Overview

Gambit is a superscalar processor with a 52-bit native operating mode. Native mode makes use of a 32-entry register file. Native mode instructions vary in length up to 52-bits. The processor manages branching using a compare instruction and status flags results.

Programming Model

General Registers

Reg			Usage
R0	z	This register is always zero	
R1	acc	Accumulator	First parameter / return value / loop count
R2	x	'x' index register	Second parameter
R3	y	'y' index register	Third parameter
R4			
R5			
R6			
R7 to 29			
R30	fp	frame pointer	
R31	sp	stack pointer	

SR	sr	status register	conditional branching

Memory Addressing

The cpu is word oriented with byte addressable memory. The default size of a memory operand is word size (52 bits). Up to 2^{52} Bytes of data are supported and 2^{52} bytes of code.

Instruction Set Summary

The cycle counts are assuming no wait states are required for either instructions or data and both instructions and data can be found in the cache.

Instruction Formats

Arithmetic / Logical

ADD	Flags: v c n z						Opcode		Bytes
51 39	38 26	25 21	20 16	15 11	10 6	5 0			
		0	~$_4$	Rb$_5$	Ra$_5$	Rt$_5$	00o	ADD Rt,Ra,Rb	2
		1	Imm$_9$		Ra$_5$	Rt$_5$	00o	ADD Rt,Ra,#imm$_6$	2
	Imm$_{23}$				Ra$_5$	Rt$_5$	01o	ADD Rt,Ra,#imm$_{14}$	3
Imm$_{36}$					Ra$_5$	Rt$_5$	02o	ADD Rt,Ra,#imm$_{30}$	4

SUB	Flags: v c n z						Opcode		Bytes
51 39	38 26	25 21	20 16	15 11	10 6	5 0			
		0	~$_4$	Rb$_5$	Ra$_5$	Rt$_5$	10o	ADD Rt,Ra,Rb	2
		1	Imm$_9$		Ra$_5$	Rt$_5$	10o	ADD Rt,Ra,#imm$_6$	2
	Imm$_{23}$				Ra$_5$	Rt$_5$	11o	ADD Rt,Ra,#imm$_{14}$	3
Imm$_{36}$					Ra$_5$	Rt$_5$	12o	ADD Rt,Ra,#imm$_{30}$	4

CMP	Flags: c n z						Opcode		Bytes
51 39	38 26	25 21	20 16	15 11	10 6	5 0			
		0	~$_4$	Rb$_5$	Ra$_5$	0$_5$	10o	ADD Rt,Ra,Rb	2
		1	Imm$_9$		Ra$_5$	0$_5$	10o	ADD Rt,Ra,#imm$_6$	2
	Imm$_{23}$				Ra$_5$	0$_5$	11o	ADD Rt,Ra,#imm$_{14}$	3
Imm$_{36}$					Ra$_5$	0$_5$	12o	ADD Rt,Ra,#imm$_{30}$	4

CMP is an alternate mnemonic for SUB where the target register is R0. CMP does not alter the overflow flag.

AND	Flags: n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb5	Ra5	Rt5	30o	ADD Rt,Ra,Rb	2
		1	Imm9		Ra5	Rt5	30o	ADD Rt,Ra,#imm6	2
	Imm23				Ra5	Rt5	31o	ADD Rt,Ra,#imm14	3
Imm36					Ra5	Rt5	32o	ADD Rt,Ra,#imm30	4

BIT	Flags: v n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb5	Ra5	05	30o	ADD Rt,Ra,Rb	2
		1	Imm9		Ra5	05	30o	ADD Rt,Ra,#imm6	2
	Imm23				Ra5	05	31o	ADD Rt,Ra,#imm14	3
Imm36					Ra5	05	32o	ADD Rt,Ra,#imm30	4

Bit is the AND operation with no target register; the overflow status is set to bit 50 of the result

OR	Flags: n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb5	Ra5	Rt5	40o	ADD Rt,Ra,Rb	2
		1	Imm9		Ra5	Rt5	40o	ADD Rt,Ra,#imm6	2
	Imm23				Ra5	Rt5	41o	ADD Rt,Ra,#imm14	3
Imm36					Ra5	Rt5	42o	ADD Rt,Ra,#imm30	4

EOR	Flags: n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb5	Ra5	Rt5	50o	ADD Rt,Ra,Rb	2
		1	Imm9		Ra5	Rt5	50o	ADD Rt,Ra,#imm6	2
	Imm23				Ra5	Rt5	51o	ADD Rt,Ra,#imm14	3
Imm36					Ra5	Rt5	52o	ADD Rt,Ra,#imm30	4

