CENG331 - Computer Organization

Ternary (Base 3) Computing

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“Perhaps the prettiest number system of all is the balanced ternary notation.” - Donald Knuth *The art of Computer Programming, Vol. 2 , 1981, p.190*

History

1840- Thomas Fowler , UK

Mechanical ternary calculator

1958- Nikolay Brusentsov, USSR

Electronic ternary computer (SETUN)

1970- Nikolay Brusentsov, USSR

SETUN-70 (improved SETUN)

Binary vs Ternary

	Classical	Quantum
Binary	→ Bits	→ Qubits
Ternary	→ Trits	→ Qutrits

Ternary trit representations

Unbalanced (unsigned)	:	{0,1,2}
Unbalanced (fractional)	:	{0,1/2,1}
Balanced (signed)	:	{-1,0,+1}

…

Storage cost of a number representation

Number of digits (d)

$\times$

Base (β)

$\downarrow$

Cost ($\beta \times d$)

Optimum (most economical) base

- If we allow non-integer base, it turns out *e=2.718…* is the best*
- Closest integer to *e* is *3* , not *2*!

** Brian Hayes, "Third Base", American Scientist, 89(9), pp.490-494, 2001*

Other advantages of balanced ternary

- Can represent (+)ve and (-)ve numbers
- Each number has a unique representation
- The most significant bit also serves as a sign bit
- Arithmetic operations work out simply and naturally - no need for special treatment for negative numbers

Thank you!