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A Report on the EU's IST Project GEMINI

By José Soler Lucas, Denmark

GEMINI stands for Generic Architecture for Customised IP-Based IN Services over Hybrid VoIP and SS7, a European Union (EU) Information Societies Technology (IST) project started in spring 2002 and finished in spring 2004, with Telekom Austria AG, Alcatel Sel AG, Solinet GmbH, Intracom S.A., Otenet S.A., and the COM Center of the Technical University of Denmark as participants.

The main objective of the project was to offer existing and next-generation customized and personalized intelligent network (IN) services in an IP-based environment to meet the demands of multiparty multiconnection multimedia calls. Additionally, GEMINI focused on interworking between IN-IP-based and IN-SS7-based architectures in order to deliver value-added services in a converged environment to both public switched telephone network (PSTN) and IP-based clients.

To achieve these aims, GEMINI designed a modular and scalable architecture. After initial definition and specification, different entities were implemented for that architecture:

IN services gateway (INS-GW): The INS-GW is the key component for interconnecting the PSTN to the voice over IP (VoIP) network in GEMINI's architecture. It implements gateway functionalities at three levels: media, call control signaling, and service-specific signaling.

Enhanced service control point (E-SCP): The E-SCP is an extended PSTN-based SCP that allows provision of IN service logic in hybrid environments and provision of IN service customization capabilities from the IP domain.

IP-based service switching point (IP-SSP): The IP-SSP is the functional equivalent of a PSTN-based SSP. Besides basic service switching functions (proxying), it also implements a conference bridge and an H.323-to-Session Initiation Protocol (SIP) interworking module.

IP-based service control point (IP-SCP): The IP-SCP is an application server that enables execution of service logic accessible from the PSTN and VoIP network.

Different concepts and technologies converged in the GEMINI architecture: process modeling (SDL), telephony signaling mechanisms over IP networks (the Internet Engineering Task Force's, IETF's, SIGTRAN), service logic supporting technologies (JSR's SIP Servlet application programming interface, API), Web services (SOAP-based remote procedure call, RPC), and others.

Once implementation of the different entities concluded, a period of integration started in fall 2003. Telekom Austria AG, Alcatel Sel AG, and Solinet GmbH performed integration testing of their equipment and developments (existing SS7 infrastructure, E-SCP, INS GW), while Intracom S.A., Otenet S.A., and the COM Center performed integration trials with theirs (IP-SSP, IP-based SCE, and IP-SCP). Intracom and Solinet also performed interoperability testing of their respective developments (IP-SSP and INS-GW, respectively).

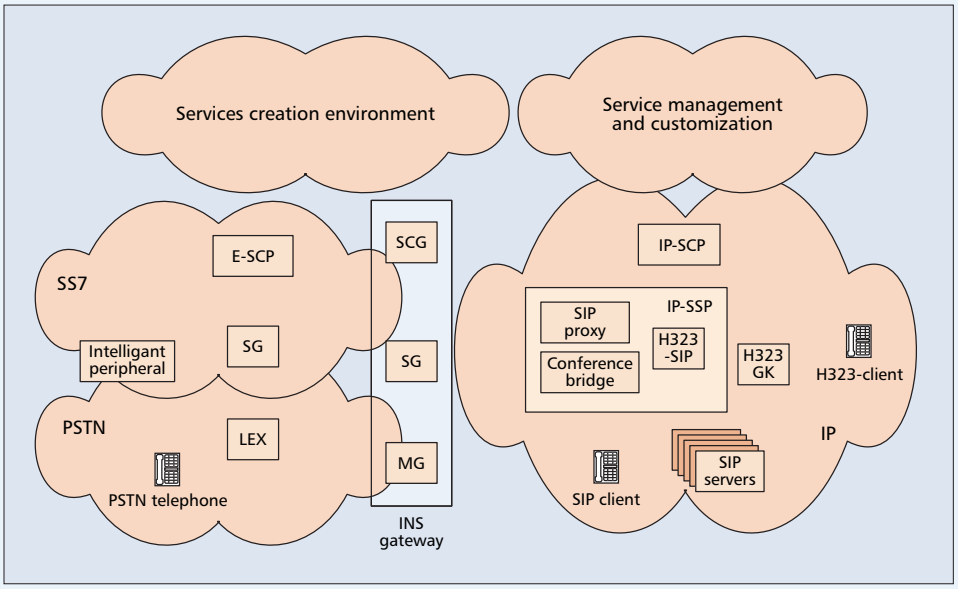

Figure 1. *Gemini architecture.*

An integration setup with all equipment and developments was built at Telecom Austria's premises, Vienna in February 2004.

A final demonstration and review of the GEMINI Project was held at the end of February 2004 in Austria. The results fulfilled the initial requirements of the project, and the final review was positive.

