

Digital Gangetic Plains (DGP): 802.11-based Low-Cost Networking for Rural India 2001-2004

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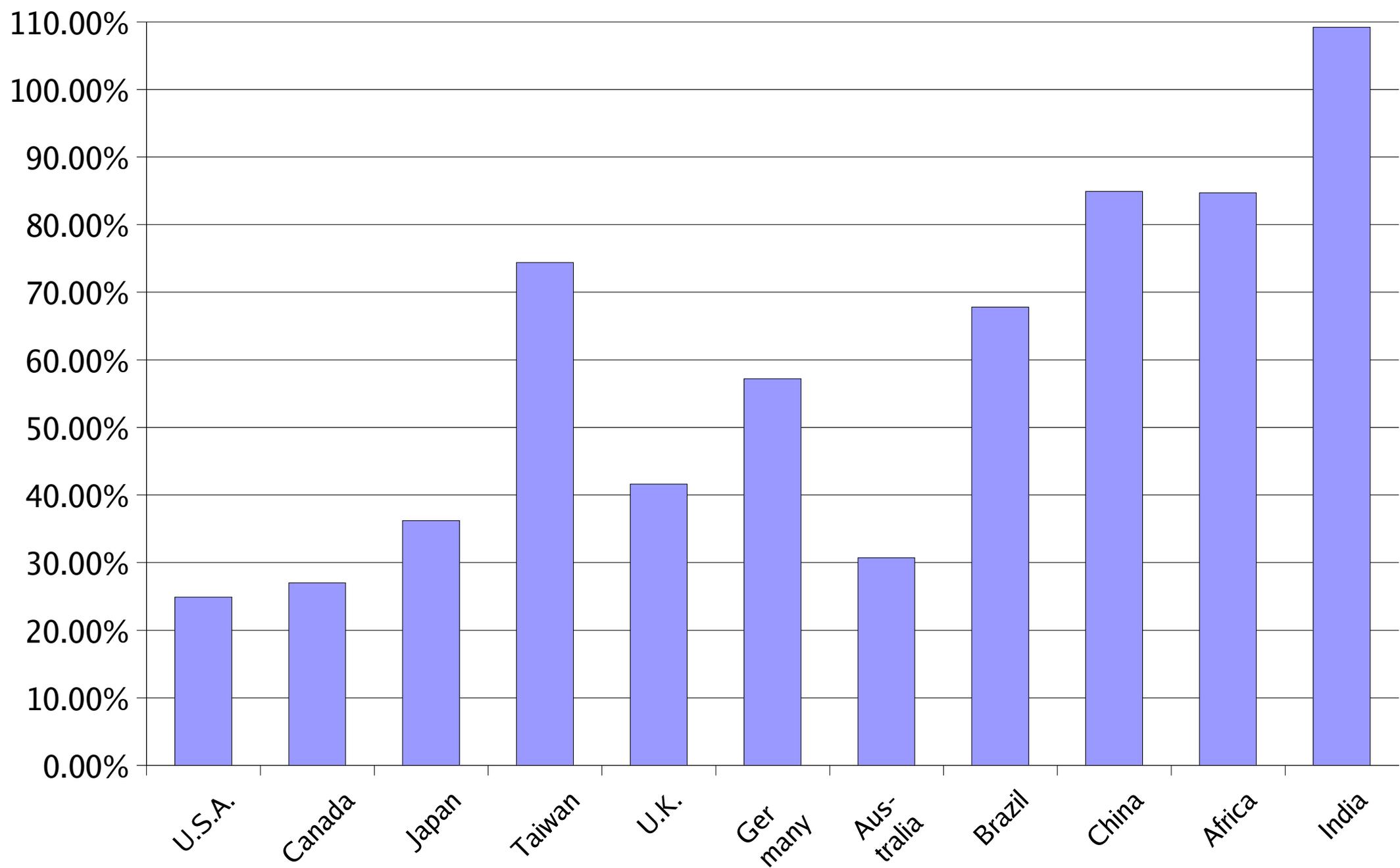
<http://www.cse.iitk.ac.in/users/braman/dgp.html>
<http://www.iitk.ac.in/mladgp/>

