

# **FINGERPRINT VENDOR TECHNOLOGY EVALUATION 2003**

## **APPENDIX D**

### **DETAILS OF RESULTS**

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# 1 Introduction

This Appendix shows complete ROCs corresponding to much of the data that was summarized in the body of the report (usually at FAR =  $10^{-4}$ ).

- Each chart corresponds to one test partition, showing the ROC for each system on that partition.
- Charts are included for many of the partitions that were summarized in the body of the report. In selecting LST partitions for inclusion in this appendix, those having a relatively large number of mated pairs were generally favored.
- Cross references to summary charts in Section 6 of the main report (Key Results) are provided. Many of the charts and tables of Section 5 (Comparison of Systems) summarize accuracy across multiple partitions, many of which are included in this appendix.
- All charts in this appendix are based on partitions having zero or one mate in the gallery for each probe.
- Unless otherwise noted, the range of the y-scale of these charts (TAR) is fixed at [0.5, 1.0].

## 2 LST

### 2.1 Detail of System Comparisons

The following table defines the partitions used for the comparisons of LST system comparison charts in Section 4 of the FpVTE Analysis Report.

LST Partitions used for System Comparison								
	# Fingers	Query Set	Probe Partition	Target Set	Gallery Partition	Probe set size	Gallery set size	# Mates
27 Partitions of Operational Data	BxA/BCC	1 B	BCC	A	Inst1	1,584	5,805	1,196
	BxA/DHS2	1 B	DHS2	A	Inst1	790	5,805	393
	BxA/Identlafis	1 B	Identlafis	A	Inst1	303	5,805	282
	BxC/Identlafis	1 B	Identlafis	C	Inst1	303	7,983	209
	HxC/Identlafis	1 H	Identlafis	C	Inst1	525	7,983	289
	HxD/12k	1 H	12k	D	Inst1	1,204	3,190	548
	HxI/Identlafis	1 H	Identlafis	I	Inst1	525	7,051	393
	HxJ/12k	1 H	12k	J	Inst1	1,204	7,329	808
	AxA/BCC	2 A	BCC	A	Inst2	4,184	2,119	1,783
	AxA/DHS2	2 A	DHS2	A	Inst2	835	2,119	334
	GxC/Identlafis	2 G	Identlafis	C	Inst1	2,280	7,983	1,482
	GxD/12k	2 G	12k	D	Inst1	2,226	3,190	337
	GxI/12k	2 G	12k	I	Inst1	2,226	7,051	409
	GxI/BEN	2 G	BEN	I	Inst1	1,199	7,051	403
	GxI/Identlafis	2 G	Identlafis	I	Inst1	2,280	7,051	1,255
	GxJ/12k	2 G	12k	J	Inst1	2,226	7,329	1,472
	CxD/12k	10 C	12k	D	Inst1	2,201	3,190	722
	CxI/12k	10 C	12k	I	Inst1	2,201	7,051	1,482
	CxI/BEN	10 C	BEN	I	Inst1	2,357	7,051	852
	CxI/Identlafis	10 C	Identlafis	I	Inst1	2,765	7,051	1,638
	CxJ/12k	10 C	12k	J	Inst1	2,201	7,329	537
	DxD/DHS10	10 D	DHS10	D	Inst2	998	792	498
	DxI/12k	10 D	12k	I	Inst1	1,486	7,051	810
	DxJ/12k	10 D	12k	J	Inst1	1,486	7,329	380
	DxJ/DHS10	10 D	DHS10	J	Inst1	998	7,329	498
	IxI/Identlafis	10 I	Identlafis	I	Inst2	2,069	866	762
	JxJ/DHS10	10 J	DHS10	J	Inst2	3,836	643	359
17 Partitions of Controlled Data	HxC/Ohio	1 H	Ohio	C	Inst1	988	7,983	610
	HxD/Ohio	1 H	Ohio	D	Inst1	988	3,190	724
	HxI/Ohio	1 H	Ohio	I	Inst1	988	7,051	915
	HxJ/Ohio	1 H	Ohio	J	Inst1	988	7,329	722
	GxC/Ohio	2 G	Ohio	C	Inst1	1,000	7,983	632
	GxD/Ohio	2 G	Ohio	D	Inst1	1,000	3,190	759
	GxI/Ohio	2 G	Ohio	I	Inst1	1,000	7,051	923
	GxJ/Ohio	2 G	Ohio	J	Inst1	1,000	7,329	760
	CxC/Ohio	10 C	Ohio	C	Inst2	660	336	250
	CxD/Ohio	10 C	Ohio	D	Inst1	660	3,190	497
	CxI/Ohio	10 C	Ohio	I	Inst1	660	7,051	551
	CxJ/Ohio	10 C	Ohio	J	Inst1	660	7,329	496
	DxD/Ohio	10 D	Ohio	D	Inst2	706	792	294
	DxI/Ohio	10 D	Ohio	I	Inst1	706	7,051	605
	DxJ/Ohio	10 D	Ohio	J	Inst1	706	7,329	703
	IxJ/Ohio	10 I	Ohio	J	Inst1	799	7,329	605
	JxJ/Ohio	10 J	Ohio	J	Inst2	707	643	283

Table D-1

FpVTE 2003 APPENDIX D — DETAILS OF RESULTS

The following table shows the detail used to construct the LST system comparison charts in Section 4 of the FpVTE Analysis Report. These results correspond directly to Figures 5 and 6 in that document.

The systems are sorted by the average TAR across the 27 operational partitions.

Comparison of Performance on LST Partitions														
Values are True Accept Rates where the False Accept Rate = 10 <sup>-4</sup>														
	NEC	Sagem L1	Cogent	Sagem L2	Dermalog	Motorola	Identix	NIST VTB	Biolink	Griaule	Golden Finger	Antheus	Raytheon	
27 Partitions of Operational Data	BxA/BCC	0.9913	0.9786	0.9711	0.9629	0.9436	0.9299	0.8931	0.8253	0.8190	0.8826	0.7940	0.8174	0.7940
	BxA/DHS2	0.9884	0.9629	0.9726	0.9395	0.9463	0.9070	0.8006	0.8088	0.6585	0.7070	0.7222	0.6148	0.7222
	BxA/Identlafis	0.9955	0.9863	0.9851	0.9838	0.9636	0.9508	0.9235	0.8802	0.7888	0.8790	0.7654	0.7405	0.7654
	BxC/Identlafis	1.0000	1.0000	0.9785	0.9844	0.9858	0.9262	0.8665	0.8745	0.7554	0.8964	0.8092	0.7486	0.8092
	HxC/Identlafis	0.9873	0.9701	0.9664	0.9565	0.9372	0.9290	0.8914	0.8417	0.8262	0.8399	0.8490	0.8052	0.8490
	HxD/12k	0.9825	0.9611	0.9587	0.9445	0.9014	0.8690	0.8282	0.7467	0.7891	0.7779	0.7412	0.6565	0.7412
	HxI/Identlafis	0.9918	0.9504	0.9528	0.9360	0.9051	0.9188	0.7390	0.7732	0.7354	0.7900	0.4415	0.7503	0.1164
	HxJ/12k	0.9895	0.9743	0.9525	0.9639	0.9233	0.8912	0.8135	0.7699	0.7140	0.7927	0.8043	0.6150	0.8043
	AxA/BCC	0.9959	0.9904	0.9867	0.9875	0.9717	0.9692	0.9516	0.9060	0.8969	0.9297	0.8338	0.8997	0.8338
	AxA/DHS2	1.0000	1.0000	0.9979	1.0000	0.9987	0.9989	0.9590	0.9785	0.7175	0.8752	0.8698	0.7919	0.8698
	GxC/Identlafis	0.9973	0.9941	0.9921	0.9933	0.9848	0.9802	0.9680	0.9416	0.9315	0.9460	0.9357	0.9143	0.9357
	GxD/12k	1.0000	0.9923	0.9918	0.9902	0.9645	0.9519	0.9236	0.8746	0.8430	0.8980	0.8278	0.8027	0.8278
	GxI/12k	1.0000	0.9991	1.0000	0.9991	0.9990	0.9970	0.9717	0.9785	0.9661	0.9872	0.9765	0.9214	0.9797
	GxI/BEN	1.0000	1.0000	0.9968	1.0000	0.9983	0.9937	0.9768	0.9720	0.9665	0.9846	0.9548	0.9308	0.9609
	GxI/Identlafis	0.9973	0.9801	0.9824	0.9746	0.9529	0.9664	0.8925	0.8569	0.8461	0.8909	0.5775	0.8625	0.1838
	GxJ/12k	0.9990	0.9987	0.9925	0.9955	0.9788	0.9681	0.9262	0.8657	0.8507	0.9028	0.8739	0.7022	0.8739
	CxD/12k	0.9999	1.0000	1.0000	1.0000	0.9851	0.9898	0.9851	0.9404	0.9615	0.9043	0.9725	0.9562	0.9725
	CxI/12k	1.0000	1.0000	1.0000	1.0000	0.9999	0.9993	0.9944	0.9819	0.9967	0.9825	0.9940	0.9806	0.9935
	CxI/BEN	0.9993	0.9997	0.9983	0.9997	0.9949	0.9926	0.9840	0.9732	0.9652	0.9666	0.9761	0.9597	0.9748
	CxI/Identlafis	1.0000	1.0000	0.9997	0.9998	0.9902	0.9970	0.9870	0.9373	0.9742	0.8856	0.9289	0.9758	0.8099
	CxJ/12k	1.0000	0.9990	1.0000	0.9990	0.9902	0.9959	0.9839	0.9170	0.9721	0.8970	0.9715	0.8469	0.9715
	DxD/DHS10	1.0000	0.9993	1.0000	0.9992	0.9952	0.9968	0.9946	0.9444	0.9675	0.9362	0.9386	0.9672	0.9386
	DxI/12k	1.0000	0.9995	1.0000	1.0000	0.9909	0.9904	0.9629	0.8722	0.9731	0.8786	0.9525	0.9416	0.9484
	DxJ/12k	1.0000	1.0000	0.9969	1.0000	0.9966	0.9955	0.9936	0.9378	0.9775	0.9319	0.9652	0.8378	0.9651
	IxD/DHS10	0.9996	0.9994	0.9983	0.9975	0.9883	0.9915	0.9873	0.9070	0.9428	0.8832	0.9338	0.8262	0.9338
	IxI/Identlafis	1.0000	0.9998	1.0000	0.9998	0.9939	0.9983	0.9913	0.9482	0.9825	0.7190	0.8744	0.9678	0.7646
	JxJ/DHS10	1.0000	1.0000	1.0000	1.0000	0.9954	0.9993	0.9861	0.9431	0.9682	0.8121	0.9703	0.7449	0.9703
Average	0.9968	0.9902	0.9878	0.9854	0.9732	0.9664	0.9324	0.8962	0.8810	0.8806	0.8613	0.8362	0.8263	
Median	0.9999	0.9991	0.9968	0.9975	0.9858	0.9898	0.9629	0.9070	0.9315	0.8909	0.8744	0.8378	0.8698	
17 Partitions of Controlled Data	HxC/Ohio	0.9996	0.9939	0.9926	0.9855	0.9841	0.9575	0.9423	0.9202	0.8929	0.9387	0.9155	0.7863	0.9155
	HxD/Ohio	0.9896	0.9637	0.9699	0.9508	0.9347	0.9075	0.8511	0.8034	0.8238	0.8576	0.7885	0.6940	0.7885
	HxI/Ohio	0.9978	0.9842	0.9811	0.9795	0.9748	0.9715	0.9253	0.8721	0.8553	0.9285	0.9134	0.7665	0.9158
	HxJ/Ohio	0.9983	0.9783	0.9801	0.9669	0.9560	0.9452	0.8745	0.7765	0.7230	0.8685	0.8382	0.6220	0.8368
	GxC/Ohio	1.0000	1.0000	1.0000	1.0000	0.9983	1.0000	0.9958	0.9979	0.9915	0.9985	0.9905	0.9772	0.9905
	GxD/Ohio	1.0000	0.9940	0.9992	0.9927	0.9892	0.9885	0.9620	0.9517	0.9487	0.9541	0.9284	0.9015	0.9284
	GxI/Ohio	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9913	0.9857	0.9696	0.9901	0.9848	0.9580	0.9862
	GxJ/Ohio	1.0000	1.0000	0.9983	1.0000	0.9948	0.9952	0.9822	0.9606	0.9510	0.9690	0.9731	0.8270	0.9718
	CxC/Ohio	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9966	1.0000	1.0000	1.0000
	CxD/Ohio	1.0000	1.0000	1.0000	1.0000	0.9971	0.9989	0.9997	0.9822	0.9990	0.9638	0.9908	0.9841	0.9908
	CxI/Ohio	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9958	1.0000	0.9932	0.9985	0.9962	0.9986
	CxJ/Ohio	1.0000	1.0000	1.0000	1.0000	0.9988	1.0000	1.0000	0.9842	1.0000	0.9672	1.0000	0.8807	0.9985
	DxD/Ohio	1.0000	1.0000	1.0000	1.0000	0.9918	1.0000	1.0000	0.9886	0.9987	0.9672	0.9850	0.9922	0.9850
	DxI/Ohio	1.0000	1.0000	1.0000	1.0000	0.9993	0.9997	0.9954	0.9471	0.9971	0.9580	0.9885	0.9805	0.9853
	DxJ/Ohio	1.0000	1.0000	1.0000	1.0000	0.9992	0.9995	1.0000	0.9728	0.9926	0.9599	0.9915	0.8781	0.9901
	IxJ/Ohio	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9990	0.9916	0.9989	0.9111	0.9931	0.8799	0.9906
	JxJ/Ohio	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9592	1.0000	0.8494	1.0000
Average	0.9991	0.9949	0.9954	0.9927	0.9893	0.9861	0.9717	0.9489	0.9495	0.9518	0.9576	0.8808	0.9572	
Median	1.0000	1.0000	1.0000	1.0000	0.9983	0.9997	0.9958	0.9822	0.9926	0.9599	0.9885	0.8807	0.9862	
Average (all 44)	0.9977	0.9920	0.9907	0.9882	0.9794	0.9740	0.9476	0.9165	0.9075	0.9081	0.8985	0.8535	0.8769	
Median (all 44)	1.0000	0.9996	0.9983	0.9995	0.9906	0.9932	0.9795	0.9410	0.9633	0.9198	0.9372	0.8703	0.9372	

Table D-2

FpVTE 2003 APPENDIX D — DETAILS OF RESULTS

Table D-3 shows the detail used to construct the LST system rank comparison tables in Section 4 of the FpVTE Analysis Report. These results correspond directly to Tables 14 and 15 in that document. The systems are sorted in the same order as in Table D-2.

