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# Affordable Broadband for Developing Countries: An Indian Perspective

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## India and Africa

- Similar Affordability
  - Parts of Africa may have lower affordability
  - Recent India's rapid growth may enhance affordability there
- Much different population density
  - India have 200+ people per sq Km even in rural areas
- Much different fibre connectivity

# World's Second Largest Telecom Market

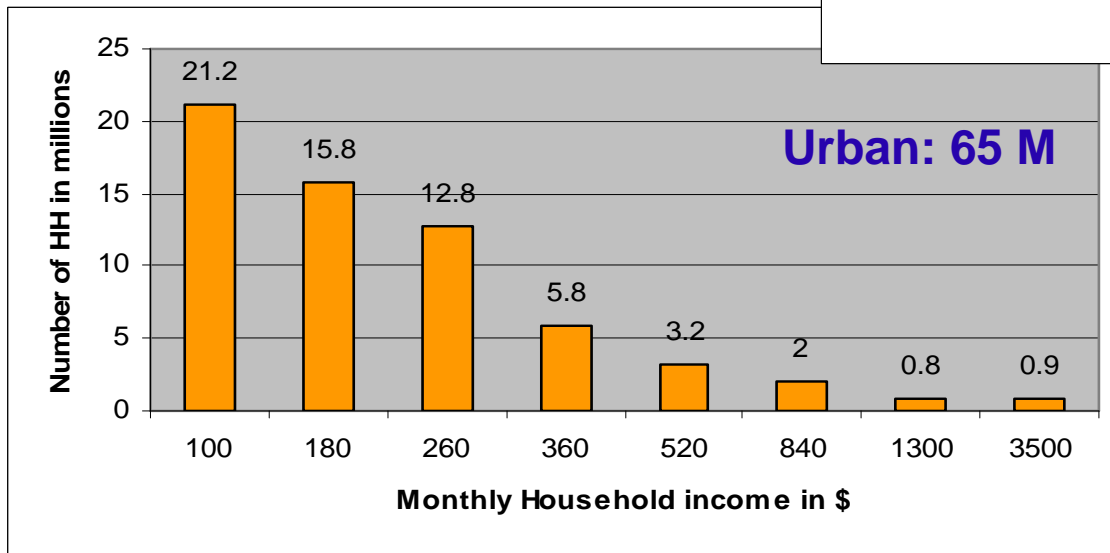
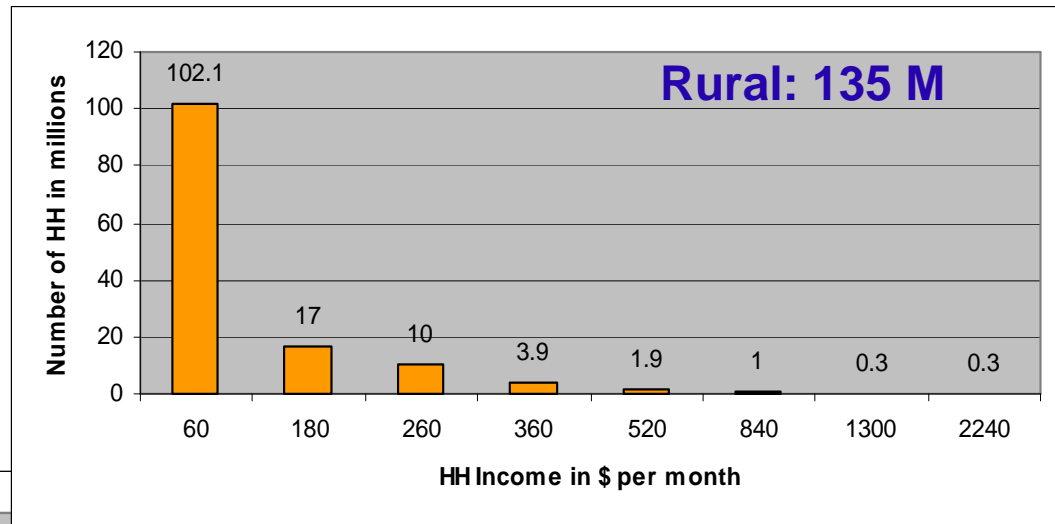
- Area – 3,287,263 Square kilometers
- Population (2007) – 1.13 Billion
- 22 National Recognized Languages
- Literacy Rate (2007) – 65%
- GDP: 1171 Billion USD
- Average Annual Growth Rate
  - Population – 1.6% (slowing)
  - GDP- >9%
- India adds **12 to 15 million** mobile phones a month today
  - Had less than 10 million phones in 1994
    - Was adding 1 million a year
- How did this happen?



Source : FICCI/ Exim bank

# Affordability is the Key to Growth in Developing Countries

- Even in 2001, barely 15 million households out of 200 M HH in India had income over USD 300 per month
  - Next 60 million HH about USD 200
  - ARPU about \$4 /month
    - Rural ARPU at \$2

