Communications Infrastructure

CSE 490c
Administrivia

- Section 490 CB will meet in MGH 058
- Homework 2 Available
- Programming Assignment 1 Available
- Reading Assignment – Ken Banks, FrontlineSMS
Things to cover

• How it works – basics of cellular communication
• Call data records
• Cellular coverage
• Telcos – structure of telecommunication companies
• Cost models for telcos – how they make money
• Cell phone payment – how people cover costs
Phone Service

• Copper wire to house
• Phone connected to wire
• Physical exchange to connect calls
• Monopoly
• Development of standards to allow international calls
  • Technical
  • Billing
Cellular Service

• Cell Tower
  • Radio transceiver
  • Power source
  • Range: Up to 40 miles, limited by
    • Terrain
    • Technology
    • Capacity

• Aside
  • OpenBTS
Cellular Technology

• Backhaul
  • Connecting base station to main network
• Wired backhaul
  • Optical Fibre or Copper
• Wireless
  • Microwave radio relay
  • High capacity radio
Cellular Connections

• Cell towers must connect to all phones in radius
  • Protocol for identifying phones
  • Needs to know to initiate action to a phone or from a phone

• Cell tower handoff
  • Mobile communication

• Connectivity info
  • Cell tower logs
  • TAC – type allocation code
  • Records all (turned on) phones
    • Not just making calls or on the network

• Call Data Records
  • Data for individual calls
    • Phone numbers, time, duration, cell tower ids
Global Cellular Coverage
Global Cellular Coverage

• Finding good cellular coverage maps is a challenge
• Areas with high population will be covered
• Low coverage in remote/mountainous areas
• Coverage between carriers is highly variable
• Often there are carriers focusing urban areas, and carriers with a rural focus
• Crowdsourced cellular data not that useful – need telco data
Telcos

- Big, global companies
- Most countries seem to have about three to five competing mobile operators
  - Possibly with some government ownership
  - A few countries have government monopolies
- List of top 15 mobile telecommunications company
  - Companies either focus on one large market or serve many countries
  - USA barely appears on this list
    - T-Mobile (Deutsche Telekom)
    - TracFone (America Movil)
  - US Based Telcos do not have a global presence
- Largest companies (by subscriptions)
  - China Mobile
  - Vodaphone Idea (India)
  - Airtel (India) [20 countries]
  - Vodafone (UK) [26 countries]
  - China Unacom
  - China Telecom
  - America Movil (Mex) [22 countries]
  - Claro
  - Telefonica (Sp) [20 countries] Movistar
  - Veon (Neth)[14 countries]
  - Reliance Jio (India)
  - MTN (SA) [20 countries]
  - Orange (France) [25 countries]
  - Telkomsel (Indonesia)
  - Telenor (Norway) [12 countries]
  - Deutsche Telekom (Ger) [16 countries]
  - T-Mobile
Charging for Calls and SMS

- Telcos want to maximize ARPU
  - High capital costs
  - Low cost per call
- Charging for service
  - Call cost
  - SMS cost
- Wide range of costs in different markets
  - Costs may be very high relative to income
- Charging for calls across networks
  - In-network vs. out of network
  - Charge incoming and out going
- Bundling of handset and services
Paying for calls and SMS
Prepaid vs Postpaid

- Utilities are often of poor quality in developing countries
- Cell phones are different with pre-paid models
  - Buy credit from vendor
  - Buy scratch card from vendor
- Behavior when calls are very expensive (relative to income)