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Reputation-Based Frameworks for High Integrity Sensor Networks

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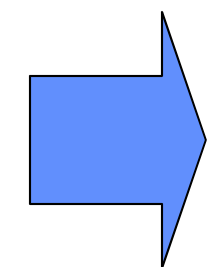
# Reputation based framework for high integrity sensor networks

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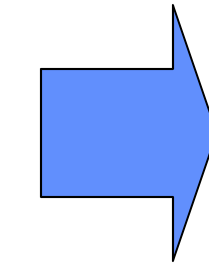
## Introduction: Sensor networks security: Issues & Challenges

Sensor nodes have to be cheap  
– No physical security is feasible  
Unmanned



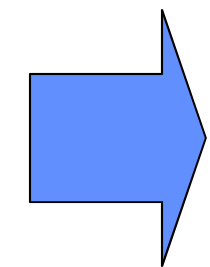
Handle compromised nodes

Severe resource constraints  
– Limited bandwidth, memory etc.  
Scale



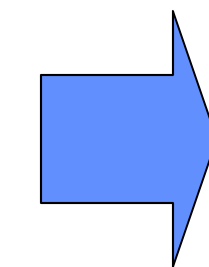
Existing solutions not portable

Collaborative behavior  
– In-network processing



End-to-end security?

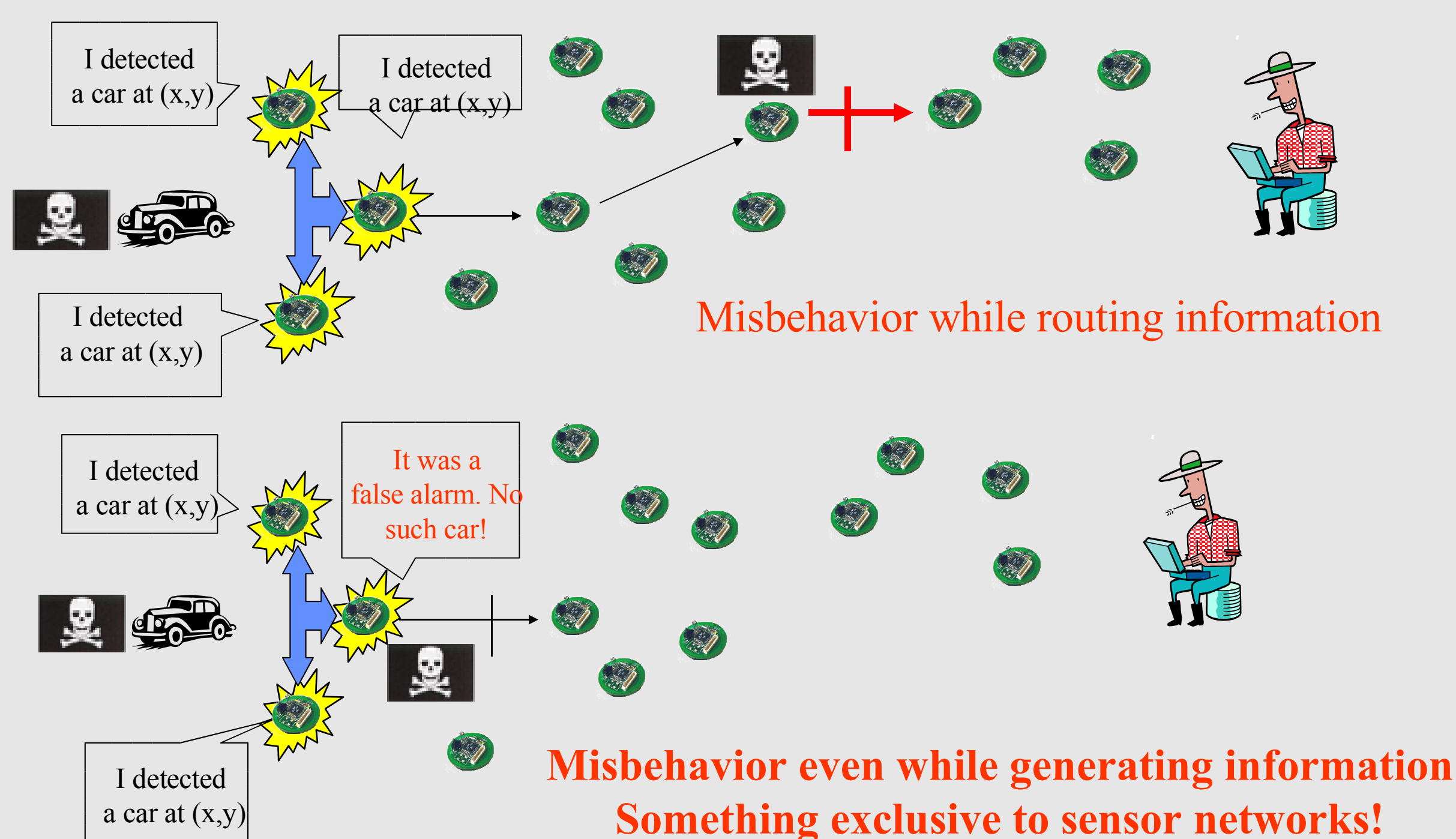
Open wireless medium  
– No access control measures



