

# A Software-Based Controller for Efficient Wireless Networks

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# On the shoulder of giants.



# SCIFI development



SCIFI (Sistema de Controle Inteligente para rede sem Fio) is an open platform for the centralized control of wireless networks.

It has gone through three one-year long development phases:

1. the kernel, which comprises the controller and the changes to APs running OpenWRT
2. the graphical interface and reports
3. the monitoring system



# OpenWRT



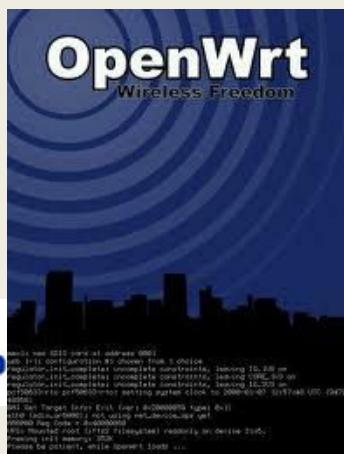
It is a Linux for embedded systems

Allows customizing the Access Points.

Opens the possibility of hardware independence (many vendors)



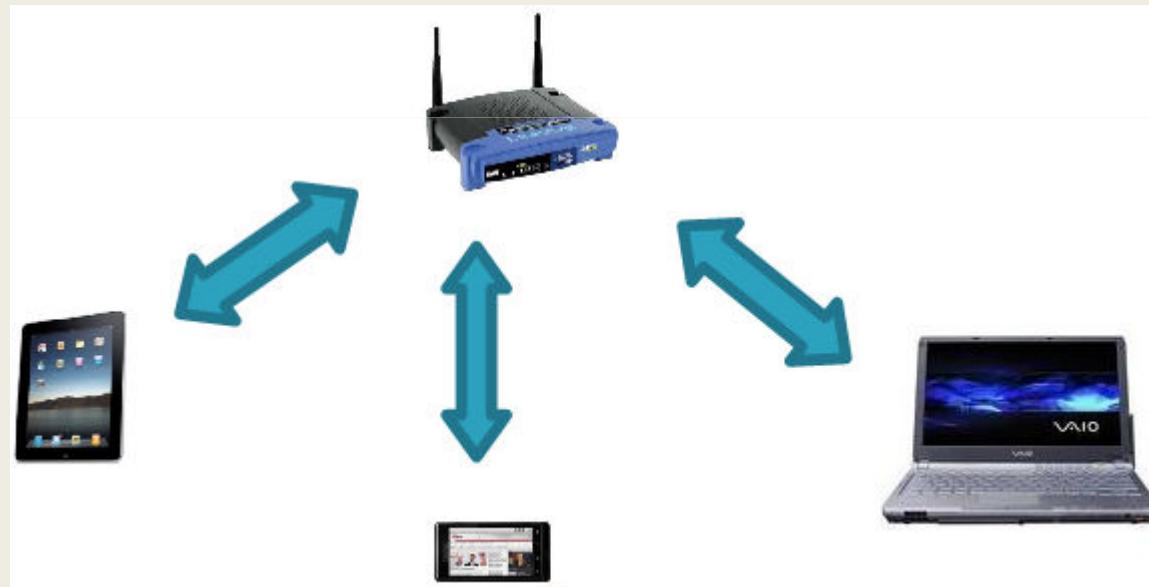
[www.openwrt.org](http://www.openwrt.org)



# Wireless Network Evolution



## Hotspots



# Corporate Networks



# The Problem with Scale



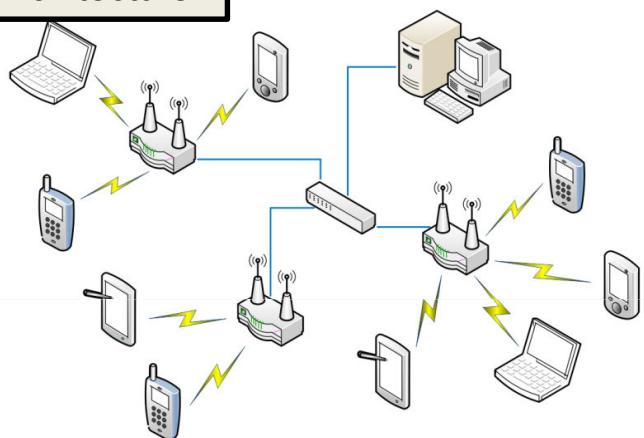
- For large networks
  - Centralized management
  - Automatic/centralized configuration
  - Monitoring
- Solutions
  - Proprietary enterprise networks
    - Cisco, Aruba, Xirrus, Motorola
  - SCIFI
    - Open software
    - Low-cost SOHO APs
    - Automatic and dynamic configuration



