NORTEL NETWORKS

# Evolution of Broadband Satellite Architecture to Full On-Board Processing System

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# Presentation Outline

- **About Nortel Networks**
- **Market Dynamics**
- **Role of Satellite**
- **Evolution vs. Revolution**
- **Satellite Multimedia Evolution Path**
- **Summary**

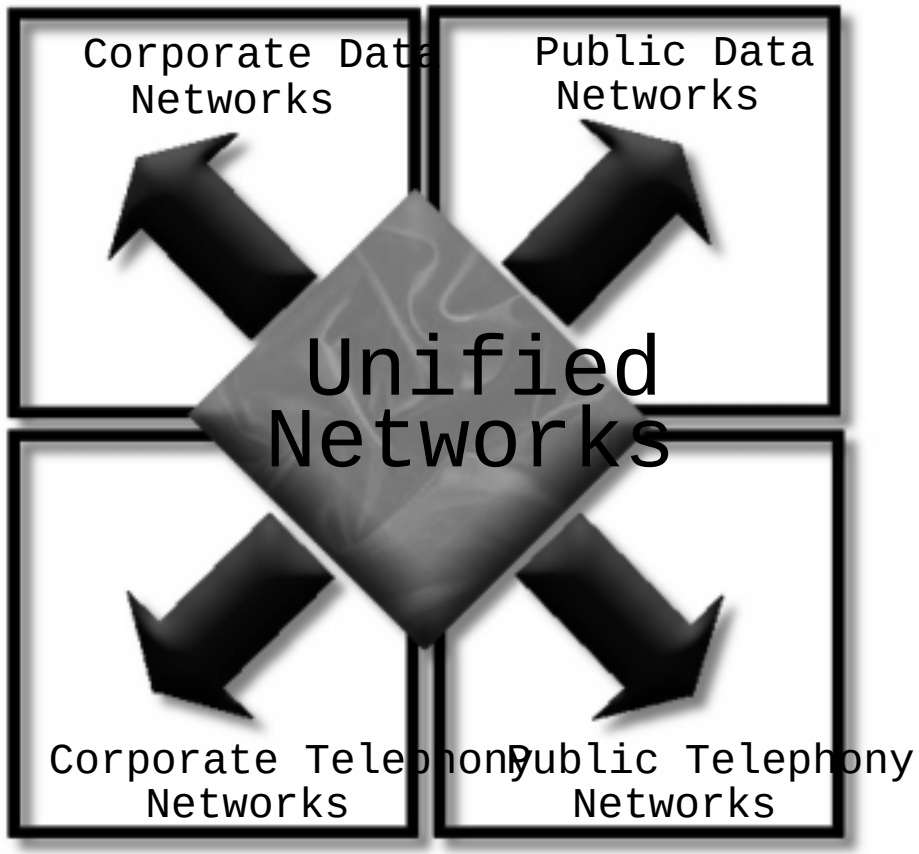
# Corporate Profile

- **Nortel Networks works with customers worldwide to design, build, and deliver telephony and IP-optimized networks.**
- **Customers include:**
  - public and private enterprises and institutions;
  - Internet service providers;
  - local, long-distance, cellular & PCS communications companies;
  - cable television carriers;
  - satellite operators; and
  - utilities
- **Focused on superior value for the customer**

# The Unified Network Brings It All Together

**Unified Network defined:**

- **Brings together the world's disparate telephony and data networks**
- **Optimized for both service providers and enterprise customers**
- **Significantly reduces network costs and enables the delivery of new services**



# Dynamics of Broadband Access Market

- **Pent up Demand for xDSL, Cable Modem, and LMDS**
  - — Operators: GTE, NorthPoint, Metricom, Advanced Radio Telecom, Teligent, WinStar, ...
  - — Manufacturers: Nortel Networks, Lucent, Alcatel, Intel, Broadcom, Copper Mountain, Newbridge Networks, ...
- **Large Carriers Acquiring Cable Companies to Provide Broadband Access**
  - — AT&T buy out of Media One and TCI
- **ISPs and New Operators Looking to Alternate Means of Providing Access to Users**
  - — AOL Investment in SpaceWay & DirecPC for Satellite Access
  - — Teligent and WinStar using LMDS
  - — Utility Companies using power lines

# Satellites Traditional Role

- **Original use for point to point TV distribution (Telstar)**
- **Evolved into trans oceanic telephony trunking (Intelsat)**
- **Step out into thin route telephony (Spade and Domsats)**

# Satellites in Broadcast

- **Satellites always have been good at broadcast (wide area coverage)**
- **First application was for narrow band messaging**
- **Lower cost ground segment invoked a DTH role and a data broadcast role**
- **Data broadcast (Equitorial) in C Band preceeded two way VSATs in Ku Band**

# Direct-to-Home

- **Key element is the availability of low cost receivers in the home unit**
- **RF technology benefited from standards in EIRP from the satellite driving a standard receiver package**
- **Analogue broadcasts were not susceptable to diverging standards. Used existing TV standards**
- **Introduction of digital TV drove the need for a standard**

# Digital TV

- **First roll out in North America used a propriatory technology (Hughes Direct TV)**
- **Europeans were more active in promoting a common standard DVB/MPEG2 (SES Astra)**
- **North Americans now realising the benefit of this standard (EchoStar, Express-Vu)**
- **A manufacturing community exists in support of DVB/MPEG (Philips et al)**

# Two Way VSATs

- **Takes advantage of the wide area coverage**
- **Often bundled with a business TV application.**
- **Some benefits from a standardised RF system.**
  - Standard satellite EIRP and interference environment (1.8m package)
- **Suffered from a lack of a digital standard**
  - Proprietary FEC coding, modulation, MAC layer and transmission rates

# Multimedia Satcom
**(Revolution or Evolution)**

Revolution

- **Much hype from the revolutionaries (Teledesic, Celestri, Skybridge, Astrolink)**
- **Revolutionary in orbits, technology, cost models or investment needs**
- **Rationalle based on lower delay, increased capacity, applications (mesh) or combinations of these.**
- **Clear role in the future for LEO based overlays delivering symetrical bandwidth for highly interactive applications. Also attractive for 3rd generation mobile (FPLMTS)**

# Multimedia Satcom
**(Revolution or Evolution)**

But

- **Ignores the role of Regional Satellite Systems**
- **Doesn’t fit the profile of early applications (high assymetry, multicast)**
- **Promotes proprietory air interfaces**
- **Ignores the synergy with existing Digital Broadcast system**
- **Carries a heavy negative cash flow prior to any revenue production.**

