(Phy-Link) Layers in the Brave New World

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www.crhc.uiuc.edu/wireless/
Wireless Networks

Look Ma, no links!
Wireless Networks

- For the most part, the protocol stacks have pretended that wireless links are equivalent to wired links (with errors)
New Reality

- With denser deployment, per-user capacity degrading
- Greater incentive for deploying more complex mechanisms

Simplicity ("purer" layers)

Performance (with cross-layer optimization)
However, if “raw” capacity improves, the balance may tilt the other way

- Cognitive radios, Ultra-wide band?
New Reality

With denser deployment, greater incentive for deploying more complex mechanisms

Most to lose
New Reality

With denser deployment, greater incentive for deploying more complex mechanisms \textit{at lower layers}

- Rise of “cooperative” wireless networks
- Adaptations aplenty

\begin{itemize}
  \item Other stuff
  \item Transport
  \item Network
  \item Link
  \item Phy
\end{itemize}

Most to lose
Cooperative Wireless Networks
Ad Hoc, Mesh, Sensor ... Networks

- Hosts cooperating to route data or information on multi-hop wireless routes
(Without) Cooperative Diversity
(With) Cooperative Diversity

\[ f(P_C) \]

\[ P_C \to P \to P_B \to P_D \]

\[ F(P_B, P_D) \]

Higher layer
Adaptations Aplenty

- Power/Rate Control
- Antenna beamforms
- Channel
- Retransmissions/Coding
- ... ??
Cross-Layer Adaptations

- Physical layer can perform many of these adaptations

- But need cross-layer interactions to maximize benefits
Impact on Protocol Layers
The Vanishing Link

What is a link anyway? Does a "link" span multiple "hops"?
The Vanishing Link

What is a link anyway?
Diversity muddles the notion of a link

Rate
$R_0 < R_1 < R_2$
The Vanishing Link

Diversity muddles the notion of a link

Channel
\( C_0 \not\equiv C_1 \not\equiv C_2 \)
The Vanishing Link

Diversity muddles the notion of a link

Beamform
\[ B_0 \not\equiv B_1 \not\equiv B_2 \]
The Vanishing Link

- Physical layer plays an important role
- Often need network-phy interaction for maximal performance
The Vanishing Boundary

- Wired autonomous systems, even if in the same physical space, can be treated as separable.
The Vanishing Boundary

- Wireless autonomous systems are not so autonomous
  - Internal decisions in an AS can affect internal performance of other ASs
Issues

- Notions of link and boundary imprecise in wireless

- Can (Should) we maintain meaningful separation between lower layers?

- Can we make the stack future-proof?

  How not to want another clean slate in another 20 years?
On a related note ...

- Will you know an ad hoc network when you see one?
On a related note ...

- Will you know an ad hoc network when you see one?
Thanks!