Why Wireless?

Training materials for wireless trainers

The Abdus Salam
International Centre
for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

Goals

- Understand why we use wireless, and how it fits into your existing network
- Realize the limits of what wireless can achieve
- See some examples of how wireless has been used to build real-world networks

What is wireless?






wavelength (meters)

town 10000 | 1000

house 100 | 10

man 1

cat 0,1

insect 0,01

seed 0,001

(Hertz) frequency

10^4 10^5 10^6 10^7 10^8 10^9 10^{10} 10^{11}

AM radio

shortwaves

FM radio

GPS

WiFi

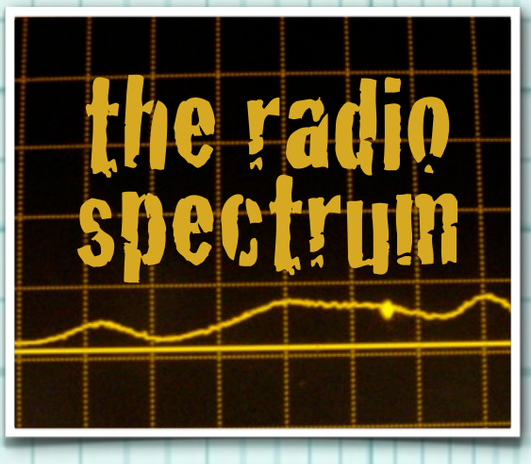
microwaves

telecom links

satellite TV

mobile phones

radars



links with submarines

radiohams

TV

Low-cost wireless: history

- Commercially available starting from early '90s ("*Spread Spectrum*" ~10k$ per link)
- Standards ratified (802.11 "WiFi") since late '90s
- After standardization: big "boom", lower costs
- Widely adopted for indoor, SOHO, industry, academic, etc.
- Some commercial solutions have been developed and marketed up to medium-long distance (1-20 km)
- Today and tomorrow: ???

cost per link:
>10.000 US$ in 1992
<100 US$ in 2009

Low-cost wireless: limits

- **1-5 km:** easy, reliable
- **5-20 km:** difficult, LoS required, QoS issues
- **20-100 km:** *experimentation*
- **>100 km:** *very difficult* (but possible)
- interference and co-location → need for planning
- regulations (ISM band) → need for planning
- variable costs (according to performance, reliability)

Low-cost wireless: a few numbers

- Throughput: 1-54 Mbps (“old” standards), now higher
- Channels at 2.4 GHz: only 3 non-overlapping channels. Many more at 5 GHz (if available)
- TX power: < 600 mW
- power consumption: 0.3-10W (usually at 12 volts, PoE)
- Cost: range from 100US$ to 5.000US$ per link
- Users per base station: 20-50 max

Low-cost wireless: examples

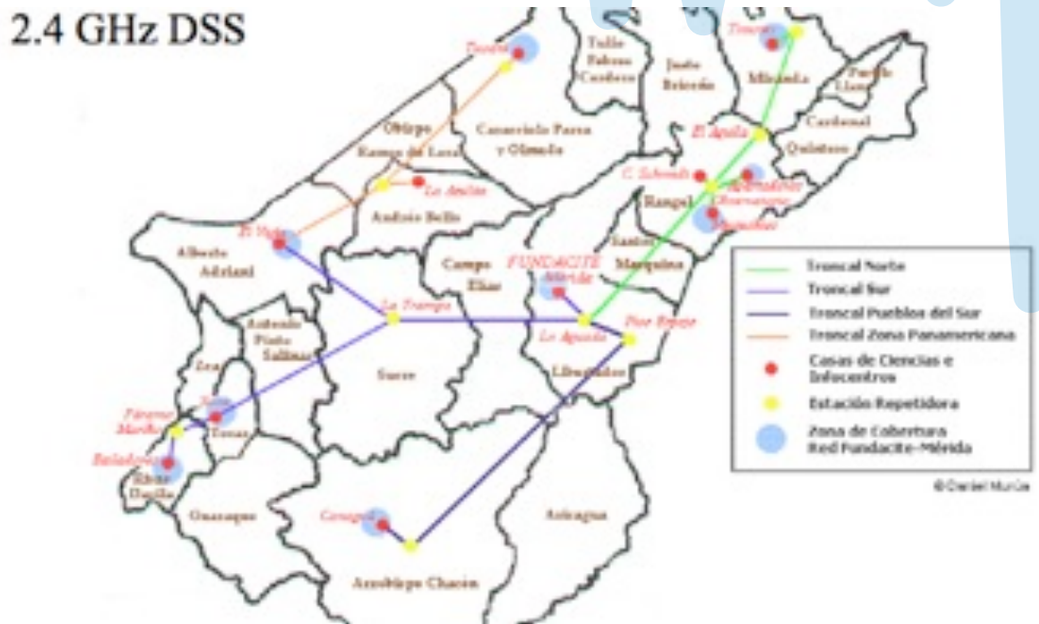
- Wireless LANs:
  - indoor/outdoor network distribution among many clients
  - typical distance: 10 - 100 m
- Point-to-Multipoint structure:
  - master station (access point, AP)
  - client station (Embedded miniPCI, PC card, USB device, wireless bridge)

