

# **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>

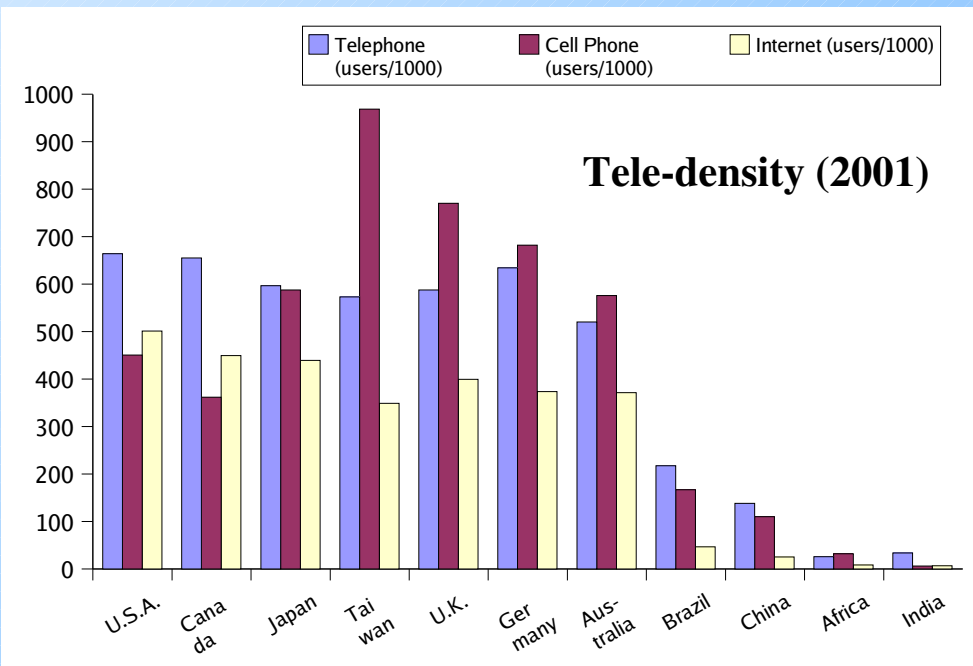
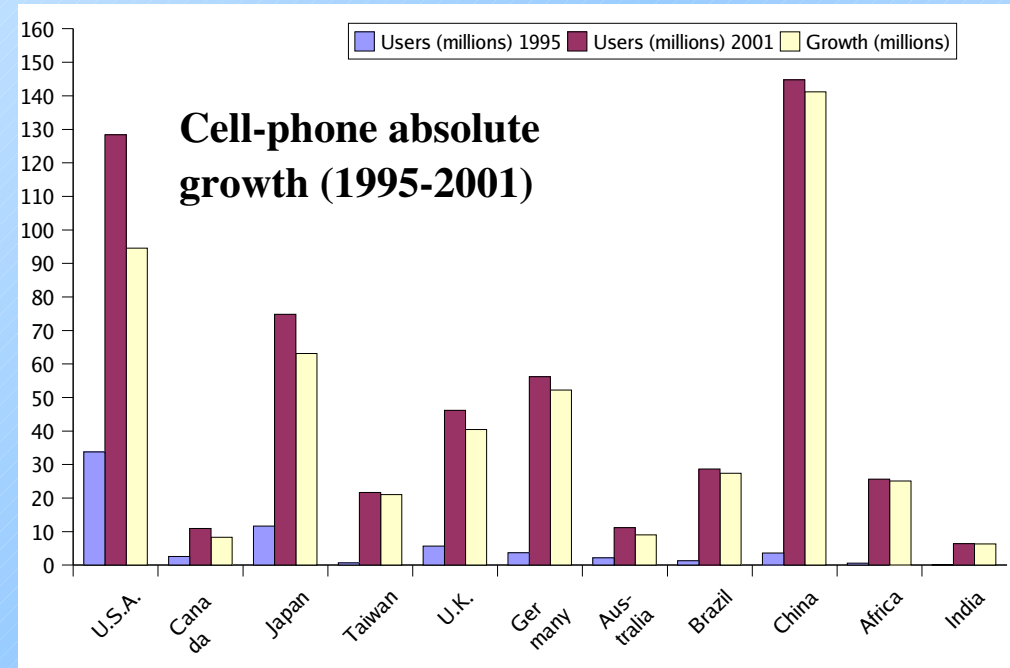
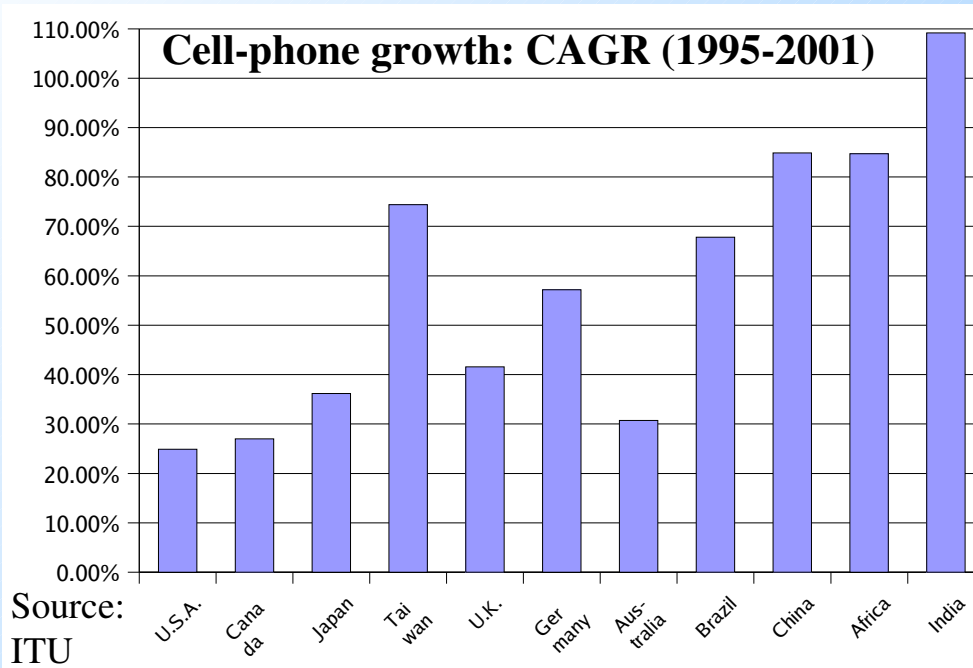
<http://www.iitk.ac.in/mladgp/>