The GEMINI project has been a successful experience toward provision of advanced IN services in converged telephony environments. The involved partners continue working in the area of service provisioning and service architectures evolution.

Further information on the project and contacts to the respective partners may be found at http://gemini.otenet.gr

Internet Search Engine Evolution: The DRIS System

By Wang Liang, Guo Yiping, and Fang Ming, China

What is the main purpose of the Internet? Information retrieval and exchange. What is the most important principle in judging a network? Maybe communication speed. Network research projects always claim how fast their networks are, but as common users, we cannot always feel the advantages of gigabyte Internet over megabyte networks. We do not usually watch TV on the Internet. On the contrary, when we input a query word in Google, we always obtain more than 10,000 records. The Internet is going farther and farther from one of is original aims, to be a knowledge source for human beings, and being transformed into a jumbled information sea.

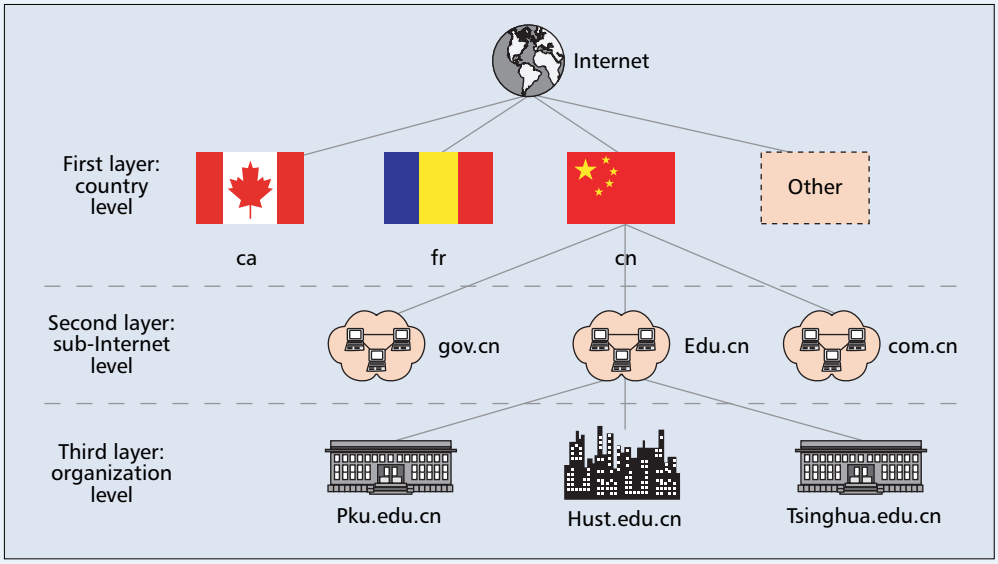

Figure 1. *DRIS architecture.*

We present a digital library project in China, a novel information retrieval system: the Domain Resources Integration System (DRIS). The main idea of DRIS is that search should be an internal function of the Internet.

So we find the first dilemma. All search engines try to provide comprehensive and fresh information for its users, but none of them builds a database system that can mirror the whole Internet.

Second, many search engine companies are concerned with how to make a profit from users by advertisement and ranking prominence, but never consider what its real customers feel. All ranking methods are kernel secrets of search engine companies. There is no surveillance of this operation. If all the information is in the charge of a small group, the Internet will surely become its own vault. So many people believe that a search engine administrates all you could know and what you couldn't otherwise attain, and that the search engine is the Internet God. But in a free market, the customer should always be God. When we have to bear bothersome advertisements and awful results and have no choices, the Internet as a kind of public goods is undermined.

So we find the second dilemma. A search engine is originally a tool for the convenience of Internet customers, but search engine companies have to use advertisements or gain selling rank prominence, both somewhat inconvenient to information retrieval, to maintain their subsistence.

DRIS

To build an efficient information retrieval system for the whole Internet, we must first deal with diverse basic dilemmas, such as the infeasibility of building a database system that can mirror the whole Internet, and the trade-off between customer convenience and advertising abuse. We propose an experimental system, DRIS, which provides a practical solution to some of these problems.

The main points of DRIS are:

- The purpose of DRIS: Building a search system that can integrate all kinds of information resources in the Internet.
- DRIS will build an information retrieval infrastructure for the whole Internet, but not the final search engines.
- The basic idea of DRIS: Searching should be an internal function of the Internet, independent of user search engines.

The main difference between DRIS and current search engines lies in its architecture. In our experience, decentralized management is much more effective than totally centralized administration in large-scale systems. So we also adopt a hierarchical architecture to manage all the information on the Internet, just like the administration methods of any large organization. The key issue is how to divide the Internet correctly. We apply the Domain Name Service (DNS) philosophy to DRIS, whose architecture is shown in Fig. 1.

