
Original software
with a special glow
from AIST

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Software serves as a critical fundamental technology to support society today.
Being a public research organization sustaining Japan's industrial science and technology, AIST actively promotes research, development, publication and spread of original software to realize what cannot always be achieved by commercial software alone.
This pamphlet introduces some of the original software from AIST which is available to the public and used by many people, as well as new software resulting from recent development. It also covers research and development of middleware which is rapidly growing more important.
This pamphlet also features multidimensional system research expected to lead software in the future.
Technologies introduced in this pamphlet are part of the many pieces of original software from AIST.
By developing and providing a wide variety of software, we, AIST will contribute to the realization of a society where everybody can use IT effectively to live a creative life.

Kazuhito Ohmaki
Research Coordinator for Information Technology

Proven Software of AIST

HORB: Distributed Object Technology

When you write a program or learn to write a program, you often want this computer and that computer to work in conjunction with each other. For instance, when you measure the amount of snowfall throughout the nation and compile the data, or you let multiple robots perform certain sequences of given processes in a factory line. A program to command such procedure is called a distributed program. Creating a distributed program is far more difficult than creating a regular program which runs on a single computer. Since the 1960s, many researchers and engineers had explored methods of creating distributed programs beyond the borders of processor and OS, but without success until the mid-1990s. HORB (Hirano's Object Request Broker), published in 1995, is the world's first processing system which enabled the easy creation of distributed programs using the popular Java language.

Once it was published on the Internet, my mail box overflowed with hundreds of e-mails offering excited and complimentary comments. I had an excited phone call from someone in New York, and received visits from several companies in the U.S. seeking license permission. One of my fondest memories was when I was awarded the Nikkei BP Technology Awards, and had a chance to talk with Dr. Shuji Nakamura at the party, who also won the award for the famous blue LEDs.

On the technical front, while leading American companies developed

Fig. 1: Hirano shares the Nippon Keidanren Chairman's Award for his contribution to Industry-Academia-Government collaboration with other corporate personnel. (Hirano stands on the extreme left.)

competitive technologies one after another, I worked too hard and fell ill, which delayed improvement of the application's functionality and reliability. Under those circumstances, I was fortunate enough to be helped by my colleagues and supported by companies that organized a user group which took over the development and holding of the symposium. I am glad that HORB has been used for developing many products. Its developmental responsibility has now returned to AIST, and an improved version of HORB is now under development by a team of four researchers studying the embedded system.

Satoshi Hirano
Information Technology Research Institute

"Mule" and "the m17n library": World Languages on a Computer

There are about 6,000 languages across the globe, which are written with various characters including Chinese characters, Arabic alphabet and Latin alphabet. What we are developing is software to handle documents of any language using any characters on a computer.

Our first multi-language software was a text editor named "Mule" developed about 10 years ago. This software has been integrated to an editor called "GNU Emacs" widely used on Linux/Unix, and enjoyed by many people around the world.

We are currently working on the development of a multi-lingualization library named "the m17n library" which has been available*1 as open source software since 2004. Most Linux distributions now contain packages for "the m17n library."

The library is a collection of components to be used when writing an application program. If the components are multilingual, the application developer can create a multilingual application even without knowledge of languages and characters. To cite a specific case, SCIM, the commonly-used input method, uses components of "the m17n library."

Mikiko Nishikimi
Information Technology Research Institute

Fig. 2:
Multiple languages are displayed with the Cairo vector graphics library.

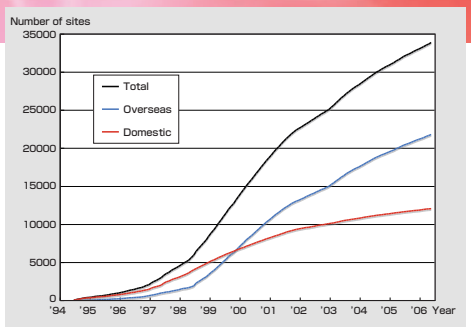
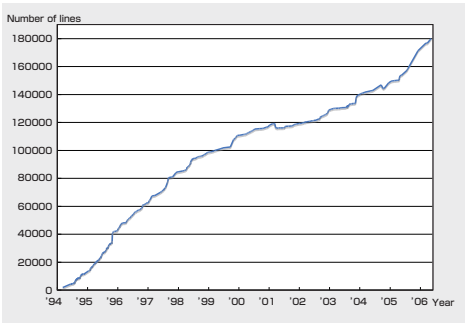


Fig. 3:
Increase in the distribution (number of sites) of DeleGate (UP) and growth in the program scale (number of lines) of DeleGate (RIGHT)



Growing "DeleGate" Relays Anything on the Internet!

DeleGate*2 is infrastructure software (proxy server) which relays communication via e-mail, Web and many other Internet services. It also supports the operation and use of these services in a variety of ways.

DeleGate has wide ranging applications including improvement of security, privacy protection (authentication, access control and encryption), reduction of communication data volume (compression and cache), integration of servers (virtual host and reverse proxy), route control and tunneling (application-layer routing), blocking junk mail, conversion of communication data and method, etc. One of its features is the ease of adding filters to convert or translate the data to relay.

DeleGate is mainly used on the firewall to connect inside and outside of an organization (site) while it is also used on personal computers of individual users. It works on most OS including Unix and Windows, and covers most basic communication methods (HTTP, FTP, SMTP, POP, IMAP, Telnet, Socks, SSL, DNS, etc.).

