



**PROJECT 6: OPENCL ARRAY MULTIPLY, MULTIPLY-ADD, AND  
MULTIPLY-REDUCE**

**PARALLEL PROGRAMMING**

MAY 23, 2018  
SPRING TERM

PREPARED FOR

**OREGON STATE UNIVERSITY**

MATTHEW MEYN

PREPARED BY

JEREMY FISCHER

# 1 ARRAY MULTIPLY AND ARRAY MULTIPLY AND ADD

## 1.1 What machine you ran this on?

I ran this on *rabbit.engr.oregonstate.edu*.

## 1.2 Results Table

### 1.2.1 Array Multiplication

	<b>1024</b>	<b>4096</b>	<b>8192</b>	<b>32768</b>	<b>65536</b>	<b>131072</b>	<b>262144</b>	<b>524288</b>	<b>1048576</b>	<b>2097152</b>	<b>3145728</b>	<b>4194304</b>	<b>5242880</b>	<b>6291456</b>	<b>7340032</b>	<b>8388608</b>
<b>8</b>	0.018	0.076	0.137	0.491	1.276	0.248	0.355	1.186	2.512	4.128	3.953	5.409	9.328	9.749	8.076	9.161
<b>16</b>	0.014	0.081	0.142	0.594	1.323	0.257	0.585	1.064	1.86	3.738	4.81	5.338	8.213	10.331	8.112	9.159
<b>32</b>	0.015	0.081	0.139	0.569	1.052	0.206	0.534	1.059	2.494	4.331	4.253	4.725	9.636	7.117	11.142	9.444
<b>64</b>	0.014	0.054	0.105	0.434	0.899	0.271	0.553	1.158	2.358	2.842	3.92	5.252	7.873	6.976	9.945	12.991
<b>128</b>	0.018	0.051	0.136	0.658	0.956	0.314	0.621	1.181	1.965	2.859	5.11	6.446	5.953	7.111	10.77	9.144
<b>256</b>	0.02	0.054	0.107	0.433	0.802	0.244	0.418	0.925	2.358	4.285	5.773	7.231	6.25	11.313	11.543	10.717
<b>512</b>	0.019	0.057	0.107	0.583	1.137	0.276	0.587	0.739	2.439	4.313	5.845	4.736	9.119	10.073	8.076	9.279

Fig. 1: A table of the *Local Work Size* vs. *Global Work Size* for the array multiplication program. The *Local Work Size* is on the Y-axis in bold and the *Global Work Size* is on the X-axis in bold

### 1.2.2 Array Multiplication and Add

	<b>1024</b>	<b>4096</b>	<b>8192</b>	<b>32768</b>	<b>65536</b>	<b>131072</b>	<b>262144</b>	<b>524288</b>	<b>1048576</b>	<b>2097152</b>	<b>3145728</b>	<b>4194304</b>	<b>5242880</b>	<b>6291456</b>	<b>7340032</b>	<b>8388608</b>
<b>8</b>	0.013	0.057	0.098	0.423	1.255	2.167	0.556	0.723	2.352	4.955	5.161	4.783	5.87	11.005	8.095	9.858
<b>16</b>	0.018	0.056	0.107	0.569	0.986	1.777	0.359	1.005	2.174	3.893	5.116	4.761	5.86	7.051	8.18	9.317
<b>32</b>	0.012	0.056	0.104	0.59	1.285	1.302	0.499	0.921	2.13	3.538	5.476	4.837	8.661	6.809	9.218	10.324
<b>64</b>	0.017	0.055	0.14	0.603	1.105	2.558	0.576	1.027	1.771	3.801	4.84	4.799	6.289	7.083	9.625	11.695
<b>128</b>	0.019	0.073	0.156	0.41	1.208	2.158	0.468	1.261	2.483	4.129	3.933	4.751	5.844	9.637	8.25	9.322
<b>256</b>	0.019	0.081	0.16	0.556	0.845	2.194	0.577	0.707	1.451	4.516	4.556	6.16	8.507	7.106	9.287	9.174
<b>512</b>	0.016	0.075	0.142	0.419	0.78	2.332	0.52	1.026	2.074	2.89	3.798	7.502	5.873	10.921	8.784	7.865