Comparison of Performance Ranks on LST Partitions														
Values are ranks, based on True Accept Rates where the False Accept Rate = 10 <sup>-4</sup>														
	NEC	Sagem L1	Cogent	Sagem L2	Dermalog	Motorola	Identix	NIST VTB	Biolink	Griaule	Golden Finger	Antheus	Raytheon	
27 Partitions of Operational Data	BxA/BCC	1	2	3	4	5	6	7	9	10	8	12	11	12
	BxA/DHS2	1	3	2	5	4	6	8	7	12	11	9	13	9
	BxA/Identlafis	1	2	3	4	5	6	7	8	10	9	11	13	11
	BxC/Identlafis	1	1	5	4	3	6	9	8	12	7	10	13	10
	HxC/Identlafis	1	2	3	4	5	6	7	10	12	11	8	13	8
	HxD/12k	1	2	3	4	5	6	7	10	8	9	11	13	11
	HxI/Identlafis	1	3	2	4	6	5	10	8	11	7	12	9	13
	HxJ/12k	1	2	4	3	5	6	7	11	12	10	8	13	8
	AxA/BCC	1	2	4	3	5	6	7	9	11	8	12	10	12
	AxA/DHS2	1	1	6	1	5	4	8	7	13	9	10	12	10
	GxC/Identlafis	1	2	4	3	5	6	7	9	12	8	10	13	10
	GxD/12k	1	2	3	4	5	6	7	9	10	8	11	13	11
	GxI/12k	1	3	1	4	5	6	11	9	12	7	10	13	8
	GxI/BEN	1	1	5	1	4	6	8	9	10	7	12	13	11
	GxI/Identlafis	1	3	2	4	6	5	7	10	11	8	12	9	13
	GxJ/12k	1	2	4	3	5	6	7	11	12	8	9	13	9
	CxD/12k	4	1	1	1	6	5	7	12	10	13	8	11	8
	CxI/12k	1	1	1	1	5	6	8	12	7	11	9	13	10
	CxI/BEN	3	2	4	1	5	6	7	10	12	11	8	13	9
	CxI/Identlafis	1	1	4	3	6	5	7	10	9	12	11	8	13
	CxJ/12k	1	3	1	4	6	5	7	11	8	12	9	13	10
	DxD/DHS10	1	3	1	4	6	5	7	10	8	13	11	9	11
	DxI/12k	1	4	1	1	5	6	8	13	7	12	9	11	10
	DxJ/12k	1	1	4	1	5	6	7	11	8	12	9	13	10
	DxJ/DHS10	1	2	3	4	6	5	7	11	8	12	9	13	10
	IxI/Identlafis	1	4	1	3	6	5	7	10	8	13	11	9	12
	JxJ/DHS10	1	1	1	1	6	5	7	11	10	12	8	13	8
<i>Average</i>	1.2	2.1	2.8	2.9	5.2	5.6	7.5	9.8	10.1	9.9	10.0	11.9	10.3	
<i>Median</i>	1.0	2.0	3.0	3.0	5.0	6.0	7.0	10.0	10.0	10.0	10.0	13.0	10.0	
17 Partitions of Controlled Data	HxC/Ohio	1	2	3	4	5	6	7	9	12	8	10	13	10
	HxD/Ohio	1	3	2	4	5	6	8	10	9	7	11	13	11
	HxI/Ohio	1	2	3	4	5	6	8	11	12	7	10	13	9
	HxJ/Ohio	1	3	2	4	5	6	7	11	12	8	9	13	10
	GxC/Ohio	1	1	1	1	7	1	9	8	10	6	11	13	11
	GxD/Ohio	1	3	2	4	5	6	7	9	10	8	11	13	11
	GxI/Ohio	1	1	1	1	1	1	7	10	12	8	11	13	9
	GxJ/Ohio	1	1	4	1	6	5	7	11	12	10	8	13	9
	CxC/Ohio	1	1	1	1	1	1	1	1	1	13	1	1	1
	CxD/Ohio	1	1	1	1	8	7	5	12	6	13	9	11	9
	CxI/Ohio	1	1	1	1	1	1	1	12	1	13	10	11	9
	CxJ/Ohio	1	1	1	1	9	1	1	11	1	12	1	13	10
	DxD/Ohio	1	1	1	1	9	1	1	10	7	13	11	8	11
	DxI/Ohio	1	1	1	1	6	5	8	13	7	12	9	11	10
	DxJ/Ohio	1	1	1	1	7	6	5	11	8	12	9	13	10
	IxJ/Ohio	1	1	1	1	1	1	7	10	8	12	9	13	11
	JxJ/Ohio	1	1	1	1	1	1	1	1	1	12	1	13	1
<i>Average</i>	1.0	1.5	1.6	1.9	4.8	3.6	5.3	9.4	7.6	10.2	8.3	11.6	8.9	
<i>Median</i>	1.0	1.0	1.0	1.0	5.0	5.0	7.0	10.0	8.0	12.0	9.0	13.0	10.0	
<i>Average (all 44)</i>	1.1	1.8	2.3	2.5	5.0	4.8	6.7	9.7	9.1	10.0	9.3	11.8	9.8	
<i>Median (all 44)</i>	1.0	2.0	2.0	3.0	5.0	6.0	7.0	10.0	10.0	10.5	10.0	13.0	10.0	

Table D-3

The following charts show the TAR information graphically. In both charts, the systems are sorted by the average performance across the 27 operational partitions.

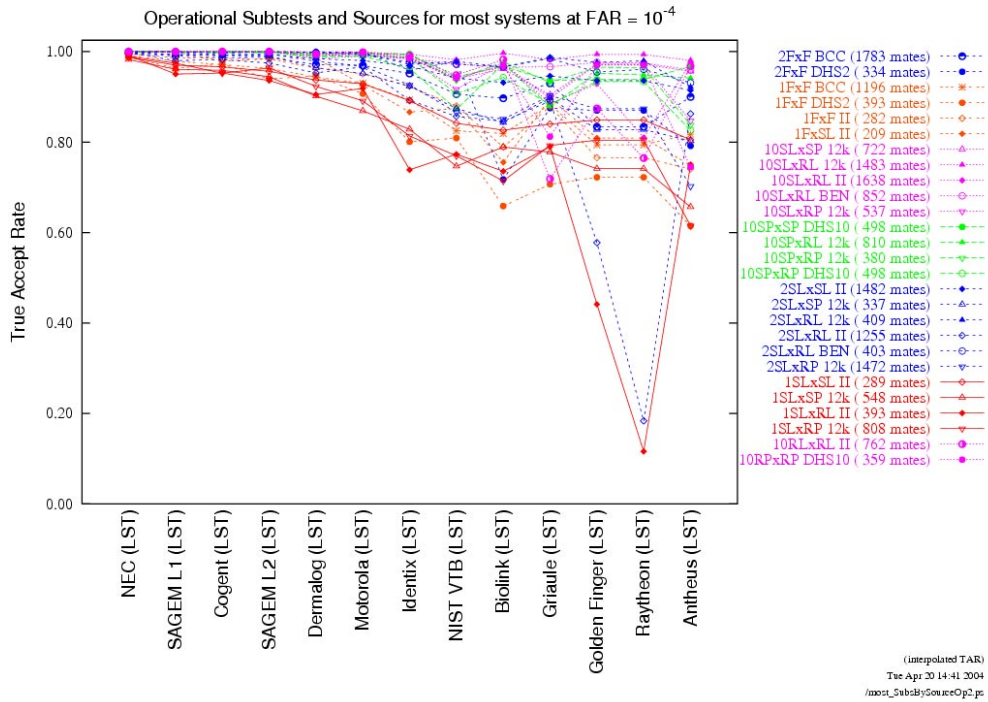


Figure D-1

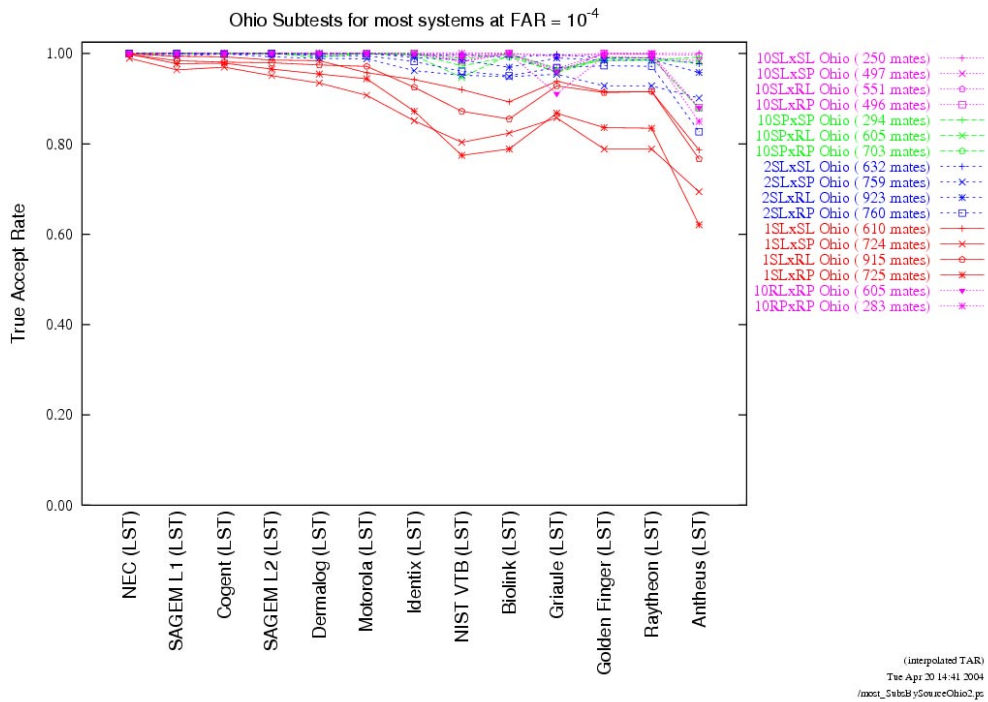


Figure D-2

The comparisons of LST systems in the Analysis Report were made at FAR =  $10^{-4}$ . The reasons for the choice of this operating point are explained in Appendix E, Section 2. One





FPVTE 2003 APPENDIX D — DETAILS OF RESULTS

Table D-5 and Table D-6 correspond to Tables 14 and 15 in the Analysis Report. The left half of each table summarizes the results where FAR = 10<sup>-6</sup>, and the right half where FAR = 10<sup>-4</sup>. Systems for which the average rank would have changed are shown in yellow. These tables are sorted by the average rank where FAR = 10<sup>-4</sup> (the same order as in Tables 14 and 15 in the Analysis Report).

	Summary of Rank over LST Partitions where FAR = 10 <sup>-6</sup>						Summary of Rank over LST Partitions where FAR = 10 <sup>-4</sup>					
	27 LST Partitions of Operational Data						27 LST Partitions of Operational Data					
	Best	5th Best	Average	Median	5th Worst	Worst	Best	5th Best	Average	Median	5th Worst	Worst
NEC	1	1	1.37	1	2	4	1	1	1.19	1	1	4
Sagem L1	1	1	2.15	2	3	4	1	1	2.07	2	3	4
Cogent	1	1	2.70	2	4	4	1	1	2.81	3	4	6
Sagem L2	1	1	2.85	3	4	4	1	1	2.93	3	4	5
Dermalog	5	5	5.56	6	6	6	3	5	5.19	5	6	6
Motorola	5	5	5.44	5	6	6	4	5	5.59	6	6	6
Identix	7	7	7.30	7	8	9	7	7	7.52	7	8	11
NIST VTB	7	9	9.89	10	11	12	7	8	9.81	10	11	13
Griaule	7	8	9.63	8	12	13	7	8	9.93	10	12	13
Golden Finger	9	9	10.85	11	12	13	8	8	9.96	10	12	12
Biolink	7	8	9.48	9	11	12	7	8	10.11	10	12	13
Raytheon	9	9	10.70	11	12	13	8	8	10.26	10	12	13
Antheus	8	9	11.48	12	13	13	8	9	11.85	13	13	13

Table D-5

	Summary of Rank over LST Partitions where FAR = 10 <sup>-6</sup>							Summary of Rank over LST Partitions where FAR = 10 <sup>-4</sup>						
	17 LST Partitions of Controlled (Ohio) Data							17 LST Partitions of Controlled (Ohio) Data						
	Best	3rd Best	Average	Median	3rd Worst	Worst	Best	3rd Best	Average	Median	3rd Worst	Worst		
NEC	1	1	1.00	1	1	1	1	1	1.00	1	1	1		
Sagem L1	1	1	1.53	1	3	3	1	1	1.47	1	3	3		
Cogent	1	1	1.59	1	3	4	1	1	1.59	1	3	4		
Sagem L2	1	1	2.00	1	4	4	1	1	1.88	1	4	4		
Motorola	1	1	3.65	5	6	6	1	1	3.59	5	6	7		
Dermalog	1	1	4.88	6	7	8	1	1	4.82	5	8	9		
Identix	1	5	6.35	7	8	8	1	1	5.29	7	8	9		
Biolink	1	7	8.06	8	11	12	1	1	7.59	8	12	12		
Golden Finger	1	9	9.18	10	11	12	1	1	8.29	9	11	11		
Raytheon	1	9	9.12	10	11	11	1	9	8.94	10	11	11		
NIST VTB	1	7	9.06	10	12	12	1	8	9.41	10	12	13		
Griaule	7	7	10.41	12	13	13	6	7	10.24	12	13	13		
Antheus	10	11	12.41	13	13	13	1	11	11.65	13	13	13		

Table D-6

## 2.2 Source

The following three charts correspond to Figure 14 of the main report, showing accuracy on single-finger, flat LST data. Note that the number of mated pairs is lower on the second two charts. Again, the Golden Finger and Raytheon results are identical, and therefore are superimposed.