It was back in 1994, when the Internet started to become common in Japan, that DeleGate first came into use as a proxy server, one of the first that emerged worldwide. For the following 12 years, it has continued to grow consistently, responding to the circumstances and users' demands of the time. Its source program has been available to public for free since the beginning, and distributed to about 34,000 domains in over 150 countries. DeleGate started to support commercial use in 2004, and is now licensed to adoptions for various products and commercial services, both at home and abroad.

Yutaka Sato
Information Technology Research Institute

*1 http://www.m17n.org/m17n-lib
*2 http://www.delegate.org/

Ever-expanding Software World of AIST

In a restricted sense, software has almost the same meaning as computer program. Software is a description of the procedure to operate a computer, written in a language understandable to computers.

They say a broad range of our social activities are supported by computers today. Without software, however, computers are just boxes. This makes it no exaggeration to say that what is truly supporting society is software.

It is widely believed that software is broadly classified into two categories; basic software (operating system) and application software. Windows, MacOS and Linux are categorized to the former while word-processing software and spreadsheet software are examples of the latter. This is a natural way of thinking from the standpoint of personal computer users. Actually, software purchased by the public consumer would fall into either of them.

In the current circumstances, however, computers are supporting human activities beyond the users' view and software actually has a wide variety of forms and areas of activity.

As a public research organization sustaining Japan's industrial science and technology, AIST actively promotes research, development, publication and spread of original software to realize what cannot always be achieved by commercial software alone. Those featured in this pamphlet are our original software that has come into common use for everybody, although we develop specialized application software and academic libraries unique to individual research fields as a matter of course.

In the previous sections, we have introduced recent status of already proven software: "HORB," "Mule · the m17n library," and "DeleGate." Since the era when AIST was national laboratories under the control of the Agency of Industrial Science and Technology, we have always played a prominent role in the initiative to develop a philosophy of "open source software." For security reasons, it is risky to depend solely on commercial software, and open source or free software is definitely needed in order to build the infrastructure of society such as kernel, programming language, networking infrastructure software, and

Recent Software Development

BayoNet: Modelize Knowledge from Vast Quantities of Data and Wise up the IT around You

These days it is quite common for people to enjoy music, TV programs and shopping via Internet or cell-phones, so as a consequence, a large part of everyone's day-to-day living activities are accumulated as computerized data. Such data is already used to recommend specific products in Internet bookshops. If we succeed in creating models that use such data, not just as purchase histories but as a knowledge base that would be reusable for wider purposes, we will be able to optimize services that meet individual needs and develop marketing for developing desired products. To develop an information technology that modelizes such knowledge, we have worked on the research and development of BayoNet; software that establishes probability models (Bayesian network) from a wealth of data and makes deductions.

Licensing and product sales of BayoNet also started in 2002. Having improved the speed and functionality, and advanced applied research for more concrete issues, we came to find its practical applications described as follows.

Applications of BayoNet

In a collaborative development project between AIST and NIFTY

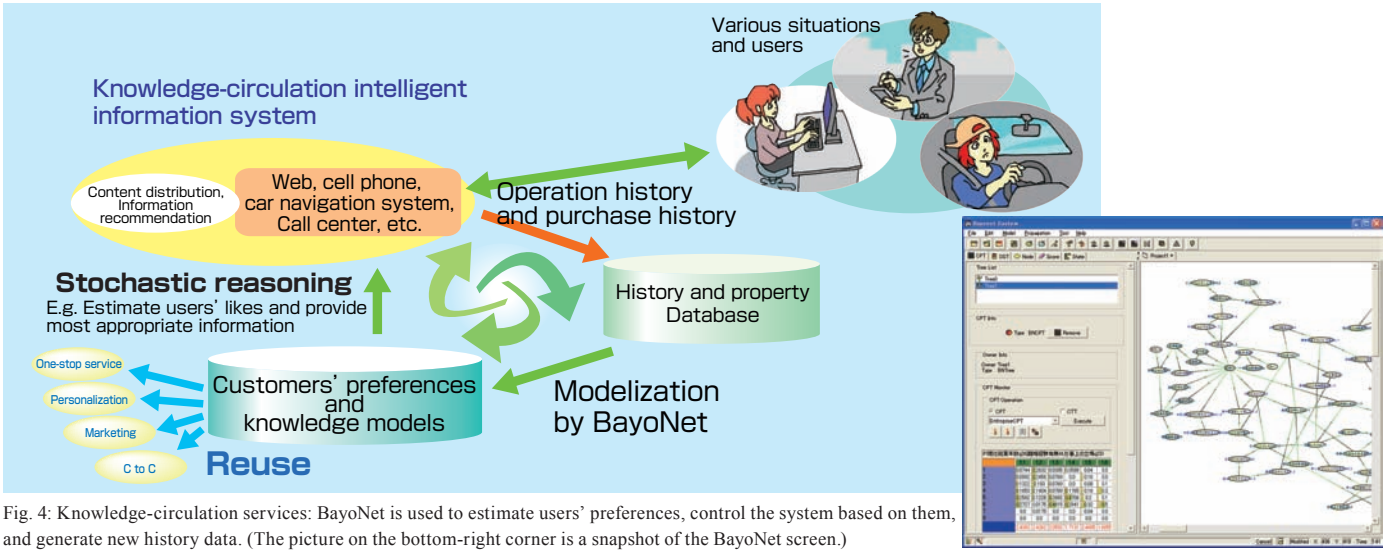


Fig. 4: Knowledge-circulation services: BayoNet is used to estimate users' preferences, control the system based on them, and generate new history data. (The picture on the bottom-right corner is a snapshot of the BayoNet screen.)

database management systems. Along this idea AIST plays a part in the world's software development. Development of "KNOPPIX Japanese version" to be introduced below is one of the activities based on such an initiative.

