

# ATM-Based OBP Payload for the MEDIS Satellite System

## Presentation Topics

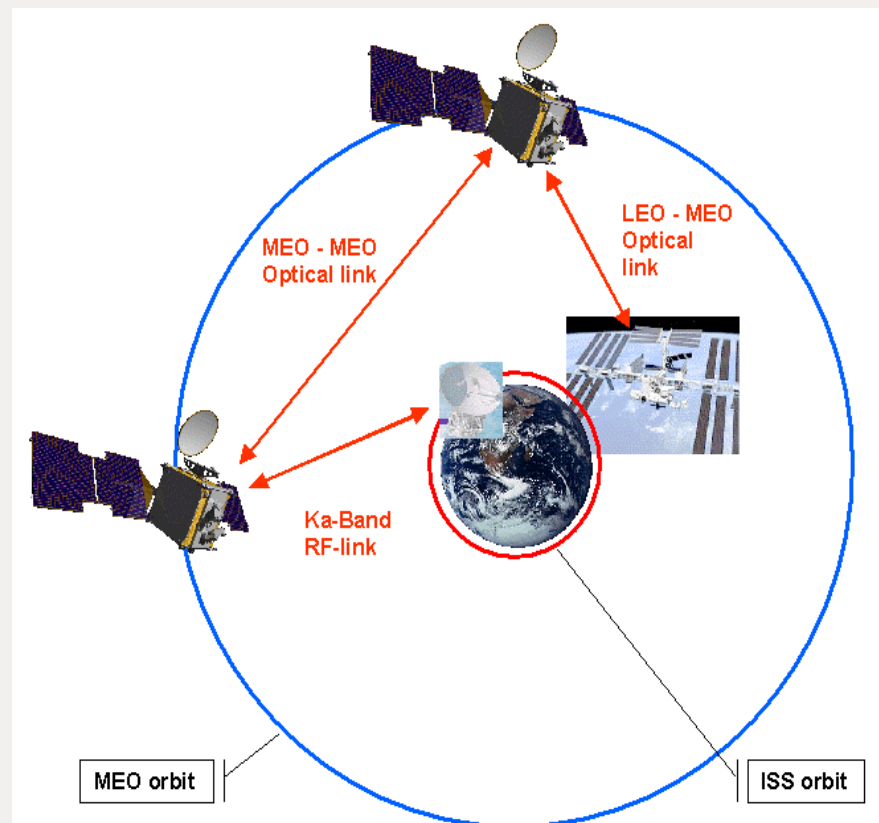
- MEDIS Satellite System
- MEDIS Payload
- OBP Assembly
- OBP Switch
- OBP Controller
- Summary

