Real-time CORBA Trade Study

Volume 5 – Scenario 5

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AUTHOR:	H. Rebecca Callison and Daniel G. Butler	9-5430	
	Sign and type: First Name MI Last Name	Org. Number	Date
APPROVAL:	Marilynn B. Goo	9-5430	
	Sign and type: First Name MI Last Name	Org. Number	Date
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1. Introduction

This volume presents the results for testing under Basic IDL Scenario 5: Client and Server on Different LynxOS/PPCs, 70 ms Frame Time. For this scenario, we report comparative data for ORB*express* and TAO only.

2. Call & Return Operations

For the Call & Return Operations tests, we report four sets of results: (1) “float” operations as representative of all transfers involving primitive data types, (2) aligned records, (3) non-aligned records and (4) CORBA Any transfers.

2.1 Summary Data: All Transfer Types

Figure 1 summarizes the performance of ORB*express* and TAO when the BasicIDL test is executed with client and background processes running on one LynxOS/PPC computer, the server on a second. The two LynxOS/PPC hosts are connected via a 10Mbps Ethernet.

Scenario 5: Client, Server on Different LynxOS/PPC Hosts

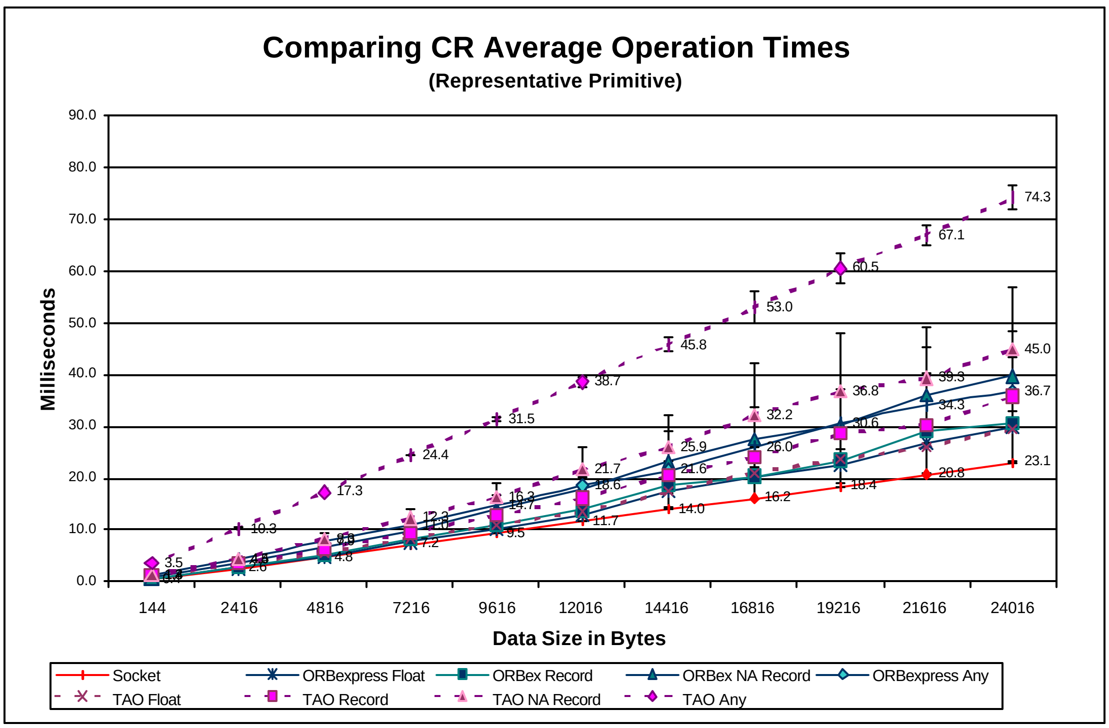


Figure 1. Call & Return Operations in Networked LynxOS/PPCs: Average

Each of the lines in the graph captures the *average* operation time for messages of increasing size for transfers involving a particular data type. Socket data plus representative ORB operations times are presented. Since all of the ORBs under evaluation use sockets to transfer data internally within the ORB, the socket performance represents a practical lower bound on the performance that can be achieved, helping us isolate the overhead added by the ORB. In this scenario, the socket measurements also help identify the underlying cost of transferring requests over a network. As with the single machine scenario, the socket performance we measured should not be construed as the best performance that can be achieved on basic sockets. We tuned our socket program just enough to get rid of obvious knees, peaks, and valleys for the program under test but did not explore the limits of socket performance.

Unless otherwise noted, any error bars in the graphs of this section depict the range of one standard deviation around the mean observed operation time. We use these bars to visually convey an impression of the temporal predictability of operations in the series.

The most striking feature of Figure 1 is the magnitude of the error bars in the primitive, record, and NA record transfers from data size 4816 up. In this case, the error bars indicate jittery behavior in both ORBs as shown in Figure 2 and Figure 3 for ORB*express* and TAO, respectively. These figures show measurements for the Float transfers, but we recorded similar behavior for other data types as well.

