Сумматор Линга Когге-Стоуна, Radix-2, 16-ти битный

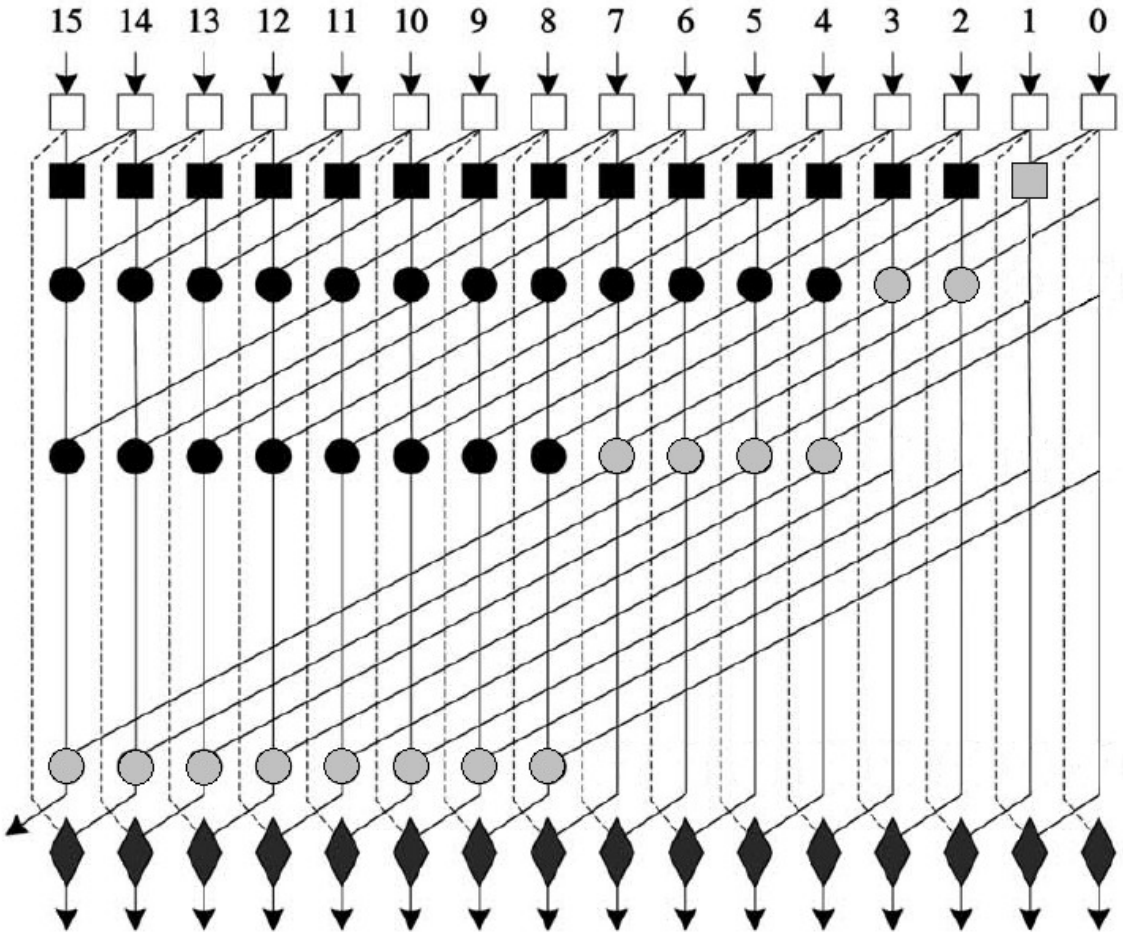

Рис.1. Граф сумматора Линга Когге-Стоуна, Radix-2, 16-ти разрядного [1].

