A MAC Protocol for ATM over Satellite

Dr. H. Bischl, J. Bostic, Matteo Sabattini

DLR Oberpfaffenhofen

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- *Szenarium*
- *Problemstellung und Anforderungen an das MAC Protokoll*
- *Protokollarchitektur*
- *MAC und Scheduling für das ATM-Sat System*
- *SDL-Realisierung und Implementierung in den ATM-Sat Demonstrator*
- *Schlussfolgerungen*

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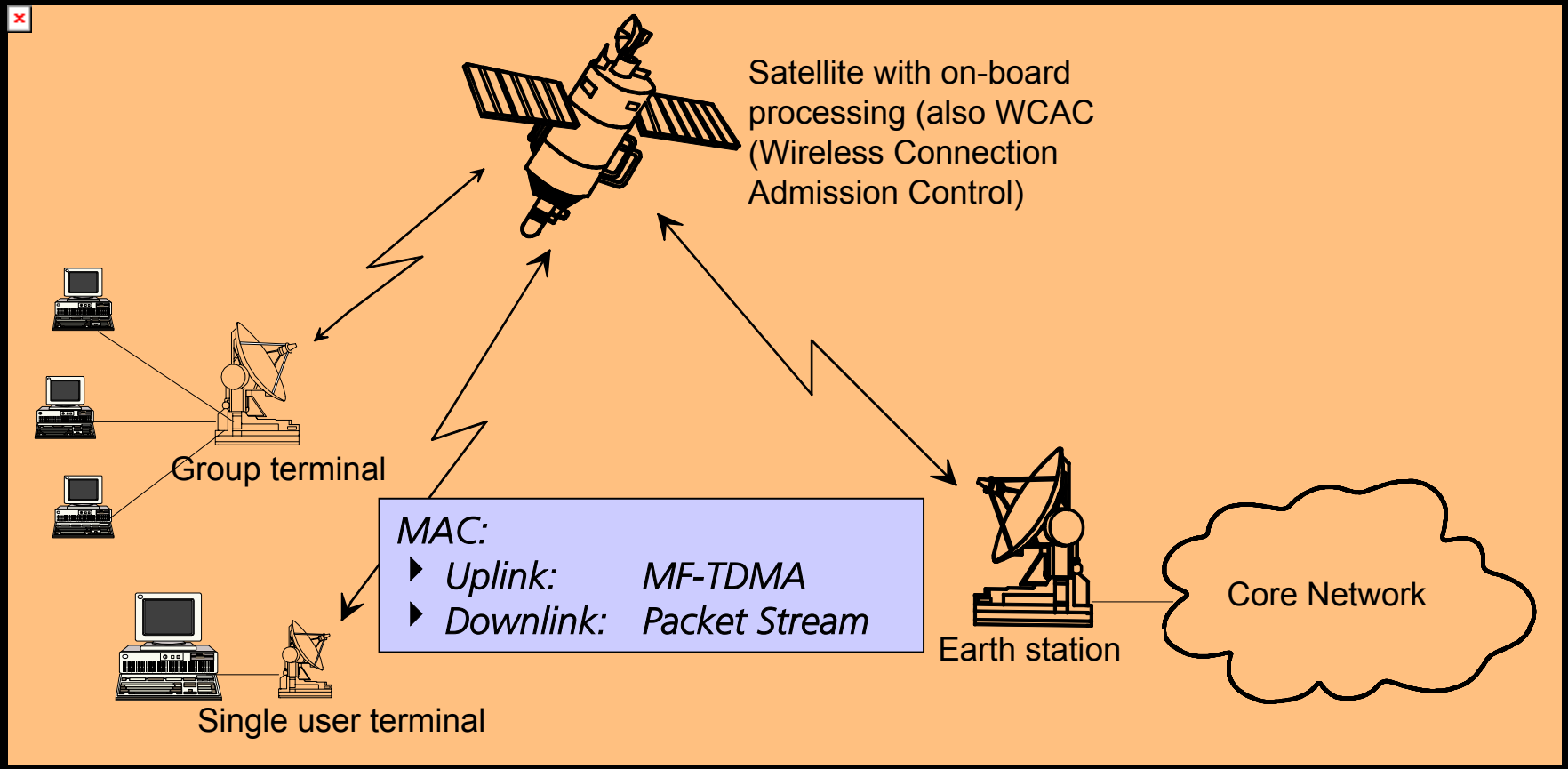
Scenario



