October 1993
Order Number: 312936-001

Paragon™ Basic Math Library

Performance Report

Intel® Corporation

REV.	REVISION HISTORY	DATE
-001	Original Issue	10/93

WARNING

Some of the circuitry inside the Paragon system operates at hazardous energy and electric shock voltage levels. To avoid the risk of personal injury due to contact with an energy hazard, or risk of electric shock, do not enter any portion of the Paragon system unless it is intended to be accessible without the use of a tool. The areas that are considered accessible are the outer enclosure and the area just inside the front door when all of the front panels are installed, and the front of the diagnostic station. There are no user serviceable areas inside the system. Refer any need for such access only to technical personnel that have been qualified by Intel Corporation.

CAUTION

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

LIMITED RIGHTS

Preface

Organization

Chapter 1	Level 1 BLAS Performance Evaluation
Chapter 2	Level 2 BLAS Performance Evaluation
Chapter 3	Level 3 BLAS Performance Evaluation

Notational Conventions

This manual uses the following notational conventions:

Bold Identifies command names and switches, system call names, reserved words, and other items that must be used exactly as shown.

Italic Identifies variables, filenames, directories, processes, user names, and writer annotations in examples. Italic type style is also occasionally used to emphasize a word or phrase.

`Plain-Monospace`
Identifies computer output (prompts and messages), examples, and values of variables. Some examples contain annotations that describe specific parts of the example. These annotations (which are not part of the example code or session) appear in *italic* type style and flush with the right margin.

`Bold-Italic-Monospace`
Identifies user input (what you enter in response to some prompt).

Bold-Monospace
Identifies the names of keyboard keys (which are also enclosed in angle brackets). A dash indicates that the key preceding the dash is to be held down *while* the key following the dash is pressed. For example:

<Break> **<s>** **<Ctrl-Alt-Del>**

[ ] (Brackets) Surround optional items.

... (Ellipsis dots) Indicate that the preceding item may be repeated.

| (Bar) Separates two or more items of which you may select only one.

{ } (Braces) Surround two or more items of which you must select one.

Applicable Documents

For more information, refer to the *Paragon™ System Technical Documentation Guide.*

For information about limitations and workarounds, see the *Paragon™ System Software Release Notes for the Paragon™ XP/S System.* Release notes are also located in the directory */vol/share/release_notes* on your Paragon system.

Comments and Assistance

Intel Supercomputer Systems Division is eager to hear of your experiences with our products. Please call us if you need assistance, have questions, or otherwise want to comment on your Paragon system.

U.S.A./Canada Intel Corporation
phone: 800-421-2823
Internet: support@ssd.intel.com

Intel Corporation Italia s.p.a.
Milanofiori Palazzo
20090 Assago
Milano
Italy
1678 77203 (toll free)

France Intel Corporation
1 Rue Edison-BP303
78054 St. Quentin-en-Yvelines Cedex
France
0590 8602 (toll free)

Intel Japan K.K.
Supercomputer Systems Division
5-6 Tokodai, Tsukuba City
Ibaraki-Ken 300-26
Japan
0298-47-8904

United Kingdom Intel Corporation (UK) Ltd.
Supercomputer System Division
Pipers Way
Swindon SN3 IRJ
England
0800 212665 (toll free)
(44) 793 491056 (*answered in French*)
(44) 793 431062 (*answered in Italian*)
(44) 793 480874 (*answered in German*)
(44) 793 495108 (*answered in English*)

Germany Intel Semiconductor GmbH
Dornacher Strasse 1
8016 Feldkirchen bel Muenchen
Germany
0130 813741 (toll free)

World Headquarters
Intel Corporation
Supercomputer Systems Division
15201 N.W. Greenbrier Parkway
Beaverton, Oregon 97006
U.S.A.
(503) 629-7600 (Monday through Friday, 8 AM to 5 PM Pacific Time)
Fax: (503) 629-9147

