

Post-Optimal Radio: Viral Radio Networks

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The Sky is Not The Limit

A simple theoretic argument suggests that the available information capacity of a fixed frequency band is proportional to the number of transceivers in the space.

If you want more capacity, add more radios.

Heuristics

- More radio density should be better
 - Assist with propagation, more degrees of freedom to control
 - Noise independent of density
- Focus on scalable, incremental, adaptive networks
- Keep it simple
- Don't seek the optimum
- Intelligence at the endpoints

More radios should be better (but are often worse)

If energy needed for distance r grows as r^d , then energy needed using n relay hops is $< 1/n^{d-1}$ of direct link

As a result, the impact of a relayed message is much less, allowing concurrent sharing for independent messages.

The limits to theory

Most research on scalable wireless networks has been theoretical

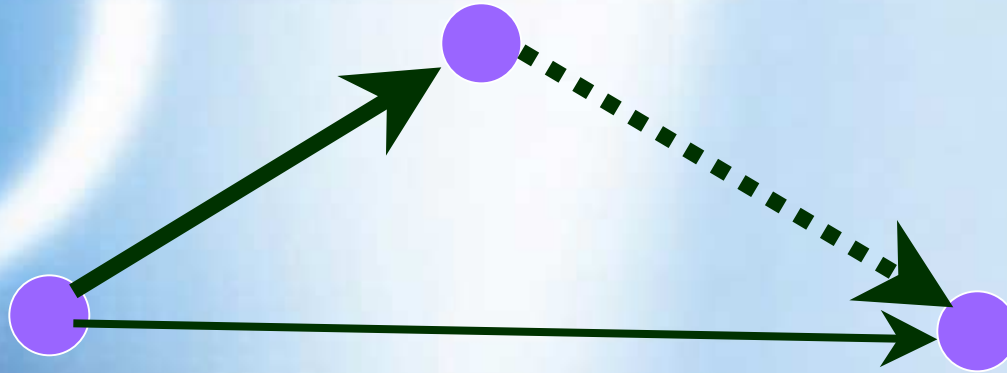
Freespace propagation

Link-based concepts: "Range",
"interference", "fading"

Practice needs to inform theory,
and vice versa.