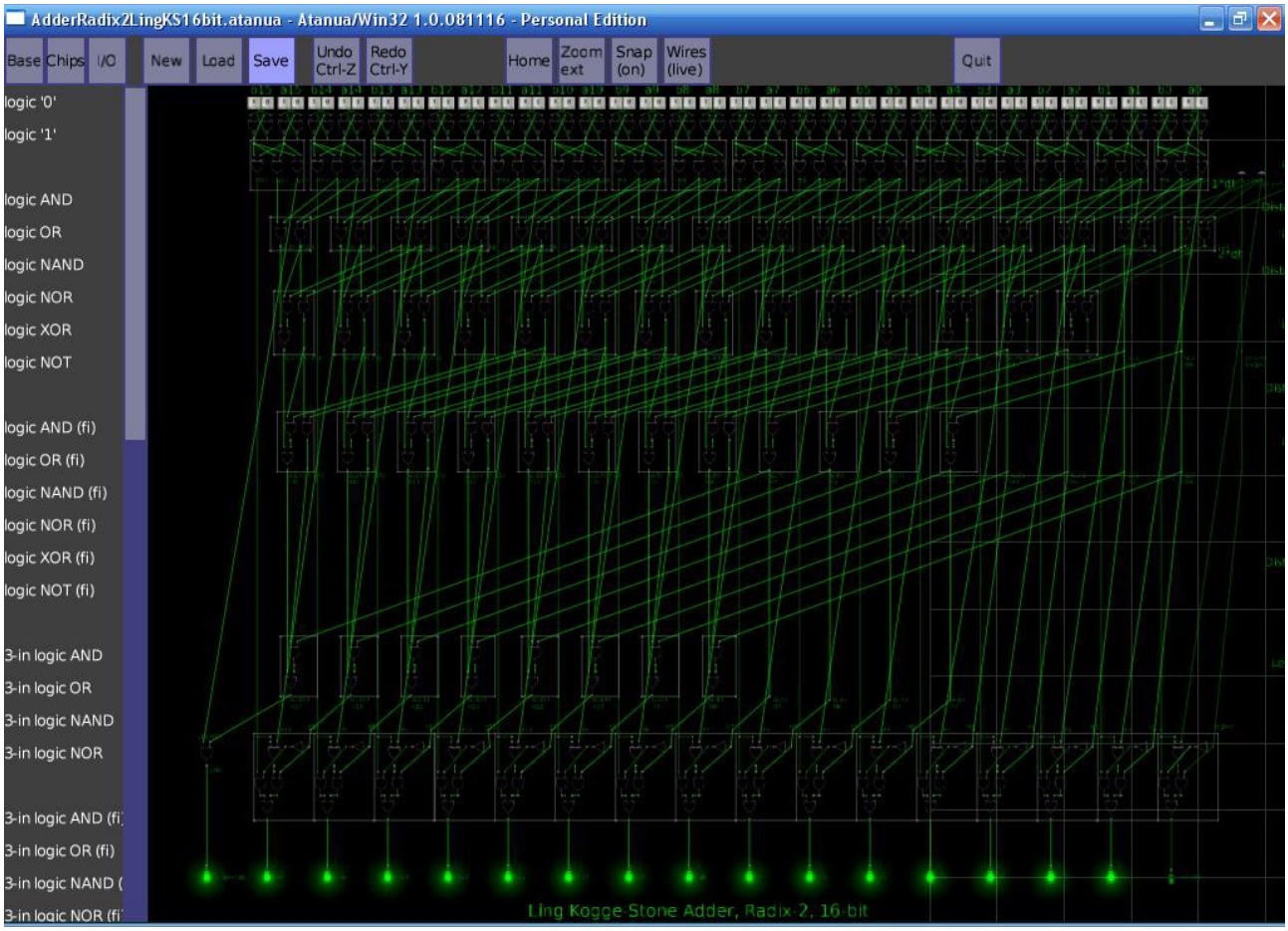

Рис.2. Снимок модели сумматора Линга, архитектура Когге-Стоуна, Radix-2, 16-ти битного (2-х байтного) в логическом симуляторе [Atanua/Win32 1.0.081116 – Personal Edition.]

Код модели сумматора Линга Когге-Стоуна, Radix-2, 16-ти битного (2-х байтного) в логическом симуляторе Atanua/Win32:
http://andserkul.narod.ru/AdderRadix2LingKS16bit.atanua

Сумматор Линга Когге-Стоуна, Radix-2, 16-ти битный (2-х байтный), в виде системы логических уравнений:

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'Level0-----------Warning-----------------------------------------
p0 = a0 OR  b0    'Initial only CLA & Ling Propagate (not in PPA)
g0 = a0 AND b0    'Initial CLA & Ling & PPA Generate
d0 = a0 XOR b0    'Only Ling Initial half bit generate (p0 in PPA)

p1 = a1 OR  b1
g1 = a1 AND b1
d1 = a1 XOR b1

p2 = a2 OR  b2
g2 = a2 AND b2
d2 = a2 XOR b2

p3 = a3 OR  b3
g3 = a3 AND b3
d3 = a3 XOR b3

p4 = a4 OR  b4
g4 = a4 AND b4
d4 = a4 XOR b4
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p5 = a5 OR  b5
g5 = a5 AND b5
d5 = a5 XOR b5

p6 = a6 OR  b6
g6 = a6 AND b6
d6 = a6 XOR b6

p7 = a7 OR  b7
g7 = a7 AND b7
d7 = a7 XOR b7

p8 = a8 OR  b8
g8 = a8 AND b8
d8 = a8 XOR b8

p9 = a9 OR  b9
g9 = a9 AND b9
d9 = a9 XOR b9

p10 = a10 OR  b10
g10 = a10 AND b10
d10 = a10 XOR b10

p11 = a11 OR  b11
g11 = a11 AND b11
d11 = a11 XOR b11

p12 = a12 OR  b12
g12 = a12 AND b12
d12 = a12 XOR b12

p13 = a13 OR  b13
g13 = a13 AND b13
d13 = a13 XOR b13

p14 = a14 OR  b14
g14 = a14 AND b14
d14 = a14 XOR b14

p15 = a15 OR  b15
g15 = a15 AND b15
d15 = a15 XOR b15

'Level1-----------------------------Distance=2^0=1
'GLi=gi OR gi-1                     'Distance=1
'PLi=pi AND pi-1 (9)                'Distance=1

GLm1 = 0              'for k<0
PLm2 = 0              'for k<0

'(GL0,PLm1)
GL0 = g0 OR  gm1                    '(g0-gm1)Distance=1
PLm1=0                'for k<0

'(GL1,PL0)
GL1 = g1 OR  g0                     '(g1-g0)Distance=1
PL0 = p0 AND pm1                    '(p0-pm1)Distance=1

'(GL2,PL1)
GL2 = g2 OR  g1                     '(g2-g1)Distance=1
PL1 = p1 AND p0                     '(p1-p0)Distance=1
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'(GL3,PL2)
GL3 = g3 OR  g2                    '(g3-g2)Distance=1
PL2 = p2 AND p1                    '(p2-p1)Distance=1

'(GL4,PL3)
GL4 = g4 OR  g3                    '(g4-g3)Distance=1
PL3 = p3 AND p2                    '(p3-p2)Distance=1

'(GL5,PL4)
GL5 = g5 OR  g4                    '(g5-g4)Distance=1
PL4 = p4 AND p3                    '(p4-p3)Distance=1

'(GL6,PL5)
GL6 = g6 OR  g5                    '(g6-g5)Distance=1
PL5 = p5 AND p4                    '(p5-p4)Distance=1

'(GL7,PL6)
GL7 = g7 OR  g6
PL6 = p6 AND p5

'(GL8,PL7)
GL8 = g8 OR  g7
PL7=  p7 AND p6       'for k<0

'(GL9,PL8)
GL9 = g9 OR  g8
PL8 = p8 AND p7                    'Distance=1

'(GL10,PL9)
GL10 = g10 OR  g9
PL9 = p9 AND p8                    'Distance=1

'(GL11,PL10)
GL11 = g11 OR  g10
PL10 = p10 AND p9                  'Distance=1

'(GL12,PL11)
GL12 = g12 OR  g11
PL11 = p11 AND p10

'(GL13,PL12)
GL13 = g13 OR  g12
PL12 = p12 AND p11

'(GL14,PL13)
GL14 = g14 OR  g13
PL13 = p13 AND p12

'(GL15,PL14)
GL15 = g15 OR  g14
PL14 = p14 AND p13

'Level2------------------------------Distance=2^1=2
'(G,P)=(g,p) o (g',p')= (g OR (p AND g'),p AND p')
'G=g OR (p AND p')
'P=      p AND p'

'(GL2,PL1) o (GL0,PLm1)
GL21 = GL2 OR (PL1 AND GL0)
'PL11 = PL1 AND PLm1               'Distance=2

'(GL3,PL2) o (GL1,PL0)
GL31 = GL3 OR (PL2 AND GL1)
PL21 = PL2 AND PL0                 'Distance=2
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'(GL4,PL3) o (GL2,PL1)
GL41 = GL4 OR (PL3 AND GL2)
PL31 = PL3 AND PL1                  'Distance=2