# MEDIS System Requirements (Operational Phase)

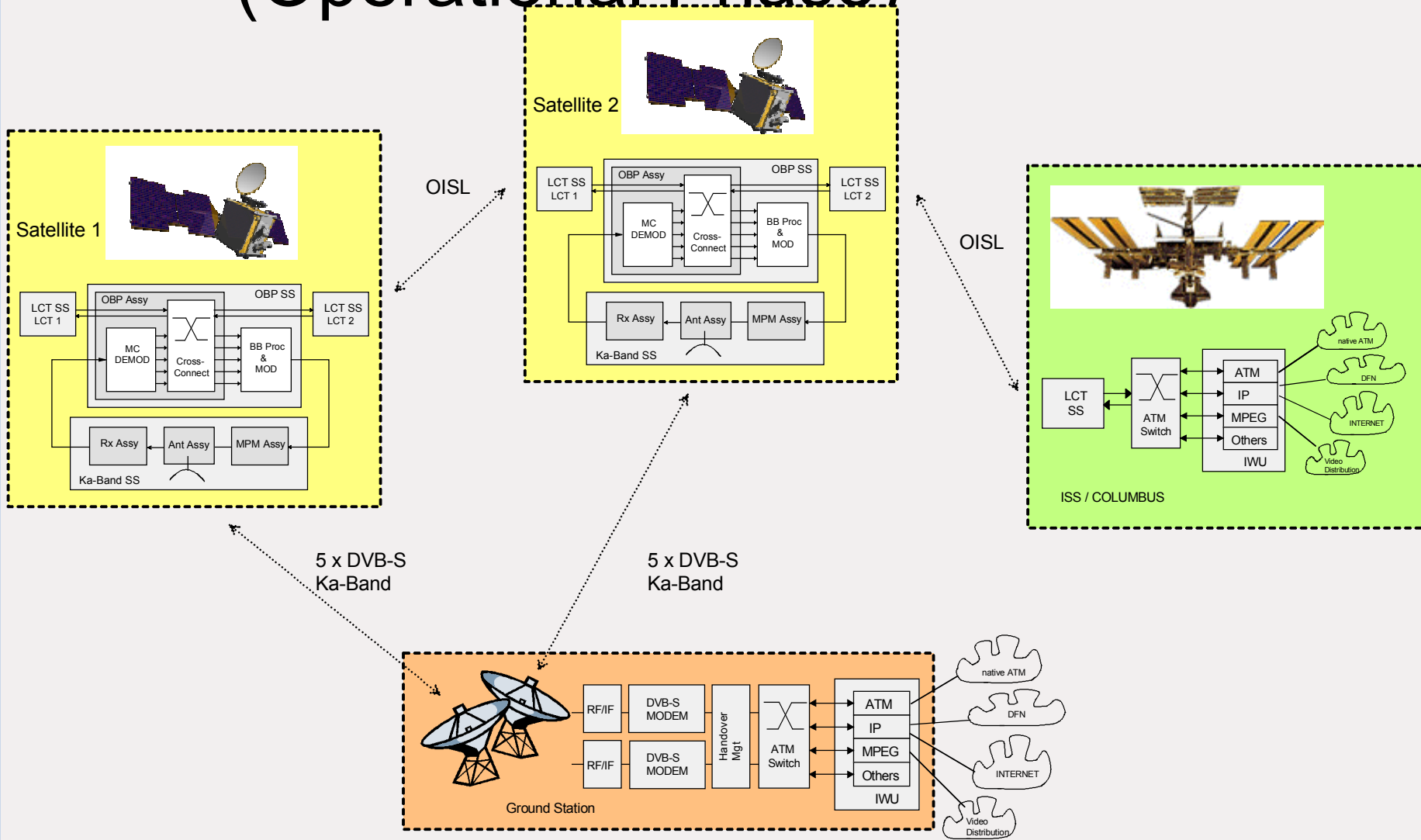
- ISS in LEO, 2 satellites in MEO (20000 km distance)
- OISL between satellites and between ISS and one satellite
- Full duplex broadband link (155 Mbps STM1 equivalent)
  - ↓ direct ISS to ground link via direct ISS-MEO-SGT
  - ↓ indirect ISS to ground link via ISS-MEO-MEO-SGT
  - ↓ seamless Ka-band link handover
  - ↓ ground to ground link
- Ka-band link operation for elevation angle min.  $10^\circ$
- BER on the various links max.  $10^{-9}$
- Availability of Ka-band links 99,7 % p.y. (during visibility)

# MEDIS Baseline System Configuration

<b>ISS altitude</b>	<b>372 km</b>
<b>Period</b>	<b>91.9 min</b>
<b>MEO altitude</b>	<b>10354 km</b>
<b>Period</b>	<b>359 min</b>
<b>MEO &amp; ISS inclination</b>	<b>51.6°</b>
<b>Relative orbit drift</b>	<b>4.5°/day</b>
<b>Ground Station Weilheim, Germany</b>	
<b>Contact time h/day</b>	<b>2.2 - 5.2</b>
<b>Mean contact time</b>	<b>3.2 h/day</b>
<b>MEO-GS off-axis angle</b>	<b>22.1° max.</b>
<b>MEO-ISS off-axis angle</b>	<b>23.8° max.</b>
<b>ISS-MEO off-axis angle</b>	<b>107° max.</b>



