Energy Efficient Routing in Nomadic Networks

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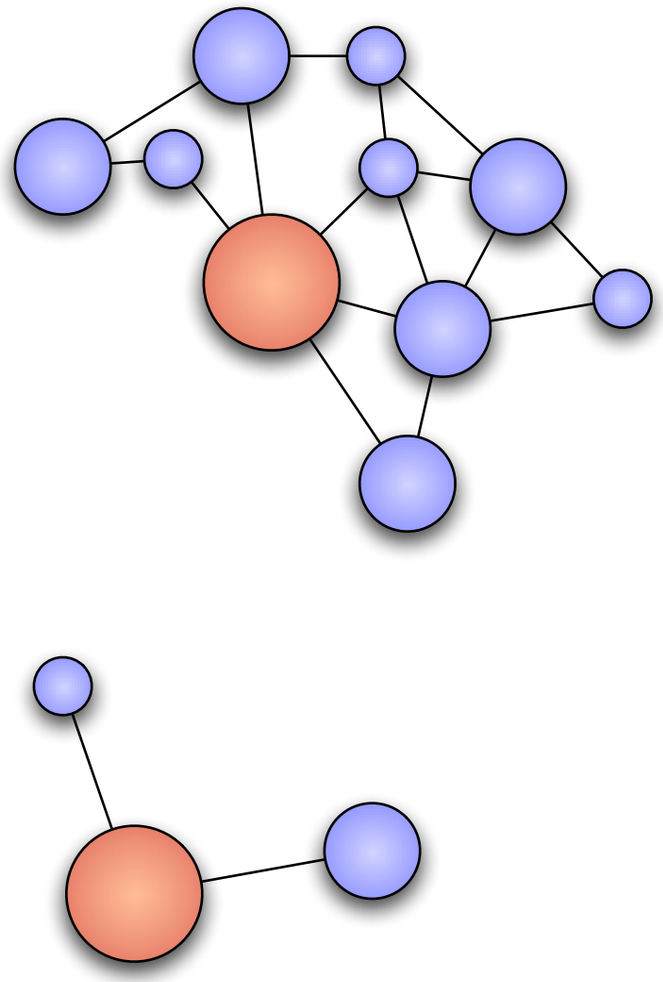
Abstract

- A novel combination of power-efficiency schemes (Span & BECA/AFECA).
- Specialization of the protocols to operate in the Nomadic Network setting.
- Simulations show that the combination is capable of energy savings of about 50%.
- Furthermore the specialization makes the protocols use between 12% and 18% less energy in the Nomadic Network setting.

Nomadic Networks

Consist of two types of nodes: *nomads*, which are small mobile devices (PDAs, laptops, mobile phones), and *oases*, which are larger more powerful devices (PCs).



Routing in Nomadic Networks

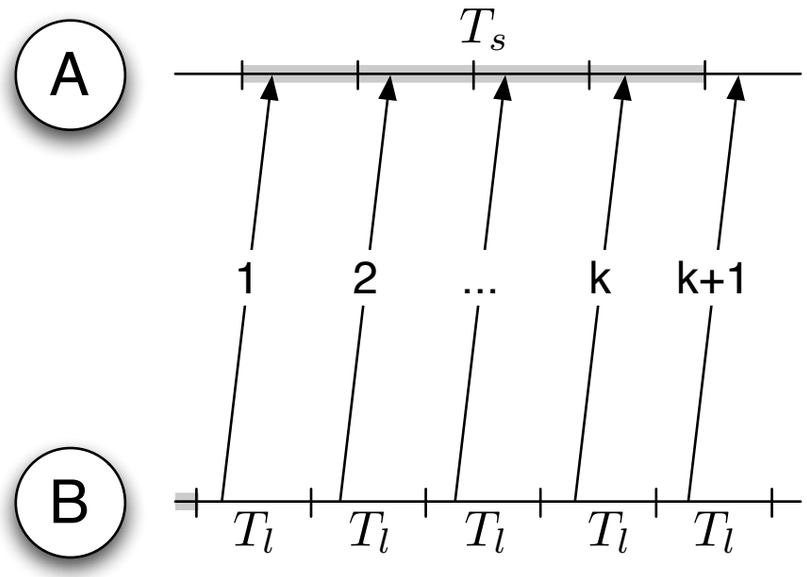
- Most energy efficient routing protocols assume that all nodes are battery powered.
- This is not the case in the nomadic network setting.
- How will the energy efficient protocols perform in this scenario? Is specialization needed?

