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Traffic classifier for Heterogeneous and Cooperative routing through WSN

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Overview

- Wireless Sensor Networks (WSNs) are composed of specific-purpose constrained devices called **sensors**
- Sensors are autonomous units → they use an independent battery power → battery is a constraint
- Lifetime → time that a sensor/network is **useful**



- **What is useful?** For **us**:

- Sensors still alive → Sensor with battery
- Critical region accessible → sensors with access to the Sink node

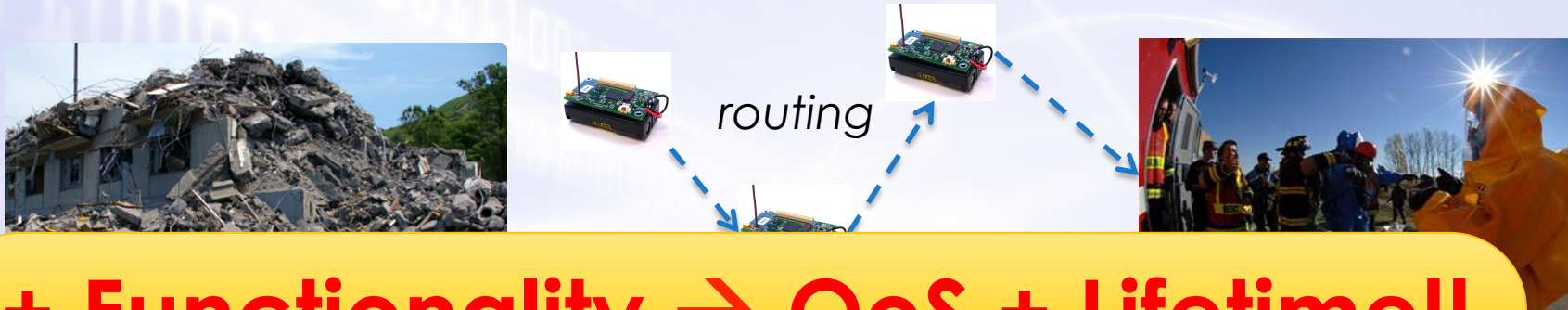


– ***Can WSNs deliver QoS-based traffic?***

- **Lifetime** is *crutial* in WSN since it determines network survival
- **QoS-based traffic** is the **future**

Motivation

- Current approaches do not allow the deployment of **collaborative sensor networks**, where different sensors can work together to provide a **common service** (e.g. routing)



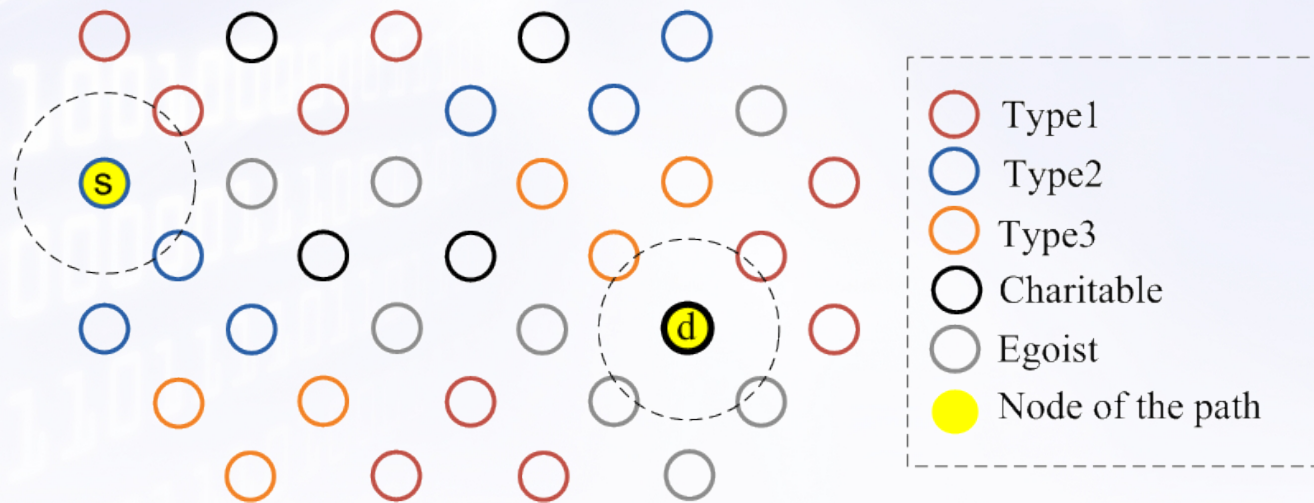
+ Functionality → QoS + Lifetime!!

