

Rural Telecommunications Access Technology II Cellular Systems / Satellite Systems

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IMT-2000 (3G) (1)

- A single global standard was aimed.
- Under standardization in ITU
- Unified Systems
 - Land Mobile
 - Cordless (dropped)
 - Fixed (Wireless Local Loop)
 - Satellite (dropped)
- Unified Services
 - Voice
 - Fax (dropped)
 - Data
 - Paging (SMS)

*WLL has been renamed to FWA (fixed wireless access)

FWA utilizing 3G

- Indonesia
- Philippines
- Mongolia
- Lao PDR
- ...

IMT-2000 (3G) (2)

- Unified Environments
 - Mobile
 - Pedestrian
 - Indoor
 - Satellite (dropped)
- Transmission Rate
 - Indoor: 2 Mbit/s
 - Mobile: 384 kbit/s

Off-loading of indoor users: Femto-cell

Use 3G radio interface but connect to public IP network

IMT-2000 (3G) (3)

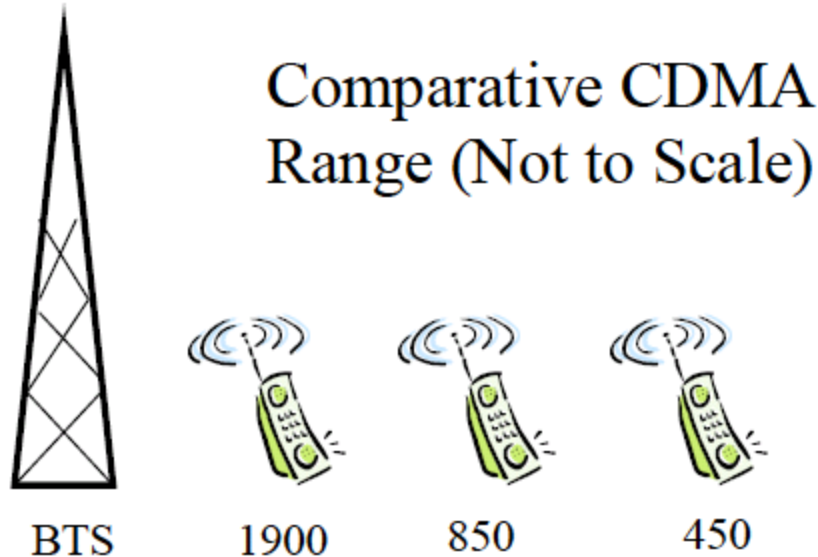
- Expected to be a global standard in ITU
 - But given up
 - Single standard could not be achieved
 - Patent battles
 - W-CDMA/UMTS, cdma2000, TD-CDMA, TD-SCDMA, DECT, mobile WiMAX (IEEE 802.16e) etc.
 - To optimize the system for different environments and services, the system is with over specification.

WCDMA vs cdma2000

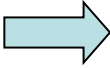
- Spectrum auction in US before standardization
- Two system proposals
 - Incompatible with US frequency allocation (5 MHz channel) -> 3GPP (WCDMA)
 - Compatible with US frequency allocation (1.25 MHz channel) -> 3GPP2 (cdma2000)
 - cdma2000 1x => cdma2000 3x (5 MHz)

cdma450

- Same idea as GSM 400
- cdmaOne-based (2.5G)
- 180km max by parameter adjustment



cdma450

- 2nd generation  3rd generation
(GSM, cdmaOne) (WCDMA, cdma2000)
- CDMA 450: 450MHz version of cdma2000
 - High quality voice
 - Data up to 153kbit/s (1x) / 2.4 Mbit/s (EV-DO)
 - Partly used as fixed
 - Candidate for replacement of NMT
 - 4-5 MHz NMT bandwidth can be used for 1.25 MHz x 3-4 frequency channels

Example

- Win Phone of LaoTel
- Fixed phone + USB adaptor





Win Phone

ໂທລະສັບຕັ້ງໂຕບໍ່ມີສາຍແບບຕື່ມເງິນ
ຊື້ປຸບ ໃຊ້ໄດ້ປັບ ບໍ່ຕ້ອງຕິດຕັ້ງ

Promotion ຊື້ພ້ອມເປີດປາໃຊ້ໃນລະຫວ່າງວັນທີ **01/05 - 31/07/2007**
 ລາຄາພິເສດ.. ພ້ອມໂທ ລ້າ ລ້າ ທັນທີ..!

