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An Energy Efficient and Fault-Tolerant Clock Synchronization Protocol for WSNs

I. Protocol

- Wait for a random duration of time t_{rand}.
- Broadcast "synchronization request" message to all neighbors.
- Wait for a fixed duration of time T_{sr} - t_{rand} to receive "synchronization reply" messages from neighbors.
- At the end of time duration T_{sr} - t_{rand} , compute the offset of all its neighbors' clock with respect to its own clock.
- Compute the average of its own clock value and the clock values of its neighbors from which "synchronization reply" message has been received, and update its own clock value with the new average value.
- In the first synchronization round, if node *i* receives the clock value from some node *j* which has already updated its clock, then the next synchronization interval of node *i* is reduced by T_{sr} - t_{rand} .

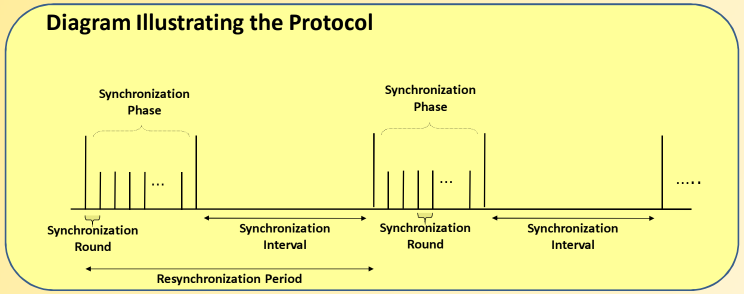


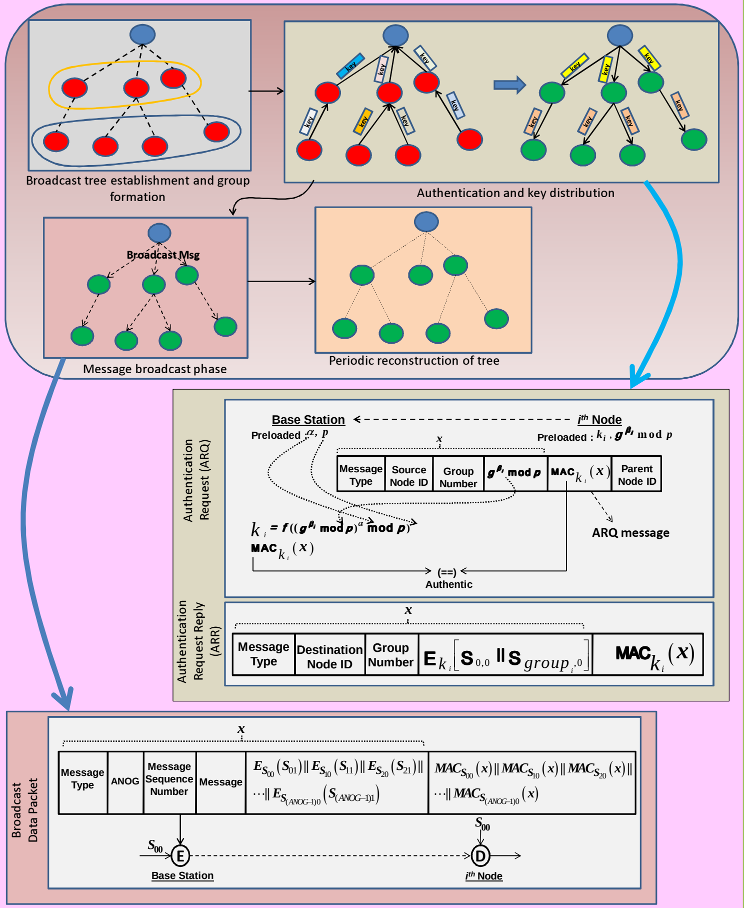
Diagram Illustrating the Protocol

II. Features of the Protocol

- Protocol is peer-to-peer based and it does not use any hierarchical structure.
- Energy consumption per node remains constant with increase in number of nodes in WSN, and therefore, the protocol is highly scalable.
- The protocol is fault-tolerant to node failure.