Low-cost wireless: examples

- Wireless Metropolitan Area Networks (MANs):
  - used by ISPs (Point-to-Multipoint)
  - typical distances: 1-10 km
  - a medium to large number of clients
  - coexistence problems (max. 3 non-overlapping channels)
  - line-of-sight, security issues, remote management

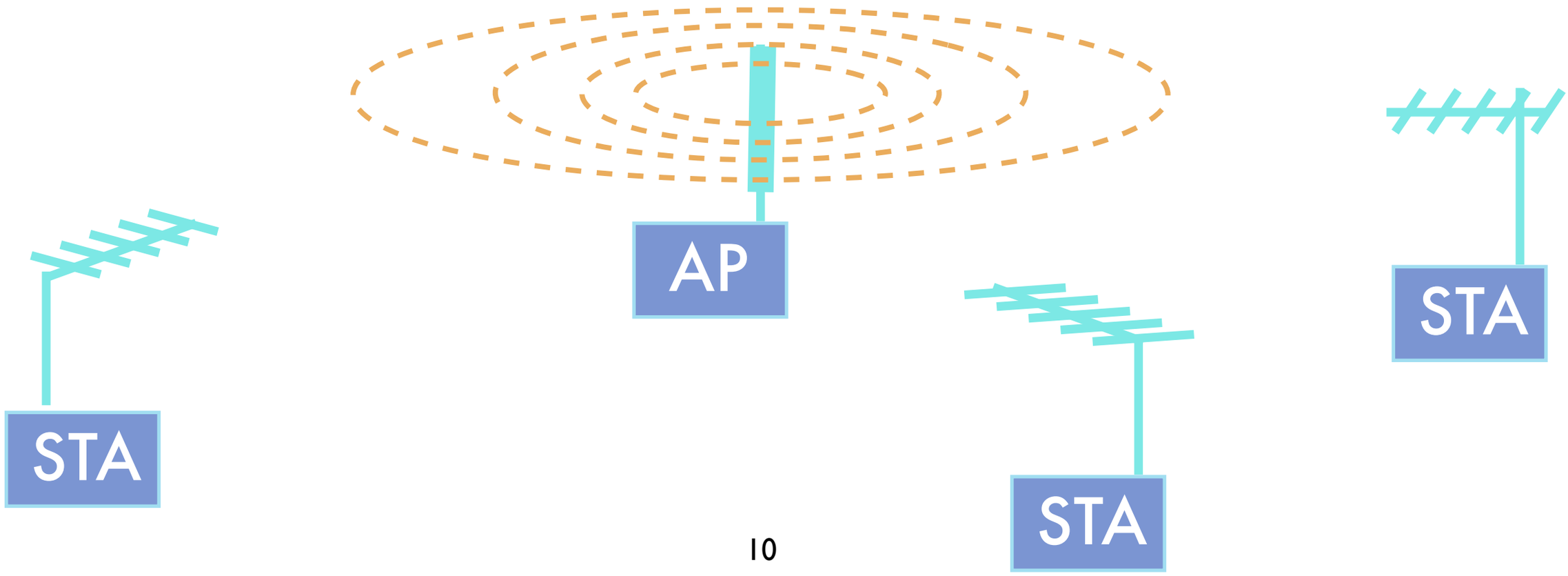
Low-cost wireless: examples

- Wireless MANs:
  - for private institutions/companies:
  - Point-to-Multipoint
  - Point-to-Point (larger distance, fewer coexistence problems)
    - line-of-sight, security issues
    - radio link planning and design



Low-cost wireless: P2MP MANs

- Point-to-Multipoint
- Star topology, one AP, many stations
- Omnidirectional antenna for AP
- Directional antennas for stations



Low-cost wireless: planning

- Distance, obstacles, power budget
- Site survey, antenna installation
- Detect and mitigate interference
- Powering and protection
- Grounding and bonding
- Security (theft/vandalism)
- Network Layer (TCP/IP)

