Strategic directions in real-time and embedded systems part-3

Engineering

4. TEN-YEAR VISION

Ten years from now almost all products and engineering processes will contain real-time features and embedded processors. There will be a greater demand for safe, dependable, and certifiable real-time systems. The demand will increase if there are major financial disasters or loss of life. Eventually, we should see the rise of a vital industry of third-party components that can be composed with respect to functionality, timing, and dependability.

For example, over the next ten years there will be an enormous increase in the prevalence of open systems. A significant fraction of the global population will interact with some form of open real-time system. Such systems will be highly distributed, offer a wide range of services including the control of commonplace artifacts, deal with many forms of data, be accessed over very wide areas, and be constantly changing and evolving. Moreover, they will begin to play an important role in the economies of developed and developing nations. While many operational aspects of these open systems are performance-related rather than real-time, there are at least three areas in which real-time systems are likely to play a key role.

(1) High-integrity real-time services that need to be delivered in well-defined time intervals. For example, there is a need to synchronize the release of important financial data to a number of different international centers, with very tight jitter requirements.

(2) QoS attributes that equate to real-time parameters. For example, various bandwidth-allocation algorithms require a precise definition of the temporal needs of video and audio streams in order to undertake the necessary run-

time reservations. QoS will become a key issue once services demand payment at the point of delivery.

(3) The ubiquitous nature of the pervasive open systems of the future may well require high-level temporal controls so that the sheer complexity of interacting with these systems can be managed. Hence, simple commands such as " deliver A to X 5 minutes before B is delivered to Y" may become a natural way of expressing commands.

These three areas indicate that open system protocols (in particular the interfaces to services, controls, and data objects) must explicitly deal with a range of nonfunctional issues such as dependability and availability of resources, QoS guarantees, and real-time requirements. Failure to address these issues will lead to increased dissatisfaction and eventually economic damage. Past lessons have taught us that non-functional properties cannot be added as an afterthought; they must be at the core of the architecture and protocol designs. Success in integrating real-time methods into open systems thus has the potential for significant social impact.

As real-time technology becomes increasingly used in everyday computing, it is our hope that widely agreed-upon interfaces and methods supporting open real-time systems will evolve. Such a development will produce a vital industry providing dependable third-party real-time components that can be composed, assembled, and used when building real-time systems - just as independently developed software components from multiple vendors can be used for building nonreal-time consumer applications today. This is both desirable and achievable.

The eventual result should be the proliferation of many products and systems that are safer, cheaper, and more available. If real-time technology is truly successful, the technology will be invisible to the public.

If accurate, our predictions of the growing importance of real-time systems technology over the next decade imply the need for a concerted effort to integrate real-time systems concepts into computer science curricula. Many of the basic concepts are well developed and well understood within the research community; others are still evolving and under investigation. A first round of real-time systems textbooks is due out during academic year 1996-1997, and will serve to formalize the training of graduate students and specialized undergraduates in real-time systems.

5. SUMMARY

Real-time computing is an enabling technology for many current and future applications that affect public safety, competitiveness, the economy, and lifestyle. Many results have been developed, but difficult research and transfer of technology issues remain [Stankovic 1988]. For example, real-time research has yet to grapple with three major realities concerning real-time applications:

- real-world real-time systems are expected to survive and continue to operate even when not all timing constraints are met or when components fail;

- due to economic and portability considerations, the tendency towards the use of off-the-shelf hardware and software components to build real-time systems is increasing;
- the prohibitive cost of modernizing an industrial real-time computing system often results from the down time and risks associated with inserting time-dependent new technologies into a functioning industrial system.

One proposed strategic decision is to develop a major funding and international research initiative in real-time computing to capitalize on current results, establish generic technology for the future, and thereby pay large dividends for safety and the economy. As an example, results that make possible an evolvable real-time computing open infrastructure would aid the safe and cost-effective insertion of hardware, software, and domain technologies into functioning industrial systems, creating a direct linkage between the ability to innovate and superiority in product quality and process agility.

Works Cited For This Essay:

- BURNS, A., AND WELLINGS, A. 1989. Real-Time Systems and Their Programming Languages. Addison-Wesley, Reading, MA.
- KLEIN, M. H., RALYA, T., POLLAK, B., OBENZA, R., AND HARBOUR, M. G. 1993. A Practitioner's Handbook for Real-Time Analysis. Kluwer Academic, Boston, MA.
- LEE, Y.-H., AND KRISHNA, C. M. 1993. Readings in Real-Time Systems. IEEE Computer Society Press, Los Alamitos, CA.

- SON, S. 1995. Advances in Real-Time Systems. Prentice Hall, Englewood Cliffs, NJ.
- STANKOVIC, J. 1988. Misconceptions about real-time computing: A serious problem for next generation systems. IEEE Computer 21, 10 (Oct.), 10-19.
- STANKOVIC, J., AND RAMAMRITHAM, K. 1988. Hard Real-Time Systems. IEEE Computer Society Press, Los Alamitos, CA.