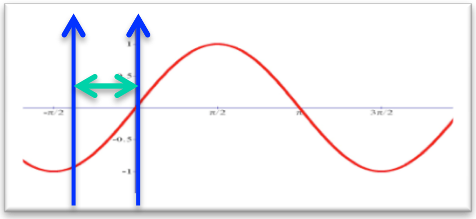
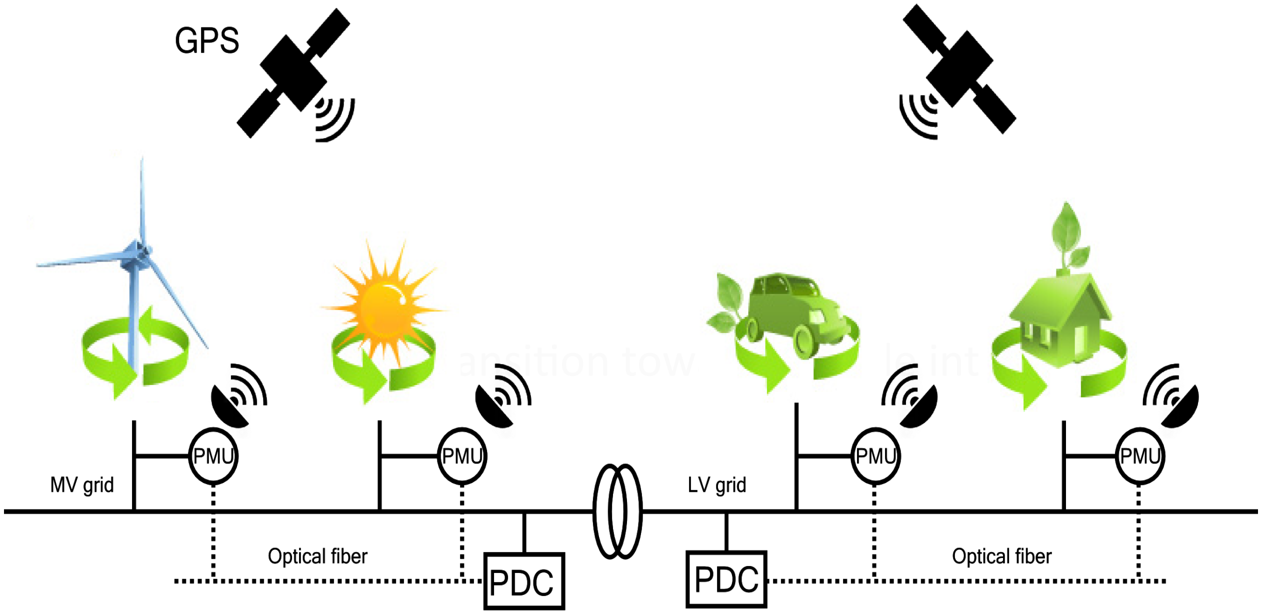
Pulse Coupled Oscillators

OBJECTIVES

- Can we **trust timing?** Today the time signal is from the GPS system and they can be attacked
- We study algorithms to generate common timing information within the measurement network

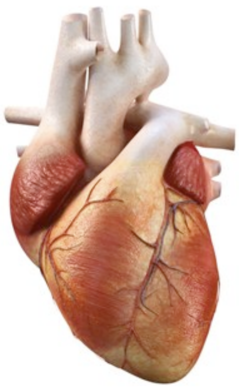




APPROACH

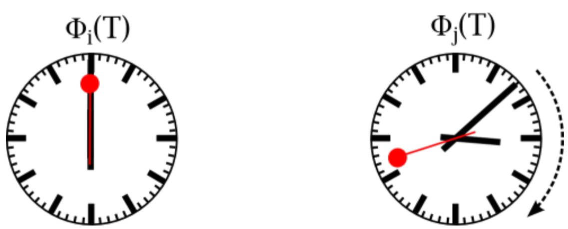
- A scalable design that works on wired media, power-line carriers and wireless networks synchronizing terminals with local interactions
- Inspired by the mechanism of pace-maker cells (adaptive, self-healing, resilient)