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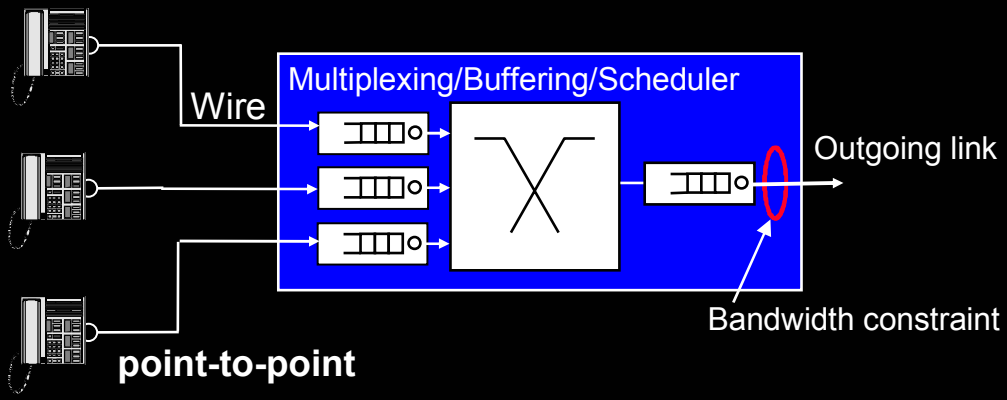
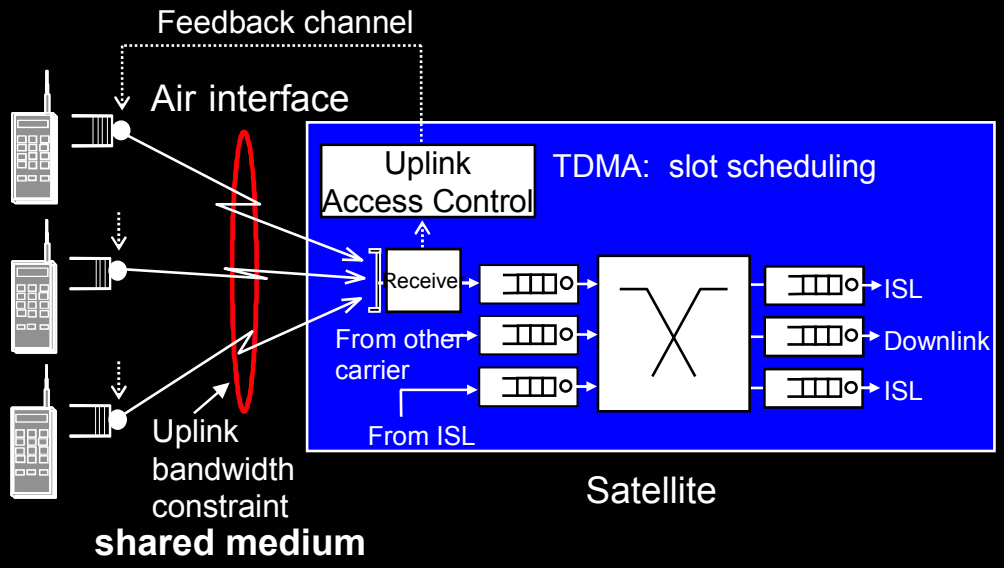
ATM in Fixed and Radio Networks

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

Anforderungen an das MAC-Protokoll

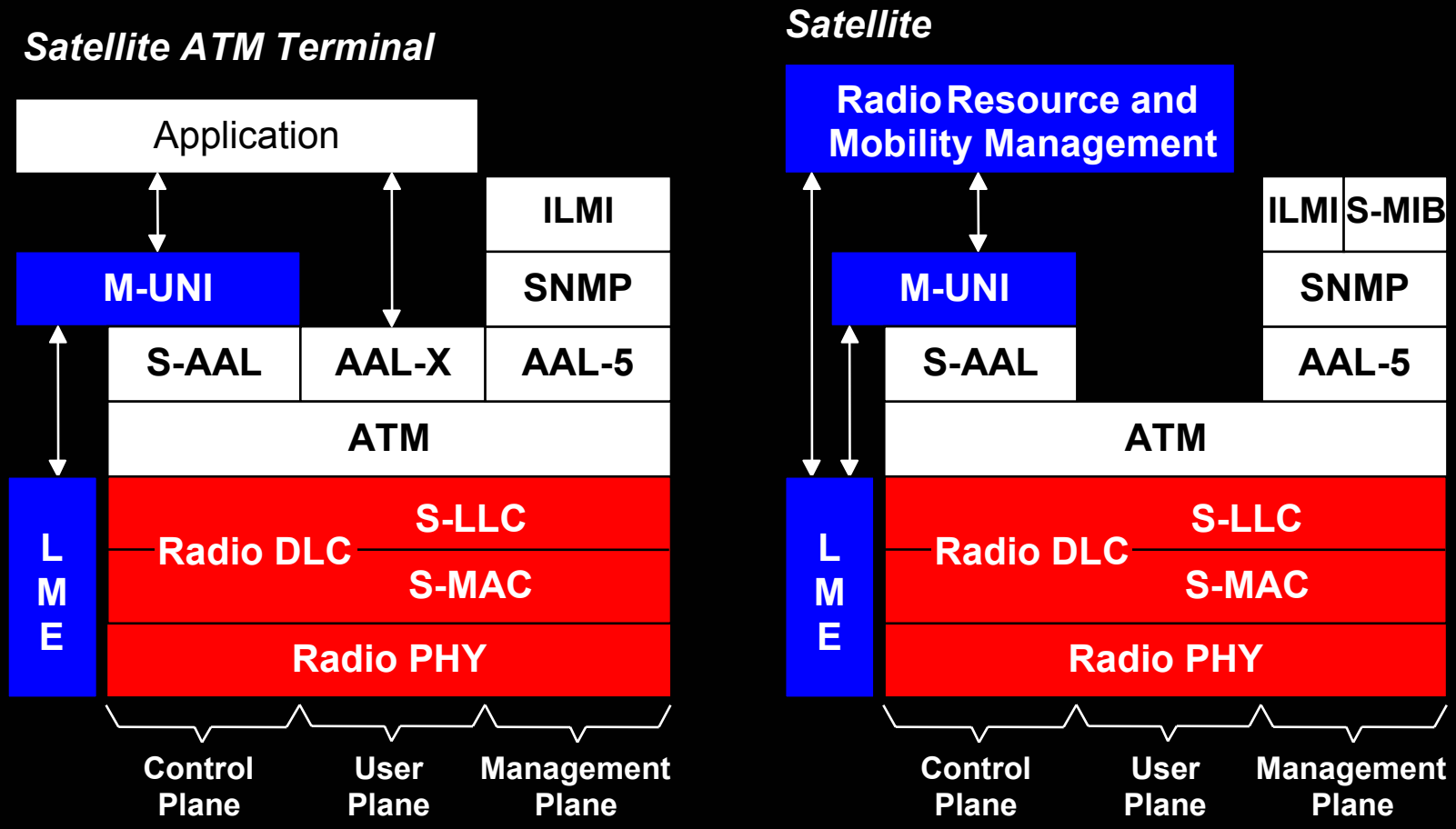
- *Effiziente Nutzung der verfügbaren Ressourcen im Uplink und im Downlink*
- *Unterstützung der ATM Dienstkategorien und Einhaltung der QoS-Garantien*
- *Unterstützung der ATM-Signalisierung*
- *Möglichst wenig Overhead durch Signalisierung*
- *Unterstützung auch einer größeren Anzahl an Terminals*
- *Unterstützung der Adressierung der logischen ATM-Switchports im Satelliten*