If you have comments about our manuals, please fill out and mail the enclosed Comment Card. You can also send your comments electronically to the following address:

techpubs@ssd.intel.com

Table of Contents

Chapter 1
Level 1 BLAS Performance Evaluation

Introduction 1-1

Level 1 BLAS Performance 1-1

Chapter 2
Level 2 BLAS Performance Evaluation

Level 2 BLAS Performance 2-1

Chapter 3
Level 3 BLAS Performance Evaluation

Level 3 BLAS Performance 3-1

Chapter 4
FFT Performance Evaluation

FFT Performance 4-1

List of Tables

Table 1-1. Level 1 BLAS: Single-Precision Performance (MFLOPS) 1-2
Table 1-2. Level 1 BLAS: Double-Precision Performance (MFLOPS) 1-3
Table 1-3. Level 1 BLAS: Single-Precision Complex Performance (MFLOPS) 1-4
Table 1-4. Level 1 BLAS: Double-Precision Complex Performance (MFLOPS) 1-5

Table 2-1. Level 2 BLAS: Single-Precision Performance (MFLOPS) 2-2
Table 2-2. Level 2 BLAS: Double-Precision Performance (MFLOPS) 2-3
Table 2-3. Level 2 BLAS: Complex Single-Precision Performance (MFLOPS) 2-4
Table 2-4. Level 2 BLAS: Complex Double-Precision Performance (MFLOPS) 2-5

Table 3-1. Level 3 BLAS: Single-Precision Real Performance (MFLOPS) 3-1
Table 3-2. Level 3 BLAS: Double-Precision Real Performance (MFLOPS) 3-2
Table 3-3. Level 3 BLAS: Single-Precision Complex Performance (MFLOPS) 3-3
Table 3-4. Level 3 BLAS: Double-Precision Complex Performance (MFLOPS) 3-4

Table 4-1. FFT: 1D Complex to Complex Performance (MFLOPS) 4-1
Table 4-2. FFT: 1D Real to Complex/Complex to Real Performance (MFLOPS) 4-2

Level 1 BLAS Performance Evaluation 1

Introduction

The Basic Math Library provides the user with a collection of routines that include the Level 1, 2 and 3 BLAS, a variety of FFT routines, tri-pentadiagonal factor and solve routines, and some vector triads. Many of the routines in this library are written in i860™ Assembler language and are highly tuned for the i860XP processor. The i860™ XP processor runs at 50 Mhz, and is capable of achieving 75 double precision Mflops and 100 single precision Mflops. A more realistic double precision performance peak is 50 Mflops, since it is difficult to structure many linear algebra computations to complete two additions and one multiply every cycle; the one add to one multiply is much more common.

Only BLAS and FFT performance is addressed in this document.

This document provides the user with a guide to enhance application performance by knowing the expected performance of a standard set of commonly used subroutines provided with the system software.

The user should expect only slight variations from the performance levels documented here. The results for the Level 2 and 3 BLAS can be duplicated by running the BLAS test suites provided with the system acceptance tests (SAT).

Level 1 BLAS Performance

The Level 1 BLAS routines perform basic vector-vector operations. For the performance evaluation of the Level 1 BLAS, only unit stride is used. The vector lengths (N) are varied from 100 to 1700 and for each vector length a corresponding MFLOPS (millions of floating-point operations per second) rating is calculated. Along with the performance characterization of each routine, the routines are also tested for correctness.

The four tables that are given that display the performance of the real and complex Level 1 BLAS in both single and double precision.

Table 1-1. Level 1 BLAS: Single-Precision Performance (MFLOPS)

N	SASUM	SAXPY	SDOT	SDSDOT	SROT	SSCAL
100	8.6	27.3	38.3	38.0	42.9	25.1
200	9.0	32.9	52.6	49.3	52.2	30.0
300	9.1	36.3	60.8	57.2	53.6	33.5
400	9.2	39.1	65.3	62.3	56.3	34.1
500	9.2	40.4	68.8	64.1	56.0	35.6
600	9.2	41.1	72.5	71.3	57.6	35.6
700	9.3	42.2	71.9	73.2	56.7	36.7
800	9.3	42.8	73.4	70.3	58.3	36.5
900	9.3	43.2	75.7	72.2	56.6	37.3
1000	9.3	43.6	77.4	72.6	57.9	37.1
1100	9.4	44.0	78.3	75.0	56.7	18.8
1200	9.4	43.6	79.6	77.6	56.4	18.4
1300	9.4	44.1	81.9	79.9	55.3	18.6
1400	9.4	44.3	84.5	79.6	53.0	18.3
1500	9.4	44.3	84.3	81.2	53.1	18.2
1600	9.4	44.7	83.8	83.3	53.0	18.1
1700	9.5	44.8	84.4	82.2	52.5	17.8

