The new
SHA-3 software shootout

D. J. Bernstein
University of Illinois at Chicago

Tanja Lange
Technische Universiteit Eindhoven

The eBASH data flow

One computer, `hydra6`,
tries hashing data with
the `sphlib` implementation
of `sha256`, compiled with
`gcc -O3 -fomit-frame-pointer`.

Read CPU cycle counter, hash,
read cycle counter, hash,
read cycle counter, hash, etc.
Record median of differences
of cycle-counter outputs.

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SHA-{2,3}-{256,512}:

56 reasonably up-to-date
measurements of `sha256`,
`sha512`, `blake256`, `blake5`
`groestl256`, `groestl512`,
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The new shootout graphs are
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AMD, high-power, 64-bit:

amd64 K8:
2005 AMD Opteron 875,
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2008 AMD Opteron 8354,
2008 AMD Phenom 9550, e

amd64 K10 45nm:
2008 AMD Opteron 2376,
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SHA-{2,3}-{256,512}:

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Intel, high-power, 64-bit:

amd64 C2 65nm:
2006 Intel Core 2 Duo E630
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amd64 C2 45nm:
2007 Intel Xeon E5420,
2008 Intel Core 2 Duo E840

amd64 Nehalem:
2008 Intel Core i7 920,
2010 Intel Xeon X7560, etc.

amd64 Westmere:
2011 Intel Core i5-480M, etc

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amd64 C2 45nm:
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2010 Intel Xeon X7560, etc.

amd64 Westmere:
2011 Intel Core i5-480M, etc.

amd64 Westmere+AES:
2010 Intel Core i5-520M, etc

amd64 Sandy Bridge:
2011 Intel Core i3-2310M, e

amd64 SB+AES:
2011 Intel Core i5-2500K, et

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amd64 Sandy Bridge:

2011 Intel Core i3-2310M, etc.

amd64 SB+AES:

2011 Intel Core i5-2500K, etc.

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amd64 Westmere+AES:

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amd64 Sandy Bridge:

2011 Intel Core i3-2310M, etc.

amd64 SB+AES:

2011 Intel Core i5-2500K, etc.

Intel/AMD, low-power:

x86 Atom:

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2011 Intel Atom Z670 (3W)

2012 Intel Atom Z2460 (1W

etc.

amd64 Atom:

2009 Intel Atom D510 (13W

2010 Intel Atom N455 (6.5W

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2010 Intel Atom N455 (6.5W),
etc.

amd64 Bobcat:

2011 AMD E-450 (18W), etc.

Other m

armeabi

2006 TI
Nokia N

armeabi

2010 NV
Samsung

armeabi

2009 Fre
Apple A

x86 Ede

2006 Via

ppc32 C

e+AES:

-520M, etc.

idge:

-2310M, etc.

:

-2500K, etc.

Intel/AMD, low-power:

x86 Atom:

2008 Intel Atom Z520 (2W),
2009 Intel Atom N280 (2.5W),
2011 Intel Atom Z670 (3W),
2012 Intel Atom Z2460 (1W?),
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amd64 Atom:

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Other manufacture

armeabi ARM11:

2006 TI OMAP 24
Nokia N280, etc.

armeabi Tegra 2:

2010 NVIDIA Teg
Samsung Galaxy T

armeabi Cortex A

2009 Freescale i.M
Apple A4 in iPhon

x86 Eden:

