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EVALUATION RESULTS REPORT FOR NEXT GENERATION COMPUTER RESOURCES OPERATING SYSTEMS INTERFACE BASELINE SELECTION

BY NEXT GENERATION COMPUTER RESOURCES (NGCR)
OPERATING SYSTEMS STANDARDS WORKING GROUP (OSSWG)

STEVEN L. HOWELL, EDITOR
UNDERWATER SYSTEMS DEPARTMENT

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EXECUTIVE SUMMARY

The U.S. Navy has embarked on a new computing resources standardization effort, the Next Generation Computer Resources (NGCR) program. The program is designed to fulfill the Navy's need for standard computing resources while allowing it to take advantage of commercial products and investments and to field technological advances more quickly. The program has identified ten (10) interface areas for standardization. The Operating Systems Standards Working Group (OSSWG) has been tasked with the identifying interfaces for operating systems (OS). The general requirements for the OS standard include Ada, real-time, distribution, multilevel security, fault tolerance, and that it be realizable on heterogeneous systems. An initial OS interface standard is expected in 1993, and the final standard is expected to be usable in the procurement of Navy systems in fiscal year 1996.

The NGCR approach is that of an open systems architecture based on the establishment of interface standards. The application of these standards will change the Navy's approach from one of buying standard computers to one of procuring computer resources which satisfy the interfaces defined by the standards. These standards will be applied to procurements at the project level rather than a Navy-wide procurement level. The interface standards will be based, to the greatest extent possible, on existing industry standards. In cases where existing industry standards do not meet Navy mission critical needs, the approach is to enhance the existing standards jointly with industry, thus assuring the most widely accepted set of nonproprietary commercially based Navy interface standards possible.

The OSSWG met throughout 1989 and early 1990 to define requirements, to identify candidates for the OS interface, and to define an evaluation process (see Evaluation Process Report). Seventeen classes of requirements have been identified. One class is programmatic issues; the other sixteen are technical service classes. Within each service class are requirements which define the evaluation criteria. The technical evaluation criteria are documented in the OSSWG Requirements Document.

Seven OS interfaces were identified as candidates:

1. Alpha
2. ARTX
3. Cronus/SDOS
4. iRMX
5. Mach/RT-Mach/T-Mach
6. ORKID
7. POSIX

Eight representative application domains were described. Weights, called Weight Set 2, were assigned to each of the OSSWG Requirements Service Classes for these domains. Other weights, called Weight Set 1, were also assigned to each criterion within a service class to determine the relative importance of the requirement to the service class.

Evaluators from the Navy, other government agencies, industry, and academia participated in rating the capabilities of each of the OS interfaces against required capabilities defined in the OSSWG Requirements Document. These evaluations produced the raw scores (0-10, 0 lowest) that were tabulated with the two weight sets applied.

Preliminary results were presented to the OSSWG at the meeting of 6-8 March 1990. The candidate OS interfaces were not identified by name, but rather by days of the week. As the results were preliminary, this was done to avoid any undue influence on evaluations that were still being compiled.

Final results were presented to the OSSWG at the meeting of 17-19 April 1990. During this meeting all candidates were identified by name.

This document includes the results of the evaluation and the results of the analysis performed on the evaluation's raw scores. For conclusions and/or discussions of the results, see the Recommendation Report.

FOREWORD

The work reported here was conducted over a period of a little more than one year by a joint team of Navy, other government, industry, and academic experts in the field of computer operating systems. Only a few of the Navy participants were actually funded to directly participate in this process.

The report was funded under NUSC Job Order Number A45146, Next Generation Computer Resources. The sponsoring activity is Space and Naval Warfare Systems Command, through the work of the Operating Systems Standards Working Group (OSSWG). The OSSWG management structure is as follows:

NGCR Program Manager, Mr. H. Mendenhall, SPAWAR 324
NGCR OSSWG Co-Chairman, CDR R. Barbour, SPAWAR 324
NGCR OSSWG Co-Chairman, Ms. T. Oberndorf, NADC
Approach Subgroup Chairman, Mr. T. Conrad, NUSC
Requirements Subgroup Chairman, Mr. R. Bergman, NOSC
Available Technology Subgroup Chairman, Mr. J. Oblinger, NUSC

Although the report is the result of work performed by the entire membership of the OSSWG, the following OSSWG members actively performed the evaluation of the final seven candidates:

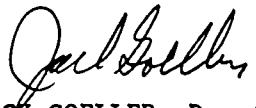
CDR Richard Barbour	SPAWAR 324
Richard Bergman	NOSC
Paul Bickness	Mitre
Richard Brogan	Booz, Allen, & Hamilton
Dale Brouhard	NOSC
Gregory Bussiere	NUSC
Antonio Carangello	Mitre
Gordon Caswell	ESL
Thomas Conrad	NUSC
B. Dasarathy	Concurrent Computer
Larry Daubert	Rockwell International
Isobel Davis	Raytheon
Steven Davis	DGM&S
Dr. Thomas Drake	Clemson University
Richard Dvorchak	Intel
LT Karl Fairbanks	NWC
Gary Fisher	NIST
Lester Fraim	Honeywell
Dr. Karen Gordon	IDA
Dr. Mars Gralia	JHU/APL
Daniel Green	NAVSWC
Raymond Gretlein	Dynamics Research

Joseph Gwinn	Raytheon
Barbara Haleen	Unisys
James Hall	NIST
Neil Henderson	Litton Data Systems
Gail Holmes	NUSC
Steven Howell	NAVSWC
John Johnson	NAC
Daniel Juttelstad	NUSC
Kari Kruempel	Unisys
Dr. James Leathrum	Clemson University
Warren Loper	Texas Instruments
Dr. Douglass Locke	IBM
Warren Loper	NOSC
Michael Morgan	Pacific International Center for High Technology Research (PICHTR)
Dr. John F. Nixon	General Electric Co. Advanced Technology Loaboratories
Patricia Oberndorf	NADC
James Oblinger	NUSC
Frank Prindle	NADC
John Reed	DEC
Carl Reinert	Computer Based Systems
Helmut Roth	NAVSWC
Dr. Timothy Saponas	Intel
John Shea	NOS
Del Swanson	Unisys
Maria Voreh	NRL
Patrick Watson	IBM

We would like to thank Carl Schmiedekamp (NADC) for his help with the data collection and analysis.

We would especially like to take this opportunity to thank the United States industry and academia for the staunch support of and participation in this working group and would like to strongly encourage their continued support and involvement.

Approved by:



JACK GOELLER, Deputy Head
Underwater Systems Department

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CHAPTER 1

INTRODUCTION

The U.S. Navy has embarked on a new computing resources standardization effort, the Next Generation Computer Resources (NGCR) program. The program is designed to fulfill the Navy's need for standard computing resources while allowing it to take advantage of commercial products and investments and to field technological advances more quickly. The program has identified ten (10) interface areas for standardization. The Operating Systems Standards Working Group (OSSWG) has been tasked with identifying a set of interfaces for operating systems (OS). The general requirements for the OS standard include Ada, real-time, distribution, multilevel security, fault tolerance, and that it be realizable on heterogeneous systems. An initial OS interface standard is expected in 1993, and the final standard is expected to be usable in the procurement of Navy systems in fiscal year 1996.

1.1 OVERVIEW

This report summarizes the results of the Next Generation Computer Resources (NGCR) Operating Systems Standards Working Group (OSSWG) evaluation of candidates for the Operating System Interface (OSIF) Baseline. Extensive details of the preplanning for the evaluation are provided in the Evaluation Process Report. The recommendation for the OSIF baseline is described in the Recommendation Report. An After Action Report provides general recommendations and lessons learned.

The OSSWG effort began early in 1989 with the first open meeting in March. Participation by industry, academia, and government was solicited. The Navy goal was to get a qualified set of people to examine a manageable number of candidate interface sets against Navy requirements. Navy requirements, candidate interfaces, and a selection process had to be developed and identified.

Meeting attendance was open. However, evaluators were required to qualify by attendance at two or more meetings. The set of evaluators submitting evaluations consisted of 21 Navy and 27 non-Navy representatives. Government (other than Navy), academia, and industry constituted the non-Navy participation.

To accomplish the work, three subgroups were established: Available Technology, Requirements, and Approach.

1.1.1 Available Technology Subgroup

The Available Technology Subgroup identified approximately 110 candidates for evaluation. By reviewing documentation of these candidates, the number was reduced to 10 candidates (See Appendix A. Description of Candidates):

1. Alpha
2. ARTX
3. Cronus
4. iRMX
5. Mach
6. ORKID
7. POSIX
8. MTOS
9. SDOS
10. T-Mach

The Available Technology Subgroup arranged to have representatives present information about their operating system interface to the OSSWG in December 1989 and January 1990. Mach, Trusted Mach and RT Mach were combined as were Cronus and SDOS, bringing the number of candidates to eight. After the December 1989 meeting, Industrial Programming Incorporated (IPI) withdrew MTOS from consideration.

1.1.2 Requirements Subgroup

The Requirements Subgroup identified 16 classes of requirements. These sixteen service classes all addressed technical areas. Each service class contained requirements which defined the evaluation criteria.

1.1.3 Approach Subgroup

The Approach Subgroup defined the evaluation process, including a seventeenth service class (service class 0) containing programmatic evaluation criteria. (See Evaluation Process Report). The Approach Subgroup was also responsible for the definition of the representative application domains (RADs). A set of eight RADs was defined.

1.2 ORGANIZATION

This document presents the results of the OSSWG evaluation process. Chapter 2 addresses the work of the Available Technology Subgroup. Weight sets developed by the Approach Subgroup and the entire OSSWG are discussed in Chapter 3. A description of the effort expended by evaluators is presented in Chapter 4. Chapter 5 presents a description of the data acquisition process including information about the briefings on the OS interfaces that were given to the OSSWG. Chapter 6 provides a summary of the results. Since there was no one candidate that was clearly superior to all others, the OSSWG considered alternate views of the data. These are discussed in Chapter 7. Chapter 8 concludes this report.

CHAPTER 2

SCREENING PROCESS RESULTS

From the initial Next Generation Computer Resources OSSWG Brief to Industry in March 1989, the Available Technology (AT) Subgroup was tasked with collecting information on available operating systems interfaces. A list of existing operating systems interfaces that the subgroup felt might fulfill any of the requirements of NGCR was compiled. This list included 110 operating systems, research projects in OS technology, and OS standards activities. A brief investigation of each of these systems was made, and a more detailed survey of the most promising was compiled and included in the Available Technology Report.

At the conclusion of this collection process, the Available Technology Subgroup had, as its major agenda item in October 1989, the narrowing of the operating systems interfaces candidate list. This "early screening," as specified by the Approach Subgroup of the NGCR OSSWG, was performed at the OSSWG Meeting held 14-16 October 1989.

To accomplish this early screening, a set of criteria was defined with which to narrow the complete Available Technology list of operating systems interfaces and interface standards to a number manageable for the formal evaluation process. The stated purpose of this process was to narrow the complete list to only those interfaces which had the potential of fulfilling the NGCR OSSWG requirements. Interfaces that were "too close to call" could be expected to be on the candidate list. The formal evaluation process would provide the final OSSWG selection.

Various methods for narrowing the rather large list of operating system interface candidates were discussed and exercised over several months. The appropriate method had a minimum number of criteria, yet provided a fair and equitable separation of the interfaces deemed to be valuable to the OSSWG from those which did not.

The screening, as finally accomplished, consisted of two separate, complementary sets of early screening criteria. The first method was known as the Decision Option Paper Method (DOP Method) and was based on a comparison of operating system capabilities against the DOP Technology area requirements described in the NGCR DOP document. The second method was called the Positive Negative Method (PN Method) and was based on a specific set of criteria for rating candidates. Positive criteria included such things as whether it was a current interface standard; negative criteria included such things as whether it was simply a narrowly focused research tool. (See the Available Technology Screening Report for information on the exact process and criteria.)

Using these screening criteria, the Available Technology Subgroup reduced the number of candidates to ten. The names of these ten were: ALPHA, ARTX, CRONUS, iRMX, MACH, MTOS, ORKID, POSIX, TMACH, and SDOS.

As OSSWG approached the 22-26 January meeting, there was some consolidation in the candidate list. Previously, in early December, the San Diego meeting had produced ten finalists and the realization that several of the candidates emanated from the same root and should therefore be presented as one.

After some discussion with both BBN, representing the CRONUS candidate, and Odyssey Research Institute, representing the SDOS candidate, it was agreed that they should be presented as one candidate. The funding for both of these products originated from Rome Air Development Center (RADC). SDOS was a product, being created by OSI, to build secure services into the CRONUS products. As one candidate, CRONUS/SDOS would be evaluated as a candidate with a greater breadth of capability than either alone. And most importantly, they were intended to work together: this was not a contrived pairing.

In a similar manner, both Mach and Trusted Mach were on the list of candidates. It seemed natural to group the Mach family of systems together. These included Mach represented by Carnegie Mellon University (CMU), Trusted Mach represented by Trusted Information Systems, and Real-Time Mach (RT Mach) represented by CMU.

An additional change to the candidate list occurred when MTOS, represented by the manufacturer, Industrial Programming Inc. (IPI), decided to withdraw from the evaluation process. The reasons cited by IPI were concerns about copyrights and releasing proprietary information. These areas of concern have always been topics of discussion in OSSWG; and certainly, the winner of the evaluation would have to be prepared to provide full access to the interface documentation.

The candidates selected by this process proved to be very capable. They provided valuable insight into their philosophies of operating system interface designs. Noting the strength of each of the candidates, the early screening process accomplished its intended purpose.

CHAPTER 3

WEIGHT SETS

In order to better understand how the results of the evaluation relate to the reality of Navy systems, various scores within the evaluation were weighted. The weights allowed the data reduction techniques used in the evaluation analysis to include the relative importance of each data point in the combined scores.

3.1 OVERVIEW

There were two sets of weights. The weights applied in the transformation from criteria scores to service class scores were called Weight Set 1. This weight set described the relative importance of each criterion score to its particular service class. The weights applied in the transformation of service class scores to representative application domains (RADs) were called Weight Set 2. This weight set described the relative importance of each service class to each representative application domain. All weights were on a 0.0 to 10.0 scale with 0.0 being the lowest possible weight and 10.0 being the highest.

3.1.1 Weight Set 1

The criteria within service classes 2 through 16 were weighted in order to arrive at a single service class score (for each service class). Table 3-1 shows the Weight Set 1. Included in this table is one standard deviation (sigma) of the weight as determined by the standard mathematical formula. In the application of these weights, each weight is multiplied by the criterion score, then the resultant scores for a service class' criteria are added together and normalized (by the total sum of the weights in the service class). The normalized weighted sum of scores represents the service class score.

TABLE 3-1. WEIGHT SET 1

Cr.	Wt.	Sigma	Cr.	Wt.	Sigma	Cr.	Wt.	Sigma	Cr.	Wt.	Sigma
2.1	1.00	0.00	6.8	8.79	2.15	9.6	7.89	2.82	13.3	4.57	1.81
3.1	7.0	0.0	6.9	9.29	1.71	9.7	7.48	2.15	13.4	7.61	2.60
3.2	7.0	0.0	6.10	9.00	1.91	9.8	8.48	1.99	13.5	5.79	2.87
3.3	5.0	0.0	6.11	8.67	2.20	9.9	6.78	1.99	13.6	6.54	2.60
3.4	8.0	0.0	6.12	7.92	2.45	9.10	6.26	2.21	13.7	7.86	2.26
3.5	6.0	0.0	6.13	7.33	2.32	9.11	6.74	2.19	13.8	6.86	2.21
3.6	6.0	0.0	6.14	8.00	2.48	9.12	7.89	2.38	13.9	5.93	2.71
3.7	3.0	0.0	6.15	4.92	2.86	9.13	5.59	2.04	13.10	6.61	2.17
3.8	5.0	0.0	6.16	8.79	2.15	9.14	6.74	2.55	13.11	7.25	2.19
3.9	5.0	0.0	6.17	7.58	2.83	10.1	6.37	3.50	14.1	8.63	1.74
3.10	3.0	0.0	6.18	7.33	2.76	10.2	6.22	3.14	14.2	8.75	2.07
3.11	10.0	0.0	6.19	7.75	2.51	11.1	7.96	2.66	14.3	6.87	2.65
3.12	3.0	0.0	6.20	7.00	2.41	11.2	6.50	2.96	15.1	8.96	1.72
3.13	5.0	0.0	7.1	8.71	1.81	11.3	5.92	2.78	15.2	7.96	2.08
3.14	4.0	0.0	7.2	8.88	1.90	11.4	5.71	3.03	15.3	6.70	2.13
3.15	10.0	0.0	7.3	8.88	1.90	11.5	6.58	2.86	15.4	5.63	3.13
3.16	10.0	0.0	7.4	8.79	1.84	11.6	5.75	1.73	15.5	5.78	3.13
3.17	7.0	0.0	7.5	8.75	1.92	11.7	6.33	2.57	15.6	8.37	1.90
3.18	3.0	0.0	7.6	8.21	2.19	11.8	7.00	2.17	15.7	6.67	2.76
3.19	6.0	0.0	7.7	7.96	1.94	11.9	7.29	2.39	16.1	8.08	2.70
3.20	1.0	0.0	7.8	6.79	2.81	11.10	6.67	2.85	16.2	7.38	3.20
3.21	7.0	0.0	7.9	7.46	2.15	11.11	6.13	2.72	16.3	7.81	2.62
3.22	9.0	0.0	7.10	6.00	3.01	11.12	5.67	2.32	16.4	7.81	2.62
3.23	4.0	0.0	7.11	5.92	2.95	11.13	5.17	2.28	16.5	7.42	2.79
3.24	2.0	0.0	8.1	7.58	2.81	11.14	5.83	2.37	16.6	4.62	2.47
4.1	1.00	0.00	8.2	6.54	2.15	12.1	7.58	2.75	16.7	8.62	2.40
5.1	7.11	2.28	8.3	6.83	2.44	12.2	7.29	2.51	16.8	8.50	2.50
5.2	7.15	2.20	8.4	5.67	2.66	12.3	8.08	1.72	16.9	5.85	2.80
5.3	7.44	2.53	8.5	6.0	2.55	12.4	7.08	2.28	16.10	5.46	2.83
5.4	6.04	2.55	8.6	5.79	2.81	12.5	7.58	2.48	16.11	7.38	2.93
5.5	6.89	3.26	8.7	5.38	2.73	12.6	6.33	2.97	16.12	7.04	2.95
5.6	7.67	2.63	8.8	5.88	2.56	12.7	6.33	2.84	16.13	7.92	2.65
6.1	7.71	2.31	8.9	5.29	2.99	12.8	6.21	3.13	16.14	5.58	3.09
6.2	7.08	2.83	8.10	3.57	2.15	12.9	6.96	2.93	16.15	7.42	2.94
6.3	7.29	3.04	9.1	8.48	2.24	12.10	6.96	2.93	16.16	7.81	2.43
6.4	7.08	2.39	9.2	7.11	3.17	12.11	6.67	2.70	16.17	5.23	3.37
6.5	6.25	3.31	9.3	8.00	2.66	12.12	6.25	2.49	16.18	6.12	2.88
6.6	5.75	2.89	9.4	5.85	3.18	13.1	8.82	1.59	6.19	8.15	2.49
6.7	9.38	1.58	9.5	7.70	2.84	13.2	8.68	2.07	6.20	7.50	3.62

Since the criteria of service class 1 (General) are not necessarily related to each other, it was determined that no weights should be generated for this service class. Additionally, service class 0 criteria are related to programmatic issues; therefore, it was decided that the NGCR program office would be the best organization to determine the relative importance of criteria within this class.

The weights of Weight Set 1 were developed by attendees of the December 1989 OSSWG meeting. The meeting was divided arbitrarily into two groups. Each group generated a subset of the weights. Each criterion was read aloud and discussed. Then each member of the group weighted the criterion from 0 to 10 as to its importance in the service class.

The weights for each criterion were arrived at by averaging all the December attendee weight scores for that criterion. The exception to the above process was for service class 3 (Security and Capability), because the requirements for this service class were not mature by the December 1989 meeting. The weights for service class 3 criteria were set once the service class was complete, but before the evaluation began using a consensus process. The weights for this service class were generated by the developers of this service class' criteria.

The individual weight scores, as well as the resulting average, were not disclosed to the OSSWG membership until after the evaluation of the seven candidates was complete. This was to eliminate the risk of prior knowledge of the weights affecting the scoring results of the evaluators. All weights, including service class 3 weights, were fixed and concealed before the official evaluation process began.

3.1.2 WEIGHT SET 2

Weight Set 2 was developed by the Approach Subgroup of the OSSWG during the OSSWG's September 1989 meeting. These weights were fixed and approved by OSSWG consensus during the October 1989 meeting. The weights were arrived at through an iterative process. In the September meeting the members of the Approach Subgroup generated the service class weights for each RAD. The weights from each subgroup member were disclosed and a discussion of each weight ensued. The members of the Approach Subgroup were given the time between the September 1989 and October 1989 OSSWG meetings to reconsider and resubmit their weights.

At the October 1989 OSSWG meeting, the weights from each Approach Subgroup member for each service class/RAD pair were averaged to generate the final weight set. As with Weight Set 1, Weight Set 2 only weighted service classes 2 through 16. Table 3-2 lists Weight Set 2. Table 3-3 presents the results of an analysis performed on Weight Set 2 before the evaluation of the seven candidates.

The total demand placed on an Operating Systems Interface (OSIF) by representative application domains is indicated by the total weights in the last row of Table 3-2. The most demanding RADs are Amethyst, Topaz, Emerald, Diamond, and Sapphire.

TABLE 3-2. WEIGHT SET 2

CLASS #	RUBY	OPAL	AMETHYST	GARNET	TOPAZ	EMERALD	DIAMOND	SAPPHIRE
2	3.2	5.3	4.2	5.8	6.0	7.2	7.8	6.0
3	5.8	2.3	9.0	3.2	4.8	9.3	4.3	7.6
4	6.4	5.5	7.7	4.3	7.7	4.8	5.5	6.2
5	5.4	7.3	7.5	7.5	6.2	7.2	8.5	7.2
6	9.2	0.5	4.7	0.3	4.2	1.7	1.7	3.4
7	5.0	5.5	4.5	6.7	6.3	5.3	6.5	6.0
8	3.8	5.2	9.5	2.8	6.2	5.3	6.0	8.8
9	4.0	4.5	5.5	3.7	5.3	5.2	6.3	8.2
10	3.0	3.7	4.2	4.7	6.2	7.3	6.5	7.6
11	3.4	6.0	7.5	8.5	8.2	9.2	8.7	8.2
12	6.0	3.0	5.5	4.0	4.3	5.0	5.3	6.8
13	5.4	5.5	7.0	4.3	4.8	5.2	8.3	7.8
14	4.6	3.5	5.0	4.3	6.3	5.2	5.5	4.6
15	3.8	7.2	7.8	7.0	6.7	6.8	7.7	8.4
16	2.4	4.5	6.8	8.2	8.8	8.7	8.3	8.8
Total Weight	71.4	69.5	96.4	75.3	92.0	93.4	96.9	105.6

Table 3-3 indicates the degree to which the eight RADs differ in their weights. The entries are the sums of the differences of the weights for the domains indicated by the column and row. Based on this data, the smallest distinction provided by these application domains is between Emerald and Diamond. In that case the difference between the sum of the weights is 16.9. This still averages to a difference greater than 1 for each weight for service classes 2 through 16. The last column of Table 3-3 is a row matrix summation of the differences. This summation gives the total weight difference between a RAD and all other RADs. Other analyses of Weight Set 2 can be found in Appendix B, Further Analysis of Weight Set 2.

TABLE 3-3. TOTAL DIFFERENCE WEIGHTS OF SERVICE CLASSES 2 THROUGH 16

	RUBY	OPAL	AMETHYST	GARNET	TOPAZ	EMERALD	DIAMOND	SAPPHIRE	***TOTAL DIFF***
RUBY	0.0	32.3	36.0	40.5	37.2	42.3	46.4	46.2	280.9
OPAL	32.3	0.0	30.1	18.2	27.1	27.3	27.4	36.3	198.7
AMETHYST	36.0	30.1	0.0	34.5	23.6	25.0	27.9	20.4	197.5
GARNET	40.5	18.2	34.5	0.0	21.3	21.9	22.0	32.9	191.3
TOPAZ	37.2	27.1	23.6	21.3	0.0	18.6	18.3	22.2	168.3
EMERALD	42.3	27.3	25.0	21.9	18.6	0.0	16.9	21.2	173.2
DIAMOND	46.4	27.4	27.9	22.0	18.3	16.9	0.0	19.7	178.6
SAPPHIRE	46.2	36.3	20.4	32.9	22.2	21.2	19.7	0.0	198.9

CHAPTER 4

EVALUATOR QUALIFICATIONS

A goal of the NGCR Program in general, and of the Operating System Interface Standard selection process in particular, was to obtain wide participation by the industrial, academic, and Navy communities. To that end, all who volunteered to participate in the process were welcomed. At least 307 different individuals responded to the call for participation by attending at least one meeting of the OSSWG.

Organizations that were represented at a minimum of two meetings by the December 1989 meeting were invited to provide two official evaluators to participate in the scoring of the candidates. More than 200 were qualified as evaluators on this basis, and letters requesting a commitment to actively support the formal evaluation of candidates were solicited from those qualified. Altogether, 71 evaluators submitted letters of intent to participate. These were given assignments such that sufficient evaluators were assigned to each aspect of the evaluation.

Table 4-1 shows the participation in the evaluation by Navy and other (University/Industry/Non-Navy Government) organizations. Appendix C, Contributing Organizations, lists all organizations represented by the 71 evaluators who submitted a letter of commitment and received an evaluation assignment. Not all were able to complete their assignments. The names of the evaluators who actually performed the scoring of the candidates are provided in Table 4-2. Overall, it is estimated that the evaluation itself (from screening process through selection) encompassed 120 person-months of effort over a period of 6 months.

TABLE 4-1. EVALUATION PARTICIPANTS

	NAVY	OTHER
INVOLVED IN ANY WAY	81	226
LETTERS OF COMMITMENT RECEIVED	25	46
EVALUATION ASSIGNMENTS COMPLETED	21	27

TABLE 4-2. PARTICIPANTS IN THE CANDIDATE SCORING PROCESS

CDR Richard Barbour	SPAWAR 324
Richard Bergman	NOSC
Paul Bicknell	Mitre
Richard Brogan	Booz, Allen, & Hamilton
Dale Brouhard	NOSC
Gregory Bussiere	NUSC
Antonio Carangello	Mitre
Gordon Caswell	ESL
Thomas Conrad	NUSC
B. Dasarathy	Concurrent Computer
Larry Daubert	Rockwell International
Isobel Davis	Raytheon
Steven Davis	DGM&S
Dr. Thomas Drake	Clemson University
Richard Dvorchak	Intel
LT Karl Fairbanks	NWC
Gary Fisher	NIST
Lester Fraim	Honeywell
Dr. Karen Gordon	IDA
Dr. Mars Gralia	JHU/APL
Daniel Green	NAVSWC
Raymond Gretlein	Dynamics Research
Joseph Gwinn	Raytheon
Barbara Haleen	Unisys
James Hall	NIST
Neil Henderson	Litton Data Systems
Gail Holmes	NUSC
Steven Howell	NAVSWC
John Johnson	NAC
Daniel Juttelstad	NUSC
Kari Kruempel	Unisys
Dr. James Leathrum	Clemson University
Michael Linnig	Texas Instruments
Dr. Douglass Locke	IBM
Warren Loper	NOSC
Michael Morgan	Pacific International Center for High Technology Research (PICHTR)
Dr. John F. Nixon	General Electric Co. Advanced Technology Laboratories
Patricia Oberndorf	NADC
James Oblinger	NUSC
Frank Prindle	NADC
John Reed	DEC
Carl Reinert	Computer Based Systems
Helmut Roth	NAVSWC
Dr. Timothy Saponas	Intel
John Shea	NOS
Del Swanson	Unisys
Maria Voreh	NRL
Patrick Watson	IBM

CHAPTER 5

DATA ACQUISITION

This chapter documents the methods used to collect the scoring data from the various industry and Navy evaluators of the seven finalist candidates.

5.1 MOBILE BRIEFING RESULTS

The activities and successes of the OSSWG meeting in Mobile, Alabama, 22-26 January 1990, are described in this section. At the time of this meeting, there were seven final candidates identified.

Before the December OSSWG meeting there had been ten final candidates. OSSWG had always assumed that the January meeting would be very intensive, requiring a full week of very detailed technical presentations. With ten candidates and five days maximum to meet, we planned that each candidate would naturally be permitted a half day for their presentation. With seven final candidates, the schedule was for a more comfortable three and a half days of presentations with time available for administrative activities.

The format required of each candidate presentation was specified so as to assist the evaluators in filling out their evaluation forms if they were so inclined. Specifically, each candidate's advocate was to format his/her presentation around the OSSWG Requirements Document. For all service classes he/she was to provide a description on how his/her interface supports, or fails to support, those requirements. Typically, the advocate also presented how his/her interface supported the individual criteria that comprised the service class. It was also required that each advocate show the linkage between their own system organization and that documented in the OSSWG Reference Model. This helped provide a frame of reference between terminology used by OSSWG and that used by the candidate.

After taking into account the travel requirements and time constraints of several of the advocates, the following agenda was set:

Monday, 22 January 1990

AM: Registration and opening discussions

PM: ORKID candidate presentation by Richard Vanderlin from Motorola.

Tuesday, 23 January 1990

AM: POSIX candidate presentation by:

Jim Isaak	from DEC
Fritz Schulz	from OSF
Jim Hall	from NIST
Steve Carter	from Bellcore
Mike Cossey	from DOE Oakridge
Doug Locke	from IBM Corp.
Steve Deller	from Verdix Corp.

PM: iRMX candidate presentation by Tim Saponas from Intel Corp.

Wednesday, 24 January 1990

AM: Open but candidate material was made available for the evaluators to begin the review and scoring of the candidates.

PM: Alpha candidate presentation by Doug Jensen from Concurrent Computer Corp.

Thursday, 25 January 1990

AM: ARTX candidate presentation by Dave Nelson-Gal from Ready Systems Corp.

PM: Mach/TMach/RTMach candidate presentation by:

Brian Boesch	from DARPA
Richard Rashid	from Carnegie Mellon University
Hide Tokuda	from Carnegie Mellon University
Steve Walker	from Trusted Information Systems

Friday, 26 January 1990

AM: Cronus/SDOS candidate presentation by Jim Berets from BBN Systems and Technologies Corp.

These presentations proved to be very beneficial to the evaluators and substantially aided them in their task of scoring the candidates. Each advocate focused on how their particular system's interface addressed, or in many cases did not address, each of the OSSWG requirements.

5.2 EVALUATION FORM COLLECTION

The OSSWG goal was to assemble enough evaluators so that, for each service class, a minimum of seven evaluators could be assigned to evaluate the seven candidate interface specifications. The OSSWG determined that a minimum of seven evaluators per service class was required to provide a statistically sufficient evaluation of each candidate specification. The requirement that an evaluator evaluate all seven candidate specifications for a service class was imposed to provide a fair and uniform evaluation process.

OSSWG members who qualified were asked to submit a letter of commitment to perform as technical evaluators for the OSSWG candidate specification evaluation process. The OSSWG members who volunteered as technical evaluators were also asked to list the service classes under which they would like to evaluate candidate specifications, based on personal preference and areas of expertise. From this compiled list, the Approach Subgroup made the final evaluator assignments with the following ground rules in mind: whenever possible, assign an evaluator to the service classes of his/her preference; have at least seven evaluators assigned to each service class; and do not overburden any evaluator with assignments.

The Approach Subgroup was able to assign the minimum of seven evaluators to each service class, and under most service classes more than seven evaluators were assigned. In addition to their assigned service classes, evaluators were encouraged to evaluate the candidate specifications under additional service classes.

A complete set of evaluation forms, instructions for completing and submitting the forms, the OSSWG Requirements Document, and service class assignments as well as the documentation on the seven candidate specifications were distributed to the technical evaluators via the United States Postal Service. An electronic copy of the evaluation forms was also made available to the technical evaluators via the OSSWG e-mail distribution list.

Evaluators were allowed to submit completed evaluation forms by one of three different methods: hand-written or typed on paper copy mailed to Naval Air Development Center (NADC); electronic copy e-mailed to a special DDN address; or interactively via an interactive evaluation tool provided on the NADC computer. The original due date for submission of evaluation forms was 2 February 1990 for hand-written and 9 February 1990 for electronically or interactively submitted forms. Due to logistics problems with the distribution of candidate specification documentation, the due date for all evaluation submissions was moved back to 28 February 1990.

Figure 5-1 provides a sample section of a blank evaluation form. The evaluation forms contain a section for each service class identified in the OSSWG Requirements Document. These evaluation form sections are further broken into subsections which correspond (one-to-one) to the interface requirements for the subject service class. For each subsection, or criterion, the evaluator was required to supply a score between 0 and 10 inclusive, a level of confidence in the score given (high, medium, or low confidence), and optionally supporting rationale for the score given and any additional comments the evaluator deemed necessary. Evaluators were encouraged to reference the OSSWG Requirements Document for descriptions of service class requirements and scoring guidelines. In general, a score of 10 indicated that the candidate specification fully supported the NGCR OSIF requirement for both distributed and non-distributed environments, while a score of 0 indicated that the requirement was not addressed/supported by the specification.

```
*              OSSWG OS Interfaces Evaluation
*
*              Project Support Environment Interaction
*Service Class:
*Evaluator Name:
*Evaluator ID:
*Candidate ID:


*10.1  Debug Support
*Score (0 - 10):
*Confidence Level (H/M/L):
*Rationale/References
*(text; don't start line with '*' or exceed 100 characters per line):


*Comments
*(text; don't start line with '*' or exceed 100 characters per line):


*10.2  Execution History
*Score (0 - 10):
*Confidence Level (H/M/L):
*Rationale/References
*(text; don't start line with '*' or exceed 100 characters per line):

*Comments
*(text; don't start line with '*' or exceed 100 characters per line):


*General Comments
*(text; don't start line with '*' or exceed 100 characters per line):


*End of evaluation form (Do not delete this line!)*
```

FIGURE 5-1. SAMPLE OSSWG SERVICE CLASS CRITERIA EVALUATION FORM

5.3 PROCESSING OF OSSWG INTERFACE EVALUATIONS

The major tasks in the data collection and analysis of the OSSWG OS Interfaces evaluation were:

- o Collecting all the evaluation forms and verifying that they were complete.
- o Parsing the evaluation forms to produce condensed data files.
- o Processing the data in the many data files to produce tables of results and graphics data files that could be downloaded to the spreadsheet program.
- o Producing reports on incomplete returns of the evaluation forms, by evaluator, by service class, and/or by candidate.

The various tools were developed in order to automate the processing by speeding the process and insuring correctness of results. Some of the common features of these tools include the following:

- o All the data files in the ad hoc evaluation data base have the date and time created as part of the file contents.
- o Every tool records its actions in a log file. The information logged briefly identifies the tool, including a time-stamp, and lists the actions taken and any errors found.

5.3.1 Interactive Input Tool

5.3.1.1 Function. This tool provides a simple to use interactive interface for an evaluator to record her/his scores, comments, etc. The tool can be executed concurrently by multiple users (i.e., any access to a common file/data structure is protected from corruption). The tool allows the user to review and/or edit an evaluation form at a later time. Evaluator passwords are required and the evaluation data is kept in an encrypted form to make it difficult for a malicious user to gain information about other evaluators' scores and to modify other evaluators' scores without being detected.

5.3.1.2 Formulas Used. (none)

5.3.1.3 Input. The input is interactive from the terminal of an evaluator. The terminal is not required to have cursor positioning or other "full screen" capabilities.

