Personal Cloud Infrastructure

Joseph R. Cavallaro

ECE Department, Rice University, Houston, TX

cavallar@rice.edu

Christoph Studer

School of ECE, Cornell University, Ithaca, NY

studer@cornell.edu

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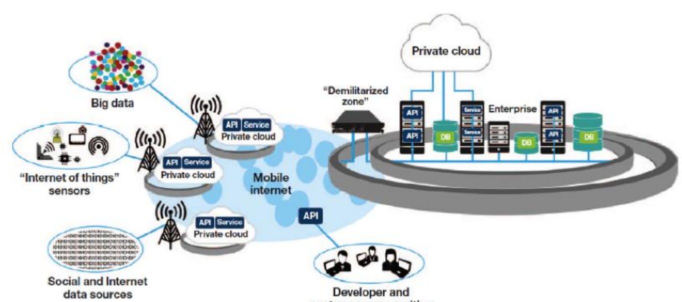
Opportunities

- 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.

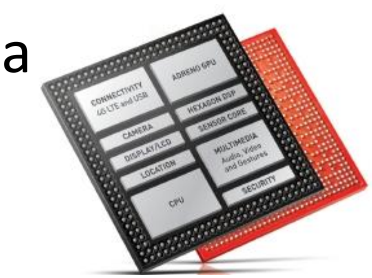
Localization and Flexibility

- 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.



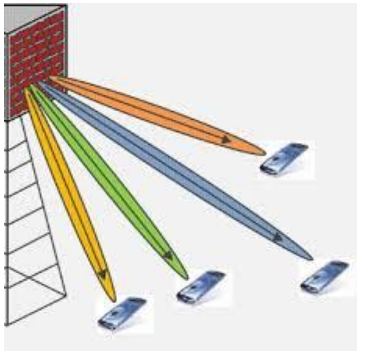
Personal Cloud Challenges

- 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.



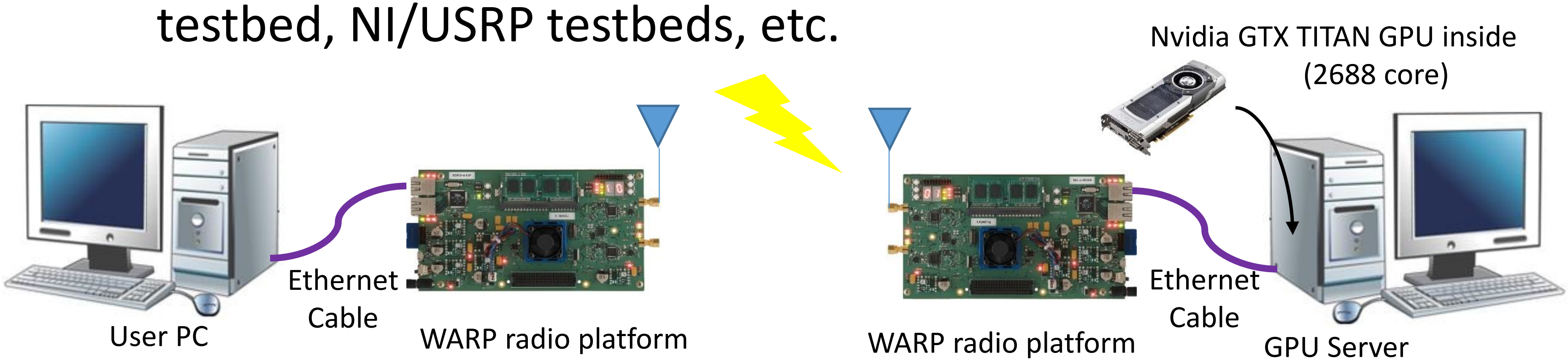
Configuration Challenges

- 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.