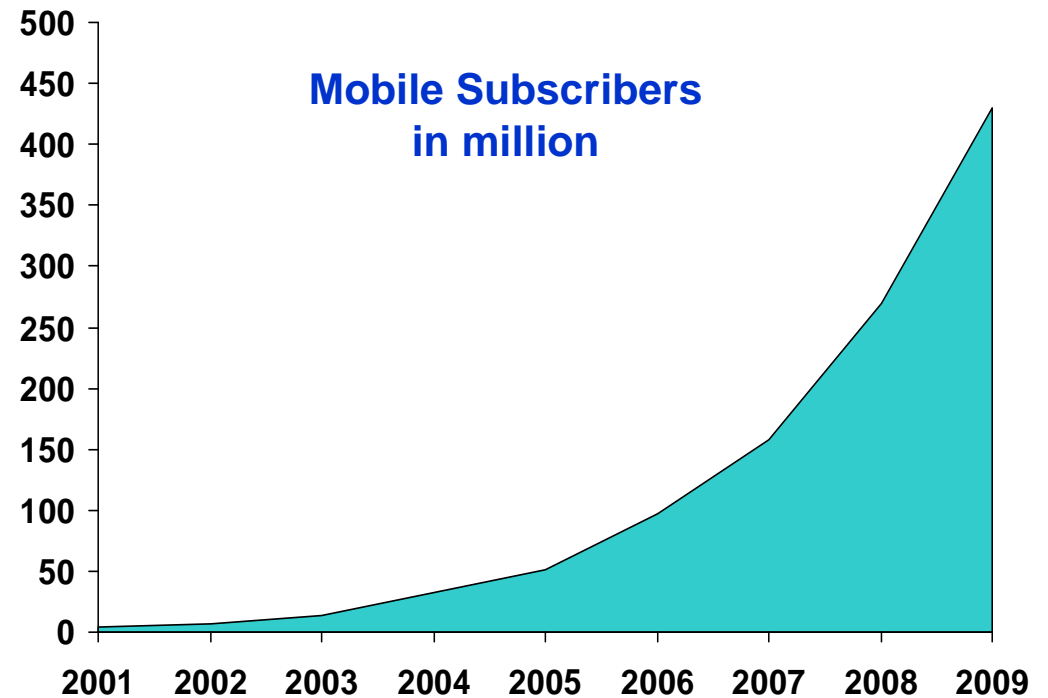


**2001 incomes**

# At right price point Mobile Market in India exploded

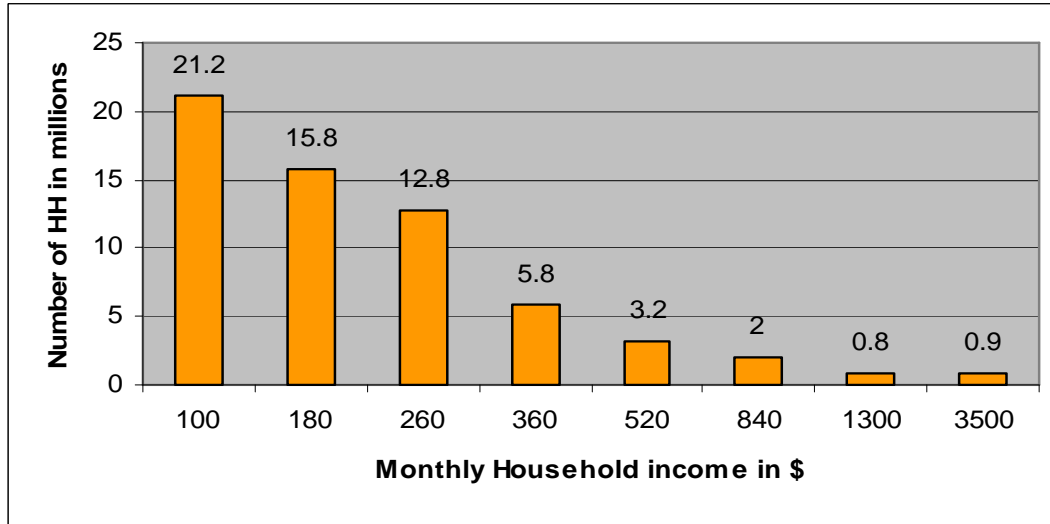
5 million  $\Rightarrow$  50 million  $\Rightarrow$  150 million  $\Rightarrow$  400 million

- Not until Mobile Infrastructure Capex < USD 60 per line
  - and with handset price of USD 30 onwards
  - service available at 1 cents per minute
  - ARPU of about \$4 / month
  - 12 -15 million subscribers added each month

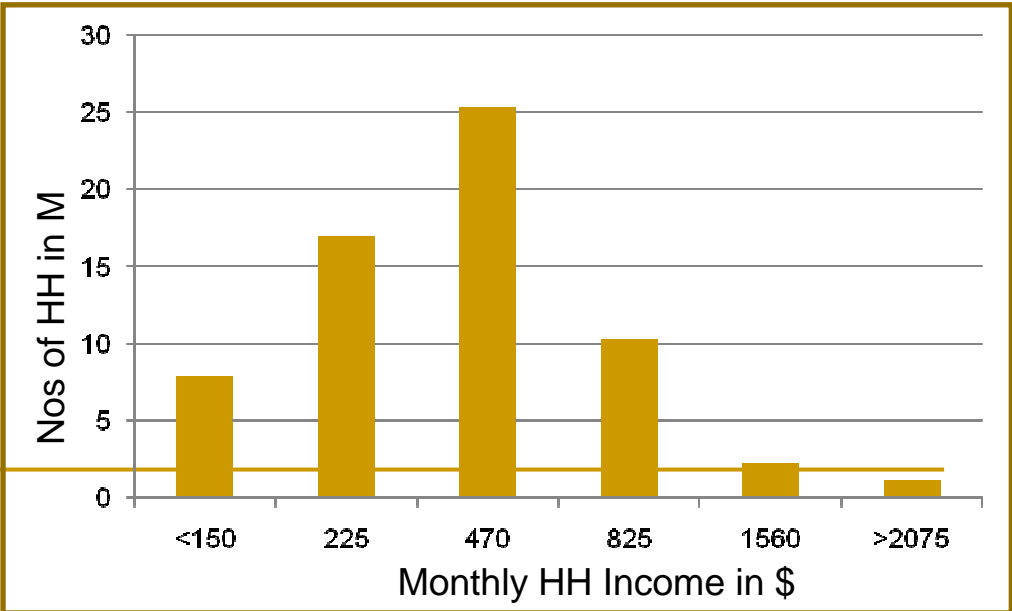


# Telecom contributed to India's Growth

## Monthly household income in 65M urban homes



2001



2007

## Turning Challenges to Opportunities..

**Innovative low cost solutions & tailor –made business models to accelerate growth and penetration**

**Initiatives to reach out the masses:**

- **Infrastructure sharing**
- **USOF support**
- **Alternate fuels**

**Creation of sustainable ecosystem is the key to reach next 500mn**

## While Mobiles in India Grew

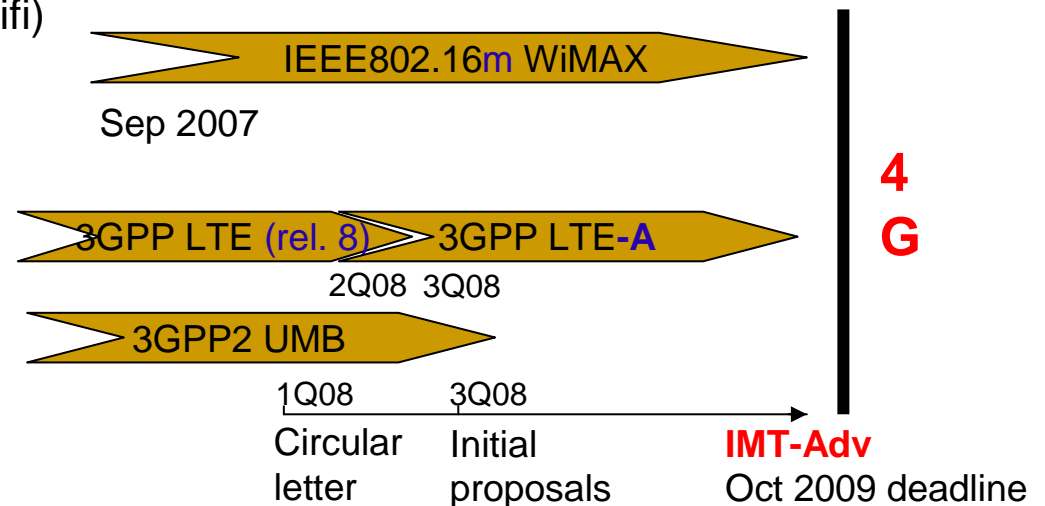


- Fibre reached within 15 Kms of 90% of villages
  - Along with Telecom Tower
    - Some towers on microwave (private operators)
  - And with Grid Power Supply (even though with irregular supply)
  - Universal Service Fund supports building tower & backhaul
    - Shared infrastructure encouraged: Tower companies formed
  
- All set for Broadband
  - Very little fibre: primarily in multi-storey buildings in cities
  - Some DSL: only 20 million homes have copper that can be used
  - And **Broadband Wireless**



## Wireless is the Key to Broadband Access

- Wireless got telephony to everyone in developing countries
- Wireless will get Brodband to everyone
  - GPRS / EDGE/ 3G-1x / EVDO available today
  - Also some 802.16D and BR-corDECT/ SNAP
    - With some 802.11b /g (Wifi)
  - Waiting for HSPA and 802.16e (wireless auction later this year)
  - And eventually 802.16m and LTE-A



- What do they provide?
- What do they need?
- What is Affordability?