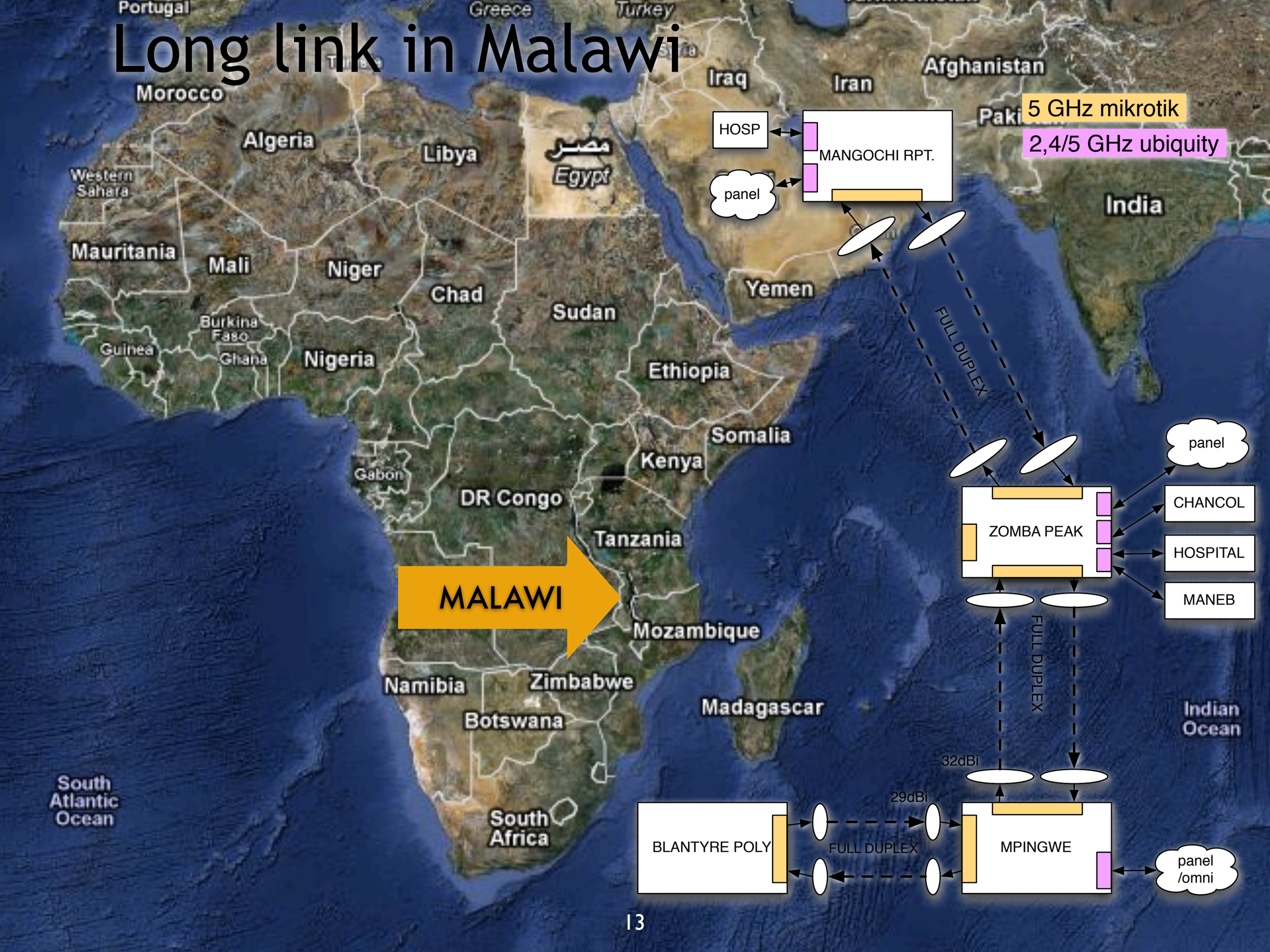
It is possible to build a very inexpensive long distance radio link with off–the–shelf devices and low cost antennas, but good planning is needed!

Low-cost wireless: long links

- From our field experiences, what is possible?
  - 2006: (Venezuela, 279km, World record for WiFi link)
  - 2007-8: Installation of a Test Bed link: 130km @2.4 + 5GHz (to study and compare the technologies)
  - 2006-8: Malawi (50+100 km @5GHz, throughput 20Mbps full duplex, double link for redundancy)

Let's analyze the last case, to show you what is it possible!