Fig. 2: A table of the *Local Work Size* vs. *Global Work Size* for the array multiplication and add program. The *Local Work Size* is on the Y-axis in bold and the *Global Work Size* is on the X-axis in bold

### 1.3 Results Graph

#### 1.3.1 Array Multiplication

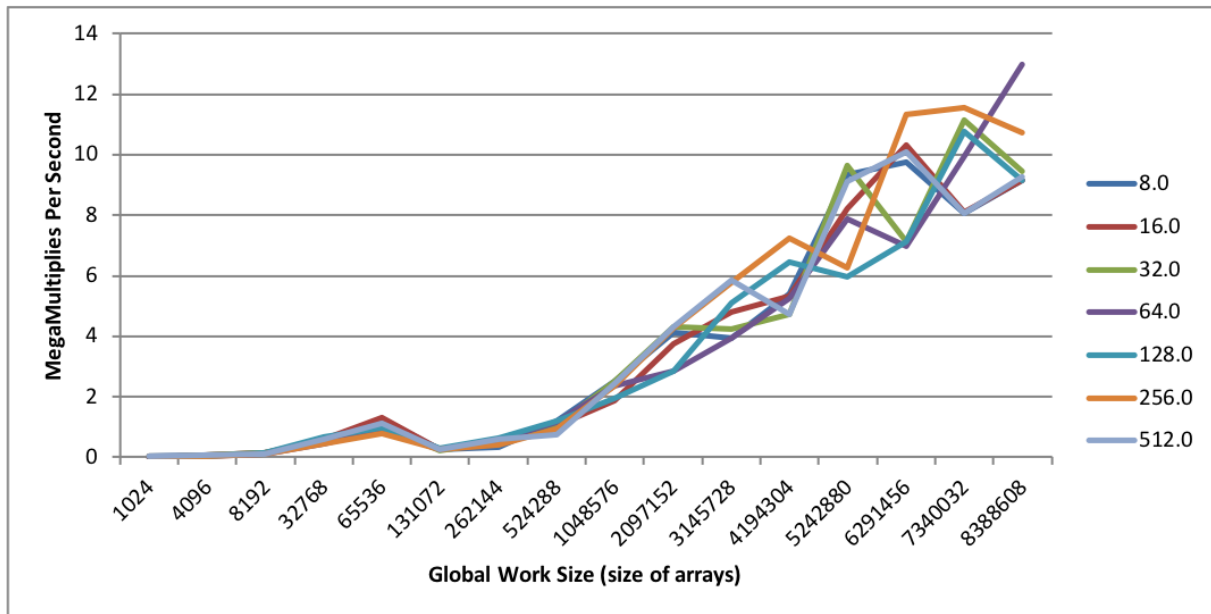


Fig. 3: A graph of the *Mega Multiplies Per Second* vs. *Global Work Size* for the array multiplication program.

