



ATM-Sat: ATM-Based Multimedia Communication via LEO-Satellites

Projektübersicht

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Projektdaten

- ▶ *Projektdauer: Juli 1999 - Juni 2002*
- ▶ *Projektpartner:*
 - *DLR Oberpfaffenhofen, Institut für Kommunikation und Navigation
Abteilung Digitale Netze (DN) - Projektleitung*
 - *DLR Oberpfaffenhofen, Institut für Kommunikation und Navigation,
Abteilung Navigations- und Leitsysteme (NL)*
 - *Fraunhofer Institut FOKUS Berlin, Competence Center for Advanced Network
Technologies and Systems (CATS)*
 - *Tesat-Spacecom GmbH & Co.KG Backnang, Space Communication Systems*
- ▶ *ATM-Sat wird finanziert aus dem Strategiefonds der Helmholtz-Gemeinschaft*

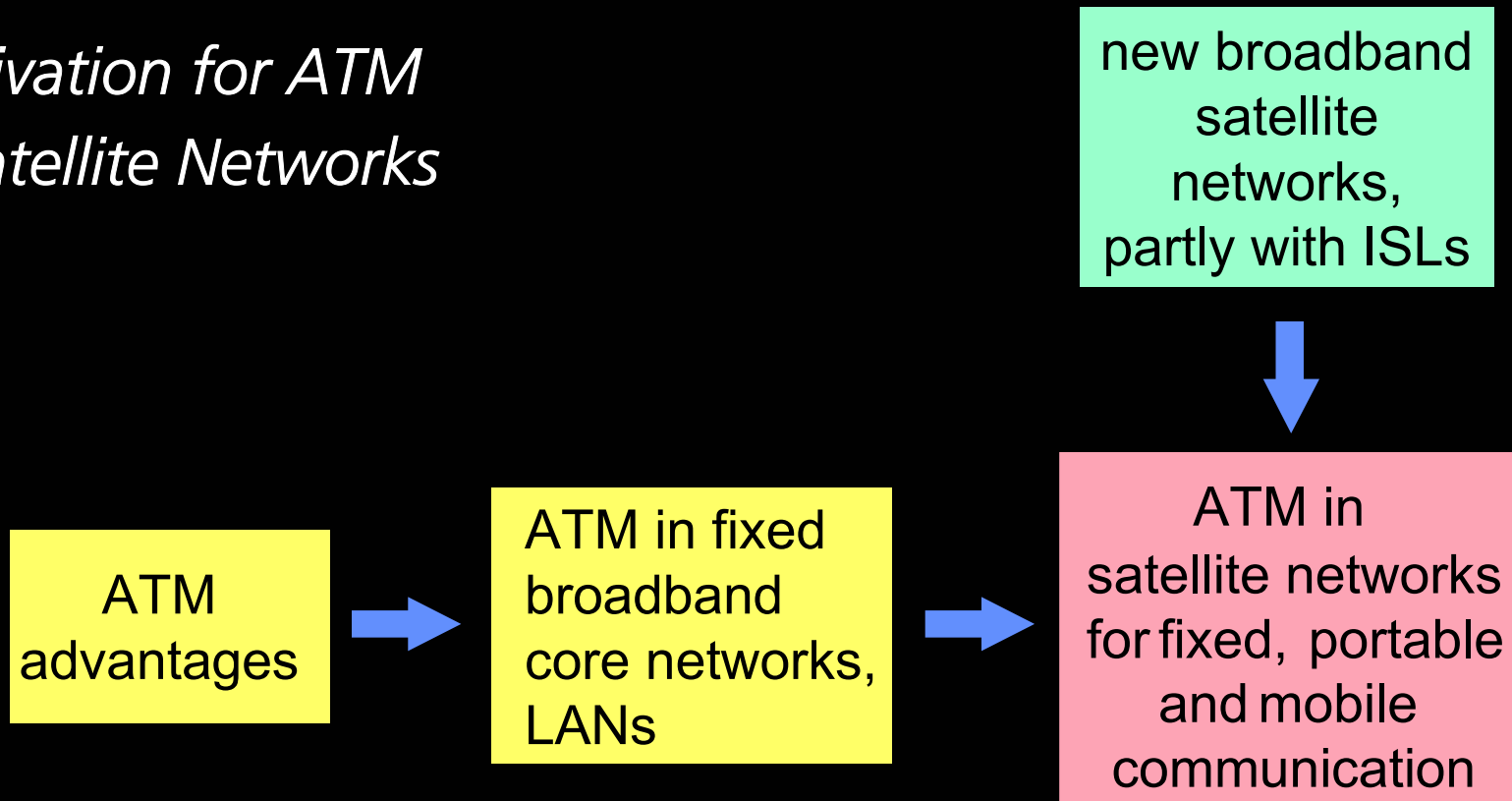


Projektziele

- ▶ *ATM-Sat will develop the concept and the communication technology for a multimedia satellite system with:*
 - *Low Earth Orbit satellites → and GEO satellites*
 - *intersatellite links*
 - *on-board ATM switching*
 - *fixed and mobile terminals*
 - *reenforced consideration of internet-based services*
- ▶ *ATM-Sat will verify the developed communication technology with a demonstrator*
- ▶ *ATM-Sat will provide support to the German space and communications industry in acquiring the future market of multimedia satellite communication*



