

ESCUELA SUPERIOR POLITECNICA DEL LITORAL



INGENIERÍA EN ELECTRÓNICA Y TELECOMUNICACIONES

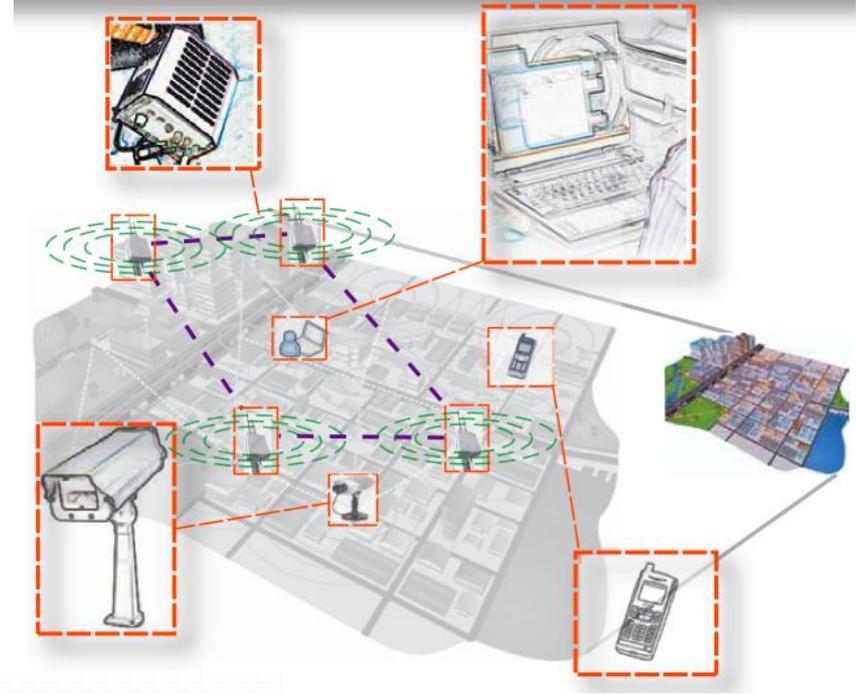
TEMA :

“Estudio y diseño de un nodo de acceso, que sirva como piloto para la implementación de una red Wireless Mesh en la Facultad de Ingeniería en Electricidad y Computación de la ESPOL”

INTEGRANTES:

MILTON CAÑARTE MANRIQUE
DANIEL PARRA LOAYZA

WIRELESS MESH NETWORKS

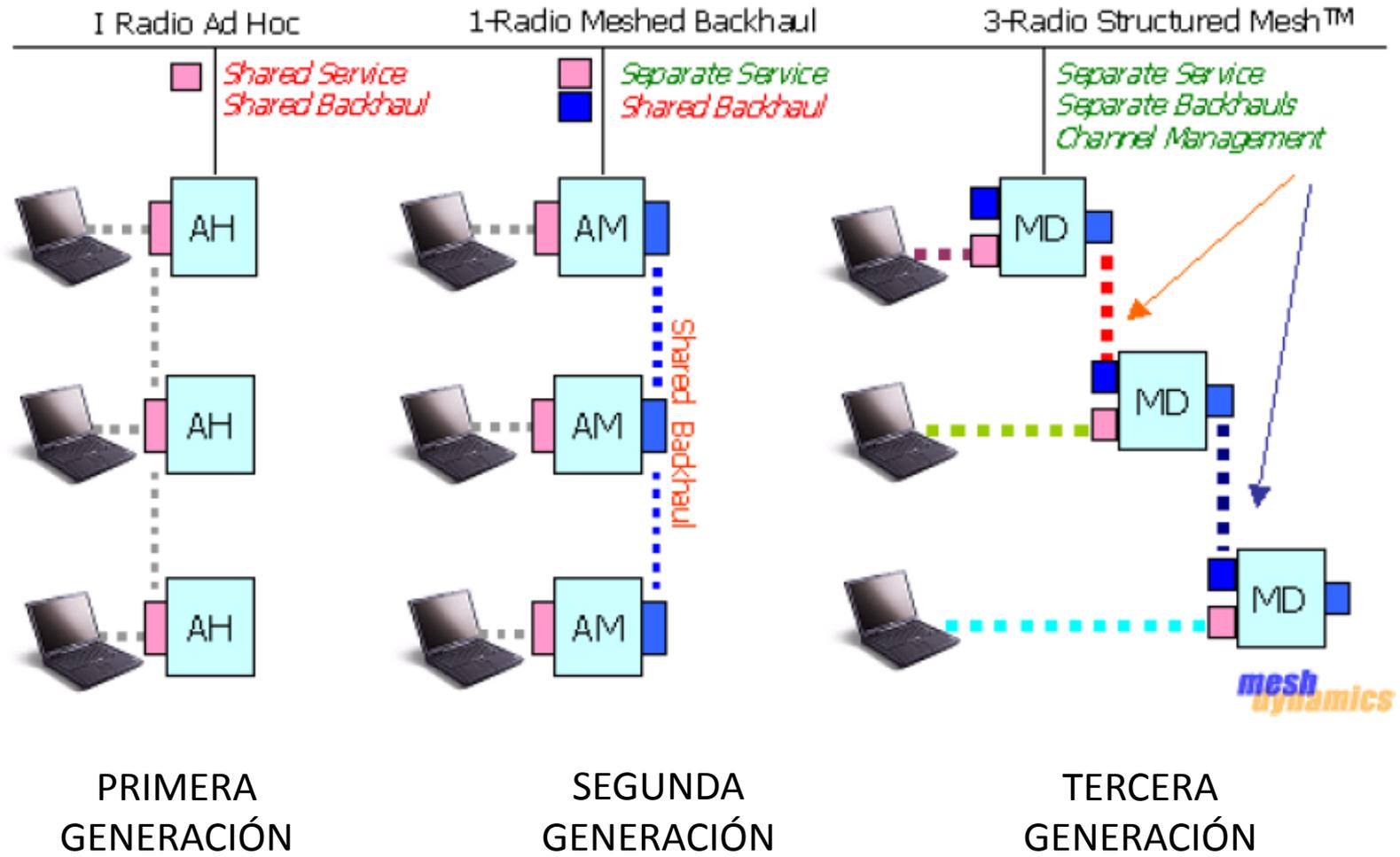


WIRELESS MESH NETWORKS

CARACTERÍSTICAS:

- ✓ REDUNDANTES
- ✓ FÁCIL DESPLIEGUE
- ✓ AUTO-REGENERABLES
- ✓ AUTO-CONFIGURABLES
- ✓ AUTO-REPARACIÓN DE RUTAS
- ✓ ROBUSTAS
- ✓ AHORRAN ENERGÍA
- ✓ ÚTILES EN ENTORNOS URBANOS Y RURALES
- ✓ MAYOR CAPACIDAD A BAJO COSTE

SISTEMAS MALLADOS:



ARQUITECTURA:

ENRUTADORES MESH

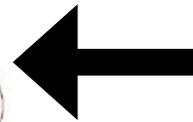
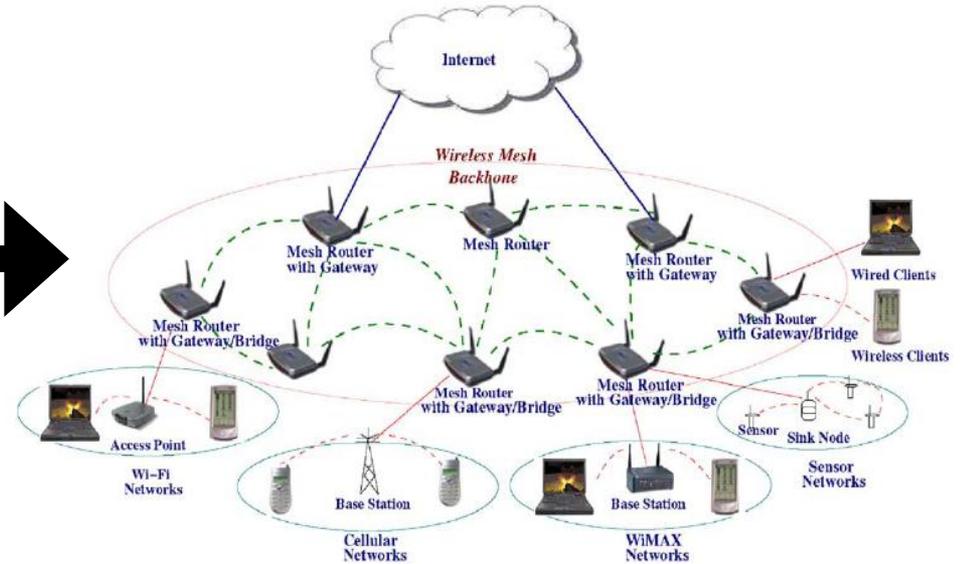
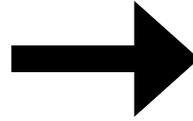


CLIENTES MESH

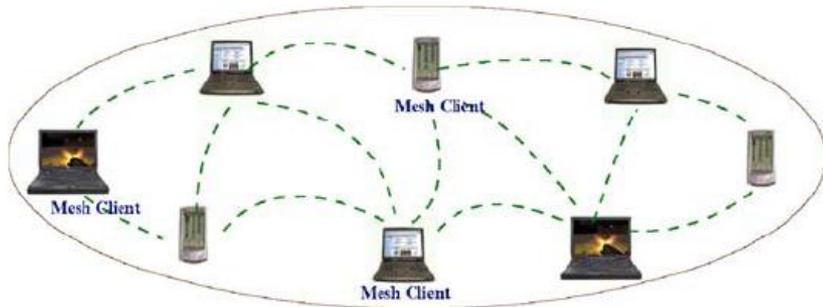


ARQUITECTURA:

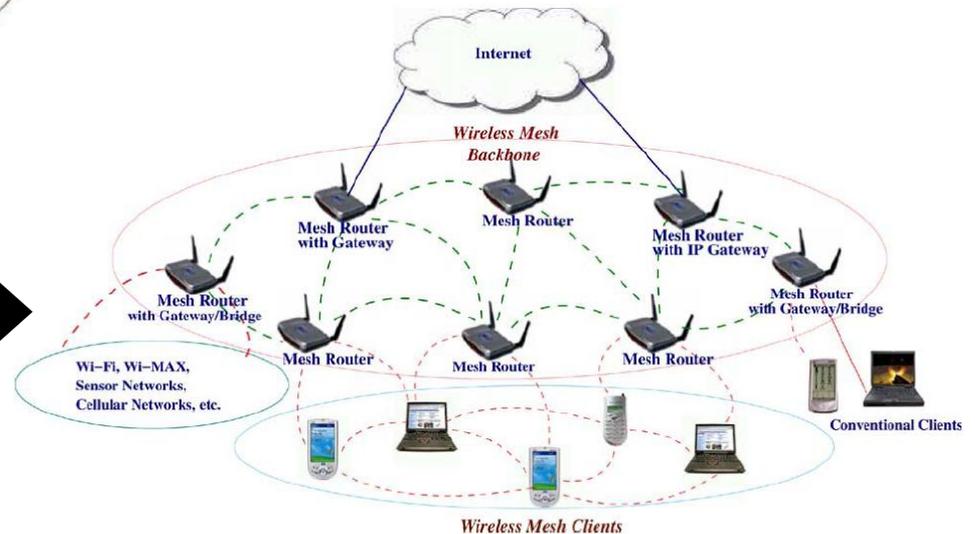
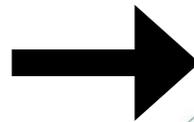
REDES INALÁMBRICAS MESH DE INFRAESTRUCTURA/ BACKBONE



REDES INALÁMBRICAS MESH CLIENTE

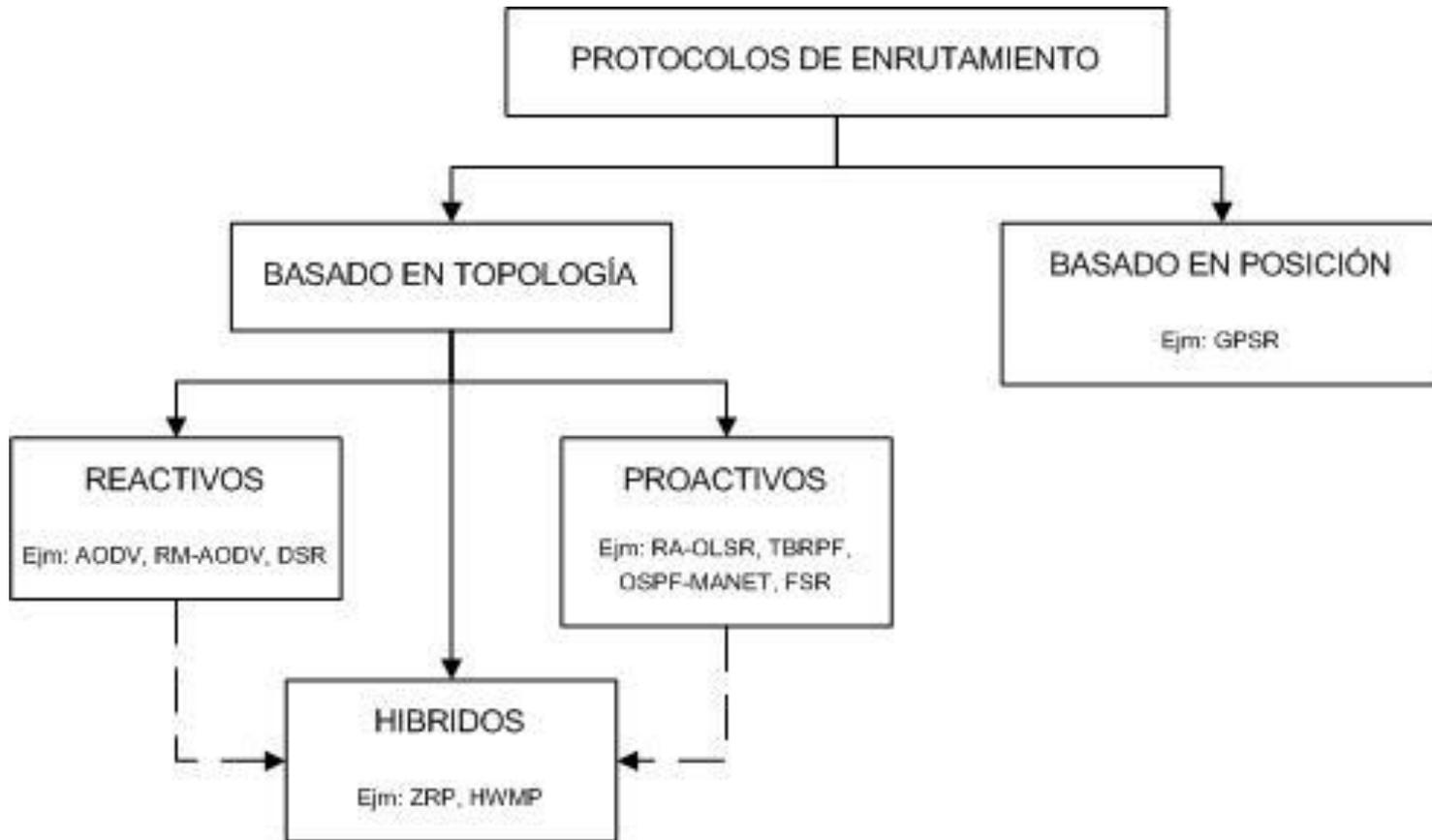


REDES INALÁMBRICAS MESH HIBRIDAS

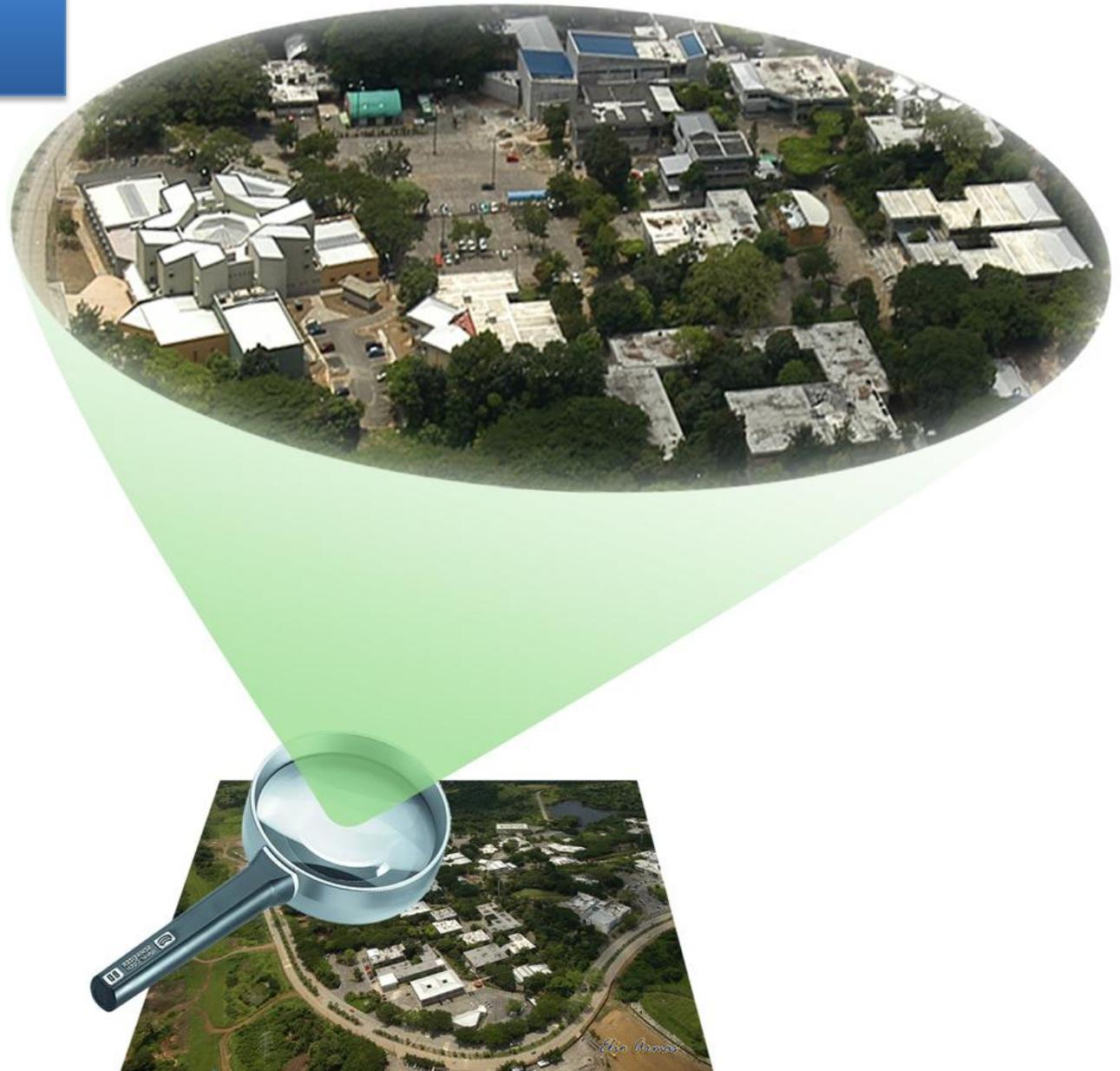


PROTOCOLOS DE ENRUTAMIENTO:

PROCOLOGOS DE ENRUTAMIENTO:



DISEÑO



PROVEEDORES

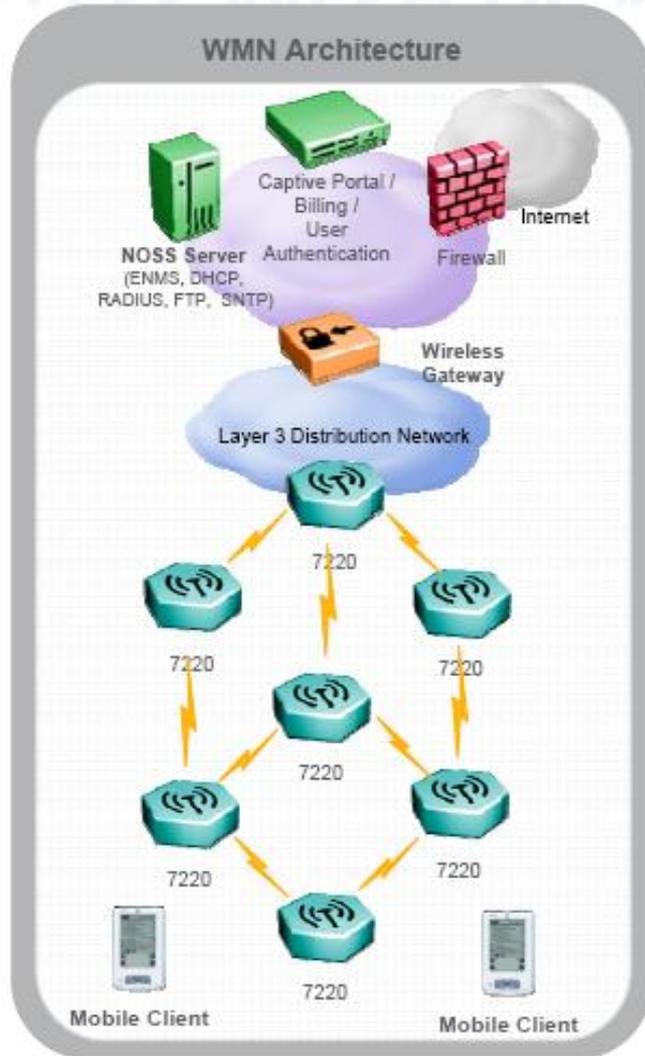
FABRICANTE	SOLUCION	TIPO DE ANTENA	CONFIGURACION AUTOMATICA	N° MAXIMO DE NODOS	N° MAXIMO DE SALTOS	EQUIPOS UTILIZADOS	ALCANCE	INTERFACES RADIO
	METROMESH	Indoor/Outdoor	SI	20 nodo/Km2	3 - 4	Routers Gateway Routers Clientes	7 metros entre routers y usuario	2 radios, 2.4 GHz y 5 GHz
	BelAir	Outdoor	SI	3 - 4 conectados al BackBone	5	BelAir200 Mesh AP + Access AP BelAir200	-	2 o más, de 2.4 GHz y 5 GHz
	SyncMesh,	Indoor/Outdoor	SI	11 nodo/Km2	4 - 5	SkyGateway SkyConnector SkyExtender SkyExtenderDual	12 - 16 Km entre nodos	2 radios, 2.4 GHz y 5 GHz
	Acces/One Network OWS	Indoor/Outdoor	SI	-	10	OWS Strix	50 m entre nodos	2 radios, 2.4 GHz y 5 GHz
	CISCO Mesh	Outdoor	No	-	-	WLAN Controller + Cisco Aironet 1510	-	-
	MOTOMESH	Indoor/Outdoor	SI	-	-	Punto de Acceso Inteligente MotoMesh + Enrutador Inalámbrico	500 m entre nodos	2 o más, de 2.4 GHz y 5 GHz
	Nortel's Wireless Mesh Network	Indoor/Outdoor	SI	90/Gateway	3	NOSS Server + Wireless Gateway + AP 7220	200-800 metros entre APs	2 radios, 2.4 GHz y 5 GHz



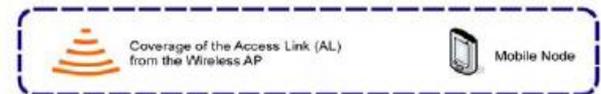
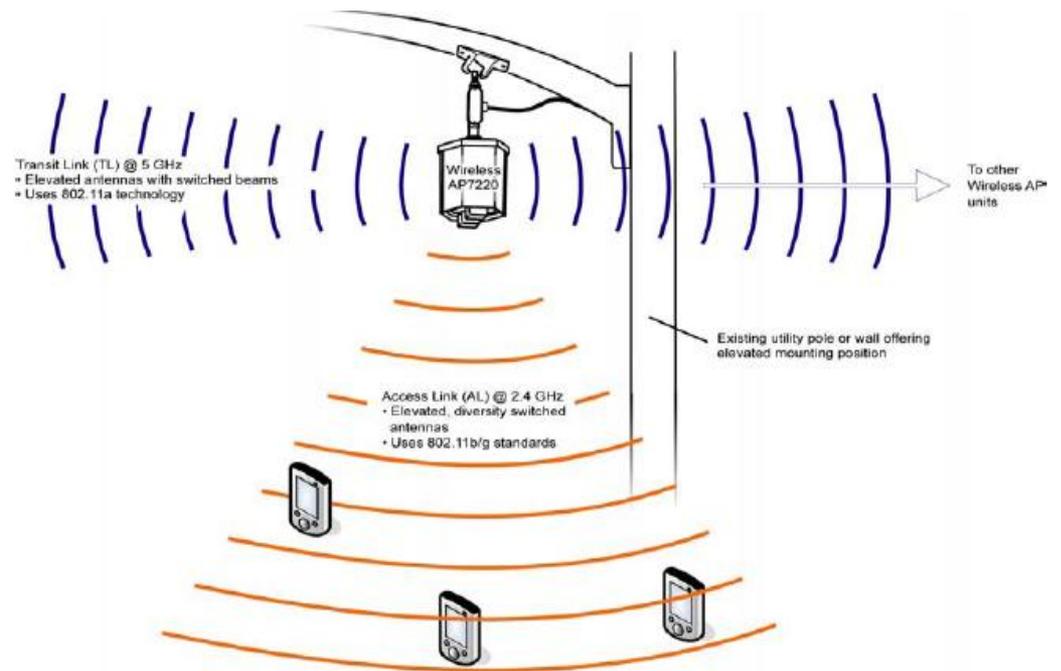
CARACTERÍSTICAS PRINCIPALES:

- ✓ **AUTO-CONFIGURABLE Y AUTO-REGENERABLE**
- ✓ **FÁCIL INSTALACIÓN**
- ✓ **PERMITE LA MOVILIDAD DEL USUARIO**
- ✓ **REDUNDANTE**
- ✓ **ESTÁNDAR 802.11**
- ✓ **ALTA SEGURIDAD**

ELEMENTOS DE LAS REDES WIRELESS MESH DE NORTEL



ENLACES DE ACCESO Y TRÁNSITO

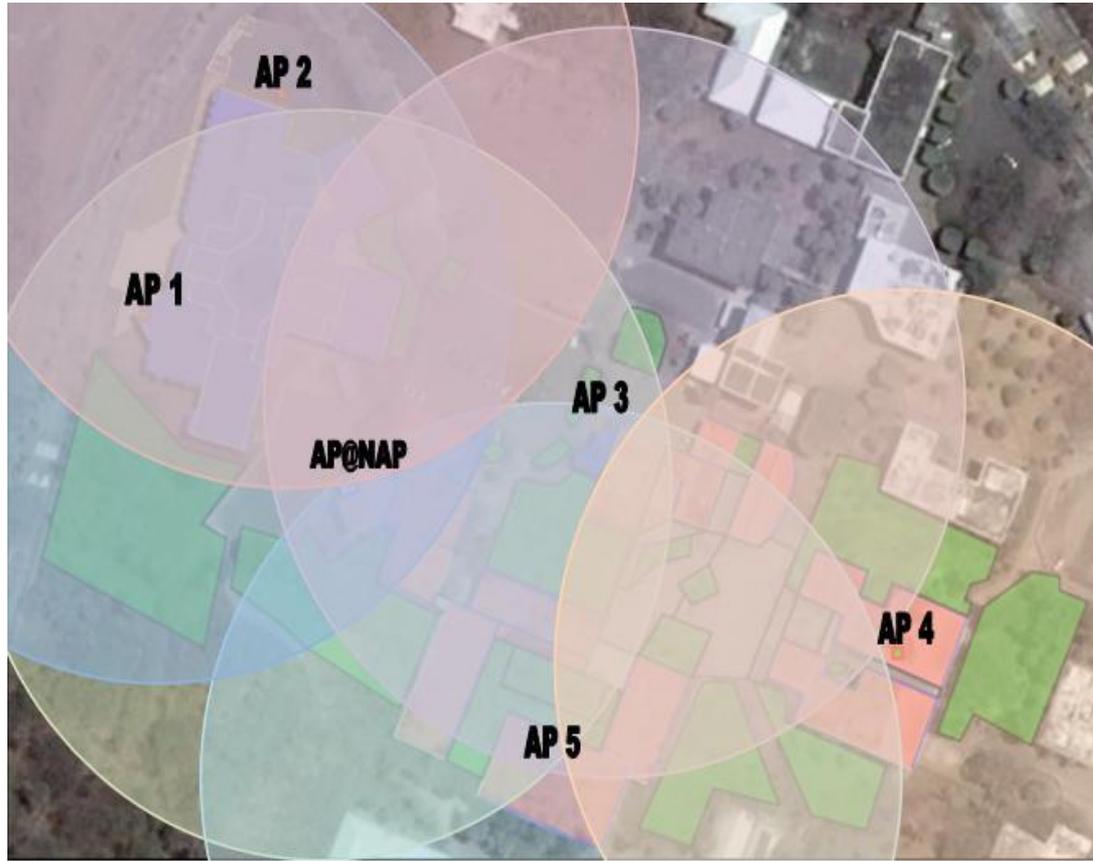


Ambiente RF Exterior	Rango del Enlace de Acceso (Radio)	Rango del Enlace de Tránsito (AP a AP)	Densidad
Enlace Limpio	300-500 metros	500-800 metros	5 por Km ²
Suburbano con LOS	200 metros	300 metros	10 por Km ²
Urbano con LOS	300 metros	500 metros	17 por Km ²