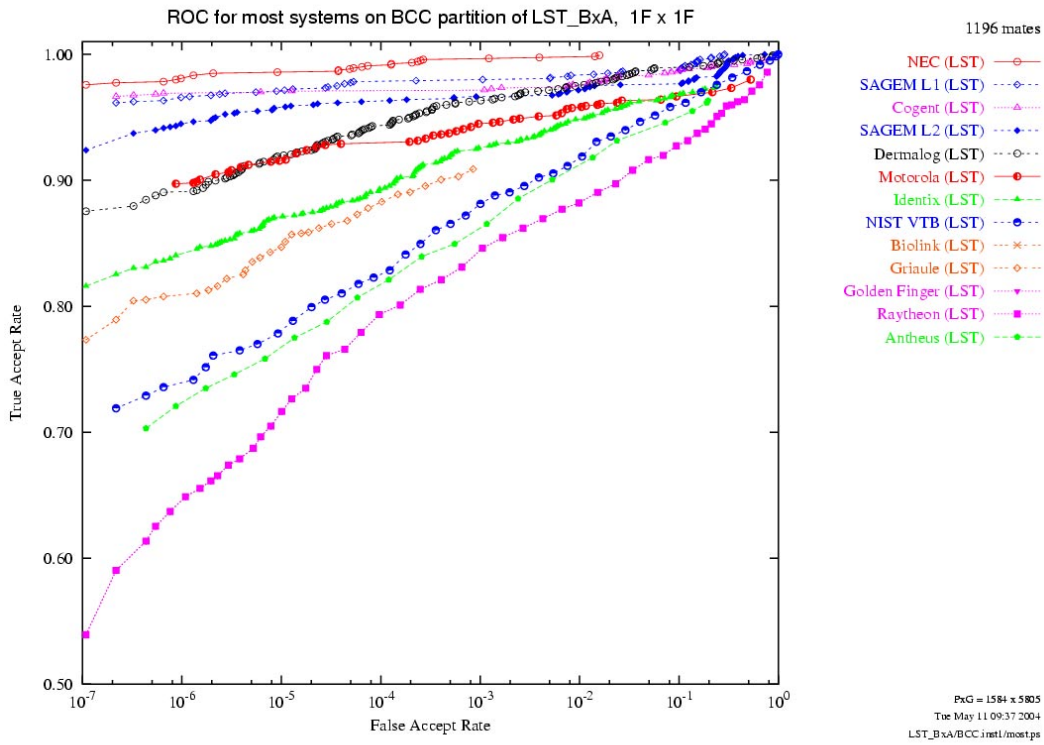


Figure D-3

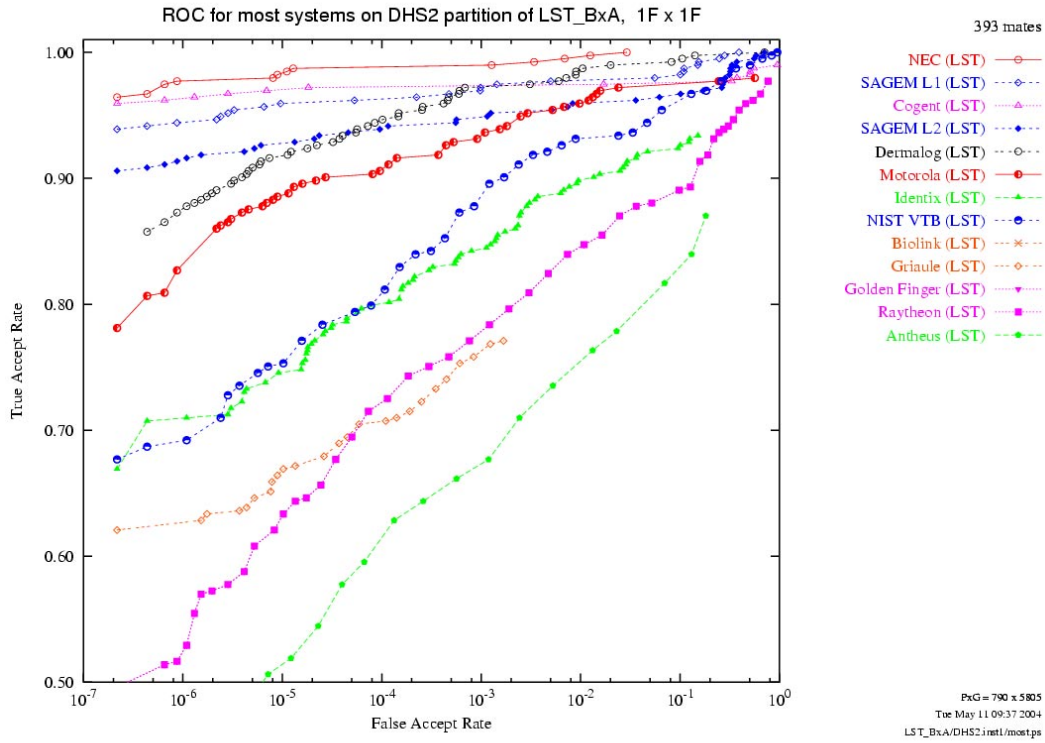


Figure D-4

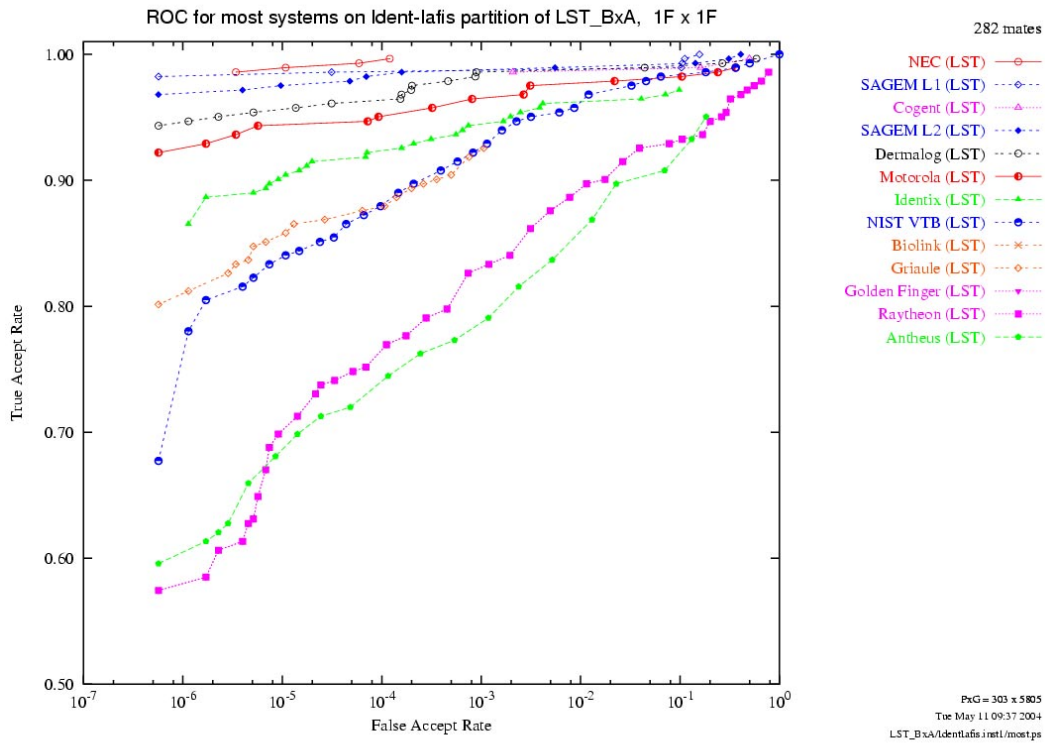


Figure D-5

### 2.3 Image Type

The next four charts correspond to Figure 22 of the main report, showing accuracy on various combinations of Slap/Rolled and Live/Paper data, using the non-operational Ohio dataset.

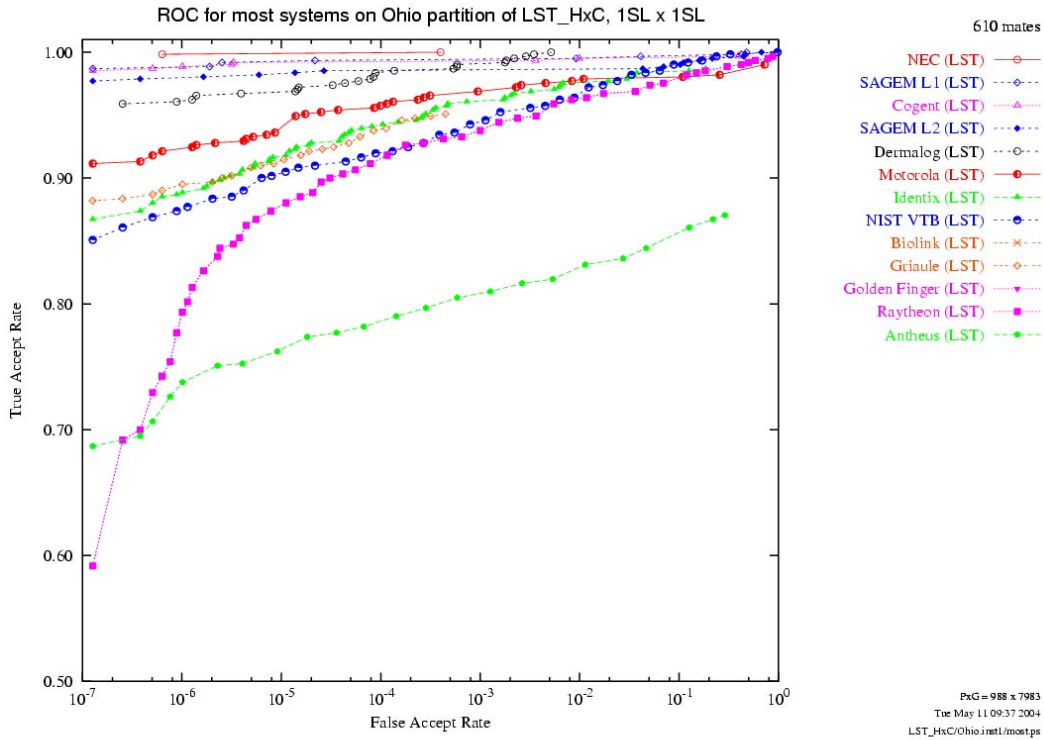


Figure D-6

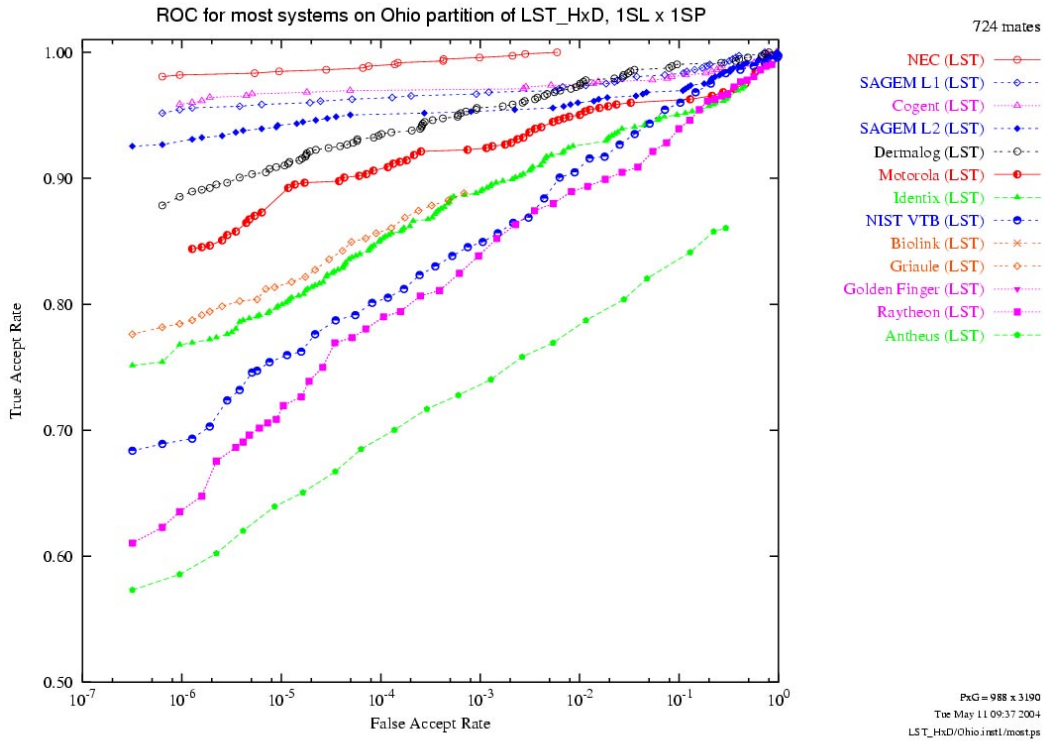


Figure D-7

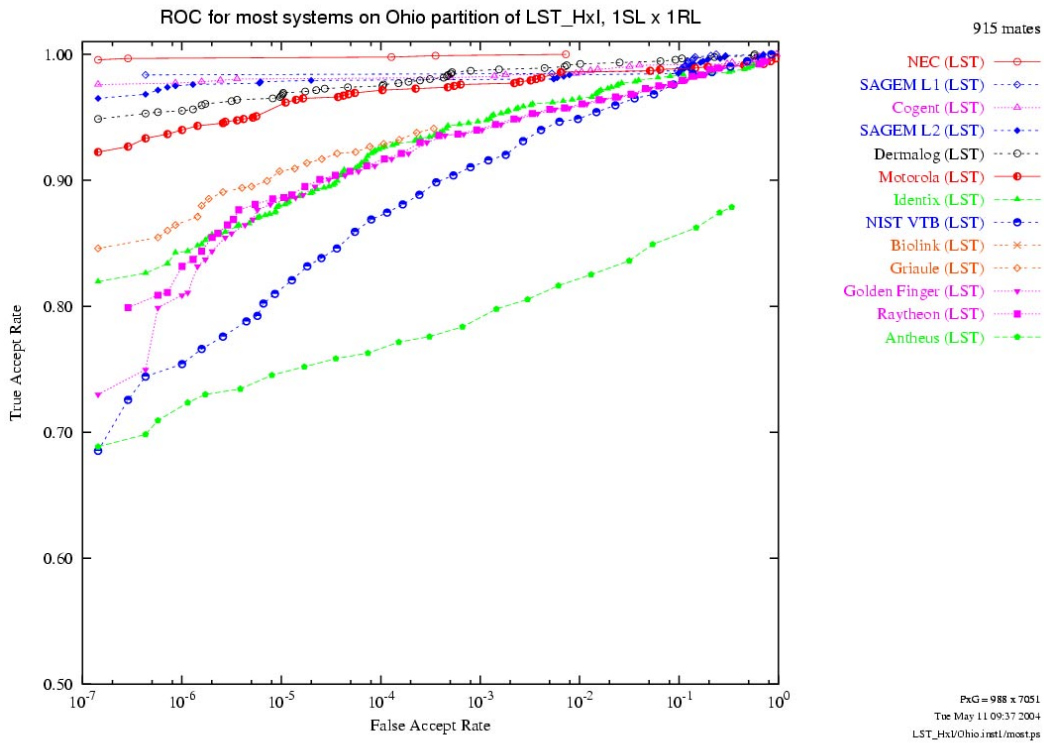


Figure D-8

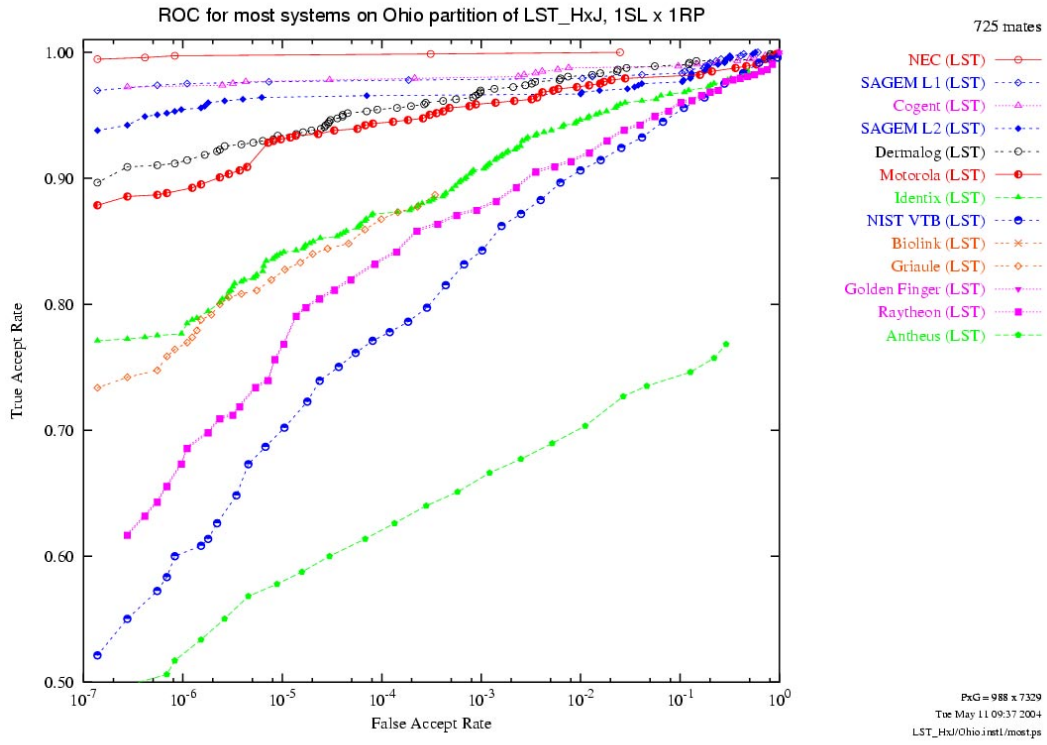


Figure D-9

## 2.4 Number of Fingers

The next three charts correspond to Figure 17 of the main report, showing accuracy on 1, 2 and 10 fingers (FBI 12k, Slap-Live x Slap-Paper).

