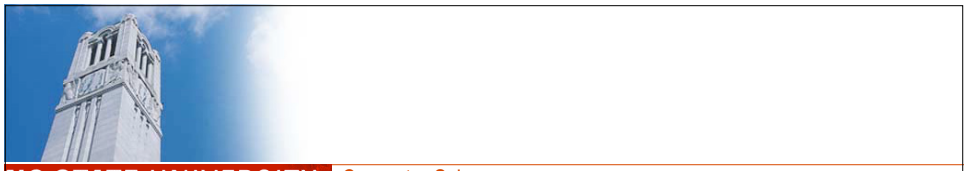


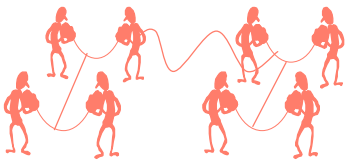
NC STATE UNIVERSITY Computer Science

CSC 774 Advanced Network Security

Topic 5.2 Tree-Based Group Diffie Hellman Protocol

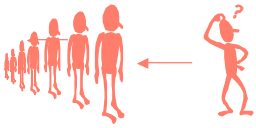
Acknowledgment: Slides were originally provided by Dr. Yongdae Kim at University of Minnesota.

Membership Operations



Formation

Group partition



Member add

Member leave

Group merge

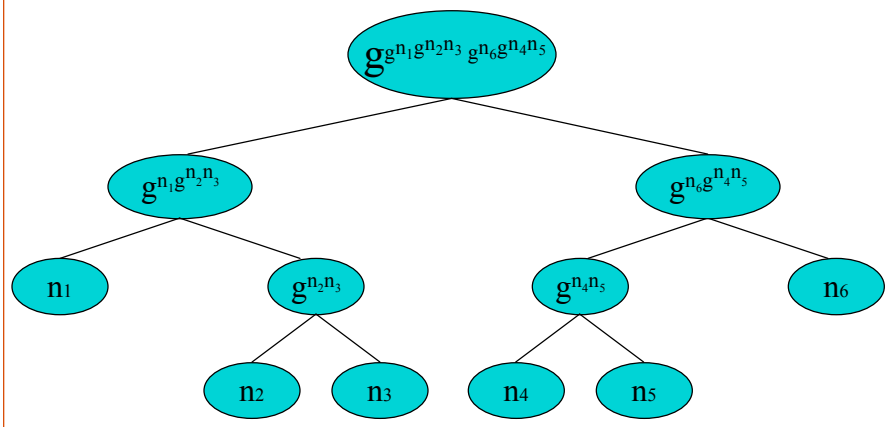
Membership Operations

- Join: a prospective member wants to join
- Leave: a member wants to (or is forced to) leave
- Partition: a group is split into smaller groups
  - Network failure: network event causes disconnectivity
  - Explicit partition: application decides to split the group
- Merge: two or more groups merge to form one group
  - Network fault heal: previously disconnected partitions reconnect
  - Explicit merge: application decides to merge multiple pre-existing groups into a single group

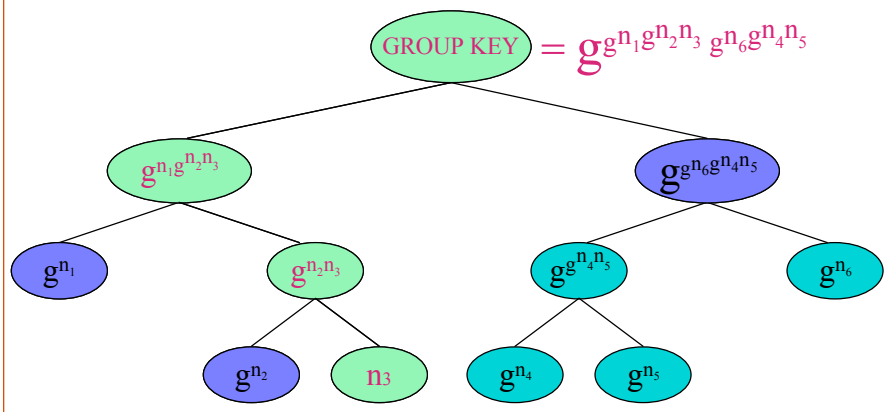
Tree-Based Group Diffie Hellman

- Simple: One function is enough to implement it
- Fault-tolerant: Robust against cascade faults
- Secure
  - Contributory
  - Provable security
  - Key independence
- Efficient
  - d is the height of key tree ($< O(\log_2 N)$), and N is the number of users
  - Maximum number of exponentiations per node $3d$