'(GL5,PL4) o (GL3,PL2)
GL51 = GL5 OR (PL4 AND GL3)
PL41 = PL4 AND PL2                  'Distance=2

'(GL6,PL5) o (GL4,PL3)
GL61 = GL6 OR (PL5 AND GL4)
PL51 = PL5 AND PL3                  'Distance=2

'(GL7,PL6) o (GL5,PL4)
GL71 = GL7 OR (PL6 AND GL5)
PL61 = PL6 AND PL4                  'Distance=2

'(GL8,PL7) o (GL6,PL5)
GL81 = GL8 OR (PL7 AND GL6)
PL71 = PL7 AND PL5                  'Distance=2

'(GL9,PL8) o (GL7,PL6)
GL91 = GL9 OR (PL8 AND GL7)
PL81 = PL8 AND PL6                  'Distance=2

'(GL10,PL9) o (GL8,PL7)
GL101 = GL10 OR (PL9 AND GL8)
PL91 = PL9 AND PL7                  'Distance=2

'(GL11,PL10) o (GL9,PL8)
GL111 = GL11 OR (PL10 AND GL9)
PL101 = PL10 AND PL8                'Distance=2

'(GL12,PL11) o (GL10,PL9)
GL121 = GL12 OR (PL11 AND GL10)
PL111 = PL11 AND PL9                'Distance=2

'(GL13,PL12) o (GL11,PL10)
GL131 = GL13 OR (PL12 AND GL11)
PL121 = PL12 AND PL10               'Distance=2

'(GL14,PL13) o (GL12,PL11)
GL141 = GL14 OR (PL13 AND GL12)
PL131 = PL13 AND PL11               'Distance=2

'(GL15,PL14) o (GL13,PL12)
GL151 = GL15 OR (PL14 AND GL13)
PL141 = PL14 AND PL12               'Distance=2

'Level3-----------------------------Distance=2^2=4
'(G,P)=(g,p) o (g',p')= (g OR (p AND g'),p AND p')
'G=g OR (p AND p')
'P=      p AND p'

'(GL41,PL31) o (GL0,PLm1)
GL42 = GL41 OR (PL31 AND GL0)       '(GL41-GL0)Distance=4

'(GL51,PL41) o (GL1,PL0)
GL52 = GL51 OR (PL41 AND GL1)       '(GL51-GL1)Distance=4

'(GL61,PL51) o (GL21,PL1)
GL62 = GL61 OR (PL51 AND GL21)      '(GL61-GL21)Distance=4

'(GL71,PL61) o (GL31,PL21)
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GL72 = GL71 OR (PL61 AND GL31)     '(GL71-GL31)Distance=4

'(GL81,PL71) o (GL4,PL31)
GL82 = GL81 OR (PL71 AND GL41)     '(GL81-GL41)Distance=4
PL72 = PL71 AND PL31               '(PL71-PL31)Distance=4

'(GL91,PL81) o (GL51,PL41)
GL92 = GL91 OR (PL81 AND GL51)     '(GL91-GL51)Distance=4
PL82 = PL81 AND PL41               '(PL81-PL41)Distance=4

'(GL101,PL91) o (GL61,PL51)
GL102 = GL101 OR (PL91 AND GL61)   '(GL101-GL61)Distance=4
PL92 = PL91 AND PL51               '(PL91-PL51)Distance=4

'(GL111,PL101) o (GL71,PL61)
GL112 = GL111 OR (PL101 AND GL71)  '(GL111-GL71)Distance=4
PL102 = PL101 AND PL61             '(PL101-Pl61)Distance=4

'(GL121,PL111) o (GL81,PL71)
GL122 = GL121 OR (PL111 AND GL81)  '(GL121-GL81)Distance=4
PL112 = PL111 AND PL71             '(PL111-PL71)Distance=4

'(GL131,PL121) o (GL91,PL81)
GL132 = GL131 OR (PL121 AND GL91)  '(GL131-GL91)Distance=4
PL122 = PL121 AND PL81             '(PL121-PL81)Distance=4

'(GL141,PL131) o (GL101,PL91)
GL142 = GL141 OR (PL131 AND GL101) '(GL141-GL101)Distance=4
PL132 = PL131 AND PL91             '(PL131-PL91)Distance=4

'(GL151,PL141) o (GL111,PL101)
GL152 = GL151 OR (PL141 AND GL111) '(GL151-GL111)Distance=4
PL142 = PL141 AND PL101            '(PL141-Pl101)Distance=4

