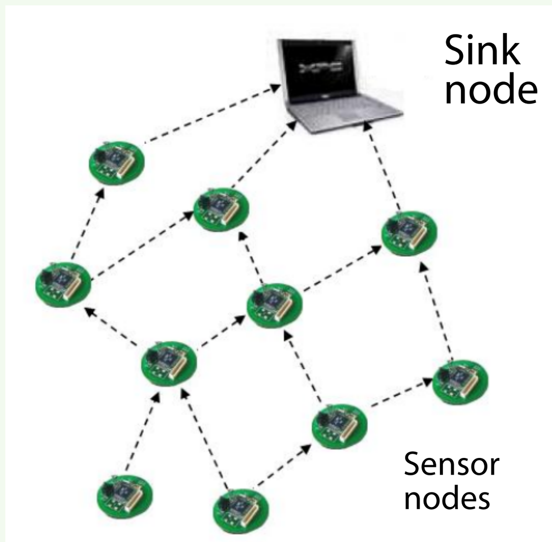
Security with Quality-of-Service Optimization in Wireless Sensor Networks

Our goal

To propose a new framework based on the Proportional Integral Derivative (PID) controller in order to dynamically select the security level adapted to the quality of service requirements in wireless sensor networks (WSN) while considering the energy consumption.

Context

Caracteristics of Wireless Sensor Netwoks (WSN): reliability, accuracy, flexibility, cheapness, easy deployment, ...



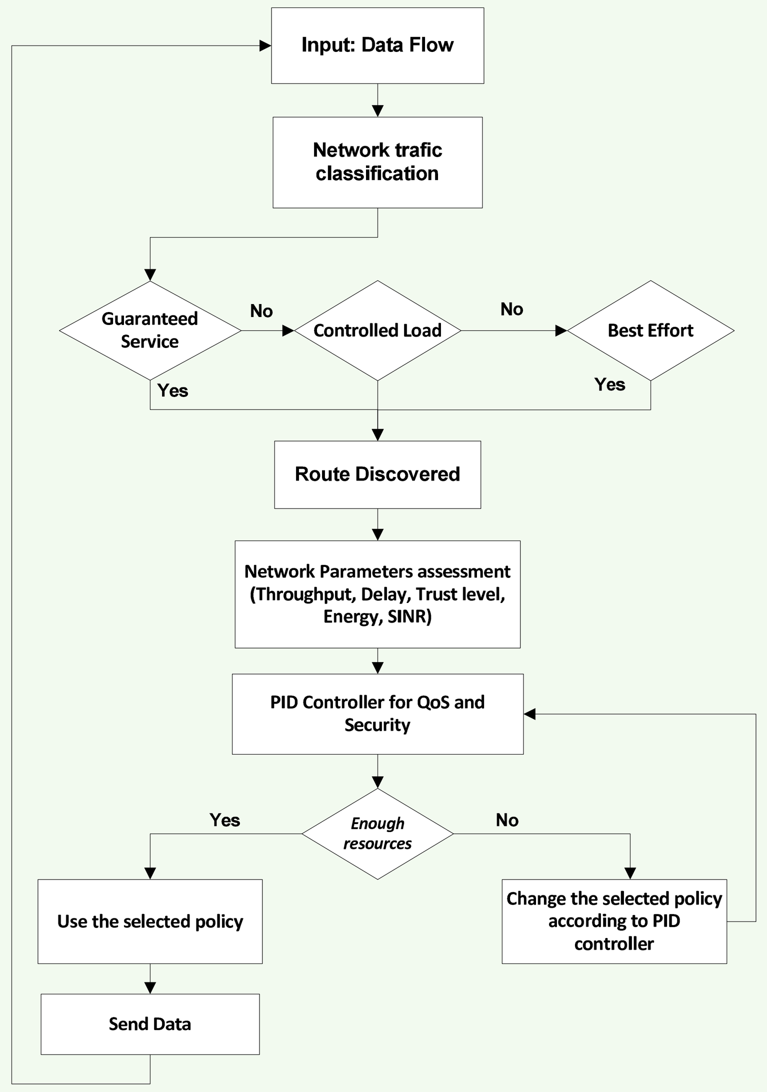
Motivation of this work

- **Security services required:** data confidentiality, mutual authentication, and data integrity.
- **Constraints:** resources limitations (energy and bandwidth). QoS and security are usually opposite parameters, and increase one level implies decreasing the other.
- **Performance:** security cost can directly impact the network performances like the QoS and the energy consumption.
- **Existing works:** focus separately on security, QoS or energy.