ATM Service Categories

ATM Service Category	Guarantees			Typical Application
	CLR	Delay Variance	Band-width	
CBR	X	X	PCR	Voice, Audio, Video, TV, ...
rt-VBR	X	X	SCR	VBR Video and Audio
nrt-VBR	X	NO	SCR	Data Transport, Frame Relay
ABR	X	NO	MCR	Data Transport, TCP/IP
UBR	NO	NO	NO	Data Transport, TCP/IP
UBR+	NO	NO	MCR	Data Transport, TCP/IP
GFR	NO	NO	MCR	Data Transport, TCP/IP

PCR: Peak Cell Rate
SCR: Sustained Cell Rate
MCR: Minimum Cell Rate

Protocol Architecture



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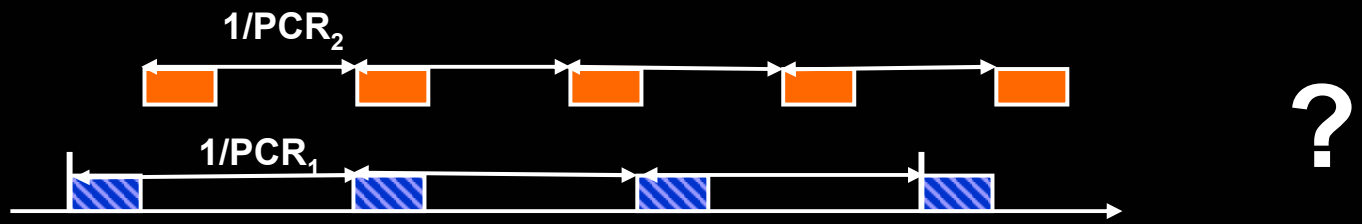
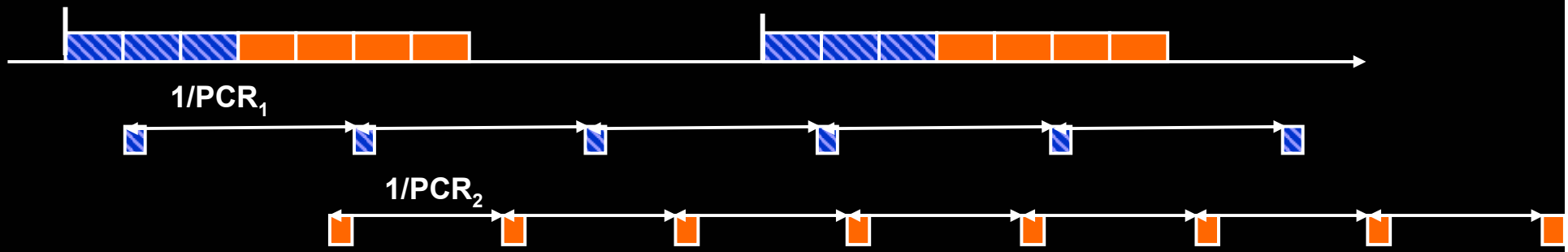
Uplink MAC for CBR Services

