Sun Microsystems Laboratories

Title: **Simple Circuits that Work for Complicated Reasons**
Date: **27 March 2000**
Author: **Charles E. Molnar and Ian W. Jones**
SML #: **2000:0154**

References:

SML# 2000:0050: Simple Circuits that Work for Complicated Reasons, Charles E. Molnar and Ian W. Jones, 31 January 2000, (final version of the paper submitted to Async 2000).

SML# 99:0569: Simple Circuits that Work for Complicated Reasons, Charles E. Molnar and Ian W. Jones, 21 October 1999, (version submitted for review for Async 2000).

SML# 99:0488: Simple Circuits that Work for Complicated Reasons, Charles E. Molnar and Ian W. Jones, 4 October 1999, (draft version submitted for Sun legal clearance).

Introduction

Attached are the slides to be presented at the IEEE Sixth *International Symposium on Advanced Research in Asynchronous Circuits and Systems* (Async2000) to be held in Eilat, Israel, 4-6 April 2000. These slides accompany the paper "Simple Circuits that Work for Complicated Reasons," SML# 2000:0050.

SIMPLE CIRCUITS THAT WORK FOR COMPLICATED REASONS

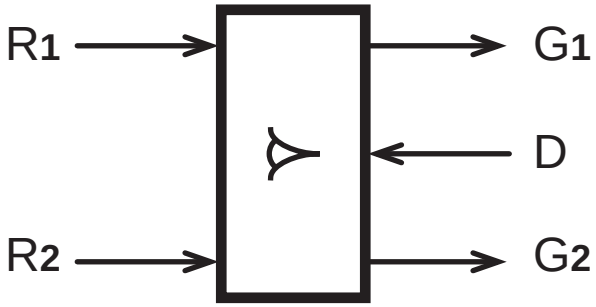
Charles E. Molnar
and
Ian W. Jones

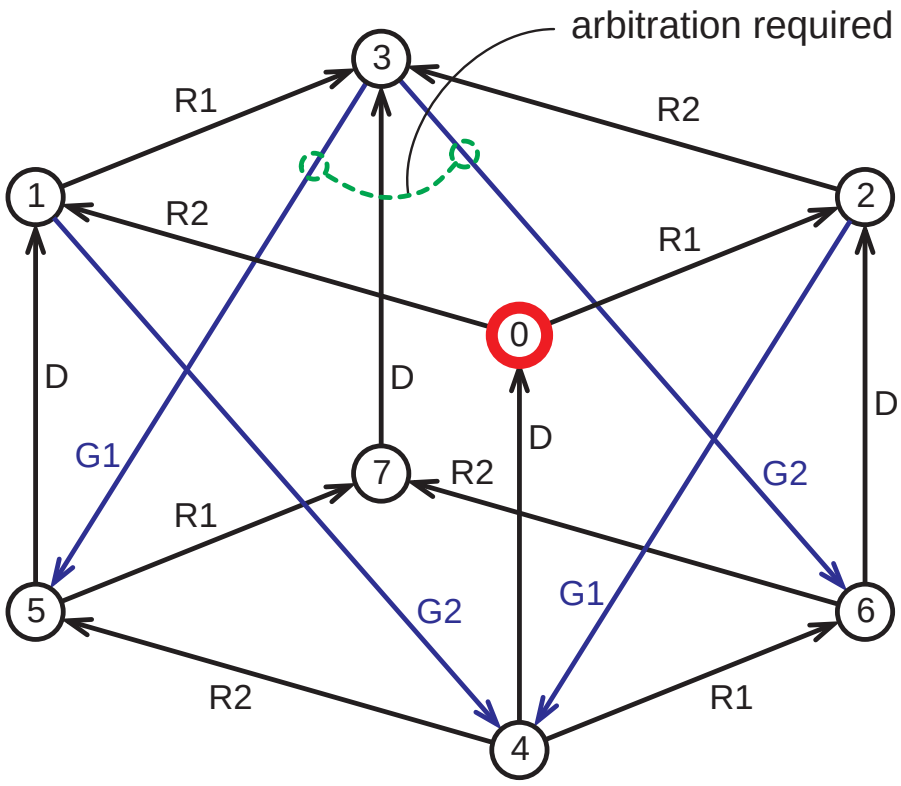
Sun Microsystems Laboratories

Presentation Outline

- **Propellor Arbiter**
  - **Before: 2-phase ⇔ 4-phase conversion**
  - **Dynamical Systems Phase Portraits**
  - **After: arbitration of 2-phase signals**
- **An Arbiter as an Umpire**
- **Using Arbiters to Measure Delay**
- **Conclusion**