2006 Via Eden UL

ppc32 G4: Freesc

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and mar
use ppc6

Many ro
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use 16-b
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Many routers
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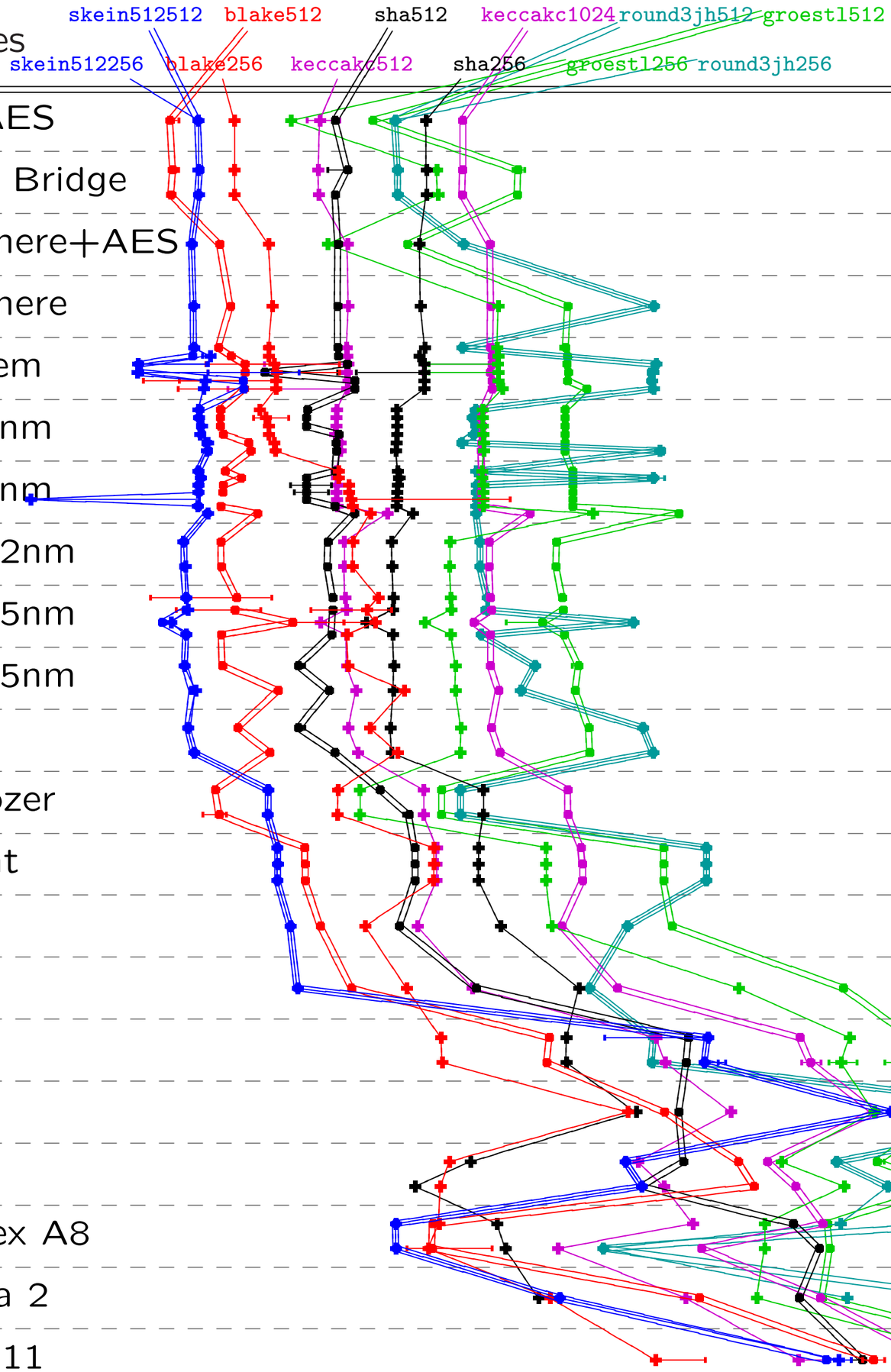
crypto_sha3
Long messages

http://bench.cr.yp.to
20120321



amd64 SB+AES
mangetsu; 4 x 3100MHz; 2011 Intel Core i5-2400; amd64; SB+AES (206a7); supercop-20120310

amd64 Sandy Bridge
h6sandy; 2 x 2100MHz; 2011 Intel Core i3-2310M; amd64; Sandy Bridge (206a7); supercop-20120310
bridge; 2 x 2100MHz; 2011 Intel Core i3-2310M; amd64; Sandy Bridge (206a7); supercop-20120310

amd64 Westmere+AES
hydra2; 4 x 2400MHz; 2010 Intel Xeon E5620; amd64; Westmere+AES (206c2); supercop-20120310

amd64 Westmere
bazinga; 2 x 2800MHz; 2010 Intel Pentium G6950; amd64; Westmere (20652); supercop-20111120

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amd64 C2 45nm
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berlekamp; 4 x 2833MHz; 2008 Intel Core 2 Quad Q9550; amd64; C2 45nm (10677); supercop-20120310
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amd64 C2 65nm
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trident; 2 x 2000MHz; 2007 Intel Core 2 Duo T7300; amd64; C2 65nm (6fb); supercop-20120310

amd64 K10 32nm
hydra4; 4 x 2600MHz; 2011 AMD A6-3650; amd64; K10 32nm (300f10); supercop-20120310
hydra5; 4 x 2900MHz; 2011 AMD A8-3850; amd64; K10 32nm (300f10); supercop-20120310

amd64 K10 45nm
phenom; 6 x 2800MHz; 2010 AMD Phenom II X6 1055T; amd64; K10 45nm (100fa0); supercop-20120310
hydra3; 6 x 3300MHz; 2010 AMD Phenom II X6 1100T; amd64; K10 45nm (100fa0); supercop-20120310
agamemnon; 6 x 3200MHz; 2010 AMD Phenom II X6 1090T; amd64; K10 45nm (100fa0); supercop-20111120
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amd64 K10 65nm
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gcc16; 8 x 2194MHz; 2008 AMD Opteron 8354; amd64; K10 65nm (100f23); supercop-20120310

amd64 K8
mace; 2 x 2000MHz; 2006 AMD Athlon 64 X2; amd64; K8 (40fb2); supercop-20120310
gcc11; 4 x 2000MHz; 2006 AMD Opteron 2212; amd64; K8 (40f13); supercop-20120310