- *Fixed assignment of resources according to PCR (min. inter-cell interval = 1/PCR)*
- *Problem with TDMA: minimum inter-cell interval difficult to guarantee*

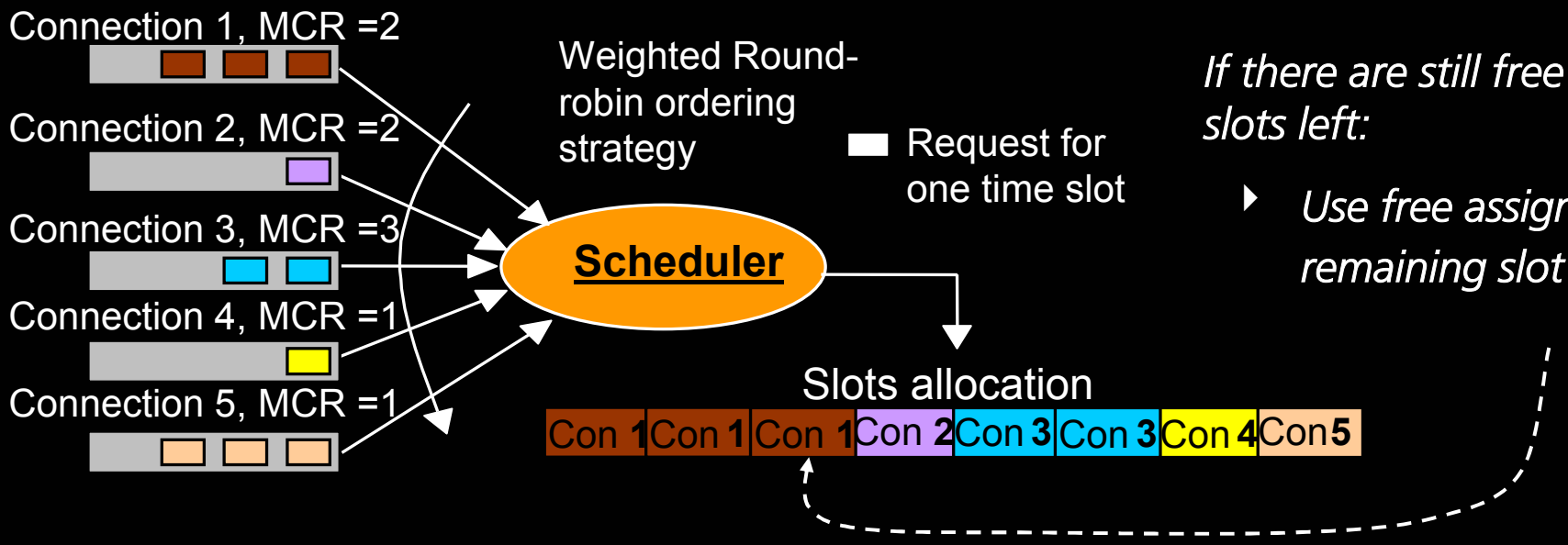


- *Solution: transmission of cells in bursts, traffic shaping to preserve inter-cell interval*



How to Guarantee MCR in the Uplink?

- *Necessary for UBR+, GFR, and ABR*
- *Algorithm similar to Weighted Round Robin (WRR)*
- *Weight is set according to the Minimum Cell Rate*

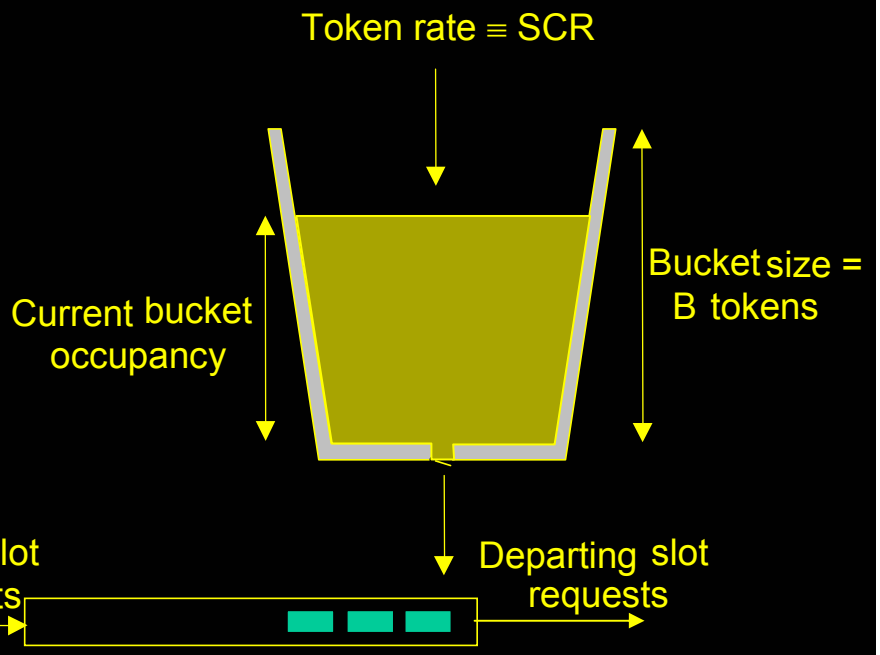


If there are still free time slots left:

- *Use free assignment for remaining slot requests*

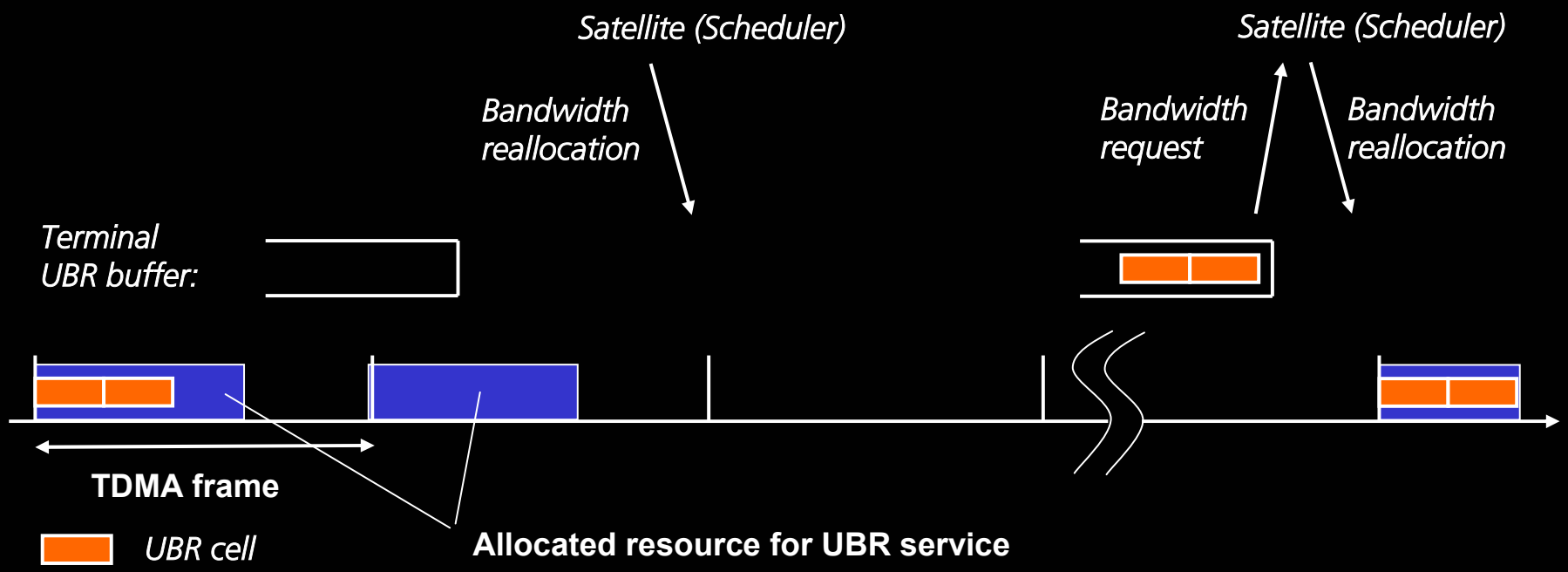
How to Guarantee SCR in the Uplink?

- *Necessary for VBR services*
- *Token bucket process is active for each flow in satellite (scheduler)*
- *The resources are allocated according to the tokens in bucket and resource requests*
- *The maximum number of allocated slots per frame is limited.*
- *In the case that there are not enough resources WRR can be used with the weights of SCR*