Long link in Malawi



Long link in Malawi: goal

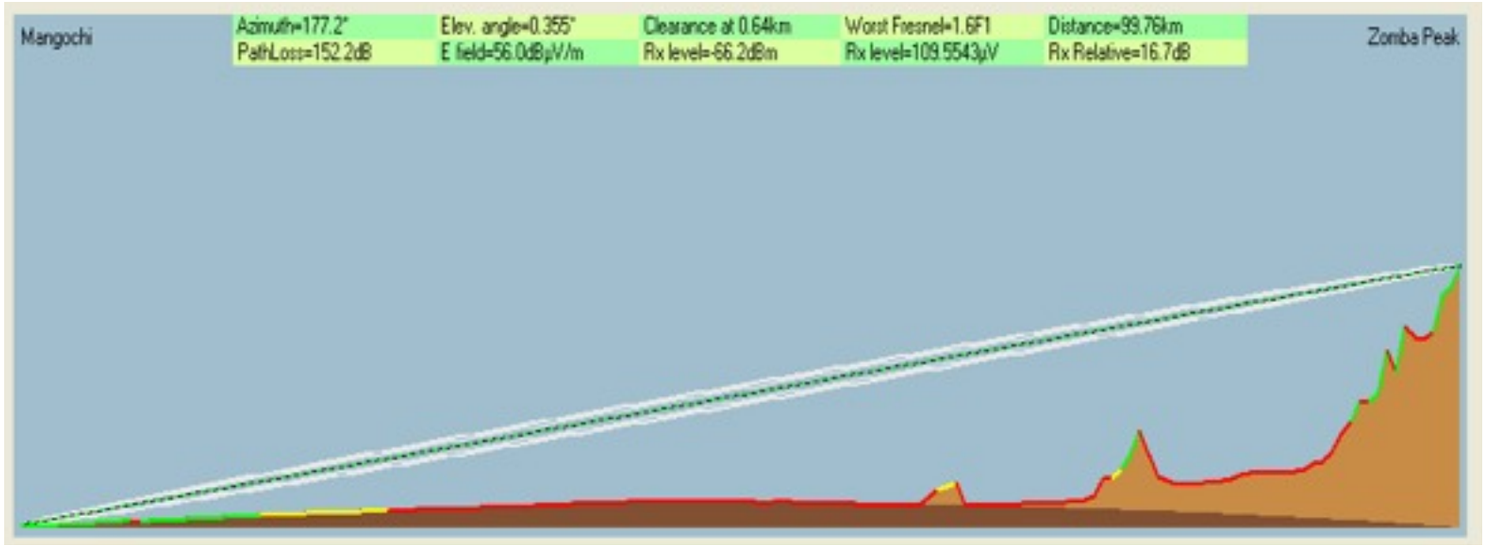
- Set the goal: to install a modern communication network to support health provisioning in hospitals and universities across Malawi

