Arthur I. Karshmer, Jürgen Nehmer (editors):

Operating Systems of the 90s and Beyond

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Arthur I. Karshmer, Jürgen Nehmer (editors)

Operating Systems of the 90s and Beyond

Dagstuhl-Seminar-Report
8.7.1991 - 12.7.1991

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* No attendance at the workshop

Workshop Schedule

Monday, July 8, 1991

Morning Session:	**Issue of Size, Scalability, and Distribution in Future Operating Systems**
Session Chair:	Morris Sloman
Speaker:	M. Satyanarayanan, "An Agenda for Research in Large Scale Distributed Data Repositories"
Afternoon Session:	**Impact on Operating Systems by Future Trends in Hardware and Communication Technology**
Session Chair:	Jean Pierre Banatre
Speaker:	B. Joy, "Future Operating Systems: An Environmental Scenario and Consequential Challenges"

Tuesday, July 9, 1991

Morning Session:	**Fault Tolerance Support in Future Operating Systems**
Session Chair:	Özalp Babaoglu
Speaker:	F. Christian, "Basic Concepts and Issues in Fault-Tolerant Distributed Systems"
Afternoon Session:	**Trends in Real-Time Operating Systems**
Session Chair:	Satish Tripathi
Speaker:	H. Kopetz, "Event-Triggered versus Time-Triggered Real-Time Systems"
Evening Session:	**Supporting Multimedia Applications in Distributed Systems**
Session Chair:	Reinhold Kröger
Speaker:	M. Lamming, "Towards a Human Memory Prosthesis"

Thursday, July 11, 1991

Morning Session:	**Security and Protection Support in Future Operating Systems**
Session Chair:	Sape Mullender
Speaker:	B.C. Neuman, "Protection and Security Issues for Future Systems"
Afternoon Session:	**Integration Heterogeneous Operating Systems**
Session Chair:	John Zahorjan
Speaker:	H. Schmutz, "Autonomous Heterogeneous Computing - Some Open Problems"

Friday, July 12, 1991

Closing Session:	**The Next Generation of Operating Systems: What is needed and how do we get it**
Session Chair:	Richard Schlichting
Speaker:	R. Needham, "What Next? Some Speculations"

Operating Systems of the 1990s And Beyond: Where Do We Go From Here?

Edited by:

Arthur I. Karshmer
New Mexico State University

Jürgen Nehmer
Universität Kaiserslautern

Architectural and hardware advances in computing systems design are occurring at an ever quickening rate, but it is not clear that the operating systems that make these new systems useful are keeping pace. Indeed, it is the operating system that masters the complexity of the ever more complex computing devices being built to make them useful tools. In the past, the existence of a variety of operating systems has made the difference between an interesting architecture and a useful computing environment.

Today, as more and more complex computational structures are emerging, and new and more powerful communication technologies are becoming available, we are faced with the need to develop new generations of operating systems to harness their power. A few of the new challenges to face the operating system implementor include, but are not restricted to:

- Unreliable communications,
- Fault tolerance,
- Issues of size and scalability,
- Integration of heterogeneous systems,
- Supporting advanced applications, such as multimedia,
- Protection and security issues in faulty/untrustworthy distributed systems,
- Coping with existing systems in networked environments.

What form should future operating systems take to address these and numerous other complex problems? In which area is further research indicated? Is the current generation of operating systems a valid platform for the operating systems of the next decade and beyond, or should we be designing a whole new generation of operating systems from the bottom up? What type of architectural support for operating systems and communications hardware should be built into the next generation of computers?

These are general questions that our workshop attempted to address. It is our belief that now is the time to address these questions in a manner that will have some chance of producing useful results in the form of guidelines for future operating systems design and development. Three compelling circumstances lead us to believe that this is the time to act in terms of plotting a rational course for operating systems of the 1990s and beyond:

- The commercially available operating systems of today, including UNIX, have been designed, or based on designs, that are twenty years old, with time-sharing on a single node machine being the foundation of the design. Networking and distributed computing facilities were "add-ons" and not part of the basic system design. Today's new computing architectures are moving in different directions, unfortunately, with operating systems that have been pieced together to do the job.

- UNIX has formed the foundation for a de facto international standard for operating systems. Is UNIX the proper foundation for future efforts? Is its basic structure appropriate for computing equipment currently coming onto the market, or more importantly for new machines that will be unveiled in the near future?
- We are now at a crossroad characterized by a change in technology from traditional single-node systems to networks of computers, distributed machines and massively parallel systems. It is not clear that current operating systems technology is poised to take advantage of these new machines when they do become available.

For all of the above reasons, an international workshop entitled "Operating Systems of the 1990s And Beyond: Where Do We Go From Here" was organized and held at the International Conference and Research Center for Computer Science (IBFI) at Dagstuhl Castle in the Federal Republic of Germany. The Overriding motivation behind the workshop was to provide an opportunity for a relatively small number of leading researchers in operating systems from both universities and industry to meet and discuss current problems and future directions.

The workshop was structured into several working sessions and one final session which was planned as a workshop summary. During each session, a white paper was presented followed by several position papers, all of which were mingled with open discussion. The complete material including the text of all white and position papers as well as a condensation of the discussion is contained in the workshop proceedings (A. Karshmer, J. Nehmer (Eds.), "Operating Systems of the 90s and Beyond", Proceedings, LNCS 563, Springer-Verlag). In the following, abstracts for each white paper presentation are given.