Motivation for ATM in Satellite Networks

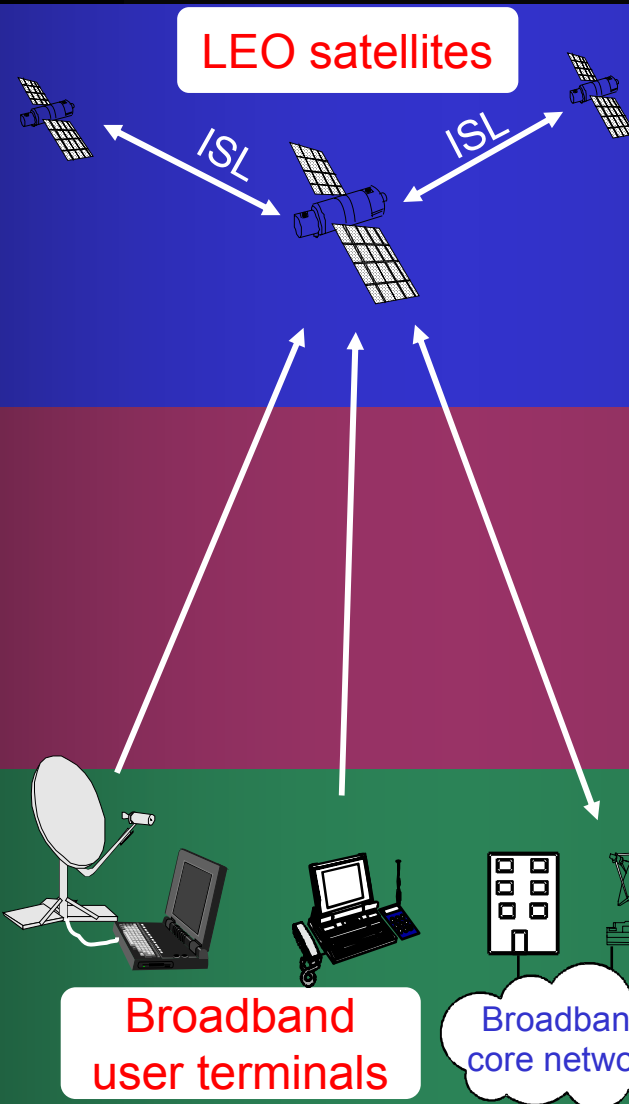




System Characteristics

- ◆ LEO satellites
 - ◆ intersatellite links
 - ◆ dynamic network topology
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- ◆ shared medium
 - ◆ limited bandwidth
 - ◆ propagation delay
 - ◆ bit errors
-
- ◆ fixed, portable, and mobile terminals
 - ◆ multiservice scenario

LEO satellites



ATM-Sat R&D

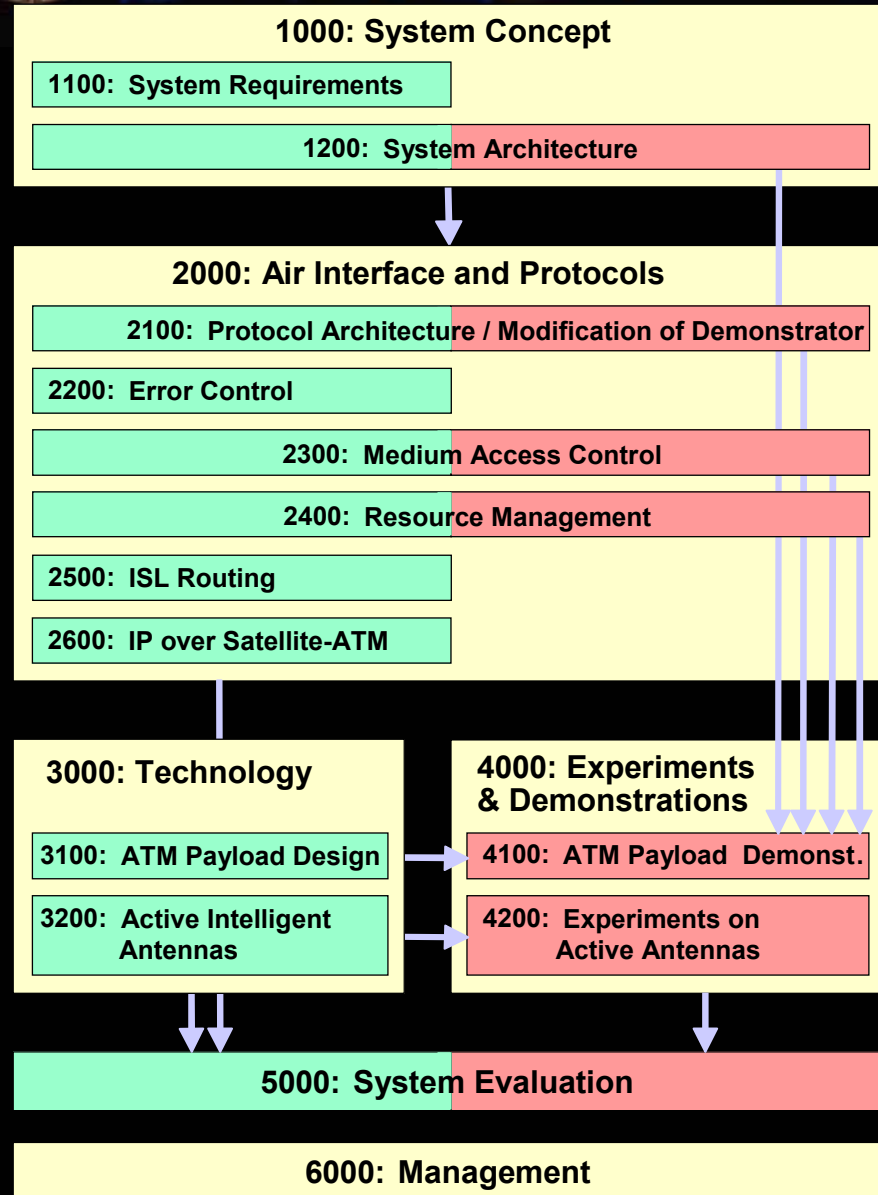
- system and protocol architecture (DLR, FhG)
 - on-board processing (Tesat)
 - ISL routing scheme (DLR)
 - radio & ATM resource (DLR) management
 - multiple access protocol (DLR, FhG)
 - error control (DLR)
 - transmission scheme (DLR)
 - support different traffic classes !
 - meet QoS requirements !
 - optimize bandwidth utilization !
-
- mobility management and handover (FhG)
 - IP over satellite-ATM (FhG, DLR)
 - active intelligent antennas (DLR)

