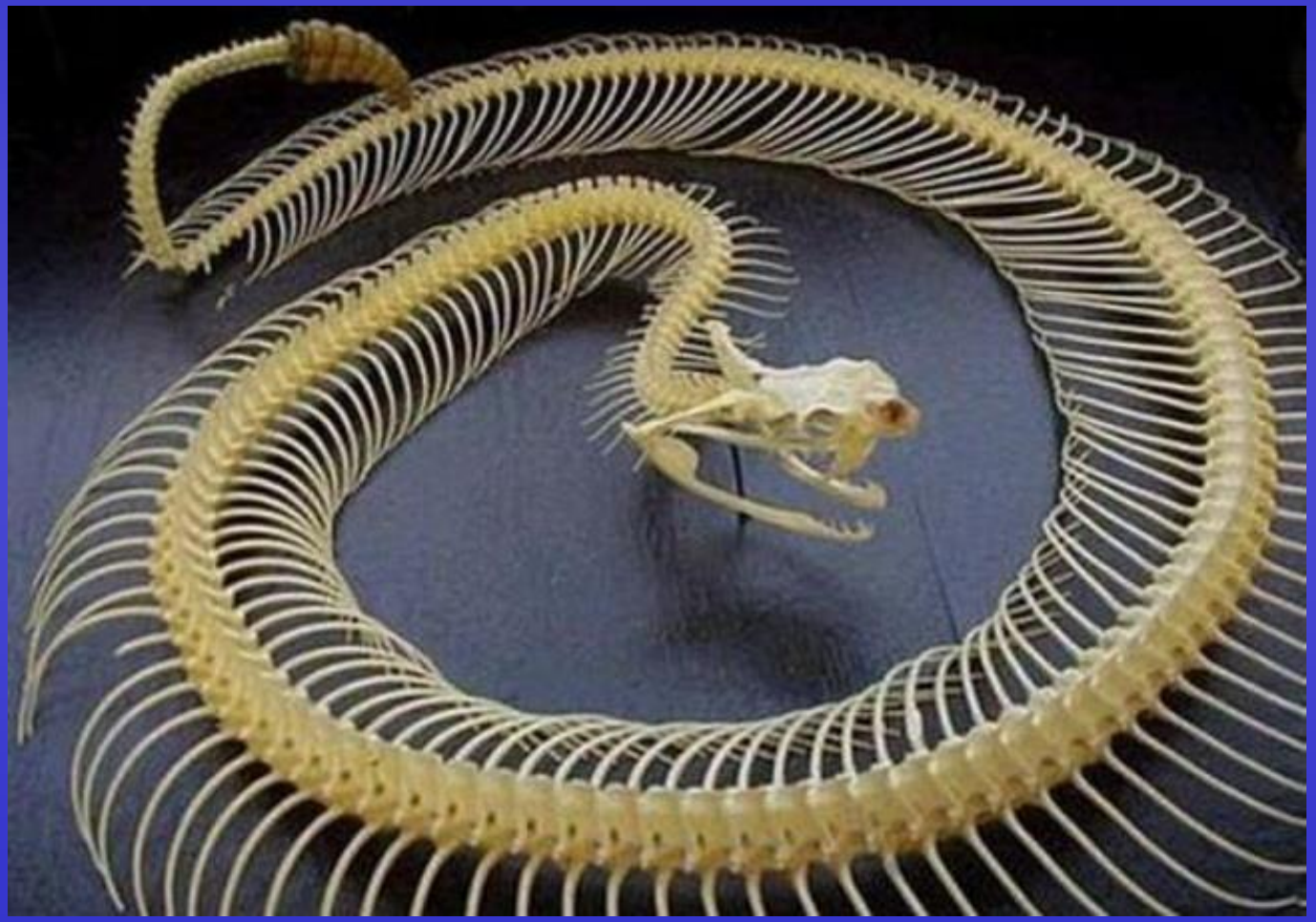
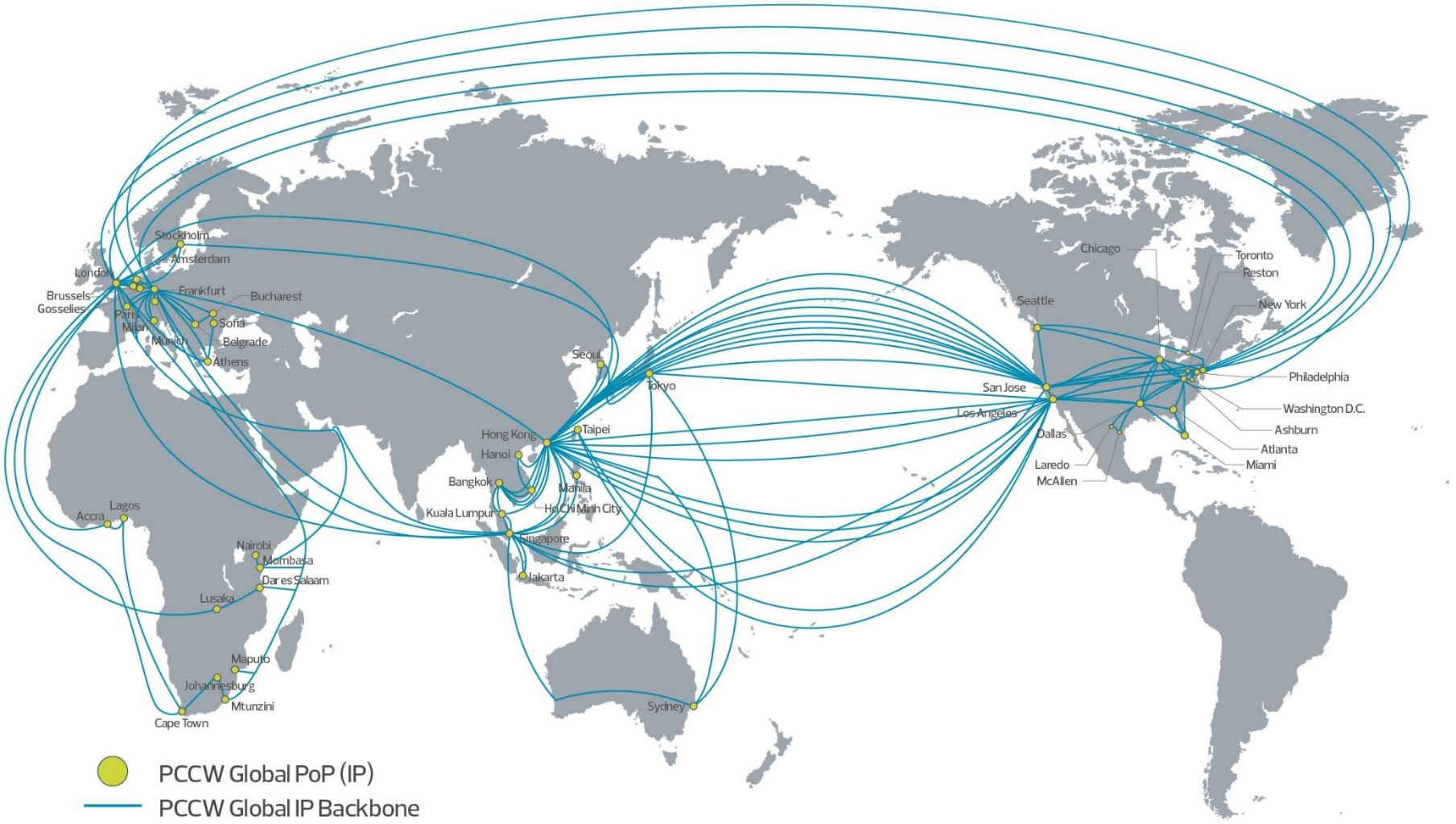
The Internet Backbone