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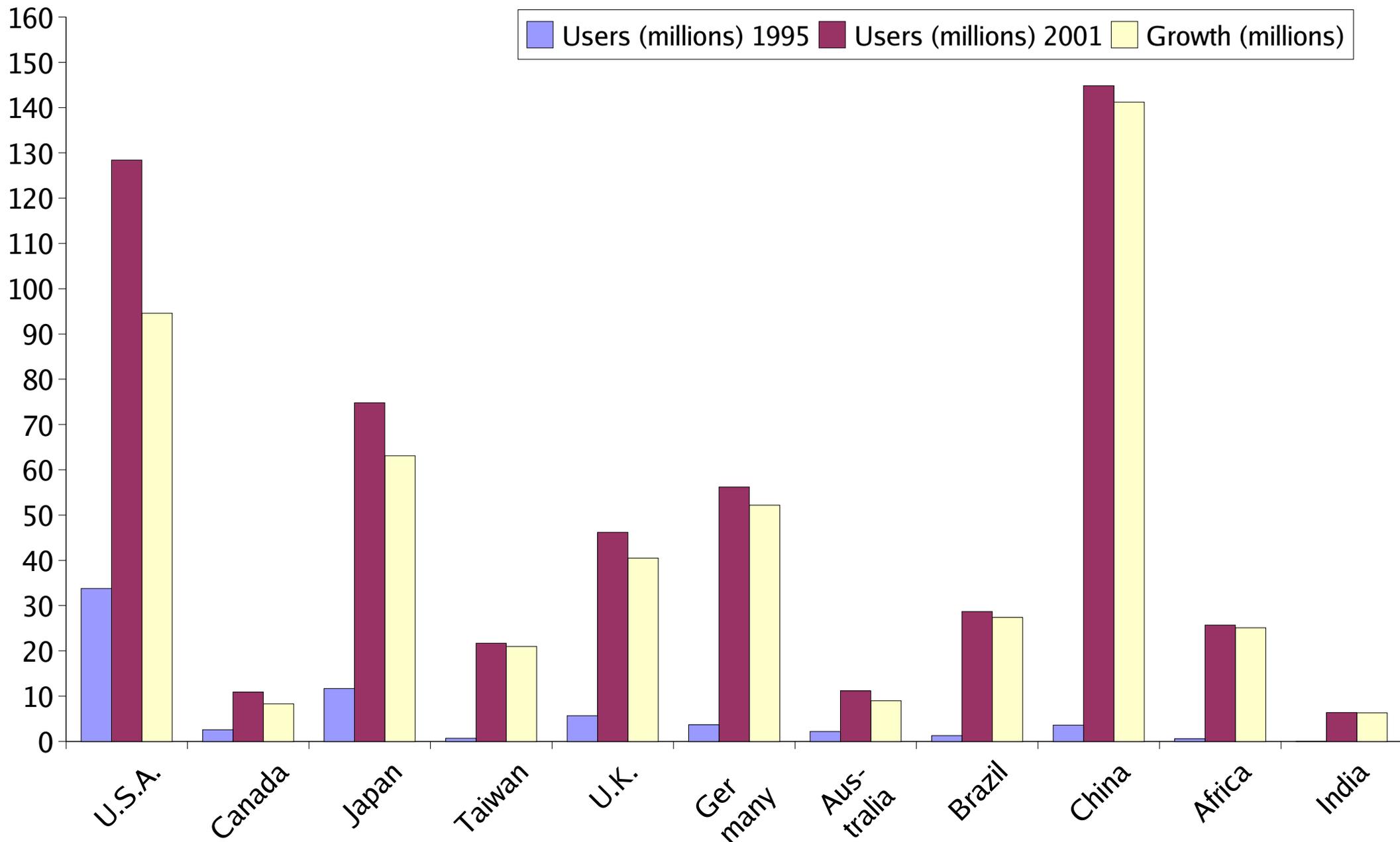
September 2004