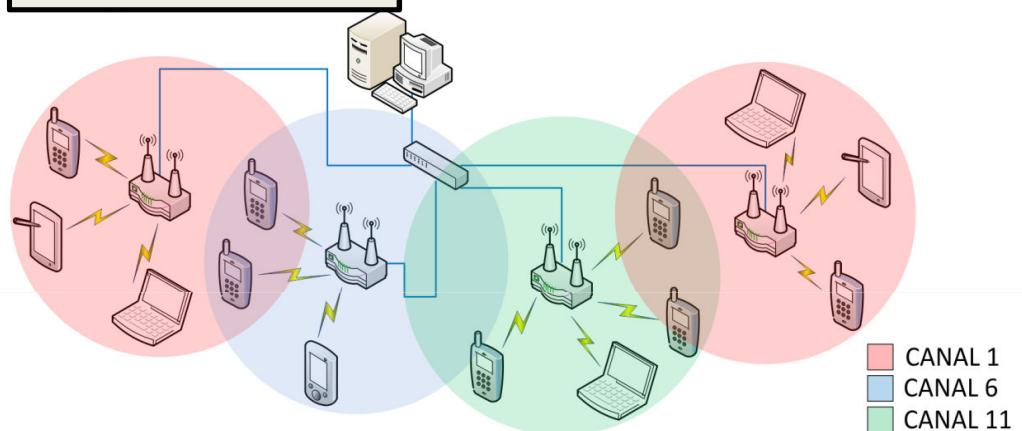
# SCIFI



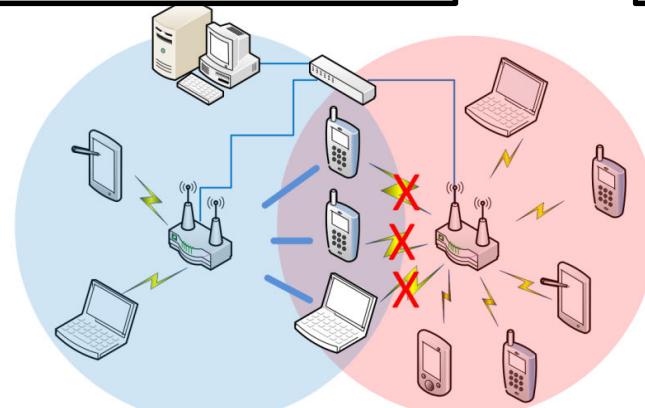
Architecture



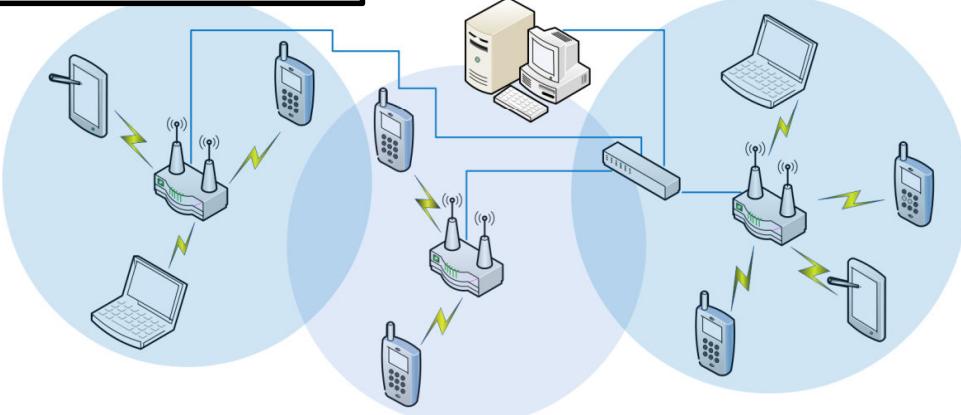
Channel Selection



Load Balancing



Power Control



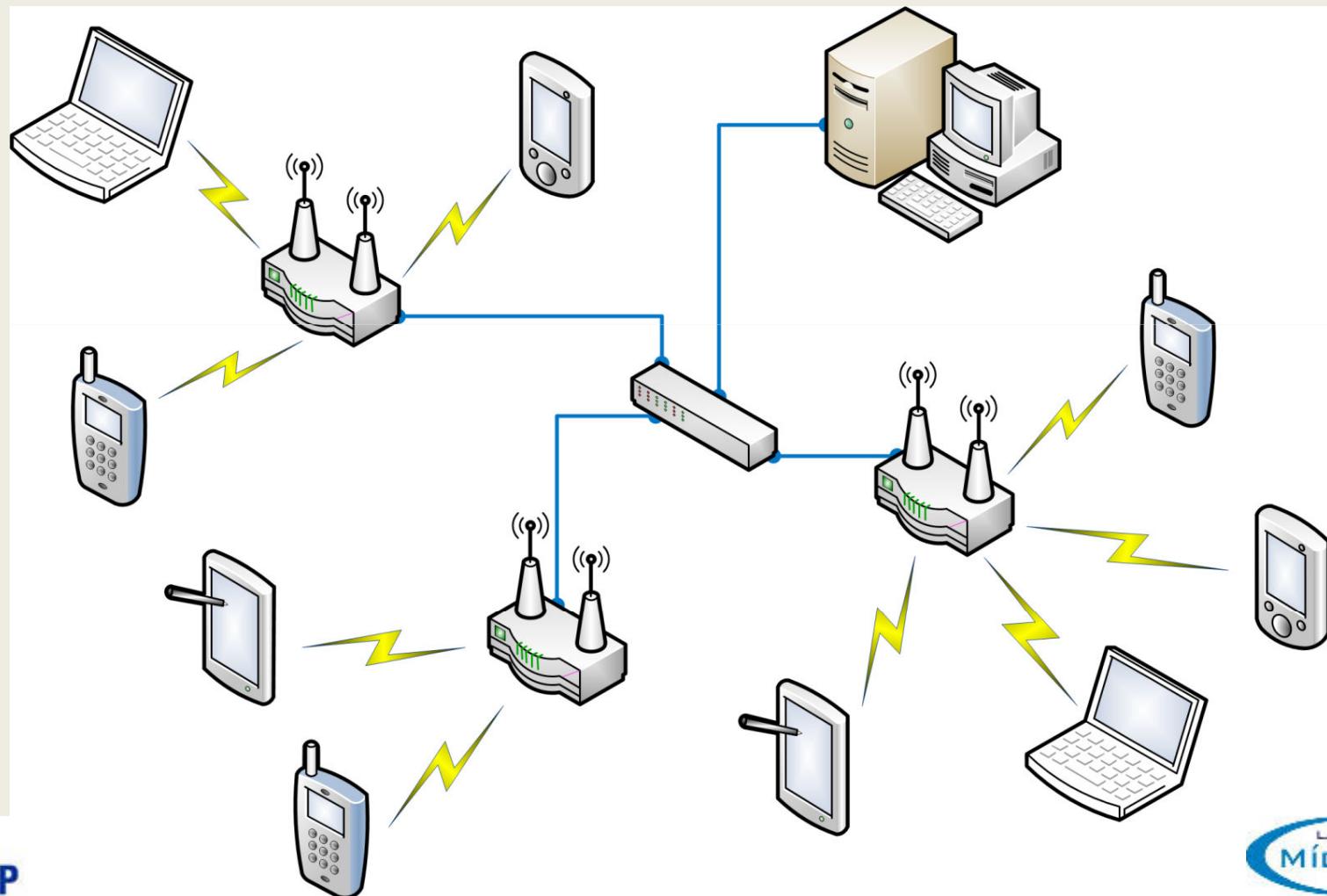


# Paradigm shift

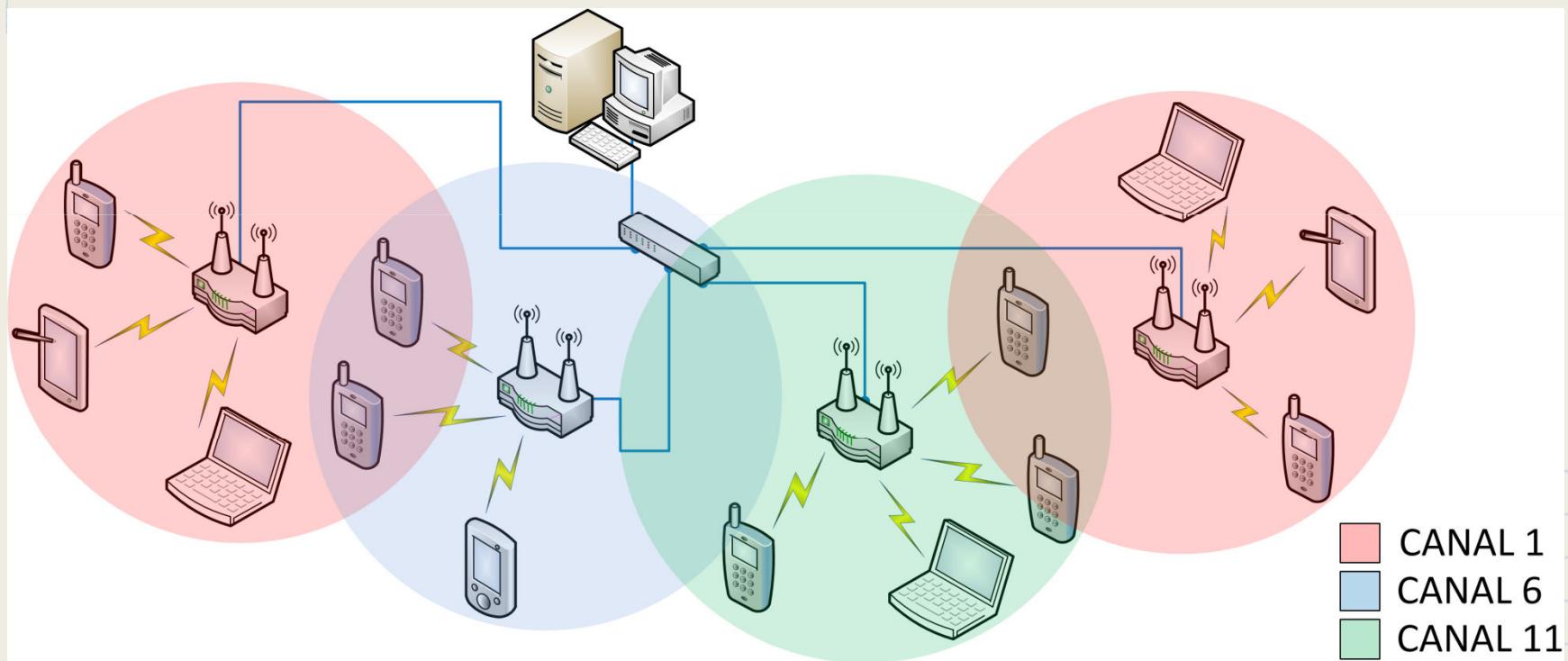
- Open source software – allows cooperative development, adapting to local needs
- Commodity hardware – low cost, many vendors, choice of best cost/benefit
- Easy to install - no site-survey
  - Maximize the number of APs – Low cost HW makes that feasible and increases the bandwidth available
  - Low cost APs do not support a large number of users. Thirty is a good compromise
  - Thirty users per AP allows 2Mbps for each – that is true even for expensive access points