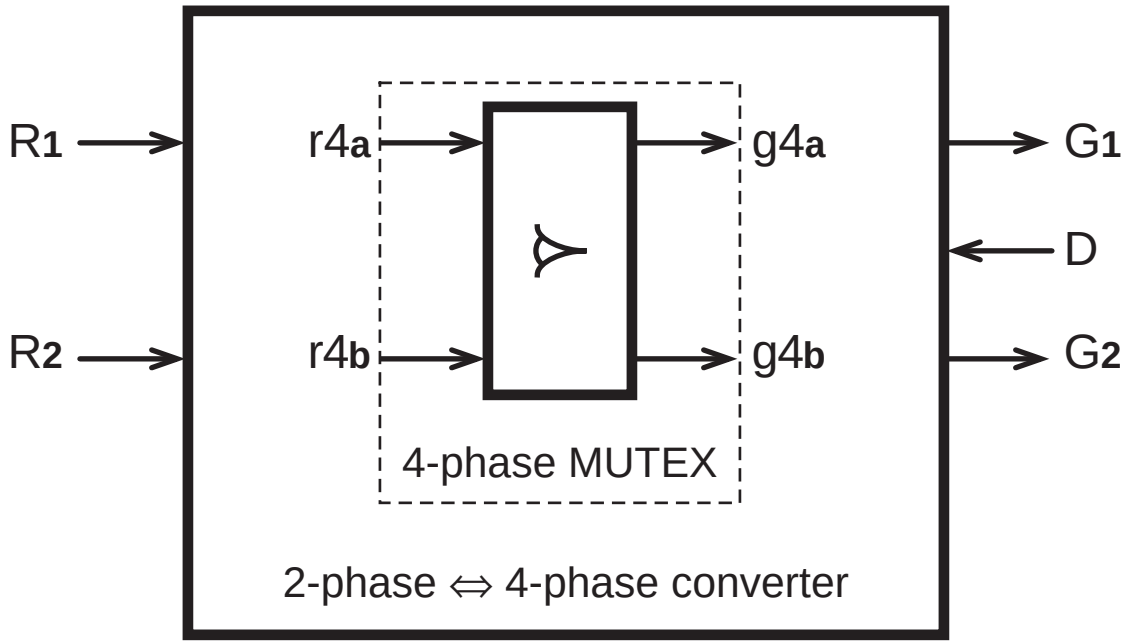
5-Wire Transition Arbiter



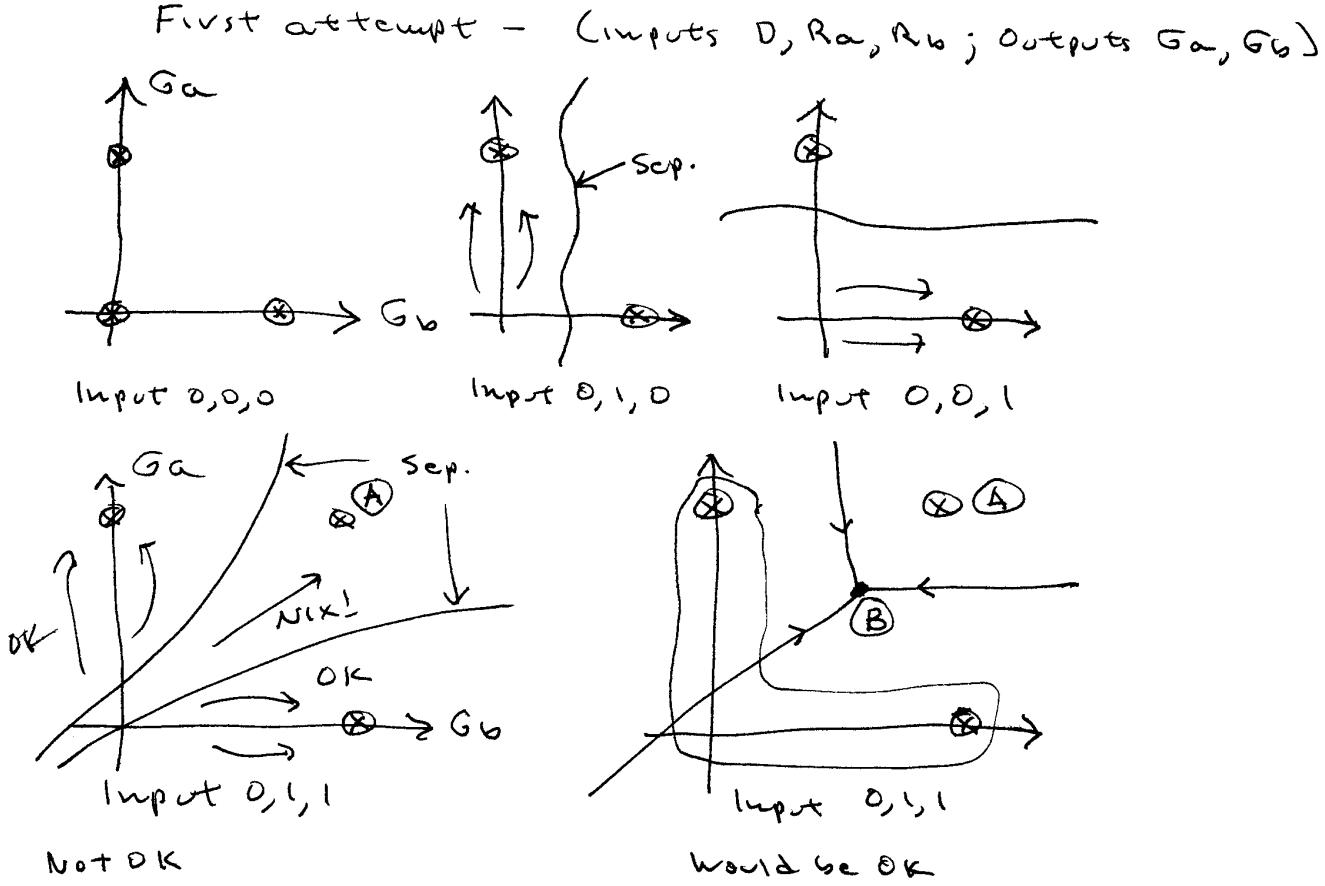


5-Wire Arbiter Implementation

Before December 1992:

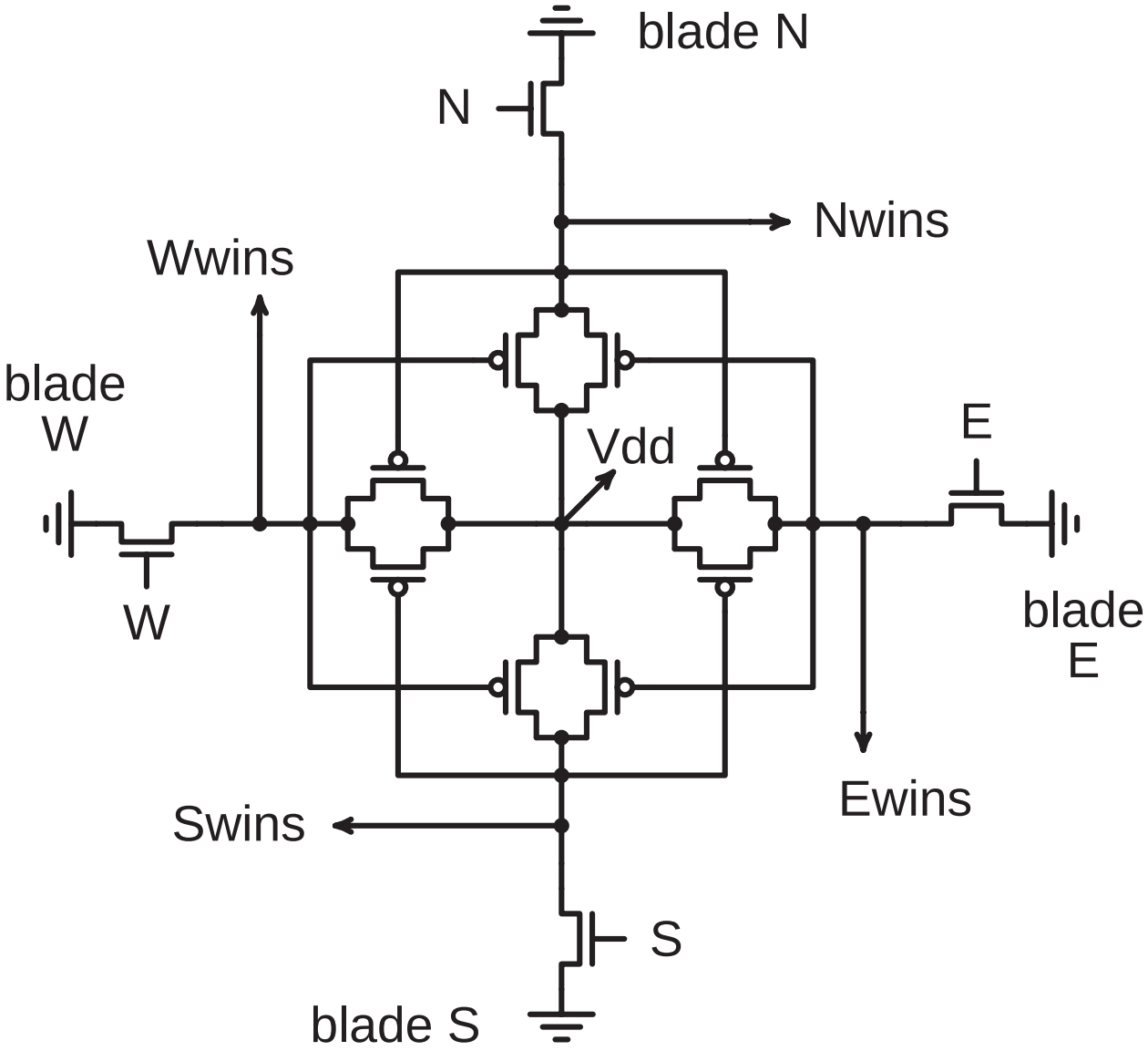


Dynamical Systems Phase Portraits

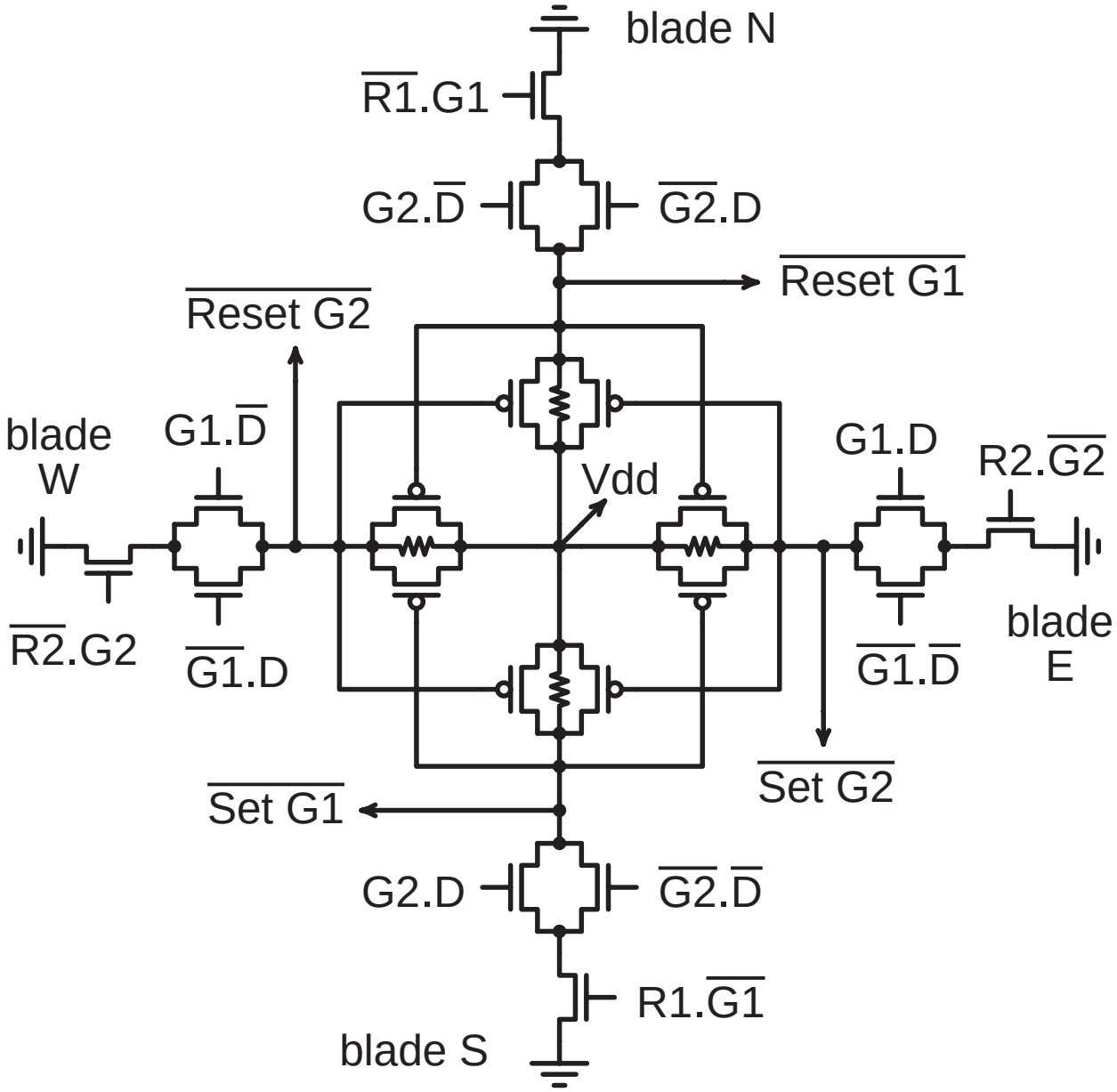


from a letter by Charles Molnar written on the M.S. Orchid, on the Nile between Esna and Edfu, December 1992.

