Clocking

Overview

- Multi-clock designs
- Synchronizers
  - Mesochronous
  - Plesiochronous
  - General-purpose asynchronous clock crossing
    - Single bit
    - Multiple bits
    - Buses
    - FIFOs

Overview Continued

- Static Timing Analysis (STA)
- Clock distribution
- Clock generation

MULTI-CLOCK DESIGNS

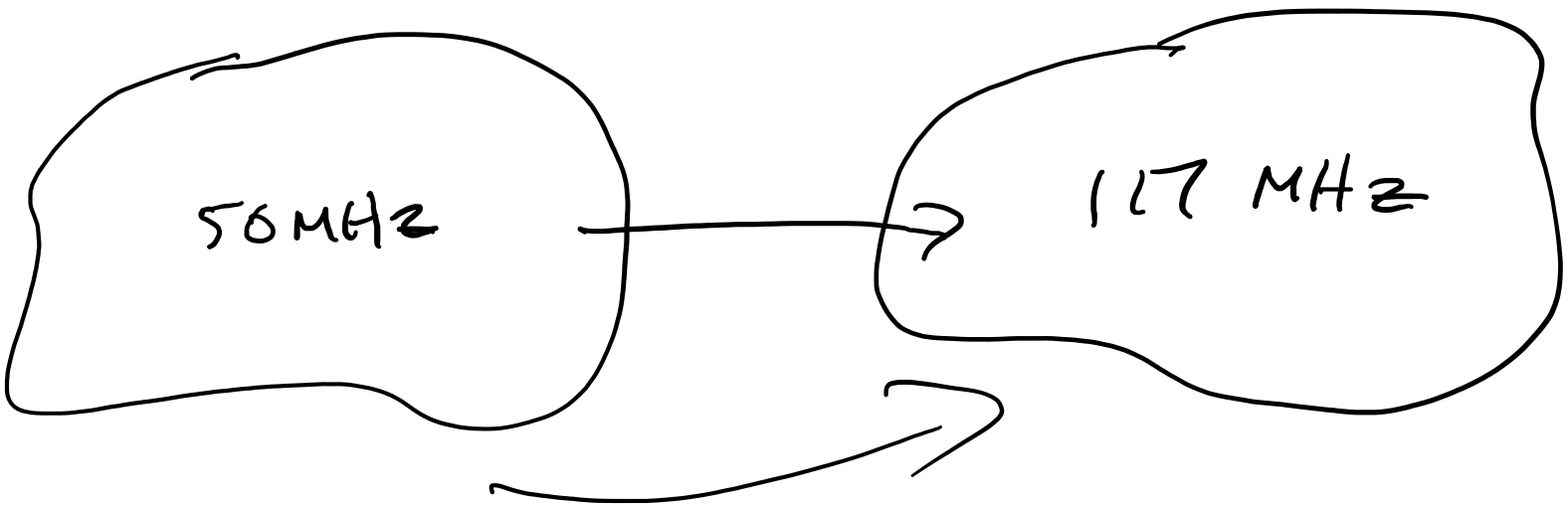
References

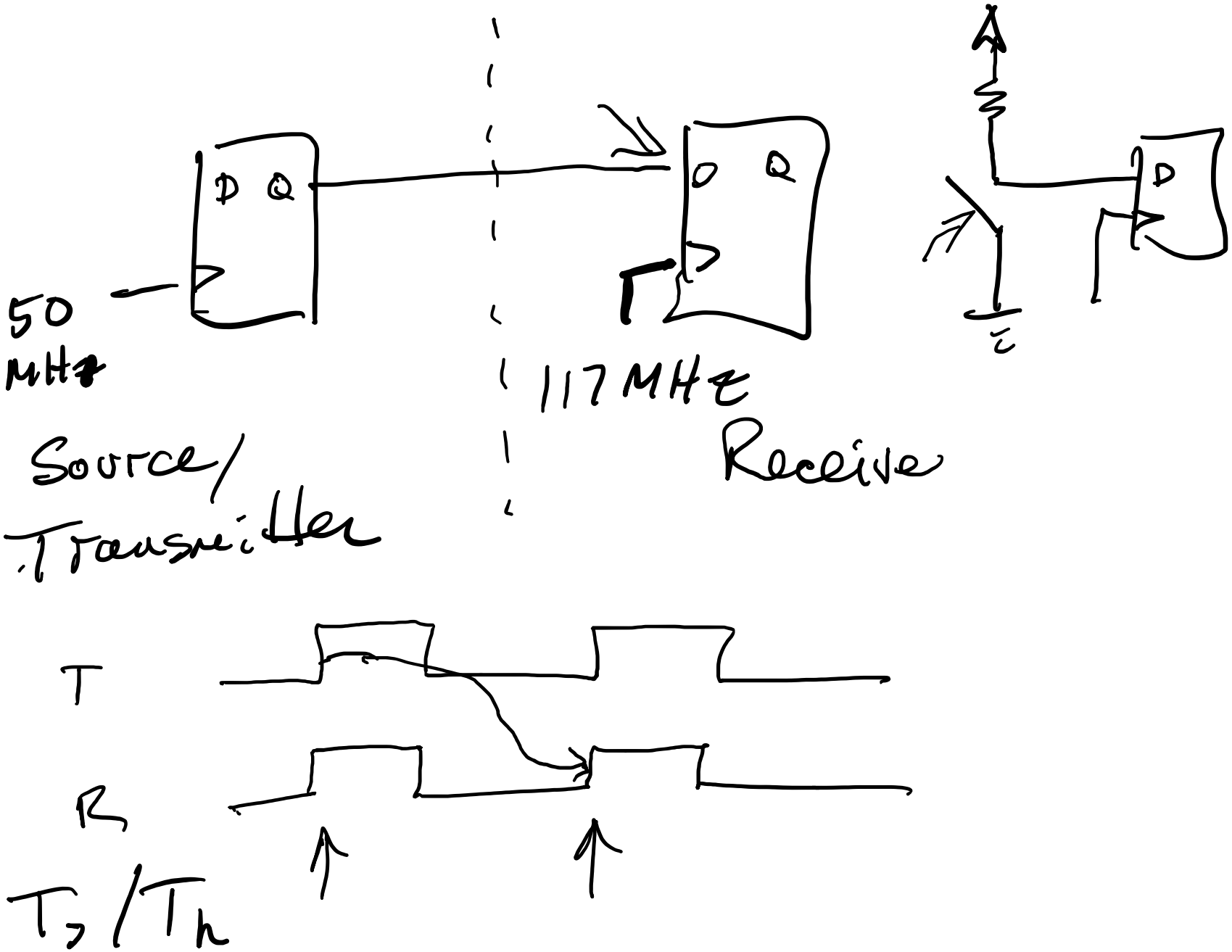
- Synthesis and Scripting Techniques for Designing Multi-Asynchronous Clock Designs
  - Cliff Cummings
    - Has many
    - excellent papers about hardware design
- Digital Systems Engineering, Dally and Poulton, Ch. 10