# System Functionality (Operational Phase)



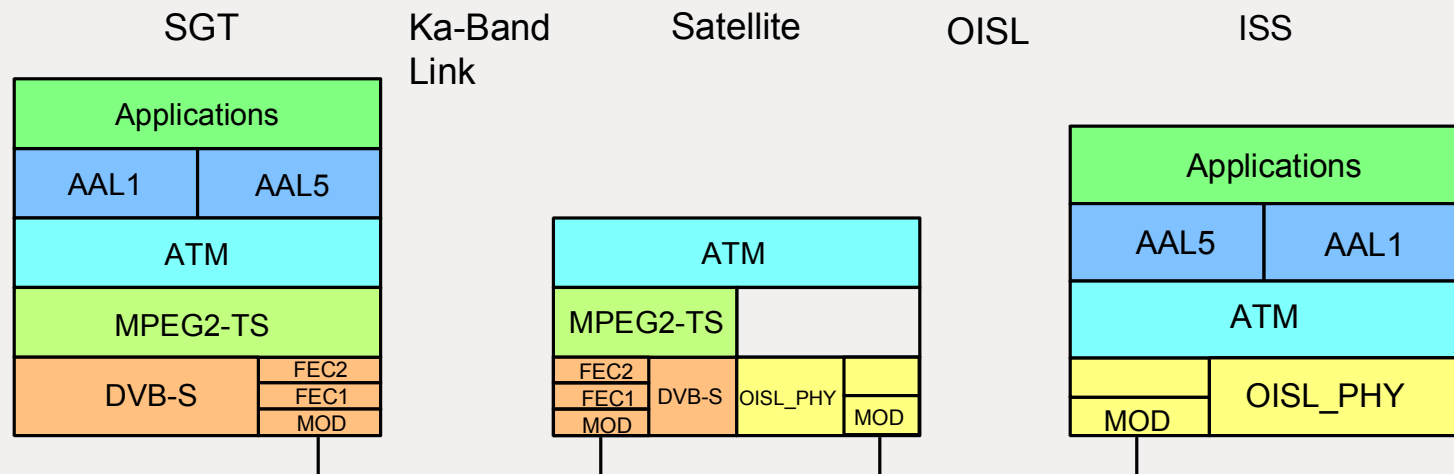
## Protocol Architecture

### Ka-Band Link

- ATM cell routing/switching
- ATM cell rate adaptation
- MPEG-TS framing
- asynchronous ATM cell mapping into MPEG-TS
- DVB-S Standard at physical layer: scrambling, coding, modulation (available technology)

