Blue Book, September 2005

20 YEARS EUREKA

European leadership

in Software-intensive Systems and Services

*The case for **ITEA 2***

The future of embedded and distributed software

ITEA 2

INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

Executive summary

European leadership in embedded Software-intensive Systems

The ITEA Programme has been a great European success story, based on the development of a shared vision of the future of Software-intensive Systems (SiS). And it has been underpinned by the ITEA Technology Roadmap, which has become widely recognised as a landmark. ITEA's portfolio of some hundred strategic projects has involved participation from all over Europe and from all stakeholders (large industry, SMEs, academia and research institutes). In essence, ITEA has put Europe back on the map in the emerging 'embedded intelligence' revolution.

ITEA 2 - Facing up to new challenges

ITEA 2 offers the crucial next step to maintain the momentum established by ITEA and builds firmly on the success and lessons from ITEA in a dramatically changing world. Software is the key to the digital revolution that is an integral part of our industrial and societal future as we face up to the second wave in this digital transition. Responding to the revolutionary challenges, ITEA 2 maintains the successful principal vision of ITEA, updated to the new global context, 'for Europe to maintain leadership in this new era of embedded Software-intensive Systems and Services building on key European strengths and industries'.

The new global context is based on the key competitive challenges for Europe:
- European R&D intensity is lagging critically behind our main competitors;
- Information and communications technologies (ICT) are rapidly invading European strongholds, such as the automotive industry;
- The need to understand and master the lag between R&D and commercial innovation;
- Off-shoring is reaching an unprecedented level; and
- The 'European paradox' – great science and technology but poor translation into products.

Together, they form the context for the 'Renewed Lisbon Agenda' for a new vibrant and strong Europe and the recent strong calls in the Kok report on the Lisbon strategy for growth and employment.

The dramatic shift to embedded systems as the core challenge of ITEA 2 is affecting all aspects of our everyday lives. As the electronics content of modern cars and new generation aircraft grows exponentially, rapid European response to the demands will result in hundreds of thousands of new high-quality jobs in the European automotive and aeronautics industries, with significant multiplier effects. The growing interconnection of consumer electronic devices to provide a host of services in the home is placing a time bomb under the need for software development – a bomb that must be defused rapidly to keep high level work in Europe. The future of healthcare and medical systems is increasingly in the software that can help and speed diagnosis and treatment – essential for our well-being and quality of life. And manufacturing is undergoing major changes, particularly with the emergence of the 'Cyber Enterprise'.

Great strides are being made in Europe on the micro-/nano-electronics side (MEDEA+ programme). But the grand challenge is to devise, create and master the software architectures, technologies and systems, solutions and services for myriad applications including safety-, security-, and time-critical functions. Europe must face up to the software requirements gap – already a core issue of

ITEA and a continuing challenge for ITEA 2 – while simultaneously ensuring rigid software quality standards, and structuring the total applications design process so as to allow applications to mingle fluently and naturally with everyday life/operation and interactions.

This can be addressed successfully only by a multi-tier approach: platform-oriented Eco-systems around specific core elements, e.g. a digital TV, making massive re-use of software, combined with massive software sharing; consensus on a high abstraction level from a multitude of interested parties around a specific core element to get things done; and massive training/re-training of engineers. These three tiers together, combined with the strong applications industries base and their driving needs, constitute a unique opportunity for the creation of an independent European software industry for embedded SiS to be fostered by ITEA 2 as catalyst, overcoming a critical and persistent European weakness.

Defining programme scope

Based on the experiences and lessons from the ITEA Programme, the scope of ITEA 2 is defined along the following axes:

- **Application domains**: maintaining the successful strong focus and extending the scope by an additional open domain and by integrating a service-oriented perspective;
- **Innovation**: extending the scope to include downstream activities on the basis of research, development and demonstration (R&D&D) – to accelerate innovative solutions and to overcome the European paradox; and
- **R&D co-operation**: intensifying R&D coordination in the European Research Area (ERA) and building relationships beyond ERA, through the co-operation of ITEA 2 with the forthcoming ARTEMIS European Technology Platform as a specific example.

Key strategies

ITEA already advocated and championed a European Framework for Innovation, including supporting active public procurement policies, based on the experiences in the programme. Fostering innovation is a cornerstone of ITEA 2. It will principally follow successful proven ITEA strategies adapted to the new challenge and new context:

- Maintaining the principal ITEA game plan of changing the battleground in ICT primarily to embedded software and services for the ‘SiS industries’, building on key European strengths and industries such as automotive and consumer electronics;
- Mounting an industry-driven pre-competitive R&D&D initiative for a sustained build-up of European capabilities in software-intensive systems and services;
- Maximising and leveraging the growing importance of SMEs to increase the momentum of the initiative from an already high participation level in ITEA;
- Fostering and leveraging the impact of academia/research institutes, first of all in continuing the solid application-oriented grounding of the programme but, in addition, intensifying co-research and transfer; and, in addition,

- Pushing the envelope on programme agility aggressively across all levels and all procedures to address better the overarching issue of time-to-market.

ITEA 2 will continue to develop the ITEA Technology Roadmap that has been a distinct success factor in ITEA. And it will maintain a strong focus on application domains and supporting software production technology and tools.

Ambitious programme

The ambition of ITEA 2 is to mobilise a total of 20,000 person-years over the full eight-year duration, translating into an effort of 2,500 person-years per year – requiring a significant increase in investment level to more than €3 billion. This level of ambition follows from the experience in ITEA, the need to close further the gap in R&D investment (3% of GDP, Lisbon objective) and the ever growing importance of SiS.

The organisation and structure of ITEA 2 is principally copied from the current ITEA programme. As in ITEA, annual Calls for Projects will be issued, based on the work plan; project duration will be three years maximum. To ensure continuity with the current ITEA programme, the first Call of ITEA 2 is scheduled to open in early 2006, to allow the start of the first ITEA 2 projects in January 2007. A programme plan has been developed covering the full eight Calls (two phases, with four annual Calls each). Key elements of the plan are: the overall architecture, the timing to ensure continuity with the current ITEA programme, and the EUREKA labelling decision.

ITEA 2 will be a high-impact programme for European competitiveness according to the companion study on ‘software-intensive systems in the future’ by IDATE/TNO:

- The focus areas of ITEA 2 (aerospace, automotive, consumer electronics, communications, medical, automation/production) *alone* represent more than 16% of Europe’s industry total;

- For these key sectors, total growth in software R&D from 2002 to 2015 is forecast to be some 130% to €133 billion, almost *double* the growth rate of their R&D total (70+%) and *more than double* the rate for classical software producers and IT services sector (60%);

- In these six key sectors, a total of about 200,000 new software R&D jobs will be created in Europe. As an indication of the multiplier effect on total European employment, the automotive sector alone will create 1.2 million new jobs in Europe of which 600,000 will be high-tech jobs in E&E (electrics and electronics). E&E is the single most important growth area in the automotive industry with an almost 60% increase in the total value add, from 22% in 2002 to 35% in 2015. Automotive SiS will account for 90% of all future innovations in cars.

Contributing to these key findings virtually guaranteeing a sustained impact of the programme on European competitiveness is the fact that the founding fathers of ITEA 2 are all leaders in their respective fields, with most figuring in the global top 100 companies. They represent a solid and dynamic economic force with €380 billion in total turnover, €29 billion in R&D spending and more than 1.5 million employees – of which 210.000 are in R&D, the vast majority of R&D being conducted in Europe. In fact, the number of R&D employees in ITEA 2 founding companies in Europe amounts to around 12% of the region’s total number of researchers.

Contents

Preface

ITEA – a European success story and first step in a major European initiative

The ITEA Programme is a great European success story. It has a portfolio of some hundred strategic projects with participation from all over Europe and from all stakeholders (see Annexes A.2 and A.3). Its success has been confirmed in its recent mid-term assessment (see Annex A.4), conducted by an external consultancy on behalf of Public Authorities, and may best be measured by its principal achievements:

- The development of a shared vision of the future of software-intensive systems (SiS)[1], underpinned by the ITEA Technology Roadmap [1] – widely recognised as a landmark;
- A solid technology portfolio base and a wealth of documented results (see Annex A.3);
- Its acknowledged contributions to European co-operation, bringing together more than 400 partners from large industry, small and medium-sized enterprises (SMEs), and academia from across Europe (see Annex A.3);
- Recognised initiatives in the framework of the European Research Area (ERA), such as the 'Strategic Domains Concept' [2] and the 'European Framework for Innovation' [3]; and
- The development of an efficient and effective organisation (see Annex A.6), with lean and industrial strength procedures, and with overheads of well under 1%.

Today, ITEA is the leading trans-national European co-operative R&D programme in SiS and essentially has put Europe back on the map in the emerging 'embedded intelligence' revolution. The success has also proved ITEA's strategic game plan for changing the battleground in information and communications technologies (ICT) to 'SiS industries', i.e. primarily ICT-using industries such as automotive, communications and consumer electronics, thereby building on Europe's strengths and key industries.

ITEA 2 – maintaining European leadership in a dramatically changing world

Building on the groundwork of ITEA, this Blue Book defines the necessary steps for maintaining European leadership in a dramatically changing competitive environment through a follow-up, next-generation programme starting in January 2007. This is packaged again as an eight-year, 20,000-person-year EUREKA[2] Cluster project, and split in to two four-year phases, each with four annual Calls for Projects – the first Call would be launched in early 2006. A summary of the work plan for the first phase of ITEA 2 is defined in Part 2 of this Blue Book.

The main lines of the ITEA 2 definition process (Annex A.0) include a special project team working with the relevant ITEA bodies, a companion study on *Software-intensive Systems in the Future* (see Annex A.1) commissioned from a high-profile consultancy in the field in concert with the Dutch and French Public Authorities, and an action line with young professionals from all sectors to critically review and complement the vision, strategies and plans. The process is accompanied by extensive consultations with all stakeholders in ERA, in particular EUREKA, national Public Authorities and relevant stakeholders in the European Commission.

[1] 'A SiS is a system in which software represents a significant segment in one or more of the following areas: system functionality, system development cost, system development risk, or development time'. [4] Examples include: an automobile/aircraft/train; a digital TV; a mobile phone; a smartcard; a radio frequency indentification (RFID) tag; a production or distribution process; and a diagnostic system.

[2] EUREKA is an intergovernmental initiative that aims to strengthen European competitiveness by promoting cross-border, market-oriented, collaborative R&D. For more information on EUREKA, see: http://www.eureka.be.

The case for ITEA 2

1.1 RATIONALE AND VISION

As ITEA 2 builds squarely on the success and lessons from the ITEA Programme (see Annexes A.2 to A.4), it is worth looking back at the rationale and vision for ITEA before presenting the rationale and charter for ITEA 2:

'Europe has become world leader in some specific fields of information and communications technology, such as telematics, GSM and smart cards. It is also a strong global player in other domains such as automotive, aircraft, high-speed trains, environmental technology and manufacturing. However, on a world scale, Europe is lagging behind in most of the core competencies of Information Technology, with a negative trade balance. Because Information Technology is one of the main driving forces for advancement, competitiveness and growth, Europe has the obligation to leapfrog into new ways of working and to contribute, via programmes in co-operation with the EU Framework Programmes, to new standards that are attractive enough to be adopted on a global scale.' [5]

In other words, the rationale for ITEA's launch was a response to the fact that the digital age is imminent and the digital transition is proceeding rapidly. *'These changes, the most significant since the Industrial Revolution, are far-reaching and global. They're not just about technology. They will affect everyone, everywhere.'*[6] **Software is the key to this revolution.** Never before has European industry mounted a concerted strategic R&D initiative to address this challenge.

Today, we are **facing the second wave in this digital transition** – often called the 'embedded' or 'ambient intelligence' revolution [7]. This is deeply penetrating the very fabric of the physical world and our interaction in and with this world, enabled by ubiquitous communications and intelligence in even the smallest objects – sometimes metaphorically called 'smart dust/smart things' [8]. This revolution is marked by ever-increasing software intensity and systems complexity and accompanied by a move from the classical product-oriented world towards a seamless services-oriented one. In other words, it is all about embedded software-intensive systems and services of unprecedented complexity, and about digital convergence, ITEA's core drive from its very beginnings.

In addition to this new set of technological and resulting business challenges, the overall context has also dramatically changed, marked by:

- **Ever fiercer technology race and competition**, driven by technological advances but also by the rise of developing new powers, most notably China and India, with far reaching implications on global work-share (off-shoring), competitive strategies and innovation cycles/time-to-market;
- **Complete transition in the over-all business model**, from the classical two-tier original equipment manufacturer (OEM)-supplier model to agile dynamic multi-tier global OEM-supplier networks, delivering seamless solutions and services to customers irrespective of sector, location, mode, etc. and giving rise to an ever increasing role for SMEs in this dynamic fabric;

Figure 1:
ITEA 2 vision: European leadership in embedded SiS building on Europe's key strengths and industries, and supporting the basic SiS abstraction model, scaled by potential for competitive differentiation

- **Major societal challenges** and their fall-out, such as: anaemic European growth rates leading to employment challenges and calling for a new cross-sectional growth enabler like SiS; 9/11 events, heightening our sensitivity to safety and security to an unprecedented level, and leading to the ever growing importance of and huge spending on ICT and on critical infrastructures to contain global threats and security risks[3]; and last but not least from European demographics calling for innovative concepts to maintain quality of life, for example through 'ambient environments'; and

- The rise of the **Open Source Software/ Open Innovation** movement. As stated in the ITEA Report on open source software [9]: '*Open source software may well be one of the best tools to escape (at least partially) from the monopolistic positions that certain giant non-European companies have established in areas that are key to European development and independence. In particular, it may also be one of the best tools for preserving and strengthening European access to and control of basic software for embedded systems in those application areas (e.g. automotive) where European software companies have a strong position, and where other global suppliers aim to extend their monopolistic positions elsewhere.*'[4]

In other words, the challenges and threats to European competitiveness and well-being are even higher today – including in world-leading sectors such as the automotive, mobile communications, aeronautics, and manufacturing and process industries. Relentless innovation is our sole means of maintaining the European model – i.e. the triple societal benefits of growth, employment and quality of life.

Responding to these revolutionary challenges, ITEA 2 maintains the successful principal vision of ITEA, updated to the new global context, ***'for Europe to maintain leadership in this new era of embedded Software-intensive Systems and Services building on key European strengths and industries'.***

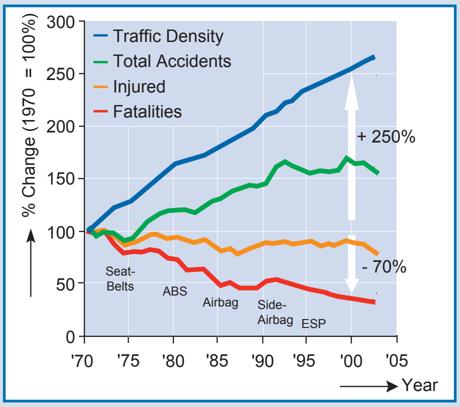
The **future snapshots** in the following insert pages highlight in more detail for key sectors what is at stake for Europe and what the European opportunities from SiS are, from both business and societal perspectives.

[3] The request in 2005 was for $130.7 billion, the largest R&D request in US history.

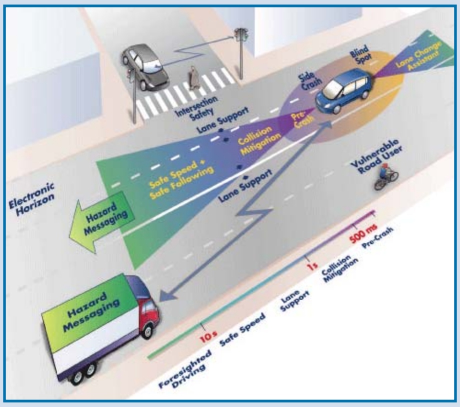
[4] In the area of operating system technology, the Linux phenomenon has demonstrated that business models using the open source software concept can lead to excellent products that radically upset existing market positions. In the domain of middleware technologies for business applications, the France-based ObjectWeb™ European Consortium is leading a similar charge (http://www.objectweb.org/).

The automotive future – *embedded systems to the rescue for dramatic reductions in road fatalities*

***Snapshot**: From 1970 to 2000, traffic density in Germany increased by a factor of 2.5 and the number of accidents by 1.7, while at the same time the number of injured persons decreased by more than 10% and the number of fatalities was reduced by about 70%; similar trends hold for Europe. Starting with the introduction of the antilock braking system (ABS) in the 1980s, all new safety systems are critically dependent on embedded systems such as sensors, actuators, electronics and software.*



Source: Statistisches Bundesamt and Bosch



Source: Prevent

In its White Paper on European Transport Policy[5], the European Union has set the ambitious goal for 2010 of halving road fatalities again from 2000 levels, at the even higher expected traffic density for 2010. In addition to a dramatic reduction in loss of life and human suffering, this would also translate into €160 billion savings in associated costs. This very ambitious goal can only be attained by using more intelligent systems, so called 'active safety' systems, with sensors, actuators and smart software literally embedded everywhere in cars, the road, objects, etc. as outlined in the graphic on the right.[6]

In 2002, the value creation per car on electrics/electronics including software was 20% – of which some two thirds were in software alone[7]. **More than 90% of all future automotive innovations will be driven by electronics and embedded software**, including other drivers for more complex embedded systems – in addition to active safety systems – such as for more comfort: with in-car information, navigation and entertainment; and helping the environment: less pollution, lower fuel consumption, new fuels, alternative propulsion technologies, etc.

In 2015, the value creation of electronics will be **35 to 40%** of total value creation per car[8]. The average annual growth rates from 2002 to 2015 will be 0.4% per car but 4.9% in the electronics part per car (in absolute terms: from €127 billion in 2002, to €316 billion in 2015). This dramatic shift to embedded systems will result in **600,000 new high-quality jobs in the European automotive industry.**

This industry with a 32% share of worldwide automotive production, which will increase slightly, is one of the most important drivers of the European economy, employing about **6% of the European work force** with an **annual net value creation of €124 billion**[9]. **Its global competitive position is inseparably connected to technological leadership**.

[5] White Paper on European Transport Policy: Time to decide. Commission Communication COM(2001) 370, 12.09.01.

[6] http://www.prevent-ip.org.

[7] Engineering in the next decade: a global study on organizational trends and success factors in automotive engineering, Roland Berger Strategy Consultant, September 2004.

[8] Future Automotive Industry Structure (FAST) 2015, Mercer Management Consulting & Fraunhofer Gesellschaft, January 2004.

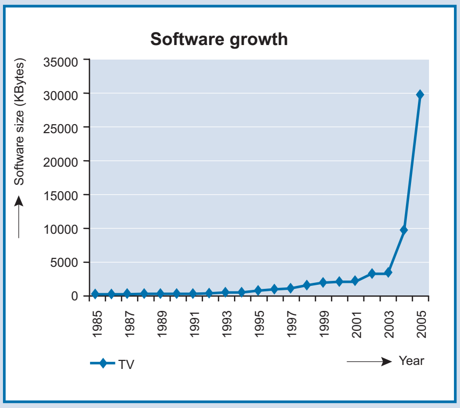
[9] Zentrum für europäische Wirtschafts-forschung (http://www.zew.de).

The future for consumer electronics

– connecting devices boosts home services but places time bomb under software development

***Snapshot**: Consumer electronics are in full transition from standalone audio-visual (A/V) products with a simple menu-driven user interface – where software is mainly used to replace hardware – to complex in-home systems (see Figure left) offering:*

- *Easy-to-experience user interfaces, supported by graphics;*
- *Connectivity, inside and outside the home;*
- *Content management, for access to content anytime, anywhere; and*
- *Integration with services beyond multimedia, such as well-being and healthcare, support for the elderly and home management – security, energy management, etc.*



This abundance of new functionality can only be realised by embedded software; as a result, the transition leads to a software explosion: even a mundane high-end TV is becoming a software-hog, with exponential growth (see Figure right).

As a consequence:

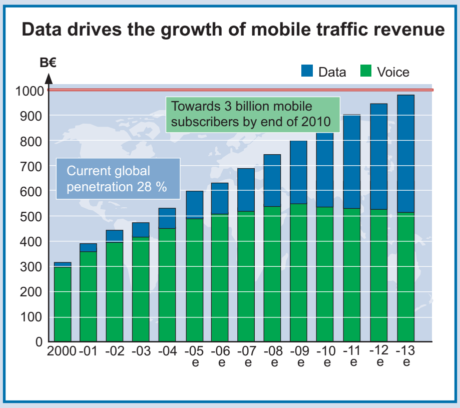
- A single company can no longer develop a total system solution (investments are just too high), so:
  - The dependency on external suppliers such as independent software vendors (ISVs) increases;
  - The need for open systems platforms and interface standards rises; and
  - The focus in system creation shifts from software development towards system integration.
- The demand for software grows faster than the number of available developers, leading to:
  - Off-shoring of development effort; and
  - A shift in Europe towards architecture and design.
- The pressure to achieve higher productivity in software development remains.
- New service and business models have to be developed to deal with the added value offered by this new software.

It is therefore obvious that it will be a strong challenge to keep high level work in Europe. But on the other hand, Europe has always been strong not only in innovation but also in creating something new by using and combining various innovations. This must be fostered.

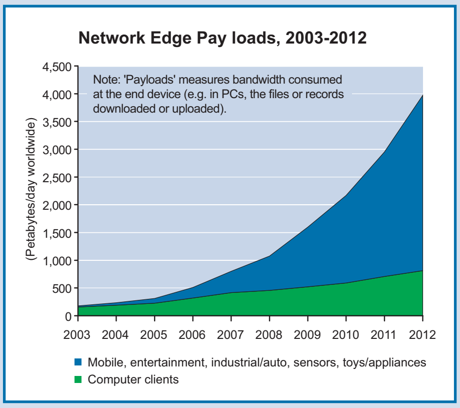
The future of communications

– it is all about data services and a dramatic shift of traffic to the edges of the converging, pervasive 'supernet'

***Snapshot**: by 2010, the number of mobile subscribers will double and exceed three billion – and the revenue split between classic voice and new value-adding data services will have already hit the 50:50 mark (see Figure left)[10].*



Source: Nokia, February 2005



Source: IDC, 2004

At the same time, there will be a dramatic shift in the very nature of communications (see Figure right)[11] as the 'download'-dominated payload between computer-based servers and clients moves to edge-centric, peer-to-peer and *ad-hoc* traffic driven by myriads of different devices on the fringes of the converging networks – such smart tags, sensors and video cameras embedded in handheld devices, toys, cars, containers, houses, etc.

SMS-messaging as the proto data service in GSM, the hallmark of European leadership in mobile communications, was introduced commercially in the late 1990s. In less than five years, it grew into a major business in many market sectors, constituting up to 20% of operator revenues, especially among younger user generations. It also provided the first simple interaction mechanism between mobile phones and large scale, computer-based services, representing an early milestone in digital convergence. New wireless access technologies such as 3G and WLAN, increasing the mobile bandwidth by orders of magnitude, and mobile devices with the processing power of advanced PCs will drive this convergence into completely uncharted territory. New applications and services will emerge in various domains, such as in media and entertainment, companies and public sector, home applications and proximity interactions. Mobile email, web-access, location-based services, video and teleconferencing, TV and news, downloading of music and films, access to corporate applications and data, public services, banking, payments, on-line gaming and peer-to-peer sharing are just a few early examples of the endless variety of possibilities already under way.

It is estimated that currently already **more than 70% of the product creation cost** of mobile devices comes **from software**, and for value-added applications it is **close to 100%.**

Ubiquitous connectivity opens up opportunities for a wide range of industries to enhance their products and services with new functionality [10]. For example, direct communication between devices such as a mobile phone and a home TV set may be exploited in finding, storing and consuming commercial, free or personal content in totally new ways. Likewise, communication between devices and remote services provides a wide range of new opportunities. Automatic, on-the-road car assistance and on-line, automatic tracking of deliveries using radio-frequency identification (RFID) technologies are just a few early examples. **It is estimated that already by 2008 the total value of this new business opportunity, devices, connectivity and services included, will be around €600 billion[11], i.e. comparable to the global revenue of today's mobile operators[10].**

[10] Nokia 2005.

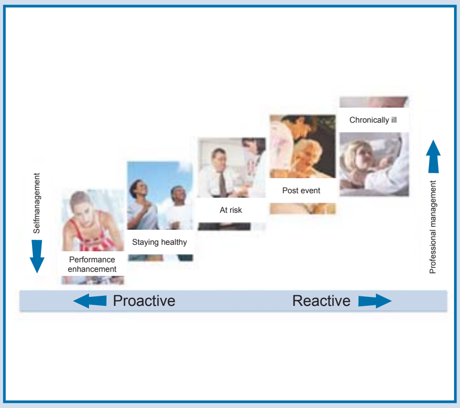
[11] IDC, October 2004.

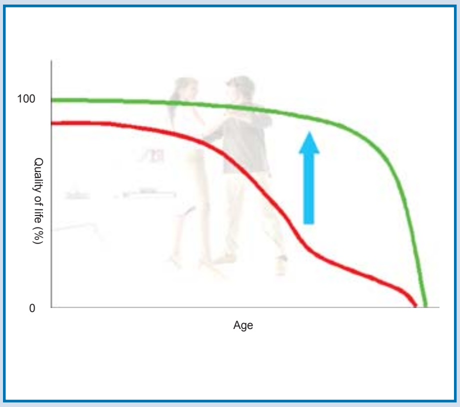
The future of healthcare

– from traditional healthcare to proactive self-management

***Snapshot**: traditionally, healthcare has been reactive, relying on two pillars, the first and oldest one being pharmaceutical based on chemistry, enabling doctors to treat patients with drugs. The second is medical imaging, looking inside a patient's body in a non-intrusive way, making use of the physical properties of body material. Now a third pillar is emerging, based on algorithms, software and silicon. This will be the enabler for the shift from:*

- *Reactive to proactive/preventive patient/person care (see Figure left); and*
- *Hospital to outpatient care.*





In addition, an integrated approach to distributed patient data will be possible. As a result:

- Quality of life of individuals can be enhanced (see Figure right);
- The trend that, in most European and North American countries, healthcare costs are growing faster than gross domestic product can be changed;
- Treatment, if necessary, can be based on evidence collected in the proactive phase;
- Access to relevant and up-to-date patient medical and medication data will allow healthcare professionals to take the right decisions with respect to treatment plans; and
- The challenges from the aging European population, related to cost increase and shortage of medical personnel, can be addressed effectively.