# Multimedia Satcom
**(Revolution or Evolution)**

## Evolution

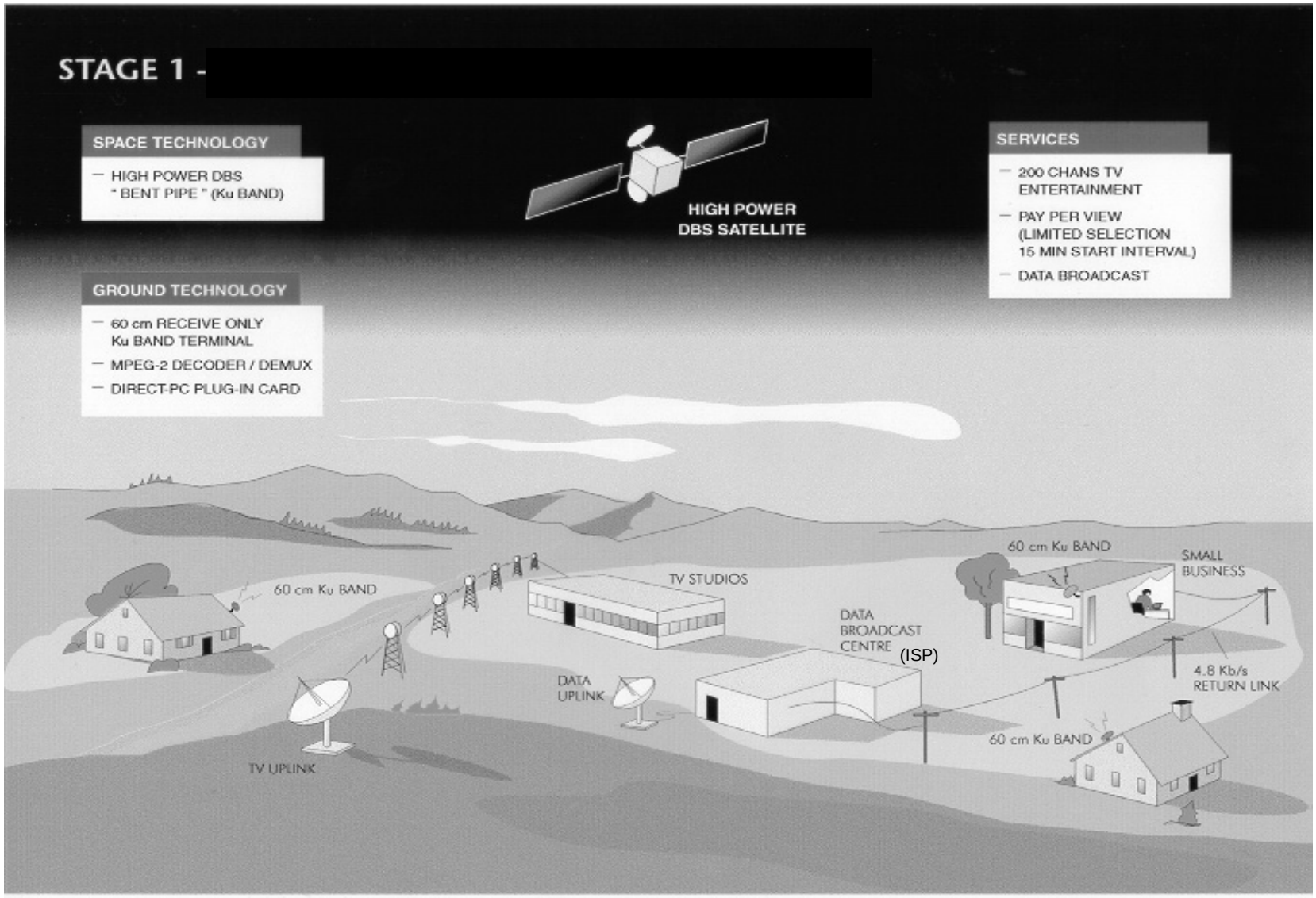
- **Builds on existing broadcast standards**
- **Evolves incrementaly with greater sophistication at each stage**
- **Incremental to current DBS infrastructure**
- **Builds on Direct to Home consumer equipment**
- **Creates a new market community based on standards that converge broadcast with two way communications**
- **Services the assymetrical and host based application areas.**
- **A natural access to the Internet**
- **Complementary to future LEO based broadband systems**

# Service Evolution Path

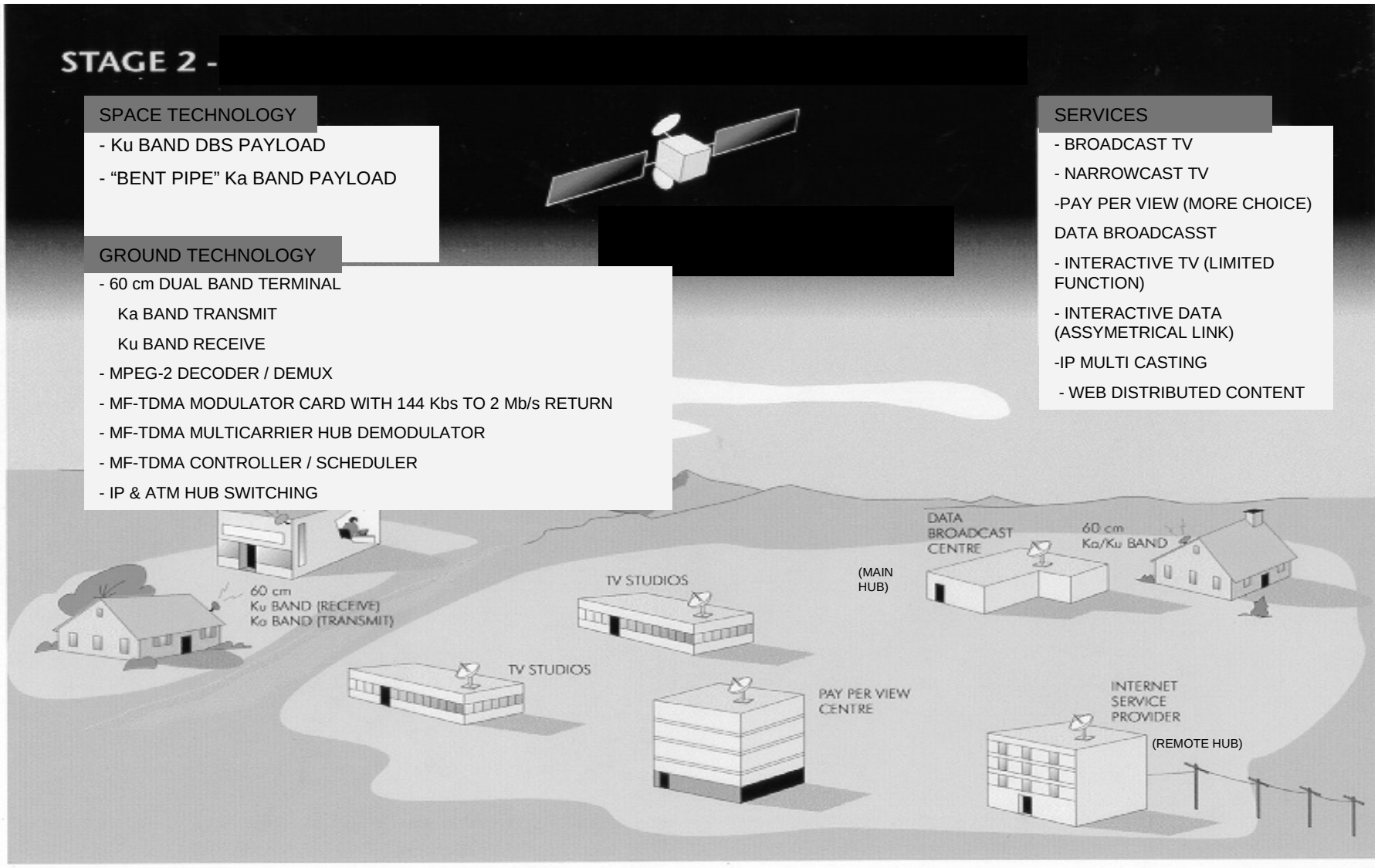
## 5 Major Steps

- **DirecPC/Astra-Net (1997)**
- **Advanced Return Channel System (ARCS) with Ka Band piggy back payload (1999)**
- **ARCS On Board Multiplex with limited downlink flexibility (2001)**
- **Fully switch OBP system (2002)**
- **LEO Overlay (2003-2004)**