5.3.1.4 Output. The output of this tool is an evaluation form which is e-mailed to the evaluator and to the account designated for collecting the evaluation forms. In the case that the evaluator does not complete all the criteria for a service class before exiting the tool, the scores are e-mailed to the evaluator along with a note that the form is incomplete and has not been submitted; no incomplete forms should be e-mailed to the collection account.

5.3.2 Evaluation Form Parser

5.3.2.1 Function. This tool parses evaluation forms produced by the interactive evaluation tool as well as those e-mailed in. Multiple service class forms are split into individual data files; e-mail headers are stripped off; the forms are checked that all criteria have valid scores (i.e., within valid range) and that the user ID and candidate ID are valid. The tool can process more than a single file within one execution of the tool.

5.3.2.2 Formulas Used. (none)

5.3.2.3 Input. The input consists of the forms e-mailed in and produced by the interactive evaluation tool. These files are ASCII files which may contain e-mail headers.

5.3.2.4 Output. The first output is the "Data Only" from the evaluation forms which is entered into the evaluation data base if and only if the form is valid. If the form is invalid (or incomplete), then the errors found are written to an error report file. The "Data base" is a collection of many files with names which identify the evaluator, candidate and service class of the data in the file.

The second output consists of entries in the log file which identify the specific form and record the success/failure of the parsing operation.

5.3.3 Evaluator Reduction and Service Class Combiner

5.3.3.1 Function. In general this tool collects all the data from the evaluation data base, produces reports for all candidates, and generates data files for producing charts with a graphics spreadsheet. For each criterion the mean of the scores from each evaluator as well as the maximum score, minimum score, standard deviation and the estimated confidence are calculated. Also checks are made that there are enough evaluators for each service class. If an evaluator has not evaluated the minimum number of candidates (7) for a specific service class, then none of that evaluator's scores are included in the results for that service class. (Note: if an evaluator has not scored all of the criteria for a service class that form would be rejected by the form parser and none of the scores for that evaluation form would be in the data base.)

5.3.3.2 Formulas Used. See Eq. 1,2,3,4,5,6,7,8,9 in Appendix D, Formulas for Reduction and Analysis of Evaluation.

5.3.3.3 Input. The input is from the data base: the scores and confidence values for each criterion for each evaluator for each service class for the specified candidate OS interface.

5.3.3.4 Output. There are three outputs from this tool. The first output is the results report (Appendix E, Criteria Scores) which lists for each criterion the processed score, minimum score, maximum score, standard deviation and confidence value. The results report also includes the results of the weighted average of scores in a service class (using weight set 1) and the results of the RAD calculation (using weight set 2).

The second output is a set of chart data files from which the spreadsheet program, running on a personal computer, can produce charts of the results.

The third output is an entry in the Evaluation System Log File which records the date and time, the candidate processed and any errors found.

5.3.4 Rationale--Comments Report Generator

5.3.4.1 Function. These tools extract the rationales or comments from each of the evaluation forms along with the ID of the evaluator, the ID of the candidate, the service class and the criterion number. Separate comments and rationale reports are produced with all the rationales/comments for one candidate collected together by criterion and service class.

5.3.4.2 Formulas Used. (none)

5.3.4.3 Input. The input is the evaluation database.

5.3.4.4 Output. The comment report tool produces a report for the specified candidates by service class and then by criteria within the service class from the comments on the various evaluation forms. All the comments about a particular criterion are collected together along with information which identifies the evaluator who submitted each comment. Service class general comments are similarly collected.

The second tool produces the report which is the collection of the rationales for each individual criterion. This report is very similar to the first one except that there is no general rationale for a service class and this report must include the actual score as well as the evaluator ID.

5.3.5 Evaluator Report Generator Tool

5.3.5.1 Function. This tool checks the database to report those evaluators who have not submitted a complete set of evaluation forms. The general rule is that, if an evaluator submits a form for one candidate for one service class, he/she is required to submit evaluation forms for all OS Interface candidates for that service class in order for any of his/her scores to be counted.

5.3.5.2 Formulas Used. (none)

5.3.5.3 Input. The input for this tool is the evaluation database. Actually a list of the file names in the database directory is used to determine which evaluators have not completed which service classes.

5.3.5.4 Output. The output report from this tool lists the evaluators (or their IDs) and the service classes for which they have submitted complete and incomplete sets of forms.

5.3.6 Candidate Report Generator Tool

5.3.6.1 Function. This tool checks the database to report those candidate OS Interfaces which do not have a complete set of evaluation forms submitted. The report lists the number of evaluators for each service class for each candidate.

5.3.6.2 Formulas Used. (none)

5.3.6.3 Input. The input for this tool is the evaluation database. A list of the files in the database directory is used to determine which evaluators have not completed which service classes.

5.3.6.4 Output. The output report lists the candidates and for each the number of evaluators for each service class that have completed evaluation forms.

5.3.7 Generation of Figures

The results of the evaluation are downloaded into a graphics spreadsheet to produce the many charts of the results.

Figures 5-2, 5-3, and 5-4 show the dataflow through the evaluation processing. Each of the tools (programs) described in sections 5.3.1 - 5.3.6 is described in more detail below.

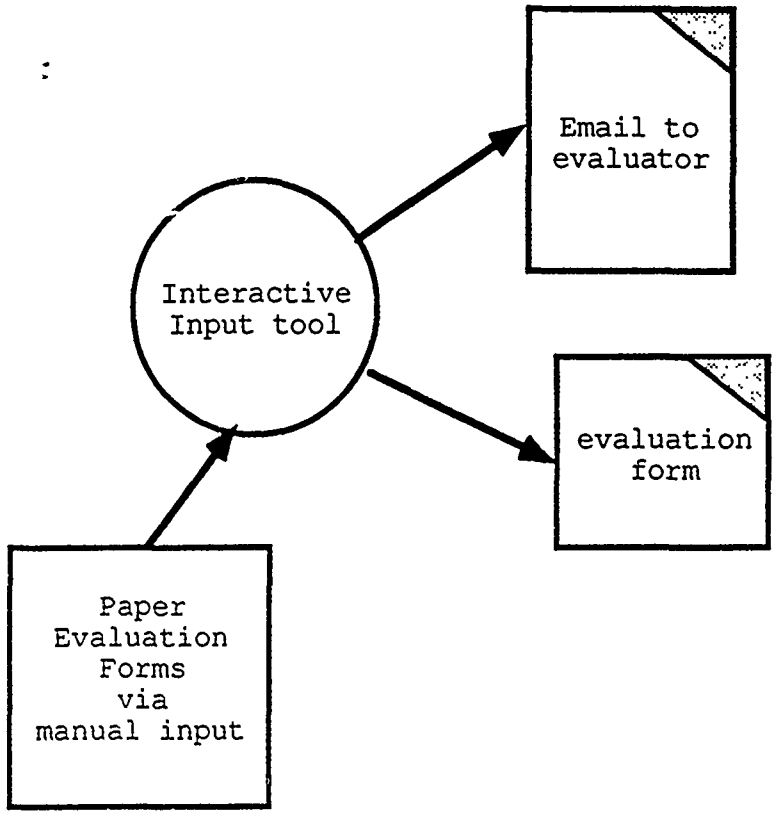

Figure 5-2. DATA COLLECTION - UNIX

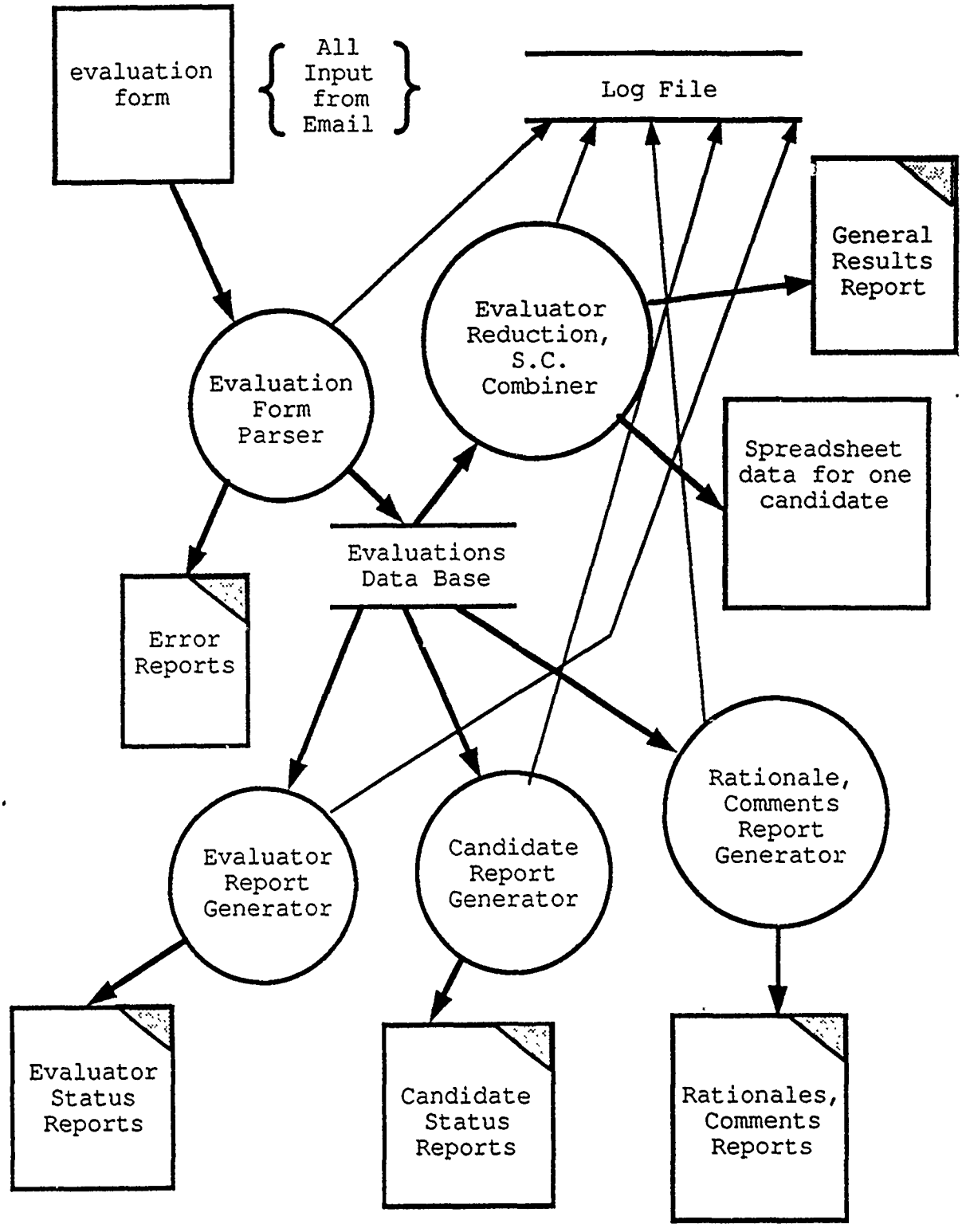

FIGURE 5-3. EVALUATION DATAFLOW - UNIX

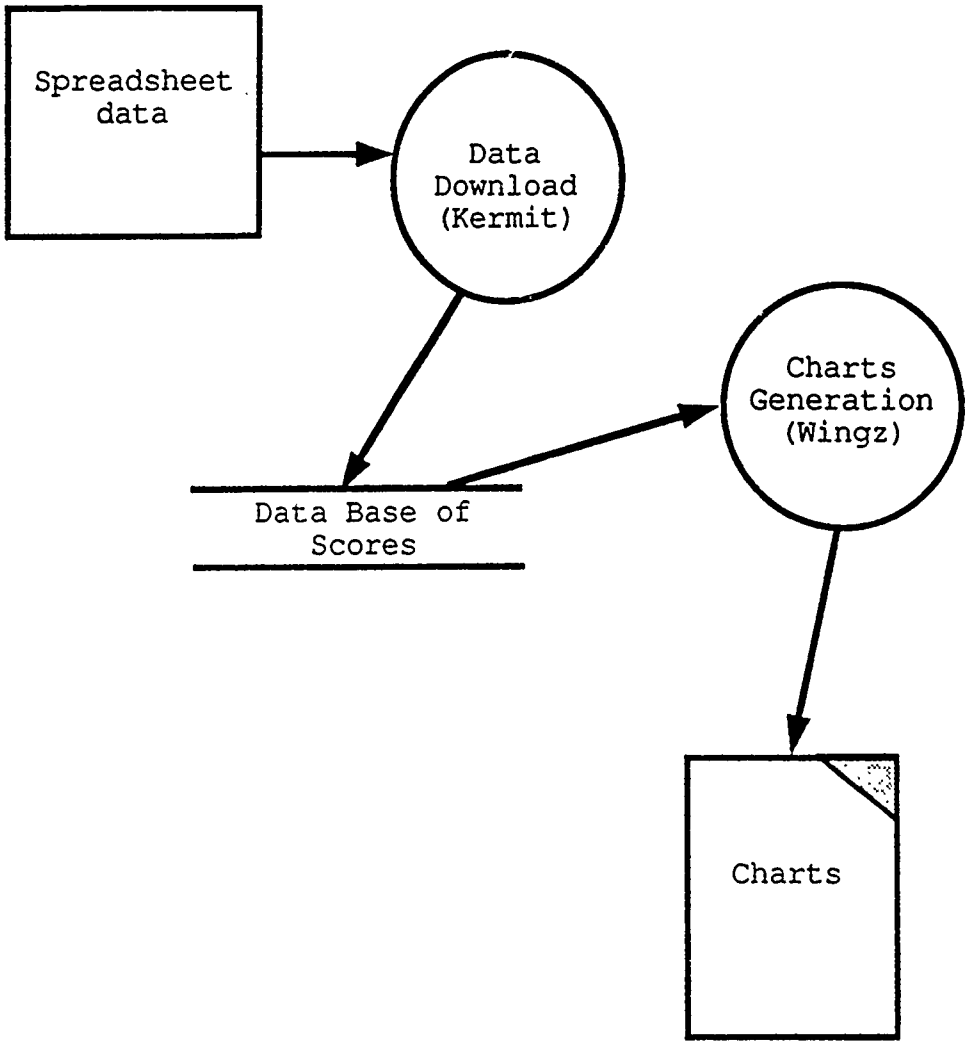

FIGURE 5-4. EVALUATION DATAFLOW - MACINTOSH

CHAPTER 6

SUMMARY RESULTS

The results documented below were derived from the raw scores provided by the evaluators, according to the averaging, weighting, and combining processes described in the Evaluation Process Report and Chapter 5 of this report. The results are generally categorized as either "technical" or "programmatic" in nature. The technical results derive from scoring the candidates against criteria defined in the Requirements Document and are presented in section 6.1 below. The programmatic results derive from scoring the candidates on programmatic issues defined in the Evaluation Process Report and are presented in section 6.2 below. See Appendix E (Criteria Scores) for a summary of the results.

Several formats are used to present the results, including both tables and charts. Tabular data includes average score, standard deviation, an evaluator confidence measure, and maximum and minimum scores. The scope of the raw data on which these results are based is as follows. A single complete set of raw scores for one candidate consists of 193 data points (8 Programmatic Issue scores, 29 scores on general technical criteria, and 156 scores on specific technical criteria). Table 6-1 shows a summary of the data collected. At least 7 independent sets of scores were obtained for each criterion for each candidate. For many subsets of the evaluation criteria many more than 7 sets of scores were obtained. As a result, the total number of data points for all candidates was 19,964.

TABLE 6-1. EVALUATION DATA BASE

Class #	# of Evaluators	# of Criteria	Data Points Per Service Class Per Candidate
0	20	8	160
1	45	29	1305
2	9	1	9
3	7	24	168
4	9	1	9
5	13	6	78
6	8	20	160
7	8	11	88
8	11	10	110
9	9	14	126
10	10	2	20
11	12	14	168
12	11	12	132
13	11	11	121
14	9	3	27
15	13	7	91
16	9	20	180
Totals		193	2852

2852 Data Points * 7 Candidates = 19,964 Total Data Points

6.1 TECHNICAL EVALUATION

The technical evaluation was performed by both Navy and non-Navy evaluators based on the requirements defined in the OSSWG Requirements Document, Version 2.0. That document identifies the 16 technical classes of operating system services. Of these, 15 relate to specific services that an operating system interface must provide. The other class contains a collection of general requirements in an operating system interface. Each service class reflects a number of specific evaluation criteria on which the candidates were judged. Table 6-2 indicates the number of evaluation criteria associated with each class.

TABLE 6-2. NUMBER OF CRITERIA PER TECHNICAL SERVICE CLASSES

SERVICE CLASS	NUMBER OF CRITERIA
1. GENERAL REQUIREMENTS	29
2. ARCHITECTURE DEPENDENT INTERFACES	1
3. CAPABILITY AND SECURITY INTERFACES	24
4. DATA INTERCHANGE INTERFACES	1
5. EVENT AND ERROR INTERFACES	6
6. FILE INTERFACES	20
7. GENERALIZED I/O INTERFACES	11
8. NETWORK AND COMMUNICATIONS INTERFACES	10
9. PROCESS MANAGEMENT INTERFACES	14
10. PROJECT SUPPORT ENVIRONMENT INTERFACES	2
11. RELIABILITY, ADAPTABILITY, MAINTAINABILITY INTERFACES	14
12. RESOURCE MANAGEMENT INTERFACES	12
13. SYNCHRONIZATION AND SCHEDULING INTERFACES	11
14. SYSTEM INITIALIZATION AND REINITIALIZATION INTERFACES	3
15. TIME SERVICES INTERFACES	7
16. ADA LANGUAGE SUPPORT INTERFACES	20

A difference between service class 1 (General) and the remaining service classes is that the criteria which compose service class 1 are independent of each other. Therefore it is not reasonable to generate an overall service class score for service class 1. For this reason, the specific and the general service class scores are presented in separate sections below. Eight RADs were defined in the Evaluation Process Report along with weights relating the overall scores on the specific service classes to a score for each application domain.

Consequently, Section 6.1.1 below provides the results for the specific service classes. Section 6.1.2 reports the effect of mapping the specific service class scores onto the eight representative application domains. Section 6.1.3 reports the results for the general service class.

6.1.1 Service Classes

The following tables and figures summarize the outcome of the evaluation by service class. Table 6-3 presents a summary of results including the score and error approximation (sigma) for each candidate against each service class. Figures 6-1(a), 6-1(b), and 6-1(c) depict the information in graphical form.

TABLE 6-3. SUMMARY OF CLASS SCORES

Cl	ALPHA		ARTX		CRONUS		IRMX		MACH		ORKID		POSIX
2	7.00	3.04	3.78	2.17	5.11	3.72	4.67	1.50	3.67	3.39	2.44	3.13	3.44	4.30
3	1.74	0.54	0.56	0.33	6.48	0.73	0.96	0.38	7.31	0.75	0.09	0.11	7.28	0.73
4	3.33	3.68	1.11	3.33	8.33	2.50	1.00	3.00	2.44	3.54	0.78	1.72	1.44	2.19
5	7.38	1.60	2.30	0.94	3.71	1.26	5.42	1.41	1.85	0.94	2.56	1.04	3.88	1.16
6	6.09	1.14	7.57	0.72	3.72	1.07	8.09	0.76	4.13	1.05	0.00	0.00	8.24	0.74
7	5.85	1.09	7.57	0.97	0.53	0.48	8.40	0.99	1.58	0.74	0.58	0.33	7.12	0.91
8	7.00	1.38	4.21	1.23	6.04	1.39	5.06	1.21	3.82	1.14	0.50	0.42	3.20	1.14
9	7.99	1.02	6.56	0.91	3.92	0.80	8.09	0.91	7.53	0.99	6.26	0.83	6.21	1.00
10	4.71	3.03	2.18	2.53	1.40	1.48	4.55	2.59	2.81	2.55	0.30	0.71	0.35	0.65
11	5.50	1.13	0.21	0.22	1.81	0.82	4.16	0.84	0.84	0.47	0.19	0.19	1.78	0.72
12	6.60	1.16	2.62	0.74	0.57	0.44	3.26	0.73	5.44	0.98	1.75	0.69	3.86	0.83
13	6.94	1.07	5.23	0.86	3.38	1.00	6.31	0.96	3.79	1.13	5.16	0.99	8.11	1.03
14	5.96	2.53	4.51	2.01	3.78	2.55	6.69	2.05	5.26	2.45	0.70	1.31	5.33	2.53
15	7.71	1.57	2.96	0.92	2.17	1.04	4.88	1.19	1.79	1.03	3.69	0.95	6.86	1.24
16	5.82	0.76	6.84	0.88	2.02	0.82	6.56	0.86	4.98	0.47	3.63	0.77	6.85	1.01

Note: scores and standard deviations (sigmas) are both listed: score|sigma

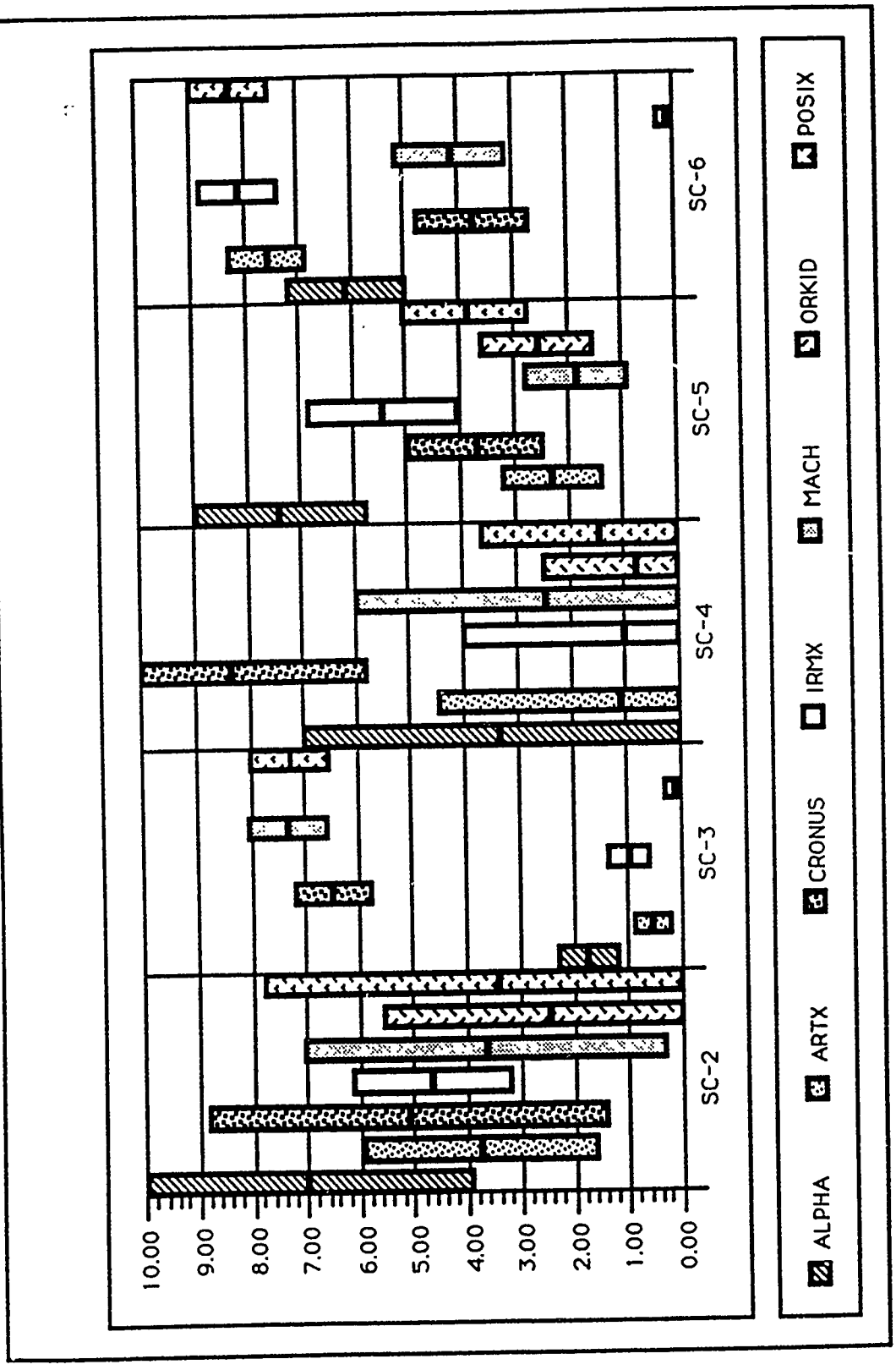

FIGURE 6-1(a). WEIGHTED CLASS SCORES FOR EACH CANDIDATE

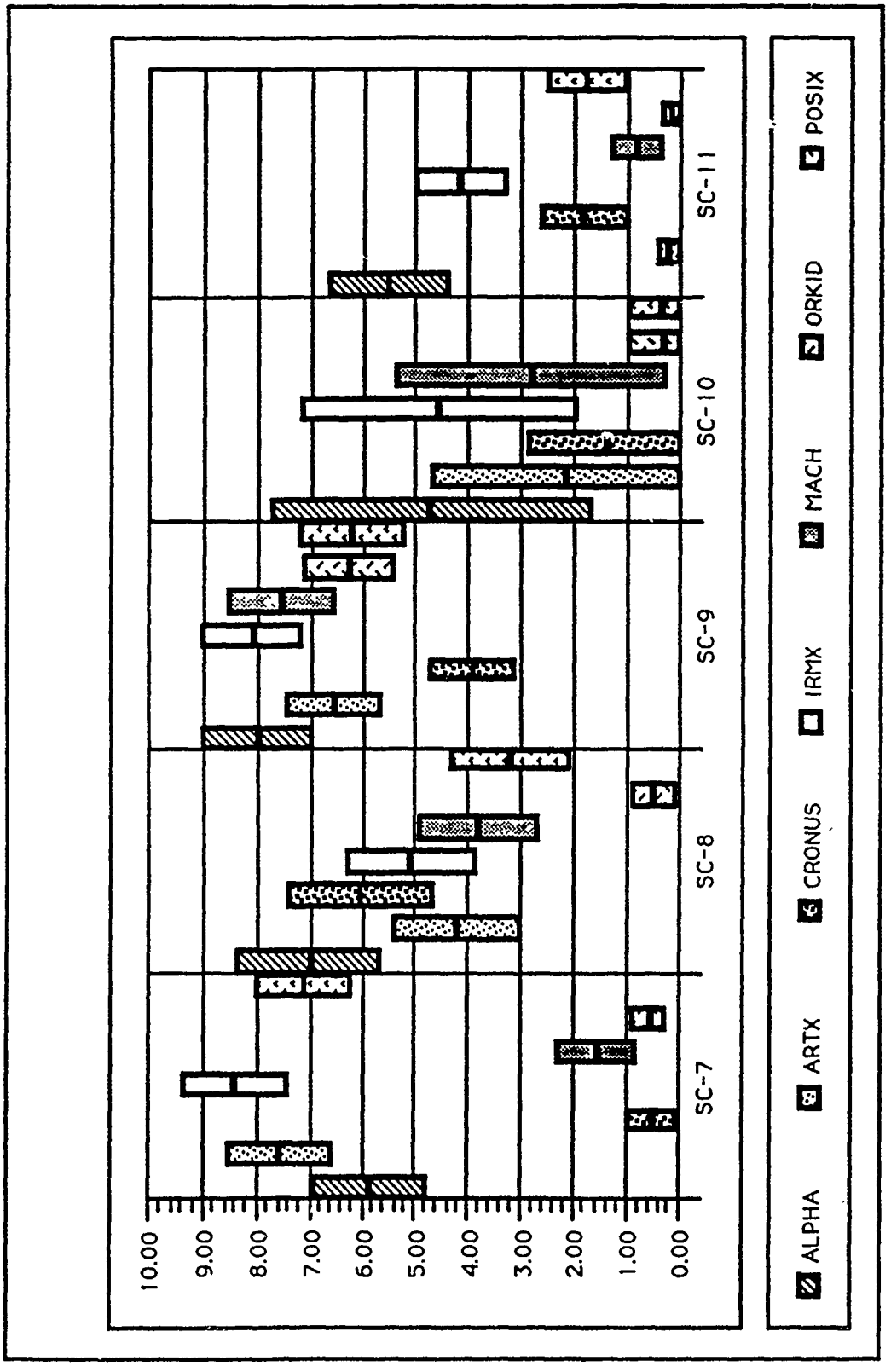

FIGURE 6-1(b). WEIGHTED CLASS SCORES FOR EACH CANDIDATE

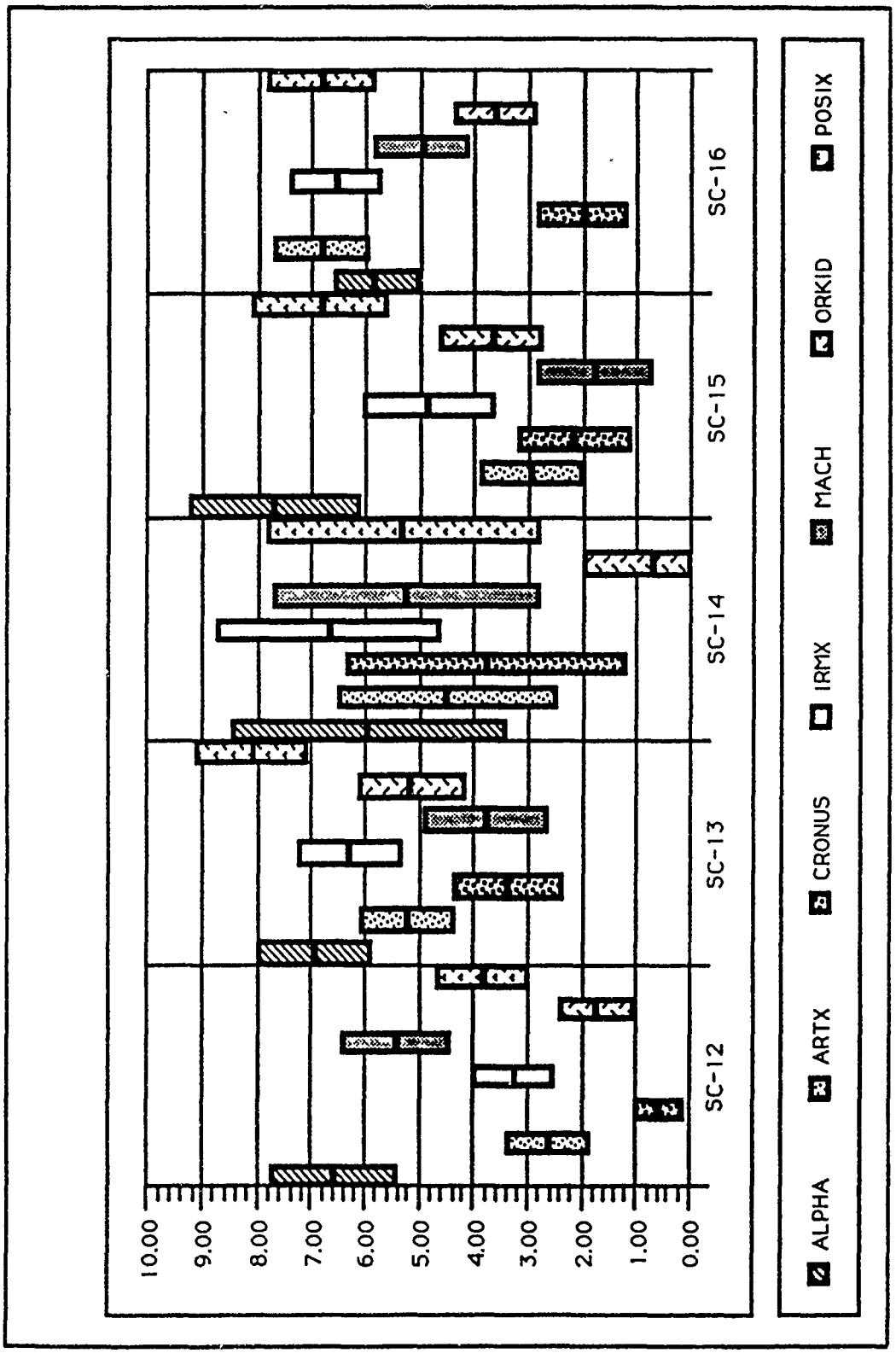

FIGURE 6-1(c). WEIGHTED CLASS SCORES FOR EACH CANDIDATE

6.1.2 Representative Application Domain Results

The following tables and figures summarize the outcome of the evaluation by RAD. Table 6-4 presents a summary of results including the score and error approximation (sigma) for each candidate against each RAD. A sigma is one standard deviation. Figure 6-2 depicts the information in graphical form.

TABLE 6-4. SUMMARY OF RAD RESULTS

RAD	ALPHA		ARTX		CRONUS		IRMX		MACH		ORKID		POSIX	
Amethyst	5.88	0.47	3.59	0.38	3.80	0.38	4.91	0.38	3.80	0.43	1.90	0.26	4.93	0.38
Diamond	6.14	0.50	3.76	0.38	3.36	0.44	5.22	0.38	3.58	0.46	2.16	0.33	4.77	0.46
Emerald	5.82	0.49	3.48	0.38	3.48	0.42	4.92	0.37	3.77	0.45	1.91	0.31	4.74	0.44
Garnet	6.09	0.50	3.67	0.38	3.15	0.43	5.20	0.39	3.37	0.45	2.07	0.33	4.71	0.46
Opal	6.21	0.53	3.67	0.41	3.50	0.45	5.17	0.41	3.37	0.48	2.18	0.34	4.69	0.47
Ruby	5.86	0.50	3.98	0.41	3.72	0.40	5.19	0.39	3.89	0.46	1.72	0.27	5.22	0.39
Sapphire	6.02	0.46	3.74	0.37	3.49	0.38	5.10	0.37	3.81	0.42	2.08	0.28	4.85	0.38
Topaz	5.94	0.52	3.79	0.42	3.53	0.43	5.16	0.41	3.62	0.48	1.89	0.31	4.73	0.44

Note: scores and standard deviations (sigmas) are both listed: score|sigma

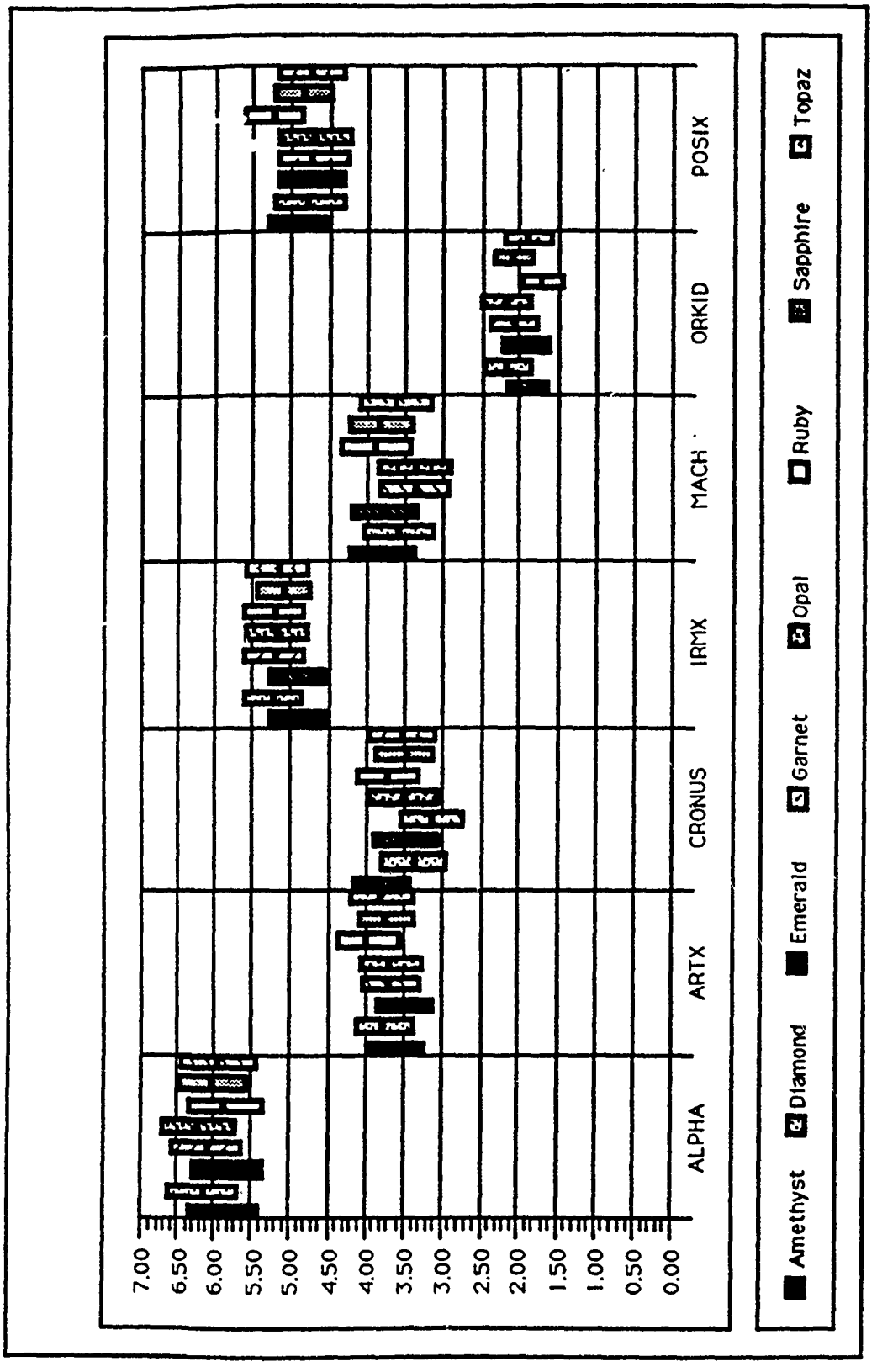

FIGURE 6-2. REPRESENTATIVE APPLICATION DOMAIN RESULTS

6.1.3 General Technical Issues

The evaluation criteria for the OSSWG baseline candidates included a collection of issues which were sufficiently pervasive to defy inclusion in the already defined service classes. These criteria were brought together into a special class called General Requirements (Service Class 1). Not only were these criteria pervasive, they were also somewhat pedestrian. Thus, they could reasonably be evaluated by all evaluators regardless of the evaluator's special expertise. Unlike the other service classes, the criteria scores in this class were collected from a large number of evaluators (i.e., 45).