Broadband user terminals

Broadband core network

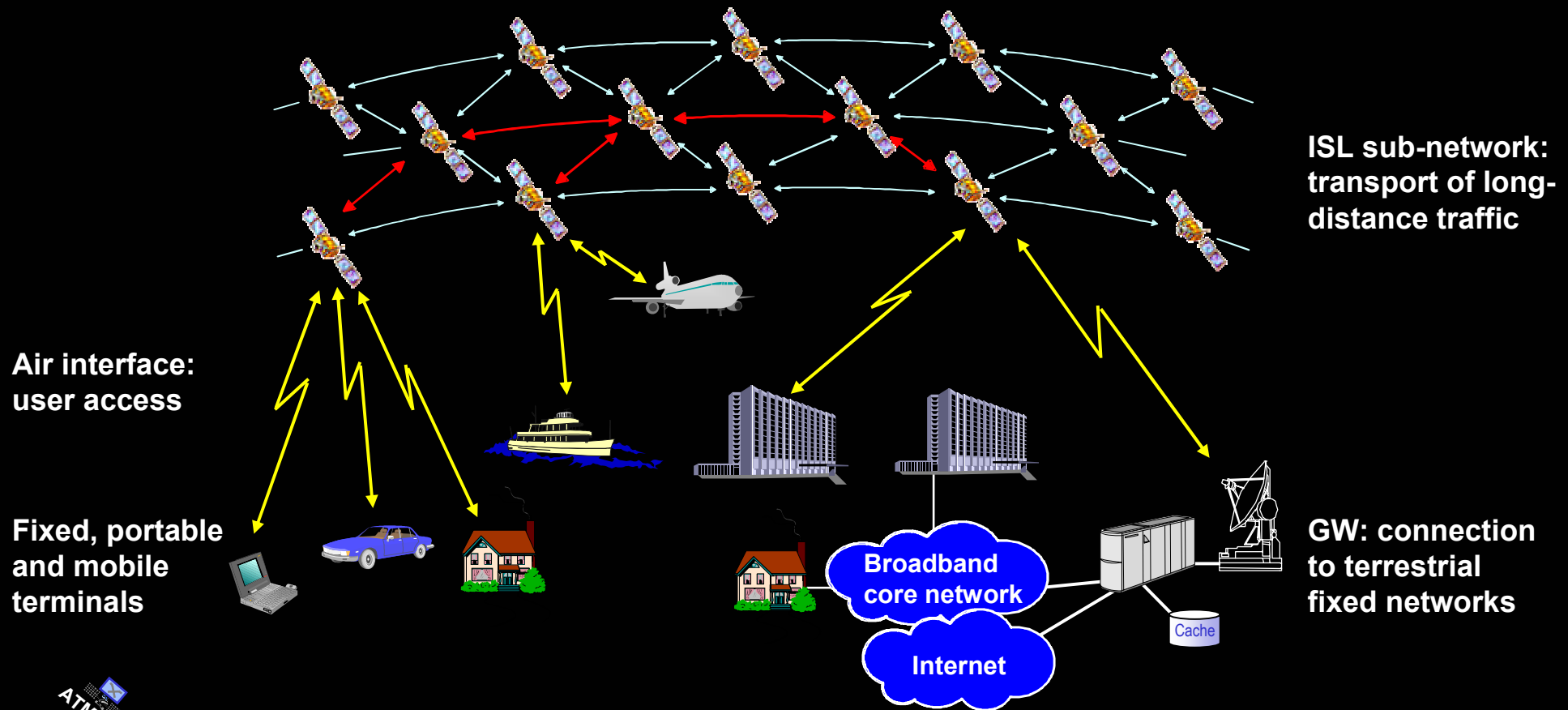


ATM-Sat Work Package Structure



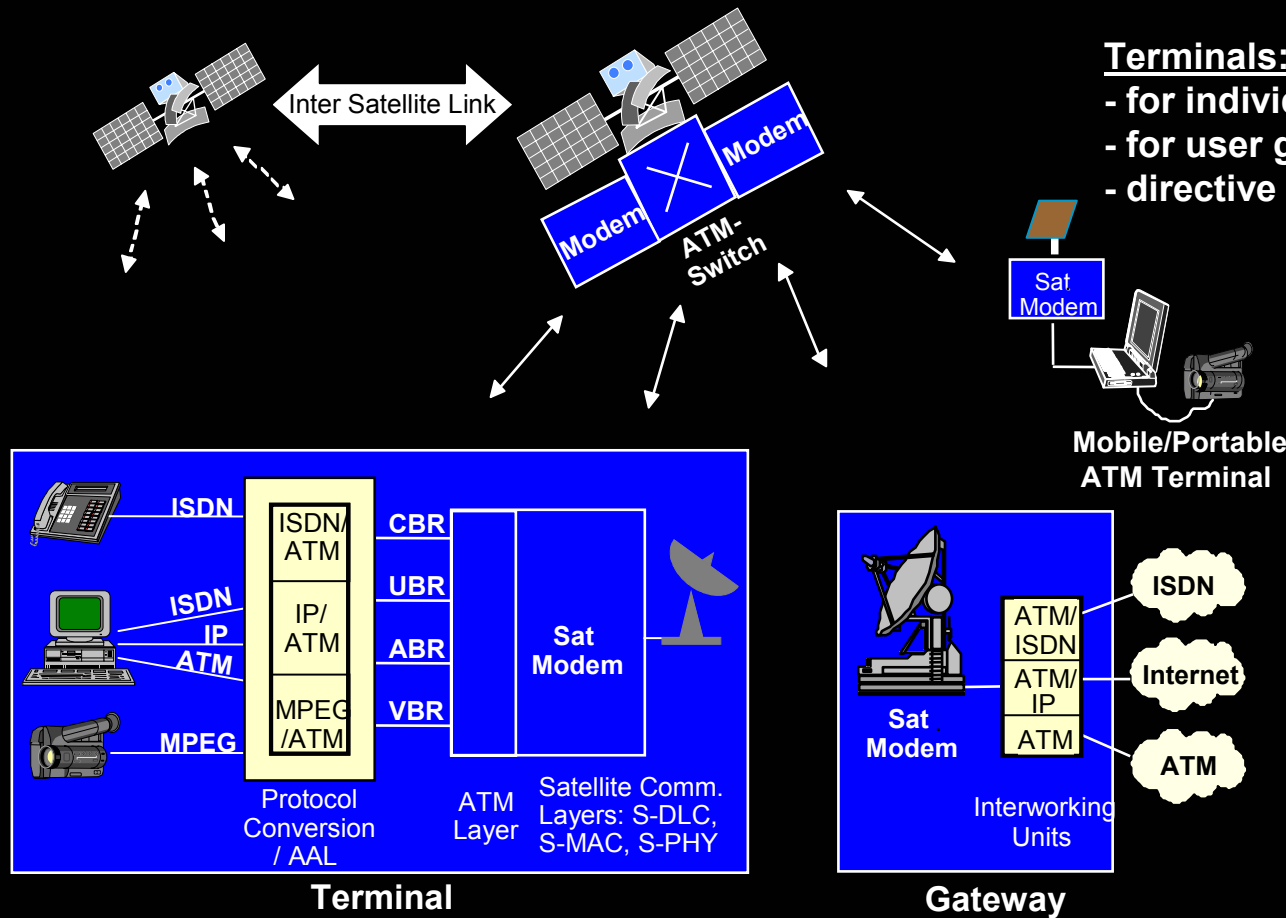


Systemkonzept eines ISL-basierten breitbandigen LEO Satellitensystems für die Multimediakommunikation





Systemkonzept / Anwendungszzenarium für das Zielsystem



Terminals:

- for individual use
- for user groups
- directive antennas, LOS !



Satellitenkonstellation

Satelliten: 72 (12*6)
Orbits: 12
Orbithöhe: 1350 km
Orbitperiode: 112.7 min
Inklination: 47°
Phasung: 25°
ISLs: ja
Minimale Elevation: 20°-30°
⇒ Ø Footprint: 3200 - 4200 km