Human social activities are increasingly oriented by the Internet. In the future, people will have an even greater need for software that provides high-quality services to all users. What society seeks is software that supports a use model that smoothly combines the information provider, the information user, and the service provider. "BayoNet" and "qwikWeb" are exactly the type of software which has started to succeed in this field.

On another front, software called "middleware" is recently receiving more public attention. It runs on operating systems, and provides application software with more advanced and concrete functions than operating systems do. In other words, middleware is a mediator between operating systems and application software. Universal functions used only in particular fields, but definitely needed in those fields are often provided in the form of middleware. Middleware irons out the differences due to operating systems and hardware, and facilitates the development of application software that can operate on a range of platforms. Robot Technology (RT) and Information Appliance are typical examples of these particular fields.

The development of software, continuing to grow while covering various fields and levels, is shifting from developing individual functions, to developing a total system. AIST will keep up its efforts across a wide range of research activities related to computers and software, including new system technologies such as grid computing and semantic computing, as well as system verification technologies to improve reliability of the system itself. We believe such efforts will contribute to the realization of an IT society where everybody can enjoy safe intellectual activities.

Katsuhiko Sakaue
Information Technology
Research Institute

Corporation, the Internet provider, we are carrying out research and development of a guidance system to facilitate the handling of inquiries from millions of customers to a call center. This system utilizes the ideal dialogue of experienced operators as a knowledge base to create models and use such models to assist novice operators. In the financial industry, financial products like deposits and investment trusts could be differentiated only by the interest rate. In recent years however, the liberalization of financial systems and diversification of customers are boosting the demand of services corresponding to individual life plans. In response to such needs, we are working on a system which uses BayoNet to analyze and modelize the questionnaire data from ten thousand people on their everyday consciousness, for marketing purposes to identify potential demand, and based on that, automatically control the customer guidance and information desk support system. This research is pursued jointly with Nomura Research Institute, Ltd. Major catalog houses have purchase histories of about 15 million customers. Such a wealth of data is expected not only to be analyzed statistically but also to be used as knowledge for future improvement. At "Modellize, Inc.," AIST's venture company for technology transfer, they are developing a system that uses BayoNet to support telephone operators. The system uses the reasons that a particular product sells to develop knowledge models for selling the next product and uses such models to present the most appropriate instructions and products to the customers.

Yoichi Motomura
Digital Human Research Center

Evolution of KNOPPIX Japanese Version

How is KNOPPIX Japanese version used?

KNOPPIX is a Linux distribution which boots from a single CD. It was developed by Mr. Klaus Knopper in Germany, and its Japanese version is maintained by us. As it does not require a hard disk, you can experience Linux applications easily even on a computer pre-installed with Windows. KNOPPIX has superior ability to automatically recognize devices connected to the computer, and configures network settings, video devices, etc. automatically when it boots. This makes it easy for novices to try out Linux. Taking advantage of this convenience, KNOPPIX is used in the Open School Platform project (Kyotanabe city, Kyoto) *3 of the Center for Educational Computing (CEC) utilizing open sources as well as in the e-municipality experiment (Tsukumi city, Oita) *4 of the Information-technology Promotion Agency, Japan (IPA).

Although KNOPPIX is convenient to use with a single CD, it used to have some negative aspects such as; another CD must be created to update the application, and users have to download an extremely large volume (approx. 700MB) of data (an image of the entire CD) when a new version is released. To solve these problems, we have developed "HTTP-FUSE KNOPPIX" which can be booted directly from the virtual CD image on the Internet.

As the virtual CD is subdivided into small files (block files), HTTP-FUSE KNOPPIX allows users to download only necessary files whenever

*3 CEC Open School Platform project http://www.cec.or.jp/e2e/osp/index.html (in Japanese)
*4 Verification of the introduction effects on the utilization of open source software by the IPA government http://www.ipa.go.jp/software/open/2005/stc/jichitaikekka.html (in Japanese)

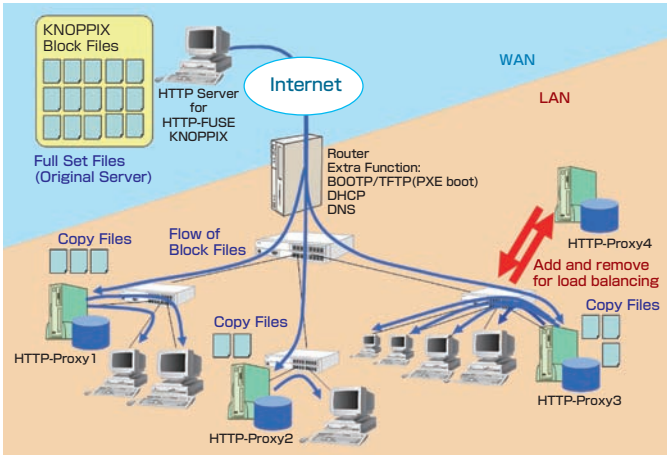


Fig. 5:
Mechanism of HTTP-FUSE KNOPPIX to boot through the Internet.

