

CS 268: Lecture 24 Sensor Network Architecture (SNA)

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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

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Sensor Network Protocols Today

Obligatory David Culler Slide...

Appin	Hood	EnviroTrack	TinyDB
Transport	FTSP	Regions	Diffusion
Routing	TTDD	SPIN	Deluge
Scheduling	CGSR	MMRP	TORA
Topology	AODVDSR	ARA	GSR
Link	DSDV	DBF	TBRPF
Phy	PAMAS	WiseMAC	TMAC
	PC	ReORg	SPAN
	GAF	FPS	Yao
	SMAC	WooMac	Pico
	Bluetooth	eyes	802.15.4
	RadioMetrix	RFM	CC1000
			nordic

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

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Internet vs Sensor Nets

Internet goals

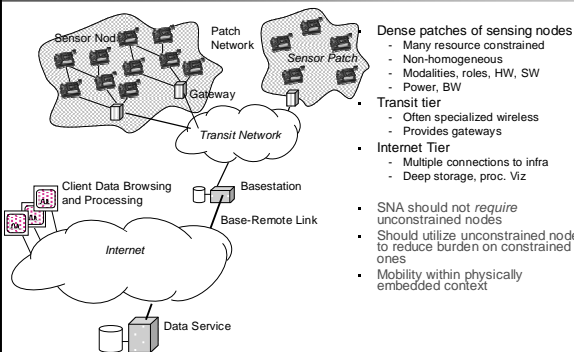
- Interconnect separate networks
- Resilience to loss and failure
- Support many comm. services
- Accommodate variety
- Distributed management
- Cost effective
- Low effort attachment
- Resource accountability
- Network Architecture

Sensor Nets

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

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Network Model



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Internet vs Sensor Nets

Internet goals

- Interconnect separate networks
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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

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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
 - Inefficient to impl. these patterns over point-to-point
- IP does not address (well):
 - Resource and energy constraints
 - Unattended operation
 - Intermittent connectivity
 - Space embedded nodes
 - ...

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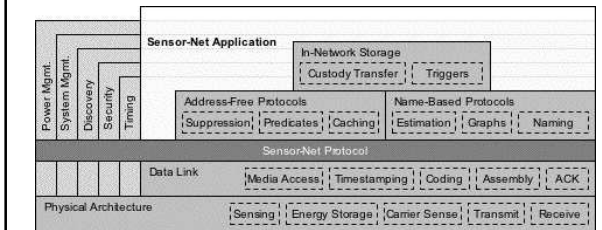
Collaborative Interface

- 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

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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



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Message Reception



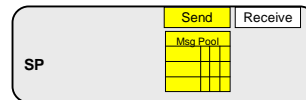
- Message arrives from link
- SP dispatches
- Network protocols establish
 - naming/addressing
 - filtering

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

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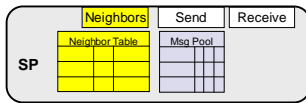
Message Transmission



- 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

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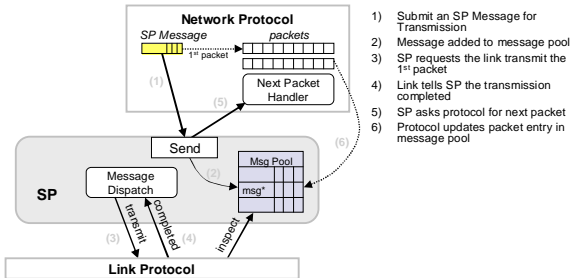
Neighbor Management



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

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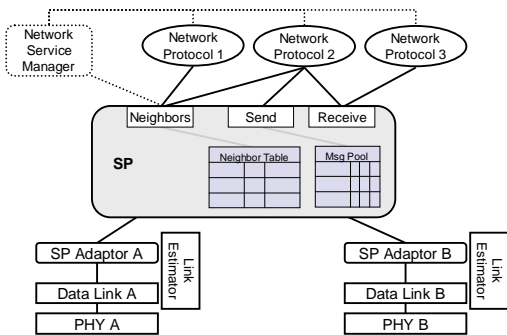
SP Message Futures



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

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SP Architecture



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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

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Neighbor Table

Neighbor	Required	Link	Network
1			
2			

address address_t
time on local time node wakes
time off local time node sleeps
listen true or false
quality estimated link quality

Message Pool

sp_message_t

destination address_t
message 1st TOSMsg to send
quantity # of pkts to send
urgent on or off
reliability on or off