Having little connection with each other, the criteria within the General Requirements service class do not lend themselves to averaging within the service class. For this reason, weights were not generated for the criteria, and the results from the 29 criteria within this service class are only presented separately with no suggestion of connections or aggregations. This information is in tabular form in Table 6-5 and graphical form in Figures 6-3(a), 6-3(b), 6-3(c), 6-3(d), 6-3(e), and 6-3(f).

TABLE 6-5. CANDIDATE RESULTS FOR EACH GENERAL REQUIREMENT

Criteria	ALPHA		ARTX		CRONUS		IRMX		MACH		ORKID		POSIX	
1	6.87	2.02	5.98	1.80	5.42	1.97	7.33	1.60	6.13	2.46	5.24	1.33	7.36	1.81
2	7.73	2.18	6.84	2.32	7.44	2.02	7.33	1.93	7.22	2.71	6.67	1.89	8.76	1.38
3	6.09	2.04	6.76	2.04	6.13	1.87	7.16	1.74	5.91	1.93	7.29	1.84	6.56	1.90
4	8.22	1.76	6.89	2.50	8.64	1.91	5.78	2.25	7.67	2.04	7.00	2.43	9.04	1.48
5	8.11	2.45	7.71	1.98	7.64	2.22	8.18	1.71	7.44	2.58	7.71	2.37	7.07	2.54
6	8.49	1.91	7.22	2.52	8.49	1.56	8.42	1.82	7.69	2.08	6.04	2.24	7.82	2.23
7	8.56	1.95	6.96	2.22	8.02	2.08	8.18	1.75	7.27	2.16	7.89	2.38	7.09	2.86
8	7.51	2.61	6.53	2.22	5.56	2.98	8.22	1.70	6.91	2.40	6.91	2.28	7.13	2.35
9	7.24	2.60	4.84	3.30	6.89	2.69	6.47	2.32	3.87	3.35	6.98	3.01	5.38	2.67
10	3.78	2.85	7.82	2.78	2.82	2.69	4.67	2.72	3.40	3.90	0.31	0.95	7.07	3.10
11	6.64	2.95	7.29	2.61	7.69	3.04	7.89	2.50	4.60	2.71	3.93	2.28	7.44	2.77
12	7.16	1.98	7.27	1.88	7.02	2.17	8.42	1.69	6.58	2.77	5.31	3.38	6.53	2.90
13	7.87	1.74	7.40	2.18	7.58	2.65	7.87	1.97	6.38	3.02	5.16	3.01	5.71	2.75
14	8.18	1.63	6.98	2.62	7.38	2.41	8.13	1.93	6.93	2.63	6.67	3.42	7.56	2.22
15	7.42	2.01	6.96	1.97	6.80	2.14	7.89	1.81	6.47	2.23	6.98	2.34	7.98	2.09
16	8.58	1.66	6.98	2.15	8.11	2.00	8.40	1.64	6.53	2.35	8.11	1.86	7.80	2.44
17	8.80	1.47	5.71	2.58	7.24	2.46	8.00	1.91	6.80	2.64	7.20	2.61	7.96	2.37
18	8.13	2.19	7.20	1.79	8.49	2.00	8.62	1.70	7.22	2.60	8.27	2.06	6.78	2.49
19	7.09	2.87	4.49	3.13	4.87	3.09	7.40	2.78	5.11	2.92	5.56	3.04	7.53	2.84
20	8.67	2.04	6.98	2.41	6.04	3.25	8.53	1.88	4.60	3.46	7.27	3.02	5.49	2.96
21	7.64	2.78	6.33	2.51	1.24	2.01	5.27	2.81	3.51	2.87	2.33	2.92	5.53	2.84
22	7.56	3.15	7.47	1.95	6.71	3.04	7.76	2.35	4.60	3.44	5.22	3.25	5.20	2.59
23	8.36	2.85	4.40	2.82	2.84	2.61	5.82	2.55	3.84	3.46	2.36	2.27	3.78	3.23
24	8.31	2.25	1.04	1.95	7.60	2.45	7.04	1.91	5.91	3.42	2.44	2.28	6.87	2.23
25	9.42	0.99	5.04	2.51	9.02	1.96	7.18	1.92	5.69	3.73	6.89	2.88	5.69	2.42
26	8.49	2.20	4.24	2.89	8.09	2.64	7.84	2.04	4.64	2.70	4.76	3.40	6.04	3.01
27	7.55	2.34	1.96	2.64	7.78	2.33	3.67	3.11	5.16	2.90	4.58	3.26	5.36	2.60
28	7.04	3.05	5.00	2.46	1.84	2.95	6.53	2.49	3.18	2.98	2.18	2.44	2.40	2.82
29	6.62	2.52	2.29	2.94	1.73	2.99	6.02	2.77	2.56	2.83	1.04	1.65	2.04	2.56

Note: scores and standard deviations (sigmas) are both listed: score|sigma

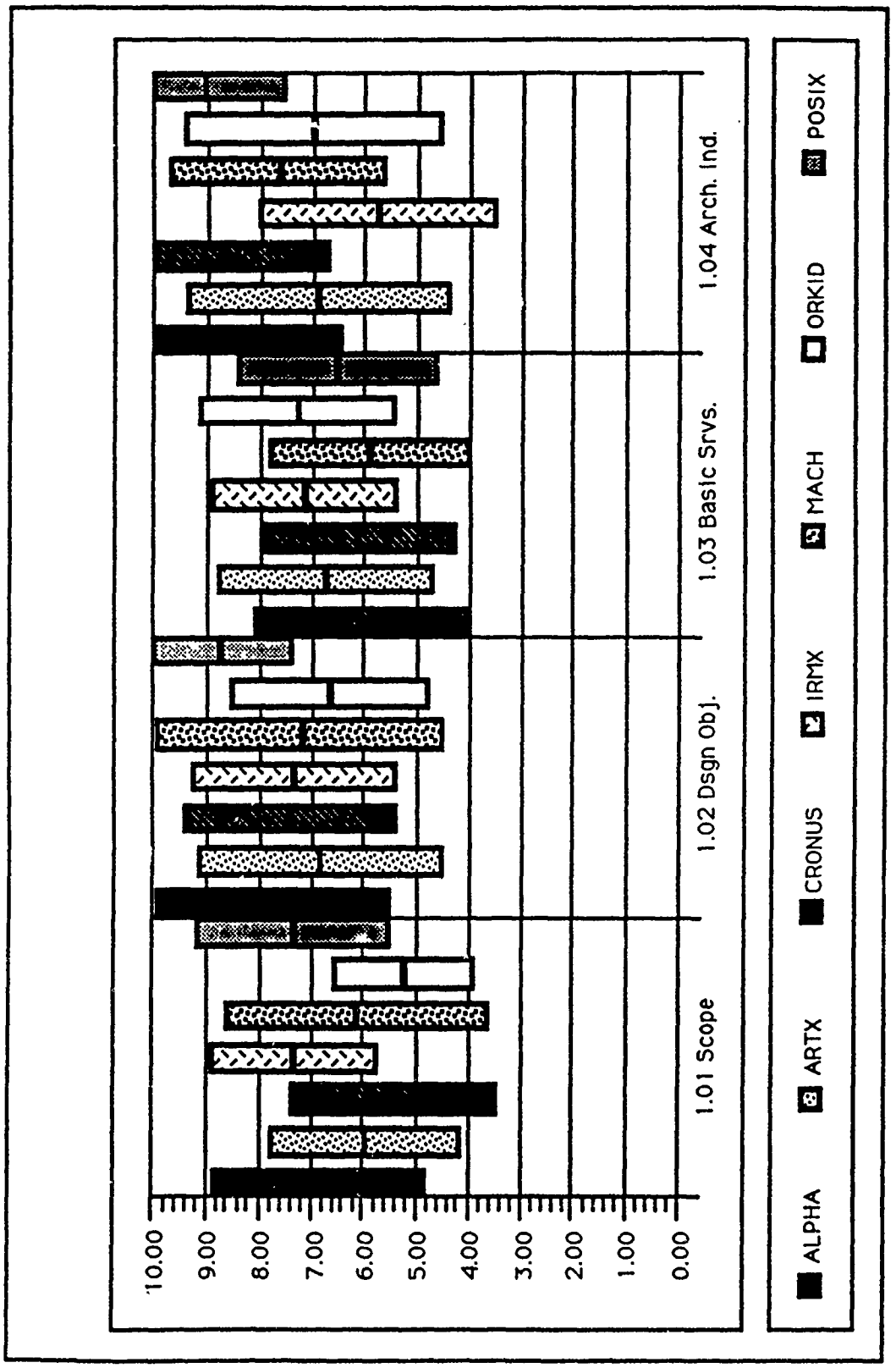

FIGURE 6-3(a). GENERAL SERVICE CLASS BY CRITERION

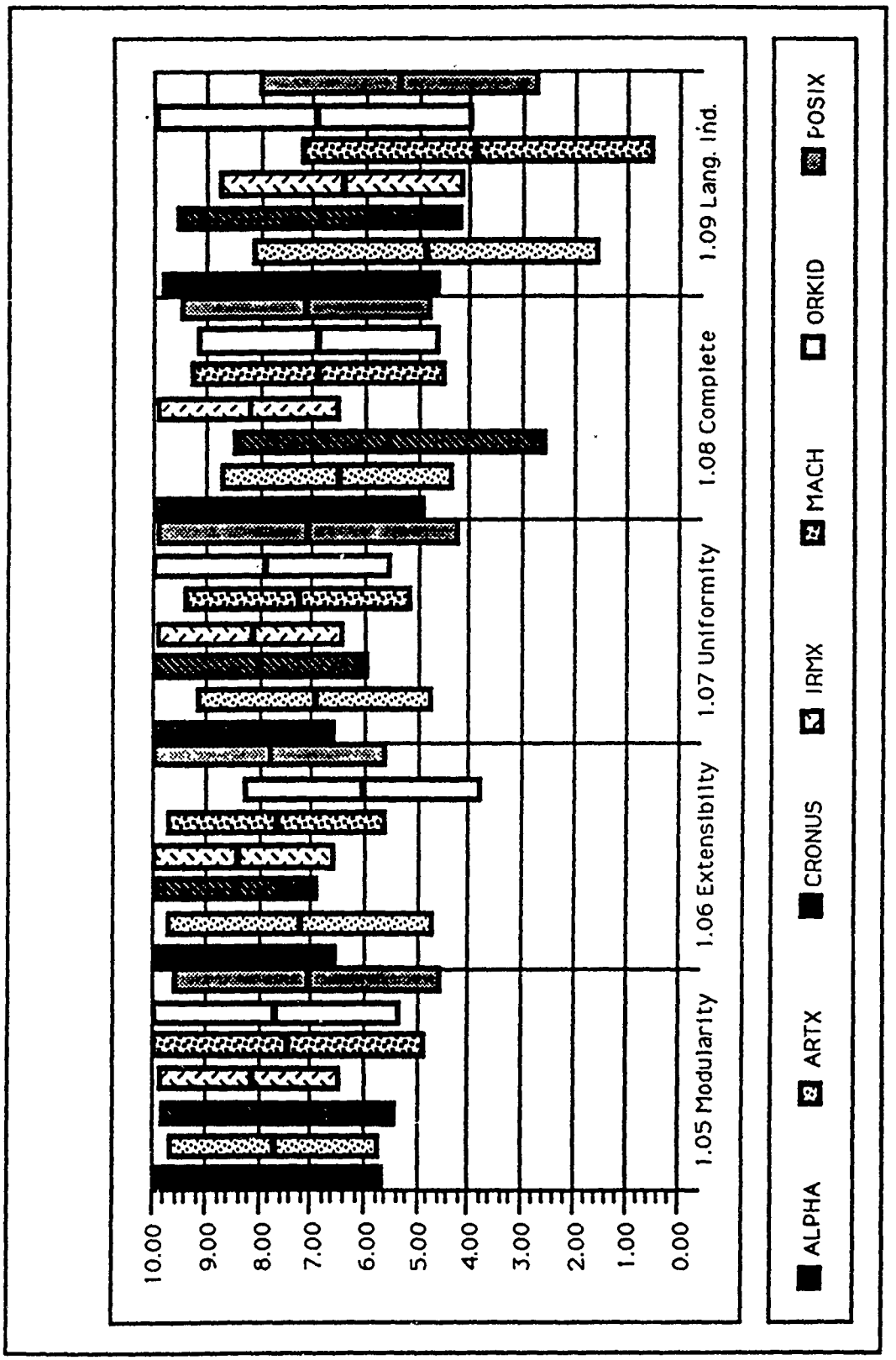

FIGURE 6-3(b). GENERAL SERVICE CLASS BY CRITERION

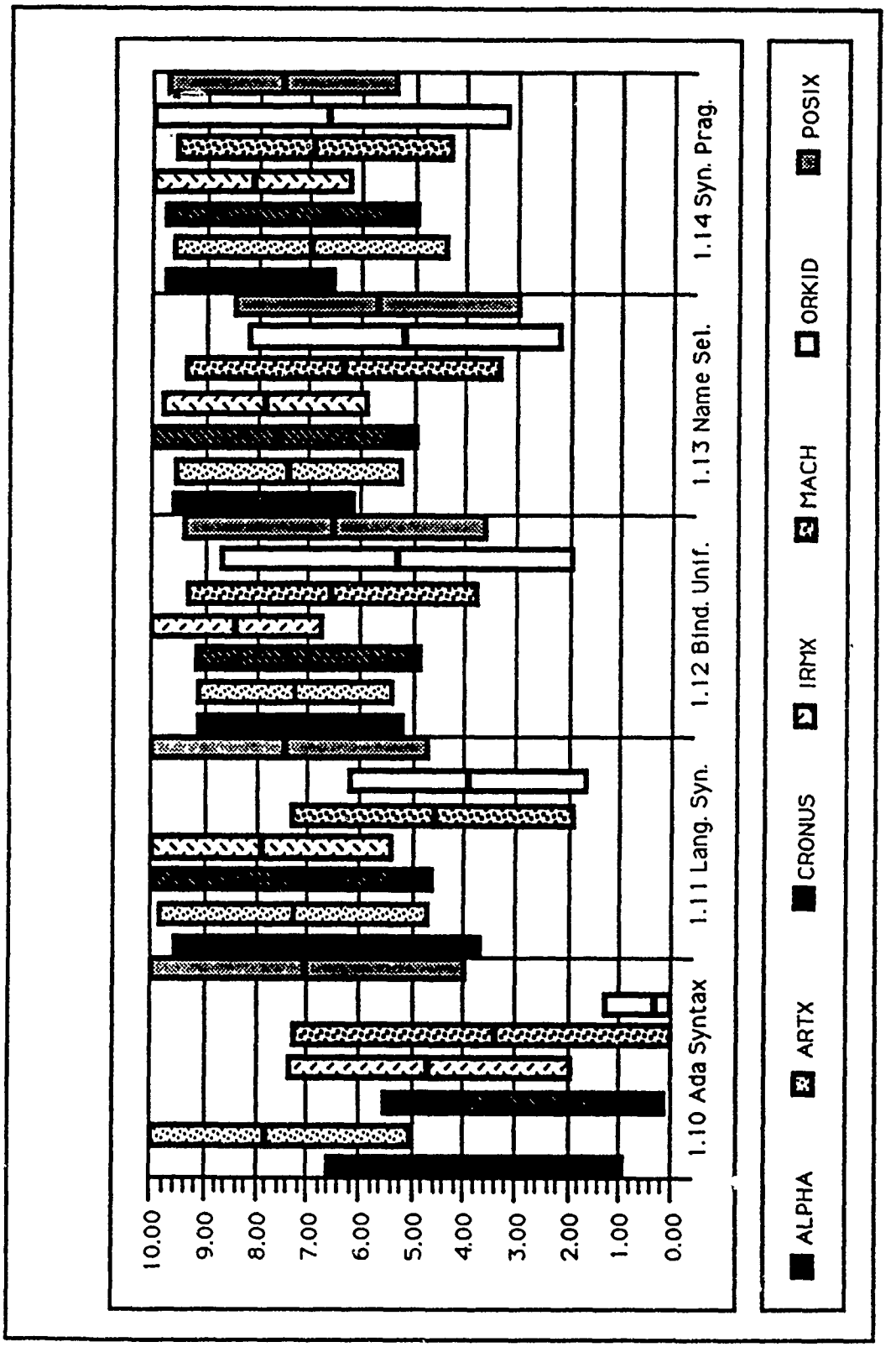

FIGURE 6-3(C). GENERAL SERVICE CLASS BY CRITERION

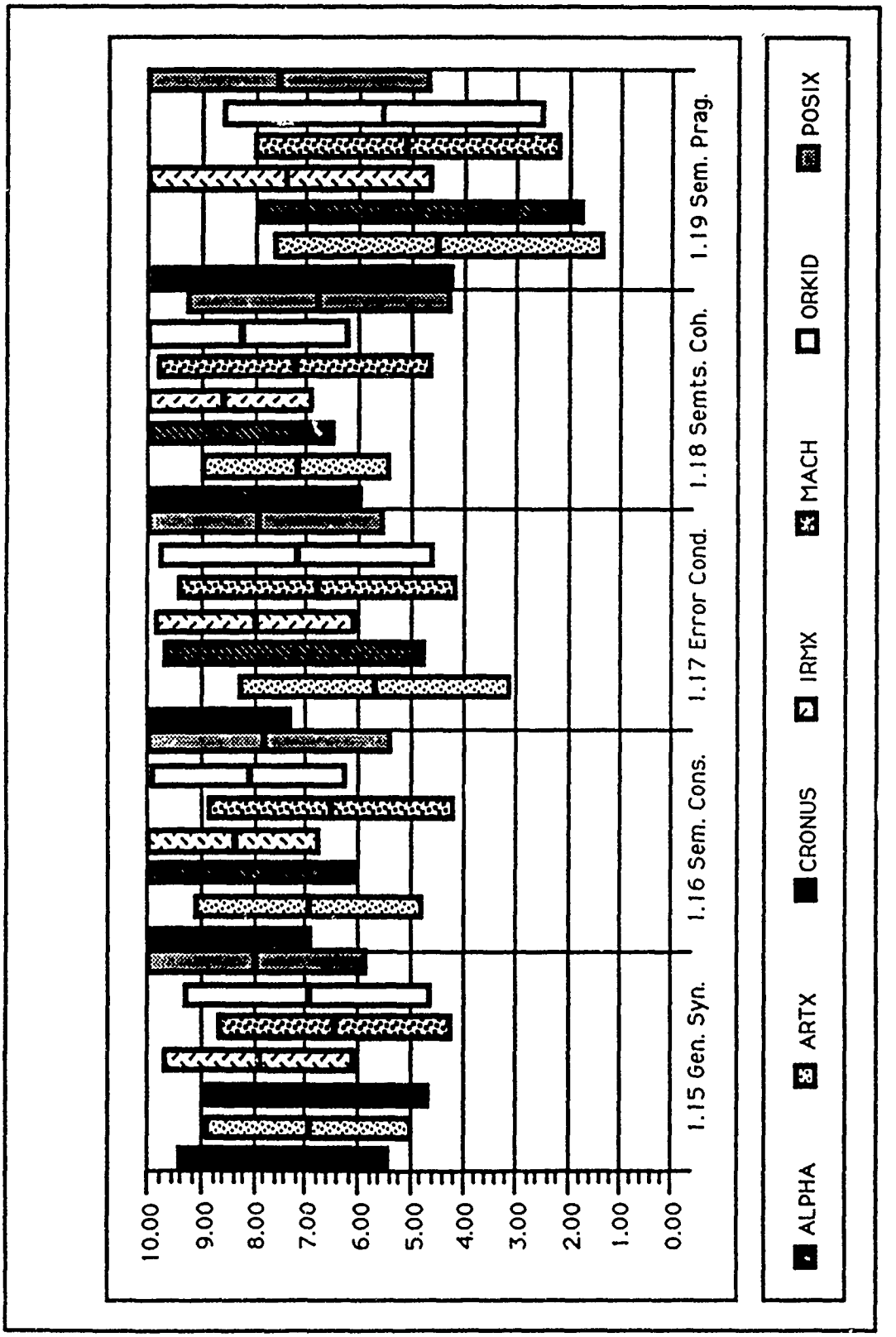

FIGURE 6-3(d). GENERAL SERVICE CLASS BY CRITERION

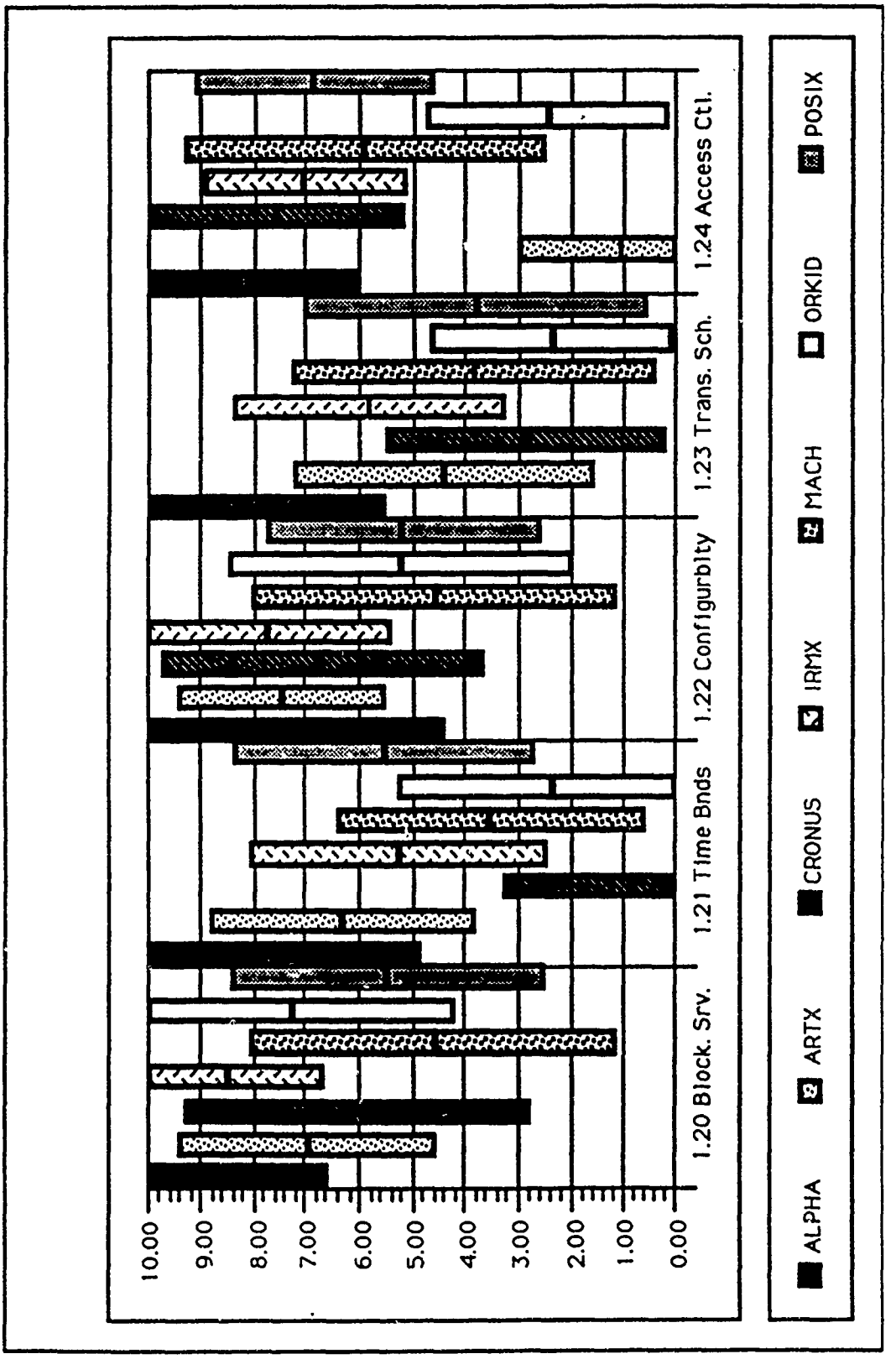

FIGURE 6-3(e). GENERAL SERVICE CLASS BY CRITERION

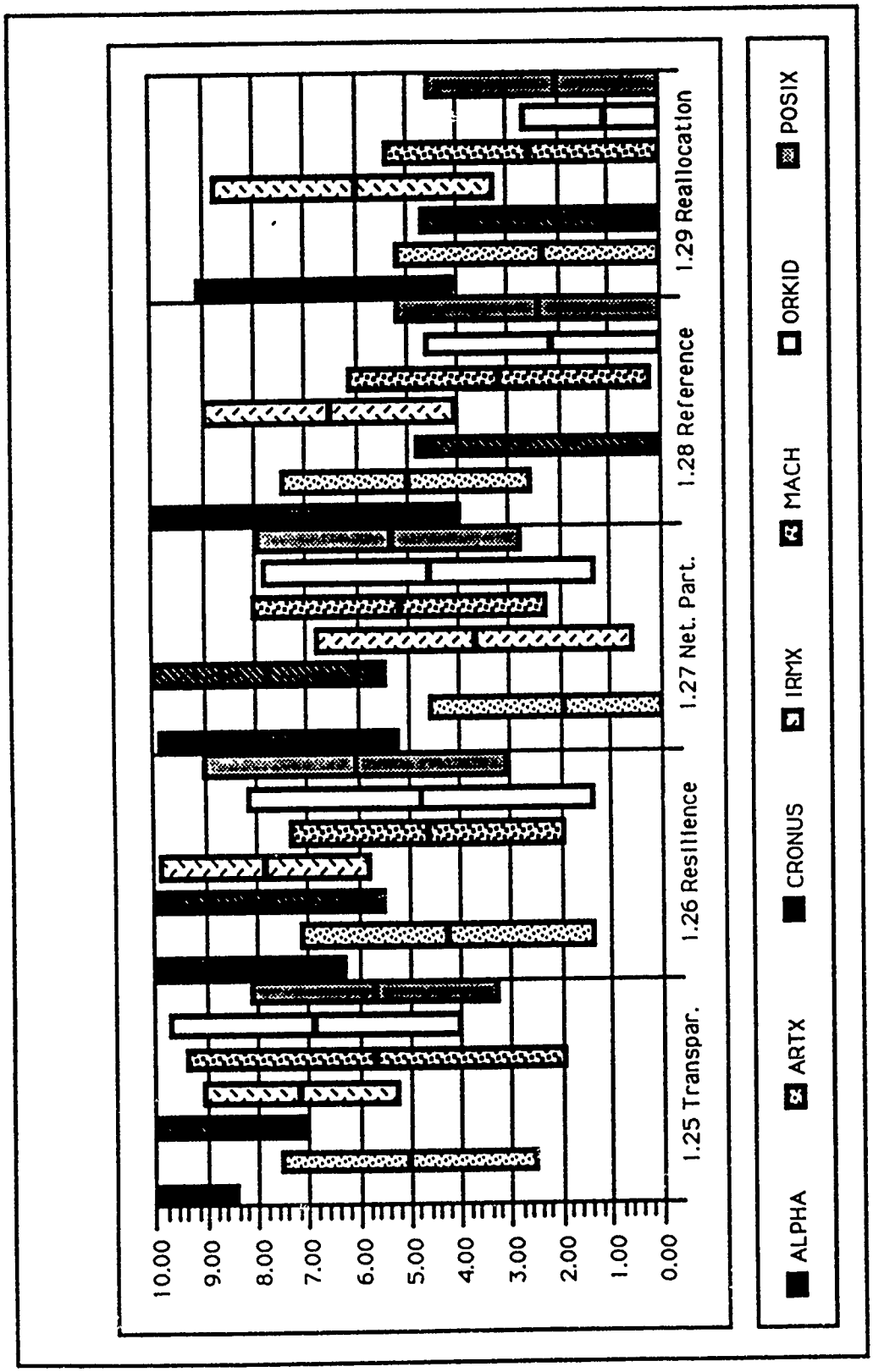

FIGURE 6-3(f). GENERAL SERVICE CLASS BY CRITERION

6.2 PROGRAMMATIC EVALUATION

The Programmatic Requirements are described in the Evaluation Process report. There are eight programmatic requirements. These were formulated to address topics that were relevant to the selection process but were not a part of the proper technical requirements for an operating system interface. They are intended to capture the other factors which are important to the Navy in this selection.

The programmatic requirements were evaluated by all of the Navy personnel. The results of these evaluations are shown in the table and chart below. Throughout most of the evaluation and analysis, the programmatic requirements were handled independently of the technical ones, with the technical ones being considered first.

Table 6-6 gives the average of the evaluators' scores for each candidate for each of the eight criteria, along with one standard deviation. Figure 6.4 graphs these scores, including the variation represented by the standard deviations (sigmas).

TABLE 6-6. PROGRAMMATIC CRITERIA RESULTS

Criteria	ALPHA		ARMX			CRONUS		IRMX		MACH		ORKID		POSIX	
1	7.50	2.16	5.45	1.28	7.40	1.98	5.45	1.19	8.40	1.73	7.90	2.88	9.45	2.24
2	6.10	2.53	5.10	2.20	5.90	1.97	5.55	2.44	4.40	2.58	5.60	2.72	6.05	2.04
3	5.45	1.90	8.15	1.84	7.00	2.00	7.80	1.77	6.75	1.59	4.05	2.35	5.95	2.26
4	6.75	2.05	8.00	1.75	7.05	1.96	8.70	1.56	6.05	2.01	6.40	2.28	7.95	1.70
5	4.75	1.68	6.20	2.86	4.80	2.61	6.30	2.62	6.05	2.19	5.05	1.96	8.75	2.29
6	6.70	2.25	8.25	1.83	7.75	1.97	8.15	1.93	6.80	1.82	6.95	2.11	6.40	2.54
7	5.45	2.31	6.45	1.47	5.45	2.46	7.40	2.04	5.55	1.90	7.50	2.44	8.85	1.35
8	5.40	2.93	5.80	2.59	6.00	2.58	5.60	2.44	5.60	2.85	6.05	2.48	6.80	2.33

Note: scores and standard deviations (sigmas) are both listed: score|sigma

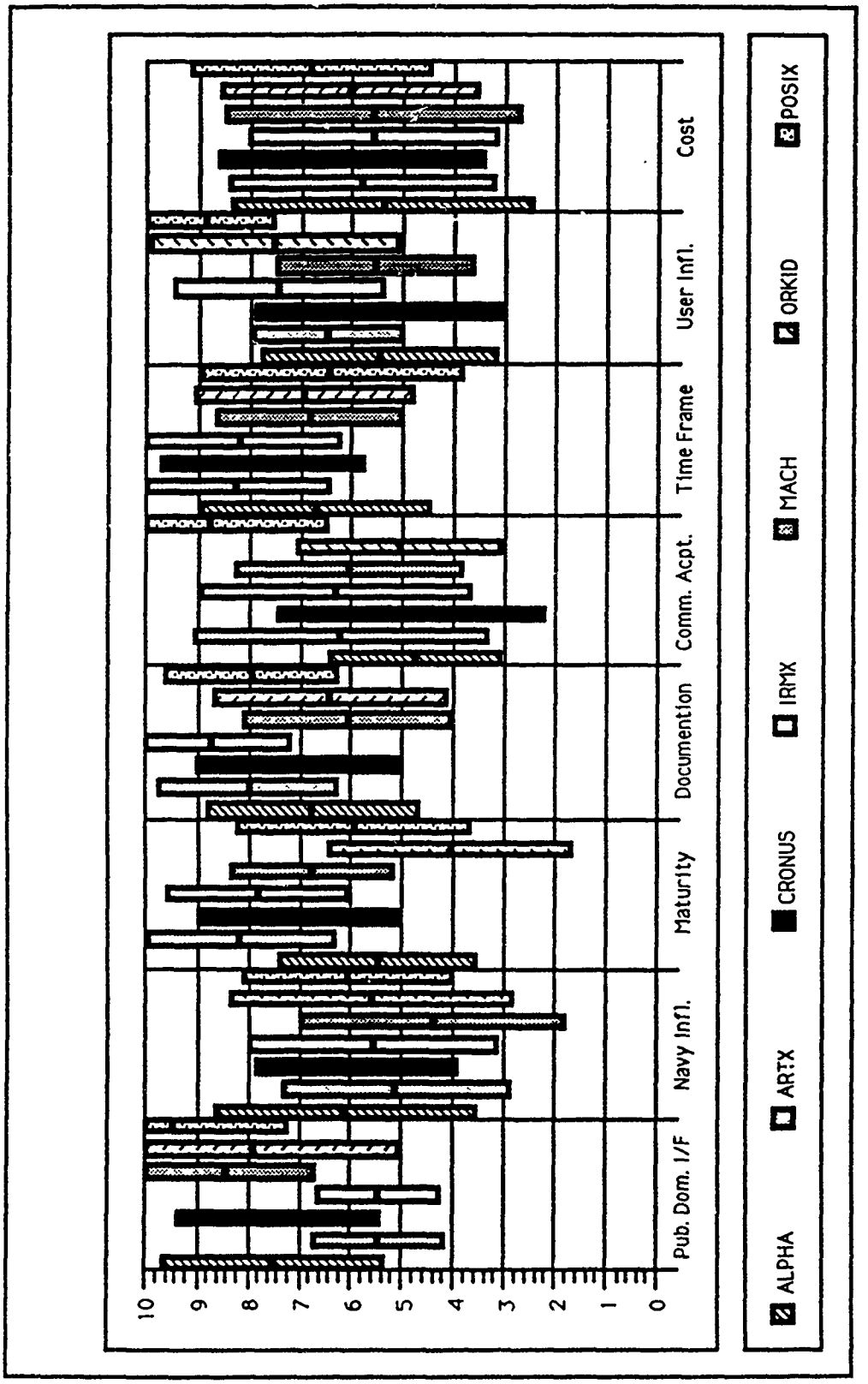

FIGURE 6-4. CRITERION LEVEL COMPARISONS FOR PROGRAMMATIC ISSUES

CHAPTER 7

ALTERNATIVE VIEWS OF DATA

Upon examination of the data, it became apparent that some additional analyses were necessary. This conclusion was driven by three circumstances:

A. The RAD scores did not show the differentiations between the candidates that its creators had anticipated; this situation needed to be understood.