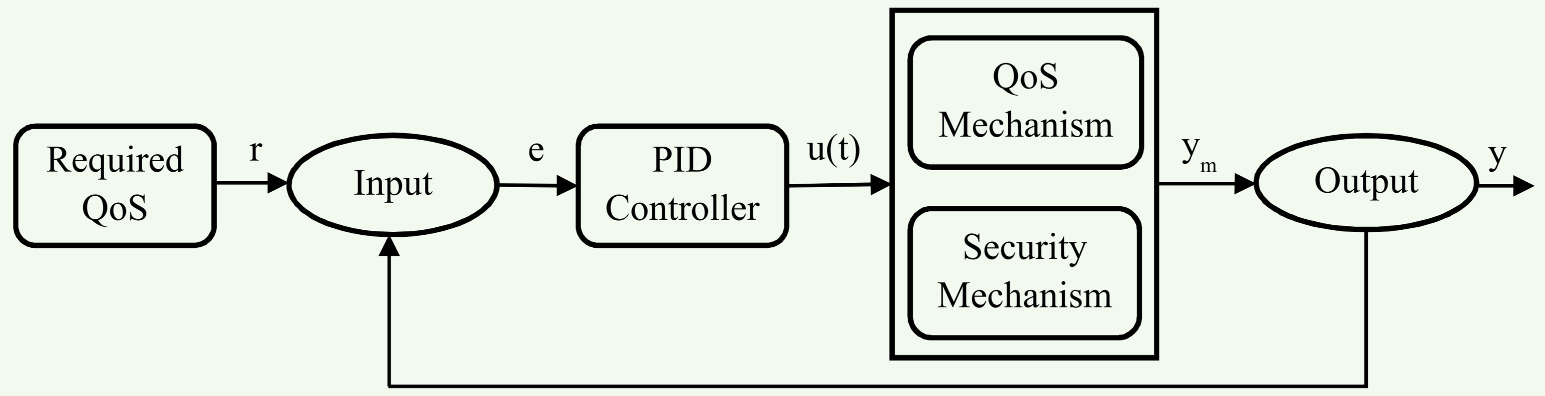
Proportional-Integral-Derivative (PID) controller

- The PID control is part of the feedback control theory.
- The basic concept of feedback control system is to make the desired output signal close to the input signal (which is considered as a reference) whatever the system dynamic's parameters variation is.
- The PID controller is based on the combination of three control actions:
  - Proportional to the error (P part),
  - Proportional to the integral of the error (I part),
  - Proportional to the derivative of the error (D part).

