

Draft WiNTeB Workshop Final Report  
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## **Executive Summary**

Researchers in US universities interested in working on wireless networks have few choices available to them. Most are forced to use WiFi. While many interesting experiments can be done with WiFi, the ability to do at-scale experiments on the dominant wireless technology (cellular), in real world situations, is limited. WiNTeB is a solution to this problem. It leverages special arrangements with cellular network operators to provide a test bed to a broad range of networking and non networking researchers. Under the leadership of Dr. Cummings an NSF funded Workshop confirmed both the problem and the solution.

Three interacting and mutually supportive visions for WiNTeB research community infrastructure services evolved during the Workshop:

- Vision I - Applications Research
- Vision II - Research On Existing Networks
- Vision III - Research on New Modes

As a test bed, WiNTeB's intellectual merit flows from what is learned about wireless networking and applications, in setting up the test bed, and the research projects conducted on it. These projects span Health, Social, Political, Environmental, Networking, and RF sciences. Early projects illustrate how researchers will be able to advance health and environmental sciences through field monitoring, test theories in Smart Grids, increase understanding of problems and solutions in multimedia on wireless, quality of service measurement on wireless, femtocell networking, wireless security and new modes in advanced wireless networking.

The broader impacts that flow from WiNTeB include enabling new educational, new research and new integrated research and education opportunities. By its very nature, WiNTeB will democratize wireless research by opening the doors to significant wireless research to smaller universities, institutions and start-up companies. It will also enable the larger universities which lead wireless research today, to make their work more meaningful. It will enable researchers to provide regulators with the data they need to make the best possible public policy and regulatory decisions. It will enable research results which help NOAA, NASA, DOE and other government agencies to better fulfill their missions. Network operator, and equipment, companies will benefit from WiNTeB in two ways: improved staff availability and improved early research results feeding their pipeline of innovation and R&D efforts. Finally, having more reliable, more secure, more robust networks with advanced services will have a profoundly positive impact on society. In addition, WiNTeB will result in improvements in the US industrial competitiveness of wireless equipment, software, semiconductor, and network operator companies.

## **I. Introduction**

Researchers in US universities interested in working on wireless networks have few choices available to them. Most are forced to use WiFi. While many interesting experiments can be done with WiFi, the ability to do at-scale experiments on the dominant wireless technology (cellular), in real world situations, is limited. WiNTEB is a solution to this problem. It leverages special arrangements with cellular network operators to provide a test bed to a broad range of networking and non networking researchers.

## **II. Process Leading Up to the Workshop**

WiNTEB grew out of discussions in late 2008 and early 2009 between James Kempf of Ericsson Labs USA and Mark Cummings. James, in his work with academic researchers was frustrated by the “Problem” described above. Mark was frustrated because he couldn’t find a way to test a revolutionary theory about wireless network organization. Together they started to develop the WiNTEB vision. Chip Elliott the head of the GENI Program Office found out about it, and he and Aaron Falk helped refine the vision into a talking paper. As the talking paper crystalized, Chip and Aaron made introductions to senior people at NSF. With help from KSU, NSF and others, the talking paper grew into a proposal for a WiNTEB Workshop.

## **III. Workshop Speakers and Attendees**

On May 5 & 6, 2010 the WiNTEB Workshop was held in Arlington sponsored by NSF and organized by Mark Cummings of KSU. Response to the Call For Participation was very strong. Early planning had been for 24 participants. That grew to 35 and finally was expanded to 60. Even so, a large number of potential attendees had to be turned away. Workshop participants included representatives of all major classes of stakeholders. The presentations and presenters were:

Explanation of the WiNTEB Concept - **Mark Cummings, KSU**

Desired Outcomes for the Workshop - **Victor Frost, NSF**

What Can Be Learned From the GENI Experience - **Aaron Falk, GENI GPO, BBN**

Wireless Equipment Company View - **James Kempf, Ericsson Labs USA**

Application Researcher View - **Deborah Estrin, CENS, UCLA**

Infrastructure Researcher View - **Sachin Katti, POMI, Stanford**

Broadband Perspective - **Walter Johnston, FCC EOT**

FCC Technology Perspective - **Jon Peha, FCC Chief Technologist**

Operators Perspective - **Andrew Apple, AT&T Mobility**

Open Discussion - **James Kempf, Ericsson Labs USA**

WiNTeb Recommendations From an Internet Pioneer **Vint Cerf, Google**

Open Discussion of Previous Day's Synthesis - **Moderated by Aaron Falk, GENI GPO, BBN**

Plan For Moving Forward - **Mark Cummings, KSU**

Lightning Talk presenters were:

Hongwei Zhang, **Wayne State University**;

Rudra Dutta, **North Carolina State University**;

Driss Benhaddou, **University of Houston**;

Kuang-Ching Wang, **Clemson University**;

B. S. Manoj, **Univ. of California, San Diego**;

Rajeev Koodli, **CISCO Systems**;

Dijiang Huang, **Arizona State University**;

Per Johansson, **Univ. of California San Diego**;

Preston Marshall, **Univ. of Southern California, Information Sciences Institute**;

Larry Foore, **National Aeronautics and Space Administration**;

Rangam Subramanian, **Idaho National Laboratory**;

Aleta Ricciardi, **SRI International**.

Other participants covered a wide range. Academic participants ranged from small regional colleges to MIT. Academic researchers covered both networking and social / environmental areas. Industry participants included AT&T Mobility, Clear Wire, and Cisco. Government organizations included the FCC, Defense Spectrum Office and NASA.

#### IV. Workshop Process

The Workshop was structured around a combination of presentations from every type of stakeholder and open discussions. The types of stakeholders represented included:

- NSF
- Commercial Industry
  - ▶ Equipment Vendors
  - ▶ Network Operators
- Academic Researchers

- ▶ Applications Researchers
  - ▶ Networking Researchers
- Regulators
  - ▶ FCC
  - ▶ DSO
- Other Government Organizations
  - ▶ NASA
  - ▶ DOE
- Public Policy Community
- Start-Up Community

Each participant was requested to think about and discuss both, in the formal sessions and in the informal social times provided, the following:

- Vision & Benefits
  - ▶ Yours
  - ▶ Others
  - ▶ How to Integrate
- Challenges
  - ▶ Identify
  - ▶ Plan for Meeting
- Issues
  - ▶ Identify
  - ▶ How to Resolve
- Path to Implementation

Discussion time was planned through out the Workshop with both discussion periods after each presentation and blocks of discussion time allocated to integrating and synthesizing views. The discussions were quite spirited while maintaining a professional and collegial atmosphere. Many of the participants started the Workshop discussions with strong views about their particular needs. As the Workshop progressed those views coalesced into three visions. At first, the champions of each of the three visions tended to see their vision as important to the exclusion of the others. However, by the end of the lunch meeting that closed the Workshop, the group came to a consensus that all three of the visions were important, mutually supportive and inter-related. As this consensus emerged, discussion started to focus on the intellectual merit of both the test bed itself and the research that the test bed would enable.

## **V. Workshop Results**

The three visions that evolved in the discussion during the Workshop are:

- Vision I - Applications Research
- Vision II - Research On Existing Networks
- Vision III - Research on New Modes

Vision I focuses on how WiNTEB can enable researchers in Mobile Health, Environmental Science, Social Science, Political Science, etc. to use existing cellular networks. In this vision, WiNTEB acts as an aggregator and “impedance matcher” for and between researchers and cellular network operators to ease access, match billing plans to researcher needs while providing cost effective services to researchers and protect production networks and the companies that operate them. It also envisions research scenarios which employ heterogeneous networks combining multiple technologies and multiple operators.

Vision II focuses on WiNTEB enabling research surrounding improving and evolving current cellular networks. Here WiNTEB provides a deep trusted relationship with network operators surrounded by technical and procedural safeguards to allow researchers access to network internals.