- Different data** to be sent to the Sink require **different paths** to be efficiently sent through a WSN



R2WSN

- **Routing algorithm for WSN** using traffic classification and **Role-assignment** to enhance lifetime while improving QoS
 - Traffic classification → **QoS** requirements
 - Role-assignment → What a node can **provide** to the network
- The information to be transmitted from **s** to **d** is sent using the path that best satisfies a criterion → roles

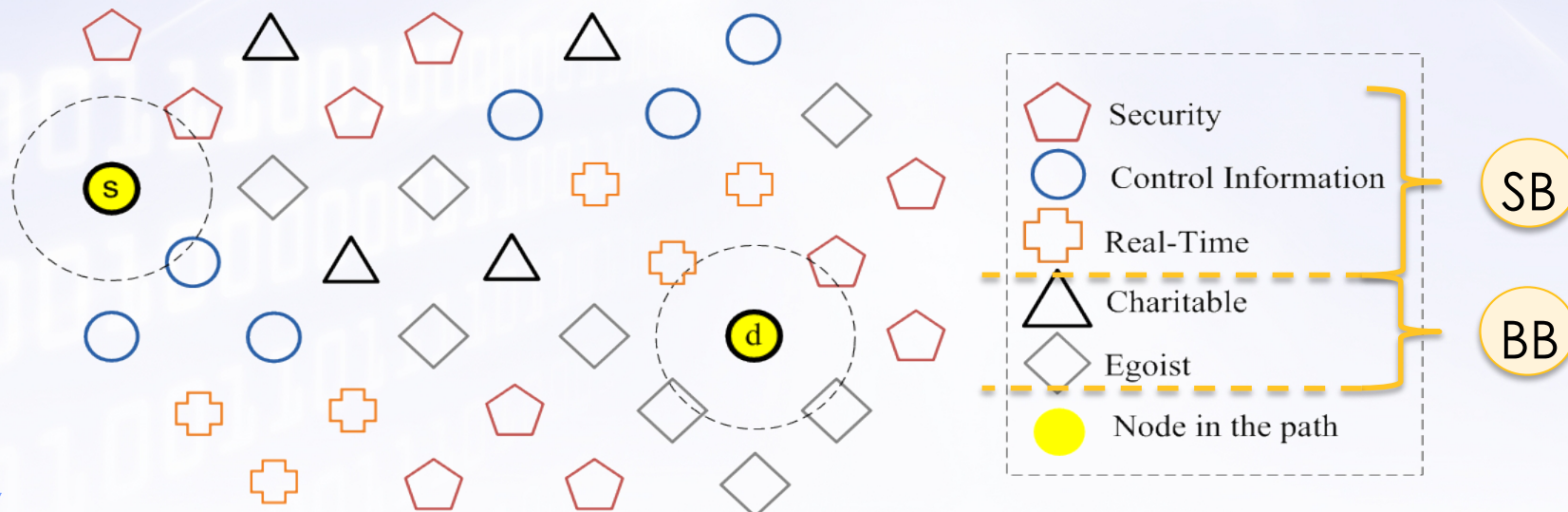


Role assignment

- Service-based roles → to provide QoS guarantees
 - Type of service that a node can provide
 - **Result** of performing a node classification based on the *characteristics allowable* in the node to **provide services** → e.g. trust level
- Behaviour-based roles → to protect lifetime
 - Behaviour defined by the node
 - **Result** of a decision process performed by the node based on the *resources allowable* in the node to prolong the **lifetime** → e.g. battery