From the definition of this third pillar, it will be clear that this will only happen with the massive use of software and electronics close to individuals. It will also require the availability of a proper ICT infrastructure, offering role-based access control that allows access only to the data relevant for the role.

Software complexity will culminate in the construction of decision-support systems enabling the medical profession to diagnose a medical situation based on terabytes of data and taking fully into account the individual patient.

The shifts mentioned above will have a very positive influence on healthcare cost: currently one out of three medical treatments is unnecessary due to wrong diagnosis based on either wrong or missing information (the cost involved is $1,00 billion annually worldwide).

The future of medical systems – *it's the software, stupid*

***Snapshot**: two of the top three companies active in the field of professional medical systems are based in Europe. Amongst other products, they produce imaging systems allowing medical specialists in hospitals to look inside a patient's body in a non-intrusive way. Systems such as magnetic resonance imaging (MRI – see Figure left) give specialists access to information about a specific part of the human body in which they suspect a problem. This helps them diagnose the situation accurately and quickly, providing the basis for effective treatment.*

These systems, based on physical properties of materials in human bodies, are highly complex and can only function due to the fact that they are filled with embedded software – several million lines of code. That is why a large amount of R&D effort (more than 50%) is related to software and this part is growing.

The demand for software continues to grow because:

- System use is shifting from standalone to more and more interoperable/connected situations (systems of systems);
- Usability has to be improved through better user interfaces and workflows;
- Resolution and speed of imaging sensors are increasing, leading to a data explosion. This has to be managed by the use of computer decision support, faster transport and processing of data and 3D representation;
- These systems tend to be quite expensive. Therefore owners try to get the maximum number of available hours out of them. This demands improved serviceability; and
- The medical world is gradually introducing (standardised) electronic patient files.

In order to deal with this growing software demand, the industry will have to:

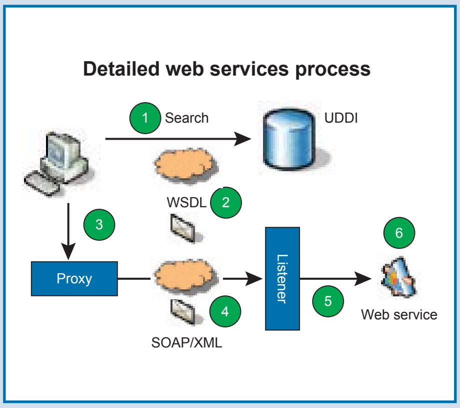
- Make greater use of commercial off-the-shelf (COTS) products;
- Re-use, leading to: higher productivity and efficiency; better quality; shorter time-to-market across product ranges; and increased connectivity and more universal interfaces (UI) across product ranges;
- Develop multi-site processes, using all available resources;
- Make use of open source software in tooling and enterprise IT areas; and
- Deal with architectural issues in order to support all the '-ilities'.[12]

As a conclusion, it can be stated that software is of prime importance to realise functionality but that industry is struggling with this. Two assumptions are necessary: use of COTS will deliver part of the solution, and software engineering will mature. However, the main challenge will be: how to cope with the complexity of systems.

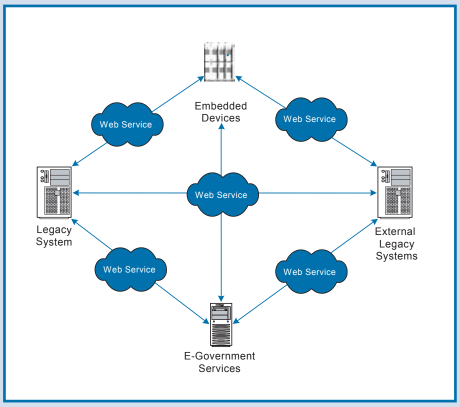
[12] Non-functional aspects, such as usability, testability, reliability, security, availability, portability, maintainability etc.

The future of enterprise systems – *it's all about web services and wrapping legacy systems into service-oriented architectures*

***Snapshot**: Almost all companies have highly-valuable legacy systems that exist in isolated environments and are restricted in their interoperability. This hinders efficient and effective sharing of information between various systems, applications and organisations. However, the demand for flexible and innovative IT infrastructure is increasing. Such infrastructure must enable and support business processes even though subject to continuous changes. Service-oriented architectures and web services provide technologies able to adapt legacy systems to the described requirements; furthermore they provide the common language for enterprise-wide connection of systems, small and large, embedded and distributed.*



Process flow of a web service[13]



Web services connecting systems

Interaction between an enterprise legacy system and those of suppliers, customers or even acquired companies can be implemented by using web-service interfaces regardless of platform or operating systems of the different legacy systems. This allows implementation of flexible business processes and, for instance, integration of embedded devices. Furthermore, services accessed via the Internet – such as in e-government – can be integrated into these processes. Web services will thus increase the adaptability of legacy systems rather then replacing them.

Legacy systems accessible by web services become future-proof. Other applications can access them on demand. Even if at some point the technology of a legacy application is changed, this has no influence on other applications that invoke that service. In other words, web services will conserve the value of legacy systems and connect them to a modern and flexible IT landscape.

Features and benefits at a glance:

Web services:

- Allow systems with different operating systems, from different vendors, and running at various partners, suppliers or customers to interact with each other;
- Boost modularity of business processes, leading to increased business agility and flexibility;
- Provide a standards-based solution to software development and future-proofing of IT investments;
- Enhance ROI of legacy applications and create new value from existing applications and systems.

Market impact:

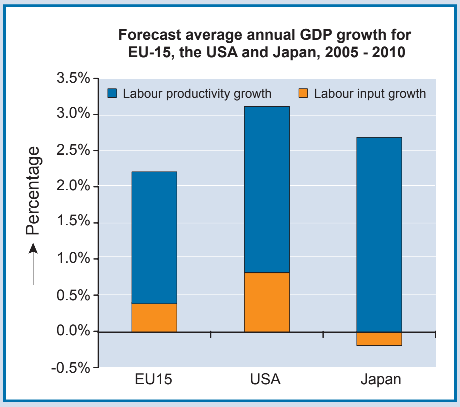
IDC predicts the move to web services would create a new market, with software spending reaching $3.4 billion by 2007, while spending on services would account for $7.5 billion, more than double that number (IDC 2003; in addition: $4.3 billion hardware market by 2007). Another study reports the combined market for web services solutions, management, integration and security will climb from $950 million in 2004 to $6.2 billion by 2008 (Internetnews 2004). A European company is market leader in a core element of this technology: XML-based tools.

[13] Source: http://www.zdnet.co.uk/i/z/tu/illo/WebServices.gif.

Future of manufacturing and the supply chain *– it's about dynamic multi-tier business processes and the digital information grid*

***Snapshot**: From a 2010 business view, the highly dynamic, complex and disaggregated nature of the manufacturing and supply chain requires up-to-date on-demand information to aid strategic 'make or buy' decisions by companies facing an increasing number of diverging challenges such as the need to reduce time-to-market, increase communication through co-development with customers and partners, and improve productivity. New models for processes are being introduced into organisations such as collaborative design, interaction with product marketing and co-production. The restructuring of companies into smaller, more independent operating units increases the need for collaboration across sites and increasingly across companies.*

Source: © Cegelec



Source: Indepen forecast

The 'global cyber enterprise of the future' focuses on project and data management[14 15]. Although requirements may vary among multinationals, SMEs, engineering companies, distributors, etc., there is a common need to support increasingly flexible, agile and dedicated organisational structures. Market analysis shows only a low single digit increase per year in the automation market for manufacturing and for processes with built-in and self-adaptive intelligence (ARC[16 17]) while at the same time studies show a more than 20% annual increase in the supporting information grid, wired and wireless. The 2010 digital manufacturing and supply chain is crucial to keep production – and thus employment – in Europe, particularly in view of the lagging labour input growth because of the demographics (see Figure right).

These evolutions will have a major impact on employment toward more knowledge, know-how and creativity.

- **Full automation solutions with time-critical constraints**: Manufacture of any piece of equipment (e.g. cars, aircraft, or embedded and distributed software) involves collaboration between several companies. Inside each, several workshops produce individual parts that are assembled and tested before delivery or shipment[18]. Information may be high-level aggregated data such as manufacturing orders, statistics, leveraging operators, or workforce knowledge.
- **Electronic market places, supplier contacts, support, training and maintenance**: Electronic market places can be based on a business-to-business (B2B) or a business-to-consumer (B2C) model. On-line catalogues can be used for supplier contacts. In e-business, outsourcing customer support occurs via help desks in phone- and web-based call centres that enable better traceability. There is a need to provide suitable access to product documentation. Multimedia training and support need to be made available on demand, based on user profiles.
- **Cyber-enterprise information system**: It is of the greatest importance for a cyber enterprise to integrate all, or most, of the above-mentioned services through computer-supported business processes. Web-based technology plays a key role (see snapshot 'The future of Enterprise Systems').

[14] http://sern.ucalgary.ca/CAG/publications/abm.html.
[15] http://www.jimpinto.com/writings/automation2005.html.
[16] http://www.arcweb.com/ (see file: Study_autodiscrete).
[17] http://www.arcweb.com/ (see file: Study_autoprocess).
[18] The discrete manufacture case here holds equally in similar ways for continuous processes/process industries.

1.2 CHALLENGES

1.2.1 Competitive challenges

Europe is facing a number of crucial competitive challenges as outlined for example in the European Competitiveness Report 2004/05 [11], the 2004 Kok report [12], the IST programme five-year assessment [13] and the CSTI report [14], and summarised in Annex A.5:

- **European R&D intensity (as percentage of GDP) as a prime measure is lagging critically behind our main competitors**.

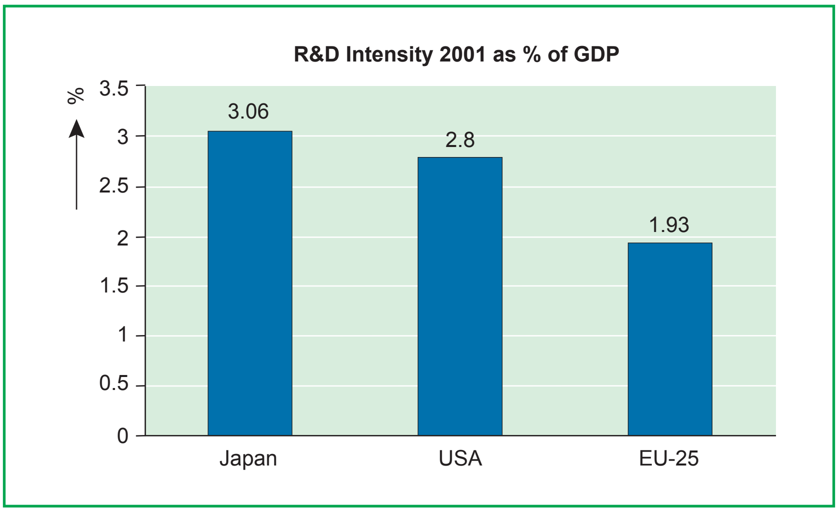


Figure 2: R&D intensity 2001

Moreover, the R&D intensity gap between the EU-25 and particularly the USA is widening as growth rates are almost diverging (Annex 5, Figure A.5-1) and as the USA has started massive investments in defence and homeland security[19] in response to 9/11 – almost one third of this goes into the ICT sector[20], both for R&D and as lead customer procurement. Given also the persistent gap in GDP *per capita* between the EU and the USA, the gap in absolute terms is striking (see Annex 5, Figure A.5-2).

It is therefore all the more important that Europe supports a focused agenda for growth and employment ('Renewed Lisbon Agenda'/Barcelona goal for R&D spending [15]).

- **The crucial importance of R&D and ICT for European competitiveness is well understood: roughly half of the European growth rate and of the productivity gains come from ICT**. This is why the recent Kok report [12] made a strong specific call **to raise the R&D investment in ICT as a key cross-sectoral enabler**, also in connection with the negative European demographic trends.

Less understood but equally important is the lag between an enabling ICT innovation and the resulting productivity gains as the ICT innovation – here in particular the impact of the Internet/Web as the first wave of the digital transition (and focal point of ITEA) – had to be translated into changes in the underlying business processes, which takes time to implement and then to show fruition [16].

By the same token, with the second wave in the digital transition enabled by embedded SiS, the focal point of ITEA 2, there will be again a lag between the R&D and the resulting higher growth rates. As this second wave will be bigger and cause more changes as it affects everyday life/operation, an even higher growth rate contribution is to be expected from SiS but will no doubt take even longer to show.

- **This second wave is rapidly sweeping European strongholds such as the automotive industry[21]: more than 90% of all future innovations in cars will be driven by electronics and software, i.e. SiS** (see the automotive future inset in Chapter 1.1). It is exactly these strongholds that Europe must build and focus on – fighting the US giants on their own turf is a losing battle as, on the contrary, they are trying to muscle onto the European turf through their stronghold in packaged software.

[19] Since 2003, the USA has been spending more than $1 billion a day, and this is continuing to grow.

[20] According to best estimates: statistics not yet available.

[21] The automotive industry is the biggest R&D spending sector in Europe - worldwide it is IT hardware, followed by the automotive industry.

- **Off-shoring is reaching an unprecedented level, primarily driven by the rise of the new powers, notably India and China.** While this is considered good business practice and a necessity in global work sharing, it must be complemented by a concerted and reciprocal drive to create high-value jobs in research, development and design in Europe and to capitalise on the European 'little tigers' from the new EU Member States [17]. This drive has also strong implications for more and better education and training (e.g. the developing gap in engineering degrees, Annex 5 - Figure A.5-7).

1.2.2 Technological and business challenges

Probably the most fundamental technological driver is the famous 'Moore's law' on the silicon side[22], essentially stating that integrated circuit complexity is doubling every 18 months (see Figure 3; *note the double log scale*) – with no end in sight [18].

The corollary of this law – even more important for embedded SiS – is that the price of a transistor is dropping at the same exponential rate to zero, enabling intelligence literally everywhere, even in the smallest things, often called 'smart dust' [8].

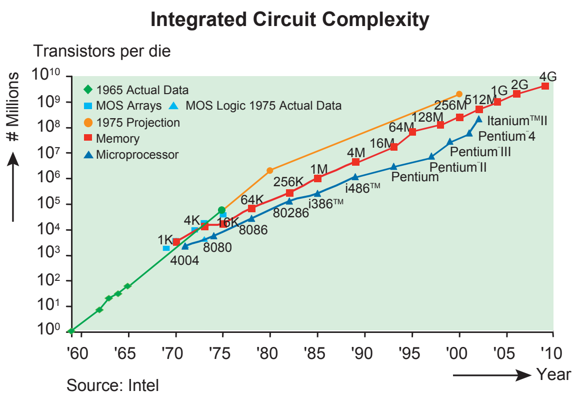


Figure 3: Moore's law: Integrated circuit complexity is doubling every 18 months

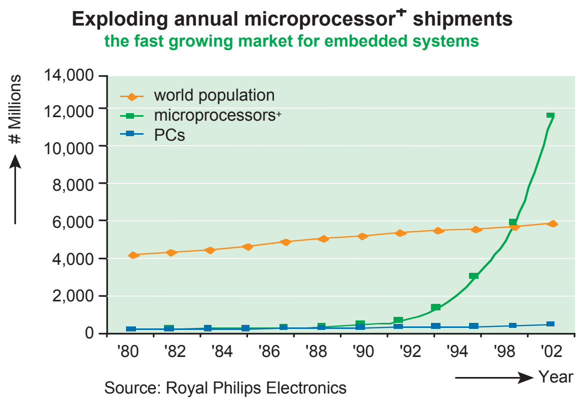


Figure 4: Annual microprocessor shipments

- **The 'European paradox': successful in science and technology (S&T) but badly lagging in translating this into successful innovations**. Contributing to this paradox is the fact that Europe also badly lacks active procurement policies in the public sector as opposed to our main competitors, notably the USA, and also in coherence of policies, such as regulations.

Only by taking on these challenges NOW and increasing the R&D investment to the competitive level can we close the gap and stay ahead of the wave ('Renewed Lisbon Agenda').

With Giga-scale circuit complexity, we are witnessing the third generation of computing and communications, marked by an exponential growth in embedded processor shipments (see Figure 4). In the near future, every one will be surrounded by more than a hundred 'smart things', ubiquitously connected, enabled by almost zero-cost communications technologies [19].

This '**double explosion**', in the number of devices – all connected – and in smartness in devices and the total system, **creates the fundamental challenge in software and SiS**. Despite all the exciting developments in micro-electronics, the **grand challenge**

[22] And focal point of sister EUREKA Cluster MEDEA+ – see www.medeaplus.org.

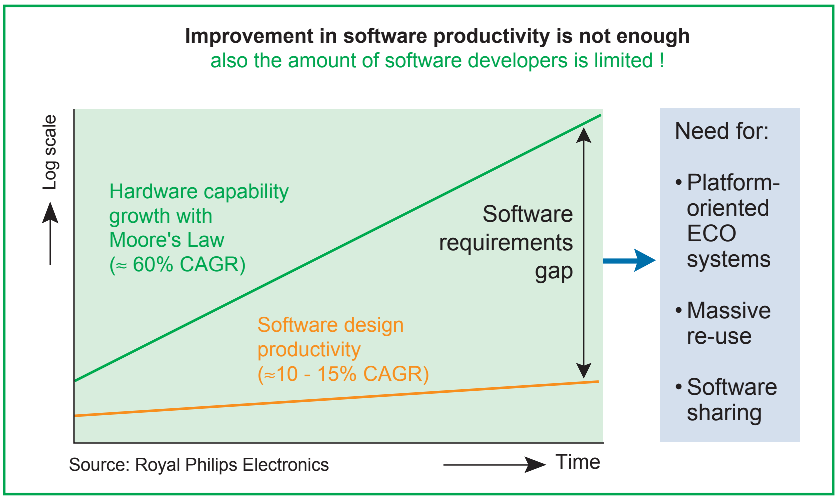


Figure 5: Software requirements gap

indeed is to devise, create and master the software architectures, software technologies and systems, solutions and services for myriad applications including safety- and security-critical applications. Specific key challenges include how to close the software-productivity gap (see Figure 5) while simultaneously ensuring rigid software quality standards, and how to structure the total applications design process so as to make the applications ambient – that is mingling fluently and naturally with every day life/operation and interactions [20].

This software requirements gap, already a core issue of ITEA and a continuing challenge for ITEA 2, can be addressed successfully only by a multi-tier approach:

- Development of so-called ‘**platform-oriented Eco systems**’, i.e. consensus on a high abstraction level from a multitude of interested parties around a specific core element to get things done efficiently – for example a digital TV or DVD player/recorder in consumer electronics, a core platform in mobile communications, or a telematics or electronic stability platform in vehicles – and thus creating a huge opportunity for independent software vendors (ISVs);
- Massive software re-use combined with massive software sharing, creating a huge opportunity for a concerted European COTS[23] components/open source software (OSS) initiative; in addition, model-driven architectures (MDA) and technologies need to play a much larger role; and
- Massive training and re-training of engineers, creating a particular call to academia and also to life-long learning measures.

All three tiers together, combined with the strong applications industries base and their driving needs, constitute a unique opportunity for the creation of an independent European software tooling industry for embedded SiS, to be fostered by ITEA 2 as catalyst.

[23] COTS: Commercial off-the-shelf (components): a movement originally coming from ‘dual-use’ for the military.

1.3 PROGRAMME SCOPE

Given the rationale, vision and challenges described in Chapters 1.1 and 1.2, and given in addition the experiences and lessons from the ITEA Programme, including the recommendations from the ITEA mid-term assessment (MTA), the scope of ITEA 2 is defined along the following principal axes:

- **Application domains:** extending the scope by an additional open domain and by integrating a service-oriented perspective while maintaining the successful strong focus;
- **Innovation:** extending the scope to include downstream activities on the basis of R&D**&D** – i.e. research, development **and demonstration** – to accelerate innovative solutions and to overcome the European paradox; and
- **R&D co-operation**: intensifying R&D coordination in ERA and building relationships beyond ERA, through the co-operation of ITEA 2 with the forthcoming ARTEMIS European Technology Platform as focal example.

Application domains

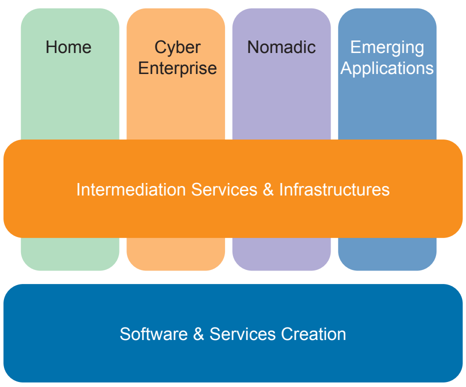
ITEA 2 will maintain the successful ITEA model of focusing on the most crucial application domains for European competitiveness [1], but adds a new 'open' domain to address novel emerging applications (see Figure 6), such as applications at the conjuncture of cognitive, bio- and nano-technologies.

Following a specific recommendation in the MTA, a particular effort will be put into the software and services creation (SSC) domain to foster an independent European software tooling industry in embedded SiS.

Innovation

ITEA had already advocated and championed a European Framework for Innovation, including supporting active public procurement policies, based on the experiences in the programme [3].

Essentially the same call was made recently in the Kok Report [12]: in the end, successful innovation – i.e. a product or service in the customer's hand – is make or break in



Home: all activities apart from nomadic applications that may be required in domestic environments to exchange information inside and outside the home (using all types of devices and appliances) and perform the corresponding tasks.

Cyber Enterprise: all activities that may be required by clusters of people or machines that communicate and interact with each other and with their environment to achieve a common technical or economic goal and/or perform a task, regardless of their organisational or geographical location.

Nomadic: all activities that may be required by itinerant operators away from their home or workplace to exchange information and perform corresponding tasks. It also includes all other mobile and transportation applications.

Emerging Applications: includes novel emerging applications such as those from the conjuncture convergence of cognitive, bio- and nano-technologies or 'smart energy' that cannot readily be attributed to one of the five established domains.

Intermediation Services & Infrastructures: all activities that may be required to support the different people that need to access and manage networks and network services (including design, implementation, sales, maintenance and billing services).

Software & Services Creation: all activities that may be required to help the different people engaged in designing, implementing, verifying, maintaining and modifying software-intensive products, systems or services.

Figure 6: ITEA 2 application domains

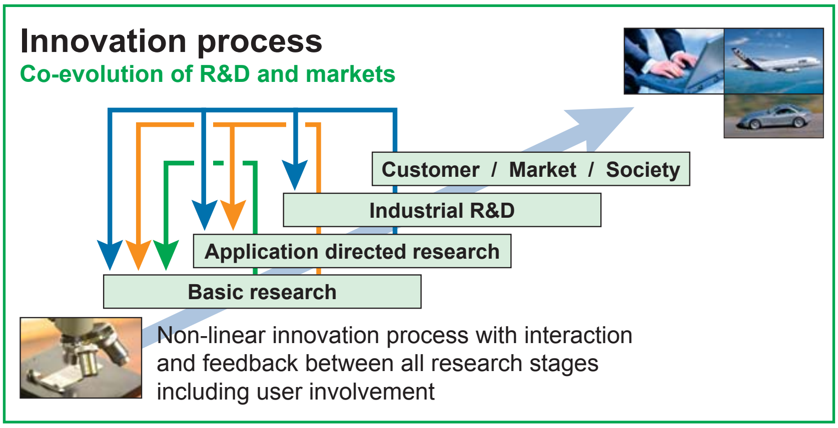


Figure 7: Innovation process today

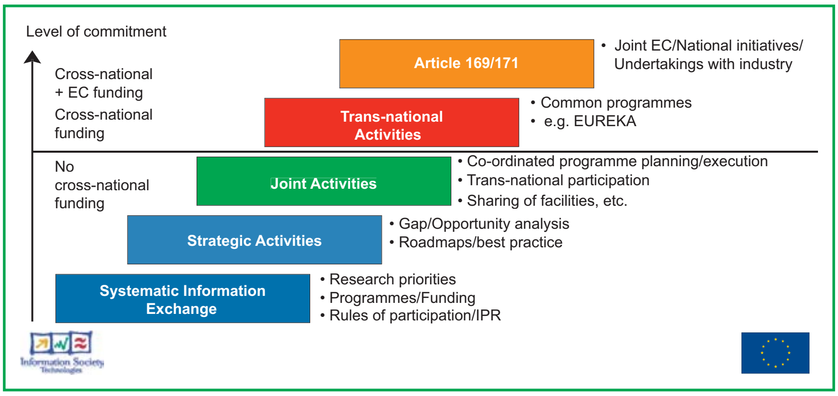


Figure 8: Levels of ERA coordination

ever fiercer competition, not just successful science and technology ('the European paradox').The time has more than come to address finally this crucial issue and extend the scope of R&D programmes to include and support downstream activities to shorten time-to-market[24], including so-called 'User experience research and centres'[20] as the time for the old linear R&D model is long gone; it has been replaced by a non-linear model with co-evolution of R&D and markets (see Figure 7). **Fostering innovation is a cornerstone of ITEA 2**.

R&D co-operation

Public support for European R&D efforts is still fragmented and Europe cannot afford such a situation anymore in view of global competition [12]. Our guiding principle must be 'to put all the wood behind one arrow'[25]. The ERA concept as a co-operation model is the way forward and a primary action line for the EUREKA Chairmanship with the European Commission and other stakeholders in the preparation for the forthcoming EU Seventh Framework Programme (FP7).

Figure 8 shows principal levels of ERA coordination, from systematic information exchange up to Joint Technology Initiatives (JTIs) between industry, the Commission and national Public Authorities as most advanced form of co-operation, with Galileo[26] as the prime example. Note that with JTIs for the first time 'variable geometry' – the cornerstone of EUREKA – is being introduced in ERA.

For ITEA 2, the co-operation issue mostly comes down to coordination with the new European Technology Platforms (ETPs) in FP7 – addressed separately in Chapter 1.8 because of its importance. In FP7, the Commission is also quite rightly addressing international co-operation in a separate line, i.e. support for building relations beyond ERA as competition becomes global, including support for standardisation actions. ITEA 2 intends to piggy-back on these lines, in particular in the context of the ETPs (Chapter 1.8).

[24] A key issue here is the pending revision of the 'EC Framework for State Aid for R&D', scheduled for later this year.

[25] Coined by Scott McNealy, CEO of SUN Microcomputers, when faced with a critical competitive situation.

[26] For more information, see http://www.europa.eu.int/comm/dgs/energy_transport/galileo/index_en.htm.