TOPOLOGÍA ACTUAL DE LA RED EN LA FIEC



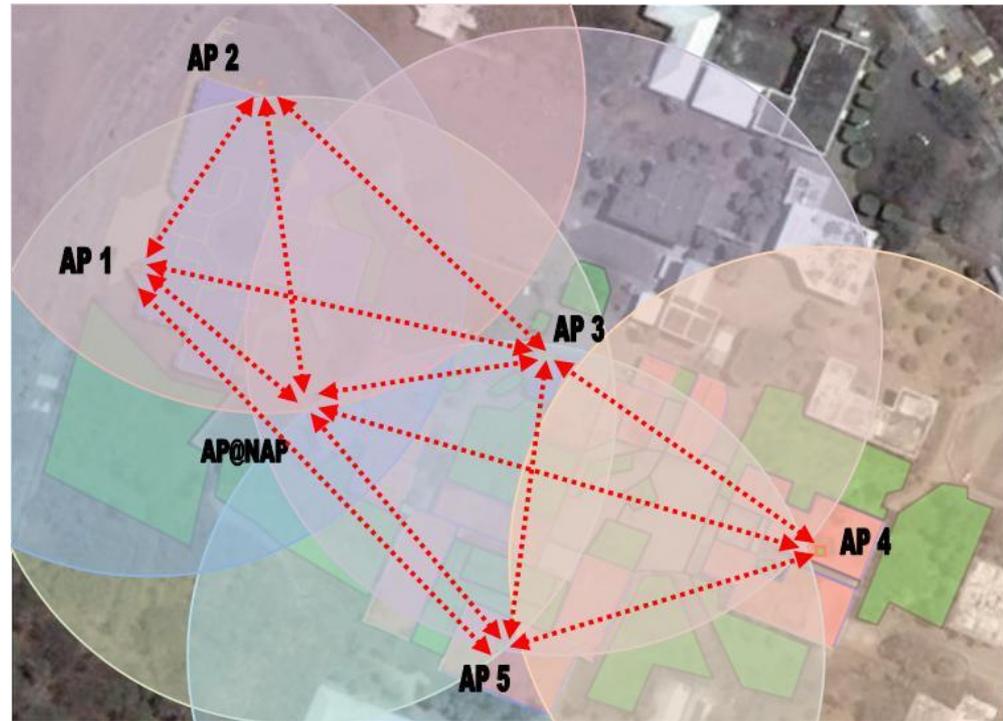
UBICACIÓN DE LOS APs



ANTENAS AUXILIARES



ENLACES DE TRÁNSITO

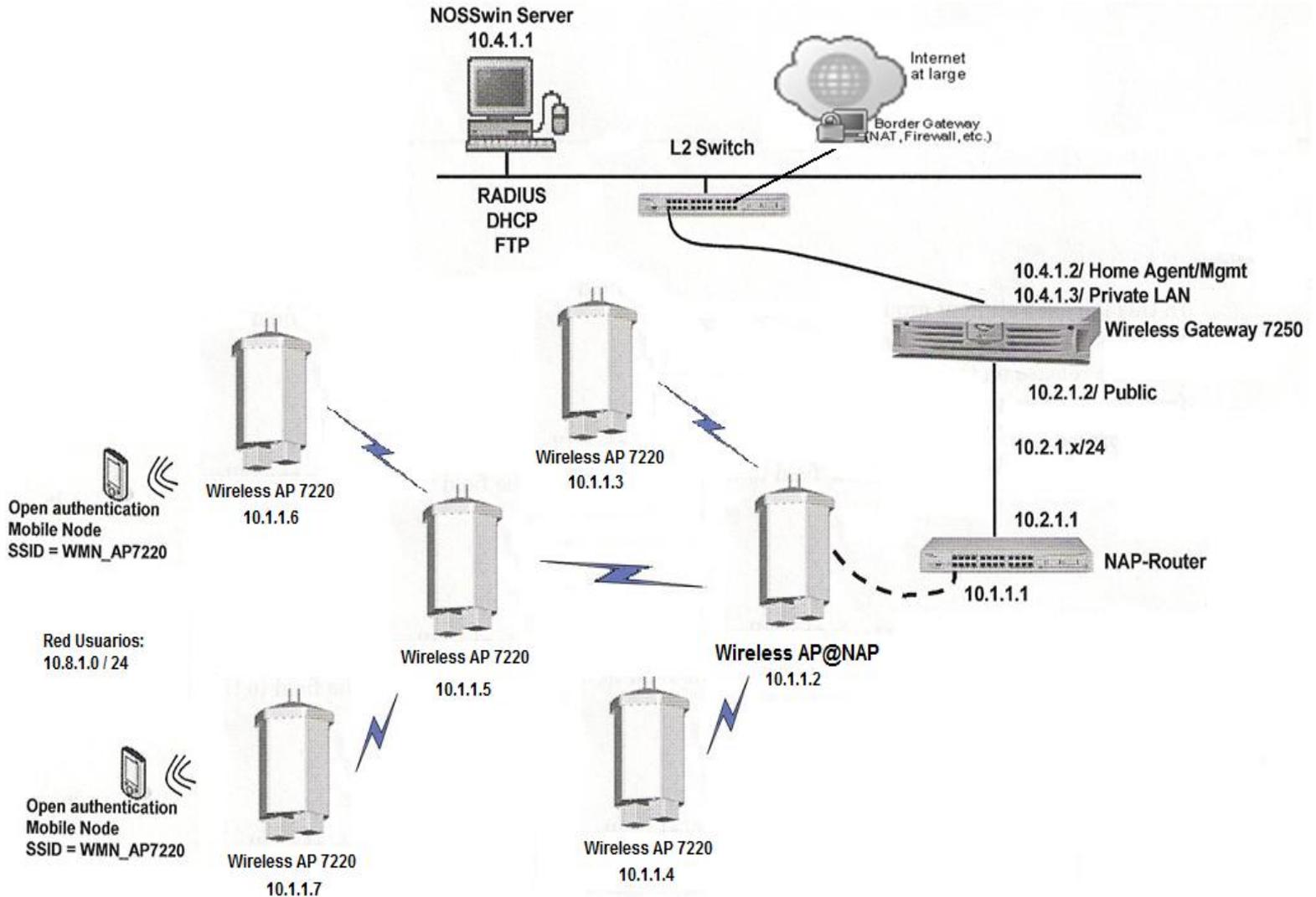


	AP NAP	AP1	AP2	AP3	AP4	AP5
AP NAP		73.98	110.97	86.31	178.78	104.81
AP1	73.98		73.98	141.8	246.6	178.8
AP2	110.97	73.98		135.63	252.77	203.45
AP3	86.31	141.8	135.63		117.14	98.64
AP4	178.78	246.6	252.77	117.14		110.97
AP5	104.81	178.8	203.45	98.64	110.97	

APROX. 200 METROS

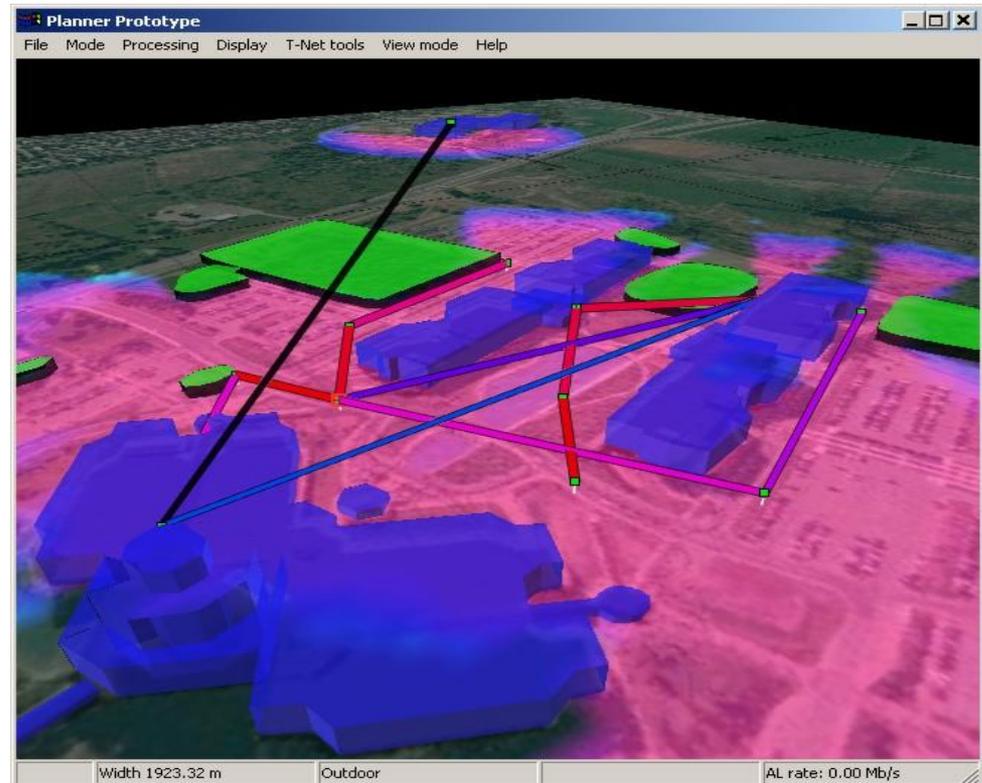


DIAGRAMA DEL DISEÑO PROPUESTO PARA LA RED MESH DE LA FIEC



SIMULACIÓN

PLANNER

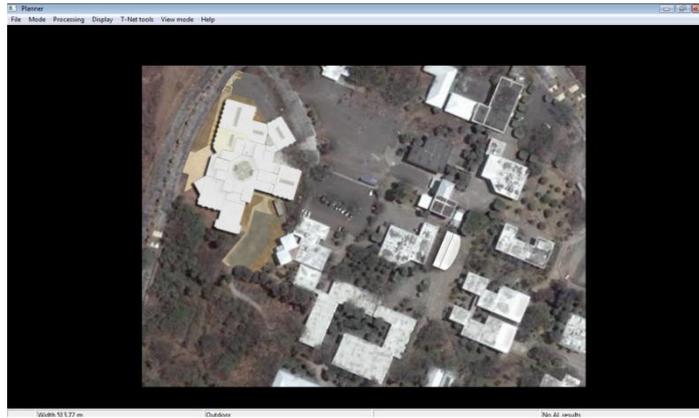
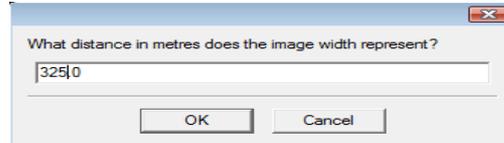