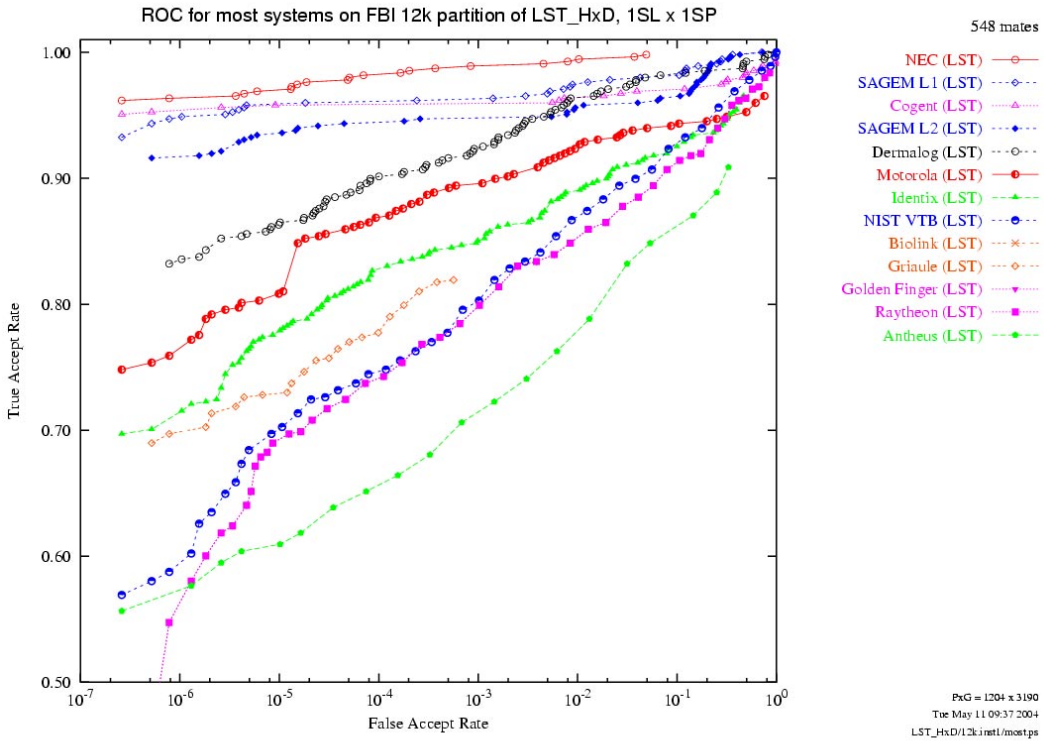


Figure D-10

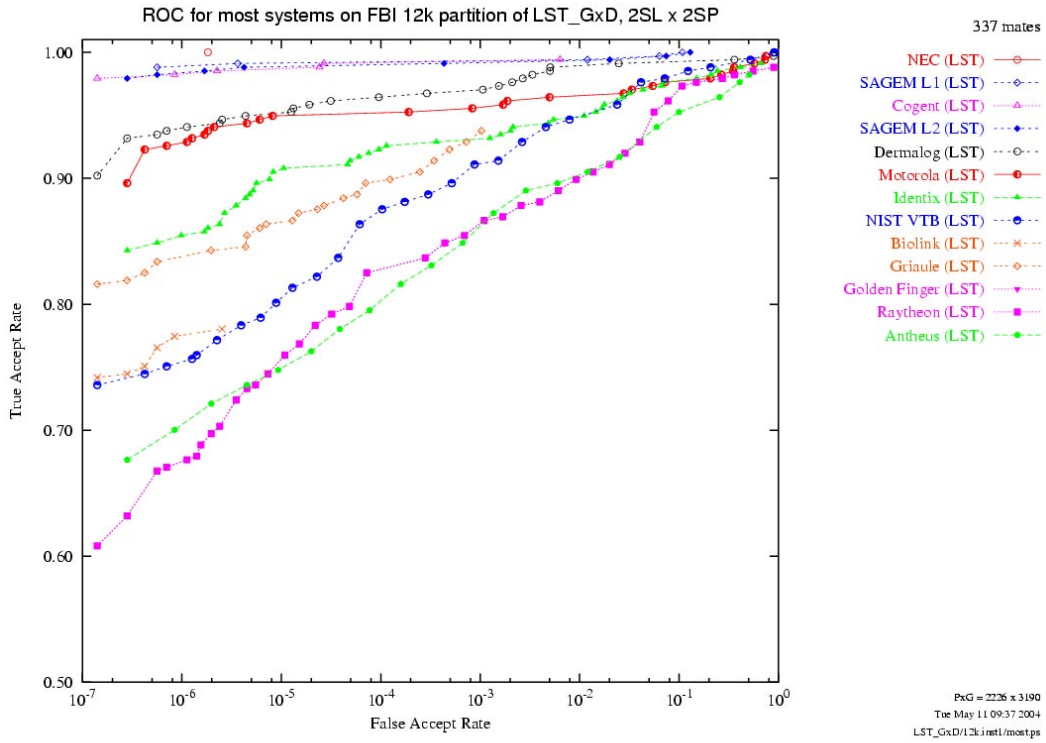


Figure D-11

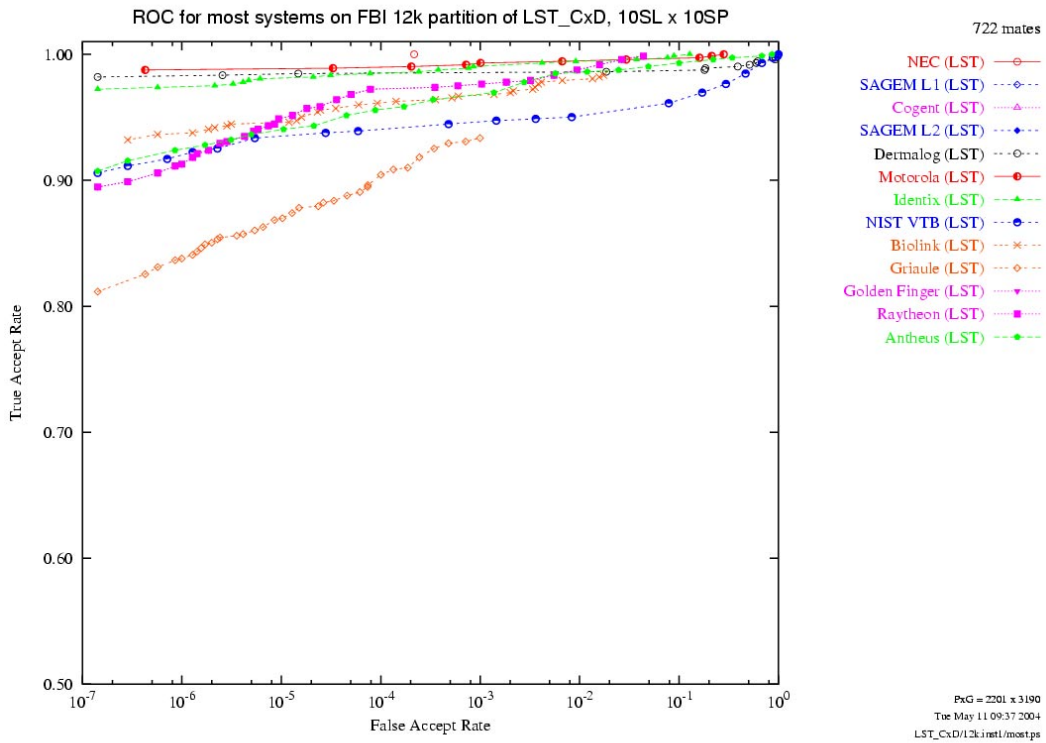


Figure D-12



### 3 MST

#### 3.1 Detail of System Comparisons

The following table defines the partitions and shows the detail used to construct the MST system comparison charts in Section 4 of the FpVTE Analysis Report. These results correspond directly to Figure 7 in that document.

The MST Standard probe partition (instance 1) includes one fingerprint for each of 5800 subjects; the probe partitions are simply those 5800 fingerprints grouped by source.

The MST Standard gallery partition (instance 2) includes one fingerprint for each of 3240 of the subjects in the Standard probe partition; the flat and slap gallery partitions are simply those 3240 fingerprints grouped by type (slap or flat).

The systems are sorted by performance on the MST Standard partition.

<b>Comparison of Performance on MST Partitions</b>								
Values are True Accept Rates where the False Accept Rate = $10^{-4}$								
Probe set	BCC	DHS2	II Flats	II Flats	BEN	II Slaps	Ohio	Standard (Inst1)
Gallery set	Flat2	Flat2	Flat2	Slap2	Slap2	Slap2	Slap2	Standard (Inst2)
Probe set size	1514	733	517	517	696	1458	882	5800
Gallery set size	1915	1915	1915	1325	1325	1325	1325	3240
# Mates	1062	493	116	216	99	321	689	3240
NEC	0.996	0.996	1.000	0.985	0.986	0.996	1.000	0.994
Cogent	0.990	0.999	1.000	0.977	0.972	0.986	1.000	0.991
SAGEM M2	0.979	0.991	0.996	0.957	0.972	0.981	0.999	0.983
SAGEM M1	0.970	0.983	0.989	0.954	0.972	0.977	0.994	0.976
Neurotech. M1	0.938	0.900	0.972	0.915	0.925	0.949	0.980	0.939
Motorola	0.944	0.939	0.971	0.866	0.892	0.923	0.984	0.934
Identix	0.907	0.853	0.934	0.830	0.831	0.887	0.959	0.895
UltraScan M2	0.841	0.818	0.945	0.779	0.881	0.913	0.940	0.863
UltraScan M1	0.841	0.802	0.945	0.780	0.881	0.913	0.940	0.860
NIST VTB	0.831	0.834	0.881	0.770	0.808	0.852	0.949	0.850
Biolink	0.874	0.564	0.822	0.823	0.853	0.883	0.964	0.835
Antheus	0.814	0.621	0.777	0.717	0.632	0.795	0.883	0.773
Phoenix	0.710	0.616	0.634	0.646	0.649	0.727	0.951	0.725
Golden Finger	0.670	0.627	0.700	0.596	0.563	0.758	0.904	0.707
Raytheon	0.670	0.627	0.700	0.596	0.563	0.758	0.904	0.707
123 ID M2	0.652	0.496	0.651	0.599	0.653	0.689	0.904	0.673
Technoimagia	0.794	0.018	0.494	0.673	0.728	0.863	0.943	0.575
Avalon	0.610	0.275	0.558	0.410	0.506	0.553	0.652	0.529

Table D-7

The following table shows the detail used to construct the MST system rank comparison tables in Section 4 of the FpVTE Analysis Report. These results correspond directly to Table 16 in that document. The systems are sorted in the same order as the previous table.

Comparison of Performance Ranks on MST Partitions										
Values are Ranks, based on True Accept Rates where the False Accept Rate = 10 <sup>-4</sup>										
Probe set	BCC	DHS2	II Flats	II Flats	BEN	II Slaps	Ohio	Standard (Inst1)	Average	Median
Gallery set	Flat2	Flat2	Flat2	Slap2	Slap2	Slap2	Slap2	Standard (Inst2)		
NEC	1	2	1	1	1	1	1	1	1.1	1.0
Cogent	2	1	1	2	3	2	1	2	1.8	2.0
SAGEM M2	3	3	3	3	2	3	3	3	2.9	3.0
SAGEM M1	4	4	4	4	4	4	4	4	4.0	4.0
Neurotech. M1	6	6	5	5	5	5	6	5	5.4	5.0
Motorola	5	5	6	6	6	6	5	6	5.6	6.0
Identix	7	7	9	7	10	9	8	7	8.0	7.5
UltraScan M2	9	9	7	10	7	7	12	8	8.6	8.5
UltraScan M1	9	10	7	9	7	7	12	9	8.8	9.0
NIST VTB	11	8	10	11	11	12	10	10	10.4	10.5
Biolink	8	15	11	8	9	10	7	11	9.9	9.5
Antheus	12	13	12	12	15	13	17	12	13.3	12.5
Phoenix	14	14	16	14	14	16	9	13	13.8	14.0
Golden Finger	15	11	13	16	16	14	15	14	14.3	14.5
Raytheon	15	11	13	16	16	14	15	14	14.3	14.5
123 ID M2	17	16	15	15	13	17	14	16	15.4	15.5
Technoimagia	13	18	18	13	12	11	11	17	14.1	13.0
Avalon	18	17	17	18	18	18	18	18	17.8	18.0

Table D-8

The following chart shows the TAR information graphically. The systems are sorted by performance on the MST Standard partition (Complete MST).