# Architecture



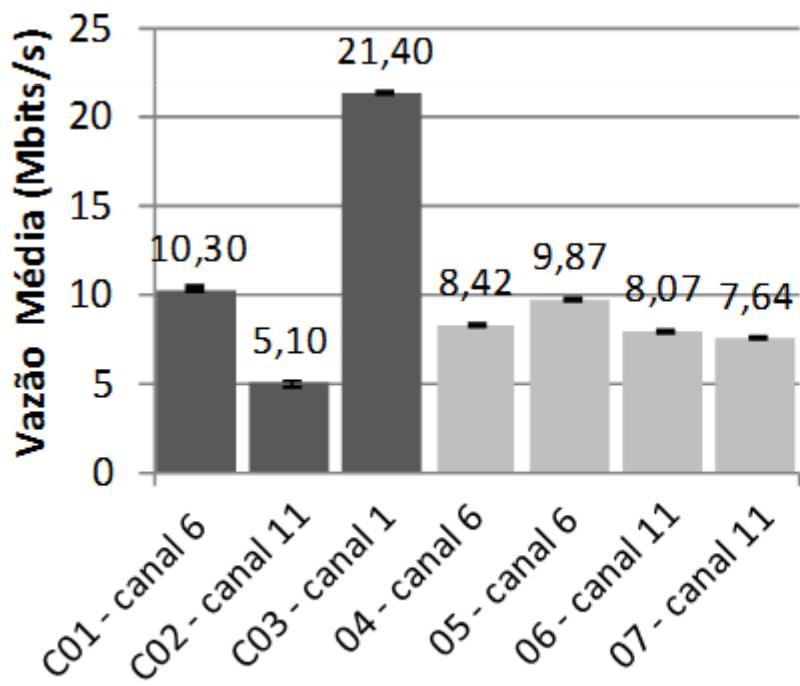
# Channel Selection



# Improvements

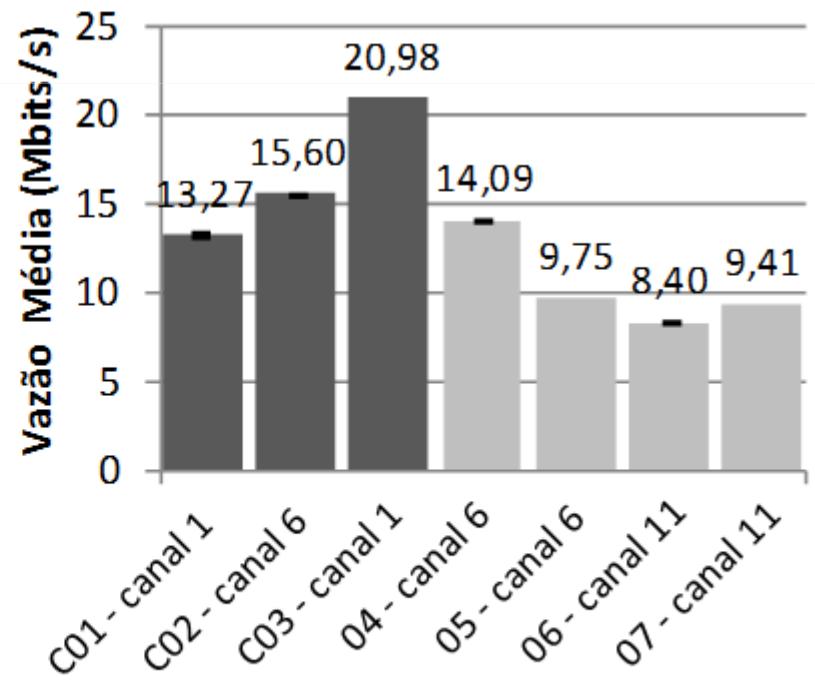


(a) Vazão Média para cada ponto de acesso da rede configurada desconsiderando-se redes vizinhas interferentes.