Scenario

- Passing information from one *clock domain* to another

Clock Domain



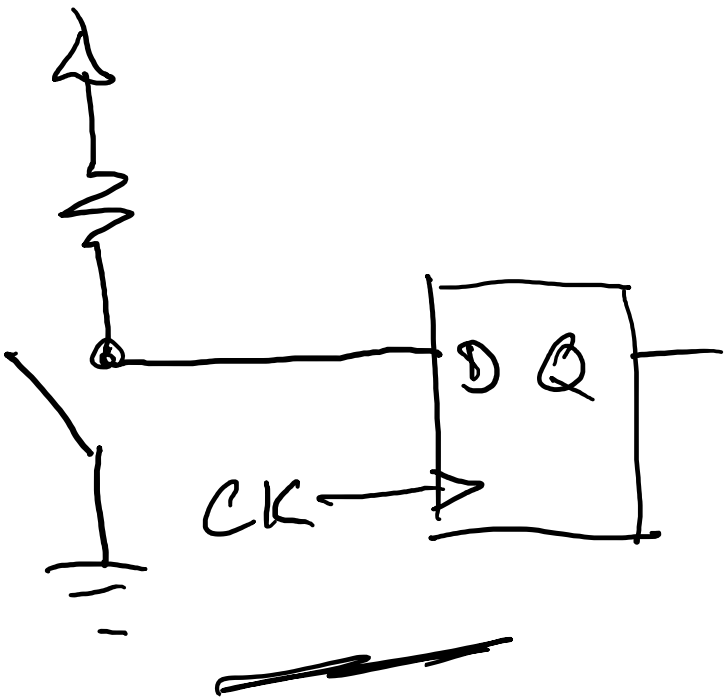

D Q
D Q
D
50 MHz
117 MHz
Source/ Transmitter
Receiver
T
R
T_s / T_h

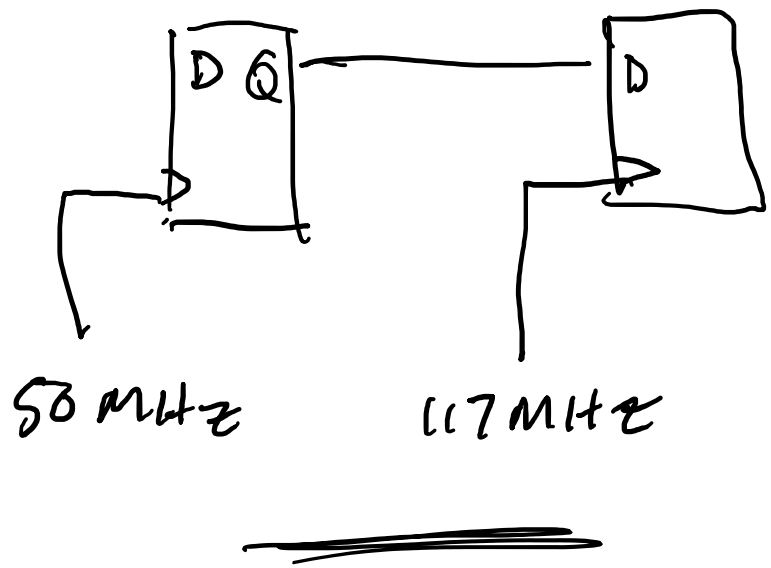
Classification of Clocking Scenarios

- Recognize and know what to do
  - Asynchronous
  - Synchronous
  - Mesochronous
  - Plesiochronous

