

Binary and Bit Operators

CS 241

Data Organization using C

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Note Taker Needed – Earn \$\$\$

- Accessibility Resource Center and/or Deaf and Hard of Hearing Services are looking for a student in this class to volunteer to provide notes.
- The student will be paid a stipend to take notes.
- The interested student should come by Accessibility Resource Center office at **2021 Mesa Vista Hall** to complete the required hiring paperwork.
- Please bring your Lobo Card with you.

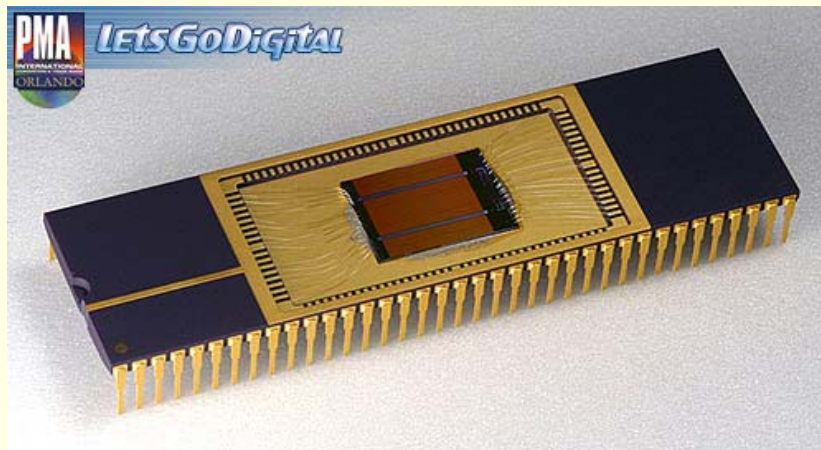
2

Powers of 2

- $2^1 = 2$
- $2^2 = 2 \times 2 = 4$
- $2^3 = 2 \times 2 \times 2 = 8$
- $2^4 = 2 \times 2 \times 2 \times 2 = 16$
- $2^5 = 32$
- $2^6 = 64$
- $2^7 = 128$
- $2^8 = 256$
- $2^9 = 512$
- $2^{10} = 1024$
- Binary with 3 bits has $2^3 = 8$ Permutations :
- 0: 000 = $0^2 + 0^1 + 0^0$
- 1: 001 = $0^2 + 0^1 + 2^0$
- 2: 010 = $0^2 + 2^1 + 0^0$
- 3: 011 = $0^2 + 2^1 + 2^0$
- 4: 100 = $2^2 + 0^1 + 0^0$
- 5: 101 = $2^2 + 0^1 + 2^0$
- 6: 110 = $2^2 + 2^1 + 0^0$
- 7: 111 = $2^2 + 2^1 + 2^0$

3

SanDisk 8-Gigabit Flash Memory Chip



How many bytes of memory does this chip store?

4

Bitwise Operators

- & bitwise AND 1010 & 0011 = 0010
- | bitwise inclusive OR 1010 | 0011 = 1011
- ^ bitwise exclusive OR 1010 ^ 0011 = 1001
- << left shift 00000100 << 3 = 00100000
- >> right shift 00000100 >> 2 = 00000001

7

Shift Operator Example

```
1. int main()
2. { int i;
3.   for (i=0; i<8; i++)
4.     { unsigned char n = 1 << i;
5.       printf("n=%d\n", n);
6.     }
7. }
```

Output:

```
n=1
n=2
n=4
n=8
n=16
n=32
n=64
n=128
```

8

<< and & Example: #1

```
1. int main()
2. { unsigned char a=17;
3.   int i;
4.
5.   for (i=7; i>=0; i--)
6.     { unsigned char n = 1 << i;
7.       if (a & n) printf("1");
8.       else printf("0");
9.     }
10.  printf("\n");
```

Output: 00010001

9

<< and & Example: #2

```
1. int main()
2. { unsigned char a=22;
3.   int i;
4.
5.   for (i=7; i>=0; i--)
6.     { unsigned char n = 1 << i;
7.       if (a & n) printf("1");
8.       else printf("0");
9.     }
10.  printf("\n");
```

Output: 00010110

10

Quiz 2-8: << and &

```
1. int main()
2. { unsigned char a=37;
3.   int i;
4.
5.   for (i=7; i>=0; i--)
6.     { unsigned char n = 1 << i;
7.       if (a & n) printf("1");
8.       else printf("0");
9.     }
10.  printf("\n");
```

- a) 00110101
- b) 00100101
- c) 00101101
- d) 00100111
- e) 00110101

11

Quiz 2-9: << and &

```
1. int main()
2. { unsigned char a=37;
3.   int i;
4.
5.   for (i=7; i>=0; i--)
6.     { unsigned char n = 1 << i;
7.       if (!(a & n)) printf("%d, ", n);
8.     }
9.   printf("\n");
```

- a) 64, 32, 16, 4, 1,
- b) 64, 16, 8, 4, 2, 1,
- c) 64, 16, 8, 4, 1,
- d) 128, 64, 16, 8, 1,
- e) 128, 64, 16, 8, 2,

12

Two's Complement

Two's Comp	Decimal
00000111	7
00000110	6
00000101	5
00000100	4
00000011	3
00000010	2
00000001	1
00000000	0

Two's Comp	Decimal
11111111	-1
11111110	-2
11111101	-3
11111100	-4
11111011	-5
11111010	-6
11111001	-7
11111000	-8

Two's Complement:

5:	0	0	0	0	1	0	1
Flip Bits:	1	1	1	1	0	1	0
Add 1:	0	0	0	0	0	0	1
-5:	1	1	1	1	0	1	1

13