Fig. 6: Router with network-boot function incorporated (right blue box) and KNOPPIX booted through network using it.

needed. Even when updating the application, they only have to add the block files relevant to the updated section of the CD to use the new KNOPPIX. As the block files are distributed on http base, they can be cached in your local http proxy, which reduces network traffic and helps server load distribution. (Fig. 5)

It is also possible to incorporate the network-boot and http proxy functions in a small store-bought router. Using a router with these functions, you can use KNOPPIX without creating a CD. Performance-wise as well, the network enables faster booting than from a CD because the network today has wider bandwidth. As this router can also boot multiple computers, it is expected to be used in facilities like school computer rooms.

Future development – highly reliable boot and virtualization –

In the future development of KNOPPIX, we plan to realize a higher reliability of boot by using the secure chip TPM (Trusted Platform Module) with security in mind, support Xeonppix*5 with Xen, the open source virtual calculation monitor incorporated, and make it possible to boot various OS including OpenSolaris and Darwin.

Kuniyasu Suzaki
Information Technology Research Institute

qwikWeb

Communication System Integrating Mailing List and Wiki

qwikWeb*6 is an information sharing system that facilitates communication in a small group by combining two communication methods, mailing list and WikiWikiWeb (Wiki). This software is designed so that users who exchange daily information only by e-mails will come to be able to use a communication system on the Web in a seamless way.

qwikWeb is an integration of "QuickML," the easy-to-use mailing list management system and originally-implemented Wiki. It is written in Ruby, the object-oriented script language, and adopts a plug-in module structure to allow easy customization. Its trial environment has been published on the Internet since August 2003, and stable performance has been confirmed over the years.

A user first creates a mailing list by sending an e-mail to the system, which creates a Wiki site accessible only by the mailing list members. Submitted e-mails are saved on the Wiki, grouped by title, and can be easily reviewed later. The URL of the corresponding Wiki page is added to the e-mail footer, and users can access the corresponding Wiki page just by clicking on it.

qwikWeb is designed to lead users to more advanced usage in stages, starting with handy communication by e-mail. We would recommend that you give it a try yourself and experience the power you get by linking up e-mails and the Web. You can create your own Wiki on the qwikWeb homepage and try it out.

What's behind the spread of Wiki

WikiWikiWeb is a collaboration system on the Web which was started by Ward Cunningham in 1995. A famous example is Wikipedia which builds up an encyclopedia through collaborative works on the Internet. Three Wiki-related companies (Socialtext, Atlassian (Confluence), and JotSpot) have emerged up to now, and more companies are introducing Wiki.

As a joint event with OOPSLA*7, the first international Wiki symposium (WikiSym 2005) was held in 2005. An international conference named "Wikimania" was also hosted on the subject of Wikipedia, proving that the academic society has started to take up Wiki. In WikiSym 2005, I also made a presentation about qwikWeb and received a favorable reception.

Spread of qwikWeb

qwikWeb is currently installed and used in various situations such as "Network Applied Communication Laboratory" with the developer of Ruby and "IPA CODE blog project" *8 by open source experts. Starting in FY 2006, qwikWeb is used for communication inside the Information Technology Research Institute. We can tell qwikWeb is coming into use as a system of choice for open source professionals. The May 2006 issue of "Software Design" carries an article of mine titled "qwikWeb Top to

*5 http://unit.aist.go.jp/itri/knoppix/xen/index-en.html
*6 http://qwik.jp/ (in Japanese)
*7 Conference on Object-Oriented Programming Systems, Languages, and Applications : argest conference on object-oriented technology
*8 https://www.codeblog.org/ (in Japanese)

Bottom" which describes its usage, installation, etc. I sincerely hope for further spread of qwikWeb in the future.

Kouichirou Eto
Information Technology Research Institute

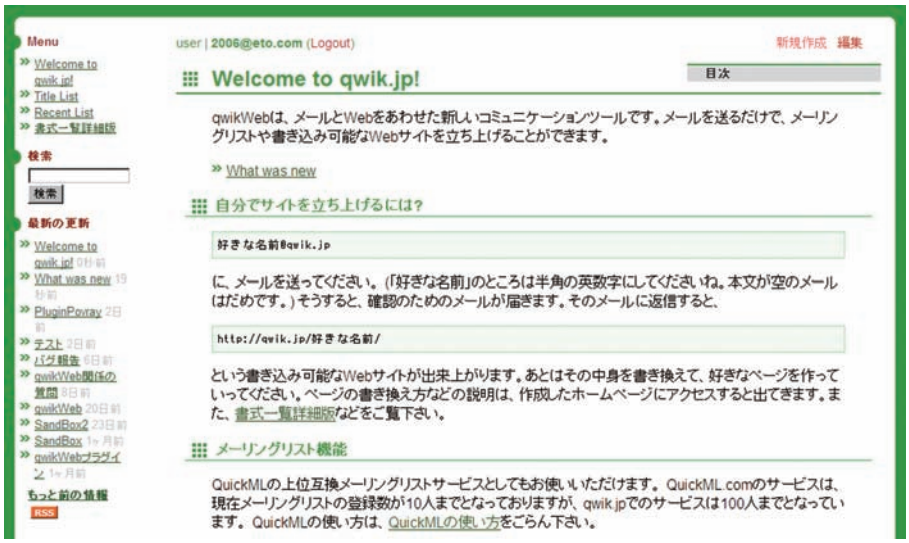


Fig. 7: Top page of qwik.jp

CCFinderX

http://www.ccfinder.net/

CCFinderX is a tool that detects code clones (overlaps in a program source code) and analyzes them using various figures and graphs.

