Language Grid: An Infrastructure for Intercultural Collaboration

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Abstract

To increase the accessibility and usability of online language services, this paper proposes the language grid to create composite language services for various communities. The language grid is called "horizontal," when the grid connects the standard languages of nations, or "vertical," when the grid combines the language services generated by communities. Semantic Web service technologies are applied in a human-centered fashion, to create composite language services through the collaboration of users and agents. Three example scenarios are given to illustrate how the language grid will organize standard and community language services for intercultural collaboration activities.

1. Introduction

Language barriers remain the biggest barrier to intercultural collaboration. This problem is more serious in Asia than Europe. Asian people are not taught neighboring languages. Japanese people do not understand Chinese or Korean and vice versa. People learn English, but often cannot think in English: serious barriers to intercultural collaboration exist, because the collaboration often requires elaborating new ideas in English.

The above background as the impetus drove us to conduct the Intercultural Collaboration Experiments in 2002 (ICE2002) with Chinese, Korean and Malaysian colleagues [6]. We thought that machine translation would be useful in facilitating intercultural experiments. We gathered machine translators to cover five languages: Chinese, Japanese, Korean, Malay and English. More than forty students and faculty members from five universities joined this experiment. The goal was to develop open source software using the participants' first language: Japanese participants use Japanese, Chinese participants use Chinese, and so on. The experiment started April 2002 and ended December 2002. During this experiment, the following problems were found in language services. Note that language services consist of language resources including dictionaries, thesaurus and corpus, and language processing functions including morphological analysis, translation and paraphrasing.

Language services are often not accessible, because of intellectual property rights and prices. We can now see many new language services on the Internet. We tend to think that effective language infrastructures have been developed, since we can use machine translations to view Web pages. However, if one tries to create new services by combining existing language services, he/she is soon forced to face the realities: the language services available come with different contracts and prices. Contracts can be complex because of the concern over intellectual property rights. Even if the prices are high, explanation is not available about their prices.

Language services are often not usable, because of unstandardized interfaces, low customizability and service quality. For application interfaces, users have to develop different wrappers for different language services. There is no quality assurance for machine translators. Users have to estimate their quality of services, when selecting one. Services are often not customizable. Machine translators seldom allow users to modify them; it is hard to add new words to their dictionaries.

To increase the accessibility and usability of language services, we propose the *language grid*, which treats existing language services as atomic components and enables users to create new language services by combining appropriate components. The rest of this paper describes the architecture, technology and field study of the language grid.

2. Intercultural Collaboration Experiment

Machine translation services can be easily applied to computer mediated communication. Although researchers have conducted rigorous research on

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machine translation for years, translation quality is hardly adequate for practical worksites. The preceding studies evaluated machine translation on written documents, and did not take account of the *interaction factor* when refining translation quality. We, on the other hand, are applying machine translation to human to human collaboration, and are trying to create interactive translation refinement procedures to be implemented between humans and between human and machines. This section reports on the result of Intercultural Collaboration Experiment 2002 [6] in a consideration of the applicability of machine translation to multinational collaborative works. Figure 1 shows the participants of ICE2002.

Figure 1. ICE2002 Participants

In this trial, the multilingual collaboration tools, TransBBS and TransWeb were provided to all participants. These tools offer translation services among Chinese, Japanese, Korean, Malay, and English. TransBBS, a multilingual bulletin board system, is utilized as a daily discussion space. TransWeb enables participants to browse software documents in their first languages. Figure 2 shows the translation pentagon used for multilingual collaboration. As described in the previous section, we spent a large effort in establishing this translation arrangement.

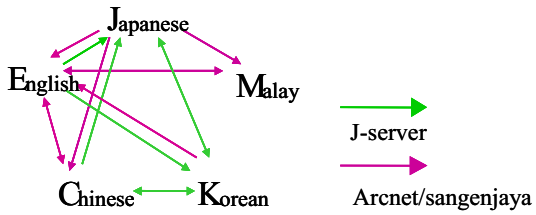

Figure 2. Translation Pentagon for ICE2002

In ICE2002, TransBBS and TransWeb are the only means of communications permitted. Team members never meet in person, but complete software with multilingual communication tools. We observed how participants achieved their goal by communicating across unreliable channels. In this experiment, a total of 31,000 messages have been collected to date. To analyze the machine translation mediated collaboration, we applied conversation and content analyses. We found different communication patterns between phases. In *self-initiated repair*, before posting a message, a message contributor repeated the repair of the message to refine the translation results, and in *other-initiated repair*, translation errors were collaboratively repaired to share common knowledge between contributors and receivers.