1.4 STRATEGIES

ITEA 2 will principally follow successful proven ITEA strategies adapted to the new challenges and new context that figure also in the recommendations of the ITEA mid-term assessment (MTA):

- Maintain the principal ITEA game plan of changing the battleground in ICT primarily to the 'SiS industries' [21] [22], building on key European strengths and industries (automotive, consumer electronics, ...) – i.e. to embedded systems and services;
- Mounting an industry-driven pre-competitive R&D&D initiative – now even stronger – for a sustained build-up of European capabilities in software-intensive systems and services;
- Maximise and leverage the growing importance of SMEs to increase the momentum of the initiative[27], from an already high participation level (see Annex A.3);
- Foster and leverage the impact of academia/research, first of all in continuing the solid application-oriented grounding of the programme but, in addition, intensifying co-research and transfer; and, in addition,
- Push the envelope on programme agility aggressively across all levels and all procedures to address better the overarching issue of time-to-market (see also Chapters 1.5 and 1.7).

Principal game plan
ITEA's principal game plan of changing the battleground in ICT primarily to the SiS industries where Europe is strong – such as automotive and consumer electronics – is more valid than ever (see also Annex 1). Only by engaging the major European actors and combining forces will the necessary critical mass and 'home footprint' be reached to sustain ever fiercer global competition, in particular in the coming standards wars. This is particularly critical for the 'glue' software, i.e. the middleware, as the US market leaders in classical ICT are trying hard to wrestle control of this critical element for the new seamless services world, leveraging their technology and market power.

There are also clear indications that the emerging powers – China and India – are trying to exploit standardisation as a key competitive weapon [11, 12].

ITEA 2 will broaden the industry footprint for even more critical mass, to be reflected also in a wider base of founding companies (see Chapter 1.7), and as *de-facto* standardisation becomes ever more critical, the programme will mount a particular action line on this strategic topic (in sync with a specific recommendation in the ITEA MTA; see Annex 3, category 1).

Industry-driven pre-competitive R&D&D initiative with strong cross-fertilisation
This has several implications and elements:

- Maintaining the strong focus on application domains and supporting software production technology and tools. For the latter, ITEA 2 will mount a particular action line on fostering a European tooling industry in SiS through, for example, spin-offs – a persistent European weakness – following also a corresponding recommendation of the ITEA MTA;
- Continuing the successful bet on **digital convergence** and '**co-opetition**'[28] as key enablers for the future seamless services world and for swiftly spreading cross-domain learning and adaptation of best practices as a unique European competitive advantage;

[27] This is often called the 'Microsoft strategy', as it was the first to apply it on a large scale.

[28] Simultaneously: co-operation and competition.

- Continuing to build on a shared technology roadmap for sound technical programme guidance and underpinning (on the current edition for the first phase work plan, and on the planned next edition for the second phase – see Chapter 1.6). The highly praised ITEA Technology Roadmap has been a distinct success factor in ITEA; and

- Complementing the strategic European efforts of MEDEA+ in micro-/nano-electronics in proven excellent co-operation and of other EUREKA clusters.

In addition, cross-fertilisation efforts include close coordination with the forthcoming ETPs such as ARTEMIS and NESSI[29] (see Chapter 1.8) and other EU and national/regional initiatives as relevant, e.g. *Coordination of IST research and national activities* (CISTRANA) and *Co-ordinating strategic initiatives on embedded systems in the European Research Area* (COSINE), and continuing the excellent co-operation with national/regional initiatives such as RNTL, the French national network for software technologies.

The key role of SMEs

As stressed earlier, SMEs play an ever increasing role in the competitive fabric and in employment.

ITEA 2 will maximise and leverage their critical significance in increasing the momentum of the initiative from the already high participation level in ITEA. The intention is to go well beyond the supportive measures in ITEA, such as favourable SME contribution rules and SME representation in all ITEA bodies including the Board, by addressing the central issue for SMEs – time-to-contract – with two key tentative additional measures:

1. Shortening the Call process, while maintaining the proven two-step Call procedure; and

2. Helping to overcome the funding synchronisation problems of the national decision calendars of the countries involved, with the 'JETI funding scheme' as the primary tentative measure (see Chapter 1.8).

We estimate that the combined effect will keep ITEA 2 as best-in-class in SME participation even while FP7 is supposedly providing specific SME-oriented measures.

More research and transfer

Academia and research institutes have already played a strong role in ITEA, in particular by their crucial input and guidance for the ITEA Technology Roadmap and by their instrumental contributions to the 'future enablers' in the ITEA project portfolio[30]. Consequently, ITEA enjoyed a continuous increase in their participation.

The interface between basic research and applied research is becoming fluid in the modern R&D model (see Figure 7, Chapter 1.3), and Europe's only option is to hold on to its societal model by driving up skill levels. ITEA 2 will therefore extend its outreach to academia and research institutes by a co-research line, in particular in connection with the 'future enablers' portfolio, including speeding-up transfer of results and researchers, and to capitalise on the notion of 'brain-drain brain-gain'.

In addition, ITEA 2 will tentatively raise the profile of academia/research institutes further in the programme, one possible avenue being to set-up a Scientific Advisory Committee, similar to that of MEDEA+, as part of ERA coordination (see Chapter 1.8).

[29] NESSI: Networked European Software and Services Initiative

[30] IRIS Book, page 30.

1.5 AMBITION – OBJECTIVES – TARGETS – IMPACT

1.5.1 Ambition

The ambition of ITEA 2 is to mobilise a total of **20,000 person-years** over the full eight-year duration, translating into an investment of **2,500 person-years per year**[31], representing **more than €3 billion in total**. This level of ambition follows from the experience in ITEA, the need to close further the gap in R&D investment (3% of GDP, Lisbon objective) and the ever growing importance of SiS as indicated in Chapter 1.1 and the companion study (see Annex 1).

1. **Experience in ITEA: extrapolation of the willingness from ITEA partners to invest**
   In the 'ITEA Rainbowbook' [5] the ambition for the total eight-year ITEA programme was defined as 20,000 person-years. The current projection (as of April 2005) for the total ITEA programme is shown in table 1.

Total Calls 1-8	Submitted PO Phase	Submitted FPP Phase	Labelled	Finished
No. of projects	175	120	110	85
Effort in person-years	22,000	17,500	16,500	9,500

Table 1: Projected number of projects and participation in person-years for total ITEA programme

During the Project Outline (PO) phase of Calls 1 to 8, in total more than 22,000 person-years were submitted and subsequently 17,500 for the Full Project Proposal (FPP) phase – after the PO evaluation and first indications on available funding to industry. This clearly shows the willingness of large industry and SMEs, universities and research labs to invest. Furthermore there is a strong growing interest in participation in ITEA projects. Figure 9 shows the development of person-years submitted for the Project Outline phase over the course of ITEA (combining even and odd Calls to average out Call variations).

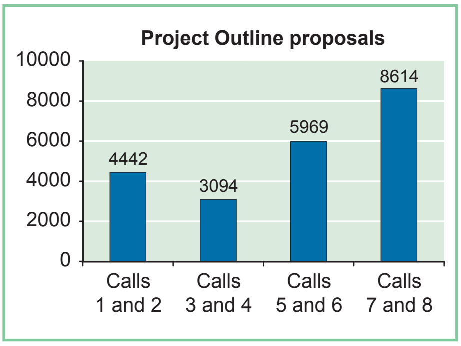


Figure 9: Growing interest (person-years) in participation in ITEA projects

2. **The need to close the gap in research & development investment (3% of GDP, Lisbon objective)**
   Currently, the overall R&D intensity in EU-25 is 1.98% of GDP and the industrial R&D intensity is 1.3% of GDP. Taking into account the Lisbon objectives, total R&D as well as industrial R&D should be increased finally by around 50%. As a consequence, the amount of research in Europe also needs to be significantly increased.

3. **The shift to software in R&D**
   From the ever growing importance of SiS as indicated in Chapter 1.1 and in the companion study (see Annex 1), it is clear that a fast growing part of total R&D in Europe is in software or software-related areas.

Taking into account the various elements mentioned above – growing interest in ITEA, the need for increasing R&D in Europe and the rising importance of the software element in R&D – it may even be a conservative estimate that ITEA 2 partners are ready to invest 20,000 person-years. As a consequence, the ambition of the ITEA 2 programme is again to mobilise a total of 20,000 person-years over the full duration of the eight-year programme, translating into an effort of 2,500 person-years per year.

[31] Person-years is the appropriate principal measure for ITEA and ITEA 2, due to the labour-intensive character of software research.

However, in contrast to ITEA, 2,500 person-years per year is considered to be the actual level necessary, which translates roughly into a doubling of the R&D investment as compared with ITEA.

In Chapter 1.8, we will discuss ways to meet this investment challenge, in particular on the Public Authorities side.

To highlight the investment challenge, Annex 3.1 shows the breakdown by country of the historic contributions to ITEA, and other relevant parameters such as GDP, R&D expenditure and population. These figures may be used as guidelines to further discuss and plan the contribution per country for ITEA 2.

1.5.2 Objectives

The overall objective of ITEA 2 is to at least maintain if not improve European leadership in SiS, in particular for the automotive industry, mobile communications, telematics, smart cards, high-speed trains, aircraft, environmental technology and manufacturing. The ITEA approach is based on a single clear goal – to boost the competitiveness of European industry – and further defined by a roadmap produced through a collaborative process.

1.5.3 Targets

The specific targets for ITEA 2 will be primarily derived from the companion study but will also include:

- Various target profiles for the project portfolio of ITEA 2 with respect to the three main project classes[32]: ‘roadblock lifters’, ‘convergence enablers’ and ‘future preparers’, with the latter as prime candidate for stimulating co-research with academia;
- The level of participation related to SMEs in Europe involved in research;
- Exploitation and dissemination of research results.

ITEA 2 Ambitions	
Number of (annual) Calls	8
Effort in person-years	20,000
Expenditure (in Euro)	3+ Billion
Number of projects	200
Number of participants	800 - 50% SMEs - 25% research institutes and universities
Exploitation (references to products/ results for internal use/ licenses / open sources)	1,000
Standardisation actions	250
Dissemination (publications / conferences)	4,000

[32] IRIS Book, page 30.

1.5.4 Impact

Key conclusions of the companion study on 'software-intensive systems in the future' [21] on the impact of the programme are:

- The selected key industrial sectors for SiS in the study (aerospace, automotive, consumer electronics, communications, medical, automation/production; which are also focus areas of ITEA 2) *alone* represent more than 16% of Europe's industry total;
- In 2002, the software R&D effort in the selected key sectors was already significantly higher than the corresponding total effort in the classical software producers and IT services sector, as measured e.g. by the widely published OECD statistics;
- Total growth in software R&D from 2002 to 2015 for these key sectors is forecast to 128% to €133 billion, almost *double* the growth rate for their R&D total (74%) and *more than double* the rate for classical software producers and IT services sector (60%);
- In the selected sectors, a total of about 200,000 new software R&D jobs will be created in Europe.

As an indication of the multiplier effect on total European employment, the automotive sector alone will create 1.2 million new jobs in Europe of which 600,000 will be high-tech jobs in E&E (electrics and electronics). E&E is the single most important growth area in the automotive industry with an almost 60% increase in the total value add, from 22% in 2002 to 35% in 2015 (see Figure 10). Automotive SiS will account for 90% of all future innovations in cars.

Contributing to these key findings virtually guaranteeing a sustained impact of the programme on European competitiveness is the fact that the founding fathers of the ITEA 2 programme are all leaders in their respective fields, with most figuring in the global top 100 companies.

The ITEA 2 companies represent a solid and dynamic economic force with €380 billion in total turnover, €29 billion in R&D spending and more than 1.5 million employees – of which 210.000 are in R&D, the vast majority of R&D being conducted in Europe. In fact, the number of R&D employees in ITEA 2 founding companies in Europe amounts to around 12% of the region's total number of researchers.

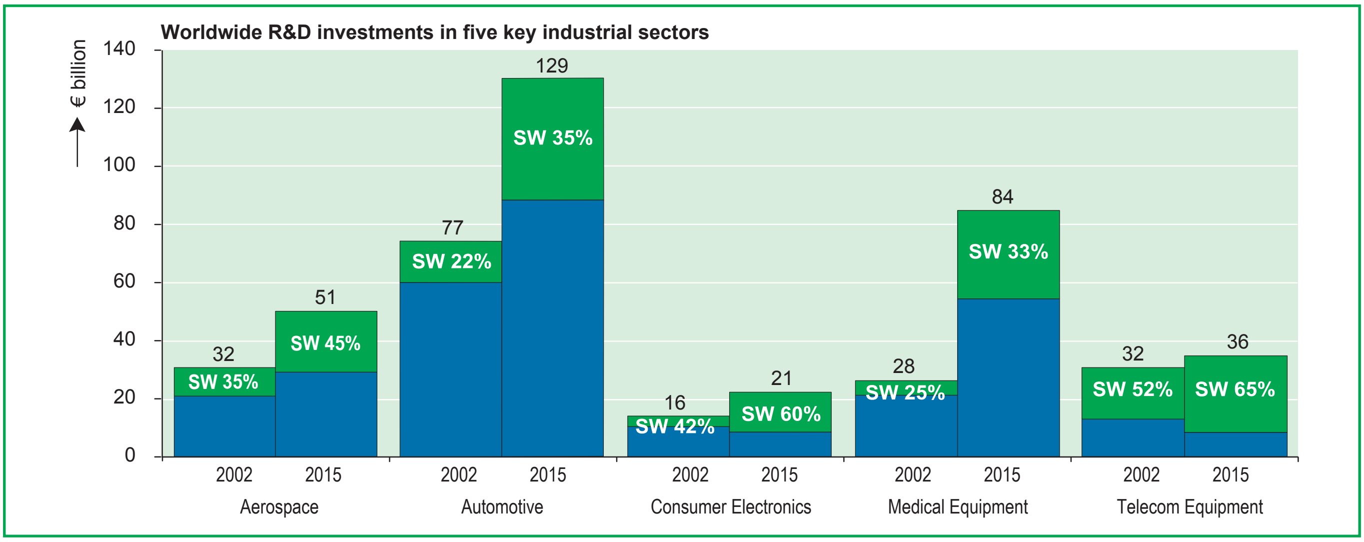


Figure 10: The shift to software R&D

1.6 PROGRAMME PLAN

The programme plan covers the full eight Calls (two phases, with four annual Calls each), as indicated earlier. Key elements of the plan are: the overall architecture, the timing to ensure continuity with the current ITEA programme, and the EUREKA labelling decision.

1.6.1 Overall programme architecture

ITEA 2 is defined as a two-phase programme (see Figure 11), with projects starting in 2007, and each phase being characterised by its specific work plan with four Calls for Projects and a mid-term assessment built-in for the final go ahead for the second phase[33].

The work plan for Phase 1 is part of this document. The Phase 2 work plan will be defined in the second semester of Phase 1, based on the results of the next generation road mapping exercise (Roadmap 3, see Figure 11) and the mid-term assessment, as well as the experiences of Phase 1 as key inputs.

As in ITEA, annual Calls for Projects will be issued, based on the work plan; project duration will be three years maximum. The highly successful ITEA processes will principally be copied for the Call process and the project evaluation procedure, with additional measures for a significant improvement in agility, in particular to help SMEs specifically.

1.6.2 Timing

To ensure continuity with the current ITEA programme[34], the first Call of ITEA 2 is scheduled to open in early 2006, to enable the start of the first ITEA 2 projects in January 2007.

The initial work plan will be the reference for the four first Calls, from early 2006 when the first Call opens until the end of 2009 (end of the evaluation of the Call 4-related project proposals).

1.6.3 EUREKA labelling

The ITEA 2 Programme was introduced to the EUREKA labelling process at the EUREKA High-Level Group (HLG) meeting on 28 and 29 June 2005, with the expectation that the HLG will have positively concluded its assessment of the proposal and granting the EUREKA label during its fall 2005 meeting (19 and 20 October), based on the ITEA 2 full application scheduled for September 2005.

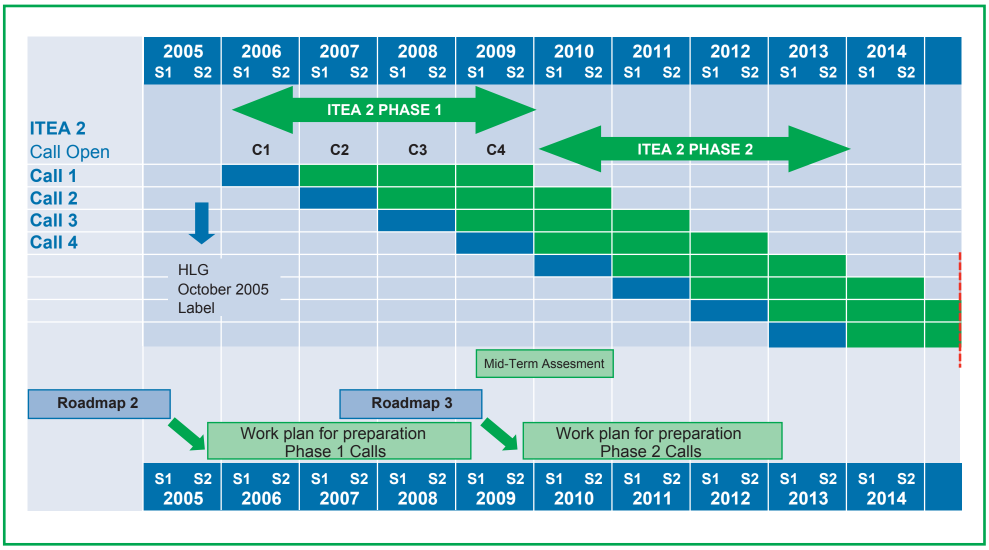


Figure 11: Overall ITEA 2 programme architecture

33 To be commissioned by Public Authorities, as in ITEA.

34 The last Call of the current ITEA programme opened 3 February 2005, for project start late 2005/early 2006.

1.7 GOVERNANCE

The organisation and structure of ITEA 2 is principally copied from the current ITEA programme; a more detailed description is given in Annex 6, and includes:

- The main structure and way of working – including the very successful intellectual property rights (IPR) management approach – based on the '*ITEA Framework Agreement*';
- Project organisation and way of working based on the '*ITEA model Project Co-operation Agreement (PCA)*' between the partners in each project consortium;
- Organisational structure (Board, Board Support Group, Steering Group and Office);
- Co-operation with Public Authorities (Directors Committee, ITEA Authorities Committee);
- Effective communications, including a high-profile annual event (Symposium);
- Main procedures (Call procedure, change requests, monitoring & reviewing, finance & accounting, etc.); and
- The formal ITEA Office legal structure based on the articles of the 'ITEA Office Association'.

The key differences with the current ITEA programme are:

ITEA 2 Board
ITEA 2 is to be founded by a maximum of 15 companies, representing a balanced mix of industrial sectors, constituencies and countries in Europe.

Board members are representatives of:

- Maximum 15 founding companies – to include at least a founding member from Spain, the New Member States (NMS) and, potentially, an additional SME;
- The European Federation of High Tech SMEs;
- Tentatively: the Scientific Committee (research institutes and universities);
- The ITEA 2 Office

Small and medium-sized enterprises (SMEs)
Beyond the special supporting measures for SMEs in ITEA – such as favourable contribution rules, no cost-sharing for ITEA bodies and a Board seat – ITEA 2 will continue to increase the SME participation further through additional specific measures, such as the JETI funding scheme discussed in Chapter 1.8, and to speed-up the 'time-to-contract' as the most critical issue for SMEs.

The goal for ITEA 2 is to stay 'best in class' with respect to SME participation.

Academia and research labs
Beyond the measures in ITEA for academia and research labs – such as participation at no charge – ITEA 2 will continue to enhance the involvement of research institutes and universities further by tentatively installing a Scientific Committee (SC), similar to that of MEDEA+ and potentially in connection with ARTEMIS, to advise ITEA 2 specifically on long-term visions and strategies, with the Chairman of the SC becoming a member of the Board, and by stimulating co-research particularly in the 'future enablers' of the ITEA 2 portfolio.

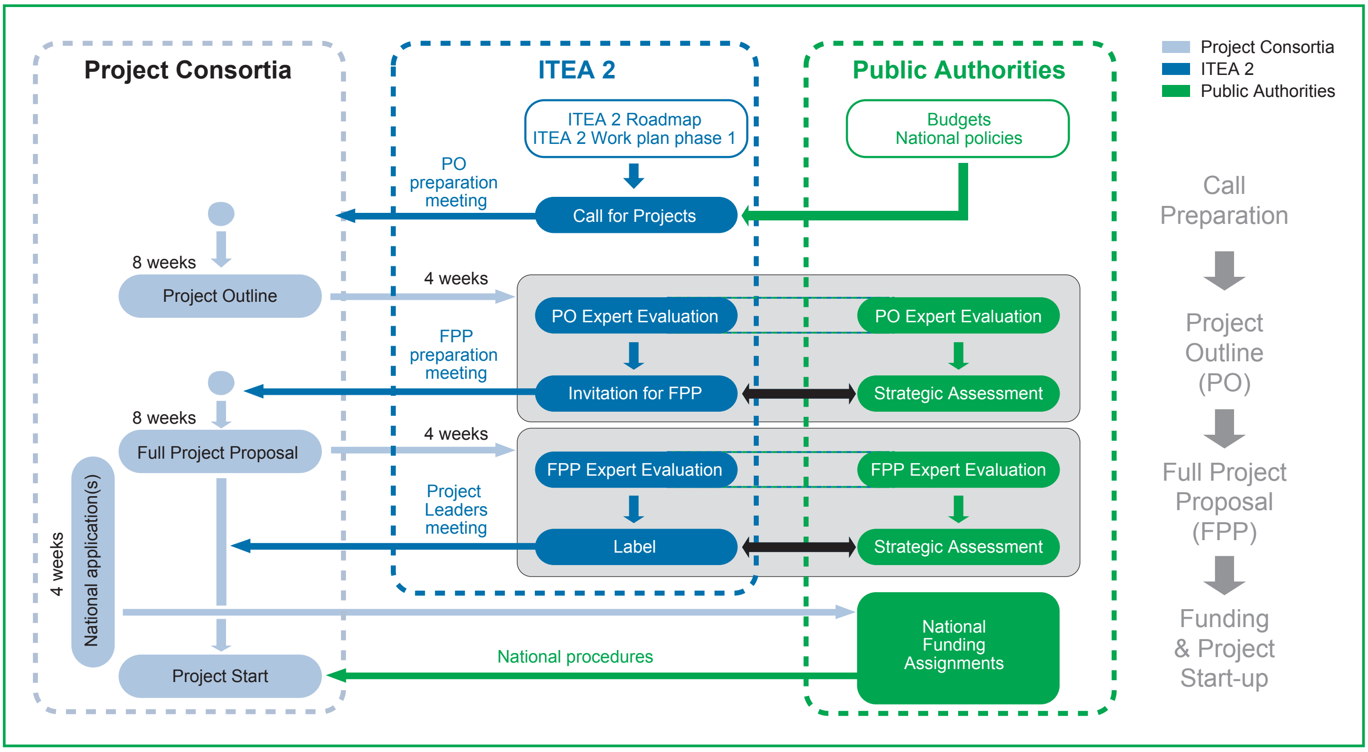


Figure 12: ITEA 2 two-step Call procedure

Time-to-contract (funding synchronisation)
ITEA 2 will base its Call procedure on the proven ITEA two-step process (see Figure 12).The **first step** in this process calls for a Project Outline (PO), with the goal of enabling an initial selection among the proposals presented by consortia, while keeping paperwork to a minimum. The **second step** calls on successful POs for the presentation of a Full Project Proposal (FPP), its evaluation and subsequently labelling by the ITEA 2 Board if successful. Public Authorities are fully in the loop in each step.

For ITEA 2, the following significant improvements are envisaged with respect to the Call process, and are being studied:

- Throughput time reduction of the Call process. Currently, the Call process (PO – FPP – Labelling – Funding Decision – Project start-up) can take 18 months and more. The goal for ITEA 2 is to shorten time-to-contract to a maximum of 12 months.
- Better synchronisation of funding decisions by national Public Authorities, e.g. via the JETI scheme, in support of the above goal.

ITEA 2 finance
ITEA 2 is a non-profit organisation financed by project contributions, with the contribution rate principally based on the project participation per year, in person-years.

For SMEs, the first three to five person-years per year are free of charge[35]; and universities participate at no charge at all. Overall it is envisaged that ITEA 2 will at least maintain the already low overhead rate of ITEA (less than 1%) if not reduce it.

[35] To be yearly decided by the ITEA 2 Board.

1.8 CO-OPERATION IN ERA

ITEA had already long championed ERA co-operation, together with MEDEA+, primarily to reach critical mass and a competitive level of R&D investment in Europe but also for efficiency gains, e.g. with the Advisory Council for ICT R&D in Europe (ACIRE) proposal [3] and the concept of focusing co-operation on and pioneering in strategic domains[36]. These efforts have more or less failed so far, at least as far as FP6 is concerned. On the other hand, ITEA succeeded in developing a fruitful co-operation with a corresponding national programme (RNTL, France)[37], to be continued under ITEA 2.

For ITEA 2, the natural 'proxy' for ERA coordination would be the ARTEMIS platform (Advanced Research and Technology for Embedded Intelligence & Systems)[38], although others might still emerge, such as the NESSI platform. As ARTEMIS and ITEA 2 have a lot in common, a proposal for a co-operation model between ETPs and EUREKA Clusters (see Figure 13), underpinned intrinsically by a novel funding scheme for the JETI side (see Figure 14), was developed in close co-operation between the Commission, ARTEMIS, national Public Authorities (COSINE) and EUREKA [23].