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A Project Supported by Media Labs Asia

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# Some Statistics on Communication

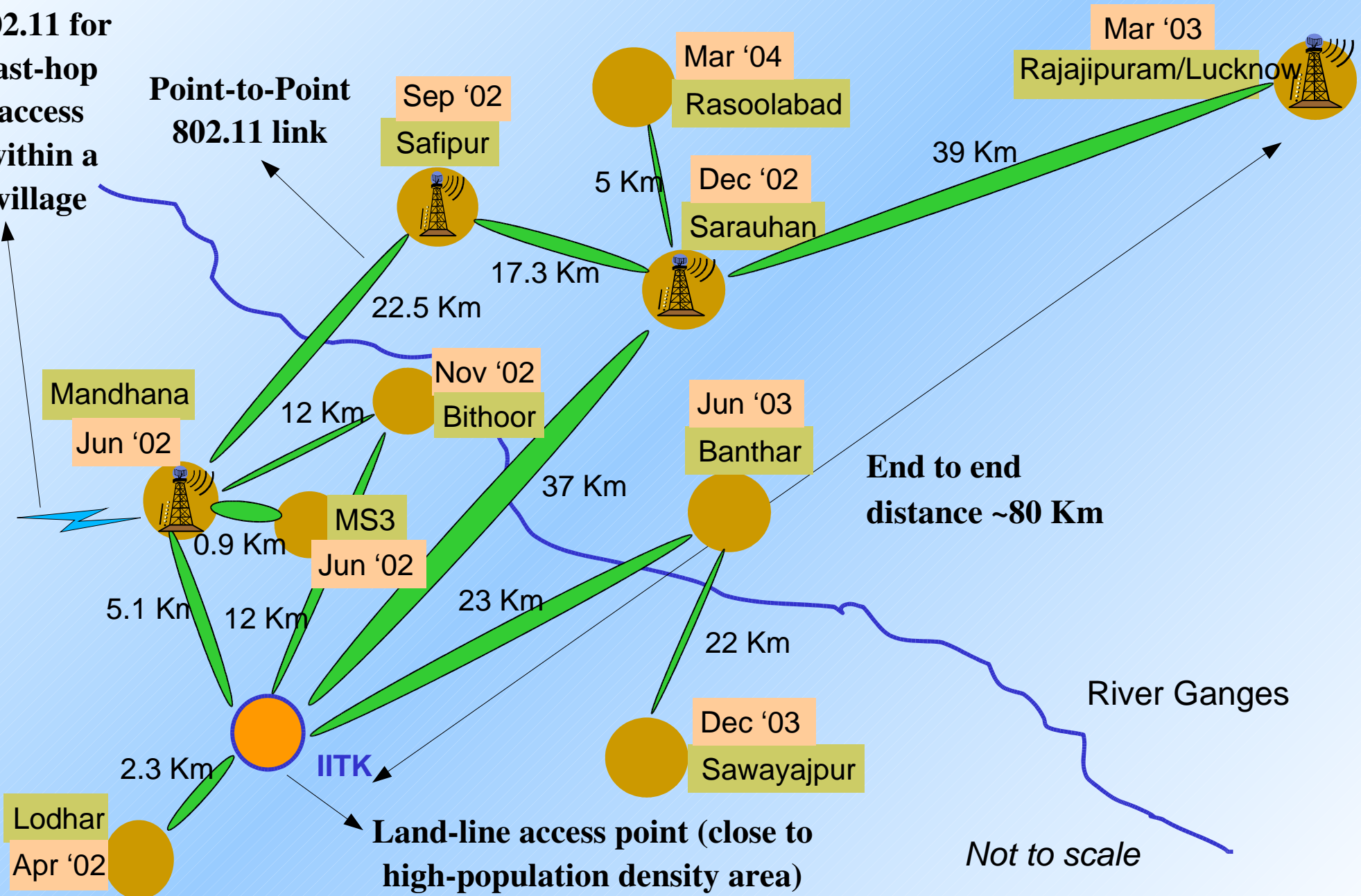


- Cost of land-line telephony: \$200/line
  - ➔ 400 million lines ==> \$80 billion
- Cellular technology is **value-priced**
- Not enough returns on investment in developing telecom economies
- 802.11 is **cost-priced**
  - ➔ Very cheap equipment