Intercultural collaboration experiments have been held in 2003, and 2005 in different settings. Several papers have been published on natural language processing and computer-supported cooperative work based on the series of experiments: how to improve translation quality [7,9], how to cope with misconceptions, how to design communication tools [4], etc. The issue we discuss in this paper, however, is focusing on the accessibility and usability of language services: how to gather and organize language services to create a language environment necessary for intercultural collaboration.

3. Architecture of the Language Grid

The language grid has two different goals. One is to connect existing online language services that cover the standard languages. Those services are created often by linguistic professionals with the support of their governments. Typical examples include online dictionaries and translation services. Another goal is to assist users to create new language services, which are often related to intercultural activities. Consequently, the language grid consists of two different types of service networks: the former is called the *horizontal language grid* and the latter is called the *vertical language grid*. Figure 3 illustrates how these two types of grids are networked.

The *horizontal language grid* combines existing language services using semantic Web service technology. We call a language service with a Web service wrapper an *atomic component*. By combining several atomic components, we can create a *composite component*. For example, by connecting WordNet [8] and an English-Japanese dictionary, we can create WordNet with a Japanese interface. The horizontal

language grid benefits a wide range of users by providing standard language services.

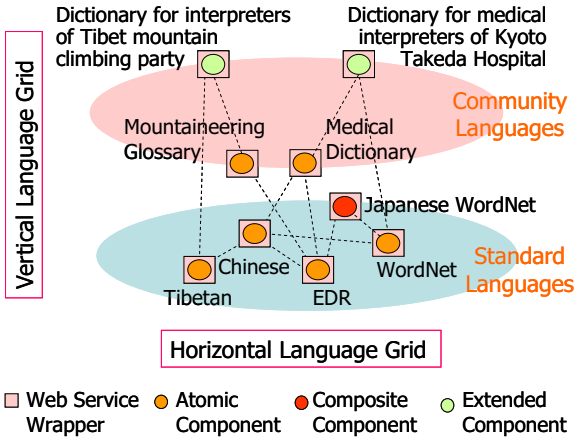

Figure 3. Language Grid Architecture

The *vertical language grid* combines community language services on the horizontal language grid to support intercultural activities For example, medical parallel texts can be created by volunteer interpreters, who help foreigner patients in local hospitals. When creating and using the medical parallel texts, volunteer interpreters often utilize the horizontal language grid. *Extended components* include human activities in Web service workflow.

4. Technology of the Language Grid

The language grid depends on Web service execution technologies including WSDL, UDDI, SOAP and BPEL [1], which support interoperable interaction over the network. By introducing service ontology like OWL [3] and OWL-S [5], the language grid adopts semantic Web service to provide search and reasoning atomic services to configure composite services. Figure 4 shows the service layer of the language grid.

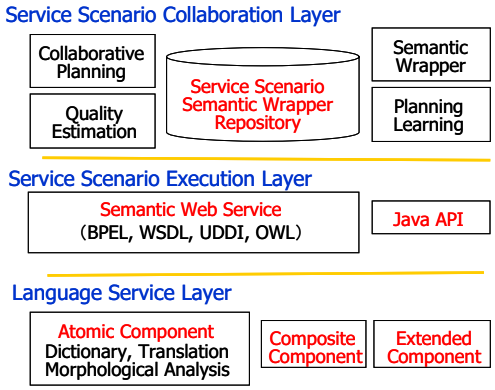

Figure 4. Language Grid Service Layer

For the *language service layer*, we need the *language service ontology* that represents entries of language resources and language processing functions. Metadata for language resources have been intensively investigated by the linguistic research community [2]. We also need metadata for language processing functions. The ontology of language services, which remains to be studied, will enable users to easily extend default service interfaces and to define their own services. Semantic wrappers should be automatically generated for newly created Web services.

