

# MEDAL: A coMpack Event

## Description and Analysis Language for Wireless Sensor Networks

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## The problem

- Event description
- Current approaches
  - SQL
  - Finite state machines
  - Event – Condition - Action rules



## Our approach

- Petri nets and event description
  - capture spatial and temporal information,
  - support collaborative decision making,
  - handle non-determinism,
  - do not suffer from state explosion,
  - provide a whole view of the system.
- Sensor network event description language



## MEDAL Petri net

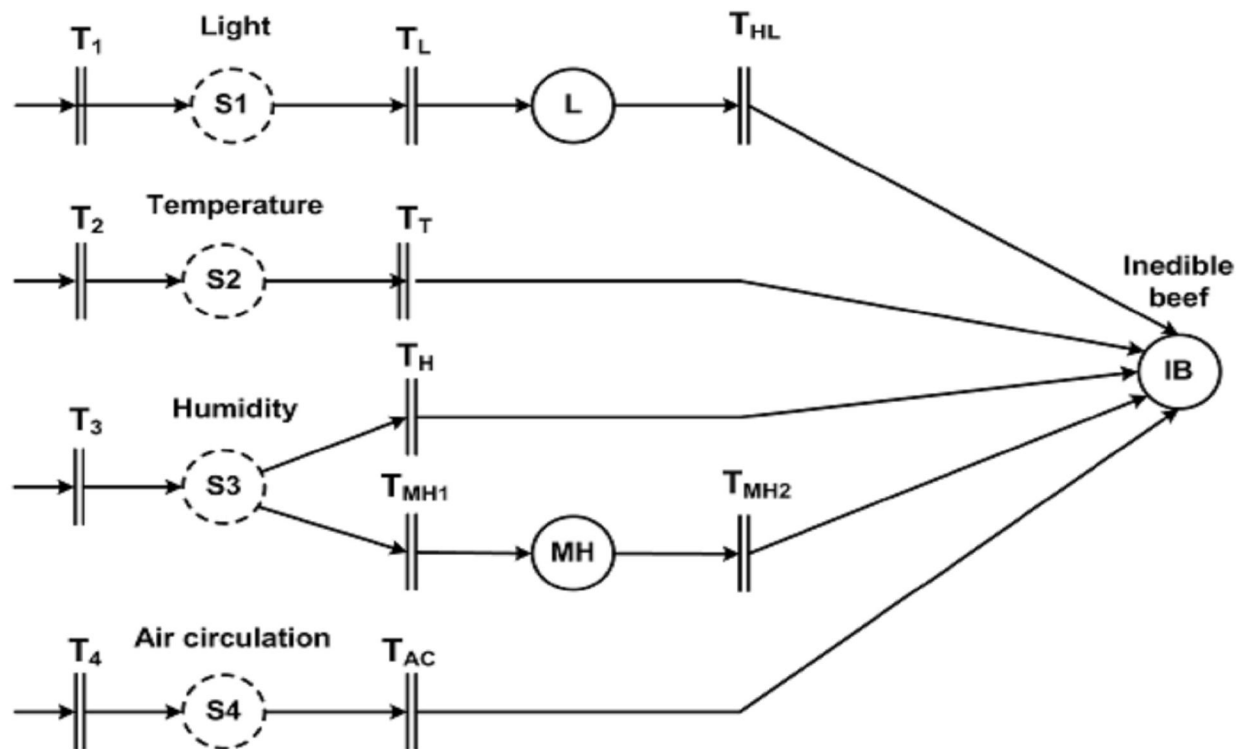
A 7-tuple structure:  $F = (P; T; A; \lambda; \beta; H; L)$ :

- $P$  : set of places,
- $T$  : set of all transitions,
- $A$  : set of arcs,
- $\lambda$  : probability/weight function for the arcs,
- $\beta$  : temporal guard function,
- $H$  : threshold function for places,
- $L$  is the spatial guard function for transition.