Tipo de Edificación	dB
Aire	0
Pared con Ventanas	6.9
Pared sin Ventanas	15
Paredes Metálicas o Bloquean Luz del Sol	30

AMBIENTE	ATENUACION	
	Enlace de Acceso	Enlace de Tránsito
Enlace Limpio	0 dB/m	0 dB/m
LOS Urbana	0.048 dB/m	0.017 dB/m
Indoor Abierto	0.22 dB/m	0.22 dB/m
Indoor Saturado	0.62 dB/m	0.62 dB/m
Vegetación	1.0 dB/m	2.0 dB/m

PLANEAMIENTO

1



2

Ambiente	Identificación en el Planner
Area Verde	Verde
Outdoor	Gris
Indoor Abierto	Azul
Indoor Recargado	Rojo

Boundary Borde	Identificación en el Planner
Limpio	Negro
Pared con Ventana	Azul
Pared sin Ventana	Gris
Bloqueo Luz Solar	Rojo

3



4

AL Data Rate Mbps
11
10-11
9-10
8-9
7-8
6-7

TL Data Rate Mbps
>50
45-50
40-45
35-40
30-35
25-30

DEFINICIÓN DE AMBIENTES DE ZONAS DE PROPAGACIÓN



AREAS VERDES



AREAS CENTRAL



BLOQUE DE AULAS



AREAS DE DISTRACCIÓN Y ESTUDIOS



EDIFICIO CENTRAL

ALTURAS PARA LAS DIFERENTES ZONAS DE LA FIEC



Area	Identificativo	Altura [m]
Edificio	1	7
Edificio	2	8
Edificio	3	10
Edificio	4	13.5
Edificio	5	15.5
Laboratorios de Computación	6	5
Aulas de Computación	7	9
Laboratorios Automatización	8	6
Laboratorios Electrónica/ Digitales	9	10
Laboratorio Redes Eléctricas	10	7
Laboratorio de Potencia	11	6
Antiguo Sala de Profesores	12	10
SASE	13	10
Comedor	14	10
Aulas FIEC	15	17.5
Piso Patio Central Bajo	16	5
Piso Patio Central Alto	17	6.5
Zona de Distracción	18	13.5
Areas Verdes	19	9
Areas Verdes	20	7
Areas Verdes	21	9
Areas Verdes	22	10
Areas Verdes	23	12
Areas Verdes	24	13
Areas Verdes	25	15
Areas Verdes	26	17
Parqueaderos	27	0

Zone Settings ✕

Height (metres)

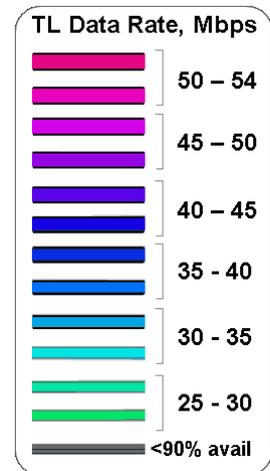
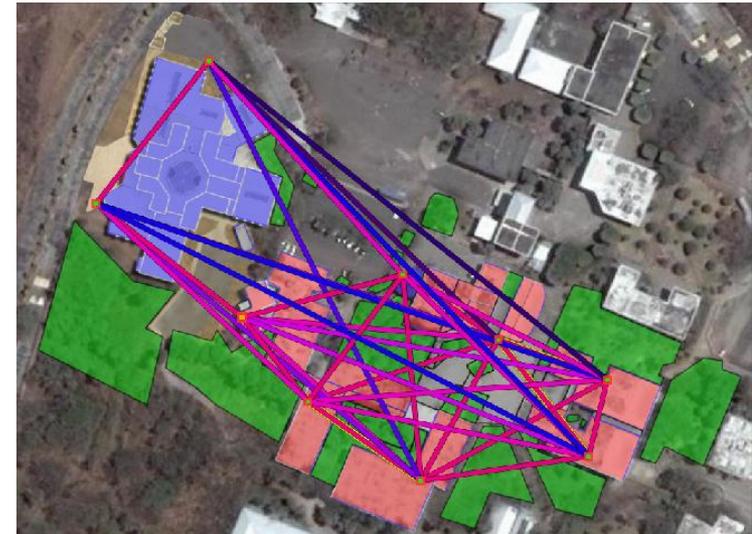
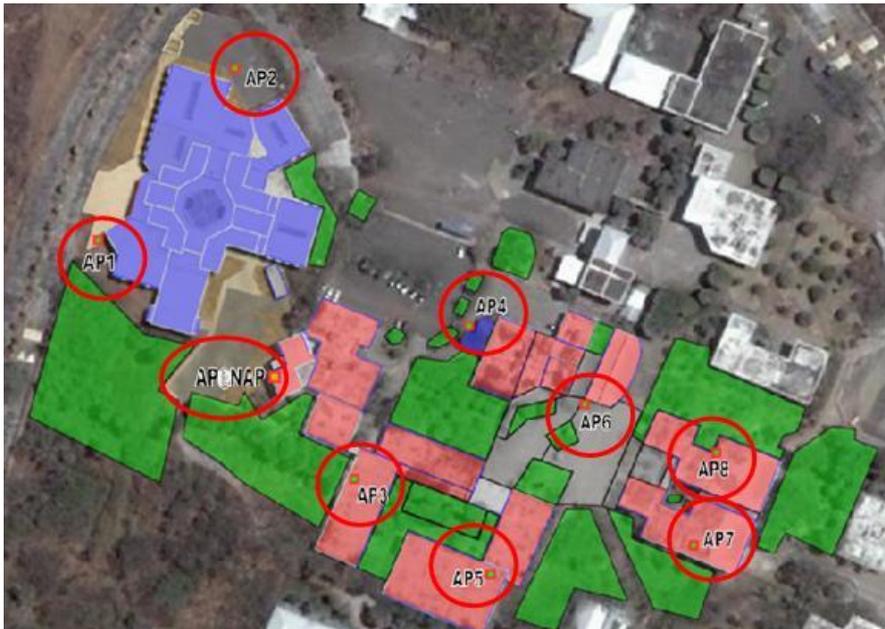


COBERTURA SIMULADA



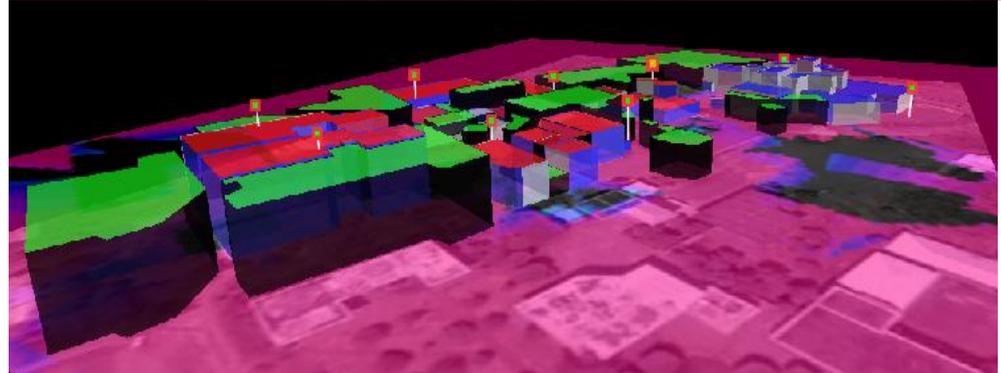
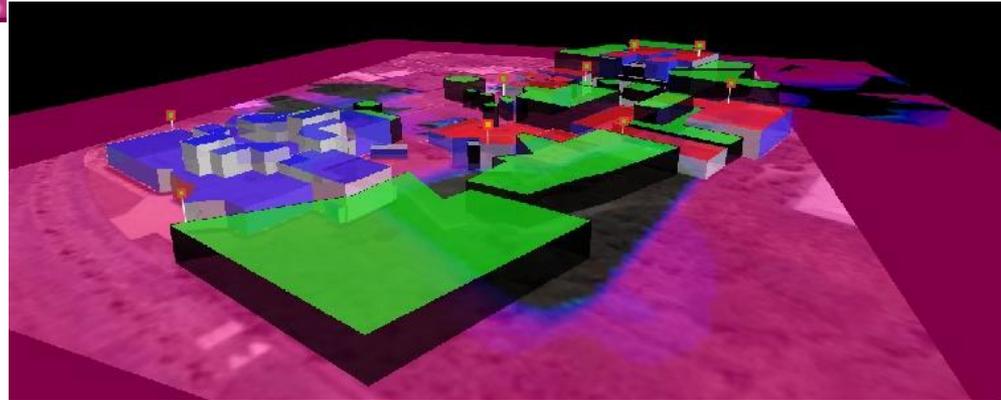
UBICACIÓN DE NUEVOS APs PARA MEJORAR COBERTURA SIMULADA

Punto de Acceso	Altura [m]
AP@NAP	15
AP1	11
AP2	11
AP3	12
AP4	15
AP5	18
AP6	15
AP7	23
AP8	21