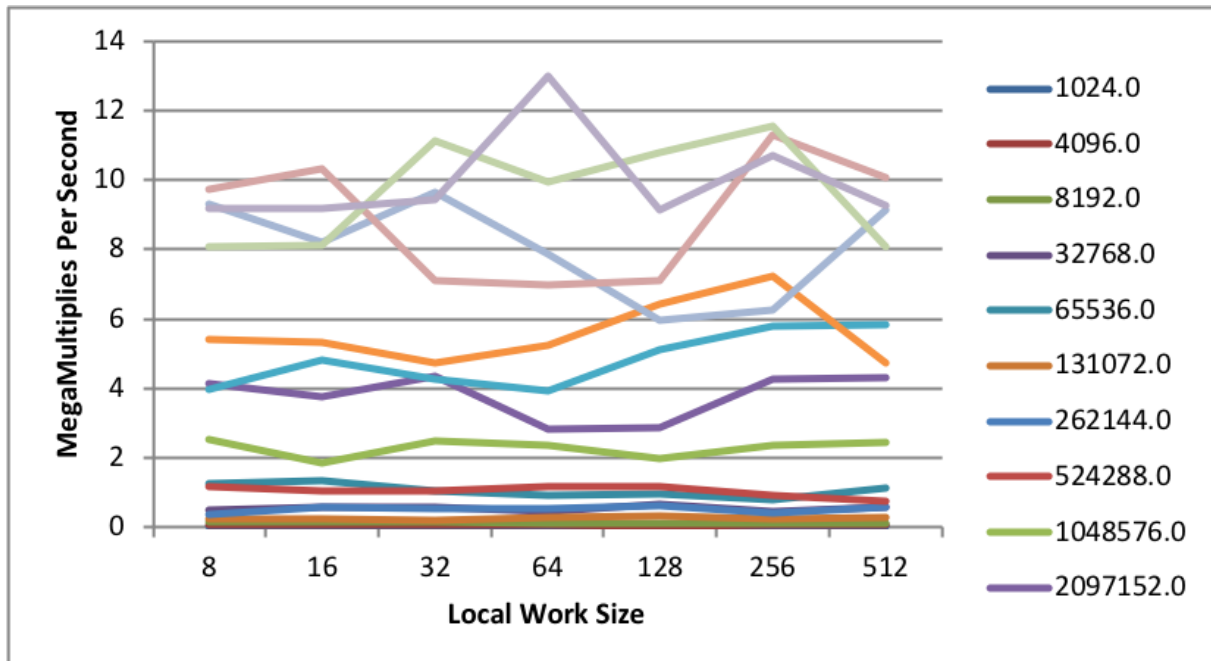


Fig. 4: A graph of the *Mega Multiplies Per Second* vs. *Local Work Size* for the array multiplication program.

