

Networking: A Key Driver for Globalization



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Summary

A major driver for increased globalization is telecom and Internet

- Because low cost of connectivity and networking, distances between US, Europe, and emerging countries have been greatly reduced

Most of the new growth in telecom and Internet is in Asia

- Economies of China and India are growing at ~10% rates due to globalization, outsourcing of manufacturing and services from US and Europe
- Low tele-densities (20% in India)

But vast majority in emerging countries still disconnected - connecting them will require disruptive networking technologies and products:

- Low-cost (due to customers with very low ARPUs)
- Auto-configurable, robust to power outages, heat, dust, ...

The Network Evolution

Yesterday...

- Networks were designed to carry voice traffic
- *Data traffic mostly overlaid on voice networks (using modems)*

Volume of data traffic exceeds voice traffic

...Today...

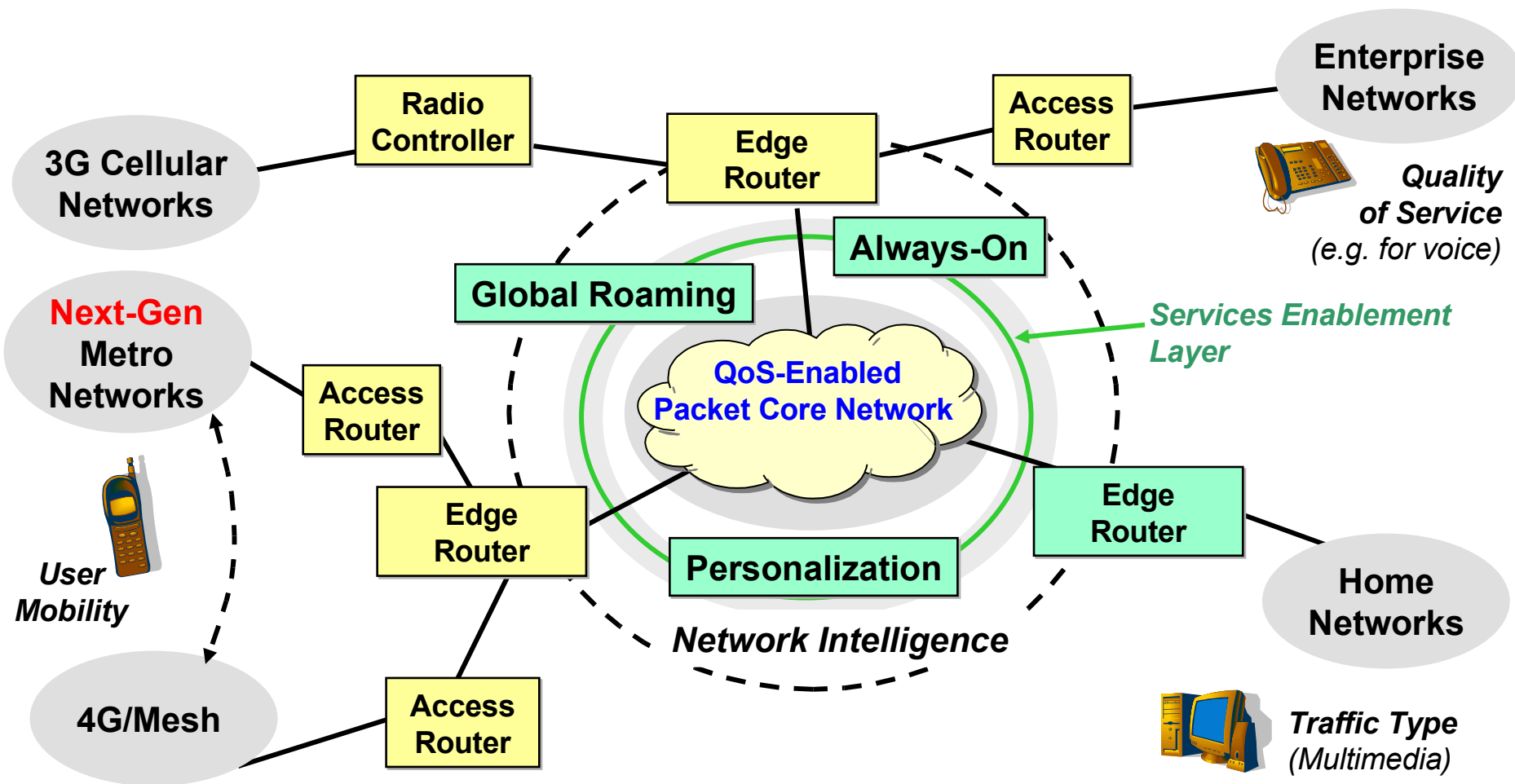
- Networks are designed to carry primarily data traffic
- *Voice traffic overlaid on data networks (e.g. VoIP)*

Content traffic becomes dominant

...Tomorrow...