Code clones are typically generated when a programmer develops source code by copy and paste. Once code clones are generated, the programmer has to make the same modification to each of those copies when changing the source code for bug fixes and function enhancements. For this reason, the existence of code clones is recognized as a critical issue reducing the productivity of software development, especially at companies with large-scale software to be maintained for an extended period.

CCFinderX is a recreated version of CCFinder developed in 2000, and was adopted in the IPA Exploratory Software Project in 2004.

In about 6 months since its first release up to today, the evaluation license version has been distributed to over 100 companies and universities in 17 countries around the world. CCFinderX is also cited in comparisons with other methods in their research presentations. As these facts indicate, CCFinderX has established a presence as a world standard.

Toshihiro Kamiya
Information Technology Research Institute

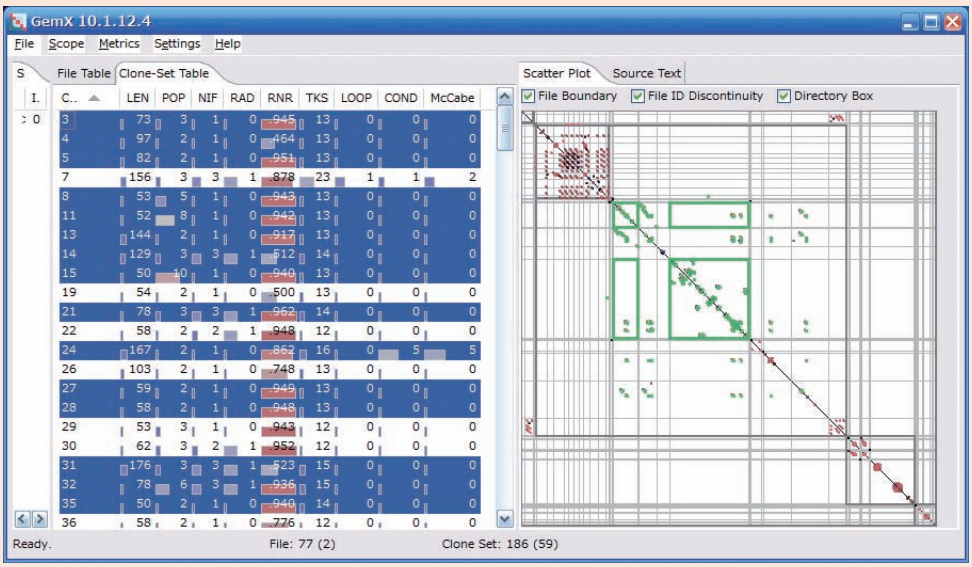


Fig. 8: Snapshot of GemX, the GUI tool included in the distribution package of CCFinderX

RT middleware "OpenRTM-aist"

As computers are becoming smaller and providing higher performance, and wireless networks are realizing higher speeds and larger capacities at astonishing pace, the subject of robot research is expanding rapidly from simple stand-alone robots like traditional industrial robots and humanoids to an "intelligence system with functions that help life in the real world utilizing robot technology." Such a system provides services like lifestyle support and nursing care by placing various sensors and actuators around the subject's environment and having them work in collaboration. The robotic technologies used for this kind of non-robot-looking systems are collectively called RT (Robot Technology).

In spite of many prototypes that exhibit the technical potential, product development has not yet shifted into full swing. In order to cultivate the new market of RT products, it is necessary to involve not only robot developers but all kinds of people who want to use the robot technologies, and to realize an environment where new applications that could benefit from RT are abundant. It is expected to improve the effectiveness of development of RT system and establish a system integration technology so that anybody can easily develop services using robot technology.

As its name implies, RT middleware is a generic term for program development environments convenient for developing RT systems efficiently. To improve development efficiency, accumulating common libraries required for establishing the systems is important. At the same time, it is also a priority to decide the standard framework of software modules for an RT system.

If we can establish a standardized integration technology as RT middleware, it will be possible to realize an RT system as a total system also connected to products from different companies. I am not talking about simple stand-alone products, but an RT system that provides services in collaboration with other products connected to the network. As they say "Connectability of equipments makes them worthwhile," what matters here is the interoperability.

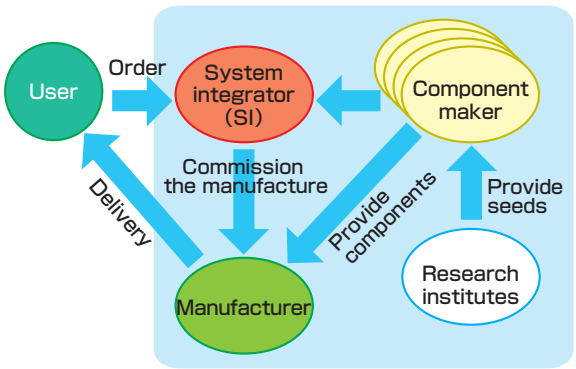


Fig. 9: Vision of RT industry structure expected to be realized in the 21st century: Introduction of the RT middleware technology advances the division of labor and allows small businesses and venture firms utilizing their respective expertise, diverse companies mixing different industries, and research and development institutes to enter the RT market through this initiative.

