

Trade-off between Efficiency and Robustness

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Robert Hartung, 2018-11-04

Typical application

- Sense data
- Transmit/Receive data

Robust if

- ... all packets arrive at the sink within deadline
- ... all nodes are alive during lifetime of network

Efficient if

- ... there are few re-transmissions
- ... there are no collisions

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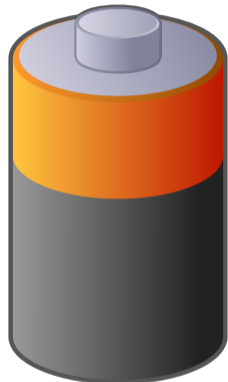
Efficient if

- ... there are few re-transmissions
- ... there are no collisions

BUT: We can either be robust or efficient

Challenge 1: Energy constrained

- Batteries
 - Lifetime estimation (before deployment)
 - State-of-Charge (SoC) estimation (after deployment)
- Energy Harvesting
 - Reliability / Predictability



Challenge 2: Environment's influence

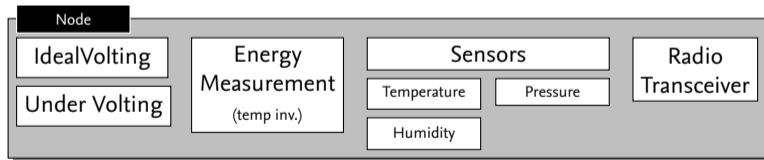
- Batteries
 - Temperature affects both
 - Available energy (voltage changes)
 - SoC estimation
- Energy Harvesting
 - Depends directly on environment, e.g. sun intensity
- Node
 - Communication (e.g. losing packets at higher temperatures)

Challenge 2: Environment's influence

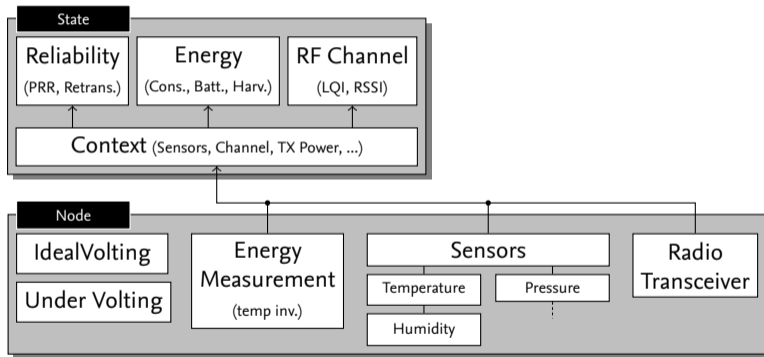
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Network performance depends on these challenges!

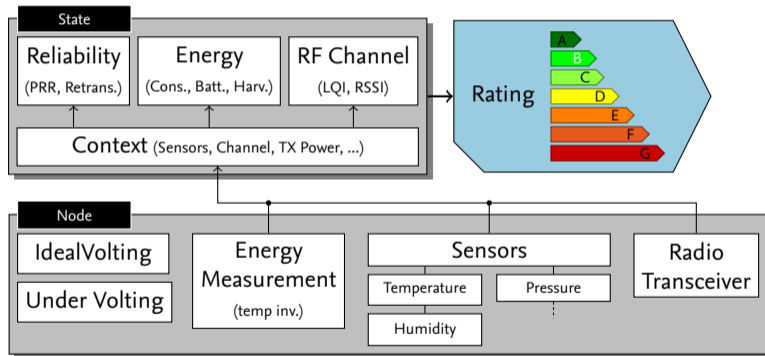
REAP: Robust and Efficient networks due to Adaption of Parameters