## An example

According to beef storage regulations meat should be stored in the dark, at temperature between  $1^{\circ}\text{C}$  and  $5^{\circ}\text{C}$ , with mean air speed - above  $0.5\text{ m/s}$ , and humidity-below  $95\%$  or, if the beef is stored for more than  $72\text{h}$ , below  $90\%$ .





## Modifying a MEDAL Petri net

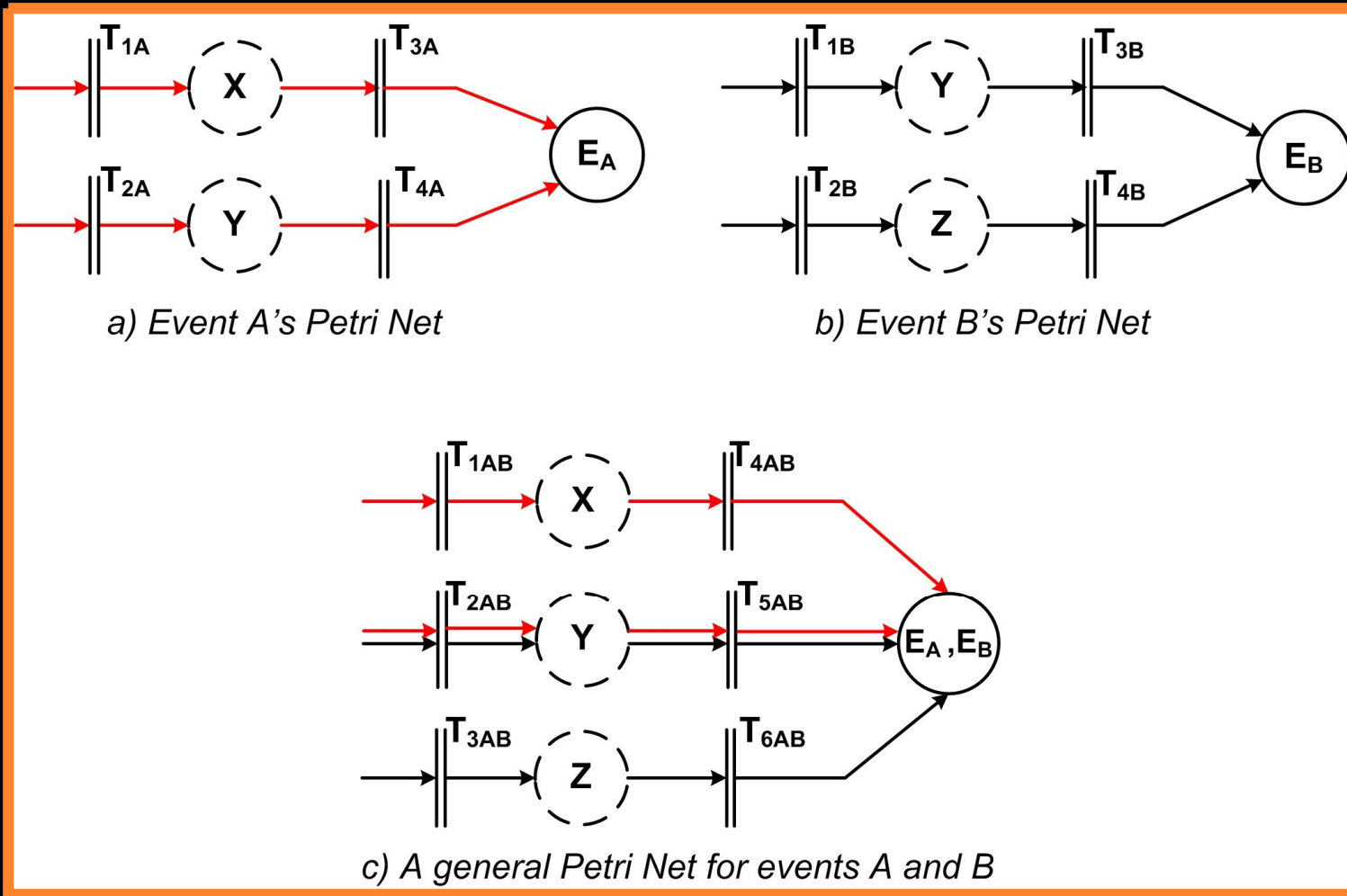
- Transitions have *bases* associated with them:

base = < event; transition; value; time >

b1 = < fire; T<sub>temperature</sub>; >70°C ; 20 seconds >



# Simultaneous detection of multiple events





## Conclusions

- MEDAL can model essential features of WSNs such as various sensor types, geographical location, temporal constraints, and probability of events
- MEDAL Petri nets can be used to monitor multiple events simultaneously:
  - decreases the computational, memory, and communication requirements of event detection.
- MEDAL can be used as an analysis tool for both system design purposes and system debugging purposes.



**Questions?**





## An example

```
INSERT INTO EventList Explosion (Event_ID, SubEvent_Set,  
    Spatial Resolution...)
```

```
VALUES (0001, SubEventSet...)
```

```
WHERE SubEventSet is
```

```
    SubEventSet= (Sound,
```

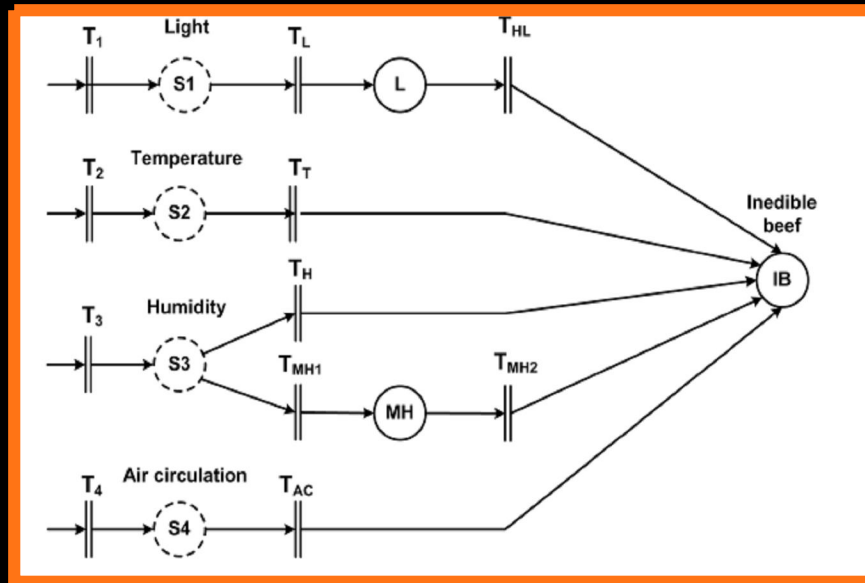
```
        Light,
```

```
        Temperature,
```

```
        Confidence Function:  $0.3 * \text{Sound} +$   
 $0.3 * \text{Temperature} + 0.4 * \text{Temperature} \geq 1 \dots$ )
```



# The bases in the beef monitoring example



Event	Transition	Value	Time period (hours)
Beef	$T_L$	yes	0
Beef	$T_{HL}$	yes	0.5
Beef	$T_T$	$< 1^\circ\text{C}$	0
Beef	$T_T$	$> 5^\circ\text{C}$	0
Beef	$T_H$	$> 95\%$	0
Beef	$T_{MH1}$	$> 90\%$	0
Beef	$T_{MH1}$	$< 95\%$	0
Beef	$T_{MH2}$	$> 90\%$	72
Beef	$T_{MH2}$	$< 95\%$	72
Beef	$T_{AC}$	$< 50 \text{ m/s}$	0



## Modifying a MEDAL Petri net

- DNA - describes the structure of the Petri net
- RNA - represents the token vector

They cannot be used to make small changes to the MEDAL Petri net