For the *service scenario execution layer*, we need an efficient Web service protocol for language services. Suppose people use machine translation in a multilingual chat room. Similar translation requests are issued again and again and the results are required in realtime. As a result, in the language grid, the same service is continuously triggered from the same application. A context-aware protocol to ensure realtime response is a key issue in the language grid.

For the *service scenario collaboration layer*, various human-centered technologies must be developed. AI planning has been studied to realize agents for automatics service composition [10]. However, we often need humans in the loop to create community language services. Furthermore, such services often need to include humans as a part of the workflow. Since AI planning cannot produce workflows which are natural to humans, best practices should be accumulated and used as the basis of new services. Learning scenarios from user behaviors also helps in defining new services, and quality estimation is needed to evaluate the scenarios.

5. Field Study of the Language Grid

The increase in the frequency of intercultural activities requires a variety of community language services. We started working with nonprofit organizations to investigate the requirements placed on the language grid.

Center for Multicultural Information and Assistance, Kyoto started a medical interpretation program from Sept. 2003 to assist foreign patients. Thirty volunteer interpreters were dispatched a total of 1300 times this year. At this moment, interpreters are also stationed in several affiliated hospitals. Chinese and Portuguese services are in strong demand. In the case of medical interpretation, machine translations are not useful due to their poor quality. Therefore, the interpreters refer to multilingual parallel texts of medical sentences.

Since this nonprofit organization has its own parallel texts tuned to support the services available in

affiliated hospitals, the organization wants to combine standard parallel texts and its own resources by using the language grid. Similarity matching can be used to compare the sentences input by voluntary interpreters and those in their parallel texts. The language grid for medical support is illustrated in Figure 5.

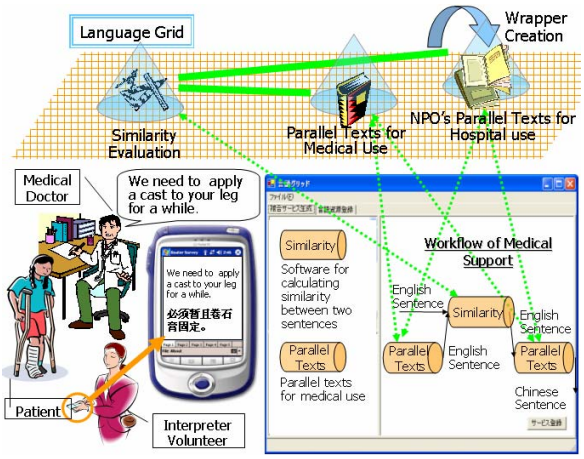

Figure 5. Multilingual Support at Hospitals

Pangaea creates a "universal playground" for kids around the world. This organization develops communication packages for kids to feel their "bonds," and use pictograms created by kids for communication support. Since activities are ongoing in Japan, Korea, Kenya and Austria, the number of pictograms will exceed more than one thousand. The representation used in the pictograms depends on the culture, even if their meaning is identical. For example, the pictograms used in Japan and Kenya to represent "morning" are different, reflecting their different cultures. Therefore, as in Figure 6, Pangaea started developing a pictogram dictionary called *pictonet*, which is grounded on WordNet.

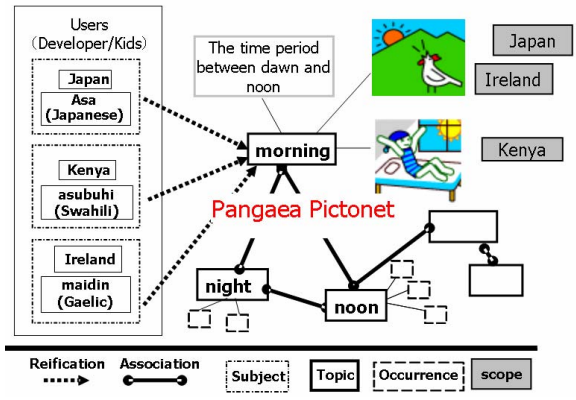

Figure 6. Pictograms Grounded on WordNet (provided by Pangaea)

If Pangaea's pictonet is connected to the language grid, we can easily create a new service, say *pictochat* between Japanese and Korean kids, by combining Japanese-Korean translation, Korean morphological analysis, and so on. Figure 7 illustrates how community language resources are utilized in the language grid.