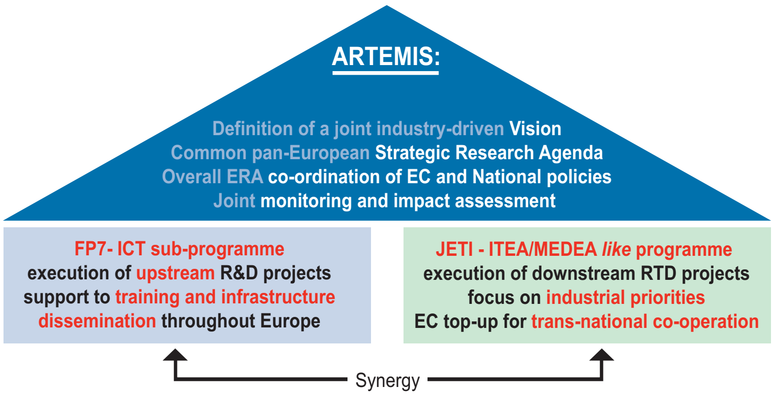


Figure 13: ARTEMIS as umbrella

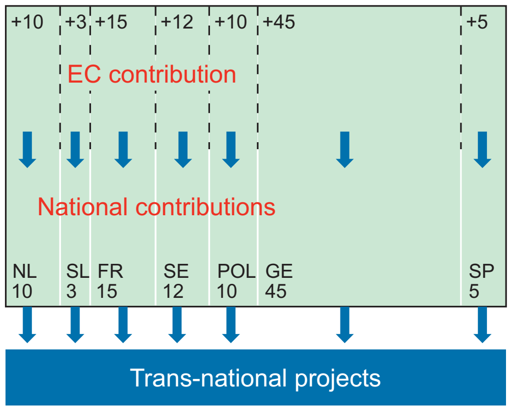


Figure 14: JETI-funding scheme

With the forthcoming FP7 and simultaneous requests by both the EU Competitiveness Council and the EUREKA Ministerial Conference 2004 for better co-operation in ERA, a considerable movement is under way to get there finally, in particular in the context of the new ETPs.

As the FP7 programme and ITEA 2 are projected for a respectively seven- and eight-year duration, both starting January 2007 (although with different first call timings), it would be a critical failure for European competitiveness if the efforts for better co-operation under FP7 were not to succeed.

In essence, this pilot model and financing scheme would address and resolve several key issues:

- It would concentrate all strategic elements under a joint umbrella, including strategic research agenda, roadmapping, monitoring and assessment, steering board, directors committee, other supporting bodies, such as working groups, and supporting initiatives, e.g. on standardisation, and delegate the actual project work to separate complementing execution pillars. This would preserve the specific strengths of the Framework Programme

[36] IRIS Book, IRIS Book, page 34.

[37] IRIS Book, page 35.

[38] For more information on ARTEMIS see: http://www.cordis.lu/ist/artemis/.

as well as the EUREKA Clusters, thereby indeed creating critical mass under a shared and focused strategic agenda;

- Via the JETI-funding scheme, it would create an incentive for the necessary increase in R&D investment in the field as well as help potentially to resolve the funding synchronisation problem on the EUREKA side. As a consequence, SME participation would further increase from an already high level, as EUREKA is intrinsically better prepared to handle SME issues because its national Public Authorities stakeholders have more and better knowledge of local specifics; and

- Create substantial efficiency gains for all stakeholders.

As such, this scheme is recommended as the basis for further discussions between all stakeholders for ITEA 2.

ACT FOCUSED,
ACT TOGETHER,
ACT NOW.

The ITEA 2 founding partners are: Airbus, Alcatel, Barco, Bosch, Bull, DaimlerChrysler, European Federation of High Tech SMEs, Italtel, Nokia, Philips, Siemens, Telvent, Thales and Thomson.

The combined 2004 totals of this group are:
- **€380 billion in turn-over**
- **€29 billion in R&D spending**
- **1.5+ million employees, of which 210.000 in R&D.**

1.9 SUMMARY & CONCLUSION

We believe that the case for ITEA 2 is compelling on all principal accounts:

- In terms of its crucial importance and sheer necessity for maintaining European leadership in embedded software-intensive systems and services in a dramatically changing world;

- In terms of its significant impact on growth and employment as cross-sectorial enabler and its contributions to a better quality of life; as well as

- In the prospects for successful execution being based on the successful ITEA programme as the first stage in a concerted strategic effort of European industry in this most crucial cross-sectional ICT space.

European industry, led by the ITEA founding fathers as core group – all leaders in their respective industries – and complemented by additional founding members in ITEA 2, is fully committed to the ambitions, objectives and targets of ITEA 2 as set out in Chapter 1.5, both from a competitive standpoint as well as a major contribution to reaching the Barcelona and Lisbon goals for the benefit of a renewed vibrant and strong Europe.

On the Public Authorities side, indications are that the continued determination and boldness of industry is shared by national Public Authorities as major stakeholders in the programme, led by the ITEA core group, and met by the necessary increase in the commitment on the Public Authority side, helped by the tentative novel co-operation scheme between EUREKA and the Commission in the context of European Technology Platforms (see Chapter 1.8).

In conclusion, ITEA 2 is fully on track on the European imperative of the Kok report [12]: ***ACT FOCUSED, ACT TOGETHER, ACT NOW***.

Work plan for Phase 1 (2007-2010)

Work plan for Phase 1 (2007-2010)

2.1 INTRODUCTION

The ITEA 2 work plan is divided in two phases (see Chapter 1.6) paving the way to the often called "ambient intelligence revolution", which is characterised by ubiquitous communications and intelligence distributed in the objects which surround us at any place and at any time. Figure 15 illustrates some aspects of the evolutionary steps which will be taken in order to reach such a dramatic change in our individual environments. This direction was already identified in the ITEA programme (see the IRIS Book) and a number of existing projects have made significant contributions to the first evolutionary changes. The ITEA 2 programme will definitively focus more on the final evolutionary steps as shown in Figure 15.

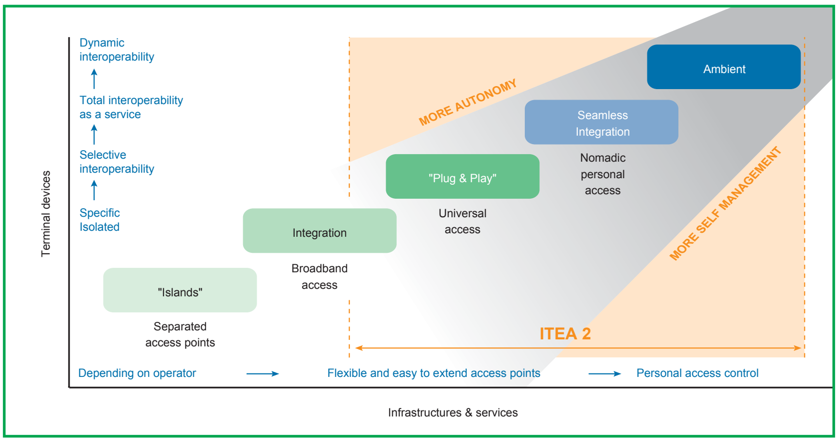


Figure 15: ITEA 2 work plan phase 1 & phase 2 in long-term perspective

Although ITEA 2 is a bottom-up, industry-driven programme, it is of major importance that the management has specific tools to steer the programme. One of the most important is a Technology Roadmap as proven in ITEA with the ITEA Roadmap. The second edition of this landmark document, published in May 2004 [1], is the reference for the ITEA 2 Phase 1 work plan; a new update will be launched in 2007 to help to define the Phase 2 work plan.

The ITEA Technology Roadmap is a guide for the years to come. It takes a two-dimensional matrix approach: on one side, the application domains and, on the other, the enabling technologies. Based upon the scenarios describing the future for the five original domains outlined in Part 1, Chapter 1.3 'Programme Scope' in terms of applications, the roadmap proposes for each a description of the short, medium and long-term vision. Then, for each scenario, the roadmap identifies the technologies that have to be mature in time to make this application a potential success. The methodology used (see Figure 16) re-enforces ITEA as a horizontal programme totally separate from the industrial sectors of its participants.

In parallel to this domain approach, and using the idea that such a programme must develop cross-fertilisation between industrial sectors as shown during the original ITEA programme with several projects, the selected technologies are clustered in four independent enabling categories as shown in Figure 16.

In each cluster, experts have identified key related technologies and their associated challenges to be mastered in the first phase of the work plan.

However, in a programme of the nature of ITEA 2 and with its duration, it is important to pay attention to the emergence of new application domains and/or new types of technologies such as those from the conjecture convergence of cognitive, bio- and nano-technologies and 'smart energy' that cannot be readily attributed to one of the five established domains. In Figure 16, dotted rectangles indicate these possibilities that will be deepened and assessed in the elaboration of the 2007 roadmap, while projects exploring these directions will be welcomed.

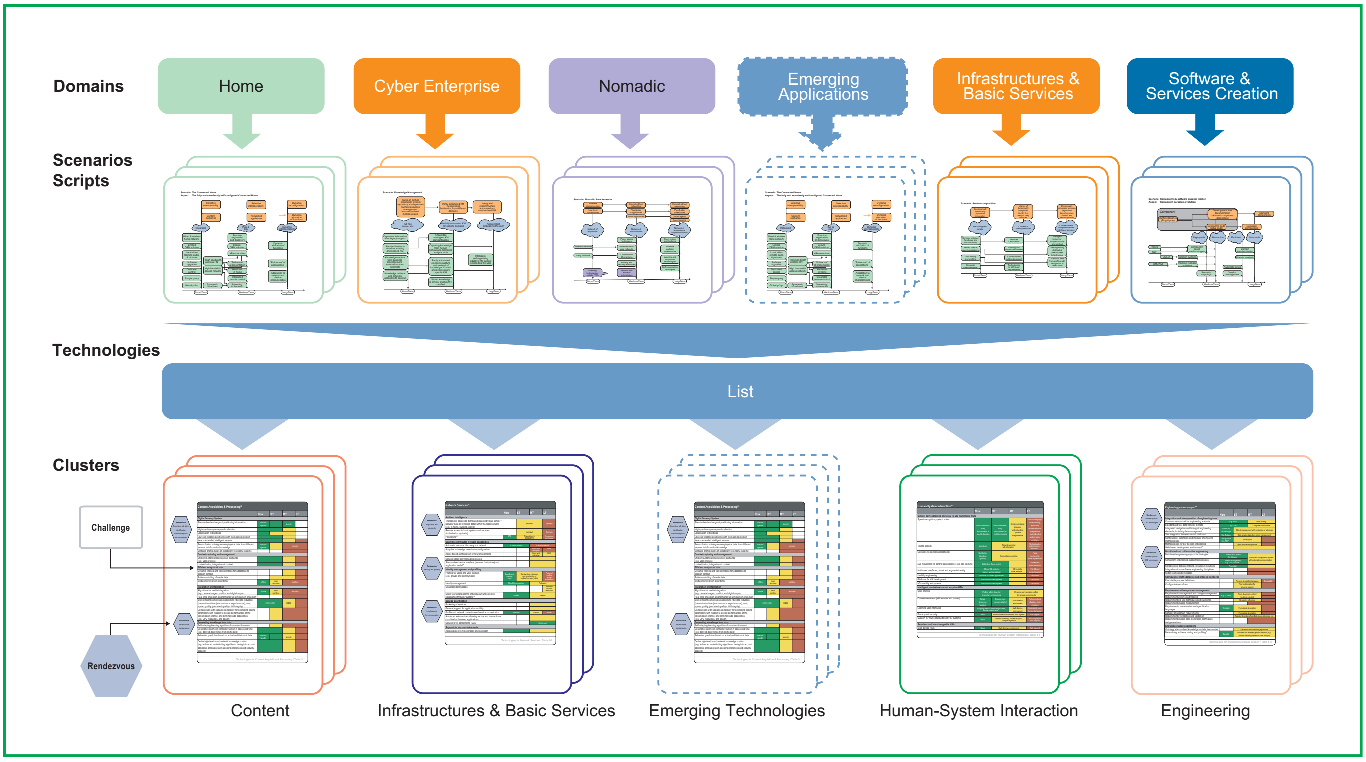


Figure 16: Methodology used in the ITEA Roadmap

The five application domains presented in the 2004 roadmap are reviewed in the next chapters, followed by a description of the associated technology clusters and their related technical challenges.

Whatever the targeted application domain or type of technology that will be used, projects in ITEA 2 will have to face a common and high level of complexity, while meeting a number of requirements to favour their success. These two aspects are stressed in the last section of this part.

2.2 APPLICATION DOMAINS

The ITEA roadmap has identified five application domains which cover future product and service markets, and help to focus and prioritise technology developments.

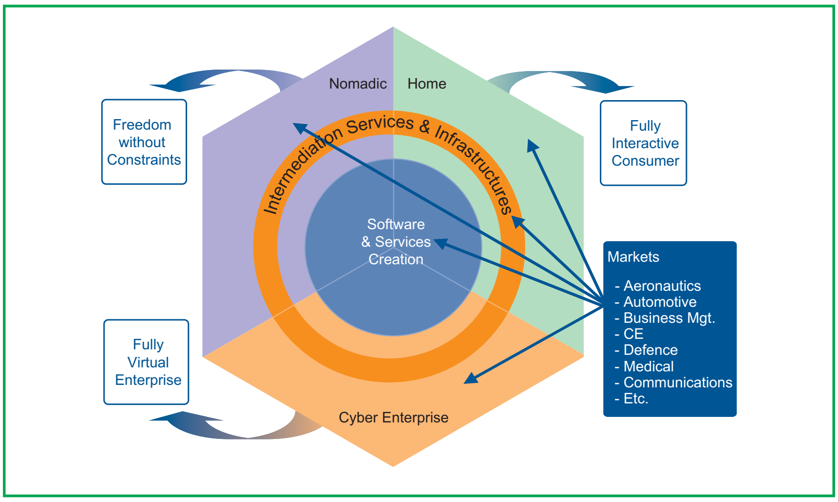


Figure 17: Domains and markets

The Home, Cyber Enterprise and Nomadic domains correspond to the end-use of the technologies, while Intermediation Services & Infrastructures and Software & Services Creation, concern the enabling tools for interconnections and system production.

These domains correspond neither to vertical sectors nor market segments but refer rather to a vision of the context of use for the technologies. Precise reference to market segments or sectors might have overlapped company product roadmaps or frozen existing boundaries between markets which may no longer exist in the future. While recognising the generic aspect of the technologies described in the previous paragraph, this classification makes it possible to characterise the deployment of these technologies according to their level of maturity.

This maturity is not generally the same in each domain and one specific domain can be the main driver for accelerating the use and the development of one technology – for example: file compression technology was deployed in Cyber Enterprise before being adopted in the Home and Nomadic environments, another example is the one of Web services. This approach favours multi communities or multi targeted market projects as shown in the ITEA projects portfolio and accelerates cross fertilisation, while extending market opportunities for each participant. Moreover, behind the five domains, needs can be identified easily for industry sectors such as aeronautics, automotive, business management, consumer electronics, defence, medical and communications, as shown in Figure 17.

2.2.1 Home

All activities that may be required by actors/ people/agents in their private environments in order to exchange information inside and outside the home (using all types of appliances) and perform the corresponding tasks.[39]

The Home domain covers the evolution of information technology in and around the house, driven by the deployment of a broad range of interactive and distributive electronic information services. This includes the introduction of new services due to the convergence of data formats and the use of personal wearable devices at home. These services are defined by considering the IT needs of the people living in the home. Three forces are driving this:

- Multifunction devices – one device to control all appliances that support remote control features, phone handset as remote control, etc.;
- Universal content – content for a range of devices: e.g. an Internet page that can be rendered on a personal computer (PC) or mobile phone screen; and
- A range of media, where cross-exploitation enhances the overall service.

[39] This does not include **nomadic** applications.

It is expected that this tendency towards convergence, sharing of networks and devices by multiple applications, will have a strong impact on the implementation of IT services in the home. This creates the concept of the 'Intelligent Home'.

The Intelligent Home of the future considers advanced interconnectivity and interoperability between devices with similar functions. This is achieved by electronic transport beyond the access network. The home is connected to outside access networks through one or more home gateways. The gateways are the entry point for electronic services. Inside, a connectivity backbone is installed. The connectivity backbone enables both in-house and external services to be brought to a point of service.

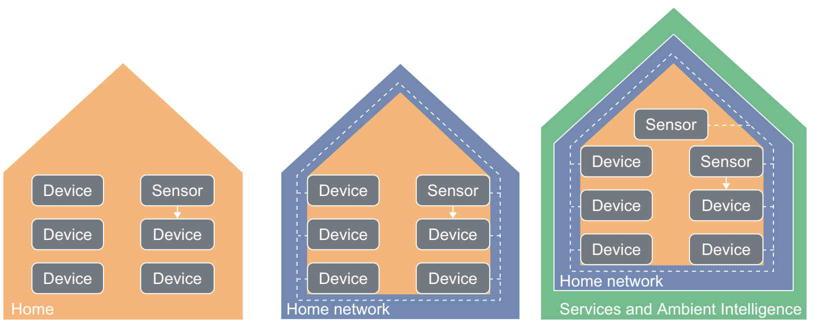


Figure 18: Evolution of the electronic home

The effect of interconnectivity and interoperability is two-fold. First, it drives the definition of standard platforms and transport mechanisms of content and dynamically configured services within the home and also external to the home. Second, a new level of information infrastructure is created beyond the access network, offering interaction between external services and the in-home infrastructure. This infrastructure is fed through a standard gateway platform by one or more services. As such, this new level drives the definition of the middleware architecture in both the gateway(s) and the in-house network.

Of course, the intelligent house is connected to the outside world to offer access to external services and to make people and services inside the home accessible to the outside world. A special situation arises in relation to nomadic people and devices that physically enter or approach the home and connect to the in-home network, or devices inside the home.

In addition to traditional entertainment applications, home management devices, security and other domestic applications will play a role – at first as stand-alone applications, and later by sharing the network and even the devices used for access and control. In the longer term, more 'intelligence' will be added to the sensors and actuators as well as to the overall management and control application, where awareness of the actual situation will become an important aspect. It is along this track that we are moving, as shown in Figure 18 – from an unconnected application, to networked appliances and, finally, to an 'ambient intelligent home'.

Furthermore, the aspects related to the infrastructure will, of course, be a large number of applications and services for the consumer. A lot of them depend on services offered through the external network, and these are to a large extent covered by the Intermediation Services & Infrastructures domain. Others are new applications, e.g. dealing with content creation and management, home security and a lot more, which we can hardly now imagine, and featured in the ambient intelligent home.

2.2.2 Cyber Enterprise

All activities that may be required by a cluster of people or machines which communicate and interact with each other as well as with the outside 'environment', in order to achieve a common goal (technical or economic) and/or perform a task together, independent of the organisational and/or geographical location of these people or machines.

In this definition, a Cyber Enterprise is not restricted to a company with social and legal status. The intention is that a Cyber Enterprise should also involve activities that span across company boundaries (joint ventures, consortia, supply networks, project-specific associations, etc.) as well as activities where various types of entities participate (governments, associations, individuals, etc.)

A Cyber Enterprise may have many different forms of organisation, management, and rules for interaction. Many different choices may be made, according to the goals, duration, nature of the tasks, etc. Furthermore, a Cyber Enterprise may evolve over time in terms of its members, their relationships, its organisation, etc.

Whatever the precise nature of a Cyber Enterprise, it always shares some knowledge and resources. A Cyber Enterprise therefore needs to protect these by appropriate means. Also, in this context, actors can be either people or machines. Machines are entering the scene when considering production/ process control in Cyber Enterprise.

2.2.3 Nomadic

All activities that may be required by nomadic actors/people/agents away from their home or workplace and on the move to exchange information and perform corresponding tasks. It also includes all mobile and transportation applications.

The Nomadic domain focuses on the evolution of information technology for devices, appliances and applications to be employed by on-the-move end-users (or nomads for short). Nomads are the users of portable or mobile equipment. Most often they are people but they could also be moving entities, robots, intelligent cars, goods, etc. The Nomadic domain focuses entirely on the impact of being mobile on the devices, appliances and applications of a nomad.

Given the different aspects which mobility can have, this includes:

- Technologies to support the safe, fast and comfortable **transport** of people and goods from one place to another;
- Technologies to support the **location independence** of people, devices, applications and services, so that they can use the same applications, services and content at any time and any place with the same quality; and
- Technologies to support **permanently moving and interconnected devices**, vehicles and applications, so that they can be used even whilst moving, driving, walking from one place to another and possibly working at the same time.

Major trends in this domain include:

- The borders between private and business roles are disappearing while one is on the move;
- Seamless and wireless access to all networks, ranging from personal area networks (PAN) to corporate networks to public global networks, makes it possible to enjoy the same connection features as in a non-nomadic environment – meaning that you can always be connected;
- Service and applications from the Cyber Enterprise and Home domains are becoming available for nomads, within increasingly shorter time periods;

- The amount and functionality of portable equipment – ranging from smart cards to cellular phones to personal digital assistants – is increasing. At the same time, specialised and general-purpose devices will co-exist;

- Portable devices are partly becoming wearable and are even becoming integrated into clothing;

- The context awareness of devices/ applications is increasing using more sensing functionalities – e.g. switching on a rear light in a dark environment; and automatic, noise-level-based volume control;

- Intelligent assistant systems that integrate information from different sources – such as navigation systems; and x-ray, video and ultrasonic sensors – will provide increased support to drivers; and

- The introduction of new active car-safety systems (e.g. pre-crash sensing, lane-change assistant) will make driving safer.

2.2.4 Intermediation Services & Infrastructures

All kinds of activities that may be required to support the different actors/people/agents who need to access and manage networks and network services (including design, implementation, sales, maintenance and billing services).

This domain is defined as: distributed adaptive services, plus the generic support and framework services used to compose the adaptive services dynamically. In general, the word service has several meanings; two obvious ones are: sellable features offered to other stakeholders, in business-to-consumer (B2C) as well business-to-business (B2B) relationships, by means of a software application/product; and work done for others – e.g. outsourcing activities such as network operation and management or maintenance. We should be aware that the division between application/product and services is often blurring in business models. In this context, however, we concentrate on the first meaning. Specifically, we concentrate on services searching and exchanging digital information; this might be the goal in itself or a means to achieve some other goal (e.g. buying in e-commerce situations or negotiating service level agreements). Even automated decision-support systems – close control systems with a feedback loop (collect, analyse and react) can be considered as intermediation services. Looking in more detail, we see that such services are often dynamically composed of network-based services, which together offer the real application functions to users or stakeholders such as network operators and content information service providers.

Major trends in this domain involve:

- The Internet Protocol (IP), most likely IPv6, will be a common vector in network infrastructure, paving the way for richer, converged services.

- Services will become user-centric, ubiquitous and mobile, context aware and anticipatory. New paradigms will make it possible to provide value-adding content aggregation.

- Ubiquitous networks and mobility will give users and devices access to services at any time and any place. This will require dynamic adaptation to changing network characteristics.

- Improvements in technology such as higher bandwidth, horizontal and vertical handover, location awareness, situational awareness and dynamic configuration will lead to new types of information services. One example: contacting persons wherever they are, on the basis of their preferences and taking into account their situation. For example, when they are in a meeting, they might receive an e-mail with a transcription of a message and in a car they might get a voice call if the traffic situation allows this. Another example is a list of shops or restaurants in response to a query which depends on whether the user is in a car, on a bike or on foot.

- There will be a large variety in terminals and ways of accessing information; this will require the adaptation to terminal characteristics and session mobility.

- Evolution of web-based services from passive access points to information towards active applications with dynamic discovery of supporting or collaborating services.

These Information Services will be constructed by integrating existing subsystems, adding new user interfaces and intelligence to them, and integrating databases and legacy systems. An integration framework will facilitate integration of loosely coupled subsystems and negotiate the services and formats for data exchange. It is expected that the Services will be the profitable market in the future. Basic content and e-commerce services already exist. Combining, enhancing, and connecting these services into intelligent services will add value. The convergence of the Internet with Information Services will become even more important as the Internet converges with the mobile communication networks: every cellular phone or personal digital assistant (PDA) will become an Internet terminal and will give access to any service from any place.

As soon as ubiquitous real broadband (more than 2 Mb/s, wired or wireless) communication facilities become available, new entertainment services will also develop. This will affect traditional broadcasting services by allowing video on demand as well as personalised services. An important issue to be solved in this context however is digital rights management (DRM), which might require new business models for the content owners. This issue needs involvement of content owners, distributors, equipment suppliers and billing services. They will share some of the services with those in use for e-commerce but will of course create new opportunities for service providers with their own needs (e.g. the Web Services infrastructure, Open Services Gateway initiative).

2.2.5 Software & Services Creation

All activities that may be required to help the different actors/people/agents engaged in designing, implementing, verifying, maintaining and modifying software-intensive products, systems or services.

In this domain we deal with the **activities of the engineering process** for software-intensive systems, rather than with the technologies needed to enable a specific feature of the resulting products. As in other industries, IT engineers need and use a huge amount of techniques, notations, methods, tools, processes and knowledge to do their work. And to do their work efficiently, they need the *right* techniques, notations, methods, tools, processes, etc. There is a growing market and industry for the production, sale and distribution of software and system production technologies.

Many companies (but also non-profit organisations and the broad open source community) provide engineers with a huge set of software production tools including compilers, profilers, debuggers, specification tools, code generators, test environments, run-time platforms, versioning tools and bug trackers. These technologies need to evolve over time and cope with the ever-increasing complexity of the systems to be built and the corresponding complexity of the engineering process.

2.3 TECHNOLOGY CLUSTERS

The existing ITEA Roadmap presents two classifications: five Application Domains (covered in Appendices 2 to 6 of the ITEA Technology Roadmap) and four Software Technologies Clusters (covered in Chapters 2 to 5 of the ITEA Technology Roadmap). Together, these cover the field of software-intensive systems as completely as possible, keeping some distance both from specific products – so as to avoid potential conflicts regarding Intellectual Property Rights (IPR) – and also from current trends, such as in architecture or computer languages.

The main Technology Clusters are arranged around four basic questions:

1. *Which end-to-end technologies are required to acquire, process and store content?*

   The **Content** cluster is articulated in three technology categories (see Table 2) and deals with signals, data, information, documents and knowledge from capture to complete processing.

2. *Which technologies are required to transport and distribute content?*

   The **Infrastructures & Basic Services** cluster, articulated in four technology categories, deals with transport mechanisms and protocols, as well as with the management of networks (including security).

3. *Which technologies are required to build effective user-system interfaces?*

   The **Human-System Interaction** cluster contains a single technology category, which deals with the interaction between human beings and the appliances and systems that support the services.

4. *Which technologies are required to engineer software-intensive systems?*

   The **Engineering** cluster involves three technology categories. It explores the complexity of engineering processes and deals with the creation of end-to-end services.

The four technology clusters are summarised in the following sections, first with a brief presentation of the cluster, followed by a table, which briefly recaps the main challenges and some examples in different domains. A final paragraph presents the main conclusions. The detailed discussion on the technologies involved can be found in the Roadmap document.

2.3.1 Content

Content is whatever is exchanged within the environment of the system, or between systems. It is processed, stored, managed and transformed. Content ranges from analogue signals to huge multimedia data depositories.

The volume of digital content is growing rapidly, entering the era of high-quality, high-definition multimedia streams – the most challenging and resource-demanding kind of content. There are two reasons for this explosion of content: first, the infrastructure for capturing content is spreading; and second, storage is available at very low cost, while accessible bandwidth is continuously increasing.

