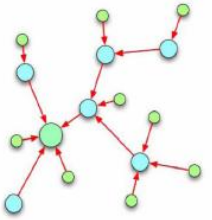

Wireless Sensor and Actuator Networks:
Technologies, Analysis and Design

WSAN Design

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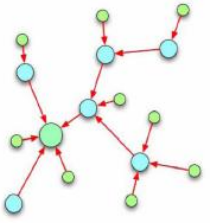


Scenario

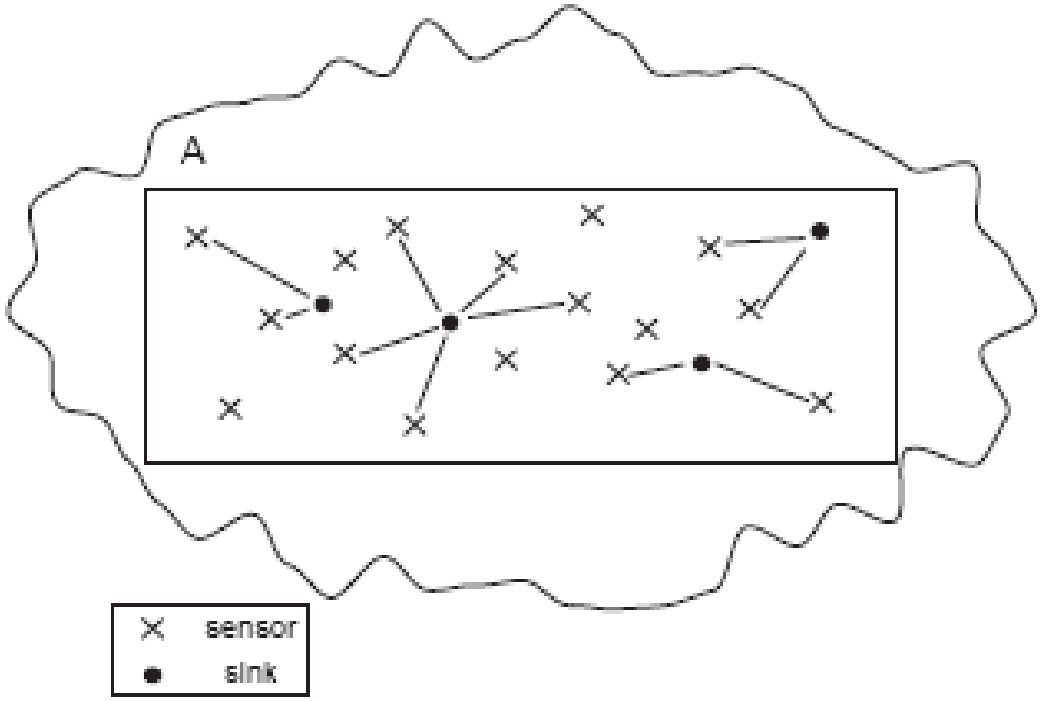
A large area is equipped with sinks and sensor nodes, both uniformly distributed.

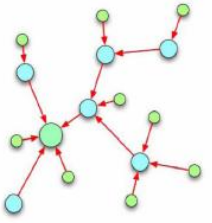
We want to achieve data from a sub-area of size A, to perform estimation of a spatial / temporal random process.

ρ_s **density of sensors [m^{-2}]**
ρ_0 **density of sinks [m^{-2}]**

The number of sinks/sensor in A Is Poisson distributed.

The average number of sinks/sensors in A is ρ_0 A and ρ_s A , respectively.