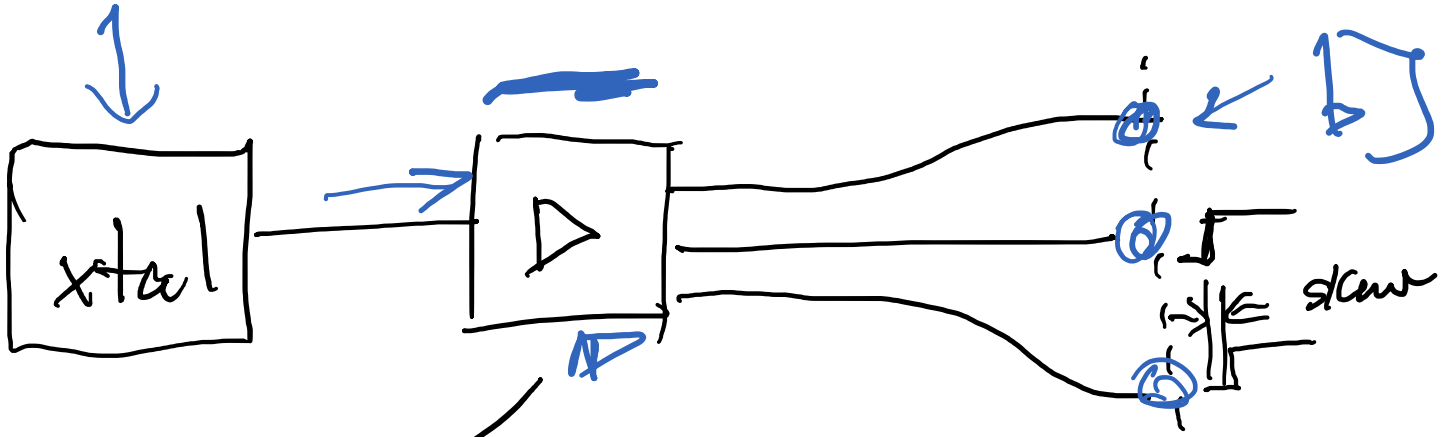
Asynchronous

- Source signals occur at arbitrary times
- No phase relationship between source and receiver clocks