RT Middleware Project *9 (2002-2004) was carried out as a joint project among AIST, Japan Robot Association and Matsushita Electric Works, Ltd. The project aimed to establish a fundamental technology in software that allows you to easily construct RT systems with new functionality by converting functional elements into software modules and combining these components freely.

To examine the concept of RT middleware, we developed a prototype of RT middleware named "OpenRTM" focusing on the component creation support tool. OpenRTM is unique in that the common specification that makes up its framework and the implementation are separated and opened. The common specification of OpenRTM defines the abstract interface and its usage to make the functional elements of RT system operate with each other and construct an RT system. The functional elements satisfying this specification are called RT components.

By creating RT components from an existing developed system, anybody can easily reuse them as individual modules. This is expected to raise the efficiency of developing RT systems which are now getting increasingly complex.

AIST developed "OpenRTM-aist" as a reference implementation of development support software, providing assistance in creation and management of RT components compliant with OpenRTM.

Up to now, OpenRTM-aist*10 has built the framework for creating components as the first stage of development. In the future, it is expected that an increased number of RT components with common functions required to develop application programs will be accumulated and they will grow into a standard set of libraries.

We are currently working on adding functions and developing tools in its succession project. Meanwhile, standardization of specifications is promoted at OMG, an international software standards body, and we plan to develop OpenRTM-aist in conformity with such standard specifications.

With the aim of sharing technology, the concept of RT middleware cannot be realized by any sole company or institution's activities. Technical feedbacks after many failures are inevitable for establishing stable technologies. It is our sincere hope that the pioneers will participate in this attempt to share robot technologies.

This software (OpenRTM-aist-0.2.0) is a research product of the NEDO project "Development of a Software Infrastructure for Robot Systems" which we promoted in partnership with Japan Robot Association and Matsushita Electric Works, Ltd.

Tetsuo Kotoku
Intelligent Systems Research Institute

*9 http://www.is.aist.go.jp/rt/ (in Japanese)
*10 http://www.aist.go.jp/aist_e/latest_research/2005/20050311/20050311.html

Information Appliance Middleware

We came to hear the term "information appliance" more often in recent years. This term represents the appliances which are connected to the network and allow people to control them remotely, or enjoy content through the network. Typical examples are network-supported air conditioners and hard disk recorders. However, connecting such appliances to the network can sometimes cause problems. One is the problem of "user interface" where users have problems in handling the operation. The other is a problem of "interoperation" where appliances of different types and different manufacturers do not work together well. I guess quite a few of you have experience of getting puzzled with many remote controllers or having difficulty trying to connect equipments of different standards.

As a solution to these problems, AIST is developing software that defines the operation of appliances in a similar form to the vocabulary used by people and makes the appliances understand the operation directly (Information Appliance Middleware). I define the appliance operation here as something expressed in terms like "turn on the power," "record," and "turn the volume up." This technology is technically known as "ontology" and is used to share a semantic interpretation between humans and computers. By standardizing the way of instruction between human and appliance as well as between appliance and appliance, you will, for example, only have to say "tune in NHK", without caring about what channel number NHK is set to, or just give an instruction of "turn on the power" to have different appliances work in collaboration.

A living space called UBRoom is set up in the Akihabara Site of AIST for development and demonstration of information appliance middleware. In the UBRoom, you can experience speech-based operations and digital content searches with appliances as well as the front door lock, lighting, blinds and many other household devices.

Akira Mori
Information Technology Research Institute

Fig. 10: "UBRoom" set up in the Akihabara Site of AIST

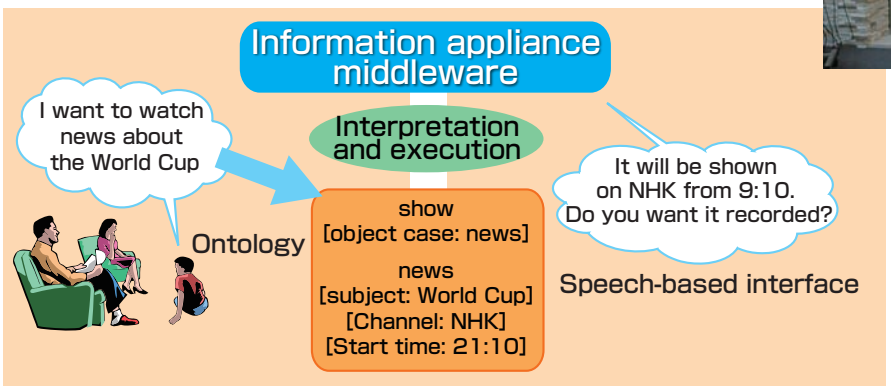


Fig. 11:
Information appliance middleware enables humans and computers to share a semantic interpretation.

From Individual Pieces to a System

Large-scale Infrastructure Software to Create International Standards Grid Middleware as an Example

There are two types of research and development of software intended for wide use in society. One is of "software to use standards" and the other is of "software to create standards." The term "standards" here includes both the "de jure standard" and "de facto standards." The "de jure standard" represents standards established by the companies, bodies and experts related to public institutions and standards bodies. XML and Unicode are some best-known examples. On the other hand, examples of "de facto standards" include Windows as the OS of a personal computer, and TCP/IP as an Internet communication protocol.