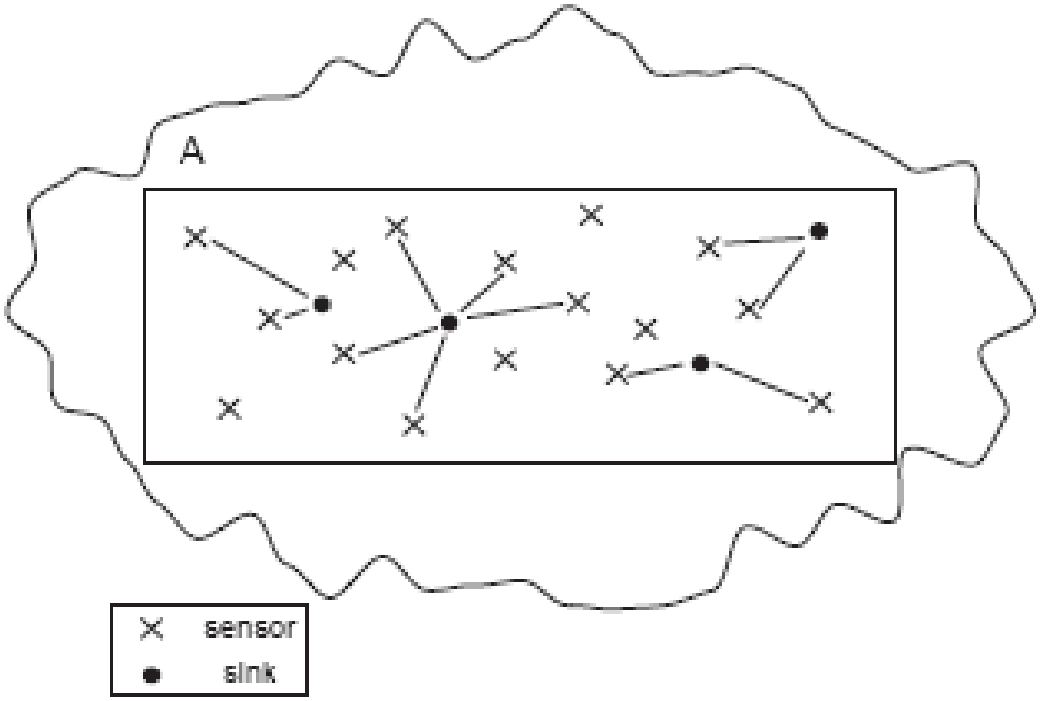


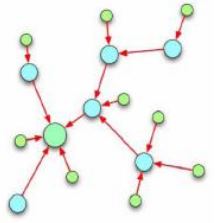
Area Throughput

The amount of samples per unit of time originated at the area A and successfully transmitted to a fusion centre through any sink.

More sensors → more samples available
More sensors → more collisions
A compromise might be fou

- **Application**
- **Radio Channel**
- **MAC**
- **PHY**





Application

Queries (60 bytes) sent by sinks synchronously every Tq seconds

Each node generates data bursts with 10 D bytes; D = H + xP

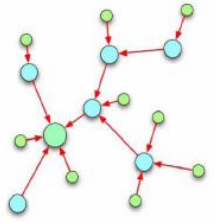
H = 2
P = 1

Concatenation: nodes can transmit one single sample (x = 1) or aggregate them and transmit x samples only every x queries.

Radio Channel

$L = k0 + k1 \ln(d) + s$

k0 = 40
k1 = 13
s is zero mean Gaussian r.v.
with standard deviation $\sigma = 4$



