

Broadband Internet Technology Development and Challenges

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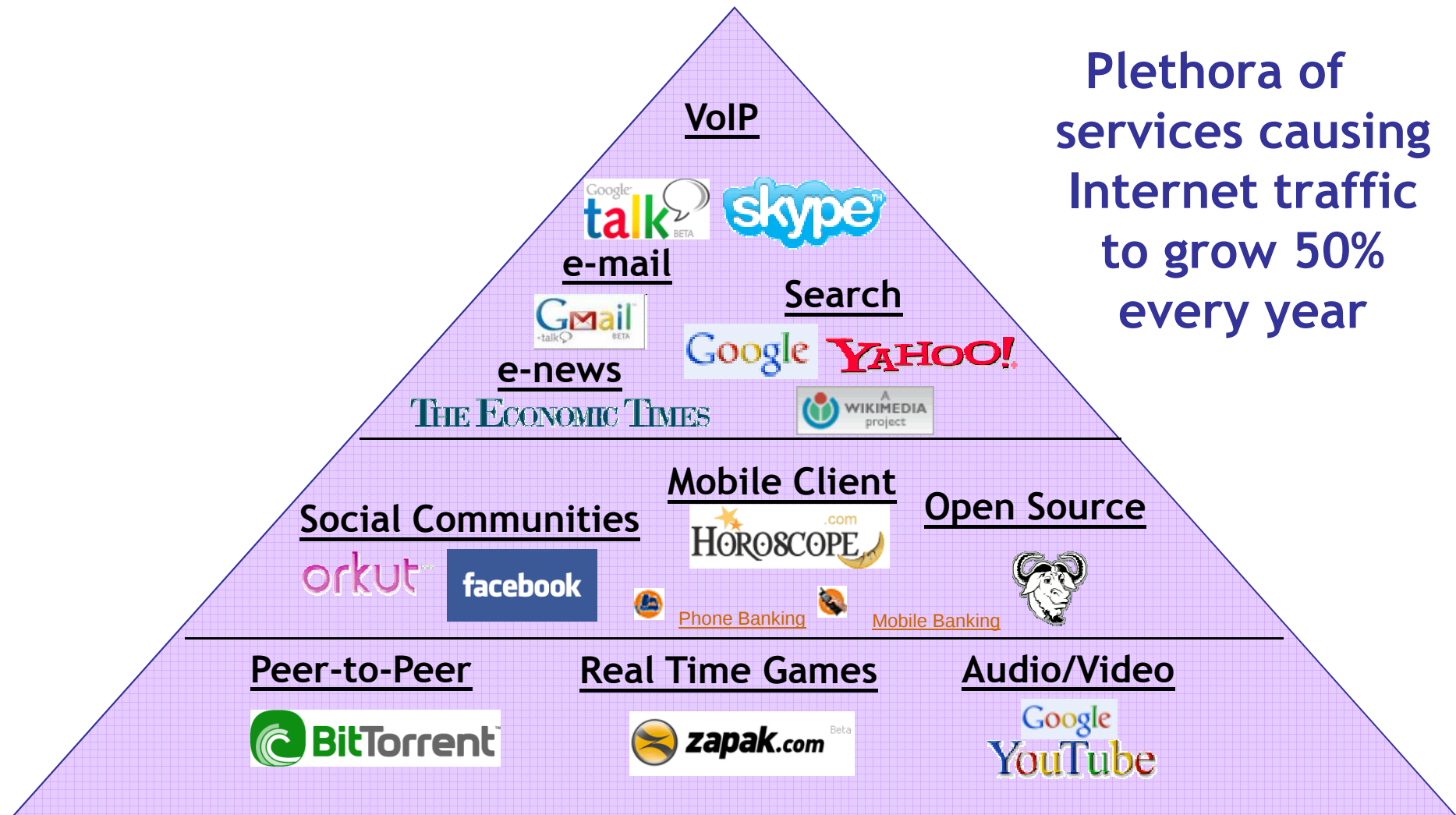