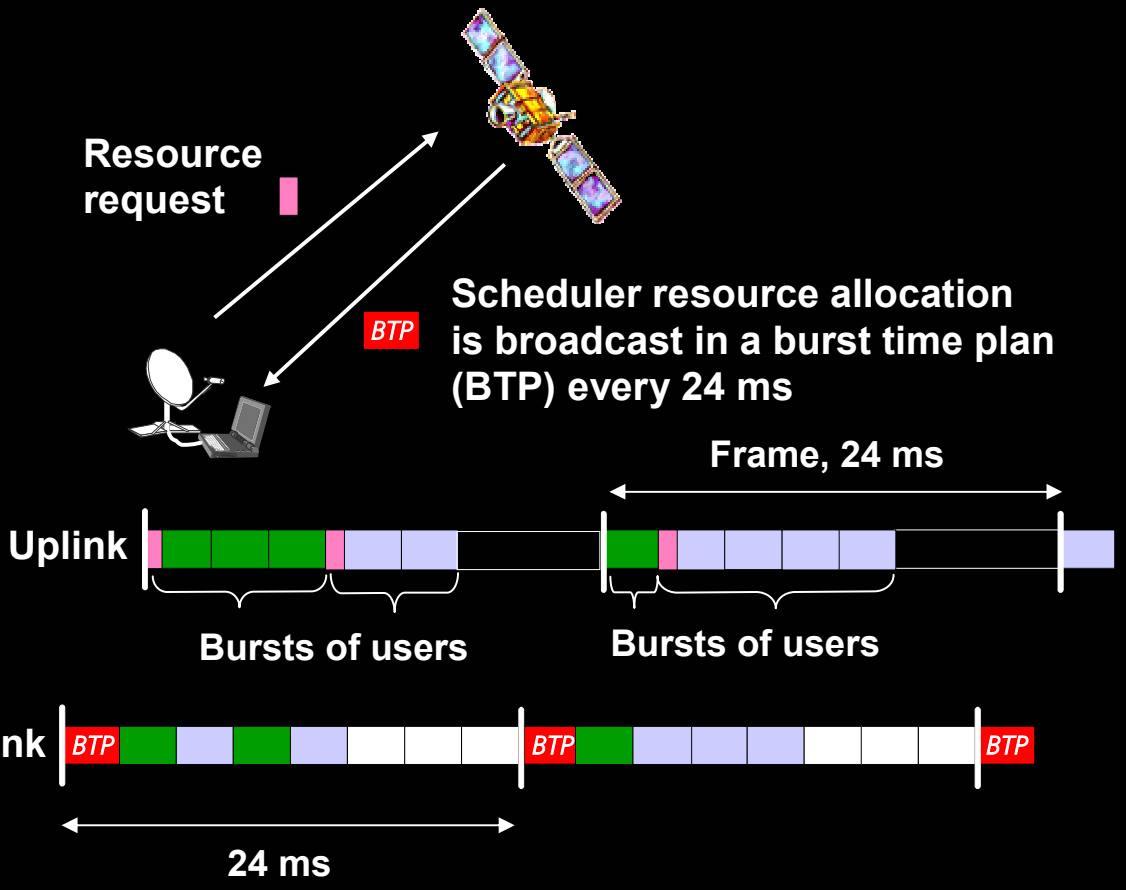
Uplink MAC for UBR Services

- No cell rate guaranteed (best effort)
- Dynamic allocation of resources (Bandwidth on Demand)

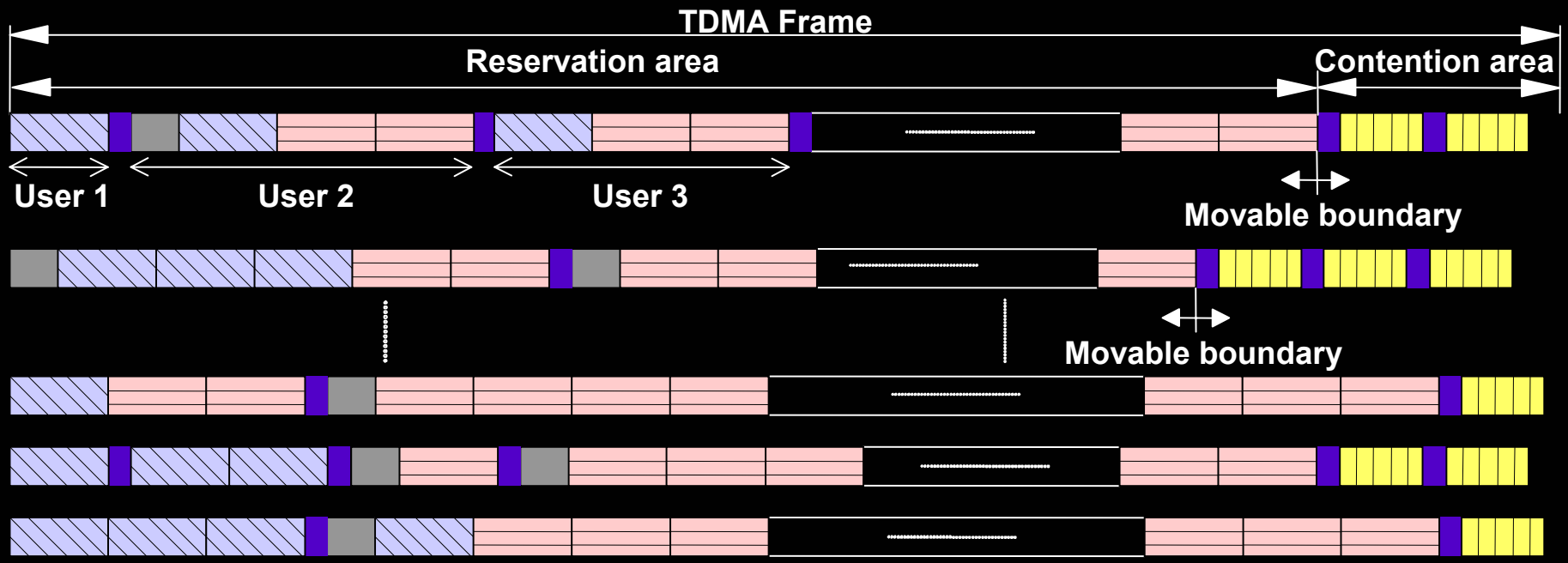


Concept of the Developed MAC-Protocol

- *Uplink*
  - *MF-TDMA with 24 ms frame duration (48 Byte ATM Payload ⇒ 16 kbit/s)*
  - *Terminals transmit ATM cells in bursts*
  - *Variable burst length*
- *Downlink*
  - *ATM-cells and MAC-signaling are broadcast in a continuous bitstream*