### Optical Inter-Satellite Link

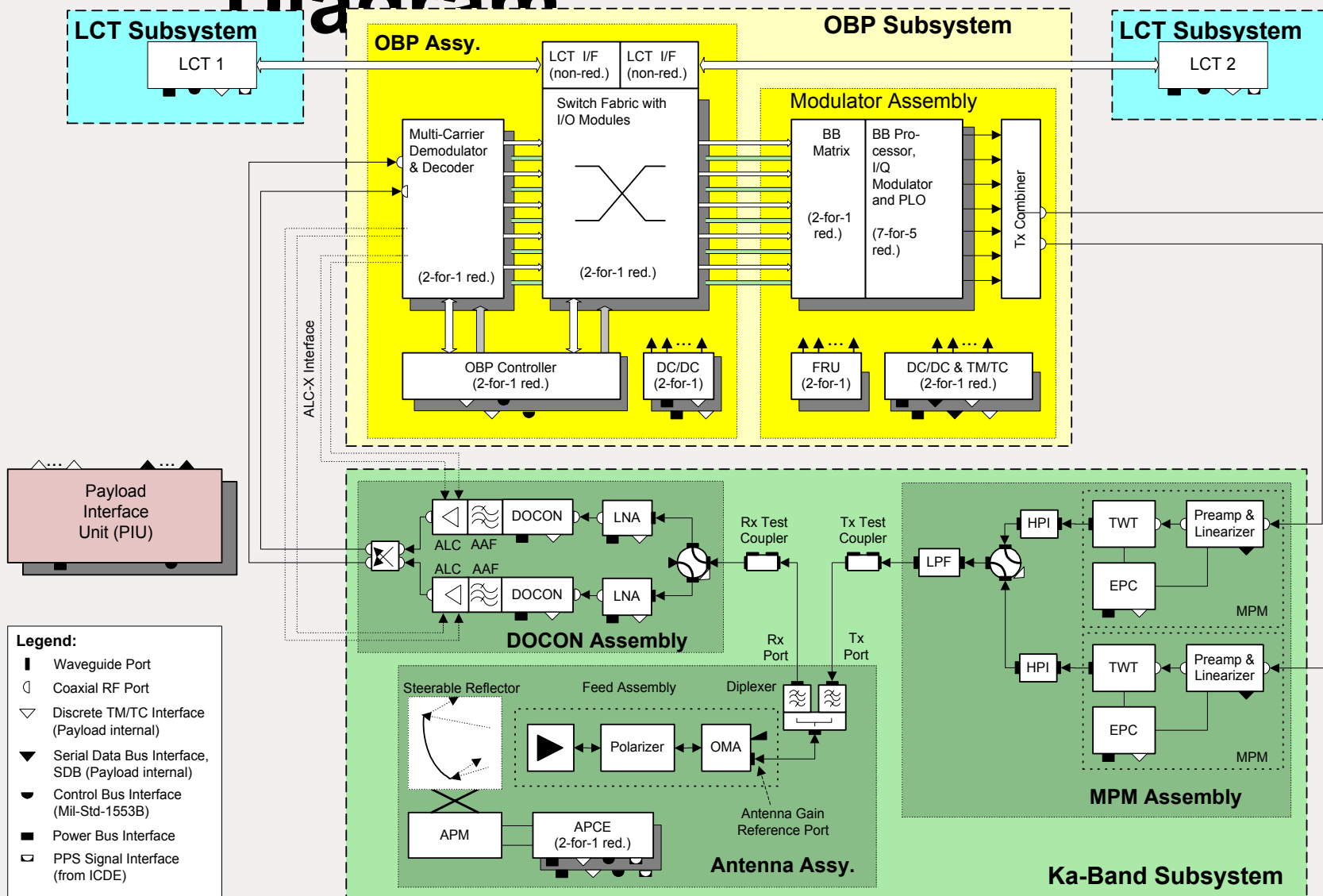
- ATM cell routing/switching
- ATM cell rate adaptation
- ATM cell mapping to a continuous data stream
- Scrambling, no FEC



# ATM-Sat Workshop 2002, June 19, Berlin

# MEDIS Payload Block

## Diagram



## Redundancy

- Basically all active devices redundant (shadowed in block diagram)
- Ka-Band: LNA / Downconverter chains (2-for-1)  
MPM chains (2-for-1)  
APCE (2-for-1, internal)
- OBP: OBP Assembly:
  - ↓ All functional units (2-for-1, internal),  
except LCT interface modules.
  - Modulator Assembly:
    - ↓ All functional units (internal 2-for-1 redundancy,  
or 7-for-5, respectively,)
- LCT: Limited internal redundancy  
(Laser pump module, 2-for-1)
- PIU: Internal redundancy (2-for-1)