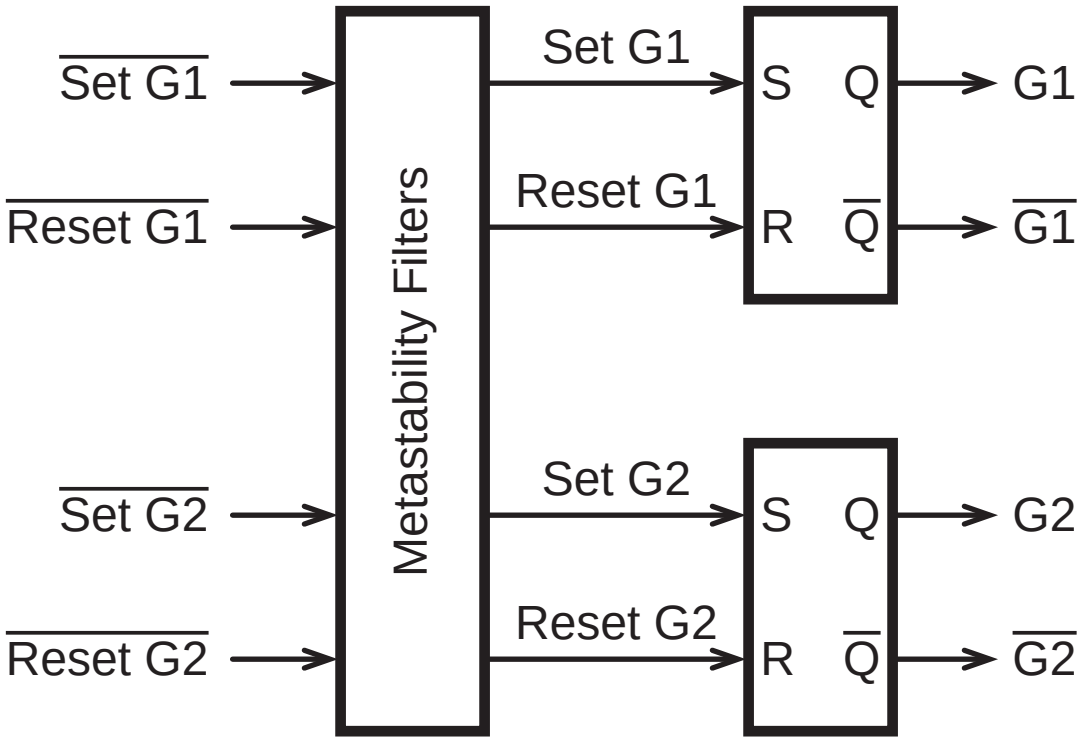
Basic Propellor Arbiter Circuit



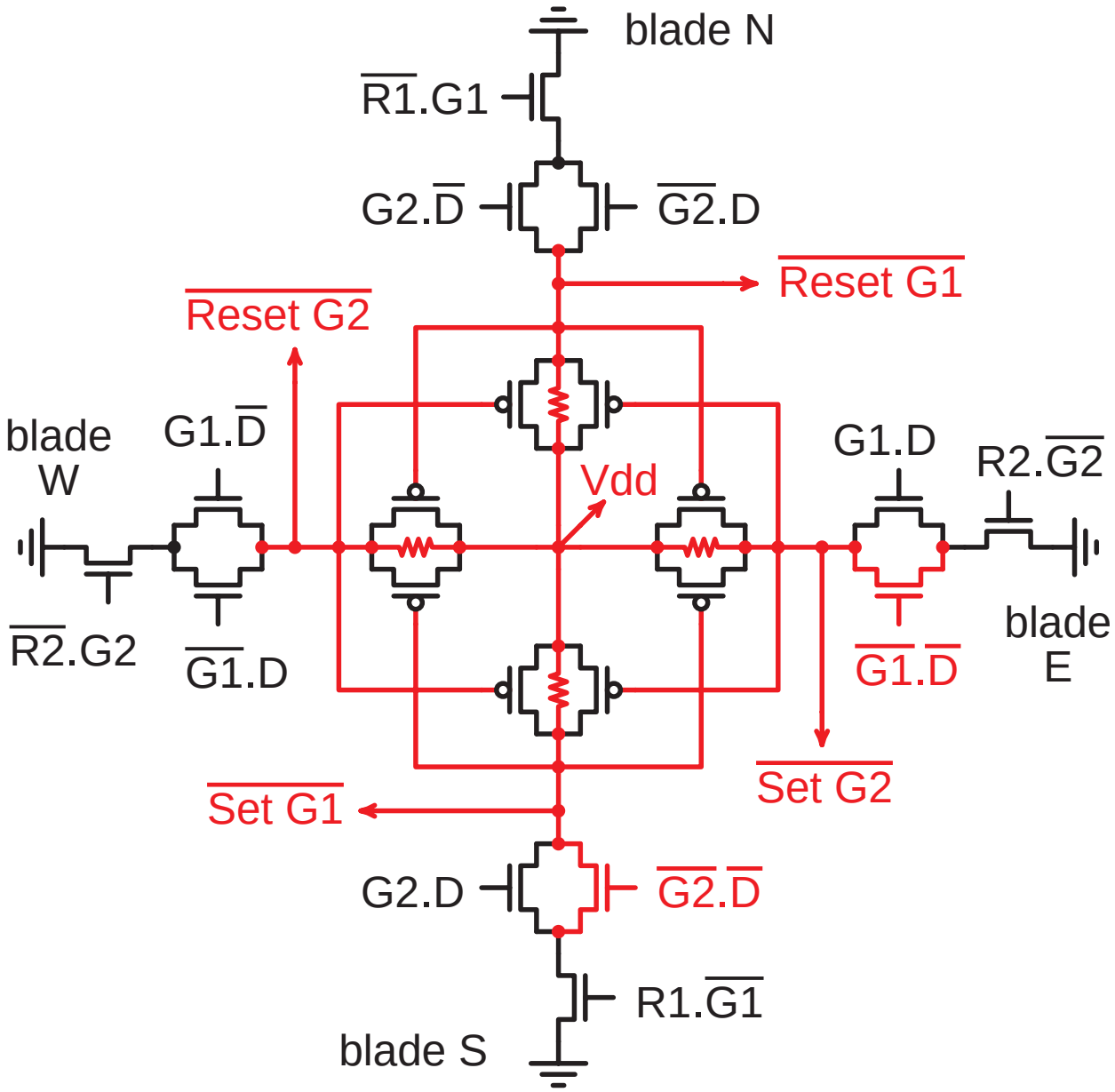
5-Wire Propellor Arbiter Circuit