B. The scores of individual evaluators for a given criterion often spanned the full range from 0 to 10, as reflected in the values of the error estimates; this needed investigation to assure the validity of the data.

C. The initial results from the data showed three candidates scoring particularly high, but still relatively close to one another; this, when coupled with the circumstance (B) above, led to a desire to examine and compare these three candidates at a greater level of detail in order to more effectively determine the true "leader."

7.1 GLASS DATA

The unexpected similarity of the "RAD Scores" for each candidate resulted in a flurry of reanalysis and sensitivity analysis using synthetic extreme-case RADs. None of these efforts had any practical effect on the results. Even the extreme RADs failed to clearly differentiate among the candidates. Consequently, a new RAD, "GLASS," with uniform weights, was created. As expected, the GLASS RAD scores were in the middle of the pack as can be seen in Table 7-1 and Figure 7-1.

TABLE 7-1. SUMMARY OF RAD RESULTS WITH GLASS RAD

RAD	ALPHA	ARTX	CRONUS	IRMX	MACH	ORKID	POSIX
Amethyst	5.88	3.59	3.80	4.91	3.80	1.90	4.93
Diamond	6.14	3.76	3.36	5.22	3.58	2.16	4.77
Emerald	5.82	3.48	3.48	4.92	3.77	1.91	4.74
Garnet	6.09	3.67	3.15	5.20	3.37	2.07	4.71
Opal	6.21	3.67	3.50	5.17	3.37	2.18	4.69
Ruby	5.86	3.98	3.72	5.19	3.89	1.72	5.22
Sapphire	6.02	3.74	3.49	5.10	3.81	2.08	4.85
Topaz	5.94	3.79	3.53	5.16	3.62	1.89	4.73
Glass	5.98	3.88	3.53	5.21	3.82	1.91	4.93

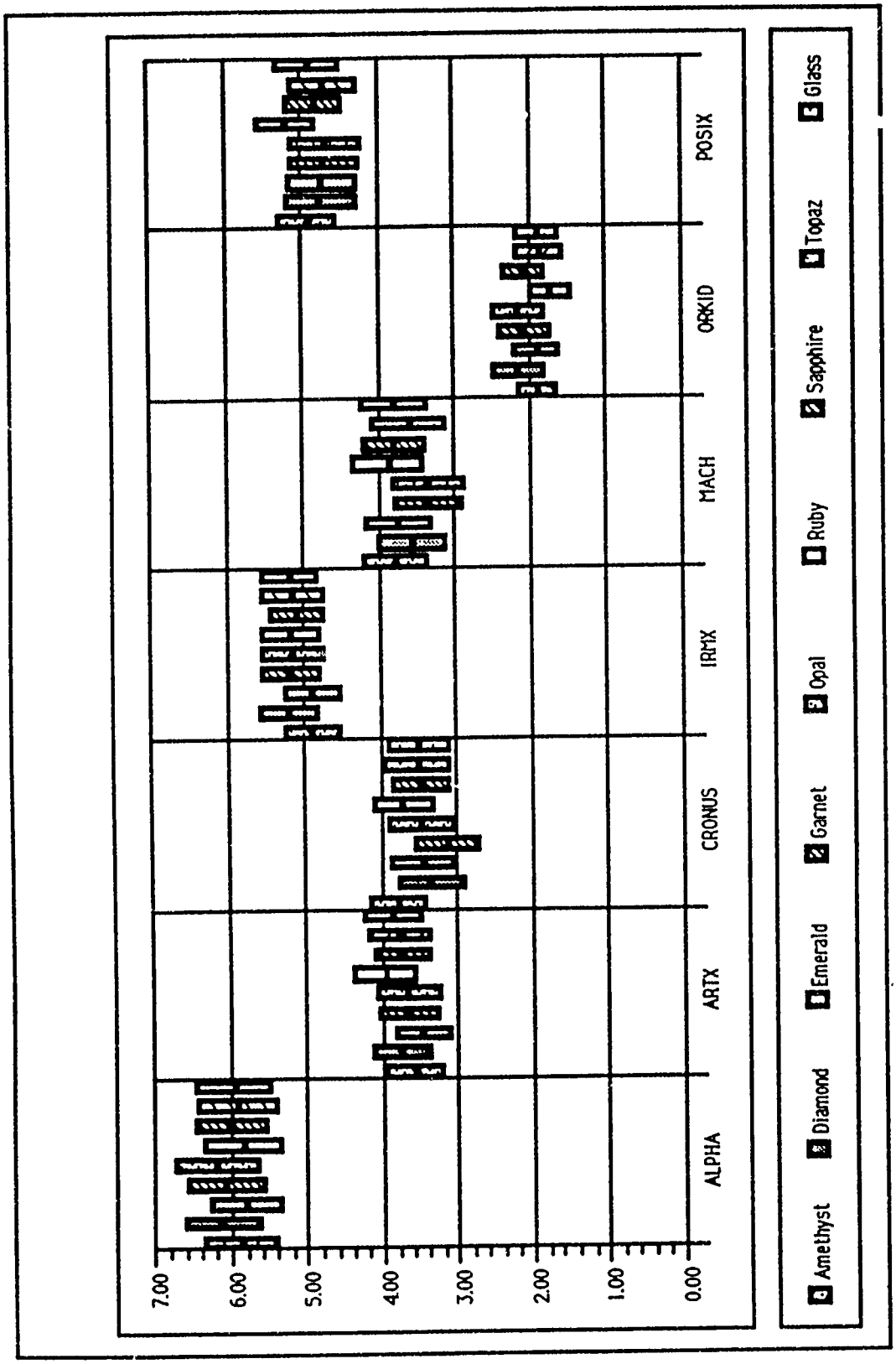

FIGURE 7-1. REPRESENTATIVE APPLICATION DOMAIN RESULTS

Note that the RAD weights (weight set 2) are applied to the raw candidate evaluation scores as aggregated by service class. Thus, the manipulations carried out here do not change any of the actual scores but merely serve as alternate interpretations of those scores. The GLASS RAD represents an application domain in which all service classes are of equal importance.

7.2 RAD ANALYSIS OF THE GENERAL CRITERIA SCORES

In an effort to investigate the conjecture that some of the "General Requirements" (i.e., Service Class 1) were potentially sensitive to the application domain, these scores were projected onto the RADs. Of the 29 original general criteria, twelve were selected as the technical subset for the purpose of further analysis. The selected criteria were:

2.1.4 Architecture Independence
2.1.10 Ada Language Binding Syntax
2.1.20 Reaction to Blocking Services
2.1.21 Bounding Operating Systems Service Times and Context Switching
2.1.22 Configurability
2.1.23 Transaction Scheduling Information
2.1.24 Access Control
2.1.25 Transparency
2.1.26 Resilience
2.1.27 Network Partition
2.1.28 Reference
2.1.29 Reallocation

As with all the other criteria, the individual evaluator scores were averaged over the evaluators for each of these "Technical General Criteria." A set of weights expressing the importance of each of these criteria to the RADs was generated by the Approach Subgroup after the raw data gathering was nearly complete. These weights were purposely biased toward extreme values in the hopes of overcoming some of the difficulties already encountered with the RAD scores. The results are shown in Tables 7-2, 7-3 and 7-4 and Figures 7-2 and 7-3. The scores listed are calculated in the same way as the RAD scores. Table 7-3 and Figure 7-2 show the results using only the General Requirements Service Class weights of Table 7-2. Table 7-4 and Figure 7-3 show the results of using both the General Requirements Service Class weights along with Weight Set 2.

TABLE 7-2. STANDARD SERVICE CLASS WEIGHTS FOR RAD MAPPING

	R	O	A	G	T	E	D	S
1.4	10	5	10	10	10	10	10	10
1.10	0	5	10	10	10	10	10	10
1.20	5	10	10	10	10	10	5	10
1.21	0	10	10	10	10	10	10	10
1.22	0	10	5	10	0	0	10	5
1.23	0	0	10	5	10	5	0	10
1.24	10	5	10	0	5	10	0	10
1.25	10	0	10	0	10	0	0	10
1.26	5	0	10	0	10	10	10	10
1.27	5	0	10	0	10	10	10	10
1.28	5	0	10	0	10	10	10	10
1.29	5	0	10	0	10	10	10	10

TABLE 7-3. RAD SCORES BASED ONLY ON GENERAL SERVICE CLASS CRITERIA (G-RADS)

RAD	ALPHA		ARTX		CRONUS		IRMX		MACH		ORKID		POSIX	
Amethyst	7.64	0.71	4.85	0.75	5.31	0.75	6.28	0.71	4.56	0.92	3.81	0.76	5.38	0.79
Diamond	7.28	0.94	5.76	0.91	5.35	0.92	6.10	0.91	4.59	1.09	4.00	1.00	5.79	0.97
Emerald	7.42	0.79	4.71	0.83	4.97	0.84	6.13	0.79	4.48	0.98	3.48	0.83	5.45	0.86
Garnet	7.28	1.08	6.85	1.03	4.89	1.10	6.35	1.01	4.67	1.34	4.24	1.10	6.22	1.12
Opal	7.56	1.13	6.37	1.00	5.23	1.18	6.73	1.02	4.71	1.40	4.38	1.24	6.16	1.17
Ruby	8.21	0.74	4.22	0.91	6.91	0.88	6.60	0.82	5.33	1.16	4.77	0.99	5.87	0.87
Sapphire	7.64	0.71	4.85	0.75	5.31	0.75	6.28	0.71	4.56	0.92	3.81	0.76	5.38	0.79
Topaz	7.61	0.73	4.90	0.80	5.13	0.78	6.17	0.75	4.50	0.96	3.80	0.80	5.32	0.83
Glass	7.64	0.71	4.96	0.74	5.36	0.75	6.34	0.70	4.56	0.92	3.86	0.77	5.38	0.78

Note: scores and standard deviations (sigmas) are both listed: score|sigma

TABLE 7-4. EXTENDED REPRESENTATIVE APPLICATION DOMAINS (E-RADS)
(INCLUDES SELECTED SERVICE CLASS 1 CRITERIA)

RAD	ALPHA		ARTX		CRONUS		IRMX		MACH		ORKID		POSIX	
Amethyst	6.84	0.44	4.28	0.45	4.62	0.44	5.66	0.42	4.22	0.54	2.94	0.43	5.18	0.46
Diamond	6.64	0.50	4.63	0.45	4.23	0.47	5.61	0.45	4.02	0.54	2.97	0.48	5.21	0.50
Emerald	6.63	0.47	4.10	0.46	4.23	0.47	5.53	0.44	4.13	0.54	2.70	0.45	5.10	0.49
Garnet	6.59	0.54	5.01	0.49	3.88	0.53	5.68	0.48	3.92	0.62	2.99	0.50	5.35	0.54
Opal	6.74	0.55	4.73	0.47	4.18	0.54	5.78	0.47	3.90	0.62	3.04	0.53	5.27	0.54
Ruby	6.88	0.43	4.09	0.46	5.11	0.45	5.80	0.42	4.52	0.57	3.05	0.46	5.50	0.44
Sapphire	6.86	0.43	4.32	0.43	4.44	0.43	5.72	0.41	4.20	0.52	2.98	0.42	5.13	0.45
Topaz	6.83	0.46	4.38	0.47	4.38	0.46	5.70	0.45	4.09	0.56	2.91	0.45	5.04	0.49
Glass	6.71	0.42	4.36	0.39	4.35	0.41	5.71	0.38	4.15	0.48	2.78	0.38	5.13	0.42

Note: scores and standard deviations (sigmas) are both listed: score|sigma

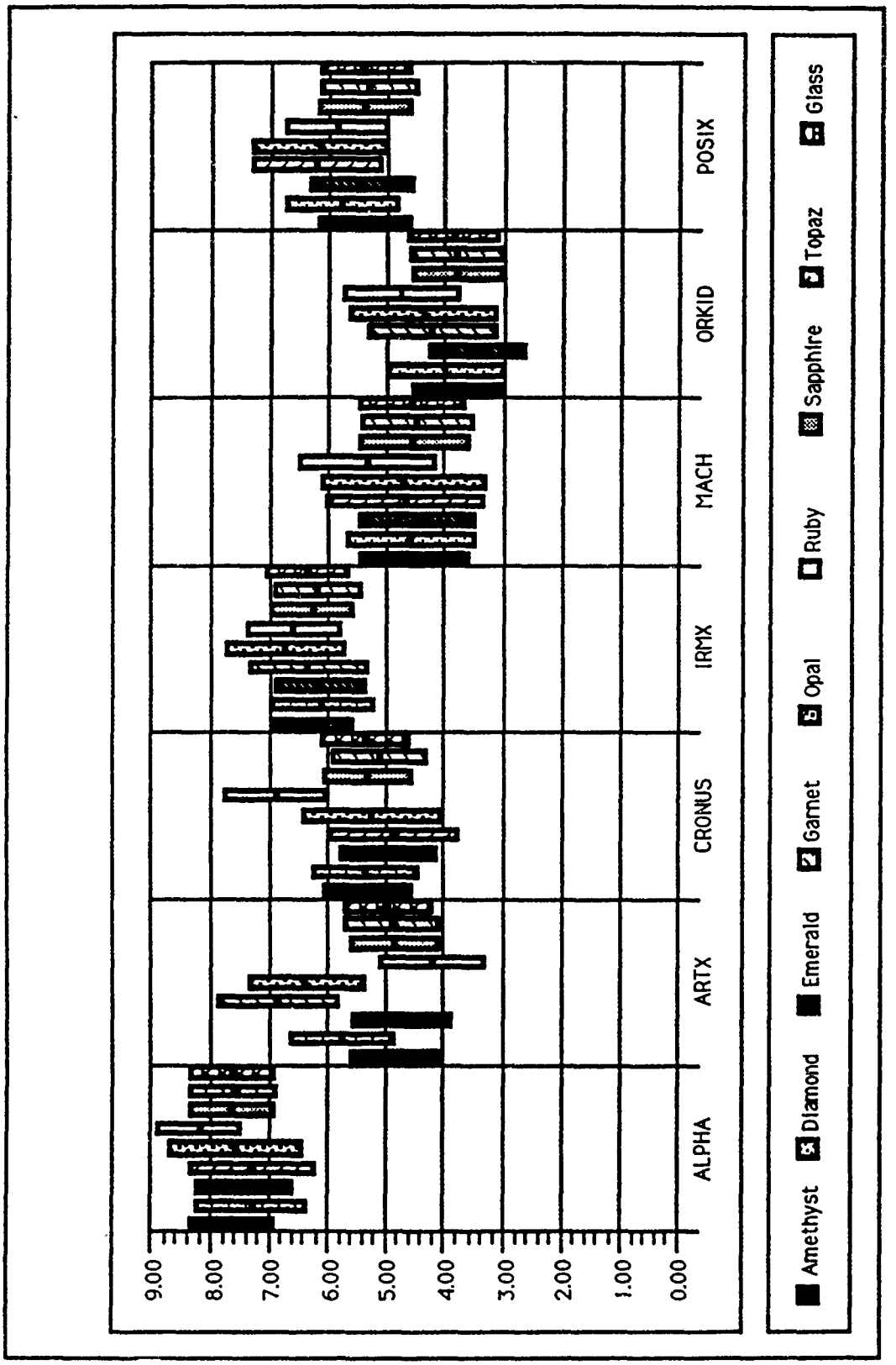

FIGURE 7-2. REPRESENTATIVE APPLICATION DOMAIN - GENERAL SERVICE CLASS ONLY

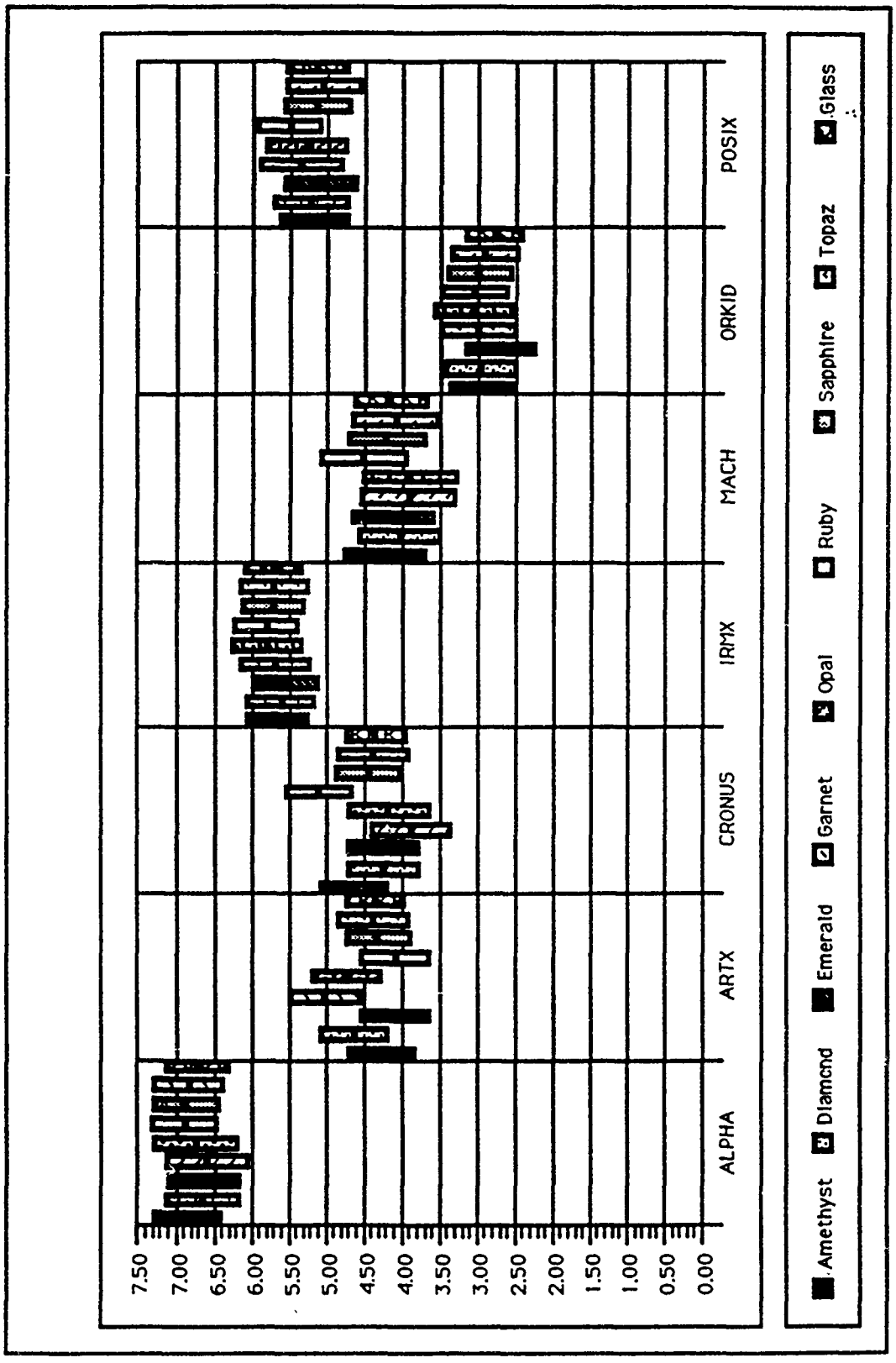

FIGURE 7-3. REPRESENTATIVE APPLICATION DOMAIN RESULTS - ALL TECHNICAL SERVICE CLASS

7.3 PROGRAMMATIC ISSUES RANKINGS

The eight programmatic requirements were initially equally weighted (i.e., unweighted). However, it was clear to the OSSWG membership that some were far more important to the success of the effort than others. In order to devise weights for them, the requirements were initially ranked in order of importance. That ranking and its rationale follow. (The references in parentheses below are to the sections in the Evaluation Process report in which the original description of the programmatic requirements can be found.)

#1 Public Domain Interfaces (3.2.1)

"In the Public Domain" is a founding precept for the NGCR view of the world. It allows free access to the interface and must remain as a top priority for the Navy and this program. Additionally, lack of public domain interfaces is grounds for de-selection of an interface. A public domain interface is important because it encourages the ultimate goal of "openness" in the sense that any vendor can plug in or build on to it. The OSSWG did not specify this ultimate goal of openness in its evaluation criteria. This criteria is a first step to openness.

#2 Navy Influence (3.2.2)

The Navy wants to influence the interface definition selected. Any selected baseline upon which to pursue a standardization effort must be able to accommodate present and future Navy needs.

The Navy is "riding industry trends" so it must be careful how much it attempts to dictate the standardization process. Too much influence and the Navy will not achieve the hoped-for commercial acceptance. If, on the other hand, the candidate does not answer the Navy user's needs and/or the Navy cannot effectively influence the candidate to accomplish this, then what has been accomplished?

#3 Commercial Acceptance (3.2.5)

The emphasis is on wide acceptance. Through acceptance of broad-based industry supported standards and products, the Navy will ensure an industrial base capable of supporting its computing needs in an era of continuing accelerated technological progress during declining DoD funding. This has evolved into being a primary consideration of not just the OSSWG but of the NGCR Program.

#4 Economics/Cost (3.2.8)

Economics and acceptance are intricately tied together. For example, an important consideration is industry's perception as to whether it can develop a cost effective implementation of the standard.

#5 Maturity/Confidence (3.2.3)

This criterion indicates whether the candidate has implementations, whether implementations are planned, etc., and the degree of Navy confidence that the wide variety of Navy implementations could be achieved.

#6 Timeframe (3.2.6)

The original rationale given in 3.2.6 applies here as well: Can a standard be achieved with the candidate in the timeframe of the OSSWG? This one is somewhat "elastic" from the perspective of the Program Management Office (PMO) itself, i.e., it is somewhat dependent on the resources the PMO is willing to dedicate (to compress, influence, etc.), or the PMO can choose to allow the schedule to "stretch out."

#7 User Influence (Historical) (3.2.7)

The original intent here was to assess the amenability of the candidate to influence. It carries little weight for actually selecting the candidate baseline now. The addition of the parenthetical note, "Historical," in the title is intended to reiterate that this "user influence" is talking about how the candidate has reacted to its users in the past; it is not trying to capture how amenable it will be to user (i.e., Navy) influence in the future, which is the focus of the "Navy Influence" requirement.

#8 Documentation (3.2.4)

We have what we have. It helped provide the evaluation data. Its potential as a discriminator for baseline selection is minimal.

After reaching agreement on this relative ranking of the programmatic requirements, consideration was given to the weight set which should be applied in order to derive scores for Service Class 0. Several alternatives were examined, but all had approximately the same effect. A weight set in which the first 4 have weights of 10 each, the next 2 have weights of 8 each and the last 2 have weights of 5 each. The results using these weights are shown in Table 7-5 below.

TABLE 7-5. PROGRAMMATIC RESULTS WEIGHTED AVERAGES

POSIX	7.50
IRMX	6.62
ARTX	6.50
CRONUS	6.39
MACH	6.23
ORKID	6.11
ALPHA	6.00

7.4 EFFECT OF NON-WEIGHTED (AVERAGE-WEIGHTED) SCORES

Because of the newness of this type of evaluation and the various types of scoring (weighting) methods and algorithms being tried, it was requested that an unweighted average method be applied to the criteria scores in order to ascertain any differences between this and other methods. The criteria scores were summed and normalized. Three averages were computed for each candidate:

(1) average score on all 193 criteria
(2) average score on all 185 technical criteria
(3) average score on the 8 programmatic issues

The results are depicted in Table 7-6. The net result of this effort was that, weighted or averaged, the leading candidates remained the same.

TABLE 7-6. UNWEIGHTED RAW SCORE AVERAGES

	ALPHA	ARTX	CRONUS	IRMX	MACH	ORKID	POSIX
ALL CRITERIA							
Average	6.01	4.51	3.88	5.62	4.58	2.56	5.96
Sigma	2.02	3.20	2.72	3.00	2.50	2.86	2.65
TECHNICAL CRITERIA							
Average	6.01	4.41	3.77	5.57	4.51	2.40	5.89
Sigma	2.06	3.23	2.72	3.04	2.52	2.80	2.67
PROGRAMMATIC CRITERIA							
Average	6.01	6.68	6.79	6.87	6.20	6.19	7.53
Sigma	0.91	1.28	1.19	1.30	1.17	1.28	1.39

7.5 RANK ORDERING DATA

Using several views of the statistical results, unweighted rank ordering of the candidates was applied in an effort to reveal a foundation for discrimination. The three views deemed pertinent were:

- Ranking by the "tops in service class"--indicating both the quantity and identification of the specific service classes in which each candidate was considered top ranked, without regard for the programmatic issues.

- Ranking based on "win, place, and show"--charting the number of occurrences of each candidate's relative positioning by service class, e.g., 4 first place, 2 seconds, 6 thirds. Programmatic scoring not included.

- Ranking order range of effectiveness--defining the range, by service class, for which scores remain in an effective range (i.e., 7 or larger). This would enable constraining the ordering to only those candidates having effectively met the requirements of a specific service class and the programmatic issues.

7.5.1 Top Ranked Data

The candidates were ranked by their superior evaluation in the service classes. These service classes are listed in Table 6-2. Table 7-7 gives a ranking of the candidates according to the greatest number of service classes in which that candidate scored highest. Service class 0 (programmatics) is not considered in this ranking.

TABLE 7-7. TOPS IN SERVICE CLASS

ALPHA (1,2,5,8,10,11,12,15)	8
IRMX (7,9,14)	3
POSIX (6,13,16)	3
CRONUS (4)	1
MACH (3)	1
ARTX	0
ORKID	0

7.5.2 Relative Success Ranking

Table 7-8 plots the various candidates' relative success in the service class evaluation. It shows the results for the technical services classes, 2 through 16. Each column represents one candidate; each row, from one to seven, represents the relative evaluation position (first, second, ...).
The top row, therefore, shows for each candidate the number of service classes for which it achieved the best evaluation.

This chart is an attempt to give a perspective on how the candidates did in the service class evaluation as compared to each other. It gives no perspective on how a candidate meets the service class requirements. By looking at the top two or three rows, it can be determined if some candidates did generally better than others.

TABLE 7-8. "WIN, PLACE, SHOW, ..."

	ALPHA	ARTX	CRONUS	iRMX	MACH	ORKID	POSIX
1st	7	0	1	3	1	0	3
2nd	4	2	2	4	1	0	2
3rd	0	1	2	5	3	0	4
4th	4	5	1	1	1	1	2
5th	0	4	1	1	6	3	0
6th	0	3	3	1	1	3	4
last	0	0	5	0	2	8	0

7.5.3 Relative Success Ranking with Acceptance

Another view of the data is the chart presented in Table 7-9. Table 7-9 was used to better understand the relationship between the candidates, especially the three (Alpha, iRMX, POSIX) that appear to be technically superior. This shows the rank ordering of all candidates for service classes 2-16, along with their scores. When attempting to make sense of this chart, it is useful to mark boundaries in each column. Two boundary values were selected at 5 and 7. It was deemed that a value of 7 or above showed at least an acceptable level of support for the service class. A value of less than 5 indicated an unacceptable level of support for the service class. The results are summarized in Table 7-10.

This view is useful when determining the service classes which are not supported by a certain candidate. From this, a measure of the 'cost to fix' can be made for bringing the candidate up to meet the OSSWG requirements. As can be seen in the figure, service classes 10, 11, 12, 14, and 16 have no candidates with acceptable scores. Service class 10 does not even have a candidate with a moderate score. Service class 4 has none of the final three in the acceptable or moderate range. Table 7-10 shows how the final three candidates fared relative to the 5 and 7 boundaries.

Some conclusions which can be reached from the service class analysis are that none of the candidates cover a wide range of the service classes really well. Of the 16 service classes Alpha is acceptable in 5, Posix in 4, and iRMX in 3. For acceptable plus moderate categories, Alpha hits 12 times, Posix 8 times, and iRMX hits 7 times. All candidate scores were low in service classes 10, 11, 12, 14 and 16. This may indicate a lack of maturity with the state-of-the-technology with which no system is yet able to deal successfully.

TABLE 7-9. SERVICE CLASS ANALYSIS

Service Class:	0	1	2	3	4	5	6	7	8
	P	α	α	M	C	α	P	i	α
	7.53	7.56	7.00	7.31	8.33	7.38	8.24	8.40	7.00
	i	i	C	P	α	i	i	A	C
	6.87	7.19	5.11	7.28	3.33	5.42	8.09	7.57	6.04
	A	P	i	C	M	P	A	P	i
	6.68	6.46	4.67	6.48	2.44	3.88	7.57	7.12	5.06
	C	C	A	α	P	C	α	α	A
	6.42	6.39	3.78	1.74	1.44	3.71	6.09	5.85	4.21
	M	A	M	i	A	O	M	M	M
	6.20	5.91	3.67	0.95	1.11	2.56	4.13	1.58	3.82
	O	M	P	A	i	A	C	O	P
	6.19	5.65	3.44	0.56	1.00	2.30	3.72	0.58	3.20
	α	O	O	O	O	M	O	C	O
	6.01	5.46	2.44	0.09	0.78	1.85	0.00	0.53	0.50

Note:
α = ALPHA, A = ARTX, C = CRONUS, i = iRMX, M = MACH, O = ORKID, P = POSIX

TABLE 7-9 (Cont.)

Service Class:	9	10	11	12	13	14	15	16
	i	α	α	α	P	i	α	P
	8.09	4.71	5.50	6.60	8.11	6.69	7.71	6.85
	α	i	i	M	α	α	P	A
	7.99	4.55	4.16	5.44	6.94	5.96	6.86	6.84
	M	M	C	P	i	P	i	i
	7.53	2.81	1.81	3.86	6.31	5.33	4.88	6.56
	A	A	P	i	A	M	O	α
	6.56	2.18	1.78	3.26	5.23	5.26	3.69	5.82
	O	C	M	A	O	A	A	M
	6.26	1.40	0.84	2.62	5.16	4.51	2.96	4.98
	P	P	A	O	M	C	C	O
	6.21	0.35	0.21	1.75	3.79	3.78	2.17	3.63
	C	O	O	C	C	O	M	C
	3.92	0.30	0.19	0.57	3.38	0.70	1.79	2.02

Note:
α = ALPHA, A = ARTX, C = CRONUS, i = iRMX, M = MACH, O = ORKID, P = POSIX

TABLE 7-10. COMPARISONS AMONG ALPHA, IRMX, AND POSIX

	Acceptable	Moderate	Unacceptable
2	α		i, p
3	p		α, i
4			α, i, p
5	α	i	p
6	p, i	α	
7	i, p	α	
8	α		i, p
9	i, α	p	
10			α, i, p
11		α	i, p
12		α	p, i
13	p	α, i	
14		i, α, p	
15	α	p	i
16		p, i, α	

Note:
α = ALPHA, i = iRMX, p = POSIX

7.6 VARIANCE ANALYSIS

There often appeared to be a significant disagreement between the evaluators with regard to the appropriate score for a candidate on a given criterion. This can be seen in the data in Appendix E where the difference between the "max" and "min" columns is large, usually resulting in correspondingly large sigma (standard deviation) values. Such large sigma values indicate that the variation across the evaluator scores may be so large (indicating, in statistical terms, a large error in the sample) that we would not be justified in placing much importance on an apparently significant difference between the scores of two candidates.

It is believed that the large sigma values result from a number of circumstances, among them:

- o different interpretations of the same requirement by two different evaluators
- o different evaluator persistence in working through the documentation to determine the existence or non-existence of a feature
- o the short time available to some evaluators on some candidates due to late receipt of the documentation

- o whether or not a given evaluator attended the January OSSWG meeting in Mobile at which the candidates were briefed
- o the varying nature of the candidates (all the way from one designed to be incorporated on top of other native operating systems to one intended to include only the bare necessities of a real-time kernel)
- o misleading cross-reference matrices from some candidates
- o inconsistent candidate definitions (i.e., some evaluators making use of some documentation which other evaluators did not consult)
- o the difficulties of cross-application of documents; e.g., in the case of POSIX, where one would have to examine both 1003.1 and 1003.4 in order to determine a proper score for all File System (Service Class 6 criteria)
- o variations in evaluator qualifications for evaluating a given service class
- o confusing candidates/quality of documentation
- o confusing requirements (criteria)
- o the difficulties of maintaining the distinction between "interface" and "implementation" semantics
- o the credibility which various evaluators were willing to grant to individual candidates.

One way in which these large sigmas were used to differentiate between the seven candidates was to examine the number of criterion sigma values for each candidate which were greater than some threshold value. This was intended to give some indication of which candidates appeared to give the most trouble to the evaluators. For the threshold value we chose 3.16, which is the value that one would expect for the standard deviation if the numbers (scores) were generated randomly. Using the sigmas from all 17 service classes, this count yielded the results in Table 7-11.

TABLE 7-11. SUMMARY OF ERROR RESULTS BY CANDIDATE

CANDIDATE	# CRITERIA WITH SIGMA > 3.16 (193 total criteria)
Mach	80
Cronus	78
Alpha	70
POSIX	62
ARTX	30
iRMX	28
ORKID	22

In statistics, the question of sampling error is dealt with using the "analysis of variance." The formulae applied use the candidate scores and their corresponding sigmas, in light of the number of sampling points (in our case, number of evaluators per criterion), to determine when one can say with high confidence that the difference between two or more sets of scores is statistically significant.

Such an analysis of variance was first applied across all seven candidates to determine whether we were justified in saying that three of the candidates (Alpha, iRMX, and POSIX) were, as a group, superior to the four others. It was applied using all 17 service classes. The hypothesis was confirmed by the analysis, showing that there was statistical significance to the score differences across the board, despite some high sigma values. This analysis also confirmed that the evaluation process utilized was a robust one resulting in useful and usable information.

Having confirmed the validity of concentrating on the top three, we next needed to determine ways of more closely examining the differences between them in order to see if one would emerge as dominant over the other two. However, first it was necessary to apply the same analysis of variance to the top three; if none of the score differences showed themselves to be significant, in light of the sigmas, then we would not find grounds in the scores for differentiating between them.

Thus, an analysis of variance was applied across just the top three candidates. This result was coupled with the results of another analysis (which will be described in the following section) to bring the comparison of the top three down to a manageable and reliable set of information.

7.7 MAJOR ISSUES PARTITION OF REQUIREMENTS

Although the RADs did not reveal what had been expected about the candidates, it was still desirable to see just how well the candidates were likely to deal with certain special aspects of target Navy applications. Early in the life of the OSSWG a set of high-level requirements was identified from information in the Operational Requirements and the Development Options Paper. These requirements were: real-time, distribution, heterogeneity, Ada, security, and reliability. It was decided that a useful additional view of the data would be to associate various requirements (criteria) with these six high-level requirements and to see how the candidates performed with respect to these selected "slices" through the Navy's needs. In addition, it was decided to further categorize the criteria associated with each major issue according to whether it was Essential or Non-Essential (i.e., poor performance by a candidate on an Essential criterion would be considered a significant black-mark against that candidate and possibly grounds for finding it unacceptable). The partition of the criteria was carried out by members of the Requirements Subgroup. The results of this partitioning can be viewed in Appendix F, Essential Criteria Partitions.