Throughput per access point without SCIFI

(b) Vazão Média para cada ponto de acesso da rede configurada pelo controlador SCIFI.



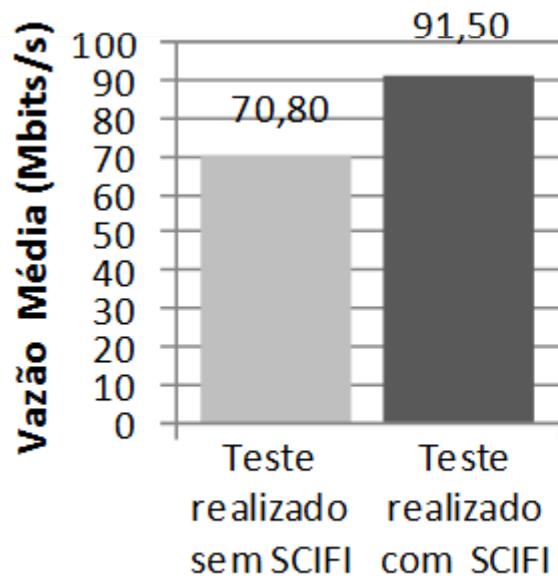
Throughput per access point with SCIFI

# Good Neighbor

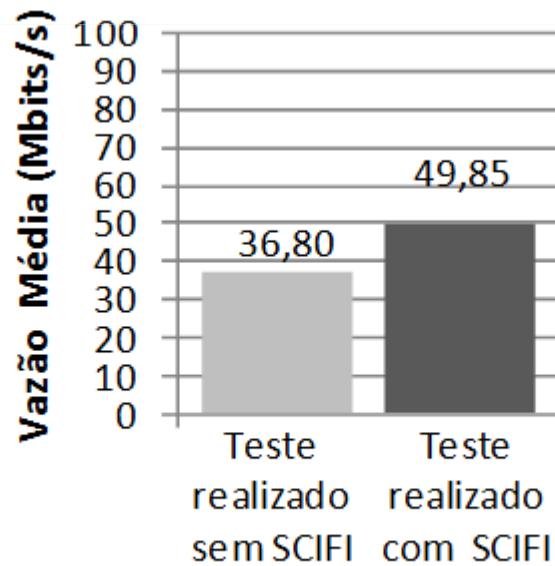


- Aggregate throughput (respectively: all APs, controlled APs, not controlled APs, each graph showing throughput without and with SCIFI)

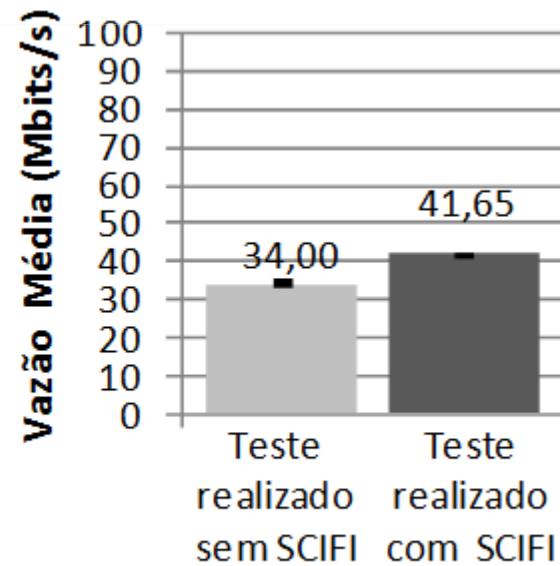
(a) Vazão Agregada Média da rede incluindo seus sete pontos de acesso.



