

Wireless Networking at Institute IMDEA Networks

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Developing the Science of Networks

- From theory to practice: for networks there is still a large gap

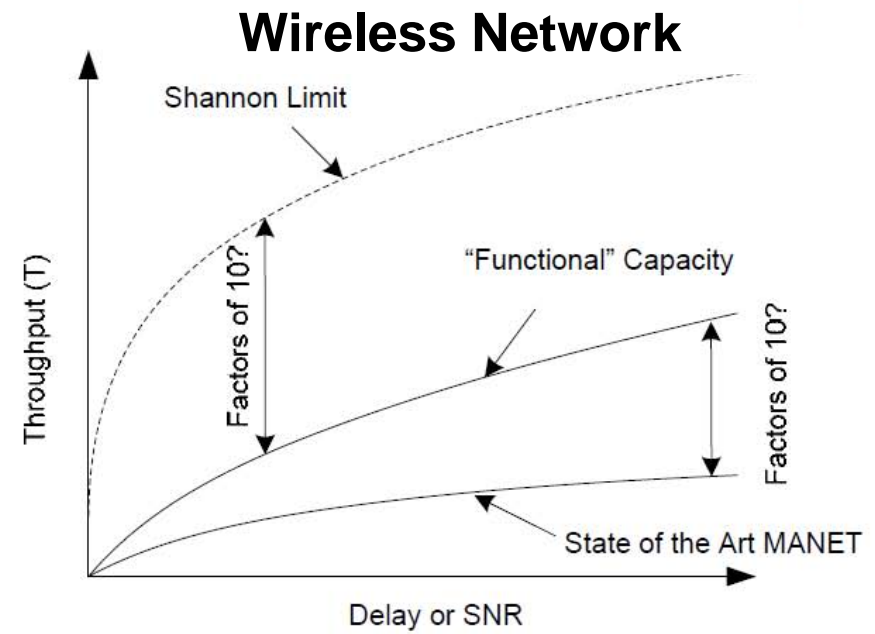
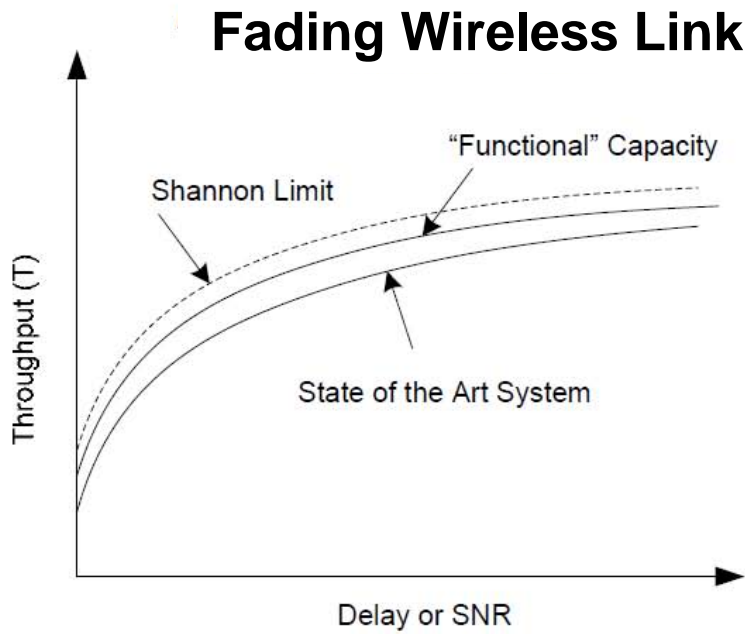


Figure from: **Rethinking Information Theory for Mobile Ad Hoc Networks**
 J. Andrews, N. Jindal, M. Haenggi, R. Berry, S. Jafar, D. Guo, S. Shakkottai, R. Heath, M. Neely, S. Weber, A. Yener

Wireless Networking Challenges

- Interference management, efficient spectrum usage
- Further capacity increases required but getting harder to obtain
- Network cost and flexibility
 - Foster evolution
- Application specific optimizations
 - Efficient video transport

Expertise

- LTE, WiMAX, WLAN
- Mesh networks, sensor networks
- MAC layer design, routing, transport
- Scheduling, load balancing
- Cross-layer design
- Modeling and optimization
- Testbeds, experiments

Architecture for Future Wireless Devices

Network architecture perspective:

- Proliferation of many different wireless technologies
- The Wireless Internet architecture needs to be rethought for efficient support of heterogeneity

Wireless aspects:

- More flexibility and programmability in future wireless technologies
- Novel programmable interfaces, expose low-level operations and control primitives
 - Service customization
 - Performance optimization
- Proof-of-concept validation through WLAN and WiMAX prototyping
- Standardization of the architecture highly important
- Industry partners:



Mobile Video

- Mobile video distribution framework for LTE/WLAN
 - Internet TV, Personal Broadcasting, Video on Demand
- Resource efficient wireless transport
 - Video application specific optimizations to different protocol layers
 - Cross-layer design
 - FEC, hybrid ARQ techniques
- CDN mechanisms for video streaming
 - Integrate P2P-inspired distribution mechanisms
 - Improve CDN efficiency through media-aware coded transport
 - Integration of coded transport and coded storage in CDNs
- Mobility management
- Standardization activities (IETF, 3GPP, IEEE), demonstrator
- Industry partners:



INOVAÇÃO



Alcatel-Lucent



Carrier-Grade Wireless Mesh Networks

- Specific focus on resource management and admission control, routing, self-configuration, and monitoring
- Example
 - Current solutions do not jointly optimize routing and MAC layers
 - Design of a novel joint routing and MAC algorithm for heterogeneous wireless mesh networks
 - Performance improvement of x2 to x4
- Joint patent with NEC Research, Heidelberg on energy efficient routing
- Industry partners:



IEEE 802.21 Standardization Activities

- Broadening the scope of IEEE 802.21: creation of Media Independent Service Layer instead of focus only on handovers
 - Self description of interface properties
 - Neighbor discovery
 - Radio interface configuration
 - Resource management
- Example use case: coexistence of wireless networks in the TV band
- New IEEE 802.21 reference model including modifications to support a Media Independent Service Layer
- Media Independent Radio Configuration contribution has been accepted and forms part of the IEEE 802.21b draft 2 (ratification pending)

LTE and WiMAX

- Opportunistic scheduling
 - Multiuser traffic optimization (fairness, QoS constraints)
 - Enhanced power management (power control, power saving)
 - Feedback mechanisms and estimation error: accuracy of channel estimation vs. resource usage
- MIMO
 - Opportunistic beamforming in LOS and NLOS
- Robust rate adaptation schemes
- Inter-Base Station Coordination
 - Self-organizing cells
 - Agile spectrum reuse
 - Load balancing techniques
 - Joint scheduling and power allocation (femto + macro)

Conclusions

- Focus on transfer of theoretic results to practical systems
- Output:
 - Patents
 - Testbeds
 - Standardization
- Many different forms of collaboration possible
- Outlook:
 - 7 trillion wireless devices serving 7 billion people in 2017 (Source: WWRF)
 - 1000 wireless devices per person
 - “Unlimited” bandwidth, always-on, ubiquitous coverage
 - Cognitive networking, collaborative communication, connectivity brokerage