Connectivity vs. Bandwidth

- **Connectivity** describes a physical connection to the Internet (wired or wireless)
- **Bandwidth** describes the speed of a physical connection


Stockholm
Amsterdam
London
Brussels
Gosselies
Frankfurt
Bucharest
Paris
Milan
Sofia
Munich
Belgrade
Athens
Seoul
Tokyo
Hong Kong
Taipei
Hanoi
Bangkok
Manila
Ho Chi Minh City
Kuala Lumpur
Singapore
Jakarta
Sydney
Seattle
San Jose
Los Angeles
Dallas
Laredo
McAllen
Chicago
Toronto
Reston
New York
Philadelphia
Washington D.C.
Ashburn
Atlanta
Miami
Lagos
Accra
Nairobi
Mombasa
Dar es Salaam
Lusaka
Maputo
Johannesburg
Mtunzini
Cape Town
PCCW Global PoP (IP)
PCCW Global IP Backbone

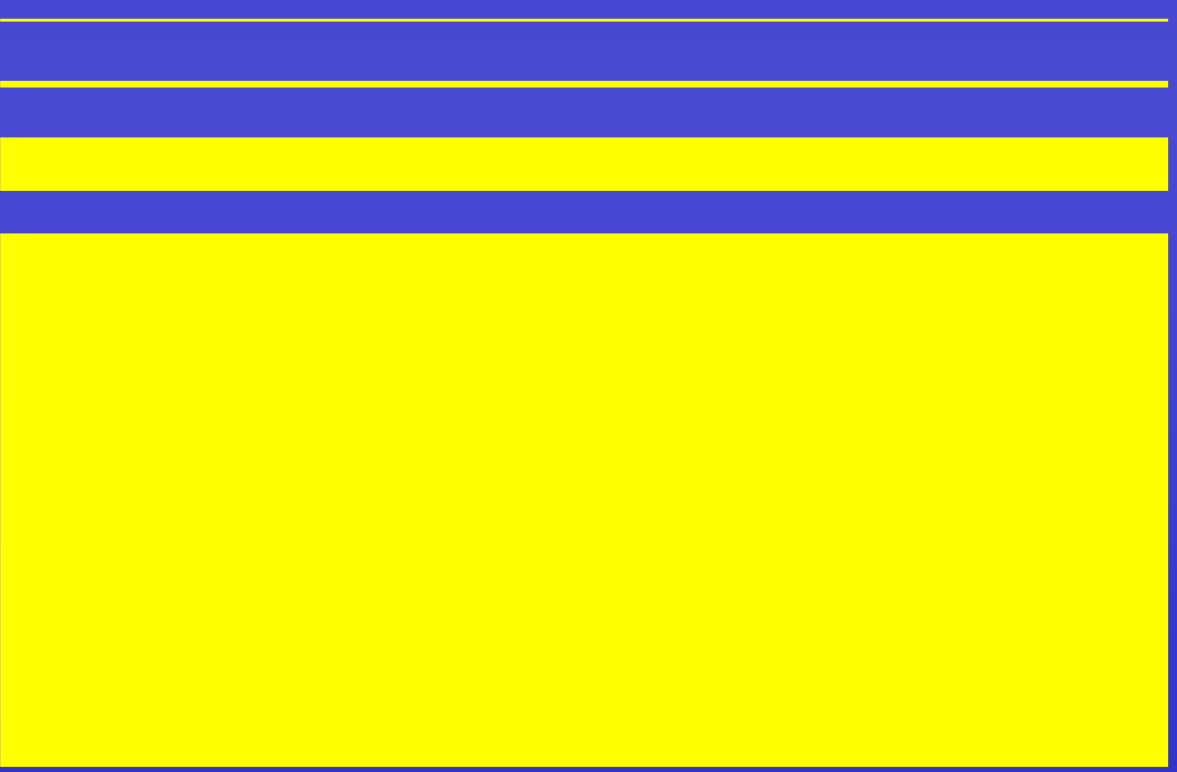
The Bandwidth Conundrum

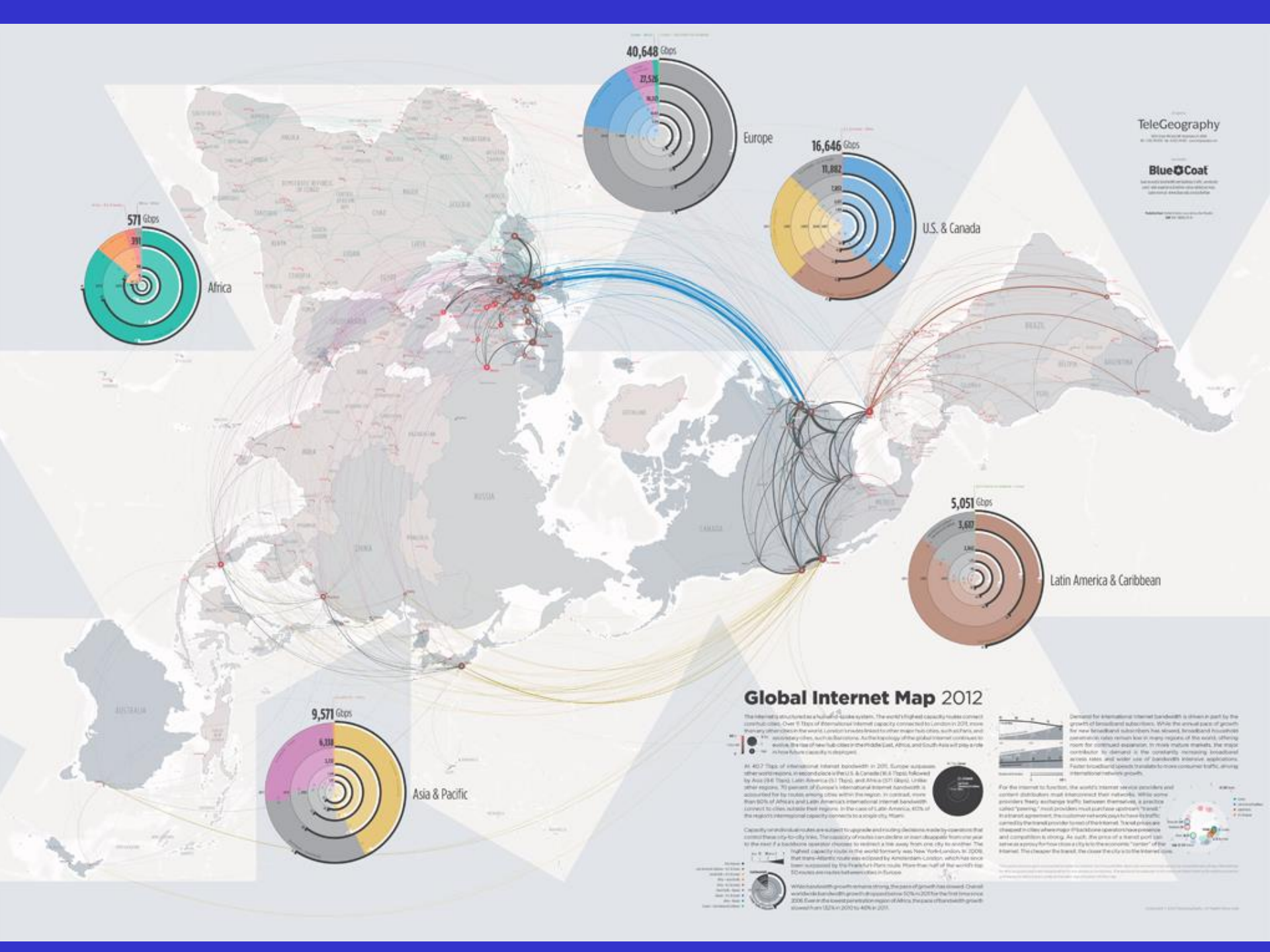
- **“Bandwidth”** is our term for measuring how much information can traverse the network from one point to another in a given time
- The amount of bandwidth between point A and point B determines
  - the amount of information that can be transferred in a given amount of time
  - the types of communication to be employed
  - how many can participate effectively

The Bandwidth Conundrum

The size of the network “pipe” determines which sorts of things can be done over the network

Multimedia, video, audio, large documents, and pictures require much more bandwidth…




40,648 Gbps
Europe
16,646 Gbps
U.S. & Canada
571 Gbps
Africa
5,051 Gbps
Latin America & Caribbean
9,571 Gbps
Asia & Pacific
TeleGeography
BlueCoat
Global Internet Map 2012

Two distinct flavors of Connectivity

- **Store and Forward**
  - the user interacts sporadically with the Internet, does the bulk of work off-line
  - the most popular application in developing countries
- **Interactive (Direct Connection)**
  - the computer is attached in real time to the Internet and can browse the World Wide Web
  - rare in the less developed countries

