# Model and Technologies to Build a Well-Organized and Scalable Broadband Data Network for Rural and Developing Areas

Round Table on "Impact of Radio Technologies on ICT for Science in Developing Countries"
Trieste, 9-10 February 2004

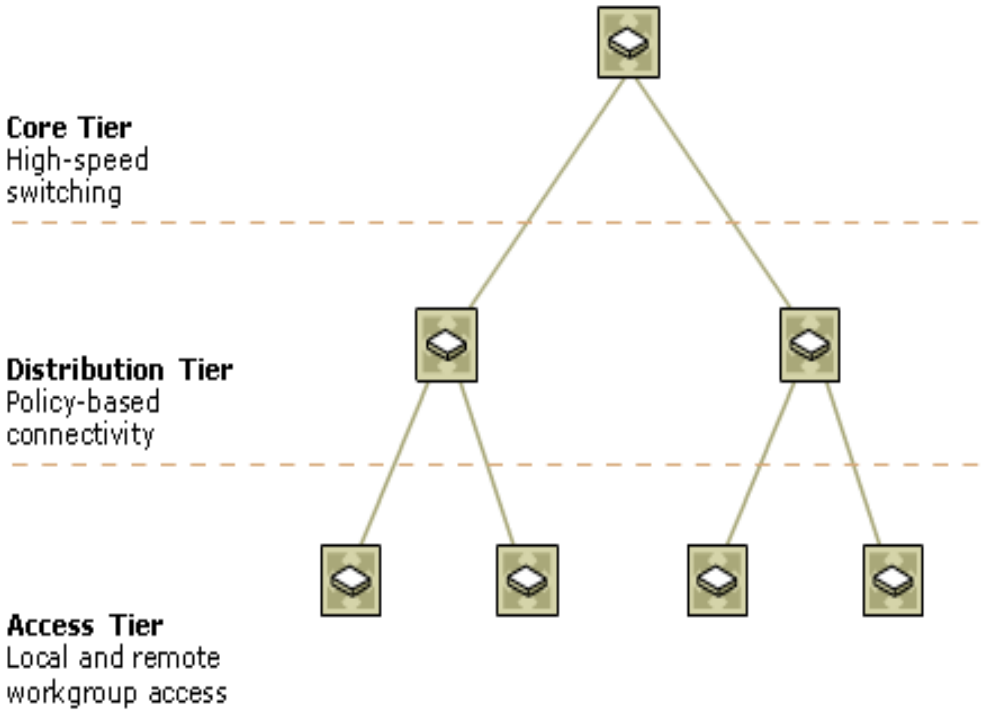
Andrea Marco Borsetti
Agente Alvarion Italia

# Goals in Design Data Network in Developing Areas

- A strong concept model (3T)
- Low cost, efficient coverage
- Performance from day one (2/4M)
- Each link with the right technology
- Flexibility with capability (a mix)
- A “well known” path with the future already in mind (low entry cost but scalable system)

# A Three Tier (3T) Network Model

**Three identifiable tiers, each with its own properties**




- Backbones (core tier) up to 40+ Mbits
- From BK to end point (distribution tier) up to 13+ Mbits
- Access tier with cell coverage (end tier) from 2+ Mbits sector/cell coverage

# 1st Tier

- Very High speed backbone (core)
- From 17 + Mbits connectivity
- Upgradable without interference
- PtP or very tight antenna openings
- OFDM and (in future Wimax 802.16 and 802.20)
- Reliable - very good fade margin
- Fault tolerance if needed
- Few simple routing policies
- PTP solution

# 2nd Tier

- High speed distribution tier
- Up to 6+ real Mbits
- Upgradable up to 12 or 18+ Mbits
- Less bandwith than core
- More mature tech Direct Spectrum 802.11b
- Less expensive
- PTM solution