Cell Phones: CAGR 1995-2001



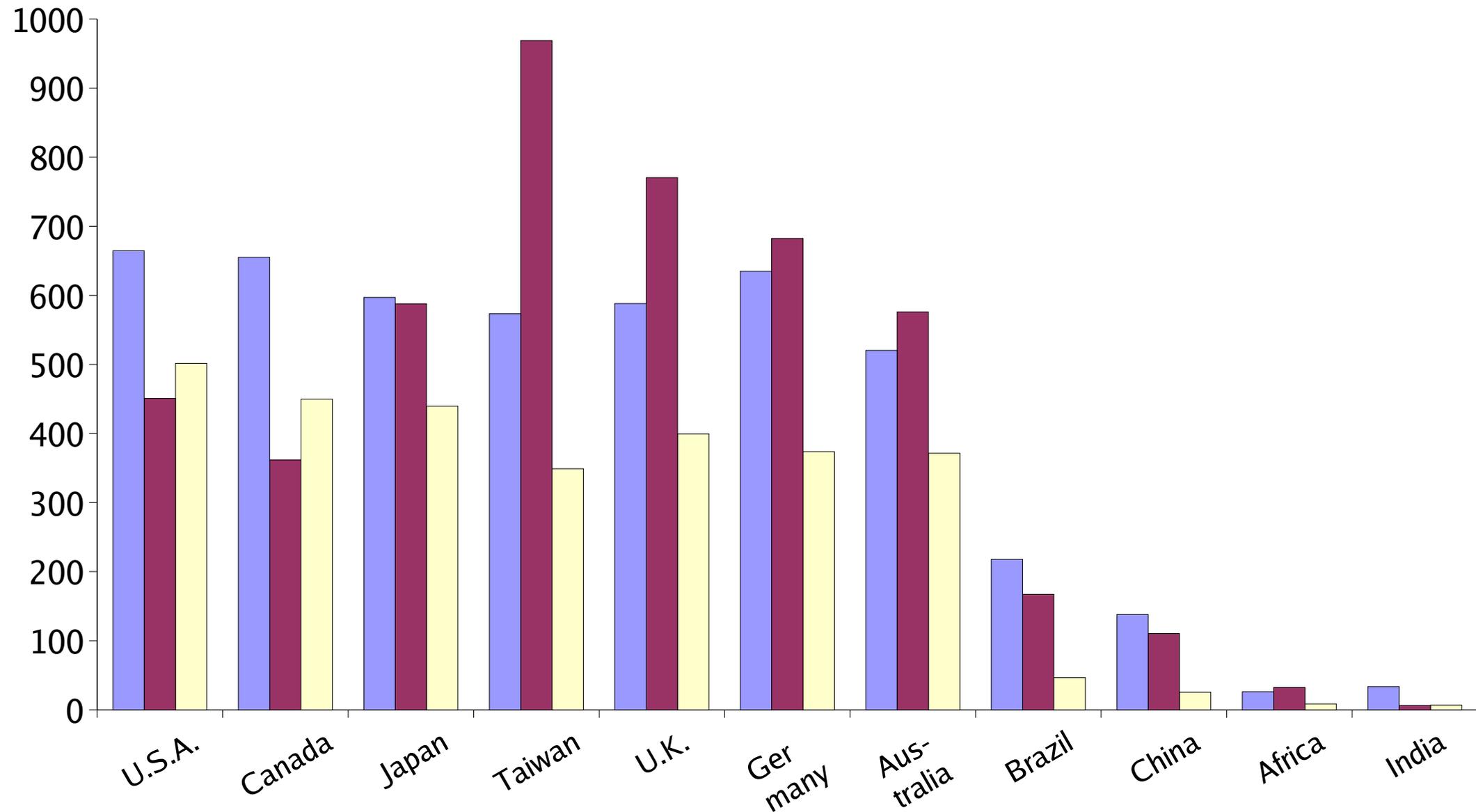
Source: ITU

Cell Phones: Absolute Growth



Tele-density (2001)

Telephone (users/1000) Cell Phone (users/1000) Internet (users/1000)