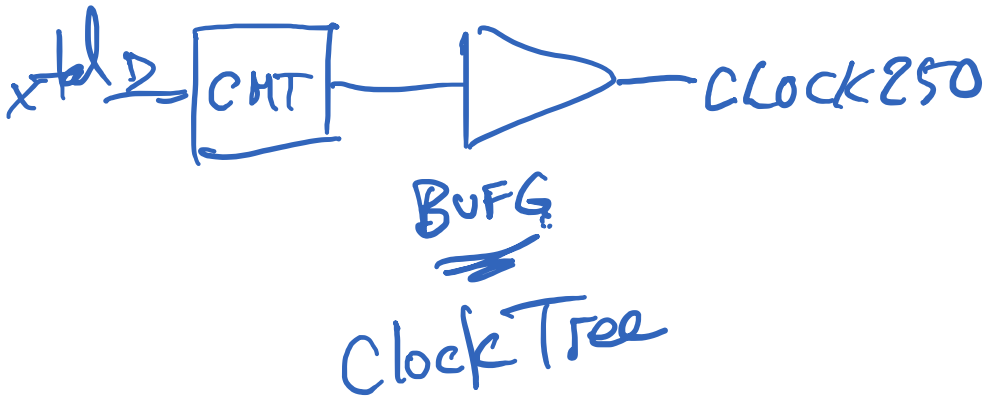


Synchronous



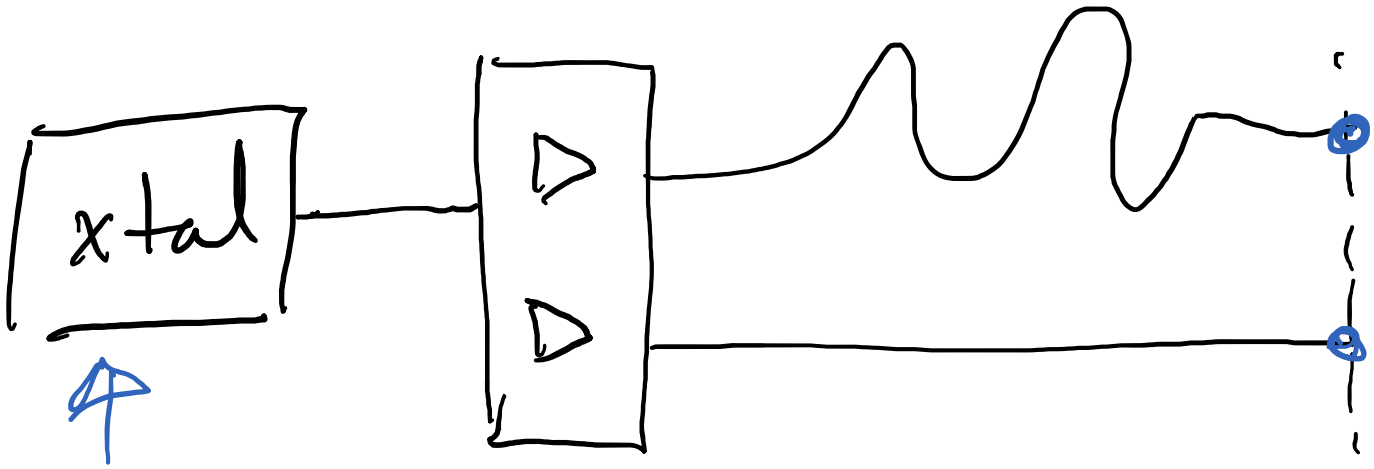
Balanced Clock Tree

Controlled Delay



- * - src/rcv in phase
  → same clock domain
- receiver samples input directly with the clock
- watch for skew + uncertainties