"An Agenda for Research in Large-Scale Distributed Data Repositories"

M. Satyanarayanan
School of Computer Science
Carnegie Mellon University

Access to shared data is provided today by distributed file systems and databases. In this paper, we explore certain usage and technological trends that will radically change the way shared data is used in the future. The usage trends include the growing need to access shared data from anywhere, increasing scale, and the increasing importance of efficient search. The technology trends include the advent of portable machines, the availability of software and hardware for using diverse types of data, and the growing diversity of network speeds and capabilities. These trends induce fundamental research problems in the area of *adaptive system behaviour*, *secure remote execution*, and *extensibility*.

"Future Operating Systems: An Environmental Scenario and Consequential Challenges"

B. Joy
Sun Microsystems
Mountain View, California

(Summary not by the author) Future operating systems should address a very different environment from those which exist today. Three different types are expected for many future systems: (1) Systems automating a building or campus, (2) Systems included in vehicles, and (3) "nomadic" systems such as personal and portable computers. In the paper, the implications of such environments for the design of operating systems in the 1990s are discussed. Of major importance for future operating systems are technical aspects such as desktop node parallelism,

high-speed communications, storage cost reduction due to the emergence of high-quality video, and support for distributed, disconnected and partially cached data. The influence of object-orientation and some of its drawbacks on next generation operating systems is also discussed.

"Autonomous Heterogeneous Computing— Some Open Problems —"

H. Schmutz
IBM European Networking Center
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The Integration of heterogeneous operating systems is, in practice, at best at its very beginning and still far from being materialized in its full potential. The subject involves a wide spectrum of issues, including those related to the semantics of functions, to security and to system management. In this paper we will identify some missing functions in each of these areas to prove that there is a significant demand for research, standardization and software extensions.

"Event-Triggered versus Time-Triggered Real-Time Systems"

H. Kopetz
Technical University of Vienna
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This paper compares the temporal properties of event-triggered and time-triggered distributed real-time systems. In an event-triggered system a processing activity is initiated as a consequence of the occurrence of a significant event. In a time-triggered system, the activities are initiated periodically at predetermined points in real-time. In the first part of this paper, a model of a distributed real-time system is presented and the characteristic attributes of TT-systems and ET-systems are described. The comparison focuses on the issue of predictability, testability, resource utilization, extensibility, and assumption coverage.

"Basic Concepts and Issues in Fault-Tolerant Distributed Systems"

F. Christian
IBM Almaden Research Center
San Jose, California

The dependability of computing services will become increasingly important in the 90s and beyond. This paper proposes a small number of basic concepts that can be used to explain the architecture of present and future fault-tolerant distributed systems and discusses a list of architectural issues that we find useful to consider when designing or examining such systems. For each issue we present known solutions and design alternatives, we discuss their relative merits and we give examples of systems which adopt one approach or the other. The aim is to introduce some order in the complex discipline of designing and understanding fault-tolerant distributed systems.

"Protection and Security Issues for Future Systems"

B.C. Neuman
Department of Computer Science and Engineering
University of Washington

(Summary not by the author) Becoming increasingly dependent on computers in daily life brings with it a heigthened need for security in the computer systems we use. The distributed nature of recent systems has made it difficult to apply many of the security techniques used in centralized systems. Additionally, many of the services which are becoming available by computers are placing new demands on protection and security mechanisms. These services require interaction between parties that are mutually suspicious of one another; the servers require protection from users, while at the same time the users require protection from malicious or incompetent service providers. The aim of this paper is to examine the problems of protection and security as applied to future computer systems and it describes recent work that addresses some of the issues.

"Towards a Human Memory Prosthesis"

M.G. Lamming
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Cambridge, England

(Summary not by the author) As the cost of computation drops and wireless data networks emerge, we can expect to see new families of *mobile applications* emerging based on hand-held stylus-based computers. Initial applications will focus on activities that involve data capture, such as insurance assessment, surveying and market research. As the infrastructure matures we can expect applications offering users benefits such as (1) the ability to carry around a personalized and familiar remote-control user-interface through which they can interact with any computer-based equipment they encounter, (2) the ability to access personal and public data bases and services wherever they are, and (3) the ability to have the computer maintain records of their activities. The paper describes a personal, multi-media, mobile application that is under investigation at EuroPARC as part of a project to investigate Activity-based Information Retrieval (AIR). It is presented as a possible example of a new class of application that may emerge in the next decade. It provides some insights in the type and level of support that mobile applications will require.

"What Next? Some Speculations"

R. Needham
University of Cambridge
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(Summary not by the author) It can be observed that sometimes too many functions are offered by operating systems in a monolithic way. Operating systems that run in workstations are frequently capable of supporting computations on the behalf of users not sitting at the workstation in addition to work on behalf of the "real" user, who may not be pleased. It isn't clear that running an operating system with that facility is a good idea. The major design goal for future operating systems should be simplicity, by means that there'll come into being one or two de facto standards, like an RPC mechanism and a small lightweight kernel. These will be used without

further clutter as a basis for building such things as file servers and so forth, and also for putting together workstation software. In consequence much of the generalized resource sharing which has been characteristic of operating systems for many years will largely go away. It is the challenge for operating systems research to develop techniques for the speedy and efficient implementation of specialised servers which will depend upon a great deal of what is now thought of as operating systems knowledge. Also of major importance for future systems is to handle material which has genuine real-time aspects, such as audio and video streams. A third topic discussed in the paper is about main memory size. Instead of struggling to get enough into memory, in the future will struggle to keep track of what's there. The state that's represented by hundreds of megabytes of material is valuable in itself, and it will be very important not to have to reload or reconstruct it, because it would take too long.

Dagstuhl-Seminar 9128: **List of Participants** (update: 13.06.91)

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H. Alt , B. Chazelle, E. Welzl (editors):
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