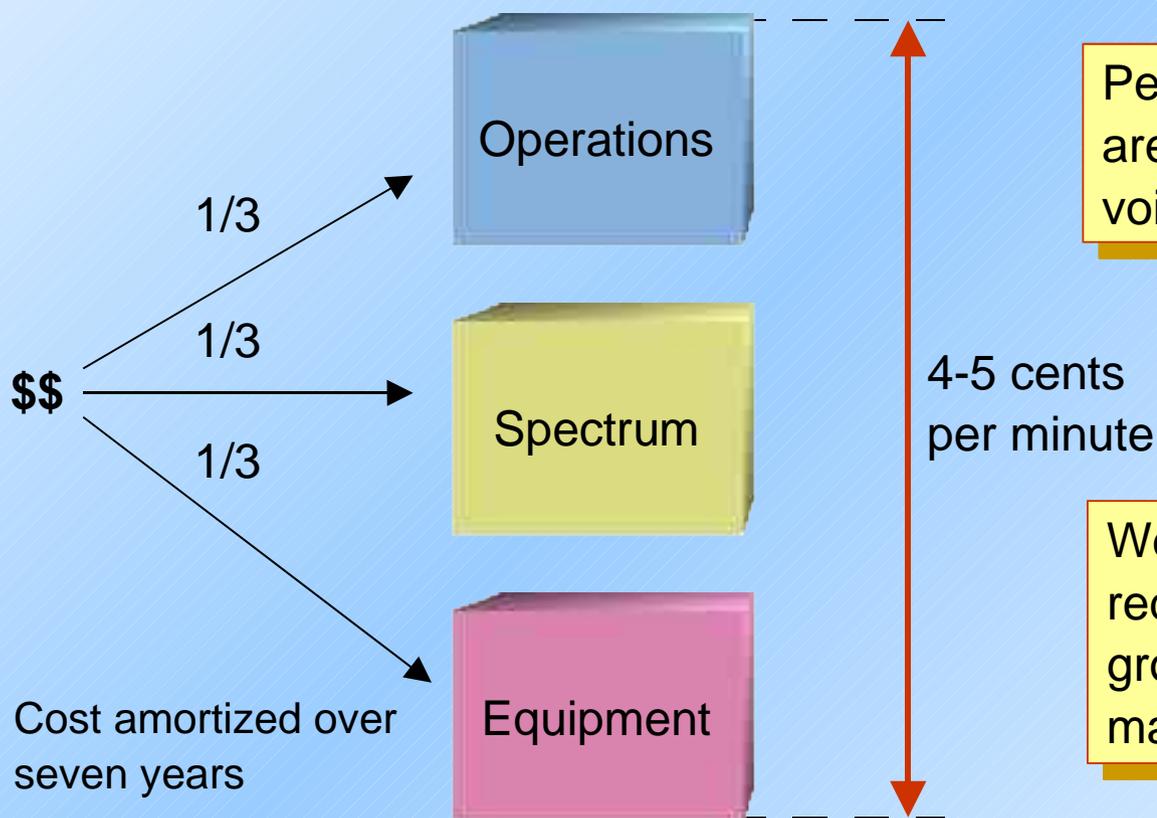


Barriers to Digital Empowerment

Cost of land-line telephony: \$400 per line --> \$200 per line

400 million lines ==> \$80 billion

Value Pricing of Cellular Technology

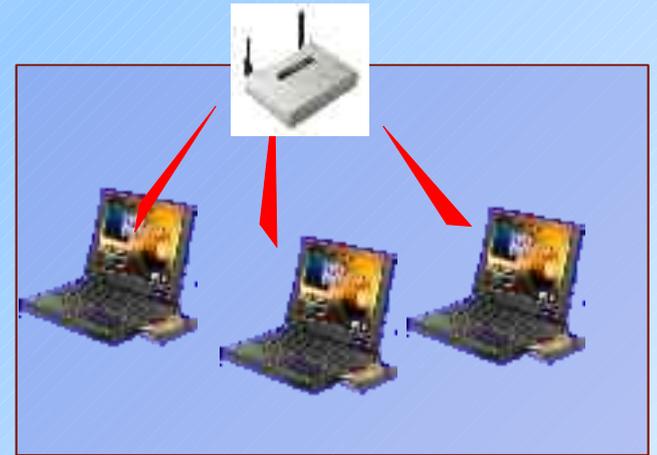


People in developed economies are willing to pay this price because voice is a very high value application

We cannot peg our hopes for price reduction on continued market growth since price elasticity in this market has already been maximized