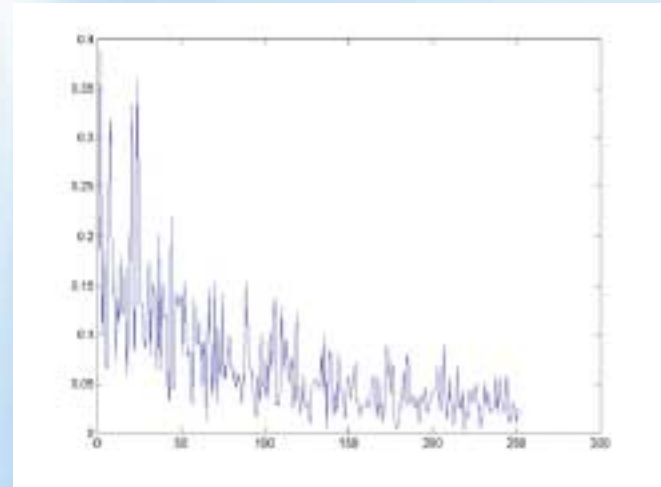
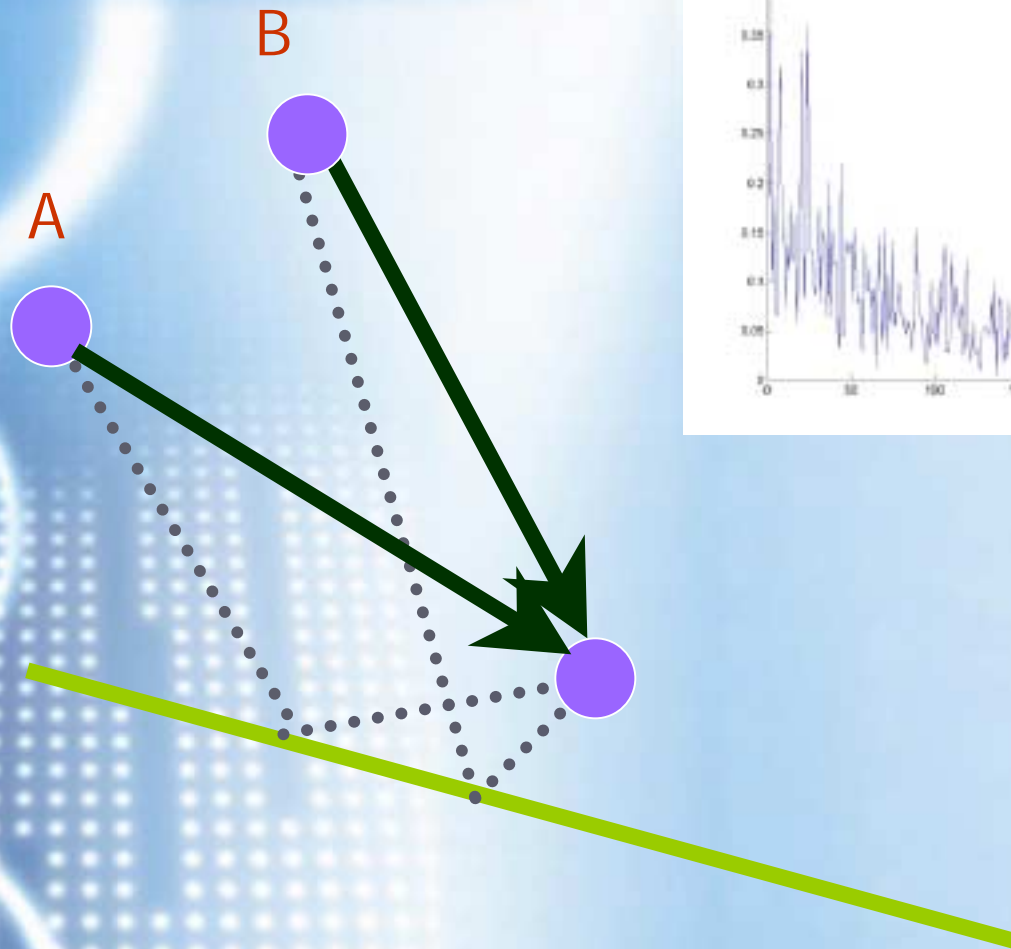
Optima are brittle

