# Energy-Scalable Algorithms and Protocols for Wireless Microsensor Networks

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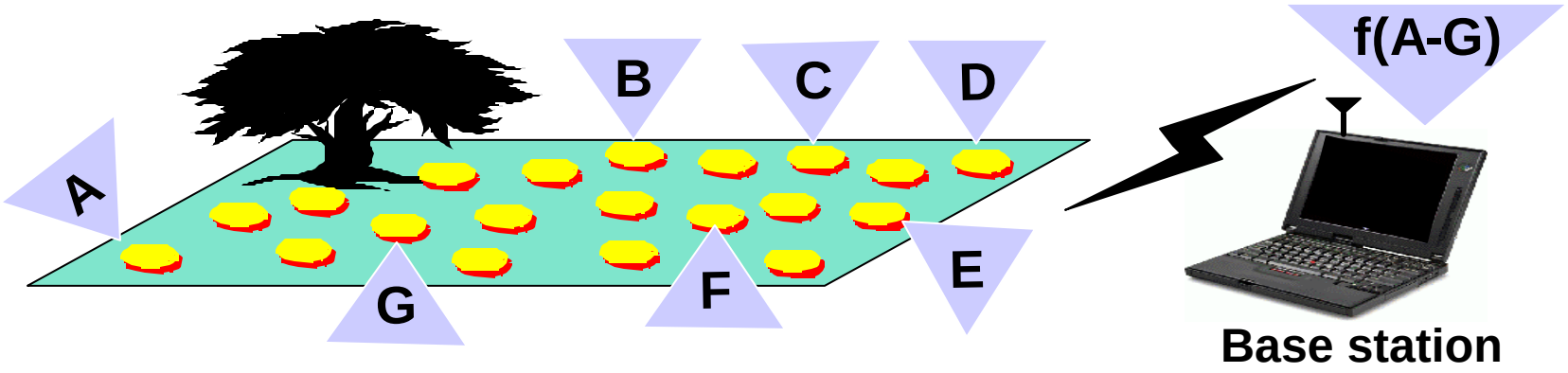
# Microsensor Networks




- Remote monitoring of the environment
- Relevant parameters:
  - System lifetime (energy efficiency)
  - Quality

**Energy-scalability: trade-off quality for energy**

# The MIT mAMPS Project

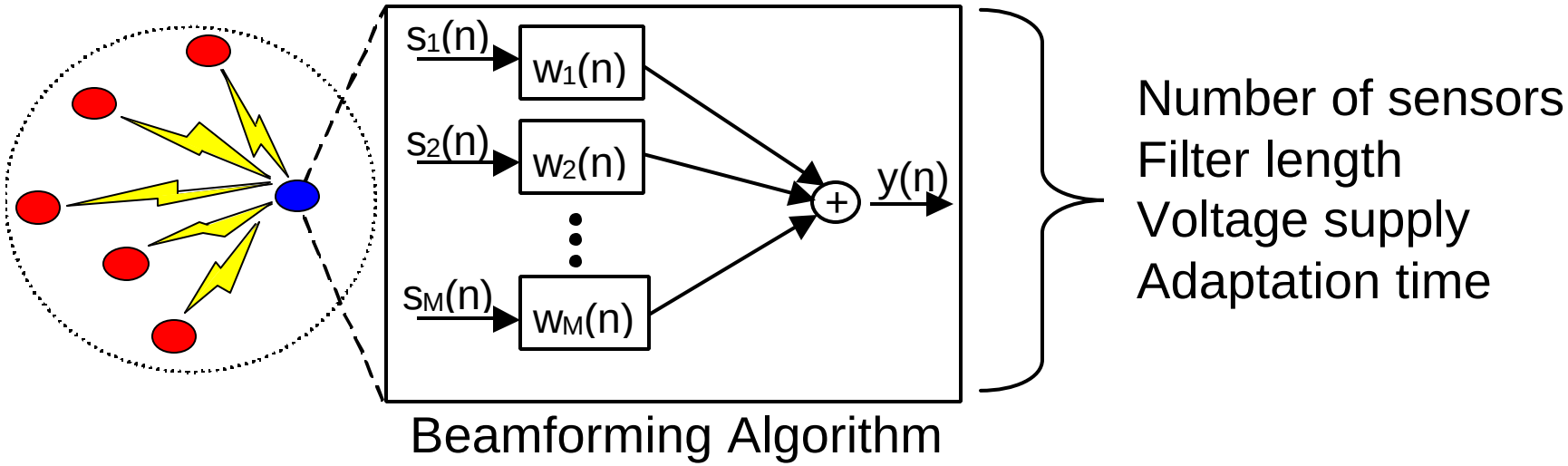
- **Time-varying resources/requirements**
- **Develop power-aware solutions**

| | |
|---|---|
| Node architecture | Variable bit-precision ALUs<br>Dynamic voltage scaling (DVS) |
| Algorithms | Algorithmic transformations<br>Variable filter length |
| Protocols | Data negotiation<br>Node shut-down |

