**ORBIT Overview: Open Access Research Testbed for Next-Generation Wireless Networking**

- ORBIT testbed aimed at facilitating at-scale, reproducible experimentation on next-gen wireless network architectures and protocols.
- 400-node ORBIT “radio grid testbed” deployed as a community resource in 2005; over 650 worldwide users in 2010, with a total 60,000 experiments conducted to date.
- Facility has had a transformative effect on wireless networking research methodology, enabling real-time prototyping at scale, providing in-depth network & radio measurements, lowering the barrier of entry for new researchers, ….
- Initially developed under NSF #CNS 0335244 (2003-08), later supported as a community testbed under NSF CNS-072505 (2008-11).
- Major equipment upgrade of radio grid also in progress under 2010 NSF CRI grant.
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- ORBIT users access the grid through a web portal, using a high-level scripting language to specify their experiment and measurements desired.
- Tools for fast imaging of radio grid with user experiment software.
- Libraries for common MAC and routing functions available to speed up experiments.
- OML (ORBIT measurement library) for automated data collection.

**ORBIT Portal Home Page** [www.orbit-lab.org](http://www.orbit-lab.org)

**ORBIT Experiment Workflow**
ORB1T Overview: Open Access Research Testbed for Next-Generation Wireless Networking

- Wide range of experiments supported by radio grid, including dense WLAN, ad hoc routing, P2P, vehicle-to-vehicle (V2V) nets, privacy/security, spectrum sensing, dynamic spectrum access, mobile content, ..
- Example of a specific experiment on scaling of video multicast in WLAN shown below:

![Topology of WLAN network evaluated](image1)

![Mcast overhead results from ORBIT experiments](image2)
ORBIT Overview: Community Testbed

Usage Statistics

- Over 650 registered experimenter groups worldwide as of mid-2010
- Wide range of research areas covered – MAC, PHY, security, routing, transport, cognitive networks, …
- ~100 published papers with ORBIT results, many more in pipeline

**By Geographic Region**

- Asia: 58%
- Australia: 17%
- Europe: 4%
- North America: 20%
- South America: 1%

**By Organization Type**

- Academic: 78%
- Commercial: 11%
- Government: 8%
- Non-profit: 1%

**Distribution of Experiments by Research Area**

- Cognitive networks
- Clean Slate PHY/MAC
- Transport Protocols
- Routing
- Driver/Kernel
- Security
- wireless applications
- PHY measurements
- 802.11 MAC+

**Experiment-hours served by Month (2009-10)**
**ORBIT Overview: Project Collaborations**

- ORBIT project has many collaborations both US and International
- Small-scale ORBIT deployments at several partner sites including NYU Poly, NICTA-Australia, INRIA-France, ...
- Some examples of joint US projects:
  - Stanford (OpenFlow for ORBIT campus network)
  - UMass Amherst (DieselNet enhancements)
  - Duke (ORCA control framework)
  - CMU (adaptive MAC using USRP2/GNU radio)
  - US Army CECOM (ad hoc routing & cognitive networks)
- Some examples of international projects:
  - NICTA-Australia (ORBIT Management Framework)
  - Toyota ITC - Japan (Vehicular network protocols)
  - 4WARD FP7 project – EU (Wireless network virtualization)
ORBIT Summary: Ongoing and Future Work

- Integration of GNU/USRP2 software defined radios and related experimenter libraries (completed ~2010)
- Major equipment upgrade to radio grid system – replacement of 400 radio nodes with next-gen platform, backend switching & computing (~2010-12)
- Resource virtualization for shared use of ORBIT resources including radio grid nodes and outdoor WiMax (~2009-2011)
- Upgrades to ORBIT Management Framework (OMF) to support vehicular mobility, federation with other testbeds (ORCA, PlanetLab, ProtoGENI, ..)
- Federation with GENI infrastructure and integration with high-speed wide-area backbone (I2, NLR)
- Support for emerging research topics including PHY-assisted security, network coding, cognitive radio, future Internet architecture
ORBİT Technical Features: Topology Control and Programmable Radios

- ORBIT radio grid testbed provides support for emulation of real-world network topologies via noise injection and packet filtering.
- Testbed recently upgraded to include programmable software defined radios (GNU USRP/USRP2) for flexible MAC/PHY experiments.

![Topology Mapping Concept for ORBIT Emulator](image)

![400-node Radio Grid Facility at WINLAB Tech Center](image)

![ORBIT Radio Grid](image)

![Programmable ORBIT radio node](image)

![Current ORBIT sandbox with GNU radio](image)
ORBIT Technical Features: Outdoor Campus Network

- Outdoor campus extensions of ORBIT intended to support “real-world” experimentation to supplement radio grid emulation
- Includes short-range WiFi and wide-area WiMax coverage
- Federated with NSF’s GENI infrastructure
ORBiT Technical Features: Support for Vehicular Mobility

- Extensions to ORBIT management software to support mobile vehicular experiments
  - Disconnection tolerance for experiment imaging & data collection
  - Spatiotemporal experiment orchestration tools

*OMF entities are in light-blue*
ORBIT Technical Features: OpenFlow Switching

- Collaboration with Stanford aimed at providing programmable wired access network capabilities to experimenters
- OpenFlow enables considerable software flexibility in routing & switching
- Implemented across both ORBIT radio grid and outdoor campus net