**Guest Editorial**

# Directions in Feature Interaction Research

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This special issue is a follow-up to the 7th International Workshop on Feature Interactions in Telecommunications and Software Systems, which was held in Ottawa, Canada, June 11-13, 2003, in the School of Information Technology and Engineering of the University of Ottawa. The proceedings of this Workshop were published in [1].

Communications systems offer services and features to their subscribers. Features are often among the main selling points of such systems and they can be implemented and provided independently by specialized operators at user request, or by users directly. Features can build on each other, but can also mutually interact in subtle and unexpected ways. A feature can modify or subvert the behavior of another one, possibly leading to system malfunctions. The topic of feature interaction deals with preventing, detecting and resolving such interactions. This phenomenon is not unique to the domain of telecommunications systems: it can occur in any software system that is subject to changes (not to mention areas of medicine, engineering, and law which may be taken into consideration in order to exploit useful analogies).

This research area started over ten years ago in the framework of research on the Intelligent Network architecture, especially with the initiative of a group within Bellcore (now Telcordia). At that time, the Intelligent Network Architecture (IN) or Advanced Network Architecture (AIN, as it was known in North America) made it possible to create complex telephony features in independent systems designed for this purpose: the Service Control Points (SCPs). It was quickly understood that a major obstacle to the development of complex features was the fact that they might well conflict. In 1993, Cameron et al. published a paper that has been often cited as the seminal reference in the area [3]. Other surveys were contributed by Keck and Kuehn [6] and more recently by Calder et al. [2]. Computer Networks dedicated special issues to the results of the 4th FIW Workshop [4] and to the results of the feature interaction contest hosted during the 5th FIW Workshop [5].

The following table lists the Feature Interaction Workshops held so far. The proceedings for each of them, except the first one, were published by IOS Press.

| *Year* | *Location* | *Chairs* |
|---|---|---|
| FIW I (1992) | St. Petersburg, Florida, USA | N. Griffeth, Y.-J. Lin |
| FIW II (1994) | Amsterdam, The Netherlands | L.G. Bouma, H. Velthuijsen |
| FIW III (1995) | Kyoto, Japan | K.E. Cheng, T. Ohta |

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| FIW IV (1997) | Montréal, Canada | P. Dini, R. Boutaba, L. Logrippo |
| FIW V (1998) | Lund, Sweden | K. Kimbler, L.G. Bouma |
| FIW VI (2000) | Glasgow, Scotland | M. Calder, E. Magill |
| FIW VII (2003) | Ottawa, Canada | D. Amyot, L. Logrippo |

In the first ten years of research in this area, the main effort has been towards the study of conflicts between commonplace telephony features, and this problem was found challenging enough to motivate hundreds of papers.

The tradition in this workshop has been to establish a meeting point between industrial and academic views. In the 2003 workshop, 17 program committee members were from universities and 9 were from industry or were independent consultants. 14 accepted papers came from university groups, 4 papers from industrial groups, 2 from mixed university and industrial groups, and 1 from a government research group. All invited speakers were from industry or independent consultants.

There were 7 papers from the UK (of which one with a Belgian collaborator), 5 from Canada, 3 from Germany and 3 from Japan, while China, France and the USA had one each. There were 8 short papers (8 pages maximum) and 13 regular papers (18 pages maximum), but both types of papers were refereed by four experts.

The FIW VII papers were grouped in the following categories, roughly corresponding to sessions (the number at the beginning indicates the number of papers):

(4) Architecture and Design Methods
(5) Emerging Application Domains
(2) Human Factors
(4) Detection and Resolution Methods
(4) Emerging Architectures
(2) Foundations

The presentations for these papers are available at http://www.site.uottawa.ca/fiw03/.

There were two awards at the workshop. The recipient of the Best Paper Award, selected by the program committee, was Pamela Zave of AT&T Labs for her paper [8]. The nomination included mention of “deep understanding of the implications of IP telephony”. The paper coauthored by Zave in this special issue is a new paper, not a rewrite of the workshop paper. This award was named in the memory of L.G. (Wiet) Bouma, formerly of KPN Research. Wiet was present at the very first workshop, co-chaired FIW II and V, and had a role in all workshops, as an author or PC member, usually as both. Sadly, he died of cancer on October 26, 2001.

The second award was a Novel Domain Award. This one was given by a committee chosen and chaired by Mark Ryan. It went to Michael Weiss for his paper on feature interaction in Web services [7], where Weiss identified new types of interactions based on service integration and where he emphasized the importance of considering non-functional requirements for analysing this new “Web of services” properly.

There were three invited talks from Bill Buxton (Architectural Considerations in the Design of Interactive Appliances), Debbie Pinard (Reducing the Feature Interaction Problem Using an Agent-Based Architecture), and Pamela Zave (Feature Disambiguation).

Finally, there were two panel sessions, one chaired by Tom Gray of PineTel on New Features in Internet Telephony and one chaired by Petre Dini of Cisco on Policy-enabled Mechanisms for the Feature Interaction Problem.