Win 3000

- ຂະໜາດ 214x156x77 ມມ
- ສະແດງເລກໝາຍທີ່ໂທເຂົ້າເທິງຫນ້າຈໍ
- ສາມາດເລືອກສຽງເອີ້ນເຂົ້າໄດ້



750,000 ກີບ

~~5,000~~ ກີບ

Promotion

ໂທ ລ້າລ້າ.. 300,000 ກີບ 60 ວັນ

Win 4000

- ຂະໜາດ 200x174x59 ມມ
- ສະແດງເລກໝາຍທີ່ໂທເຂົ້າເທິງຫນ້າຈໍ
- ຮັບ-ສົ່ງໂທລະສັບ SMS
- ຮັບ-ສົ່ງ PC FAX
- ສາມາດເລືອກສຽງເອີ້ນເຂົ້າໄດ້
- ເຊື່ອມຕໍ່ ອິນເຕີເນັດ ຄວາມໄວສູງ



900,000 ກີບ

~~5,000~~ ກີບ

Promotion

ໂທ ລ້າລ້າ.. 350,000 ກີບ 60 ວັນ

Win 1000

- ຂະໜາດ 182x182x42 ມມ
- ຮັບ-ສົ່ງ ແອັກ
- ເຊື່ອມຕໍ່ ອິນເຕີເນັດຄວາມໄວສູງ
- ສາມາດເລືອກສຽງເອີ້ນເຂົ້າໄດ້



990,000 ກີບ

~~990,000~~ ກີບ

Promotion

ໂທ ລ້າລ້າ.. 5,000 ກີບ 60 ວັນ

ສາຍ USB CABLE

ສາຍລຸ້ນ Win 1000

ລາຄາ

170,000 ກີບ



ຕື່ມເງິນ ວິນ ໂທ:

ບັດ 10,000 ກີບ ເກົ່າໂຊດ	180 ວັນ
ບັດ 20,000 ກີບ ເກົ່າໂຊດ	365 ວັນ
ບັດ 25,000 ກີບ ເກົ່າໂຊດ	365 ວັນ
ບັດ 50,000 ກີບ ເກົ່າໂຊດ	365 ວັນ
ບັດ 100,000 ກີບ ເກົ່າໂຊດ	365 ວັນ

http://www.laotel.com/laotel2006/index_winphone.php

Frequency Issue

- Pros and cons
 - Reach distance
 - Penetration into shadowed region
 - Antenna size
 - Antenna efficiency

Evolution of Cellular Systems

	1G (analog) 1979	2G (digital) 1993	2.5G (packet) 1997	3G (multimedia) 2001	3.5G (HS DL) 2006	4G (broadband) 2011
Europe and rest	Local analog systems	GSM	GPRS	UMTS/ WCDMA (3GPP)	HSDPA => LTE	LTE- Advanced WiMAX (802.16m)
Japan	Local system	PDC	PDC packet			
USA	AMPS TACS	IS-136 (TDMA)	IS-95 (cdmaOne)	cdma2000 (3GPP2)	EV-DO	

3.9G

WiMAX

800MHz

IMT-2000
(800MHz -) 2GHz

IMT-Advanced
(800MHz -) 3.5GHz

OpenBTS

- Unix application
 - Software radio to present a GSM air interface to standard 2G GSM handset
 - SIP soft switch or PBX to connect calls
- A new type of cellular network with substantially lower cost
 - Rural cellular deployments
 - Private cellular networks in remote areas

OpenBTS

Typical OpenBTS development kit

- USRP
- Laptop
- handsets



Asterisk

- Open source telephony project
 - Software PBX for
 - Analog telephone (PSTN)
 - Digital telephone (ISDN)
 - IP phone
 - Specific boards to connect phones