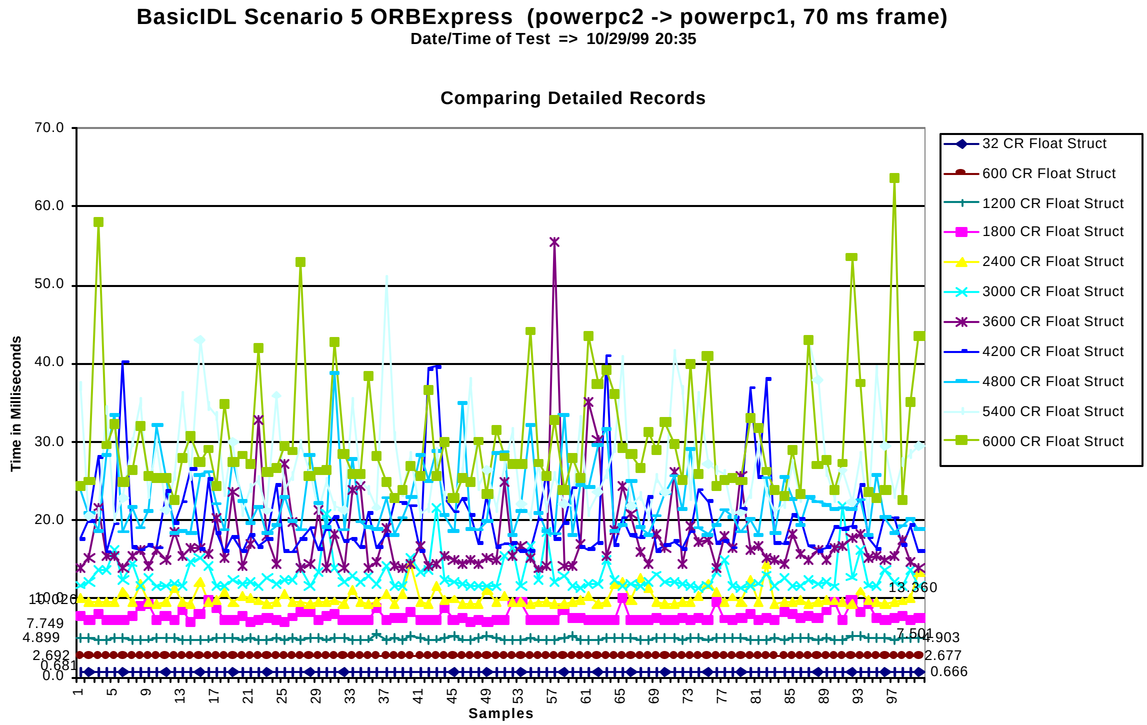


Figure 2. Detailed Performance Data: ORB*express* CR Floats

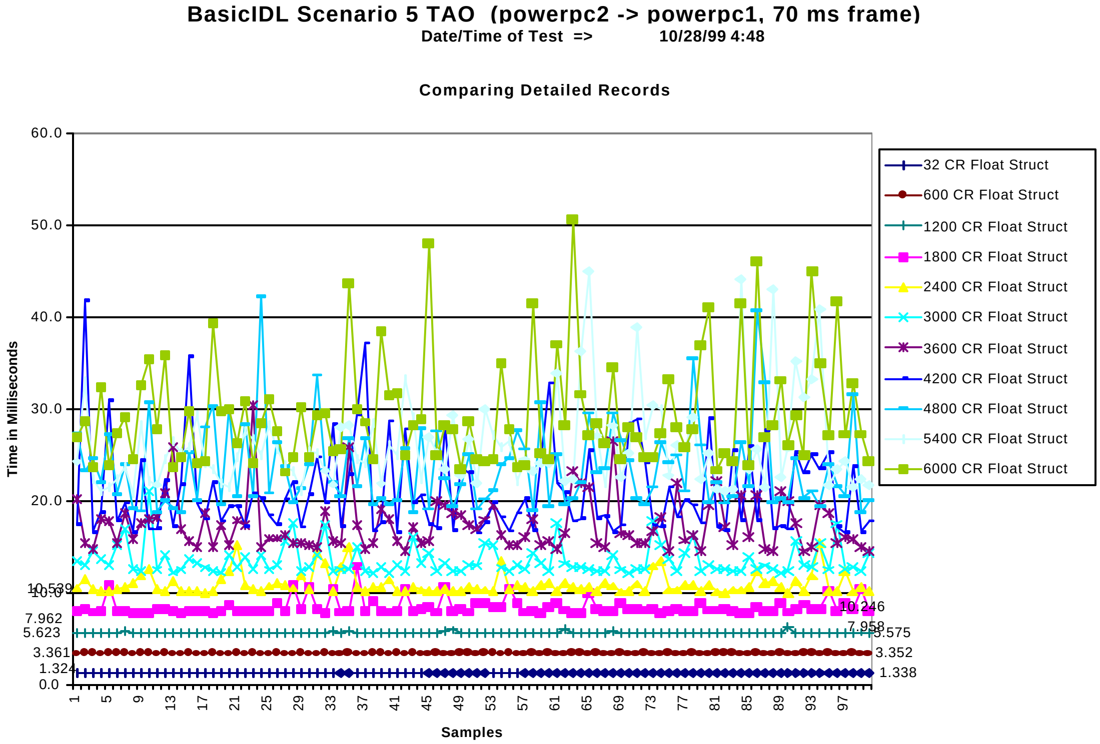


Figure 3. Detailed Performance Data: TAO CR Floats

2.2 Records and Primitives

In Figure 4 we removed CORBA Any transfers from the graph, enabling a closer look at other transfer methods and data types. With the 10 Mbps ethernet inserted into the path between client and server, some of the relationships between ORBs in Scenario 3a change. As shown, ORB*express* and TAO results for primitive data are very similar. As the size of the data increases, the advantage on average transfer time flip-flops between ORBexpress and TAO for this series of tests.

We calculated trend line equations for transfer of the “float” primitive data (and other CR data sets), but they have little value for these data sets, because the noise of the environment obscures the behavior attributable to the individual ORB.

2.3 Aligned Records

ORB*express* handles records in this environment with greater efficiency than TAO recording lower average operation times at all data sizes. Once again, trend line equations are omitted because they characterize the noise level in the system more than ORB behavior.