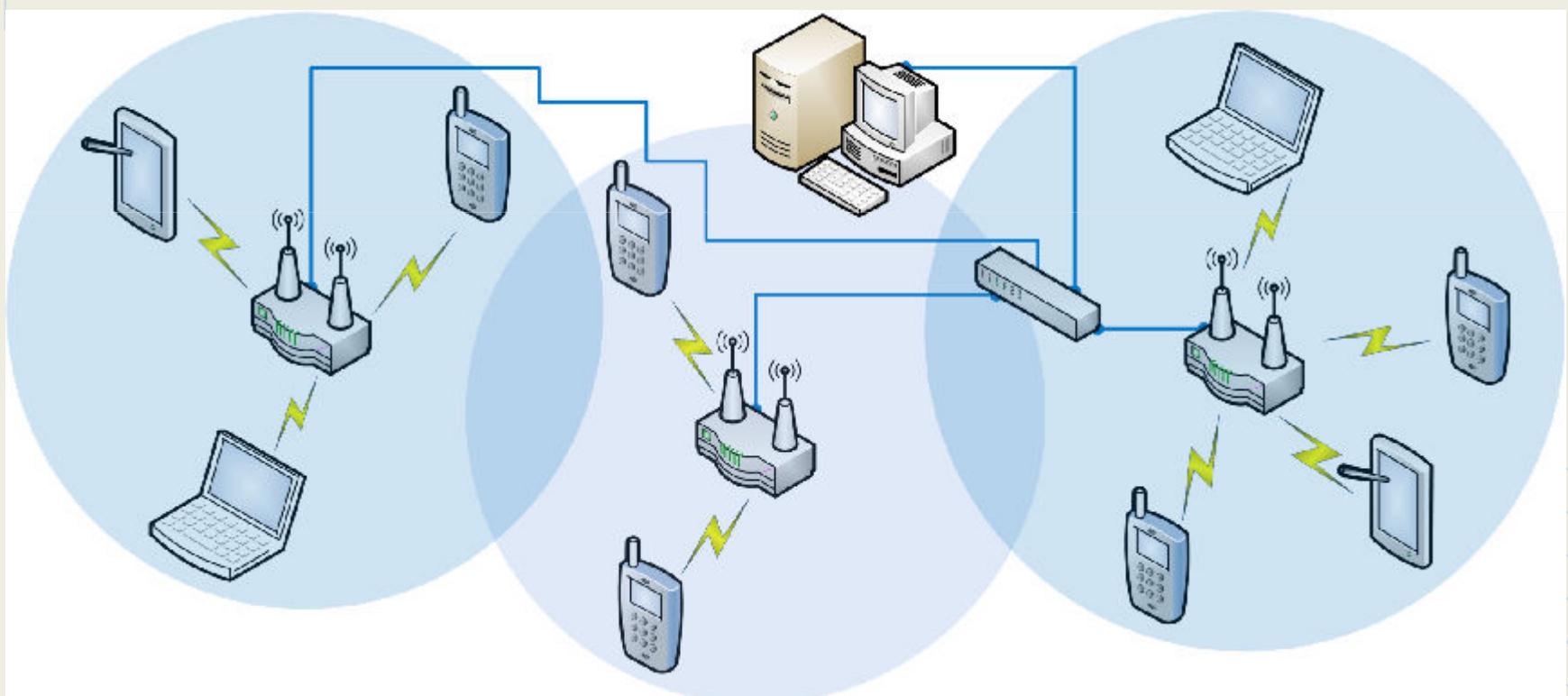
(b) Vazão Agregada Média dos três pontos de acesso controlados (C01, C02, C03)



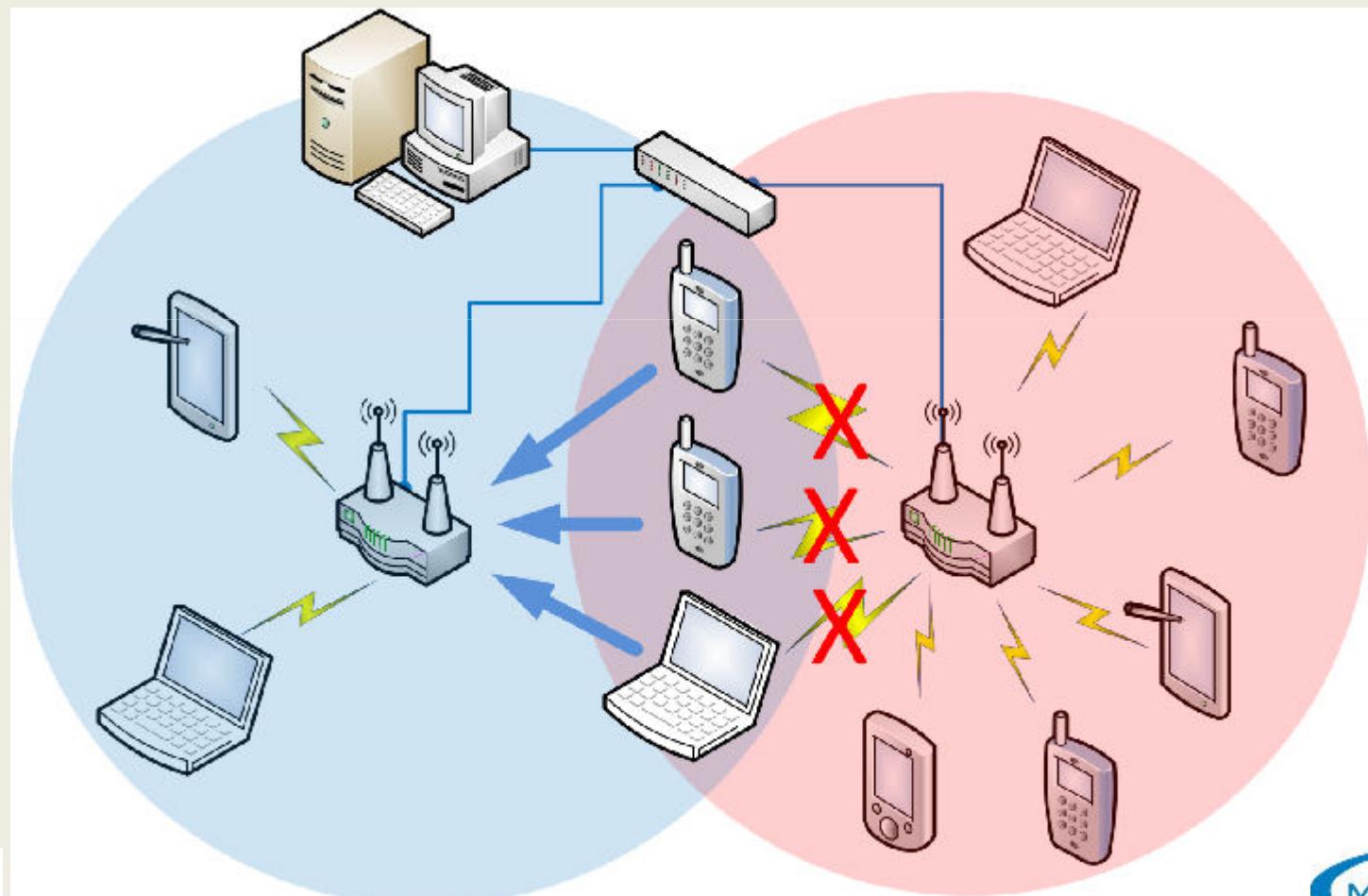
(c) Vazão Agregada Média dos quatro pontos de acesso não controlados (04, 05, 06 e 07)