Einige Systemparameter

- ▶ *Terminal data rate:*
uplink: 16 kbit/s, 32 kbit/s, ..., 2 Mbit/s
downlink: 16 kbit/s up to 32 Mbit/s
- ▶ *Satellite switch capacity:* 5 Gbit/s - 10 Gbit/s
- ▶ *Spotbeams per satellite:* 100 - 300
- ▶ *Carriers per satellite:* 150 - 300
- ▶ *Maximum number of carriers per spotbeam (dynamic):* 30 - 60
- ▶ *Maximum number of downlink channels (16 kbit/s) per carrier:* 2000
⇒ *Unidirectional downlink channels (16 kbit/s) per satellite:* 300000 - 600000
⇒ *Bidirectional channels (16 kbit/s) per satellite:* 150000 - 300000



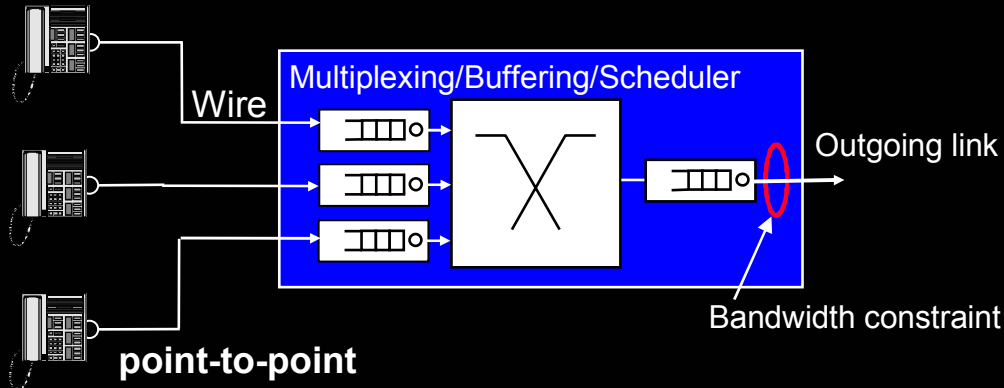
Dienste und Anwendungen (Auswahl)