Load and Store Instructions

LD	Flags: n z						Opcode		Bytes
51 39	38 26	25 16		15 11	10 6	5 0			
	0	~$_4$	Rb_5	Ra_5	Rt_5	60o	Rt.[Ra+Rb]	2
	1	$Disp_9$		Ra_5	Rt_5	60o	Rt,d9[Ra]	2
	$Disp_{23}$			Ra_5	Rt_5	61o	Rt,d23[Ra]	3
$Addr_{36}$				Ra_5	Rt_5	62o	Rt,d36[Ra]	4

LDB	Flags: n z				Opcode		Bytes
51 39	38 26	25 16	15 11	10 6	5 0		
$Addr_{36}$			Ra_5	Rt_5	64o	Rt,d[Ra]	4

ST	Flags: n z						Opcode		Bytes
51 39	38 26	25 16		15 11	10 6	5 0			
	0	~$_4$	Rb_5	Ra_5	Rs_5	70o	Rs.[Ra+Rb]	2
	1	$Disp_9$		Ra_5	Rs_5	70o	Rs,d9[Ra]	2
	$Disp_{23}$			Ra_5	Rs_5	71o	Rs,d23[Ra]	3
$Addr_{36}$				Ra_5	Rs_5	72o	Rs,d36[Ra]	4

STB	Flags:				Opcode		Bytes
51 39	38 26	25 16	15 11	10 6	5 0		
$Addr_{36}$			Ra_5	Rs_5	74o	Ra,d[Ra]	4

Shift Operations / Read-modify-write memory operations.

ASL	Flags: c n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb_5	Ra_5	Rt_5	06o	Rt,Ra,Rb	2
		1	~3	Imm_6	Ra_5	Rt_5	06o	Rt,Ra,#imm_{10}	2

ROL	Flags: c n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb_5	Ra_5	Rt_5	16o	Rt,Ra,Rb	2
		1	~3	Imm_6	Ra_5	Rt_5	16o	Rt,Ra,#imm_{10}	2

LSR	Flags: c n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb_5	Ra_5	Rt_5	26o	Rt,Ra,Rb	2
		1	~3	Imm_6	Ra_5	Rt_5	26o	Rt,Ra,#imm_{10}	2

ROR	Flags: c n z						Opcode		Bytes
51 39	38 26	25	21	20 16	15 11	10 6	5 0		
		0	~4	Rb_5	Ra_5	Rt_5	36o	Rt,Ra,Rb	2
		1	~3	Imm_6	Ra_5	Rt_5	36o	Rt,Ra,#imm_{10}	2

Flow Control

JMP	Flags:			Bytes
	$Address_{46}$	04o	JMP abs46	4
	$\sim_2$ Ra_5	44o	JMP [Ra]	1

JSR	Flags:			Bytes
	$Address_{46}$	14o	JSR abs46	4
	$\sim_2$ Ra_5	54o	JSR [Ra]	1

RTS	Flags:	$\sim_4$	0	24o	RTS	1
RTI	Flags: z n c v b d i u	$\sim_4$	1	24o	RTI	1
PFI	Flags:	$\sim_4$	2	24o	PFI	1
WAI	Flags:	$\sim_4$	4	24o	WAI	1
STP	Flags:	$\sim_4$	6	24o	STP	1
NOP	Flags:	$\sim_4$	7	24o	NOP	1

BEQ	Flags:	$Disp_4$	0	05o	BEQ disp	1
	$Disp_{17}$		0	15o	BEQ disp	2
BNE	Flags:	$Disp_4$	1	05o	BNE disp	1
BPL	Flags:	$Disp_4$	2	05o	BPL disp	1
BMI	Flags:	$Disp_4$	3	05o	BMI disp	1
BVS	Flags:	$Disp_4$	4	05o	BVS disp	1
BVC	Flags:	$Disp_4$	5	05o	BVC disp	1
BCS	Flags:	$Disp_4$	6	05o	BCS disp	1
BCC	Flags:	$Disp_4$	7	05o	BCC disp	1
BRA	Flags:	$Disp_4$	0	25o	BRA disp	1

RST	Flags: b	~4	0	34o	RST	1
NMI	Flags: b	~4	1	34o	NMI	1
IRQ	Flags: b	~4	2	34o	IRQ	1
BRK	Flags: b	Const4	3	34o	BRK	1

Stack push and pop operations.