Table 1-2. Level 1 BLAS: Double-Precision Performance (MFLOPS)

N	DASUM	DAXPY	DDOT	DROT	DSCAL	DSDOT
100	8.7	19.3	28.4	33.1	14.7	31.3
200	9.1	21.4	30.4	34.7	17.0	49.7
300	9.3	22.2	32.1	35.2	17.2	57.1
400	9.4	22.0	34.7	35.4	18.2	60.9
500	9.4	22.3	35.5	35.5	18.3	62.6
600	9.5	22.6	40.4	35.4	18.7	64.3
700	9.5	22.7	40.4	35.3	18.3	68.0
800	9.5	22.8	39.2	34.1	18.9	68.4
900	9.5	22.7	40.4	33.9	18.5	71.7
1000	9.5	22.7	42.0	33.7	19.0	70.5
1100	9.5	22.8	42.0	29.8	19.1	70.7
1200	9.5	22.9	43.7	26.3	19.1	76.6
1300	9.5	22.9	43.7	23.4	18.8	76.2
1400	9.5	22.8	44.1	21.5	12.7	77.2
1500	9.5	22.8	44.6	20.2	12.0	81.1
1600	9.5	22.8	44.9	19.0	11.9	79.3
1700	9.5	22.5	43.9	18.4	11.9	80.4

Table 1-3. Level 1 BLAS: Single-Precision Complex Performance (MFLOPS)

N	SCASUM	CAXPY	CSCAL	CSSCAL	CDOTC	CDOTU
100	9.2	60.6	56.2	35.8	68.6	68.1
200	9.5	77.2	64.1	40.1	86.6	86.5
300	9.6	80.3	65.9	42.0	89.4	89.4
400	9.6	83.6	67.3	44.3	91.3	91.1
500	9.6	85.1	68.7	46.1	92.0	92.0
600	9.6	85.7	69.6	46.6	92.7	92.6
700	9.7	86.0	70.5	46.3	93.5	93.3
800	9.7	86.2	70.4	46.6	93.5	93.3
900	9.7	86.9	70.8	47.1	93.7	93.3
1000	9.6	87.2	70.7	47.3	94.1	94.5
1100	9.6	87.3	71.7	46.9	93.9	94.5
1200	9.6	87.3	71.2	46.9	94.7	94.0
1300	9.6	87.1	71.6	47.0	94.3	94.5
1400	9.6	87.5	71.2	47.0	94.6	94.6
1500	9.6	87.4	71.3	47.1	94.5	94.4
1600	9.5	87.6	71.6	47.1	94.1	94.5
1700	9.5	86.4	69.7	46.1	94.1	93.2

Table 1-4. Level 1 BLAS: Double-Precision Complex Performance (MFLOPS)

N	DZASUM	ZAXPY	ZSCAL	ZDSCAL	ZDOTC	ZDOTU
100	9.2	38.2	32.2	60.2	44.9	45.4
200	9.5	42.7	34.7	67.2	45.5	44.9
300	9.5	44.3	35.2	69.2	48.6	48.4
400	9.6	44.5	35.7	70.1	51.0	50.4
500	9.6	45.2	35.9	70.8	51.7	52.0
600	9.6	45.3	35.8	71.1	52.3	52.6
700	9.6	45.3	35.5	71.6	53.4	53.2
800	9.6	45.3	35.9	70.7	52.7	53.4
900	9.5	44.5	34.7	68.5	52.5	52.2
1000	9.5	44.4	34.9	64.8	52.5	52.3
1100	8.9	33.0	31.2	52.8	37.2	37.1
1200	8.3	33.0	28.0	41.5	37.2	37.2
1300	7.9	33.1	26.2	35.5	37.3	37.3
1400	7.6	33.2	24.4	31.6	37.4	37.4
1500	7.4	33.3	23.1	28.4	37.4	37.4
1600	7.3	33.3	23.1	26.7	37.3	37.3
1700	7.1	33.2	23.1	25.2	37.4	37.4

Level 2 BLAS Performance Evaluation 2

Level 2 BLAS Performance

The Level 2 BLAS routines perform matrix-vector operations. The routines used to evaluate the performance of the Level 2 BLAS are adopted from the public domain LAPACK BLAS test programs. With each test routine, a data file is supplied that contains information such as the test ratio threshold value, the values of N, K, stride, ALPHA, BETA, and the name of the routine to be evaluated.