Two paths are better than one

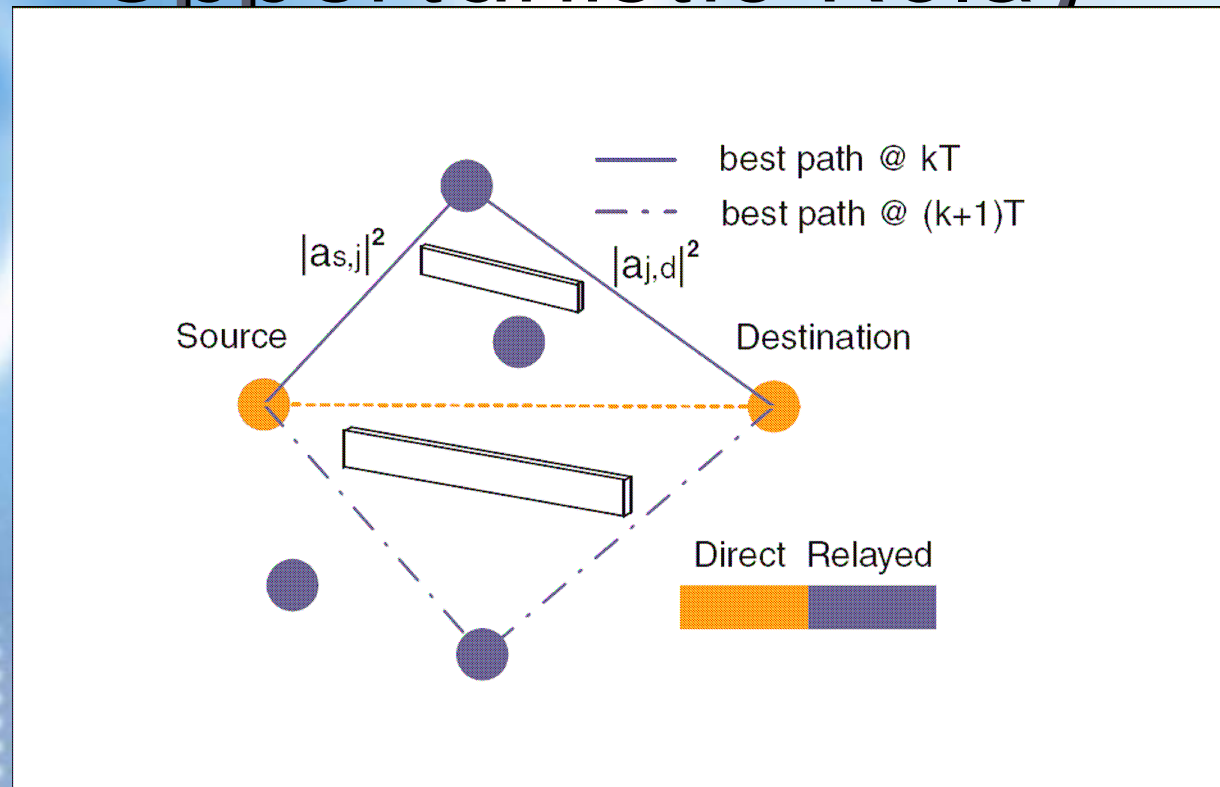


“Zero latency relaying” during symbol
Relies on software defined DSP-based
techniques at Tx and Rx
Superposition can be inverted, giving
additional diversity gain, e.g. Rake.

Exploiting propagation



Opportunistic Relay



Willing, idle nodes offer to relay
Create BitTorrent-like incentives

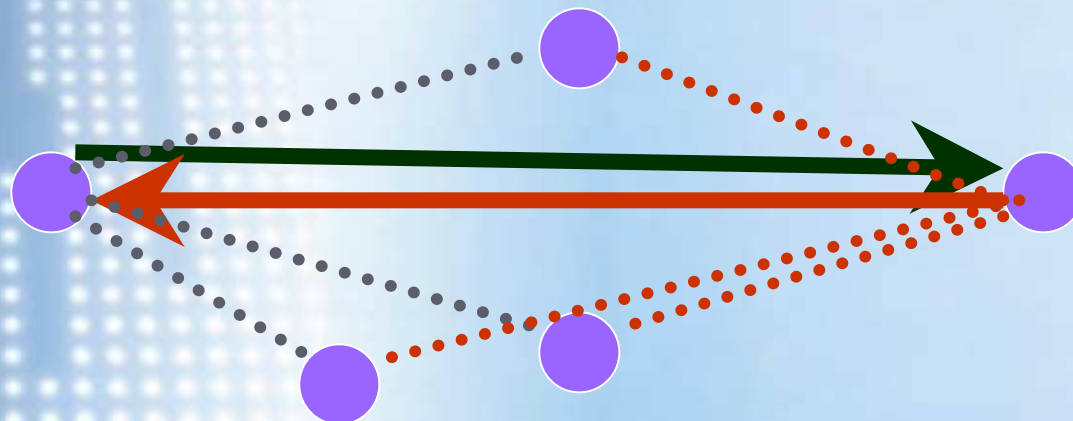
Picking the "best" relay

Effectiveness depends on channel quality:
source-relays, relays-dest, source-dest

Willing relays measure RTS/CTS

Relay "offers" time-delayed by $f(\text{channel})$

First relay to respond wins, defines Tx params



Observations & questions

Idle nodes act as sensors

Propagation variability *helps*

Voluntary cooperation -> gain

BitTorrent-like incentives (help me,
or I won't help you next time)

Can it scale?

What range of demand can it
serve?

Extensions being explored

Wideband signals

frequency-dependent fading is a feature, not a bug

Relay subbands “independently”

Exploit cheap software radio, such as GNU USRP

Support multicast traffic (Li)

Network “fairy dust”

Spectrum Policy

Favor radio *networks* that *cooperate*,
interoperate, and *adapt* - *OpenSpectrum*

How can spectrum be both scarce and empty?

Why shouldn't the bulk of wireless connectivity be infrastructure-free, cooperative, and incremental? Like automobiles, not subways?

If wireless networks can support exponential improvement for the next 25 years, shouldn't regulators step out of the way?

The missing bureau

FCC recognizes radio:

Broadcasting

Point-to-point communications

Networks

Why doesn't it have a Bureau of
Radio Internetworks