- *Central goal of DGP: How to use 802.11 for cost-effective rural networking?*

# Digital Gangetic Plains

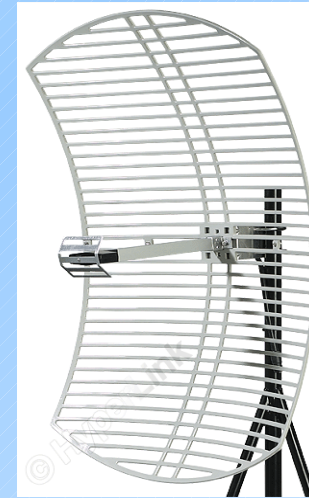
802.11 for  
last-hop  
access  
within a  
village

Point-to-Point  
802.11 link



# DGP Testbed

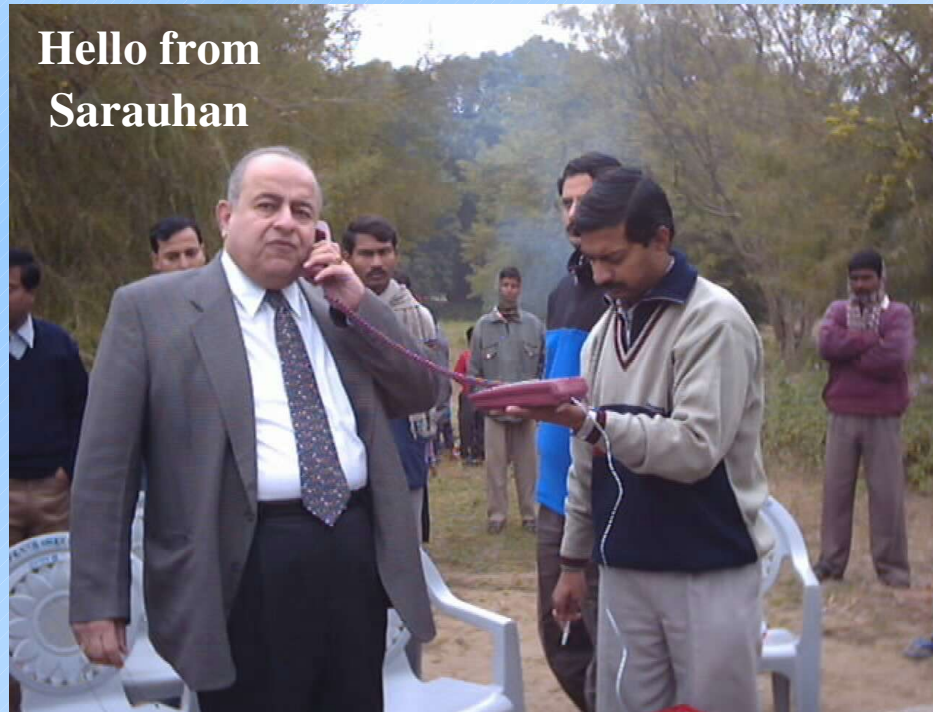
- Off-the-shelf equipment
  - 802.11b Access Points, PCMCIA cards, Parabolic-grid antennae
- Pre-existing towers, high-rise buildings, masts, makeshift towers for setting up antennae: 15-40 metres