### 1.3.2 Array Multiplication and Add

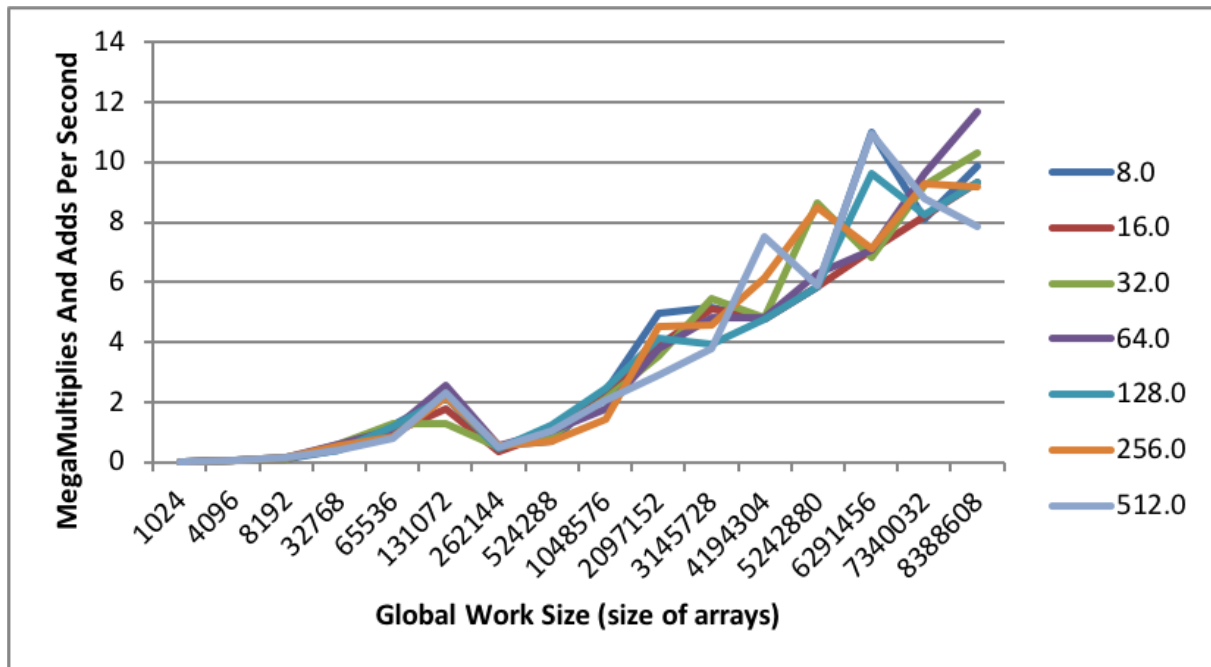


Fig. 5: A graph of the *Mega Multiplies And Adds Per Second* vs. *Global Work Size* for the array multiplication and add program.

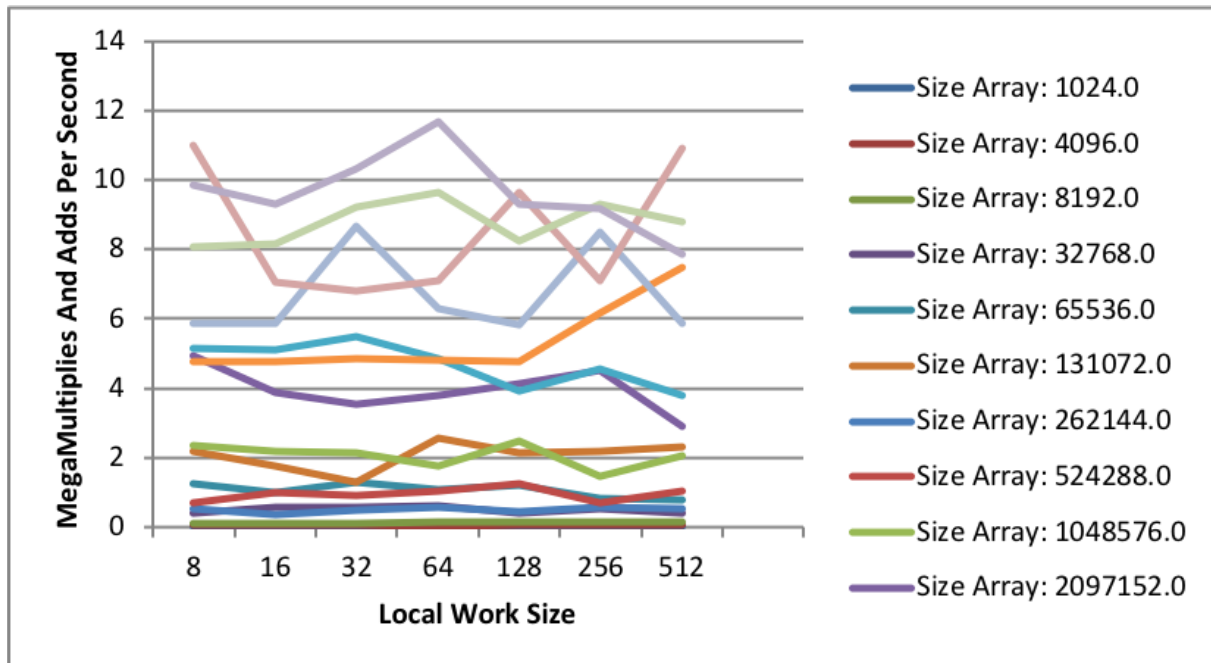


Fig. 6: A graph of the *Mega Multiplies And Adds Per Second* vs. *Local Work Size* for the array multiplication and add program.