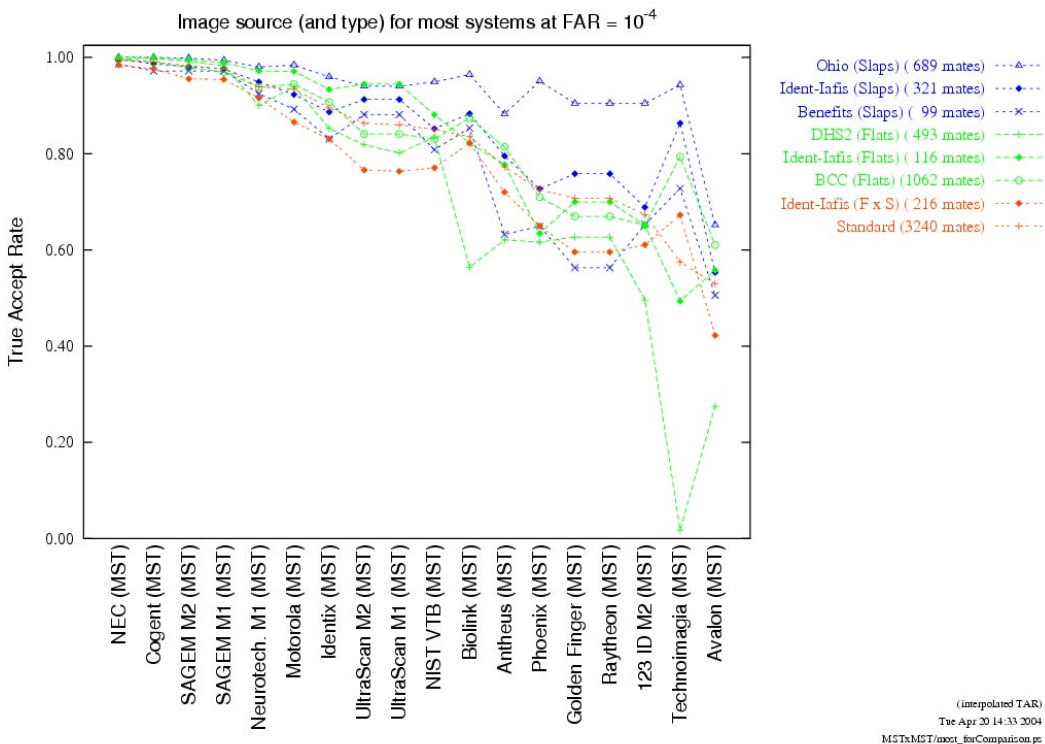


Figure D-13

The comparisons of MST systems in the Analysis Report were made at FAR = 10<sup>-4</sup>. The reasons for the choice of this operating point are explained in Appendix E, Section 2. One of the reasons for the choice of this operating point was that the comparisons are generally valid for lower FARs. The following tables show what the effect would have been if MST systems had been compared at FAR = 10<sup>-6</sup> instead of 10<sup>-4</sup>. Table D-9 corresponds directly to Table D-7, except that the FAR is 10<sup>-6</sup> instead of 10<sup>-4</sup>.

Comparison of Performance on MST Partitions								
Values are True Accept Rates where the False Accept Rate = 10 <sup>-6</sup>								
Probe set	BCC	DHS2	II Flats	II Flats	BEN	II Slaps	Ohio	Standard (Inst1)
Gallery set	Flat2	Flat2	Flat2	Slap2	Slap2	Slap2	Slap2	Standard (Inst2)
NEC	0.988	0.992	1.000	0.969	0.978	0.976	1.000	0.987
Cogent	0.975	0.986	0.998	0.968	0.958	0.972	0.999	0.977
SAGEM M2	0.951	0.980	0.983	0.925	0.967	0.962	0.987	0.961
SAGEM M1	0.938	0.942	0.981	0.900	0.961	0.946	0.984	0.944
Motorola	0.913	0.902	0.964	0.804	0.823	0.872	0.971	0.892
Neurotech. M1	0.887	0.827	0.938	0.863	0.867	0.925	0.972	0.880
Identix	0.861	0.775	0.845	0.758	0.778	0.815	0.920	0.831
NIST VTB	0.737	0.730	0.834	0.680	0.737	0.739	0.908	0.759
UltraScan M2	0.693	0.624	0.861	0.676	0.807	0.825	0.895	0.749
UltraScan M1	0.693	0.612	0.861	0.674	0.807	0.825	0.895	0.746
Biolink	0.746	0.442	0.772	0.682	0.757	0.800	0.931	0.733
Antheus	0.735	0.357	0.664	0.610	0.561	0.725	0.816	0.672
Phoenix	0.605	0.482	0.517	0.555	0.594	0.667	0.926	0.636
Golden Finger	0.594	0.466	0.534	0.486	0.483	0.660	0.764	0.573
Raytheon	0.594	0.466	0.534	0.486	0.483	0.660	0.764	0.573
123 ID M2	0.448	0.318	0.440	0.435	0.524	0.566	0.808	0.516
Avalon	0.302	0.130	0.233	0.139	0.259	0.289	0.329	0.256
Technomagija	0.457	0.011	0.037	0.394	0.672	0.719	0.870	0.063

Table D-9

In Table D-9, the results for Technomagija appear contradictory, but are an artifact due to the unusual variations in performance based on source. See the ROCs in Section 3.3.

Table D-10 corresponds to Table 16 in the Analysis Report. The left half of the table summarizes the results where FAR = 10<sup>-6</sup>, and the right half where FAR = 10<sup>-4</sup>. Systems for which the rank would have changed are shown in yellow. These tables are sorted by the average rank where FAR = 10<sup>-4</sup> (the same order as in Table 16 in the Analysis Report).

System	Distribution of System Rank over 7 MST Partitions where FMR = 10 <sup>-5</sup>						Summary of Rank over 7 MST Partitions where FAR = 10 <sup>-4</sup>					
	Best	2nd Best	Average	Median	2nd Worst	Worst	Best	2nd Best	Average	Median	2nd Worst	Worst
NEC	1	1	1.0	1	1	1	1	1	1.1	1	1	2
Cogent	2	2	2.3	2	2	4	1	1	1.7	2	2	3
SAGEM M2	2	3	2.9	3	3	3	2	3	2.9	3	3	3
SAGEM M1	3	4	3.9	4	4	4	4	4	4.0	4	4	4
Neurotech. M1	5	5	5.4	5	6	6	5	5	5.4	5	6	6
Motorola	5	5	5.6	5.5	6	6	5	5	5.6	6	6	6
Identix	7	7	8.1	8	9	9	7	7	8.1	8	9	10
UltraScan M1	7	7	9.1	8.5	11	11	7	7	8.7	9	10	12
UltraScan M2	7	7	8.9	8	11	11	7	7	8.7	9	10	12
Biolink	7	8	9.7	9	11	14	7	8	9.7	9	11	15
NIST VTB	8	9	9.7	9.5	11	11	8	10	10.4	11	11	12
Antheus	10	12	12.7	12	14	15	12	12	13.4	13	15	17
Technoimagia	12	13	15.3	14.5	18	18	11	11	13.7	13	18	18
Phoenix	8	11	12.4	13	14	15	9	14	13.9	14	16	16
Golden Finger	12	13	14.3	14	16	16	11	13	14.3	15	16	16
Raytheon	12	13	14.3	14	16	16	11	13	14.3	15	16	16
123 ID M2	15	15	16.0	16	17	17	13	14	15.3	15	17	17
Avalon	17	17	17.7	18	18	18	17	17	17.7	18	18	18

Table D-10

### 3.2 Equal Error Rates

In some evaluations, systems are compared using the Equal Error Rate, which is the point on an ROC where FAR = FRR (FRR = 1 – TAR). This table shows the equal error rates (with corresponding TAR and FAR values) for the MST systems, sorted by EER.

Equal Error Rates for MST systems			
System	EER	TAR	FAR
NEC	0.002	0.998	2.1E-03
Cogent	0.003	0.997	3.3E-03
SAGEM M2	0.006	0.994	6.4E-03
SAGEM M1	0.009	0.991	8.5E-03
Neurotech. M1	0.023	0.977	2.3E-02
Motorola	0.036	0.964	3.6E-02
UltraScan M2	0.039	0.961	3.9E-02
UltraScan M1	0.042	0.958	4.2E-02
Identix	0.044	0.956	4.4E-02
NIST VTB	0.048	0.952	4.8E-02
Biolink	0.065	0.935	6.5E-02
Golden Finger	0.076	0.924	7.6E-02
Raytheon	0.076	0.924	7.6E-02
Antheus	0.086	0.914	8.6E-02
123 ID M2	0.116	0.884	1.2E-01
Phoenix	0.138	0.862	1.4E-01
Avalon	0.141	0.859	1.4E-01
Technoimagia	0.151	0.849	1.5E-01

Table D-11

### 3.3 Image Source

These six charts correspond to Figure 13 of the main report, showing accuracy on Slap and Flat images from various sources. The charts are in alphabetic order by source.

Note that the y-scale of the DHS2 chart is extended to TAR=0 to show the full range of performance.

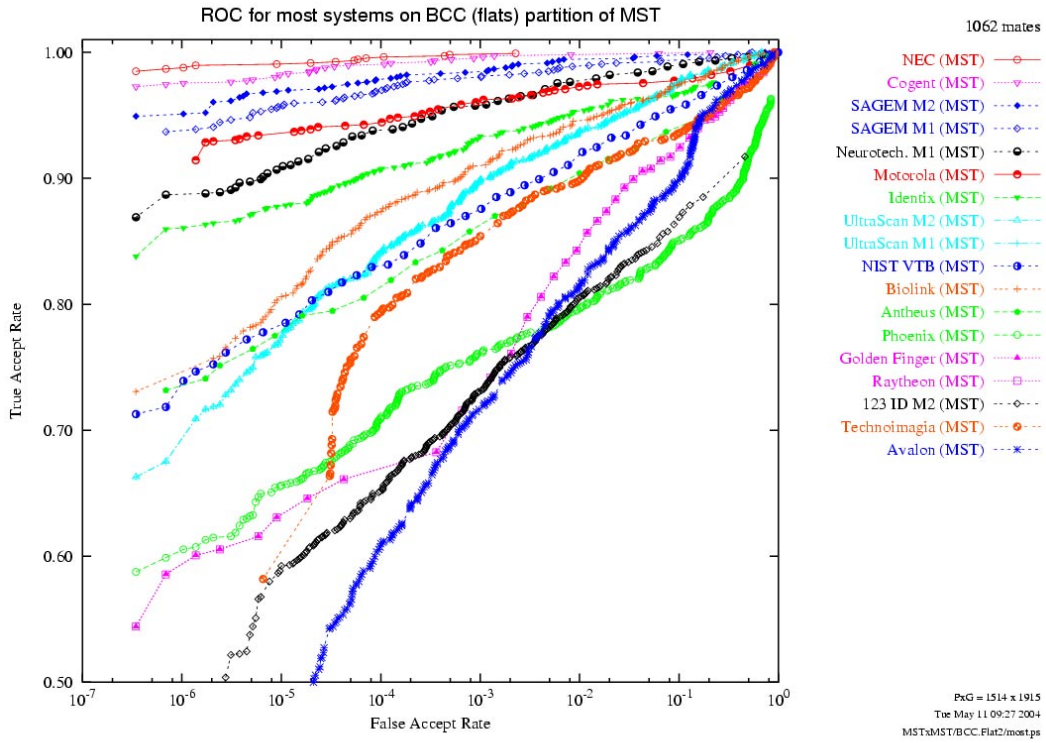


Figure D-14

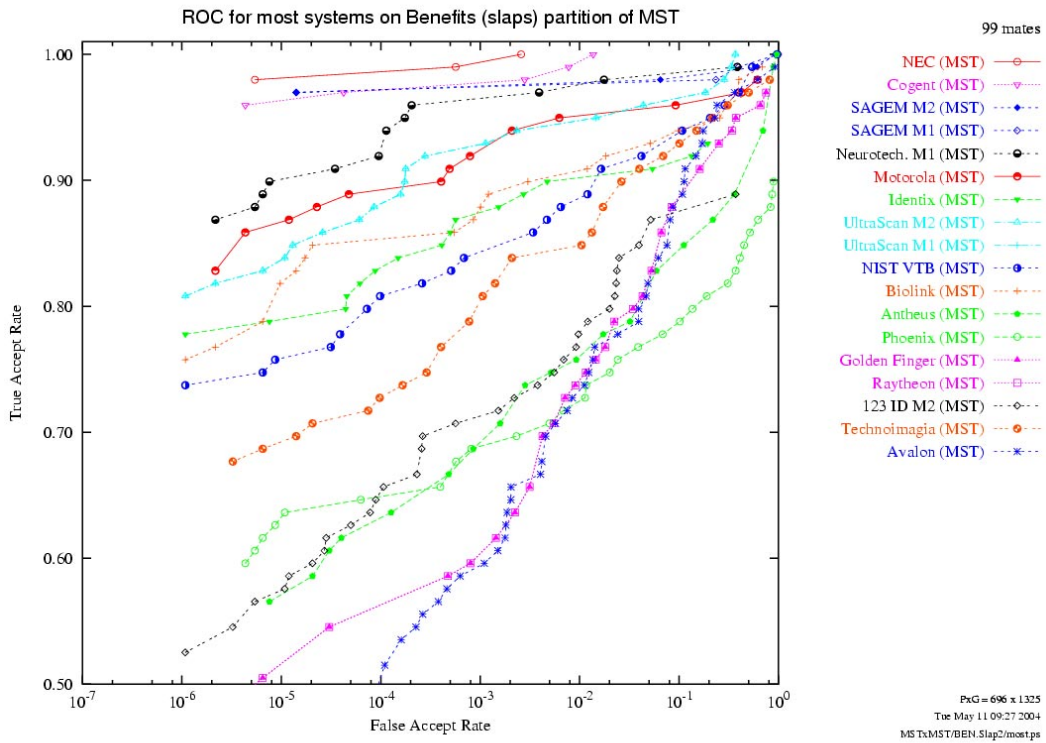


Figure D-15

Note that the y-scale of the DHS2 chart is extended to show the full range of performance.

