

Why Data Aggregation?

✓ Sensor Networks

❖ Functions

- Sensing
- In-network Processing
- Ad-hoc Communication

❖ Applications

- Military Surveillance
- Homeland Security



✓ Without Aggregation

❖ Data Redundancy

- ❖ Communication Cost
- ❖ Energy Expenditure

➤ Reporting Raw Data is

Unnecessary!

✓ Aggregation Reduces Overhead in Data Collection!

Security Challenges

✓ A Lossy Data Compression Process

✓ Compromised Intermediate Nodes Change Aggregated Data

✓ BS cannot Verify Results without Knowing Original Readings

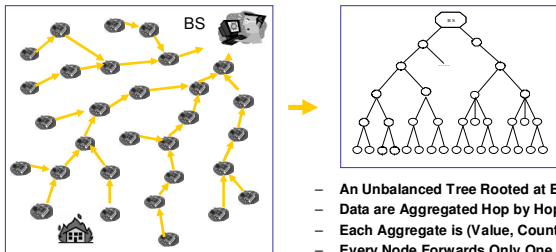
➤ How can BS Obtain a Good Approximation of Aggregation Result with a Fraction of Compromised Nodes?

Our Solutions

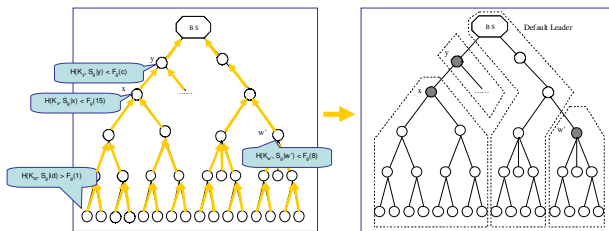
Divide and Conquer

- Partition Aggregation Tree into Multiple Logical Groups of Similar Sizes

Tree Construction & Query Dissemination



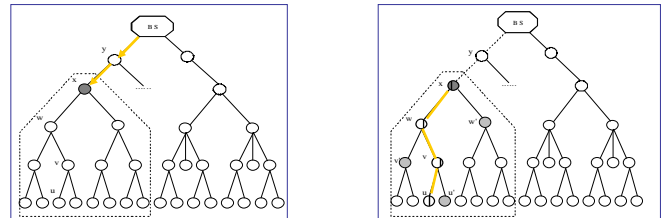
Probabilistic Grouping & Data Aggregation



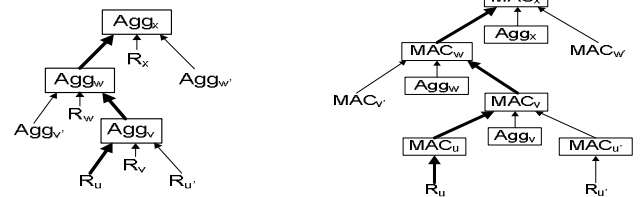
Commit and Attest

- Each Group Generates a Commitment that cannot be Denied Later
- BS Identifies Abnormal Groups from Set of Group Commitments based on a Bivariate Multiple Outlier Detection Grubbs' Test
- Groups under Suspicion Prove Correctness of Submitted Commitments to BS by Probabilistic Path Selection
- BS Discards Commitments from Groups Failing to Support Previous Values when Computing Final Aggregates

Group Attestation



BS Reconstruction



Security Analysis and Performance Evaluation

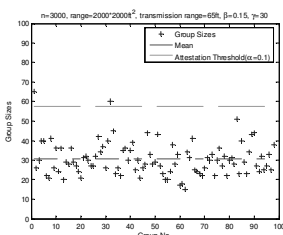
❖ Zero False Positive Rate

- Attack-free Groups will Pass Grubbs' Test Anyway

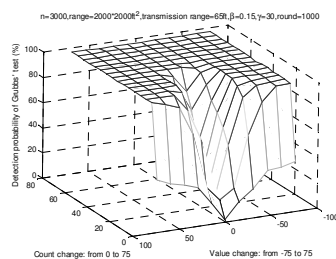
❖ Grouping Function

$$- F_g(c) = (1 - e^{-\beta c})^\gamma \quad (0 < \beta \leq 1, \gamma \geq 1)$$

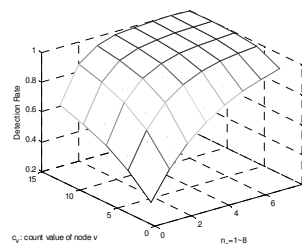
Grouping Result



Detection Capability of Grubbs' Test



Detection Capability of Group Attestation



Message Overhead in Packet*Hop