Original ideas matter in the research and development of software that will use already established standards. Meanwhile, when researching and developing software to create standards, in addition to originality, they are required to develop a reference program that will enable a third party to confirm the validity of the ideas at the same time, as well as meeting the deadline and other procedures provided by standards bodies, etc. They also have to take a proactive and careful stance on verifications of interoperability and other features in order to earn the trust of the community. This section introduces an example of original software from AIST which "creates standards" in the Global Grid Forum (GGF), the international grid standards body.

Grid refers to the abstraction layer which provides the basic functions of information and communication; computing function (computing unit), storage function (storage), and communication function (network) as function-provision services. By virtualizing the hardware connected to

the network, you can share the time and space needed to provide services without obstruction. The basic design to realize this aim is provided as Open Grid Services Architecture (OGSA) at GGF, and the basic services needed to build the grid are provided within such a framework.

With the Grid Technology Research Center as the core of the project, AIST is carrying out research and development of original software to build standard grid environments, which are already used by many. Especially, Ninf-G and Grid MPI are providing the environment to develop and execute programs on the grid in the NAREGI project of the Ministry of Education, Culture, Sports, Science and Technology.

In the Ninf project, we are developing Ninf-G, programming middleware based on the "Grid-enabled Remote Procedure Call (GridRPC)." Ninf-G was designed and developed as programming middleware that can efficiently carry out computations by easily using the computing machines and databases that are on the network. We succeeded in the long-term experiment of Ninf-G to perform a large-scale calculation over 50 days by combining grid computers on the operation scale of AIST Supercluster, U.S. TeraGrid and Asia Pacific Grid Partnership (ApGrid), thus proving the validity of Ninf-G.

Ninf-G (current version is ver. 4.1.0) was published in March 2004 after a lapse of 10 years since the development of the initial version, and its number of downloads has reached 1740 (17 countries). Furthermore, Ninf-G was adopted as one of the "standard grid software" in the software package created and distributed at the NSF Middleware Initiative (NMI) led by the NSF (National Science Foundation) in the U.S. It was the first time that software developed outside the U.S. was included in the NMI. This means that NMI admitted that Ninf-G is high-quality standard software effective (convenient) for developing grid applications. As NMI is widely utilized for projects of universities, research institutes and NSF throughout the U.S., bundling in NMI is expected to further accelerate the international diffusion of Ninf-G.

AIST will maintain its compliance within the framework of international standards and make efforts to have the API and protocol of our unique development recognized as a standard in the community. This will enable us to continue our research and development pursuing the goal of software that can be used by more people with a sense of security.

[Reference URL]

Grid Technology Research Center http://projects.gtrc.aist.go.jp/en/

Ninf-G http://ninf.apgrid.org/

Grid MPI http://www.gridmpi.org/

Gfarm http://datafarm.apgrid.org/index.en.html

NAREGI http://www.naregi.org/index_e.html

TeraGrid http://www.teragrid.org/

ApGrid http://www.apgrid.org/

Satoshi Sekiguchi
Grid Technology Research Center

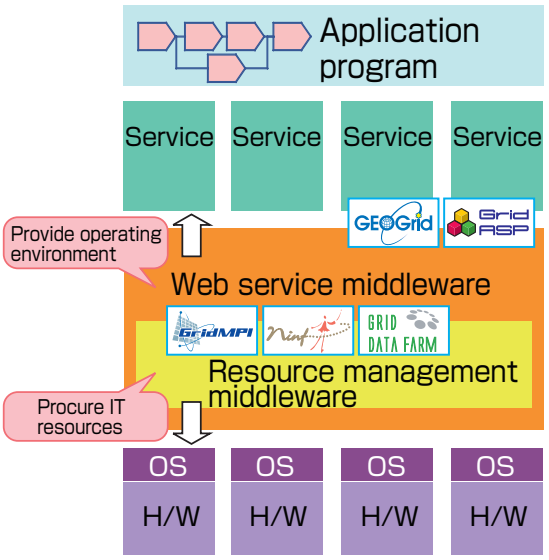


Fig. 12: Software and architecture of the Grid Technology Research Center

Science and Technology for System Verification

Research fields of science and technology which emerged in the late 20th century have finally grown to maturity recently. Presenting convenient tools and providing stories of an ideal future are no longer enough to respond to society's expectations. Dependability of information processing systems, for example, is a critical issue for computer science. Quite a long time has passed since the basic quality of a system such as its reliability, safety and security came to exert a substantial influence on society. The technology that verifies the system is operating as intended plays a vital role in improving dependability. The Research Center for Verification and Semantics (CVS) studies mathematical verification methods including what is referred to as formal methods.

Then why do "mathematical" verification methods matter? Because they are verification methodologies based on mathematics such as logic and category theory. A large part of system development technology in this country is still made up of the skill of a craftsman or implicit knowledge. However, technologies that have been clearly demonstrated on the basis of science offer the advantage that they can easily pass on a certain level of system construction ability to a large number of people. The time when expert minority programmers could just take their time to learn outstanding technologies by watching someone's example has passed.

With mathematical verification methods, we build a mathematical model of the system, formulate the properties expected of the system as propositions for the mathematical model, and attempt to prove them to verify the system. If it turns out that we cannot prove them and a counter example is found, then we can examine it to identify the problem. By using verification methods for detecting bugs, we can use them to improve the reliability and productivity of the system.