# 3rd Tier

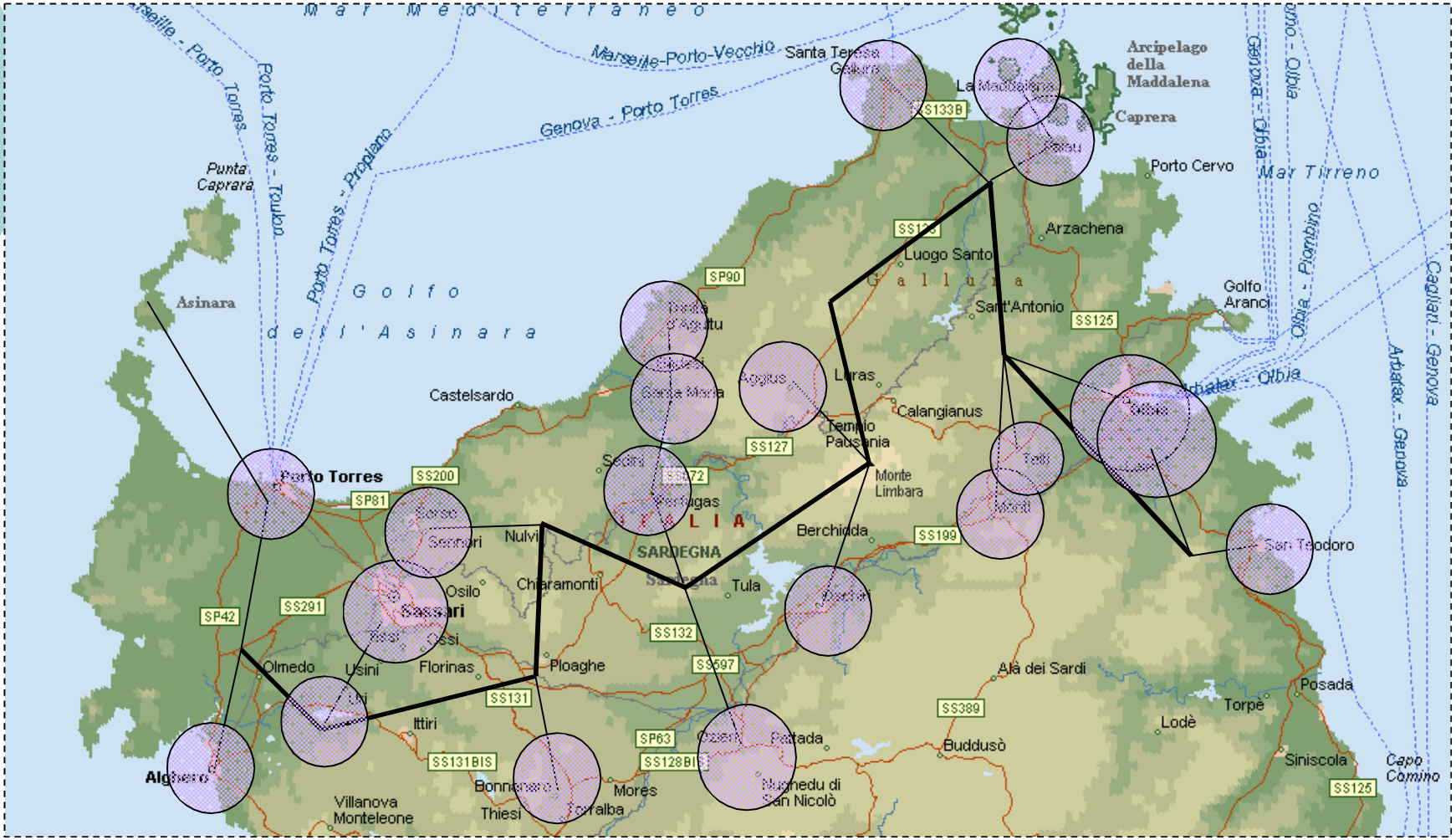
- Local cell and workgroup access
- 2 mbit for each radio
- Upgradable to 26 (13 radio max x cell!)
- FH tech very reliable
- Secure transport (layer 2)
- Cell coverage up to 6 or 15 Km
- Scalable deployment
- Each subscriber unit is configurable by CIR/MIR

# Example

Backbone

Distribution

Access



# Tier technologies

| Tier | modulation | advantages | disadvantages | notes |
|---|---|---|---|---|
| 1st | OFDM 802.xx<br>5,4 – 5,8 Ghz | Good performance<br>Fast<br>BW scalable<br>High number of units per node | Expensive<br>New trend | It could be the future 5,4 or 5,8 Ghz<br>NLOS |
| 2nd | DS 802.11b<br>2,4 Ghz | Good performance<br>Easy installation<br>Low cost | Not easy BW scalable | Mature tech well known and accepted |
| 3rd | FH 802.11<br>2,4 Ghz | Perfect for access/voice<br>CIR/MIR configurable<br>Cell coverage<br>BW scalable | Short range<br>Max 2 mbits for radios | Very good for security reasons and overall performance |
| 3rd | DS 802.11b<br>2,4 Ghz | Good performance<br>Easy installation<br>Better range than FH | Not secure<br>No voice | Everyone has an interface ??!!?? |

# Tier tech and economics

| Tier | Modulation | Price | range | notes |
|---|---|---|---|---|
| 1st | OFDM 802.xx<br>5,4 – 5,8 Ghz<br>1-3 watt | From 6.500 to 10.000 per each link PTP | FCC<br>50 Km<br>30 Miles | Strong new upgradeable tech |
| 2nd | DS 802.11b<br>2,4 Ghz | From 2.800 to 3,200 per each link PTP<br>From 1.700 to 2.200 per each link PTM | FCC<br>25 Km<br>16 Miles | Strong mature and low cost tech |
| 3rd | FH 802.11<br>2,4 Ghz | About 3.000 per sector about 750 each subscriber unit<br>18.000 a full 6x6 cell | FCC<br>15 Km<br>9 Miles | Strong mature and low cost tech |
| 3rd | DS 802.11b<br>2,4 Ghz | 1700 each AP<br>1100 each slave | FCC<br>15 Km<br>9 Miles | Strong mature and low cost tech |

