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AMICA

Main Research Areas within the AMICA Architecture

- Transport Protocols services for networks with wireless last hop(s).
- Link Layer Protocols for transmission optimization over wireless links
- Usage of Multiple hops in the wireless access
- MAC Protocols for wireless LANs
- Handover in heterogeneous networks
- Protocol reloading/modification in terminals and Access Points
- Power Saving in Mobile Networks
- Admission control/route selection in Access networks
- IP over WDM

We follow the vision of end-systems being connected mainly via wireless technologies to an optical communication infrastructure. We believe that the communication will be based on multimedia-support enhanced Internet, with quality of service support being achieved by segregation rather than reservation.
In addition to wireless access also nomadicity and mobility will have to be increasingly supported. In our approach, called AMICA: Adaptable, Mobile; Internet-based Communication Architecture we investigate several crucial aspects of such future systems, following original research hypothesis.

- **Transport Protocols services for networks with wireless last hop(s).**
  Efficiency problems of TCP over wireless are well known.
  We believe that the data flow in the internet
  "backbone - underlying the global congestion control rules"
  should be decoupled from the data pacing on wireless
  hop, which should be locally optimized.
  We follow the idea of supporting TCP/UDP
  sockets (with original semantics) in a proxy-based
  architecture called ReSoA (Remote Socket Architecture).
  This architecture consists of two Layers:
  - The socket export Layer, which supports the remote access to the transport Layer services, and is dependent only on their semantics. Thus this layer should be changed only if, for example, new socket interface would be suggested.
  - The link layer protocol, called Last Hop Protocol (LHP) offering different Quality of Service to different flows (up to -possibly - knowledge of the semantic

of the coding schema for voice, video,..etc)
The following of the ReSoA approach, makes it much easier to extract the information about the individual flows (e.g. using the port numbering convention) without the need of decoding IP/UDP packet headers or extending IP protocol fields.

Following the ReSoA approach- with congestion control for the backbone located in ReSoA server not in the end-system will also make it much easier to enforce globally unifies congestion control - also for UDP traffic.
We develop a formal specification, simulation models and prototype implementation for this architecture.
For comparison of its performance with other approaches (Snoop, Eiffel,,etc) we develop a unified simulation and experimental environment

- **Link Layer Protocols for transmission optimization over wireless links**
  Wireless links are known for varying quality.
  We believe that efficient support of diffferent applications might be best achieved by link layer protocols which use both:
  - Statistical knowledge about the channel, supported by actual dynamic knowledge of the temporary state of the channel
  - Use of information about the semantic of individual data flow (up to -possibly - knowledge of the semantic of the coding schema for voice, video,..etc)

  We work on approaches using the fluctuation of the channel quality, for non-uniform, or even non-continuous transmission rather than trying to achieve constant link quality. We develop a family of Link-Layer protocols for different assumptions on Physical Layer: IEEE802.11 type, CDMA Type etc. as well as for different flows: WWW_traffic, MPEG Video, Voice over IP...
  One good example of our activities is the usage of multiple CDMA codes in parallel in good channel states to remove the backlog of data packets created during the fading phase in CDMA based systems (like UMTS).

- **Usage of Multiple hops in the wireless access**
  Due to fundamental laws of Physics the energy needed for successful transmission is proportional to the distance in the power of 3 or 4. Thus - theoretically- usage of multiple hops should decrease the needed energy, as well as the interference generated by the senders involved.
  On the other hand processing in intermediate hops causes energy usage and delays, hidden terminal effects appear..
  We investigate the potential and possible solutions for

increasing system capacity and end-system energy usage by introducing multi-hop, ad-hoc organization of traffic among end-systems and base stations in cellular systems.

- **MAC Protocols for wireless LANs**
  We believe that an important role within the plethora of different wireless technologies will be played by Wireless LANs. Therefore we investigate the performance, as well as possible modifications of MAC protocols, as well as the schedulers implemented of top of them. We consider different technologies: IEEE 802.11 being the most intensively studied, but also HiperLAN and Bluetooth.
  We are interested in development of scheduling rules and protocols supporting different types of traffic flows.
  For example one specific class of traffic, which we would like to support with proper MAC on top of IEEE802.11 PHY is industrial process control traffic, we aim at offering in wireless a service semantics similar to that of PROFIBUS.
  We are also interested in exploiting in MAC the features of new Physical Layer technologies, like OFDM and smart antennas.

- **Handover in Heterogeneous Networks**
  There seems to be more and more interest in a vision of hierarchical radio coverage using different radio technologies from different radio providers rather than a unique, homogeneous infrastructure, like in today cellular networks.
  Handover in the heterogeneous environment means change of the Physical layer technology to one with different Quality of Service, means possibly a dramatic change of the information routing (e.g. change form the WLAN extension of the campus network to an overlay from an INT-2000/UMTS operator) as well as authorization /charging/billing schemata.
  We believe that the basic Mobile IP approach, designed for nomadicity support is not enough for the future mobile Internet.
  We believe that there will be a plethora of approaches, assuring mobility in different scenarios and at different levels.
  IN our research we follow selected ideas. We investigate the possibility of using multicast as a basic mechanism for handover support, and consider which additional features should a future multicast mechanism have in order to offer optimal handover support (MOMBASA). We believe that the development of handover functionalities so far mostly ignored the existence of Performance enhancing proxies and investigate approaches to unify the handover enhancing proxies with PEPs. We focus on perfomance and security aspects of different handover mechanisms and policies.

- **Protocol Reloading/Modification in Terminals and Access Points**
  Switching among different technologies needs not only change of the

Physical layer, which will be in the future assured by soft-radio and reconfigurable radio technologies, but also change of the MAC/Link Layer protocols and possibly deployment of proxy clients in the end-systems.
We believe that this should be done in a dynamic way, by downloading proper modules to the end-systems rather than pre-storing them.
We are investigating the execution environments for end-systems as well as secure and efficient download mechanisms.
On the other hand, the proxy servers - both for mobility and performance enhancing proxies- have to be deployed at access points and other infrastructure elements. We are investigating the potential of current active network concepts to support such deployment, we are interested in defining the minimum functionality of active nodes needed for such deployment

- **Power Saving in Mobile Networks**
  Power economy is definitely one of the important design criteria for wireless communication support of numerous classes of end-systems: lap-tops, palm-tops but also sensors.
  We believe that an impressive energy economy effect might be achieved by proper tuning of the protocol stack. Typical actions which we have investigated for W-LANs, are optimization of active/sleep phases of mobile hosts, but also joint optimization of packet length and transmission power, possibly in pace with the dynamics of the channel quality. We are interested in harmonization and joint optimization of operation of the whole protocol stack from the power economy point of view.

- **Admission Control and Route Selection in Access Networks**
  Despite the increasing capacities of the fixed network, the proper Quality of Service in fixed network can not always be expected, especially for more demanding real-time traffic.
  We believe that traffic separation in backbone is the proper way, route separation being one of promising approaches. We investigate measurement based decision policies as for route selection and admission control.

- **IP over WDM**
  We believe in an "optical transmission meets wireless transmission" future of the Internet. Therefore in addition to supporting the vision of Wireless/mobile internet access, we investigate the options for "IP over WDM". We follow here especially the idea to use AWGs in order to create both single-hop and multi-hop architectures supporting IP over WDM.
  We are also interested in network structures for efficient use of the "radio on the fiber concept"

Questions? Contact webmaster.

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