Personal Cloud Infrastructure

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Opportunities

• Global interconnection of users and devices in the billions.
• Create a scalable communication infrastructure that will support orders of magnitude decreases in power and increases in bandwidth.
• Move away from rigid centralized system to more decentralized collection of resources.
• “Personal cloud” – local computing and storage - more agile and able to adapt to dynamic environments and mobility.
  • Beginning trend with IoT, "fog" computing, smart cities (MetroLab – Rice Social Sciences/Houston), TFA (Knightly), tactile internet, smart routers, body area networks, GIS, etc.
• Provide fast local communication and computation for quick response, & rich access to big data and "cloud services" such as navigation guidance and location aware services.
Localization and Flexibility

• Identify: what is nearby (via localization) in terms of network access, and then pick the most appropriate communication strategy, perhaps in a software defined radio (SDR) capability.

• Respond quickly: a system (or perhaps a human) will need to quickly decide whether it is more beneficial to go directly to a large traditional base station or whether a short hop to a smart local gateway or another device is sufficient.

• While limiting interference.
Personal Cloud Challenges

• Fast, yet energy & spectrum efficient wireless network and computing services.
• New scalable standards with agile SDR will be required – both analog and digital baseband.
• Computation substrate needed (FPGA / SoC / GPU processors) to provide best network & computing.
• Provide best control efficiency for:
  • Local edge computing when real-time analysis is needed
  • Fast communication with a cloud server when data science applications are active.
Configuration Challenges

• Designing a single standard that covers diverse scenarios,
  • without having a plethora of different protocols and modulation schemes
  • a single standard that scales from ultra low power transmission to high throughput Gb/s transmission.
• It would be inefficient for a person or an IoT cluster to continuously switch between standards.
• Development of a unified standard that covers orders of magnitude in terms of bandwidth, energy efficiency, latency, range, etc.
Testbed Infrastructure

• Design space exploration
  • Assess the area-time-power to cost computation and communication efficiencies of new algorithms and architectures for "personal cloud."

• Experience gained from programmable testbeds
  • Universities & industry for 3G and 4G communication
  • Small scale MIMO, Rice WARP (Sabharwal et al) wireless testbed, NI/USRP testbeds, etc.
Going Forward

• Existing testbeds used in 5G proposals
  • Massive MIMO: Argos Rice (Zhong), NI/USRP Lund
  • But reaching limits due to cost, power requirements, and complexity of system integration and signal routing.

• New generation of testbeds need greater modularity, flexibility, with a variety of communication, computing and storage performance at each node
  • To study & identify opportunities, bottlenecks, & design tradeoffs in a heterogeneous & adaptable "personal cloud" network.