BIO-INSPIRED



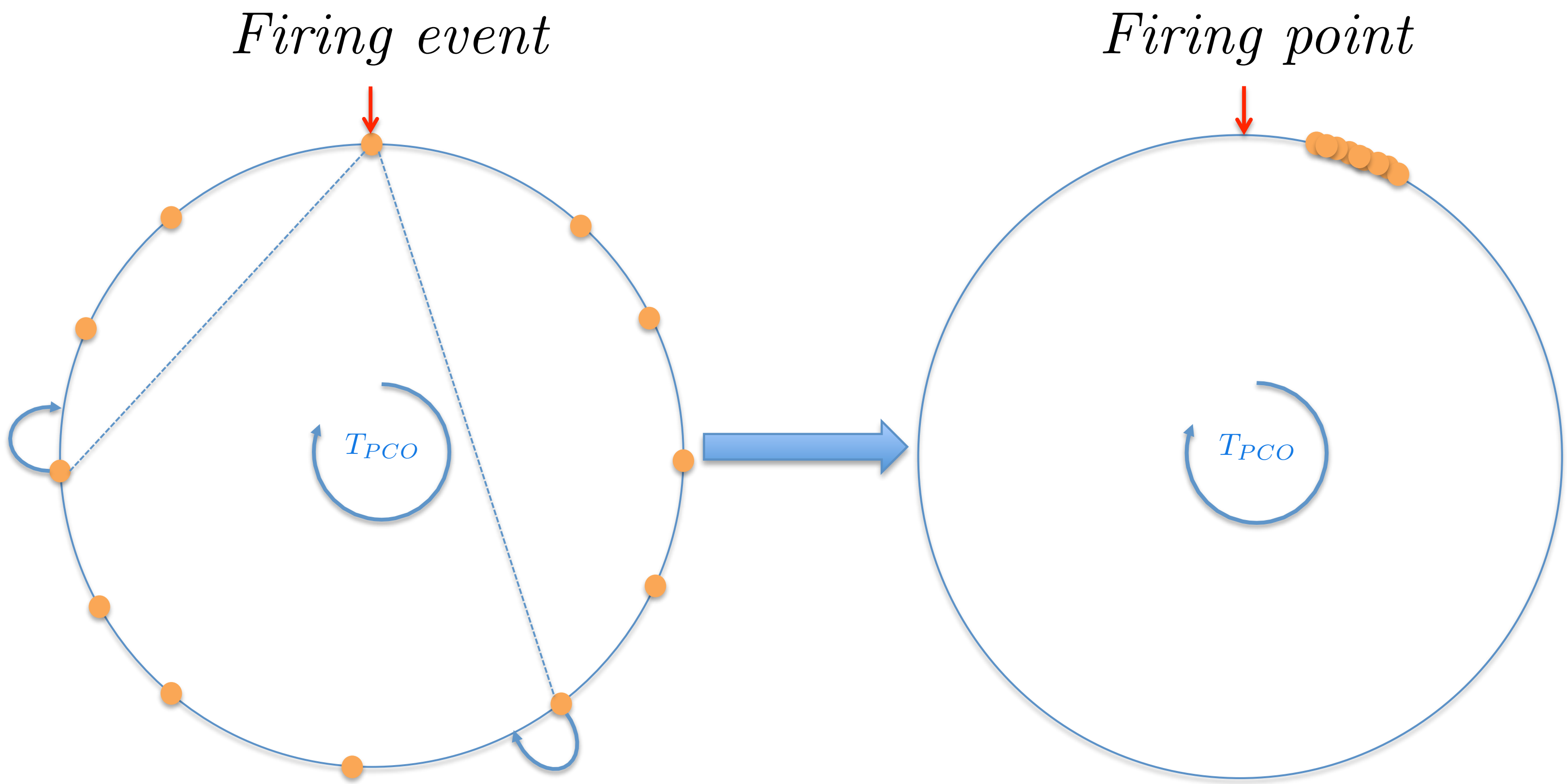
- Inspired by the mechanism of pace-maker cells (adaptive, self-healing, resilient)