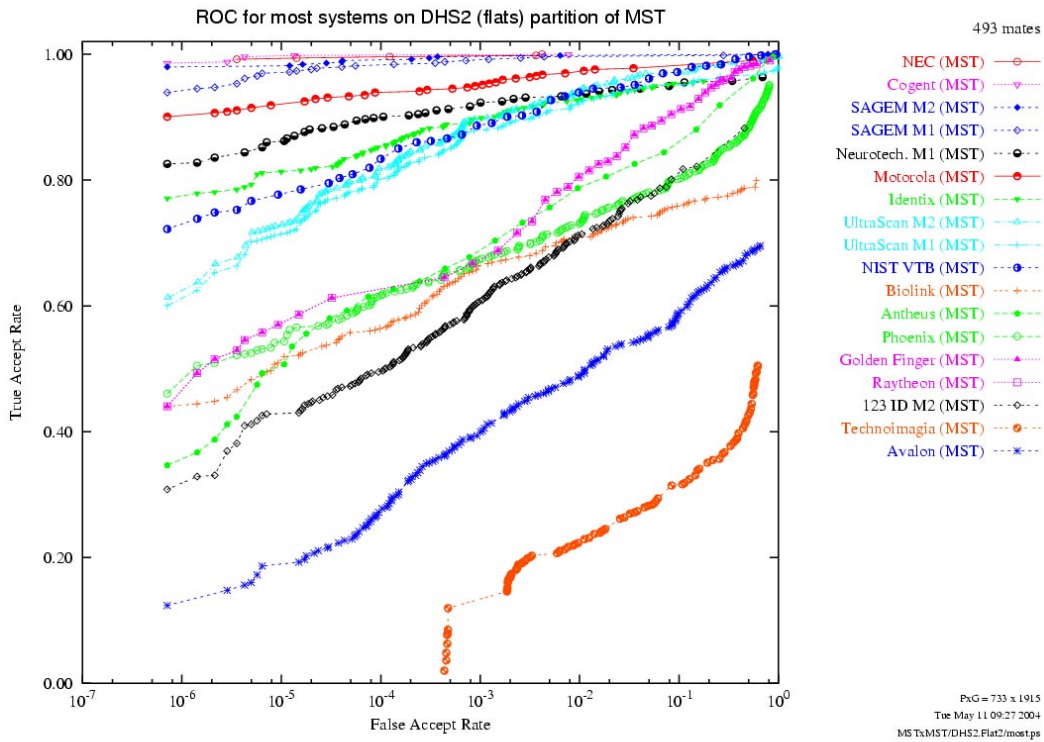


Figure D-16

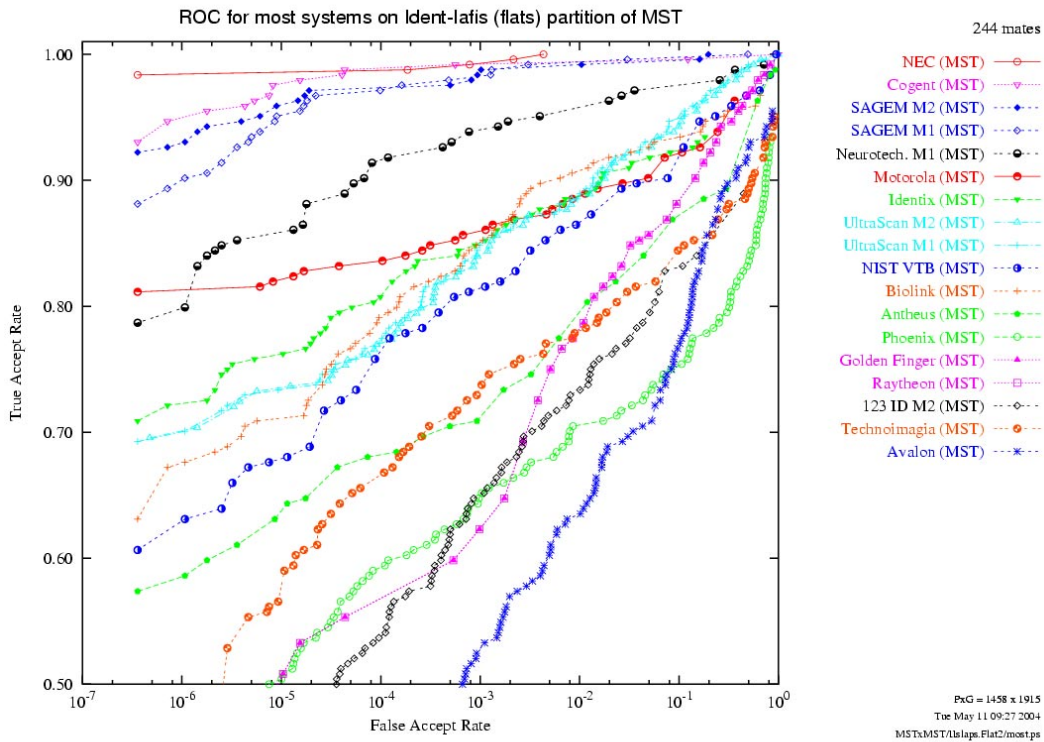


Figure D-17

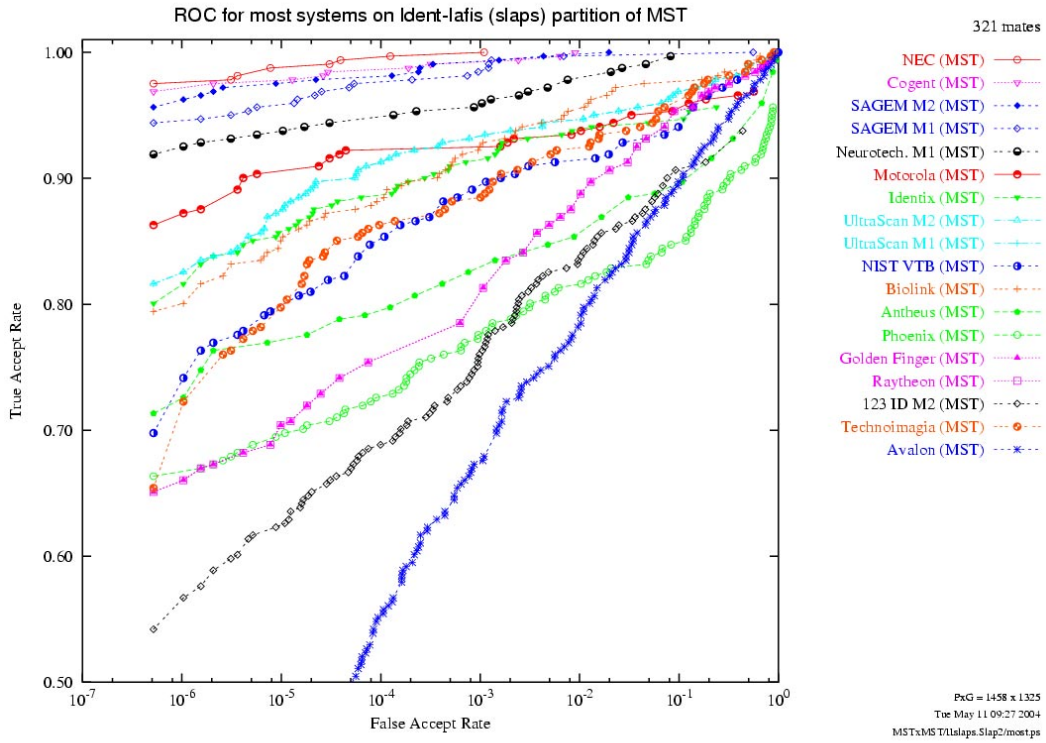


Figure D-18

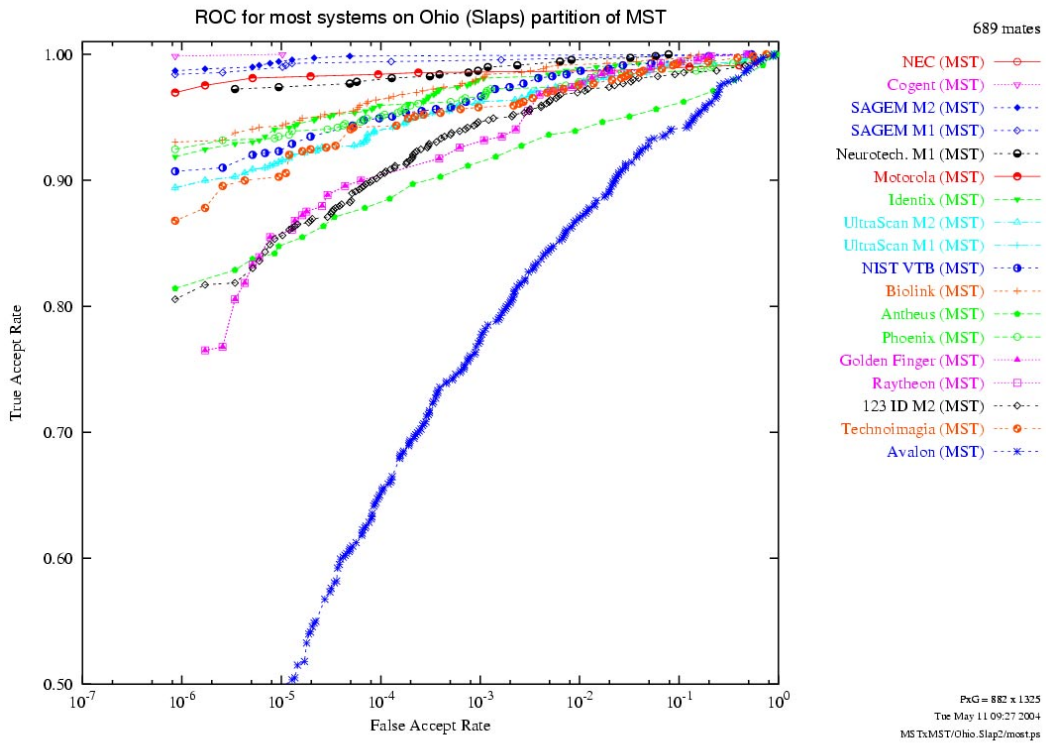


Figure D-19

### 3.4 Image Quality

The next four charts correspond to Figure 12 of the main report, showing accuracy on images of varying quality.

The range of the y-scale of these charts is extended to TAR=0.

Note that the number of mated pairs gets progressively lower over the four charts, corresponding to the quality distribution in the data.