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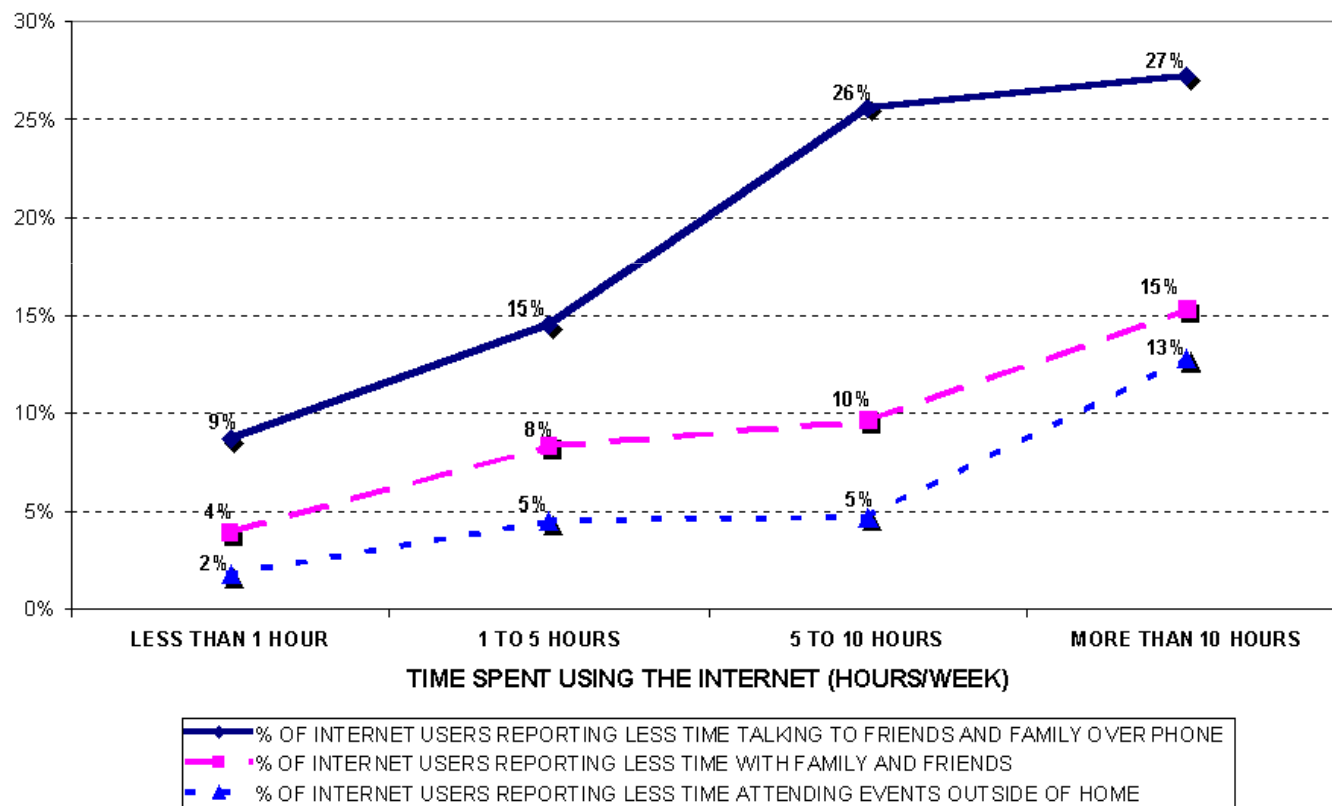
Drivers for Broadband