Key Tree (General)

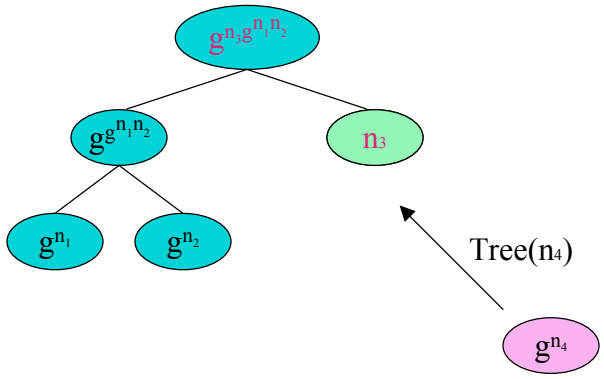


Key Tree (n_3's view)

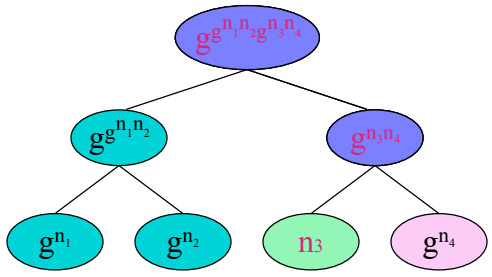


Any member who knows blinded keys on every nodes and its session random can compute the group key.

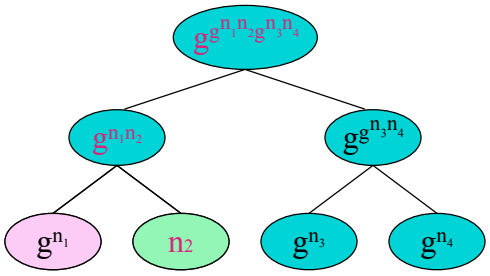
Join (n_3's view)



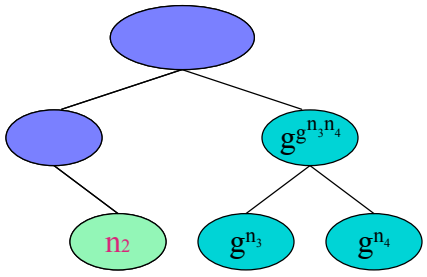
Join (n_3's view)



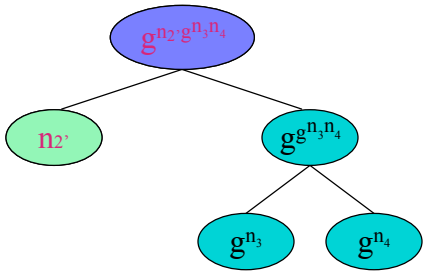
Leave (n_2's view)



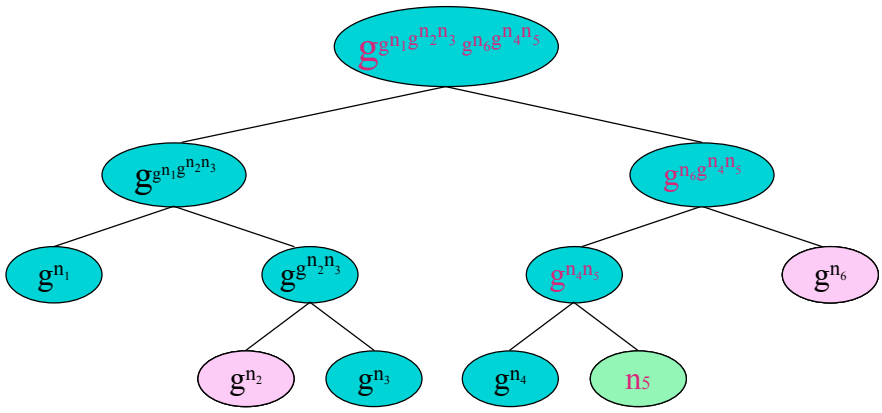
Leave (n_2's view)