# Stage 1

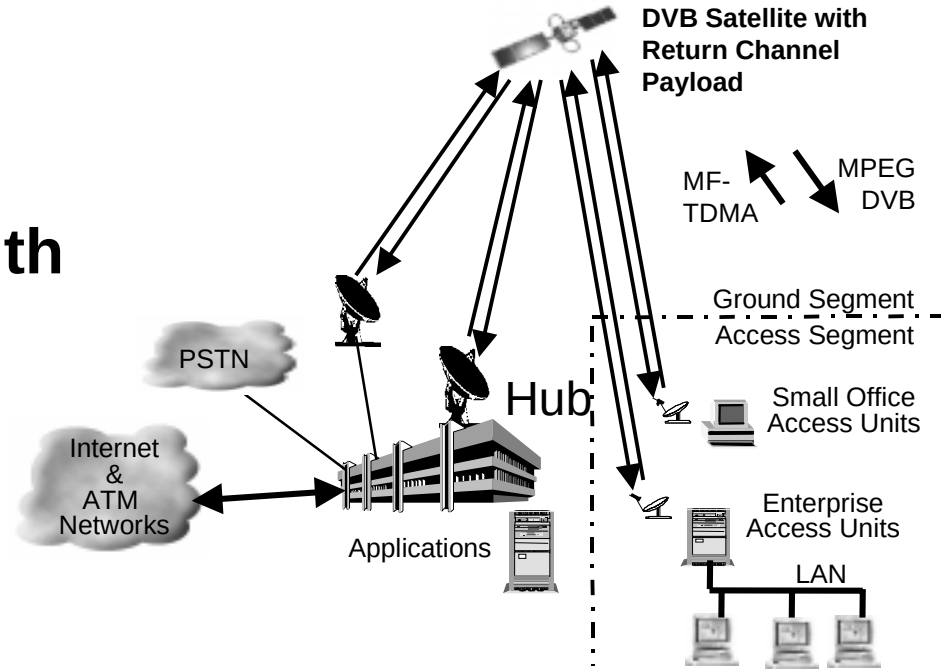

STAGE 1 -
SPACE TECHNOLOGY
– HIGH POWER DBS
" BENT PIPE " (Ku BAND)
HIGH POWER
DBS SATELLITE
SERVICES
– 200 CHANS TV
ENTERTAINMENT
– PAY PER VIEW
(LIMITED SELECTION
15 MIN START INTERVAL)
– DATA BROADCAST
GROUND TECHNOLOGY
– 60 cm RECEIVE ONLY
Ku BAND TERMINAL
– MPEG-2 DECODER / DEMUX
– DIRECT-PC PLUG-IN CARD
60 cm Ku BAND
TV STUDIOS
DATA
BROADCAST
CENTRE
(ISP)
60 cm Ku BAND
SMALL
BUSINESS
DATA
UPLINK
4.8 Kb/s
RETURN LINK
60 cm Ku BAND
TV UPLINK

# Stage 2


STAGE 2 -
SPACE TECHNOLOGY
- Ku BAND DBS PAYLOAD
- "BENT PIPE" Ka BAND PAYLOAD
GROUND TECHNOLOGY
- 60 cm DUAL BAND TERMINAL
Ka BAND TRANSMIT
Ku BAND RECEIVE
- MPEG-2 DECODER / DEMUX
- MF-TDMA MODULATOR CARD WITH 144 Kbs TO 2 Mb/s RETURN
- MF-TDMA MULTICARRIER HUB DEMODULATOR
- MF-TDMA CONTROLLER / SCHEDULER
- IP & ATM HUB SWITCHING
SERVICES
- BROADCAST TV
- NARROWCAST TV
-PAY PER VIEW (MORE CHOICE)
DATA BROADCASST
- INTERACTIVE TV (LIMITED FUNCTION)
- INTERACTIVE DATA (ASSYMETRICAL LINK)
-IP MULTI CASTING
- WEB DISTRIBUTED CONTENT
60 cm
Ku BAND (RECEIVE)
Ka BAND (TRANSMIT)
TV STUDIOS
TV STUDIOS
DATA
BROADCAST
CENTRE
(MAIN
HUB)
60 cm
Ka/Ku BAND
PAY PER VIEW
CENTRE
INTERNET
SERVICE
PROVIDER
(REMOTE HUB)

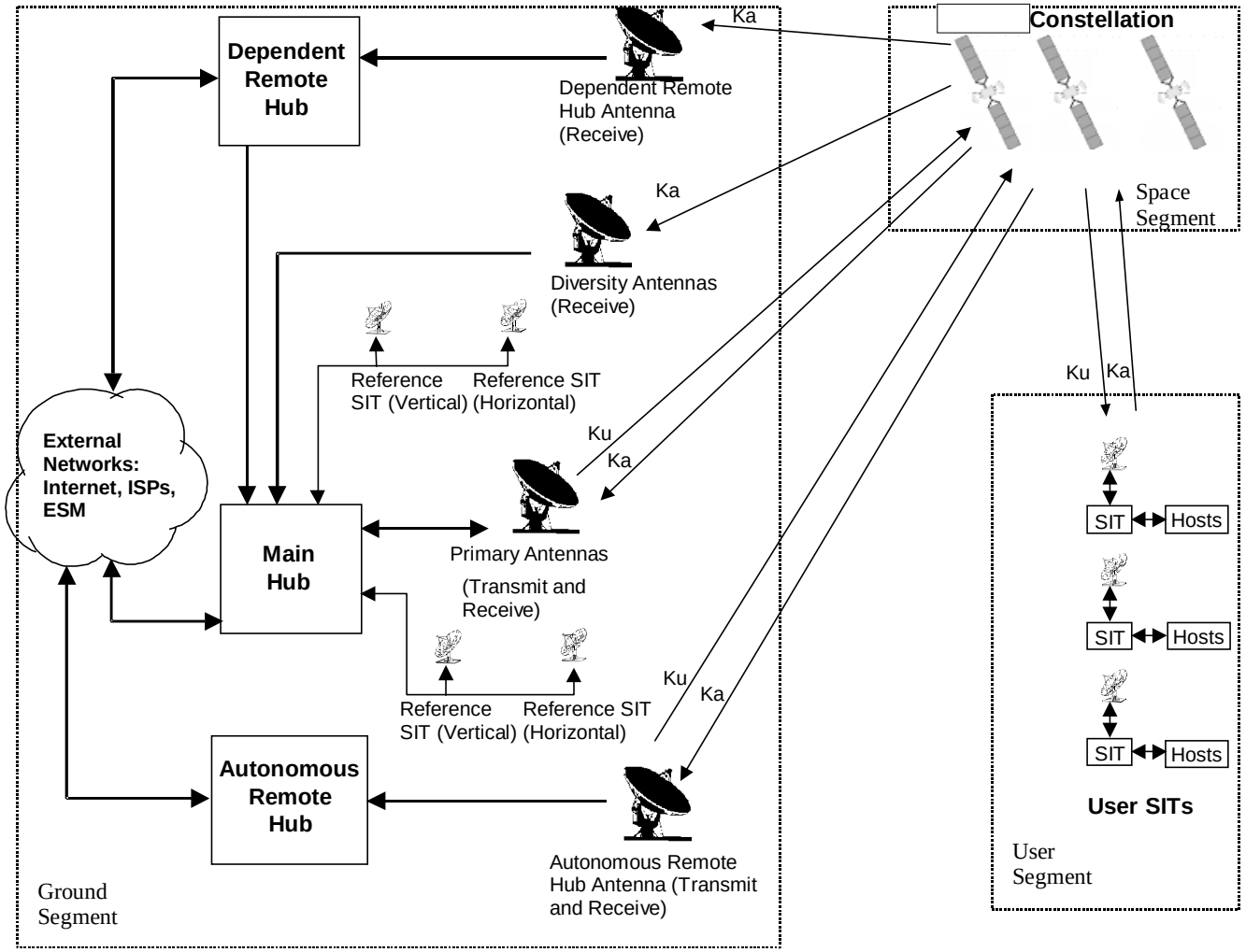
# Advanced Return Channel Systems

- **Asymmetric broadband service across a region**
  - **38 Mbps to user**
  - **2 Mbps from user**
- **Cost-effective access with small dish size**
- **Application-oriented architecture**
- **Open system design**




Superior approach to provide broadband services for regional satellite operators & broadcasters