- ***Future networks should be designed primarily for efficient content distribution and content search/location***
 - Content distribution should *not* only be overlaid, but built in from ground up
- ***Future networks should also be able to effectively carry best-effort data traffic and QoS-sensitive multimedia traffic***
- ***New content applications being deployed faster in Japan and Korea because of large broadband deployment***

Tomorrow's Converged Network



An emerging country like India has unique networking needs

740 million people live in rural villages

- Low incomes: monthly per-capita income - \$17.50
- Low literacy: 60%
- Unreliable power: frequent outages
- Low teledensity: 2 phones per 100 people
- Low PC penetration
- Very few Internet users

Challenges for Networking to Improve Globalization

Low cost infrastructure

- VillageNet: Connectivity of remote villages at very low price points
- Base Station Router: Cellular network in a box

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Programs

Low cost handsets

- \$30 handset, \$100 laptop

Addition of broadcast channels for content distribution to current Internet

VillageNet: 802.11-based Broadband Connectivity for Rural Areas

Goal 1: Provide a **broadband “pipe”** to villages in rural areas

- Enable applications such as telemedicine, distance education, weather/crop info, e-governance etc

Goal 2: Infrastructure should be **highly inexpensive**

- Because of low paying capacity of people

Environment (in India):

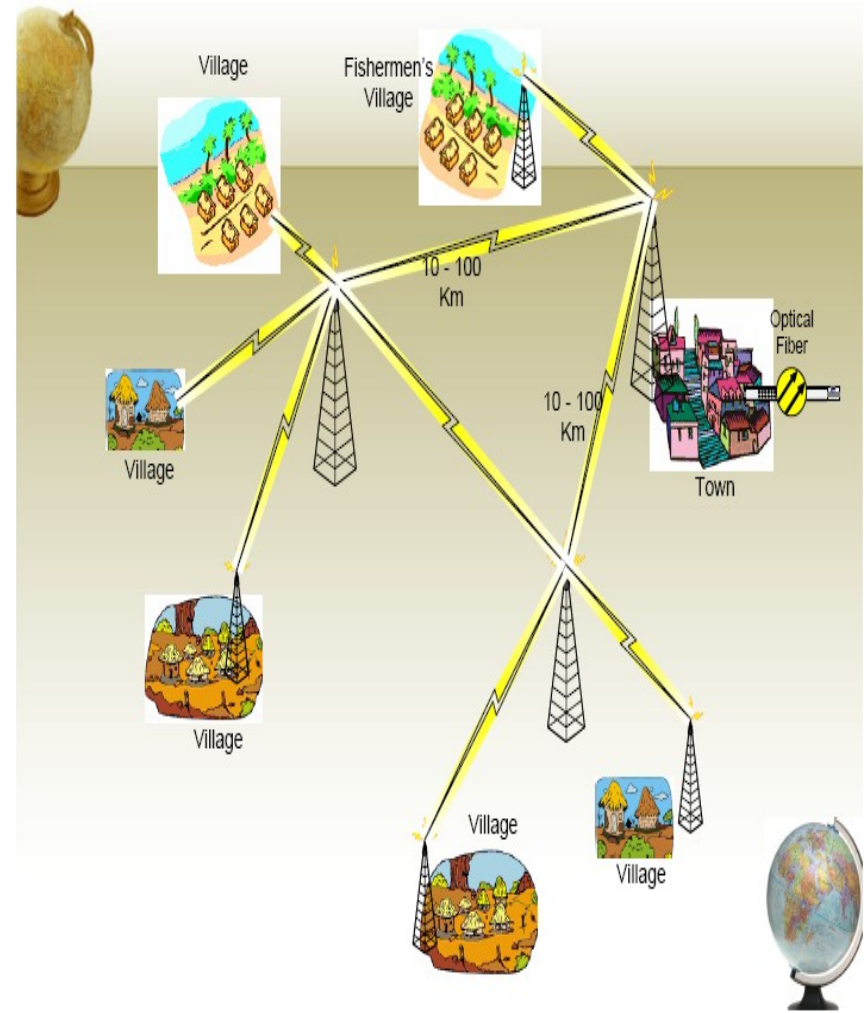
- Most villages are within 25 Kms of a fiber drop - small towns (called **“gateway”** nodes) with Internet connectivity
- Average inter-village distance: **7-8 Kms**
- **Last “25 Kms” problem**: how to extend this internet connectivity to the villages in an inexpensive manner?