$$u(t) = K_P e(t) + K_I \int_0^t e(\alpha)\,d\alpha + K_D \frac{de}{dt}$$



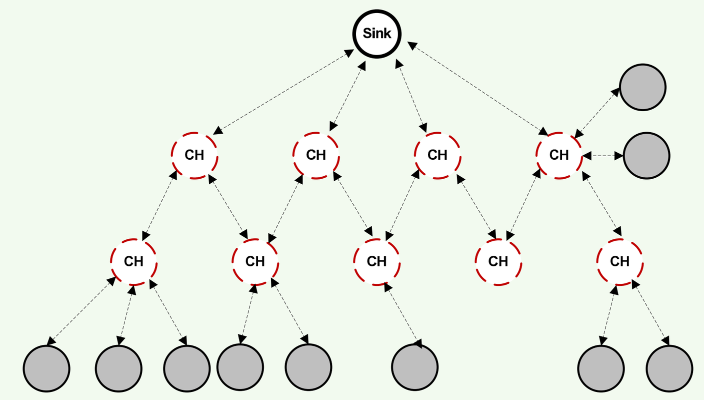
Flowchart of QwS-AODV



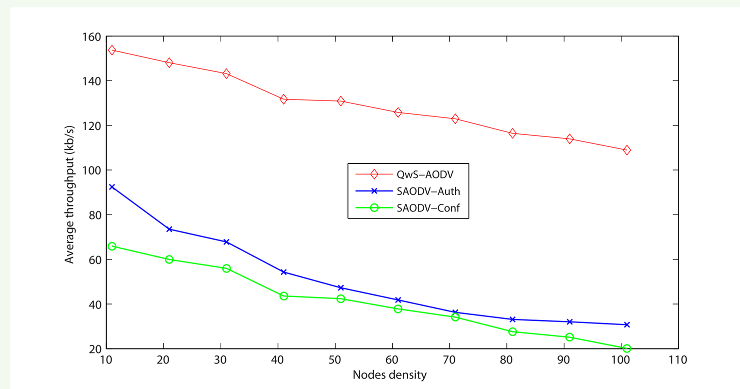
PID controller for QoS and security parameters

Area size	500 x 500 m^2
MAC/Physical Channel	80.15.4
IFQ size	50
Nodes density	11-101
Network traffic patterns	CBR/VBR
CBR/VBR rates	16kb/s
Simulation time	1000 sec

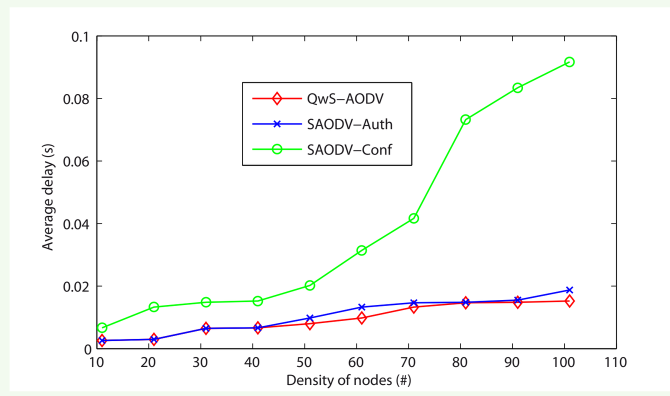
NS2 - Simulation parameters



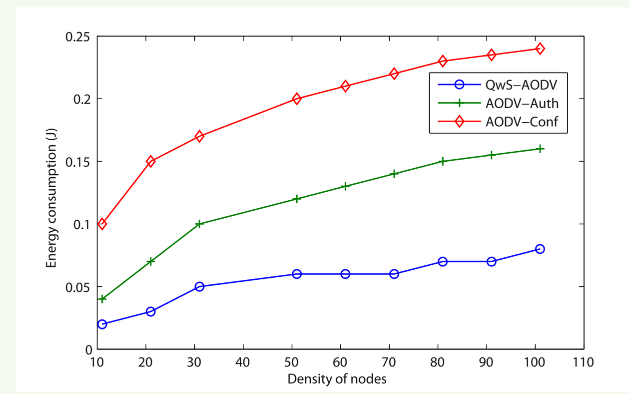
An example of a cluster-based network topology



Average throughput versus density of nodes



Average delay versus density of nodes



Energy consumption versus density of nodes

Conclusion and future work

- The QoS and the energy consumption parameters are combined with the security levels to find the optimal solution for the routing process (QwS-AODV).
- The simulation results illustrate that the QwS-AODV protocol ensures security without negative impact on the network performance.
- The QwS-AODV protocol increases the lifetime duration of nodes by around 50% compared to the static security services implemented in the routing protocol AODV.
- We plan to extend our study to dynamic WSNs by taking into account the mobility parameters.

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