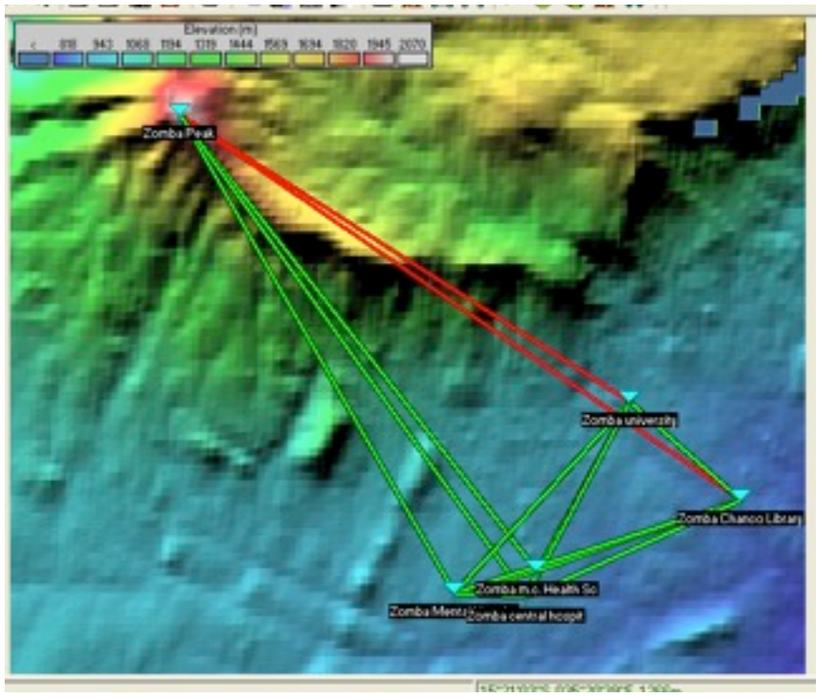
Long link in Malawi: where

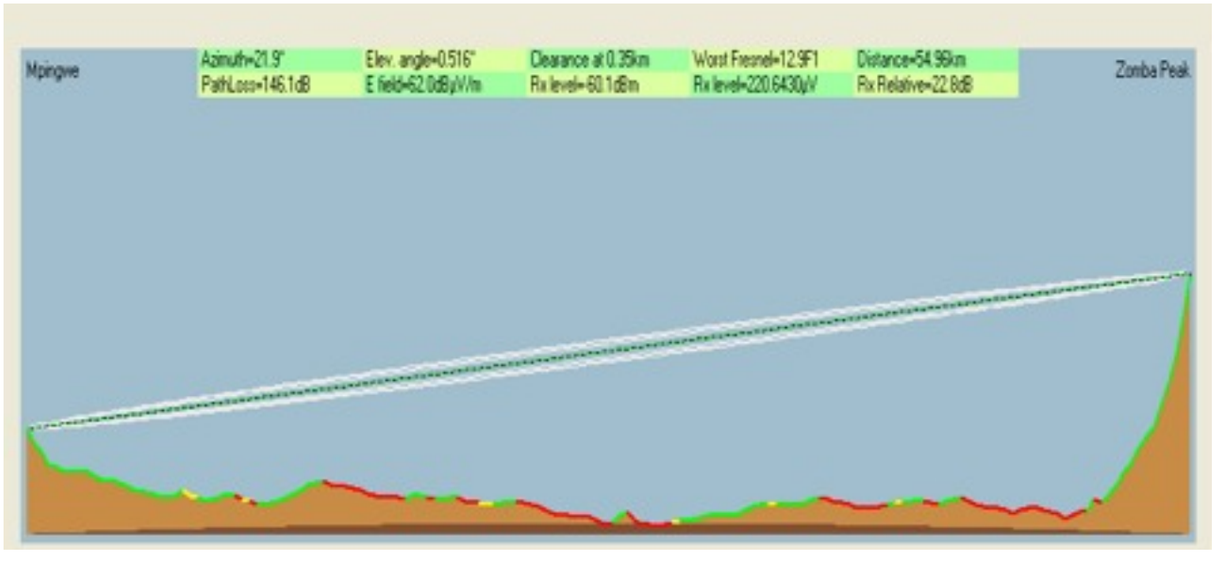
- 3 hospitals in 3 different towns (distance by road ~200 km)