VillageNet Approach (see also TIER, DGP)

Use commodity **IEEE 802.11** radio equipment to reduce costs

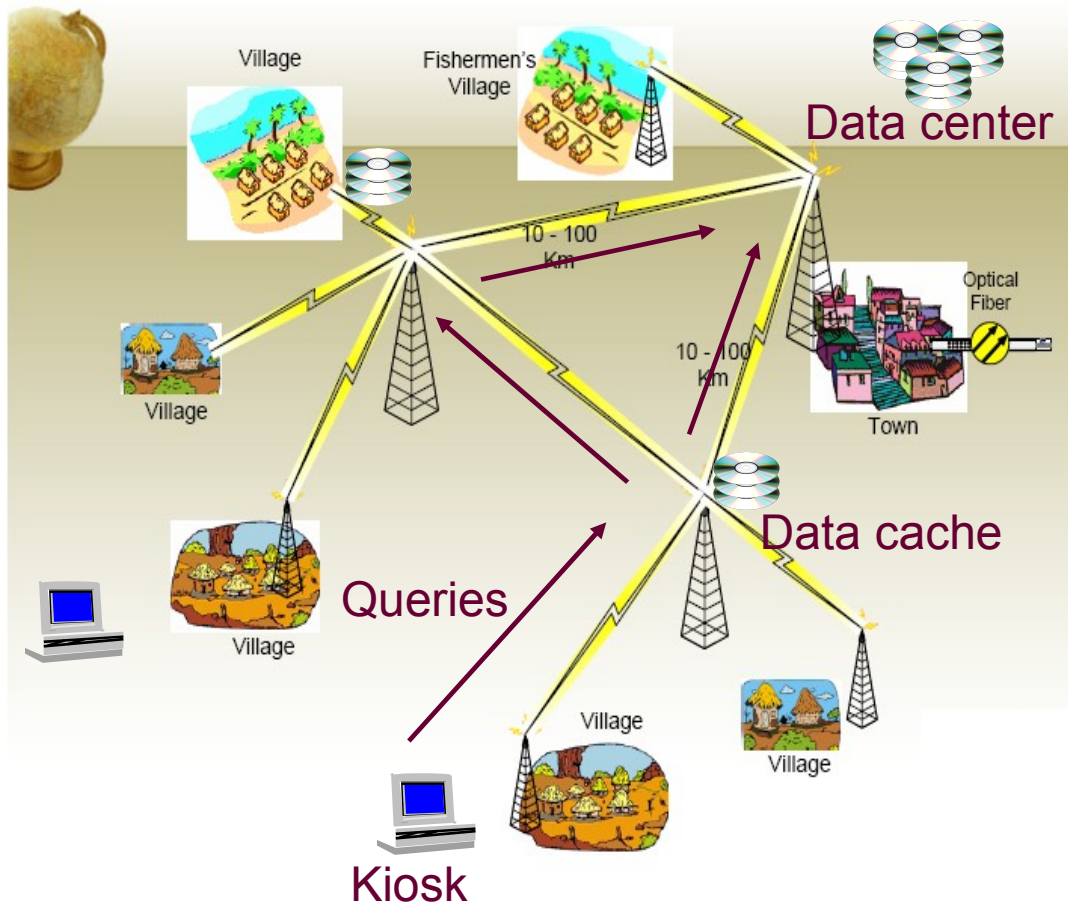
Use **multi-hop mesh** architecture built out from gateway node to cover long distance

- point-to-point links established using **directional antennas** mounted on towers to establish line-of-sight