Antennae at  
Mandhana



Hello from  
Sarauhan



# 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?

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

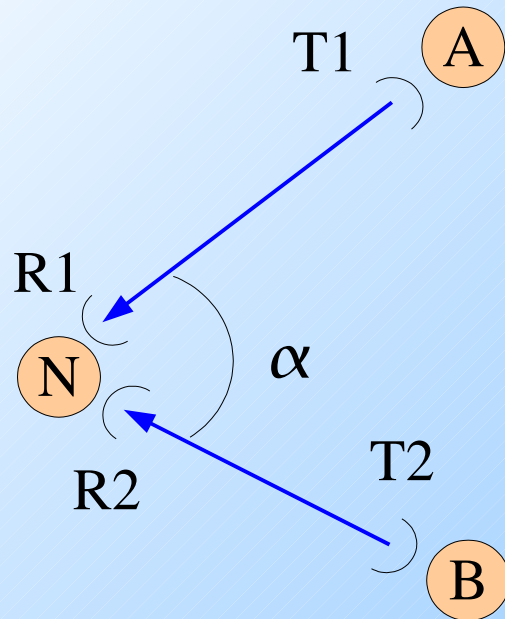
Per-link costs

# Technical Issues Addressed

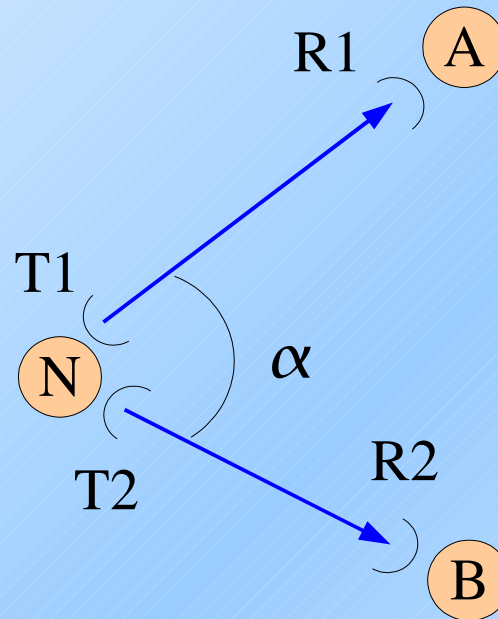
- Understanding of *path-loss* in the long-distance links
- SynOp: how to operate the mesh network using a single 802.11 channel?
  - Current understanding: poor performance in a mesh network
  - Not true with protocol redesign
  - Design done, implementation in progress
- TeNs: The Enhanced Network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