SB

BB



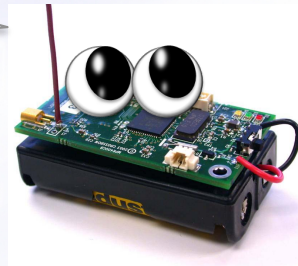
SB

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Traffic Classifier

- Similar to **role-assignment** but without considering behaviour-based roles
- The classification task is performed **locally in the node**
 - The data to be sent is tagged with a service-based role in origin
 - Only local information (QoS requirements) is used

This data requires to be **ciphered** and there are no time constraints

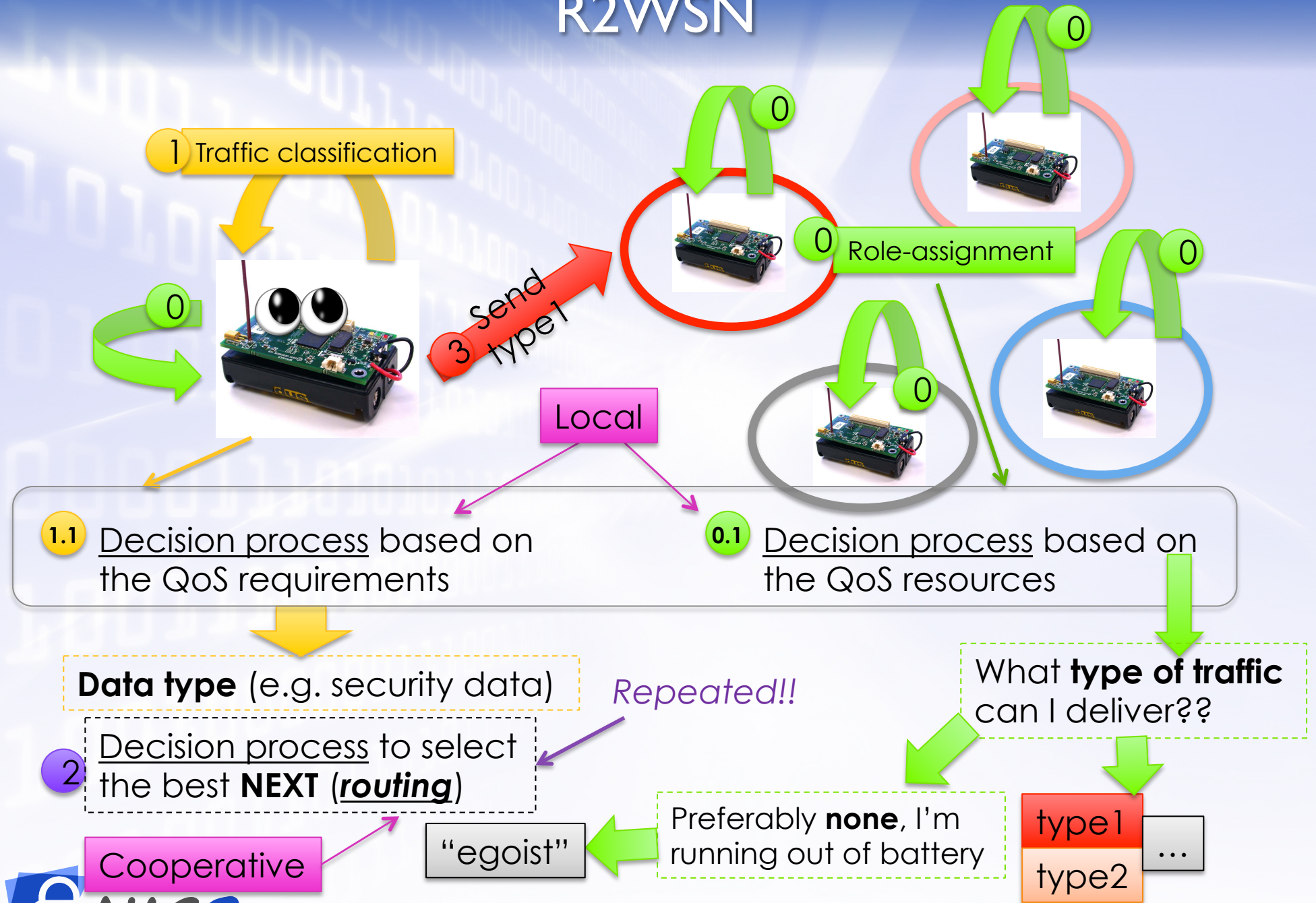


I need to exchange **security data**

I will **select** the best path available

- Based on the **decision process**

R2WSN



Decision Process

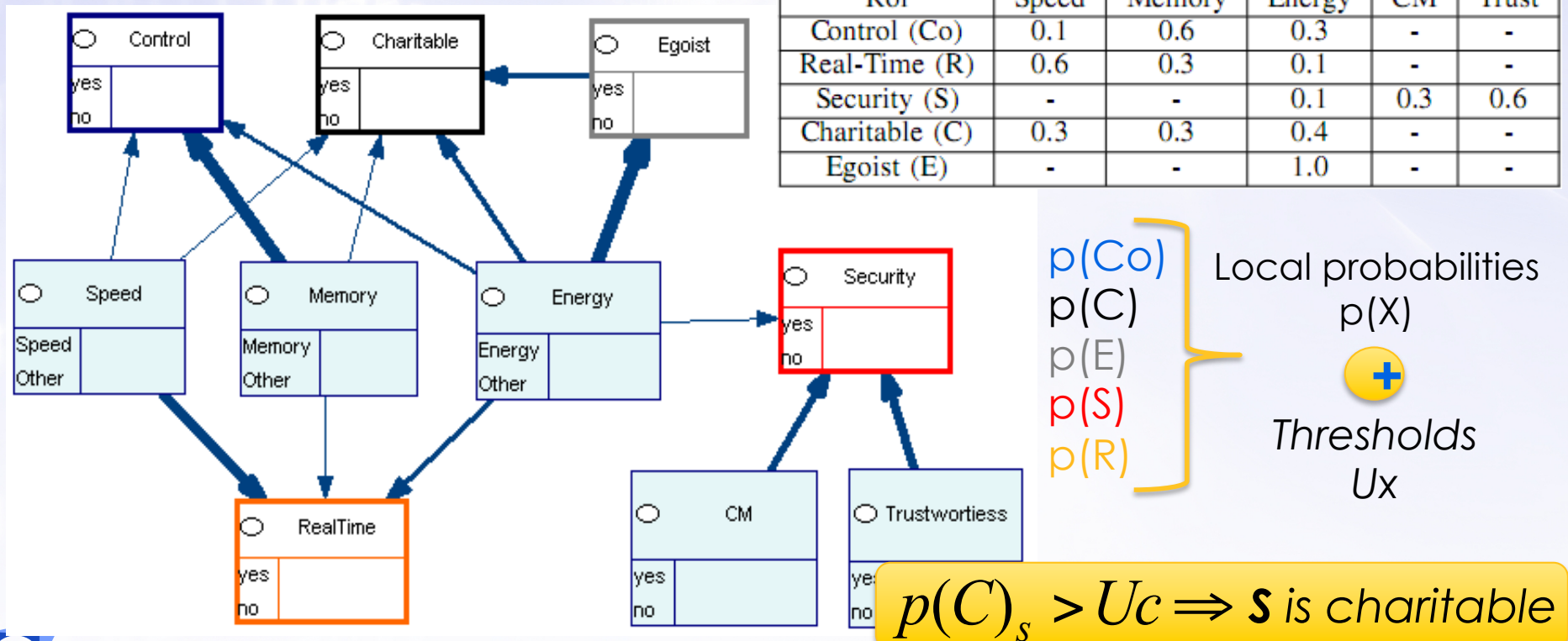
- Local Decision
 - Based on the **local resources** of the node
 - What a node can provide
- Cooperative decision
 - Based on information recovered from the **neighbour nodes**
 - We want to detect clusters of services
- Example:

Decision Process	Implementation
Local Decision	Bayesian network
Cooperative decision	$P(X)_n = \left(\frac{1}{V_n} \sum_{i=1}^N p(X)_i nb(n,i) \right) + KV_{nx}$

Local Decision: Bayesian network

- Roles:
 - Service-based roles: security, control-information, real-time
 - Behaviour-based roles: charitable, egoist

Bayesian Network:



Cooperative Decisions

- The decision process is based on:
 - Lifetime → Behaviour-based role → egoist node?
 - **Maximum value of $P(X)$ → requirements**
 - Direction to the destination node
- } suitability
- Routing algorithm
 - Ideally, the next node in the path (n), must satisfy:

$$P(E)_n < U_E$$

Lifetime preserving

$$P(X)_n \geq P(X)_i, \forall i \in \{k \mid nb(n, k) = 1\}$$

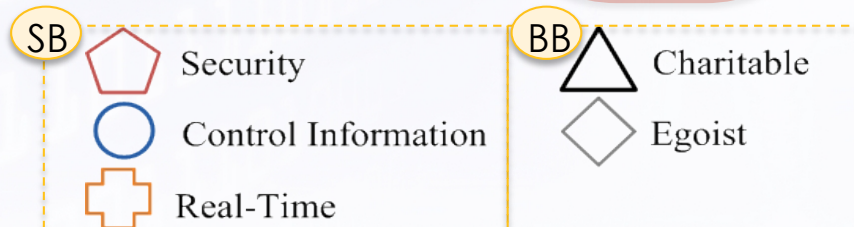
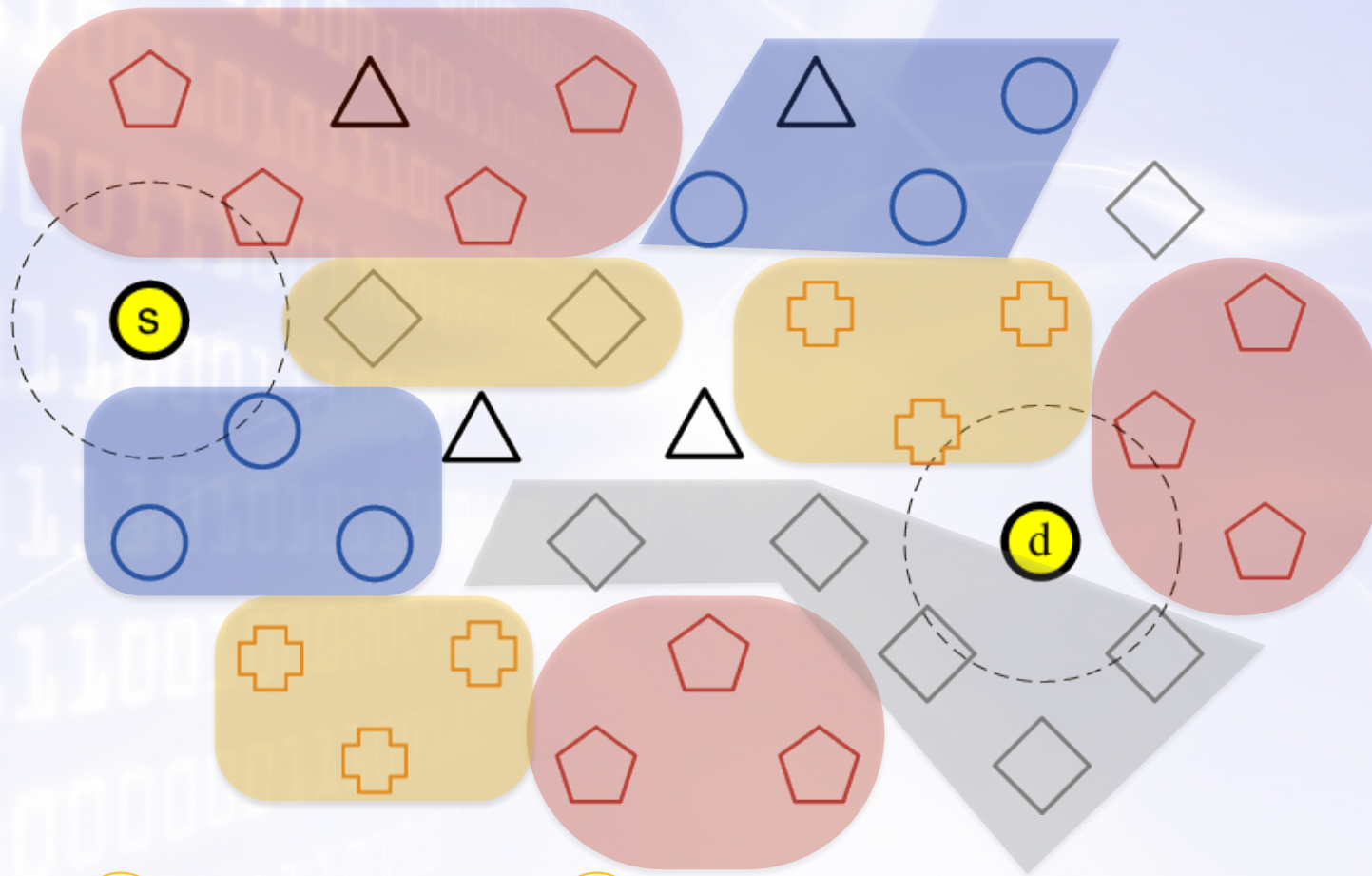
Best suitability