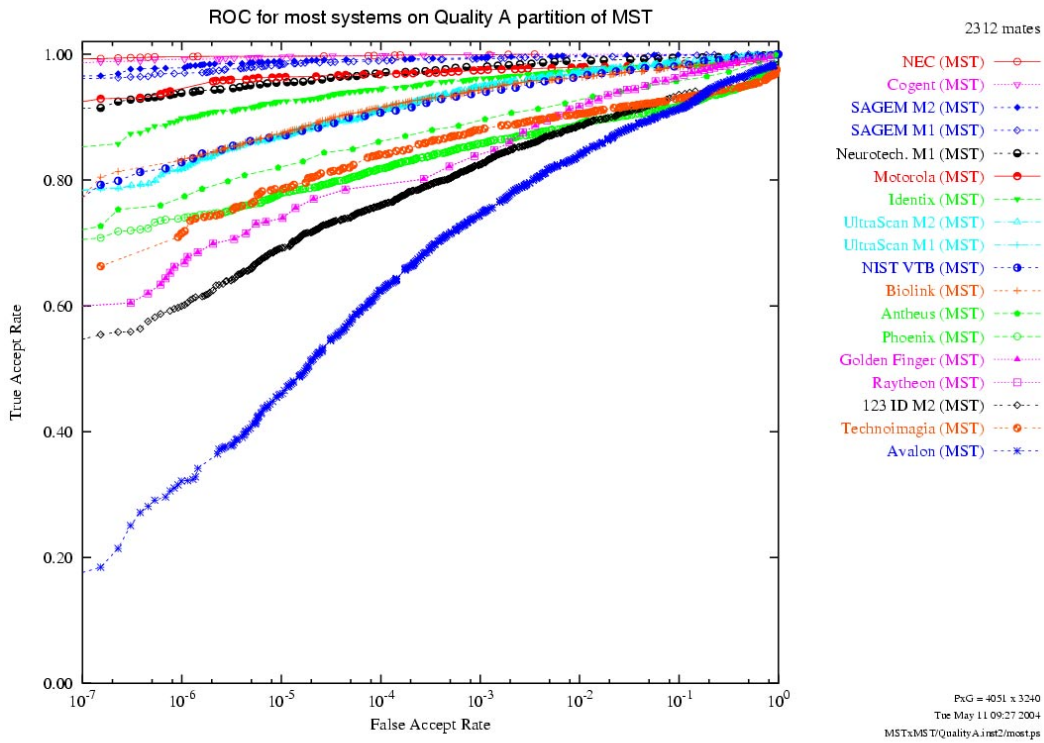


Figure D-20



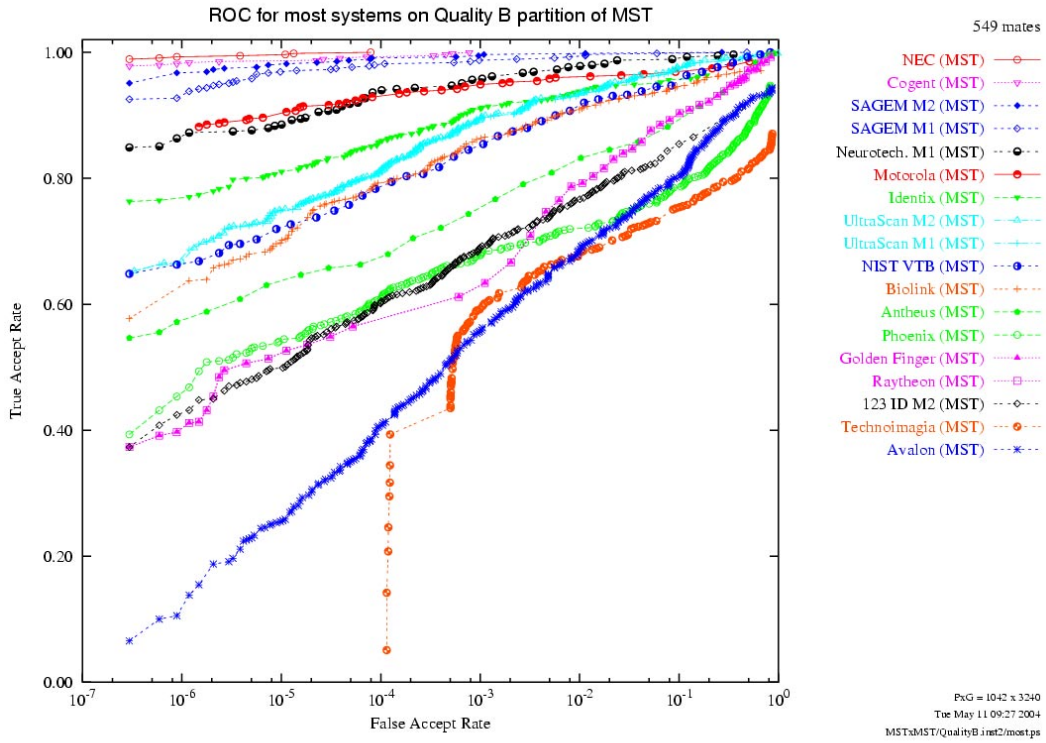


Figure D-21

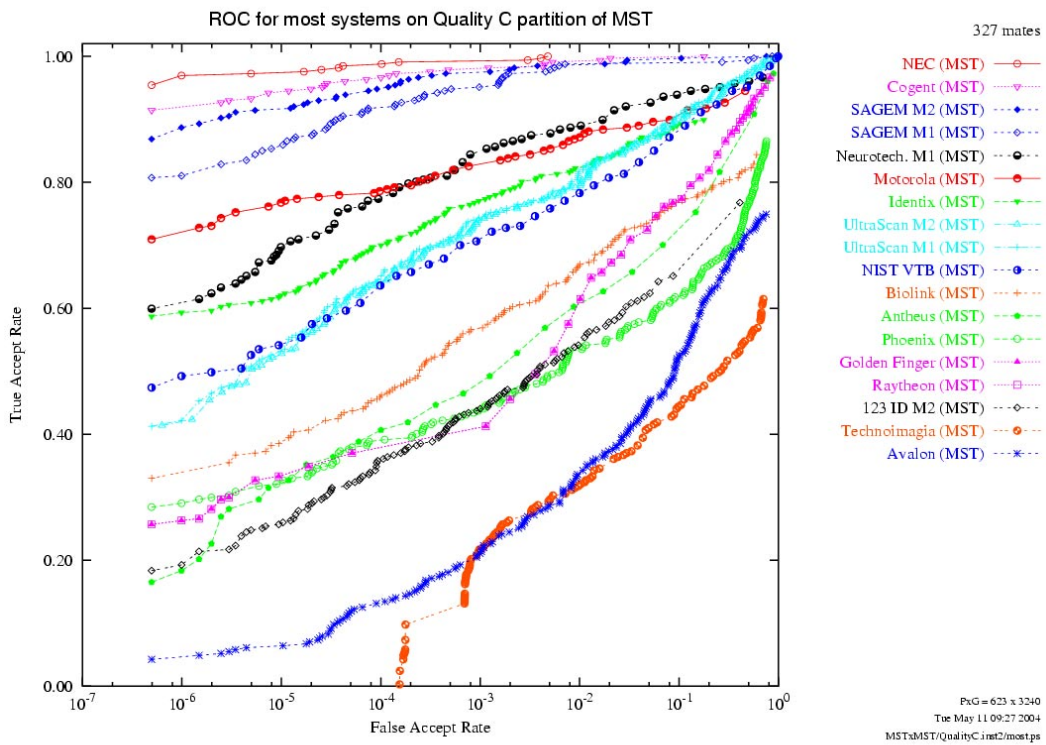


Figure D-22

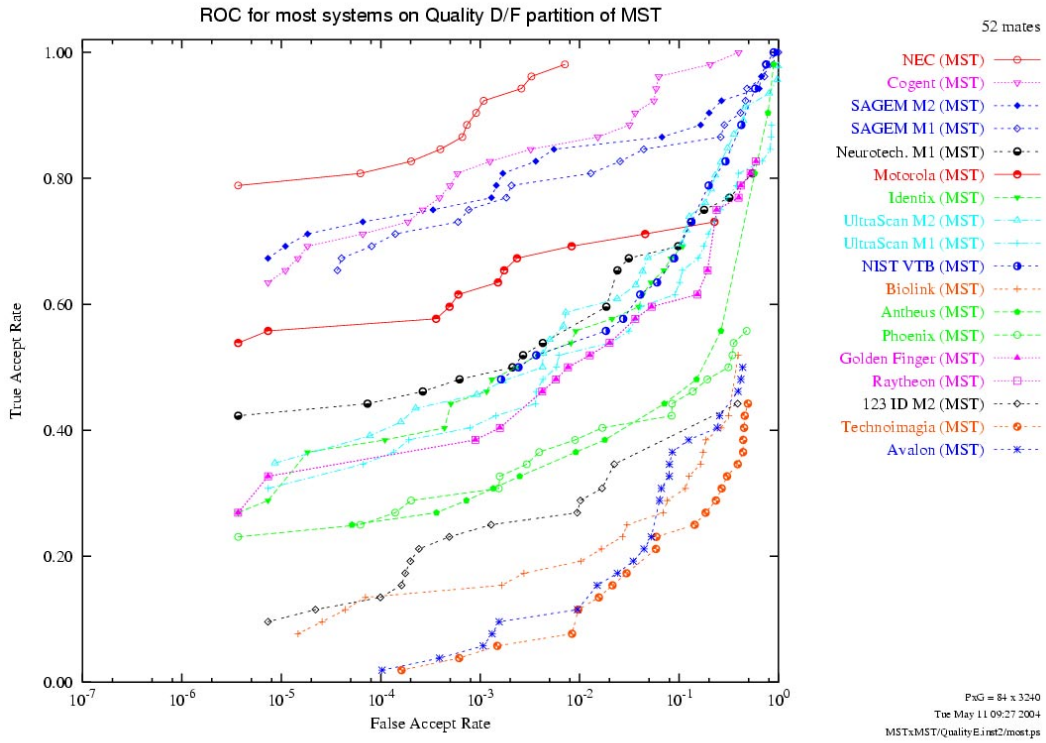


Figure D-23

## 4 SST

### 4.1 Detail of System Comparisons

The following table defines the partitions and shows the detail used to construct the SST system comparison charts in Section 4 of the FpVTE Analysis Report. These results correspond directly to Figure 10 in that document.

The systems are sorted by performance on the SST Standard partitions.

Note that these results are at FAR=10<sup>-3</sup>, *not* 10<sup>-4</sup> as is true for most of the charts in this report. This is because of the small size of SST.

<b>Comparison of Performance on SST Partitions</b>			
Values are True Accept Rates where the False Accept Rate = 10 <sup>-3</sup>			
<b>System</b>	<b>Standard</b>	<b>BCC</b>	<b>DHS2</b>
Probe set size	473	329	144
Gallery set size	368	368	368
# Mates	368	264	104
NEC (MST-SST)	0.999	0.998	1.000
Cogent (MST-SST)	0.997	0.996	1.000
Cogent (SST)	0.997	0.996	1.000
SAGEM M2 (MST-SST)	0.989	0.985	1.000
SAGEM M1 (MST-SST)	0.988	0.983	1.000
Motorola (MST-SST)	0.968	0.973	0.963
Neurotech. M1 (MST-SST)	0.953	0.966	0.923
Identix (MST-SST)	0.932	0.942	0.911
UltraScan M2 (MST-SST)	0.901	0.915	0.874
UltraScan M1 (MST-SST)	0.896	0.915	0.857
NIST VTB (MST-SST)	0.892	0.901	0.874
NIST VTB (SST)	0.892	0.901	0.874
Bioscrypt (SST)	0.885	0.972	0.668
Biolink (MST-SST)	0.838	0.923	0.627
Antheus (MST-SST)	0.828	0.886	0.670
Golden Finger (MST-SST)	0.752	0.760	0.741
Raytheon (MST-SST)	0.752	0.760	0.741
Phoenix (MST-SST)	0.728	0.744	0.694
123 ID M2 (MST-SST)	0.690	0.742	0.584
Technoimagia (MST-SST)	0.655	0.862	0.131
Avalon (MST-SST)	0.638	0.734	0.395

Table D-12

## 4.2 Image Source

Note that in all SST comparisons, the number of mated pairs is low due to the limited size of the test. On the second chart, no data is shown for Cogent because that system achieved perfect separation of mate and non-mate scores (TAR=1, FAR=0).

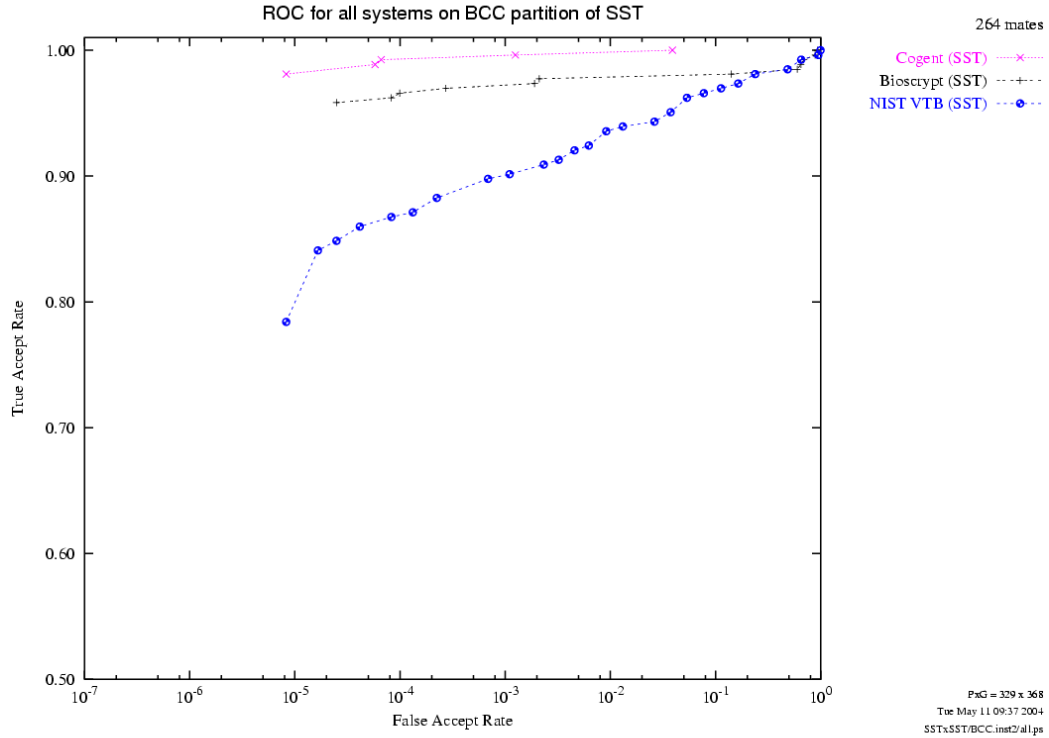
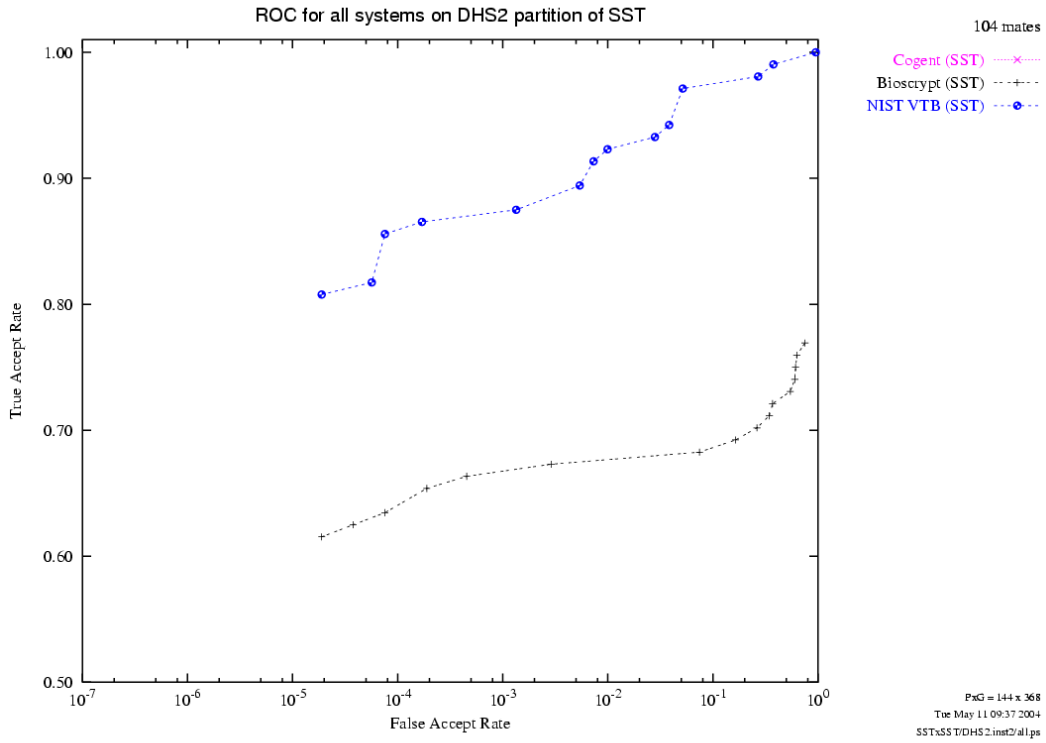


Figure D-24



**Figure D-25**

The following charts show the same results, but also include the MST systems' results for the corresponding SST partitions. Note that NEC, Cogent, and SAGEM M2 achieve perfect separation of the DHS2 match and non-match distributions in this FAR range, and therefore do not appear on the graph.

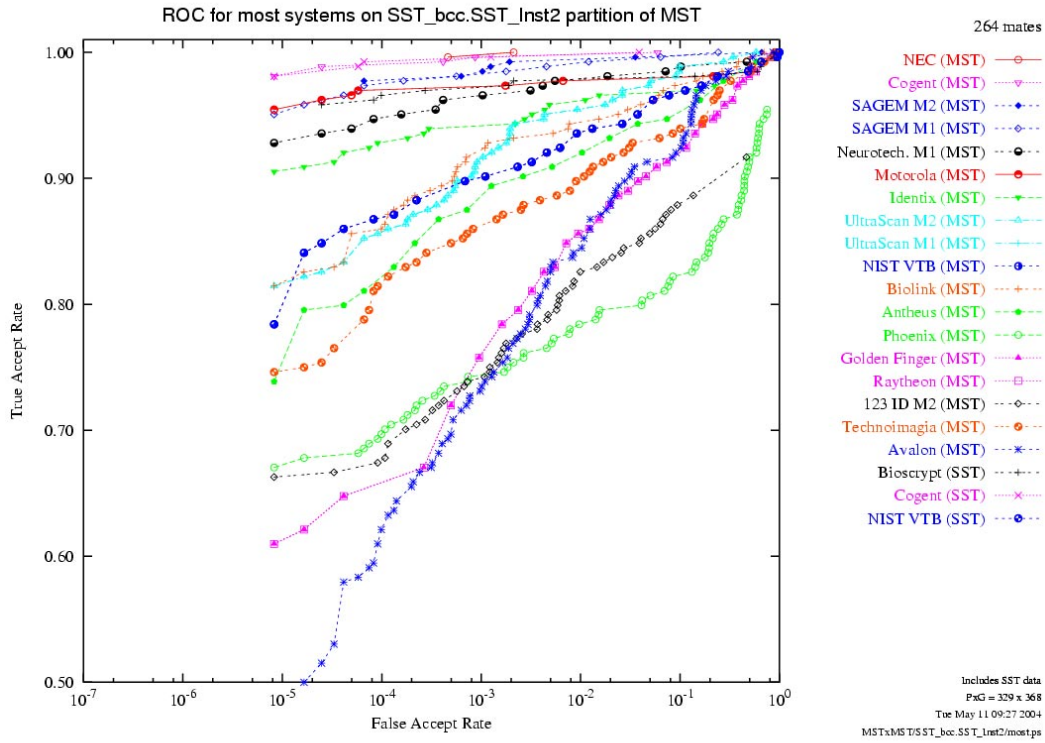


Figure D-26

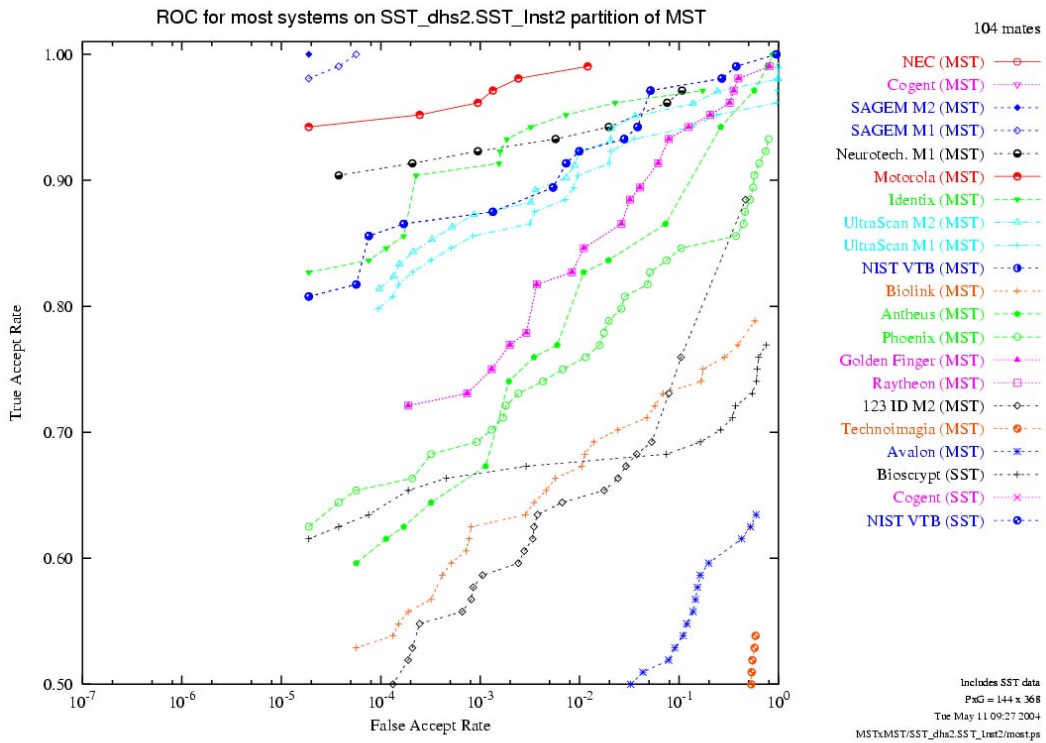


Figure D-27

### 4.3 Image Quality

These two charts roughly correspond to Figure 12 of the main report, except that these are for A and B quality data and SST systems. Note that the number of mated pairs is low on both charts (statistically small samples for estimating accuracy on these populations). Charts for Quality D and F data are not included here due to the small sizes of those sets.

