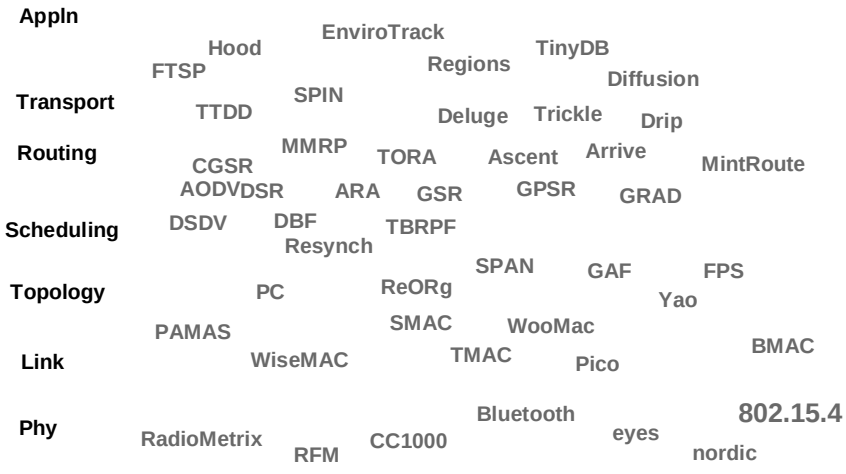
CS 268: Lecture 24 Sensor Network Architecture (SNA)

Ion Stoica
Computer Science Division
Department of Electrical Engineering and Computer Sciences
University of California, Berkeley
Berkeley, CA 94720-1776

1

Sensor Network Protocols Today

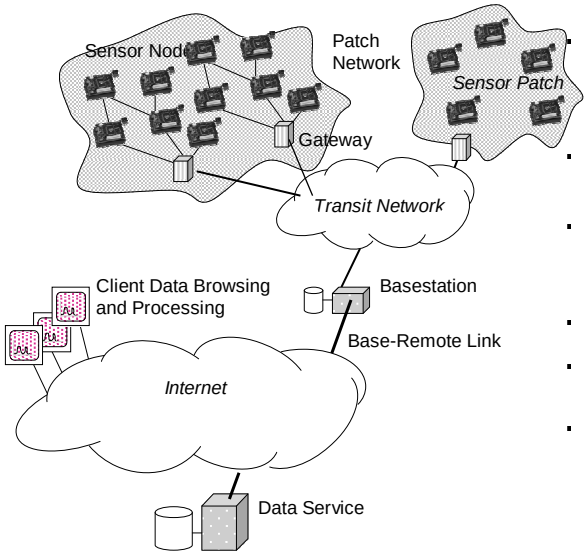
Obligatory David Culler Slide…



What if I want to use any two protocols together??

2

Network Model



- Dense patches of sensing nodes
  - Many resource constrained
  - Non-homogeneous
  - Modalities, roles, HW, SW
  - Power, BW
- Transit tier
  - Often specialized wireless
  - Provides gateways
- Internet Tier
  - Multiple connections to infra
  - Deep storage, proc. Viz
- SNA should not *require* unconstrained nodes
- Should utilize unconstrained nodes to reduce burden on constrained ones
- Mobility within physically embedded context

3

What is an Architecture?

- Architecture is how to "organize" implementations
  - What interfaces are supported
  - Where functionality is implemented
- Architecture is the modular design of the network
- Architecture is not the implementation itself

4

Internet vs Sensor Nets

Internet goals
- Interconnect separate networks
- Resilience to loss and failure
- Support many comm. services
- Accommodate variety
- Distributed management
- Cost effective
- Low effort attachment
- Resource accountability
- Network Architecture

Sensor Nets
- Resource efficiency
- Data centric design
- Deal with intermittent connectivity
- Self-managed
- Observation, monitoring of various environments
- Cost effective
- Scalability

5

Internet vs Sensor Nets

Internet goals
- Interconnect separate networks
- Resilience to loss and failure
- Support many comm. services
- Accommodate variety
- Distributed management
- Cost effective
- Low effort attachment
- Resource accountability
- Network Architecture

Sensor Nets
- Dense real world monitoring
- Resilience to loss, failure and noise
- Support many applications
- Scale to large, small, long
- Cost effective
- Evolvable in resources
- Composable
- Security