The allocation of the evaluation criteria to the high-level requirements was then used to highlight the performance of the top three candidates on those criteria which seemed to matter most. However, in order to do so justifiably, we first applied the results of the variance analysis (see Section 7.6), which told us on which criteria the differences between the top three candidates' scores could be considered statistically significant. This reduced the comparison between the top three to the following technical criteria (i.e., it does not address the programmatic).

TABLE 7-12. ESSENTIAL CRITERIA FOR WHICH DIFFERENTIATION IN TOP THREE CANDIDATES' SCORES IS SIGNIFICANT

Cr.	Cr.	Cr.	Cr.	Cr.	Cr.	Cr.
1.4	3.1	3.9	3.19	11.5	12.7	15.7
1.20	3.2	3.10	3.22	11.7	12.8	
1.21	3.3	3.12	5.4	11.9	12.9	
1.23	3.4	3.13	5.5	11.10	12.10	
1.25	3.5	3.14	8.2	11.11	13.5	
1.26	3.6	3.15	8.9	11.14	13.9	
1.27	3.7	3.16	9.13	12.2	15.1	
1.28	3.7	3.17	10.2	12.5	15.4	
1.29	3.8	3.18	11.4	12.6	15.5	

Finally, a tally was made of all those criteria on the above list for which each candidate scored below 5 points; a second tally was made of all those criteria on the list for which each candidate scored 7 or above. A score of less than 5 points is considered significant because of the general phrasing of the

evaluation criteria: in general, a score of 5 is used to describe a feature as something which could be used and tolerated, at least as a starting point, whereas a score lower than that indicates some way in which the feature is seriously lacking in capability. A score of 7 or above was also considered significant because it indicates a level at which most grading scales give passing or superior assessments. The results of this tallying are shown in Table 7-13, where * indicates scores above 7 and - indicates scores below 5. The number indicates the number of criteria where the candidate scored less than 5 or more than 7.

TABLE 7-13. RESULTS OF TALLY CRITERIA SCORES <5 & >7 AMONG ALPHA, IRMX, AND POSIX

SC	ALPHA	IRMX	POSIX
1	8*	3* 1-	1* 3-
3	19-	19-	14*
5	1*	2-	2-
8	1*	1* 1-	2-
9	1*	1-	1-
10	1-	1-	1-
11	3-	5-	7-
12	2* 2-	6-	2* 5-
13	1*	1-	1* 1-
15	4*	3-	2* 2-
TOTALS	18* 25-	4* 40-	20* 24-

For completeness, when a similar process was applied to the programmatics (i.e., considering only those criteria for which the variation in the scores could be considered significant; note that the programmatic requirements were not allocated to the six high-level requirements), the results were as given in Table 7-14 below.

TABLE 7-14. SIGNIFICANT SCORES FOR CRITERIA SCORES <5 & >7 FOR PROGRAMMATICS AMONG ALPHA, IRMX, AND POSIX

CRITERIA	ALPHA	IRMX	POSIX
0.1	1*		1*
0.3		1*	
0.5	1-		1*
0.7		1*	1*
TOTAL	1* 1-	2*	3*

CHAPTER 8

CONCLUSIONS

This report documented the results of the OSSWG evaluation process, carried out in order to select a baseline candidate operating system interface for NGCR standardization. The results show this to have been a very complete look at the candidates. They also give reason to believe that the process as conceived and conducted and the results which it generated were as good as could possibly have been expected. The OSSWG can say with confidence that the seven candidates were fairly evaluated and that they can reasonably be differentiated into two groups: those that scored in the top three positions (Alpha, iRMX, and POSIX) and the other four which did not.

BIBLIOGRAPHY

After Action Report for Next Generation Computer Resources Operating Systems Interface Baseline Selection Process, Version 1.0, 7 May 1990.

Evaluation Process Report for Next Generation Computer Resources Operating Systems Interface Baseline Selection, Version 1.0, 7 May 1990.

Next Generation Computer Resources Development Options Paper: COMSPAWARSYSCOM LTR 324/253 of 30 Oct 1987.

Next Generation Computer Resources Operating Systems Standards Working Group Reference Model, Version 1.03, 6 Dec 1989.

Next Generation Computer Resources Operating Systems Standards Working Group Requirements Document, Version 2.0, 21 Dec 1989.

Operational Requirement For Next Generation Computer: CNO Transmittal 098r/8u55086, 8 Aug 1988.

Recommendation Report for Next Generation Computer Resources Operating Systems Interface Baseline Standard, 7 May 1990.

APPENDIX A

DESCRIPTION OF CANDIDATES

CANDIDATE: Alpha

DEFINING DOCUMENTS:

Alpha Operating System Kernel Interface Specification, Revision 0.2, June 1989.

BACKGROUND AND STATUS

The Alpha OS arose as part of the Archons Project on new paradigms for real-time decentralized computer systems, which began at Carnegie-Mellon University (CMU) in 1979. Alpha design started in 1985 and the initial prototype was operational in 1987. This prototype ran on multiprocessor nodes built by modifying Sun workstations, which were then interconnected by an Ethernet. Another copy of this Alpha testbed was installed at General Dynamics' Ft. Worth facility. Alpha was sponsored at CMU primarily by the USAF Rome Air Development Center (RADC), with additional funding from the Naval Ocean Systems Center (NOSC) and several corporations. The focus of Alpha R&D moved in 1988 to Concurrent Computer Corporation's Boston facility, where it continues to be sponsored in part by RADC. Concurrent is leading a group of organizations which are performing a second generation, commercial quality design and implementation of the Alpha OS in a series of increasing functionality releases. Release 2 of the kernel is scheduled for delivery to a number of Government and industry sites in mid-1990, on MIPS based multiprocessors interconnected by FDDI. Alpha is portable and will be next available on 68030/68040 multiprocessors; Alpha will be running on a multivendor heterogeneous RISC and CISC system by the end of 1990. Alpha-compatible API's will be available for UNIX and a number of industry real-time executive products, and a POSIX-compliant API will be available on Alpha. Alpha is non-proprietary and in the public domain for Government use.

INTENDED TARGET DOMAIN

The Alpha OS is intended for larger, more complex, more distributed, mission-critical real-time systems. The most demanding such systems are always found first in military warfare environments, ranging from combat platform and battle management to C3I, due to the conflicting imperatives of accommodating the large number of extremely dynamic uncertainties inherent in hostile missions, while nonetheless assuring maximal dependability of effectiveness, survivability, and safety. Alpha is already being designed

into major DoD programs for land, sea, and air applications. However, similar needs are becoming increasingly common in industrial (e.g., factory automation, telecommunications), and even in commercial (e.g., on-line transaction processing), applications. Concurrent is committed to an Alpha product for these environments as well.

TECHNICAL OVERVIEW

Alpha's kernel consists of mechanisms which are directed by policy modules at the system layer of the OS. The kernel primitives are designed to manage all physical and logical resources (such as processor cycles, memory, i/o, semaphores, atomic transactions) directly with the actual task time constraints and relative importance specified by the application. Alpha's API is specifically intended for distributed real-time programs and is object oriented. The computational entities are threads which span objects and (transparently and reliably) physical node boundaries. Threads carry their attributes (such as real-time and transactional state) so that trans-node resource management can be performed in the best interests of the distributed applications and mission. Alpha's kernel includes mechanisms for real-time atomic transactions (non-serializable as well as serializable), to support maintaining application-specific correctness of distributed execution and consistency of distributed (replicated and partitioned) data. One unified exception handling construct deals with unsatisfied time constraints, transaction aborts, hardware faults, and application-specific exceptions.

REFERENCE

Jensen, E. Douglas and J. Duane Northcutt, "Alpha: An Open Operating System for Mission Critical Real-Time Distributed Systems," Proceedings 1989 Workshop on Operating Systems for Mission-Critical Computing, ed. Gordon, Hwang, and Agrawala, ACM Press, 1990.

CANDIDATE: ARTX (Ada Real-Time eXecutive)

DEFINING DOCUMENTS:

VRTX32C, Versatile Real-Time Executive, User's Guide
MPV, Multiprocessor VRTX, User's Guide
TNX-E, TCP/IP Network Executive Communication Package, User's GUIDE
IFX User's Guide
RTAda, Real-Time Ada, User's Guide
RTAda, Real-Time Ada, Board Support Package, Developer's Guide ARTX32 Engineering Implementation

BACKGROUND

ARTX was developed by Ready Systems to implement the critical "kernel" services of an Ada multitasking real-time Runtime System for embedded microprocessor applications. It is upwardly compatible with Ready Systems' industry standard kernel VRTX32, so that application tasks written in other languages (C, Fortran and assembly language) can be easily integrated into the system without any changes.

INTENDED TARGET DOMAIN

Ready Systems' family of operating systems has been targeted for two markets: commercial data processing, and aerospace, defense and engineering real-time embedded systems. It serves as the basis for a wide range of diverse applications such as accounting, banking, vehicle control, instrumentation, avionics, and telecommunications.

TECHNICAL OVERVIEW

ARTX supports a full range of Ada semantic operations, including the complete Ada tasking model. ARTX's real-time capabilities include the following: deterministic algorithms with fixed, specified timing for task rescheduling, rendezvous calls and accepts, memory allocation, interrupt latency, and interrupts-off time; a fully preemptive scheduler so that the highest priority task in the system will always be executing; and it allows task priority to be changed at run-time. ARTX provides additional communication and synchronization primitives besides the standard Ada rendezvous. ARTX can also be configured to provide a multi-processor networked runtime environment by using its two companion components: RTAda-MP, which supports tightly-coupled, shared memory multiprocessor systems, and RTAda-Net for multiprocessor communication over local area networks.

REFERENCE

"RTAda, Real-Time Ada, User's Guide, for Sun/Unix-to-68020," Ready Systems, 812-112-001, Jun 1989

CANDIDATE: Cronus/SDOS (Secure Distributed Operating System)

DEFINING DOCUMENTS:

Cronus User's Reference Manual, Release 1.4
Cronus Programmer's Reference Manual, Release 1.4
Cronus Summary Document (cross-reference)
Specification Document for the Experimental Secure Distributed Operating System Development, 6 Feb 1989

Design Document for the Experimental Secure Distributed Operating System Development, 2 Jun 1989
Formal Security Model for the Experimental Secure Distributed Operating System Development, 7 Oct 1989
Software Requirements Specification Documents for the Experimental Secure Distributed Operating System Development (Volumes I--VI) 2 Jun 1989
Software Design Document for the Experimental Secure Distributed Operating System Development (Volume I--PartI)
Software Design Document for the Experimental Secure Distributed Operating System Development (Volume II - Parts II--VIII), 30 Dec 1989 (Draft)

BACKGROUND

Cronus has been under development at BBN Systems and Technologies Corporation since 1981. It has been sponsored by the Rome Air Development Center (RADC) to address the problems of developing and maintaining complex distributed applications. The ultimate goal of Cronus is to integrate heterogeneous computer systems into an effective general-purpose distributed computing environment for the development and execution of large-scale applications.

SDOS is in experimental development at Odyssey Research Associates, Inc, and is being funded by RADC. The system is being designed and built to meet TCSEC B3 security and assurance requirements. SDOS borrows many of its concepts from Cronus, but the system architecture has been redesigned to provide multi-level security.

INTENDED TARGET DOMAIN

Cronus is an environment to support coherent integration of heterogeneous (UNIX, VMA, other) computer systems. Typically, the computer systems fall under a common administrative domain and are interconnected by one or more high-speed local area networks. The computer systems may also be interconnected by wide area networks, via an internet (such as the DARPA Internet).

Cronus is currently funded by the government for both system enhancements and for use in Command and Control applications development. Cronus is presently being used by several Navy projects such as the Fleet Command and Control Battle Management Program (FCCBMP).

Command and Control applications potentially needed by the Air Force are representative applications that SDOS is intended to support.

TECHNICAL OVERVIEW

Cronus incorporates many desirable distributed processing features, such as heterogeneity, transparency and object-oriented programming, as well as high-level features such as survivability and replication, multi-site database access, and distributed monitoring and control facilities.

Cronus is designed to interoperate with, rather than to replace or totally encapsulate, constituent (i.e., native) operating systems. It is also designed to ease the integration of existing software into a distributed processing environment. It provides uniform interprocess communication portable across a wide range of host and operating systems types, plus an extensible set of system services to support user authentication, symbolic naming, configuration management, and other essential functions. It also has tools to facilitate and manage the development of complex distributed applications that must be scalable, survivable, and evolve over long lifetimes.

SDOS is modeled after Cronus; all areas are the same except security. It has a layered architecture, built on top of a secure constituent operating system (UNIX System V/MLS), which will provide an extensible, small Trusted Computing Base (TCB).

REFERENCES

Vinter, Stephen T., "Integrated Distributed Computing Using Heterogeneous Systems," SIGNAL, Armed Forces Communications and Electronics Association, pp. 157-162, Jun 1989

Berets, James C., Richard M. Sands, "Introduction to Cronus," Technical Report 6986, BBN Systems and Technologies Corporation, Jan 1989

Varadarajan, R., J. R. McEnerney, and D.G. Weber, "The Secure Distributed Operating System - An Overview," Proceedings 1989 Workshop on Operating Systems for Mission Critical Computing, University of Maryland, Sept 1989.

CANDIDATE: iRMX

DEFINING DOCUMENTS:

iRMK I.3 Real-Time Kernel Reference Manual
Distributed iRMX Nucleus System Calls
Distributed iRMX I/O System Calls
Distributed iRMX Networking Services System Calls
Distributed iRMX Application Loader System Calls

Distributed iRMX Interactive Configuration Utility User's Guide
Distributed iRMX Configuration Guide

BACKGROUND AND STATUS

The Distributed iRMX Operating System was developed by Intel Corp. to serve as the latest member of Intel's iRMX family of real-time operating systems which has been used in approximately 7,500 designs over the last decade. The iRMX family of operating systems has been used in a wide range of applications including avionics, missile control, classified Navy projects, National Security Agency projects, radar control systems, satellite communications, and a host of non-military applications. The Distributed iRMX Operating System was designed from scratch, building upon the extensive knowledge obtained from the development of earlier members of the iRMX family of operating systems. It extends the capabilities of the iRMX operating systems to be able to satisfy the needs of applications of much greater complexity that were currently using large minicomputer systems. This would be accomplished by offering a distributed operating system capable of harnessing the computing power available in a multicomputer system based on 386-based single board computers interconnected by the MULTIBUS II bus.

INTENDED TARGET DOMAIN

The iRMX family of operating systems has traditionally been sold in the OEM market with the operating system serving as the basis for a wide variety of applications in such areas as military systems, process control, factory automation, communications, and data acquisition. These operating systems have been used in applications in both the commercial and government sector. Typical applications have required a high performance, real-time operating system. The Distributed iRMX Operating System will be sold into the same kind of markets but will provide additional computing due to its support for distribution and fault-tolerance.

TECHNICAL OVERVIEW

The Distributed iRMX Operating System is a distributed, real-time operating system. It is object oriented, with a core set of objects and corresponding operations defined by the operating system along with facilities that allow the user to define additional objects and operations in order to extend the functionality of the operating system. These facilities have been designed to allow transparent access to objects residing on remote hosts. In addition to facilities to support transparent distribution, the design includes the specification of additional facilities to enable fault-tolerant operation of the system to ensure that the distributed operating system continues to run and remain consistent in the presence of host failures. The facilities to support fault-tolerance include the ability to provide information to users concerning changes in system configuration, thus enabling users to build fault-tolerant applications.

REFERENCE

Saponas, Timothy G., and Demuth, Roger B., "The Distributed iRMX Operating System--A Real-Time Distributed Operating System," Proceedings 1989 Workshop on Operating Systems for Mission Critical Computing, Karen Gordon, Phil Hwang, and Ashok Agrawala (ed.), ACM Press.

CANDIDATE: Mach

DEFINING DOCUMENTS:

Mach Kernel Interface Manual, R.V. Baron, et al., CMU, 1 Jan 1990.
"Network Server Design," Mach Networking Group, 31 Aug 1989.
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"MACH Kernel Modifications for the Implementation of the Security Policy," D.I. Dalva, Trusted Information Systems, Inc., Sept 1989.
"Trusted Mach Name Server Interface Document," H. Tajalli and J. Graham, Trusted Information Systems, Inc., 15 Sept 1989.
"Trusted Mach File Server Interface Document," J. Graham, Trusted Information Systems, Inc., 15 Sept 1989.
"Trusted Mach Audit Server Interface Document," J. Graham, Trusted Information Systems, Inc., 19 Sept 1989.
"Trusted Mach Verification Server Interface Document," K.D. Henriksen and J. Graham, Trusted Information Systems, Inc., 15 Sept 1989.

BACKGROUND

The Mach project was initiated at Carnegie Mellon University in 1984 as the operating system effort of DARPA's Strategic Computing Initiative (SCI). DARPA envisioned Mach as a vehicle for providing a uniform (namely, UNIX-compatible) software base across the architectures existing at the time, as well as the new advanced architectures being developed as part of the SCI. Mach has lived up to its promise. It has been ported to numerous architectures, system platforms, and multiprocessors. Commercial versions are

available from several vendors, including BBN, Encore, and NeXT. The Open Software Foundation (OSF) has incorporated Mach into its strategy for achieving a general-purpose, vendor-neutral open software environment.

INTENDED TARGET DOMAIN

Mach is a portable minimal kernel. Various operating system environments can be built on top of Mach. However, to gain leverage from, as well as to offer leverage to, the abundant supply of UNIX-based software, Mach has been purposefully associated with UNIX (namely, 4.3 BSD). The Mach kernel has traditionally been distributed in a package that includes an operating system environment and interface offering binary compatibility with 4.3 BSD. In keeping with its UNIX heritage, the primary application domain for Mach has been interactive computing. But through DARPA-sponsored projects such as Real-Time Mach and Trusted Mach, Mach is being extended to the mission-critical computing domain.

TECHNICAL OVERVIEW

As a minimal kernel, Mach implements processes, interprocess communication (IPC), and memory management. Processes are implemented through tasks and threads. A task is an address space and the unit of resource allocation; a thread is the unit of computation--a lightweight process. Multiple threads can execute concurrently within a task. IPC is implemented through ports and messages. Ports are similar to capabilities, in terms of their roles in naming and protection. Objects are represented as ports; operations on objects are performed, subject to the port rights of the sender, by sending messages to the ports that represent them. Virtual memory management is tightly integrated with IPC, and it is distinguished by its portability, advanced functionality, and high performance.

REFERENCES

Accetta, M., et al., "Mach: A New Kernel Foundation for UNIX Development," Proceedings Summer USENIX, Jul 1986

Rashid, R.F., et al., "Mach: A Foundation for System Software," Proceedings 1989 Workshop on Operating Systems for Mission Critical Computing, ed. Gordon, Hwang, and Agrawala, ACM Press, 1990.

CANDIDATE: ORKID (Open Real-Time Kernel Interface Definition)

DEFINING DOCUMENTS:

ORKID: Open Real-Time Kernel Interface Definition, Draft 1.0 for Public Comments, July 1989.

BACKGROUND

ORKID is being developed by a small working group of the Software Subcommittee of the VITA Technical Committee. VITA (VME International Trade Association) is an organization of VMEbus hardware manufacturers. VITA promotes VMEbus an open bus architecture. VITA promotes ORKID as an open real-time software interface that is not particular to any bus or hardware architecture. The ORKID working group began meeting in March 1988. It made ORKID Draft 1.0 available for public comments in July 1989. The ORKID working group reviews comments and revises the draft standard at quarterly meetings. In 1990, the ORKID working group plans to present a version of the standard for approval to the VITA membership and to begin marketing it to other standards organizations.

INTENDED TARGET DOMAIN

ORKID specifies an application program interface to a real-time kernel. The motivation behind its development is to allow users to create robust and portable code (at the source code level), while also allowing implementors the freedom to proliferate their compliant products. To this end, ORKID is designed to be implementable efficiently across a wide range of microprocessors. Furthermore, ORKID is designed to operate effectively across a wide range of real-time systems, from tightly embedded systems to complex multiprocessor systems.

TECHNICAL OVERVIEW

To ensure that it could be implemented efficiently and also to enhance its chances of acceptance in the user community, ORKID is based upon proven technology. The ORKID standard defines standard kernel object types, including standard operations on those types. Standard object types known as tasks and queues provide for processes and interprocess communication. Standard object types known as regions and partitions provide for dynamic allocation of variable-sized segments and fixed-sized blocks, respectively. Other standard object types include semaphores, events, exceptions, interrupts, a clock, and timers. At the present time, ORKID does not provide for virtual memory, but the ORKID working group views virtual memory support as the next major topic on its agenda.

REFERENCES

The defining document cited above is the best reference.

CANDIDATE: POSIX (IEEE Standard Portable Operating System Interface for Computer Environments)

DEFINING DOCUMENTS:

1003.1-1988 IEEE Standard Portable Operating System Interface for Computer Environments
1003.2 (Draft) Shell and Utilities
1003.4 (Draft) Realtime Extensions
1003.5 (Draft) Ada Language Bindings
1003.6 (Draft) Trusted System Extensions
1003.8 (Draft) Networking Standards

BACKGROUND AND STATUS

The POSIX standard is under development and refinement in open forum under the auspices of the Computer Society of the Institute of Electrical and Electronics Engineers. The initial standard (1003.1-1988) is complete and has been published; the remaining portions of the standard defined above and reviewed for use by the NGCR OSSWG are either currently undergoing the IEEE balloting process (i.e., 1003.2, 1003.4) or are nearing the balloting process. All of these documents are expected to successfully pass balloting before the end of 1991.

INTENDED TARGET DOMAIN

The POSIX standard defines a robust source-level application interface to an operating system providing a complete set of services supporting the underlying hardware. It is addressed, via extensive subsetting options, to a wide range of targets, from large, distributed application domains to small, embedded systems. It is intended that secondary standards called Application Environment Profiles will define the specific subset definitions for specific application domains.

TECHNICAL OVERVIEW

Initially, the POSIX standards are based upon interfaces currently in use by the UNIX(tm-AT&T) operating system. The 1003.1 interface definition contains the basic library interfaces to support processes and files for one or more simultaneous users, as well as interfaces to commonly supported devices (e.g., terminals and timers) needed by applications. The 1003.2 standard describes the interfaces provided by a "shell" which allows applications to be managed by a console user, as well as interfaces to a number of commonly used utilities (e.g., copying files). The 1003.4 standard defines extensions to the basic 1003.1 standard to support applications which need predictable time response; these extensions provide interfaces to alternate functions avoiding unbounded delays, such as priority scheduling, precision clocks and timers, asynchronous I/O, memory locking, contiguous files, etc. The 1003.5 standard defines Ada interfaces to replace the C bindings of the other standards. The 1003.6 standard defines the requirements for interfacing to a trusted (i.e., secure) underlying operating system, and the 1003.8 standard defines POSIX application interfaces to other networking standards.

REFERENCE

The best reference to the scope of the POSIX work is found in the introduction (and Appendix A) to the 1003.1-1988 standard document itself referenced above. The document is available from the IEEE Press.

APPENDIX B

FURTHER ANALYSIS OF WEIGHT SET 2

TABLE B-1. RANGES OF WEIGHTS FOR EACH SERVICE CLASS

SERVICE CLASS	MIN WEIGHT	MAX WEIGHT
2	3.2	7.8
3	2.3	9.0
4	4.3	7.7
5	5.4	8.5
6	0.3	9.2
7	4.5	6.7
8	2.8	9.5
9	3.7	8.2
10	3.0	7.6
11	3.4	9.2
12	3.0	6.8
13	4.3	8.3
14	3.5	6.3
15	3.8	8.4
16	2.4	8.8

TABLE B-2. DISTRIBUTION OF WEIGHTS

RANGE	OCCURRENCES
0.0-0.4	X
0.5-0.9	X
1.0-1.4	
1.5-1.9	XX
2.0-2.4	XX
2.5-2.9	X
3.0-3.4	XXXXXX
3.5-3.9	XXXXX
4.0-4.4	XXXXXXXXXX
4.5-4.9	XXXXXXXXXX
5.0-5.4	XXXXXXXXXXXXXX
5.5-5.9	XXXXXXXXX
6.0-6.4	XXXXXXXXXXXXXX
6.5-6.9	XXXXXXX
7.0-7.4	XXXXXXXX
7.5-7.9	XXXXXXXXXXX
8.0-8.4	XXXXXXX
8.5-8.9	XXXXXXX
9.0-9.4	XXXX
9.5-9.9	X

TABLE B-3. RANGES OF WEIGHTS FOR EACH REPRESENTATIVE APPLICATION DOMAIN

REPRESENTATIVE APPLICATION DOMAIN	MIN WEIGHT	MAX WEIGHT
RUBY	2.4	9.2
OPAL	0.5	7.3
AMETHYST	4.2	9.5
GARNET	0.3	8.5
TOPAZ	4.2	8.8
EMERALD	1.7	9.3
DIAMOND	1.7	8.7
SAPPHIRE	3.4	8.8

APPENDIX C

CONTRIBUTING ORGANIZATIONS

NAVY ORGANIZATIONS

NAVAL AIR DEVELOPMENT CENTER
NAVAL UNDERWATER SYSTEMS CENTER
NAVAL OCEAN SYSTEMS CENTER
NAVAL SURFACE WARFARE CENTER
NAVAL WEAPONS CENTER
NAVAL AVIONICS CENTER
NAVAL RESEARCH LABORATORY
NAVAL ORDNANCE STATION
NAVAL AIR TEST CENTER
SPACE AND NAVAL WARFARE SYSTEMS COMMAND
DEPARTMENT OF THE NAVY (INFORMATION RESOURCES MANAGEMENT)
NAVAL AIR SYSTEMS COMMAND
Note: NAVAL SEA SYSTEMS COMMAND (PMS-412) participated in the evaluation through a contractor.

UNIVERSITY, INDUSTRY, AND OTHER GOVERNMENT ORGANIZATIONS

ARNOLD ASSOCIATES
BOOZ, ALLEN, & HAMILTON INC.
CLEMSON UNIVERSITY
COMPUTER-BASED SYSTEMS INC.
CONCURRENT COMPUTER CORP.
DGM&S INC.
DIGITAL EQUIPMENT CORP.
DYNAMICS RESEARCH CORP.
ESL
FORD AEROSPACE
GENERAL ELECTRIC AEROSPACE
GENERAL ELECTRIC CO. ADVANCED TECHNOLOGY LABORATORIES
HONEYWELL FEDERAL SYSTEMS, INC.
IBM CORP.
INSTITUTE FOR DEFENSE ANALYSES
INTEL CORP.
IPI
JOHNS HOPKINS UNIVERSITY/APPLIED PHYSICS LABORATORY
LITTON DATA SYSTEMS
MANAGEMENT & ENGINEERING INC.

MITRE CORP.
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
OPEN SOFTWARE FOUNDATION

UNIVERSITY, INDUSTRY, AND OTHER GOVERNMENT ORGANIZATIONS

PACIFIC INTERNATIONAL CENTER FOR HIGH TECHNOLOGY RESEARCH (PICHTR)
RAYTHEON CO. EQUIPMENT DIVISION
READY SYSTEMS
ROCKWELL INTERNATIONAL CORP.
SCTC INC.
TEXAS INSTRUMENTS, INC.
TRUSTED INFORMATION SYSTEMS
TRW FEDERAL SYSTEMS GROUP
UNISYS CORP.

APPENDIX D

FORMULAS FOR REDUCTION AND ANALYSIS OF EVALUATION

Formulas for Reduction and Analysis of Evaluation

The formulas below describe the processing that was performed on the scores and confidence values collected from the evaluation forms. The basic operation performed on the scores was the aggregation of the raw scores through the mean and through weighted sums to produce a single score for a service class, a programmatic issue or a representative application domain (RAD).

There are two estimates of the errors in the scores. The first estimate is the standard deviation which is derived from the deviations of the scores submitted by different evaluators for the same criterion. The second estimate is from the confidence value that the evaluators were asked to provide for each score. The confidence level is rated as "H" for high, "M" for medium, or "L" for low. These ratings are converted to error estimates by assuming "H" implies a low error in the entered score (± 1) while the "M" implies an error estimate of +/-2 and "L" implies a larger error (± 3). The two error estimates are comparable but are analyzed separately to allow comparisons.

Formulas:

Reduction on Evaluators yields a score for a criterion:

$$S_c^i = \frac{1}{N_k} \sum_{e=1}^{N_k} S_{ce}^i \qquad \text{(Eq. 1)}$$

$$s_c^i = \sqrt{\frac{\left\{ \sum_{e=1}^{N_k} (S_{ce}^i)^2 \right\} - N_k \left(S_c^i\right)^2}{N_k - 1}} \qquad \text{(Eq. 2)}$$

$$r_c^i = \frac{1}{N_k} \sqrt{\sum_{e=1}^{N_k} (r_{ce}^i)^2} \qquad \text{(Eq. 3)}$$

Reduction on Criteria yields a Score for a Service Class:

$$S_k^i = \frac{\sum_{c \in C_k} (W_{ck}\ s_c^i)}{\sum_{c \in C_k} W_{ck}} \qquad \text{(Eq. 4)}$$

$$s_k^i = \left(\frac{1}{\sum_{c \in C_k} W_{ck}} \right) \sqrt{\sum_{c \in C_k} \left((W_{ck}\ s_c^i)^2 + (s_c^i\ s_{ck}^w)^2 \right)} \qquad \text{(Eq. 5)}$$

$$r_k^i = \left(\frac{1}{\sum_{c \in C_k} W_{ck}} \right) \sqrt{\sum_{c \in C_k} \left((W_{ck}\ r_c^i)^2 + (s_c^i\ s_{ck}^w)^2 \right)} \qquad \text{(Eq. 6)}$$

Mapping Service Class Scores into Representative Application Domain Scores:

$$R_m^i = \frac{\sum_{\text{service classes}} (W_{km}\ S_k^i)}{\sum_{\text{service classes}} W_{km}} \qquad \text{(Eq. 7)}$$

$$s_m^i = \left(\frac{1}{\sum_{\text{service classes}} W_{km}} \right) \sqrt{\sum_{\text{service classes}} (W_{km}\ s_k^i)^2} \qquad \text{(Eq. 8)}$$

$$r_m^i = \left(\frac{1}{\sum_{\text{service classes}} W_{km}} \right) \sqrt{\sum_{\text{service classes}} (W_{km}\ r_k^i)^2} \qquad \text{(Eq. 9)}$$

Quantities in formulas:

s_{ce}^{i} The "raw" score for candidate **i**, for criterion **c** from evaluator **e**.

s_{c}^{i} The combined score for for candidate **i** for criterion **c**

N_k The number of evaluators for service class (or pragmatic issue) **k**.

s_{c}^{i} The standard deviation for the score for candidate **i** for criterion **c**.

r_{ce}^{i} The ("raw") confidence value estimated by evaluator **e** for raw score s_{ce}^{i}.

r_{c}^{i} The estimated confidence value for s_{c}^{i}.

W_{ck} The weight (0 .. 10) which indicates the importance of criterion **c** to service class(or programmatic issue) **k**. Where 0 indicates the criterion has no importance to this service class. These weights are sometimes referred to as "weight set 1".

s_{ck}^{w} The standard deviation (error estimate) of W_{ck}.

C_k The set of criteria which apply to service class **k**.

S_{k}^{i} The Service Class score for service class (or pragmatic issue) **k** for candidate **i**.

s_{k}^{i} The standard deviation for S_{k}^{i}.

r_{k}^{i} The confidence value for S_{k}^{i}

W_{km} The weight (0 .. 10) which indicates the importance of service class **k** to representative application **m**. These weights are assumed to have no error. These weights are sometimes referred to as "weight set 2"

R_{m}^{i} The score for representative application **m** for candidate **i**.

s_{m}^{i} The standard deviation for R_{m}^{i}.

r_{m}^{i} The confidence value for R_{m}^{i}.