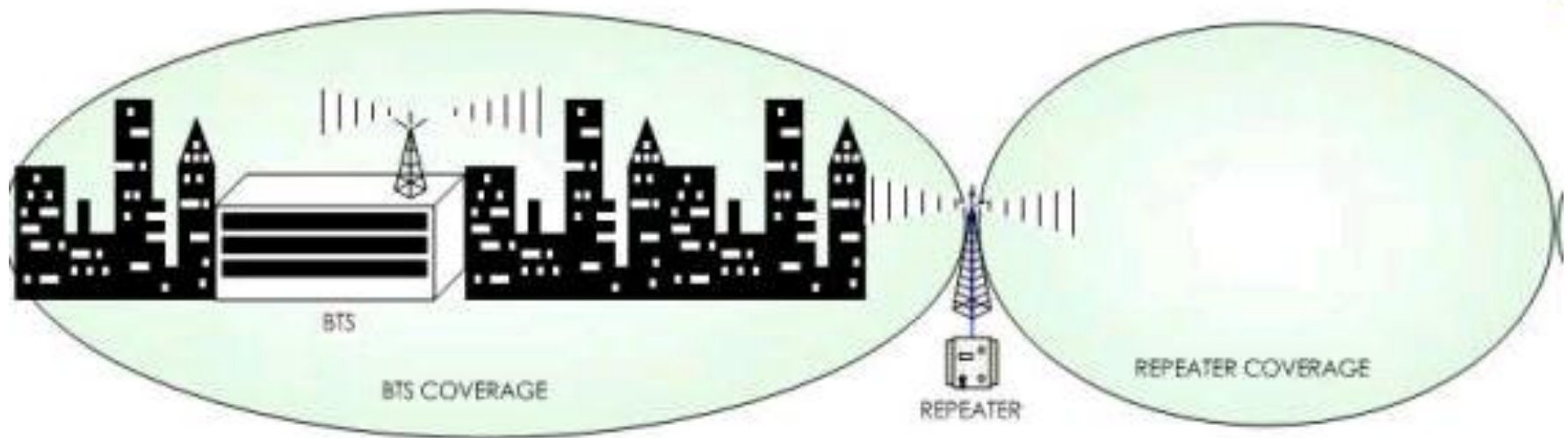
Transition from 2G to 3G

Class Observation

- Introduction of smart phones
- Provision of high data rate for mobile modems
- Telco competition
 - Slow speed in proprietary service
 - Competition among private sectors to attract consumers
- Co-location of GSM BTS and CDMA BTS (node-B)
 - From network viewpoint UMTS is just evolution of GSM

Repeater (1)

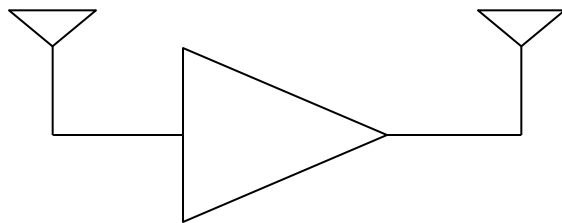
- Installed within base station coverage
- Amplifies (AF) or relays (DF) from base station to designed area and vice versa



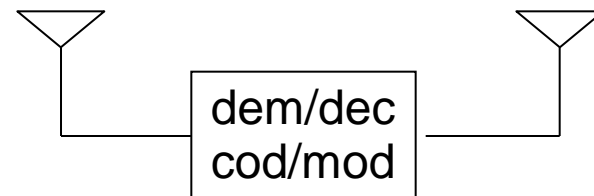
RF REPEATER SYSTEM

Repeater (2)

- Base station underused in sparse area
- Hybrid network to design base stations and repeaters together
- Advantage in CDMA
 - Single frequency-reuse scheme
 - => Can be used anywhere in the network