In the third layer of DRIS (organization level), a conventional database system will be built; in the second layer a metadata harvest system is applied; in the top layer, we will build a distributed search system. By applying an appropriate information retrieval system, we can build an information management frame for the whole Internet.

Who will control DRIS? It is administered by none of us and all of us. DRIS is managed by its users and coordinated by a public organization, just like the management method of DNS. Every organization is its customer as well as its builder. DRIS is an open system, which does not extract any profit from its users and, of course, needs no advertisements. So the second dilemma above is solved.

How can we get information from DRIS? In DRIS, every node is an integrated search engine and can provide a search interface to anyone. We can get results from DRIS just as we do through a conventional search system, but that crude service can only provide the same results for the same query words submitted by anyone, which does not reflect one's own interests. In fact, DRIS only builds the information retrieval infrastructure for the Internet. It will provide a standard search service (application program interface) in a three-level scope of the Internet for free. Intelligent search systems can use DRIS as a data source to provide a high-quality personal search service.

We expect to deploy DRIS in the China Education and Research Network (CERNET) in fall 2004. We plan to develop it to a larger extent as part of IPv6 (there is an IETF work group proposal).

eInfrastructure: Changing How Research is Done

Mário Campolargo, European Union

Today's demanding research challenges require a well coordinated global approach to joint research undertakings, involving collaboration between leading researchers and research infrastructures worldwide.

The fundamental role that advanced information and communication technologies (ICTs) play in scientific and technological progress is widely acknowledged and has led to the concept of extended science (eScience), where sharing ideas, information, and research facilities is an absolute necessity.

Through its Framework Research Programmes, the European Commission is committed to helping Europe develop a fabric of research infrastructures of the highest quality and performance to serve the needs of all the various research communities.

Building on the existence of one of the most performant networks for research in the world, GÉANT, the European Commission has started an ambitious program in Europe to undergird the concept of eInfrastructure.

The eInfrastructure enables much closer cooperation among researchers in all of the European countries and, by so doing, constitutes a major building block of the European research area (ERA), the research and innovation equivalent of the European Union's "common market" for goods and services. It provides a means of ubiquitous computing and communications for researchers across Europe.

The European Commission is also fully committed, through common policies, to broadening the eInfrastructure user base, which will maximize benefits for industry and citizens in general. As well as promoting growth and cohesion, these efforts will ensure much larger-scale international cooperation.

The deployment of eInfrastructure is central to the 6th Research and Development Framework Programme (in which an overall budget of €300 million is foreseen over a period of four years).

The Context

The eInfrastructure concept was first proposed in 2003 to coin a vision for the development of a next generation of trans-national ICT research infrastructures in Europe. This concept envisions the researcher's ability to have controlled, secure, seamless, easy, and economical access to shared science and engineering resources, enabled by the provision of a fully integrated advanced information and communications infrastructure.

In the provision of an advanced eInfrastructure, the most advanced ICTs — such as broadband, grid, IPv6, semantic Web, and mobile communications — play a strategic role in changing the way science and engineering will be carried out in the future in fields as diverse as physics, genomics, astronomy, environment, business, and aeronautics.

Various infrastructural layers — computing, communication, and services — are required to create pan-European virtual centres of excellence and research laboratories. On top of communication and computing capabilities, ICT research will provide technologies for collaboration, knowledge sharing, and experimentation in various areas of science and engineering.

Building the European Research Area

The concept of eInfrastructure, responding to the needs of advanced research communities eager to get the benefits of virtual collaborative environments, has been well adopted in Europe.

The eInfrastructure concept builds on Europe's strong position in communication networks for research (national research and education networks, NRENs, and the European backbone GÉANT) and the successful results of experimental large-scale grid testbeds (e.g., DATAGRID, Eurogrid, DAMIEN, and CrossGrid, projects carried out in the context of the EU Fifth R&D Framework Programme).

Furthermore, a number of national programs in Europe are creating similar models for the shared use of resources across different institutional and user application domains. This favors the development of a common approach in which the European and national efforts are complementary (the subsidiarity principle) and can mutually benefit. One of the most characteristic examples is the e-Science programme in the United Kingdom, in which a grid-based infrastructure is being built to enable next-generation scientific research with a particular focus on the shared use of computing and data resources across the country and across numerous scientific disciplines.

The eInfrastructure concept is key for the realization of the European research area (ERA) since it has the potential to bring the power and services of large facilities to the desktop of the individual researcher. At the same time it provides a truly European dimension to facilities of European interest, independent of their physical location (resource virtualization), thereby promoting cohesion and rationalization of investments.

This initiative runs in parallel with similar ICT development programs in North America (e.g. cyberinfrastructure in the United States and iInfrastructures in Canada) and Asia-Pacific (e.g., Naregi and APGrid).