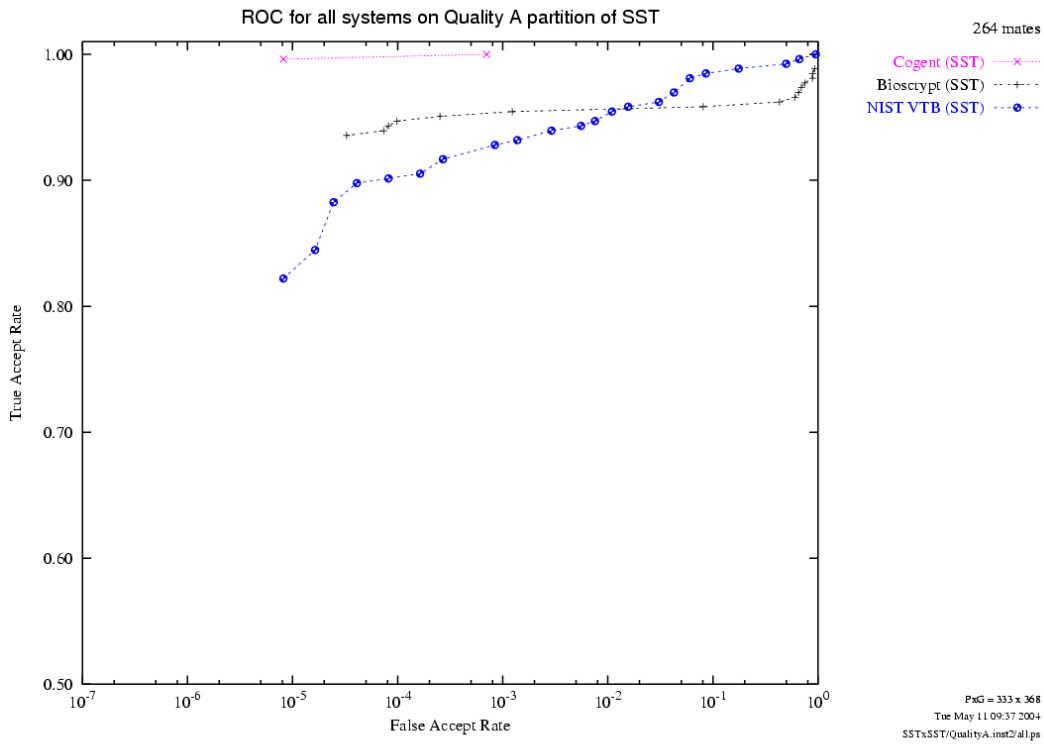


Figure D-28

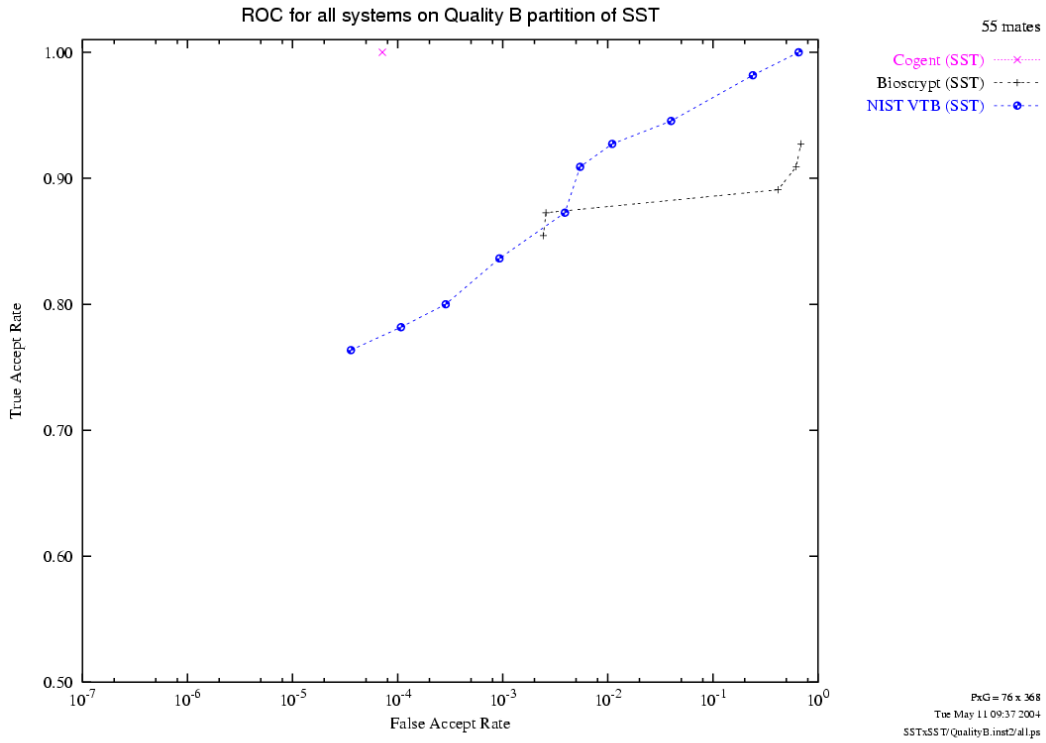


Figure D-29

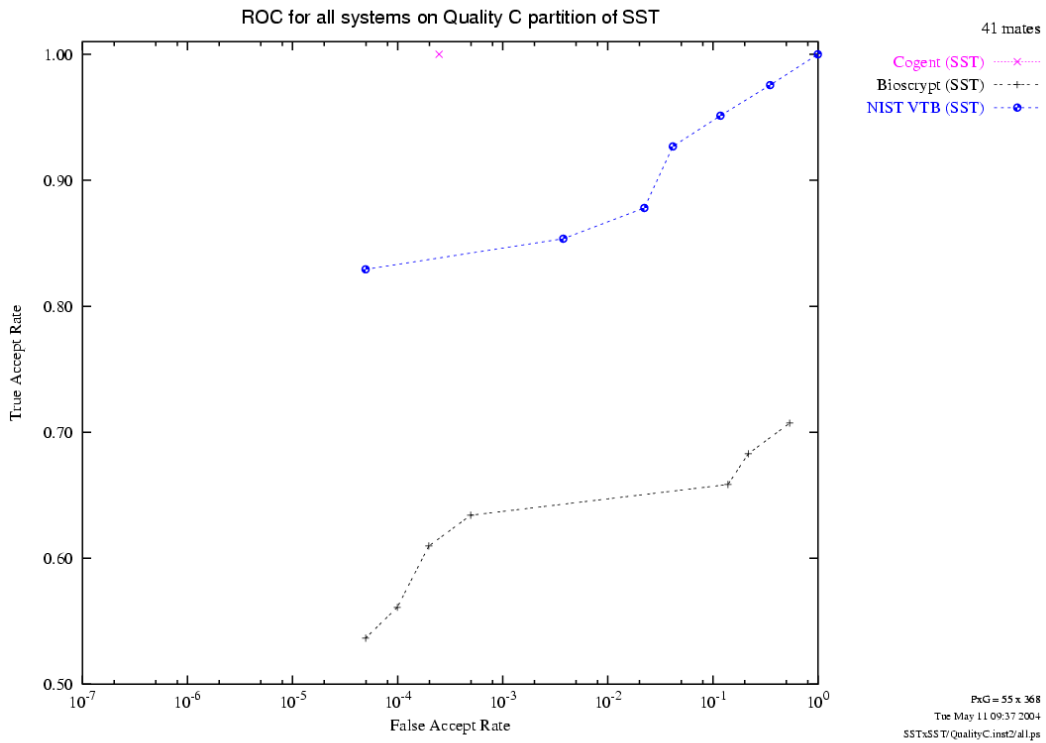


Figure D-30



## 5 Other Results

### 5.1 Relationship of Accuracy to System Size

The amount of hardware used by a system clearly had no relationship to accuracy in any FpVTE test. For example, Table D-13 shows the MST systems and hardware, sorted by their overall performance in MST. Three of the five most accurate systems were single-CPU systems, while the largest systems are at rank positions 6, 10, and 16 in the list.

System ID	Hardware	TMR @ FMR=10-4, MST Standard
1 NEC (MST)	3 dual Xeon	99.42%
2 Cogent (MST)	1 IBM xSeries 335 Server, dual CPU	99.14%
3 SAGEM M2 (MST)	1 Pentium4	98.27%
4 SAGEM M1 (MST)	1 Pentium4	97.65%
5 Neurotechnologija M1 (MST)	1 Pentium4	93.88%
6 Motorola (MST)	16 dual Xeon	93.44%
7 Identix (MST)	IBM X Series 8 Blade System	89.51%
8 UltraScan M2 (MST)	1 Pentium4	86.32%
9 UltraScan M1 (MST)	1 Pentium4	86.01%
10 NIST VTB (MST)	20 dual Xeon	85.03%
11 Biolink (MST)	1 Pentium4	83.54%
12 Antheus (MST)	1 dual Pentium4	77.27%
13 Phoenix (MST)	1 Pentium4	72.52%
14 Raytheon (MST)	2 Pentium4	70.71%
14 Golden Finger (MST)	4 dual Xeon	70.71%
16 123 ID M2 (MST)	16 HP xw6000 search nodes + HP a330n	67.31%
17 Technoimagia (MST)	1 dual Xeon	57.50%
18 Avalon (MST)	1 Pentium4	52.93%

Table D-13. Hardware and Accuracy for MST Systems

### 5.2 Relationship of Accuracy to Processing Time

The FpVTE evaluations were not intended to measure system throughput or speed: the only throughput requirement was that systems complete the test in the allotted time.

For MST, there was a limited relationship between each system's completion time and its accuracy, as shown in Table D-14. The three most accurate systems had three of the four longest completion times. Some systems allow tuning of algorithms so that increased processing time can result in higher accuracy, so it appears that the most accurate systems made effective use of the available time.

System ID	TMR @ FMR=10-4, MST Standard	Approx. Completion time (days)
1 NEC (MST)	99.42%	9
2 Cogent (MST)	99.14%	6
3 SAGEM M2 (MST)	98.27%	10
4 SAGEM M1 (MST)	97.65%	4
5 Neurotechnologija M1 (MST)	93.88%	2
6 Motorola (MST)	93.44%	1
7 Identix (MST)	89.51%	1
8 UltraScan M2 (MST)	86.32%	2
9 UltraScan M1 (MST)	86.01%	2
10 NIST VTB (MST)	85.03%	12
11 Biolink (MST)	83.54%	4
12 Antheus (MST)	77.27%	1
13 Phoenix (MST)	72.52%	5
14 Golden Finger (MST)	70.71%	1
14 Raytheon (MST)	70.71%	1
16 123 ID M2 (MST)	67.31%	1
17 Technomagia (MST)	57.50%	5
18 Avalon (MST)	52.93%	1

Table D-14. Completion Time and Accuracy for MST Systems

For LST, however, there was no significant relationship between each system’s completion time and its accuracy, as shown in Table D-15.

System ID	Distribution of TAR over 27 Operational LST Partitions where FAR = 10 <sup>-4</sup>			Approx. Completion time (days)
	Min	Average	Max	
NEC (LST)	0.983	0.997	1.000	19
SAGEM L1 (LST)	0.950	0.990	1.000	7
Cogent (LST)	0.952	0.988	1.000	8
SAGEM L2 (LST)	0.936	0.985	1.000	6
Dermalog (LST)	0.901	0.973	1.000	11
Motorola (LST)	0.869	0.966	0.999	18
Identix (LST)	0.739	0.932	0.995	6
NIST VTB (LST)	0.747	0.896	0.982	21
Biolink (LST)	0.658	0.881	0.997	6
Griaule (LST)	0.707	0.881	0.987	17
Golden Finger (LST)	0.441	0.861	0.994	12
Antheus (LST)	0.615	0.836	0.981	14
Raytheon (LST)	0.116	0.826	0.994	15

Table D-15. Completion Time and Accuracy for LST Systems

### 5.3 1:1 Matches

In FpVTE 2003, systems may internally have performed 1:1 (verification) matches, or 1:N (identification) matches; they were not constrained to perform 1:1 matches. Whether a system performed 1:1 or 1:N matches is of some interest during comparisons of identification and verification results; see Section 5.4 of the FpVTE Analysis Report for context.

Analysis showed that some systems in FpVTE did in fact perform true 1:1 matches. The trivial datasets were subsets of the evaluation datasets. These redundant comparisons provided a means to determine whether a system varied individual scores based on the test

context. The following MST systems always gave the same score for a comparison, regardless of context, which is indicative of unnormalized 1:1 matches:

- Golden Finger
- Identix
- NIST VTB
- Raytheon
- SAGEM M1
- SAGEM M2
- Technoimagia
- UltraScan M1
- UltraScan M2

Note that performing 1:1 matches was not required of systems. Being on this list is of interest during analysis, and should *not* be viewed as either preferable or problematic in any way.