6

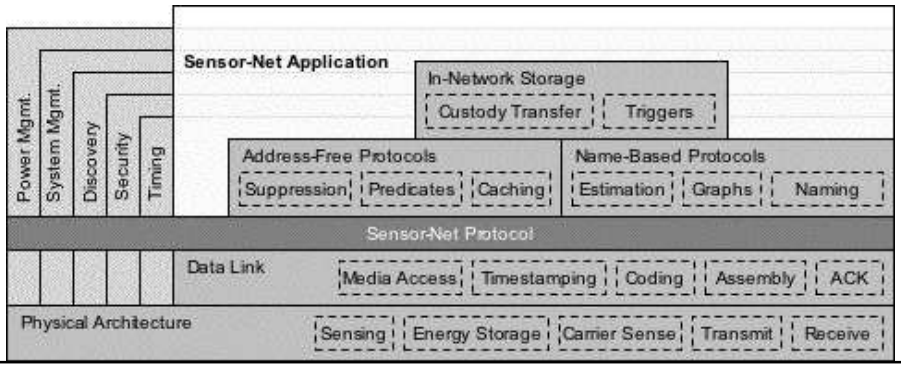
Why not IP?

- One or very few applications running on a sensornet vs huge number running in the Internet
- Large variety of traffic patterns (most *not* point-to-point):
  - Any-to-any, many-to-one, many-to-few, one-to-many
  - Inneficient to impl. these patterns over point-to-point
- IP does not address (well):
  - Resource and energy constraints
  - Unattended operation
  - Intermittent connectivity
  - Space embeded nodes
  - ...

7

A Sensor Network Architecture (SNA)

- Narrow waist: Sensornets Protocol (SP)
  - Goals: *generality* and *efficiency*
  - Position: between data-link and network layers
  - Service: best-effort, single hop
  - Common to both single- vs multiple-hop deployments



Properties of SP

- SP provides ***mechanisms*** for network protocols to operate
  - Network protocols may introduce ***policy***
- Three key elements of SP:
  - Data Reception
  - Data Transmission
  - Neighbor Management

9

Collaborative Interface

- Control
  - Reliability Best effort to transmit the msg
  - Urgency Priority mechanism
- Feedback
  - Congestion Was the channel busy?
    - Should I slow down?
  - Phase Was there a better time to send?
    - Decouple appl sampling from communication

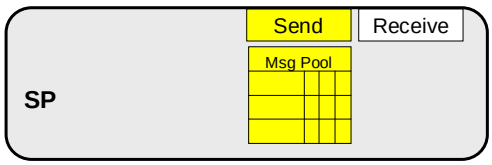
10

Message Reception

- Message arrives from link
- SP dispatches
- Network protocols establish
  - naming/addressing
  - filtering

11

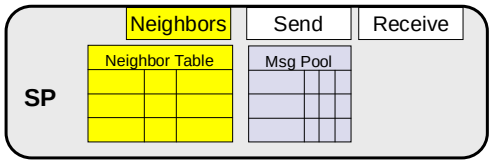
Message Transmission



- Messages placed in shared *message pool*
  - All entries are a promise to send a packet in the future
- Messages include
  - Pointer to first packet and # of packets
  - Control information: reliability and urgency
  - Feedback information: congestion and phase