COBERTURA SIMULADA DE LA RED MEJORADA

COBERTURA 3D



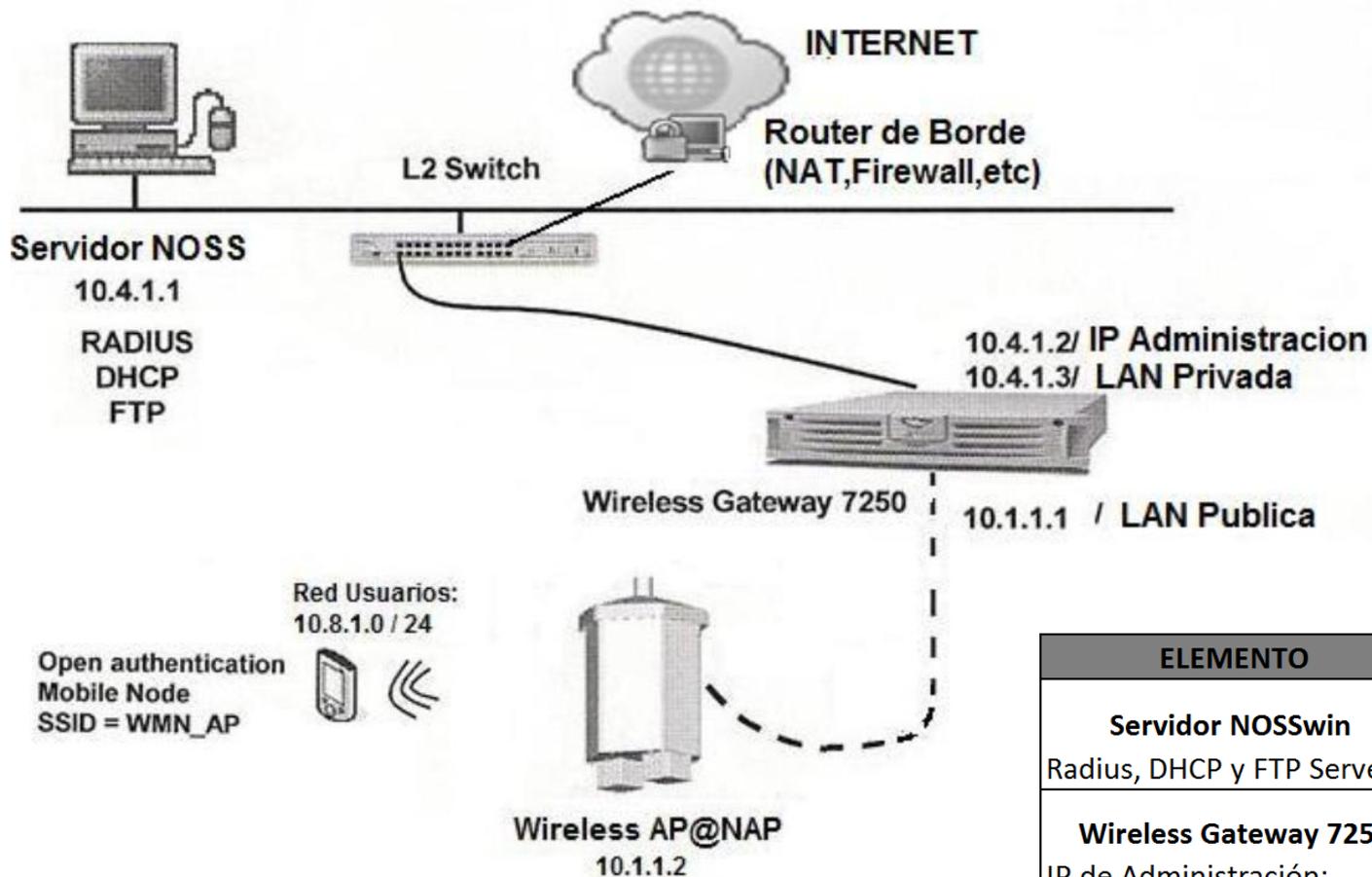
COMPARACIÓN DE DISEÑOS



Simulación del Diseño Teórico

Simulación del Diseño Mejorado

PROTOTIPO



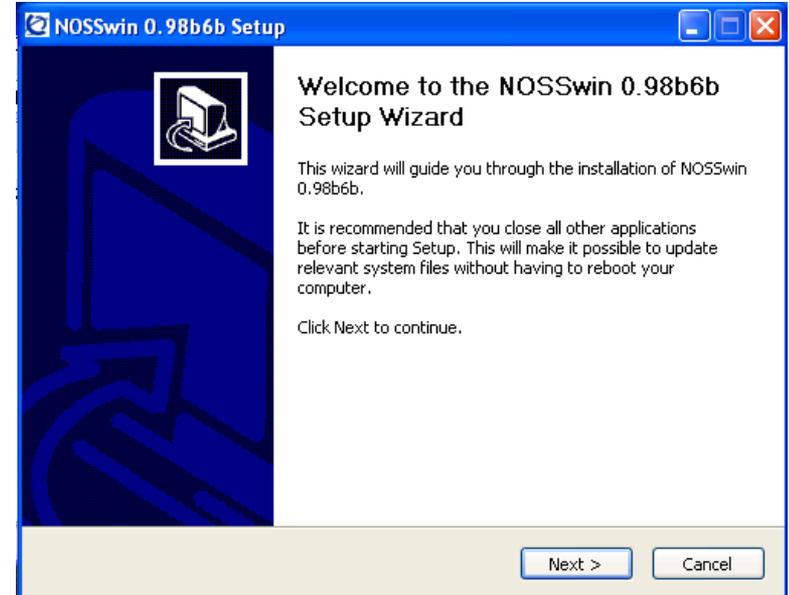
ELEMENTO	DIRECCIONAMIENTO IP
Servidor NOSSwin Radius, DHCP y FTP Server:	10.4.1.1 / 24
Wireless Gateway 7250 IP de Administración:	10.4.1.2 / 24
IP Privada:	10.4.1.3 / 24
IP Publica:	10.1.1.1 / 24
AP@NAP:	10.1.1.2 / 24
Usuarios Terminales:	10.8.1.x / 24

NOSS

1



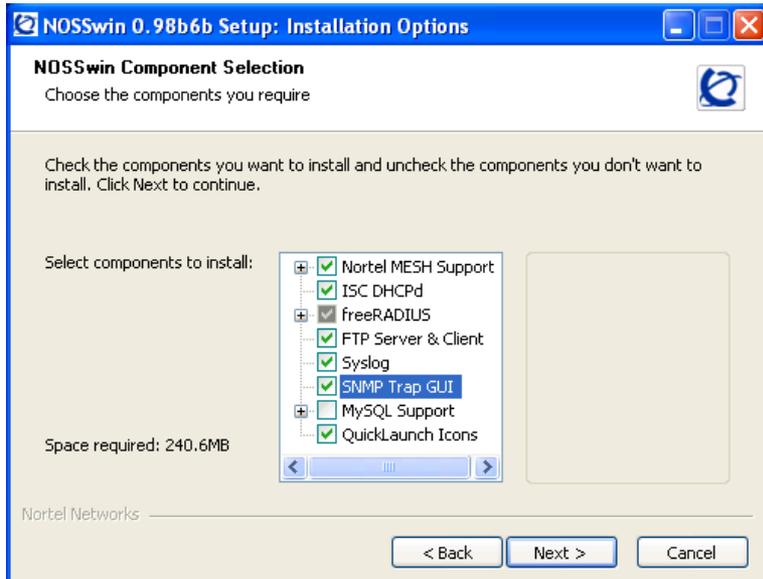
3



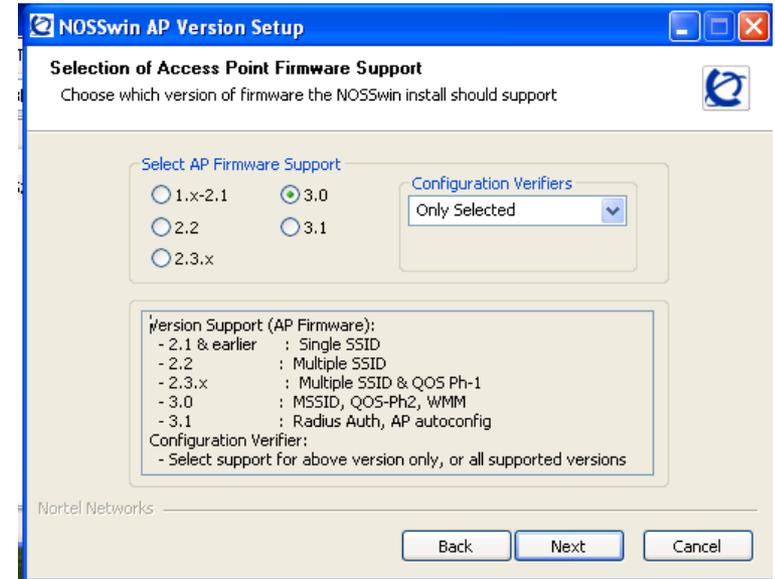
2



4



5



NOSS

NOSSwin v0.98b6b

```
Welcome to NOSSwin !  
...starting up servers and applications  
NOSSDrive Success!  
El servicio de MySQL está iniciándose.  
El servicio de MySQL se ha iniciado con éxito.
```

CONFIGURACIÓN DEL PUNTO DE ACCESO AP@NAP

CA. Telnet 10.1.1.11

```
Tower1# configure  
Tower1(configure)# show
```

Static Configuration In Use

```
-----  
Area Id Address = 10.0.0.0  
  IP Address = 10.1.1.11  
  Netmask = 255.255.255.0  
Wireless Gateway = 10.1.1.1  
  Default Router = 10.1.1.1  
  Role = Cnap
```

Static Configuration Saved In Flash

```
-----  
Area Id Address = 10.0.0.0  
  IP Address = 10.1.1.11  
  Netmask = 255.255.255.0  
Wireless Gateway = 10.1.1.1  
  Default Router = 10.1.1.1  
  Role = Cnap
```

```
Ethernet address = 00:16:ca:f5:42:78
```

CONFIGURACIÓN DE ADMINISTRACIÓN DEL PUNTO DE ACCESO AP@NAP

CA. Telnet 10.1.1.11

```
Tower1# configmgr  
Tower1(configmgr)# show
```

Configuration Manager Configuration In Use

```
-----  
FTP server =  
File name =  
username = nortelWarp (default)  
password = nortelWarp (default)
```

Configuration Manager Configuration Saved In Flash

```
-----  
FTP server = 10.4.1.1  
File name = ap.ftp  
username = nortelWarp  
password = nortelWarp
```

CONFIGURACIÓN DEL EQUIPO WIRELESS GATEWAY 7250

The screenshot shows a web browser window with the URL <http://10.4.1.2/>. The browser's address bar also shows "AVG" and "ospf". The page content includes the "NORTEL NETWORKS" logo and the heading "Welcome to the WIRELESS GATEWAY 7250".