Plethora of services causing Internet traffic to grow 50% every year



Sacrificing what - Lesser Traditional Social Interaction ?

SOCIAL ISOLATION INCREASES



Source: Stanford

But....socializing on Internet

Major Drivers

- ◆ **Social Networking**

- Peer to peer applications dominate

- ◆ **Multimedia intensive**

- Interactive video, mobile TV, on-line gaming
- M Learning

- ◆ **Heterogeneity of Devices**

- Desktops, Laptops, PDA, Handhelds
- Small sensors, actuators

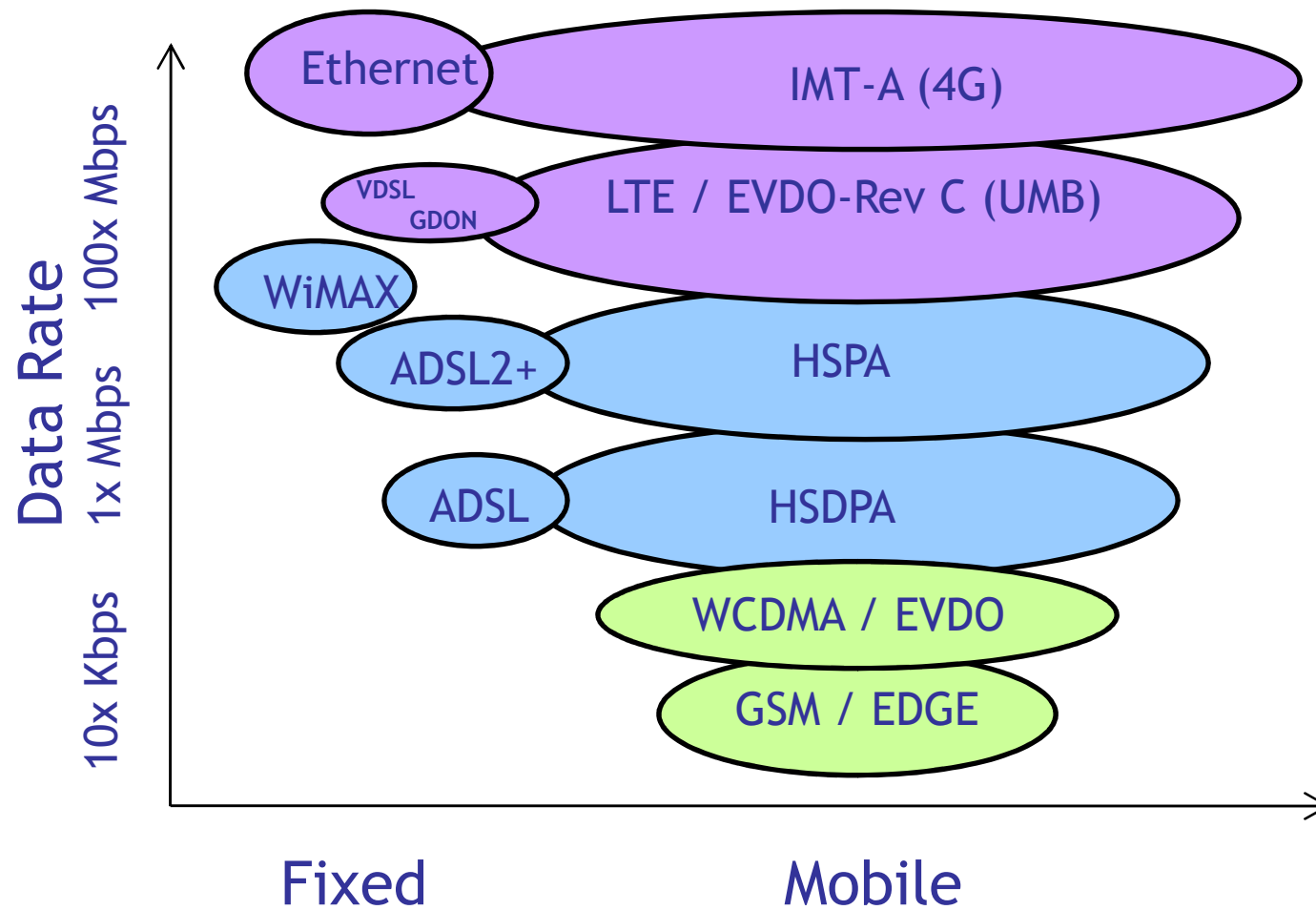
What are their impacts?