Content is not only data but also applications and algorithms, both on- and off-line. In general, it can be considered at different levels of abstraction: signal, data, information and knowledge. While these terms appear similar at first glance, from a user's perspective they are very different:

- **Signals** are considered to be raw recordings of a physical nature – observation of physical events, analogue voice, depending on time or space, satellite images, etc.;

Personal healthcare case for Content:

Patient monitoring and eventually even treatment based on collecting sensor data within and on a patient's body (using an on-body sensor network and collection device) as well as the from the environment (using a home network or direct connection with the collection device) will require that raw data might be processed on the collection device, resulting in feedback through actuators, audio or visible indicators, or sent to other systems for further processing and storage. In case of sensors in the environment, the dynamic joining and leaving of sensors is important.

- **Data** is a raw representation in binary format – bytes that make up a data item with a very low information value to end-users, unless they possess a suitable decoding device;

- **Information** is a representation of content that can be understood by a user – a table of contents in a document that makes it possible to navigate a document;

- **Knowledge** is information that is of interest to users – has added value over information, although it is normally represented in the same way.

Content should be easily accessible and needs to be managed with sophisticated technologies (e.g. efficient searching and consistency management) in distributed and heterogeneous environments. This needs intelligent indexing techniques based on metadata (e.g. MPEG-7). One important aspect is the analysis of all kind of data together with their generation context, usage environment and ownership. Content without context or metadata is of little or no use, especially if sustainable content management is the aim. Examples are: detection and tracking of moving objects in video surveillance systems, automated indexing and classification of audio streams.

Automotive case for Content:

The concept of dynamic navigation and guidance is based on timely and accurate traffic information (e.g. actual travel times) between two road network nodes. This information must be available not only for motorways and interurban connections but also for metropolitan inner-city areas to allow balanced traffic also on the metropolitan road network. The integration of information from all other traffic participants (e.g. cars and pedestrians around) and all traffic operators (public passenger transport, railway, airline, …) will make inter-modal navigation and guidance possible. Also, more individual preferences will be supported, such as interesting routes with additional information about special places (POI) or routes which avoid dangerous areas.

Navigation and guidance systems for pedestrians will enhance inter-modal navigation and guidance, and can also be used inside large buildings – airports, railway stations, subways and even warehouses and congress centres. These systems need an enhanced positioning infrastructure and portable appliances with new positioning and connectivity features. They will support pre-trip planning, on-trip guidance and post-trip accounting – including an enhanced digital log book with links to other data, such as photographs taken by a digital camera or the hotel bill.

The key to coping with this challenge lies with context awareness and metadata, which guide the user through the massive amount of content that can be exploited by semi-automatic reasoning on a formally defined semantic basis through a semantic web and ontologies. Semantic Web is an approach to enhance Web properties to be automatically processed by software systems. The Semantic Web takes current Web infrastructure (XML, URIs, HTTP) providing a standardised representation for data (XML/RDF – Resource Description Framework) and conceptual structures (RDF Schema, Web Ontology Language). There is a clear future synergy between Web Services and Content as Web content will be processed by Web Services that will also be Web resources.

Another major challenge – one that will become increasingly important in the years ahead – is the security of content (i.e. ensuring that data is received only by those authorised to receive it) and also its trustworthiness (i.e. ensuring that people receive the correct data). Critical in this area will be ease of use and acceptance of the technologies by end-users.

Content is distributed over various media and shared between highly interactive users as well as those who communicate in communities. This includes small devices

Content categories	Category definition	Major challenges
Content Acquisition & Processing	Technologies that are relevant to acquiring, transforming and modifying content, and more generally which generate knowledge from data.	Digital sensory system; capturing and managing contexts; efficient analysis of data; integration of information.
Content Representation	Technologies for representing and structuring data while at the same time making the most appropriate and efficient use of resources.	Generic structuring of data; integrated multimedia streams; distinction between content and presentation of data; semantic data; semantic classification of content; virtual representation of real-world items; virtual/ augmented reality; cyber representation of active entities; standardisation (institutional or *de facto*).
Data & Content Management	Technologies for managing and retrieving content while ensuring data integrity in dispersed and heterogeneous environments. Technologies for dynamically aggregating data from multiple heterogeneous databases into one database model.	Guaranteeing the integrity of data, intellectual property management and protection; certification of content; offering unique virtual identity capabilities and management of the context; personal or professional content management and intelligent search; role-based access to subsets of data.

Table 2:

Major challenges for Content technologies

connected only part-time to a network (such as PDAs today), fully networked computing devices and digital entertainment devices. By coupling the infrastructures involved using intelligent mechanisms, it will then also be possible to include all kinds of digital data. In addition to person/machine centric communication, there will be the concept of communication communities, where communities can be any static or dynamic multi-person/ machines group – households, extended families, members of what ever organisational entity, people watching the same programme, or those with another common interest. In such situations, content will become accessible within the overall communities but also remain consistent with any concurrent accesses that may be occurring.

Moreover, having more and more data and information in a digital format allows not only for easier storage, but also for advanced manipulation, analysis and automated feedback. This creates opportunities for new applications and services, especially when combined with advances in network technology.

One important issue is converting raw data into information and making it available to a variety of applications and services by aggregation or integration from different sources.

Three technology categories with specific related challenges and technologies can be identified (see table 2)[40].

Conclusion

Content is important in the digital world. However, one could ask if it is king or only a subject. Owners of commercial content will claim that content is king and that the role of networks is centred on secure electronic commerce and delivery of digital content. Another view is that digital content is the object for all kind of services and has to be transported from a content distributor to a user. Only part of this content is commercial content.

Content has a strong relationship to business models. Therefore changing and possibly completely new business models will inevitably influence content delivery technologies.

[40] For details, see ITEA Technology Roadmap for Software-Intensive Systems, 2nd edition, May 2004, Chapter 2.

2.3.2 Infrastructures & Basic Services (IBS)

A solid trusted networking and computing structure is essential for providing ubiquitous services. Such an infrastructure consists of protocols, transport mechanisms and basic services. The network needs to be managed – either in a traditional way or self-managed, for example through *ad-hoc* networks – and maintained, and network services middleware should make it transparent to the applications that are deployed.

To achieve this, all kinds of resources such as processors, bandwidth, display, time, energy, memory and storage, network resources (routers, proxies, etc.) need to be managed as well. The network infrastructure is moving on from its role as mere infrastructure to one that of provides network services, i.e. middleware that delivers virtualisation to networked, distributed applications such as accounting, storage and profiling.

One important set of services involves security, property management and privacy issues. These play a role in several places in the digital world, such as secure transport, authorised access and conditional access.

There are a number of issues related to the use of technology for 'shared' services – e.g. quality of life and publicly used infrastructures. These touch on technological challenges such as:

- Collection of large amounts of data – e.g. home-based health services with information distributed to doctors and pollution control;
- Large-scale distributed modelling – such as those requested by e.g. complex sensor fusion or weather models;
- Large-scale computations; and
- Context awareness.

Table 3 shows the four identified technology categories with specific related challenges and technologies.

IBS categories	Category definition	Major challenges
Network Transport	Technologies carrying digital data from one place to another.	Heterogeneous network interoperability; increased bandwidth, range and mobility support; Internet Protocol in any device; optimised streaming and broadcasting; fully distributed environments.
Network Services	Technologies for managing the dynamically changing network infrastructure for roaming users and services. Including publishing discovery and dynamic binding of services.	Ambient intelligence; seamless distributed networking capabilities; service coordination; identity management and profiling network services; web services architecture from large distributed information systems to integration into devices; support for accountable events.
Resource Management	Implementation technologies that take account of resource constraints (physical, computing, time, spatial, radio frequency).	Small lightweight devices with long-lasting energy source; optimising between conflicting goals; dynamic management.
Trustworthy (including Security)	Technologies that provide characteristics such as reliability, safety, security, autonomy, availability and privacy to individual services as well as the overall integrated system.	Creating secure network transport and access services, protecting privacy, protecting content and recognition of ownership of Intellectual Property. Creating easy, reliable and safe personal identification. Creating automatic re-configurable, self-manageable or self healing systems.

Table 3: Major challenges for Infrastructures & Basic Services technologies

Network technology is expected to evolve rapidly. Such technology will be necessary to provide ambient intelligence, combined with capabilities for seamless distributed interoperable networking. The way towards ubiquitous access and self-organising networks will be paved by wireless networks, increased bandwidth and reliable quality-of-service (QoS) Internet Protocol that will be used by web services and peer-to-peer (P2P) protocols, service co-ordination, identity management and profiling services.

Personal healthcare case for IBS:

Patient monitoring and eventually even treatment based on collecting sensor data within and on a patient's body as well as from the environment will require trustworthy operation from sensors and actuators connected by a sensor network to a processing and networking resource. The data might be processed locally and presented by the patient station or forwarded to a remote service of a medical care provider. Guaranteed secure access and transportation is needed, privacy across the full end-to-end system should be ensured, and the reliability of the overall system should be high. Resource management and QoS is important with respect to shared resources such processors and network connections. Tracking of all events is needed for traceability in case of liability.

As an example, distributed platforms may use devices as supporting resources for web services that exchange real-time and reliable information through P2P protocols above IP layers. Automatic aggregation and integration of services and resources will provide a dynamic self-organising application.

The Industrial case for IBS:

'Distributed Control' is a major breakthrough in industrial applications, meaning that there is a rapid move from centralised intelligence towards intelligence distributed in devices – such as low cost sensors and actuators.

To make achievable, Internet Protocol in any device – including the cheapest ones – will become a reality, providing the required device embedded service capability. Moreover, corresponding network exchanges are moving from synchronous periodic exchanges between clients and servers to asynchronous event driven exchanges between peer devices.

QoS, safety, security and reliability are major concerns that must be taken into account when designing the IBS required for the Industrial world.

A major breakthrough in this domain will be the integration of Web Services technology at the device level.

However, if an appliance, device or system is able to function optimally, constrained resources such as memory and storage, bandwidth, display size, time, power and network resources will have to be properly managed. Terminal power management is critical to this. To share resources across organisations, complex distributed architectures will use new technologies such as grid technology. For critical applications, dynamic resource management is becoming more and more important – e.g. for self-healing or self-protecting.

In the background, the key challenge for security will be to get users to trust systems, giving them the assurance that 'they are in control'. This is a major technical challenge, however, as the systems in use will become larger, more networked and more dynamic – whereby users may find them less predictable. To address this concern, security will become pervasive, and it will be handled at all stages of the software life cycle.

2.3.3 Human-System Interaction

Technological advances in software-intensive systems can provide more functionality to end-users and, at the same time, lower prices make them available for more people. However interaction between people and systems, and their supporting devices have become quite complex – making acceptance of new systems a real challenge for both the new potential users and existing ones.

One consequence of the increasing functionality in devices is that they are increasingly able to replace each other: it is possible to take pictures with film and digital cameras, but also with mobile phones, PDAs and PCs (using a web camera). However, the consumer will only select a converged device if its ease of use is at the same level as that of the single-purpose device – the device that can only take pictures, play music or tell time. The extra functionality in the multi-device only benefits the user if the user interface makes all the functionality easily available.

Interestingly, the ultimate multi-purpose information technology device – the personal computer – is increasingly seen as overkill for many purposes. Sharing images, playing music from the Internet or finding locations based on a street address are now possible without a PC, using reasonably priced devices. The popularity of these devices – DVD players, media servers and GPS with maps – indicates the appeal of simple, single-purpose devices, even when one PC could replace several single-purpose devices.

One user interface challenge is that the new devices need to interact with other services over a network. Some single-vendor solutions have been very successful in providing a unified user experience that combines local and remote services. Obviously, having a single company provide all the pieces in an end-to-end solution is not always the best solution. Therefore, a new challenge will be to create the same level of integration and user satisfaction in a multi-company system.

Finally, related to the new user groups in new growth markets, many software-intensive systems are undergoing a shift from the technology-savvy early adopter markets to mainstream. This means increasing cost competition and also a clientele that understands well what they require from the system. The early adopters like to have as many features as possible and are willing to spend the effort to learn to use them. The mainstream users are unwilling to pay for features that they do not understand or cannot use.

Challenges

User interfaces need to support multilingual versions in distributed, collaborative, multi-cultural and multi-user environments, and must allow simple and quick authoring, navigation and access to multimedia data. Particularly important are multimodal (referring to modalities such as sound and vision), adaptive, personalised and scaleable user interfaces. New appliances, for example in intelligent Home and Nomadic devices and those used in industrial applications and systems – process control, air traffic control, medical systems, etc. – require multimodal interaction. In recent years, the games industry has been particularly influential. Heavy competition and the demand for ever better versions in very short cycles have significantly fostered the development of Human-System Interaction (HSI), which comprises technologies that handle interaction with the user.

Even as people become increasingly familiar with complex systems, spending time coping with complexity is becoming less acceptable. HSIs should therefore hide underlying complexities from users and provide the best possible user experience, so that the user feels in control. A specific challenge here is to select appropriate modalities intelligently and provide ‘zero configurability’ within multidimensional environments consisting of different networks and access technologies, devices, people and services. In addition, future user interfaces need to be able to learn user preferences and store, manage and spread this information to relevant related services and devices. This needs to be secure and protect the user’s privacy. However, acceptance of new HSIs that replace familiar, although complex, ones will take time unless the new HSIs can support accepted modes of interaction naturally.

The main challenges in realising future HSIs include creating ‘simple, self-explanatory and easy-to-use multimodal HSIs’, ‘intelligent context-aware and adaptive HSIs’ and ‘seamless and interoperable HSIs’. To meet these challenges, the user interface and interaction technologies cannot remain isolated, but must be tightly linked to the underlying technologies and platforms through common application programming interfaces (APIs). The user-driven approach needed in designing new HSIs poses new demands for the whole software and systems design and engineering process.

Summary and conclusions

In recent years, the various technologies have probably been overemphasised. For those who use them, it is the entire user experience that determines whether the new technologies provide real added value or not. It should also be noted that the added value usually comes indirectly through the services and applications that intelligently apply the new technologies – not from the technologies as such.

Therefore, in order to be able to fulfil users' needs and meet general requirements for future systems, the R&D in underlying technologies and platforms should be carried out in close co-operation with the R&D in user interface and interaction technologies, and vice versa. Moreover, other disciplines outside of the area of software systems also need to be involved in the process so that software engineers can better understand user requirements, transfer them into software systems and improve the acceptability of outcomes; this includes, among others, behavioural science specialists and physiologists.

In short, the target for the new HSIs is that they should be:

- Simple, self-explaining and easy to use;
- Intelligent, context-aware and adaptive; and
- Seamless and interoperable.

The whole process should largely be user-driven, which also poses new demands for software and systems design and engineering.

2.3.4 Engineering

The trend that more and more products and systems are based on programmable processors is far from ended. Even today, less than 10% of the programmable processors produced are built into computers, which are also the base for a lot of services. Most of them can be found in systems such as cars, phones, washing machines, aircraft, cash dispensers, robots, traffic systems, cameras and audio/video equipment and also in all kind of infrastructures such as communication networks, broadcasting equipment, traffic control systems, building control and security systems. And this trend towards programmable systems is still accelerating. Software not only increases the variability, configurability, extendibility and changeability of everyday systems, it will also soon allow for a greater variety of functions based on the advanced information processing capabilities – more and faster processors, larger memories, cheaper storage, improved connectivity in-home and wide area – built into these systems. Future systems will be further dominated by software, since more and more functions will be implemented in software. The amount of software in those products and systems is increasing. For a number of products, there is also enormous price erosion, reduction of profit margins and shorter product lifecycles. This calls for a new approach to implement the software. As a consequence, the engineering and maintenance process of software-intensive systems is undergoing dramatic changes because software is becoming not only a major part of the product – with respect to development time and costs, including licences – but also the critical path of the system engineering process.

Embedding software into systems increases the complexity of these systems as well as the complexity of the engineering process. Complexity becomes apparent whenever it becomes difficult to comprehend and manage all the aspects, requirements, consequences, interrelationships and relations associated with a specific product and the product creation process. It emerges from the combination of architecture decisions, restrictions on existing physical resources, integration of legacy functionality, required non-functional properties and the use of heterogeneous technologies. In general, complexity increases the effort needed to develop products, services or infrastructure, and increases the already high tension between time-to-market and general development cost on the one hand and the quality and adequacy of the product on the other. As you can imagine the quality requirements, including the issues related to reliability, availability, safety, etc, differ between applications and this has its impact on software as well. The effective engineering of efficient, reliable and safe systems is essential and needs support

The case of using COTS, open source or internally developed components:

Integrating existing components (either COTS, open source or internally developed) will play a major role in the development of future software-intensive systems. This might be a full operating system such as CE-Linux, middleware for a specific application domain, drivers or application components. In all cases, this needs special attention with respect to: source or object code management of all components involved, tracking what is part of the generated system, certification or testing of the individual components, regression testing of individual components and the full system, and validating and verifying the full system. Tools to automate these processes are needed. In the case of embedded software, this might also include the development environment and maintaining this environment for the specific target system and a connection to the target system for upgrading the code in the target, which might be in flash memory. If it is expected that upgrades can be carried out at the user site, a supporting environment is required as well to allow this to be carried out safely – with possible roll back and keeping the user context, such as files and configuration settings.

from appropriate technologies, such as methodologies, notation languages, design and implementation techniques, generation techniques, tools, knowledge, processes, guidelines and maintenance support. An important aspect in this the process is the need to develop the right system for the users using an approach called 'user centric design', based on extensive investigation of the needs of all stakeholders involved in the system.

The automotive, aerospace or industrial case:

The so-called '-ilities' (safety, reliability, etc.) will vary from domain to domain. For instance: the requirements for safety and reliability for automotive applications are a lot higher than for consumer electronics applications. One should be able to specify and verify these particular constraints. Languages and tools to make it possible should be available, together with process support environments to enforce the use of these tools in a proper way.

Particular emphasis has to be put on the non-functional or quality aspects, the so-called '-ilities', such as usability, reliability (resource management and performance), availability, portability, modularity, evolve-ability, scalability, flexibility, personality, security and maintainability of software-intensive embedded systems. The requirements for these '-ilities' vary between domains – e.g. entertainment, automotive, medical or aerospace. To cope with these '-ilities', new approaches are required to support large-scale distributed systems engineering, involving expertise from a broad range of disciplines. Real-time specifications are particularly important in designing applications to address quality-of-service issues and constructing high availability or fault-tolerant systems.

But it is not just technological challenges that we should be expecting. To a large extent, success will also depend on other factors, such as appropriate business models (e.g. for components), the way we deal with intellectual property for software, and they way in which the growing open source development scene influences the engineering of systems. To take just one example, the move to component-based systems will impact the business model of industrial organisations as well as software technology and tool vendors. Business models for software components may range through 'free' software and open source models, to licensing components and pay-per-use. It is not inconceivable that standard components – especially with respect to platform and frameworks – may emerge from open source development. Probably the timing is highly dependent on the domain and the number of interested people outside. Integrating existing components – either commercial off-the-shelf (COTS), open source, or internally developed – will play a major role in the development of future SiS.

From a process perspective, the design, development and maintenance of complex systems implies a growing complexity of the corresponding product development (engineering) process. The rising amount of engineering artefacts, the number of design and development steps, and the relation between the artefacts in the different steps needs to be managed in a consistent way. The whole process from requirements capturing to system validation and verification after implementation should be covered and supported. This includes support for multiple cycles of the development, maintenance and evolution process of systems. In addition, the engineering process may require many engineers in, potentially, many teams to work on different aspects of the product at the same time. A common understanding of the domain is essential. Teams become distributed across multiple sites, hence support for the collaboration of physically distributed teams located in different sites, organisations, cities, countries or continents is needed. The problems related to distributed organisations require specific attention with respect to project and data management.

Future impacts and challenges in the engineering of software-intensive systems can be looked at from the point of view of three different categories (see Table 4).

Conclusions
A number of important challenges have been mentioned to increase the efficiency, effectiveness and quality of systems and software. The emphasis is to a large extent on methodologies and less on specific tools.

This might need some explanation. Tools can be categorised as follows:
- Data and process modelling and coding;
- Supporting processes and integration of proprietary, COTS and open source components (some kind of software eco-system); and
- Verification and validation tools

With respect to the first category, we should consider that the market is rather small and only development of tools targeted for specific domains with a well defined and addressable market will be valuable. From the other two, the verification and validation tools seem to be the most urgent with respect to quality, the process and integration tools are important with respect to efficiency. Developing methodologies that build know-how – supported open source tools – and ways to transfer knowledge to small and medium-sized enterprises (SMEs) and consulting companies results in secondary benefits larger than the commercial impact by selling tools.

Table 4:
Major challenges for
Engineering technologies

Engineering categories	Category definition	Major challenges
Systems Engineering	Techniques, methodologies and tools for the design and construction of systems under constraints (time-to-market, technological, legal, economic and legacy).	Evolutionary systems; product line engineering; automation in verification and validation; systems architecture trade-off analysis; hardware/software co-design.
Software Engineering	Techniques, methodologies and tools for the design and construction of architectures and adaptive technologies for implementation, deployment, execution, exploitation and maintenance of software systems. Product family approaches; platforms and frameworks allowing integration of proprietary, COTS and open source components.	Re-use support; certification of COTS and open source components; component markets and software suppliers; crosscutting concern engineering; design pattern support; model-based development; self-organising software agents; user-centred design approaches.
Engineering Process Support	Methodologies, techniques and tools that support an engineering and distributed engineering process.	Integration and interoperation of engineering tools; distributed and collaborative engineering; configurable methodologies and process standards; requirements-driven process management; knowledge-based engineering; distributed engineering with configuration management and process support across the whole process.

2.4 SYSTEM CHARACTERISTICS

Rather than facing technology challenges in one cluster dimension only, the systems to be built will have to take into account, more than ever, constraints resulting from a combination of various dimensions. Having evoked these dimensions, some consequences in terms of business model or industrial co-operation are drawn. Then, whatever the application domain, the various future system properties will have to be verified in order to consolidate their acceptance are listed.

2.4.1 System complexity

Systems providing 'ambient intelligence'-like solutions are characterised by ubiquitous communications and intelligence distributed in the objects that surround us.The embedded intelligence entails software everywhere (distributed) and means that processors will not be visible as such (embedded). Providing the intelligence required for usability when the possibilities are many entails a significant amount of critical software.

In addition to this we are also experiencing convergence between:

- Devices able to cope with different content formats;
- Devices able to use different physical media;
- Applications from different domains on a single device or shared among a set of devices; and
- Sharing the same basic protocols (e.g. Internet protocols).

In a context of global connectivity, *real-time co-operation between basic computing entities (BCE) define the system to be build. These can be described physically (in terms of its parts) or through its functionality with respect to the user, environment and other systems*.

A physical description is suitable when the parts are well known. A functional description helps in understanding the mission of the system.

In the context of this document, complex systems are entities aligned with the vision above; those with a primary[41] nature of being real-time and/or distributed and/or embedded. They can be defined within space constraints such as aircraft or cars, more geographically distributed – smart infrastructures for optimised use and distribution of energy – or ubiquitously accessible, implemented as a dynamically configurable set of distributed services.

Complex system can be defined in terms of BCE or more elementary systems. It is also frequently possible to define higher-level system when everything is interconnected – e.g.: for a remote maintenance and diagnosis system for vehicles, these are sub-systems. Complex systems are not necessarily hierarchical. A system or a BCE can be part of multiple systems and, when the level of distribution and intelligence increases, it can contribute to build systems that are created and deleted dynamically on demand.

Figure 19 represents three major trends of systems as complexity dimensions:

- Functional and non-functional qualities;
- Distribution and aggregation; and
- Contents.

This space can be used for positioning the relative complexity of systems which will be build. As examples, 'Web services'- or 'Web semantics'-like applications combine the three dimensions but this can be also the case for specific sensor networks or video content analysis and networked delivery architectures.

To hide the increasing complexity and make it manageable by humans/machines (both developers and users), two enveloping dimensions of this space that need to be addressed are also represented:

- System engineering; and
- Human-system interaction.

[41] They can place some responsibility in non-embedded real-time systems as this is a long-term vision with different evolving stages that may depend on the domain.

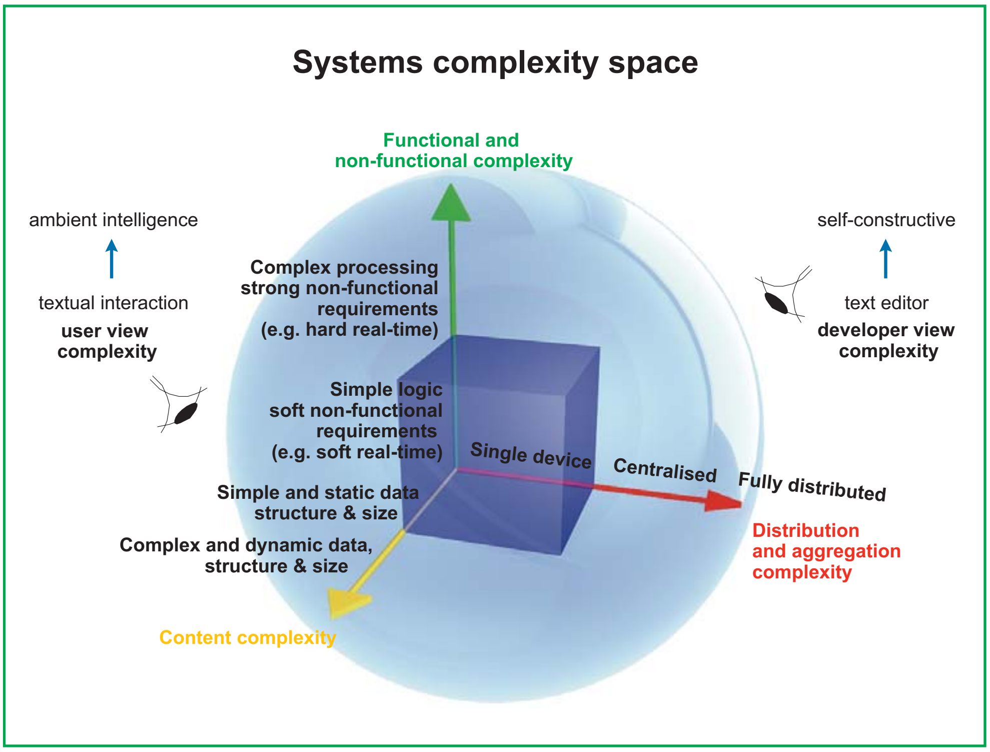


Figure 19:
Major trends of systems as complexity dimensions

These also have complexity levels before reaching the long-term convergence; self-constructing ambient-intelligence solutions.