## India's Broadband needs

- Connect 1 Mbps+ **sustained** connection / home: 200 million
- 1Mbps+ **sustained** connection on laptops: 1 M -> 50 M
- 256 – 512 kbps **sustained** on handheld / mobiles: 500 M
  
- How much is the affordability?
  - \$5 per month: smaller numbers can have higher ARPU

Service	Features	Mobility Class
Internet browsing	DSL or cable modem quality Individual peak rate ~1Mbps Average (incl read time) 64kbps DL/16 kbps UL	Portable / Mobile Peak rate when mobile could be somewhat lower
Video multicast	25/30 frames per second, normal sized screen (640 x 480) 2-3 hrs of continuous feed @ 750 kbps – 1.5 Mbps (MPEG 4)	Portable
Real-time Interactive Classroom/Video Conferencing	Bursty, lower frame-rate acceptable, 1hr/1.5hr sessions 64 - 256 kbps	Portable
Computing / Thin clients	Always on 512 kbps DL / 256 kbps UL sustained	Portable / Nomadic
File transfer / conferencing uploads	Low frame rate acceptable, delay acceptable Short sessions of few minutes 64 -256 kbps	Portable / Nomadic Mobility optional
Background trickle (Audio, ticker broadcast etc)	20-30kbps	Portable / Mobile

# Geographical coverage – do we have the capacity?

## ■ And does it make business sense?

- Dense Urban (Case: Mumbai)
    - 70% of 16M people
      - In area of 600 sq Km
    - ~3733 households per sq km
      - Assuming 5 per household
    - ~50% wireless internet subscribers
      - ~ 1866 wireless internet/sq km
    - cell radius = 0.75 km
      - ~ 3300 subscribers/cell
    - Assuming 5 competitive operators in each area =>
      - 660 subscribers/operator/cell
  - Urban (Case: Pune)
    - 70% of 4.2M people
      - In area of 400 sq Km
    - ~1470 households per sq km
      - Assuming 5 per household
    - ~ 60% wireless internet subscribers
      - ~ 882 wireless internet/sq km
    - cell radius = 1 km
      - ~ 2800 subscribers/cell
    - Assuming 5 competitive operators in each area =>
      - ~560 subscribers/operator/cell
- 
- Typical scenarios evaluated by Indian operators
  - Technology must have sufficient coverage (up to 3 km) within regulatory constraints without capacity loss

## And as we go Rural – what technology capacity do we need?

- Suburban
  - ~400 households / sq km
- 70% are BWA customers
- cell radius of 1 km - 3 km (use 2 km)
- Five competitive service providers assumed in each area
  - ~700 customers/service provider/cell
- Rural Plains
- About 600,000 villages
- Each village has 5 households who would take BWA and an equal number of public access/kiosks
- Cell radius ~ 15 km  $\Rightarrow$  150 villages
- Room for growth from 1 to 2 or 3 service providers
  - ~500-750 customers/service provider/cell

Wireless technology needs to support 500 to 800 Broadband subscribers /operator / cell

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## To make Business sense and support these numbers:

- Wireless needs to give 10 bps/Hz/cell
  - Smaller density and higher spectrum availability would require lesser performance
  - But may still need these many subscribers per cell to make business sense
- Yesterday: 3G1X / EDGE: less than 1 bps/Hz/cell
- Today: EVDO / 802.16d (fixed): 1.5 bps/Hz/cell
  - BB-corDECT (fixed): 4 bps/Hz/cell
- Tomorrow: HSPA: 2-3 bps/Hz/cell, 802.16e: 3-4 bpx/Hz/cell
- Day-after: 802.16m / 3GPP (LTE-A): 7-10 bps/cell/Hz
- But will these be Affordable? When?

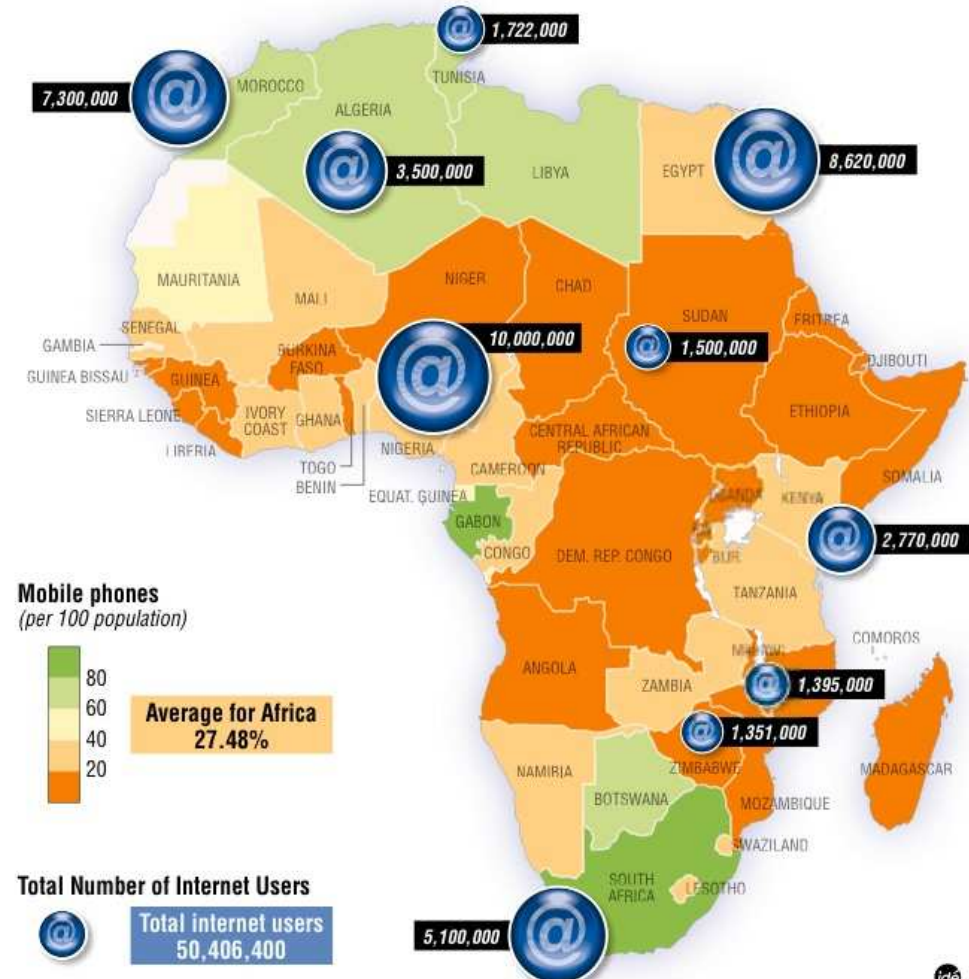
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# Africa Today: Mobile and Broadband

## Mobile expanding rapidly - Broadband Nascent

- 53 countries in Africa
- Privatization since 2005
  - Lucrative market for investors; hampered by ambiguity in regulatory policies & political environment
  - Converged licensing regimes introduced – MNOs allowed to self provide
- Africa has shown good mobile penetration but poor broadband reach

Mobile phone density and top ten countries in internet use



[http://whiteafrican.com/wp-content/uploads/2008/08/african\\_mobile\\_internet\\_map.jpg](http://whiteafrican.com/wp-content/uploads/2008/08/african_mobile_internet_map.jpg)