Vision III focuses on WiNTEB enabling research on new modes with special consideration of interference issues and security. To do this, the FCC would authorize experimental spectrum near enough to existing commercial bands that available commercial equipment could be tuned to it, and far enough away that research activities in the experimental band could not have a detrimental effect on production networks. In some cases, network operator partnerships would assist in the fielding of equipment.

By the end of the Workshop, a consensus developed that although these appear to be three separate visions with separate and possibly competing audiences, they are actually interactive and mutually supportive. This realization led to the conclusion that each needs the other two and that all three should be pursued together. Vint Cerf’s description of DTN played an important role in the group’s coming to this realization. Vint pointed out that the history of the development of DTN (Delay Tolerant Networking) showed how Application research plays a key role in Network research. He pointed out that DTN was developed as a direct result of Application research in that Exo Planet Researchers found that they could not get the data being collected by the Mars probes back to Earth with current wireless technology and protocols. This led to the development of DTN, which can be roughly described as a store and forward version of TCP/IP. It was created and loaded into craft in orbit around Mars, and the Earth to make it possible to get the data and pass it on. The development of the first version of DTN opened up an extremely wide area of experimentation and implementation in terrestrial networks.

The group came to the conclusion that experiments in Vision would reveal requirements that needed to be explored in Visions II and III and visa versa. In reaching this consensus, the group confirmed the need for WiNTEB and the general direction of the solution.

As this consensus developed attention started to turn to the intellectual merit of WiNTEB and the other benefits it would generate. Conclusions included that WiNTEB’s intellectual merit flows from what is learned about wireless networking and applications, in setting up the test bed, and the research projects conducted on it. These projects span Health, Social, Political,

Environmental, Networking, and RF sciences. For example, researchers will be able to advance health and environmental sciences through field monitoring, test theories in Smart Grids, increase understanding of problems and solutions in multimedia on wireless, quality of service measurement on wireless, femtocell networking, wireless security and new modes in advanced wireless networking.

The broader impacts that flow from WiNTEB will include enabling new educational, new research and new integrated research and education opportunities. By its very nature, WiNTEB will democratize wireless research by opening the doors to significant wireless research to smaller universities, institutions and start-up companies. It will also enable the larger universities which lead wireless research today, to make their work more meaningful. It will enable researchers to provide regulators with the data they need to make the best possible public policy and regulatory decisions. It will enable research results which help NOAA, NASA, DOE and other government agencies to better fulfill their missions. Network operator, and equipment, companies will benefit from WiNTEB in two ways: improved staff availability and improved early research results pipeline feeding their innovation efforts. Finally, having more reliable, more secure, more robust networks with advanced services will have a profoundly positive impact on society. In addition, WiNTEB will result in Improvements in US industrial competitiveness of wireless equipment, software, semiconductor, and network operator companies.

## **VI.Recommendations Going Forward**

The Workshop attendees reached the conclusion that additional work to create the test bed was in order. There were two alternative routes discussed. One was to prepare a proposal for an NSF Planning Grant. The other was to prepare a proposal for an NSF CRI Grant to build and operate the test bed. If the second approach is taken, it should be focused on making the test bed self sufficient at the end of four years of NSF support. It was clear that whichever route was chosen, a proposal team would be required. Several people volunteered to be part of such a team. It also became clear that the choice between routes would best be determined by the level of understanding of the network operator partnership that could be achieved. In Workshop follow up activities, it became clear that the foundation for an NSF CRI Grant was in place.

## **VII. Conclusions**

In conclusion, the Workshop validated the need for WiNTEB and the approach of partnering with network operators. It resulted in the definition of three interacting sets of research community infrastructure services. Finally, it brought a core team of leaders, partners and users together which created the foundation for a successful launch.

Appendices (Please see <http://www.kennesaw.edu/ogc/WiNTEB/agenda.html> for material in these Appendices)

a. Call For Participation

- b. Workshop Agenda
- c. Attendee List
- d. Workshop Presentations