Secure relaying

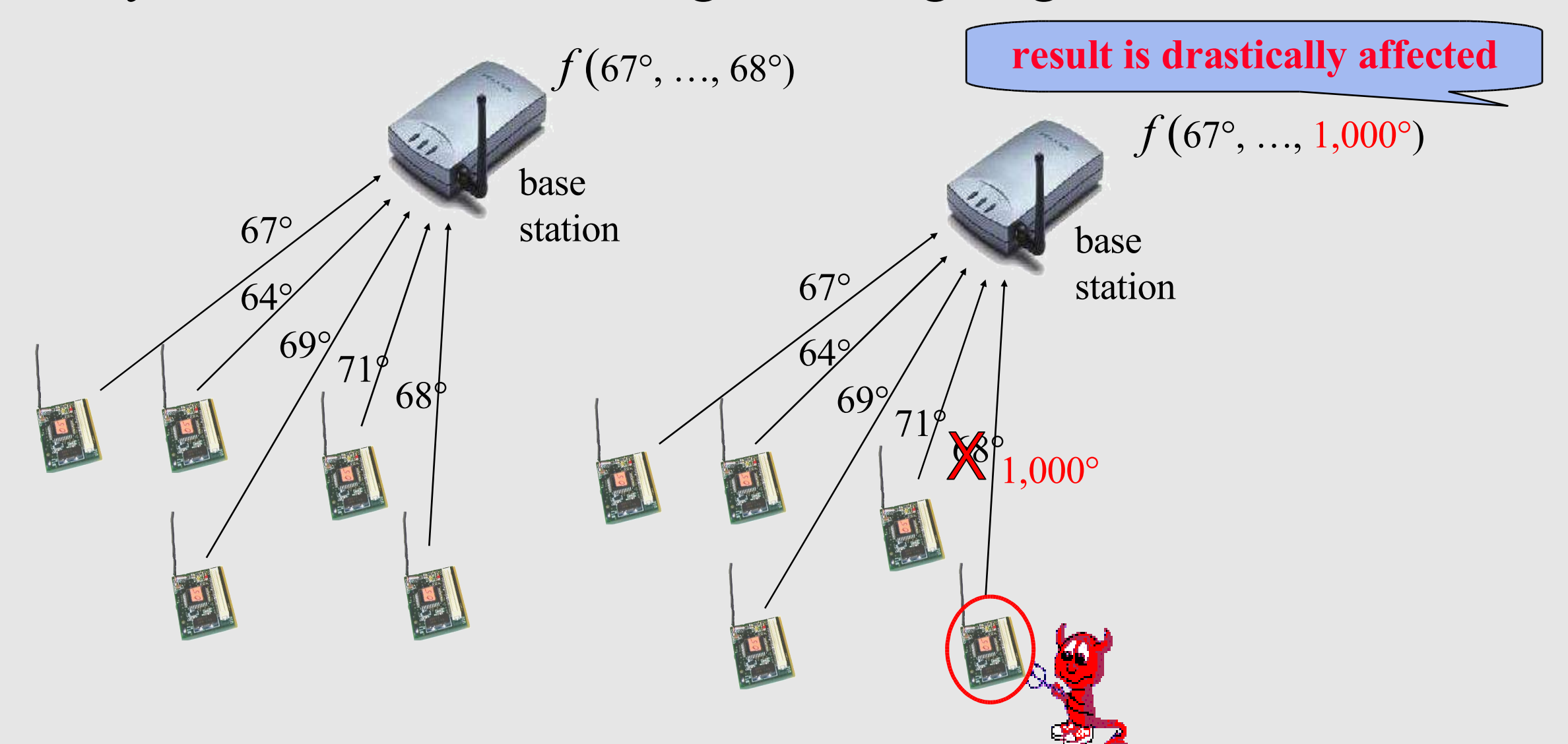
## Problem Description: Need for moving beyond cryptography

### Decentralized decision making



### Data Authentication

- Compromised node can insert bogus data into the network.
- Faulty sensors can result in generating bogus data.