# Payload Mass Budget

Last update: 23.01.02		Mass per Unit			Mass	
Equipment	Quantity	Redundancy	Nominal [g]	Uncert'y (+/-) [g]	Nominal [g]	Uncert'y (+/-) [g]
<b>Ka-Band Subsystem</b>					<b>18.385</b>	<b>3.115</b>
<b>Antenna S/S</b>					<b>10.210</b>	<b>2.670</b>
Reflector	1	no	1.750	250	1.750	250
Feed System	1	no	650	100	650	100
Feed Brackets	1 set		600	200	600	200
Diplexer	1	no	200	50	200	50
Diplexer Transitions	1 set		230	50	230	50
APM	1	no	4.500	1.500	4.500	1.500
APCE	1	2:1	2.200	500	2.200	500
W/G Interconnections	1		80	20	80	20
<b>DOCON Assembly</b>					<b>2.765</b>	<b>233</b>
RF Switch	1	no	165	10	165	10
LNA	1	2:1	180	20	180	20
Docon	2	2:1	670	35	1.340	70
Antialiasing Filter	2	2:1			-	
ALC Amplifier	2	2:1	400	50	800	100
Output Filter	2	2:1	100	10	200	20
Coupler	1	no	50	5	50	5
RF Cables	2		15	4	30	8
<b>MPM Assembly</b>					<b>5.410</b>	<b>212</b>
MPM-EPC+Lin./Preamp.	2	2:1	1.550	50	3.100	100
MPM-TWT	2	2:1	850	20	1.700	40
HPI	2	2:2	120	20	240	40
RF Switch	1	no	170	10	170	10
Low-Pass Filter	1	no	120	10	120	10
W/G Interconnections	4		20	3	80	12
<b>OBP Subsystem</b>					<b>24.300</b>	<b>1.200</b>