'Level4-----------------------------Distance=2^3=8
'(G,P)=(g,p) o (g',p')= (g OR (p AND g'),p AND p')
'G=g OR (p AND p')
'P=      p AND p'

GL83 = GL82 OR (PL72 AND GL0)      '(GL82-GL0)Distance=8

GL93 = GL92 OR (PL82 AND GL1)      '(GL92-GL1)Distance=8

GL103 = GL102 OR (PL92 AND GL21)   '(GL102-GL21)Distance=8

GL113 = GL112 OR (PL102 AND GL31)  '(GL112-GL31)Distance=8

GL123 = GL122 OR (PL112 AND GL42)  '(GL122-GL42)Distance=8

GL133 = GL132 OR (PL122 AND GL52)  '(GL132-GL52)Distance=8

GL143 = GL142 OR (PL132 AND GL62)  '(GL142-GL62)Distance=8

GL153 = GL152 OR (PL142 AND GL72)  '(GL152-GL72)Distance=8

'Ling PsevdoCarry (H)-------------------
Hm1 = GLm1                   'Ling PsevdoCarry

H0 = GL0                     'Ling PsevdoCarry

H1 = GL1                     'Ling PsevdoCarry

H2 = GL21                    'Ling PsevdoCarry
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H3 = GL31                    'Ling PsevdoCarry

H4 = GL42                    'Ling PsevdoCarry

H5 = GL52                    'Ling PsevdoCarry

H6 = GL62                    'Ling PsevdoCarry

H7 = GL72                    'Ling PsevdoCarry

H8 = GL83                    'Ling PsevdoCarry

H9 = GL93                    'Ling PsevdoCarry

H10 = GL103                  'Ling PsevdoCarry

H11 = GL113                  'Ling PsevdoCarry

H12 = GL123                  'Ling PsevdoCarry

H13 = GL133                  'Ling PsevdoCarry

H14 = GL143                  'Ling PsevdoCarry

H15 = GL153                  'Ling PsevdoCarry

'SUM-------------------------------------------------
'si=(/Hi-1 AND di) OR (Hi-1 AND (di XOR pi-1))

s0 = ((1-Hm1) AND d0) OR (Hm1 AND (d0 XOR pm1))  's0=d0

s1 = ((1-H0) AND d1) OR (H0 AND (d1 XOR p0))

s2 = ((1-H1) AND d2) OR (H1 AND (d2 XOR p1))

s3 = ((1-H2) AND d3) OR (H2 AND (d3 XOR p2))

s4 = ((1-H3) AND d4) OR (H3 AND (d4 XOR p3))

s5 = ((1-H4) AND d5) OR (H4 AND (d5 XOR p4))

s6 = ((1-H5) AND d6) OR (H5 AND (d6 XOR p5))

s7 = ((1-H6) AND d7) OR (H6 AND (d7 XOR p6))

s8 = ((1-H7) AND d8) OR (H7 AND (d8 XOR p7))

s9 = ((1-H8) AND d9) OR (H8 AND (d9 XOR p8))

s10 = ((1-H9) AND d10) OR (H9 AND (d10 XOR p9))

s11 = ((1-H10) AND d11) OR (H10 AND (d11 XOR p10))

s12 = ((1-H11) AND d12) OR (H11 AND (d12 XOR p11))

s13 = ((1-H12) AND d13) OR (H12 AND (d13 XOR p12))

s14 = ((1-H13) AND d14) OR (H13 AND (d14 XOR p13))

s15 = ((1-H14) AND d15) OR (H14 AND (d15 XOR p14))

c16 = p15 AND H15  'Cout=c16
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Программа проверки системы логических уравнений сумматора Линга Когге-Стоуна, Radix-2, 16-ти битного (2-х байтного), на TurboBasic'e: http://andserkul.narod.ru/R2LKS16B.bas

Литература:

1. High-Speed Parallel-Prefix VLSI Ling Adders. Giorgos Dimitrakopoulos and Dimitris Nikolos.

2. Сумматор Линга, Radix-2, 4-х битный. Куликов А.С.

3. Сумматор Линга Когге-Стоуна, Radix-2, 8-ми битный. Куликов А.С.

Приложение 1.

TurboBasic 1.0

Куликов А.С., Россия-Русь, Москва, Царицыно, версия 2021.11.10.