## Proposed Solution: Reputation based Framework for Sensor Networks (RFSN)

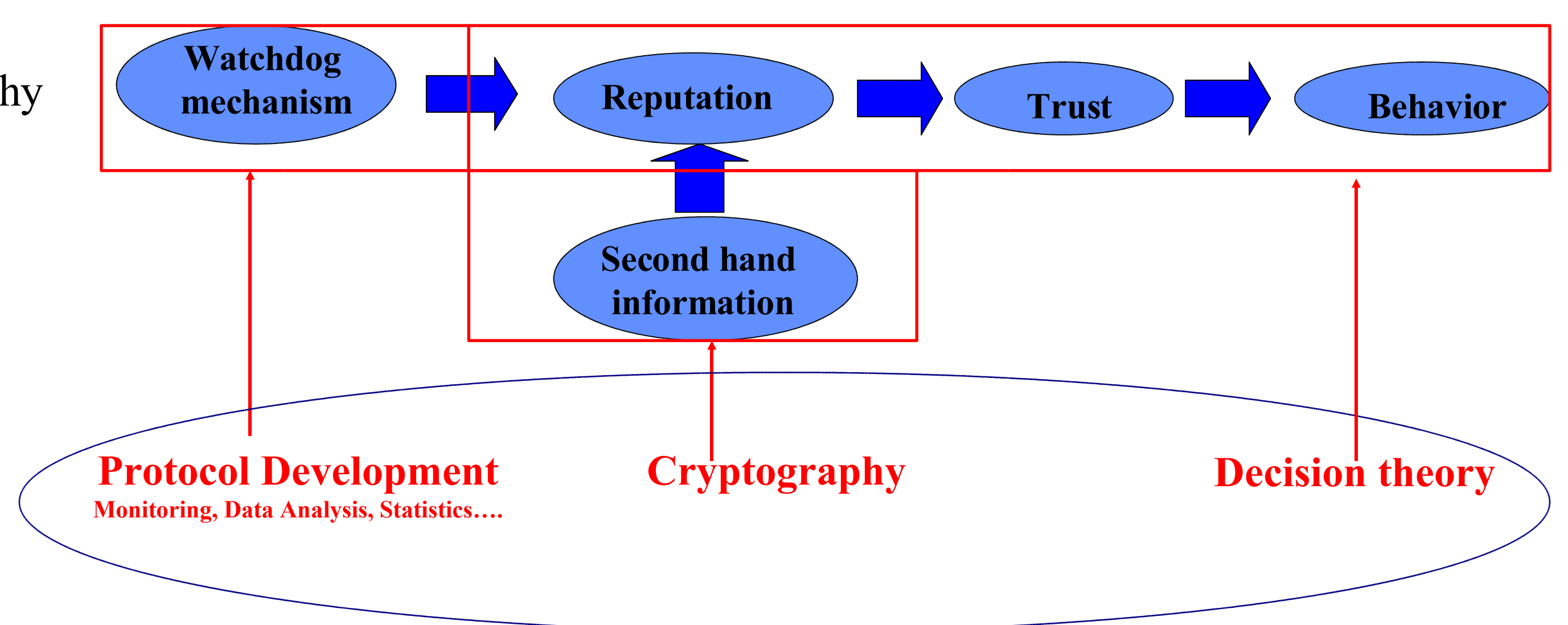
### How do nodes trust each other?

- Embedded in every social network is a web of trust  
– When faced with uncertainty, trust those whom you think are trustworthy
- Similar approach  
– Nodes maintain reputation for each other.  
– Help them to differentiate between good and bad/faulty nodes.

### Why this approach?

- Sensor networks already follow a community model  
– Collaborative information gathering, data processing and relaying.
- Missing element is trust.....  
– Nodes are dumb and they collaborate with everybody.
- RFSN incorporates intelligence into nodes  
– Cooperate with only those that are trustworthy.