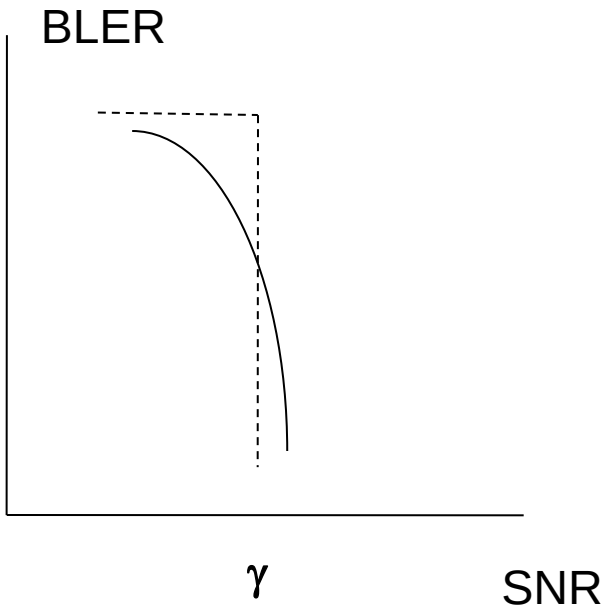
PHY

L < Lth → data burst is received

L > Lth → data burst is not received

Lth = Pt – Pn – γ

Pt = 4 dBm
Pn = En / Tt
Pn + γ = -102 dBm



Pcon **Probability that a data burst is correctly received**

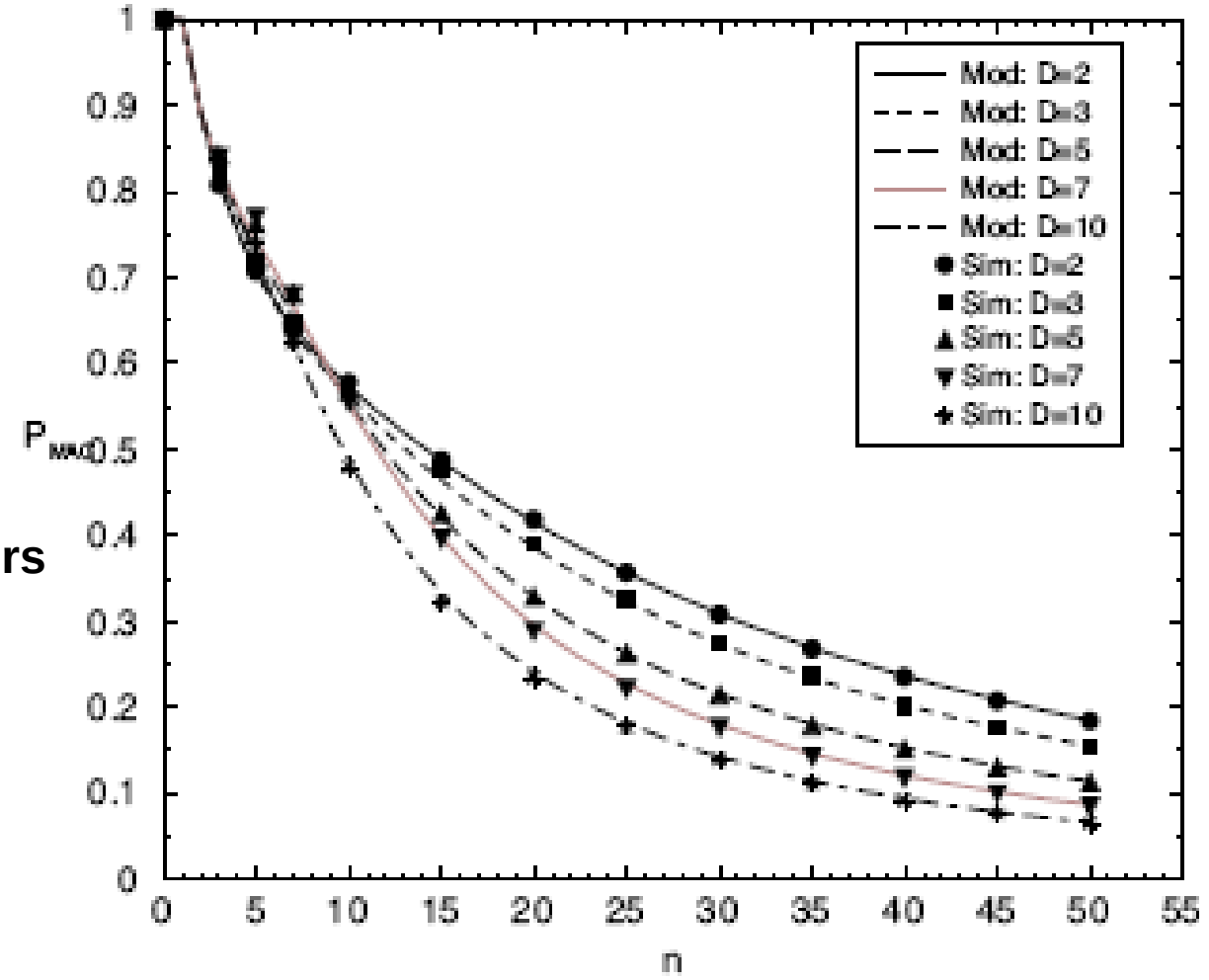
Pcon = Prob [L < Lth] = Prob [s < Lth – ko – k1 ln(d)]
averaged over statistics of d