amd64 Bulldozer
hydra6; 4 x 3100MHz; 2011 AMD FX-8120; amd64; Bulldozer (600f12); supercop-20120310
bulldozer; 4 x 3600MHz; 2011 AMD FX-8150; amd64; Bulldozer (600f12); supercop-20120310

amd64 Bobcat
h5e450; 2 x 1650MHz; 2011 AMD E-450; amd64; Bobcat (500f20); supercop-20120310
h4e350; 2 x 1600MHz; 2011 AMD E-350; amd64; Bobcat (500f20); supercop-20120310
h4e450; 2 x 1650MHz; 2011 AMD E-450; amd64; Bobcat (500f20); supercop-20120310

amd64 Nano
h5nano; 1 x 1000MHz; 2009 Via Nano U3500; amd64; Nano (6f8); supercop-20120316

amd64 Atom
h2atom; 1 x 1000MHz; 2010 Intel Atom N455; amd64; Atom (106ca); supercop-20120310

x86 Atom
slim; 1 x 1667MHz; 2009 Intel Atom N280; x86; Atom (106c2); supercop-20120310
h3atom; 1 x 1330MHz; 2008 Intel Atom Z520; x86; Atom (106c2); supercop-20120219

x86 Eden
h1eden; 1 x 1600MHz; 2006? Via Eden ULV; x86; Eden (6d0); supercop-20120120

ppc32 G4
gggg; 2 x 533MHz; 2001 Motorola PowerPC G4 7410; ppc32; G4 (G4); supercop-20120310
h1g4; 1 x 1416MHz; 2005 Motorola PowerPC G4 7447a; ppc32; G4 (G4); supercop-20120310

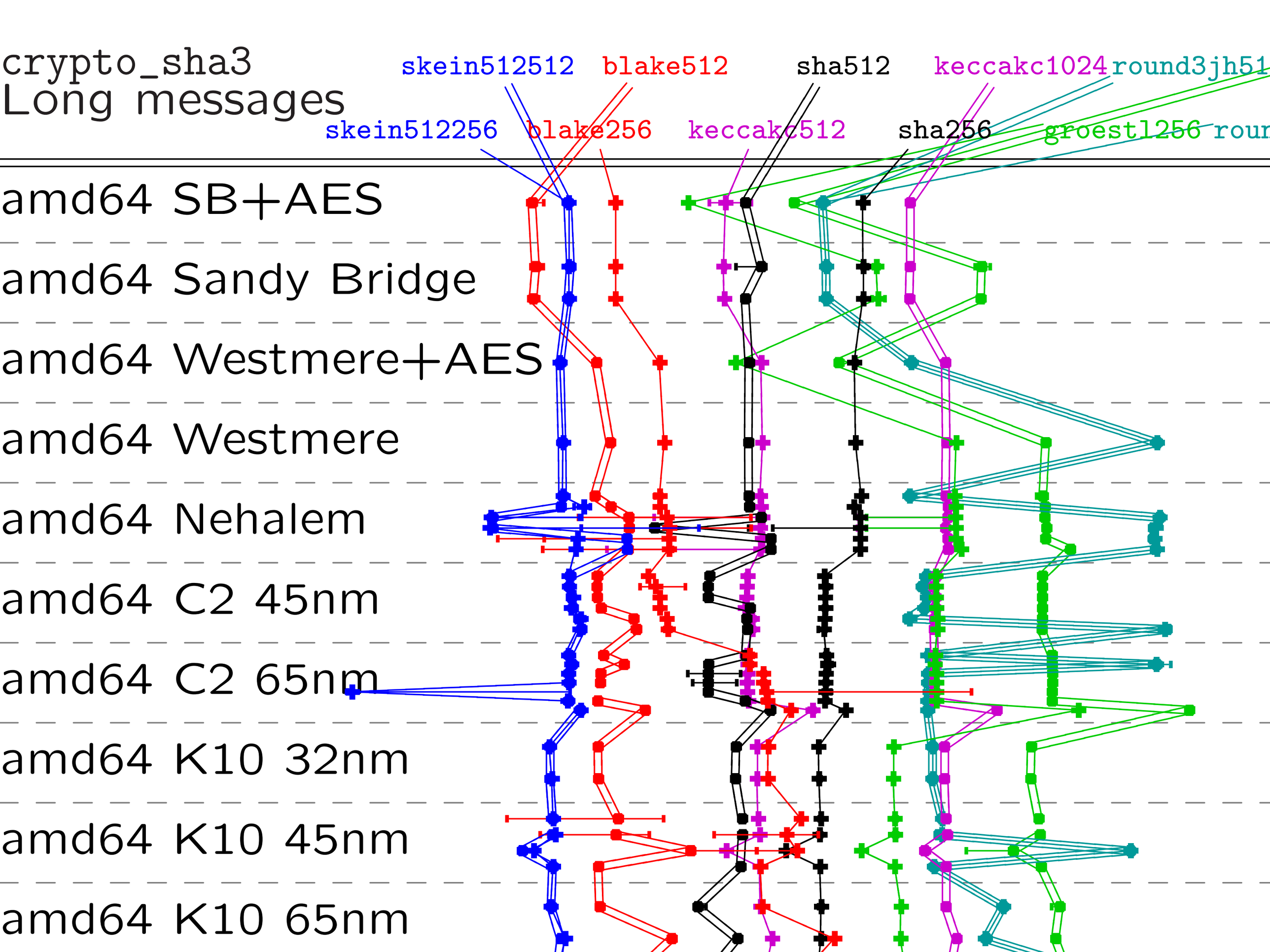
armeabi Cortex A8
h1mx515; 1 x 800MHz; 2009 Freescale i.MX515; armeabi (v7-A, Cortex A8); supercop-20120310
h4mx515e; 1 x 800MHz; 2009 Freescale i.MX515; armeabi (v7-A, Cortex A8); supercop-20120316

