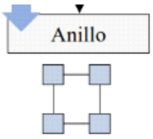
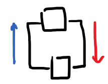
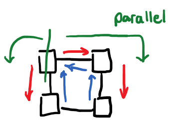
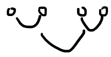
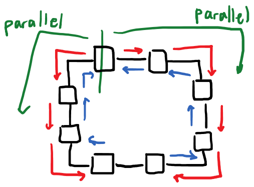
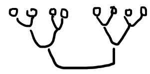
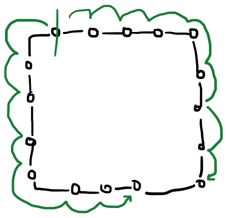
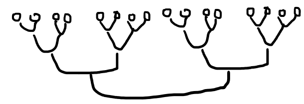
(b) Conmuted - Direct - Ring

Solution



Considering computation time complexity as:

$$t(np, n) = \left[\frac{n}{np} + 1\right] + kp = \left[\frac{n}{np} + 1\right] + \log_2 np$$

Case			Data/Diagram	time	Tree (sums)
(serial)	$kp=0$	$2^{kp} = 2^0 = 1$	$\boxed{P_1}$	$t = \varnothing$	$\varnothing$
(parallel)	$kp=1$	$2^{kp} = 2^1 = 2$		$t = 6 = 1(2)(3) + \varnothing(2)(3)$, $\varnothing \to \frac{np}{2} - 1$	1 
	$kp=2$	$2^{kp} = 2^2 = 4$		$t = 1(2)(3) + 1(2)(3) = 12$, $1 \to \frac{np}{2} - 1$	2 
	$kp=3$	$2^{kp} = 2^3 = 8$		$t = 1(2)(3) + 3(2)(3) = 24$, $3 \to \frac{np}{2} - 1$	3 
	$kp=4$	$2^{kp} = 2^4 = 16$		$t = 1(2)(3) + 7(2)(3)$, $7 \to \frac{np}{2} - 1$	4 

Thus, in a general way, we see that

$$t_c = (2)(3) + \left[\frac{np}{2} - 1\right](2)(3)$$

$$t_c = 6 + \left[\frac{np}{2} - 1\right]6$$

$$t_c = 6 + \frac{6np}{2} - 6$$

$$t_c(np, n) = \boxed{t_c = 3np}$$

for communication time complexity in a commuted-direct-ring network.