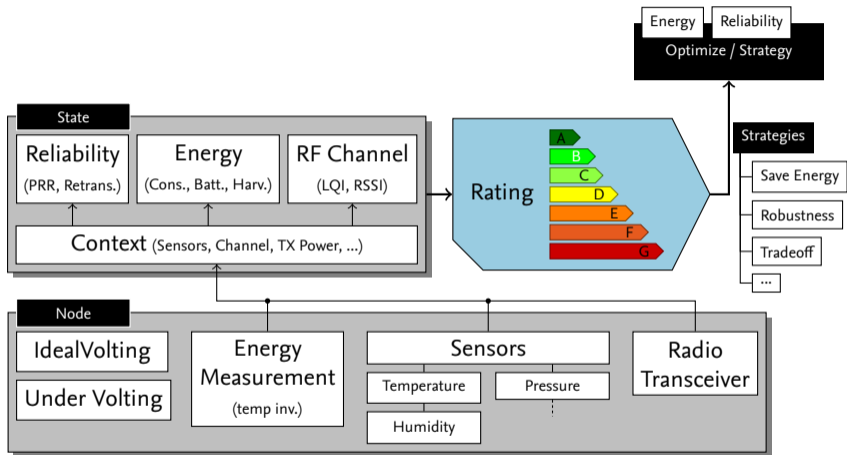
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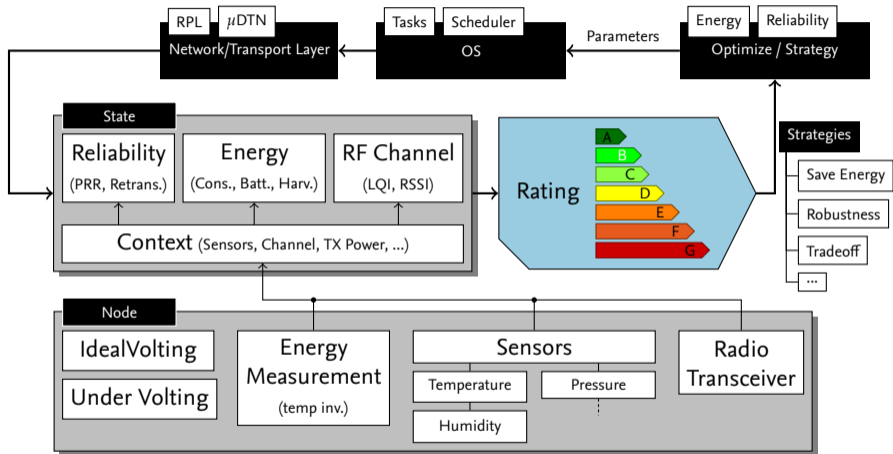
REAP: Robust and Efficient networks due to Adaption of Parameters



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REAP: Robust and Efficient networks due to Adaption of Parameters



Under Volting

- Run below specific operating voltage

IdealVolting¹

- Under Volting at higher temperatures
- Saves up to 30% of energy

¹IdealVolting – Reliable Undervolting on Wireless Sensor Nodes, Kulau et. al, ACM Transactions on Sensor Networks (TOSN), 2016

Model

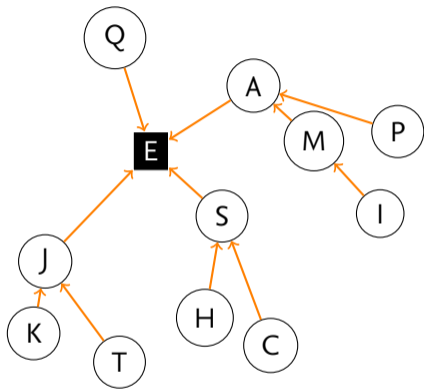
- Unique to each node
- Build model on node itself
 - Depends on many parameters
 - Constrained in size and computing power available
 - Additional energy

Rating

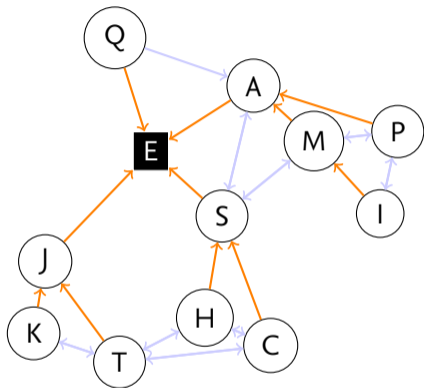
- Node rates itself in relation to other neighbors
- Different strategy depending on rating
 - Change duty cycle
 - Use alternative path
- Rating is be shared with neighbors

- Send data if deadline is too close (prefer robustness)
- Reduce sensing frequency if energy is low/critical (prefer efficiency)
- Delay sending packets to more suitable time slot (e.g. warmer)

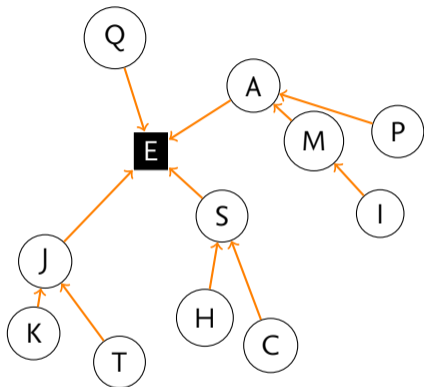
Routing



Routing



Routing



Develop a RPL OF that chooses parent node based on parameters / link rating

Conclusion

- Trade-off between efficiency and robustness:
- Depends on a lot of parameters, e.g.
 - Environmental influences
 - Energy source
 - Neighbors and network topology
 - Application