Store and Forward

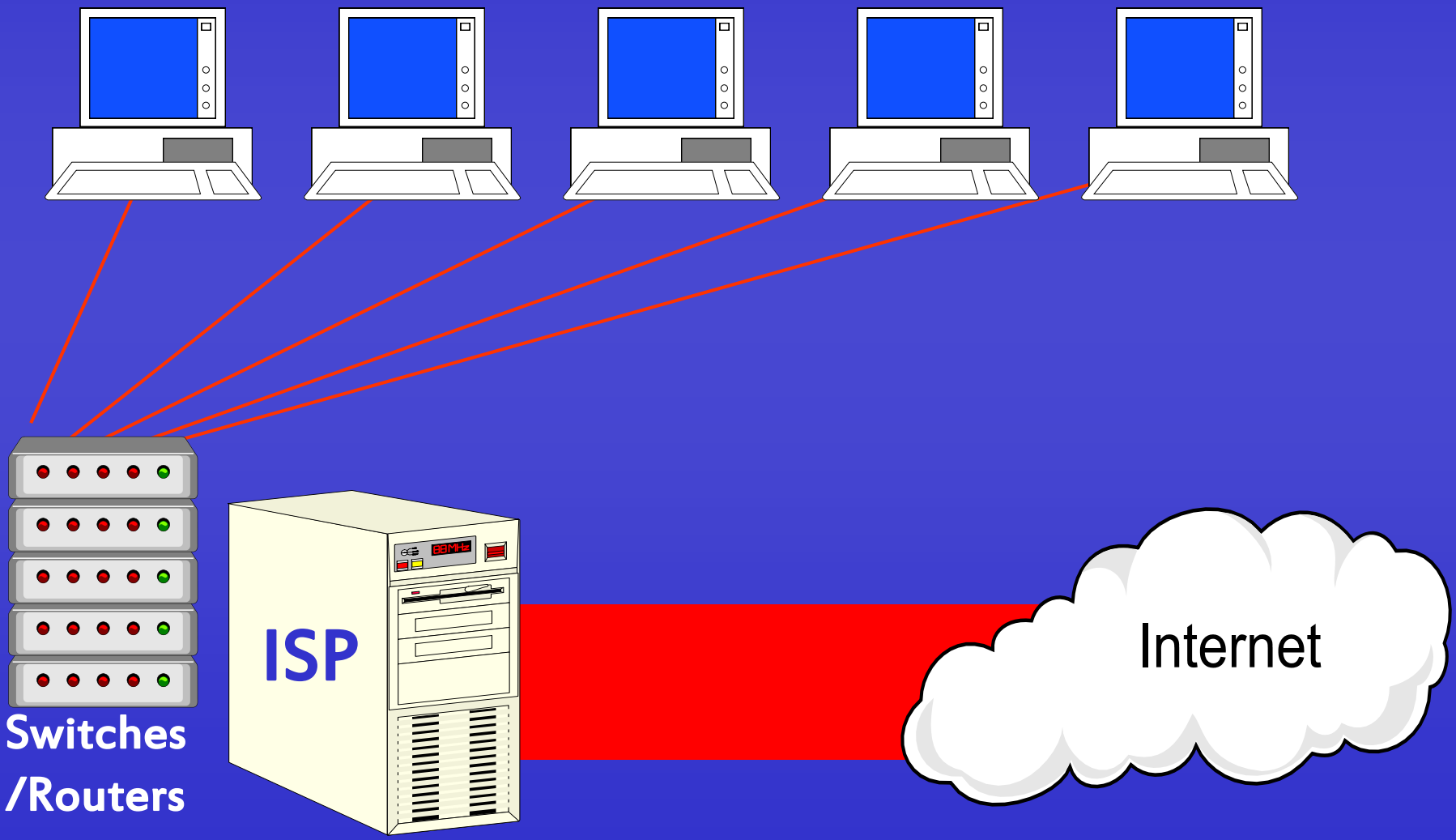
- asynchronous
- scalable from “sneaker net” to full IP connection
- Most cost effective communication available
- Hybrid solutions that “sync”
- Users sometimes “Pay by the bit.”