MAC

BE mode used

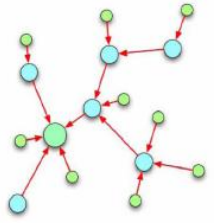
n nodes per sink

n is a Poisson r.v. which depends on the number K of sensors and of sinks in A.



Ps **Prob. that a data burst is correctly received in a network of n nodes**

Ps **= Pcon Pmac = Ps|K**



Area Throughput

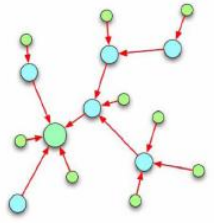
$S = \sum S(k)\ \text{Prob}(K = k)$ [samples / sec]

$S(k) = K\ Ps|K\ /\ Tq$

Prob (K = k) is Poisson

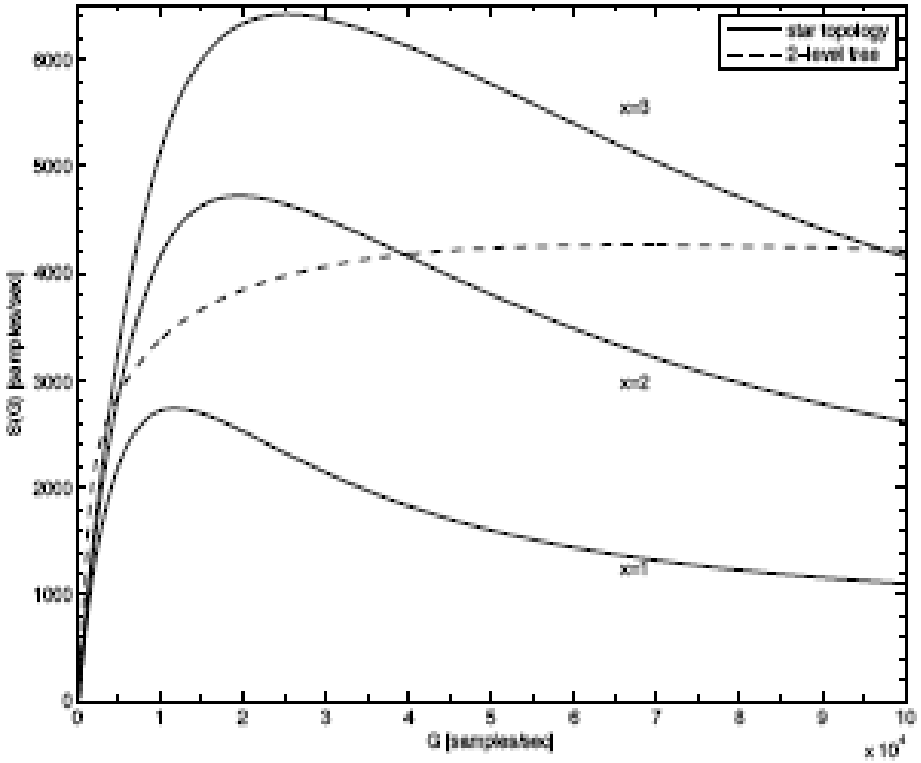
Available Area Throughput

$G = \rho_s A\ /\ Tq$ [samples / sec]



Area Throughput vs Available Area Throughput

SO = 2



D = 10