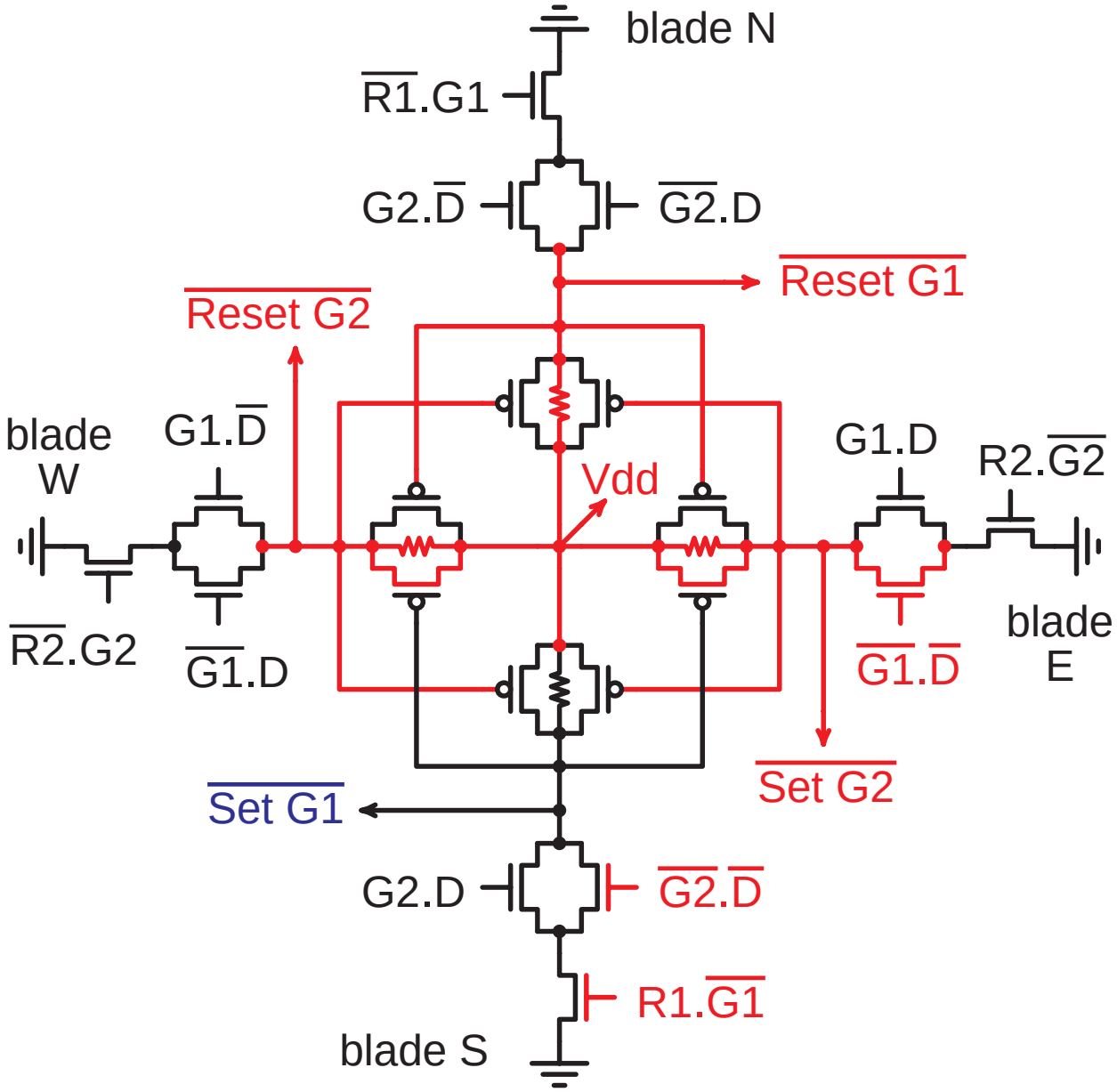
Metastability Filters and Latches



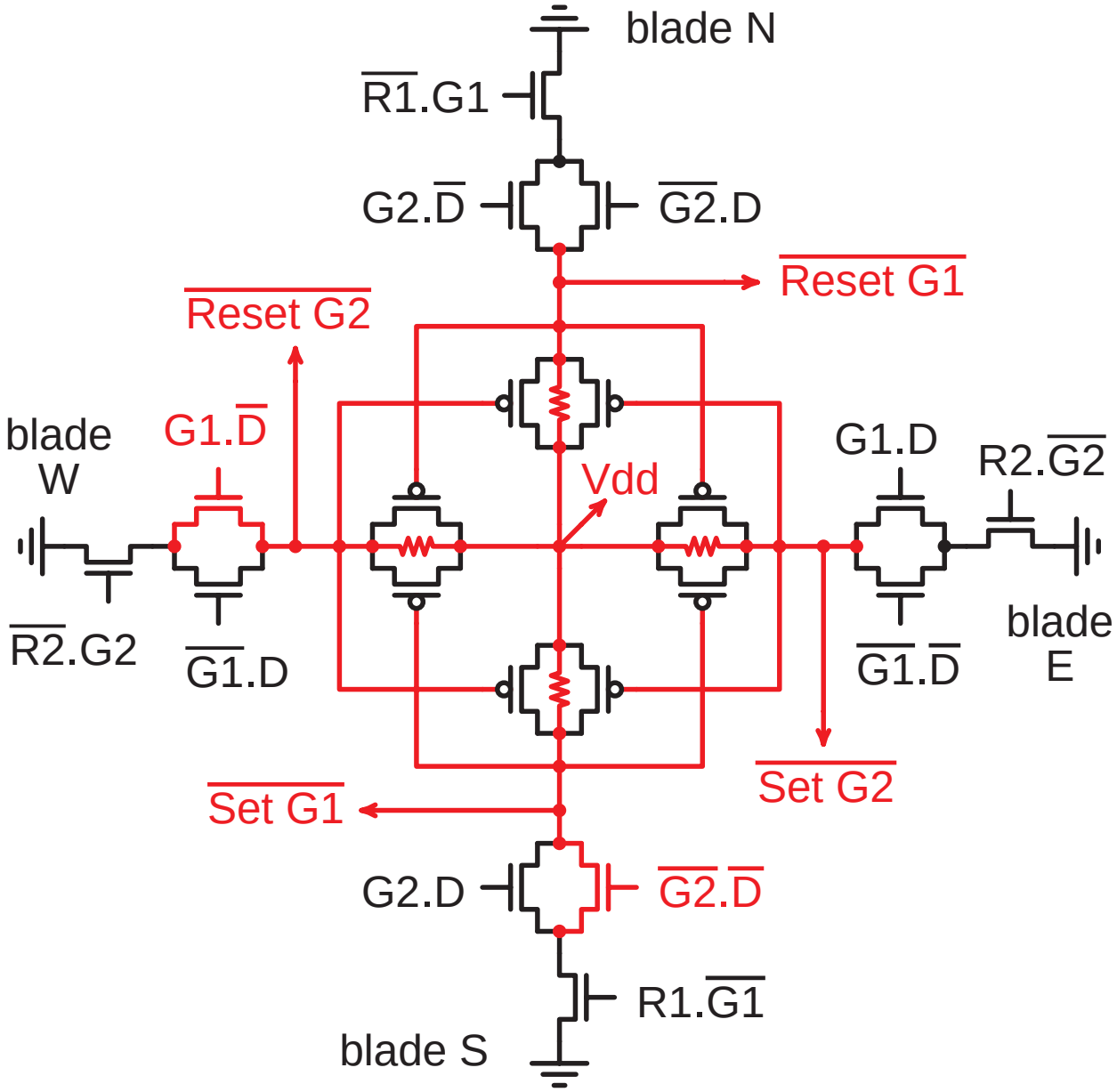
Initial state



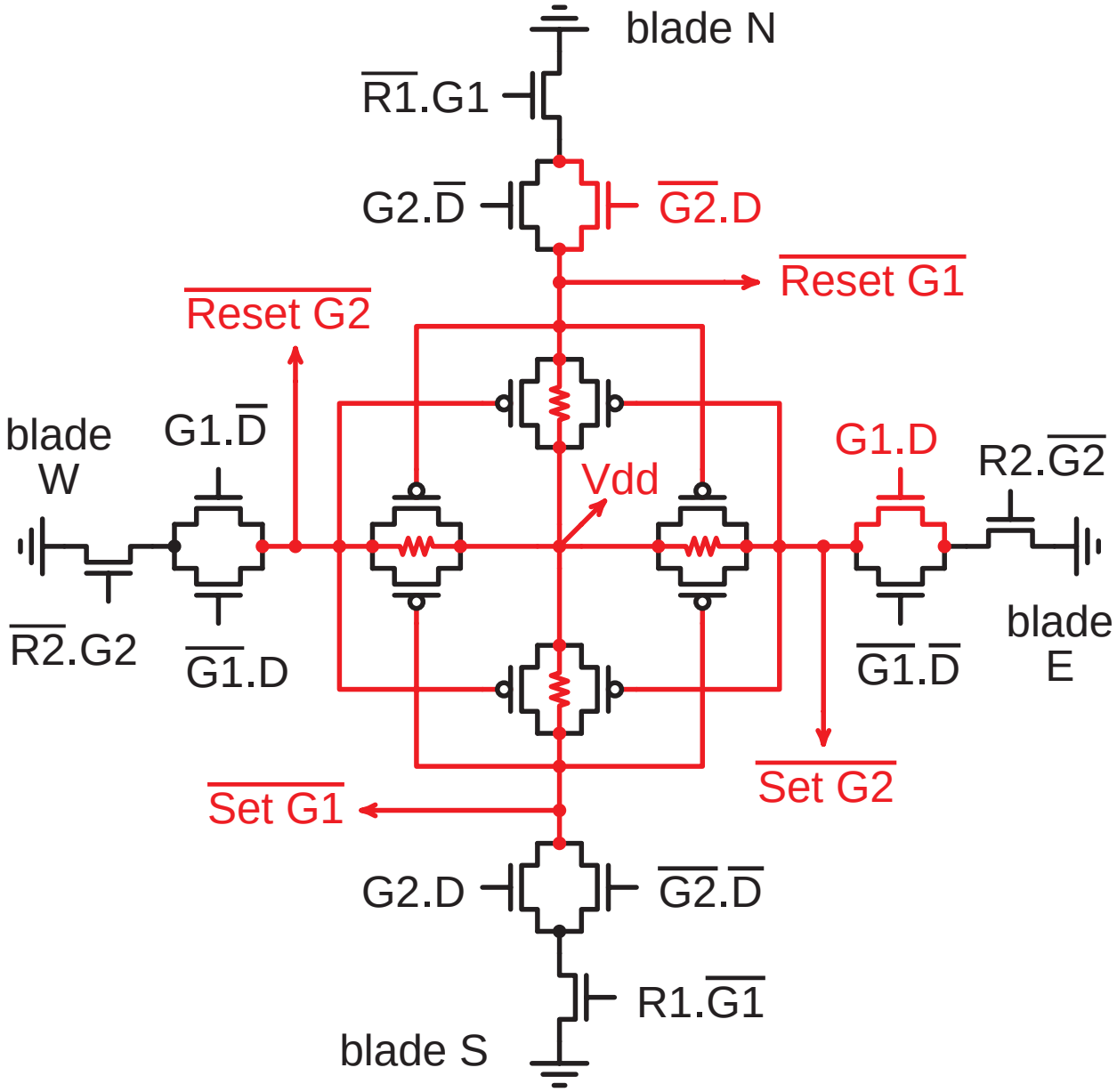