	<i>Standard</i>	<i>Bit rate</i>	<i>Mapping ATM services</i>
<i>Voice</i>	<i>LD-CELP, ADPCM, SB-ADPCM, PCM</i>	<i>16 - 64 kbit/s</i>	<i>CBR</i>
<i>CD quality audio</i>	<i>MPEG-1 audio (MP3)</i>	<i>32 - 224 kbit/s</i>	<i>CBR</i>
	<i>MPEG audio FFT</i>	<i>384 kbit/s</i>	<i>CBR</i>
<i>Video conferencing and video telephony</i>	<i>H.261</i>	<i>p*64 kbit/s, p=1, 2, ..., 30</i>	<i>CBR, rt-VBR, nrt-VBR</i>
	<i>JPEG</i>	<i>1, ..., 2 (5) Mbit/s</i>	<i>CBR, nrt-VBR</i>
	<i>MJPEG</i>	<i>1, ..., 2 (10) Mbit/s</i>	<i>CBR, nrt-VBR</i>
<i>Broadcast TV quality video</i>	<i>MPEG-2</i>	<i>2, 4, 6, to > 20 Mbit/s</i>	<i>CBR, rt-VBR, nrt-VBR</i>
<i>Multimedia applications</i>	<i>MPEG-4</i>	<i>64 kbit/s, ..., 2 (4) Mbit/s</i>	<i>CBR, rt-VBR</i>
<i>Web browsing, file transfer, IP over ATM</i>	<i>http, ftp</i>	<i>p*16 kbit/s, p=1, 2, ...</i>	<i>UBR, UBR with MCR, ABR</i>
<i>Network interconnection</i>		<i>p*16 kbit/s, p=1, 2, ...</i>	<i>UBR, UBR with MCR, CBR, nrt-VBR, ABR</i>



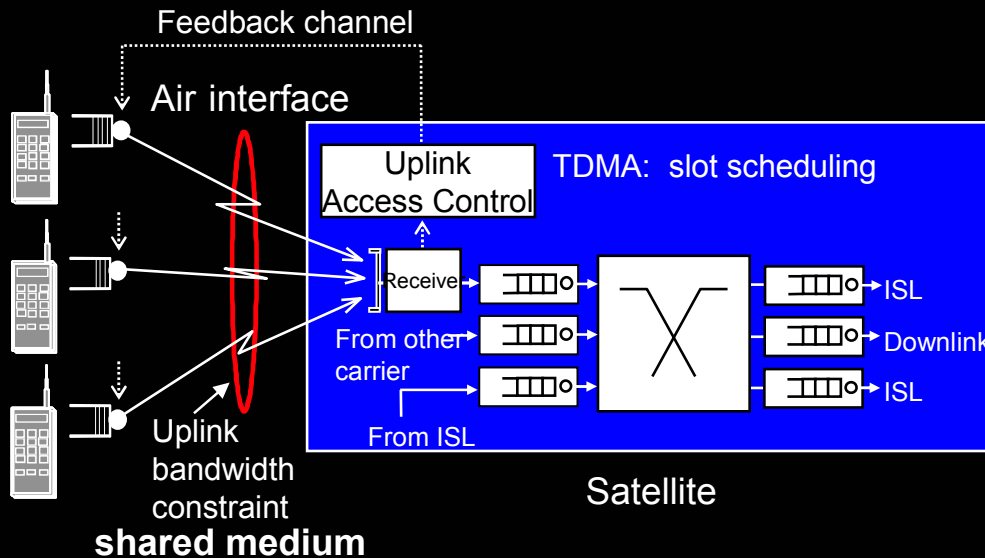
ATM in fixed and radio networks

Fixed Network



Only one terminal per ATM switch port

Radio (ATM-Sat) Network



Problems:

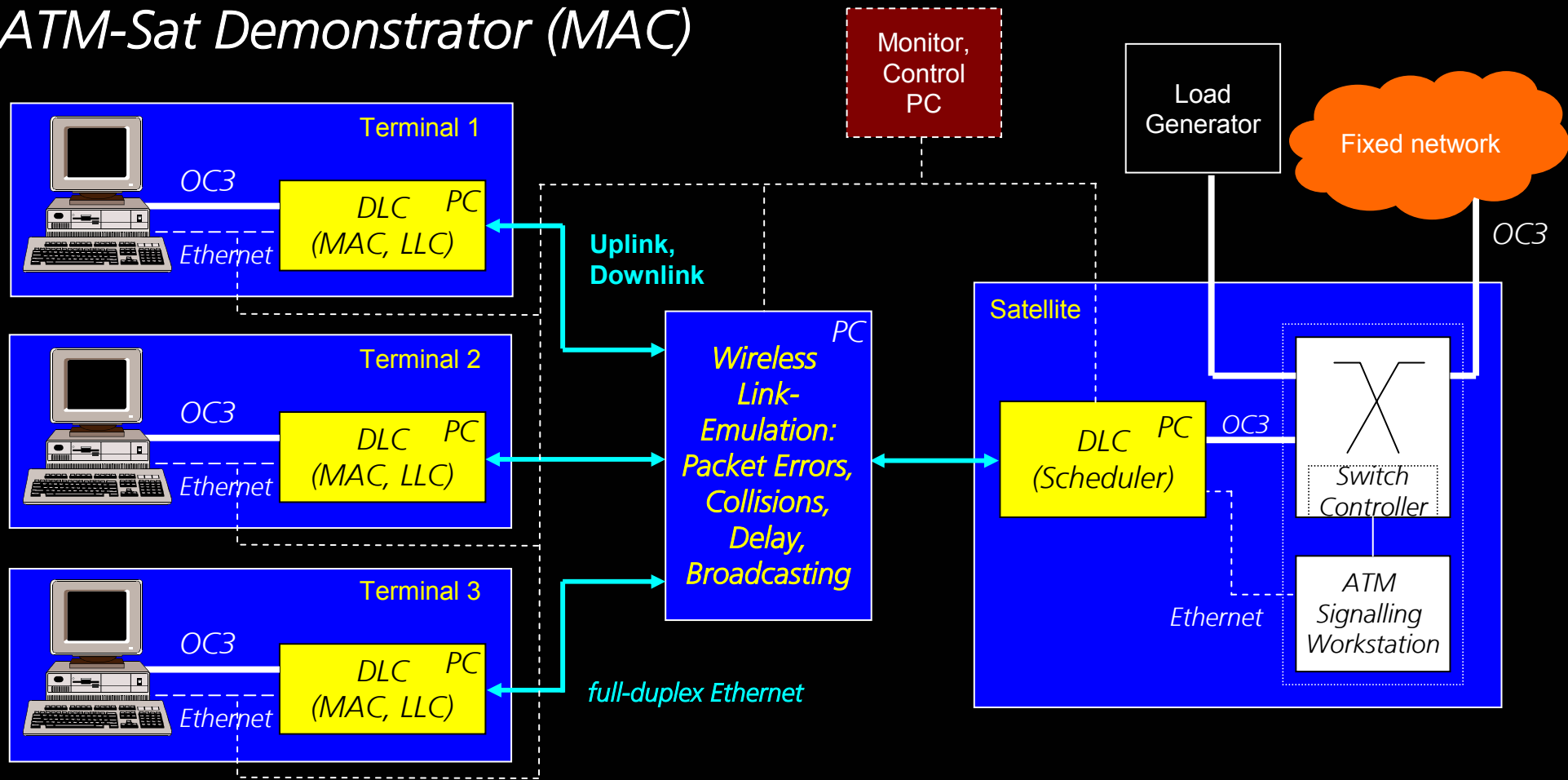
More than one terminal per ATM switch port !