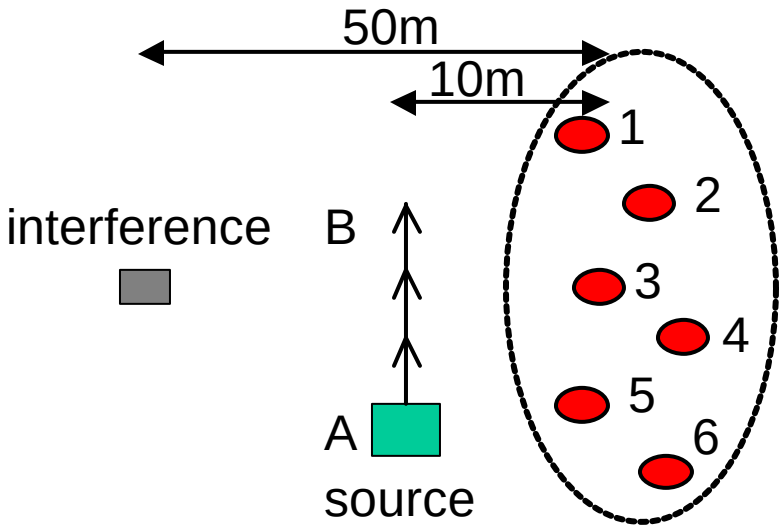
- **Develop energy models for computation and communication**

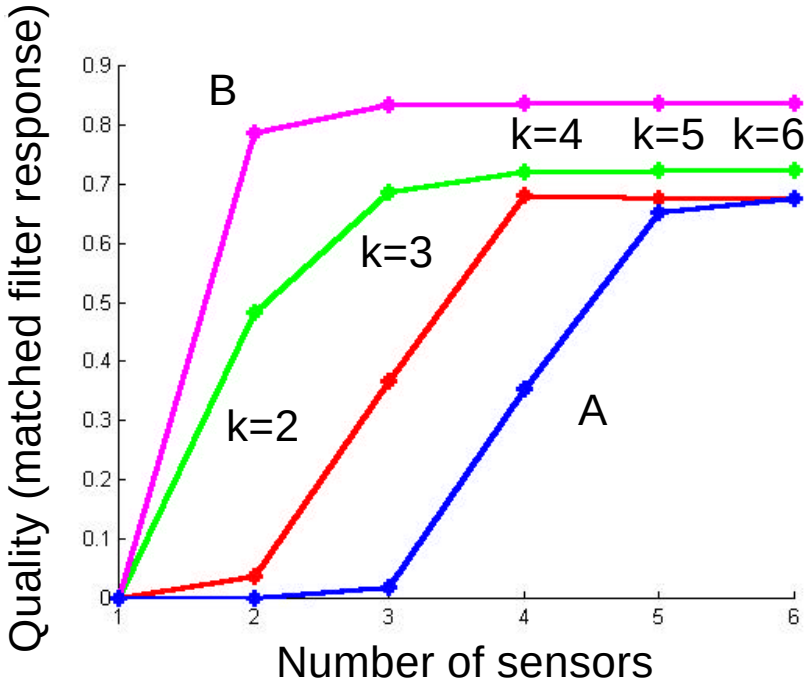
# Energy-Quality (E-Q) Scalability

- **Why is this needed?**
  - **Adapt to end-user requirements**
  - **Want energy efficiency for range of quality**
- **Must determine flexible parameters**