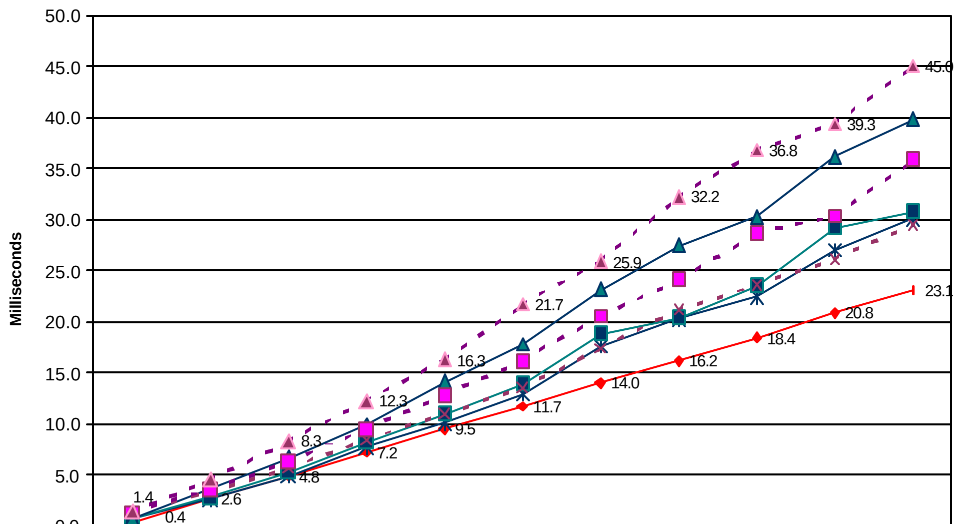
2.4 Non-Aligned Records

As with the Aligned Records, the addition of the network does not significantly change the relative performance for the non-aligned record format that we observed in Scenario 3a.

Scenario 5: Client, Server on Different LynxOS/PPC Hosts

Comparing CR Average Operation Times

(Representative Primitive, No Any)



Data Size in Bytes	144	2416	4816	7216	9616	12016	14416	16816	19216	21616	24016
Socket	0.43642	2.61727	4.84801	7.24061	9.47941	11.7080	13.9840	16.2124	18.4411	20.8436	23.0721
ORBexpress Float	0.661	2.659	4.943	7.757	10.107	12.938	17.560	20.231	22.463	27.006	30.087
ORBex Record	0.677	2.850	5.316	8.251	10.965	13.932	18.867	20.406	23.520	29.144	30.769
ORBex NA Record	0.704	3.599	6.656	9.955	14.138	17.810	23.171	27.477	30.276	36.155	39.769
TAO Float	1.317	3.366	5.640	8.465	10.946	13.518	17.403	21.167	23.624	26.105	29.514
TAO Record	1.333	3.611	6.281	9.486	12.777	16.183	20.541	24.083	28.648	30.325	35.892
TAO NA Record	1.369	4.504	8.290	12.258	16.323	21.687	25.937	32.239	36.813	39.342	45.049

Figure 4. Call & Return Operations in Networked LynxOS/PPCs
(“Any” Transfers Removed)

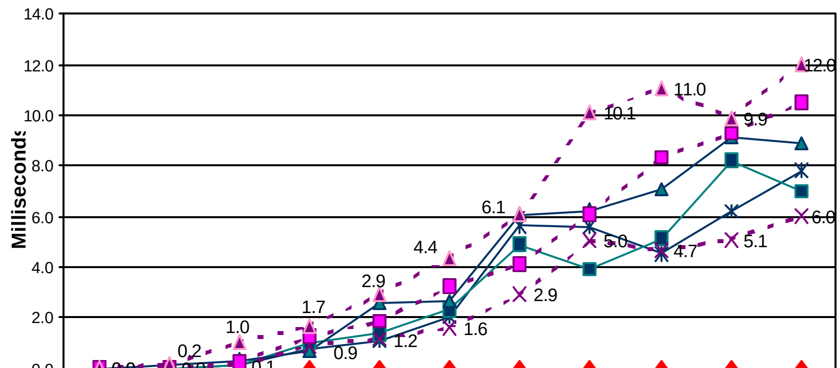
2.5 Standard Deviations

Figure 5 plots standard deviations calculated for the data sets of the scenario. In studying these graphs, we are looking for data sets with unusual jitter and/or the highest number of or most excessive anomalies. In this graph the large standard deviations attest to the jitter observed in CR operation times (e.g., Figure 2 and Figure 3).

Scenario 5: Client, Server on Different LynxOS/PPC Hosts

Comparing CR Operation Standard Deviations

(Representative Primitive, No Any)



Data Size in Bytes	144	2416	4816	7216	9616	12016	14416	16816	19216	21616	24016
Socket	0.0064	0.0032	0.0057	0.0042	0.003	0.0028	0.0068	0.0045	0.0037	0.0031	0.0047
ORBexpress Float	0.0095	0.0091	0.119	0.7421	1.0742	2.0423	5.6198	5.6105	4.5133	6.218	7.8039
ORBexpress Record	0.0098	0.0072	0.1403	1.0001	1.3643	2.2996	4.895	3.9248	5.1279	8.2085	7.0112
ORBexpress NA Record	0.0109	0.1313	0.3296	0.6785	2.5783	2.6584	6.0917	6.2254	7.0931	9.1299	8.8838
TAO Float	0.009	0.015	0.1044	0.8998	1.1649	1.6119	2.9133	5.0478	4.6634	5.0813	6.0278
TAO Record	0.0103	0.0226	0.2333	1.2631	1.8682	3.2389	4.1198	6.099	8.3235	9.2737	10.492
TAO NA Record	0.0091	0.1611	1.0414	1.6743	2.9203	4.3584	6.0816	10.1	11.046	9.8964	12.02

Figure 5. Standard Deviations for Scenario 5 CR Operations

3. One-way Operations

The measurements for one-way operations do not generally demonstrate the trend to jitter we observed in the CR operations between two LynxOS/PPC platforms. Figure 6 shows average operation time, including CORBA Any transfers. CORBA Any's are removed in Figure 7. ORB*express* now exhibits a slight but consistent advantage over TAO for operations on primitive data types. This advantage increases for Records and NA Records.

Table 1, Table 2, and Table 3 capture the one-way trend line equations.

Standard deviations are plotted in Figure 8. In contrast with the standard deviations for Call & Return operations, these values remain relatively small.