TDMA: scheduling delay
hard limitation

CDMA: complexity, back-off power control



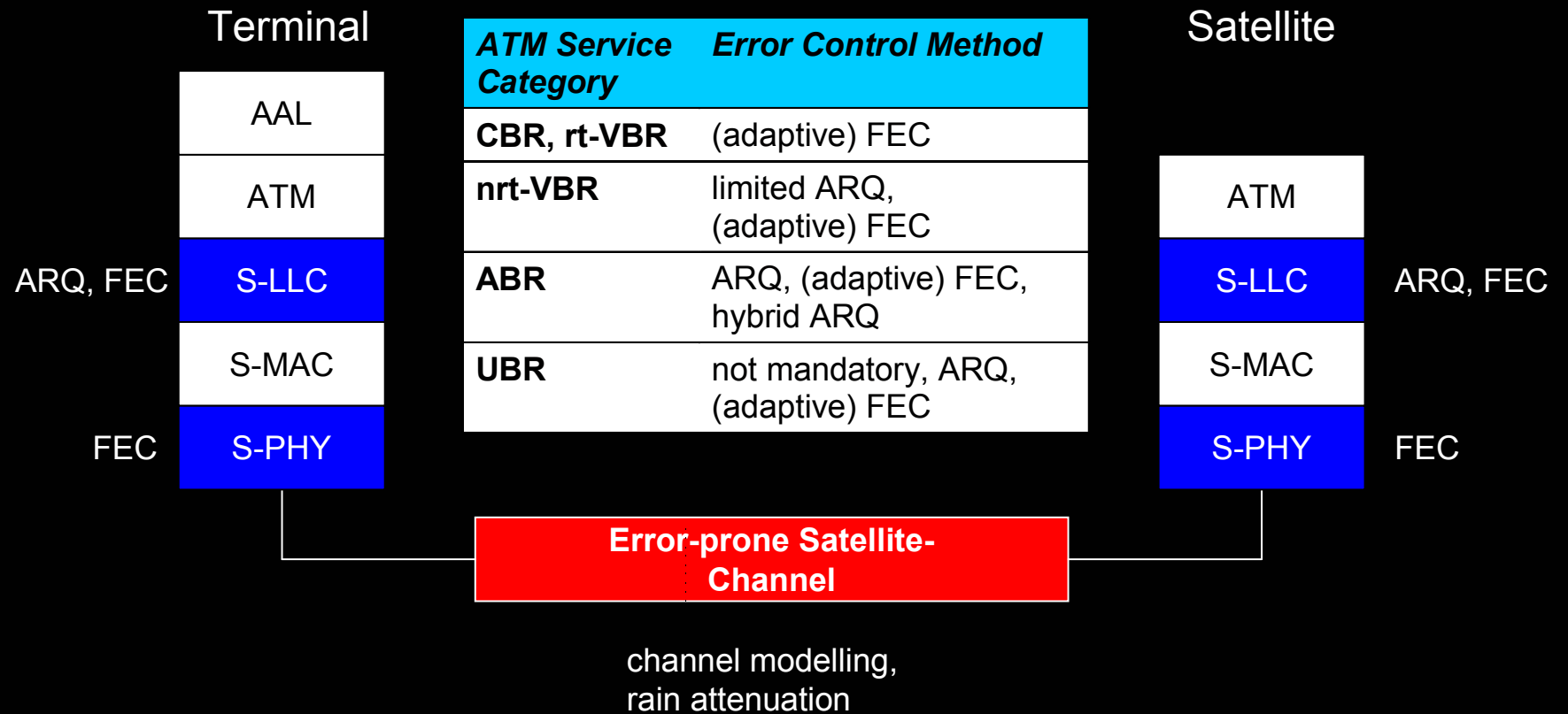
ATM-Sat Demonstrator (MAC)



