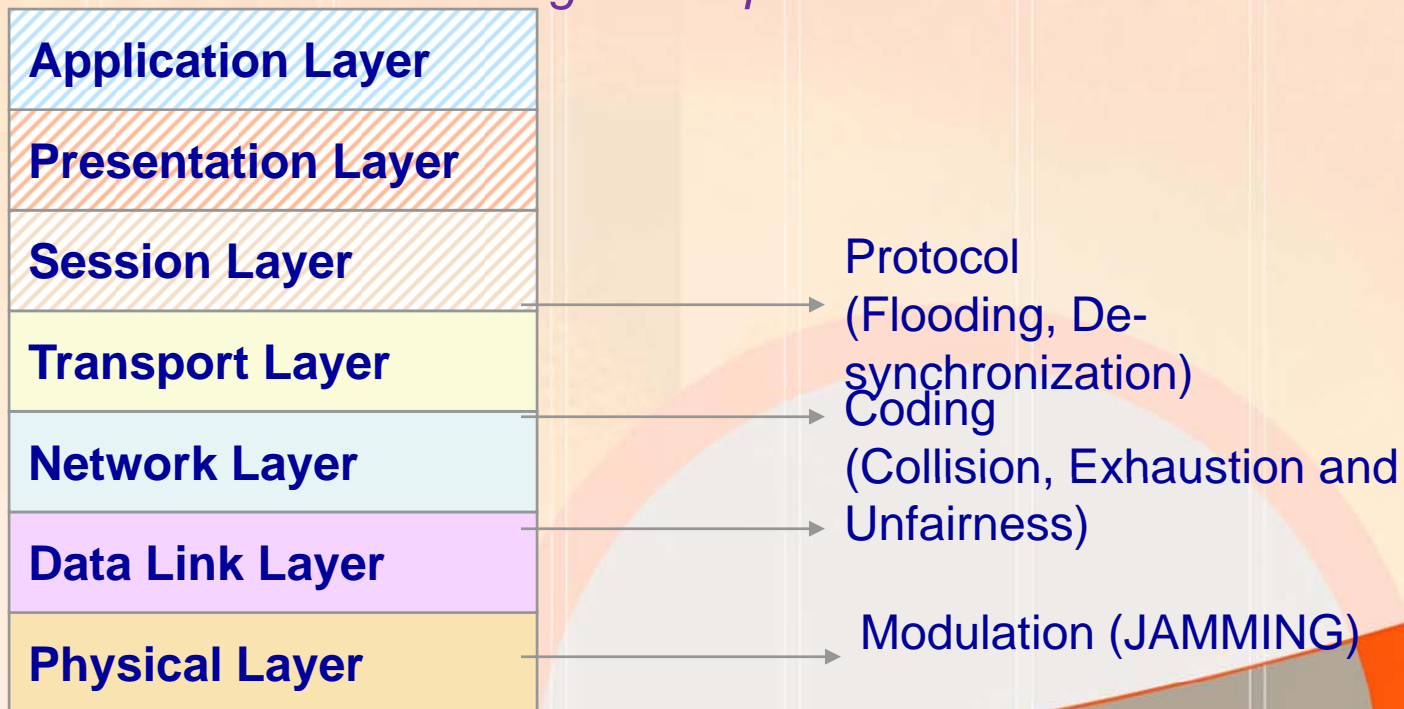




Security: Sensor Network?

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



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, PI, 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