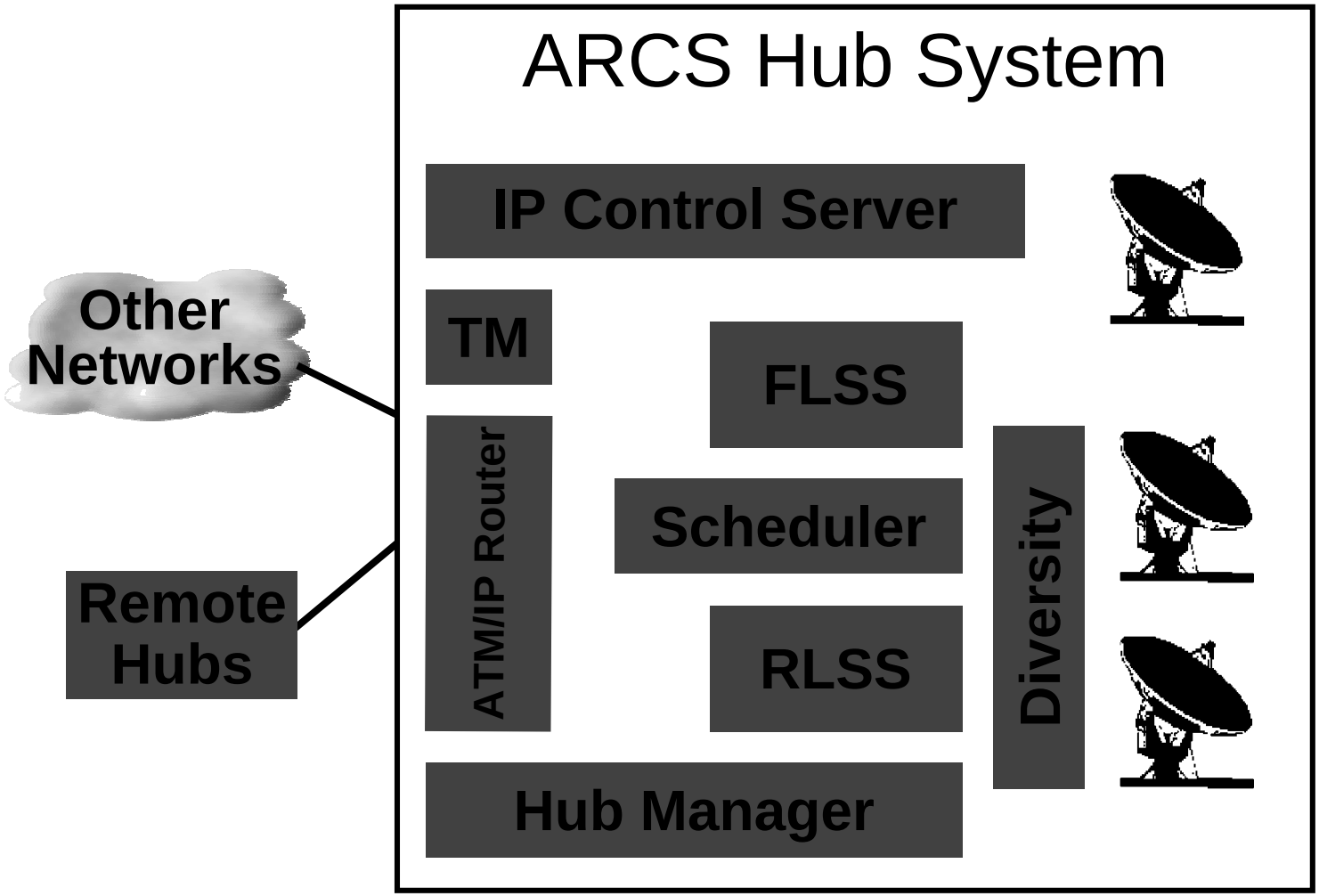
# System Architecture Overview



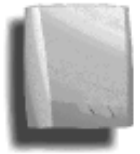
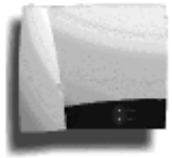
# ARCS Features

- **IP Access Network**
- **Bandwidth-on-demand**
- **IP Multicast**
  - — Efficient
  - — Reliable
- **Secure Access**
- **Redundancy: Carrier Grade**
- **High Capacity**
- **Low Cost Terminals**
- **Evolution to IP-QoS and ATM**