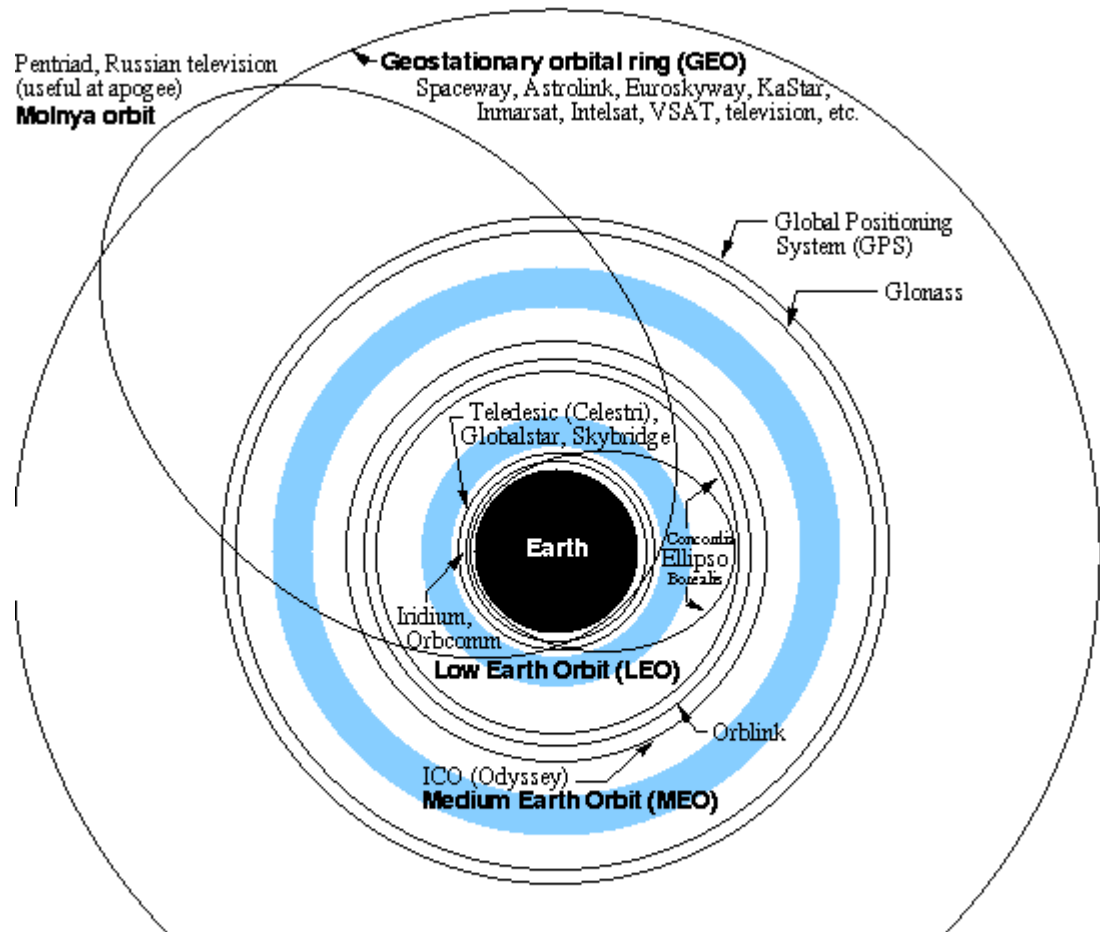


Amplify and Forward (AF)



Decode and Forward (DF)

Satellite Orbits



Orbital altitudes for satellite constellations

■ peak radiation bands of the Van Allen belts (high-energy protons)

orbits are not shown at actual inclination; this is a guide to altitude only

from Lloyd's satellite constellations <http://www.ee.surrey.ac.uk/Personal/L.Wood/constellations/>

<http://www.ee.surrey.ac.uk/Personal/L.Wood/constellations/>

Satellite-based Systems

- Very small aperture terminals (VSATs)
- Lower earth orbit mobile communications
- Satellite-based Internet access

Very Small Aperture Terminals (VSATs)

- Antenna aperture diameter < a few meters
- Price US\$2000 – 8000
- Frequency: C-band (4 GHz) or Ku-Band (14 GHz)