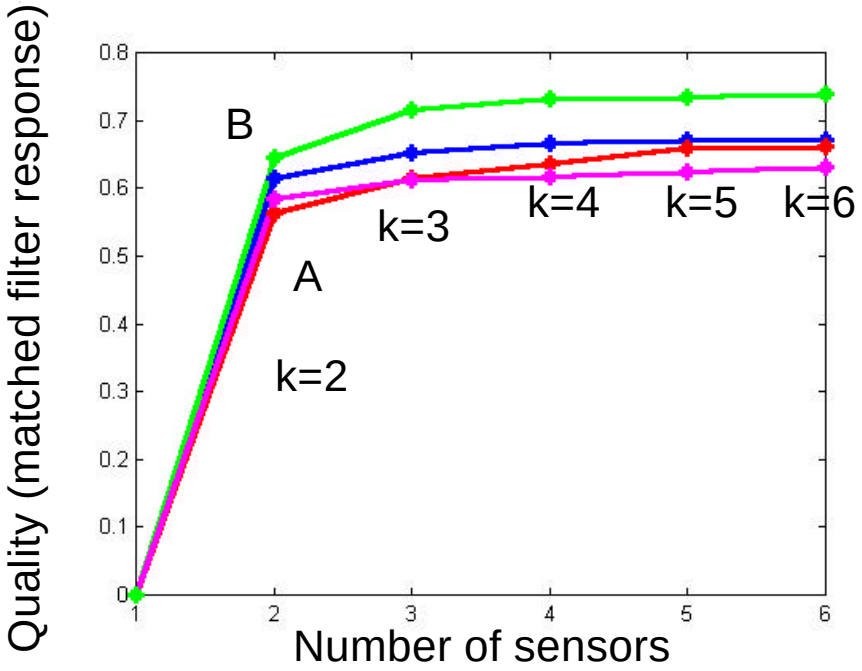
# E-Q Performance of Beamforming



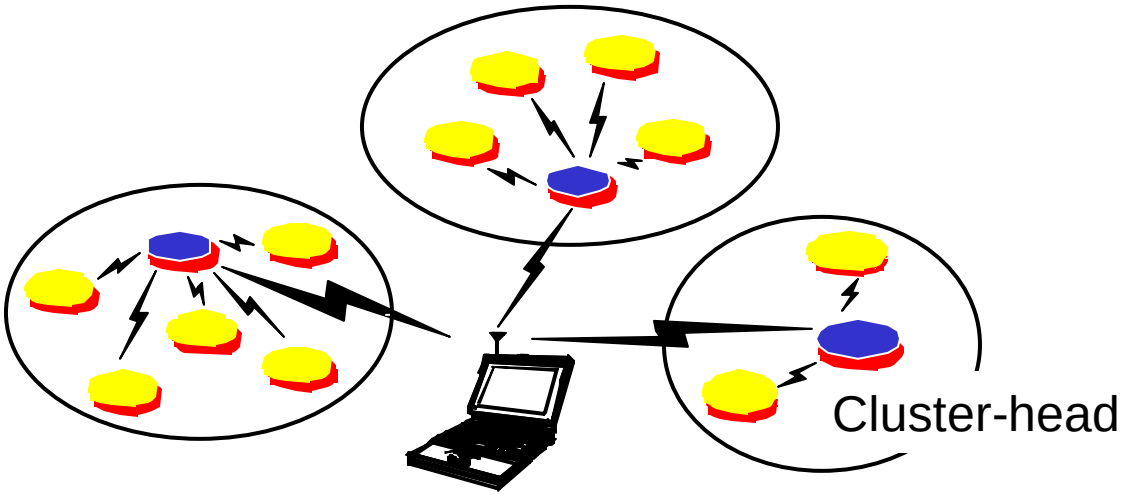

- **Scale number of sensors used for beamforming**
  - **Use preset order <1,2,3,4,5,6>**
  - **Determine quality as source moves from A → B**
  - **E-Q performance depends on source location**

# Algorithmic Transformation



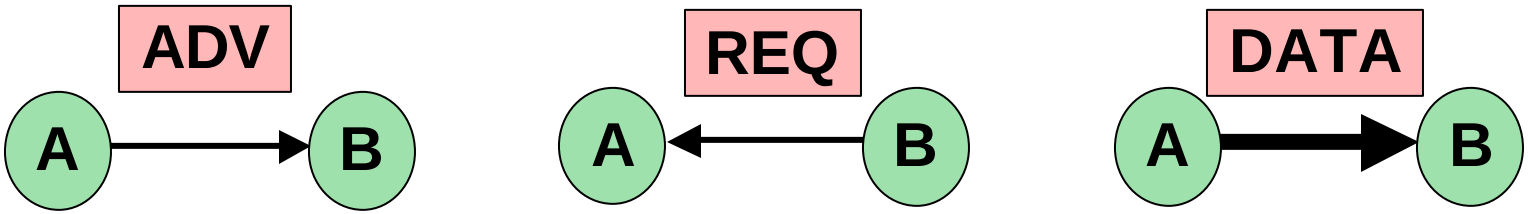

- **Initial pre-processing improves performance**
  - **Most significant first transform**
  - **Determine signals with large SNR**
  - **Use quick-sort algorithm to obtain order**
- **Requires low overhead transformation**