# Return Channel Hub Elements

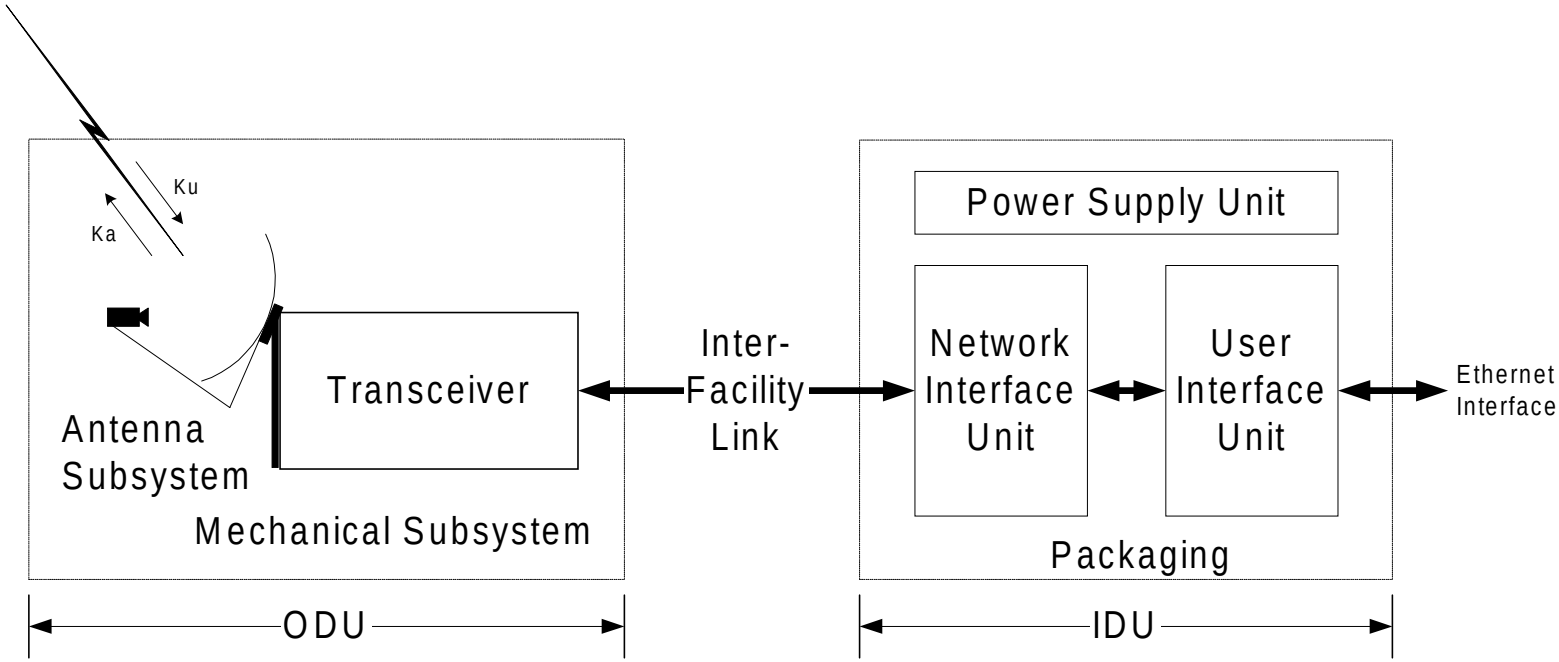


# ARCS Access Portfolio

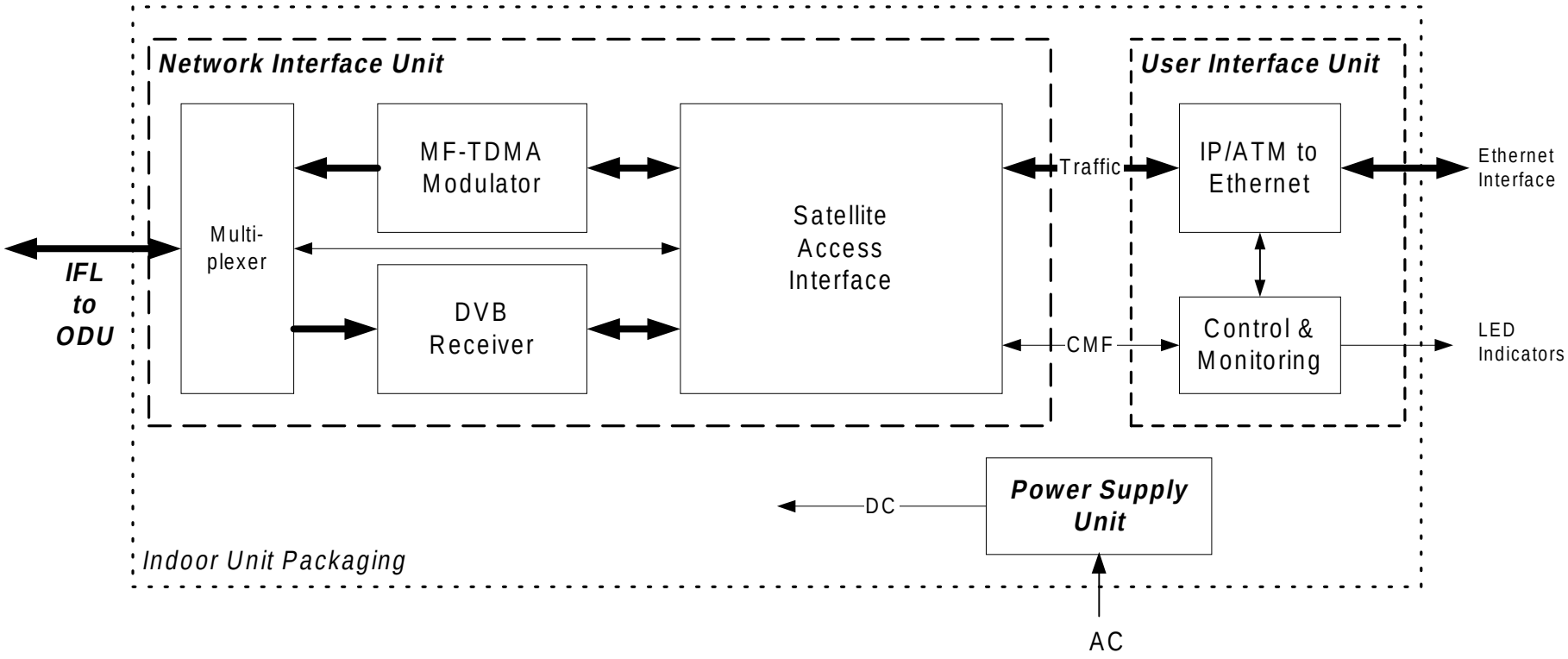
| | | | |
|---|---|---|---|
|  0.6 m | 150 Kbps ↕ 38 Mbps |  190 mm | 10BaseT |
|  0.9 m | 380 Kbps ↕ 38 Mbps |  270 mm | 10BaseT |
|  1.2 m | 2048 Kbps ↕ 38 Mbps |  400 mm | 10BaseT |

- High reliability, hig performance enterpris full portfolio
- Totally new price performance paradigm relative to VSAT - competitive with ANY terrestrial solution
- Minimal “out of the b assembly and configuration facilit broad deployment
- Unobtrusive antenna designs lowers community resistance

# Satellite Interactive Terminals (SIT)



# Indoor Unit Block Diagram



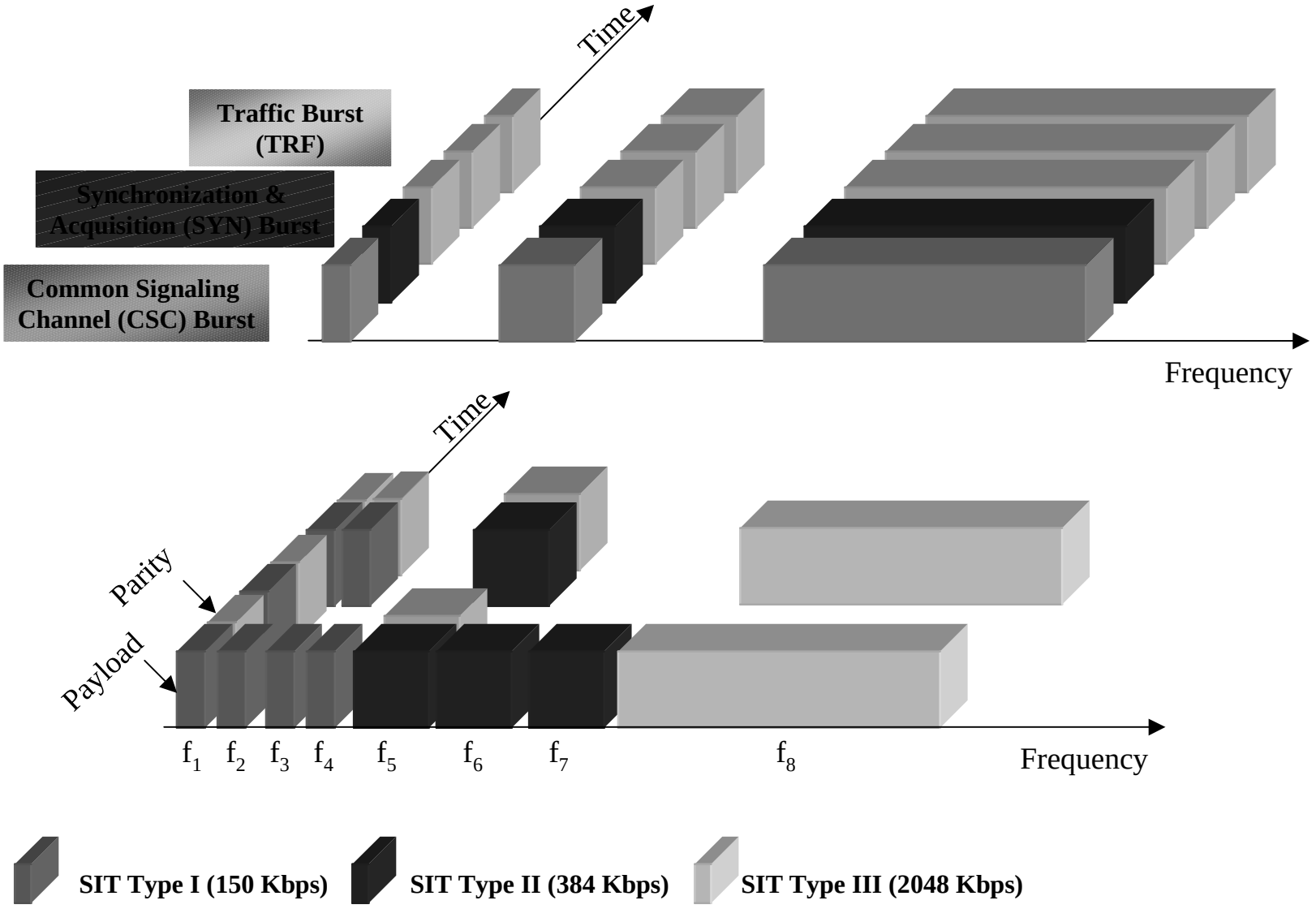
# ARCS Air Interface Standardization

- **Satellite Return Channel air-interface specifications are under standardization at the ETSI-DVB (Digital Video Broadcasting) group, DVB-RCS Ad-Hoc Group.**
- **The baseline for the proposed standard is the RCS air-interface specification developed by ESA/ESTEC group (Eutelsat, Hispasat, Telenor, Telesat, Teracom, SES-Astra).**
- **The DVB-RCS Ad-Hoc Group is chaired by Nortel Networks and the vice-chair is from Philips**

# Air Interface: Return Link

- **Multiple Access: MF-TDMA**
- **Modulation and Channel Coding: Quadrature Phase Shift Key (QPSK) modulation with a combination of concatenated channel coding (an inner convolutional coding with various encoding rates and an outer Reed-Solomon Forward Error Correcting (FEC) coding)**
- **Medium Access Control (MAC) Scheme: CF-DAMA (Combined Free – Demand Access Multiple Assignment)**
- **Burst Structure: Typical bursts will be composed of up to 4 cells with fixed cell size of 53 bytes (Migration to ATM in the future)**