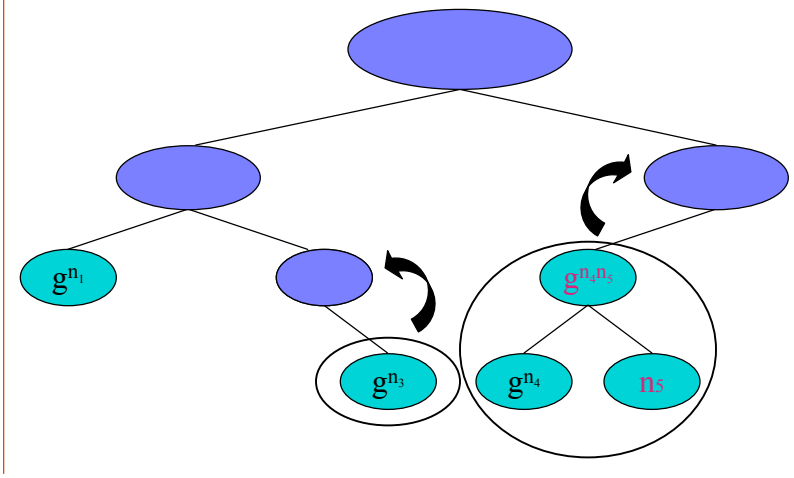
Leave (n_2's view)



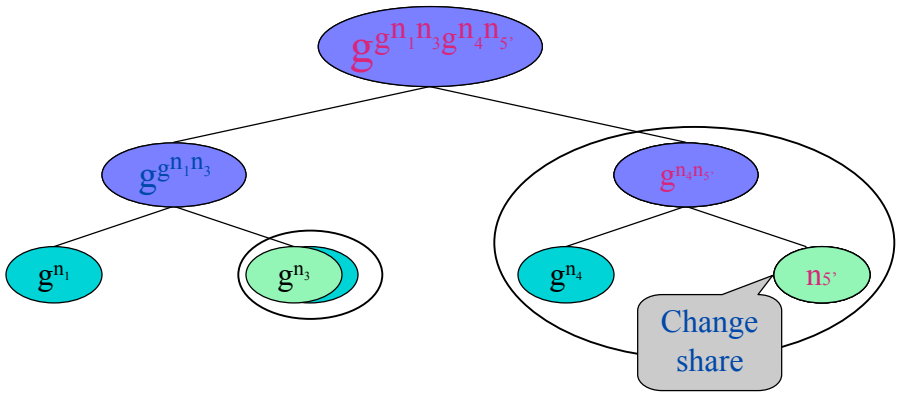
Partition (n_5's view)



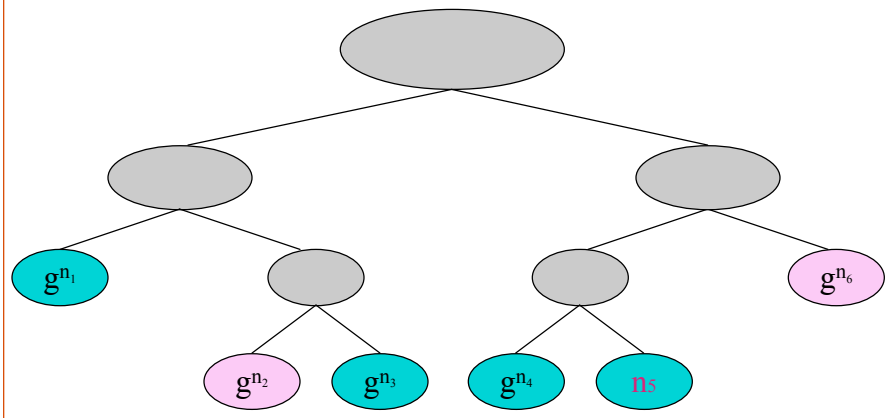
Partition (n_5's view)



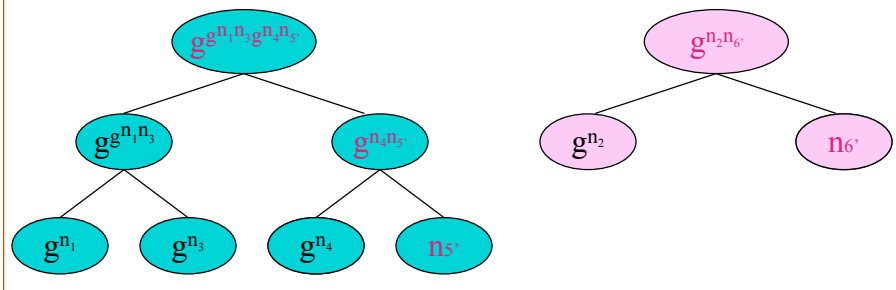
Partition (n_5's view)