Aug 2008 Data



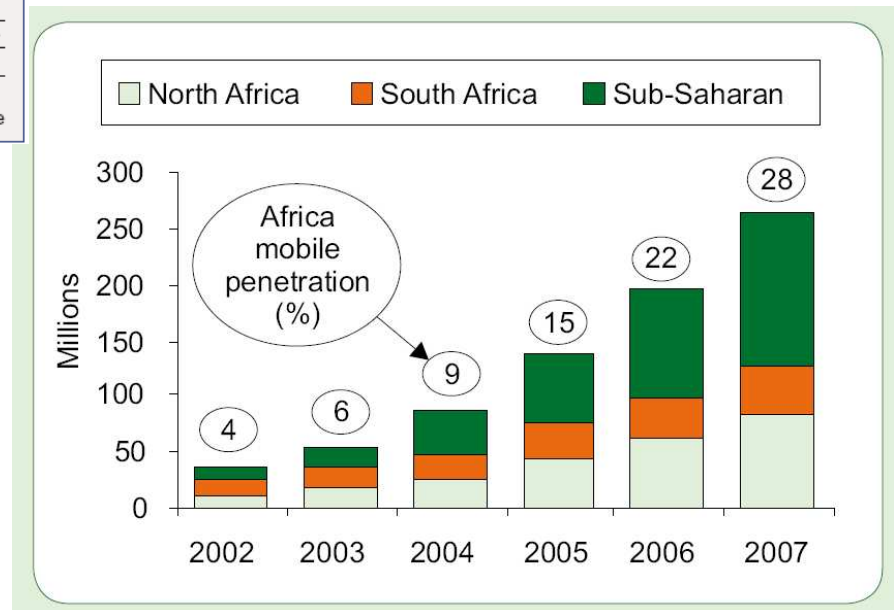
# Rapid Mobile Growth

## AFRICA, LEADING RANKINGS BY CONNECTIONS

	Country	Company	Q2 2008	Q3 2008
1	South Africa	Vodacom	24,891,000	25,245,000
2	Nigeria	MTN	18,565,000	20,171,000
3	Egypt	Mobinil	17,518,000	18,911,000
4	Nigeria	Glo Mobile (Globacom)	17,372,834	18,568,533
5	Egypt	Vodafone	15,202,000	16,391,000
6	South Africa	MTN	15,590,000	16,173,000
7	Nigeria	Zain	14,803,000	15,905,000
8	Morocco	Maroc Telecom	14,211,000	14,629,000
9	Algeria	Djezzy (Orascom)	14,197,208	14,455,123
10	Kenya	Safaricom	11,137,969	12,152,544
11	Algeria	Algerie Telecom	10,340,848	10,855,440
12	Morocco	Meditel	7,079,300	7,309,400
13	Libya	Libyana	5,556,762	5,723,174
14	Ghana	MTN	4,997,000	5,713,000
15	South Africa	Cell C	5,299,605	5,344,549

Source: Wireless Intelligence

- Africa has the highest mobile annual growth rate; 65 million new subscribers added in 2007





## Africa: ~ 3x lower penetration than any other region

huge potential market

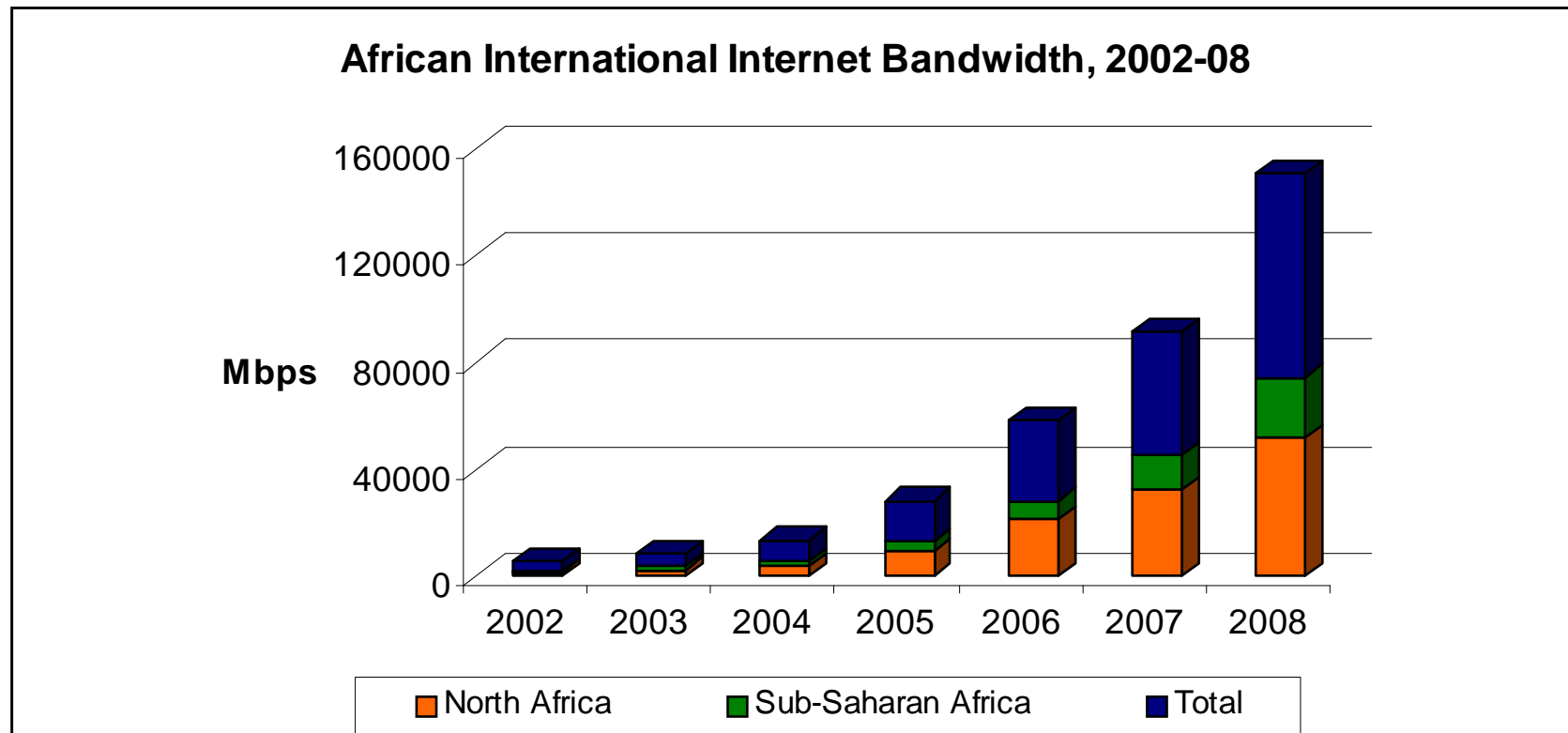
Huge growth

WORLD INTERNET USAGE AND POPULATION STATISTICS						
World Regions	Population (2006 Est.)	Population % of World	Internet Usage, Latest Data	% Population (Penetration)	Usage % of World	Usage Growth 2000-2006
<a href="#">Africa</a>	915,210,928	14.1 %	32,765,700	3.6 %	3.0 %	625.8 %
<a href="#">Asia</a>	3,667,774,066	56.4 %	394,872,213	10.8 %	36.4 %	245.5 %
<a href="#">Europe</a>	807,289,020	12.4 %	308,712,903	38.2 %	28.4 %	193.7 %
<a href="#">Middle East</a>	190,084,161	2.9 %	19,028,400	10.0 %	1.8 %	479.3 %
<a href="#">North America</a>	331,473,276	5.1 %	229,138,706	69.1 %	21.1 %	112.0 %
<a href="#">Latin America/Caribbean</a>	553,908,632	8.5 %	83,368,209	15.1 %	7.7 %	361.4 %
<a href="#">Oceania / Australia</a>	33,956,977	0.5 %	18,364,772	54.1 %	1.7 %	141.0 %
<b>WORLD TOTAL</b>	6,499,697,060	100.0 %	1,086,250,903	16.7 %	100.0 %	200.9 %

NOTES: (1) Internet Usage and World Population Statistics were updated for Sept. 18, 2006. (2) CLICK on each world region for detailed regional information. (3) Demographic (Population) numbers are based on data contained in the [world-gazetteer](#) website. (4) Internet usage information comes from data published by [Nielsen//NetRatings](#), by the [International Telecommunications Union](#), by local NICs, and other other reliable sources. (5) For definitions, disclaimer, and navigation help, see the [Site Surfing Guide](#). (6) Information from this site may be cited, giving due credit and establishing an active link back to [www.internetworldstats.com](http://www.internetworldstats.com). © Copyright 2006, Miniwatts Marketing Group. All rights reserved