- Each cell has its own clock.
- Each cell sends a beacon when it contracts.
- When 'hearing' a beacon from another cell the time of beacon u: Φ_u becomes



$$\Phi_u(t+) = \Phi_u(t)(1+\gamma) \pmod 1$$

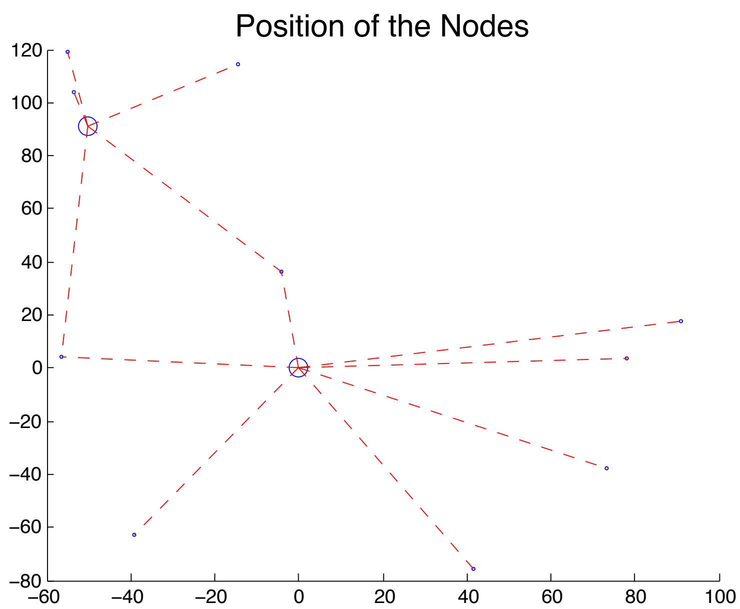
BIO-INSPIRED

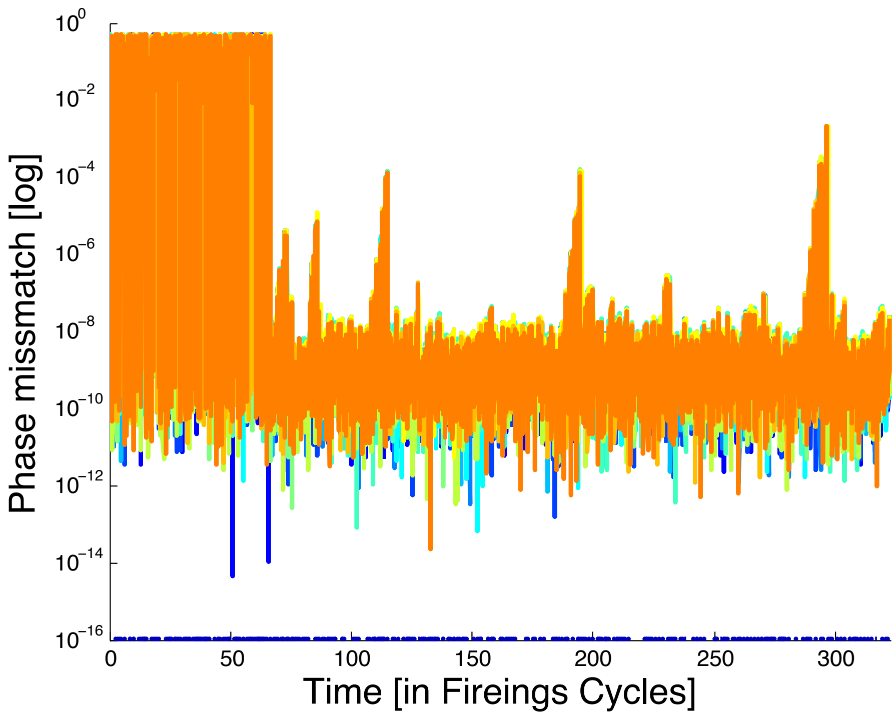


$$\Phi_u(t+) = \Phi_u(t)(1+\gamma) \pmod 1$$

SIMULATION RESULT

- Simulation results:





- Does not converge to 0 because of jitter, miss detections and limited SNR&Bandwidth

SCHEDULING

s=start of transmission

e=end of transmission

δ= desired distance of nodes

D= Demand of each node

α= coupling factor

s_{u-1}= start of previous node

e_{u+1}= end of next node

t=time

t^{+}= time update

- Now we want to add scheduling to the system: start-data-end.
- Split clock in continuous and discrete part:

$$\Phi_u^s(t) = s_u(t) \pmod{L} + \Phi_u^{(c)}(t) \pmod{1}$$

$$\Phi_u^e(t) = e_u(t) \pmod{L} + \Phi_u^{(c)}(t) \pmod{1}$$

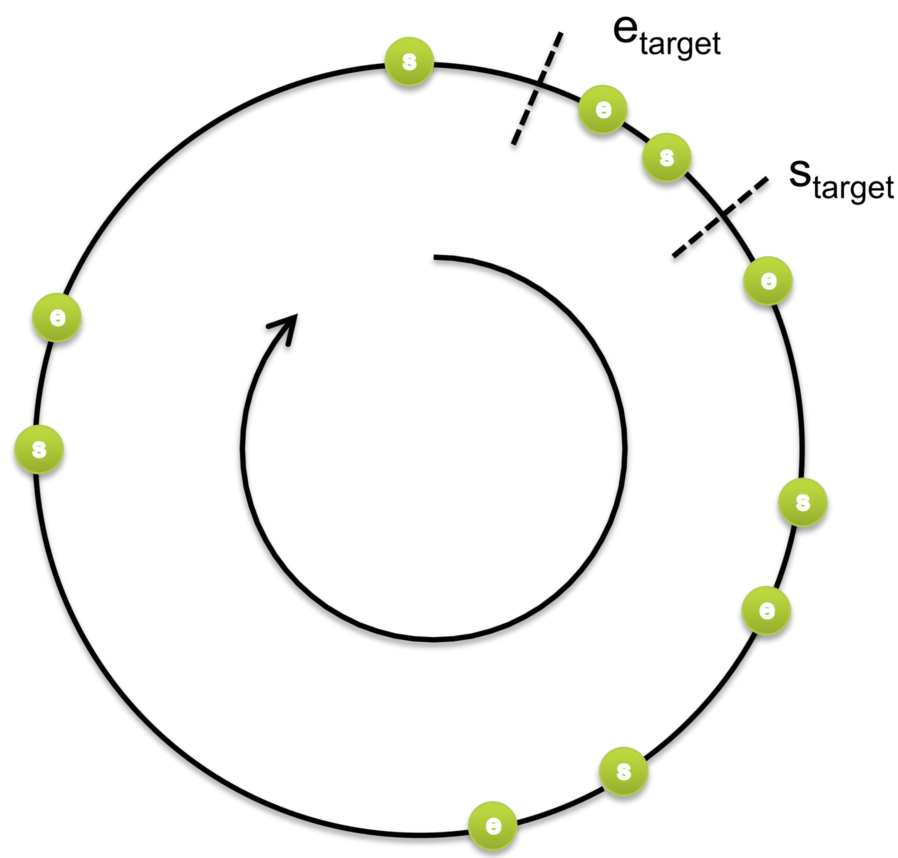
- Move each start-end graduately:

$$s_u^{target}(t) = \frac{\delta}{D_u + 2\delta} s_{u-1}(t) + \frac{D_u + \delta}{D_u + 2\delta} e_{u+1}(t)$$

$$e_u^{target}(t) = \frac{D_u + \delta}{D_u + 2\delta} s_{u-1}(t) + \frac{\delta}{D_u + 2\delta} e_{u+1}(t)$$