<b>OBP Assembly</b>					<b>20.000</b>	<b>1.000</b>
<b>Modulator Assemb.</b>					<b>4.300</b>	<b>200</b>
<b>LCT Subsystem</b>					<b>48.000</b>	<b>2.400</b>
<b>LCT 1</b>					<b>24.000</b>	<b>1.200</b>
<b>LCT 2</b>					<b>24.000</b>	<b>1.200</b>
<b>P/L Interface Unit (PIU)</b>					<b>4.000</b>	<b>400</b>
<b>Harness RF/DC/TTC</b>					<b>6.250</b>	<b>650</b>
<b>Total Payload</b>					<b>100.935</b>	<b>7.765</b>
<b>Total payload maximum mass [g]:</b>					<b>108.700</b>	



## Payload DC Power

MODE (Status)	1	2	3	4	5	6
Ka-Band, OBP & PIU Status	a	r	a	r	r	a
LCT1 Status	a	a	a	a	r	r
LCT2 Status	a	a	r	r	r	r

a = active

r = ready mode

Operation at 4 dB OBO from 27.5 W saturated RF output power

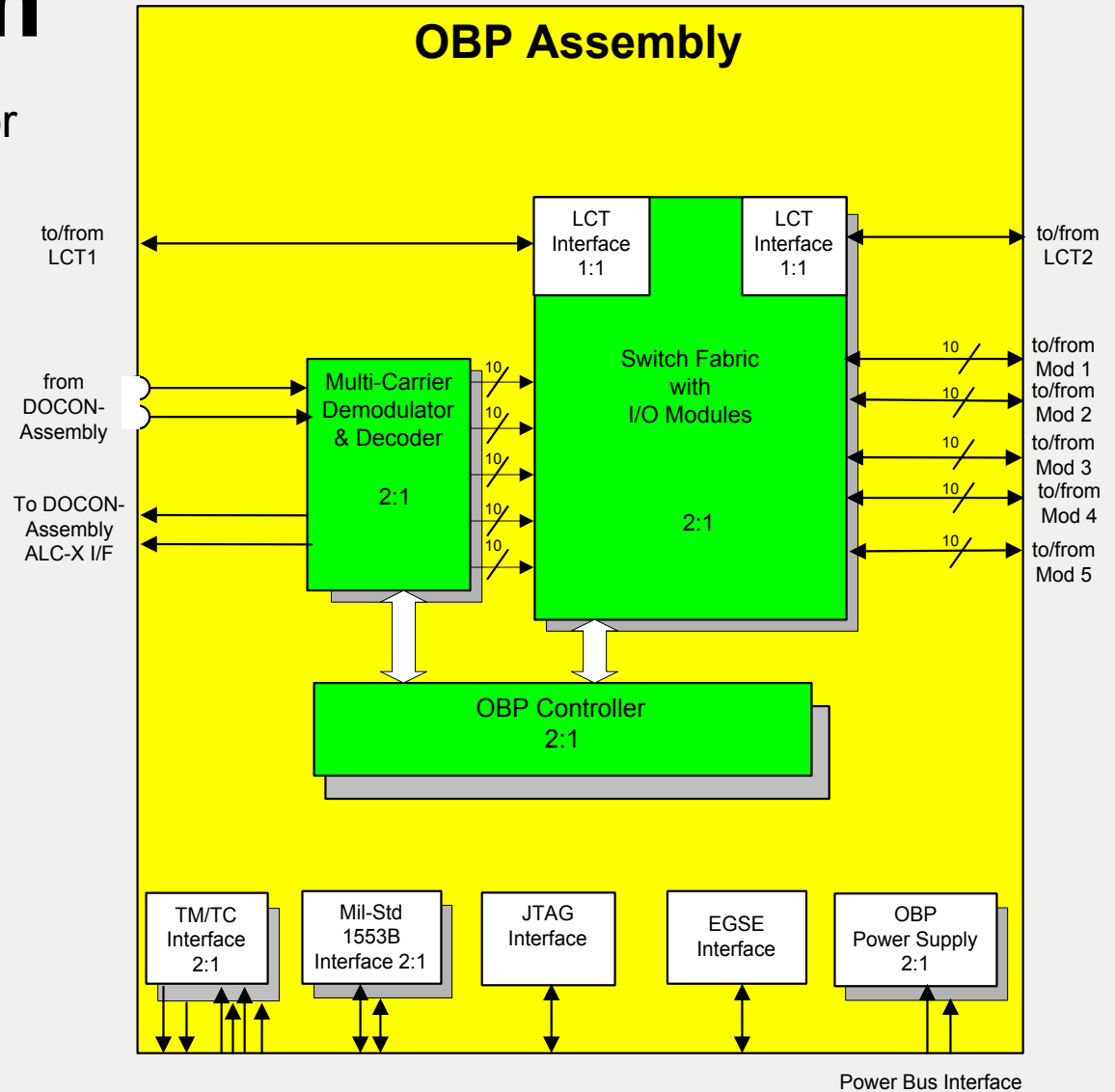
MODE (POWER)	1	2	3	4	5	6
Ka-Band Power [W]	77,1	2,0	77,1	2,0	2,0	77,1
OBP Power [W]	154,0	70,0	154,0	70,0	70,0	154,0
LCT1-S/S Power [W]	125,0	125,0	125,0	125,0	60,0	60,0
LCT2-S/S Power [W]	125,0	125,0	60,0	60,0	60,0	60,0
PIU Power [W]	10,0	10,0	10,0	10,0	10,0	10,0
<b>Total Power [W]</b>	<b>491,1</b>	<b>332,0</b>	<b>426,1</b>	<b>267,0</b>	<b>202,0</b>	<b>361,1</b>