Ongoing Management

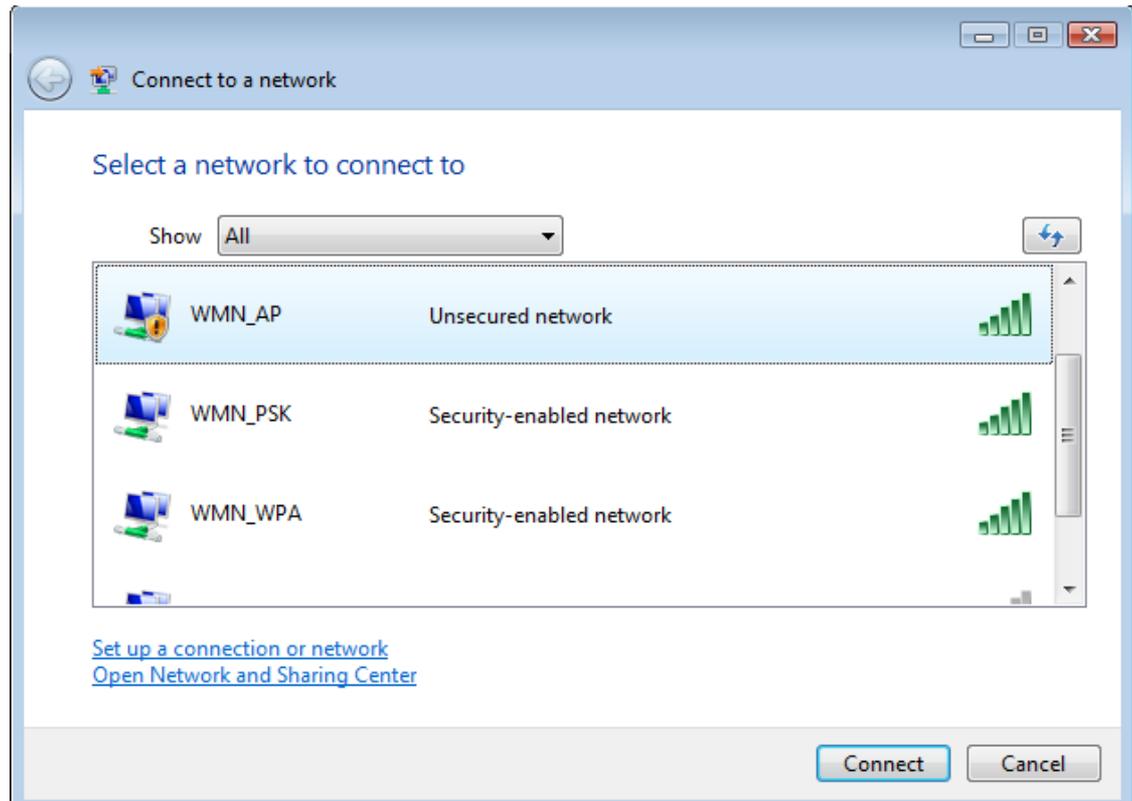
- MANAGE SWITCH** - The management interface used for the day-to-day management and monitoring of the Wireless Gateway.
- MANAGE from NOTEBOOK** - Reduced graphics version of the management interface. Excellent for small monitors and notebook PCs.

Getting Started

- QUICK START** - A great way to get your new Wireless Gateway up and running in just minutes. By completing just a single set-up screen, you can configure the Wireless Gateway to support PPTP tunnels.
- GUIDED CONFIG** - Guides you through the entire management interface, providing hints on how to configure the extensive list of features.

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SSIDs DISPONIBLES PARA UN USUARIO MÓVIL MESH EN LA FIEC



AUTENTICACIÓN DEL SERVIDOR RADIUS PARA LA RED DE LA FIEC

ASIGNACIÓN DE LA DIRECCIÓN IP SERVIDOR DHCP PARA UN USUARIO MÓVIL

```
freeRADIUS
21:54:40 Access-Request from host 10.3.1.49:1812 id=2 len=134
  User-Password = "unknown"
  Framed-MTU = 1400
  Calling-Station-Id = "0021000e7a7e"
  Called-Station-Id = "OPEN:WMN_AP"
  Acct-Session-Id = "0016caf542780021000e7a7e0000000000000002"
  User-Name = "unknown"
  NAS-Port-Type = Wireless-802.11
  NAS-IP-Address = 10.3.1.49
+- entering group authorize
++[preprocess] returns ok
++[chap] returns noop
++[mschap] returns noop
   rlm_eap: No EAP-Message, not doing EAP
++[eap] returns noop
   users: Matched entry unknown at line 18
++[files] returns ok
++[pap] returns updated
   rad_check_password: Found Auth-Type
auth: type "PAP"
+- entering group PAP
   rlm_pap: login attempt with password unknown
   rlm_pap: Using clear text password.
   rlm_pap: User authenticated successfully
++[pap] returns ok
Access-Accept of id 2 sent to 10.3.1.49 port 1812
   Tunnel-Private-Group-Id:1 = "nortel"
Finished request 2.
Going to the next request
Waking up in 4.9 seconds.
Cleaning up request 2 ID 2 with timestamp +925
Ready to process requests.
```

```
isc dhcpd
MON:1:4:41 DHCPDISCOVER on 10.8.1.3 to 00:21:00:0e:7a:7e via 10.3.1.49
MON:1:4:42 DHCPDISCOVER from 00:21:00:0e:7a:7e via 10.3.1.49
MON:1:4:43 DHCPDISCOVER on 10.8.1.3 to 00:21:00:0e:7a:7e (DANIEL-PC) via 10.3.1.49
MON:1:4:44 DHCPREQUEST for 10.8.1.3 (10.4.1.1) from 00:21:00:0e:7a:7e (DANIEL-PC) via 10.3.1.49
MON:1:4:45 DHCPACK on 10.8.1.3 to 00:21:00:0e:7a:7e (DANIEL-PC) via 10.3.1.49
MON:1:4:46 DHCPINFORM from 10.8.1.3 via 10.3.1.49
MON:1:4:47 DHCPACK to 10.8.1.3 (00:21:00:0e:7a:7e) via eth0
```

CONECTIVIDAD ENTRE EL GATEWAY 7250 Y EL SERVIDOR NOSS

Ping

Target Address	10.4.1.1
Source Address (Optional)	10.4.1.2

Ping

Results

```
PING 10.4.1.1: 36 data bytes
64 bytes from 10.4.1.1: icmp_seq=0. time=<16 ms
64 bytes from 10.4.1.1: icmp_seq=1. time=<16 ms
64 bytes from 10.4.1.1: icmp_seq=2. time=<16 ms
----10.4.1.1 PING Statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip (ms)  min/avg/max = <16/<16/<16
```

CONECTIVIDAD ENTRE EL GATEWAY 7250 Y EL PUNTO DE ACCESO AP@NAP

Date: 10/11/2009 Time: 22:56:35

LINK LEVEL ARP TABLE

Destination	Gateway	Flags	Ref	Use	Intf	MTU	OuterCtxt	CircMap	RtEntryP
10.1.1.11	00:16:ca:f5:42:78	30405	1	76	fei1	1500	6e24318	5218668	6bb686c

CONECTIVIDAD ENTRE EL GATEWAY 7250 Y UN USUARIO MÓVIL

Ping

Target Address	10.8.1.3
Source Address (Optional)	