BECA/AFECA

(Xu et al.)

A power-save approach based on re-transmissions and timing information.

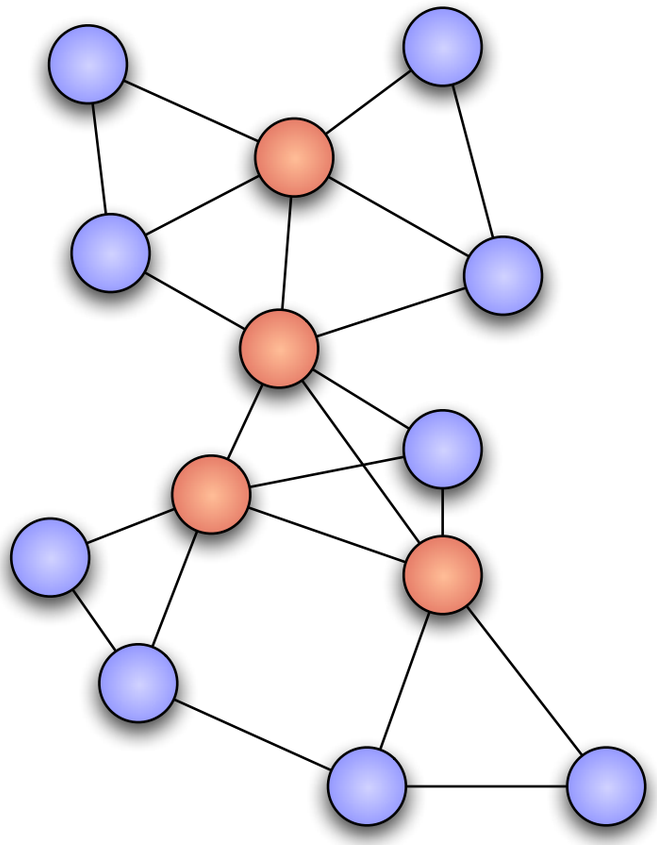
$T_l =$ listen time
$T_s =$ sleep time
$T_s = k \times T_l$



Span (Chen et al.)

Distributed computation of a connected dominating set of coordinator nodes.

Calculations are based on information about two-hop neighbors.



back-off delay = $$\left(\left(1-\frac{E_r}{E_m}\right)+\left(1-\frac{C_i}{\binom{N_i}{2}}\right)+R\right)\times N_i \times T$$

Why choose Span and BECA/AFECA?

- Because of its coordinator selection scheme Span seemed likely to perform well in the nomadic setting.
- ... but Span in itself does not save energy – this is done by the IEEE 802.11 AHPSM.
- AFECA seemed more adept at preserving power than the AHPSM – furthermore AFECA could be optimized by using Span.

AFECA optimizations

- AFECA is based on retransmissions.
- When Span is utilized no retransmissions are needed between coordinator nodes.
  - ... since coordinator nodes do all the routing this means that retransmissions are only needed at the edges of the communication.
- The ratio between T_l and T_s can be larger when Span is in play.

Nomadic version of the protocols

- All protocols were based on the AODV routing protocol.
- In the nomadic version oases were forced into being coordinator nodes.

