken over right away; the results need to be digested before they can go into commercial use. One exception, though, is the *techno-economic* work done in the earlier mentioned chain of EU (and one Eureka) projects. The results from these projects are business models and tools for strategy planning of subscriber networks, tools that have frequently been used in Telenor. For most other projects, the results are to be found in bits and pieces around in our organization.

The *competence* gained through international collaboration should not, however, be undervalued. It is very important for the Telcos to have sufficient competence not to be overrun by the vendors in investment discussions etc. This was the case when the author of this document joined Televerket in the mid-70s to participate in a project[7)] looking into the troublesome Oslo network. At that time Televerket did not have sufficient system competence to overrule the vendors in disputes about network congestion or other failures. The only remedy the vendors could give was: "Buy more equipment"! The situation changed radically during the next 4-5 years when both TF and the Technical Department in Televerket built up their own switching and tele-traffic competence. The result was falling equipment costs, and in fact, cost per subscriber dropped as much as 75% through digitalization of our network, a digitalization that was only made possible, at that early stage, through the very high competence of our engineers that was built up during the late 1970s and early 1980s.

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7) *Project ARON*

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Appendix – Economic considerations

In Chapter 2 we gave a description of Telenor's engagement in EU research without mentioning any economic issues. The financial contribution from EU to the projects is usually based upon 50% for technical work, but since the hourly rates accepted by EU are somewhat lower than our internal ones (based on factual costs), the resulting contribution will be closer to 40% than 50%. (The coverage is a bit higher when we are project coordinator since (a limited amount of) administrative work is covered 100%.)

The graph below gives a snapshot picture for the years 2000-2004 of projects from FP5 (2000-2003) and the start-up of FP6 (2004). We note first of all the substantial contribution from EU to our long-term research, accumulating to 43 mill NOK for FP5 giving an average funding close to 11 mill NOK over the four year period. Next we note the typical behavior during a framework program; an increasing funding during the first part of the program when we may enter new projects from subsequent calls, and then a decrease due to termination of projects. We also note the peak of 22 mills in 2004 due to the very high success rate of Telenor in the first call of FP6!

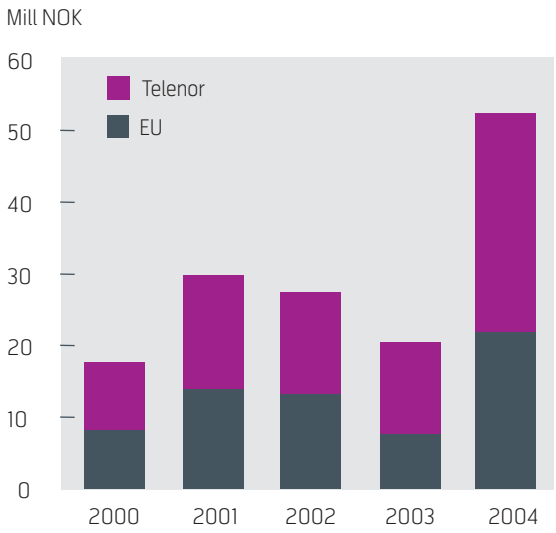

Figure 1 Distribution between internal and EU funding for Telenor's participation in FP5 and FP6

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