# Economics example

| Tier | Tech | N° Link | Link price | $ cost | range | Km | MD |
|---|---|---|---|---|---|---|---|
| 1st | OFDM 802.20? 5 Ghz | (x2) | 8.500 | 340.000 | 50 | 1000 | PTP |
| 2nd | DS 802.11b 2,4 Ghz | 50 | 3.000 | 150.000 | 20 | 1000 | PTP PTM |
| 3rd | FH 802.11 2,4 Ghz | 15 (cell) | 1.200* 18 link | 324.000 | 15 | 4050 | PTM |

* Based on 6 users per sector and 3 sectors covered

# Hypothetic Numbers

N° of link 70 (about 2.000 Km/1.250 Ml covered)

Cost per link 7.000 $

Cost per Km = 245 $ - Cost per Ml = 390 $

N° of cell 15

N° of users per Cell 18

N° of users end point 270

Cost x end point 3.010 $

# Bandwith ??

With a Backbone able to deliver approx 40 Mbit in its first phase we could estimate some numbers.

Some assumption:

a good model for net occupancy is 1 to 5 on line

- so 200 user mean 40
- or 3.000 user mean 600

Radio Situation N° 1

40 Mbit/40 users = 1 Mbit user

Radio Situation N° 2

40 Mbit /600 User ?? = 6,8 K user

# Hypothetic Numbers (2)

| N° of cell | Cell sector | N° User for cell | Total cost $ Cell+Bkbone | Cost per user | **Bandwidth * Kbyte** | **Bandwidth * *Kbyte** |
|---|---|---|---|---|---|---|
| 15 | 3 | 18 | 814.000 | 3.014 | 74 | 148 |
| 15 | ¥6 | 100 | 1.585.000 | [redacted] | 13,3 | 26,6 |
| 15 | ¥6 | 200 | 1.960.000 | #653 | 6,6 | 13,2 |
| | | | | | | |

**¥. Here we assume that more user need more radio sectors**

**#. Here we assume that the CPE cost could be reduced by quantity**

*** Based on 1/5 user rate**

*** * Based on 1/10 user rate**

# Profit ??

1/3 Business 2/3 Soho – 1 & 2 Year projection

Equipment and installation cost user 1.057 $

| | **Cost Business** | **Cost Soho** | **Break Even** | **Media $ month** | **Media $ year** | **Revenue** | **Total profit in a 2 year period** |
|---|---|---|---|---|---|---|---|
| 12 months | 150 | 70 | 11 months | 97 | 1.160 | 1.160 | 1.263 |
| 24 months | 120 | 55 | 14 months | 77 | 833 | 1666 | 783 |
| | | | | | | | |
| | | | | | | | |

*** Based on 1.500 user calculation at 1056 $ each**

**(user cost as show in the previous slide)**

# Coverage ….

1 Backbone for 1.000 Km

50 Distribution link for 1.000 Km

15 Cell area for about 10.600 Km2

If user 1500 and covered 10.600 Km2 than…

1 user every 6 Km2  !!!!!

North Senegal 18 citizens x Km2 !!

In a rural country this means 1 served user each 108 citizens!!

# Upgrade Path

The OFDM modulation is expected to be released next year as Wimax 802.16 in PTM and 802.20 in PTP.

Each link could be upgraded by adding new radios or by changing the modulation and using new tech.

The radios from Core/Backbone in the future could be used in distribution tier and each link could shift to lower layer.

Access technology could be used for two years and later changed with a new one, maybe in OFDM also with better NLOS capability

# No Radios items

- We must consider routing and switching very strongly. Radios in digital are able to bring data fast and far, but they are not done for logic routing rules.
- Each tier have to implement logic and rules to avoid packet stormcast or unwanted traffic.
- Shaping services/ports could also improve the service in general, better email and web worse Kazaa and movie (especially at working hours)

# Note on numbers

- Sizes (Km, range, etc..) was calculated using all the power capability available, this model could not be thinked in ETSI environment or were power is restricted.
- Price are just for example, they are close to real "ones" but every list price is subject to change...
- In the model we was not calculating the cost of infrastructure and the cost of human labor they must do, of course.
- This numbers are just an example, we do not forget that every project have his owns items, maybe after a site survey we need a lot more link or we do not have good fade margins, take care!

# End of the story..

The idea of this presentation was not to teach in "detail" but just to give some ideas on how to organize and explore new scenarios.

"..ut facta eveniant.." (latin sentence)

Or in english

"…to make things happen.."

I hope you enjoy this session and thanks to all!

Andrea Marco Borsetti

Agente Alvarion Italia

andreab@sinewire.com

andreamarco.borsetti@poste.it

alvarion
We're on your wavelength.