armeabi Tegra 2
h5tegra; 2 x 1000MHz; 2010 NVIDIA Tegra 2; armeabi (v7-A, Tegra 2); supercop-20120310

armeabi ARM11
diablo; 1 x 400MHz; 2006? TI OMAP 2420; armeabi (v6, 1136J); supercop-20110914

Cycles per byte 4 8 16 32 64 128 256 512 1024 2048 4096

crypto_sha3
Long messages



amd64 Nehalem

amd64 C2 45nm

amd64 C2 65nm

amd64 K10 32nm

amd64 K10 45nm

amd64 K10 65nm

amd64 K8

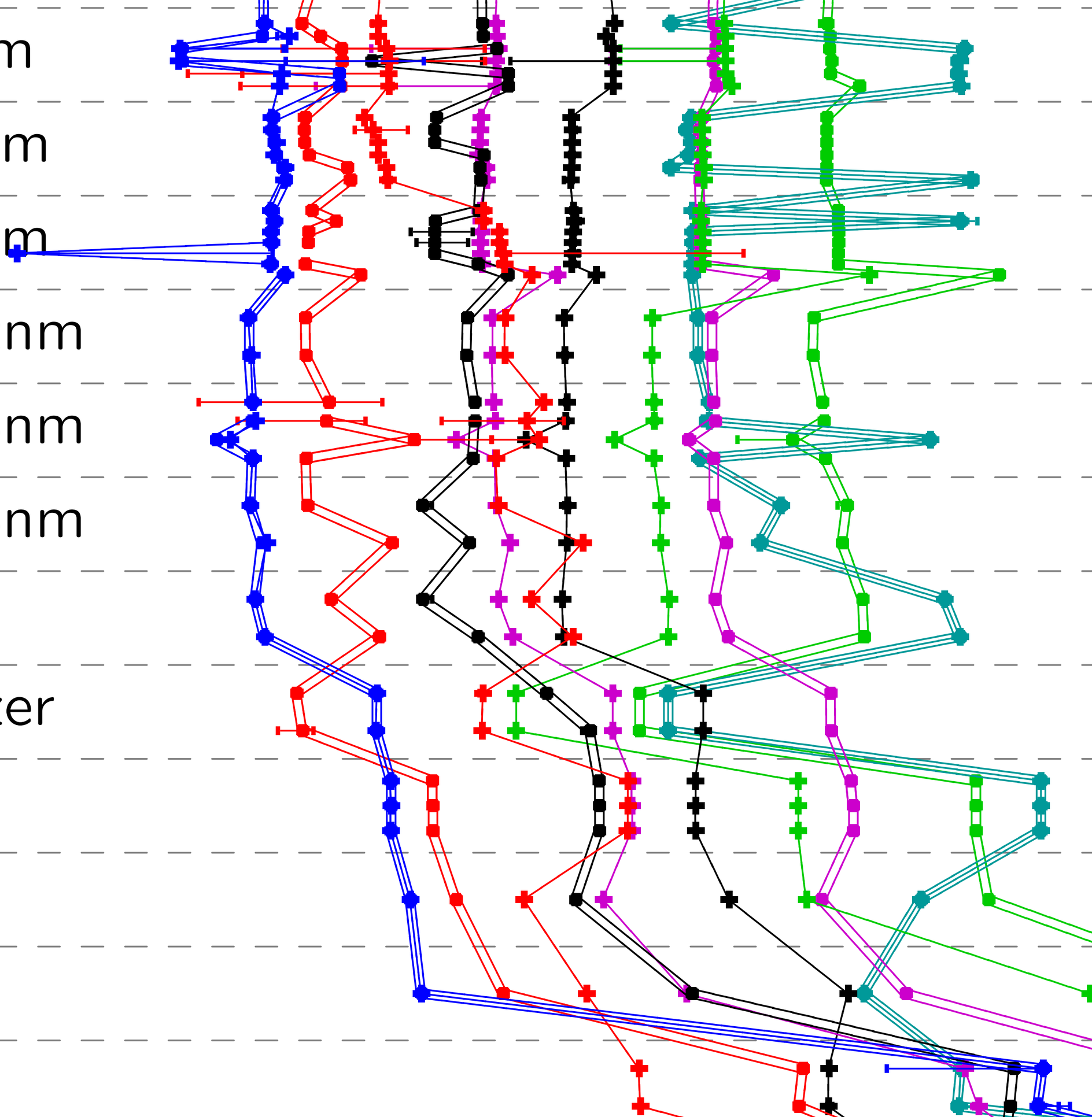
amd64 Bulldozer

amd64 Bobcat

amd64 Nano

amd64 Atom