We know the location of **d**!!!!

$$\arccos\left(\frac{a^2 - b^2 - c^2}{-2bc}\right) \leq 90$$

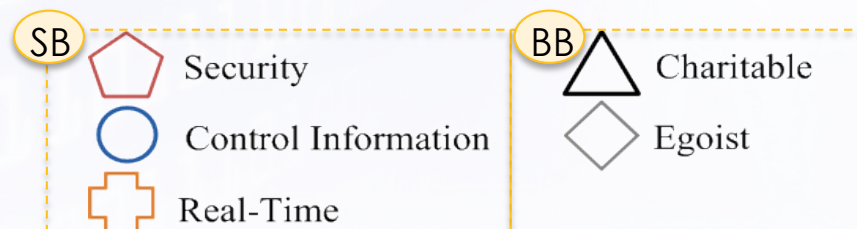
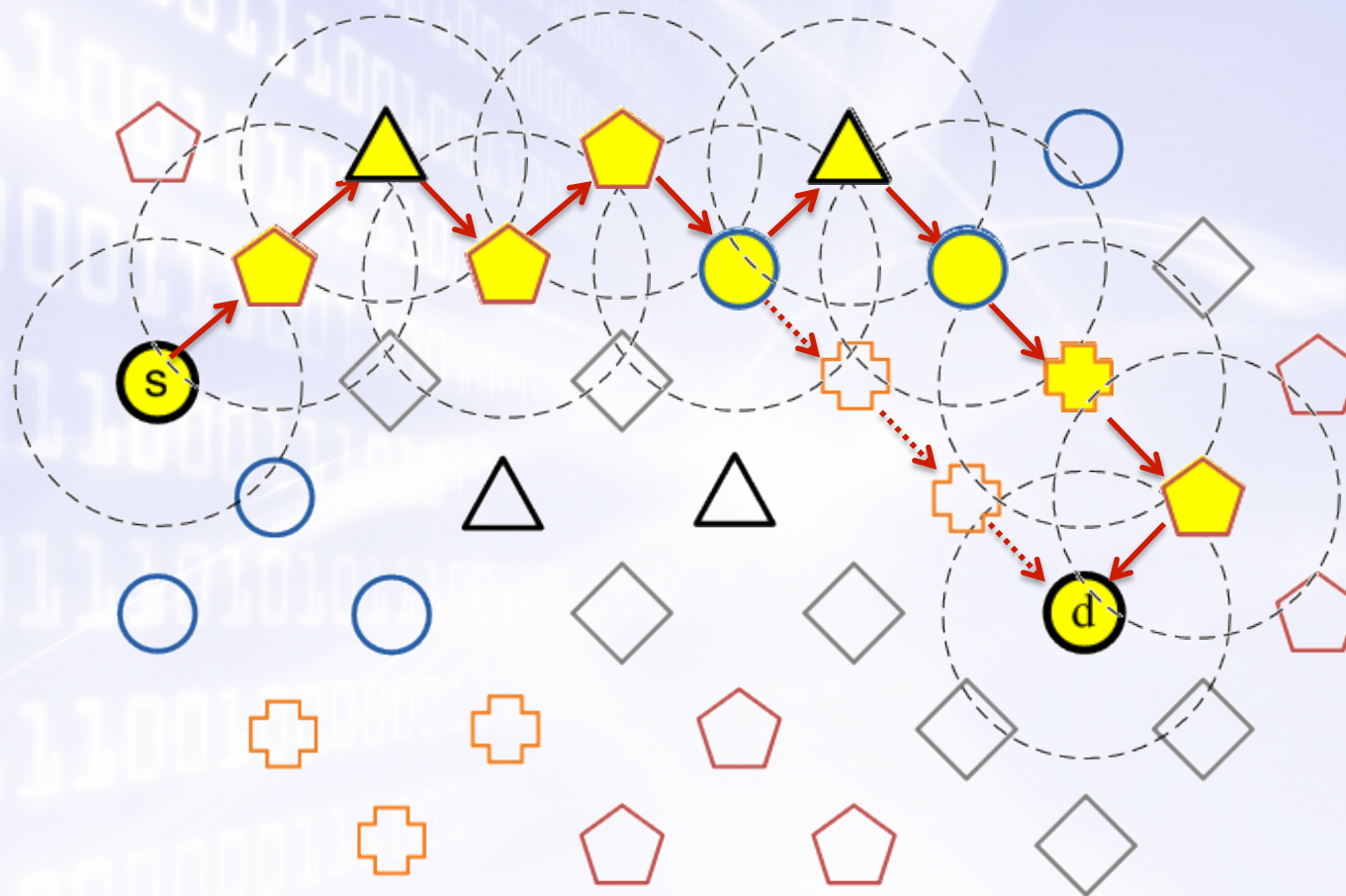
Direction