Uplink bit rate: $\approx 2 \text{ Mbit/s}$
 Downlink bit rate: up to 32 Mbit/s

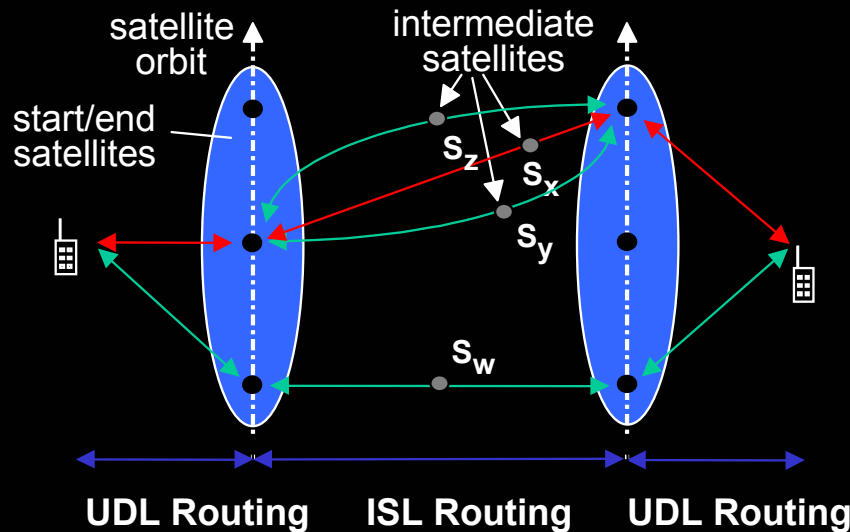


Error Control

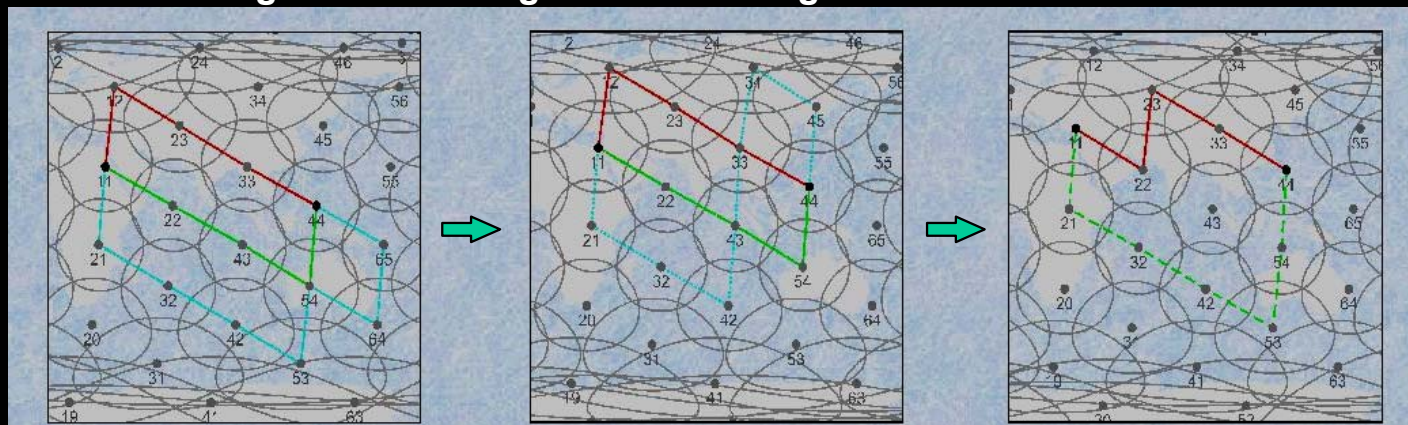




ATM-Based ISL Routing



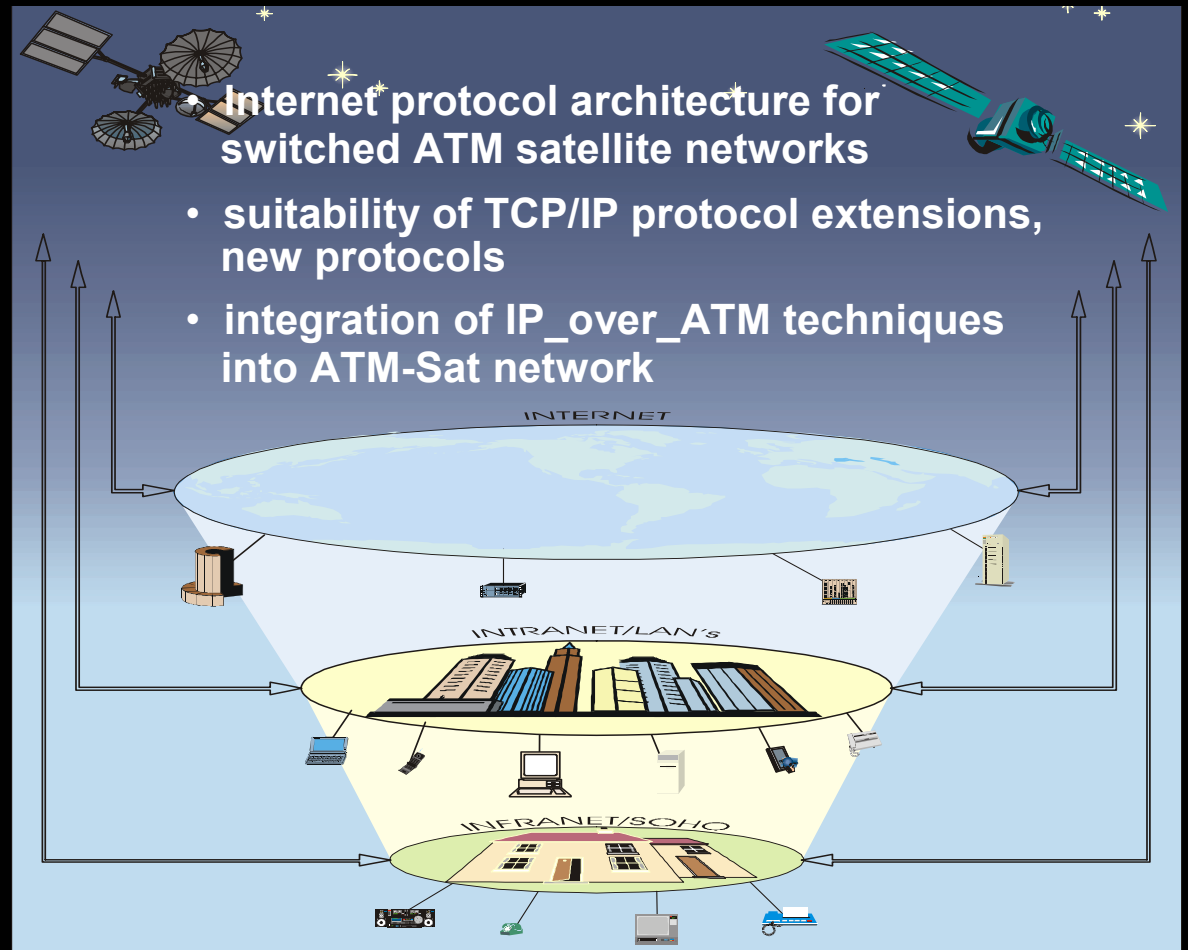
- ◆ multiservice routing scheme
- ◆ integration of UDL/ISL routing
- ◆ integration of routing with CAC
- ◆ combined routing/dimensioning problem