x86 Atom



amd64 K8

amd64 Bulldozer

amd64 Bobcat

amd64 Nano

amd64 Atom

x86 Atom

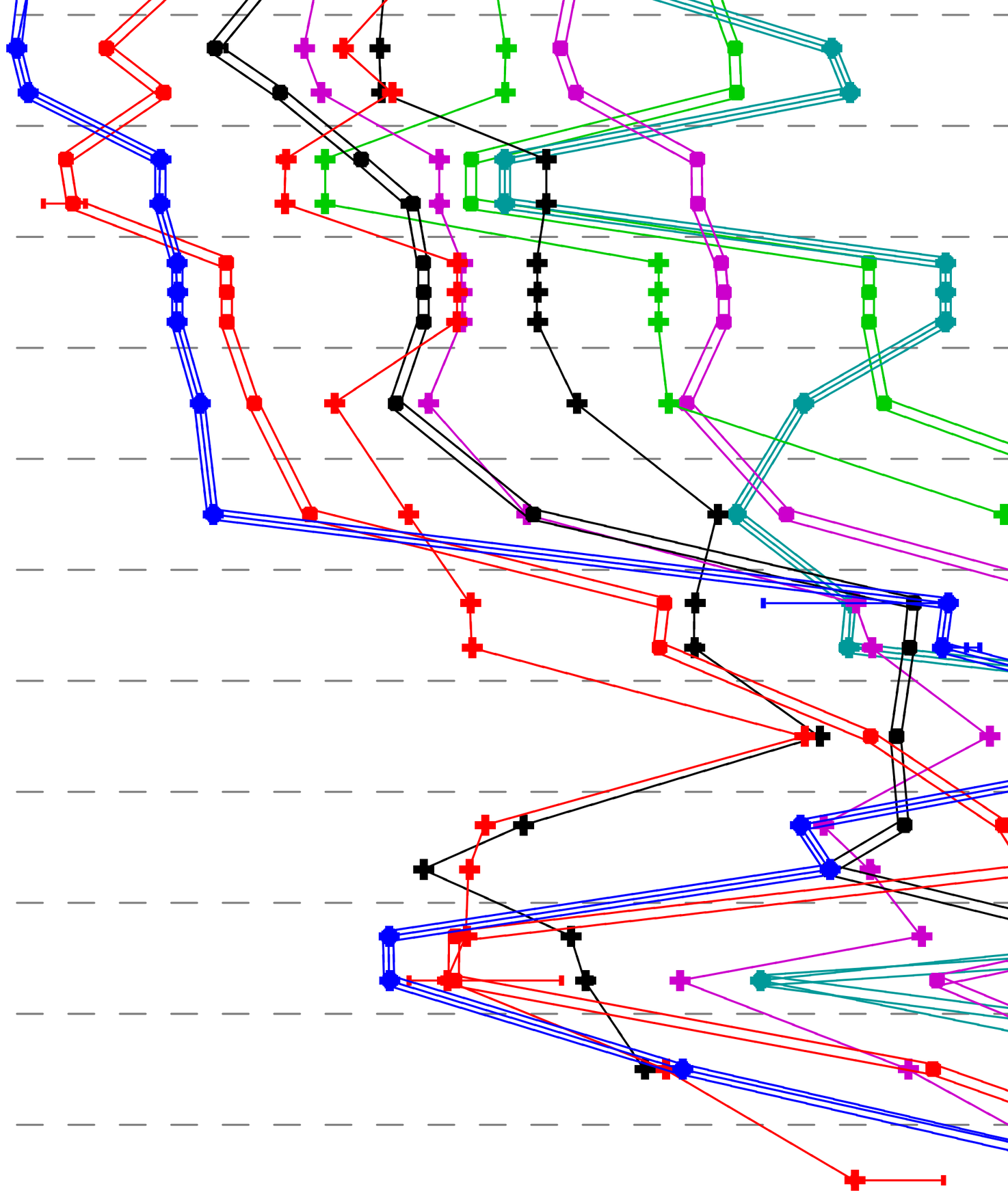
x86 Eden

ppc32 G4

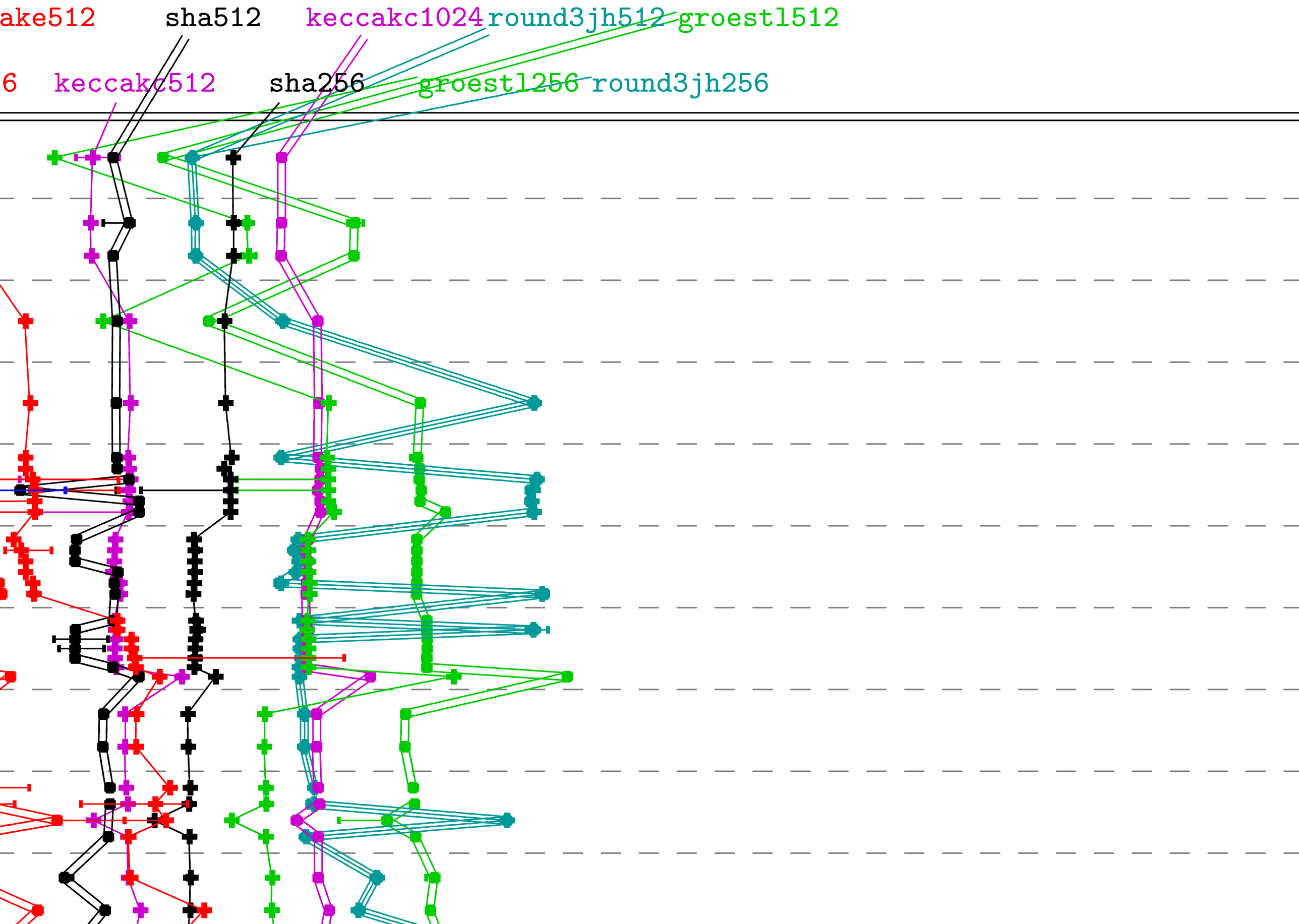
armeabi Cortex A8

armeabi Tegra 2

armeabi ARM11