Uncontested R1



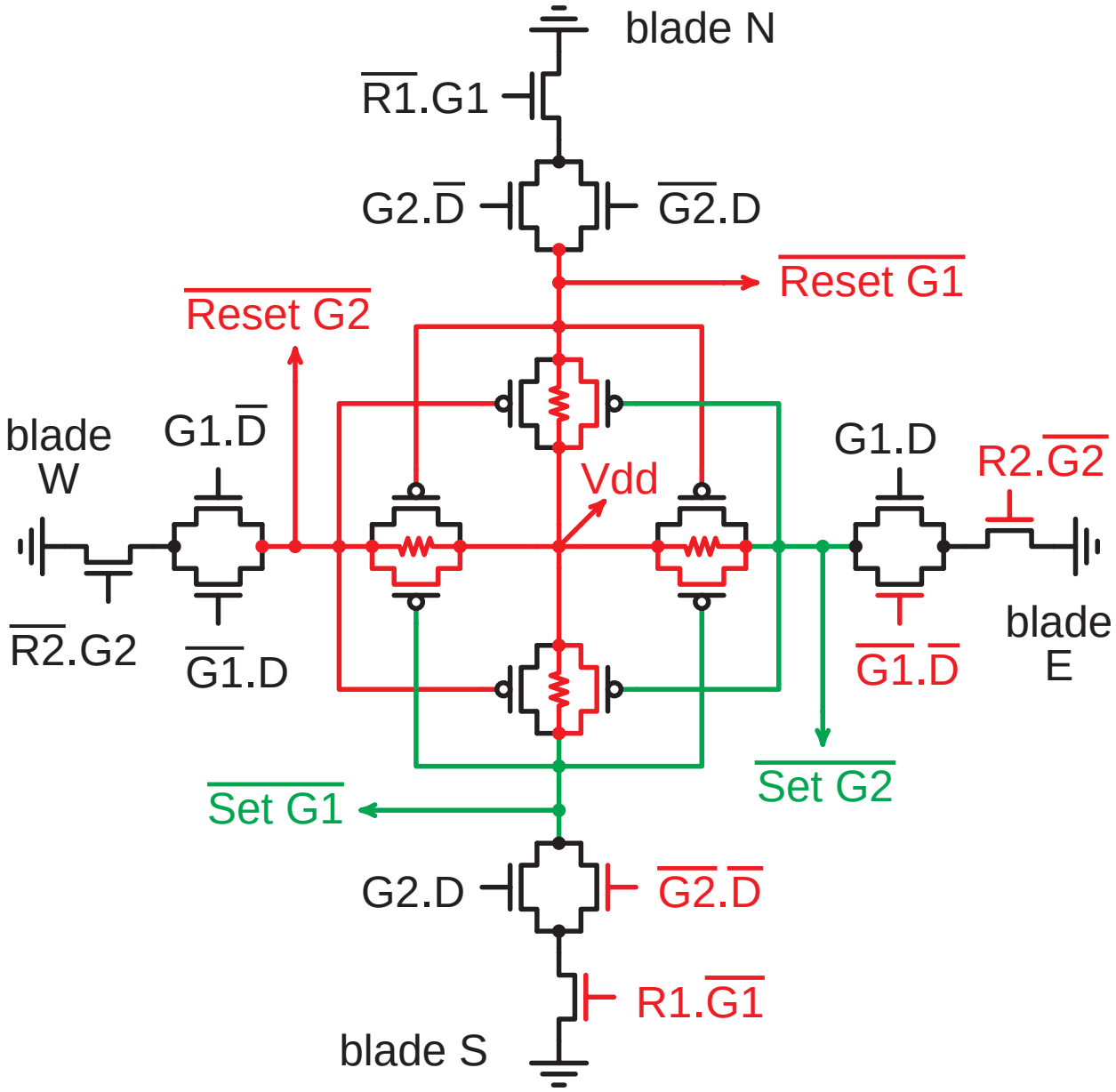
Uncontested R1 → G1



Uncontested R1 → G1 → D



Competing requests R1 and R2



Observing Arbiter

Three umpires were discussing their roles in the game of baseball.

First umpire (novice):

"I calls 'em the way I sees 'em."

Second umpire (smart):

"I calls 'em the way they are!"