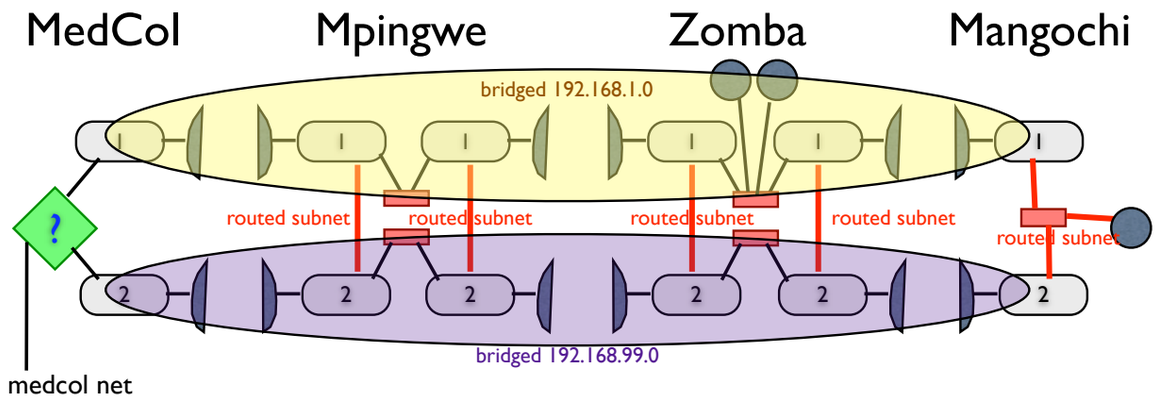
Long link in Malawi: planning

- design the network, plan the survey, setup and test activities







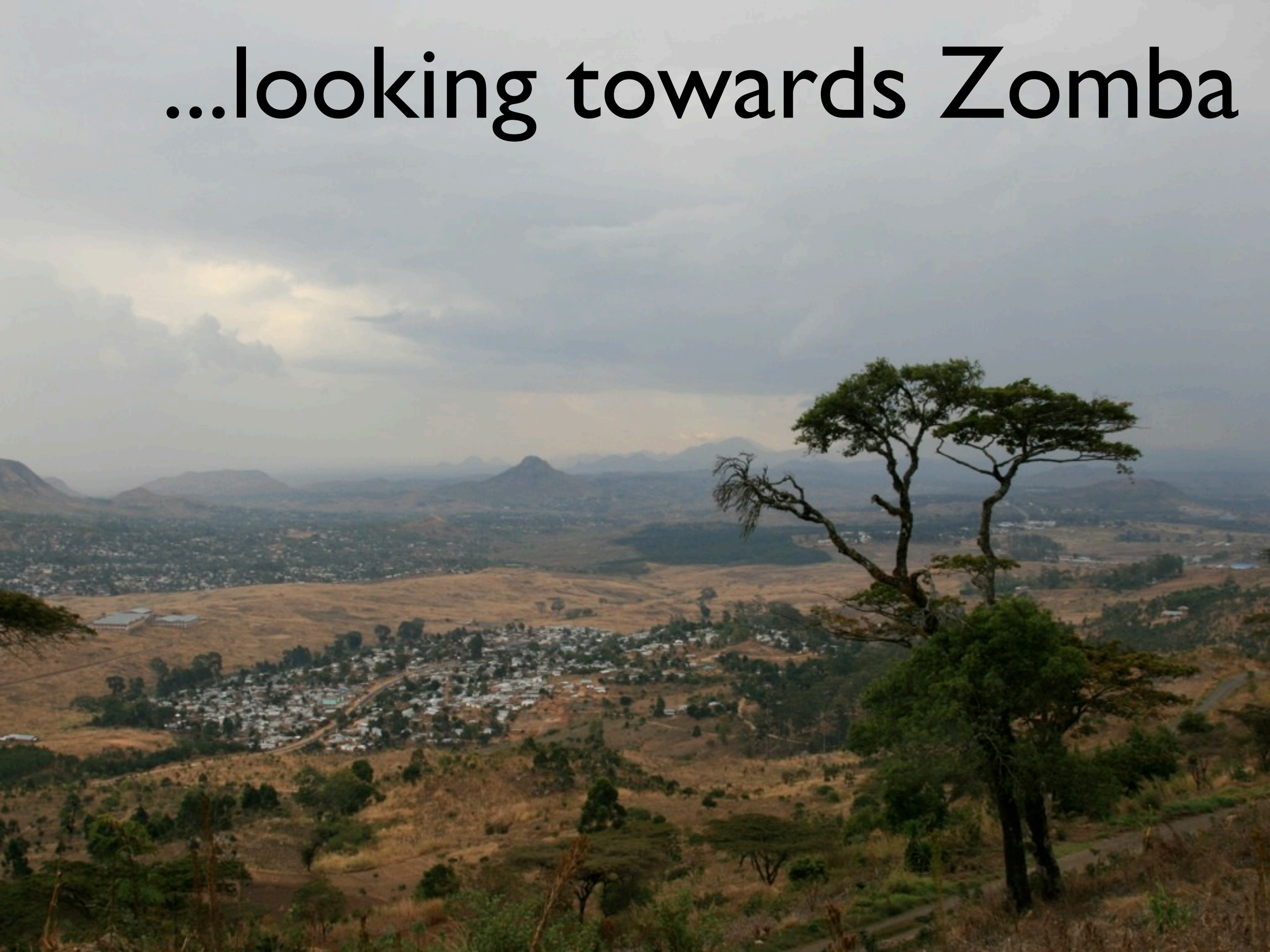


Long link in Malawi: towers

- thanks to a local operator, we had access to towers

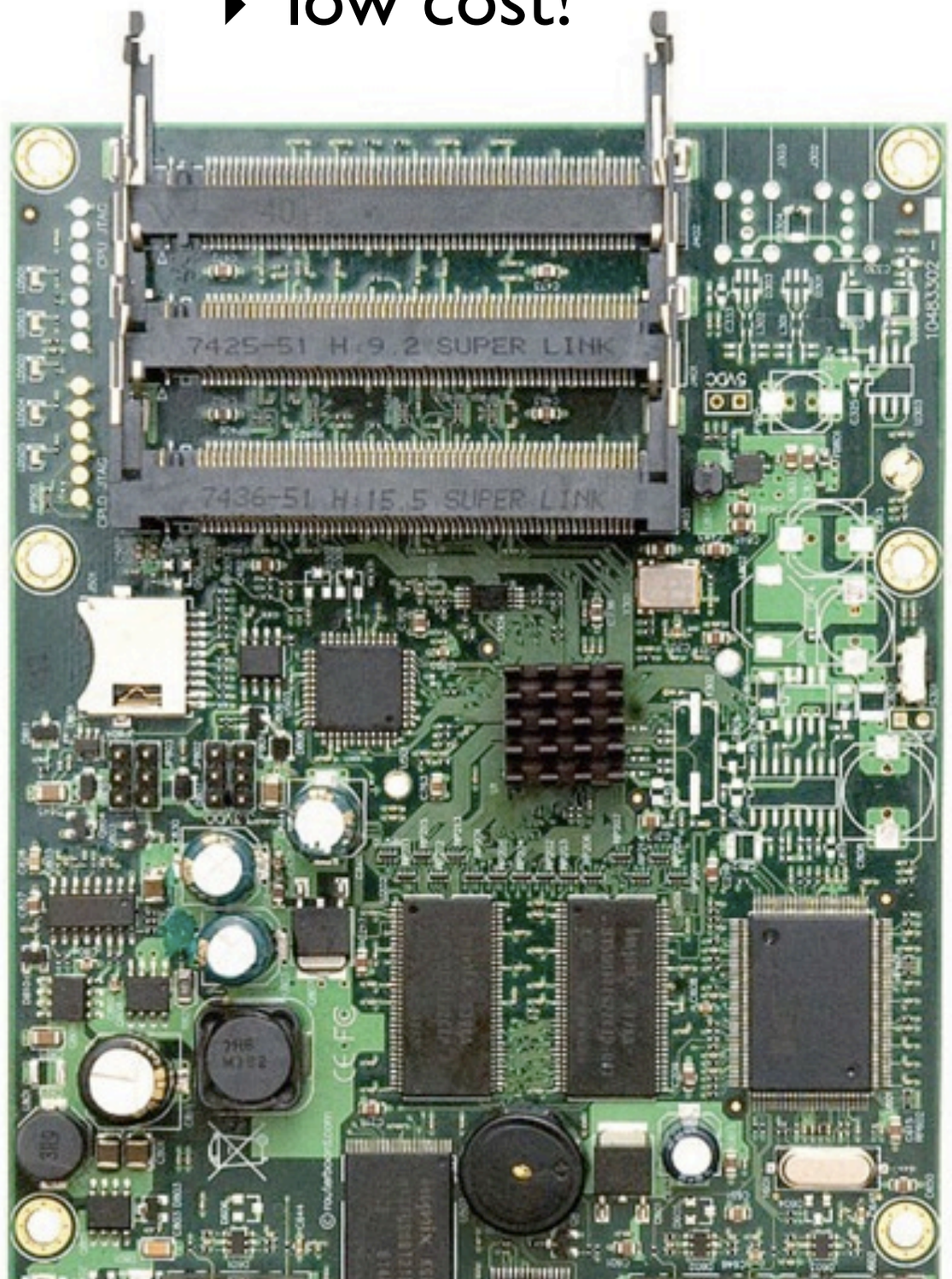
Mpingwe

...looking towards Zomba



Long link in Malawi: equipment

- low cost!



Mikrotik RouterBOARD 433 with Atheros AR7161 680MHz Network CPU (overclock to 800MHz), 128MB DDR RAM, 3 10/100 ethernet ports with MDI/X, 3 miniPCI, microSD, 64MB NAND with RouterOS L5.

SAVE 17%

Supports POE on ether1: 10 to 28vdc on un pairs (no power over datalines), or 10-28vdc jack support. Overall dimensions: 150mm x (5.9in x 4.13in).

New product - in stock!

Details

SKU	RB/433AH
Quantity in stock	66 item(s) available
Weight	0.35 lbs
Documentation (PDF)	Brochure
Price:	**$149.00**