Cycles per byte 4 8 16 32 64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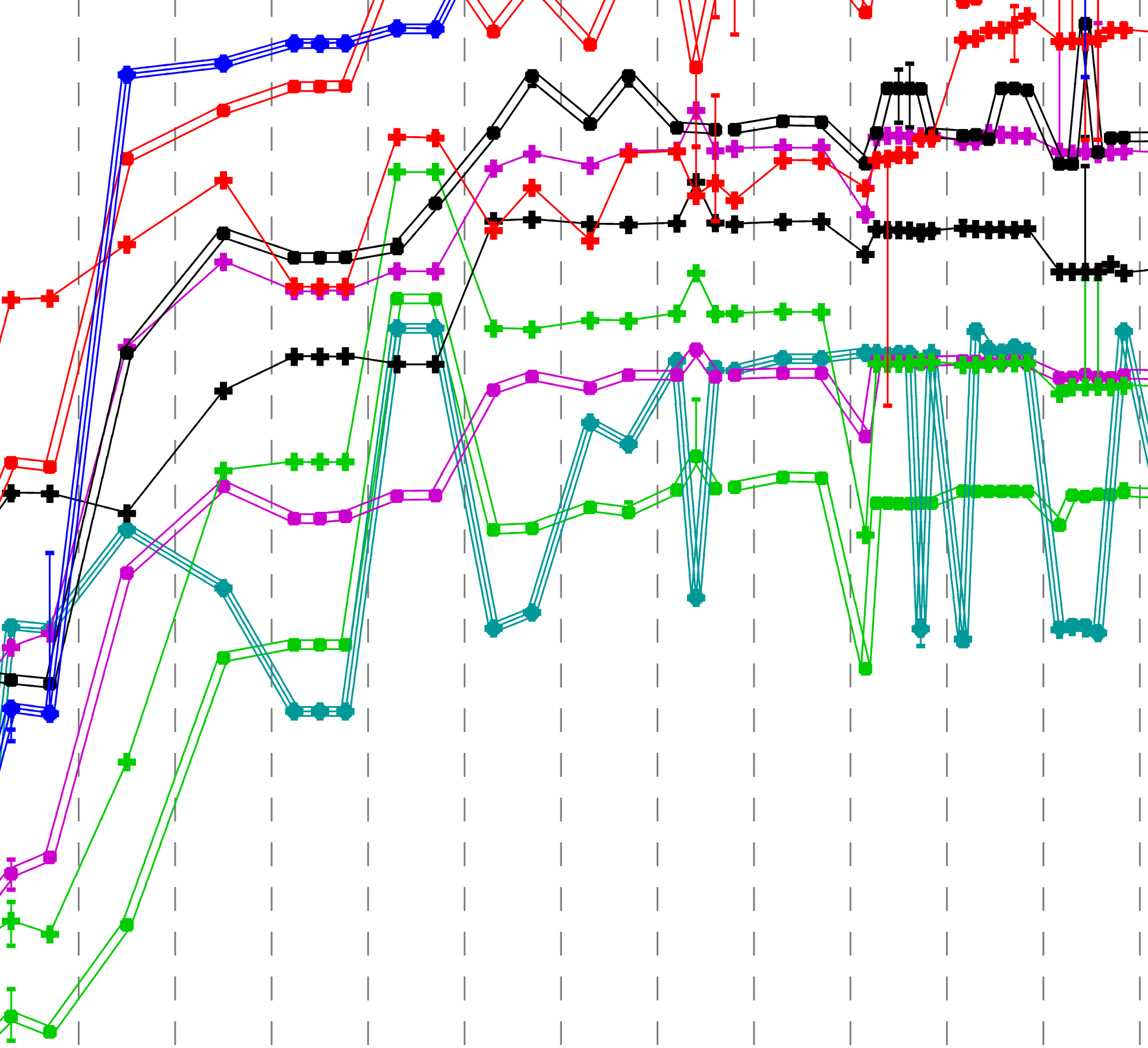
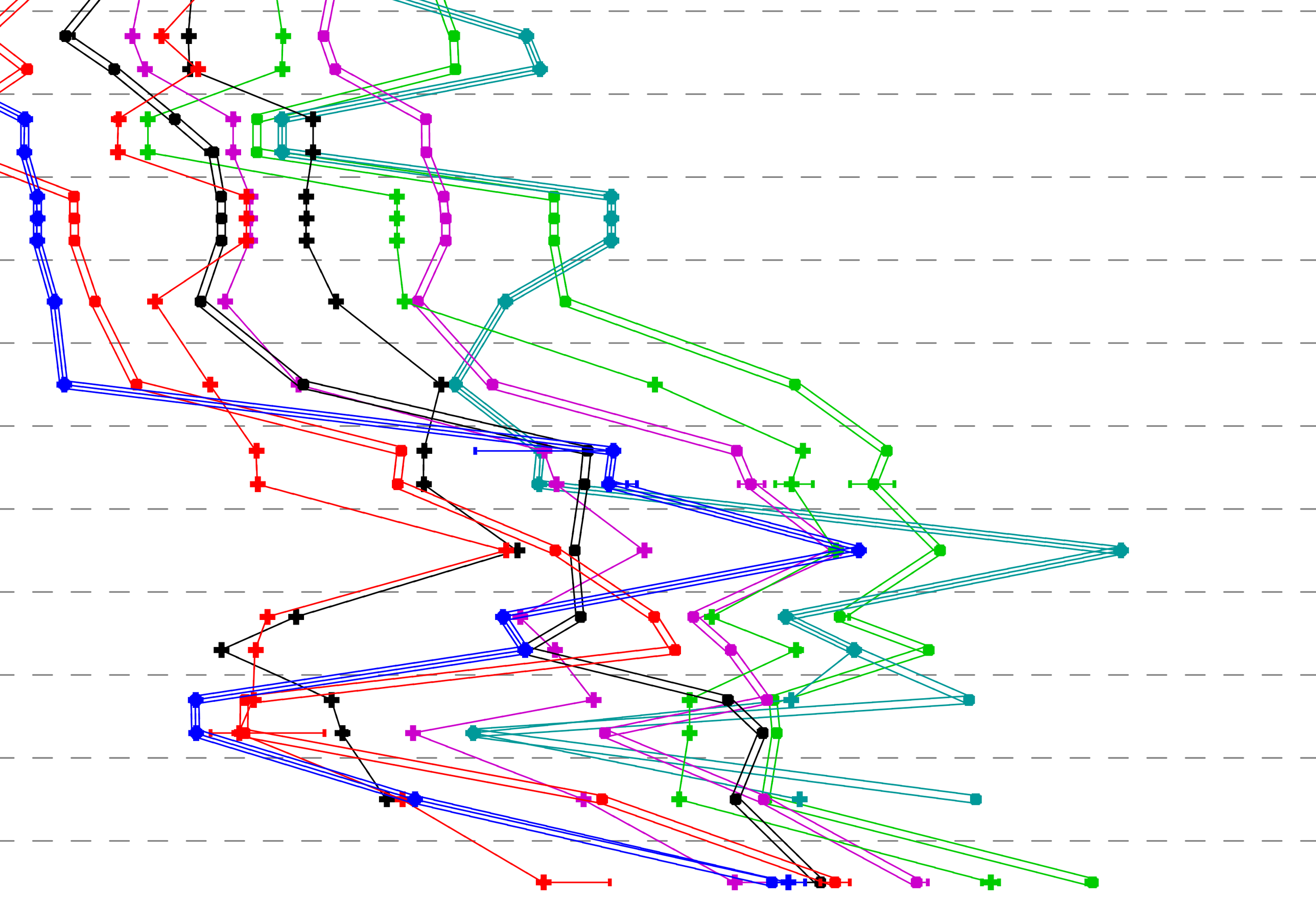
sha512
keccakc1024
round3jh512
groestl512
6
keccakc512
sha256
groestl256
round3jh256

