Secure Communication in Heterogeneous Sensor Network

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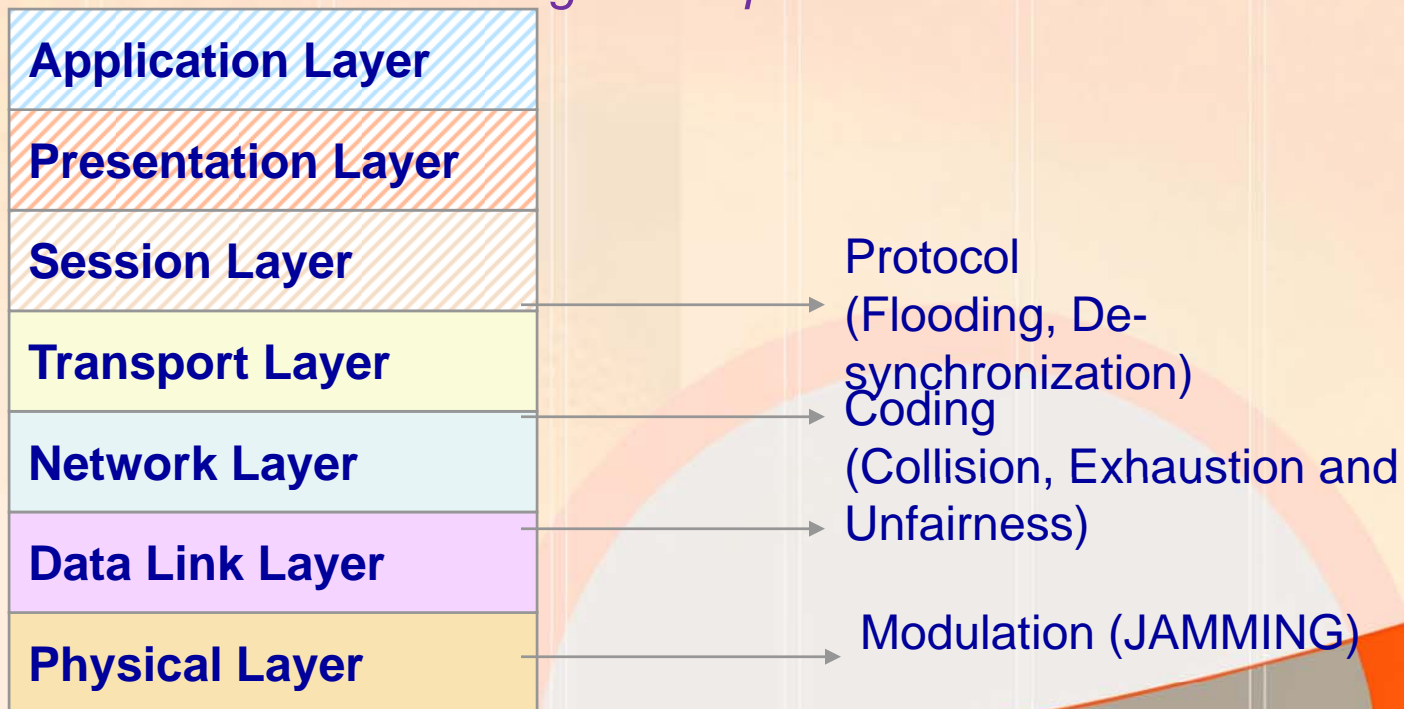
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Security: Sensor Network?

- *Limited resource constraint – No traditional security measures*
- *Data aging – No heavy security schemes*
- *Mission driven application – Performance parameter based protocols*
- *Adaptive & Distributive – Learning techniques*

| Application Layer |
| Presentation Layer |
| Session Layer |
| Transport Layer |
| Network Layer |
| Data Link Layer |
| Physical Layer |

Protocol (Flooding, De-synchronization)

Coding (Collision, Exhaustion and Unfairness)

Modulation (JAMMING)

A.D. Wood and J.A. Stankovic, "Denial of Service in Sensor Networks", IEEE Computer, Vol 35, Issue: 10, Oct 2002

Cognitive Intelligence (CI)

CI = Ant Colony Optimization + Bayesian Inference Model

Ant Colony Optimization System - Swarm intelligence[1]

- ❖ *E. O. Wilson in 1953 studied the social behavior of ants at Harvard University*
  - ❖ *Communicate through pheromone*
  - ❖ *Different fixed action responses to different pheromones – Normal & Benevolent traffic*
  - ❖ *Isolated ants act completely randomly and do not survive*
  - ❖ *Masses of ants thrive and defend each other*

Bayesian Inference Model

- ❖ *Adaptive weights on each 'performance' parameters.*
- ❖ *Reduced false alarm detection*
- ❖ *Prognostic Intrusion measures using training data*

Why Cognitive Intelligence?

- ❖ *Decentralized & resource aware approach*
- ❖ *Self adaptive nature – (Minimal human intervention)*
- ❖ *Hypothesis testing based on node characteristics*

1. Kennedy J, Shi Y. and Eberhart R.C., " Swarm Intelligence " , Morgan Kaufmann Publishers, San Francisco, 2001.

2. Marco Dorigo, "The Ant System: Optimization by a Colony of Cooperating Agents", IEEE Transactions on Systems, Man and Cybernetics-Part B, Vol-26, No. 1, Sept1996,pp 1-13.

Summary

❖ *The robustness of cross-layer algorithm is analyzed simulated scenario - noisy & fading channel, MUI.* [1]

❖ *Designed cross-layer protocol is application dependent – affects parameter's weight* [2]

❖ *The feedback characteristic of the ant system – Pheromone deposition can be used to penalize the attacked nodes* [3]

❖ *The performance parameters such as energy, Pd, Pl, BER and location of jammer & its characteristics influence the DoS attack* [4]

❖ *Hypothesis testing helps in setting a threshold, which can be varied depending on the environment and the node's characteristic* [5]

❖ *An energy efficient cross layer detection and countermeasure scheme increases the lifetime of the sensors and application****

1. R. Muraleedharan, W. Gao , L.A.Osadciw, **"Swarm Intelligence Managed UWB Waveform and Cognitive Sensor Network Protocol "**, IEEE Swarm Intelligence Symposium, Nashville, Tennessee, March 2009

2. R. Muraleedharan, L.A.Osadciw, Y. Yan, " **Resource Optimization in Distributed Biometric Recognition Using Wireless Sensor Network",** Multidimensional Systems and Signal Processing Journal, 2009

3. R. Muraleedharan, L.A.Osadciw, **" Security: Cross Layer Protocols in Wireless Sensor Networks", INFOCOMM, Barcelona, Spain, 2006.**

4. R. Muraleedharan, L.A.Osadciw , **"Secure Health Monitoring Network Against Denial-Of-Service Attacks Using Cognitive Intelligence***",* Communication Networks and Service Research Conference,(CNSR), Halifax, Canada, 2008

5. R. Muraleedharan, L.A.Osadciw , **"Jamming Attack Detection and Countermeasures In WSN using Swarm Intelligence", SPIE** Defense and Security Symposium, Orlando, FL, April 2006