phase Δ adjustment
congestion true or false

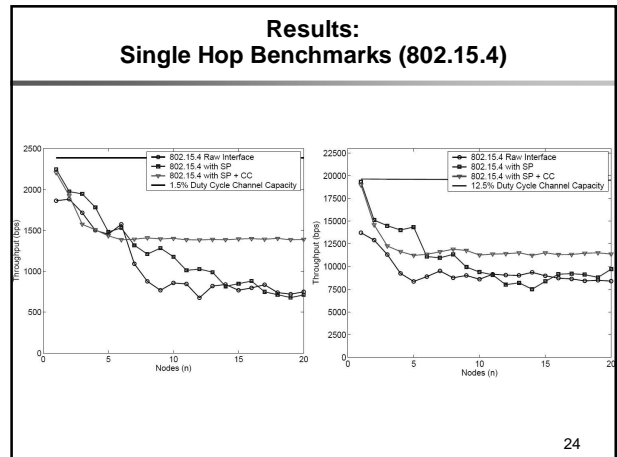
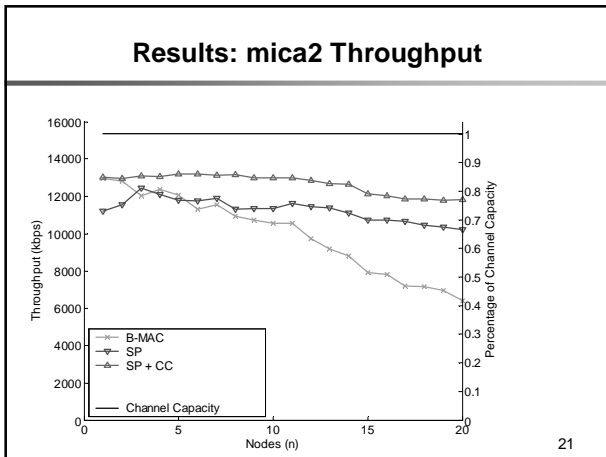
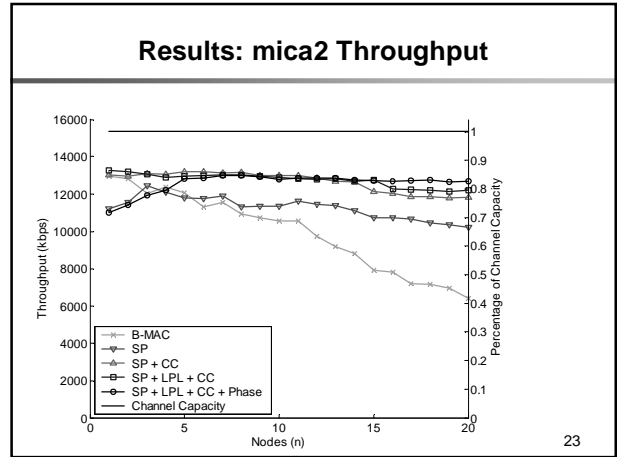
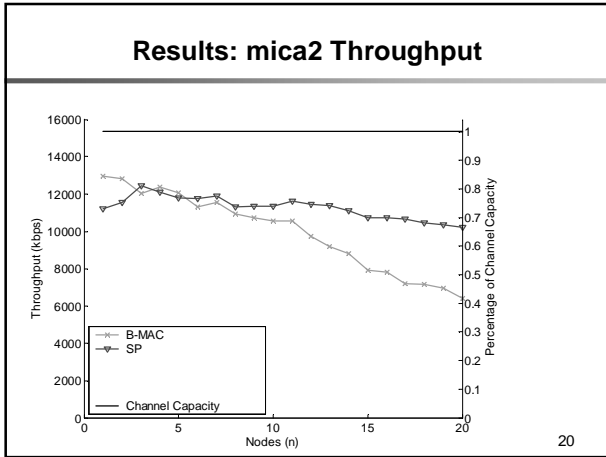
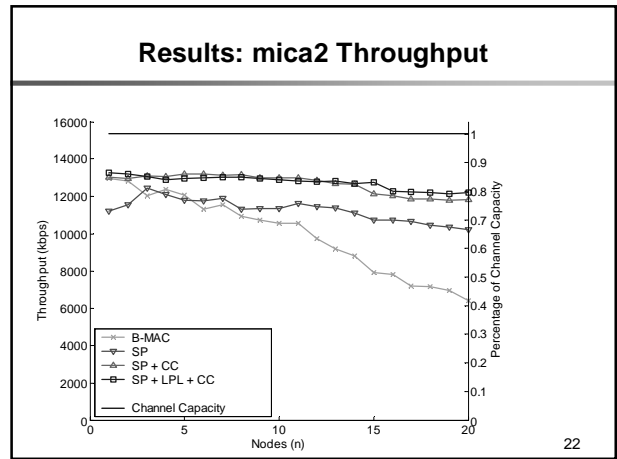
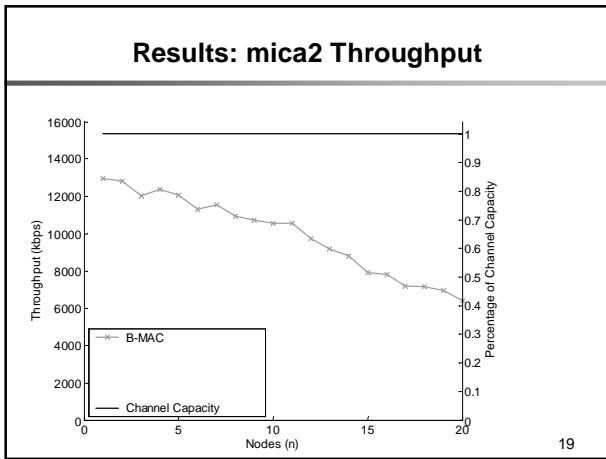


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Benchmarks

- 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

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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

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