The test programs are modified so that only unit stride was used and both ALPHA and BETA were neither zero nor one. The value of N was varied by factors of 2 from 8 to 512, and for each N the routine to be evaluated was called multiple times with different values of K, UPLO, TRANS, and/or DIAG. The value of M was set to both MAX=(N-N/2-1, 0) and MIN(N+N/2+1,512). A Mflop rating was calculated for each value of N as an average of all the calls. Along with this performance characterization, the routines were also tested for correctness.

The four tables given display the performance (in MFLOPS) of both the real and complex Level 2 BLAS in both single and double precision

Table 2-1. Level 2 BLAS: Single-Precision Performance (MFLOPS)

N	SGEMV	SGBMV	SSYMV	SSBMV	SSPMV	STRMV
8	3.1	3.1	1.8	3.1	1.8	1.7
16	6.9	5.4	3.3	5.2	3.4	3.5
32	16.2	7.4	5.4	7.6	5.9	6.5
64	33.9	8.9	13.4	8.9	12.7	14.0
128	52.7	11.0	25.9	11.5	26.7	27.4
256	68.0	16.3	43.4	14.7	44.0	43.1
512	76.2	20.4	57.6	17.6	60.2	59.9

N	STBMV	STPMV	STRSV	STBSV	STPSV	SGER
8	2.2	2.4	1.1	1.1	1.3	3.7
16	3.7	5.4	2.5	2.0	3.3	7.0
32	5.0	9.0	4.8	2.5	5.8	15.6
64	5.8	12.2	10.4	2.9	9.1	22.1
128	6.3	24.6	20.7	3.1	18.7	34.4
256	6.5	40.9	34.4	3.1	32.5	38.0
512	6.4	57.3	50.9	3.1	48.4	41.3

N	SSYR	SSPR	SSYR2	SSPR2
8	1.9	1.9	5.1	4.8
16	3.4	3.3	10.6	10.6
32	5.9	6.1	16.9	17.0
64	9.8	10.6	21.3	21.4
128	17.6	18.4	31.6	30.6
256	25.8	27.5	50.8	50.6
512	34.3	34.4	66.5	64.1

Table 2-2. Level 2 BLAS: Double-Precision Performance (MFLOPS)

N	DGEMV	DGBMV	DSYMV	DSBMV	DSPMV	DTRMV
8	3.2	2.5	1.7	2.8	1.9	1.6
16	7.4	4.3	3.2	4.6	3.5	3.1
32	14.2	5.7	6.8	5.8	7.1	6.0
64	24.0	6.7	13.2	6.7	13.3	12.3
128	32.6	9.2	21.4	9.7	22.4	19.8
256	38.9	12.0	29.1	11.6	30.7	27.8
512	41.0	13.7	35.5	12.9	36.3	34.0

N	DTBMV	DTPMV	DTRSV	DTBSV	DTPSV	DGER
8	2.1	2.4	.95	.94	1.3	3.4
16	3.3	5.3	2.0	1.5	2.9	8.1
32	4.1	8.6	4.0	1.9	4.2	12.3
64	4.6	11.6	8.2	2.1	8.2	19.8
128	5.1	20.3	15.1	2.2	14.4	21.6
256	5.1	29.0	22.7	2.2	22.9	22.1
512	5.0	35.2	29.8	2.2	30.7	22.3

N	DSYR	DSPR	DSYR2	DSPR2
8	1.8	2.2	4.8	5.1
16	3.8	4.2	8.9	9.7
32	5.7	6.3	13.4	14.6
64	10.4	11.1	14.0	16.4
128	15.1	14.7	21.8	22.6
256	18.2	19.0	28.5	29.8
512	20.2	20.6	33.7	34.4

Table 2-3. Level 2 BLAS: Complex Single-Precision Performance (MFLOPS)