# Power Control



# Load Balancing



# Management Interface



Bem Vindo! - ATENÇÃO: Há 3 pontos de acesso incomunicáveis

Bem vindo à sessão administrativa do Sistema de Controle Inteligente para Redes Sem Fio (SciFi). Utilize os links contidos na barra esquerda para realizar ações.

Antes de adicionar Pontos de Acesso, adicione uma Região de Controle. Todo Ponto de Acesso deverá estar contido em uma Região de Controle. O controlador funciona automaticamente, entretanto, se desejar forçar a execução de comandos utilize o link "Executar Comandos do Controlador". Altere parâmetros do controlador através do link "Editar Configurações do Controlador".

Filtro:

Satélite

Google

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Legenda:

# Management Interface



The image shows a screenshot of the SCIFI Management Interface. It consists of two main panels:

- Bem Vindo!** (Welcome): This panel features a large "SCIFI" logo at the top. Below it, there are several icons representing different management functions. A message in Portuguese reads: "Antes de adicionar novos dispositivos, adicione os parâmetros de rede necessários. O controlador funciona automaticamente." At the bottom, there are logos for UFF (Universidade Federal Fluminense), Mídiacom, Instituto de Computação, and RNP.
- Executar Comandos do Controlador** (Execute Controller Commands): This panel also features a large "SCIFI" logo. It contains a grid of icons with corresponding labels:
  - Reiniciar Controlador (Restart Controller)
  - Forçar Reinicio dos Temporizadores (Force Timer Reset)
  - Forçar Seleção de Canal (Force Channel Selection)
  - Forçar Controle de Potência (Force Power Control)
  - Forçar Escaneamento do Ambiente (Force Environment Scan)
  - Forçar Coleta de Dados dos Usuários (Force User Data Collection)
  - Reiniciar todos os Pontos de Acesso (Restart all Access Points)
  - Forçar Análise de Configurações dos Pontos de Acesso (Force Access Point Configuration Analysis)

# Management Interface



**MENU** Visualizar Pontos de Acesso

	MAC	IP	Localização	Região	Canal	Lista de Potências	Potência Atual	Número de Usuários	Status	Limite de Carga Baixa	Limite de Sobrecarga	Informação de Scan	Ações
1	00:27:22:████	10.0.0.10	Engenharia 5º Andar - Entrada Principal	Engenharia	1	{6,8,10,12,14,16,18,20}	6	0	Carga Baixa	10	25		 
2	00:27:22:████	10.0.0.11	Engenharia 2º Andar - Entrada Principal	Engenharia	1	{6,8,10,12,14,16,18,20}	6	0	Carga Baixa	10	25		 
3	00:27:22:████	10.0.0.12	Engenharia 2º Andar - Entrada Secundária	Engenharia	1	{6,8,10,12,14,16,18,20}	6	0	Carga Baixa	10	25		 
4	00:27:22:████	10.0.0.13	Laboratório MídiaCom	Engenharia	11	{6,8,10,12,14,16,18,20}	20	0	Carga Baixa	10	25		 
5	00:27:22:████	10.0.0.14	Engenharia 1º Andar - Entrada Secundária	Engenharia	1	{6,8,10,12,14,16,18,20}	6	0	Carga Baixa	10	25		 
6	00:27:22:████	10.0.0.15	Auditório da Engenharia	Engenharia	6	{6,8,10,12,14,16,18,20}	6	1	Carga Baixa	10	25		 
7	00:27:22:████	10.0.0.16	Auditório da Engenharia	Engenharia	1	{6,8,10,12,14,16,18,20}	6	0	Carga Baixa	10	25		 
8	00:15:6D:████	10.0.0.19	Quiosque do Cláudio (Eng)	Engenharia	11	{6,8,10,12,14,16,18,20}	6	0	Carga Baixa	10	25		 