- ◆ **Traffic Models and Usage Behavior altered**
 - Peer to peer applications has different traffic profile
 - Effect on paradigms of network design
- ◆ **Resource Allocation**
 - QoS requirements need new ways of allocating resources
- ◆ **Network Modeling**
 - Massively large telecom graph
 - ▶ WebGraph
- ◆ **Security**
 - Content regulation

Now what??

- ◆ Edge
 - ➔ Broadband Wireless
- ◆ New QoS Paradigm
- ◆ Storage
- ◆ Security

Wireless Broadband at Edge



IMT-Advanced = 4G = Broadband Wireless

◆ Peak Spectral Efficiency

- 15 bps/Hz - DL
- 6.75 bps/Hz UL

◆ Operating Bandwidth

- 5 to 100 MHz

◆ Cell Edge Spectral Efficiency

- 0.06 bps/Hz - DL
- 0.03 bps/Hz - UL

◆ Mobility (bps/Hz at Km/hr)

- 0.55 at 120 Km/hr
- 0.25 at 350 Km/hr

◆ Latency

- Control plane < 100 ms
- Data plane < 10 ms

◆ VoIP Capacity

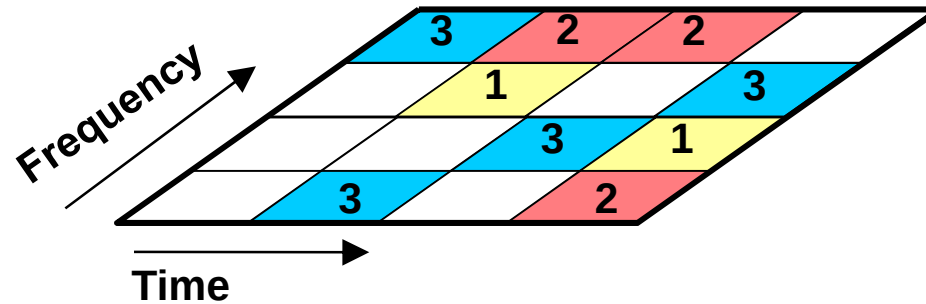
- 40 active users / MHz / sector

◆ Spectrum (IMT Bands)

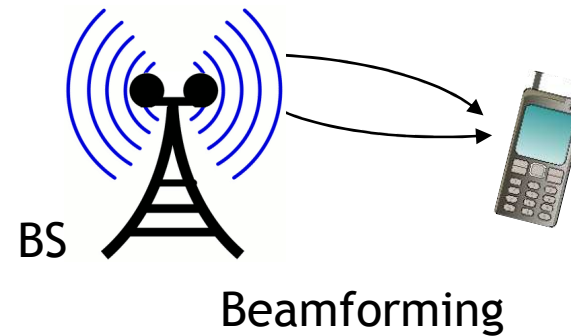
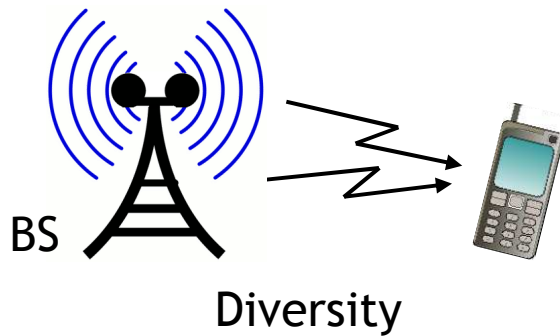
- 450 - 3600 MHz bands