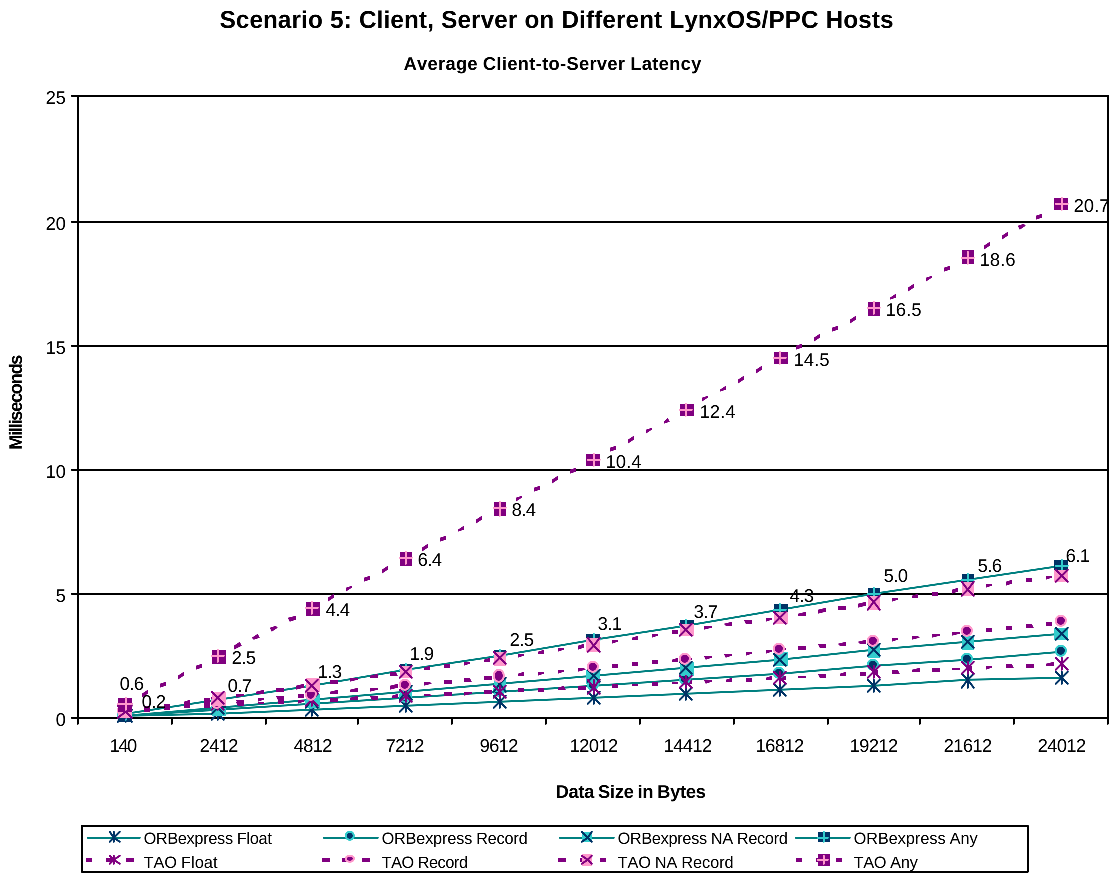
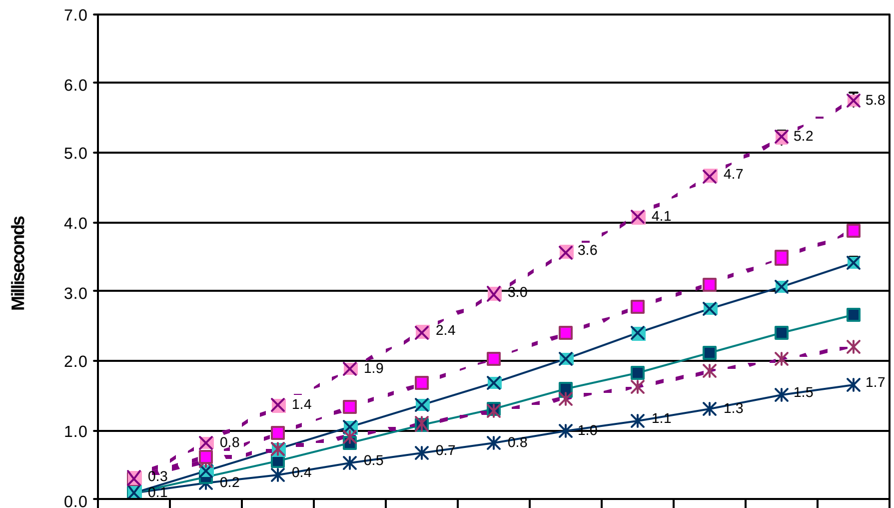


Figure 6. One-way Operations in Networked LynxOS/PPCs: Average

Comparing OW Average Operation Times
(Representative Primitive, No Any)



Data Size in Bytes	144	2416	4816	7216	9616	12016	14416	16816	19216	21616	24016
ORBexpress Float	0.096	0.2292	0.3661	0.539	0.6842	0.8212	0.9938	1.1451	1.3043	1.5207	1.663
ORBexpress Record	0.1039	0.3357	0.5674	0.8284	1.066	1.3075	1.583	1.8315	2.1131	2.3984	2.6568
ORBexpress NA Record	0.1076	0.4136	0.7203	1.0433	1.3652	1.6919	2.0271	2.3984	2.7443	3.0723	3.4144
TAO Float	0.2994	0.5624	0.7279	0.9152	1.0913	1.2772	1.4617	1.6317	1.8518	2.0225	2.2091
TAO Record	0.3061	0.6274	0.9548	1.3277	1.6819	2.0385	2.391	2.7692	3.1059	3.4835	3.8596
TAO NA Record	0.3123	0.8241	1.3561	1.8825	2.4144	2.9651	3.5658	4.0698	4.6625	5.2175	5.7559