The Approach

The eInfrastructure can only be realized effectively through the integration of several distinct elements:

- The pan-European networking infrastructure for research (GÉANT and NRENs)
- The distributed computing, storage, and data resources provided by national or international facilities all over Europe, as well as access to the available instrumentation (ranging from the smallest of application-specific sensors to large-scale instruments such as the large hadron collider at CERN)
- A new generation of grid-based middleware services, which allow any authorized user to share resources efficiently for collaborative research work, embedded in a pan-European infrastructure bringing together the key science and engineering facilities in Europe
- A framework of administrative and policy mechanisms to remove barriers related to deployment and use of new technologies

The Achievements

The concept of eInfrastructure builds very much on the achievements of previous projects launched in the context of the Fifth Framework Programme (IST Programme, area of research networking): GÉANT and the IPv6 and grid testbeds.

In 2004, a first wave of new projects is materializing the eInfrastructure concept:

- GN2, a project that will be responsible for the second generation of GÉANT, extending and improving the functionalities and services provided by the current GÉANT network (http://www.dante.net)
- EGEE, a project that will deploy the largest international grid infrastructure with the combined capacity of over 20,000 CPUs, federating 70 institutions in more than 20

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countries, supporting, among others the high energy physics and biomedics communities (http://egee-intranet.web.cern.ch/egee-intranet/gateway.html)
- DEISA, a project that aims to build a distributed tera-scale supercomputing facility made up of six major supercomputing centers across Europe (http://www.deisa.org/)
- SEE-Grid, a project extending the pan-European grid infrastructure to southeastern Europe (http://see-grid.inima.al/).
- A series of testbeds promoting the integration, testing, validation, and demonstration of networking technologies and favoring the uptake of technologies by fostering the interoperability of solutions across different disciplines

Further to this R&D effort, experience shows that full exploitation of a new innovative paradigm with such a broad scope and cross-border relevance as the eInfrastructure concept is better achieved when the appropriate administrative and policy mechanisms are put in place. Consequently, and in line with the recommendation of an event organized under the aegis of the Greek presidency, an eInfrastructure Reflection Group (eIRG) was eventually established during the Italian Presidency, composed of members appointed at the ministerial level. The main objective of the eIRG is to support, on the political, advisory, and monitoring levels, the creation of a policy and administrative framework for easy and cost-effective shared use of electronic resources in Europe (focusing on grid computing, data storage, and networking resources) across technological, administrative, and national domains.

The Impact

The current developments are creating the expectation that the underlying technologies are maturing quickly enough to support the emergence of eInfrastructure. The eInfrastructure concept is a concrete implementation of a new paradigm according to which the shared use of computing and data resources across diverse technological, administrative, and national domains will become a commodity service. It is obvious that such a paradigm has the potential to dramatically change the way people work and do business over the Internet.

Once the eInfrastructure is implemented and becomes operational, benefiting users will perceive it as one unified large-scale computational resource. It is key for the eInfrastructure concept that the complexity of the service organization and underlying computational fabric remain transparent to the user.

Researchers linked to the EU eInfrastructure will therefore benefit from the following.

Simplified access to scientific resources: Today, researchers have to deal with various user accounts in the numerous computer centres accessed, each subject to different resource allocation procedures. The overhead caused by this fragmentation is quite significant. The eInfrastructure will reduce this overhead by providing means for users to join virtual organizations encompassing all needed operational resources.

Large-scale resources: Some of the complex problems being addressed by specific research communities can no longer be handled by a single computer. The eInfrastructure, combining the power of many individual computers, will open up new avenues to address previously intractable problems in strategic application domains.

Europe-wide pervasive access: The eInfrastructure will ensure access to all relevant scientific resources from any geographic location, thus providing regions with limited computer resources the possibility of access on an as-needed basis to large resources.

On-demand scientific computing: By allocating resources efficiently, the eInfrastructure promises greatly reduced waiting times for access to resources.

Sharing of scientific software and data sets: Just a unified computational fabric created by the eInfrastructure will empower widespread user communities to be able to share software and data sets in a transparent way.

Virtual research organizations: eInfrastructure, by federating resources of all types and providing seamless access to them, will foster the emergence of new virtual organizations in which global communities will cooperate.

Improved support for research communities: The concept of a deployed eInfrastructure goes hand in hand with the implementation of policies for resource sharing, and encompasses the important aspects of operational support and training. This will constitute significantly improved support for all key applications, including around-the-clock technical systems support for the innovative grid services made available.

Moreover, the eInfrastructure vision has inspiring long-term implications for the ICT industry. By pioneering the sort of comprehensive production grids and networking services that are currently envisioned by scientists and ICT experts, which at present are beyond the state of the art and national or enterprise-wide grid initiatives, eInfrastructure will address solutions to issues such as scalability and security that go substantially beyond what can be achieved in limited-scale R&D projects. This process will lead to the spinoff of innovative ICT technologies, which will doubtless have benefits for industry, commerce, and society in general.

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