# LEACH Protocol Architecture



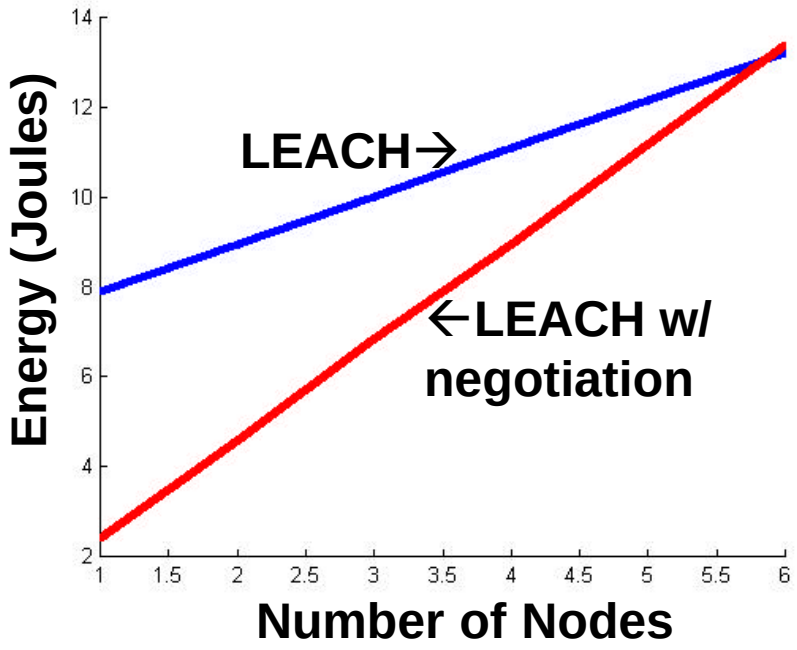

- Low-Energy Adaptive Clustering Hierarchy
  - Adaptive, self-configuring cluster formation
  - Application-specific data aggregation
    - Cluster-head node beamforms signals
    - Aggregate signal sent to base station

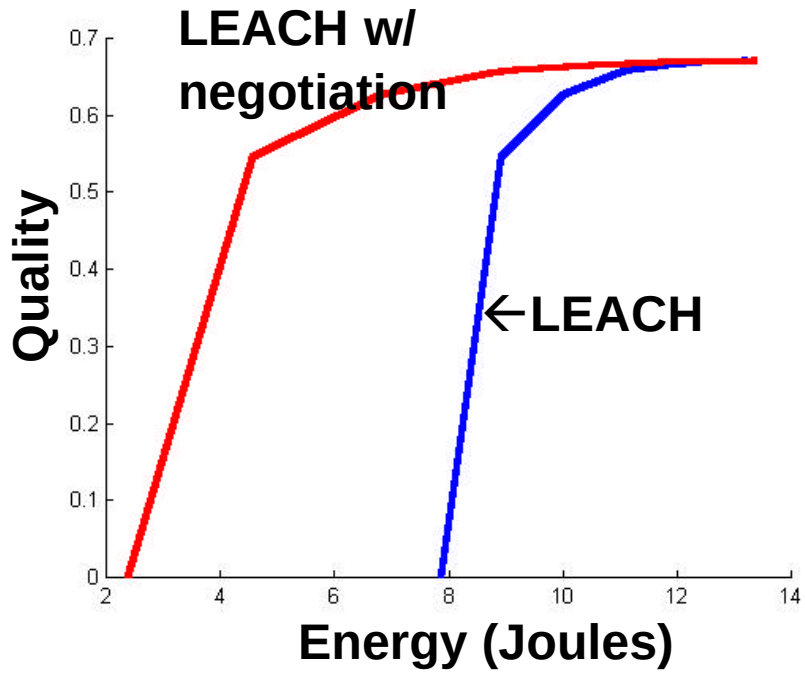
# Data Negotiation




- **LEACH extensions improve E-Q scalability**
  - **Use high-level negotiation (e.g., SPIN protocol)**
  - **Meta-data reduces unnecessary data transfers**
- **Data aggregation with variable number nodes**
  - **Nodes send signal energy (ADV)**
  - **Cluster-head requests data from *k* nodes (REQ)**
  - **Nodes send data (DATA)**

# LEACH with Negotiation




- Negotiation saves up to 70% energy
- LEACH with negotiation better E-Q curve

# Summary

- Energy-quality scalability important
  - Time-varying resources
  - Want highest quality for all energy points
- Need accurate energy models
- Improve E-Q scalability via
  - Algorithmic transformation
  - Protocol extensions
- Provides end-user flexibility