Asynchronicity
is the
Poor Person's
Best Friend

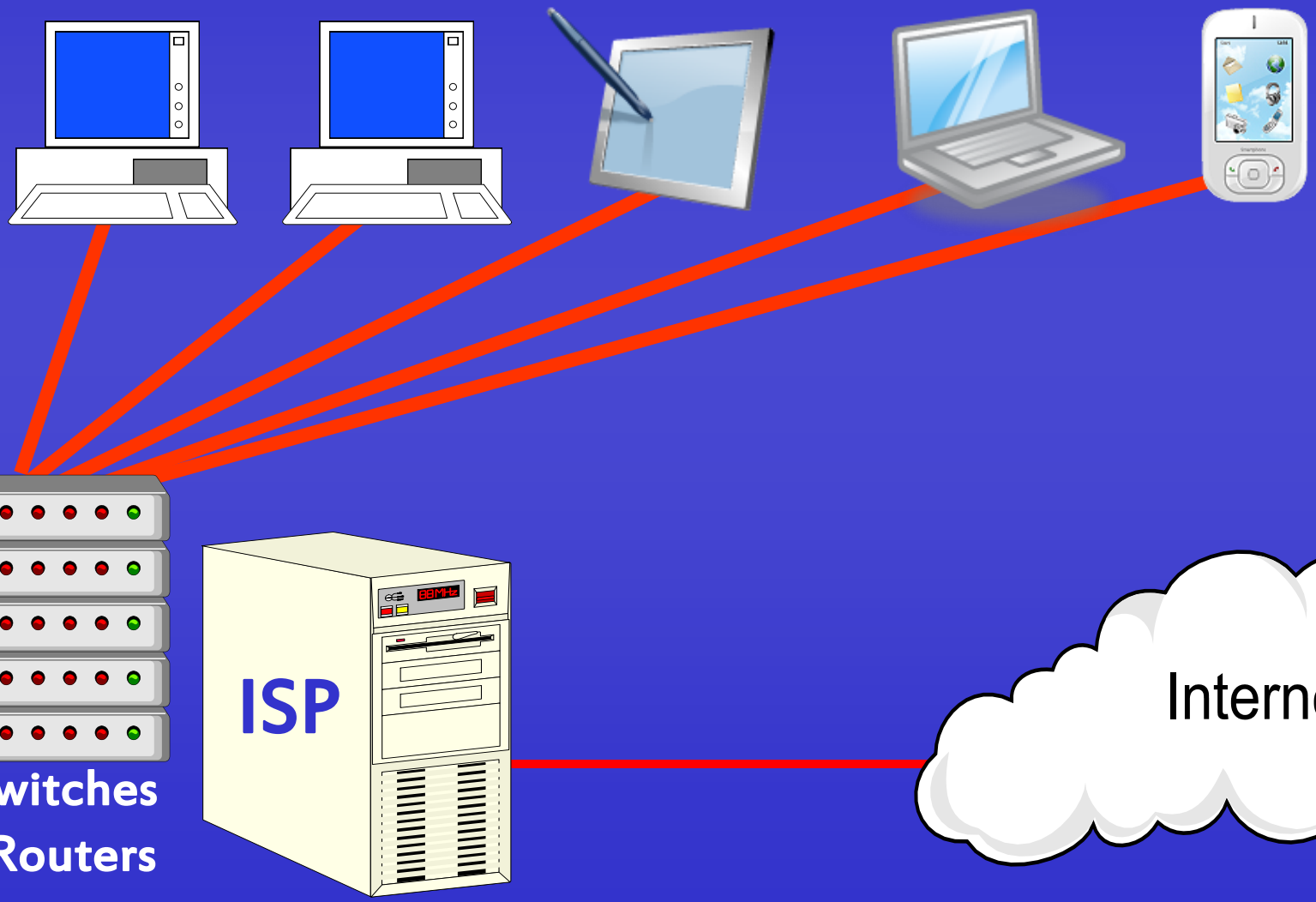
Interactive: TCP/IP

- an actual network “wire” to the Internet
- scalable throughput
- via network card or modem
- Works on packet level: interacting computers can negotiate transmission in real time
- Basis of the “World Wide” Web