When both the distribution and the functionality increase, the conventional product becomes more diffuse as co-operating BCE and/or systems provide the functionality. Therefore, the value to the user (human/machine) will derive from this co-operation rather than from the stand-alone product. The trend will push the market towards selling more and more services, decoupled from the product sales.

In an industrial context, the business perspective for defining the scope of a system or a solution is particularly relevant. Systems can be defined in terms of what is sold (a product or a service). Business models and the allocation of roles to stakeholders within the value chain will have a major influence on the co-operative approach between systems. Charging models, reduced time-to-market provided by the independence between products and services, will have a major impact on the adoption by consumers.

Due to the expected networking and dynamic aggregation of systems – in which systems will be part as never before – industrial co-operation is a must for building the new space.

The global competitiveness of a technology community will depend on synergies and interoperability across the system full lifecycle – vision, design, development, operation and maintenance. The open source model can provide this type of mutualisation.

2.4.2 Key success factors

Bearing in mind that the market success of a system cannot obviously rely only on technological 'exploits', and looking back at all domains covered by the ITEA 2 programme, the work plan will enforce four basic features to be involved in future systems as compared with their present status:

1. They will be dynamic evolutionary systems: solutions and systems proposed to the market must be able to be improved from time to time to compete and to serve better the customer in a short feedback loop;

2. They will exhibit adaptive and anticipatory behaviour: persons or agents are no longer passive but will interact with each other in respect of local regulation and human behaviour;

3. They will process knowledge and not only data, as an upper layer of abstraction, including an holistic approach, semantic and ontology processes; and

4. They will allow the user to stay in control, a major issue since most of the embedded intensive software systems are time and safety critical.

The keys for development and deployment of these systems are of two kinds:

- Key drivers for acceptance are:
  - Interoperability of products, systems and applications, showing once more the importance of middleware specification; and
  - '-ilities': security, usability, testability, reliability, safety, etc. – all have to be taken into account even at the very beginning of the launch of product and services.

- Key issues for implementation are:
  - Technical: mastering of size, complexity, adaptability, etc. with their direct consequences on testability and certification; and
  - Economic: middleware business models must be better understood to keep cost under control, in particular the open source model.

The overarching issue for the future of software-intensive systems for the ITEA 2 work plan Phase 1 is '*Design for Change (DFC)*' with new constraints on systems that must be 'always on' but with severe energy constraints. The systems should remain 'on' even though continuous modification of technologies or services as well as of terminals or use must be implemented without noticeable interruption. These features will impact on openness of middleware, meaning large efforts on standardisation but keeping the cost of development, time-to-market and market size under control to stay alive in worldwide competition.

2.5 CONCLUSION

The first phase of the ITEA 2 work plan results from a sound and proven methodology which led to the establishment of the 2004 roadmap, which will be followed by the 2007 roadmap. In the 2004 roadmap, five application domains have been identified that cover future products and services markets, and help to focus and prioritise technology developments. These domains characterise future key uses of information technology at home, in the professional environment or in between – i.e. nomadic uses. Moreover two additional domains are respectively devoted to the basic infrastructures, which will enable the previously mentioned uses, as well as the engineering process, which will lead to the construction of software systems and services delivering the actual desired uses.

The technologies necessary to implement the corresponding solutions are grouped into four clusters. In each cluster, experts have identified fundamental challenges that have to be met in order to progress, in particular, towards so-called innovative ambient intelligence solutions relying on quality software and human interactions being accepted by the many.

In addition to these technology clusters and application domains, specific attention will be given, in the forecasting or project selection processes of ITEA, to anticipate the maturity of emerging application area and related technologies.

Better than facing technology challenges in one cluster dimension only, the systems to be built will have to take into account, more than ever, constraints coming from the combination of at least three dimensions and leading to their intrinsic complexity: the functional, but also the non-functional characteristics of the systems components, the distribution/aggregation of these components over various types and various scales of communication infrastructures as well as the distribution/aggregation of information/knowledge and finally the complexity of the representation of the information itself. Moreover, strong general considerations such as the evolutionary aspect of future systems, their 'always on' capability and their auto adaptive property are key to their acceptance by the market. These critical considerations will therefore be part of the work plan.

ITEA has put Europe back on the map in the emerging embedded intelligence revolution. Meeting the various technical challenges of the ITEA 2 work plan in the context of solutions (products and services) bringing significant value to the user in the different application domains described, will certainly ensure European leadership in this new era of embedded Software-intensive Systems, building on key European strengths and industries.

Annexes

A.0 ITEA 2 DEFINITION PROCESS

Figure A.0 documents the various parallel processes launched to ensure proper timing and synchronisation, consistency and consolidation:

- The Project Team mainly focused on producing the Blue Book but also supported the study by commenting on its status report as well as liaising between TNO, IDATE and the ITEA founding companies;
- The results of the study will provide software-intensive-specific figures that serve as a foundation to the rationale of the programme;
- The workshop with young software engineers focused mainly on their views, perspectives and inputs, in particular in connection with the ITEA Roadmap for establishing the work plan of the first phase (Part 2);
- The overall schedule of these three main activities enabled proper monitoring and control by the various ITEA bodies (e.g. BSG and Board) and for presentation to, and feedback from, the Public Authorities and other stakeholders.

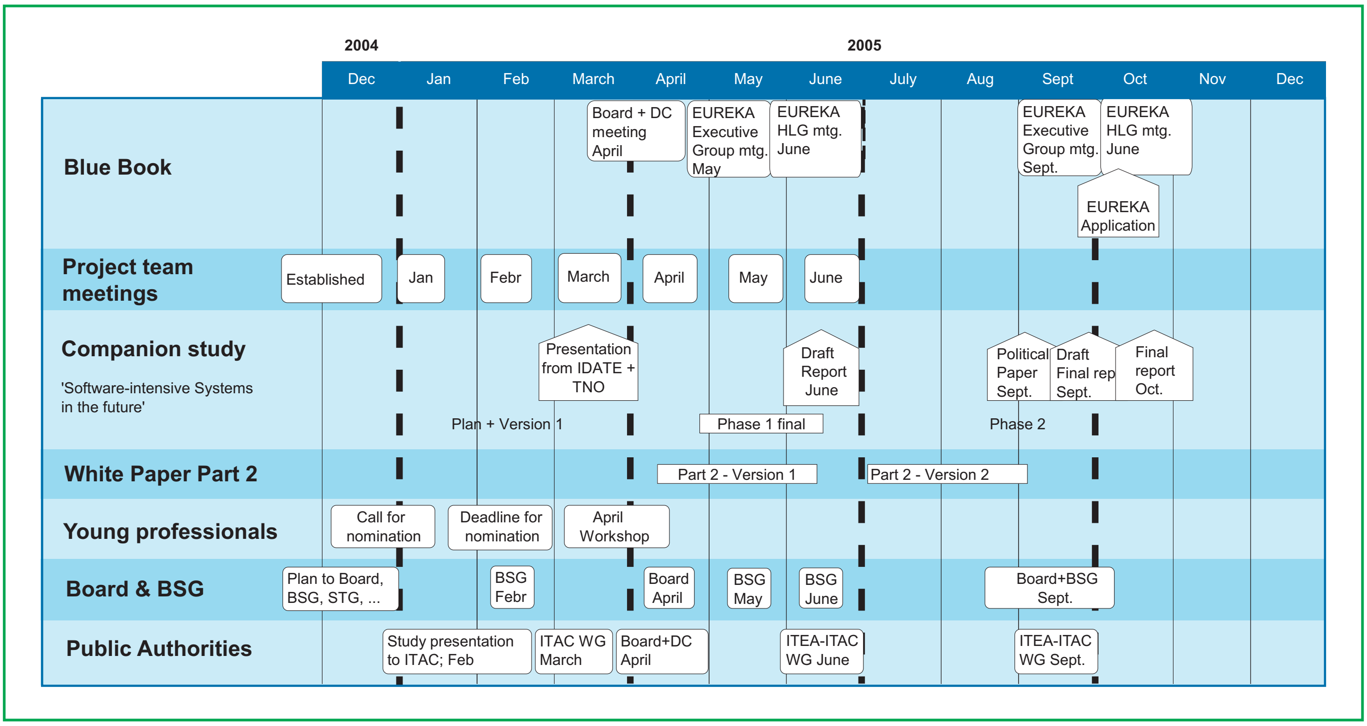


Figure A.0-1: The ITEA 2 definition process

A.1 STUDY 'SOFTWARE-INTENSIVE SYSTEMS IN THE FUTURE'

IDATE/TNO - *Executive Summary*

The goal of the ITEA programme (a EUREKA cluster), is to develop pre-competitive cooperation and create synergies between SiS (Software-intensive Systems) players in Europe. Today, ITEA is the leading trans-national co-operative R&D programme in Europe.

Public Authorities from France and the Netherlands as well as the ITEA Office commissioned two independent consulting companies to conduct the study: TNO and IDATE. It first analyses the methods to define and measure software intensity. Then, based on an in-depth study of key industrial sectors, it provides software intensity estimates for 2002[43] and its potential evolution through 2015. It finally addresses the likely impacts of SiS on the overall activity (growth, employment) as well as on some major societal trends.

A.1.1 Presentation and context of the study

A.1.1.1 Software-intensive Systems

'A Software-intensive System is a system in which software represents a significant segment in one or more of the following areas: system development cost, system development risk, system functionality, or development time.' (Carnegie Mellon Software Engineering Institute [4]). SiS examples include: aircrafts, digital TV processing engines, smartphones, RFID tags, diagnostic systems, ...

A.1.1.2 The importance of software development inside and outside of the ICT sector

The common knowledge behind the ICT (information and communication technologies) sector definition is that it is producing ICT goods (including software, computers, telecom equipment, IT and telecom services) and selling them, and that all other sectors are end-users. Software is in that sense considered as 'producer good' – i.e. packaged software developed and marketed as a discrete product.

However, the SiS domain is not covered by the ICT definition, which only takes into account the traditional primary software industry. Software is also developed outside the primary software industry and can be sold as a product, used internally for improving productivity in all areas of the supply chain or included in products, services and applications. Considering the panel of participants from various ITEA projects, it is obvious that **the main contributors to software development are much broader than those from the software market**.

A main goal of this study is to investigate the internal development of software, in both ICT and non-ICT sectors, and, more precisely, to analyse the current and future importance of software development for the entire European industry. Six key industrial sectors have been selected: **automotive, aerospace, medical equipment & automation (non-ICT sectors) and telecom equipment & consumer electronics (ICT sectors)**. In Europe, they represent in terms of value added 16.2% of the total European manufacturing industry, which includes many other sectors such as food products, wood, chemicals and pharmaceutical. Figure A.1-1 resumes for EU-15 the respective values of total GDP, total manufacturing value added and value added of the 6 considered sectors.

[42] 2002 has been selected as it is the most recent year for which consistent worldwide industry figures exist.

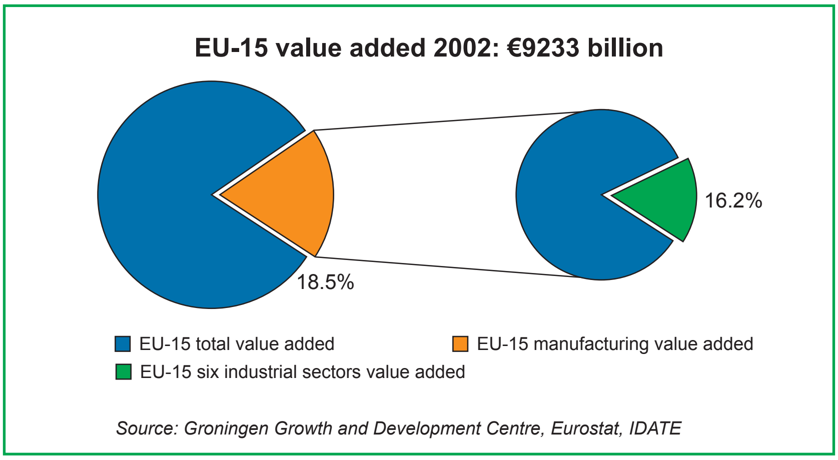


Figure A.1-1: EU-15 total GDP, total manufacturing value added, and the selected industrial sectors

This study addresses only the six sectors mentioned above but we may expect that similar results could be obtained for several other sectors. One basis for this hypothesis is the ranking of industries according to their share of broadly defined ICT-skilled employment, published by OECD[43] in 2005. We expect that ICT skills imply in many cases a significant level of software skills. Automotive ranks relatively low with 21%, but there are a large number of sectors above 20%, such as manufacture of coke, refined petroleum and nuclear fuel, manufacture of chemicals and chemical products, collection and distribution of water, publishing, manufacture of equipment and others.

A.1.1.3 Lack of internal software development data

There is no existing measurement for the internal software development, whether from industry or from SNA (Systems of National Accounts). One of the reasons is that software has very specific features. Not including packaged software sold on the market, software is an intermediary, almost invisible product. To the best of our knowledge, this is the first study which has developed estimates for what we call software intensity in the selected industrial sectors.

A.1.1.4 Methodology

We concentrated on 6 sectors[44], and measured software intensity by estimating software R&D expenses. These data are put in perspective with value added and turnover for each sector. These estimates have been developed using both OECD and industry data. **All data are worldwide, unless otherwise indicated**. We used value added data in order to avoid double counting when dealing with OEM and one or several levels of suppliers.

Estimates have been developed during a first phase from desk-based research (OECD data, industry data, public reports, official statistics, TNO and IDATE databases, ...). Reference studies were used when available. The gathering of data per sector was supported by the development of an expertise in each sector, taking into account its main characteristics (value chain, industry structure, trends, etc...). Forecasts for 2015 have been developed for each sector, with a focus on software development. Growth forecasts by sector are based on past evolution and on industry expectations when available.

In a second phase, estimates were consolidated through more than 30 interviews, including several European industry leaders for each industrial sector. The total revenues of the companies interviewed represent more than one fourth of the total revenues of the six sectors worldwide and more than 30% in Europe. People interviewed are mostly directors of R&D and of software development teams, but also industry experts, industrial associations as well as statisticians from OECD. All estimates the sole responsibility of the authors of this report. Detailed and complete computational methods are available in the full report.

The methodology is appropriate when dealing with software in total value, but interpreting results requires some caution, most notably with software spending in percentage of value added. If the

[43] New perspectives on ICT skills and employment 22/4/2005.

[44] Sector definition was based on the international ISIC classification (including both OEM and relevant suppliers).

software has been internally developed, the duplication cost is almost nil. If the software has been bought, there will probably be a licence cost per unit (with a decreasing price for large quantities), unless the software is some kind of open source software. Maintenance costs are almost nil for consumer products such as mobile phone, whereas they may be very significant for the B2B market.

A.1.2 The 2002 situation: already a high level of software R&D effort

Key findings of the study stress the critical impacts of software on European industry competitiveness in industrial and manufacturing sectors, which are not considered as primary ‘software sectors’.

2002	R&D expenses (Billion Euro)	Software R&D expenses (% of total R&D expenses)	Software R&D expenses (Billion Euro)	WW market size (Billion Euro)	Value added (Billion Euro)
Aerospace	32	35%	11	213	119
Automotive	77	22%	17	968	503
Consumer Electronics	16	42%	7	152	85
Medical Equipment	28	25%	7	184	109
Telecom Equipment	32	52%	16	226	127
Automation	1	10%	0.1	20	14
TOTAL	€187 billion		€58 billion	€1,763 billion	€957 billion

Table A.1-1: Estimates for 2002 of software R&D effort worldwide (Source: IDATE)

In 2002, the total software R&D effort (whether developed internally, subcontracted or bought) in the six economic sectors is much larger than the corresponding effort from packaged software as a ‘producer good’. The 6 sectors spent €58 billion in software R&D in 2002, which is more than double the software development expenses by packaged software producers (€27 billion). Even if we add IT services software development, which represent €12 billion, the 6 sectors still have 50% more software development.

Based on the estimated level of software intensity in the six sectors, the total number of software R&D jobs in the six sectors represents an **impressive level of employment of 640,000 jobs worldwide in 2002**, with an average worldwide person-year cost estimated at €90,000.

Sectors such as automotive, aerospace or medical equipment are not classified as ICT, but are among the largest software developers. The amount spent in software R&D by these sectors is explained by the critical impact of software on each sector. It points out that, to a large and increasing extent, software defines the attributes and functionalities of many products and services. The existence of specific software needs has been recognised by large IT services companies, which developed specific activities by sector. Even packaged software producers (SAP, ORACLE) have an increasing effort towards industrial sectors.

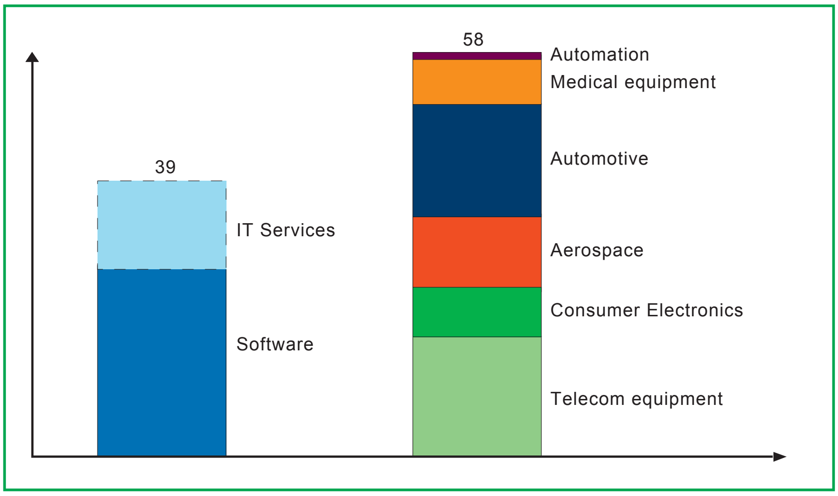


Figure A.1-2: Software development expenses worldwide from IT services, packaged software and the industrial sectors in 2002 (Source: IDATE)

One should note that European industry is ahead, or at least has a strong position in the six industrial sectors studied in this report. SiS are a major leverage for industry competition.

Software impact on the six industries is already very strong, whether we look at the amount of software included in the product or at the tools to design or simulate it.

At the process level, software is key for a 'dematerialised' design, making use of simulation and CAD tools (Computer Aided Design), which has proven to be faster and more efficient (time spent, money, error chasing, …) especially for cars and airplanes. In automation, software contributes to increase productivity and decrease cost by using more sophisticated and integrated process control, obtaining decrease of power consumption or of downtime.

At the product level, software may be considered as a tool to **manage the increasing complexity of new devices and networks**, and also to hide this level of complexity as much as possible from the final user, in order to reach a level of complexity 'acceptable to the user'. It is therefore **a powerful tool for differentiation and innovation**. Software contributes to manage the increase in complexity implied by a more interconnected world, and to answer the multiple requests for new functionalities. In airplane and automotive, it allows the exchange of information between the different types of control units. In consumer electronics, it is a key part of new devices.

A.1.3 Main evolutions towards 2015 : Software R&D effort keeping up the rhythm

A.1.3.1 Forecasts for 2015

The forecasts for 2015 show **a strong global increase in the size of software development for all sectors considered, from €58 billion to €132 billion**. This increase will be well above the market growth. So there is an obvious evolution towards more software development in these sectors in the future, meaning that software development is a key and increasingly strategic factor for industry competitiveness overall.

In all sectors, R&D expenses, expressed in percentage of the revenues, will be stable, or in a few cases increase slightly. **The software development increase is mainly the consequence of the increase of the percentage of software expenses in the total R&D budget**. The growth is also related to the growth of the market size. This level of increase differs according to the sectors, and their current situation.

There will probably be some kind of upper limit to the percentage of software R&D expenses, compared to overall R&D expenses, **but this limit will not be reached in the next 10 years** except for some specific products.

Software growth is a general trend at the manufacturer's level to differentiate its products or services. **But it will also be pushed by (and will enable) a large number of societal requests from the end-users**. In automotive, it provides answers to new regulations concerning road safety or protection of the environment. In Consumer Electronics, software provides benefits from the shift to digital while keeping product use as simple as possible. In aerospace, security and surveillance are key issues. The demand for medical equipment is influenced by an increasing patient population (aging population but also extension of lives of very ill people) and the focus on healthcare cost and preventative therapies. Software may represent 70% expenses for products like imaging.

2015	R&D expenses (Billion Euro)	Software R&D expenses (% of total R&D expenses)	Software R&D expenses (Billion Euro)	WW market size (Billion Euro)	Value added (Billion Euro)
Aerospace	51	45%	23	341	191
Automotive	129	35%	45	1,355	705
Consumer Electronics	21	60%	13	197	110
Medical Equipment	84	33%	28	471	280
Telecom Equipment	36	65%	23	257	144
Automation	3	15%	0.5	42	30
TOTAL	€324 billion		€132 billion	€2,663 billion	€1,460 billion

Table A.1-2: Forecasts for 2015: Software R&D effort worldwide (Source: IDATE)

A.1.3.2 Scenarios for management of software R&D effort's growth

Companies will probably implement this needed increase of software effort by a mix of different methods, which have all already been observed (and possibly new ones):

- Creating new jobs,
- Subcontracting the development to an IT services company,
- Retraining current hardware specialists, which has been typical in consumer electronics industry,
- Creation of new software companies providing the same needed software to industry such as Symbian or OpenTV,
- Buying the non-critical parts as software COTS using a component-based development method.

Evolution of the mix will basically depend on industrial decisions about the needed capabilities to differentiate them from the competitors. Companies will have to operate a classical trade-off between making things or buying them. They will have to determine which parts/components should be owned (or bought from an IT service) in order to operate and which parts may be used from another organisation (usually in order to minimise costs).

Internal development will continue for low volume products, as in some medical equipment. So job creation will be both internal and external, by the development of new software products and companies.

Given these remarks, if we translate the growth of software expenses in 2015 in employment, **a rough estimate obtained by translating expenses into manpower, leads for the 6 sectors between 150 to 200,000 'new' jobs in Europe.** Overall worldwide employment in software R&D for the six sectors should represent approximately 1.3 million jobs in 2015.

A.2 ITEA SUCCESS STORIES

ITEA's current project portfolio (Calls 1 to 7) comprises 79 projects as of January 2005 – 33 projects are completed, 26 are running and 20 are in a start-up phase. Several success stories can be highlighted and each year the very top are nominated for the ITEA Achievement Award. This section brings together the most significant, starting with the winners of the Award, in order to illustrate the diversity of size, targets and type of results that are produced by the programme.

PEPiTA

The PEPiTA project received the 2002 ITEA Achievement Award for its outstanding

PEPiTA: Platform for enhanced provisioning of terminal independent applications

PEPiTA was initiated by a consortium consisting of participants from Belgium, the Czech Republic, France and Ireland, led by French company Bull. The challenge was to optimise increasingly complex system and application engineering for developing Internet applications to enable companies in several sectors to conduct major parts of their business over the Internet. There was a clear need for high-level application programming interfaces (APIs) that hid the underlying complexity of common tasks such as transaction, security, and network resources and management.

PEPiTA has created a four-level generic platform with secure connections for (mobile) phones, smartcards and computers through a common architecture, including an API for virtual services and an Enterprise Java Beans (EJB) platform for application services. The middleware helps companies connect their applications to different terminals. This reduces the complexity of applications and helps speed up development.

The platform is referenced on the ObjectWeb™ site (http://www.objectweb.org), which distributes it as open source under the name JOnAS.

AMBIENCE

The AMBIENCE project received the 2003 ITEA Achievement Award for paving the way to a visionary approach

AMBIENCE: Context aware environment for ambient services

AMBIENCE was formed by a consortium of Austrian, Belgium, Dutch, Finnish, French, Greek, Italian and UK participants, led by Dutch company Philips. The goal was to develop the key capabilities needed for the creation of ambient intelligent environments.

Ambient intelligence is an exciting new concept in information technology that empowers people and improves their quality of life by providing a digital environment that is conscious of their presence, and is both sensitive and responsive to their needs, habits, gestures and emotions.

The AMBIENCE project jointly created concepts and developed architectures, methods and tools for context aware environments. To validate the concepts, the required technologies were integrated into operational systems, and were demonstrated on systems for home, office and public building environments.

EAST-EEA

EAST-EEA received the 2004 ITEA Achievement Award for having shown a major step forward for the European car industry

EAST-EEA: Electronics architecture and software technology – embedded electronic architecture

The EAST-EEA project addressed the need for hardware and software interoperability through the development of an integration platform for automotive electronics, based on the definition of open systems architecture. By enabling re-use of hardware and software, the project offered opportunities for dramatic cost reductions and ensured the leading position of European car manufacturers and suppliers into the future. Eight European manufacturers and eight suppliers of electronics and controls, together with eight universities and research centres from France, Italy and Sweden, led by Germany have contributed to the project.

EAST-EEA produced open and layered middleware architecture with interfaces and services that support portability of embedded software modules at a high quality level. The middleware, as well as the communications layer concepts, was implemented and validated in demonstrators in different automotive areas: body electronics, powertrain, chassis, telematics and human-machine interfaces. In addition to the technical work, EAST-EEA provided a widely accepted technical glossary.

Manufacturers are now using EAST-EEA outputs/results as the basis for the industry's AUTOSAR[45] initiative.

ESAPS CAFÉ FAMILIES

The aim of these projects was to improve significantly processes, methods, platforms, components and tools to support the demand for fully-fledged system families

ESAPS-CAFÉ-FAMILIES to manage software diversity in system families

Over 36 organisations from nine European countries (Austria, Finland, France, Germany, Italy, The Netherlands, Norway, Spain and Sweden), led by Dutch company Philips, combined forces in these projects to create a Family Evaluation Framework that can be used to assess organisations requiring a system family approach. The partners represented large industry, SMEs, universities and research institutes involved in professional and consumer electronics, cars, healthcare, financial information, air traffic control, public utility management and communications.

In ESAPS, an initial system-family development process was created, together with platforms, components, methods, tools and processes for managing these assets. CAFÉ broadened the use of the system-family approach for bringing neighbouring systems into the family by maturing existing platforms and by providing investment when a system-family approach proves beneficial. ESAPS and CAFÉ established a clear global lead for European System Family Engineering. The FAMILIES project is the last project in this series that will finish at the end of 2005. It aims to consolidate and standardise – e.g. in the Object Management Group (OMG) – the results gained so far into fact-based management and to explore areas not covered in the previous projects. The main result of FAMILIES will be the institutionalisation of the Family Evaluation Framework (FEF) addressing the four main target groups: industry; consultants and tool vendors; academia and the general public.

