The case for a cooperative protocol stack for wireless multihop networks

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It is believed that the proliferation of mobile wireless multifunctional devices is one of the key phenomena that will shape the future Internet. Up to now, most of the protocols used for connecting such devices are direct translations of protocols developed for fixed and wired networks. IP-based communication stacks for multi-hop wireless networks, for instance, use a point-to-point abstraction for links and paths, which has been useful in the wired networks context, but which ignores some fundamental properties of wireless media, such as the broadcast wireless transmission, the various forms of diversity, or the ethereal nature of wireless links.

This leads to the idea of *cooperative protocols*, which allow nodes of a wireless network to use the resources of adjacent nodes to virtually increase their communication and processing capacities. Cooperative protocols are aware of the special characteristics of wireless transmission, exploiting the broadcast advantage of wireless transmission in order to reduce the cooperation overhead or to obtain diversity gains.

Most of the early work on cooperative networking has focused on improving transmission parameters through an emulation of a multiple-antenna array, but the idea of cooperation, however, has been progressively applied to upper layers in the stack. Network coding, opportunistic forwarding, cooperative relaying, cooperative ARQ or cooperative IDS are examples of this. We believe that introducing cooperation in a single protocol is not enough, and thus *we devise a communication stack designed to fully exploit cooperation among nodes, that we call cooperative stack.*

For designing such a stack, we should introduce changes in the used abstractions and mechanisms, and in its structure and organization. The design space introduced by cooperation is enormous and it is a matter of engineering judgment to select the features more adequate for each scenario. Examples of these changes are: *new link abstractions*, *new objects and addressing schemes*, *new forwarding schemes*, and *new layer and cross-layer organization*. Of course, an important issue to be addressed is the interworking with legacy protocol stacks.

In this talk we discuss the challenges and opportunities given by the cooperative protocols, proposing a cooperative stack organization, and discussing its impact on the architecture of the future next generation Internet.

Talk outline:

- Cooperative networking basics
- Cooperative protocols review
  - Network Coding
  - Opportunistic Forwarding
  - Cooperative Relaying
  - Cooperative ARQ
  - Cooperative transmission
  - Cooperative IDS
- A communication stack of cooperative protocols
  - New link abstractions
  - New objects and addressing schemes
  - New forwarding schemes
  - Layer organization and cross-layering
  - Inter-working with TCP/IP
- Challenges and opportunities
- Conclusions