Promising Technology: 802.11b

- Equipment: **cost priced**
 - Open, inter-operable standard
 - Competitive mass production
 - Chip-sets: \$25-30, Access-Points: \$120-700, PCMCIA cards: \$60-110
- Tremendous growth and acceptance in US/Europe markets
- Designed for last-hop indoor (office/home) use



DGP: Central Goal

*How to use 802.11 for cost-effective
rural networking?*

Digital Gangetic Plains

802.11 for last-hop access within a village

Point-to-Point 802.11 link

Mandhana
Jun '02

Sep '02
Safipur

Mar '04
Rasoolabad

Mar '03
Rajajipuram/Lucknow

Dec '02
Sarauhan

Nov '02
Bithoor

Jun '03
Banthar

MS3
Jun '02

Dec '03
Sawayajpur

Lodhar
Apr '02

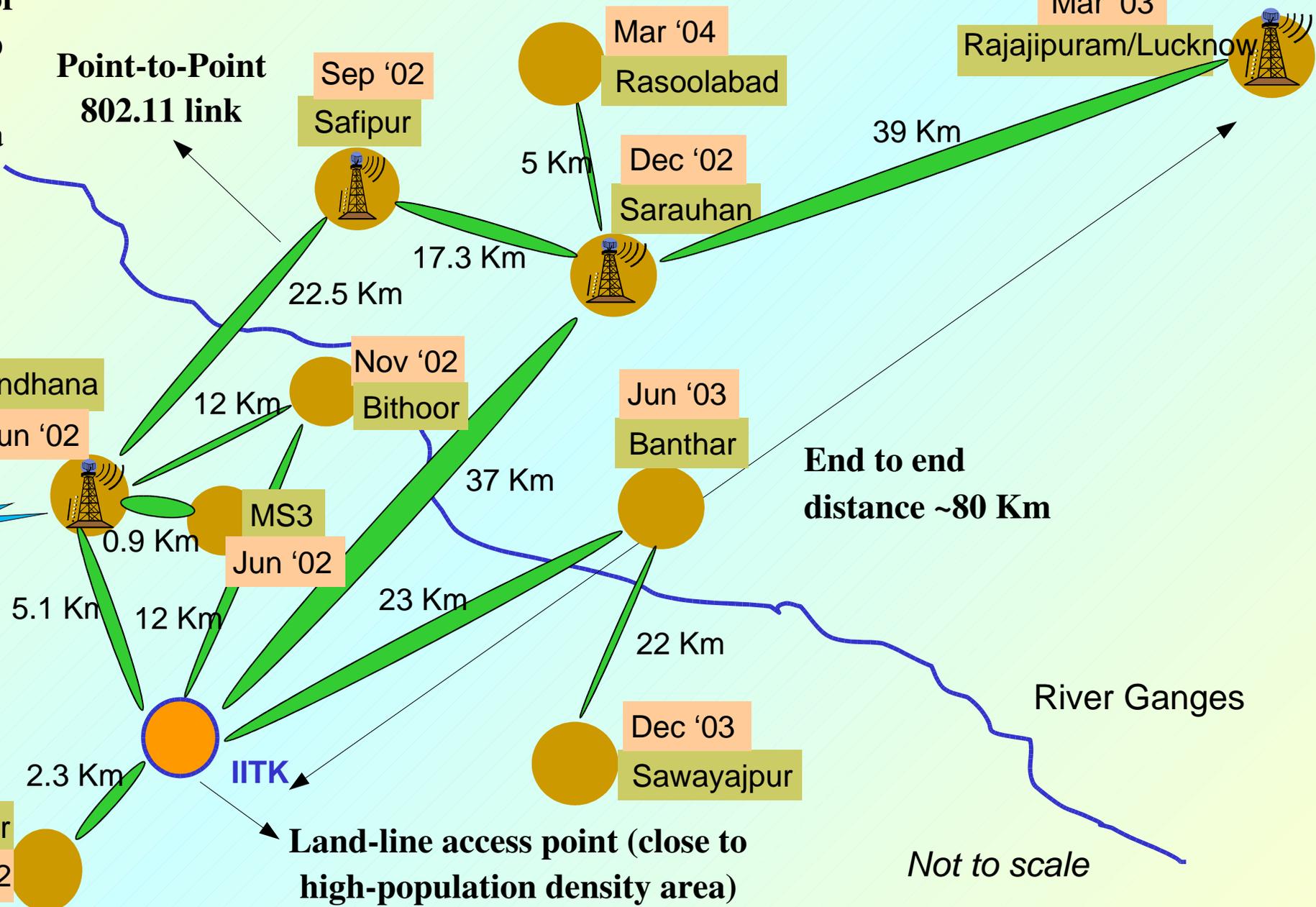
IITK

Land-line access point (close to high-population density area)