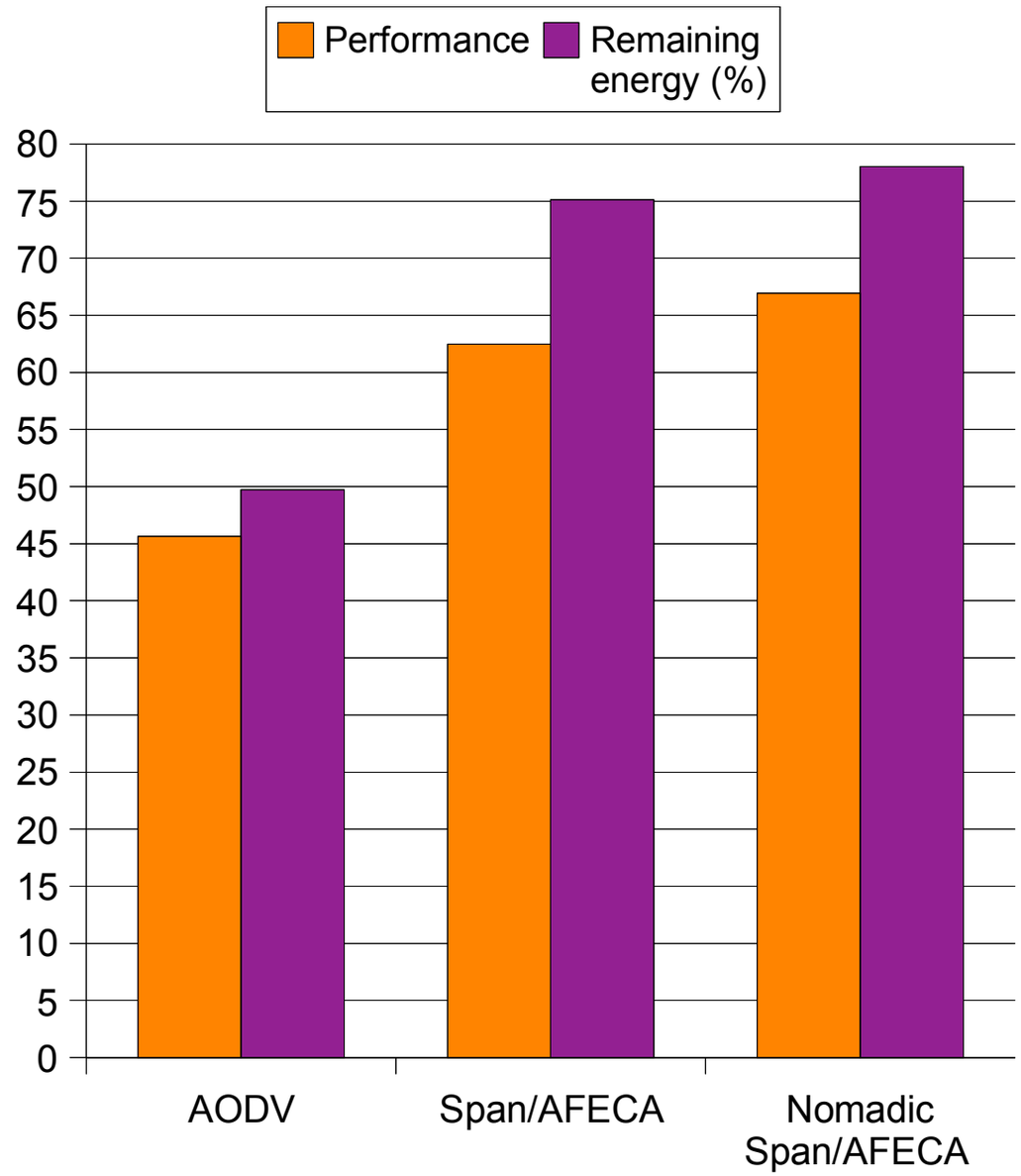
Simulations

- Simulations were done in high (~10 neighbors) and low (~5 neighbors) node densities.
- Nodes move by a random way-point model.
- For more details see the paper...
- A "performance" measure was introduced that takes both energy usage and delivery ratio into consideration.

$$\text{performance} = E_{remain} \times D_{ratio}$$

Results

- ~50% energy is saved when using energy efficient protocols.
- The nomadic version uses ~12% less energy than the non-nomadic one.
- Performance measures are higher for the energy efficient protocols.
- ... but still show that the delivery ratio drops when an energy efficient protocol is used.



Conclusions

- It is certainly worthwhile using an energy efficient routing protocol (improvements >50%).
- Using Span and BECA/AFECA together yields some good results – they complement each other well.
- Forcing oases into the coordinator role yields a better performance (improvements of 12% to 18%).

Future work...

- Experiment with Spans coordinator election scheme to make it perform better in the Nomadic Network setting.
  - The coordinator selection scheme could be altered to place *more* importance on energy (and less on connectivity?)
- Benchmark Span/AFECA against Span/IEEE 802.11 AHPSM.