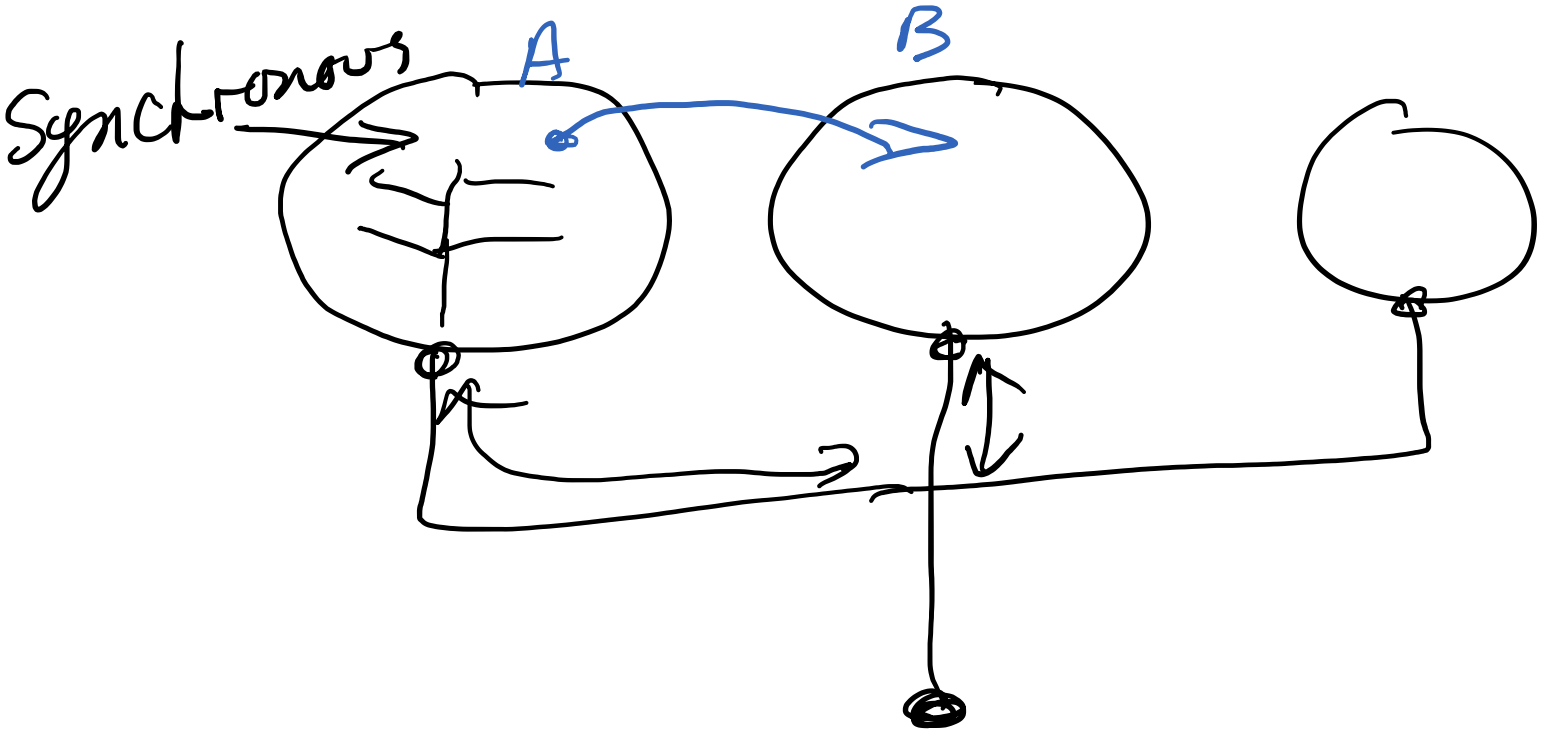
Mesochronous



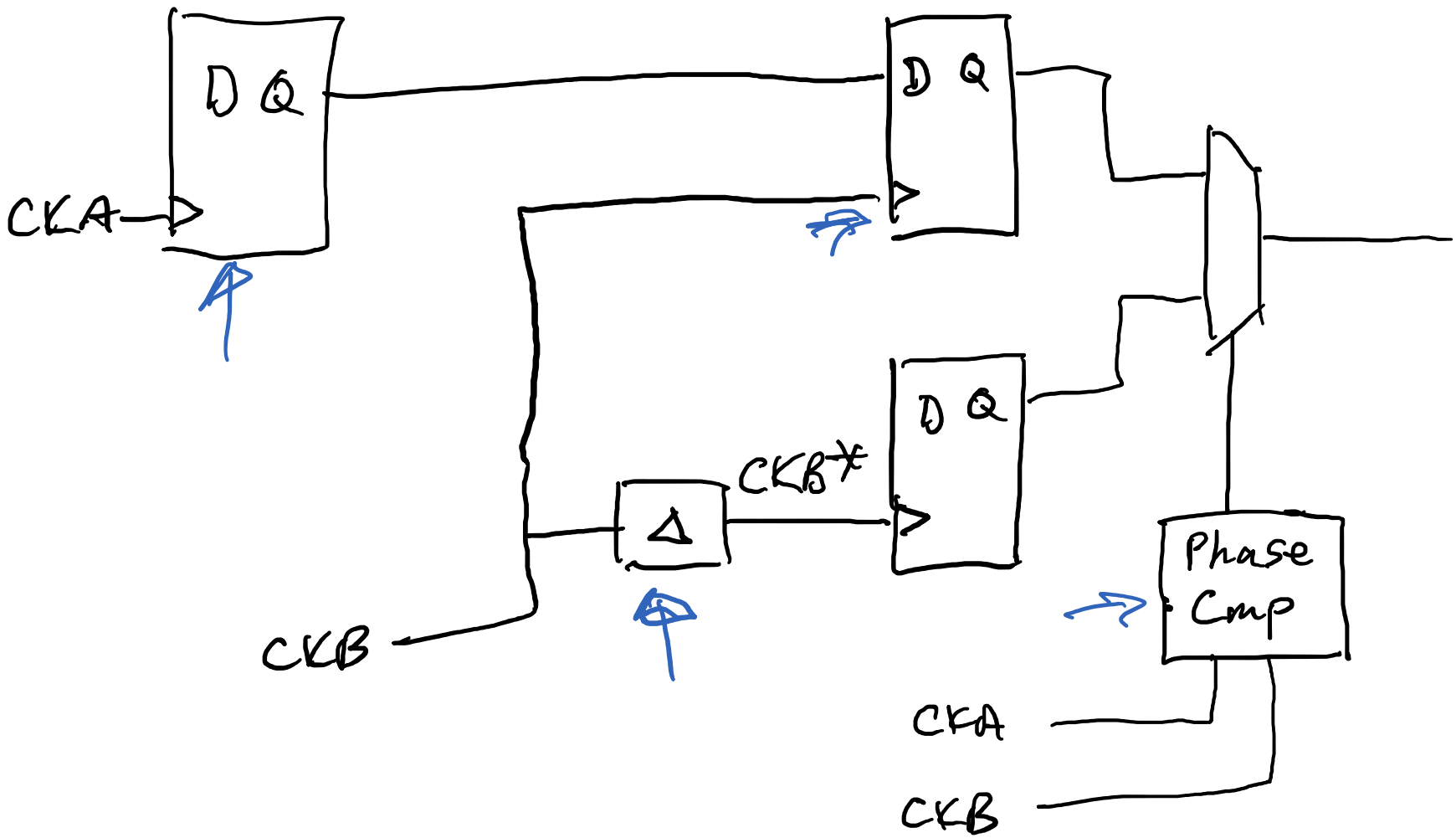
- edges at the same rate – same clock source
- not necessarily in phase – some arbitrary phase shift – constant
- same clock source distributed without control of delays