Technology Components for 4G

- ◆ OFDMA

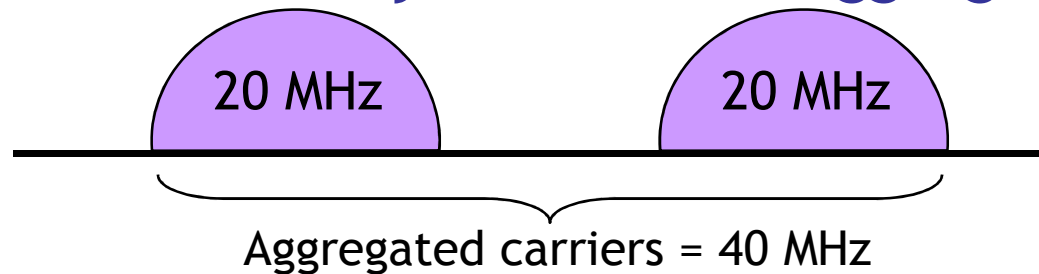


- ◆ Multi-Antenna (MIMO)

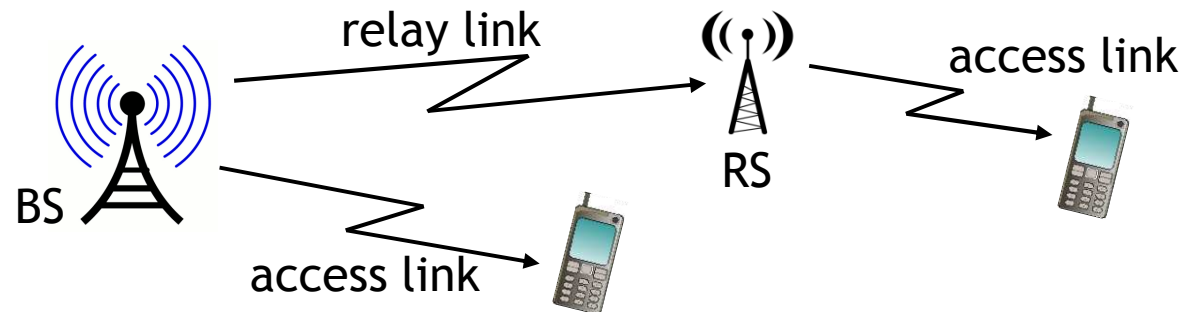


Technology Components for 4G

- ◆ Spectrum flexibility and Carrier aggregation



- ◆ Relaying



- ◆ Coordinated Multipoint transmission

- ➔ Geographically distributed antennae coordinate

Technology Components for 4G

- ◆ Enhanced Quality of Service support
 - End to End delay optimization
- ◆ Self organization and Self optimization
 - Plug and Play form of operation

SON will play a major role in 4G Wireless Broadband in India

New QoS principle required

- ◆ P2MP traffic with interactivity
 - Should be possible to offer any single TV channel from anywhere in the world - which cable-TV cannot offer
- ◆ HDTV quality demand more resources
- ◆ VoD and Digital Video Recorder has removed any restrain on the user

New Design Principles required for managing QoS

New Storage Requirement

- ◆ Content servers being saturated or overloaded
 - Operators providing many local cache
- ◆ Circulation of contents from one cache to another
 - zonal-time-difference, language, newness of the content
- ◆ Fiber bandwidth will get exhausted soon!

New Paradigms in Storage Required

New Security Challenges

- ◆ Packet based radio access pose new challenges
- ◆ Security infrastructure need to be scalable
 - ◆ Peer to peer applications- each user is a potential broadcaster of (un)regulated information
- ◆ Content regulation and ownership
- ◆ Challenges for legal intercept

Conclusions

- ◆ **Broadband Internet -particularly wireless broadband has many challenges**
 - Traditional traffic models and design no longer valid- new paradigms needed
 - Creation and dissemination of multimedia contents - new framework
- ◆ **Heterogeneity of devices, storage, security and servers posing other challenges**
- ◆ **Major shift in policy also required**