

Abstract

Magnets is a next-generation WiFi-based wireless infrastructure consisting of a wireless mesh with 50 nodes, and a **high-speed wireless backbone** with a raw end-to-end throughput of 108Mb/sec. The main theme in the design of the Magnets and its key distinguishing characteristic from similar efforts is **heterogeneity**. It is integrated with cellular networks based on GPRS, UMTS and next-generation wireless technology based on WiMAX. Magnets combines a **research environment** where new protocols and future architecture ideas can be deployed and experimentally evaluated. It encompasses a **production environment** where students at the TU Berlin are offered free access to the network.

Design Goals

Magnets is designed with three-fold goal:

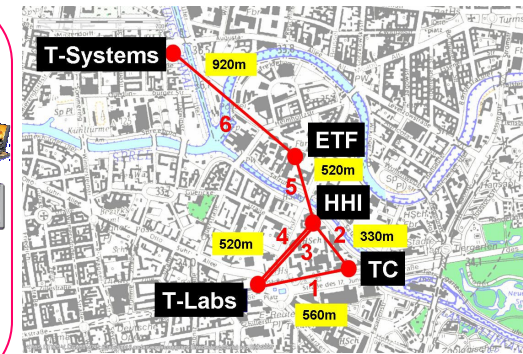
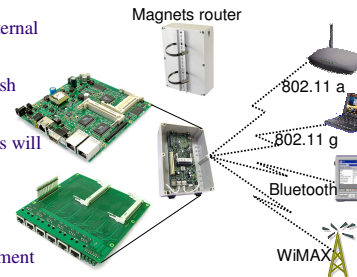
- Provide a combination of semi-production environment and research testbed
 - Traffic created by students of TU Berlin
 - Asses the research outcome suitability w.r.t realistic traffic assumptions
- Serve as a platform for investigating interoperability issues (stemming from carefully planned, high speed backbone to an untethered, low-capacity, and extended diameter urban mesh.
- Leverage and help evaluate the multi-tier design approach in the contexts of mesh environments (a design trend followed in p2p and sensor networks.

Back Bone

- Five nodes on top of high-rise with unobstructed line of sight,
- Unlicensed spectrum (2.4GHz and 5GHz),
- Workstation support for management and services,
- 12 WiFi access points (APs) supporting 802.11a/g modes (at 54Mbps) and proprietary Turbo Mode (108Mbps), with outdoor suitability, attached to routers
- APs are connected to directional antennas, 8 operating at 2.4GHz and 4 operating at 5GHz
- Shortest link 330 meters and longest link 920 meters
- Multi-path routing (T-Labs to HHI via 2 separate links (3,4) or via TC (link 2)

WiFi Mesh and Heterogeneous Nodes

- 50 Mesh Nodes, H/W: RouterBoards with multiple Mini PCI cards, ability to attach external storage attachment. Each node is equipped with 3 to 6 WiFi interfaces
- Phase I: 15 nodes will be deployed and with operational success, the diameter of the mesh will be extended in an ad hoc fashion
- By taking advantage of multiple Mini PCI slots, GPRS, UMTS and WiMax technologies will provide an opportunity to superimpose multiple network configurations
- Issues with TCP performance during vertical handovers between multiple access technologies will be explored
- Investigations will be carried out on operator-driven optimizations for resource management and load-balancing, as well as opportunities for the separation of control and data planes
- As an extension, few nodes will be furnished with low-range Bluetooth and Zigbee communication interfaces for integrating sensor networks



Magnets WiFi backbone in the heart of Berlin

Constellation of Mesh Networks in Berlin

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- 3 mesh networks in Berlin
 - Magnets (50 nodes)
 - Olsr-experiment (250)
 - Berlin Roofnet (50)
 - ☞ Islands under different administrations
 - Interconnect to investigate
 - Routing policies among different meshes
 - Multi-operators/providers (virtualization)

Preliminary Measurements on the Backbone

Link	Freq [GHz]	Channel	Level [dBm]	TCP [Mbps]	UDP [Mbps]	RTT [ms]
1	5	Dynamic Frequency Selection	-49	26.3		2
2	2.4	7	-55	13.6	12.6	3
3	2.4	1	-58	12.3	15.3	21
4	2.4	13	-56	15.5	13.3	3
5	2.4	13	-76 - -80	6.4	2.9	10
			-74 - -77	4	1.6	10
6	5	Dynamic Frequency Selection	-81	5.2	8.7	150 - 200
			-81	1.7		150 - 200

Conclusions

- How shall we deploy wireless access networks?
 - Real experiences: Antenna setup, lightning protection
 - Environmental influence (radar, interferences of APs)
- How do protocols perform?
 - Planning (raw 54 Mbps) vs measured (TCP 13-16 Mbps)
 - Future: network capacity, end-to-end throughput, latency, influence of routing protocol, SIP and video adaptation
- How far can / shall we design new protocols?
 - Open router platform for cross-layer optimization
 - Clean-slate approach: information and experimentation