Figure 7. One-way Operations in Networked LynxOS/PPCs: Average, No Any

Table 1. Comparative Trends in One-way Primitives

Middleware used	Trend line equations for "float" operations
ORB*express*	y = 0.00007x + 0.05928
TAO	y = 0.00008x + 0.33825

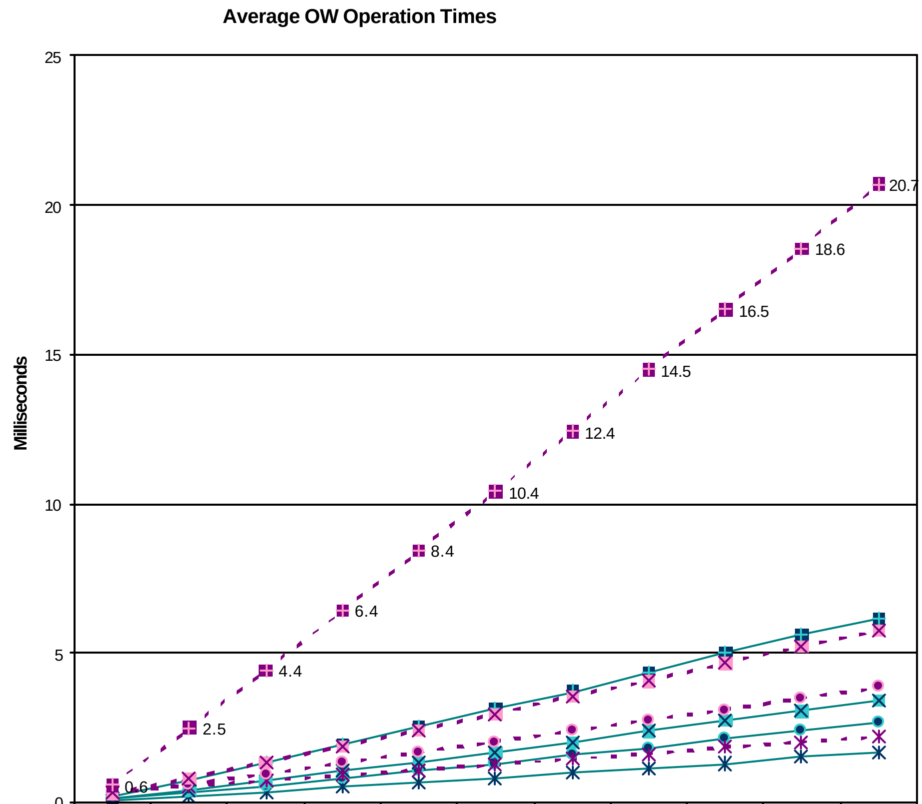
Table 2. Comparative Trends in One-way Records

Middleware used	Trend line equations for "Record" operations
ORB*express*	y = 0.00011x + 0.05784
TAO	y = 0.00015x + 0.25756

Table 3. Comparative Trends in One-way NA Records

Middleware used	Trend line equations for "NA Record" operations
ORB*express*	y = 0.00014x + 0.05494
TAO	y = 0.00023x + 0.25128

Scenario 5: Client, Server on Different LynxOS/PPC Hosts



Data Size in Bytes	140	2412	4812	7212	9612	12012	14412	16812	19212	21612	24012
ORBexpress Float	0.09598	0.22921	0.36612	0.53896	0.68419	0.82122	0.99377	1.14508	1.3043	1.5207	1.66301
ORBexpress Record	0.10391	0.33569	0.56738	0.82841	1.06596	1.30755	1.58299	1.83146	2.11315	2.39838	2.65679
ORBexpress NA Record	0.10764	0.41359	0.72031	1.04325	1.36523	1.69187	2.02712	2.39837	2.7443	3.07231	3.41443
ORBexpress Any	0.17724	0.73406	1.34579	1.94462	2.52483	3.13404	3.71882	4.34231	5.00452	5.599	6.14986
TAO Float	0.2994	0.56241	0.7279	0.91515	1.0913	1.27715	1.46172	1.63171	1.85178	2.02249	2.20911
TAO Record	0.30606	0.62744	0.95478	1.32767	1.68186	2.03849	2.39101	2.76916	3.10586	3.48349	3.85955
TAO NA Record	0.31234	0.82409	1.35613	1.88249	2.41437	2.96506	3.5658	4.06978	4.66253	5.21751	5.75593
TAO Any	0.58737	2.5043	4.43689	6.44195	8.43707	10.4125	12.4309	14.5076	16.5034	18.5604	20.6993

Figure 8. One-way Operations in Networked LynxOS/PPCs: Standard Deviations

4. Server Side Data

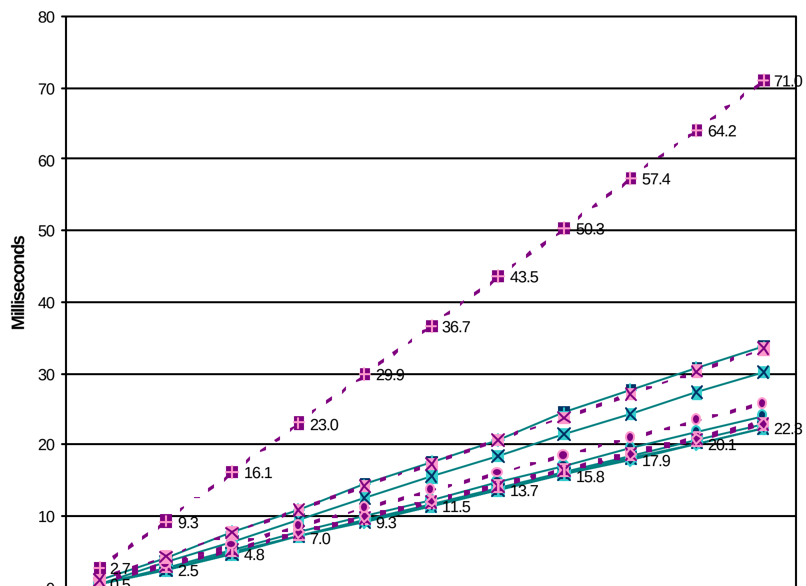
Figure 9, Figure 10, and Figure 11 display the client-to-server latencies we measured between client and server running in different LynxOS/PPC platforms. In reporting this data, we do not adjust the latency for estimated discrepancies between clocks on the client and server machines. Although clocks were synchronized using NTP, we were unable to achieve synchronization accuracy that was adequate to produce adjusted numbers in which we had reasonable confidence.