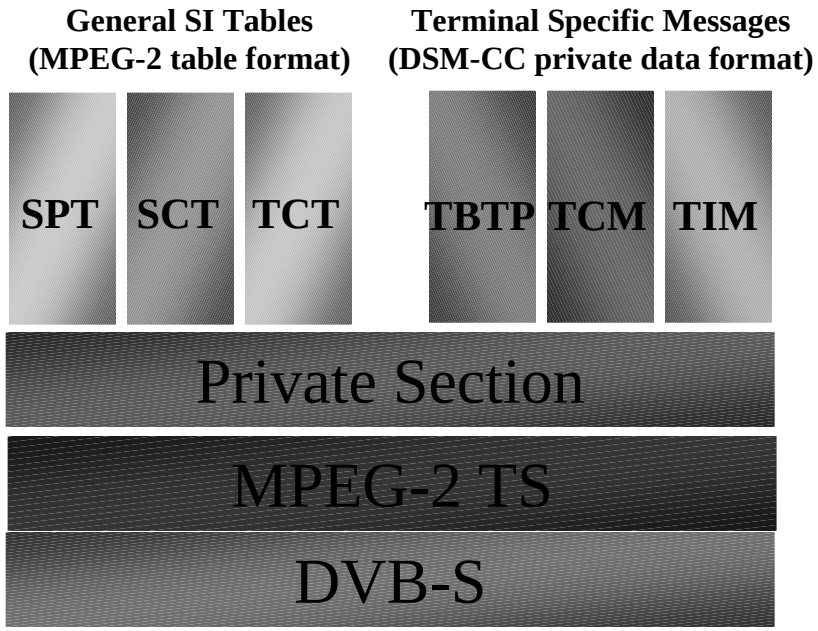
# Air Interface: Return Link (MF - TDMA)



# Air Interface: Forward Link

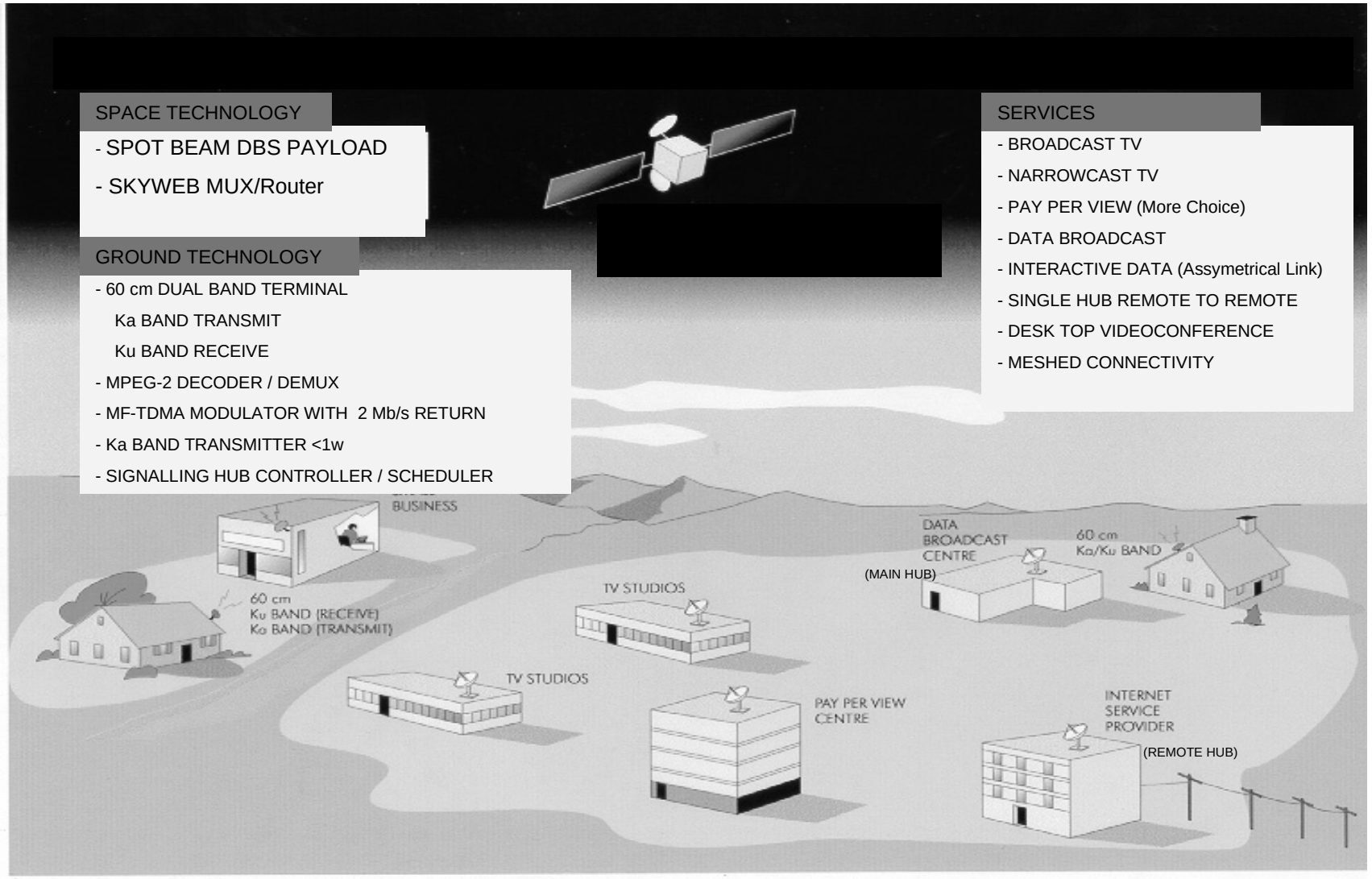
- **Standard IP & ATM over DVB**
  - **ETSI EN 301 192: Digital Video Broadcasting (DVB); DVB specification for data broadcasting, 1998**
- **The Forward Link carries a multiplex of ARCS traffic and signaling.**
- **Includes Service Information (SI) to describe all streams on the forward link.**

# Forward Path Signaling Protocol Stack



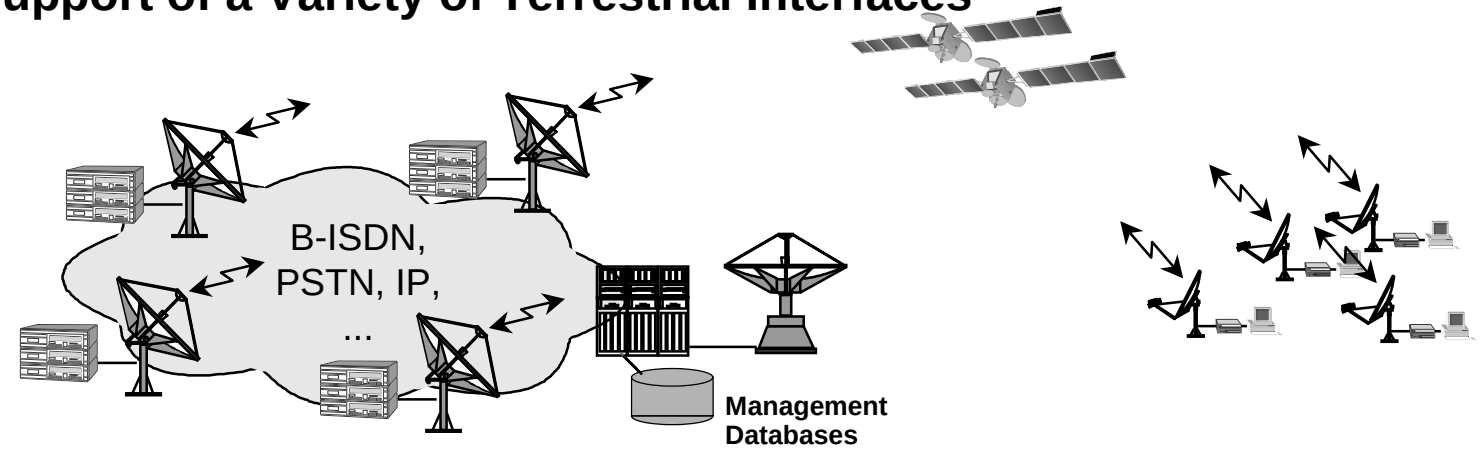

**SPT: Satellite Position Table**
**SCT: Superframe Composition Table**
**TCT: Time-Slot Composition Table**
**TBTP: Terminal Burst Time Plan**
**TCM: Terminal Correction Message**
**TIM: Terminal Information Message**