APPENDIX E

CRITERIA SCORES

CANDIDATE: ALPHA

Results with data for evaluations with no less than 7 candidates evaluated.
221 files for candidate ALPHA for Class 0 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
0	1	7.50000	2.16430	0.38079	10	5	20
0	2	6.10000	2.53190	0.44721	10	2	20
0	3	5.45000	1.90498	0.42426	10	2	20
0	4	6.75000	2.04875	0.40620	10	3	20
0	5	4.75000	1.68195	0.43301	7	0	20
0	6	6.70000	2.25015	0.41533	10	3	20
0	7	5.45000	2.30503	0.46098	9	0	20
0	8	5.40000	2.92719	0.51478	10	0	20

Mean Service Class Score for Class 0:
Score:6.01250 Sigma:0.79741 Rho:0.15449 evaluators:20.00000

CANDIDATE: ALPHA

for Class 1 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
1	1	6.86667	2.01810	0.26294	10	2	45
1	2	7.73333	2.17841	0.26667	10	0	45
1	3	6.08889	2.04297	0.26294	10	2	45
1	4	8.22222	1.75666	0.26010	10	4	45
1	5	8.11111	2.45155	0.25434	10	0	45
1	6	8.48889	1.91433	0.25240	10	1	45
1	7	8.55556	1.94884	0.25724	10	0	45
1	8	7.51111	2.60787	0.28458	10	0	45
1	9	7.24444	2.59506	0.27933	10	0	45
1	10	3.77778	2.85155	0.29481	10	0	45
1	11	6.64444	2.94769	0.26943	10	0	45
1	12	7.15556	1.97663	0.33921	10	2	45
1	13	7.86667	1.73991	0.30388	10	5	45
1	14	8.17778	1.62773	0.32811	10	5	45
1	15	7.42222	2.00555	0.28371	10	2	45
1	16	8.57778	1.65816	0.28631	10	5	45
1	17	8.80000	1.47093	0.31111	10	5	45
1	18	8.13333	2.19089	0.28371	10	0	45
1	19	7.08889	2.86691	0.31111	10	0	45
1	20	8.66667	2.04495	0.24845	10	0	45
1	21	7.64444	2.78107	0.25915	10	0	45
1	22	7.55556	3.15188	0.26200	10	0	45
1	23	8.35556	2.84569	0.27844	10	0	45
1	24	8.31111	2.25451	0.26943	10	2	45
1	25	9.42222	0.98832	0.25628	10	6	45
1	26	8.48889	2.20147	0.27487	10	2	45
1	27	7.55556	2.34090	0.28889	10	0	45
1	28	7.04444	3.05224	0.29979	10	0	45
1	29	6.62222	2.51621	0.29897	10	0	45

Mean Service Class Score for Class 1:
Score:7.66282 Sigma:0.72028 Rho:0.57986 evaluators:45.00000

for Class 2 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
2	1	7.00000	3.04138	0.76980	10	0	9

Weighted Combined Service Class Score for Class 2:
Score:7.00000 Sigma:3.04138 Rho:0.76980 evaluators:9.00000

CANDIDATE: ALPHA

for Class 3 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
3	1	1.42857	1.81265	0.57143	5	0	7
3	2	1.28571	1.79947	0.57143	5	0	7
3	3	2.00000	3.60555	0.57143	10	0	7
3	4	1.28571	1.79947	0.57143	5	0	7
3	5	2.57143	2.93582	0.57143	8	0	7
3	6	2.28571	2.75162	0.57143	8	0	7
3	7	2.00000	1.63299	0.57143	5	0	7
3	8	3.00000	3.36650	0.57143	10	0	7
3	9	1.28571	1.79947	0.57143	5	0	7
3	10	1.71429	1.79947	0.57143	5	0	7
3	11	2.00000	3.60555	0.57143	10	0	7
3	12	1.28571	1.79947	0.57143	5	0	7
3	13	1.85714	1.77281	0.57143	5	0	7
3	14	1.71429	1.79947	0.57143	5	0	7
3	15	1.28571	1.79947	0.57143	5	0	7
3	16	1.28571	1.79947	0.57143	5	0	7
3	17	2.28571	1.79947	0.57143	5	0	7
3	18	1.28571	1.79947	0.57143	5	0	7
3	19	1.28571	1.79947	0.57143	5	0	7
3	20	2.00000	3.60555	0.57143	10	0	7
3	21	2.85714	3.76070	0.57143	10	0	7
3	22	1.28571	1.79947	0.57143	5	0	7
3	23	1.28571	1.79947	0.57143	5	0	7
3	24	2.00000	3.60555	0.57143	10	0	7

Weighted Combined Service Class Score for Class 3:
Score:1.74265 Sigma:0.53711 Rho:0.12758 evaluators:7.00000

for Class 4 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
4	1	3.33333	3.67423	0.57735	10	0	9

Weighted Combined Service Class Score for Class 4:
Score:3.33333 Sigma:3.67423 Rho:0.57735 evaluators:9.00000

for Class 5 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
5	1	8.53846	2.06621	0.46790	10	5	13
5	2	7.23077	2.45472	0.46790	10	3	13
5	3	7.69231	2.65784	0.46790	10	3	13
5	4	6.69231	3.14602	0.52736	10	0	13
5	5	7.00000	3.26599	0.57048	10	1	13
5	6	7.00000	3.26599	0.57048	10	1	13

Weighted Combined Service Class Score for Class 5:
Score:7.37543 Sigma:1.59842 Rho:1.11909 evaluators:13.00000

CANDIDATE: ALPHA

for Class 6 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
6	1	6.62500	4.24054	0.82916	10	0	8
6	2	5.87500	4.48609	0.82916	10	0	8
6	3	6.87500	4.58063	0.80039	10	0	8
6	4	7.37500	4.56501	0.75000	10	0	8
6	5	5.75000	4.16619	0.78062	10	0	8
6	6	5.25000	3.84522	0.75000	10	0	8
6	7	5.25000	4.68280	0.72887	10	0	8
6	8	5.25000	4.68280	0.72887	10	0	8
6	9	5.75000	4.86239	0.59948	10	0	8
6	10	5.87500	4.96955	0.59948	10	0	8
6	11	5.87500	4.96955	0.59948	10	0	8
6	12	6.50000	4.40779	0.71807	10	0	8
6	13	6.50000	4.40779	0.71807	10	0	8
6	14	6.50000	4.40779	0.71807	10	0	8
6	15	5.25000	4.30116	0.63738	10	0	8
6	16	6.00000	5.01427	0.59948	10	0	8
6	17	7.25000	4.52769	0.59948	10	0	8
6	18	7.25000	4.52769	0.63738	10	0	8
6	19	5.37500	4.74906	0.59948	10	0	8
6	20	5.50000	4.98569	0.78062	10	0	8

Weighted Combined Service Class Score for Class 6:
Score:6.09314 Sigma:1.14066 Rho:0.47735 evaluators:8.00000

for Class 7 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
7	1	6.50000	3.11677	0.85696	10	2	8
7	2	5.62500	3.37797	0.90139	10	1	8
7	3	5.62500	3.37797	0.90139	10	1	8
7	4	5.62500	3.37797	0.90139	10	1	8
7	5	5.62500	3.37797	0.90139	10	1	8
7	6	7.50000	2.00000	0.85696	10	5	8
7	7	5.62500	3.37797	0.90139	10	1	8
7	8	5.37500	3.24863	0.90139	10	1	8
7	9	6.87500	3.52288	0.87500	10	2	8
7	10	4.50000	2.92770	0.85696	10	1	8
7	11	4.87500	2.74838	0.90139	10	1	8

Weighted Combined Service Class Score for Class 7:
Score:5.85028 Sigma:1.08954 Rho:0.56273 evaluators:8.00000

CANDIDATE: ALPHA

for Class 8 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
8	1	8.09091	2.34327	0.53009	10	2	11
8	2	8.27273	2.53341	0.53009	10	2	11
8	3	6.81818	3.18805	0.60984	10	0	11
8	4	6.72727	3.19659	0.60984	10	0	11
8	5	6.36364	3.77552	0.58916	10	0	11
8	6	7.27273	3.25856	0.60984	10	0	11
8	7	6.90909	2.80908	0.64282	10	2	11
8	8	6.54545	3.04512	0.62984	10	0	11
8	9	6.27273	3.31936	0.62984	10	0	11
8	10	5.72727	3.77070	0.68030	10	0	11

Weighted Combined Service Class Score for Class 8:
Score:7.00022 Sigma:1.38290 Rho:0.99275 evaluators:11.00000

for Class 9 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
9	1	8.55556	2.29734	0.50918	10	3	9
9	2	8.88889	2.26078	0.50918	10	3	9
9	3	8.44444	2.40370	0.56656	10	3	9
9	4	6.66667	2.54951	0.64788	10	3	9
9	5	8.77778	2.27913	0.54433	10	3	9
9	6	9.00000	2.29129	0.50918	10	3	9
9	7	7.55556	3.12694	0.47140	10	1	9
9	8	6.11111	3.44400	0.54433	10	0	9
9	9	8.00000	2.54951	0.56656	10	3	9
9	10	7.00000	2.64575	0.59835	10	3	9
9	11	7.88889	2.52212	0.64788	10	3	9
9	12	8.44444	2.45515	0.56656	10	3	9
9	13	8.11111	1.96497	0.56656	10	5	9
9	14	8.11111	2.75882	0.54433	10	3	9

Weighted Combined Service Class Score for Class 9:
Score:7.99199 Sigma:1.02226 Rho:0.76154 evaluators:9.00000

for Class 10 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
10	1	5.70000	4.08384	0.50000	10	0	10
10	2	3.70000	2.49666	0.60000	8	0	10

Weighted Combined Service Class Score for Class 10:
Score:4.71191 Sigma:3.02544 Rho:1.87466 evaluators:10.00000

CANDIDATE: ALPHA

for Class 11 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
11	1	6.58333	4.14418	0.47871	10	0	12
11	2	6.41667	3.70401	0.53359	10	0	12
11	3	4.66667	3.14305	0.50000	10	0	12
11	4	4.50000	3.14787	0.47871	10	0	12
11	5	4.58333	2.57464	0.47871	8	0	12
11	6	3.91667	3.47611	0.53359	10	0	12
11	7	6.16667	3.58870	0.50000	10	0	12
11	8	4.41667	3.60450	0.53359	10	0	12
11	9	5.91667	3.57919	0.47871	10	0	12
11	10	6.50000	3.96576	0.54645	10	0	12
11	11	4.66667	3.55050	0.51370	10	0	12
11	12	5.58333	3.31548	0.57735	10	0	12
11	13	7.25000	2.34036	0.66667	10	4	12
11	14	5.58333	4.01040	0.54645	10	0	12

Weighted Combined Service Class Score for Class 11:
Score:5.50050 Sigma:1.12867 Rho:0.62468 evaluators:12.00000

for Class 12 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
12	1	7.45455	3.11010	0.61658	10	2	11
12	2	7.36364	3.07482	0.69234	10	2	11
12	3	9.45455	0.82020	0.57496	10	8	11
12	4	6.54545	3.90803	0.62984	10	0	11
12	5	8.36364	1.96330	0.59613	10	5	11
12	6	5.72727	3.46672	0.61658	10	0	11
12	7	4.63636	3.90571	0.59613	10	0	11
12	8	4.63636	3.90571	0.59613	10	0	11
12	9	5.72727	3.43776	0.58210	10	0	11
12	10	5.63636	3.44304	0.56040	10	0	11
12	11	7.18182	3.70994	0.62984	10	0	11
12	12	5.09091	2.84445	0.64922	10	0	11

Weighted Combined Service Class Score for Class 12:
Score:6.59533 Sigma:1.15673 Rho:0.72626 evaluators:11.00000

CANDIDATE: ALPHA

for Class 13 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
13	1	8.36364	1.96330	0.48105	10	5	11
13	2	7.90909	2.87939	0.50616	10	2	11
13	3	4.90909	3.11302	0.56773	10	0	11
13	4	6.36364	3.61311	0.56773	10	0	11
13	5	8.09091	2.34327	0.48105	10	5	11
13	6	6.90909	3.33030	0.53009	10	0	11
13	7	7.18182	2.48267	0.53009	10	4	11
13	8	7.54545	2.50454	0.54545	10	5	11
13	9	5.45455	1.50756	0.58210	10	5	11
13	10	7.09091	2.58668	0.58210	10	3	11
13	11	5.27273	2.61116	0.56773	9	0	11

Weighted Combined Service Class Score for Class 13:
Score:6.93892 Sigma:1.07270 Rho:0.70945 evaluators:11.00000

for Class 14 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
14	1	6.33333	4.09268	0.65734	10	0	9
14	2	6.77778	4.02423	0.65734	10	0	9
14	3	4.44444	4.18662	0.72860	10	0	9

Weighted Combined Service Class Score for Class 14:
Score:5.95858 Sigma:2.53252 Rho:0.96473 evaluators:9.00000

for Class 15 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
15	1	8.69231	2.17503	0.44189	10	5	13
15	2	8.30769	3.11942	0.42829	10	0	13
15	3	4.84615	3.78255	0.56527	10	0	13
15	4	7.92308	3.45112	0.51025	10	0	13
15	5	8.00000	3.39116	0.52172	10	0	13
15	6	8.61538	2.78503	0.46154	10	0	13
15	7	7.00000	4.00000	0.44189	10	0	13

Weighted Combined Service Class Score for Class 15:
Score:7.71179 Sigma:1.56847 Rho:1.01730 evaluators:13.00000

CANDIDATE: ALPHA

for Class 16 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
16	1	6.44444	2.45515	0.70273	10	3	9
16	2	6.11111	2.08833	0.70273	10	3	9
16	3	6.77778	2.72845	0.67586	10	3	9
16	4	6.77778	2.72845	0.67586	10	3	9
16	5	5.66667	1.65831	0.70273	8	3	9
16	6	6.11111	2.14735	0.70273	10	3	9
16	7	4.77778	2.27913	0.67586	8	0	9
16	8	4.77778	2.27913	0.67586	8	0	9
16	9	6.44444	2.24227	0.67586	10	5	9
16	10	5.88889	1.83333	0.67586	10	5	9
16	11	5.77778	3.03223	0.67586	10	1	9
16	12	6.77778	2.72845	0.67586	10	3	9
16	13	6.22222	2.48886	0.72008	10	3	9
16	14	6.44444	2.24227	0.67586	10	5	9
16	15	5.33333	2.69258	0.67586	10	0	9
16	16	5.33333	2.69258	0.67586	10	0	9
16	17	5.11111	1.26930	0.67586	8	3	9
16	18	5.11111	1.26930	0.67586	8	3	9
16	19	5.88889	2.84800	0.67586	10	0	9
16	20	5.00000	2.17945	0.67586	8	0	9

Weighted Combined Service Class Score for Class 16:
Score:5.82425 Sigma:0.75630 Rho:0.54562 evaluators:9.00000

CANDIDATE: ARTX

Results with data for evaluations with no less than 7 candidates evaluated.
221 files for candidate ARTX
for Class 0 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
0	1	5.45000	1.27630	0.41833	10	4	20
0	2	5.10000	2.19809	0.51720	9	1	20
0	3	8.15000	1.84320	0.41533	10	5	20
0	4	8.00000	1.74718	0.45552	10	5	20
0	5	6.20000	2.85804	0.46904	10	0	20
0	6	8.25000	1.83174	0.43875	10	5	20
0	7	6.45000	1.46808	0.46904	9	5	20
0	8	5.80000	2.58742	0.51720	10	0	20

Mean Service Class Score for Class 0:
Score:6.67500 Sigma:0.72116 Rho:0.16406 evaluators:20.00000

CANDIDATE: ARTX

for Class 1 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
1	1	5.97778	1.80264	0.27035	10	2	45
1	2	6.84444	2.31552	0.28545	10	2	45
1	3	6.75556	2.03554	0.29481	10	2	45
1	4	6.88889	2.49747	0.29144	10	0	45
1	5	7.71111	1.98428	0.28974	10	2	45
1	6	7.22222	2.52162	0.28458	10	0	45
1	7	6.95556	2.21519	0.30551	10	1	45
1	8	6.53333	2.22179	0.29731	10	0	45
1	9	4.84444	3.30259	0.28889	10	0	45
1	10	7.82222	2.78216	0.26667	10	0	45
1	11	7.28889	2.60787	0.27666	10	1	45
1	12	7.26667	1.87568	0.30062	10	3	45
1	13	7.40000	2.17841	0.30062	10	0	45
1	14	6.97778	2.62409	0.31348	10	0	45
1	15	6.95556	1.96510	0.30144	10	3	45
1	16	6.97778	2.14782	0.32584	10	0	45
1	17	5.71111	2.58160	0.30225	10	0	45
1	18	7.20000	1.79139	0.29897	10	5	45
1	19	4.48889	3.13066	0.32508	10	0	45
1	20	6.97778	2.40727	0.29979	10	0	45
1	21	6.33333	2.51360	0.28974	10	0	45
1	22	7.46667	1.94936	0.28717	10	2	45
1	23	4.40000	2.82360	0.29481	10	0	45
1	24	1.04444	1.95350	0.28889	10	0	45
1	25	5.04444	2.51320	0.31348	10	0	45
1	26	4.24444	2.89322	0.32508	10	0	45
1	27	1.95556	2.63676	0.32508	10	0	45
1	28	5.00000	2.45875	0.32735	10	0	45
1	29	2.28889	2.93585	0.28889	10	0	45

Mean Service Class Score for Class 1:
Score:5.90738 Sigma:0.65184 Rho:0.46882 evaluators:45.00000

for Class 2 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
2	1	3.77778	2.16667	0.68493	6	0	9

Weighted Combined Service Class Score for Class 2:
Score:3.77778 Sigma:2.16667 Rho:0.68493 evaluators:9.00000

CANDIDATE: ARTX

for Class 3 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
3	1	0.71429	1.88982	0.51508	5	0	7
3	2	0.42857	1.13389	0.51508	3	0	7
3	3	0.42857	1.13389	0.51508	3	0	7
3	4	0.42857	1.13389	0.51508	3	0	7
3	5	0.42857	1.13389	0.51508	3	0	7
3	6	0.42857	1.13389	0.51508	3	0	7
3	7	1.85714	3.76070	0.51508	10	0	7
3	8	1.85714	3.76070	0.51508	10	0	7
3	9	0.42857	1.13389	0.51508	3	0	7
3	10	0.42857	1.13389	0.51508	3	0	7
3	11	0.71429	1.88982	0.51508	5	0	7
3	12	0.42857	1.13389	0.51508	3	0	7
3	13	0.42857	1.13389	0.57143	3	0	7
3	14	0.42857	1.13389	0.51508	3	0	7
3	15	0.42857	1.13389	0.51508	3	0	7
3	16	0.28571	0.75593	0.51508	2	0	7
3	17	0.42857	1.13389	0.51508	3	0	7
3	18	0.42857	1.13389	0.51508	3	0	7
3	19	0.42857	1.13389	0.51508	3	0	7
3	20	0.71429	1.88982	0.57143	5	0	7
3	21	0.71429	1.88982	0.57143	5	0	7
3	22	0.42857	1.13389	0.57143	3	0	7
3	23	0.42857	1.13389	0.57143	3	0	7
3	24	0.71429	1.88982	0.57143	5	0	7

Weighted Combined Service Class Score for Class 3:
Score:0.55882 Sigma:0.33008 Rho:0.11751 evaluators:7.00000

for Class 4 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
4	1	1.11111	3.33333	0.54433	10	0	9

Weighted Combined Service Class Score for Class 4:
Score:1.11111 Sigma:3.33333 Rho:0.54433 evaluators:9.00000

for Class 5 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
5	1	3.46154	1.71345	0.56001	5	0	13
5	2	2.38462	2.32875	0.54393	6	0	13
5	3	2.23077	1.87767	0.54393	5	0	13
5	4	0.61538	1.19293	0.49852	3	0	13
5	5	2.92308	2.62874	0.48650	8	0	13
5	6	2.00000	2.41523	0.48650	7	0	13

Weighted Combined Service Class Score for Class 5:
Score:2.30391 Sigma:0.94164 Rho:0.42565 evaluators:13.00000

CANDIDATE: ARTX

for Class 6 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
6	1	6.75000	3.49489	0.75000	10	0	8
6	2	3.87500	2.41646	0.78062	6	0	8
6	3	2.75000	2.71241	0.85696	7	0	8
6	4	7.37500	3.46152	0.78062	10	0	8
6	5	5.50000	3.81725	0.72887	10	0	8
6	6	1.37500	1.84681	0.72887	5	0	8
6	7	9.37500	0.91613	0.67315	10	8	8
6	8	9.62500	0.74402	0.69597	10	8	8
6	9	9.25000	1.16496	0.67315	10	7	8
6	10	8.37500	3.46152	0.63738	10	0	8
6	11	9.75000	0.70711	0.59948	10	8	8
6	12	9.62500	1.06066	0.63738	10	7	8
6	13	10.00000	0.00000	0.71807	10	10	8
6	14	10.00000	0.00000	0.55902	10	10	8
6	15	0.00000	0.00000	0.59948	0	0	8
6	16	9.37500	1.76777	0.59948	10	5	8
6	17	8.75000	2.12132	0.63738	10	4	8
6	18	8.75000	2.12132	0.69597	10	4	8
6	19	8.12500	2.23207	0.72887	10	5	8
6	20	5.75000	3.45378	0.87500	10	0	8

Weighted Combined Service Class Score for Class 6:
Score:7.57321 Sigma:0.72398 Rho:0.55498 evaluators:8.00000

for Class 7 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
7	1	9.00000	1.19523	0.59948	10	7	8
7	2	9.12500	1.12599	0.63738	10	7	8
7	3	9.12500	1.24642	0.69597	10	7	8
7	4	8.25000	2.71241	0.69597	10	2	8
7	5	8.25000	2.71241	0.69597	10	2	8
7	6	4.37500	3.46152	0.72887	10	0	8
7	7	8.75000	1.58114	0.59948	10	6	8
7	8	6.25000	2.25198	0.76035	10	3	8
7	9	6.00000	3.74166	0.66144	10	0	8
7	10	7.62500	2.97309	0.69597	10	1	8
7	11	5.12500	2.90012	0.76035	10	1	8

Weighted Combined Service Class Score for Class 7:
Score:7.57396 Sigma:0.96979 Rho:0.66297 evaluators:8.00000

CANDIDATE: ARTX

for Class 8 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
8	1	2.72727	2.14900	0.55298	5	0	11
8	2	4.54545	4.03395	0.53009	10	0	11
8	3	6.45455	3.61562	0.48956	10	0	11
8	4	4.18182	3.48764	0.59613	10	0	11
8	5	2.81818	3.31114	0.60984	7	0	11
8	6	7.36364	3.17089	0.53009	10	0	11
8	7	5.45455	4.00908	0.51426	10	0	11
8	8	4.00000	3.00000	0.55298	10	0	11
8	9	2.27273	2.93567	0.53009	8	0	11
8	10	1.09091	2.02260	0.53009	5	0	11

Weighted Combined Service Class Score for Class 8:
Score:4.21190 Sigma:1.22583 Rho:0.65922 evaluators:11.00000

for Class 9 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
9	1	7.77778	1.85592	0.50918	10	5	9
9	2	6.55556	2.24227	0.50918	10	3	9
9	3	6.00000	2.91548	0.50918	10	0	9
9	4	4.00000	3.39116	0.50918	9	0	9
9	5	8.77778	1.64148	0.47140	10	5	9
9	6	8.77778	1.64148	0.47140	10	5	9
9	7	6.11111	3.10018	0.50918	10	0	9
9	8	8.00000	1.41421	0.50918	10	6	9
9	9	7.22222	2.53859	0.50918	10	3	9
9	10	4.33333	2.78388	0.50918	9	0	9
9	11	7.77778	3.15348	0.50918	10	0	9
9	12	6.33333	3.08221	0.56656	10	1	9
9	13	1.44444	2.24227	0.47140	5	0	9
9	14	6.11111	2.52212	0.62854	10	2	9

Weighted Combined Service Class Score for Class 9:
Score:6.55620 Sigma:0.90845 Rho:0.63213 evaluators:9.00000

for Class 10 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
10	1	4.30000	4.39823	0.50000	10	0	10
10	2	0.00000	0.00000	0.52915	0	0	10

Weighted Combined Service Class Score for Class 10:
Score:2.17562 Sigma:2.52606 Rho:1.24952 evaluators:10.00000

CANDIDATE: ARTX

for Class 11 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
11	1	0.08333	0.28868	0.47871	1	0	12
11	2	0.00000	0.00000	0.50000	0	0	12
11	3	0.50000	1.44600	0.47871	5	0	12
11	4	0.50000	1.44600	0.47871	5	0	12
11	5	0.25000	0.62158	0.47871	2	0	12
11	6	0.00000	0.00000	0.47871	0	0	12
11	7	0.00000	0.00000	0.47871	0	0	12
11	8	0.00000	0.00000	0.47871	0	0	12
11	9	0.33333	0.77850	0.47871	2	0	12
11	10	0.00000	0.00000	0.47871	0	0	12
11	11	0.41667	1.44338	0.47871	5	0	12
11	12	0.16667	0.57735	0.47871	2	0	12
11	13	0.83333	1.94625	0.52042	5	0	12
11	14	0.00000	0.00000	0.47871	0	0	12

Weighted Combined Service Class Score for Class 11:
Score:0.20744 Sigma:0.22494 Rho:0.13480 evaluators:12.00000

for Class 12 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
12	1	0.00000	0.00000	0.51426	0	0	11
12	2	0.00000	0.00000	0.51426	0	0	11
12	3	7.18182	3.12468	0.61658	10	0	11
12	4	0.00000	0.00000	0.51426	0	0	11
12	5	4.09091	2.80908	0.59613	8	0	11
12	6	5.81818	2.99393	0.63636	10	1	11
12	7	0.00000	0.00000	0.51426	0	0	11
12	8	0.00000	0.00000	0.51426	0	0	11
12	9	3.81818	3.12468	0.64922	10	0	11
12	10	4.00000	3.46410	0.64922	10	0	11
12	11	4.54545	2.01810	0.64922	8	2	11
12	12	1.27273	2.05382	0.57496	5	0	11

Weighted Combined Service Class Score for Class 12:
Score:2.62307 Sigma:0.74252 Rho:0.41133 evaluators:11.00000

CANDIDATE: ARTX

for Class 13 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
13	1	8.63636	1.74773	0.53009	10	5	11
13	2	8.45455	1.96792	0.50616	10	5	11
13	3	0.00000	0.00000	0.40656	0	0	11
13	4	7.45455	2.42337	0.50616	10	4	11
13	5	0.36364	1.20605	0.43598	4	0	11
13	6	4.90909	1.86840	0.57496	10	3	11
13	7	3.18182	2.78633	0.46355	8	0	11
13	8	4.27273	1.27208	0.50616	5	2	11
13	9	5.45455	3.01210	0.53009	10	0	11
13	10	6.36364	2.61812	0.50616	10	2	11
13	11	4.27273	2.72363	0.55298	8	0	11

Weighted Combined Service Class Score for Class 13:
Score:5.23006 Sigma:0.85735 Rho:0.55669 evaluators:11.00000

for Class 14 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
14	1	5.55556	3.35824	0.68493	10	0	9
14	2	5.11111	3.40751	0.72860	10	0	9
14	3	2.44444	2.87711	0.80890	8	0	9

Weighted Combined Service Class Score for Class 14:
Score:4.51381 Sigma:2.00623 Rho:0.77566 evaluators:9.00000

for Class 15 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
15	1	5.61538	1.55662	0.48038	10	4	13
15	2	6.69231	3.03822	0.46154	10	0	13
15	3	0.38462	1.38675	0.38462	5	0	13
15	4	0.00000	0.00000	0.38462	0	0	13
15	5	0.00000	0.00000	0.38462	0	0	13
15	6	2.23077	2.52170	0.48038	5	0	13
15	7	3.53846	2.98930	0.51602	10	0	13

Weighted Combined Service Class Score for Class 15:
Score:2.96454 Sigma:0.91737 Rho:0.43637 evaluators:13.00000

CANDIDATE: ARTX

for Class 16 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
16	1	8.55556	2.24227	0.54433	10	5	9
16	2	9.00000	2.00000	0.50918	10	5	9
16	3	9.44444	1.66667	0.53287	10	5	9
16	4	9.44444	1.66667	0.47140	10	5	9
16	5	8.66667	2.17945	0.56656	10	5	9
16	6	1.11111	2.20479	0.53287	5	0	9
16	7	9.11111	1.83333	0.50918	10	5	9
16	8	9.44444	1.66667	0.50918	10	5	9
16	9	8.22222	2.43812	0.59835	10	5	9
16	10	5.44444	3.53946	0.64788	10	0	9
16	11	4.66667	3.00000	0.59835	8	0	9
16	12	5.00000	3.42783	0.56656	10	0	9
16	13	9.22222	1.71594	0.61864	10	5	9
16	14	6.00000	3.16228	0.67586	10	0	9
16	15	6.44444	2.74368	0.64788	10	3	9
16	16	5.44444	3.87657	0.59835	10	0	9
16	17	3.44444	4.27525	0.59835	10	0	9
16	18	3.44444	4.27525	0.59835	10	0	9
16	19	3.88889	3.65529	0.64788	10	0	9
16	20	5.77778	3.38296	0.67586	10	2	9

Weighted Combined Service Class Score for Class 16:
Score:6.84386 Sigma:0.87917 Rho:0.63015 evaluators:9.00000

CANDIDATE: CRONUS

Results with data for evaluations with no less than 7 candidates evaluated.
221 files for candidate CRONUS
for Class 0 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
0	1	7.40000	1.98415	0.40620	10	4	20
0	2	5.90000	1.97084	0.45552	10	2	20
0	3	7.00000	2.00000	0.43012	10	4	20
0	4	7.05000	1.95946	0.44159	10	3	20
0	5	4.80000	2.60768	0.46098	10	0	20
0	6	7.75000	1.97017	0.41533	10	4	20
0	7	5.45000	2.45967	0.46098	9	0	20
0	8	6.00000	2.57519	0.49749	10	0	20

Mean Service Class Score for Class 0:
Score:6.41875 Sigma:0.78086 Rho:0.15799 evaluators:20.00000

CANDIDATE: CRONUS

for Class 1 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
1	1	5.42222	1.97126	0.26759	10	2	45
1	2	7.44444	2.01760	0.28109	10	2	45
1	3	6.13333	1.86596	0.28717	10	2	45
1	4	8.64444	1.90878	0.26851	10	3	45
1	5	7.64444	2.21724	0.30872	10	1	45
1	6	8.48889	1.56121	0.28889	10	5	45
1	7	8.02222	2.08336	0.29144	10	1	45
1	8	5.55556	2.98142	0.30144	10	0	45
1	9	6.88889	2.69024	0.30631	10	0	45
1	10	2.82222	2.69080	0.31348	10	0	45
1	11	7.68889	3.03631	0.26105	10	0	45
1	12	7.02222	2.16888	0.31427	10	2	45
1	13	7.57778	2.64995	0.28889	10	0	45
1	14	7.37778	2.41481	0.33993	10	2	45
1	15	6.80000	2.13839	0.30631	10	0	45
1	16	8.11111	2.00252	0.31427	10	2	45
1	17	7.24444	2.46019	0.29565	10	0	45
1	18	8.48889	1.99570	0.29979	10	0	45
1	19	4.86667	3.08663	0.33921	10	0	45
1	20	6.04444	3.25406	0.28458	10	0	45
1	21	1.24444	2.01309	0.30225	7	0	45
1	22	6.71111	3.04229	0.29979	10	0	45
1	23	2.84444	2.61078	0.29481	10	0	45
1	24	7.60000	2.45320	0.28974	10	0	45
1	25	9.02222	1.95969	0.26387	10	0	45
1	26	8.08889	2.63561	0.28889	10	0	45
1	27	7.77778	2.33442	0.31427	10	0	45
1	28	1.84444	2.94615	0.28109	10	0	45
1	29	1.73333	2.98785	0.28545	10	0	45

Mean Service Class Score for Class 1:
Score:6.38739 Sigma:0.68018 Rho:0.50590 evaluators:45.00000

for Class 2 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
2	1	5.11111	3.72305	0.65734	10	0	9

Weighted Combined Service Class Score for Class 2:
Score:5.11111 Sigma:3.72305 Rho:0.65734 evaluators:9.00000

CANDIDATE: CRONUS

for Class 3 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
3	1	7.71429	2.98408	0.51508	10	2	7
3	2	7.57143	2.76026	0.51508	10	2	7
3	3	8.28571	2.05866	0.51508	10	5	7
3	4	7.85714	2.67261	0.51508	10	3	7
3	5	6.14286	3.93398	0.65465	10	0	7
3	6	8.57143	1.81265	0.57143	10	5	7
3	7	8.57143	1.90238	0.57143	10	5	7
3	8	7.85714	3.57904	0.57143	10	0	7
3	9	6.28571	3.49830	0.65465	10	0	7
3	10	6.28571	3.49830	0.65465	10	0	7
3	11	7.00000	3.36650	0.57143	10	0	7
3	12	4.14286	4.33699	0.45175	10	0	7
3	13	7.42857	2.14920	0.51508	10	4	7
3	14	7.14286	2.03540	0.57143	10	4	7
3	15	5.71429	2.98408	0.51508	10	2	7
3	16	6.00000	2.76887	0.51508	10	2	7
3	17	4.28571	4.27061	0.45175	10	0	7
3	18	6.85714	3.93398	0.57143	10	0	7
3	19	5.28571	3.35233	0.51508	10	1	7
3	20	3.71429	4.68025	0.51508	10	0	7
3	21	7.57143	2.63674	0.57143	10	3	7
3	22	4.14286	4.41318	0.45175	10	0	7
3	23	4.42857	4.39155	0.51508	10	0	7
3	24	3.71429	4.68025	0.45175	10	0	7

Weighted Combined Service Class Score for Class 3:
Score:6.48214 Sigma:0.72539 Rho:0.11907 evaluators:7.00000

for Class 4 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
4	1	8.33333	2.50000	0.67586	10	5	9

Weighted Combined Service Class Score for Class 4:
Score:8.33333 Sigma:2.50000 Rho:0.67586 evaluators:9.00000

for Class 5 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
5	1	3.23077	2.38586	0.61056	7	0	13
5	2	5.92308	3.14806	0.58583	10	1	13
5	3	5.00000	3.13581	0.53294	10	0	13
5	4	6.15385	3.78255	0.54393	10	0	13
5	5	0.53846	1.05003	0.57048	3	0	13
5	6	1.76923	2.16617	0.61056	5	0	13

Weighted Combined Service Class Score for Class 5:
Score:3.71087 Sigma:1.26076 Rho:0.64973 evaluators:13.00000

CANDIDATE: CRONUS

for Class 6 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
6	1	3.62500	4.24054	0.82916	10	0	8
6	2	1.12500	1.80772	0.75000	5	0	8
6	3	2.12500	3.64251	0.69597	10	0	8
6	4	4.62500	5.04090	0.78062	10	0	8
6	5	2.37500	3.37797	0.76035	8	0	8
6	6	2.37500	3.37797	0.76035	8	0	8
6	7	4.87500	5.22186	0.69597	10	0	8
6	8	5.00000	5.34522	0.66144	10	0	8
6	9	4.75000	5.11999	0.69597	10	0	8
6	10	5.00000	5.34522	0.69597	10	0	8
6	11	5.00000	5.34522	0.69597	10	0	8
6	12	3.62500	4.40576	0.78062	10	0	8
6	13	3.62500	4.40576	0.76035	10	0	8
6	14	3.87500	4.48609	0.76035	10	0	8
6	15	1.25000	2.31455	0.69597	5	0	8
6	16	5.00000	5.34522	0.69597	10	0	8
6	17	3.50000	4.40779	0.78062	10	0	8
6	18	2.25000	2.49285	0.81009	5	0	8
6	19	4.50000	4.98569	0.69597	10	0	8
6	20	2.87500	4.18970	0.78062	10	0	8

Weighted Combined Service Class Score for Class 6:
Score:3.72251 Sigma:1.06547 Rho:0.30213 evaluators:8.00000

for Class 7 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
7	1	0.00000	0.00000	0.66144	0	0	8
7	2	0.62500	1.76777	0.59948	5	0	8
7	3	0.62500	1.76777	0.59948	5	0	8
7	4	0.62500	1.76777	0.59948	5	0	8
7	5	0.62500	1.76777	0.59948	5	0	8
7	6	0.50000	1.41421	0.59948	4	0	8
7	7	0.62500	1.76777	0.59948	5	0	8
7	8	1.00000	1.92725	0.59948	5	0	8
7	9	0.00000	0.00000	0.59948	0	0	8
7	10	0.62500	1.76777	0.59948	5	0	8
7	11	0.62500	1.76777	0.59948	5	0	8

Weighted Combined Service Class Score for Class 7:
Score:0.52556 Sigma:0.48067 Rho:0.19286 evaluators:8.00000

CANDIDATE: CRONUS

for Class 8 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
8	1	2.36364	3.07482	0.48956	10	0	11
8	2	3.18182	3.89405	0.48956	10	0	11
8	3	8.90909	1.70027	0.53009	10	5	11
8	4	7.27273	3.95198	0.62324	10	0	11
8	5	5.27273	3.79713	0.60984	10	0	11
8	6	7.90909	3.17662	0.58916	10	0	11
8	7	8.81818	1.83402	0.55298	10	5	11
8	8	7.90909	3.14498	0.60984	10	0	11
8	9	5.63636	3.47197	0.62984	10	0	11
8	10	3.18182	3.84235	0.66183	10	0	11

Weighted Combined Service Class Score for Class 8:
Score:6.03731 Sigma:1.38629 Rho:0.94291 evaluators:11.00000

for Class 9 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
9	1	6.11111	1.76383	0.62854	8	3	9
9	2	6.77778	2.33333	0.62854	10	3	9
9	3	2.44444	3.53946	0.54433	10	0	9
9	4	1.00000	1.73205	0.54433	5	0	9
9	5	2.44444	3.53946	0.54433	10	0	9
9	6	2.44444	3.53946	0.54433	10	0	9
9	7	0.77778	1.71594	0.54433	5	0	9
9	8	8.33333	2.12132	0.57735	10	5	9
9	9	5.00000	2.73861	0.62854	10	1	9
9	10	4.88889	2.71314	0.62854	10	1	9
9	11	0.66667	1.41421	0.50918	4	0	9
9	12	8.88889	1.69148	0.54433	10	5	9
9	13	2.11111	3.21887	0.54433	9	0	9
9	14	0.77778	1.71594	0.50918	5	0	9

Weighted Combined Service Class Score for Class 9:
Score:3.92302 Sigma:0.80059 Rho:0.44303 evaluators:9.00000

for Class 10 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
10	1	1.40000	1.83787	0.48990	5	0	10
10	2	1.40000	2.06559	0.48990	5	0	10

Weighted Combined Service Class Score for Class 10:
Score:1.40000 Sigma:1.47631 Rho:0.62722 evaluators:10.00000