Uplink MAC Structure



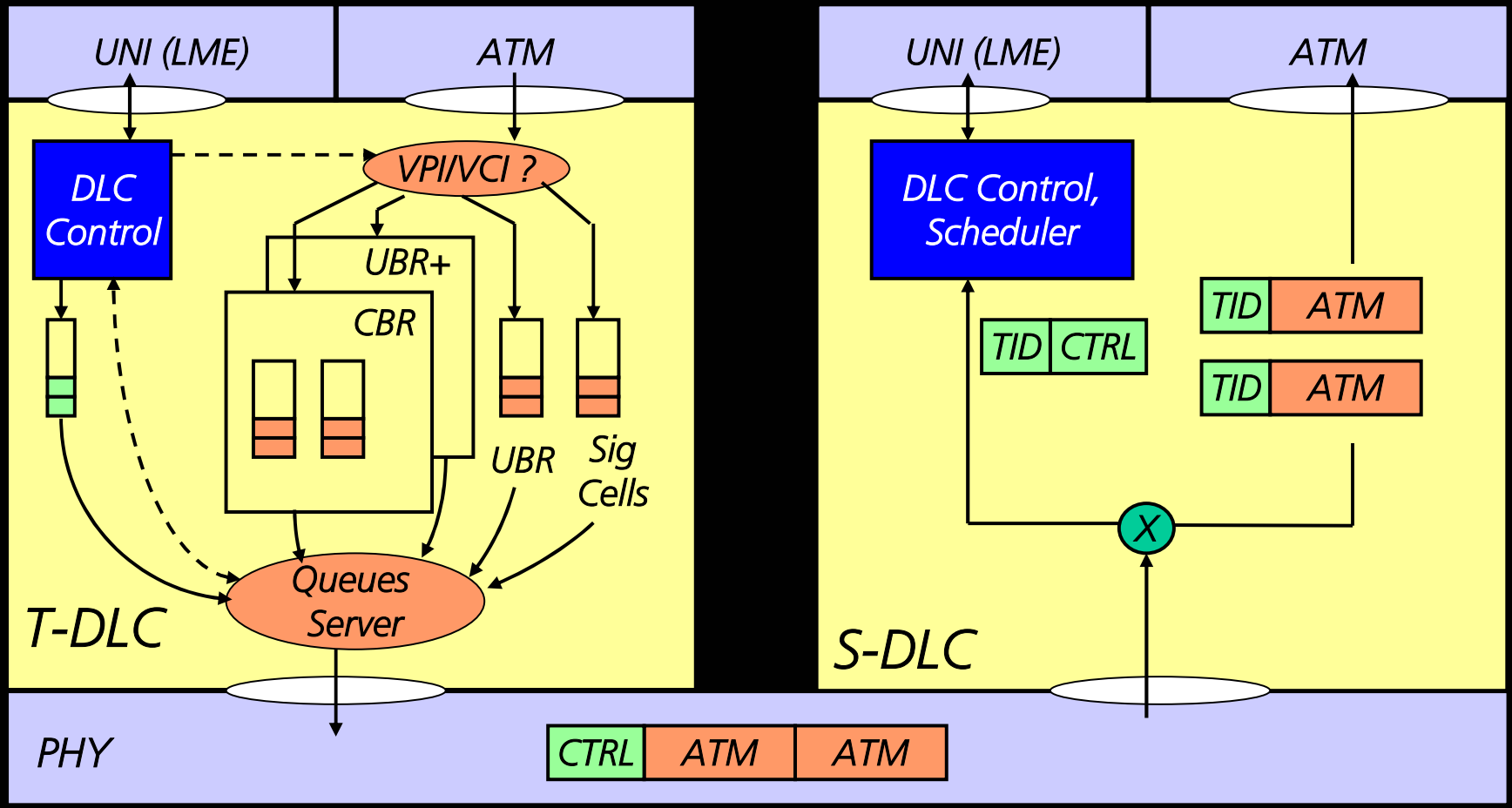
- CBR assigned slots
- BoD slots
- Mini-slot (control slot), used for DLC layer signalling
- Guard time
- Random access slots, for initial access and out-of-band signaling