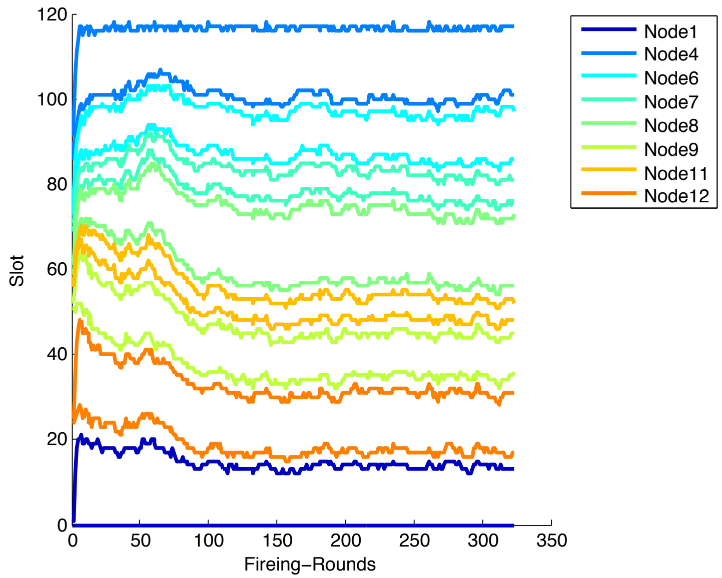
$$s_u(t^+) = (1-\alpha)s_u(t) + \alpha s_u^{target}(t)$$

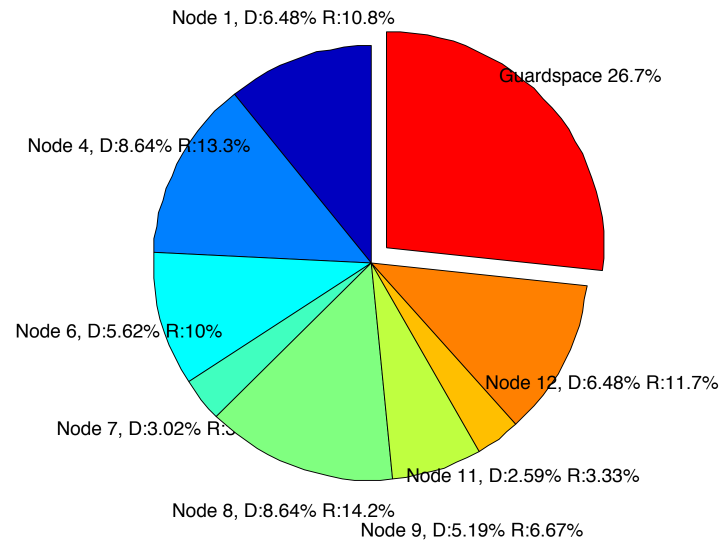
$$e_u(t^+) = (1-\alpha)e_u(t) + \alpha e_u^{target}(t)$$