<http://www.internetworldstats.com>

## Internet in Africa limited by International connectivity



Source: Telegeography

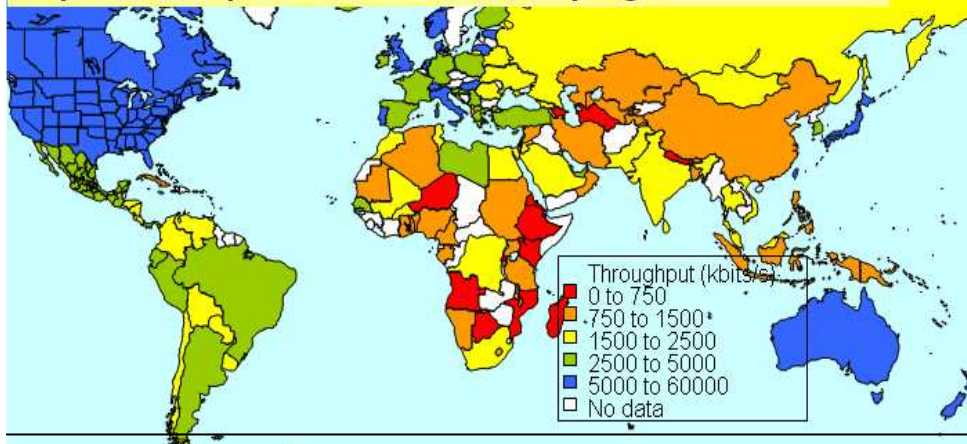
- From 2002 to 2008, Africa's international internet bandwidth has risen at a compound annual rate of 86 %
- However, only 4 out of 100 Africans use the internet and penetration is less than 1%

# Africa's connectivity to outside world is limited

## Data Transfer

### PingER Normalized Derived Throughput

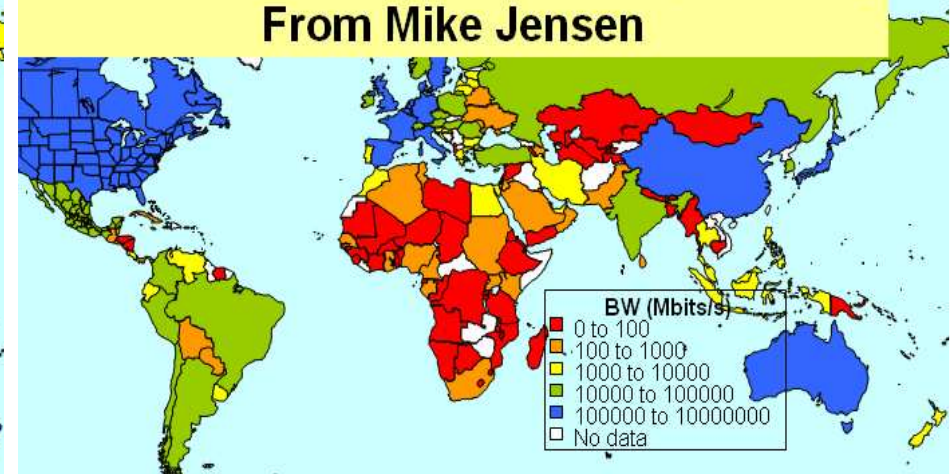
<http://www-iepm.slac.stanford.edu/pinger>



## Capacity

### International Bandwidth 2005 by Country

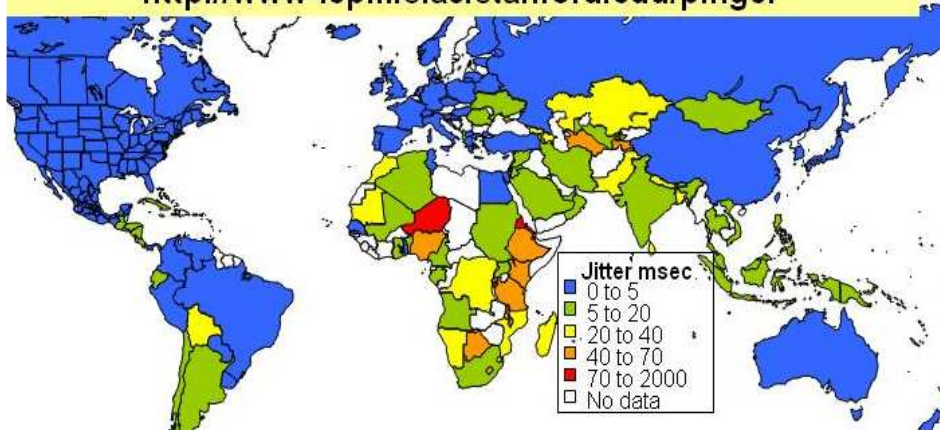
From Mike Jensen



## Voice & video (de-jitter)

### PingER Jitter from US to World Jan-Sep '07

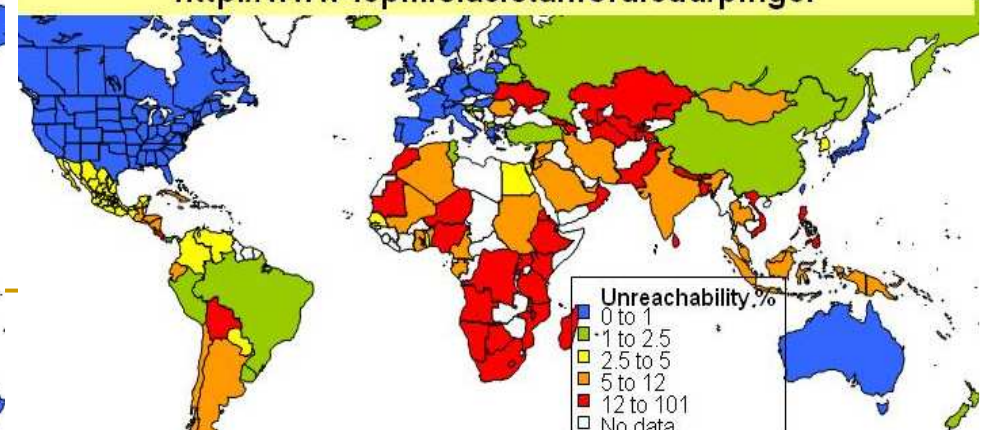
<http://www-iepm.slac.stanford.edu/pinger>