VillageNet Data Access over Unreliable Wireless Meshes

Nodes are power-constrained, may be down due to unreliable power



Minimize communication to conserve power

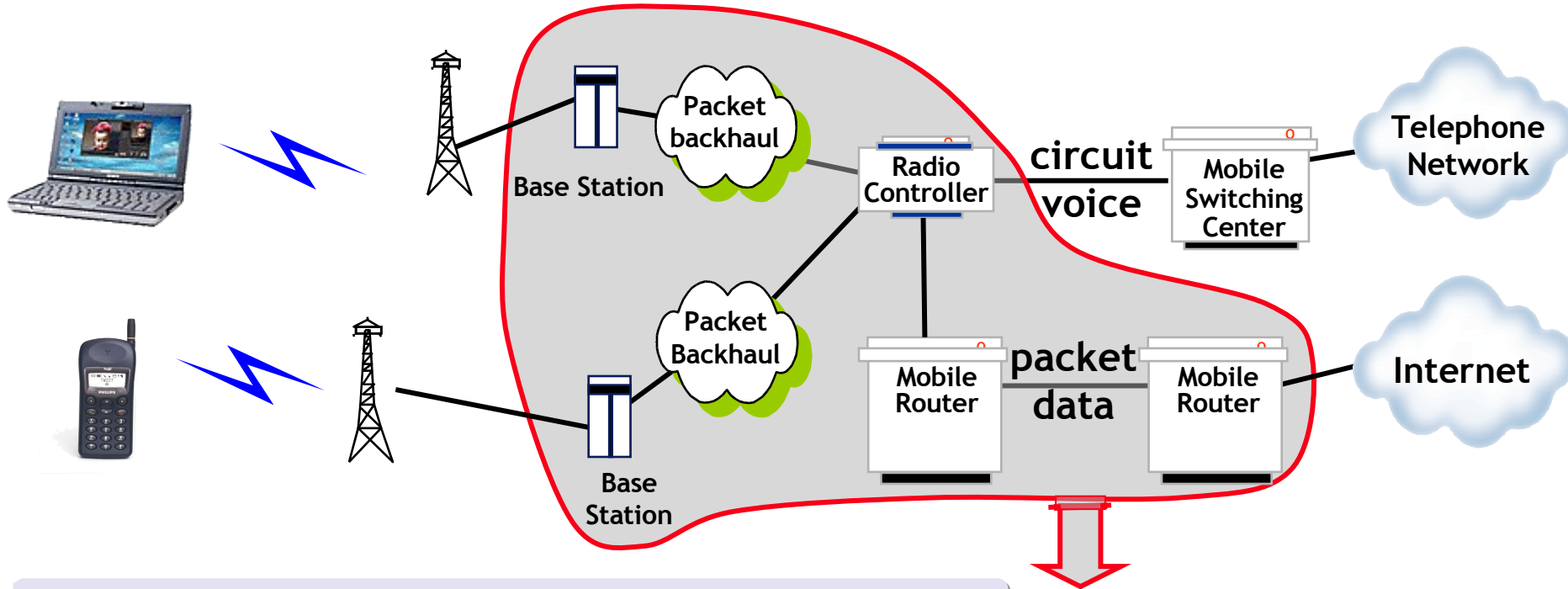
- Cache items based on access patterns
- Batch queries, route results along optimal routes

Route around power outages to maximize throughput

Base Station Router: Cellular Network in A Box

Base Station Router terminates all air-interface-specific functions in the base station

Can create low-cost networks with one backhaul link



- Collapsing Radio Access Network elements into the base station simplifies network and reduces latency
- Pushing IP intelligence to the base station results in better Quality of Service support

Low-Cost Computing Devices

Current low-cost PC efforts

- One Laptop Per Child (MIT Media Labs - \$100PC)
- Eduwise (Intel)
- Simputer (Picopeta)

Distinctive Features

- Thin clients (network computing), open-source, low power displays

Widespread Adoption?

Meanwhile ...

- 200m mobile subscribers in India growing at 8m a month!
- 500m mobile subscribers in China growing at 6m a month!
- By 2010, 3.7b worldwide cell phone subscribers!
- Cell phone costs coming down dramatically (< \$50)

Could cell phones be the low cost computing devices of the future?



Challenge for Educational Institutions

What should educational institutions do to train their students in globalization?

- Expose students to unique challenges of developing countries like China and India
- Teach courses on how to design low cost products
- Offer courses over networks of the future
- Conduct research in network based computing for low-cost laptops and handsets