12

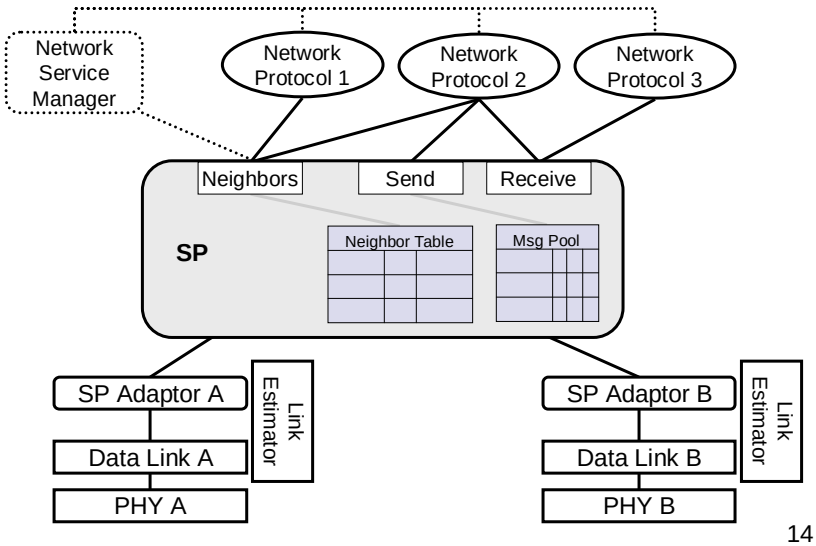
Neighbor Management



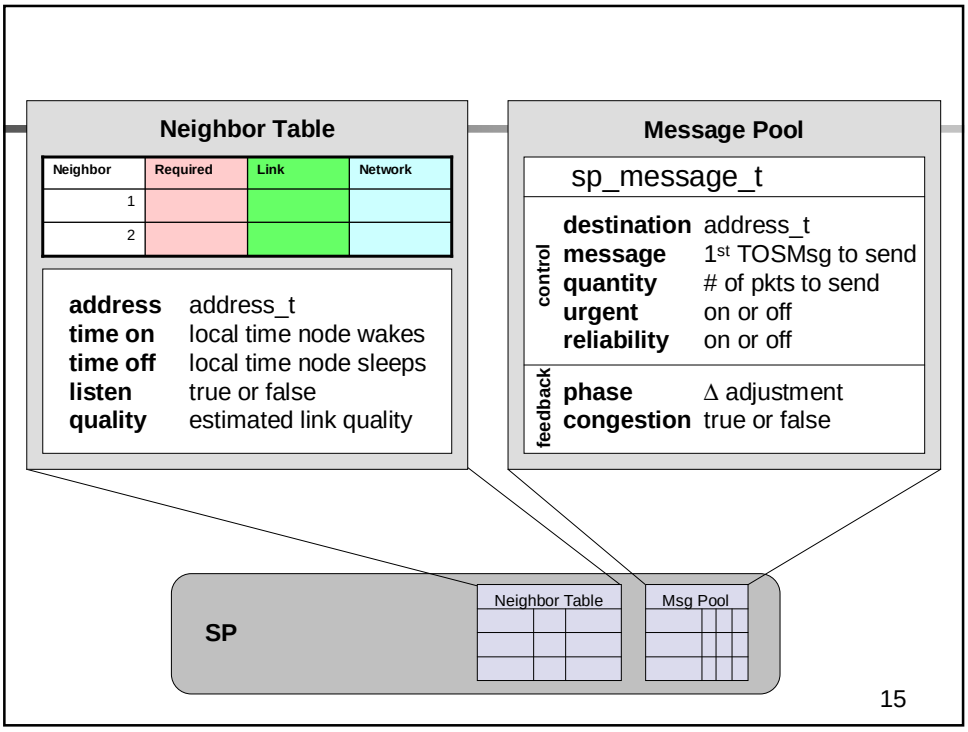
- SP provides a shared *neighbor table*
  - Cooperatively managed
  - SP mediates interaction using table
    - No policy on admission/eviction by SP
    - Scheduling information

13

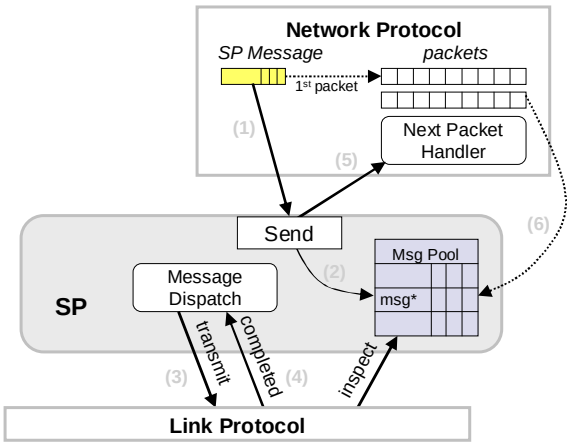
SP Architecture



14



SP Message Futures



1) Submit an SP Message for Transmission
2) Message added to message pool
3) SP requests the link transmit the 1st packet
4) Link tells SP the transmission completed
5) SP asks protocol for next packet
6) Protocol updates packet entry in message pool

16

What SP Isn't

- SP does not dictate any header fields
  - Messages are opaque to SP
- Instead, rely on abstract data types
  - Can query for address, length, etc
- No explicit security mechanism
  - Message content opaque to SP
  - Link, Network, and App security can be built transparently to SP

