Circuit Challenge 10

What is the theoretical minimum propagation delay across a perfectly square integrated circuit whose area is 25 nanoacres?

Think about it, then scroll down.

Analysis for Challenge 10

Clearly, the first task will be to convert 25 nanoacres to a square of manageable dimensions.

We first define a term: The Acre Edge (AE=acre$^{1/2}$). If the reader can accept this terminology, then the edge dimension is given by

$$(25\times10^{-9}\text{ acres})^{1/2}\bullet(208.71033\text{ ft/AE})\bullet(12\text{in/ft})\bullet(2.54\text{cm/in}) = 1.0058\text{ cm}$$
$$= 0.010058\text{ meter}$$

Philosophical Commentary

The absolute fastest signal-traverse would necessarily be limited by the speed of light. In a realistic circuit the signal path would include circuitry (which would slow the propagation). If only a wire (or light pulse) was needed (no signal management, no amplification, etc.), the integrated circuit would not be required.

The Calculation

Per **Wikipedia**, the speed of light (with certain qualifying conditions) is given by

$$c = 299{,}792{,}458\text{ meters/sec}$$

Thus,

$$t_{Prop}(\text{min}) = (0.010058\text{ meter})/(299{,}792{,}458\text{ meters/sec})$$

$$t_{Prop}(\text{min}) = 33.6\text{ picoseconds}$$

which is about one-thirtieth of one nanosecond. This represents, then, a figure of merit for best-performance. Any practical circuit whose line-of-sight signal path is approximately 1cm must necessarily be slower:

1. The actual signal path (up, down, over, under, around, and through) will be greater than 1cm
2. Signal movement will be slowed because of the need to charge & discharge junctions, etc.
3. The medium is not the vacuum of space