CANDIDATE: CRONUS

for Class 11 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
11	1	4.83333	4.30292	0.51370	10	0	12
11	2	1.66667	3.67630	0.47871	10	0	12
11	3	1.08333	2.60971	0.47871	8	0	12
11	4	1.16667	2.85509	0.47871	9	0	12
11	5	3.41667	2.46644	0.57130	8	0	12
11	6	1.75000	3.46738	0.50000	10	0	12
11	7	1.08333	2.87492	0.51370	10	0	12
11	8	1.58333	3.17543	0.53359	10	0	12
11	9	4.16667	3.21455	0.61237	10	0	12
11	10	0.50000	1.44600	0.50000	5	0	12
11	11	0.58333	1.08362	0.54645	3	0	12
11	12	0.25000	0.86603	0.51370	3	0	12
11	13	0.25000	0.86603	0.54645	3	0	12
11	14	1.25000	3.10791	0.47871	10	0	12

Weighted Combined Service Class Score for Class 11:
Score:1.80940 Sigma:0.81801 Rho:0.27765 evaluators:12.00000

for Class 12 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
12	1	0.18182	0.60302	0.51426	2	0	11
12	2	0.18182	0.60302	0.51426	2	0	11
12	3	3.27273	3.77070	0.61658	10	0	11
12	4	0.18182	0.60302	0.51426	2	0	11
12	5	0.63636	1.56670	0.51426	5	0	11
12	6	0.18182	0.60302	0.55298	2	0	11
12	7	0.18182	0.60302	0.53783	2	0	11
12	8	0.18182	0.60302	0.53783	2	0	11
12	9	0.27273	0.64667	0.53783	2	0	11
12	10	0.27273	0.64667	0.53783	2	0	11
12	11	0.18182	0.60302	0.51426	2	0	11
12	12	0.63636	1.56670	0.51426	5	0	11

Weighted Combined Service Class Score for Class 12:
Score:0.57220 Sigma:0.44313 Rho:0.17283 evaluators:11.00000

CANDIDATE: CRONUS

for Class 13 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
13	1	6.63636	2.69343	0.58916	10	3	11
13	2	6.81818	2.85721	0.58916	10	3	11
13	3	0.90909	3.01511	0.45455	10	0	11
13	4	4.45455	4.29799	0.62984	10	0	11
13	5	1.90909	3.20794	0.56773	10	0	11
13	6	3.09091	3.67300	0.57496	10	0	11
13	7	1.81818	2.99393	0.60984	8	0	11
13	8	2.27273	3.00303	0.62984	8	0	11
13	9	2.27273	3.00303	0.60984	8	0	11
13	10	4.27273	3.37908	0.60984	10	0	11
13	11	0.00000	0.00000	0.50616	0	0	11

Weighted Combined Service Class Score for Class 13:
Score:3.38001 Sigma:1.00068 Rho:0.39158 evaluators:11.00000

for Class 14 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
14	1	2.00000	3.50000	0.54433	10	0	9
14	2	4.66667	4.55522	0.65734	10	0	9
14	3	4.88889	4.72875	0.60858	10	0	9

Weighted Combined Service Class Score for Class 14:
Score:3.78062 Sigma:2.55193 Rho:0.76695 evaluators:9.00000

for Class 15 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
15	1	4.92308	3.25222	0.53846	10	0	13
15	2	0.15385	0.55470	0.47419	2	0	13
15	3	2.15385	2.51151	0.55470	6	0	13
15	4	2.92308	3.98877	0.52736	10	0	13
15	5	0.00000	0.00000	0.49255	0	0	13
15	6	2.23077	2.97640	0.52736	10	0	13
15	7	2.07692	2.21591	0.46154	5	0	13

Weighted Combined Service Class Score for Class 15:
Score:2.17191 Sigma:1.04210 Rho:0.35983 evaluators:13.00000

CANDIDATE: CRONUS

for Class 16 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
16	1	2.22222	3.63242	0.62854	10	0	9
16	2	2.00000	3.50000	0.67586	10	0	9
16	3	2.00000	3.50000	0.62854	10	0	9
16	4	2.00000	3.50000	0.62854	10	0	9
16	5	2.00000	3.50000	0.62854	10	0	9
16	6	2.22222	3.63242	0.62854	10	0	9
16	7	2.00000	3.50000	0.62854	10	0	9
16	8	2.00000	3.50000	0.62854	10	0	9
16	9	2.00000	3.50000	0.62854	10	0	9
16	10	2.00000	3.50000	0.62854	10	0	9
16	11	2.00000	3.50000	0.62854	10	0	9
16	12	2.00000	3.50000	0.62854	10	0	9
16	13	2.00000	3.50000	0.67586	10	0	9
16	14	2.00000	3.50000	0.62854	10	0	9
16	15	2.00000	3.50000	0.62854	10	0	9
16	16	2.00000	3.50000	0.62854	10	0	9
16	17	2.00000	3.50000	0.62854	10	0	9
16	18	2.00000	3.50000	0.62854	10	0	9
16	19	2.00000	3.50000	0.62854	10	0	9
16	20	2.00000	3.50000	0.62854	10	0	9

Weighted Combined Service Class Score for Class 16:
Score:2.01992 Sigma:0.81556 Rho:0.23066 evaluators:9.00000

CANDIDATE: IRMX

Results with data for evaluations with no less than 7 candidates evaluated.
216 files for candidate IRMX
for Class 0 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
0	1	5.45000	1.19097	0.39686	10	5	20
0	2	5.55000	2.43818	0.49497	10	1	20
0	3	7.80000	1.76516	0.43012	10	5	20
0	4	8.70000	1.55935	0.38730	10	5	20
0	5	6.30000	2.61775	0.47434	10	0	20
0	6	8.15000	1.92696	0.47958	10	5	20
0	7	7.40000	2.03651	0.46904	10	5	20
0	8	5.60000	2.43656	0.53385	9	0	20

Mean Service Class Score for Class 0:
Score:6.86875 Sigma:0.72414 Rho:0.16286 evaluators:20.00000

CANDIDATE: IRMX

for Class 1 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
1	1	7.33333	1.59545	0.27666	10	5	45
1	2	7.33333	1.93061	0.27756	10	3	45
1	3	7.15556	1.74454	0.29397	10	5	45
1	4	5.77778	2.24508	0.29648	10	0	45
1	5	8.17778	1.70945	0.29313	10	4	45
1	6	8.42222	1.81520	0.28109	10	5	45
1	7	8.17778	1.74888	0.28631	10	5	45
1	8	8.22222	1.70412	0.28458	10	5	45
1	9	6.46667	2.32183	0.29481	10	0	45
1	10	4.66667	2.72196	0.28197	10	0	45
1	11	7.88889	2.49747	0.27126	10	1	45
1	12	8.42222	1.68535	0.30388	10	5	45
1	13	7.86667	1.97254	0.29313	10	1	45
1	14	8.13333	1.92590	0.33036	10	4	45
1	15	7.88889	1.81186	0.31427	10	5	45
1	16	8.40000	1.64317	0.32356	10	4	45
1	17	8.00000	1.90693	0.29481	10	3	45
1	18	8.62222	1.69610	0.29229	10	5	45
1	19	7.40000	2.78307	0.31817	10	0	45
1	20	8.53333	1.87810	0.27126	10	5	45
1	21	5.26667	2.80746	0.31427	10	0	45
1	22	7.75556	2.34671	0.29979	10	0	45
1	23	5.82222	2.55208	0.29979	10	0	45
1	24	7.04444	1.90640	0.28803	10	3	45
1	25	7.17778	1.92223	0.29979	10	4	45
1	26	7.84444	2.04446	0.28197	10	2	45
1	27	3.66667	3.11156	0.29313	10	0	45
1	28	6.53333	2.49180	0.29979	10	0	45
1	29	6.02222	2.76742	0.30551	10	0	45

Mean Service Class Score for Class 1:
Score:7.18956 Sigma:0.68293 Rho:0.55192 evaluators:45.00000

for Class 2 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
2	1	4.66667	1.50000	0.60858	7	2	9

Weighted Combined Service Class Score for Class 2:
Score:4.66667 Sigma:1.50000 Rho:0.60858 evaluators:9.00000

CANDIDATE: IRMX

for Class 3 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
3	1	1.42857	1.98806	0.45175	5	0	7
3	2	1.00000	1.91485	0.45175	5	0	7
3	3	0.42857	1.13389	0.45175	3	0	7
3	4	0.42857	1.13389	0.45175	3	0	7
3	5	0.71429	1.25357	0.45175	3	0	7
3	6	2.14286	3.18479	0.51508	8	0	7
3	7	1.14286	1.57359	0.45175	4	0	7
3	8	0.71429	1.25357	0.45175	3	0	7
3	9	0.57143	0.97590	0.45175	2	0	7
3	10	0.85714	1.06904	0.45175	2	0	7
3	11	1.28571	1.88982	0.45175	5	0	7
3	12	0.85714	1.06904	0.45175	2	0	7
3	13	1.28571	1.70434	0.45175	4	0	7
3	14	1.00000	1.29099	0.45175	3	0	7
3	15	1.14286	1.46385	0.45175	3	0	7
3	16	1.42857	1.98806	0.45175	5	0	7
3	17	0.42857	1.13389	0.45175	3	0	7
3	18	1.14286	2.03540	0.45175	5	0	7
3	19	1.14286	2.03540	0.45175	5	0	7
3	20	1.42857	3.77964	0.45175	10	0	7
3	21	0.71429	1.88982	0.45175	5	0	7
3	22	0.57143	1.51186	0.55328	4	0	7
3	23	0.28571	0.75593	0.45175	2	0	7
3	24	0.71429	1.88982	0.45175	5	0	7

Weighted Combined Service Class Score for Class 3:
Score:0.96429 Sigma:0.38409 Rho:0.10363 evaluators:7.00000

for Class 4 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
4	1	1.00000	3.00000	0.50918	9	0	9

Weighted Combined Service Class Score for Class 4:
Score:1.00000 Sigma:3.00000 Rho:0.50918 evaluators:9.00000

for Class 5 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
5	1	6.53846	2.25889	0.44853	10	4	13
5	2	7.15385	2.30384	0.48038	10	4	13
5	3	6.23077	2.74329	0.49852	10	0	13
5	4	1.61538	1.85016	0.48038	5	0	13
5	5	2.92308	3.22649	0.54393	8	0	13
5	6	7.23077	3.70031	0.48038	10	0	13

Weighted Combined Service Class Score for Class 5:
Score:5.42204 Sigma:1.41020 Rho:0.83903 evaluators:13.000

CANDIDATE: IRMX

for Class 6 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
6	1	9.12500	1.80772	0.59948	10	5	8
6	2	8.62500	2.66927	0.66144	10	3	8
6	3	4.12500	4.08613	0.59948	10	0	8
6	4	8.25000	2.05287	0.75000	10	5	8
6	5	6.00000	2.92770	0.69597	10	0	8
6	6	2.00000	1.92725	0.71807	6	0	8
6	7	9.12500	1.24642	0.63738	10	7	8
6	8	9.50000	0.92582	0.63738	10	8	8
6	9	9.12500	1.45774	0.59948	10	6	8
6	10	9.75000	0.46291	0.59948	10	9	8
6	11	7.75000	3.57571	0.55902	10	0	8
6	12	9.87500	0.35355	0.55902	10	9	8
6	13	9.87500	0.35355	0.55902	10	9	8
6	14	9.87500	0.35355	0.51539	10	9	8
6	15	0.00000	0.00000	0.46771	0	0	8
6	16	8.37500	3.46152	0.55902	10	0	8
6	17	9.50000	0.92582	0.55902	10	8	8
6	18	9.00000	1.19523	0.62500	10	7	8
6	19	8.37500	3.54310	0.55902	10	0	8
6	20	7.62500	3.33542	0.51539	10	1	8

Weighted Combined Service Class Score for Class 6:
Score:8.09092 Sigma:0.76040 Rho:0.58874 evaluators:8.00000

for Class 7 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
7	1	6.37500	3.06769	0.72887	10	2	8
7	2	8.75000	2.05287	0.72887	10	5	8
7	3	9.37500	1.76777	0.63738	10	5	8
7	4	9.00000	1.77281	0.67315	10	5	8
7	5	9.12500	1.80772	0.67315	10	5	8
7	6	7.87500	2.99702	0.81009	10	3	8
7	7	8.25000	2.05287	0.72887	10	4	8
7	8	9.12500	1.24642	0.69597	10	7	8
7	9	9.25000	1.16496	0.66144	10	7	8
7	10	9.75000	0.70711	0.76035	10	8	8
7	11	5.12500	3.64251	0.63738	10	0	8

Weighted Combined Service Class Score for Class 7:
Score:8.40252 Sigma:0.98897 Rho:0.76363 evaluators:8.00000

CANDIDATE: IRMX

for Class 8 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
8	1	3.18182	2.22792	0.46355	5	0	11
8	2	7.90909	2.62505	0.48956	10	3	11
8	3	9.00000	1.41421	0.48956	10	7	11
8	4	1.81818	3.62817	0.46355	10	0	11
8	5	3.27273	4.60632	0.55298	10	0	11
8	6	7.36364	3.20227	0.51426	10	0	11
8	7	8.27273	2.96954	0.46355	10	2	11
8	8	6.27273	2.90141	0.56040	10	2	11
8	9	0.00000	0.00000	0.43598	0	0	11
8	10	1.36364	3.23335	0.58210	10	0	11

Weighted Combined Service Class Score for Class 8:
Score:5.05986 Sigma:1.21205 Rho:0.80796 evaluators:11.00000

for Class 9 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
9	1	9.22222	1.09291	0.47140	10	7	9
9	2	9.55556	1.01379	0.47140	10	7	9
9	3	7.22222	2.10819	0.47140	10	5	9
9	4	6.00000	3.12250	0.61864	10	0	9
9	5	9.22222	1.30171	0.56656	10	7	9
9	6	9.22222	1.30171	0.56656	10	7	9
9	7	6.44444	1.58990	0.59835	9	5	9
9	8	9.33333	1.00000	0.47140	10	7	9
9	9	9.22222	0.83333	0.47140	10	8	9
9	10	7.55556	1.58990	0.47140	10	5	9
9	11	8.44444	2.06828	0.47140	10	5	9
9	12	8.55556	3.28295	0.43033	10	0	9
9	13	1.44444	3.35824	0.47140	10	0	9
9	14	9.55556	0.72648	0.50918	10	8	9

Weighted Combined Service Class Score for Class 9:
Score:8.08862 Sigma:0.91287 Rho:0.77591 evaluators:9.00000

for Class 10 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
10	1	8.60000	1.77639	0.61644	10	5	10
10	2	0.40000	0.84327	0.50000	2	0	10

Weighted Combined Service Class Score for Class 10:
Score:4.54885 Sigma:2.58982 Rho:2.42572 evaluators:10.00000

CANDIDATE: IRMX

for Class 11 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
11	1	6.41667	2.71221	0.47871	10	2	12
11	2	6.83333	2.82307	0.47871	10	2	12
11	3	3.25000	1.54479	0.52042	5	1	12
11	4	3.33333	1.77525	0.55277	5	1	12
11	5	3.58333	1.67649	0.55277	6	1	12
11	6	3.75000	2.92715	0.52042	8	0	12
11	7	5.25000	3.33371	0.51370	10	0	12
11	8	3.58333	1.92865	0.52042	6	0	12
11	9	5.41667	3.05877	0.55277	10	0	12
11	10	4.00000	3.46410	0.47871	10	0	12
11	11	0.41667	1.16450	0.47871	4	0	12
11	12	4.83333	3.04014	0.51370	10	1	12
11	13	6.33333	2.93361	0.47871	10	2	12
11	14	0.33333	1.15470	0.40825	4	0	12

Weighted Combined Service Class Score for Class 11:
Score:4.15814 Sigma:0.84425 Rho:0.51185 evaluators:12.00000

for Class 12 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
12	1	0.45455	0.82020	0.57496	2	0	11
12	2	1.81818	2.35874	0.53783	7	0	11
12	3	8.18182	1.88776	0.53783	10	5	11
12	4	6.90909	1.64040	0.56040	10	5	11
12	5	4.54545	3.38714	0.62984	10	0	11
12	6	6.54545	2.76997	0.59613	10	3	11
12	7	0.00000	0.00000	0.57496	0	0	11
12	8	0.00000	0.00000	0.57496	0	0	11
12	9	0.54545	1.80907	0.57496	6	0	11
12	10	0.54545	1.80907	0.57496	6	0	11
12	11	5.63636	2.33550	0.61658	9	2	11
12	12	3.00000	2.32379	0.61658	6	0	11

Weighted Combined Service Class Score for Class 12:
Score:3.25912 Sigma:0.73056 Rho:0.45889 evaluators:11.00000

CANDIDATE: IRMX

for Class 13 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
13	1	8.90909	1.44600	0.46355	10	6	11
13	2	8.63636	1.96330	0.50616	10	5	11
13	3	3.63636	2.73030	0.53009	8	0	11
13	4	8.63636	1.74773	0.48956	10	5	11
13	5	2.09091	2.25630	0.46355	5	0	11
13	6	6.27273	3.55221	0.48956	10	0	11
13	7	5.72727	2.45320	0.53009	10	2	11
13	8	6.54545	2.62159	0.51426	10	2	11
13	9	5.45455	2.94495	0.48956	10	1	11
13	10	6.36364	3.13920	0.46355	10	0	11
13	11	4.09091	2.11918	0.48956	7	0	11

Weighted Combined Service Class Score for Class 13:
Score:6.31206 Sigma:0.96023 Rho:0.63614 evaluators:11.00000

for Class 14 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
14	1	8.33333	2.17945	0.68493	10	5	9
14	2	7.44444	3.84419	0.74536	10	0	9
14	3	3.66667	3.08221	0.88192	10	0	9

Weighted Combined Service Class Score for Class 14:
Score:6.69054 Sigma:2.05181 Rho:1.05644 evaluators:9.00000

for Class 15 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
15	1	5.61538	1.19293	0.40704	8	5	13
15	2	6.07692	3.22649	0.42829	10	0	13
15	3	3.07692	2.32600	0.46154	5	0	13
15	4	3.15385	3.82636	0.48038	10	0	13
15	5	3.61538	3.73136	0.49255	10	0	13
15	6	6.92308	2.95696	0.44853	10	0	13
15	7	4.23077	1.83275	0.38462	7	0	13

Weighted Combined Service Class Score for Class 15:
Score:4.87557 Sigma:1.18810 Rho:0.59965 evaluators:13.00000

CANDIDATE: IRMX

for Class 16 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
16	1	7.22222	2.33333	0.60858	10	5	9
16	2	6.55556	3.32081	0.60858	10	0	9
16	3	7.77778	2.63523	0.60858	10	5	9
16	4	7.66667	2.78388	0.65734	10	4	9
16	5	7.44444	2.65100	0.65734	10	4	9
16	6	5.44444	3.28295	0.65734	10	0	9
16	7	4.88889	2.84800	0.68493	10	0	9
16	8	4.88889	2.84800	0.68493	10	0	9
16	9	7.44444	2.40370	0.57735	10	5	9
16	10	4.88889	1.83333	0.70273	8	2	9
16	11	6.00000	2.64575	0.60858	10	2	9
16	12	7.11111	2.52212	0.57735	10	5	9
16	13	7.33333	2.54951	0.57735	10	5	9
16	14	5.33333	2.54951	0.57735	9	0	9
16	15	7.66667	2.78388	0.65734	10	4	9
16	16	6.88889	3.48010	0.62854	10	0	9
16	17	3.33333	4.15331	0.50918	10	0	9
16	18	7.55556	2.50555	0.57735	10	5	9
16	19	7.66667	2.54951	0.60858	10	5	9
16	20	6.55556	2.18581	0.57735	10	5	9

Weighted Combined Service Class Score for Class 16:
Score:6.56234 Sigma:0.85603 Rho:0.60206 evaluators:9.00000

CANDIDATE: MACH

Results with data for evaluations with no less than 7 candidates evaluated.
220 files for candidate MACH
for Class 0 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
0	1	8.40000	1.72901	0.40927	10	5	20
0	2	4.40000	2.58335	0.47697	9	0	20
0	3	6.75000	1.58529	0.43301	10	5	20
0	4	6.05000	2.01246	0.44441	10	3	20
0	5	6.05000	2.18789	0.45552	9	0	20
0	6	6.80000	1.82382	0.48218	10	3	20
0	7	5.55000	1.90498	0.45000	8	2	20
0	8	5.60000	2.85436	0.52202	10	0	20

Mean Service Class Score for Class 0:
Score:6.20000 Sigma:0.75121 Rho:0.16274 evaluators:20.00000

CANDIDATE: MACH

for Class 1 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
1	1	6.13333	2.46429	0.29979	10	0	45
1	2	7.22222	2.71267	0.31190	10	0	45
1	3	5.91111	1.92852	0.29731	10	2	45
1	4	7.66667	2.04495	0.28803	10	4	45
1	5	7.44444	2.58101	0.31032	10	0	45
1	6	7.68889	2.07608	0.28545	10	3	45
1	7	7.26667	2.15744	0.30872	10	3	45
1	8	6.91111	2.40097	0.31817	10	2	45
1	9	3.86667	3.35478	0.30470	10	0	45
1	10	3.40000	3.89872	0.33555	10	0	45
1	11	4.60000	2.70857	0.29397	10	0	45
1	12	6.57778	2.76742	0.36175	10	0	45
1	13	6.37778	3.01729	0.33628	10	0	45
1	14	6.93333	2.63197	0.36107	10	0	45
1	15	6.46667	2.23200	0.30712	10	3	45
1	16	6.53333	2.35102	0.32886	10	1	45
1	17	6.80000	2.64231	0.33555	10	0	45
1	18	7.22222	2.60148	0.32660	10	0	45
1	19	5.11111	2.92499	0.34925	10	0	45
1	20	4.60000	3.46016	0.31111	10	0	45
1	21	3.51111	2.87325	0.34570	8	0	45
1	22	4.60000	3.44040	0.30307	10	0	45
1	23	3.84444	3.45724	0.32356	10	0	45
1	24	5.91111	3.41669	0.30307	10	0	45
1	25	5.68889	3.73450	0.32203	10	0	45
1	26	4.64444	2.69811	0.34783	10	0	45
1	27	5.15556	2.89949	0.34570	10	0	45
1	28	3.17778	2.97939	0.33481	10	0	45
1	29	2.55556	2.83289	0.32126	10	0	45

Mean Service Class Score for Class 1:
Score:5.64908 Sigma:0.68377 Rho:0.43453 evaluators:45.00000

for Class 2 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
2	1	3.66667	3.39116	0.65734	9	0	9

Weighted Combined Service Class Score for Class 2:
Score:3.66667 Sigma:3.39116 Rho:0.65734 evaluators:9.00000

CANDIDATE: MACH

for Class 3 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
3	1	7.71429	3.68394	0.60609	10	0	7
3	2	9.28571	0.95119	0.57143	10	8	7
3	3	7.28571	3.59232	0.51508	10	0	7
3	4	7.57143	3.55233	0.57143	10	0	7
3	5	6.42857	3.86683	0.69985	10	0	7
3	6	8.85714	1.86445	0.57143	10	5	7
3	7	7.42857	3.73529	0.51508	10	0	7
3	8	7.28571	3.68394	0.65465	10	0	7
3	9	5.71429	4.02965	0.69985	10	0	7
3	10	5.00000	4.58258	0.65465	10	0	7
3	11	8.85714	1.86445	0.51508	10	5	7
3	12	5.71429	3.77334	0.65465	10	0	7
3	13	7.42857	3.73529	0.60609	10	0	7
3	14	8.42857	1.71825	0.51508	10	5	7
3	15	7.42857	3.73529	0.51508	10	0	7
3	16	7.28571	3.72891	0.65465	10	0	7
3	17	5.00000	4.47214	0.65465	10	0	7
3	18	5.28571	3.90360	0.65465	10	0	7
3	19	7.28571	2.56348	0.65465	10	4	7
3	20	5.85714	5.17779	0.60609	10	0	7
3	21	7.00000	3.55903	0.65465	10	0	7
3	22	7.28571	3.72891	0.60609	10	0	7
3	23	8.71429	1.97605	0.60609	10	5	7
3	24	5.57143	4.19750	0.65465	10	0	7

Weighted Combined Service Class Score for Class 3:
Score:7.31408 Sigma:0.75276 Rho:0.13404 evaluators:7.00000

for Class 4 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
4	1	2.44444	3.53946	0.59835	8	0	9

Weighted Combined Service Class Score for Class 4:
Score:2.44444 Sigma:3.53946 Rho:0.59835 evaluators:9.00000

for Class 5 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
5	1	3.84615	2.37508	0.57564	10	0	13
5	2	3.69231	3.27579	0.57564	10	0	13
5	3	1.69231	2.21302	0.58583	5	0	13
5	4	0.46154	1.12660	0.54393	3	0	13
5	5	0.61538	1.55662	0.56001	5	0	13
5	6	0.61538	1.55662	0.56001	5	0	13

Weighted Combined Service Class Score for Class 5:
Score:1.84597 Sigma:0.93909 Rho:0.38561 evaluators:13.00000

CANDIDATE: MACH

for Class 6 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
6	1	0.87500	2.47487	0.68465	7	0	8
6	2	5.00000	4.75094	0.77055	10	0	8
6	3	2.12500	4.01559	0.77055	10	0	8
6	4	3.25000	4.36708	0.77055	10	0	8
6	5	0.62500	1.76777	0.71807	5	0	8
6	6	0.62500	1.76777	0.68465	5	0	8
6	7	5.37500	5.04090	0.68465	10	0	8
6	8	5.37500	5.04090	0.68465	10	0	8
6	9	5.37500	5.04090	0.68465	10	0	8
6	10	5.62500	4.95516	0.68465	10	0	8
6	11	5.62500	4.95516	0.68465	10	0	8
6	12	5.25000	4.68280	0.68465	10	0	8
6	13	5.25000	4.68280	0.68465	10	0	8
6	14	5.25000	4.68280	0.68465	10	0	8
6	15	0.00000	0.00000	0.68465	0	0	8
6	16	5.25000	4.68280	0.68465	10	0	8
6	17	5.25000	4.68280	0.68465	10	0	8
6	18	5.25000	4.68280	0.68465	10	0	8
6	19	5.62500	4.95516	0.68465	10	0	8
6	20	0.87500	2.47487	0.68465	7	0	8

Weighted Combined Service Class Score for Class 6:
Score:4.12887 Sigma:1.04928 Rho:0.33975 evaluators:8.00000

for Class 7 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
7	1	2.37500	2.66927	0.82916	7	0	8
7	2	1.00000	1.51186	0.63738	4	0	8
7	3	1.00000	1.51186	0.63738	4	0	8
7	4	1.87500	2.85044	0.69597	8	0	8
7	5	1.87500	2.85044	0.69597	8	0	8
7	6	1.37500	2.19984	0.63738	6	0	8
7	7	1.00000	1.51186	0.63738	4	0	8
7	8	2.00000	3.25137	0.59948	9	0	8
7	9	3.12500	3.44083	0.75000	10	0	8
7	10	0.75000	1.48805	0.59948	4	0	8
7	11	0.75000	1.48805	0.55902	4	0	8

Weighted Combined Service Class Score for Class 7:
Score:1.57979 Sigma:0.73932 Rho:0.24992 evaluators:8.00000

CANDIDATE: MACH

for Class 8 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
8	1	2.90909	2.21154	0.64282	5	0	11
8	2	5.54545	2.54416	0.62984	10	2	11
8	3	3.63636	4.52267	0.56040	10	0	11
8	4	2.54545	3.35749	0.63636	10	0	11
8	5	2.27273	3.43776	0.63636	10	0	11
8	6	6.36364	3.77552	0.58210	10	0	11
8	7	6.54545	2.29624	0.58916	10	5	11
8	8	4.45455	1.86353	0.66183	7	0	11
8	9	1.27273	2.00454	0.63636	5	0	11
8	10	2.00000	3.31662	0.63636	10	0	11

Weighted Combined Service Class Score for Class 8:
Score:3.81598 Sigma:1.14258 Rho:0.61725 evaluators:11.00000

for Class 9 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
9	1	8.88889	1.96497	0.56656	10	4	9
9	2	9.44444	1.33333	0.50918	10	6	9
9	3	7.88889	2.14735	0.59835	10	5	9
9	4	5.88889	2.93447	0.56656	10	0	9
9	5	9.00000	1.73205	0.47140	10	6	9
9	6	9.44444	1.33333	0.47140	10	6	9
9	7	3.11111	3.25747	0.64788	9	0	9
9	8	7.55556	2.35112	0.50918	10	4	9
9	9	8.66667	1.58114	0.54433	10	6	9
9	10	5.77778	3.30824	0.64788	10	0	9
9	11	7.11111	3.29562	0.56656	10	0	9
9	12	8.55556	2.18581	0.56656	10	4	9
9	13	4.88889	3.98260	0.56656	10	0	9
9	14	7.66667	3.84057	0.56656	10	0	9

Weighted Combined Service Class Score for Class 9:
Score:7.53155 Sigma:0.99287 Rho:0.73735 evaluators:9.00000

for Class 10 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
10	1	3.80000	3.73571	0.54772	8	0	10
10	2	1.80000	2.57337	0.66332	8	0	10

Weighted Combined Service Class Score for Class 10:
Score:2.81191 Sigma:2.55076 Rho:1.22544 evaluators:10.00000

CANDIDATE: MACH

for Class 11 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
11	1	0.83333	1.74946	0.58333	5	0	12
11	2	0.33333	1.15470	0.61237	4	0	12
11	3	1.25000	2.59808	0.61237	8	0	12
11	4	1.25000	2.59808	0.61237	8	0	12
11	5	0.58333	1.24011	0.60093	4	0	12
11	6	0.00000	0.00000	0.60093	0	0	12
11	7	0.25000	0.86603	0.60093	3	0	12
11	8	0.08333	0.28868	0.60093	1	0	12
11	9	0.66667	1.23091	0.58333	3	0	12
11	10	1.33333	1.77525	0.62915	4	0	12
11	11	1.91667	2.84312	0.64010	8	0	12
11	12	0.66667	1.23091	0.66667	3	0	12
11	13	2.16667	2.65718	0.70711	7	0	12
11	14	0.75000	1.60255	0.58333	5	0	12

Weighted Combined Service Class Score for Class 11:
Score:0.83830 Sigma:0.47485 Rho:0.20289 evaluators:12.00000

for Class 12 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
12	1	8.18182	1.94001	0.58210	10	4	11
12	2	6.54545	3.98406	0.59613	10	0	11
12	3	9.45455	0.82020	0.51426	10	8	11
12	4	9.36364	0.92442	0.53783	10	8	11
12	5	7.72727	2.96954	0.58210	10	0	11
12	6	3.45455	2.76997	0.68030	7	0	11
12	7	2.00000	2.60768	0.71002	7	0	11
12	8	1.72727	2.64919	0.71002	7	0	11
12	9	3.27273	3.03615	0.71002	7	0	11
12	10	3.27273	3.03615	0.71002	7	0	11
12	11	4.18182	3.60051	0.64922	9	0	11
12	12	3.72727	2.49363	0.64922	7	0	11

Weighted Combined Service Class Score for Class 12:
Score:5.43678 Sigma:0.97831 Rho:0.61897 evaluators:11.00000

CANDIDATE: MACH

for Class 13 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
13	1	5.63636	4.22546	0.66804	10	0	11
13	2	6.00000	3.68782	0.61658	10	0	11
13	3	6.72727	3.22772	0.60302	10	0	11
13	4	3.09091	3.04810	0.65555	8	0	11
13	5	2.81818	3.65563	0.65555	10	0	11
13	6	3.18182	3.28080	0.67420	10	0	11
13	7	3.00000	3.00000	0.68635	9	0	11
13	8	3.09091	3.91036	0.66804	10	0	11
13	9	2.18182	3.25017	0.66804	10	0	11
13	10	2.90909	3.61814	0.66804	10	0	11
13	11	2.72727	2.93567	0.60302	8	0	11

Weighted Combined Service Class Score for Class 13:
Score:3.78866 Sigma:1.13433 Rho:0.41706 evaluators:11.00000

for Class 14 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
14	1	5.11111	4.25572	0.70273	10	0	9
14	2	6.22222	3.19287	0.70273	10	0	9
14	3	4.22222	4.65773	0.76980	10	0	9

Weighted Combined Service Class Score for Class 14:
Score:5.26021 Sigma:2.44778 Rho:0.89659 evaluators:9.00000

for Class 15 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
15	1	2.53846	3.01705	0.56527	8	0	13
15	2	2.00000	2.76887	0.56527	8	0	13
15	3	1.15385	2.26738	0.58076	7	0	13
15	4	1.07692	2.28989	0.56527	7	0	13
15	5	1.07692	2.28989	0.56527	7	0	13
15	6	2.30769	2.78043	0.60569	7	0	13
15	7	1.76923	2.24179	0.59584	5	0	13

Weighted Combined Service Class Score for Class 15:
Score:1.79347 Sigma:1.03047 Rho:0.30390 evaluators:13.00000

CANDIDATE: MACH

for Class 16 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
16	1	6.00000	3.04138	0.59835	10	0	9
16	2	6.11111	3.10018	0.59835	10	0	9
16	3	6.55556	2.60342	0.56656	10	4	9
16	4	6.55556	2.60342	0.56656	10	4	9
16	5	5.77778	3.03223	0.56656	10	0	9
16	6	5.55556	3.00463	0.64788	10	0	9
16	7	4.77778	3.59784	0.64788	10	0	9
16	8	4.22222	3.92994	0.64788	10	0	9
16	9	6.00000	2.59808	0.59835	10	2	9
16	10	5.33333	3.67423	0.64788	10	0	9
16	11	3.88889	4.16667	0.66667	10	0	9
16	12	3.88889	3.33333	0.64788	10	0	9
16	13	5.00000	3.53553	0.72008	10	0	9
16	14	3.55556	3.71184	0.72008	10	0	9
16	15	6.44444	2.12786	0.59835	10	5	9
16	16	3.55556	3.35824	0.76174	10	0	9
16	17	3.00000	3.50000	0.76174	10	0	9
16	18	2.77778	3.63242	0.76174	10	0	9
16	19	4.66667	3.12250	0.72008	10	0	9
16	20	5.11111	3.21887	0.67586	10	0	9

Weighted Combined Service Class Score for Class 16:
Score:4.98215 Sigma:0.86838 Rho:0.47406 evaluators:9.00000

CANDIDATE: ORKID

Results with data for evaluations with no less than 7 candidates evaluated.
218 files for candidate ORKID
for Class 0 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
0	1	7.90000	2.88189	0.41833	10	0	20
0	2	5.60000	2.72223	0.48734	10	0	20
0	3	4.05000	2.35025	0.49497	10	0	20
0	4	6.40000	2.28035	0.48218	10	0	20
0	5	5.05000	1.95946	0.49497	8	0	20
0	6	6.95000	2.11449	0.47958	10	5	20
0	7	7.50000	2.43872	0.49497	10	0	20
0	8	6.05000	2.48098	0.53852	10	0	20

Mean Service Class Score for Class 0:
Score:6.18750 Sigma:0.85561 Rho:0.17230 evaluators:20.00000

CANDIDATE: ORKID

for Class 1 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
1	1	5.24444	1.33409	0.27756	9	3	45
1	2	6.66667	1.89497	0.28974	10	3	45
1	3	7.28889	1.84172	0.29565	10	5	45
1	4	7.00000	2.43086	0.28197	10	1	45
1	5	7.71111	2.37048	0.27397	10	0	45
1	6	6.04444	2.23562	0.29397	10	0	45
1	7	7.88889	2.37623	0.27035	10	0	45
1	8	6.91111	2.28456	0.28284	10	0	45
1	9	6.97778	3.01126	0.28021	10	0	45
1	10	0.31111	0.94922	0.24444	5	0	45
1	11	3.93333	2.28035	0.27035	8	0	45
1	12	5.31111	3.38326	0.33775	10	0	45
1	13	5.15556	3.01478	0.32735	10	0	45
1	14	6.66667	3.42451	0.33921	10	0	45
1	15	6.97778	2.34025	0.28545	10	0	45
1	16	8.11111	1.86136	0.29897	10	2	45
1	17	7.20000	2.60768	0.30952	10	0	45
1	18	8.26667	2.06045	0.28889	10	0	45
1	19	5.55556	3.04180	0.34427	10	0	45
1	20	7.26667	3.01813	0.29481	10	0	45
1	21	2.33333	2.92326	0.32126	9	0	45
1	22	5.22222	3.24660	0.30144	10	0	45
1	23	2.35556	2.26791	0.27844	10	0	45
1	24	2.44444	2.28190	0.27487	8	0	45
1	25	6.88889	2.87799	0.29313	10	0	45
1	26	4.75556	3.39890	0.32660	10	0	45
1	27	4.57778	3.26475	0.32049	10	0	45
1	28	2.17778	2.44288	0.29313	10	0	45
1	29	1.04444	1.65083	0.28803	6	0	45