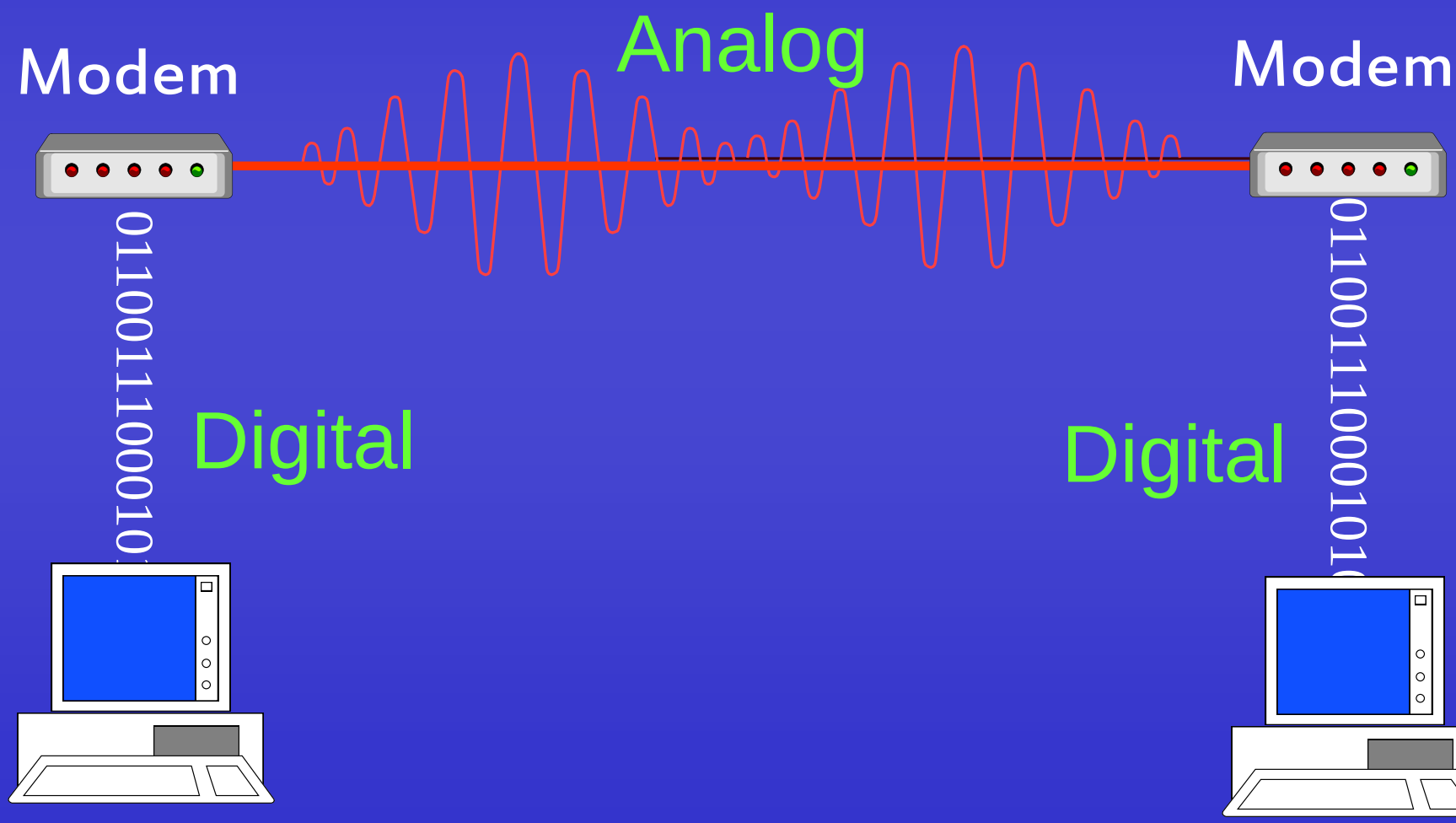
Ideal Internet Service Provider



Internet Service Provider



Modems

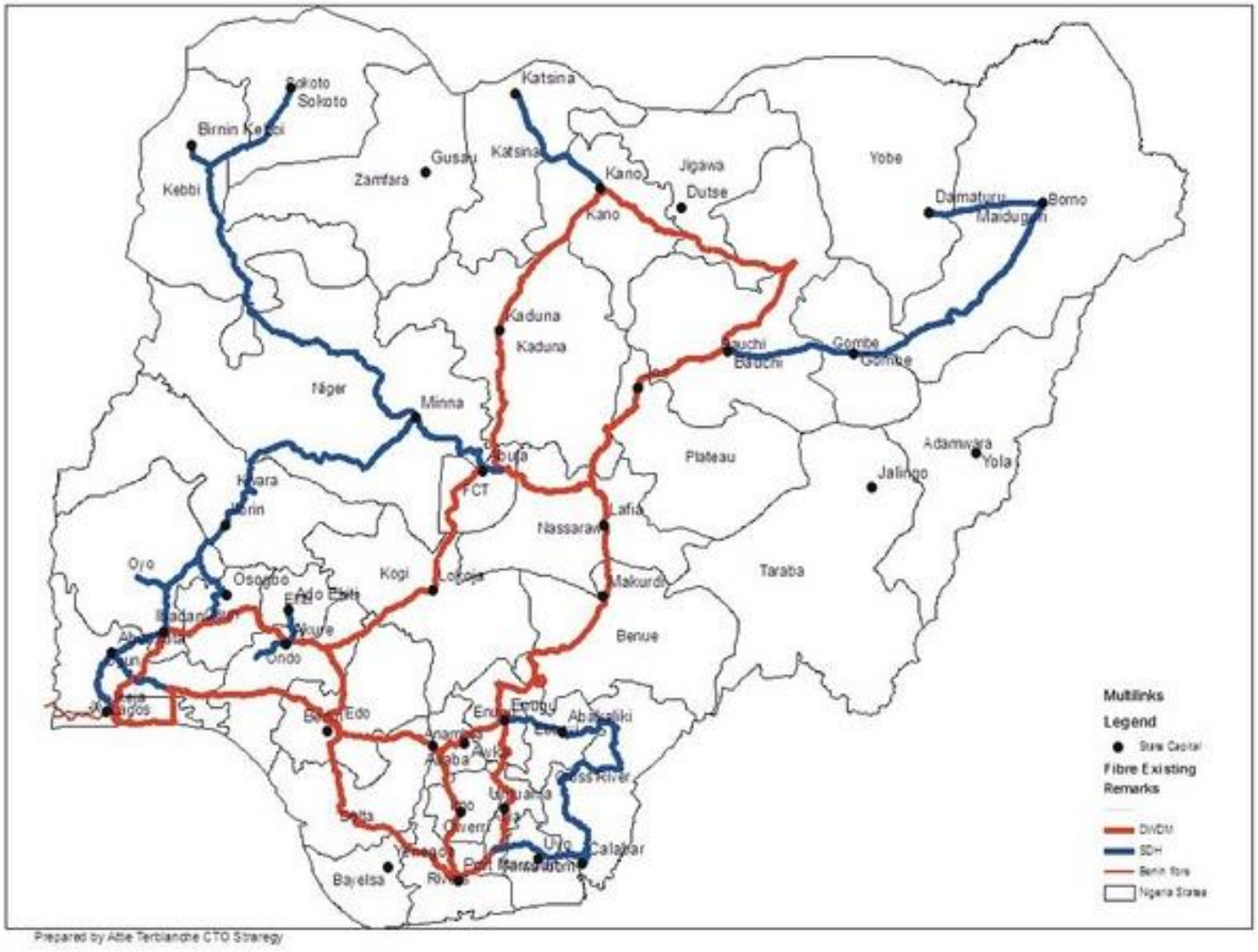


Ethernet Speeds

Cable	10	10Mb/s	10BASE-T
	100	100Mb/s	100BASE-TX
	1,000	Gigabit	1000BASE-T
	10,000	10 Gb/s	10GBASE-T
	100,000	100 Gb/s	100GBASE-T
Wireless	54	54 Mb/s	802.11a
	11	11 Mb/s	802.11b
	54	54 Mb/s	802.11g
	65	65 Mb/s	802.11n
	150	150 Mb/s	802.11n
	300	300 Mb/s	802.11n
73Tbit record			