Options

Quantity 1

Quantity:	10-19 Items	20-59 Items
Price:	$144.00	$140.00

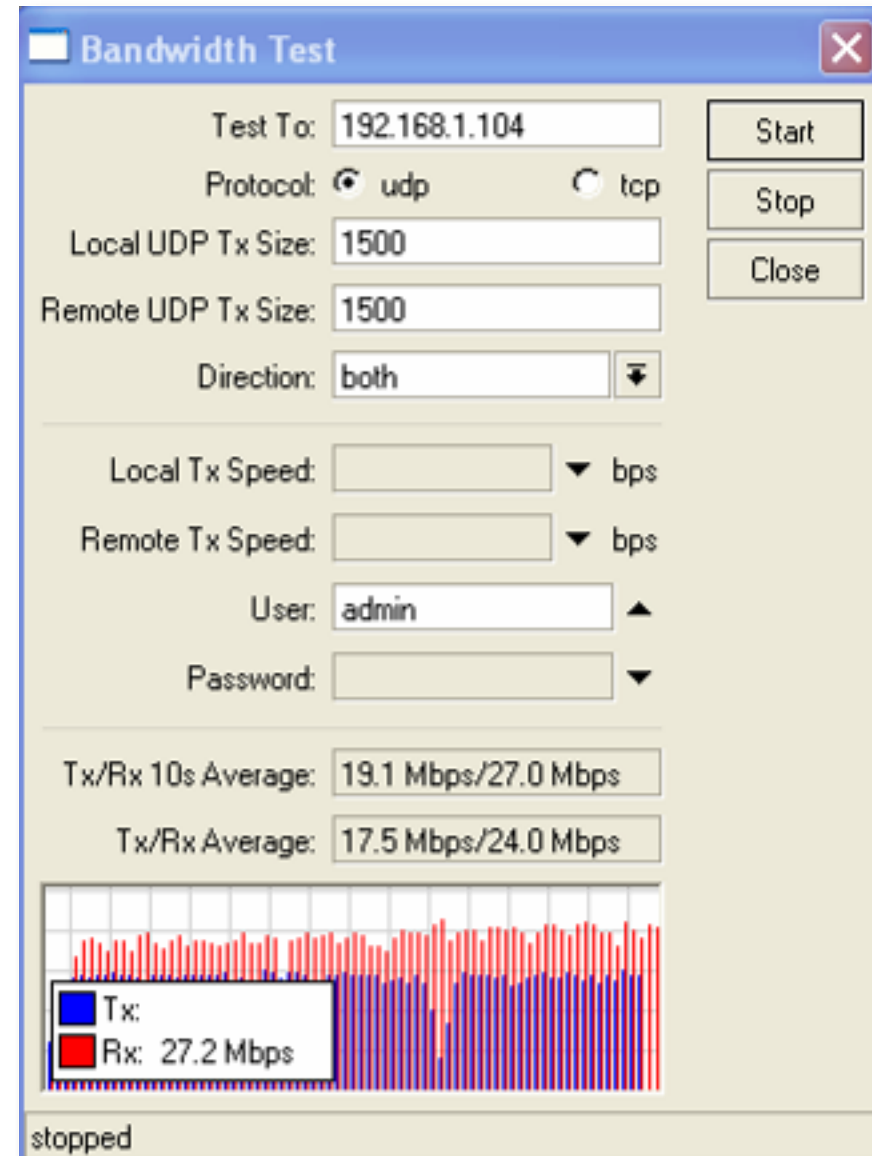
Add to cart Add to wish list

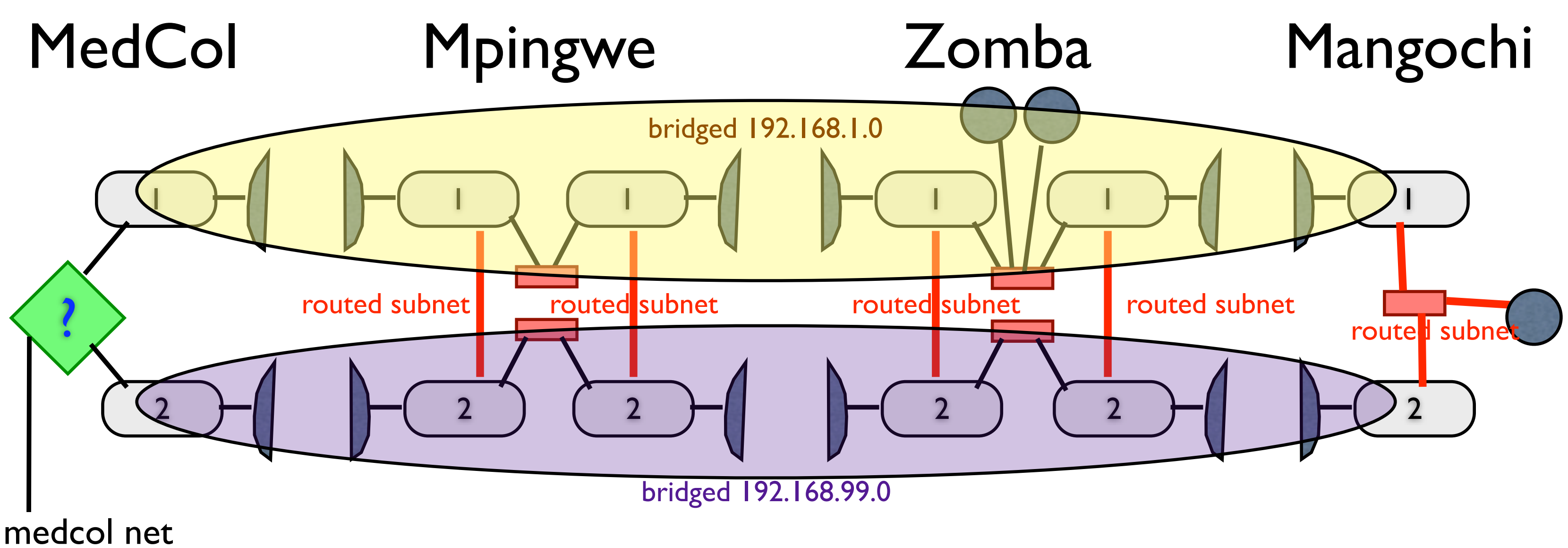
243,96€

Order or Qty		Price
> 500€	5+	**239,08€**
> 1000€	10+	**234,20€**
> 2000€	20+	**229,32€**
> 5000€	50+	**224,44€**
> 10000€	100+	**219,56€**

Long link in Malawi: results

- > 20 Mbps full duplex for each link
- Two independent links from Blantyre through Mpingwe, Zomba, and all the way to Mangochi.





Thank you for your attention

For more details about the topics presented in this lecture, please see the book ***Wireless Networking in the Developing World***, available as a free download in many languages:

http://wndw.net/