PHP	Flags:	~7		75o	PHP	1
PSH	Flags:	~2	Ra5	76o	PSH Ra	1
PLP	Flags: z c v n i b d u	~7		65o	PLP	1
POP	Flags: n z	~2	Rt5	66o	POP Rt	1

Status Register Operations

REP	Flags: c v n z i u	Mask7	56o	REP	1
SEP	Flags: c v n z i u	Mask7	46o	SEP	1

String Operations

MVNB	Flags:	~4	0	45o	MVN	1
MVPB	Flags:	~4	1	45o	MVP	1
STSB	Flags:	~4	2	45o	STS	1
CMPSB	Flags: c n z	~4	3	45o	CMPS	1
MVN	Flags:	~4	4	45o	MVN	1
MVP	Flags:	~4	5	45o	MVP	1
STS	Flags:	~4	6	45o	STS	1
CMPS	Flags: c n z	~4	7	45o	CMPS	1

Opcode Maps

Root Level

	xxx000	xxx001	xxx010	xxx011	xxx100	xxx101	xxx110	xxx111
000xxx	ADD 2r,i9	ADD 2r,i23	ADD 2r,i36		JMP	Bcc d4	ASL 2r,i6	
001xxx	SUB / CMP	SUB / CMP	SUB / CMP		JSR	Bcc d17	LSR 2r,i6	
010xxx					RTS / RTI	Bcc d4	ROL 2r,i6	
011xxx	AND / BIT	AND / BIT	AND / BIT		BRK	Bcc d17	ROR 2r,i6	
100xxx	OR	OR	OR		JMP [Rn]	{string}	SEP	
101xxx	EOR	EOR	EOR		JSR [Rn]		REP	
110xxx	LD	LD	LD		LDB	PLP	POP	
111xxx	ST	ST	ST		STB	PHP	PSH	

Appendix

The first nine bits of the instruction are used as a nine-bit index into a table which holds pointers to micro-instructions.

Micro-op Instruction Format

Micro-instructions are 24 bits in size.

FL_2	$Opcode_6$	$Cnst_4$	$Src2_4$	$Src1_4$	Tgt_4

FL_2 are two bits holding the first / last micro-instruction indicators. 00 = middle instruction, 01 = first, 10 = last, 11 = first and last.

Micro-op Fields

Tgt_4	Meaning
0	The value 0
1	Get from instruction bits 6 to 10
2	The accumulator register
3	The X register
4	The Y Register
5	The stack pointer
6	the tmp1 register
7	the tmp2 register
8	the SR register
9	the PC register (source)
10	PC + 1
11	PC + 4

$Src1_4$	Meaning
0	The value 0
1	Get from register spec instruction bits 11 to 15
2	The accumulator register
3	The X register
4	The Y Register
5	The stack pointer

6	the tmp1 register
7	the tmp2 register
8	the SR register

$Src2_4$	Meaning
0	The value 0
1	Get from register spec instruction bits 16 to 25
2	The accumulator register
3	The X register
4	The Y Register
5	The stack pointer
6	the tmp1 register
7	the tmp2 register
8	the SR register
9	the value 1
11	
15	the value -1

$Cnst_4$	Meaning
0	the value 0
1	the value 1
2	the value 2
3	the value 3
4	the value 4
5	bits 9 to 25
6	bits 9 to 12 (branches)
7	bits 6 to 51 (JMP / JSR)
8	bits 16 to 25 of instruction
9	bits 16 to 38 of instruction
10	bits 16 to 51 of instruction
11	bits 6 to 12 (REP / SEP)
13	the value -3
14	the value -2
15	the value -1

Micro-op Lists for Instructions

BRK

```
SUB   SP,SP,#4
ST    PC+1,[SP]
SUB   SP,SP,#4
ST    FLAGS,[SP]
SEP   #i
LD    TMP,$FFFFFFFFFFFFC
JMP   0[TMP]
```

MVN

```
LD    tmp,[X]
ST    tmp,[Y]
ADD   X,X,4
ADD   Y,Y,4
SUB   AC,AC,#1
```

```
        BNE     PC

MVP
        LD      tmp,[X]
        ST      tmp,[Y]
        SUB     X,X,#4
        SUB     Y,Y,#4
        SUB     AC,AC,#1
        BNE     PC
STS
        ST      X,[Y]
        ADD     Y,Y,#4
        SUB     AC,AC,#1
        BNE     PC
CMPS
        LD      tmp1,[X]
        LD      tmp2,[Y]
        ADD     X,X,#4
        ADD     Y,Y,#4
        SUB     ac,ac,#1
        BEQ     PC+1
        CMP     tmp1,tmp2
        BEQ     PC
```

Micro-Instruction Opcodes

Opc_6		Flags Updated
0	ADD	-
1	ADD.	c v n z
2	SUB	-
3	SUB.	c v n z
4	AND.	n z
5	OR.	n z
6	EOR.	n z
7	LD	-
8	LD.	n z
9	LB	-
10	LB.	n z
11	ST	-
12	STB	-
13	ASL.	c n z
14	ROL.	c n z
15	LSR.	c n z
16	ROR.	c n z
17	BRA	-
18	BEQ	-
19	BNE	-
20	BMI	-
21	BPL	-
22	BCS	-
23	BCC	-
24	BVS	-
25	BVC	-
26	SEP	c v n z i u
27	REP	c v n z i u
28	JMP	
29	STP	
30	WAI	
31		