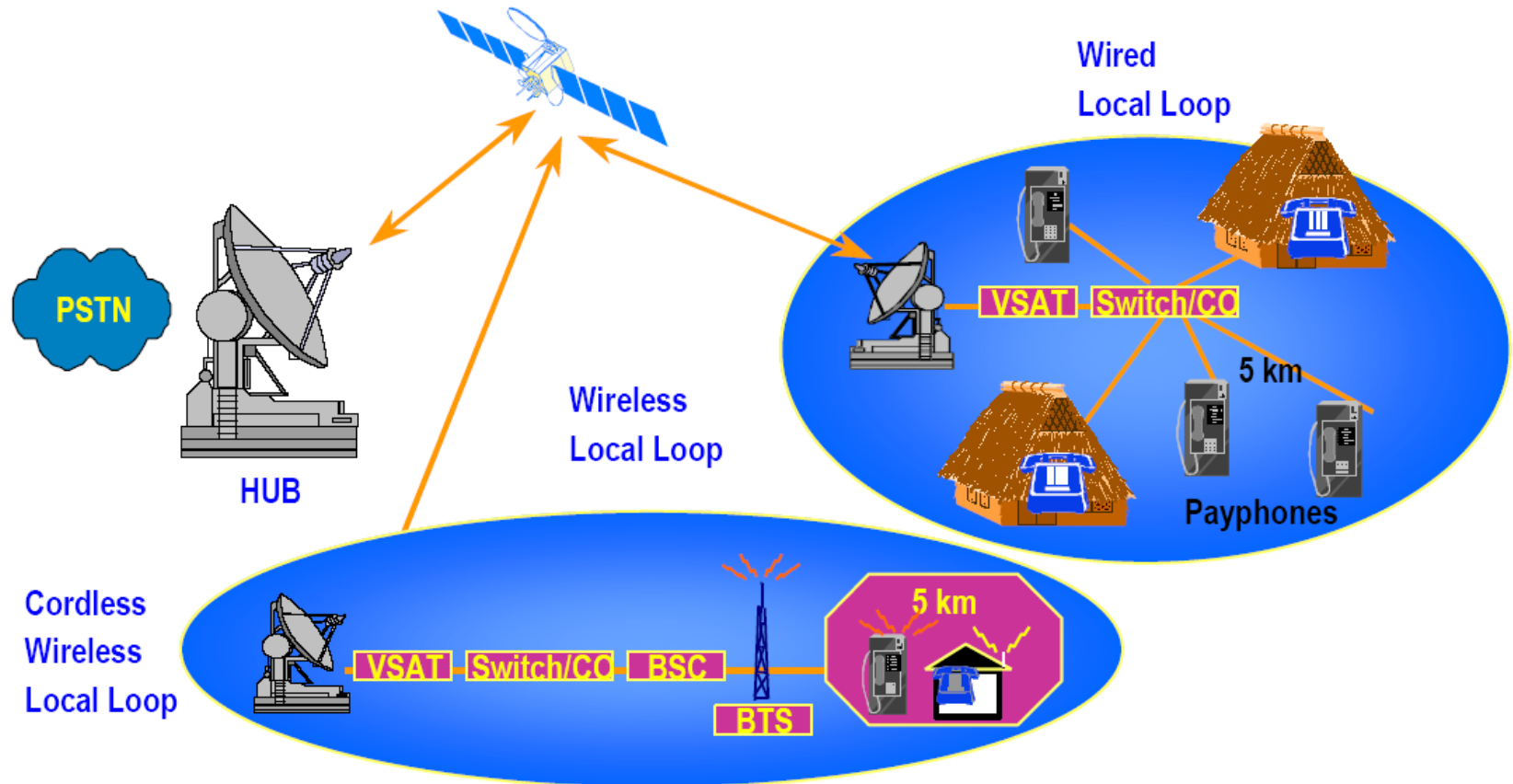


VSAT-based Rural Telephony

A case in Peru

- VSAT-based thin route telephony with up to three voice channels per VSAT
- Low power consumption of approximately 40 watts per VSAT
- Star network topology
 - 7.6 m Hub station in the capital city
 - 1.2 m or 1.8 m remote VSAT station in each town
- Prepaid system instead of coins
- Centralized network management system at Hub