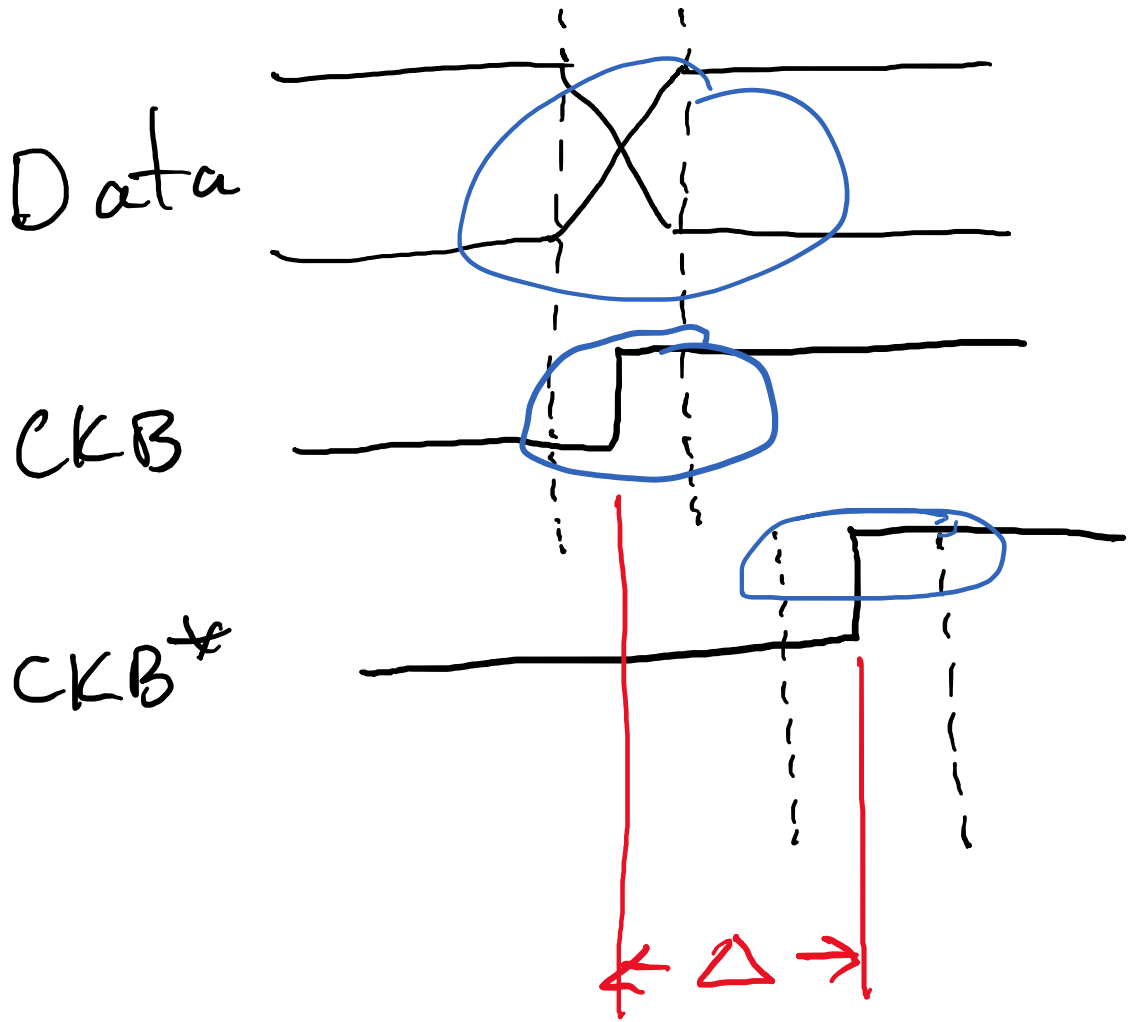
Example: GALS

Globally Asynchronous, Locally Synchronous



Mesochronous Synchronizer

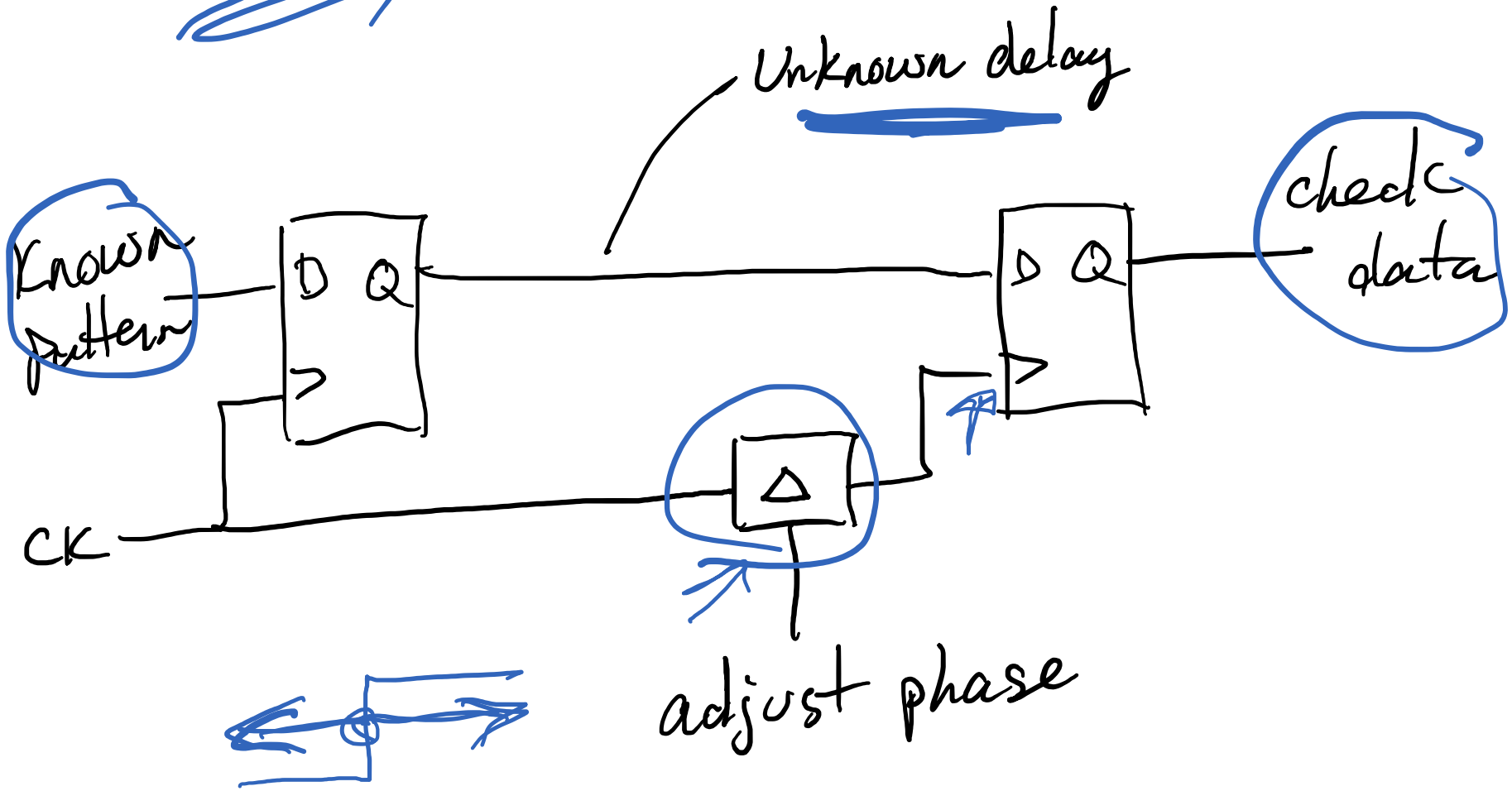