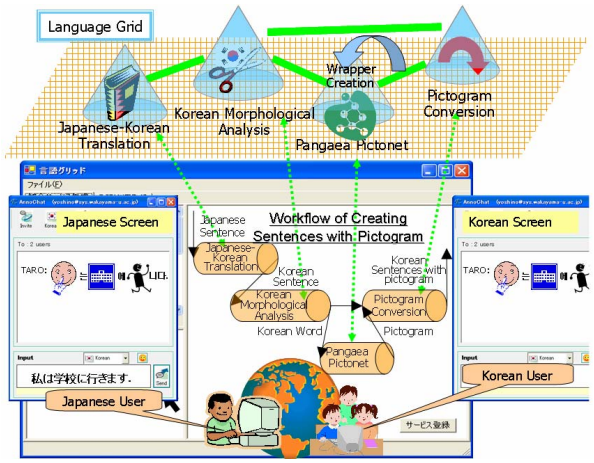

Figure 7. Pictogram Dictionary Service

Kyoto Community Broadcast started an FM station in March 2003. This is the first FM radio station established by a nonprofit organization in Japan. Radio program production workshops were organized for foreign residents, aiming to make multilingual radio programs that gather and broadcast information in various languages especially in case of disaster. Foreign residents can broaden their human networks and their experiences through the workshop. Since workshop participants can include more than ten nationalities, they need language support tools. As described in Figure 8, the language grid can create a multilingual blackboard to summarize discussions by using machine translators and multilingual dictionaries.

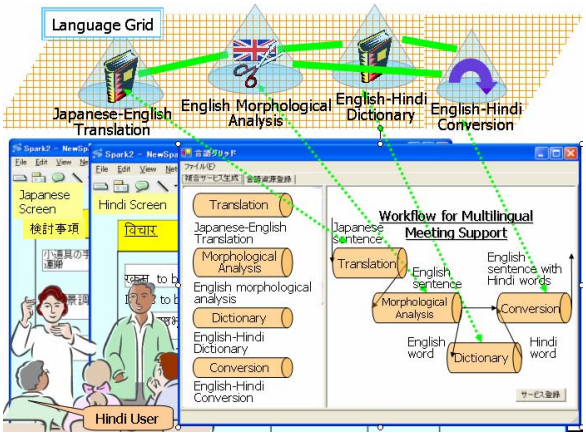

Figure 8. Multilingual Blackboard for Discussion

The language services required by the three nonprofit organizations are very different. For hospital support, accurate interpretation is required. For kids' communication, accuracy is not the biggest concern. Pictograms motivate children to communicate with each other and to understand different cultures. For radio production workshops, language support for more that ten languages is required for consensus building.

As described above, field study is essential in the research activities of the language grid to understand how language services are to be created by not only professionals but also communities.

6. Conclusion

This paper presented the design philosophy of the *language grid*, which aims at increasing the accessibility and usability of language services. The language grid consists of the *horizontal language grid*, which connects the standard languages of nations, and the *vertical language grid* for creating community language services. The technology needed for the horizontal grid is language service ontology to create composite language services automatically, while for the *vertical language grid* assists communities through the use of human-centered semantic Web services to create new language services for their activities. Field studies were presented to explain the design philosophy of the language grid.

According to Global Reach (glabal-reach.biz), the number of English speaking people online was 35.2% in September 2004. Though English has become the standard language in various areas, people do not use it in local activities. To increase mutual understanding between different cultures and of opinions in different languages, it is essential to build a language infrastructure on top of the Internet. Using the analogy of communication networks, language services are like dedicated line services: only big companies can use them to configure their own services. Intercultural activities need services embedded in human society and various organizations have started to create their own services. We believe that improving the accessibility and usability of existing language services will accelerate the development of community language services that can bridge different people and cultures.

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