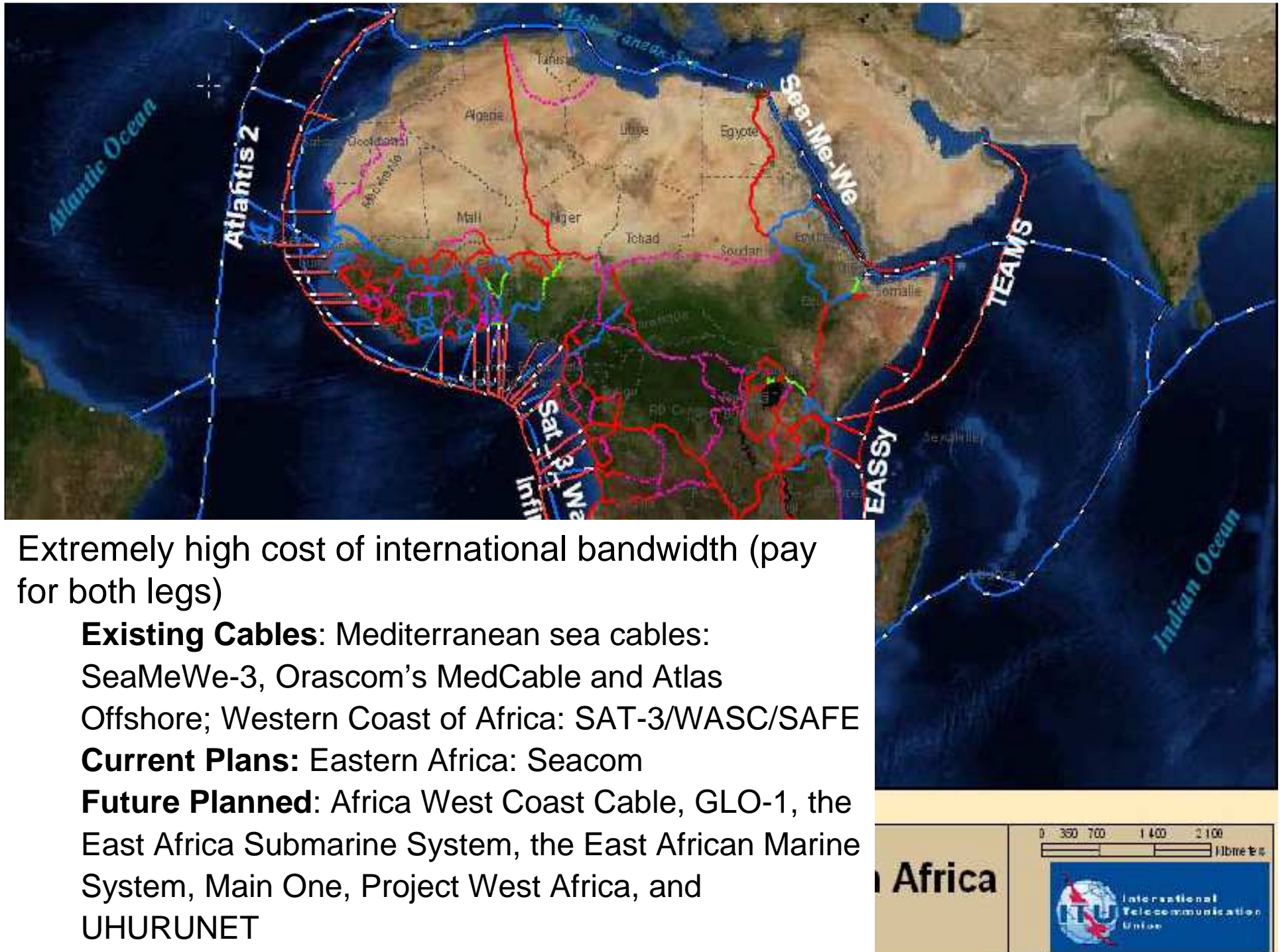


## Network & Host Fragility

### PingER Unreachability from US Jan - Sep '07

<http://www-iepm.slac.stanford.edu/pinger>





Extremely high cost of international bandwidth (pay for both legs)

**Existing Cables:** Mediterranean sea cables: SeaMeWe-3, Orascom's MedCable and Atlas Offshore; Western Coast of Africa: SAT-3/WASC/SAFE

**Current Plans:** Eastern Africa: Seacom

**Future Planned:** Africa West Coast Cable, GLO-1, the East Africa Submarine System, the East African Marine System, Main One, Project West Africa, and UHURUNET

## High Tariff a big barrier

- Also, average retail price for basic broadband in Sub Saharan Africa in 2006 was US\$ 366/ month compared with US\$ 44 month in India

Broadband Rates: Sample African City					
Connectivity	ADSL (Retail)	Wireless (Retail)	Wireless (SME)	VSAT (Enterprise)	WiMax (SME/ Enterprise)
Speed	128 kbps	128 kbps	256 kbps	64 kbps	32 kbps
Per Month Rate	\$ 100	\$ 80	\$ 185	\$ 250	\$ 500
One Time Setup	\$ 100	\$ 275	\$ 574	\$ 1,500	\$ 1,000
Lock In Period	12 months	12 months	12 months	12 months	12 months

Broadband Rates: Sample Indian City		
Connectivity	ADSL (Retail)	Wireless (Retail)
Speed	348 kbps	348 kbps
Per Month Rate	\$ 25 - 30	\$ 25 - 30
One Time Setup	Nil	Nil
Lock In Period	4 months	4 months

Sample African City: Dar es Salaam, Tanzania, Service Provider: Africa Online  
 Sample India City: Mumbai, Service Provider: Tata Indicom

## Numbers is Power: Africa Needs to act as a Nation

African Governments, telcos, will need to work together to ensure rapid and region-wide broadband penetration

Establishing  
National &  
Regional  
IXPs

Creation of  
Fiber Optic  
Digital Arteries

Purchasing  
Jointly

Access to  
Intl. BW  
Providers

Local  
Content  
Hosting

Promoting  
Alternate  
Technologies

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**Network roll-out making Business Sense:  
Technology & Policy Imperatives in Low ARPU situation  
Controlling Capex and Opex**

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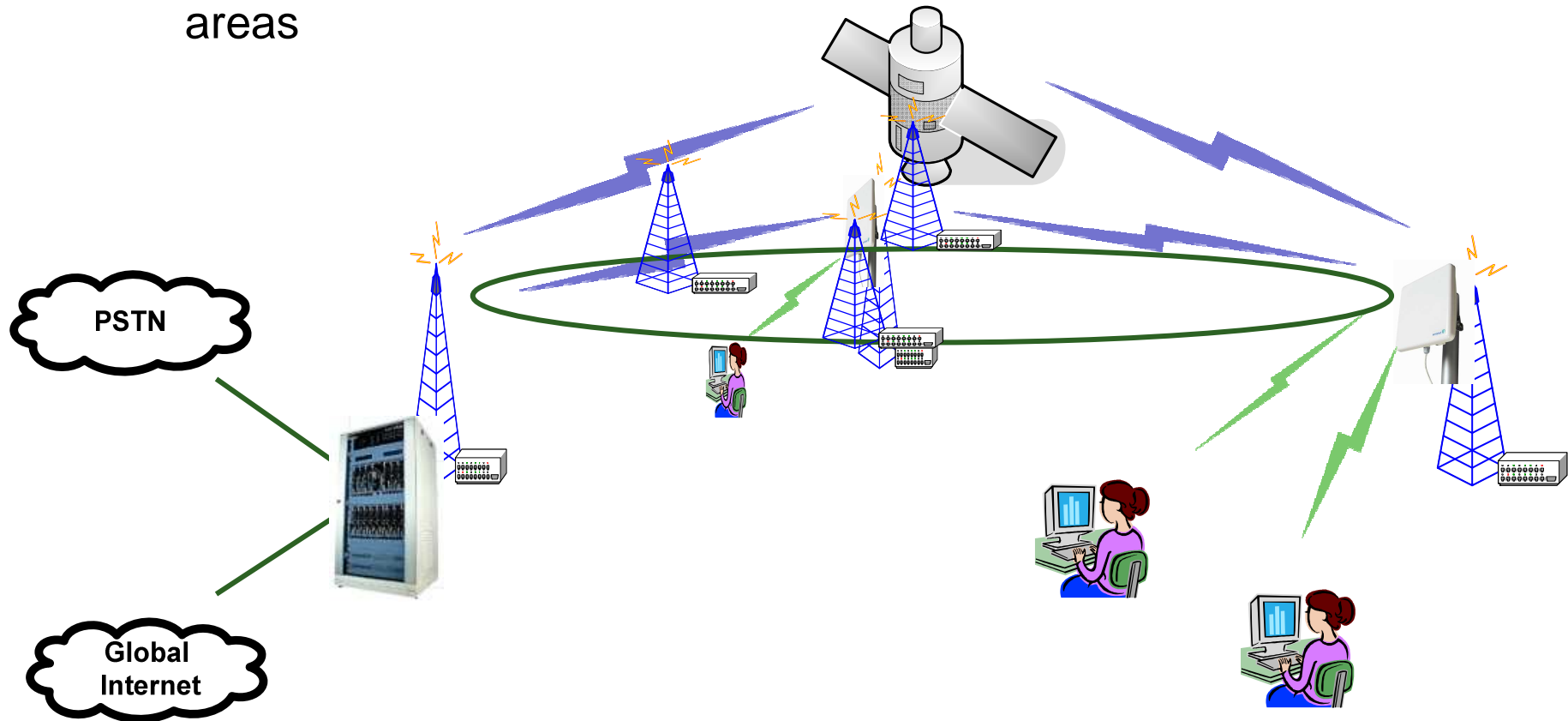
## 1. Shared Infrastructure