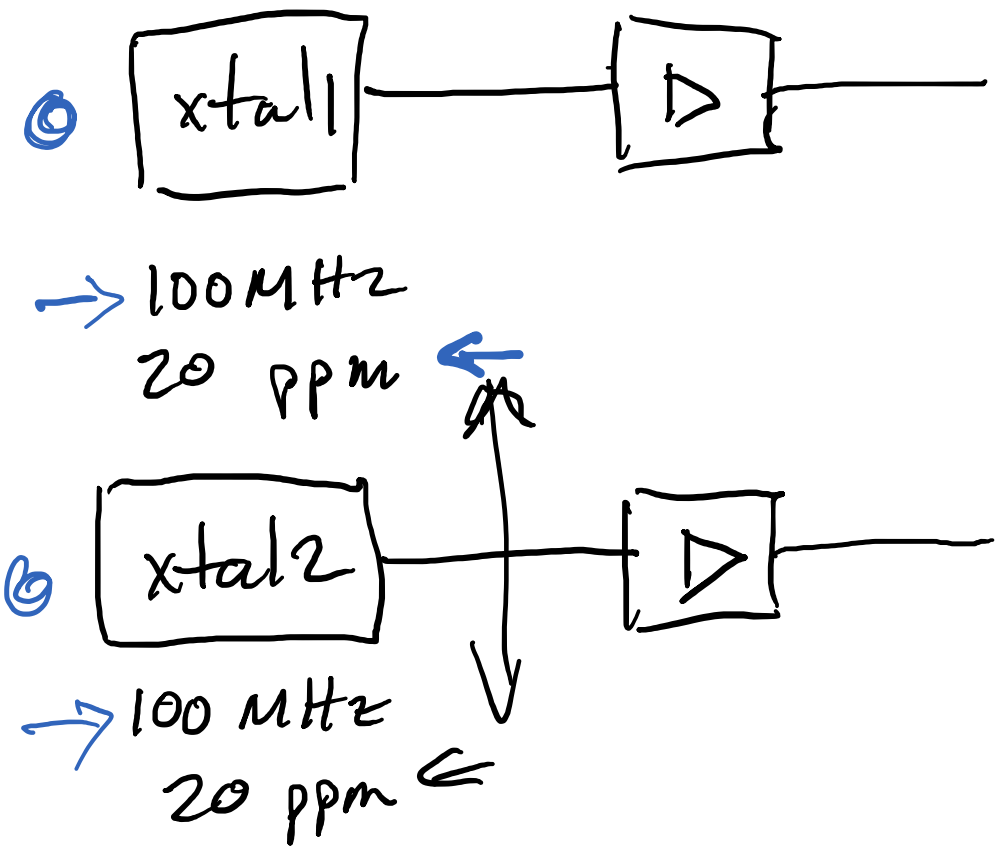
Δ is large enough such that if Data transitions in CKB Keep out then it cannot be transitioning in CKB* Keep Out