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mangetsu; 4 x 3100MHz; 2011 Intel Core i5-2400; amd64; SB+AES (206a7); supercop-20120310

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gcc11; 4 x 2000MHz; 2006 AMD Opteron 2212; amd64; K8 (40f13); supercop-20120310

hydra6; 4 x 3100MHz; 2011 AMD FX-8120; amd64; Bulldozer (600f12); supercop-20120310

bulldozer; 4 x 3600MHz; 2011 AMD FX-8150; amd64; Bulldozer (600f12); supercop-20120310

h5e450; 2 x 1650MHz; 2011 AMD E-450; amd64; Bobcat (500f20); supercop-20120310
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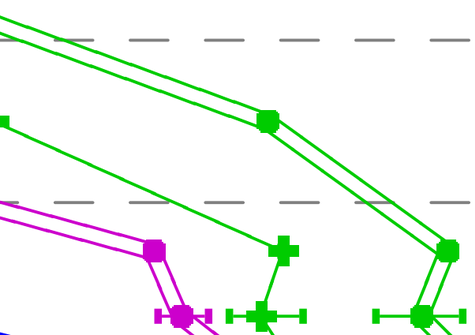

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hydra6; 4 x 3100MHz; 2011 AMD FX-8120; amd64; Bulldozer (600f12); supercop-20120310

bulldozer; 4 x 3600MHz; 2011 AMD FX-8150; amd64; Bulldozer (600f12); supercop-20120310

h5e450; 2 x 1650MHz; 2011 AMD E-450; amd64; Bobcat (500f20); supercop-20120310

h4e350; 2 x 1600MHz; 2011 AMD E-350; amd64; Bobcat (500f20); supercop-20120310

h4e450; 2 x 1650MHz; 2011 AMD E-450; amd64; Bobcat (500f20); supercop-20120310

h5nano; 1 x 1000MHz; 2009 Via Nano U3500; amd64; Nano (6f8); supercop-20120316

h2atom; 1 x 1000MHz; 2010 Intel Atom N455; amd64; Atom (106ca); supercop-20120310

slim; 1 x 1667MHz; 2009 Intel Atom N280; x86; Atom (106c2); supercop-20120310

h3atom; 1 x 1330MHz; 2008 Intel Atom Z520; x86; Atom (106c2); supercop-20120219

h1eden; 1 x 1600MHz; 2006? Via Eden ULV; x86; Eden (6d0); supercop-20120120

gggg; 2 x 533MHz; 2001 Motorola PowerPC G4 7410; ppc32; G4 (G4); supercop-20120310

h1g4; 1 x 1416MHz; 2005 Motorola PowerPC G4 7447a; ppc32; G4 (G4); supercop-20120310

h1mx515; 1 x 800MHz; 2009 Freescale i.MX515; armeabi (v7-A, Cortex A8); supercop-20120310

h4mx515e; 1 x 800MHz; 2009 Freescale i.MX515; armeabi (v7-A, Cortex A8); supercop-20120316

h5tegra; 2 x 1000MHz; 2010 NVIDIA Tegra 2; armeabi (v7-A, Tegra 2); supercop-20120310

diablo; 1 x 400MHz; 2006? TI OMAP 2420; armeabi (v6, 1136J); supercop-20110914

128 256 512 1024 2048 4096