The average latencies are consistent with expectation, given the measured operation times reported for the client CR operations. (Caveats regarding absolute accuracy, as discussed for

Solaris measurements in Volume 3, still apply. Because of low confidence in the accuracy of the clock synchronization, the absolute latency may be plus or minus a few hundred microseconds of the reported measurement.) It is noteworthy that the standard deviations for client-to-server latency are small, growing with data size but maxing out well under a millisecond for the largest data sizes. These measurements contrast sharply with the more jittery results for the Call & Return operations on the client side, indicating that the irregular timing behavior occurs during the return of the operation response to the client. We are working with the ORB vendors and LynxOS to identify the causes of this behavior.

Scenario 5: Client, Server on Different LynxOS/PPC Hosts

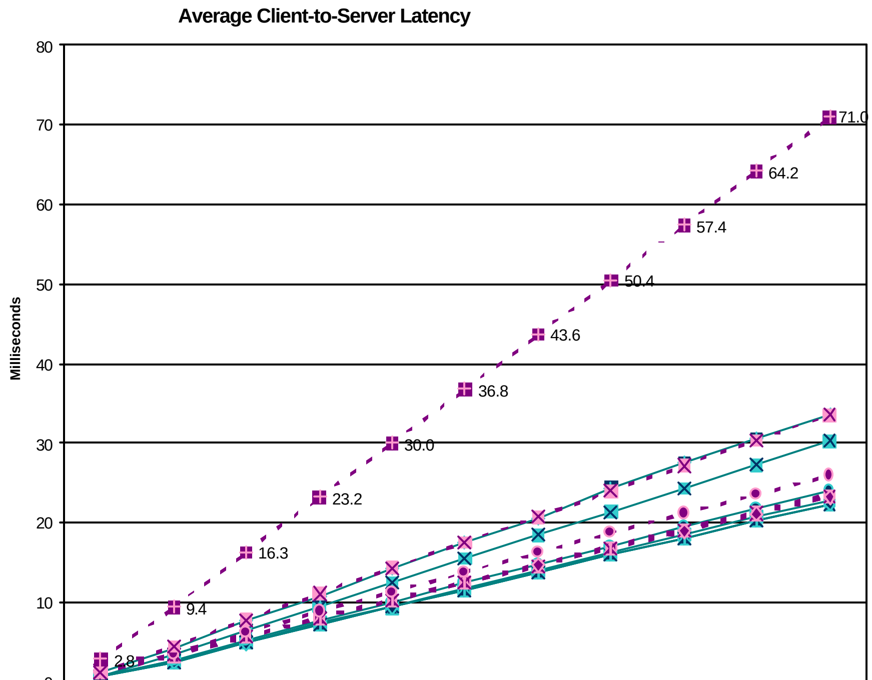
Average Client-to-Server Latency



Data Size in Bytes	140	2412	4812	7212	9612	12012	14412	16812	19212	21612	24012
ORBexpress CR Short	0.4688	2.5241	4.8365	7.2188	9.4884	11.747	14.024	16.211	18.344	20.642	22.762
ORBexpress CR Long	0.4584	2.4661	4.7476	7.0783	9.2857	11.479	13.604	15.862	18.007	20.198	22.328
ORBexpress CR Float	0.463	2.4713	4.751	7.09	9.253	11.481	13.678	15.872	18.039	20.185	22.325
ORBexpress CR Double	0.4634	2.4682	4.7639	7.0492	9.2623	11.477	13.708	15.777	17.928	20.133	22.273
ORBexpress CR Record	0.4766	2.6533	5.1081	7.6168	10.042	12.352	14.675	17.076	19.398	21.751	24.043
ORBexpress CR NA Record	0.5368	3.4321	6.4283	9.5206	12.519	15.494	18.469	21.416	24.304	27.257	30.279
ORBexpress CR Any	1.0945	4.1397	7.6426	10.799	14.317	17.481	20.561	24.442	27.57	30.605	33.668
TAO CR Short	0.8669	2.9441	5.2738	7.6581	9.8922	12.165	14.419	16.609	18.925	21.084	23.2
TAO CR Long	0.8724	2.9309	5.2144	7.5526	9.7851	11.982	14.253	16.341	18.562	20.698	22.868
TAO CR Float	0.9137	2.9733	5.245	7.6396	9.8134	12.024	14.29	16.392	18.628	20.799	22.978
TAO CR Double	0.964	3.0213	5.3058	7.7185	9.8956	12.083	14.314	16.445	18.658	20.785	22.973
TAO CR Record	1.0264	3.3179	5.9274	8.5533	11.088	13.543	15.988	18.491	20.927	23.369	25.794
TAO CR NA Record	1.1145	4.2497	7.6158	10.886	14.201	17.39	20.656	23.829	27.056	30.304	33.44
TAO CR Any	2.7169	9.294	16.118	23.014	29.861	36.67	43.549	50.298	57.405	64.167	71.034