A Broadcast Authentication Protocol for Multi-Hop Wireless Sensor Networks

I. Protocol



Broadcast tree establishment and group formation
Authentication and key distribution
Message broadcast phase
Broadcast Msg
Periodic reconstruction of tree
Authentication Request (ARQ)
Base Station
i^{th} Node
Preloaded : α, p
Preloaded : k_i , g^{β_i} mod p
x
ARQ message
(==)
Authentic
Authentication Request Reply (ARR)
x
Broadcast Data Packet
x
S_{00}
E
S_{00}
D
Base Station
i^{th} Node

Message Type	Source Node ID	Group Number	g^{β_i} mod p	$MAC_{k_i}(x)$	Parent Node ID

$k_i = f((g^{\beta_i} \bmod p)^{\alpha} \bmod p)$

$MAC_{k_i}(x)$

Message Type	Destination Node ID	Group Number	$E_{k_i}[S_{0,0} \| S_{group_i,0}]$	$MAC_{k_i}(x)$

Message Type	ANOG	Message Sequence Number	Message	$E_{S_{00}}(S_{01}) \| E_{S_{10}}(S_{11}) \| E_{S_{20}}(S_{21}) \|$ $\cdots \| E_{S_{(ANOG-1)0}}(S_{(ANOG-1)1})$	$MAC_{S_{00}}(x) \| MAC_{S_{10}}(x) \| MAC_{S_{20}}(x) \|$ $\cdots \| MAC_{S_{(ANOG-1)0}}(x)$

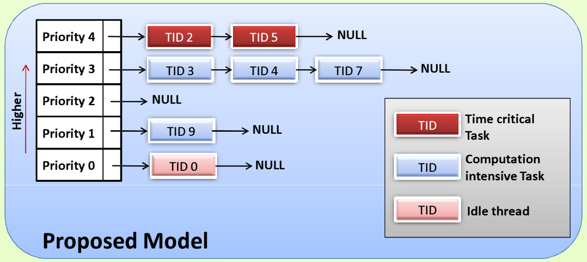
II. Features of the Protocol

- The protocol provides broadcast authentication in multi-hop WSNs using different hash key chain for each group.
- The protocol exhibits individual authentication, instant authentication, and low overhead in communication and storage.

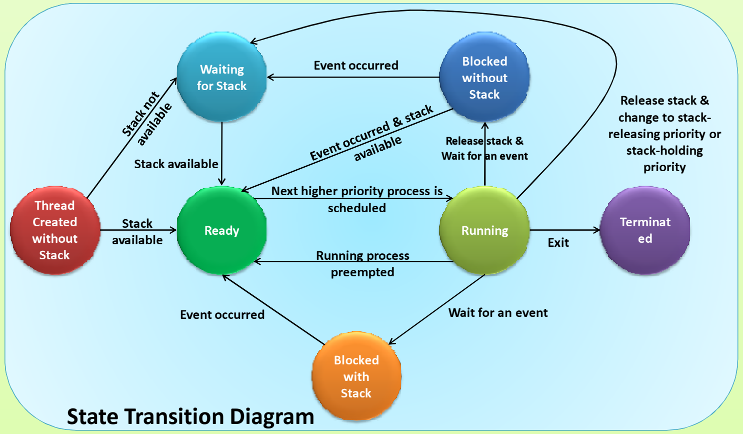
Design and Implementation of Energy Efficient Operating System for WSNs

I. Proposed Model

- Fixed number of Priority Levels (changed at compile-time only).
- Each level may have more than one stack. All threads in a priority level either hold stack or release stack.
- Fixed priority preemptive scheduling policy, with FIFO at same level (**threads can change priority upon releasing the stack**).



Proposed Model



State Transition Diagram

Waiting for Stack
Event occurred
Blocked without Stack
Stack not available
Event occurred & stack available
Release stack & Wait for an event
Release stack & change to stack-releasing priority or stack-holding priority
Stack available
Thread Created without Stack
Stack available
Ready
Next higher priority process is scheduled
Running
Exit
Terminated
Running process preempted
Event occurred
Wait for an event
Blocked with Stack

II. Features of the Proposed Model

- Many threads with limited number of stacks may be created.
- Energy efficiency is achieved by reducing memory requirements and number of context switches.

Distributed Computing Lab