Example: sending security data



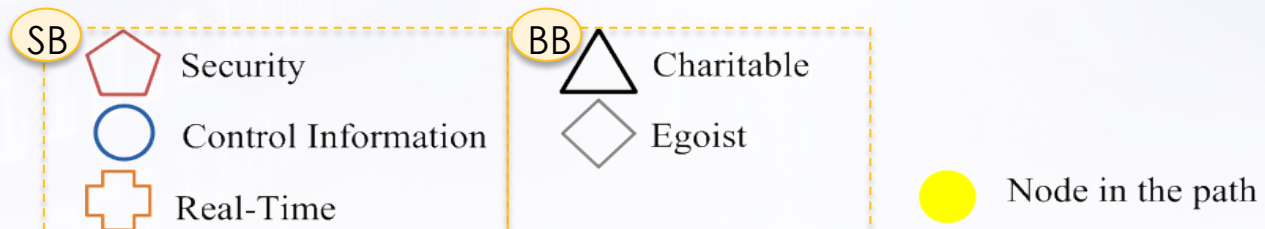
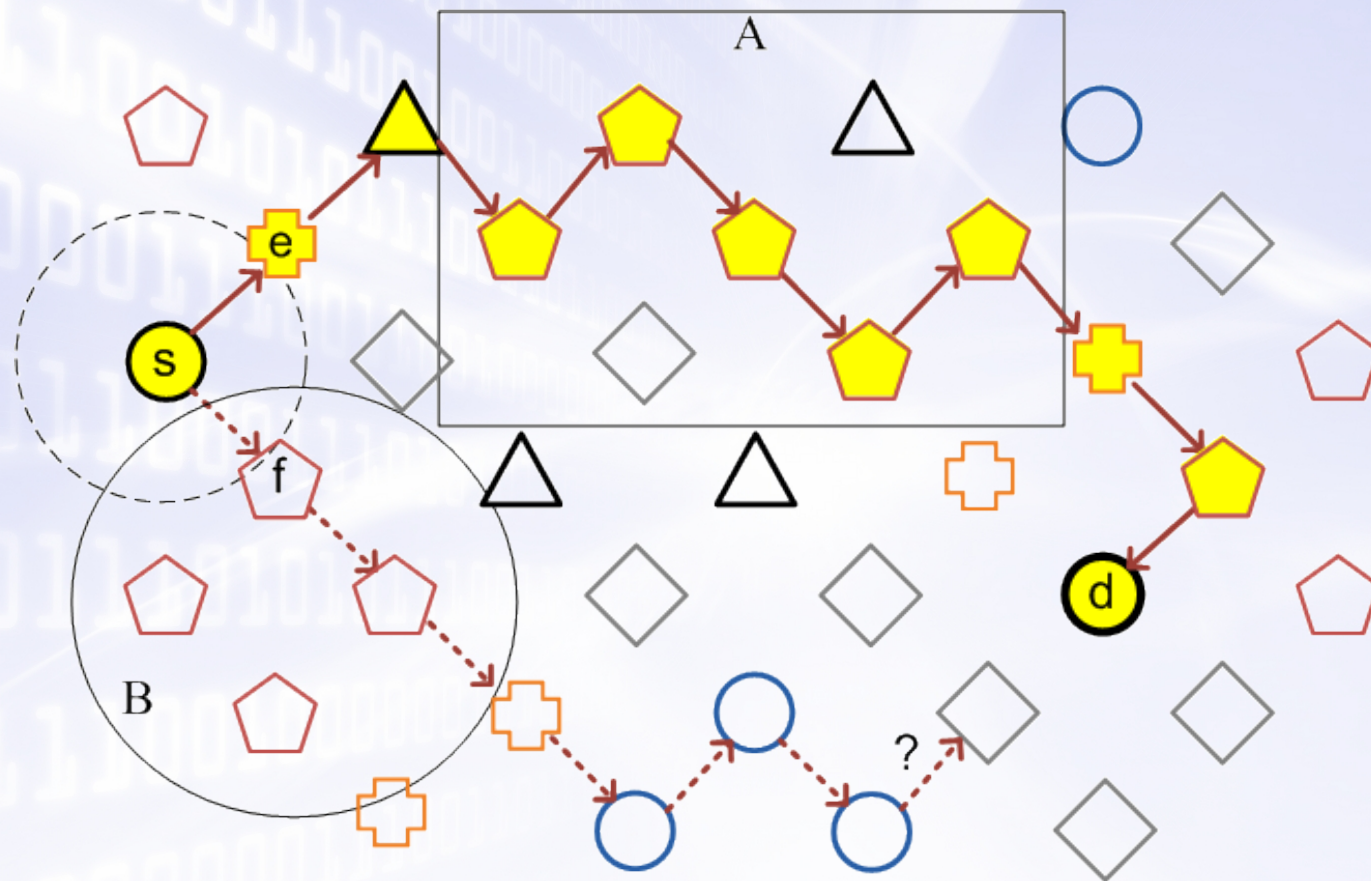
 Node in the path

Example: sending security data



Node in the path

Example: sending security data



Conclusions and Future Work

- We have introduced R2WSN, a routing protocol for heterogeneous WSN by using traffic classification and role-assignment
- R2WSN considers both: lifetime and QoS application preferences for data routing
- **Lifetime** is increased due to...
 - Role-assignment allows the node to declare itself “**Egoist**”
 - Role-assignment enables **implicit load balance mechanism**
- **QoS restrictions** are performed due to...
 - Traffic classification enables the node to classify the traffic according its **preferences**
 - (load balance mechanism)
- We provide an example to perform traffic classification and role-assignment by using **Bayesian Networks** following our approach