End to end distance ~80 Km

River Ganges

Not to scale



Testbed Equipment

- Off-the-shelf equipment
 - 802.11b Access Points
 - PCMCIA cards
 - Parabolic-grid antennae
- Pre-existing towers, high-rise buildings, masts, makeshift towers for setting up antennae: 15-40 metres



Some Pictures



Antennae at Mandhana



Hello from Saroha

Testbed Contributors (subset)



DGP: Issues Addressed

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graph TD; A[DGP: Issues Addressed] --> B[Operational issues]; A --> C[Technical issues]; A --> D[Application issues];
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Operational issues

Technical issues

Application issues

Operational Issues

- How to setup an *outdoor* 802.11 network with *long-distance, point-to-point* links?
 - Antenna alignment, weather proof casing
- Which off-the-shelf equipments work under the above conditions?
 - Interoperability issues, configuration and running
- What are the various **costs** involved in the network setup?

Costs Involved

Antenna tower (15m)	Rs. 70K
Antenna tower (25m)	Rs. 105K
Antenna tower (40m)	Rs. 265K
Antenna mast (10m)	Rs. 4K
Antenna mast (15m)	Rs. 6K
Antenna mast (20m)	Rs. 8K

Per-node costs

Dominant

Bridges	U.S. \$100-\$1,000
Access Points	U.S. \$100-\$1,000
Client devices	U.S. \$20-\$120
Directional antennae	U.S. \$50-\$100

Per-link costs

Technical Issues Addressed

- Understanding of *path-loss* in the long-distance links
- SynOp: how to operate the mesh network using a single 802.11 channel?
 - Current understanding: poor performance in a mesh network
 - Not true with protocol redesign
 - Design done, implementation in progress
- TeNs: The Enhanced Network Simulator
 - Sabyasachi Roy, Ashwini Kumar (BTech project)
 - [Software release](#); >200 downloads to date