# Stage 3


SPACE TECHNOLOGY
- SPOT BEAM DBS PAYLOAD
- SKYWEB MUX/Router
GROUND TECHNOLOGY
- 60 cm DUAL BAND TERMINAL
Ka BAND TRANSMIT
Ku BAND RECEIVE
- MPEG-2 DECODER / DEMUX
- MF-TDMA MODULATOR WITH 2 Mb/s RETURN
- Ka BAND TRANSMITTER <1w
- SIGNALLING HUB CONTROLLER / SCHEDULER
SERVICES
- BROADCAST TV
- NARROWCAST TV
- PAY PER VIEW (More Choice)
- DATA BROADCAST
- INTERACTIVE DATA (Assymetrical Link)
- SINGLE HUB REMOTE TO REMOTE
- DESK TOP VIDEOCONFERENCE
- MESHED CONNECTIVITY
BUSINESS
60 cm
Ku BAND (RECEIVE)
Ka BAND (TRANSMIT)
TV STUDIOS
TV STUDIOS
PAY PER VIEW
CENTRE
DATA
BROADCAST
CENTRE
(MAIN HUB)
60 cm
Ka/Ku BAND
INTERNET
SERVICE
PROVIDER
(REMOTE HUB)

# Architectural Attributes

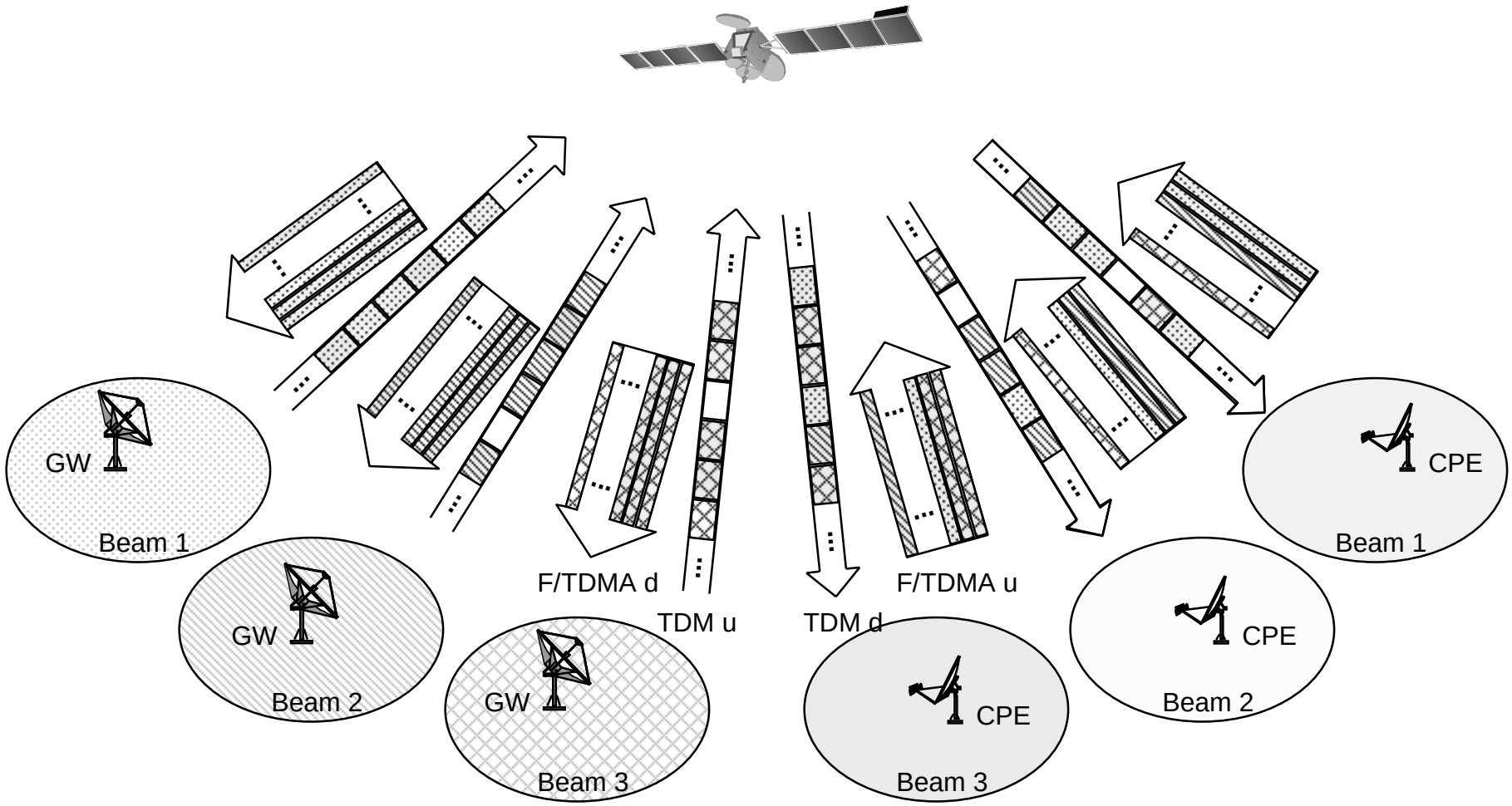
- **Two Tiered Resource Management**
  - Centralized Resource Allocation at NCC
  - Distributed Real Time Resource Management (CAC, MAC, BOD) at Gateways
- **Support of Least Cost Routing between CPEs and Gateways**
- **Centralized Subscriber Management Functions**
  - Billing, Authentication, Registration
- **Service Transportability (Virtual Home Environment)**
- **Support of Lawful Interception**
- **Support of a Variety of Terrestrial Interfaces**