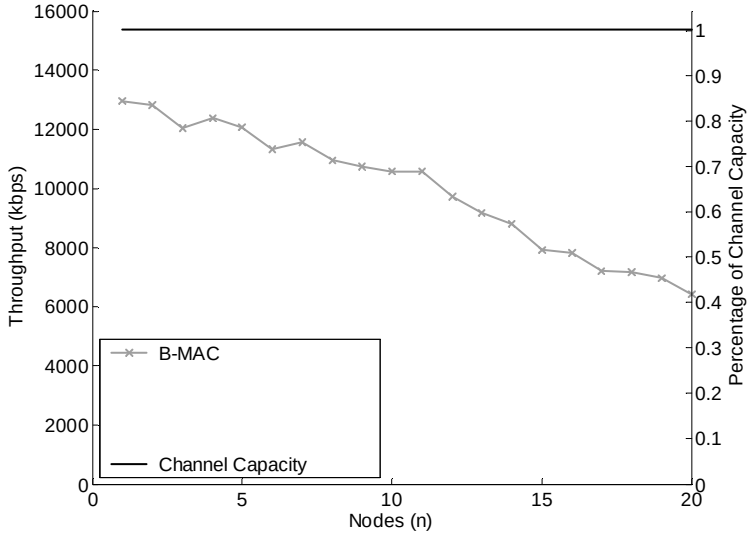
17

Benchmarks

- Minimal performance reduction in single hop
  - Compare to B-MAC paper
  - Compare to IEEE 802.15.4
- Simpler multihop/network protocol code
- Power consumption
- Network protocol co-existence