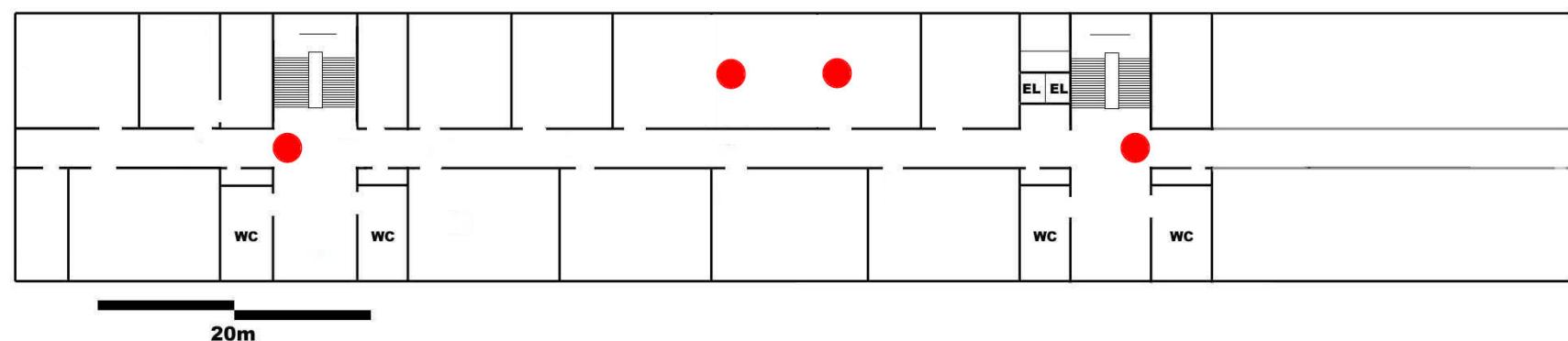
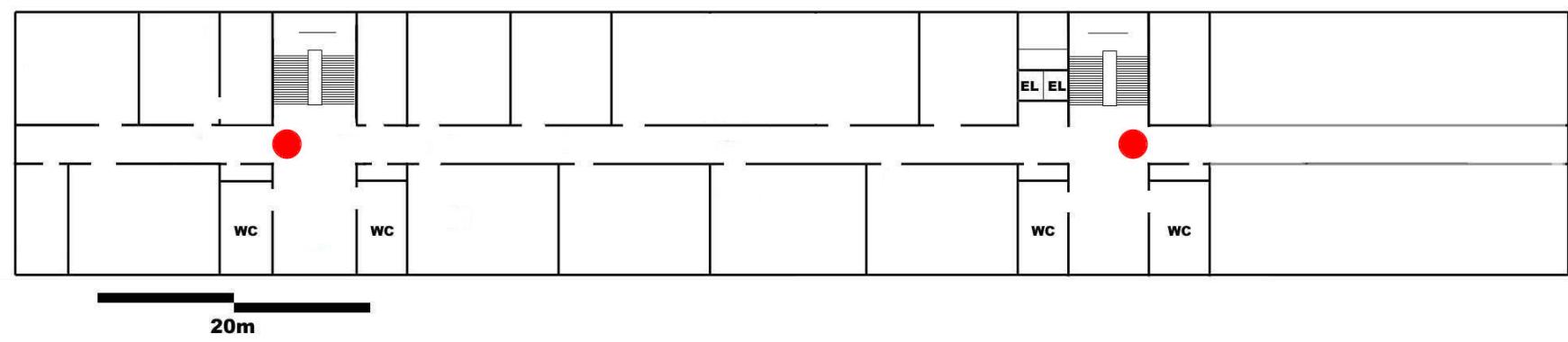
# Pilot



- UFF uses SCIFI for wireless coverage on its campi
  - Managed network
  - Less expensive than other similar solutions
  - More configurable than other software controller solutions
- Allows expansions
  - Access control
  - Security cameras
- Pilot at Praia Vermelha campus
  - Engineering, CS, Architecture, Physics



# Indoor Network



# Photos



# Outdoor Nework



# Photos



# Development



Initial development was supported by RNP through work group calls

Some institutions that installed SCIFI, like Universidade Federal de Ouro Preto are helping with development

A lot has been done, but much work remains!





# Block Diagram



# GitHub



Software available at GitHub

<https://github.com/Sci-Fi>

We will be redesign SCIFI to make it more streamlined.

Help is welcome!



# Conclusions



- SCIFI is a low cost solution for large scale wireless networks.
- Hardware independent (Ubiquiti, DLink, Linksys, TPlink) – many Aps are compatible with OpenWRT
- Easy to install
  - Number of APs is calculated from the number of simultaneous users divided by 30
  - Areas for scalability
  - Automatic and dynamic configuration





# Obrigado!

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