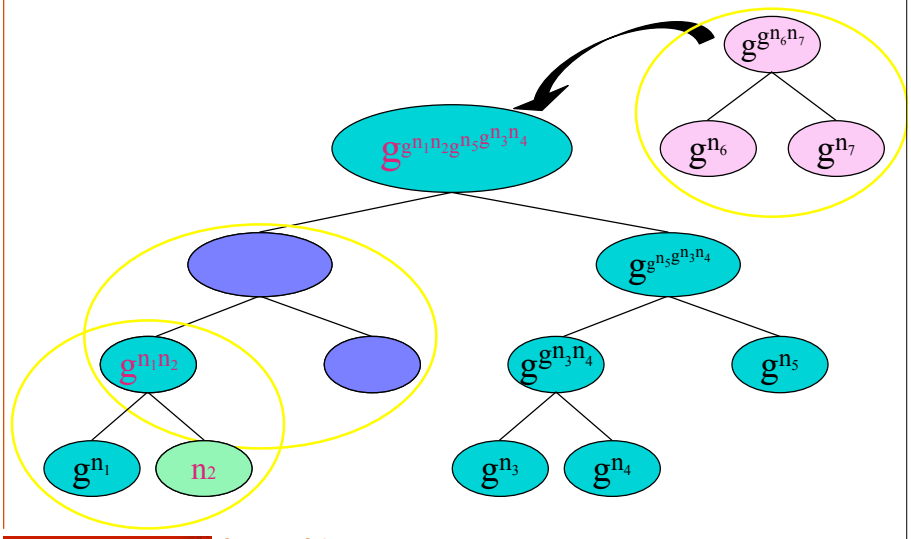
Partition: Both Sides



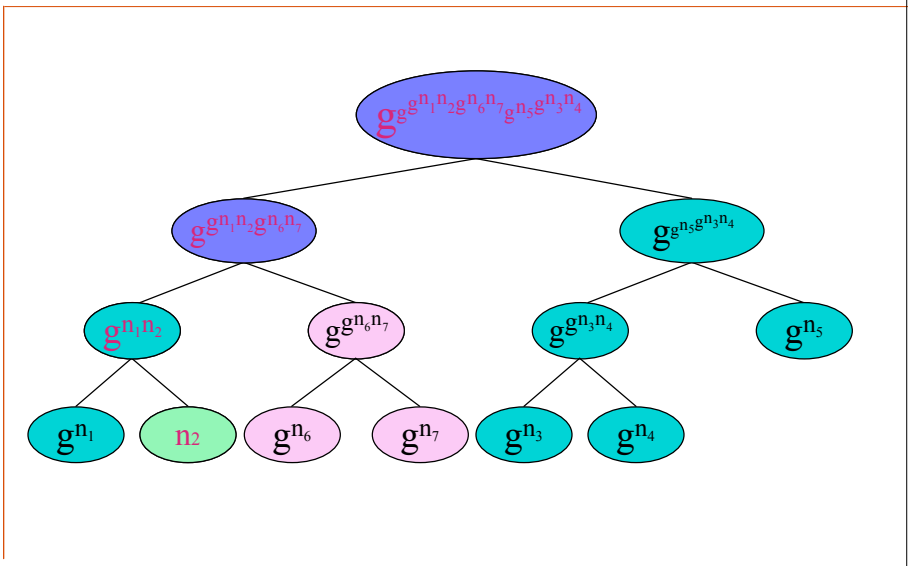
Partition: Both sides (N_5 and N_6)



Merge (N_2's view)



Merge (to intermediate node)



Tree Management: do one's best

- Join or Merge Policy
  - Join to leaf or intermediate node, if height of the tree will not increase.
  - Join to root, if height of the tree increases.
- Leave or Partition policy
  - No one can expect who will leave or be partitioned out.
  - No policy for leave or partition event
- Successful
  - Still maintaining logarithmic (height < $2 \log_2 N$)

Discussion

- Efficiency
  - Average number of mod exp: $2 \log_2 n$
  - Maximum number of round: $\log_2 n$
- Robustness is easily provided due to self-stabilization property