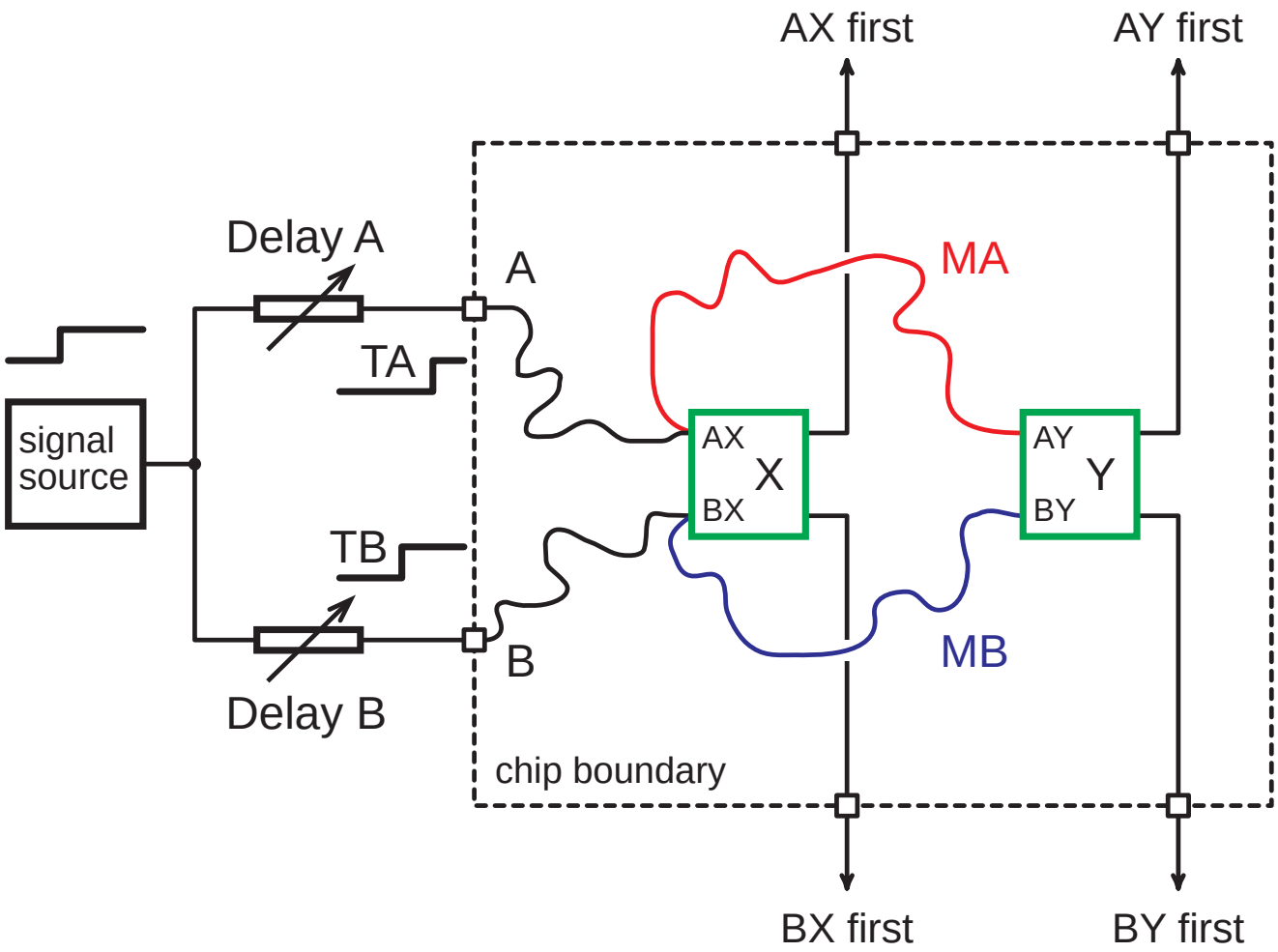
Third umpire (wise):

"They ain't nothin' until I calls 'em!"

abstracted from:

"Inventing Reality, Physics as a Language," Wiley.

Using Arbiters to Measure delay

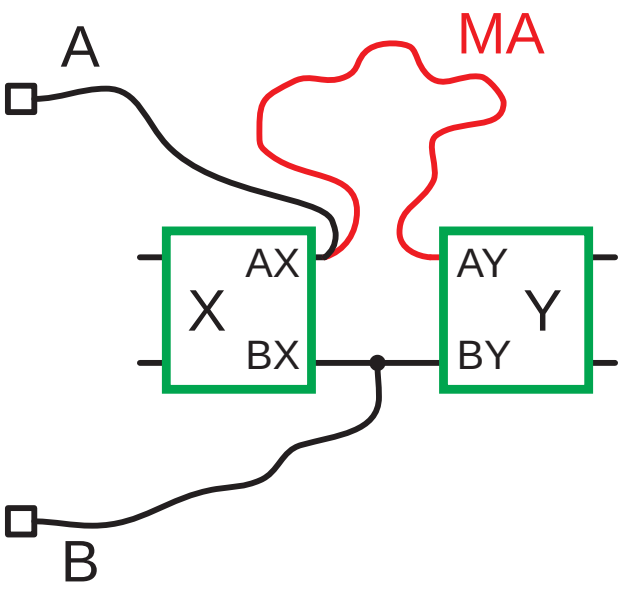


X and Y are arbiters

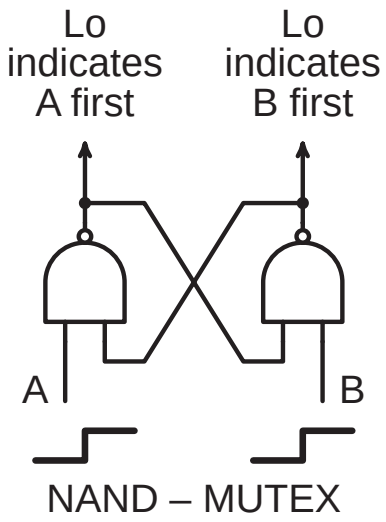
$$D_A - D_B = (T_{AX} - T_{BX}) - (T_{AY} - T_{BY})$$

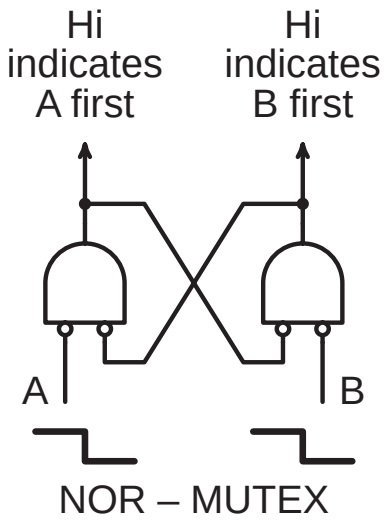
To Measure Absolute Delay:

X and Y are arbiters



$D_A = T_{AX} - T_{AY}$





Conclusion

- **Propellor Arbiter**
  - **Achieves speed by sharing transistors**
  - **Disadvantage - heavy loading on cross-tied connections**
- **An Arbiter as an Umpire**
  - **Example application of using arbiters to measure delay**
- **Charlie Boxes**
  - **See paper**

The Hungarian Precept

"Don’t trust nobody!"

Charlie Molnar, frequently.