2 - VSATs and Local Loops



BSC = Base Station Controller
BTS = Base Transceiver Station
CO = Central Office

Integrated VSAT/WLL Systems

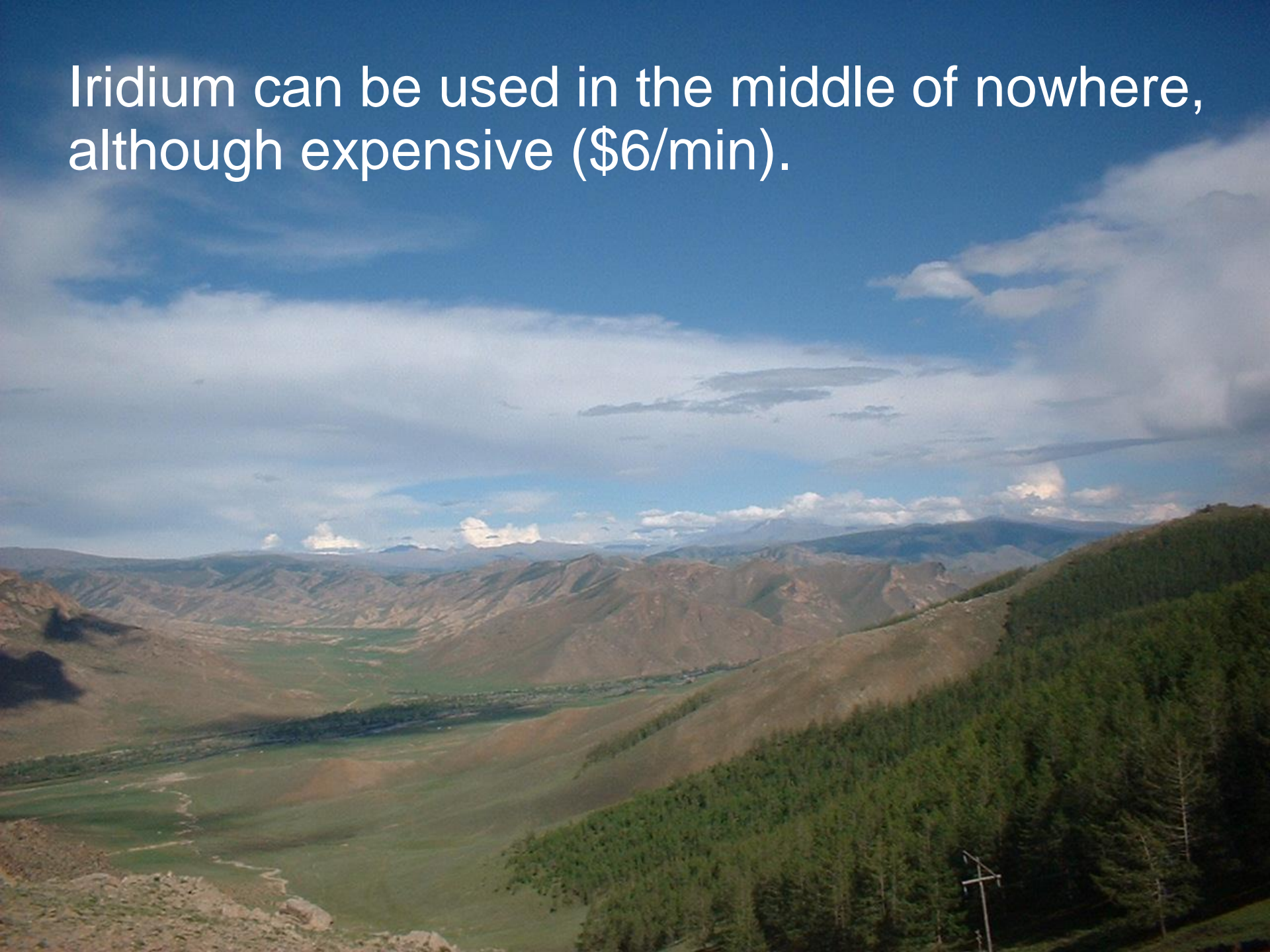
A case of Intelsat

- VSATs with wired or cordless local loop systems are generally feasible for clusters of population requiring between 20 and 300 lines per site.
- VSAT plus macrocellular wireless local loop (up to 30 km radius) could be a feasible solution to serve medium density populations requiring more than 300 lines per site.

