WINLAB Research Summary
IAB/Research Review
Oct 29 & 30, 2001

Rutgers University
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Wireless Information Network Laboratory

- Cooperative industry-university research center at Rutgers University, focused on wireless technology
- In operation since 1989, with a strong track record of research contributions to wireless data networking
- Research program a mix of core R&D, focus projects and industry collaboration

- ~20+ Industry sponsors, NSF, State of NJ, ...
- ~20 faculty/staff + ~30-50 students

...more details to be given during WINLAB strategic plan presentation at IAB mtg on 10/30
WINLAB Research Scope

- Wireless information networks from a systems perspective. Scope includes:
  - RF/modem technology
  - Wireless system-on-chip (SOC)
  - MAC/data link control
  - Radio resource management
  - Mobile network protocols
  - Mobile information services middleware
  - Mobile computing software & applications
  - Wireless system architecture

- WINLAB has pioneered wireless data system design for over 10 yrs, and looks forward to being a major force in pre-competitive R&D for the emerging mobile Internet...
WINLAB Activity Model

Sponsor Fees, RU & Govt research funds

Core Research Areas

DARPA Projects (e.g. Infostations)

Major NSF Projects (e.g. FreeBits)

NJCST Project (NJ Center for Wireless Comm)

Focus Project(s) with Sponsor Companies

New system concepts, IPR...

Tech Reports, Sponsor mtgs, Software tools, etc.

Pre-commercial technology

RU, NJCST.. (TBD)

Tech Transfer Center (Planned)

Additional Project Support
WINLAB Core Research Areas

Basic Radio/Modem Technology
Radio Resource Management & Wireless Systems
Mobile Network Architecture & Protocols
Mobile Computing Middleware & Applications

Faculty:
Y. Lu
J. Evans
P. Spasojevic
L. Greenstein (Adjunct)
J. Lin (Adjunct)
+ TBH
R. Yates
C. Rose
N. Mandayam
S. Mau (Post-Doc)
D. Frenkiel
Z. Gajic
D. Raychaudhuri
P. Bhagwat (Adjunct)
I. Seskar (Res Eng.)
M. Ott (Adjunct)
...+ 2 TBH
B.R. Badrinath
T. Imielinski
H. Hirsh
Mobile Internet Research: Strategic Themes (near-future)

Several fundamental problems need to be solved before the mobile Internet can take off:

- Developing PHY/MAC for broadband radios
  - \( \text{Kbps} \rightarrow \text{Mbps} \rightarrow \text{Gbps} \), adaptive, robust, QoS, ...

- Scaling wireless system capacity
  - \text{widespread service implies } \text{Gbps/Sq-Km}

- Designing wireless system-on-chip (SOC)
  - low-cost/low-power, integrated CMOS

- Unifying wireless network architectures (WLAN/IP, 2.5G, 3G cellular) & protocols
  - multiple radio technologies, faster/simpler standards process

- Creating “useful” mobile information services
  - ...beyond web browsing on hand-held devices
Mobile Internet Research: Strategic Themes (long-term)

- Pervasive computing (connecting people with their physical environment) viable in 5-10 yrs

- Technical challenges:
  - self-organizing (ad-hoc) networks
  - low-power/low-cost/multipurpose wireless sensors
  - scalable network routing and content distribution
  - distributed information processing in the network
  - end-user interfaces & applications

- Above topics involve wireless, but are also inherently interdisciplinary

- Not too early for companies to start thinking about products in this space...
Wireless Product Evolution

Wireless local loop (WLL)

Digital Cellular (2/2.5G)

Wireless LAN (802.11b)

Short-range radio (Bluetooth)

MIMO/OFDM, ATM/IP, WCDMA, 3G.PP, etc.

OFDM, mob IP, QoS MAC

UWB, ad-hoc net

Wireless LAN (802.11a)

UWB LAN/PAN, 802.11b-, etc.

Home LAN (Bluetooth-II)

driver technologies

Integrated Cellular (3G)

Hiperlan or other WLAN+?

Broadband Wireless Access (BWA)

Wireless LAN (802.11b)

Home network sensor nets, etc. (consumer & verticals)

2001

2002-03

>2005

BWA/3G combo (local access providers)

WLAN/3G/2G (cellular operators)

potentially disruptive technology areas

convergence opportunities??

2001

2002-03

>2005
WINLAB R&D Map

System Prototypes
- Infostations-I (DARPA)
- Open Arch Mobile Net
- Infostations-II (MUSE)

Protocols & Software
- Diffusion routing
- WLAN QoS, mcast,.. I-valet
- 3G/WLAN Interworking
- Content Multicast + other new services

Core Technology
- MITSAW, ZnO, MEMS devices
- Software radio
- nx100 Mbps OFDM Radio
- Multimodal sensor
- Multimodal sensor-on-silicon (MUSE)
- Wireless SOC

Algorithms, Analysis & Simulation
- Interference avoidance & cancellation algorithms for 2.5/3G, etc
- SSF/3G simulator
- Dynamic Pricing
- Dynamic spectrum mgmt
- Interference avoidance & cancellation algorithms for WLAN, UWB, sensor net, etc
- SSF/UWB simulator

'00-01
'01-02
'02-03
Core Research: Radio/Modem & SOC Technology

- RF devices & sensors
  - Lu, Lin

- Wireless system-on-chip (SOC)
  - Lu, Lin, Raychaudhuri

- Software Radio Testbed
  - Seskar, Mandayam, Rose

- Radio modems (CDMA, OFDM, UWB,...)
  - Evans, Yates, Rose, Mandayam, Spasojevic, Greenstein
Core Research: Radio Resource Management

- Interference Avoidance/Suppression
  - *Rose, Mandayam, Yates*

- SSF simulation for WCDMA, EDGE
  - *Mandayam, Yates*

- Dynamic Pricing/Resource Mgmt
  - *Mandayam, Yates, Mau*
Core Research: Mobile Network Protocols

- WLAN enhancements & interworking with cellular/Bluetooth
  - Seskar, Bhagwat, Raychaudhuri
- Open-architecture IP-based mobile network for 3G.PP, WLAN, etc.
  - Ott, Seskar, Raychaudhuri
- Content-driven multicast routing for real-time mobile information services
  - Hirsh, Raychaudhuri, Ott
Core Research: Mobile Computing

- Infostations services
  - Badrinath

- Digital sprinklers (sensor net)
  - Badrinath

- DataMAN
  - Imielinski, Badrinath

- I Valet, content/location aware applications
  - Hirsh
WINLAB Focus Projects

- Infostations (DARPA, '98-'01)
  - Multi-disciplinary system project involving several CS & ECE faculty. PI's: Badrinath, Frenkel

- FreeBits (NSF, '00-'02)
  - Collaborative program (with Princeton & NJIT) involving both theory & prototyping. PI: Yates

- NJ Center for Wireless Communications ('00-)
  - State-funded center-of-excellence involving Rutgers, Princeton, NJIT and Stevens

- Several new focus projects (UWB, MobNet, Sensor-on-Silicon, dynamic spectrum mgmt) being scoped with govt agencies and sponsors