Figure 9. Client to Server Latency: CR Operations between LynxOS/PPCs

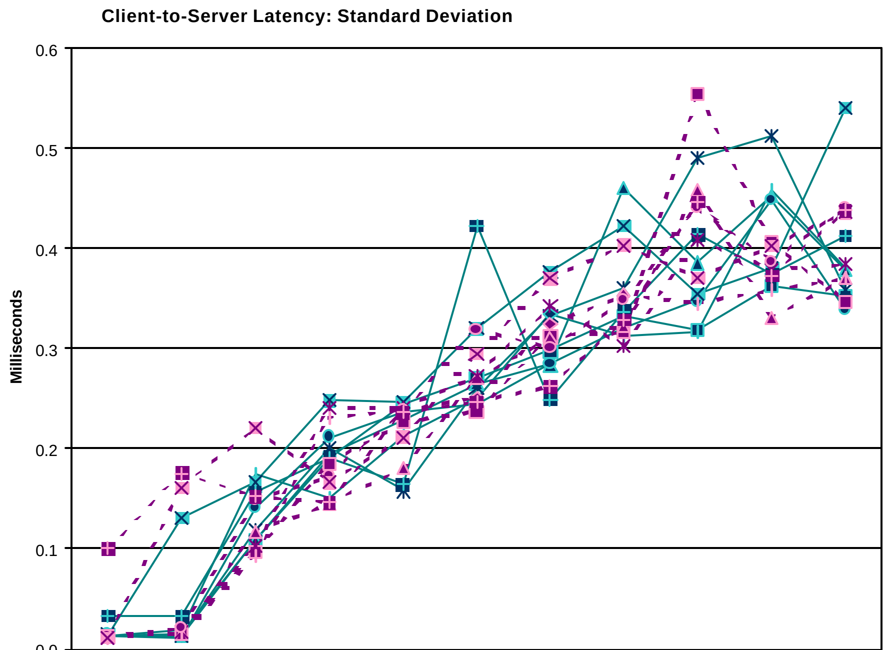
Scenario 5: Client, Server on Different LynxOS/PPC Hosts



Data Size in Bytes	140	2412	4812	7212	9612	12012	14412	16812	19212	21612	24012
ORBexpress OW Short	0.53565	2.59732	4.90279	7.33613	9.56164	11.7926	14.0619	16.2279	18.4397	20.6955	22.8114
ORBexpress OW Long	0.52205	2.53483	4.82504	7.15634	9.32943	11.5562	13.698	15.9112	18.0714	20.2362	22.3197
ORBexpress OW Float	0.52156	2.53712	4.82353	7.16768	9.36704	11.5647	13.6783	15.9137	17.9891	20.2282	22.2818
ORBexpress OW Double	0.52415	2.5363	4.8084	7.18111	9.34028	11.5254	13.6873	15.9365	18.0361	20.2915	22.378
ORBexpress OW Record	0.53321	2.71565	5.16199	7.7167	10.0124	12.3755	14.7569	17.0624	19.3877	21.7236	24.0503
ORBexpress OW NA Record	0.56186	3.46267	6.48282	9.53015	12.4795	15.4688	18.4619	21.3644	24.3082	27.2751	30.2137
ORBexpress OW Any	1.10477	4.13704	7.69728	10.8208	14.2955	17.4808	20.5714	24.3883	27.5271	30.6247	33.6178
TAO OW Short	1.18429	3.28908	5.64289	8.07121	10.3072	12.5657	14.7881	17.0364	19.2548	21.4602	23.568
TAO OW Long	1.24647	3.31371	5.62085	7.95516	10.2263	12.3839	14.6061	16.7724	18.9625	21.0838	23.2042
TAO OW Float	1.27314	3.33587	5.63461	8.00448	10.2221	12.4687	14.5727	16.7822	18.9453	21.149	23.3263
TAO OW Double	1.29403	3.34828	5.63768	7.97896	10.2328	12.3813	14.6054	16.7338	18.8817	21.1141	23.1511
TAO OW Record	1.26065	3.5464	6.17888	8.81513	11.3073	13.7157	16.2156	18.6909	21.138	23.5112	25.8967
TAO OW NA Record	1.26465	4.41404	7.79602	11.0767	14.3196	17.5541	20.7256	23.937	27.1444	30.3781	33.483
TAO OW Any	2.80644	9.37615	16.2995	23.1912	29.9858	36.7548	43.6203	50.4282	57.378	64.2204	71.0061

Figure 10. Client to Server Latency: OW Operations between LynxOS/PPCs

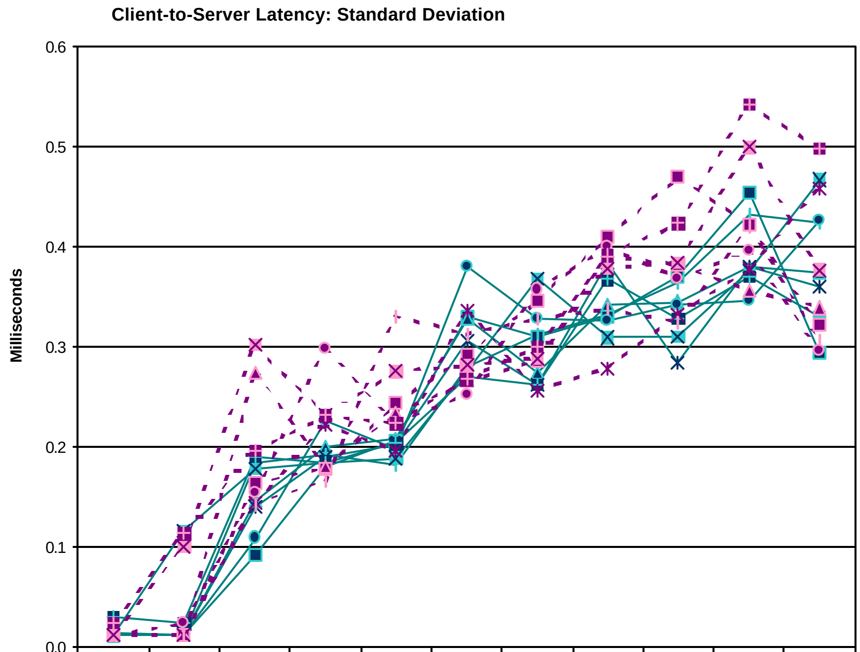
Scenario 5: Client, Server on Different LynxOS/PPC Hosts