The sixth and seventh FIW workshops have seen a slow evolution in research direction, from features based on the Intelligent Network architecture to the new features made possible by architectures based on the Internet Protocol. There were papers addressing the new challenges in emerging types of systems based on policies, mobility, or new architectures such as Parlay and dynamic (Web) services. The proliferation of players and software/service engineering techniques coupled with the constant pressure for the rapid introduction of new services and features can lead to undesirable interactions that jeopardize the quality of the services delivered as well as user satisfaction. Note that ideally, each subscriber should be able to create or customize her own features dynamically, as the need arises; but, different subscribers (who may or may not become connected) may have conflicting goals and objectives. Techniques successfully applied to conventional telecommunications systems are still useful in many cases, yet they may no longer be able to cope with the complexity of emerging systems.

Starting with these considerations, the organizers of FIW VII decided to solicit further contributions, to appear in this special issue, directed specifically to these emerging areas. 16 papers were submitted and six were selected as a result of the refereeing process. Most of these papers are enhanced versions of papers submitted at the workshop and another (Dini et al.) was co-authored by the participants in one of the panel sessions.

The paper by Reiff-Marganiec and Turner sets forth the assumption that the feature interaction problem is evolving towards a policy interaction and policy conflict problem, and presents a perspective on these problems. It notes that little work exists on policy conflicts, and reviews the related literature. It then proposes a taxonomy of conflicts in their various dimensions, namely policy types, domain entities, roles, policy relations, and modalities. Many illustrative examples are provided of conflicts manifesting themselves in each of these dimensions or involving more than one dimension. It concludes by proposing a three-layer architecture for handling conflicts in policy-controlled systems, independent of the application domain.

The paper by Petre Dini et al. is an extended report, including after-the-fact reflections, of a panel session that was organized by Dini, involving mostly industrial participants. It is based on similar assumptions as the paper by Reiff-Marganiec and Turner, and engages in wide-ranging remarks on the relationships of the two paradigms of feature and policy. Among the questions discussed are formalisms for the representation of policies, the relationship between the world of human law and the world of policies, feature interactions between service provisioning systems, and policy-based service management.

In their paper, Nakamura et al. concentrate on a specific practical problem, the problem of detecting feature interactions in CPL scripts. The Call Processing Language (CPL) is an XML-based language that is being developed within the IETF for the specification of simple feature policies in Internet telephony. CPL enables end users to create their own personalized features. CPL scripts can, of course, lead to feature interactions, within a single script or among scripts. The authors' method and tool detect many types of interactions (called semantic warnings) in single scripts, and ingeniously extend the idea to cover interactions among scripts of different users. The paper contains a sizeable and realistic case study based on CPL scripts found in the VOCAL system. Problematic situations in this system were unveiled.

The paper by Metzger owes its interest to the fact that it substantiates what the feature interaction community has been saying from the beginning, that the phenomenon of feature interactions in telecommunications is only a special case of a phenomenon that is pervasive in systems design. Examples of feature interactions are presented from the areas of building automation, automotive control, and railway crossings. An efficient detection method is developed, which uses several levels of information, and is based on existing design documents that are automatically parsed. Interestingly however, the author observes that methods developed for this area of application and methods used for feature interaction detection in telecommunications do not have much in common, because of the lesser importance of the environment in the second case.

Zave et al. contributed a more technical paper illustrating the potential of coordination mechanisms, like those found in the Distributed Feature Composition architecture, for managing features configurations and interactions. They focus on a case study involving the definition of novel personal mobility features and their interactions with other types of voice-over-IP features. The authors explain how they have solved the challenges faced during the development of this complex service by composing and coordinating smaller features. Of particular interest are the major causes of the feature interactions discussed (connection paths, functional dependence, shared signals, and address translation) as well as principles for global behaviour of telecommunications systems, namely privacy, authenticity, and returnability.

The last paper of this special issue, written by Turner, suggests that the concepts of feature and feature interaction can also be found in emerging Interactive Voice Response (IVR) services. The author presents an approach based on the CRESS graphical service notation for designing IVR features at a higher level of abstraction than those written directly in the standard VoiceXML language. These service descriptions are used to generate VoiceXML code automatically, as well as LOTOS specifications for automated analysis. As with most formal approaches, handling large state spaces for analysis remains a challenge, which is addressed here with MUSTARD, a new textual language for defining scenario-based tests of services. MUSTARD test cases are converted to LOTOS observer processes in order to validate the IVR service descriptions and to detect undesirable interactions. The analysis results are expressed in terms of the original test notation, which effectively hides the underlying LOTOS formalism. This paper demonstrates the generality of these techniques, which were used successfully in the past for the description and analysis of Intelligent Networks and Internet telephony features.

The conclusion of the workshop and of this special issue is that the areas of feature interaction and feature design are in full evolution, with new perspectives and increasing importance in the coming era of custom-designed features and policies. The papers presented in this issue provide an excellent introduction to the problems of this new era. Many other problems exist which could not be addressed here (e.g., problems related to 3rd and 4th generation mobility, grid networks, active networks, ad-hoc networks, Web services, and e-commerce applications).

Interested researchers are invited to participate in the next Feature Interaction Workshop, tentatively planned for May or June 2005 in Leicester, UK, under the chairmanship of Stephan Reiff-Marganiec and Mark Ryan.

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