- At least Towers, back-haul and fibre
  - Government / Universal Service Fund should support build up of shared infrastructure in hinterland
- May be Base stations
- Definitely backbone fibre



## 2. Backhaul to Telecom Towers

- Invest in Fibre wherever possible
  - Digital Microwave Radio if fibre not possible
  - Satellite as backhaul as an immediate option to reach remotest areas



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### 3. Control end-to end costs

- Watch not just the communications costs
- Other costs may be substantial
  - Powering remote Base stations
    - Low power BS significantly reduces CAPEX
      - Requires technology
  - Air-conditioning can be killer
    - Can one avoid this
      - Or use it primarily for battery
  - Maintenance: high OPEX and lowers Qos
    - Base stations
    - Subscriber terminals (PC's / thin clients for Broadband)

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## 4. Incremental CAPEX

- High Initial Investment can be a problem in emerging markets
  - Technology which allows you to invest as one acquires more and more subscribers
    - Network may be sub-optimal to begin with
      - Example: 802.16e rev B
      - Must get to optimal network finally (eg: 802.16m rev C)
  
- Upgrade and Pay for Bandwidth as one needs
  - Good NMS to monitor QoS
    - May require USO support to begin with

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## 5. Watch out

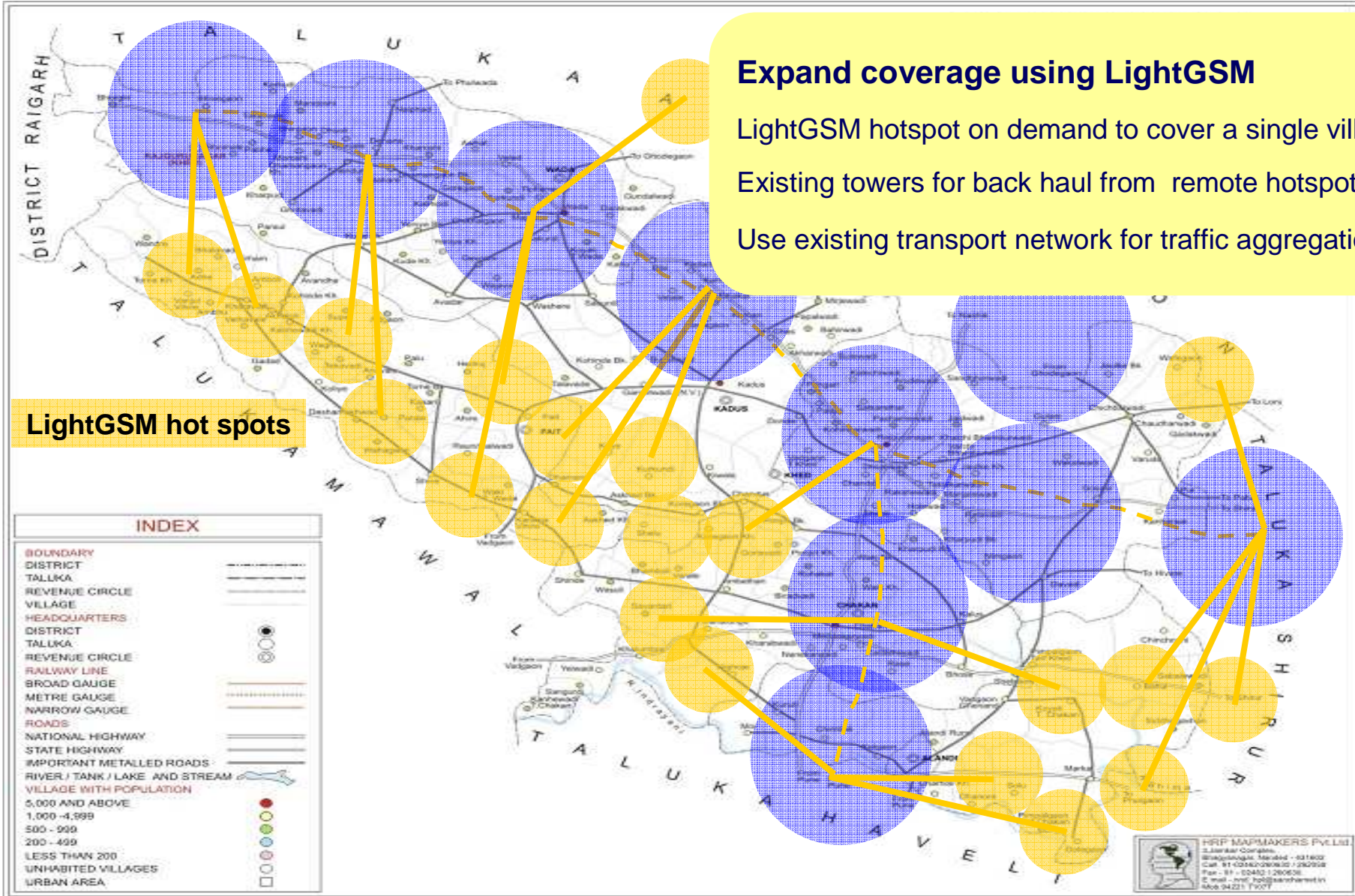
- Fixed wireless is generally more expensive
  - In spite of having bit-rate advantage at any time
    - Unless special care is taken: installation costs, volumes
  
- Satellite connectivity is shared bandwidth
  - Avoid except where there is no other choice..
  - Terrestrial wireless focus
  
- Are Base stations software upgradable
  - To emerging standards
  - To future spectrum
  
- Backend IT costs can sky-rocket

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## 6. Preparing for Tomorrow's Cellular Infrastructure

- Lower cost Base Stations
- Low Power Base Stations
  
- Next Generation Base Stations
  - Consisting of
    - Low Noise Amplifiers, Power Amplifiers, A/D and D/A
      - And so low power
    - Software driven base stations
      - So that new base stations become software change rather than hardware as new standards evolve
    - Fibre (with DWDM) backhaul carrying a digitized signals to central Base Station Processing unit (BSPU)
      - BSPU is Core Computing with parallel processing
        - Similar to that used today for billing, network management and customer care today

*Light GSM: low cost low power base stations to  
reduce CAPEX / OPEX*



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## Broadband Wireless

- Yesterday
  - 3G1X / EDGE provides Internet connectivity where there is none
- Today
  - EVDO provides decent data rate
    - Avoid 802.16d (fixed)
    - Limited use of BB-corDECT (fixed)
- New build-outs today
  - HSPA has matured and pushed up data rate
  - 802.16e is superior, but must be upgradable
- Look-out for and accelerate availability
  - 802.16m
  - 3GPP (LTE-A)
- Important to define Africa requirements
  - depending on topology, terrain, population density and affordability and incorporate in Nexgen standards
    - like for eg: Cell – edge performance

## Broadband Devices

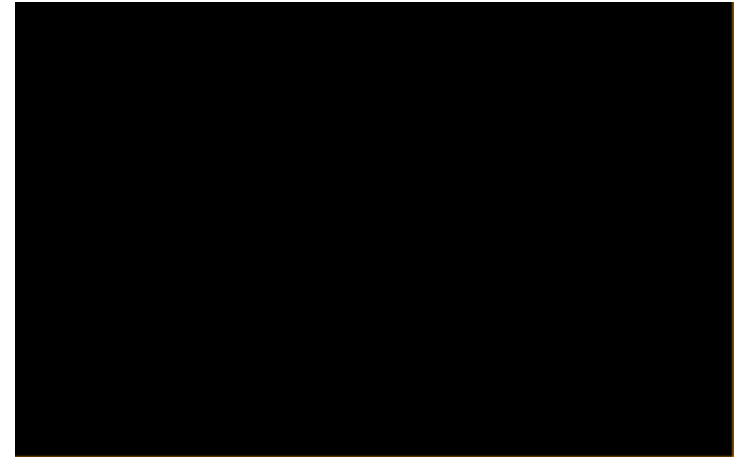
- International Volume drive down the costs
  - Emerging Markets can have substantial volumes of its own
- Hand-helds: handsets / PDA's
- Laptops and Personal Computers
  - Watch out for Supply chain, Maintenance, Power and usability
- Thin clients may be key to Broadband
  - Low maintenance, power
  - Broadband as a service: No back-ups / viruses