→ could use $\overline{CKB}$

Training

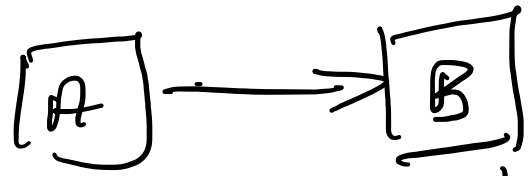

Unknown delay
Known pattern
D
Q
check data
D
Q
CK
adjust phase

Plesiochronous



$$\frac{2\ \text{kHz}}{100\ \text{MHz}} = 1.73\ \text{s/day}$$

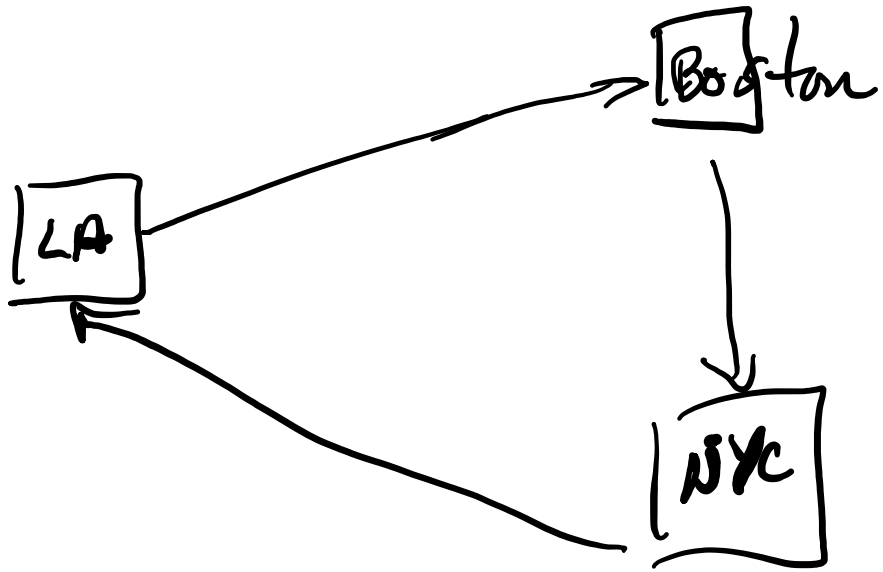
- same "nominal" freq
- actually different clocks
- variations in freq are constrained
- no limit to phase variation

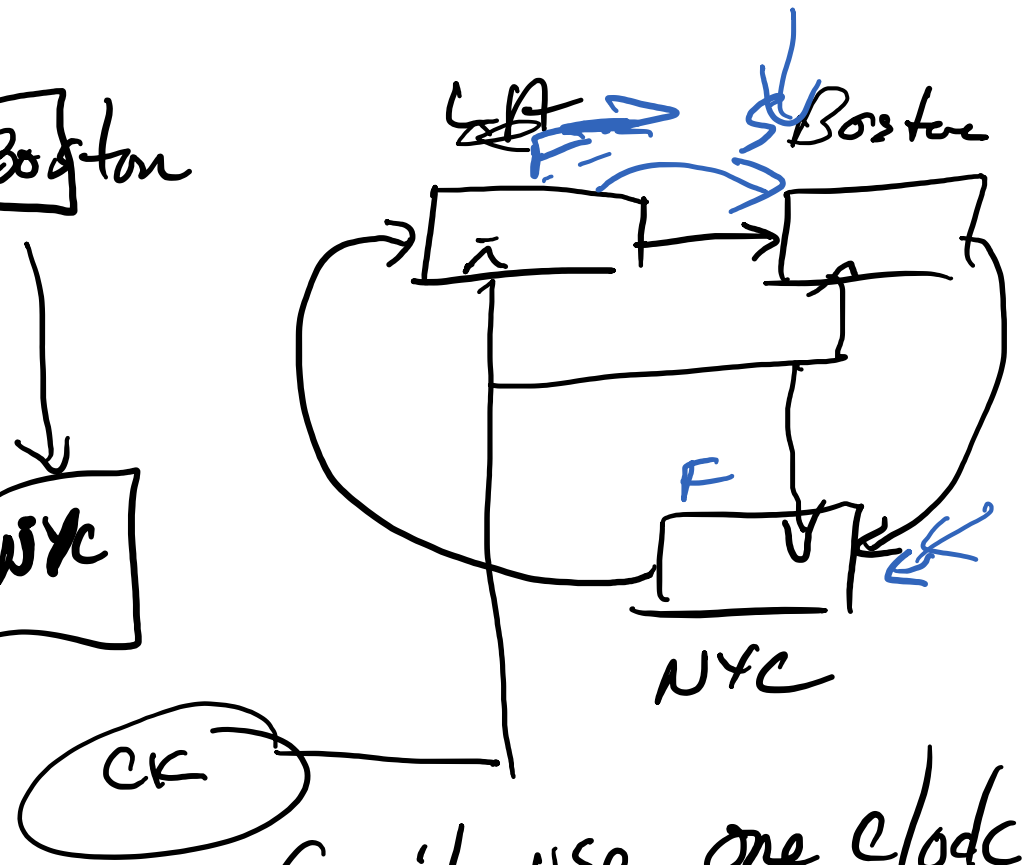


faster
slower

will be overrun
underflow

SONET - Synchronous Optical Network





- Can't use one clock
- can't distribute
- use the same "nominal" clock

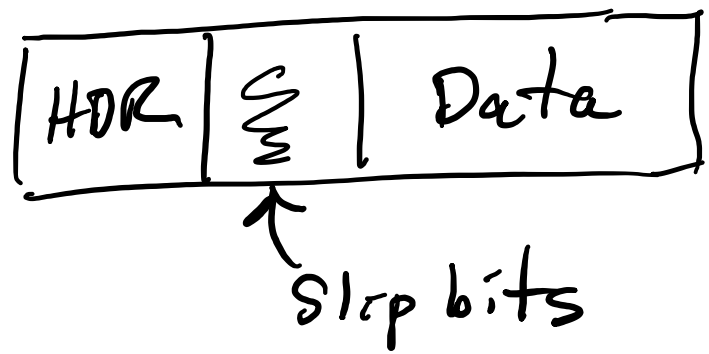
Plesiochronous Synchronization

Slip bits

- leverage that freq. not that different

LA : 1025

BOS : 1024



Flow Control

→ back pressure

- higher level signaling