Data Size in Bytes	140	2412	4812	7212	9612	12012	14412	16812	19212	21612	24012
ORBexpress CR Short	0.0134	0.0151	0.1086	0.1909	0.2441	0.2709	0.2979	0.3319	0.3182	0.3621	0.3529
ORBexpress CR Long	0.0141	0.0123	0.1093	0.1957	0.2281	0.2648	0.2838	0.4599	0.3858	0.4536	0.378
ORBexpress CR Float	0.0134	0.0137	0.1198	0.2008	0.1579	0.2603	0.332	0.3597	0.491	0.5133	0.3587
ORBexpress CR Double	0.0139	0.019	0.1751	0.1514	0.2124	0.2517	0.3355	0.3119	0.3168	0.459	0.3807
ORBexpress CR Record	0.0141	0.0119	0.1406	0.2118	0.2377	0.2446	0.2846	0.3202	0.3479	0.4493	0.3395
ORBexpress CR NA Record	0.014	0.1311	0.1658	0.2485	0.247	0.3203	0.3762	0.4225	0.3553	0.3812	0.541
ORBexpress CR Any	0.0329	0.0326	0.1575	0.1918	0.164	0.4232	0.2487	0.3376	0.4143	0.3738	0.4128
TAO CR Short	0.0139	0.0164	0.0966	0.1857	0.2264	0.2377	0.3128	0.316	0.5553	0.407	0.3468
TAO CR Long	0.0135	0.0153	0.1176	0.145	0.1813	0.2705	0.3111	0.3225	0.4584	0.3307	0.3707
TAO CR Float	0.0116	0.0165	0.1028	0.2417	0.2413	0.2728	0.3428	0.3033	0.409	0.3787	0.3843
TAO CR Double	0.0119	0.0155	0.0924	0.2313	0.2388	0.2512	0.325	0.3537	0.3455	0.3588	0.3703
TAO CR Record	0.0129	0.0209	0.1485	0.1732	0.2381	0.3192	0.3008	0.3492	0.4412	0.387	0.4411
TAO CR NA Record	0.0117	0.1612	0.2216	0.1663	0.2116	0.295	0.3704	0.4037	0.3706	0.4032	0.4362
TAO CR Any	0.1006	0.1758	0.1522	0.1466	0.2363	0.2471	0.2623	0.329	0.4466	0.3729	0.4382

Figure 11. Client to Server Latency for Scenario 5 CR Operations: Standard Deviations

Scenario 5: Client, Server on Different LynxOS/PPC Hosts



Data Size in Bytes	140	2412	4812	7212	9612	12012	14412	16812	19212	21612	24012
ORBexpress OW Short	0.012	0.0123	0.0921	0.1797	0.2065	0.3297	0.3095	0.33	0.3696	0.4536	0.2928
ORBexpress OW Long	0.0116	0.0123	0.1465	0.2002	0.2072	0.3274	0.2741	0.3425	0.3446	0.3791	0.3743
ORBexpress OW Float	0.0117	0.0127	0.1389	0.1895	0.2021	0.3061	0.262	0.3837	0.283	0.3806	0.3595
ORBexpress OW Double	0.0131	0.0118	0.1848	0.1915	0.1812	0.2794	0.3126	0.3311	0.3632	0.4322	0.4242
ORBexpress OW Record	0.0121	0.0122	0.1088	0.2263	0.1978	0.3799	0.3274	0.3259	0.3424	0.3457	0.4257
ORBexpress OW NA Record	0.0111	0.1158	0.1784	0.1839	0.1888	0.2758	0.3683	0.3089	0.3103	0.3757	0.4667
ORBexpress OW Any	0.0296	0.0235	0.1903	0.1845	0.203	0.2689	0.2624	0.367	0.3274	0.37	0.3299
TAO OW Short	0.0122	0.0116	0.1631	0.1787	0.2429	0.291	0.3462	0.4094	0.4698	0.4211	0.3209
TAO OW Long	0.0116	0.0119	0.2743	0.1799	0.2332	0.265	0.2859	0.3911	0.3811	0.356	0.3389
TAO OW Float	0.0123	0.0118	0.1432	0.2221	0.1954	0.3366	0.2563	0.2783	0.3318	0.3781	0.458
TAO OW Double	0.0128	0.0115	0.1425	0.1663	0.3307	0.3124	0.3281	0.337	0.3245	0.4194	0.3065
TAO OW Record	0.0117	0.0235	0.1543	0.297	0.2234	0.2521	0.3566	0.3997	0.3677	0.3951	0.2967
TAO OW NA Record	0.0119	0.1006	0.302	0.2314	0.2752	0.281	0.2887	0.3782	0.3839	0.4993	0.3767
TAO OW Any	0.0238	0.1133	0.1956	0.231	0.2231	0.2672	0.2996	0.3908	0.4227	0.542	0.4979

Figure 12. Client to Server Latency for Scenario 5 OW Operations: Standard Deviations

Glossary

ACE	ADAPTIVE Communication Environment
ADAPTIVE	A Dynamically Assembled Protocol, Transformation and Validation Environment
AWACS	Airborne Warning and Control System
BDI	Basic data integrity
CORBA	Common Object Request Broker Architecture
CR	Call and return
DII COE	Defense Information Infrastructure Common Operating Environment
IDL	Interface definition language
IIOP	Internet inter-ORB protocol
IPT	Integrated Product Team
JTT	Joint Tactical Terminal
LMFS	Lockheed Martin Federal Systems (Produces and supports HARDPack)
NA	Non-aligned
OCI	Object Computing, Inc. (Supports TAO)
OIS	Objective Interface Systems (Produces and supports ORB*express*)
OMG	Object Management Group
ORB	Object request broker
OS	Operating system
OW	One way
POA	Portable Object Adapter
PPC	Power PC
RT	Real-time
RTOS	Real-time operating system
TAO	The ACE ORB
TWG	Technical Working Group

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