LEO Satellites: Iridium



Iridium can be used in the middle of nowhere,
although expensive (\$6/min).



Satellite-based Internet Access

- 2-way Internet access via satellite
 - Very big cost – space segment
- No service available in Japan
 - SkyPerfecPC in failure
 - Uplink – telephone
 - Downlink – DBS satellite
- Service in Thailand
 - iPSTAR
- Trial in Japan again
 - Kizuna (WINDS)

In early deployment of broadband, traffic was modeled asymmetry.

IPSTAR-1

- World's first commercial IP satellite
- Shin Satellite Public Company (Thailand)
- Launched in August 2005
- Capacity of 45 Gbit/s
- Covers 4 continents
 - Asia, Europe, Australia and Africa.



Technologies of IPSTAR

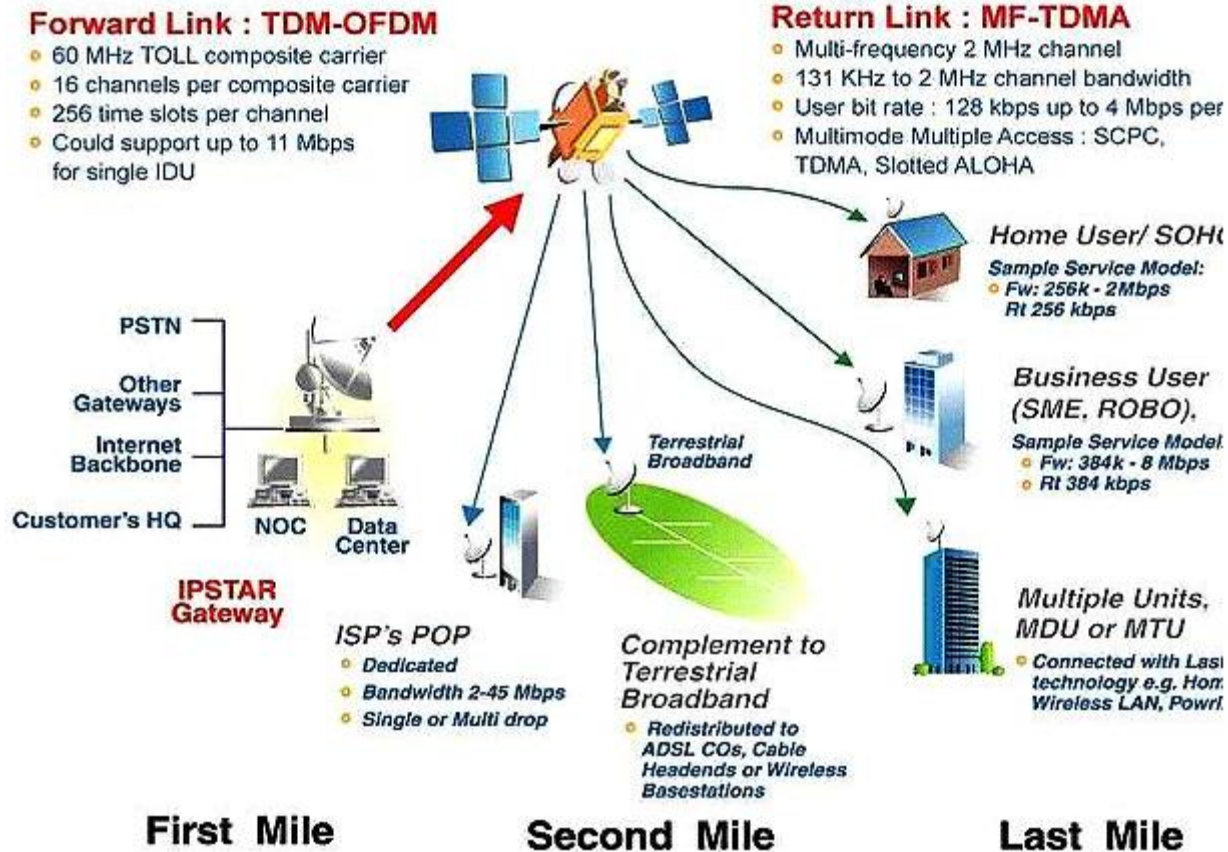
- CDMA
- Bent-pipe satellite
 - No advanced on-board equipments
- QoS (quality of services) support
 - Voice and off-line data have quite different requirements.
- Optional one-way connection using telephone line as the Return Link