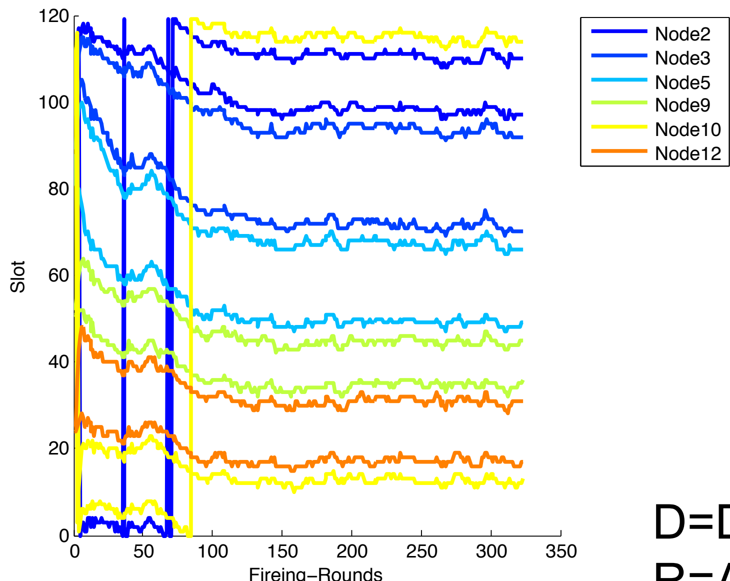


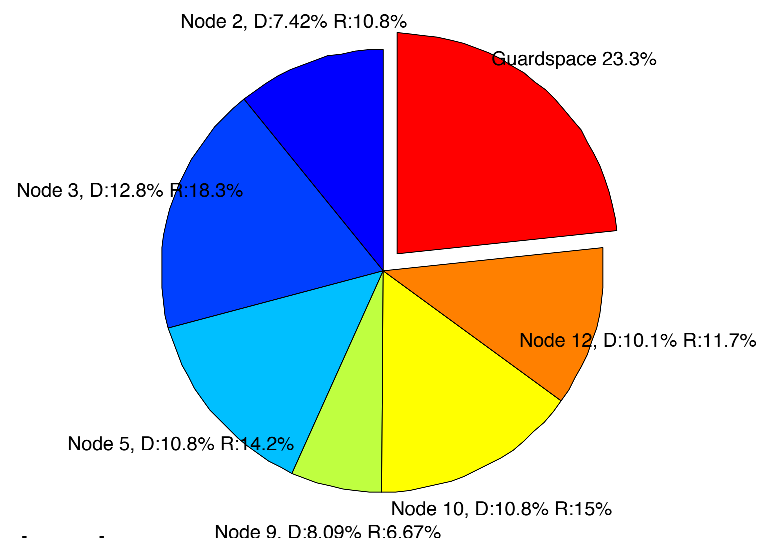
e_{target}
s_{target}

SIMULATION RESULT



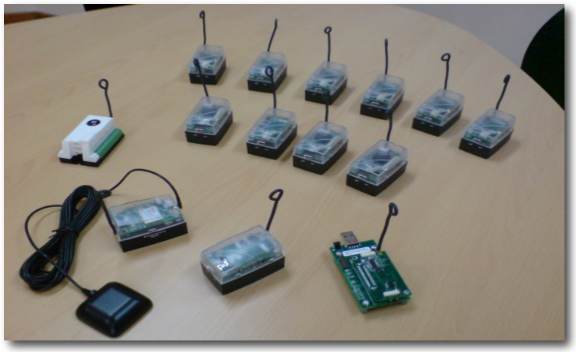


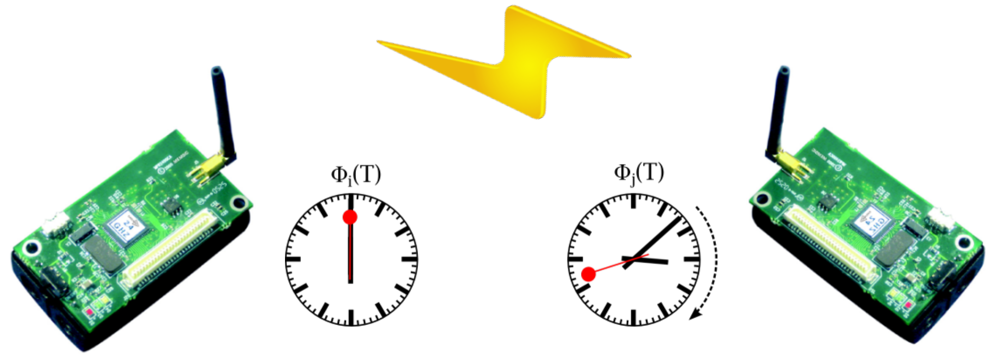




D=Demand;
R=Actually received

FUTURE WORK





- **Future work: Implementation in Microcontroler**