N	CGEMV	CGBMV	CHEMV	CHBMV	CHPMV	CTRMV
8	12.8	9.3	10.2	8.3	7.1	5.6
16	26.7	12.5	15.7	11.3	12.2	11.1
32	51.2	15.0	24.3	13.7	25.2	21.2
64	70.7	21.4	41.1	20.6	43.0	37.7
128	83.8	27.5	57.5	25.0	62.5	55.1
256	87.9	33.9	73.2	30.2	74.3	70.2
512	90.9	38.8	82.5	32.1	83.2	79.8

N	CTBMV	CTPMV	CTRSV	CTBSV	CTPSV	CGERC
8	6.2	7.9	3.6	4.3	4.8	13.5
16	8.9	13.0	8.3	6.3	9.1	21.5
32	10.4	22.2	16.7	7.4	17.0	47.3
64	11.3	38.1	30.8	8.0	31.0	63.7
128	11.9	57.0	48.3	8.3	49.8	76.1
256	11.6	71.9	64.3	8.2	66.6	83.3
512	11.4	82.5	75.8	8.2	78.8	85.2

N	CGERU	CHER	CHPR	CHER2	CHPR2
8	14.3	5.2	5.3	10.0	11.2
16	22.2	9.4	9.2	17.9	19.5
32	48.7	19.4	19.3	26.7	29.0
64	66.7	34.6	33.9	39.8	42.4
128	78.7	52.6	51.9	60.2	62.2
256	83.3	67.0	67.2	75.3	76.1
512	84.1	75.6	76.0	82.2	84.9

Table 2-4. Level 2 BLAS: Complex Double-Precision Performance (MFLOPS)

N	ZGEMV	ZGBMV	ZHEMV	ZHBMV	ZHPMV	ZTRMV
8	13.2	7.8	7.9	6.7	6.2	5.3
16	24.8	10.3	11.4	9.0	12.9	10.7
32	33.9	13.1	20.8	13.9	20.6	18.2
64	46.8	18.9	31.7	17.0	31.0	30.2
128	53.5	23.0	40.4	20.6	40.4	41.7
256	56.0	25.7	44.9	22.4	45.0	49.3
512	59.4	24.4	48.0	22.8	46.8	53.5

N	ZTBMV	ZTPMV	ZTRSV	ZTBSV	ZTPSV	ZGERC
8	5.9	7.1	3.1	3.6	4.0	13.3
16	7.7	10.5	7.2	4.8	7.0	23.7
32	8.9	18.7	14.0	5.9	13.9	30.7
64	9.4	29.6	25.0	6.4	24.4	38.8
128	9.0	40.0	36.8	6.4	33.6	41.8
256	8.9	45.7	45.0	6.2	42.5	43.7
512	8.8	49.3	51.7	6.2	47.4	44.2

N	ZGERU	ZHER	ZHPR	ZHER2	ZHPR2
8	13.2	4.9	5.0	8.3	8.7
16	23.0	9.0	9.1	11.4	12.1
32	31.2	15.6	16.0	19.1	21.0
64	37.7	24.3	24.6	32.1	32.4
128	42.4	29.9	33.0	43.1	44.9
256	44.1	37.8	38.0	51.3	52.0
512	44.5	41.2	41.5	54.2	54.0

Level 3 BLAS Performance Evaluation 3

Level 3 BLAS Performance

The Level 3 BLAS perform matrix-matrix operations. The routines used to evaluate the performance of the Level 3 BLAS were adopted from the public domain LAPACK BLAS test programs. With each test routine, a data file is supplied that contains information such as the test ratio threshold value, the values of N, ALPHA, BETA, and the names of the routines to be evaluated.

The test programs were modified so that both ALPHA and BETA were neither zero nor one. The value of N was varied from 8 to 512, with M and K equal to N. For each N, the routine to be evaluated was called multiple times with different values of UPLO, SIDE, TRANS, and/or DIAG. A Mflops rating was calculated for each value of N. Along with this performance characterization, the routines were also tested for correctness.

The four tables that are given display the performance (in Mflops) of both the real and complex Level 3 BLAS in both single and double precision.

.