Slot length = multiple of mini-slot, guard time

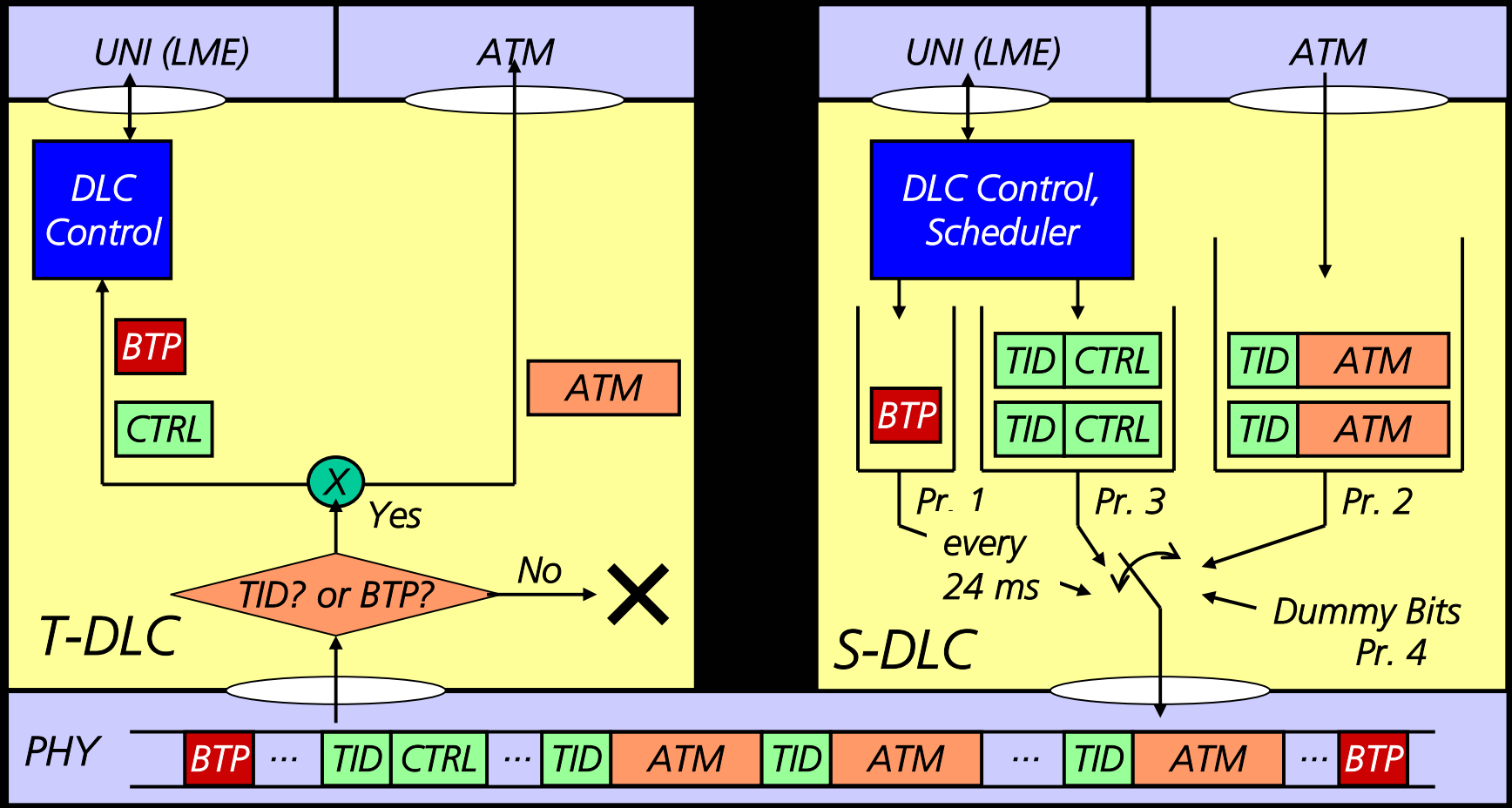
Features of the DLC Layer Protocol Implemented in the Demonstrator (Complete SDL-Specification)

- *TDMA Frame Synchronisation*
- *Authentisation and Registration*
- *Connection Setup and Release (incoming and outgoing calls)*
- *More than one ATM connection per terminal is possible*
- *Uplink data rates: up to 2 Mbit/s, downlink up to 30 Mbit/s (in steps of 16 kbit/s)*
- *Dynamic DLC channel allocation for transmission of ATM signaling cells*
- *Support of CBR, UBR and UBR+ service categories*
- *Addressing of logical ATM switch ports of the modified ATM switch in the satellite*

Model of DLC Layer Realized in the Demonstrator (Uplink)



Model of DLC Layer Realized in the Demonstrator (Downlink)



ATM-Sat Demonstrator (MAC)

Monitor, Control PC

Load Generator

Fixed network

OC3

Terminal 1

OC3

DLC PC (MAC, LLC)

Ethernet

Terminal 2

OC3

DLC PC (MAC, LLC)

Ethernet

Terminal 3

OC3

DLC PC (MAC, LLC)

Ethernet

Uplink, Downlink

full-duplex Ethernet

PC

Wireless Link-Emulation: Packet Errors, Collisions, Delay, Broadcasting

Satellite

DLC PC (Scheduler)

OC3

Switch Controller

ATM Signalling Workstation

Ethernet

Uplink bit rate: ≈ 2 Mbit/s

Downlink bit rate: up to 32 Mbit/s

Schlussfolgerungen

- *Das MAC Protokoll für das ATM-Sat System berücksichtigt die verschiedenen ATM Dienstkategorien*
- *Der zentrale Scheduling-Algorithmus im Satelliten garantiert QoS*
- *Das MAC Protokoll nutzt effizient die zur Verfügung stehende Bandbreite durch die dynamische Allokierung der Ressourcen (Bandwidth on Demand)*
- *Das MAC-Protokoll wurde in SDL spezifiziert und in einem Demonstrator implementiert*