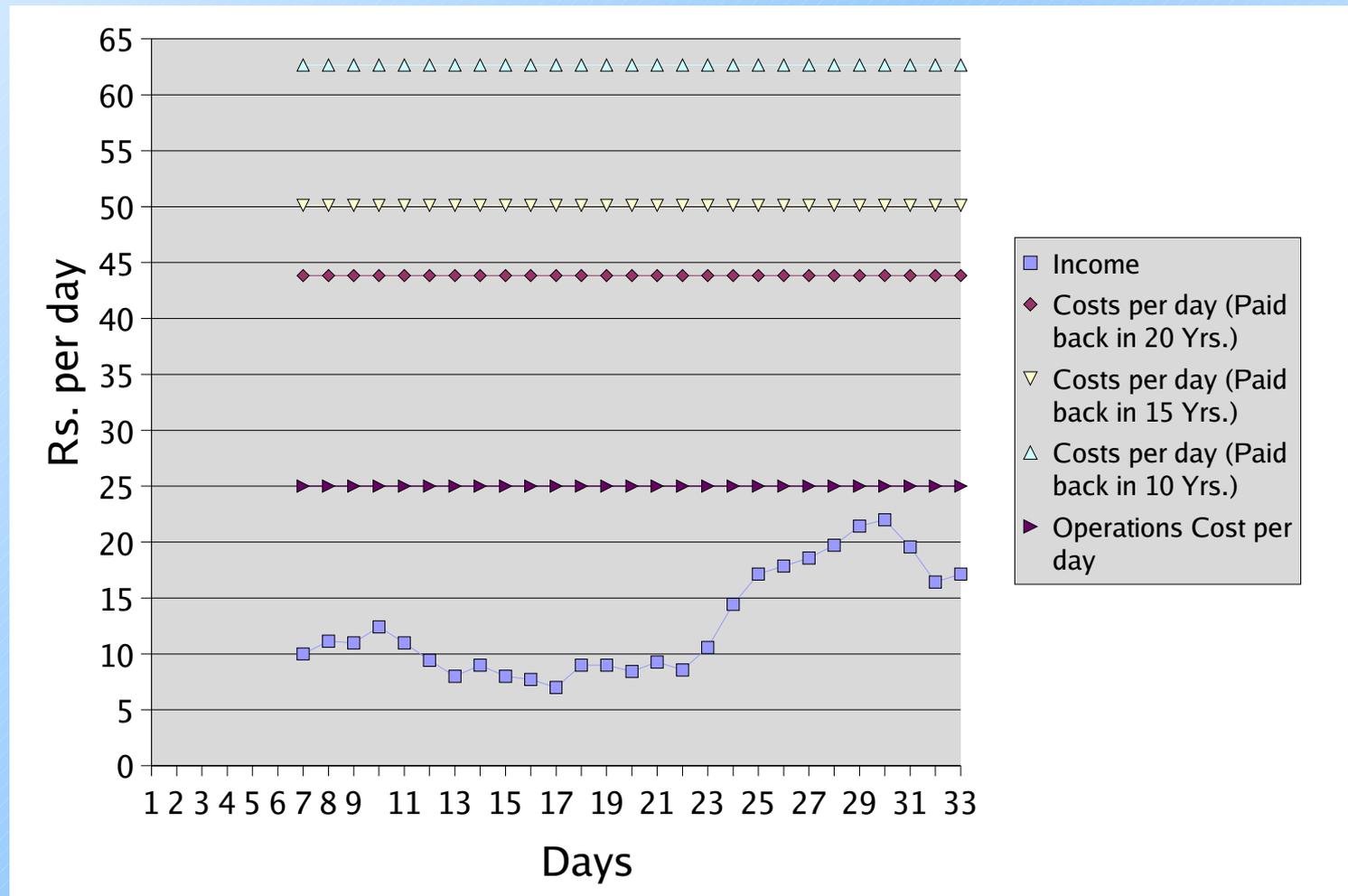
Applications for DGP

- Infothela uses DGP for last-hop connectivity
- Telemedicine group for video application
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- Any rural application requiring connectivity could use DGP

Application Issues

– Voice-over-IP

- Sarauhan PCO setup using 802.11 in last-hop
- Experiment in economic viability (Jan/Feb 2004)



Going Forward...

- Implementation and experience with SynOp
 - To operate network under *single* 802.11 channel
 - Collaboration with UCSD/Cal-IT2 for implementation
 - Potential for production after prototyping
- Network monitoring tools
- Experimenting with low-cost antenna towers
- Experience with 802.11g

Going Forward... (continued)

- For commercialization of technology
 - Need lowering of licensing fee
 - Presently about few thousand rupees per 25KHz for long-distance links (higher if above 5km)
 - Or, delicensing, with power restrictions
 - For at least one 802.11 channel

Summary of Contributions

- Establishing technical feasibility of 802.11 for long-distance wireless networking to villages
- Understanding of various costs involved
- Development of simulator for performance studies
- Protocol enhancement for better performance using a single 802.11 channel
- Experiments with applications
- Detailed report at:
<http://www.cse.iitk.ac.in/users/braman/dgp.html>

Conclusions

- >75% of world remains to be networked
 - Optimization point changes
 - Cost reduction is primary concern
 - Power efficiency in various aspects
- Digital Gangetic Plains
 - 802.11 is cost-priced
 - How to tighten the nuts and bolts to adapt the technology for outdoor setting?
- Need lowering of licensing costs, or delicensing for commercialization

Backup Slides

802.11 versus CorDECT

- 802.11 is fundamentally data-based
 - Telecomm. world moving towards a data-centric model
 - Can leverage protocols, standards, applications
- 802.11 can provide up to 54Mbps (at least 11Mbps)
 - CorDECT only a max of 70 Kbps
- Growing popularity of 802.11
 - Falling prices; trend likely to be stronger than for CorDECT

802.11b Channels