## Services: Do people want Broadband?

- Broadband must serve developmental goals
  - Enhance education, health care and livelihood
- Rural BPO: taking IT enabled services to villages
- Rural contract Manufacturing:
  - taking manufacturing to villages
- Internet Based coaching to pass school exams
  - Spoken English
  - Training for employment

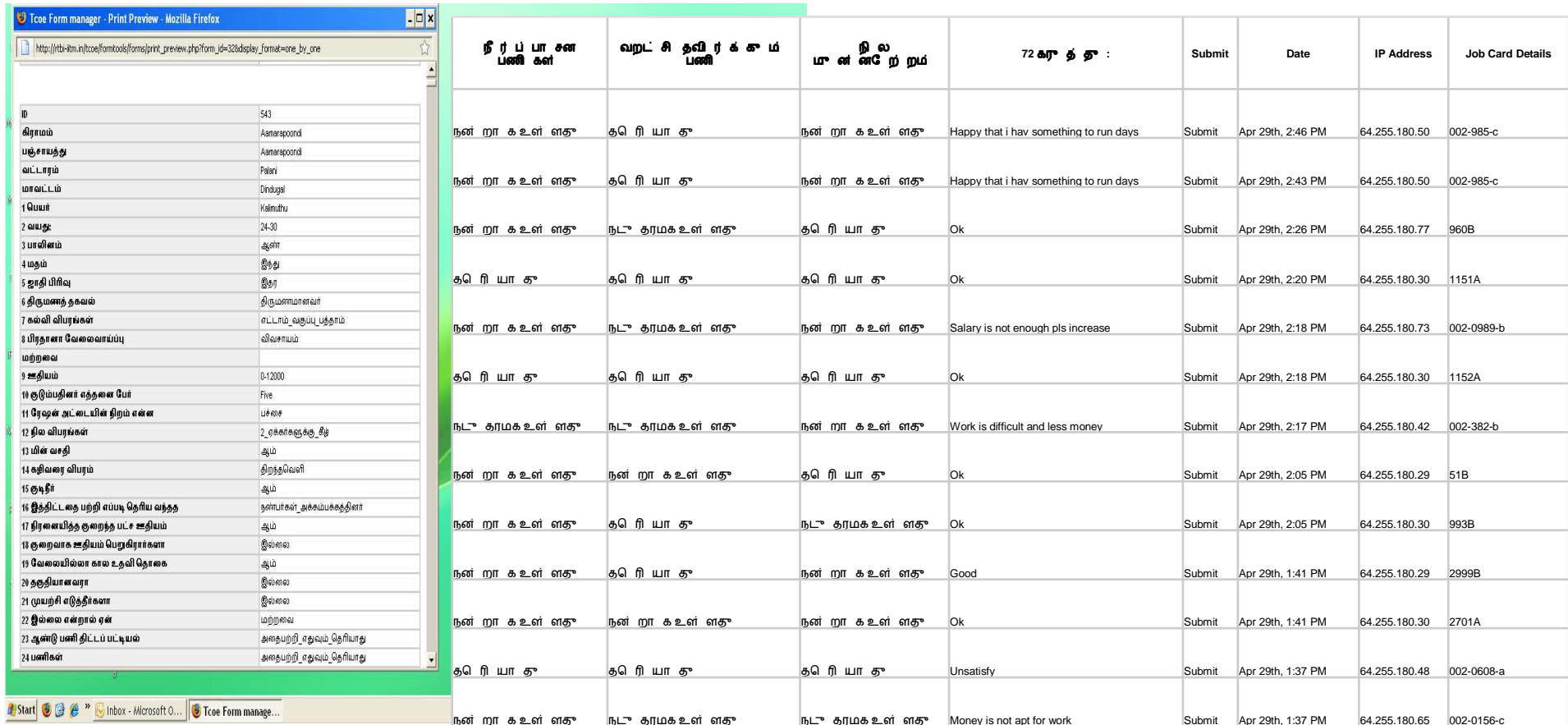


- Enhancing health care through tele-medicine
- ICT technologies to strengthen
  - Agriculture
  - Financial Inclusion



## And above all – driving small and medium businesses

- Driving efficiency: IT for better management and control
  - Even with GPRS



The screenshot shows a web browser window titled 'Tcoe Form manager - Print Preview - Mozilla Firefox'. The address bar displays 'http://tcb-atom.in/tcoe/formtools/forms/print\_preview.php?form\_id=32&display\_format=one\_by\_one'. On the left, there is a list of form fields with their corresponding values. On the right, a table displays the submitted data for 24 forms.

ID	வார்டர் கார்டு	வார்டர் கார்டு	மூலக்கூறு	72 கார்டு :	Submit	Date	IP Address	Job Card Details
543	நன் நா க உள் எது	கெ ரி யா கு	நன் நா க உள் எது	Happy that i hav something to run days	Submit	Apr 29th, 2:46 PM	64.255.180.50	002-985-c
	நன் நா க உள் எது	கெ ரி யா கு	நன் நா க உள் எது	Happy that i hav something to run days	Submit	Apr 29th, 2:43 PM	64.255.180.50	002-985-c
	நன் நா க உள் எது	நட் குரமக உள் எது	கெ ரி யா கு	Ok	Submit	Apr 29th, 2:26 PM	64.255.180.77	960B
	கெ ரி யா கு	கெ ரி யா கு	கெ ரி யா கு	Ok	Submit	Apr 29th, 2:20 PM	64.255.180.30	1151A
	நன் நா க உள் எது	நட் குரமக உள் எது	நன் நா க உள் எது	Salary is not enough pls increase	Submit	Apr 29th, 2:18 PM	64.255.180.73	002-0989-b
	கெ ரி யா கு	கெ ரி யா கு	கெ ரி யா கு	Ok	Submit	Apr 29th, 2:18 PM	64.255.180.30	1152A
	நட் குரமக உள் எது	நட் குரமக உள் எது	நன் நா க உள் எது	Work is difficult and less money	Submit	Apr 29th, 2:17 PM	64.255.180.42	002-382-b
	நன் நா க உள் எது	நன் நா க உள் எது	கெ ரி யா கு	Ok	Submit	Apr 29th, 2:05 PM	64.255.180.29	51B
	நன் நா க உள் எது	கெ ரி யா கு	நட் குரமக உள் எது	Ok	Submit	Apr 29th, 2:05 PM	64.255.180.30	993B
	நன் நா க உள் எது	கெ ரி யா கு	நன் நா க உள் எது	Good	Submit	Apr 29th, 1:41 PM	64.255.180.29	2999B
	நன் நா க உள் எது	நன் நா க உள் எது	நன் நா க உள் எது	Ok	Submit	Apr 29th, 1:41 PM	64.255.180.30	2701A
	கெ ரி யா கு	கெ ரி யா கு	கெ ரி யா கு	Unsatisfy	Submit	Apr 29th, 1:37 PM	64.255.180.48	002-0608-a
	நன் நா க உள் எது	நட் குரமக உள் எது	நட் குரமக உள் எது	Money is not apt for work	Submit	Apr 29th, 1:37 PM	64.255.180.65	002-0156-c

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## To Conclude

- Broadband can indeed empower Africa
  - Need will and determination
- Define time-frame to have broadband in each village
- Experiment and scale ICT based developmental efforts