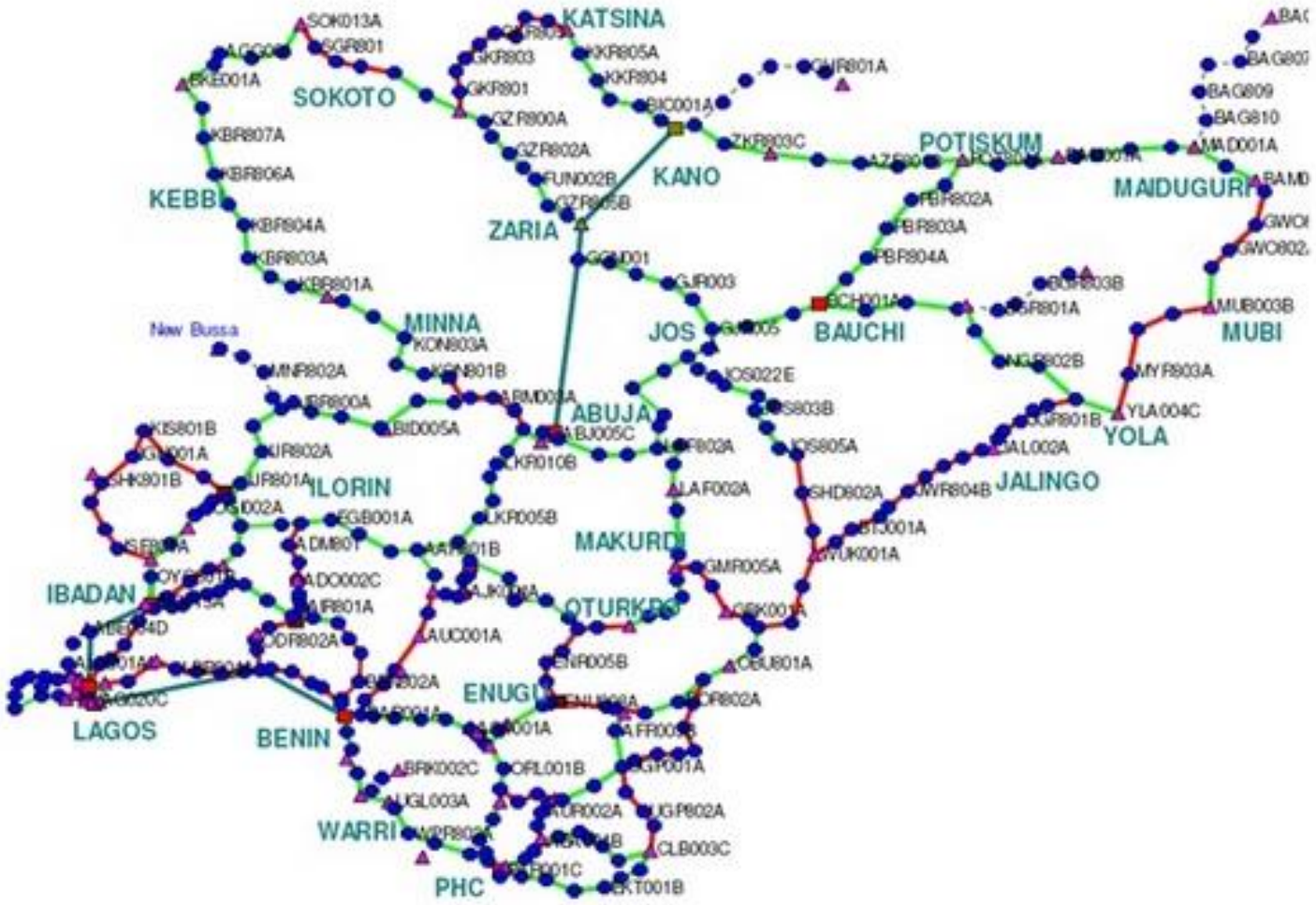
Long Distance Options

- Fiber Optics
- Copper Wires
- Microwave Terrestrial Radio
- Satellite



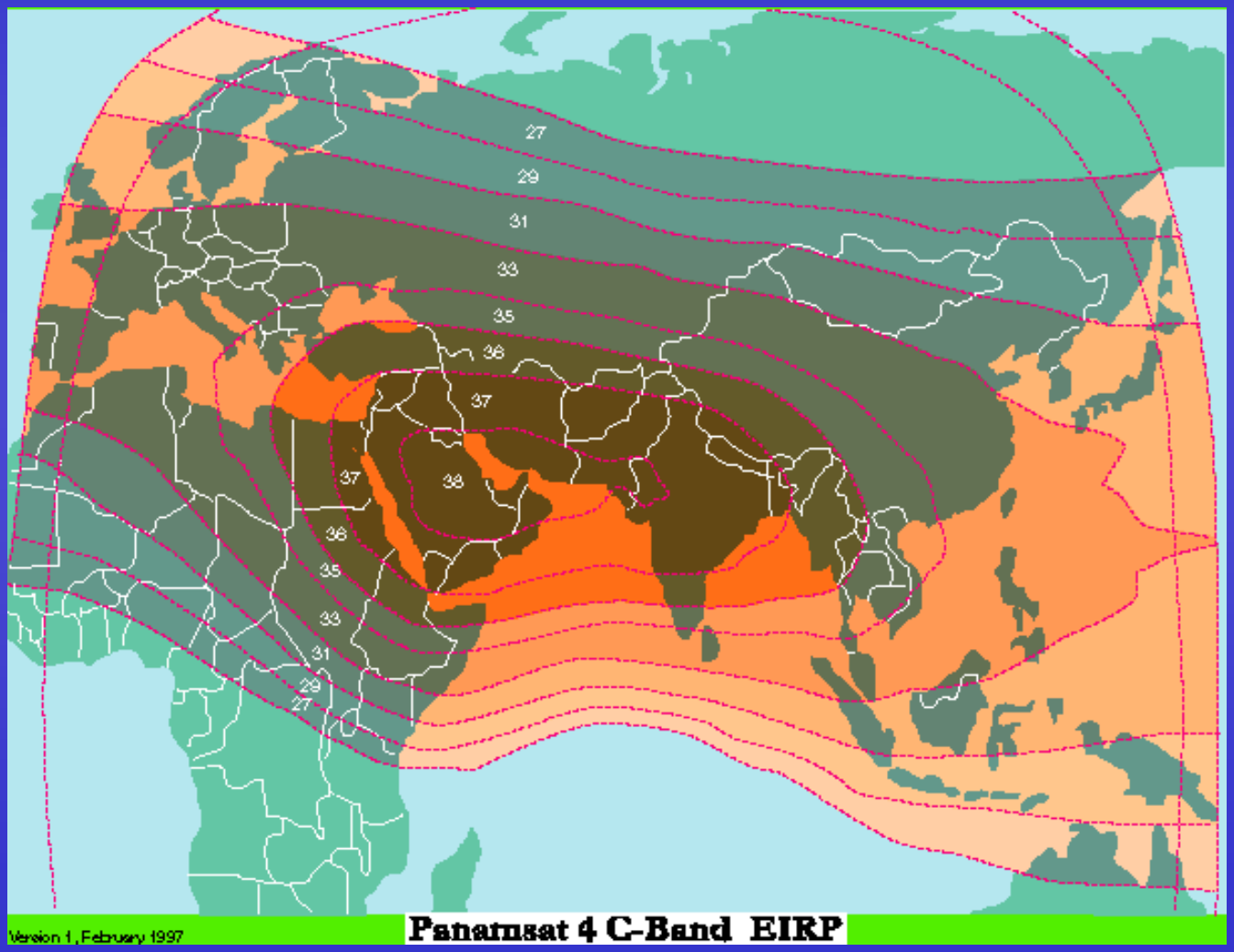
Nigeria - MultiLinks Fibre Backbone

Microwave Network



Globacom have a Microwave network that practically spans the whole of Nigeria. On the SDH network the capacity is a minimum STM2 with 1+1 redundancy. This network alongside OFC network is used to carry most of our traffic nationwide.