Table 3-1. Level 3 BLAS: Single-Precision Real Performance (MFLOPS)

N	SGEMM	SSYMM	STRMM	STRSM	SSYRK	SSYR2K
8	1.1	2.9	2.1	1.7	2.6	2.3
16	4.1	5.0	4.3	3.5	5.1	6.3
32	40.6	22.2	21.9	18.4	16.7	17.0
64	57.7	33.0	41.6	38.4	37.3	36.3
128	77.0	56.2	62.0	58.2	58.6	58.0

Table 3-1. Level 3 BLAS: Single-Precision Real Performance (MFLOPS)

N	SGEMM	SSYMM	STRMM	STRSM	SSYRK	SSYR2K
256	83.7	65.4	73.2	71.4	73.8	70.8
512	87.8	72.0	81.2	80.5	81.6	79.1

Table 3-2. Level 3 BLAS: Double-Precision Real Performance (MFLOPS)

N	DGEMM	DSYMM	DTRSM	DTRMM	DSYRK	DSYR2K
8	8.4	3.8	1.6	2.3	3.3	2.8
16	8.4	8.3	3.8	4.9	7.7	7.7
32	20.8	19.1	16.5	15.5	15.2	19.4
64	41.5	29.9	26.0	29.8	31.4	30.4
128	45.1	37.8	37.0	38.1	39.7	38.2
256	45.8	41.0	41.3	41.4	42.5	41.2
512	45.9	43.3	43.7	44.0	44.2	43.4

Table 3-3. Level 3 BLAS: Single-Precision Complex Performance (MFLOPS)

N	CGEMM	CHEMM	CSYMM	CTRMM	CTRSM
8	15.2	6.68	6.6	5.5	5.0
16	39.0	15.7	15.5	14.4	12.5
32	63.8	33.1	33.5	34.0	31.1
64	78.3	52.6	52.0	54.2	48.9
128	86.0	68.3	67.8	70.3	66.3
256	89.2	77.8	77.4	78.7	76.4
512	91.4	84.1	83.7	84.5	83.3

N	CHERK	CSYRK	CHER2K	CSYR2K
8	11.3	8.7	9.9	8.4
16	19.2	14.7	17.5	16.6
32	37.6	36.3	32.5	33.8
64	58.6	59.7	50.7	52.8
128	75.1	75.0	66.6	67.7
256	81.5	81.5	75.9	77.4
512	85.6	86.1	83.0	82.5

Table 3-4. Level 3 BLAS: Double-Precision Complex Performance (MFLOPS)

N	ZGEMM	ZHEMM	ZSYMM	ZTRMM	ZTRSM
8	20.6	4.7	6.9	5.3	4.6
16	33.3	14.0	13.7	13.7	12.0
32	45.0	26.0	25.1	29.0	30.3
64	54.1	38.1	38.3	45.2	44.9
128	57.5	47.2	46.9	52.4	52.9
256	59.3	52.6	52.4	54.7	55.7
512	58.4	55.9	55.9	57.1	58.0

N	ZHERK	ZSYRK	ZHER2K	ZSYR2K
8	10.2	12.3	9.2	5.6
16	19.6	23.7	18.8	25.0
32	33.4	41.0	29.9	40.2
64	44.4	52.3	41.5	51.1
128	51.7	57.3	47.1	55.0
256	54.6	58.8	51.6	57.2
512	56.9	58.6	55.5	59.0

FFT Performance Evaluation 4

FFT Performance

The Basic Math Library contains three routines for doing Fast Fourier Transforms (FFTs) in place: complex to complex (forward and inverse), real to complex (forward), and complex to real (inverse).

A MFLOPS rating is the average of 100 iterations of both the forward and inverse transforms. The table initialization was excluded from the computation timings.

The two tables that are given display the performance (in MFLOPS) of the available FFT routines in both single and double precision.

Table 4-1. FFT: 1D Complex to Complex Performance (MFLOPS)

N	CFFT1D	ZFFT1D
32	42.5	29.2
64	57.9	35.6
128	64.3	41.1
256	68.4	43.9
512	71.1	45.3
1024	58.9	42.1
2048	61.1	24.6

Table 4-2. FFT: 1D Real to Complex/Complex to Real Performance (MFLOPS)

N	SCFFT1D / CSFFT1D	DZFFT1D / ZDFFT1D
32	18.1	14.4
64	30.5	20.4
128	44.1	25.2
256	53.3	29.0
512	61.3	30.7
1024	66.0	32.0
2048	56.8	27.2