The international workshops on system family development that have been running for over three years now will continue.

[45] The AUTOSAR (AUTomotive Open System ARchitecture) initiative's first results are expected by 2010. For more information see: http://www.autosar.org.

ATHOS

A consortium of six partners from France and Italy, let by Italian firm Italtel, launched ATHOS in mid 1999

ATHOS used in the VoIP trunk connection between Milan and Rome

Convergence of telecommunications and IP technologies creates an exciting opportunity for both Internet service providers (ISPs) and network operators, extending the services they can offer. However, rapid introduction of such services and a high degree of customisation are crucial. The aim of the ATHOS project was to investigate, develop and validate an advanced distributed computational environment that should represent the basis for an easy deployment of basic and advanced communications services in a fast provisioning perspective.

ATHOS finally developed an advanced distributed computational environment that enables easy deployment of communications services. It provides switched- and Internet-based services on a common platform so that customers enjoy more services more easily and that ISPs can use network resources efficiently and maximise profit margins, while increasing market share by attracting new subscribers.

In fall 2002, the voice-over-Internet (VoIP) connection between Milan and Rome was fully operational thanks to a decisive contribution from the project – ATHOS middleware-enabled advanced call servers are part of the IMSS Softswitch classes 4.20.10 and 5.20.20.

OSMOSE

The OSMOSE project involves 22 partners from Belgium, the Czech Republic, France, Greece, Ireland, the Netherlands, Spain and Switzerland, led by Spanish company Telvent

OSMOSE: Open source middleware for open systems in Europe

The OSMOSE project builds on the successes of ObjectWeb™ and further contributes to this by developing and enhancing a comprehensive set of adaptable, open source middleware components. Supporting the middleware with industrial developments is also essential to guarantee the critical mass required in a self-maintained open source community. This will provide commercial testing and inputs for further advanced middleware features, thus allowing the environment to be used to support various commercial activities, such as tools and applications that may not be open source.

The project builds on and improves ObjectWeb's work, developing a scalable component-based software architecture for distributed middleware, and enhancing and extending ObjectWeb's code base in several ways.

The OSMOSE project has improved functional coverage, increased the level of conformity to standards such as Java, OMG, W3C and OSGi, enhanced the quality of service and scalability properties – in particular, to increase availability and fault tolerance – and improved system management such as configuration, deployment and monitoring.

The middleware will be used to configure a range of platforms – including avionics test-bed, platforms for telecommunications services, home gateway and hybrid platforms – to work with these flexible, scalable middleware components.

P2I

Led by French SME Esterel Technologies, the P2I consortium brought together two large companies from Finland and France, two Finnish universities and two French research laboratories

P2I and VACCAT: small size projects managed directly by SMEs

P2I (Prompt to Implementation): From specification to implementation of real-time embedded systems

P2I's goal was to reduce both the cost and the time-to-market of the development of real-time embedded systems:

The traditional approach consisted in validating real-time embedded applications based on manual optimisation very late in the process and requiring the availability of all hardware and software, hence expensive and leading to a too-long time-to-market.

Using a new Unified Modelling Language (UML)-oriented approach for embedded systems, P2I has provided a system-level methodology, taking into account both functional and architectural constraints, for simulating, testing, prototyping and implementing real-time embedded systems, providing a seamless end-to-end flow from the early specification up to the final implementation. The methodology developed by P2I is based on:
- A specialisation of UML 2.0 for real-time embedded systems, through a 'P2I profile' and
- The extension of existing tools relying on synchronous methods and languages;

and was validated on an application in the wireless domain.

The project:
- Intensively disseminated its results (more than 36 papers and presentations, which testifies to the relevance of the subject);
- Collaborated with UML tools editors; and
- Initiated various standardisation actions and in particular in OMG with an essential contribution (with respect to 'profile') to the RT/E-ML Request For Proposal.

VACCAT

The VACCAT project consortium consists of 11 partners from Belgium, France, the Netherlands, Sweden and the UK, led by Belgian company VARTEC

VACCAT: Virtual augmented content for co-operative advanced design technologies

In the future cyber-enterprise, designing complex systems will be an 'e-group' process that requires smooth integration of all communications processes with co-operation and coordination between the members of the design team. The goal of the VACCAT consortium was to integrate such a communication, co-operation and coordination (CCC) platform with advanced design decision support tools that can handle engineering design tasks.

The VACCAT platform is a direct answer to vital design needs in sectors such as transport, the oil industry, medicine and pharmaceuticals. Its negotiation-support tools increase the speed of decision-making and advanced indexing solutions help with searching and retrieving large amounts of visual data. Large high-performance wall displays and fully immersive environments enhance visualisation of such data, which is often spread across the network. The results of the VACCAT project will boost the competitiveness of the European design industry.

PROTEUS

The French company CEGELEC is leader of the project with 14 partners from France and Germany

PROTEUS: A generic platform for e-maintenance

The ambition of PROTEUS is to engineer a change in the landscape of today's maintenance support tools. The project will provide a fully integrated platform that is able to support any broad e-maintenance strategy.

Maintenance is considered an integral part of global enterprise asset optimisation (EAO) policies currently being implemented by a growing number of industrial organisations. Predictive maintenance requires the harmonious integration of continuous remote monitoring of equipment throughout its lifetime, maintenance and repair management, and comprehensive data presentation and synthesis.

PROTEUS is developing a generic European software architecture for web-based e-maintenance centres, targeting transportation, energy and other industries. The project will promote a *de-facto* form of standardisation through extensive use of new data-structuring technologies (XML – Extensible Mark-up Language), application-integration techniques and Internet-related technologies. This generic e-maintenance platform will provide methods and APIs for tool integration. Exploitation of PROTEUS results will allow large companies as well as SMEs to implement e-maintenance and logistics centres in a variety of industrial sectors.

A.2.1 ITEA project portfolio

The following provides short outlines of the current ITEA project portfolio (Calls 1-7, status June 2005). More details can be found on ITEA's website (http://www.itea-office.org - under 'Projects').

CALL 1	
ATHOS	Advanced platforms and technologies for the provision of communication services
BEYOND	Concepts and tools for user-centred interactive products and services
BRIC	Broadcast & internet convergence
CO-VAR	Co-operative software design architecture based on augmented virtual objects
DESS	Software development process for real-time embedded software systems
DIGITAL HEAD-END	Digital cable network head-end: new architectures for multi-media interactive applications
EUROPA	End-user resident open platform architecture
ESAPS	Engineering software architectures, processes and platforms for system families
PEPiTA	Platform for enhanced provisioning of terminal-independent applications
RTIPA	Real-time internet platform architectures
TASSC	Transaction value added services with smart cards
UMSDL	The powerful real-time UML
VHE MIDDLEWARE	Middleware for virtual home environments

CALL 2	
@TERMINALS	Architecture and tools to deliver adaptive contents and applications to terminals
NETCARE	Secure infrastructure supporting services for healthcare applications
SOPHOCLES	System level development platform for system applications implementation
TESI	Trusted European security infrastructure
VIVIAN	Middleware platform for mobile terminals

CALL 3	
AMBIENCE	Context aware environment for ambient services
CAFÉ	From concept to application in system-family engineering
DIGITAL CINEMA	Architecture for a digital cinema infrastructure
EAST-EEA	Embedded electronic vehicle architecture
HOMENET2RUN	Extending home network communications capabilities
KLIMT	Knowledge intermediation technology
POLLENS	Platform for open, light, legible & efficient network services
ROBOCOP	Robust open component-based software architecture for configurable devices project

CALL 4	
3DWORKBENCH	Open source CAD/CAM/CAE middleware and infrastructure based on standards
ADANETS	Adaptive networks and service
EMPRESS	Evolution management process for real-time embedded software systems
HYADES	High level system RT application development environment for SMP & clusters
MOOSE	Software engineering methodologies for embedded systems
PROMPT2IMPLEMENTATION	Providing a system-level co-design methodology for real-time embedded systems
PROTEUS	Software platform for remote technical support tool handling information exchange via the Web
VACCAT	Virtual/augmented content co-operation for automotive technology

CALL 5	
CANDELA	Content analysis and networked delivery architectures towards intelligent video
COPS	Copy protection system
FAMILIES	Fact-based maturity through institutionalisation lessons-learned and involved exploration of system-family engineering
JULES VERNE	Matching industrial content creation to future home terminals
LASCOT	Large scale collaborative decision support technology
MOBILIZING THE INTERNET	Establishing a new business approach to wireless and mobility
NOMADIC MEDIA	Innovative concepts for technologies and products
OSMOSE	Open source middleware for open systems in Europe
SATURN	Security applications and technologies for universal information networks
SIRENA	Service infrastructure for real-time embedded networked applications
SPACE4U	Fault, power and terminal management related aspects
TBONES	Simulator for DWDM backbone optical networks
TT-MEDAL	Test & testing methodologies for advanced languages

CALL 6	
AGILE	Agile software development of embedded systems
AMEC	Ambient ecologies
AURORA	Multimodal multimedia personal information centre
DIGINEWS	News for mobile e-paper terminal
EASY-WIRELESS	Seamless roaming between wireless networks while maintaining quality of service
MAGELLAN	Multimedia application gateways for enterprise level LANs
MERCED	Market enabler for retargetable COTS components in the embedded domain
MERLIN	Embedded systems engineering in collaboration
SHOPS	Smart home-payment services

CALL 7	
ANSO	Autonomic networks for SOHO users
BOON COMPANION	Autonomous cognitive system (ACS) integrating perception, reasoning and learning
COSI	Co-development with inner & open source in software-intensive products
ELF@SMARTHOME	Easy life at smart home
EMODE	Enabling model transformation-based cost efficient adaptive multi-modal user interfaces
ENERGY	Empowered network management
HD4U	High definition TV for Europe
LOMS	Local mobile services
MARTES	A model-driven approach to real-time embedded systems development
OSIRIS	An open source infrastructure for run-time integration of services
PASSEPARTOUT	Exploitation of AV content protocols by coupling home media-centres to home networks
PELOPS	Networked media for sport production workflow
SAFEUML-SINAPSE	Integrate software security, reliability and reverse-engineering in UML models
SERIOUS	Software evolution, refactoring and improvement of operational and usable systems
SERKET	An innovative software approach for security of places and public events
S4ALL	Services for all
SUMO	Service ubiquity in mobile and wireless realm
TRUST4ALL	A trustful middleware software architecture for embedded systems

A.2.2 Projects mapping into ITEA domains and technology clusters

Call	Project	Domains					Technologies			
		Home	Cyber Enterprise	Nomadic (1)	Intermediation Services & Infrastructure	Software & Services Creation (2)	Content	Infrastructures & Basic Services	Human-System Interaction	Engineering
Call 5	JULES VERNE	Major	Minor				Major	Minor		
Call 7	PASSEPARTOUT	Major					Major	Minor		
Call 7	HD4U	Major			Minor	Major	Major	Major		
Call 5	COPS	Major		Minor			Major	Minor		
Call 3	HOMENET2RUN	Major			Minor			Major		Minor
Call 7	ELF@SMARTHOME	Major		Minor			Minor		Major	
Call 7	BOON COMPANION	Major		Minor					Major	
Call 7	TRUST4ALL	Major		Minor						Major
Call 7	ANSO	Major		Minor				Minor		Major
Call 1	EUROPA	Major			Minor		Minor	Minor		Major
Call 1	CO-VAR		Major		Minor		Major	Minor	Minor	
Call 4	VACCAT		Major			Minor	Major		Minor	Minor
Call 3	DIGITAL CINEMA		Major		Minor		Major	Minor		
Call 3	KLIMT		Major		Minor		Major			
Call 4	3DWORKBENCH		Major		Minor		Major			Minor
Call 7	PELOPS		Major				Major	Minor		
Call 2	NETCARE		Major		Minor			Major		Minor
Call 5	LASCOT		Major		Minor		Minor		Major	
Call 1	PEPITA		Major		Minor			Minor		Major
Call 4	PROTEUS		Major		Minor		Minor			Major
Call 5	MOBILIZING THE INTERNET			Major	Minor			Major		
Call 6	EASY WIRELESS			Major	Minor			Major		
Call 3	EAST-EEA			Major		Minor		Major		Minor
Call 5	NOMADIC MEDIA	Minor		Major					Major	
Call 7	SUMO			Major	Minor		Minor	Minor		Major
Call 1	BRIC	Minor			Major		Major	Minor		
Call 7	SERKET		Minor		Major		Major			Minor
Call 6	DIGINEWS			Minor	Major		Major		Minor	
Call 2	@TERMINALS				Major	Minor	Major		Minor	Minor
Call 1	VHE MIDDLEWARE	Minor			Major			Major	Minor	
Call 3	POLLENS				Major	Minor		Major		
Call 5	TBONES				Major			Major		
Call 1	RTIPA				Major			Major		
Call 1	DIGITAL HEAD-END	Minor			Major		Minor	Major		
Call 1	ATHOS		Minor		Major			Major		
Call 4	ADANETS			Minor	Major		Minor	Major		
Call 6	MAGELLAN				Major		Minor	Major		
Call 7	ENERGY				Major		Minor	Major		Minor
Call 6	SHOPS	Minor			Major			Major		Minor
Call 5	SATURN		Minor		Major			Major		
Call 2	TESI				Major	Minor		Major		Minor
Call 3	AMBIENCE	Minor	Minor		Major		Minor		Major	
Call 6	AURORA	Minor	Minor		Major		Major		Minor	
Call 5	SIRENA		Minor		Major			Minor		Major
Call 1	TASCC		Minor		Major			Minor		Major
Call 2	VIVIAN			Minor	Major		Minor	Minor		Major
Call 5	CANDELA	Minor	Minor			Major	Major	Minor		
Call 7	OSIRIS		Minor			Major		Major		Minor
Call 6	AMEC	Minor				Major			Major	Minor

Call	Project	Domains					Technologies			
		Home	Cyber Enterprise	Nomadic (1)	Intermediation Services & Infrastructure	Software & Services Creation (2)	Content	Infrastructures & Basic Services	Human-System Interaction	Engineering
Call 7	EMODE			Minor		Major			Major	Minor
Call 1	BEYOND					Major			Major	Minor
Call 1	ESAPS		Minor			Major				Major
Call 3	CAFÉ		Minor			Major				Major
Call 2	SOPHOCLES		Minor			Major				Major
Call 5	TT-MEDAL					Major		Minor		Major
Call 5	FAMILIES					Major				Major
Call 4	P2I					Major				Major
Call 7	MARTES					Major				Major
Call 3	ROBOCOP		Minor			Major		Minor		Major
Call 6	MERCED		Minor			Major				Major
Call 7	LOMS			Minor		Major	Minor	Minor		Major
Call 6	AGILE			Minor		Major				Major
Call 7	S4ALL				Minor	Major			Minor	Major
Call 7	SAFEUML-SINAPSE				Minor	Major	Minor		Minor	Major
Call 5	SPACE4U					Major		Minor		Major
Call 5	OSMOSE					Major		Minor		Major
Call 1	DESS					Major		Minor		Major
Call 4	MOOSE					Major				Major
Call 6	MERLIN					Major				Major
Call 1	UMSDL					Major				Major
Call 4	HYADES					Major				Major
Call 7	COSI					Major				Major
Call 7	SERIOUS					Major				Major
Call 4	EMPRESS					Major		Minor		Major

(1) Also known as “Mobile”

(2) In Roadmap 1 described as “Complex System Engineering”

A.3 ITEA IN NUMBERS

ITEA Cluster programme Σ! 2023 - Global data, based on forecast of April 2005, ITEA Calls 1-8		
Programme duration	**1 July, 1999 - 30 June, 2007**	
	Including prolongation	31 Dec. 2008
Number of Project Calls	**8**	
Total effort	**9,500 person-years**	
	Large industry	64%
	SMEs	16%
	Research institutes + Universities	20%
Number of participants	**400**	
	Large industry	27%
	SMEs	45%
	Research institutes + Universities	28%
Number of projects	**85**	
Average project size		
	In person-years	120
	Number of participants	13
	Number of countries	4
Project duration	**3 years (maximum)**	
Effort top countries	**94% of total**	
	France	31%
	Netherlands	19%
	Spain	11%
	Finland	10%
	Germany	9%
	Belgium	8%
	Italy	7%
Exploitation	**Total: 450**	
	No. of expected product references to be included in the portfolio of all partners	185
	No. of expected OEM references to be sold by al partners	55
	No. expected results used for internal purposes	120
	No. of expected licenses to be sold by partners	60
	No. of open source	30
Standardisation	**Total: 150**	
	No. of standardisation actions launched	20
	No. of actions in progress	100
	No. of actions issued or published	30
Dissemination		
	Publications and conferences	1650
	Project websites	55

A.3.1 Basic data by country

Country	Average ITEA effort (2001-2005) (person-years) *	Population	GDP	R&D expenditure		
				Total	Business	Per person
		Million 2002	Billion € 2002	Billion $ 2001	Billion $ 2001	$
France	363	59	1521	35	22	592
Netherlands	228	16	444	8	5	516
Spain	130	40	694	8	4	203
Finland	116	5	140	5	3	922
Germany	111	82	2108	54	38	654
Belgium	94	10	261	5	4	476
Italy	80	56	1285	15	9	272
Total ITEA key countries (7)	1122	270	6453	130	85	483
Sweden	6	9	255	10	8	1112
Greece	3	11	141	1	0	101
UK	5	59	1659	29	20	499
Austria	4	8	217	4	2	543
Portugal	2	10	129	2	1	146
Ireland	4	4	128	1	1	368
Luxembourg	2	0	22			
Denmark		5	183	3	2	604
Total EU-15 countries in ITEA	1148	377	9187	181	119	482
Czech Republic	4	10	74	2	1	
Slovenia	1	2	23	1		
Cyprus		1	11	0		
Estonia		1	7	0		
Hungary		10	70	1	1	
Lithuania		3	15			
Latvia		2	9	0		
Malta		0	4			
Poland		39	200	3	1	
Slovakia		5	25	0	0	
Total EU-25 countries in ITEA	1153	450	9625	188	122	96
Norway	12	5	202	3	2	600
Israel	10	6	109	6		998
Switzerland	6	7	284	6	4	778
Turkey	1	69	192	3	1	39
Croatia		8	17	0		33
Iceland		0	9	0		1500
Monaco						
Romania						
Russia				12		
San Marino						
Serbia and Montenegro						
Total EUREKA countries in ITEA	1182	545	10438	218	129	400

*) This does not represent all funded person-years. E.g. for a number of Call 7 projects the funding is not yet decided.

A.4 ITEA MID-TERM ASSESSMENT – RECOMMENDATIONS

ITEA is a strategic programme aiming at improving European industrial competitiveness that contributes to the European Research Area through flexible international co-operative projects focusing R&D forces on strong priorities. As with other EUREKA Clusters, ITEA has set performance objectives, including a regular assessment of results.

In 2003, Public Authorities supporting the ITEA programme requested a mid-term assessment by two independent consultant companies – IDATE and TNO – with two main objectives, to:

1. Benchmark the current status of the clusters relative to their own objectives and to the current state and trends of the industry and related technologies; and
2. Provide recommendations for the future direction of the programme.

Based upon these assessments, the consultant companies concluded that the ITEA programme is running according to plan and should continue (recommendation no. 1).

The outcome of the assessment emphasises the importance of structured initiatives for strategic technologies in software technologies areas, making it possible to gain critical mass to address key fields for the competitiveness of European industry. Therefore, ITEA contributes to achieving the Lisbon European Council goal in 2000 of making Europe the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion with, amongst other measures, a target of 3% of GDP invested in R&D by 2010 (Barcelona council).

The other recommendations of the assessment have been grouped in seven categories:

1. Evolution of the objectives

- In future, more attention should be given also to software producers (tools & applications).
  - Internally, encouraging participation by software producers through the promotion of specific types of project, such as:
    - Encouraging spin-offs providing software products and services;
    - Encouraging projects that bring together software product developers and software users (such as in MEDEA+);
    - Encouraging from the start projects including partners dedicated to product commercialisation; and
    - Modify slightly the composition of the Board to include more representatives of the software industry.
  - Externally, for example by using support measures such as technology platforms and test beds. To monitor progress in terms of the software industry, the ITEA Office should assemble specific information that would allow measurement of the involvement and the results achieved specifically by software companies.
- It is essential to supplement technological research with at least a limited programme of research (with earmarked resources) on the 'large software market contexts and strategies pertaining to European firms'. In particular, efforts to study possibilities offered by different business models such as open software should continue. It is also necessary to study how to encourage the development of European software companies, in relation to commonalities discovered and technologies developed; and
- A more pronounced standardisation strategy within ITEA could further enhance its goals.

2. Results of the programme

In the second phase of ITEA, more stress should be placed on the goal of achieving industrial applications and products.

3. Selection, review and monitoring

- Although proposal quality and representation of European industry as a whole have improved throughout the first phase of ITEA, this improvement should continue, supported actively by the ITEA organisation;
- The participation of SMEs is above average for such big projects, but probably could be even greater in view of the large number of existing software SMEs;
- The existing ITEA selection process must be kept oriented to select the most efficient partners, whatever their nationalities; and
- It is recommended that non-participants and recent participants should be consulted on this matter, and that software service companies should be invited to participate.

4. ITEA organisation

- An increase in size should be related only to an increase of workload (more projects or more specific tasks). The financial burden of the ITEA organisation is kept at a minimum, which is very reasonable;
- The ITEA organisation should increase efforts to explain the parameters of its activities to potential participants, mainly to avoid confusion on funding aspects;
- The ITEA organisation is making a significant effort in communicating to the research community, but should develop further its ability to communicate at the political level: i.e. not just with officials in the public authorities, but also with policy makers; and
- The ITEA organisation should promote a stronger basis for developing the EUREKA brand name in the international marketplace and in collecting feedback on marketing initiatives involving the EUREKA label that would be valuable for all participants.

5. Co-operation

An ongoing dialogue should be continued in the second phase of ITEA on the issue of open source versus proprietary source solutions to ensure present levels of co-operation continue and can be enhanced.

6. Relationship with national and European programmes

- Funding decisions should be made more quickly and efforts should be made to synchronise national decisions as much as possible;
- The policies and mechanisms in each country for managing the relationship between EUREKA and national programmes should be made more transparent and available to all current and potential ITEA participants.

7. Relationship between ITEA and the Framework Programme

As they address almost the same technical domains, a much better degree of coordination should be reached soon. The immediate goal should be to avoid overlaps, requiring agreement on a protocol for information exchange. The ITEA Roadmap could be exploited in this context to help position the various Information Society Technology (IST) and ITEA projects and to estimate expected time-to-market for resulting products. Such ’light synchronisation‘ could be a first step towards closer co-operation.