Mean Service Class Score for Class 1:
Score:5.45714 Sigma:0.64873 Rho:0.44215 evaluators:45.00000

for Class 2 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
2	1	2.44444	3.12694	0.65734	9	0	9

Weighted Combined Service Class Score for Class 2:
Score:2.44444 Sigma:3.12694 Rho:0.65734 evaluators:9.00000

CANDIDATE: ORKID

for Class 3 Mean scores for each Criterion are;

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
3	1	0.42857	1.13389	0.45175	3	0	7
3	2	0.42857	1.13389	0.45175	3	0	7
3	3	0.42857	1.13389	0.45175	3	0	7
3	4	0.42857	1.13389	0.45175	3	0	7
3	5	0.00000	0.00000	0.45175	0	0	7
3	6	0.00000	0.00000	0.45175	0	0	7
3	7	0.00000	0.00000	0.45175	0	0	7
3	8	0.00000	0.00000	0.45175	0	0	7
3	9	0.00000	0.00000	0.45175	0	0	7
3	10	0.00000	0.00000	0.45175	0	0	7
3	11	0.00000	0.00000	0.45175	0	0	7
3	12	0.00000	0.00000	0.45175	0	0	7
3	13	0.00000	0.00000	0.45175	0	0	7
3	14	0.00000	0.00000	0.45175	0	0	7
3	15	0.00000	0.00000	0.45175	0	0	7
3	16	0.00000	0.00000	0.45175	0	0	7
3	17	0.00000	0.00000	0.45175	0	0	7
3	18	0.00000	0.00000	0.45175	0	0	7
3	19	0.00000	0.00000	0.45175	0	0	7
3	20	0.00000	0.00000	0.45175	0	0	7
3	21	0.00000	0.00000	0.45175	0	0	7
3	22	0.00000	0.00000	0.45175	0	0	7
3	23	0.00000	0.00000	0.45175	0	0	7
3	24	0.00000	0.00000	0.51508	0	0	7

Weighted Combined Service Class Score for Class 3:
Score:0.08508 Sigma:0.11401 Rho:0.10093 evaluators:7.00000

for Class 4 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
4	1	0.77778	1.71594	0.50918	5	0	9

Weighted Combined Service Class Score for Class 4:
Score:0.77778 Sigma:1.71594 Rho:0.50918 evaluators:9.00000

for Class 5 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
5	1	3.76923	1.92154	0.42829	7	0	13
5	2	3.53846	2.47034	0.49852	9	0	13
5	3	2.61538	2.87340	0.51602	8	0	13
5	4	0.69231	1.18213	0.42829	3	0	13
5	5	3.69231	3.01066	0.46790	8	0	13
5	6	0.92308	1.70595	0.44853	5	0	13

Weighted Combined Service Class Score for Class 5:
Score:2.55932 Sigma:1.04134 Rho:0.47150 evaluators:13.00000

CANDIDATE: ORKID

for Class 6 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
6	1	0.00000	0.00000	0.46771	0	0	8
6	2	0.00000	0.00000	0.46771	0	0	8
6	3	0.00000	0.00000	0.46771	0	0	8
6	4	0.00000	0.00000	0.51539	0	0	8
6	5	0.00000	0.00000	0.46771	0	0	8
6	6	0.00000	0.00000	0.46771	0	0	8
6	7	0.00000	0.00000	0.46771	0	0	8
6	8	0.00000	0.00000	0.46771	0	0	8
6	9	0.00000	0.00000	0.46771	0	0	8
6	10	0.00000	0.00000	0.46771	0	0	8
6	11	0.00000	0.00000	0.46771	0	0	8
6	12	0.00000	0.00000	0.46771	0	0	8
6	13	0.00000	0.00000	0.46771	0	0	8
6	14	0.00000	0.00000	0.46771	0	0	8
6	15	0.00000	0.00000	0.46771	0	0	8
6	16	0.00000	0.00000	0.46771	0	0	8
6	17	0.00000	0.00000	0.46771	0	0	8
6	18	0.00000	0.00000	0.46771	0	0	8
6	19	0.00000	0.00000	0.46771	0	0	8
6	20	0.00000	0.00000	0.46771	0	0	8

Weighted Combined Service Class Score for Class 6:
Score:0.00000 Sigma:0.00000 Rho:0.10620 evaluators:8.00000

for Class 7 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
7	1	1.12500	1.64208	0.66144	4	0	8
7	2	0.50000	0.92582	0.62500	2	0	8
7	3	0.50000	0.92582	0.62500	2	0	8
7	4	0.50000	0.92582	0.62500	2	0	8
7	5	0.50000	0.92582	0.62500	2	0	8
7	6	1.00000	1.51186	0.66144	4	0	8
7	7	0.37500	0.74402	0.62500	2	0	8
7	8	0.25000	0.70711	0.62500	2	0	8
7	9	0.50000	0.92582	0.66144	2	0	8
7	10	0.50000	0.92582	0.62500	2	0	8
7	11	0.50000	0.92582	0.62500	2	0	8

Weighted Combined Service Class Score for Class 7:
Score:0.57940 Sigma:0.32990 Rho:0.20004 evaluators:8.00000

CANDIDATE: ORKID

for Class 8 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
8	1	1.18182	1.83402	0.37483	5	0	11
8	2	1.45455	1.75292	0.48105	5	0	11
8	3	0.27273	0.90453	0.48105	3	0	11
8	4	0.09091	0.30151	0.43598	1	0	11
8	5	0.45455	1.50756	0.48105	5	0	11
8	6	0.00000	0.00000	0.43598	0	0	11
8	7	0.54545	1.50756	0.43598	5	0	11
8	8	0.45455	1.50756	0.46355	5	0	11
8	9	0.00000	0.00000	0.43598	0	0	11
8	10	0.00000	0.00000	0.43598	0	0	11

Weighted Combined Service Class Score for Class 8:
Score:0.49861 Sigma:0.42480 Rho:0.16782 evaluators:11.00000

for Class 9 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
9	1	8.88889	0.92796	0.43033	10	8	9
9	2	5.22222	1.09291	0.47140	8	4	9
9	3	9.77778	0.44096	0.43033	10	9	9
9	4	4.55556	1.74005	0.47140	6	0	9
9	5	9.55556	0.72648	0.43033	10	8	9
9	6	9.66667	0.70711	0.43033	10	8	9
9	7	6.00000	2.95804	0.50918	10	0	9
9	8	7.88889	2.31541	0.47140	10	5	9
9	9	3.33333	4.03113	0.56656	9	0	9
9	10	5.55556	2.40370	0.47140	9	2	9
9	11	2.55556	3.32081	0.59835	8	0	9
9	12	8.00000	1.87083	0.47140	10	5	9
9	13	2.22222	1.64148	0.49690	5	0	9
9	14	0.44444	1.33333	0.50918	4	0	9

Weighted Combined Service Class Score for Class 9:
Score:6.25949 Sigma:0.83393 Rho:0.64399 evaluators:9.00000

for Class 10 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
10	1	0.20000	0.63246	0.46904	2	0	10
10	2	0.40000	1.26491	0.51962	4	0	10

Weighted Combined Service Class Score for Class 10:
Score:0.29881 Sigma:0.71131 Rho:0.36778 evaluators:10.00000

CANDIDATE: ORKID

for Class 11 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
11	1	0.16667	0.38925	0.45644	1	0	12
11	2	0.16667	0.38925	0.45644	1	0	12
11	3	0.00000	0.00000	0.43301	0	0	12
11	4	0.00000	0.00000	0.43301	0	0	12
11	5	0.58333	1.24011	0.45644	4	0	12
11	6	0.00000	0.00000	0.43301	0	0	12
11	7	0.08333	0.28868	0.47871	1	0	12
11	8	0.33333	0.77850	0.45644	2	0	12
11	9	0.00000	0.00000	0.43301	0	0	12
11	10	0.25000	0.62158	0.45644	2	0	12
11	11	0.08333	0.28868	0.43301	1	0	12
11	12	0.16667	0.38925	0.43301	1	0	12
11	13	0.83333	1.94625	0.47871	5	0	12
11	14	0.00000	0.00000	0.43301	0	0	12

Weighted Combined Service Class Score for Class 11:
Score:0.18688 Sigma:0.17870 Rho:0.12490 evaluators:12.00000

for Class 12 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
12	1	0.18182	0.60302	0.46355	2	0	11
12	2	0.18182	0.60302	0.46355	2	0	11
12	3	7.09091	3.53425	0.58916	10	0	11
12	4	0.36364	1.20605	0.46355	4	0	11
12	5	3.90909	3.53425	0.57496	10	0	11
12	6	0.54545	1.50756	0.50616	5	0	11
12	7	0.72727	1.55505	0.46355	5	0	11
12	8	0.72727	1.55505	0.46355	5	0	11
12	9	1.72727	2.14900	0.51426	6	0	11
12	10	1.72727	2.14900	0.51426	6	0	11
12	11	1.18182	2.63887	0.46355	7	0	11
12	12	1.45455	2.65946	0.46355	8	0	11

Weighted Combined Service Class Score for Class 12:
Score:1.74980 Sigma:0.68857 Rho:0.26224 evaluators:11.00000

CANDIDATE: ORKID

for Class 13 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
13	1	7.18182	2.18258	0.48105	10	5	11
13	2	8.63636	1.96330	0.40656	10	5	11
13	3	0.27273	0.90453	0.37483	3	0	11
13	4	6.63636	3.35478	0.43598	10	1	11
13	5	0.36364	1.20605	0.37483	4	0	11
13	6	6.54545	2.94495	0.40656	10	0	11
13	7	4.81818	3.12468	0.53009	10	0	11
13	8	3.18182	2.78633	0.48105	9	0	11
13	9	3.81818	4.04520	0.48105	10	0	11
13	10	6.72727	2.76011	0.40656	10	2	11
13	11	4.54545	2.87623	0.48105	9	0	11

Weighted Combined Service Class Score for Class 13:
Score:5.15853 Sigma:0.98554 Rho:0.54480 evaluators:11.00000

for Class 14 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
14	1	0.00000	0.00000	0.49690	0	0	9
14	2	1.66667	3.53553	0.43033	10	0	9
14	3	0.33333	1.00000	0.49690	3	0	9

Weighted Combined Service Class Score for Class 14:
Score:0.69581 Sigma:1.31501 Rho:0.31107 evaluators:9.00000

for Class 15 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
15	1	5.76923	1.23517	0.42133	8	5	13
15	2	7.23077	2.89119	0.38462	10	0	13
15	3	0.61538	1.55662	0.38462	5	0	13
15	4	0.23077	0.83205	0.38462	3	0	13
15	5	0.23077	0.83205	0.38462	3	0	13
15	6	6.92308	3.25222	0.38462	10	0	13
15	7	1.61538	2.10311	0.47419	5	0	13

Weighted Combined Service Class Score for Class 15:
Score:3.68936 Sigma:0.95031 Rho:0.48124 evaluators:13.00000

CANDIDATE: ORKID

for Class 16 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
16	1	4.22222	2.48886	0.47140	7	0	9
16	2	3.55556	2.24227	0.54433	5	0	9
16	3	4.77778	3.59784	0.56656	10	0	9
16	4	4.77778	3.59784	0.56656	10	0	9
16	5	4.00000	3.04138	0.56656	10	0	9
16	6	4.55556	3.28295	0.56656	10	0	9
16	7	3.11111	2.42097	0.50918	5	0	9
16	8	3.11111	2.42097	0.50918	5	0	9
16	9	3.11111	2.66667	0.50918	7	0	9
16	10	1.55556	2.35112	0.43033	5	0	9
16	11	3.11111	3.25747	0.47140	9	0	9
16	12	5.88889	3.98260	0.43033	10	0	9
16	13	5.00000	3.53553	0.47140	10	0	9
16	14	2.77778	2.81859	0.47140	7	0	9
16	15	4.66667	4.09268	0.43033	10	0	9
16	16	3.00000	3.42783	0.53287	10	0	9
16	17	2.88889	3.40751	0.53287	10	0	9
16	18	1.77778	2.22361	0.53287	5	0	9
16	19	3.66667	2.64575	0.56656	8	0	9
16	20	2.00000	2.64575	0.47140	7	0	9

Weighted Combined Service Class Score for Class 16:
Score:3.62818 Sigma:0.76749 Rho:0.34834 evaluators:9.00000

CANDIDATE: POSIX

Results with data for evaluations with no less than 7 candidates evaluated.
217 files for candidate POSIX
for Class 0 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
0	1	9.45000	2.23548	0.26926	10	0	20
0	2	6.05000	2.03845	0.40927	10	2	20
0	3	5.95000	2.25890	0.44721	9	0	20
0	4	7.95000	1.70062	0.38079	10	5	20
0	5	8.75000	2.29129	0.38079	10	0	20
0	6	6.40000	2.54227	0.45277	10	0	20
0	7	8.85000	1.34849	0.37081	10	5	20
0	8	6.80000	2.33057	0.45277	9	0	20

Mean Service Class Score for Class 0:
Score:7.52500 Sigma:0.75115 Rho:0.14128 evaluators:20.00000

CANDIDATE: POSIX

for Class 1 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
1	1	7.35556	1.81102	0.27666	10	3	45
1	2	8.75556	1.38425	0.25915	10	5	45
1	3	6.55556	1.90162	0.26574	10	3	45
1	4	9.04444	1.47641	0.23413	10	4	45
1	5	7.06667	2.53521	0.27397	10	0	45
1	6	7.82222	2.22883	0.28371	10	0	45
1	7	7.08889	2.85897	0.28458	10	0	45
1	8	7.13333	2.35102	0.29481	10	0	45
1	9	5.37778	2.67385	0.27126	10	0	45
1	10	7.06667	3.09985	0.27126	10	0	45
1	11	7.44444	2.76796	0.24444	10	0	45
1	12	6.53333	2.90454	0.32126	10	0	45
1	13	5.71111	2.75204	0.29814	10	0	45
1	14	7.55556	2.22134	0.34427	10	0	45
1	15	7.97778	2.09424	0.28197	10	0	45
1	16	7.80000	2.43647	0.29731	10	0	45
1	17	7.95556	2.37368	0.30631	10	0	45
1	18	6.77778	2.48531	0.30631	10	0	45
1	19	7.53333	2.84125	0.31111	10	0	45
1	20	5.48889	2.95898	0.33110	10	0	45
1	21	5.53333	2.84125	0.30388	10	0	45
1	22	5.20000	2.59019	0.30551	10	0	45
1	23	3.77778	3.22553	0.29313	10	0	45
1	24	6.86667	2.23200	0.28803	10	1	45
1	25	5.68889	2.41983	0.33110	10	0	45
1	26	6.04444	3.00723	0.30551	10	0	45
1	27	5.35556	2.59506	0.33628	10	0	45
1	28	2.40000	2.82360	0.30952	10	0	45
1	29	2.04444	2.55801	0.31972	9	0	45

Mean Service Class Score for Class 1:
Score:6.46189 Sigma:0.68018 Rho:0.49769 evaluators:45.00000

for Class 2 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
2	1	3.44444	4.30439	0.57735	10	0	9

Weighted Combined Service Class Score for Class 2:
Score:3.44444 Sigma:4.30439 Rho:0.57735 evaluators:9.00000

CANDIDATE: POSIX

for Class 3 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
3	1	7.00000	3.55903	0.69985	10	1	7
3	2	7.85714	2.41030	0.65465	10	3	7
3	3	7.85714	2.41030	0.65465	10	3	7
3	4	7.28571	3.72891	0.65465	10	1	7
3	5	7.28571	3.72891	0.65465	10	1	7
3	6	8.57143	2.57275	0.65465	10	3	7
3	7	8.42857	2.63674	0.65465	10	3	7
3	8	7.14286	2.79455	0.69985	10	3	7
3	9	6.42857	3.40867	0.69985	10	1	7
3	10	6.71429	3.54562	0.69985	10	1	7
3	11	7.42857	3.35942	0.57143	10	1	7
3	12	6.28571	3.40168	0.69985	10	1	7
3	13	8.14286	2.54484	0.65465	10	3	7
3	14	7.28571	2.56348	0.65465	10	3	7
3	15	8.42857	2.50713	0.65465	10	3	7
3	16	8.14286	2.41030	0.65465	10	3	7
3	17	6.71429	3.72891	0.69985	10	1	7
3	18	6.85714	3.53217	0.65465	10	1	7
3	19	7.14286	3.62531	0.65465	10	1	7
3	20	6.28571	4.34796	0.57143	10	0	7
3	21	5.71429	4.15188	0.62270	10	0	7
3	22	7.28571	3.72891	0.65465	10	1	7
3	23	4.71429	4.75094	0.69985	10	0	7
3	24	5.00000	4.69042	0.62270	10	0	7

Weighted Combined Service Class Score for Class 3:
Score:7.27836 Sigma:0.72626 Rho:0.14592 evaluators:7.00000

for Class 4 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
4	1	1.44444	2.18581	0.54433	5	0	9

Weighted Combined Service Class Score for Class 4:
Score:1.44444 Sigma:2.18581 Rho:0.54433 evaluators:9.00000

for Class 5 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
5	1	5.61538	2.29269	0.50442	10	2	13
5	2	5.84615	2.57702	0.53294	10	2	13
5	3	5.92308	2.53185	0.60079	10	2	13
5	4	0.46154	0.96742	0.48650	3	0	13
5	5	1.53846	2.33150	0.61056	7	0	13
5	6	3.23077	2.91987	0.60079	9	0	13

Weighted Combined Service Class Score for Class 5:
Score:3.87614 Sigma:1.15971 Rho:0.64637 evaluators:13.00000

CANDIDATE: POSIX

for Class 6 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
6	1	8.50000	2.26779	0.46771	10	5	8
6	2	4.75000	2.76457	0.64952	10	0	8
6	3	5.12500	2.79987	0.66144	10	0	8
6	4	7.75000	2.37547	0.66144	10	5	8
6	5	6.62500	4.43807	0.71807	10	0	8
6	6	2.87500	2.74838	0.62500	8	0	8
6	7	9.87500	0.35355	0.51539	10	9	8
6	8	9.25000	1.75255	0.58630	10	5	8
6	9	9.25000	1.75255	0.58630	10	5	8
6	10	10.00000	0.00000	0.51539	10	10	8
6	11	8.75000	1.90863	0.64952	10	5	8
6	12	10.00000	0.00000	0.54486	10	10	8
6	13	10.00000	0.00000	0.58630	10	10	8
6	14	9.37500	1.76777	0.54486	10	5	8
6	15	1.87500	3.72012	0.54486	10	0	8
6	16	10.00000	0.00000	0.46771	10	10	8
6	17	9.62500	0.74402	0.54486	10	8	8
6	18	9.50000	1.06904	0.64952	10	7	8
6	19	9.62500	1.06066	0.54486	10	7	8
6	20	6.25000	5.17549	0.58630	10	0	8

Weighted Combined Service Class Score for Class 6:
Score:8.24423 Sigma:0.74391 Rho:0.58990 evaluators:8.00000

for Class 7 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
7	1	2.37500	3.06769	0.66144	7	0	8
7	2	9.37500	0.91613	0.55902	10	8	8
7	3	9.50000	0.92582	0.55902	10	8	8
7	4	9.62500	0.74402	0.55902	10	8	8
7	5	9.62500	0.74402	0.55902	10	8	8
7	6	8.50000	3.20713	0.59948	10	1	8
7	7	7.87500	2.29518	0.63738	10	4	8
7	8	8.87500	1.72689	0.55902	10	5	8
7	9	6.50000	4.24264	0.59948	10	0	8
7	10	2.12500	2.47487	0.63738	5	0	8
7	11	0.62500	1.76777	0.59948	5	0	8

Weighted Combined Service Class Score for Class 7:
Score:7.11975 Sigma:0.91094 Rho:0.63434 evaluators:8.00000

CANDIDATE: POSIX

for Class 8 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
8	1	2.00000	2.09762	0.60302	5	0	11
8	2	2.54545	2.84125	0.54545	8	0	11
8	3	4.81818	3.45885	0.65555	10	0	11
8	4	3.90909	3.96118	0.67420	10	0	11
8	5	4.00000	4.17133	0.65555	10	0	11
8	6	3.54545	3.69767	0.73293	10	0	11
8	7	4.63636	3.77552	0.67420	10	0	11
8	8	2.27273	2.64919	0.62324	7	0	11
8	9	2.27273	2.64919	0.62324	7	0	11
8	10	1.54545	2.46429	0.65555	7	0	11

Weighted Combined Service Class Score for Class 8:
Score:3.19931 Sigma:1.13805 Rho:0.51459 evaluators:11.00000

for Class 9 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
9	1	6.00000	3.42783	0.47140	10	0	9
9	2	6.77778	3.63242	0.47140	10	0	9
9	3	4.88889	3.25747	0.47140	10	0	9
9	4	3.44444	4.00347	0.47140	10	0	9
9	5	6.44444	3.50397	0.47140	10	0	9
9	6	5.55556	3.20590	0.47140	10	0	9
9	7	8.66667	2.12132	0.43033	10	5	9
9	8	8.22222	2.10819	0.47140	10	4	9
9	9	6.44444	3.35824	0.47140	10	0	9
9	10	6.33333	3.16228	0.47140	10	0	9
9	11	5.22222	2.77389	0.47140	10	0	9
9	12	8.66667	2.34521	0.47140	10	3	9
9	13	0.33333	1.00000	0.43033	3	0	9
9	14	7.77778	3.30824	0.47140	10	0	9

Weighted Combined Service Class Score for Class 9:
Score:6.21389 Sigma:1.00233 Rho:0.59398 evaluators:9.00000

for Class 10 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
10	1	0.40000	0.84327	0.54772	2	0	10
10	2	0.30000	0.94868	0.46904	3	0	10

Weighted Combined Service Class Score for Class 10:
Score:0.35060 Sigma:0.64782 Rho:0.38530 evaluators:10.00000

CANDIDATE: POSIX

for Class 11 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
11	1	4.00000	4.06761	0.55277	10	0	12
11	2	4.08333	4.23102	0.58333	10	0	12
11	3	1.00000	2.37410	0.47871	7	0	12
11	4	0.41667	1.44338	0.53359	5	0	12
11	5	1.08333	1.72986	0.53359	5	0	12
11	6	0.25000	0.86603	0.54645	3	0	12
11	7	0.83333	1.64225	0.59512	5	0	12
11	8	2.50000	1.78377	0.63465	5	0	12
11	9	0.33333	0.88763	0.56519	3	0	12
11	10	1.16667	1.58592	0.62915	5	0	12
11	11	2.58333	2.46644	0.63465	7	0	12
11	12	2.25000	1.91288	0.66144	5	0	12
11	13	2.75000	3.62128	0.62915	10	0	12
11	14	1.08333	2.93748	0.57735	10	0	12

Weighted Combined Service Class Score for Class 11:
Score:1.77788 Sigma:0.72157 Rho:0.28572 evaluators:12.00000

for Class 12 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
12	1	1.36364	2.11058	0.53783	7	0	11
12	2	7.27273	3.77070	0.55298	10	0	11
12	3	3.54545	2.69680	0.57496	8	0	11
12	4	0.72727	1.67874	0.53009	5	0	11
12	5	8.63636	1.50151	0.53783	10	5	11
12	6	1.81818	2.44206	0.55298	7	0	11
12	7	3.27273	2.19504	0.72157	7	0	11
12	8	3.27273	2.19504	0.72157	7	0	11
12	9	3.81818	2.04050	0.69234	7	0	11
12	10	3.81818	2.04050	0.69234	7	0	11
12	11	4.36364	2.20330	0.62984	8	2	11
12	12	3.81818	2.60070	0.62984	7	0	11

Weighted Combined Service Class Score for Class 12:
Score:3.85600 Sigma:0.83191 Rho:0.50407 evaluators:11.00000

CANDIDATE: POSIX

for Class 13 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
13	1	8.63636	2.06265	0.50616	10	5	11
13	2	8.09091	2.21154	0.46355	10	5	11
13	3	7.72727	3.31936	0.50616	10	0	11
13	4	9.18182	1.53741	0.50616	10	5	11
13	5	4.81818	2.89200	0.57496	10	0	11
13	6	8.90909	1.57826	0.46355	10	5	11
13	7	8.18182	1.94001	0.51426	10	5	11
13	8	8.63636	1.96330	0.48956	10	5	11
13	9	9.00000	1.48324	0.43598	10	5	11
13	10	8.09091	2.21154	0.51426	10	5	11
13	11	7.18182	1.88776	0.51426	10	5	11

Weighted Combined Service Class Score for Class 13:
Score:8.10540 Sigma:1.02608 Rho:0.82190 evaluators:11.00000

for Class 14 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
14	1	5.88889	4.56740	0.62854	10	0	9
14	2	5.55556	3.71184	0.64788	10	0	9
14	3	4.33333	4.09268	0.72008	10	0	9

Weighted Combined Service Class Score for Class 14:
Score:5.32793 Sigma:2.53136 Rho:0.87976 evaluators:9.00000

for Class 15 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
15	1	8.53846	2.14536	0.46154	10	5	13
15	2	8.84615	1.95133	0.49255	10	5	13
15	3	5.46154	3.35697	0.54393	10	0	13
15	4	2.07692	3.20056	0.54393	10	0	13
15	5	1.69231	3.11942	0.54393	10	0	13
15	6	9.15385	1.86396	0.46154	10	5	13
15	7	9.30769	1.54837	0.47419	10	5	13

Weighted Combined Service Class Score for Class 15:
Score:6.86413 Sigma:1.23743 Rho:0.85022 evaluators:13.00000

CANDIDATE: POSIX

for Class 16 Mean scores for each Criterion are:

Cl	Cr	Score	Std dev	Rho	Max	Min	#Evaluators
16	1	7.88889	3.44400	0.59835	10	0	9
16	2	7.88889	3.44400	0.59835	10	0	9
16	3	6.11111	3.98260	0.64788	10	0	9
16	4	6.11111	3.98260	0.59835	10	0	9
16	5	7.33333	3.46410	0.59835	10	0	9
16	6	3.55556	4.18662	0.62854	10	0	9
16	7	6.11111	4.22624	0.64788	10	0	9
16	8	6.11111	4.22624	0.64788	10	0	9
16	9	6.66667	3.77492	0.56656	10	0	9
16	10	7.00000	3.50000	0.59835	10	0	9
16	11	7.44444	3.46811	0.56656	10	0	9
16	12	7.33333	3.96863	0.56656	10	0	9
16	13	7.22222	2.72845	0.56656	10	3	9
16	14	7.00000	2.78388	0.59835	10	3	9
16	15	7.11111	2.20479	0.59835	10	5	9
16	16	7.77778	3.41971	0.59835	10	0	9
16	17	6.33333	3.96863	0.59835	10	0	9
16	18	5.77778	3.73423	0.59835	10	0	9
16	19	7.44444	2.60342	0.59835	10	3	9
16	20	7.33333	3.24037	0.59835	10	0	9

Weighted Combined Service Class Score for Class 16:
Score:6.84962 Sigma:1.01341 Rho:0.63187 evaluators:9.00000

APPENDIX F

ESSENTIAL CRITERIA PARTITION

The partition of requirements by DOP requirement area is shown in Table F-1. In the table, only the criteria believed to be "essential" to a given system aspect are listed. The headings for the allocation correspond to the high-level requirements as follows: R = real-time; D = distributed; H = heterogeneity; A = Ada; S = security; F = reliability (fault tolerance). If an entry is blank, then the criterion listed is not considered to have any special significance for that high-level requirement. If the entry is "E", the criterion is considered to be essential; if the entry is "NE", the criterion is considered to be important for the high-level requirement, but not so important that its absence should be considered a significant black-mark against a candidate.

TABLE F-1. ESSENTIAL CRITERIA PARTITIONS

CRITERION		ALLOCATION					
		R	D	H	A	S	F
1.4	Arch.Indep.		E	E			
1.10	Ada Binding		NE	NE	NE		
1.11	Other Lang. Bind.		E	E			
1.20	Reaction to Blocking	E	E			NE	E
1.21	Bounded ... Times	E	E			NE	E
1.23	Transaction Sched.	E	E				NE
1.24	Access Control		E			E	E
1.25	Transparency		E				E
1.26	Resilience		E				E
1.27	Network Partition		E			E	E
1.28	Reference		E				E
1.29	Reallocation		E				E
2.1	Non-NGCR Intf.		NE				
3.1	Audit Data Stor.					E	
3.2	Audit Generation					E	
3.3	Audit Record Contents					E	
3.4	Audit Data Manip.					E	
3.5	Device Labels					E	
3.6	Basic DAC					E	
3.7	DAC Incl./Exclu.					E	
3.8	DAC Propagation					E	
3.9	Labelling Exp. Chan.					E	
3.10	Setting Comm. Labels					E	
3.11	Ident. and Authentic.					E	
3.12	Labelling of HR Output					E	
3.13	Subj./Obj. Labelling					E	
3.14	Label Contents					E	
3.15	MAC Policy					E	
3.16	MAC Manip.					E	
3.17	Object Reuse					E	
3.18	User Notif. of Sens.					E	
3.19	Sens. Label Query					E	
3.20	System Integrity					E	
3.21	Ident. of Users by Roles					E	
3.22	Least Privilege					E	
3.23	Trusted Path					E	
3.24	Trusted Recovery					E	
4.1	Data Interch. Services		NE	NE			

TABLE F-1 (Cont.)

CRITERION		ALLOCATION					
		R	D	H	A	S	F
5.1	Event/Error Receipt	E	E				E
5.2	" Distribution	NE	E				E
5.3	" Management	E	E				E
5.4	Event Logging	NE	E			E	E
5.5	Enable/Disable Intrpts.	E	E				E
5.6	Mash/Unmask Intrpts.	E	E				E
6.1	Contiguous Read of File	E	NE				
6.2	Protect Area in File	E	NE				
6.3	File Mgt. Sched.	E	E				
6.4	File Mgt. Susp/Res - Proc	E	E				
6.5	File Mgt. Block Rqsts	E	E				
6.6	Round Robin File Mgt.	NE	NE				
6.7	Open a File	E	E				
6.8	Point Within File	E	E				
6.9	Read File	E	E				
6.10	Close File	E	E				
6.11	Delete File	E	E				
6.12	Create Directory	NE	E				
6.13	Specify Default Dir.	NE	E				
6.14	Delete Directory	NE	E				
6.15	Shadow Files	E	E				
6.16	Create File	E	E				
6.17	Query File Attrib.	E	E				
6.18	Modify File Attrib.	E	E				
6.19	Write File	E	E				
6.20	Write Contig. File	E	NE				
8.1	Intf/Ctrl of F+/SN/1553		NE				NE
8.2	Intf/Ctrl of Others		E				NE
8.3	Reliable Virt. Circ. Comm.		E				E
8.4	Unrel. Virt. Circ. Comm.		E				E
8.5	Rel. Datagram Transfer		E				E
8.6	Unrel. Datagram Transfer		E				E
8.7	Request-Reply Service		E				E
8.8	Unrel. Broadcst/Multicst		E				E
8.9	Rel. Broadcst/Multicst		E				E
8.10	Atomic Broadcst/Multicst		E				E

TABLE F-1 (Cont.)

CRITERION		ALLOCATION					
		R	D	H	A	S	F
9.1	Create Process	E	E				
9.2	Terminate Process	E	E				
9.3	Start Process	E	E				
9.4	Stop Process	E	E				
9.5	Suspend Process	E	E				
9.6	Resume Process	E	E				
9.7	Delay Process	E	E				
9.8	Interprocess Comm.	E	E				
9.9	Exam. Process Attrib.	NE	E				
9.10	Modify Process Attrib.	NE	E				
9.11	Exam. Process Status	E	E				
9.12	Process Id.	E	E				
9.13	Save/Restart Process	NE	E				E
9.14	Prog. Mgt.	NE	E				
10.1	Debug Support						NE
10.2	Execution History		E			E	E
11.1	Fault Info. Coll.	NE	NE				E
11.2	Fault Info. Request	NE	E				E
11.3	Diag. Test Request	E	E				NE
11.4	Diag. Test Results	E	E				NE
11.5	Operational Status	E	E			E	E
11.6	Fault Detec. Threshhld.	E	E				E
11.7	Fault Isolation	E	E				E
11.8	Fault Response	E	E				E
11.9	Reconfiguration	E	E			E	E
11.10	En./Dis. Sys. Component	E	E			E	E
11.11	Perf. Mon.	E	E				E
11.12	Set Resource Util. Lims.	E	E				E
11.13	Resource Util. Lim. Viol.	E	E				E
11.14	Chkpt. Data Structures		NE				E
12.2	Virtual Space Locking	E					
12.3	Dyn. Mem. Alloc/Dealloc.	NE			NE		
12.5	Shared Memory	E					
12.6	Alloc/Dealloc/Mnt/Dsmnt		E				NE
12.7	Designate Control		E				NE
12.8	Release Control		E				NE
12.9	Allocate Resource		E				NE
12.10	Dealloc. Resource		E				NE
12.11	Sys. Resrc. Rqts. Spec.		E				NE
12.12	Sys. Resrc. Capacity		E				NE

TABLE F-1 (Cont.)

CRITERION		ALLOCATION					
		R	D	H	A	S	F
13.1	Process Synch.	E	E				
13.2	Mutual Exclus.	E	E				
13.3	Cum. Process Execu. Time	E					
13.4	Attach Proc. to Event	NE	E				
13.5	Transac. Sched. Info.	NE	E				
13.6	Sched. Delay	E					
13.7	Periodic Sched.	E	E				
13.8	Mult. Sched. Policies	E	E				
13.9	Selec. of Sched. Policy	E	E				
13.10	Mod. of Sched Params.	E	E				
13.11	Precise Sched.	E	NE				
14.1	Image Load		NE				E
14.2	Sys. Init/Reinit		E				E
14.3	Shutdown		E				E
15.1	Read Sel. Clock	E	E				
15.2	Set Sel. Clock	E	E				
15.3	Synch of Sel. Clocks	E	E				
15.4	Sel. Prim. Ref. Clock	E	E				
15.5	Locate Prim. Ref. Clock	E	E				
15.6	Timer Services	E	E				
15.7	Precision Clock	E	E				
16.1	Create Task				E		
16.2	Abort Task				E		
16.3	Suspend Task				E		
16.4	Resume Task				E		
16.5	Terminate Task				E		
16.6	Restart Task						E
16.7	Ada Task Entry Calls				E		
16.8	Ada Task Call Accept/Sel.				E		
16.9	Access Task Chars.				E		
16.10	Mon. Task Execu. Status				E		
16.11	Access to R-T Clock				E		
16.12	Access to T-o-D Clock				E		
16.13	Dyn. Task Priorities				E		
16.14	Sched. Policy Selection				E		
16.15	Mem. Alloc/Dealloc.				E		
16.16	Interrupt Binding				E		
16.17	En./Dis. Intrpts.				E		
16.18	Mask/Unmask Intrpts.				E		
16.19	Raise Exception				E		
16.20	Ada I/O Support				E		

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