Satellite Footprints

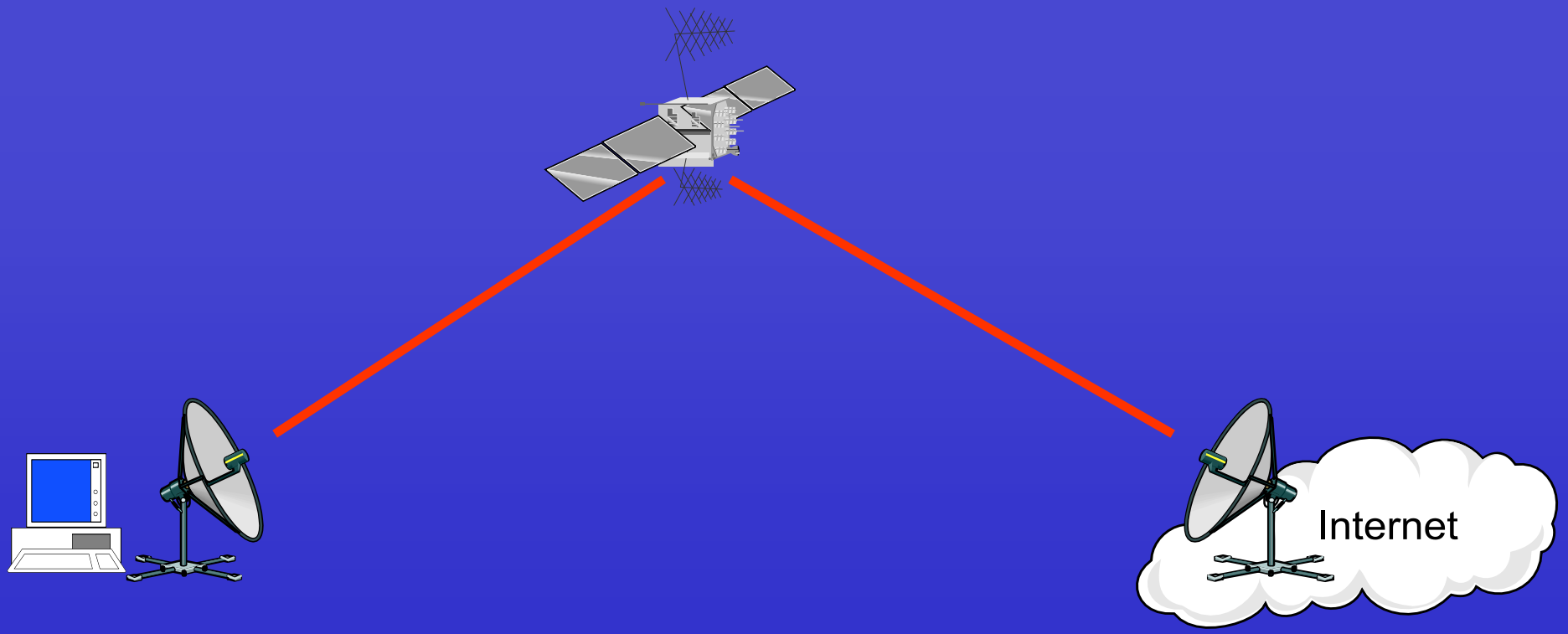


Satellite communications

- Inmarsat, IntelSat, PanAmsat, Hughes, etc:
  - full scale telecommunications links
  - large footprints covering several continents
  - gigabits of bandwidth
- VITASAT
  - intermittent links, small footprints
- Still a fraction of what fiber can deliver

Bent Pipe

- Satellite simply relays data using radio
- Users contract for a portion of the “birds” bandwidth



The End