### Node level skeleton structure of RFSN

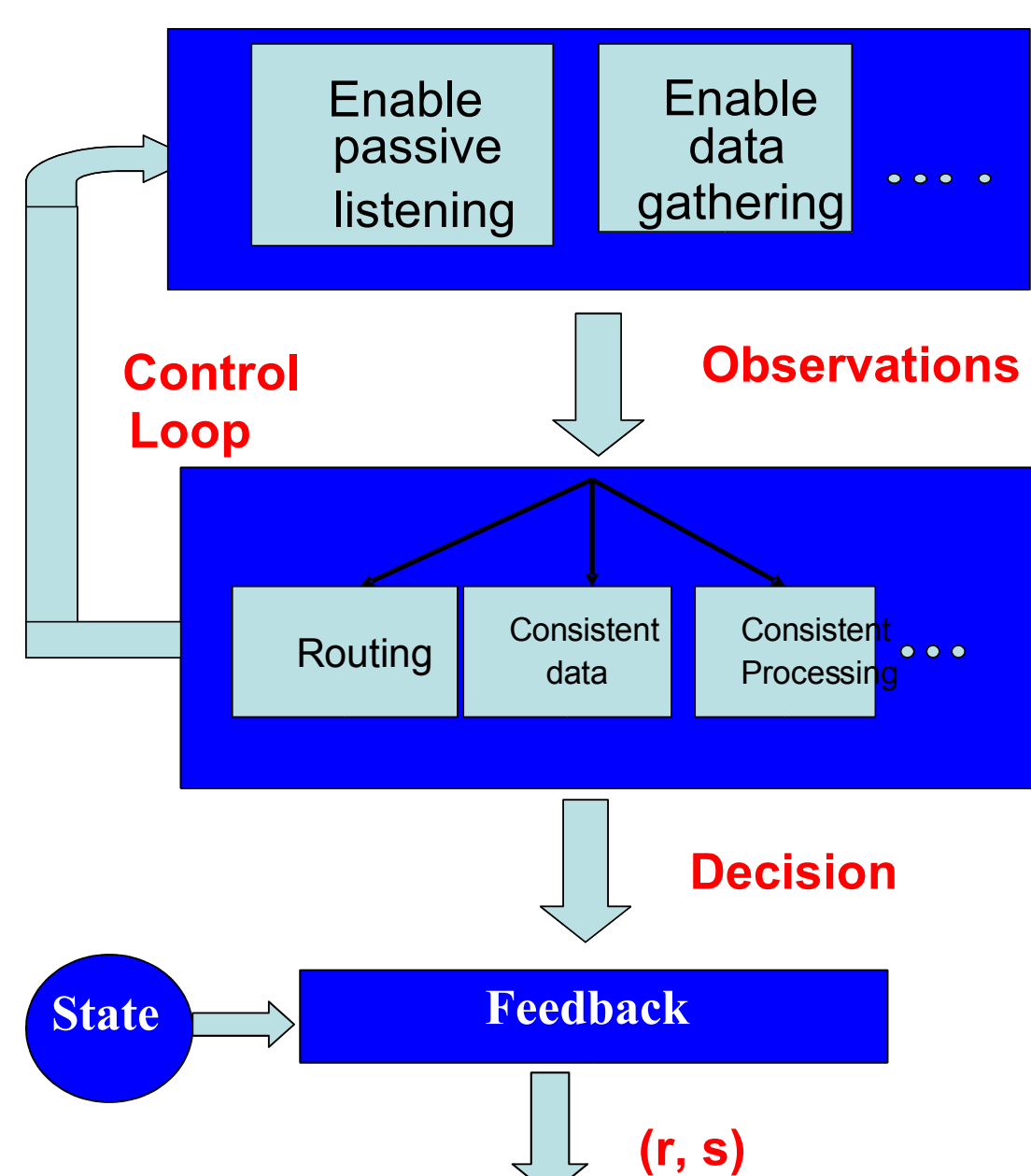


Development of high integrity sensor networks will be a combination of techniques from different fields

## Proposed Solution: Beta Reputation system for Sensor Networks (BRSN)

### Watchdog Mechanism

- Collection of Modules
- Each module imposes energy, memory, processing cost.
- Efficient choice is paramount!



### Bayesian Formulation

- Reputation representation  
 $R_{ij} = \text{Beta}(\alpha_j, \beta_j)$
- Reputation updates  
 $\alpha_j^{\text{new}} = \alpha_j + r; \beta_j^{\text{new}} = \beta_j + s$
- Reputation integration  
$$\alpha_j^{\text{new}} = \alpha_j + \frac{\{2 * \alpha_k * \alpha_j^k\}}{\{(\beta_k + 2) * (\alpha_j^k + \beta_j^k + 2)\} + \{2 * \alpha_k\}}$$
  
$$\beta_j^{\text{new}} = \beta_j + \frac{\{2 * \alpha_k * \beta_j^k\}}{\{(\beta_k + 2) * (\alpha_j^k + \beta_j^k + 2)\} + \{2 * \alpha_k\}}$$

- Trust representation

$$T_{ij} = E[R_{ij}] = \frac{\alpha_j + 1}{\alpha_j + \beta_j + 2}$$

- Behavior representation

$$B_{ij} = \begin{cases} \text{cooperate} & \forall T_{ij} \geq TH \\ \text{don't cooperate} & \forall T_{ij} < TH \end{cases}$$