Meanwhile, the necessity of system quality regulation started to be pointed out even by the communication industry, which is to be the regulated end, and standard authentication of systems aimed at the fields of security,

function safety, statutory metrology, etc. both here and abroad. In order to gain authentication, we need the technology to verify if a system meets the standard. In partnership with the Metrology Institute of Japan, the CVS is cultivating an integrated field to research information technology relating to the standard authentication of information processing systems.

CVS is devoted to the scientific research of mathematical verification methods, while contributing to society by increasing the reliability and productivity of development for system developers and supporting the activities surrounding standard authentication for system users.

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Outlook of AIST-SOA

"Service" in the Service Oriented Architecture (SOA) represents services that use software including Web services, which have high reusability and take on meanings understandable to the general public, such as reservations, orders, search as well as distribution of content and schedule management. SOA is a method of constructing a large-scale system by combining such services in a way that is easily amendable and flexibly scalable. On another front, in the coming era of a knowledge society, it is expected to enhance the vitality of organizations and society by maximizing each individual's ability and knowledge, and having them work together.

To quote the philosophy of SOA, the concept lies in the social information infrastructure for knowledge spiral, where human knowledge is converted into services that are flexibly linked together, circulated and are reproduced on an expanded scale. The effective way to realize this is perceived to be the collaboration of "grid computing technology" and "semantic computing technology." The former enables flexible utilization of computing resources without regard to the physical arrangement of computers and storage units, nor to differing OS. The latter enables individuals to build and use information services and content in line with their relevant meaning, according to each individual's life and operations.

The "Service oriented architecture for knowledge spiral (AIST-SOA)" project, ongoing from FY2005 through FY2007 as an "AIST research initiative for industrial reform"*11, aims to provide such information infrastructure at a low price based on open source compliant with international standards. Grid computing and semantic computing collaborate with each other through virtual machines with a high degree of freedom. This will enable many people to provide various services for each other and combine them to flexibly make compound services designed to meet further diversified needs.

It is obvious that this approach can form the basis of creating a variety of knowledge-based industries in a sustainable way. We would rather like to point out here that this kind of "industrial reform" as the base of a knowledge society is headed in the opposite direction to the well-known neo-liberal market economy and globalization. Technically speaking, if knowledge as software circulates and works together, knowledge as content, such as ordinary documents, would also circulate and work together. This is why technologies like AIST-SOA revitalize the links within a community by circulating and sharing various kinds of knowledge and enhance its intellectual ability, thereby becoming tools to manage the economy and society by human wisdom, not by God's invisible hand.

The social information infrastructure based on the flexible and inexpensive provision of computing resources and collaboration of semantic services and content will bring about a secure, safe and prosperous society where social cohesion is reconstructed along the spiral of knowledge creation in a sustainable way, instead of a competitive society where the weak are victims of the strong and people suffer from the collapse of social cohesion and public order.

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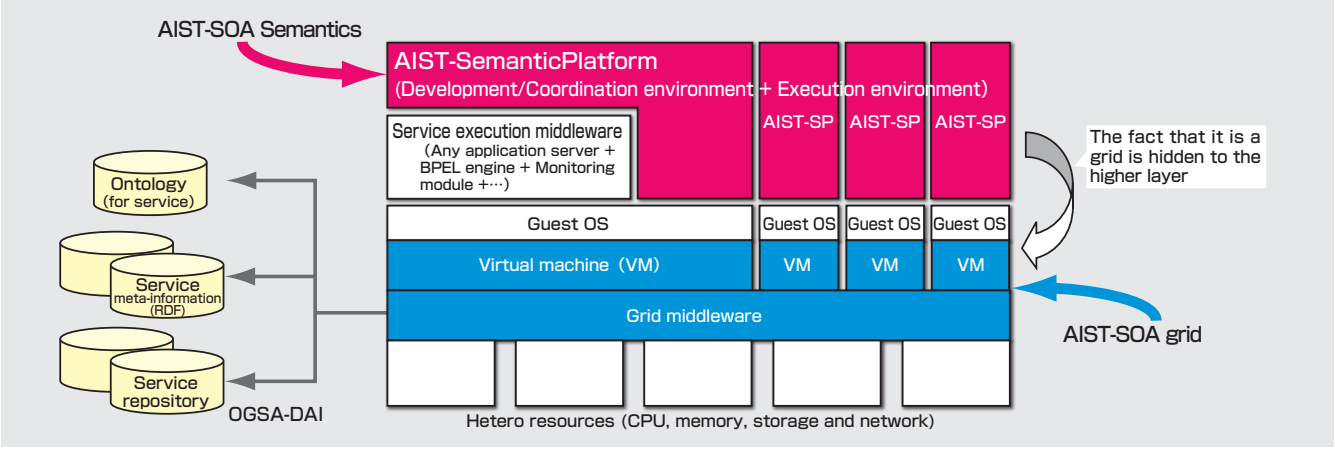

Fig. 13: Architecture of AIST-SOA

*11 The new cooperation scheme to be addressed by government, industry and academia, sharing a clear scenario for generating new industries Press release: July 13, 2005 http://www.aist.go.jp/aist_j/press_release/pr2005/pr20050713/pr20050713.html (in Japanese)

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