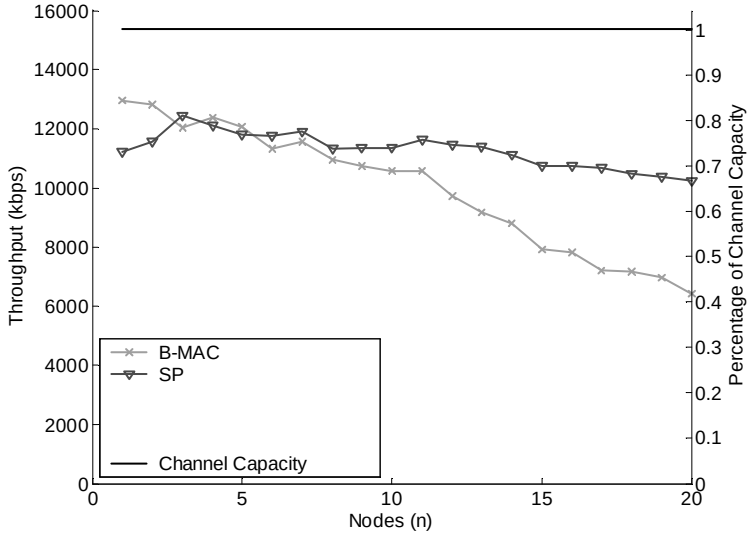
18

Results: mica2 Throughput



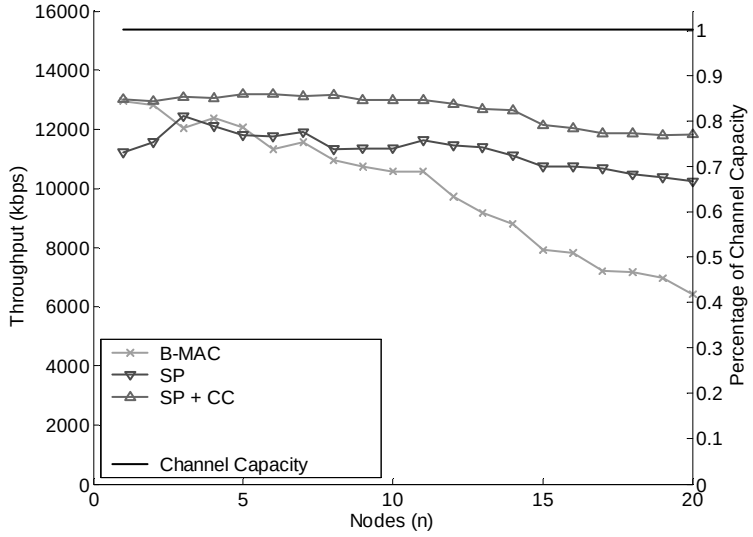
19

Results: mica2 Throughput



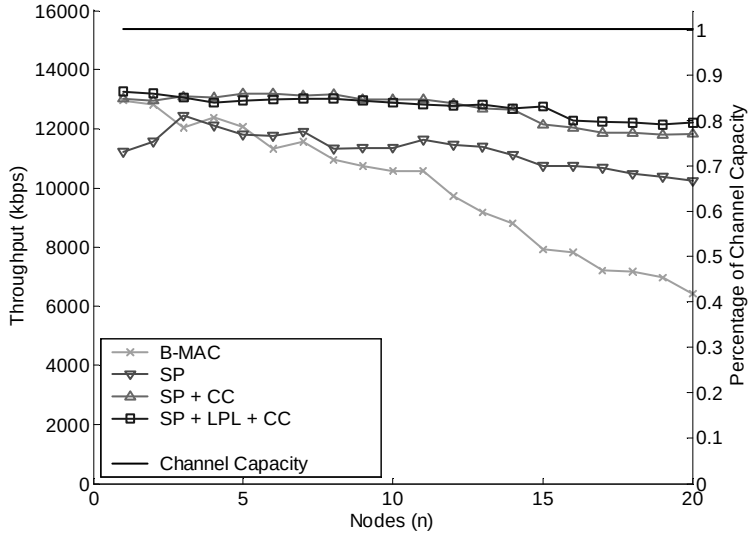
20

Results: mica2 Throughput



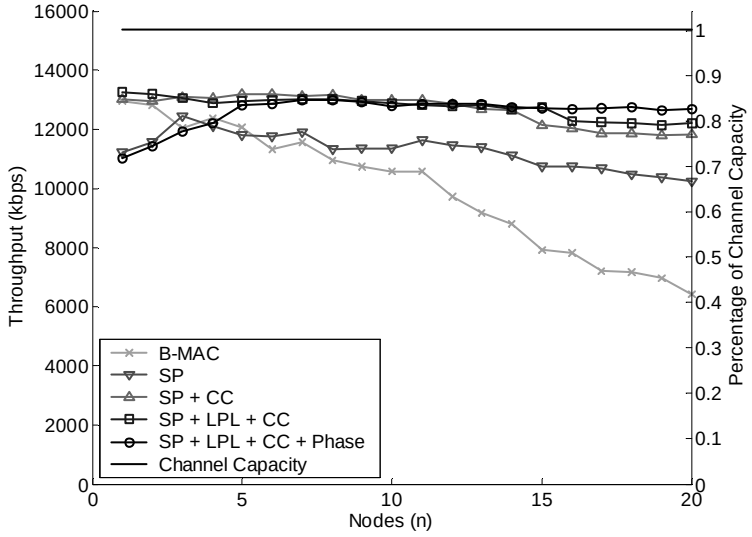
21

Results: mica2 Throughput



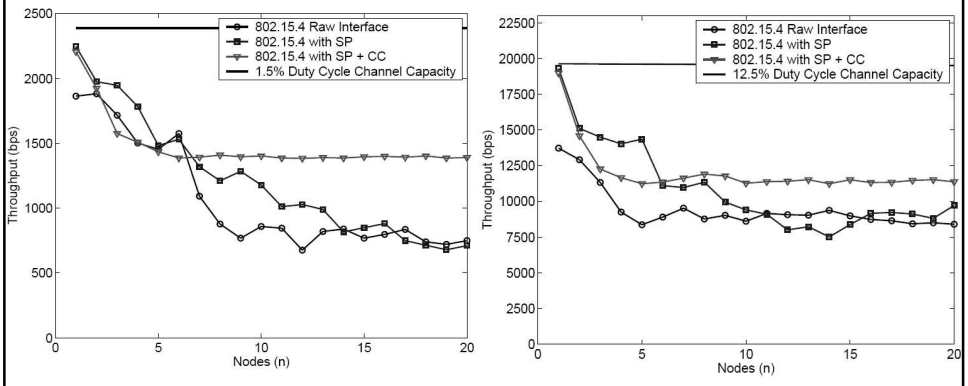
22

Results: mica2 Throughput



23

Results: Single Hop Benchmarks (802.15.4)



24

Conclusion

- SNA: provide context for sharing our community work and accelerate the development and deployment of sensornet applications
- Effective link abstraction, **SP**, allows network protocols to run efficiently on varying power management schemes

25