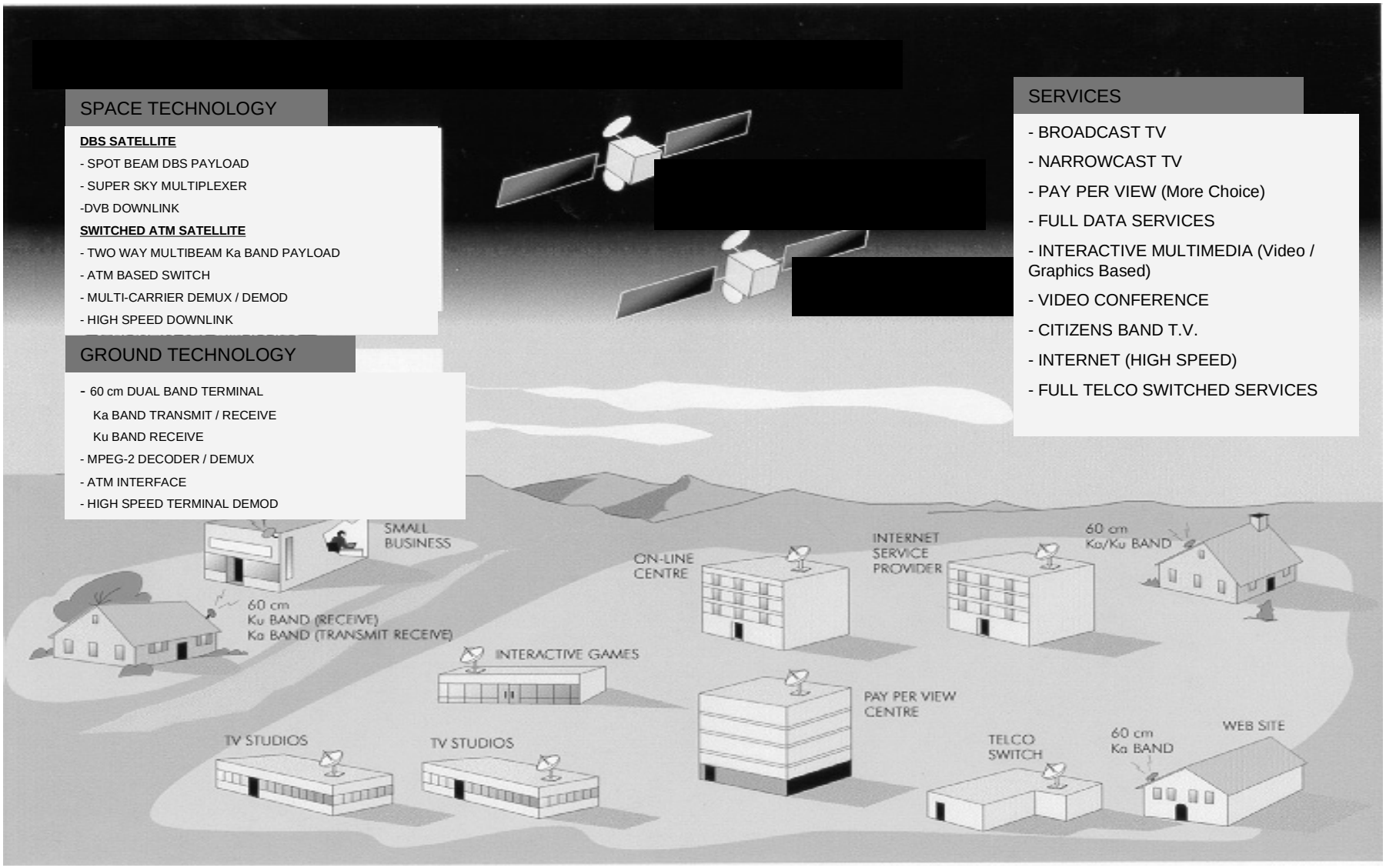
# Communications services

- **Connectivity :**
  - CPE <--> Gateway : single hop, full beam-to-beam connectivity (least cost routing)
  - CPE <--> CPE : double hop, full beam-to-beam connectivity
  - Gateway <--> Gateway : terrestrial (if needed)
  - NCC <--> Gateway : terrestrial inter-CC network
  - NCC <--> CPE : via Gateway
- **Quality of Service :**
  - ATM class 1, BER : $1 \times 10^{-10}$
  - Availability : 99.5 %, call blocking : 1 to 3 %
- **Services :**
  - ATM
  - IP
  - IP multicast

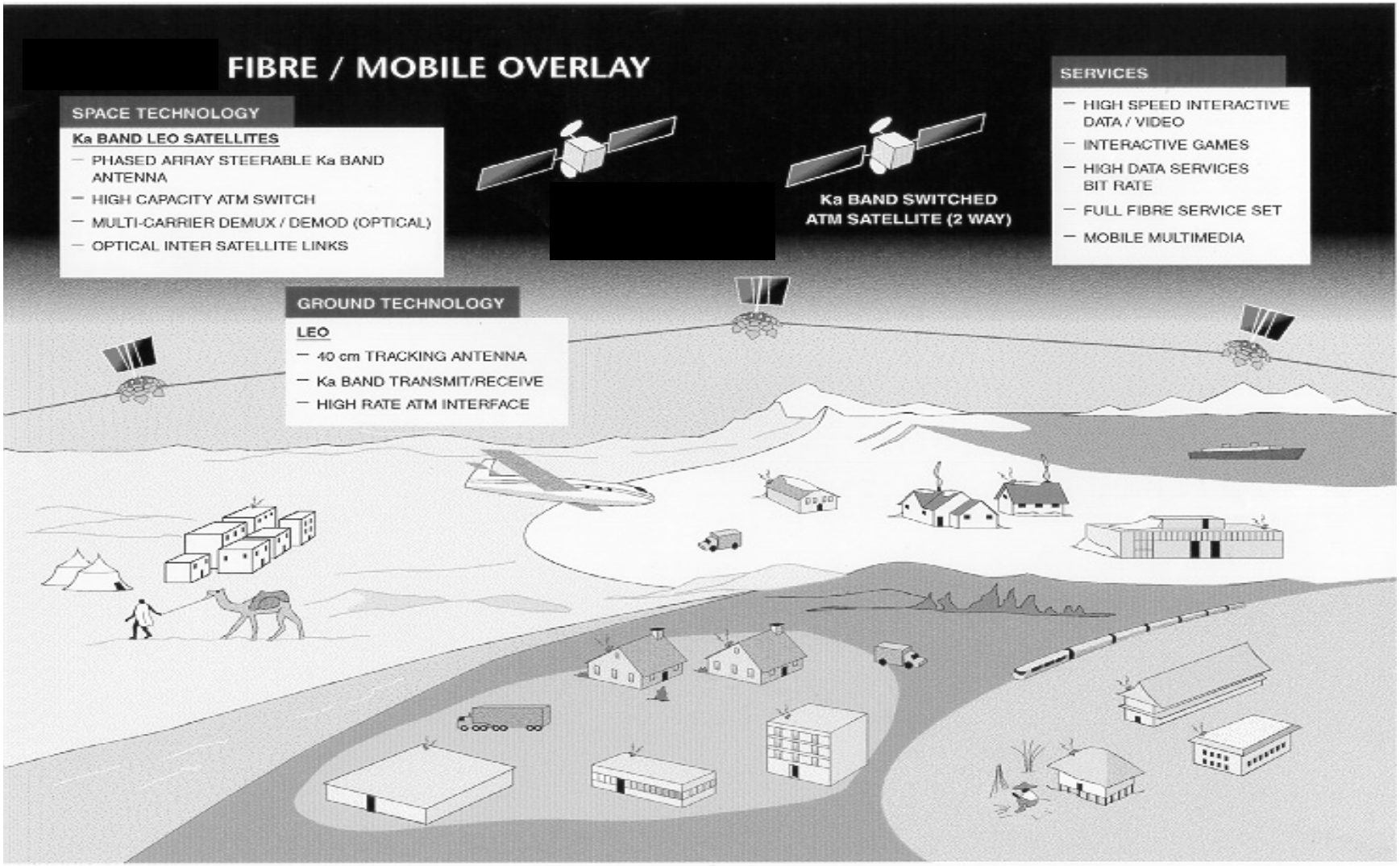
# Air interface



# Stage 4


SPACE TECHNOLOGY
DBS SATELLITE
- SPOT BEAM DBS PAYLOAD
- SUPER SKY MULTIPLEXER
-DVB DOWNLINK
SWITCHED ATM SATELLITE
- TWO WAY MULTIBEAM Ka BAND PAYLOAD
- ATM BASED SWITCH
- MULTI-CARRIER DEMUX / DEMOD
- HIGH SPEED DOWNLINK
GROUND TECHNOLOGY
- 60 cm DUAL BAND TERMINAL
Ka BAND TRANSMIT / RECEIVE
Ku BAND RECEIVE
- MPEG-2 DECODER / DEMUX
- ATM INTERFACE
- HIGH SPEED TERMINAL DEMOD
SERVICES
- BROADCAST TV
- NARROWCAST TV
- PAY PER VIEW (More Choice)
- FULL DATA SERVICES
- INTERACTIVE MULTIMEDIA (Video / Graphics Based)
- VIDEO CONFERENCE
- CITIZENS BAND T.V.
- INTERNET (HIGH SPEED)
- FULL TELCO SWITCHED SERVICES
SMALL BUSINESS
60 cm
Ku BAND (RECEIVE)
Ka BAND (TRANSMIT RECEIVE)
ON-LINE CENTRE
INTERNET SERVICE PROVIDER
60 cm
Ka/Ku BAND
INTERACTIVE GAMES
PAY PER VIEW CENTRE
TV STUDIOS
TV STUDIOS
TELCO SWITCH
60 cm
Ka BAND
WEB SITE

# Stage 5


FIBRE / MOBILE OVERLAY
SPACE TECHNOLOGY
Ka BAND LEO SATELLITES
– PHASED ARRAY STEERABLE Ka BAND ANTENNA
– HIGH CAPACITY ATM SWITCH
– MULTI-CARRIER DEMUX / DEMOD (OPTICAL)
– OPTICAL INTER SATELLITE LINKS
Ka BAND SWITCHED ATM SATELLITE (2 WAY)
SERVICES
– HIGH SPEED INTERACTIVE DATA / VIDEO
– INTERACTIVE GAMES
– HIGH DATA SERVICES BIT RATE
– FULL FIBRE SERVICE SET
– MOBILE MULTIMEDIA
GROUND TECHNOLOGY
LEO
– 40 cm TRACKING ANTENNA
– Ka BAND TRANSMIT/RECEIVE
– HIGH RATE ATM INTERFACE

# Summary

- **Demand for Broadband Access**
- **Satellite as another Alternate Access Vehicle**
- **Ambiguity in Market Place**
  - — Reduce investment requirements
- **Technical Glitches in Recent Mobile Systems**
  - — Simplicity the key
- **Commercial Problems of Recent Satellite Programs**
  - — Avoiding premature obsolescence
- **Evolutionary and Standards-based Approach to Broadband Multimedia via Satellite Most Appropriate Technique for Cost and Time-to-Market**