Coverage of IPSTAR

- 22 countries throughout the Asia-Pacific Rim
- Spot beam and dynamic power allocation



Service Model of IPSTAR



Broadband Internet Access via IPSTAR

Dedicated Fixed Bandwidth

Class of Service			
Download Speed	128 kbps	256 kbps	512 kbps
Upload Speed	64 kbps	128 kbps	128 kbps
Sharing Ratio	1:1	1:1	1:1

Broadband Shared Bandwidth

Class of Service	Light	Medium	Heavy
Download Speed	256 kbps	1 Mbps	2 kbps
Upload Speed	128 kbps	256 kbps	512 kbps
Sharing Ratio	80:1	40:1	20:1

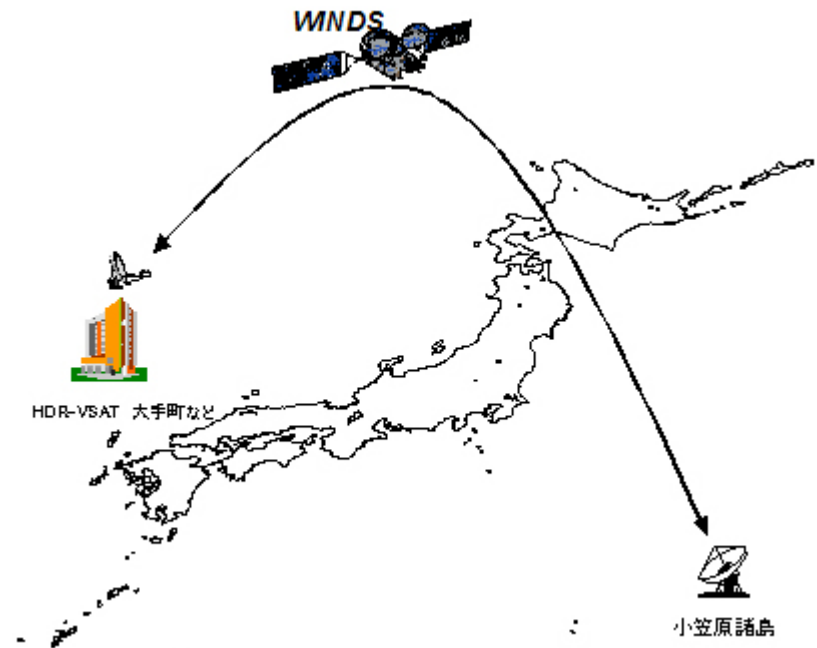
KIZUNA Internet Satellite

- National Internet satellite of Japan (JAXA and NICT)
- Launched on February 23, 2008
- 155Mbps (down) / 6Mbps (up) for households with 45 cm aperture antennas
- 1.2 Gbps for offices with 5 m antennas



KIZUNA Internet Satellite

- Establishing a domestic ultra high speed Internet network
- Constructing ultra high speed international Internet access, especially with Asian Pacific countries and regions
- Demonstration of validity and usefulness
 - Digital divide mitigation
 - Education
 - Medicine
 - Disaster measures
 - Intelligent Transport Systems



Pros and Cons of Satellite Links

Class opinion/observation

- Mobile phone company uses satellite links for backhaul of remote areas
- Connection to schools

Assignment in place of next week class

- Please check numbers of subscribers of GSM and 3G in **your country**, and compare with total population.
- If you know any interesting practice of your operators to provide rural/remote coverage, please identify.
- Reports are to be submitted by Jan 20 to Abdur abdur@ap.ide.titech.ac.jp.