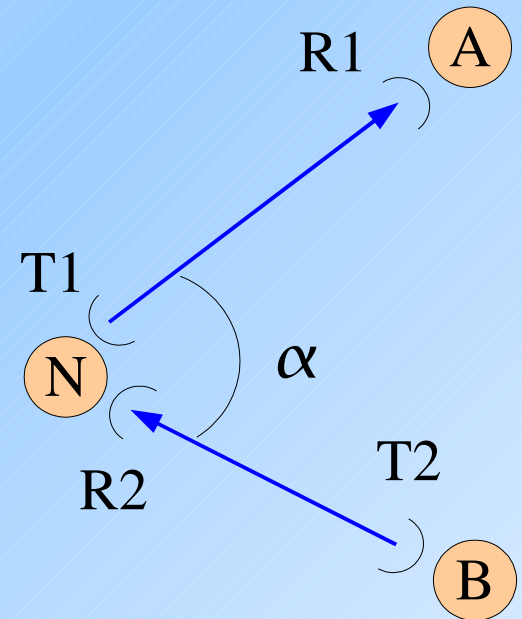
# 2P: A MAC for the Mesh Network



(a) Syn-Rx



(b) Syn-Tx

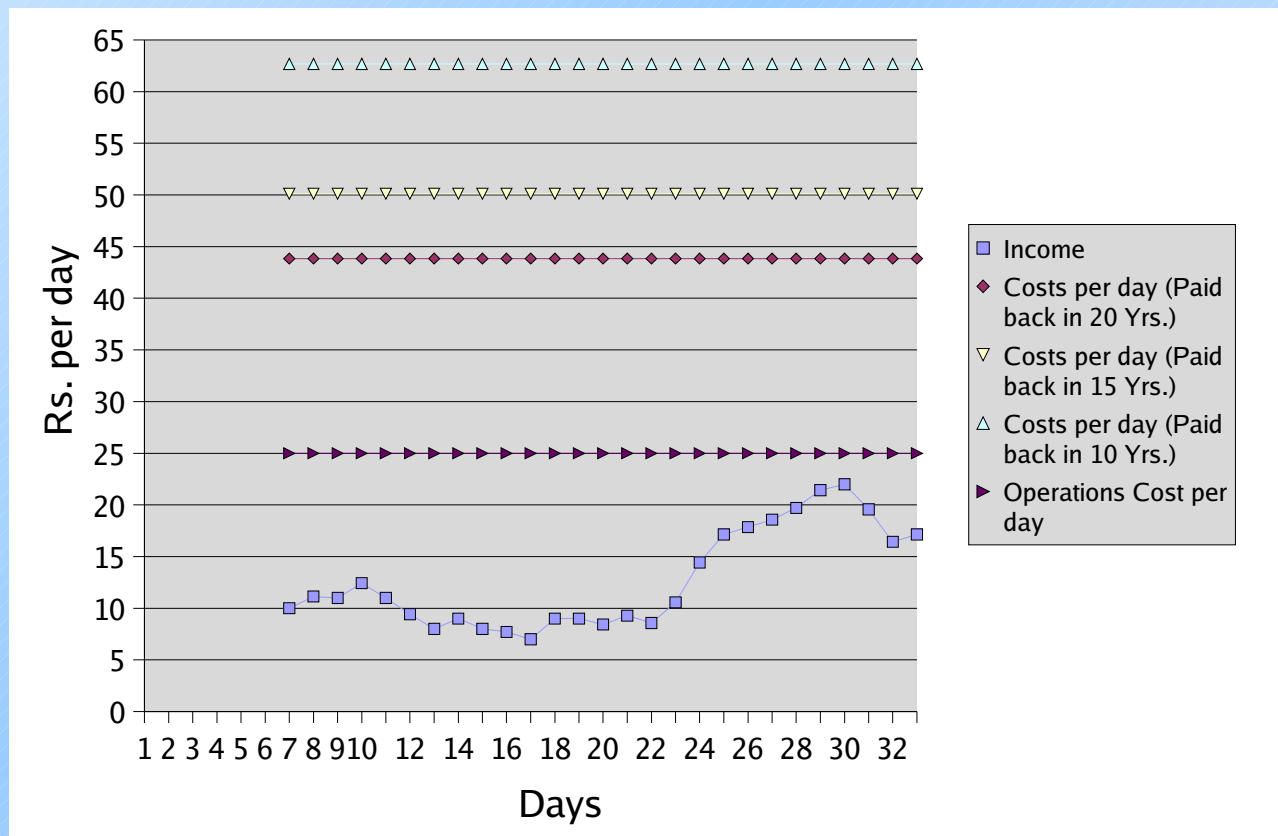


(c) Mix-Rx-Tx

- Exposed interface problem, in CSMA/CA
- 2P/SynOp: use SynTx+SynRx
- Experimentally verified SynOp on testbed
- Working on MAC modification implementation

# Applications for DGP

- Infothela, Telemedicine, Kiosks
- Voice-over-IP
  - Sarauhan PCO setup using 802.11 in last-hop
  - Experiment in economic viability (Jan/Feb 2004)





# Summary and Conclusions

- >75% of the world remains to be networked
  - Optimization point should be *system cost*
- Digital Gangetic Plains:
  - How to use 802.11 for low-cost rural networks?
  - Technical feasibility established
  - 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
- Need lowering of licensing costs, or delicensing for commercialization
- Detailed report at:  
<http://www.cse.iitk.ac.in/users/braman/dgp.html>