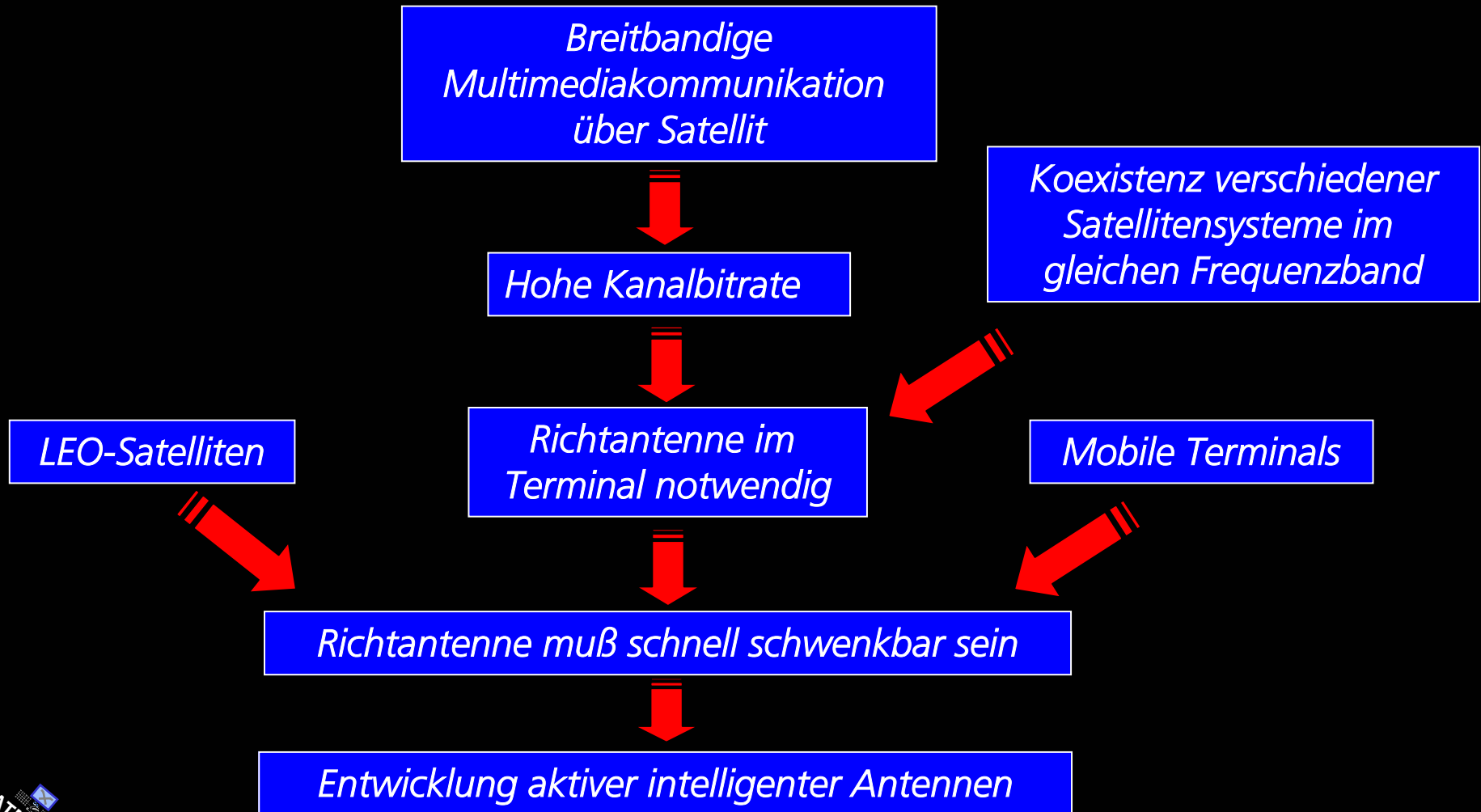
IP over Satellite-ATM

Global ATM-Satellite network
 with „satellite enhanced“
 TCP/IP (roundtrip delay,
 delay jitter, connection re-
 routing, error recovery,
 congestion control)





Warum aktive intelligente Antennen?





Ergebnisse

- ▶ Definition einer **Systemarchitektur** für die ATM-Übertragung über LEO-Satelliten
- ▶ Definition von **Protokollarchitektur, Fehlersicherung, Medium Access Control (MAC), Ressourcenmanagement, ISL Routing** und von Verfahren für **IP over Satellite-ATM** mit Simulationsergebnissen
- ▶ Realisierung eines **LLC/MAC-Demonstrators** für ATM über Satellit (Priority Scheduling, Radio Resource Management)
- ▶ **End-zu-End Demonstrationen** und **Performance-Messungen** am Demonstrator
- ▶ Analysen und Empfehlungen zu **aktiven intelligenten Terminal-Antennen**