1.4 What patterns are you seeing in the performance curves?

1.5 Why do you think the patterns look this way?

1.6 What is the performance difference between doing a Multiply and doing a Multiply-Add?

1.7 What does that mean for the proper use of GPU parallel computing?

## 2 ARRAY MULTIPLY WITH REDUCTION

### 2.1 Results Table

	<b>1024</b>	<b>4096</b>	<b>8192</b>	<b>32768</b>	<b>65536</b>	<b>131072</b>	<b>262144</b>	<b>524288</b>	<b>1048576</b>	<b>2097152</b>	<b>3145728</b>	<b>4194304</b>	<b>5242880</b>	<b>6291456</b>	<b>7340032</b>	<b>8388608</b>
<b>32</b>	0.001	0.007	0.019	0.045	0.094	0.289	0.61	0.961	2.125	3.517	7.154	5.476	6.204	7.416	8.658	9.698

Fig. 7: A table of the *Local Work Size* vs. *Global Work Size* for the array multiplication with reduction program. The *Local Work Size* is on the Y-axis in bold and the *Global Work Size* is on the X-axis in bold

### 2.2 Results Graph

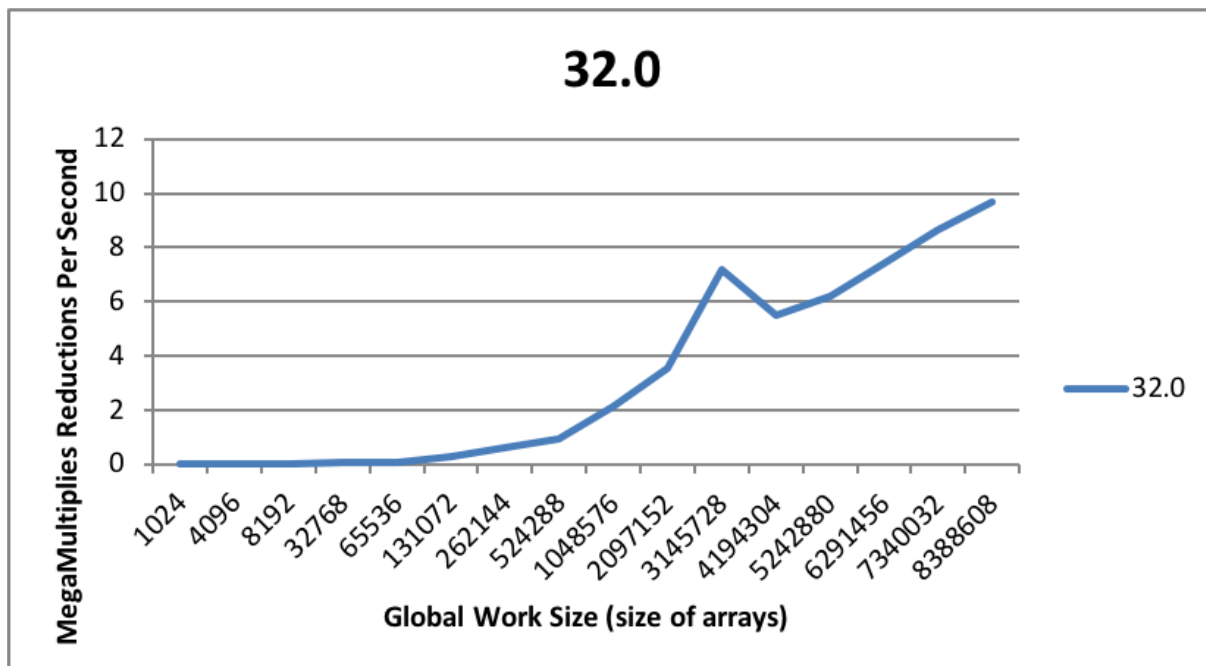


Fig. 8: A graph of the *Mega Multiplies With Reductions Per Second* vs. *Global Work Size* for the array multiplication with reductions program.

2.3 What pattern are you seeing in this performance curve?

2.4 Why do you think the pattern looks this way?

2.5 What does that mean for the proper use of GPU parallel computing?