A.5 KEY NUMBERS / INDICATORS ON EUROPEAN COMPETITIVENESS

GDP growth

The growth of the Gross Domestic Product (GDP) in the year 2002:

- EU: 1.0 %
- USA: 2.4 %
- India: 6.0 %
- China: 8.0 %

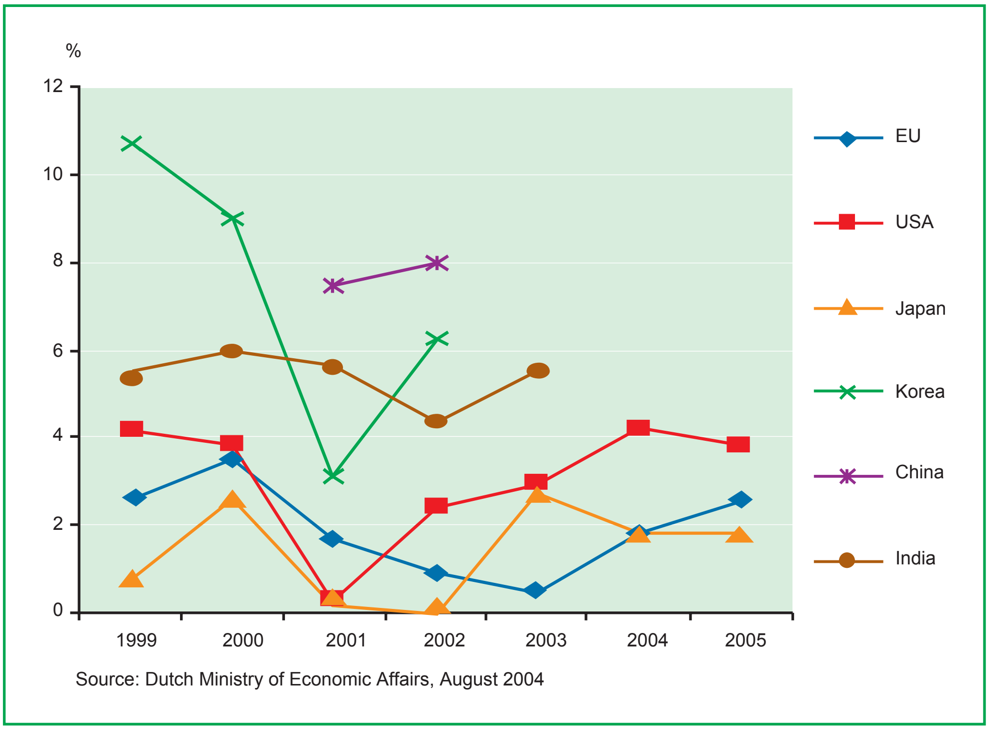


Figure A.5-1: Real GDP growth in EU-15, USA, Japan, Korea, China, India (2002)

R&D Investment in 1995

- EU: € 126 billion
- USA: € 141 billion (12% more than EU)

R&D Investment in 2001

- EU: € 178 billion
- USA: € 315 billion (77% more than EU)

R&D investment/ population in 2001

(Euro per inhabitant)

- EU: € 390 / person
- USA: € 1097 / person

(in USA allmost 3x more than EU)

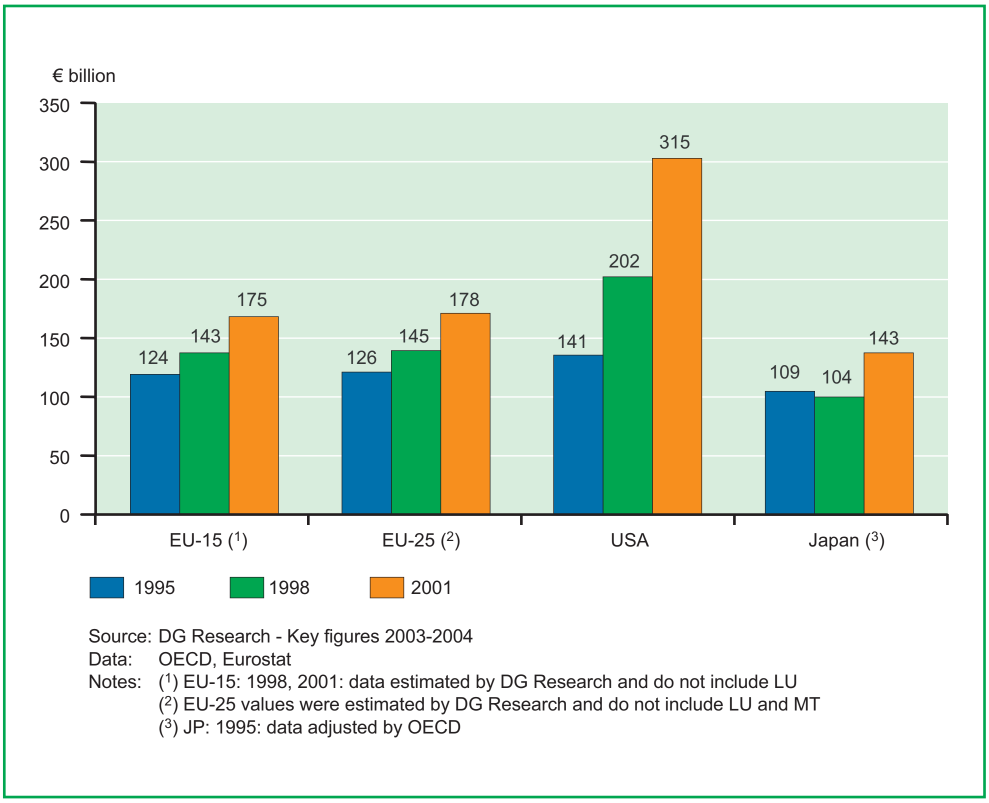


Figure A.5-2: R&D investment 1995, 1998 and 2001

Business R&D Expenditure in 1995

- EU: € 79 billion
- USA: € 101 billion (28% more than EU)

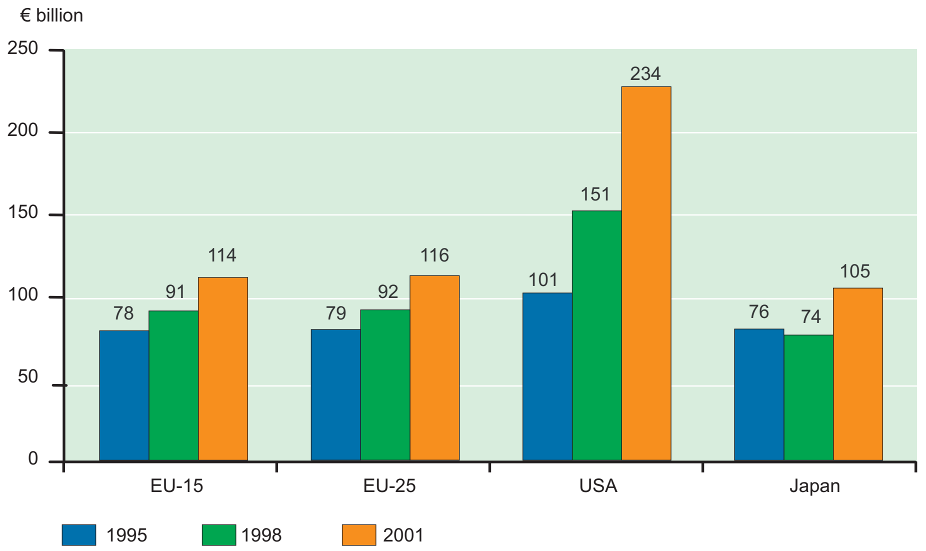
Business R&D Expenditure in 1995

- EU: € 116 billion
- USA: € 234 billion (102% more than EU)

Business R&D Expenditure/population in 2001

(Euro per inhabitant)

- EU: € 257 / person
- USA: € 815 / person
  (in USA over 3x more than EU)



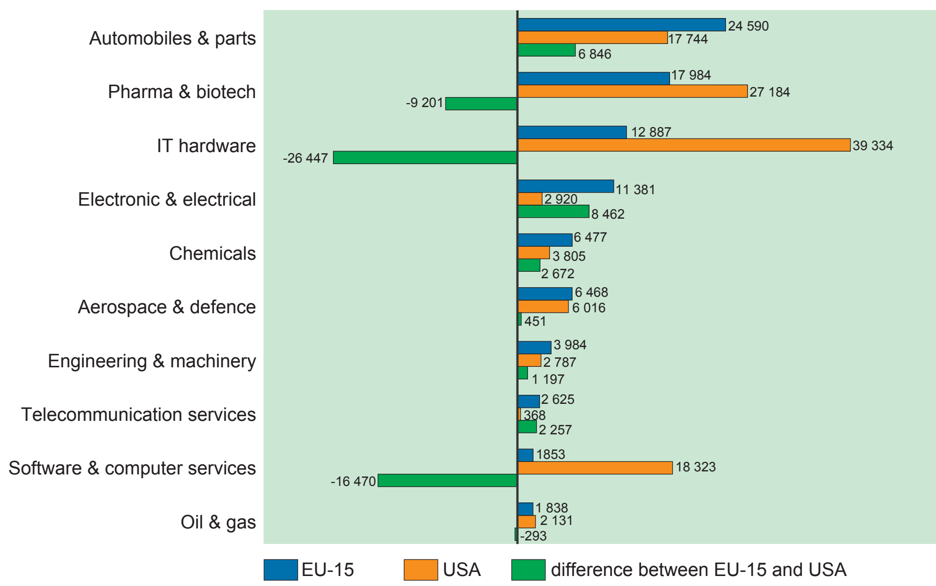
Source: DG Research - Key figures 2003-2004
Data: OECD, Eurostat
Notes: EU-15, EU-25: Data are estimated by DG Research and do not include LU and MT

Figure A.5-3: Evolution of business expenditure on R&D

R&D expenditure

Europe expends more in R&D in a number of ITEA related sectors:

- Automobiles and parts
- Electronic & Electrical
- Aerospace & Defence
- Telecommunication Services



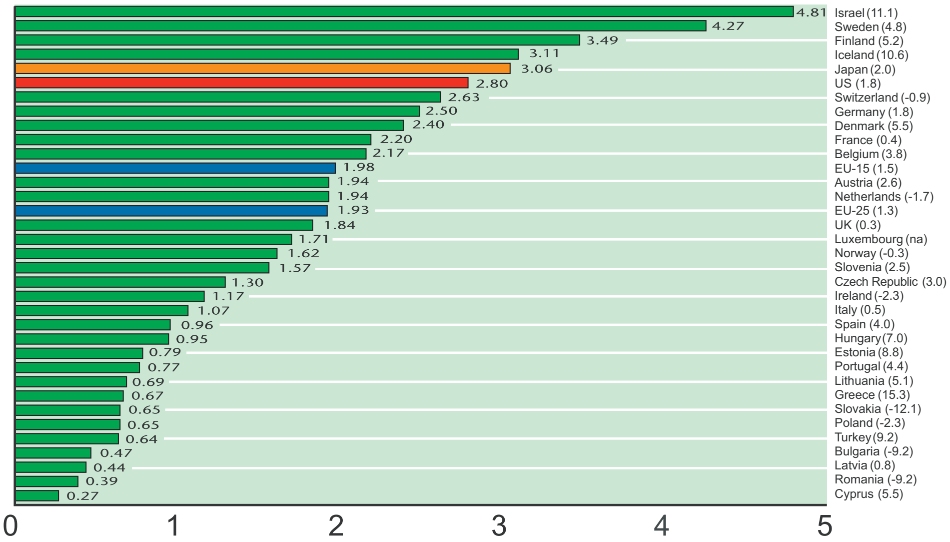
Source: DC Research - Key figures 2003-2004
Data: R&D Scoreboard 1992, 2003, DTI Future & Innovation Unit and Company Reporting Ltd.

Figure A.5-4: R&D expenditure by top EU-15 and top USA business R&D spenders in selected sectors (2002)

R&D intensity (GERD as % of GDP) in 2001

- The R&D intensity in Europe is in spite of the 3% Lisbon Goal less than 2% of GDP
- The R&D intensity in the USA is 2.8% and in Japan over 3% of GDP

The gap between EU and USA/Japan is growing.



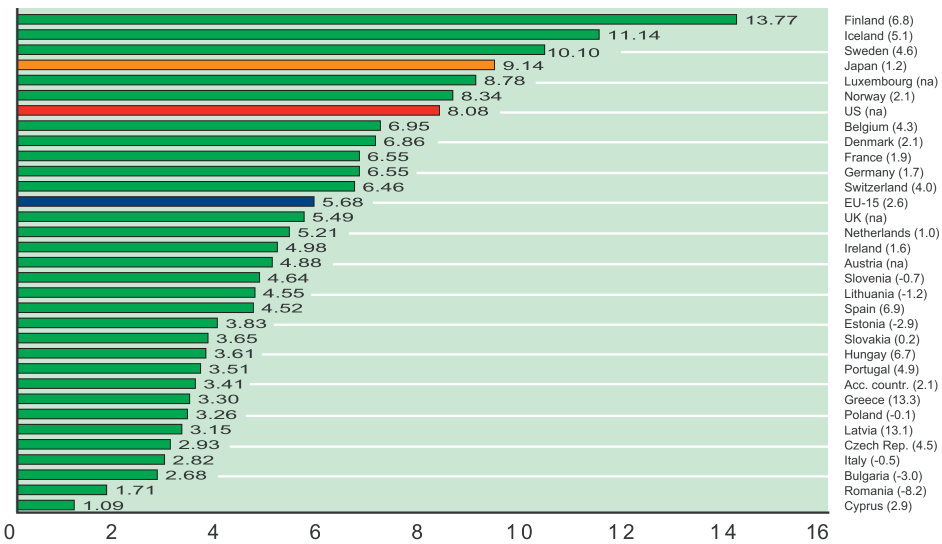
• R&D intensity (GERD as % of GDP) in 2001 (1)
• In brackets: average annual growth rates of R&D intensity (%) 1997-2001 (2)

Source: DG Research - Key Figures 2003-2004
Data: OECD, Eurostat
Notes: (1) or latest available year: EL: 1999; IT, NL, LU, CH, TR: 2000; DE, FR, AT, PT, FI, UK, IS, US: 2002. EU-15, EU-25 data are estimated by DG Research and do not include MT
(2) or nearest available years: CH: 1996-2000; EL: 1997-1999; IT, NL, TR: 1997-2000; CY, EE: 1998-2001; BG:1999-2001; BE, DK, ES, all other countries 1997-2002. IE, SE, EU-15, CZ, HU, LT, LV, PL, SI, SK, EU-25, RO, NO, JP IL: 1997-2001; FR: 2000-2002. EU-15, EU-25 data are estimated by DG Research and do not include LU and MT.

Figure A.5-5: R&D intensity (GERD as % GDP) in 2001

Number of researchers in 2001

- The number of researchers (FTE) per 1000 labour force is in the USA over 8 and in Japan over 9 researchers/1000 labour force.
- In Europe the number of researchers is only 5.6 researchers/1000 labour force



• Number of researcher (FTE) per 1000 labour force in 2001 (1)
• In brackets: average annual growth rates (%), 1996-2001 (2)

Source: DG Research - Key Figures 20003-2004
Data: Benchmarking Indicator, Eurostat/Member States
Notes: Data for DE, PT, JP are estimated. EU-15 data do not include UK, ACC data do not include MT
(1) or latest available year: PT, IS, JP: 2002; FR, IT, LU, NL, CH: 2000; BE, EL: 1999; AT, UK: 1998; US: 1997
(2) or nearest available years: PT, IS, JP: 1996-2002; SE, CZ, PL, RO, NO:1997-2001; IT, NL, CH: 1996-2000; BE: 1996-1999; EL. 1997-1999; CY: 1999-2001; BG: 2000-2001

Figure A.5-6: Number of researchers (FTE) per 1000 labour force (2001)

University graduates in Science & Engineering in 2001

(ISCED 5 and 6)

- The number of university graduates in S&E is in Europe around twice as high as in the USA.

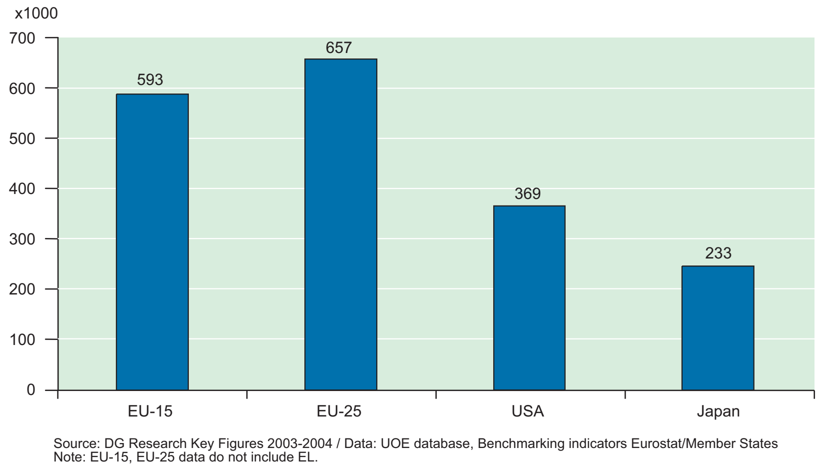


Figure A.5-7: Number of university graduates in Science & Engineering (2001)

Gross Domestic R&D Expenditure in 2001

New upcoming countries with respect to Gross Domestic R&D Expenditure:

- China is in the mean time no. 3
- Korea no. 7
- India no. 8.

Rank		US $ billion	% of total world
	Global	778	100%
	Total OECD	645	83%
	Non OECD	132	17%
1	USA	282	36%
	EU	186	24%
2	Japan	104	13%
3	China	60	8%
4	Germany	54	7%
5	France	35	5%
6	UK	29	4%
7	Korea	22	3%
8	India	19	3%
9	Canada	17	2%
10	Italy	16	2%
11	Brazil	14	1%
12	Russian Federation	12	1%
13	Chinese Taipei	11	1%
14	Sweden	10	1%
15	Spain	8	1%
16	Netherlands	8	1%
17	Australia	8	1%

Source: OECD Science, Technology and Industry Scoreboard

Figure A.5-8: Gross Domestic R&D Expenditure (2001)

Business enterprise R&D expenditure (BERD)

Top 5 countries (year 2002) with respect to Business R&D expenditure as % of value added in industry:

- Sweden: 5.2%
- Finland: 3.5%
- Japan: 3.3%
- USA: 2.9%
- Korea: 2.8%

(Percentage: BERD in relation to the value added in industry)

	% 2000	% 2001	US $ 2001	Growth 1995-2001
USA	2.80%	2.90%	210	6.1%
Japan	3.10%	3.30%	77	4.3%
OECD	2.20%	2.30%	449	5.3%
EU	1.80%	1.80%	120	4.4%
Sweden		5.20%	8	
Finland	3.50%	3.50%	3	
Iceland	2.50%	2.80%		
Korea	2.40%	2.80%	17	
Germany	2.50%	2.50%	38	
Belgium	2.20%		4	
France	2.00%	2.00%	22	
UK	1.80%	1.90%	20	
Netherlands	1.60%	1.60%	5	
Norway		1.40%	2	
Italy	0.80%	0.80%	9	
Spain	0.70%	0.70%	4	

Source: OECD Science, Technology and Industry Scoreboard

Figure A.5-9: Business enterprise R&D expenditure

A.6 ITEA 2 ORGANISATION

A.6.1 Tasks and organisational structure of ITEA 2

The main tasks of the organisation will be to:

- Create/increase awareness of the programme;
- Help set up projects and continue to support them throughout their working period;
- Ensure rigorous quality from call to completion; and
- Monitor changes in technology and steer the technical content of the programme accordingly, while maintaining strong co-operation with Public Authorities and other EUREKA Cluster programmes.

Four bodies will be in place – the Board, the Board Support Group, the Steering Group and the ITEA 2 Office to achieve these goals in combination with efficient procedures and the implementation of a full-scale communications policy.

All members of ITEA 2 bodies will have to sign a non-disclosure agreement (NDA) covering all the information they work with, related to their duties. The different tasks of these bodies are shown in Figure A.6-1.

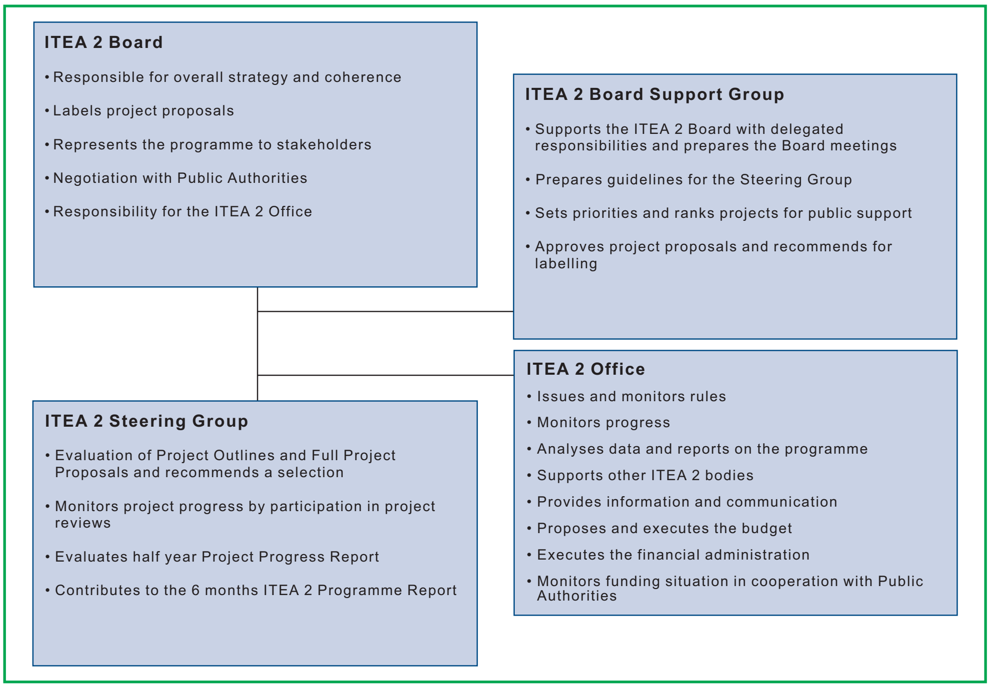


Figure A.6-1: The ITEA 2 organisation

In addition, supporting scientific committee(s), working group(s) and forum(s) will be implemented when necessary.

The ITEA 2 Office will be part of the combined office for the former ITEA programme as well as for ITEA 2. In summary, the combined Office:

- Will execute the office tasks for ITEA;
- Will execute the office tasks for ITEA 2; and
- Will be part of and will support the virtual office of the ARTEMIS European Technology Platform.

Voting Members of the Board will be representatives of ITEA Founding Companies. Non-voting members are the Chairman, Vice-Chairman, Office Director, a representative of the High Tech Federation of SMEs and *ad hoc*.

A.6.2 ITEA 2 and Public Authorities

The Public Authorities that support ITEA 2 will harmonise and synchronise measures related to the ITEA 2 programme to ensure continuity and optimal execution of the programme.

A Directors Committee and an Authorities Committee will directly interface respectively with the ITEA Board and the ITEA Board Support Group (Figure A.6-2).

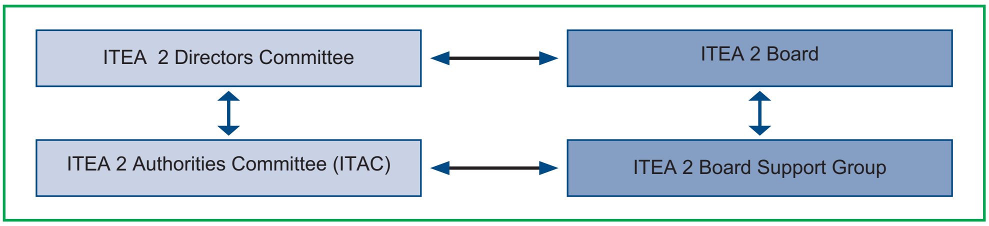


Figure A.6-2: Co-operation with Public Authorities

A.6.3 Main procedures

Procedures will be defined for:

- Call procedure
- Change requests
- Monitoring and reviewing
- Co-operation with Public Authorities
- Finance and accounting
- Legal
- Communications
- Human resources
- Document control
- Database management (project database, address database, etc)

The most important procedures and the way of working will published in the *Rules & Regulations* document, internal procedures in the *ITEA 2 Office Handbook*.

A.6.4 ITEA 2 framework agreement

The ITEA 2 organisation will be built and managed according the ITEA 2 framework agreement, signed by the ITEA 2 founding companies.

A.6.5 ITEA 2 Office Association

The legal identity of ITEA 2 will be an Office Association based in the Netherlands. The members of the general assembly of the association will be representatives of the ITEA 2 founding companies. The Board of Directors will be appointed by the general assembly of the association and will manage this office association. The articles of the ITEA Office Association will be signed by the ITEA 2 founding companies.

A.6.6 Project Co-operation Agreement

The ITEA 2 organisation will have no direct financial control over the projects performed. Technical know-how, ownership of results and responsibility for project management, execution and reporting will remain with the project partners and will be agreed upon in the Project Co-operation Agreement (PCA).

GLOSSARY

Term	Explanation
3D	Three dimensional
3G	Third generation mobile phones
A/V; AV	Audio-visual; audio video
ABS	Antilock braking system
ACIRE	Advisory Council for ICT R&D in Europe
ACS	Autonomous cognitive system
API	Application programming interface. A way to separate logical interaction from application and real interaction.
ARC	Advanced RISC computing
ARTEMIS	Advanced Research and Technology for Embedded Intelligence & Systems ETP
AUTOSAR	AUTomotive Open System ARchitecture
B2B	Business-to-business
B2C	Business-to-consumer
BCE	Basic computing entity
BERD	Business enterprise R&D expenditure
BSG	Board support group
CAD/CAM/CAE	Computer aided design / computer aided manufacturing / computer aided engineering
CAGR	Compound annual growth rate
CCC	Communication, co-operation and coordination
CE	Consumer electronics
CISTRANA	Coordination of IST research and national activities
COSINE	Co-ordinating strategic initiatives on embedded systems in the European Research Area
COTS	Commercial off-the-shelf
CSTI	Conseil Supérieur des Technologies de l'Information
DC	Directors Committee
DFC	Design for change
DRM	Digital rights management
DTI	Department of trade and industry
DVD	Digital versatile disk
DWDM	Dense wave division multiplex
E&E	Electrics and electronics
EAO	Enterprise asset optimisation
EC	European Commission
EJB	Enterprise Java Beans
ERA	European Research Area
ESP	Electronic stability programme / Extra sensory perception
ETP	European Technology Platform
EU	European Union
EUREKA	An intergovernmental initiative that aims to strenghten European competiveness by promoting cross-border, market-oriented, collaborative R&D
FEF	Family evaluation framework
FP	Framework Programme
FP6 / FP7	Sixth / Seventh EU Framework Programme
FPP	Full project proposal
FTE	Full time equivalent
GDP	Gross domestic product
GERD	Gross domestic expenditure on R&D
GPS	Global positioning system
GSM	Global system for mobile communications (cellular phone technology)

Term	Explanation
HLG	High Level Group
HSI	Human-system interaction
HTTP	Hypertext transfer protocol
IBS	Infrastructures and basic services
ICT	Information and communications technologies
IDATE	Institut de l'Audiovisuel et des Télécommunications en Europe (Independent research institute in France)
IDC	A global market intelligence and advisory firm in the information technology and telecommunications industries
IMSS	InterScan Messaging Security Suite OR Internet and Management Support for Storage
IOA	ITEA Office Association
IP / IPv6	Internet Protocol / Internet Protocol version 6
IPR	Intellectual property rights
ISCED	International Standard Classification of Education
ISIC	International standard industrial classification
ISP	Internet service provider
ISSCC	International Solid State Circuits Conference
IST	Information Society Technologies: a research programme managed by the European Commission Information Society DG
ISTAG	IST Advisory Group
ISV	Independent software vendor
IT	Information technology
ITAC	ITEA Authorities Committee
ITEA	Information Technology for European Advancement
JETI/JTI	Joint technology initiatives
JOnAS	Java Open Application Server
JTI/JETI	Joint technology initiatives
LAN	Local area network
MDA	Model-driven architecture
MEDEA+	Microelectronics Development for European Applications
MOS	Metal-oxide semiconductor
MPEG	Motion pictures experts group
MRI	Magnetic resonance imaging
MTA	Mid-term assessment
NDA	Non-disclosure agreement
NESSI	Networked European Software and Services Initiative
NMS	New member state
ObjectWeb™	A European open source software community
OECD	Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer
OMG	Object management group
ORACLE	A packaged software producer
OSGi	Open Services Gateway Initiative
OSS	Open source software
P2P	Peer-to-peer
PAN	Personal area network
PC	Personal computer
PCA	Project co-operation agreement
PDA	Personal digital assistant (electronic handheld information device)
PO	Project Outline
QoS	Quality of service
R&D	Research & development

Term	Explanation
R&D&D	Research, development and demonstration
RDF	Resource description framework
RFID	Radio frequency identification
RNTL	Réseau National des Technologies Logicielles (National Network for software technologies)
ROI	Return on investment
RT	Real-time
S&E	Science and engineering
S&T	Science and technology
SAP	A packaged software producer
SC	Scientific committee
SDL	Specification and description language
SiS	Software-intensive systems
SME	Small and medium-sized enterprise
SMP	Symmetric multi-processing
SMS	Short message service (cellular phone text messaging)
SNA	Systems of national accounts
SOAP/XML	Simple object access protocol / Extensible mark-up language
SOHO	Small Office / Home Office
SSC	Software and services creation
STG	Steering Group
TNO	An independent research institute in the Netherlands
UDDI	Universal description, discovery and integration - an XML-based registry for businesses worldwide to list themselves on the Internet
UI	User interface / Universal interface
UML	Unified modeling language
URI	Uniform resource identifier
VoIP	Voice over Internet Protocol
WC3	Worldwide web consortium
WG	Work group
WLAN	Wireless local area network
WSDL	Web services description language
WW	Worldwide
XML	Extensible mark-up language

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European leadership in Software-intensive Systems and Services

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