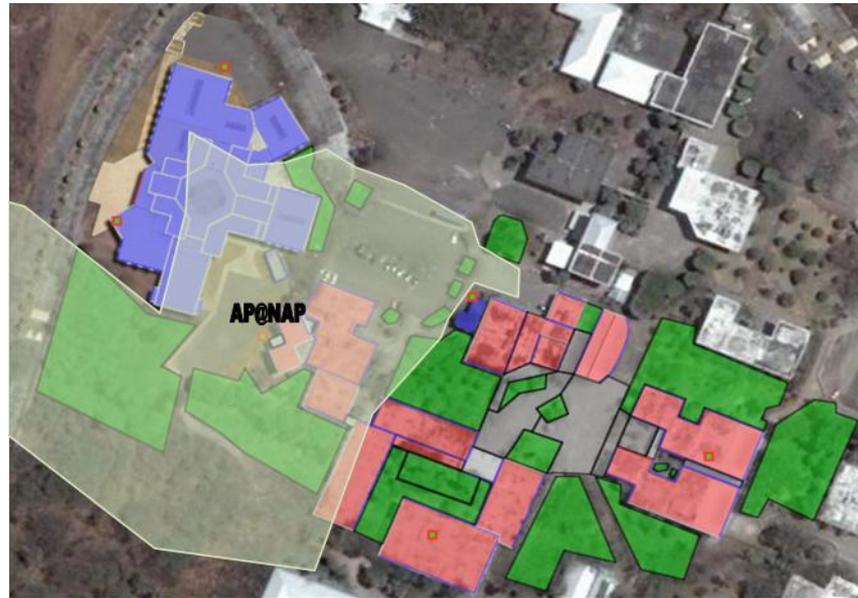
Ping

Results

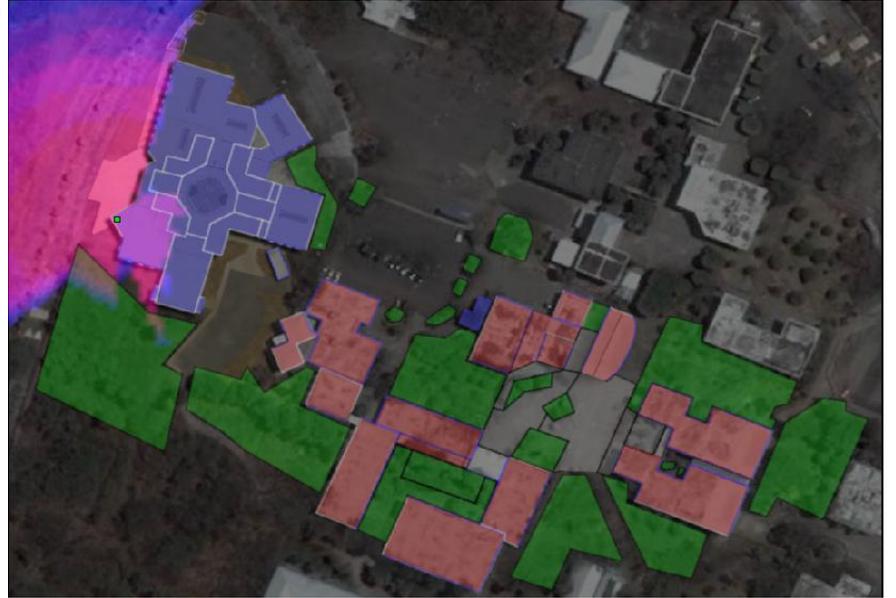
```
PING 10.8.1.3: 36 data bytes
64 bytes from 10.8.1.3: icmp_seq=0. time=<16 ms
64 bytes from 10.8.1.3: icmp_seq=1. time=<16 ms
64 bytes from 10.8.1.3: icmp_seq=2. time=<16 ms
----10.8.1.3 PING Statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip (ms)  min/avg/max = <16/<16/<16
```


RESULTADOS TEÓRICOS, SIMULADOS Y REALES

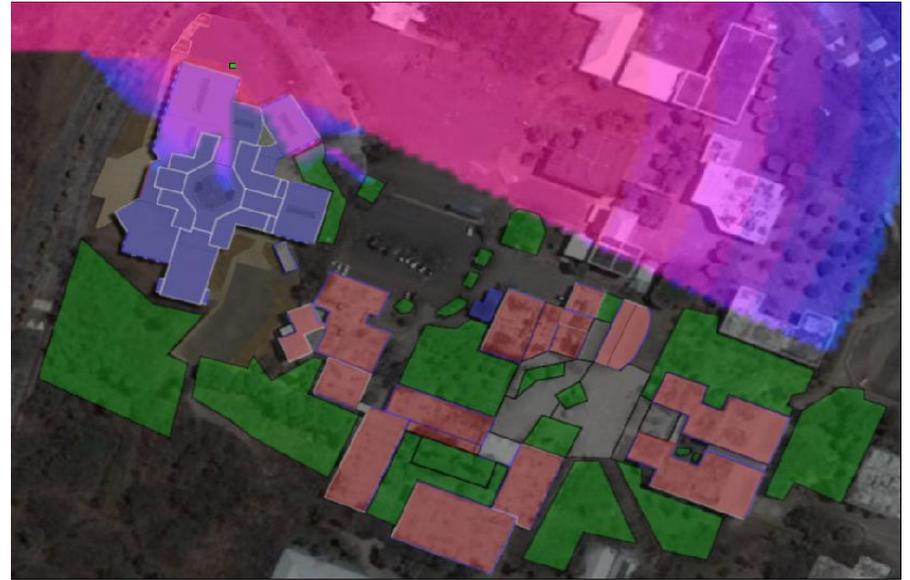
AP@NAP



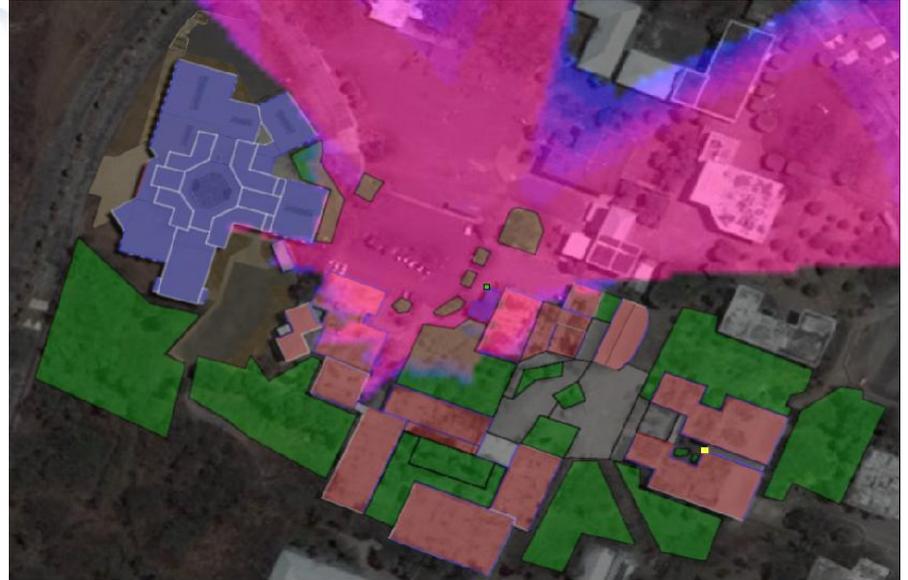
AP1



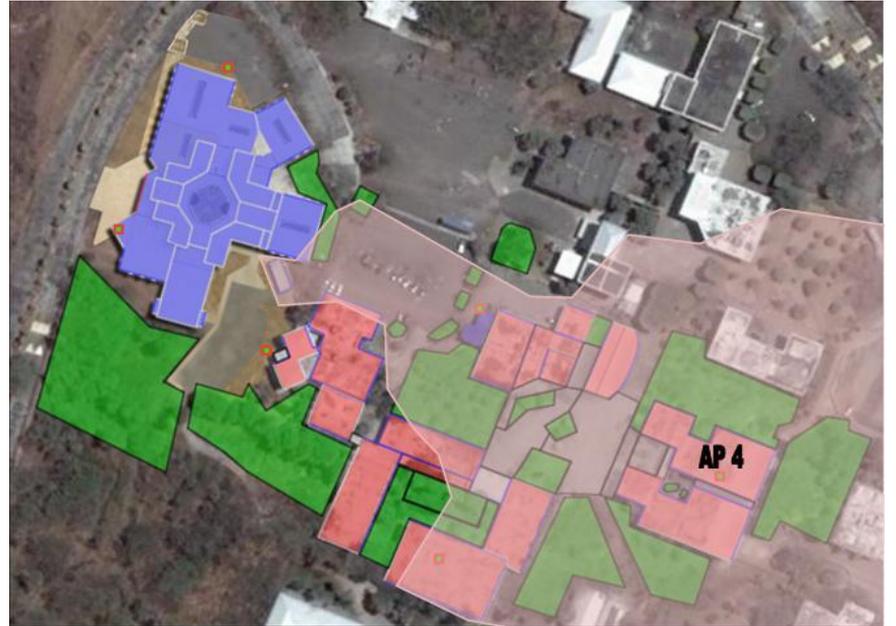
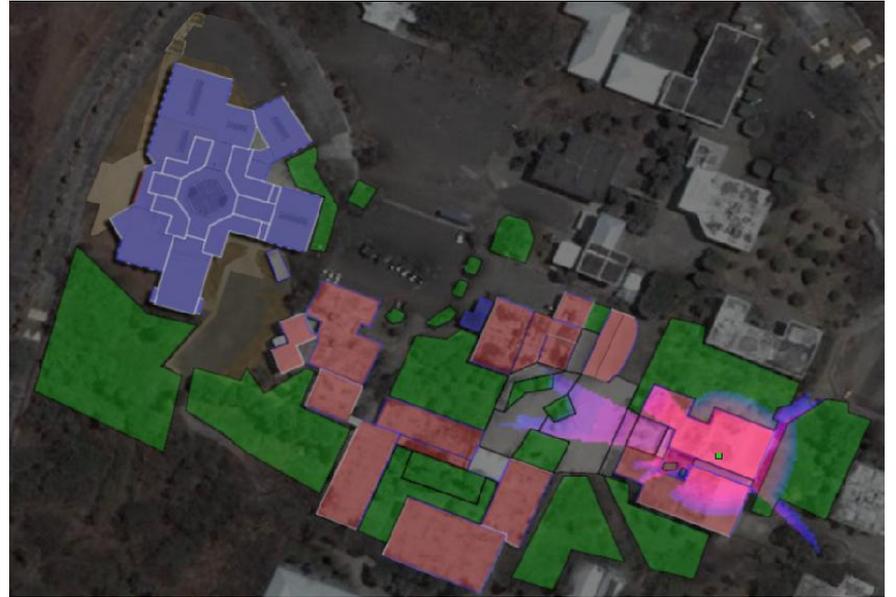
AP2



AP3



AP4



AP5



COTIZACIÓN

EQUIPO	MARCA	PRECIO UNITARIO	CANTIDAD	PRECIO TOTAL
Wireless Gateway 7250 Dual 10/100 Ethernet LAN Ports	NORTEL	7,000.00	1	7,000.00
Nortel VPN Router 1100, 5 tunnels, single 10/100 Enet	NORTEL	1,499.00	1	1,499.00
Wireless AP7220 with Co- linear Antenna	NORTEL	3,500.00	6	21,000.00
Router Cisco 871	CISCO	390.00	1	390.00
Switch TPLink 8 Puertos	TPLINK	12.00	1	12.00
SERVIDOR	S/N	426.00	1	426.00
TOTAL				30,327.00

MATERIAL	PRECIO UNITARIO	CANTIDAD	PRECIO TOTAL
Mástil	40.00	6.00	240.00
Abrazaderas	3.30	6.00	19.80
TOTAL			\$ 259.80



CONCLUSIONES Y RECOMENDACIONES