MODE (Dissipation)	1	2	3	4	5	6
Ka-Band Dissipation [W]	68,0	2,0	68,0	2,0	2,0	68,0
OBP Dissipation [W]	154,0	70,0	154,0	70,0	70,0	154,0
LCT1-S/S Dissipation [W]	125,0	125,0	125,0	125,0	60,0	60,0
LCT2-S/S Dissipation [W]	125,0	125,0	60,0	60,0	60,0	60,0
PIU Dissipation [W]	10,0	10,0	10,0	10,0	10,0	10,0
<b>Total Dissipation [W]</b>	<b>482,0</b>	<b>332,0</b>	<b>417,0</b>	<b>267,0</b>	<b>202,0</b>	<b>352,0</b>

# OBP Assembly Block

## Diagram

- Subassemblies:
  - ↓ Multi-Carrier Demodulator and Decoder
  - ↓ OBP Switch
  - ↓ OBP Controller
- The subassemblies are mechanically integrated in one housing.



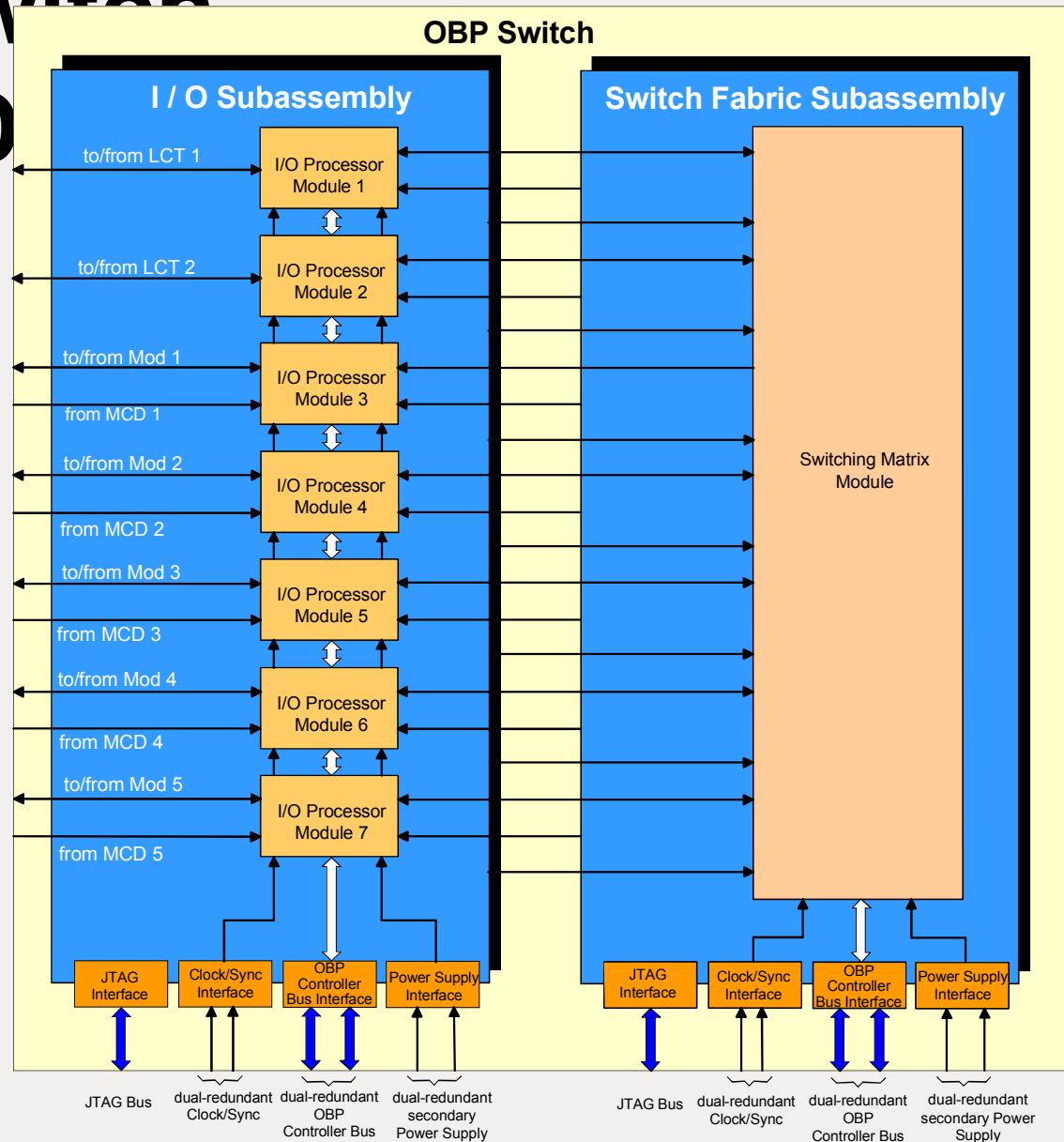
# OBP Assembly Performance

- OBP Aggregate Throughput: > 700 Mbps
- Max. Number of Receive Carriers: 5
- Min. Receive Data Rate per Carrier: 1 Mbps
- Max. Receive Data Rate per Carrier: 34.8 Mbps
- Max. Aggregate Receive Data Rate: > 174 Mbps
- Max. Number of Transmit Carriers: 5
- Min. Transmit Data Rate per Carrier: 1 Mbps
- Max. Transmit Data Rate per Carrier: 52.4 Mbps
- Max. Aggregate Transmit Data Rate: > 262 Mbps
- Max. LCT Data Rate Transmit/Receive: 155 Mbps

# OBP Switch

## Block Diagram

- Packet Switching/Routing of fixed-length ATM cells
- provides all required functionality of the Transmission Convergence Sublayer and the ATM Layer
- Unicast and Multicast Routing
- two levels of traffic priority
  - ↓ Constant Bit Rate (CBR)
  - ↓ Unspecified Bit Rate (UBR)
- flexible, modular and scalable Hardware Design
- fault tolerance provided by subassembly redundancy (2 for 1)



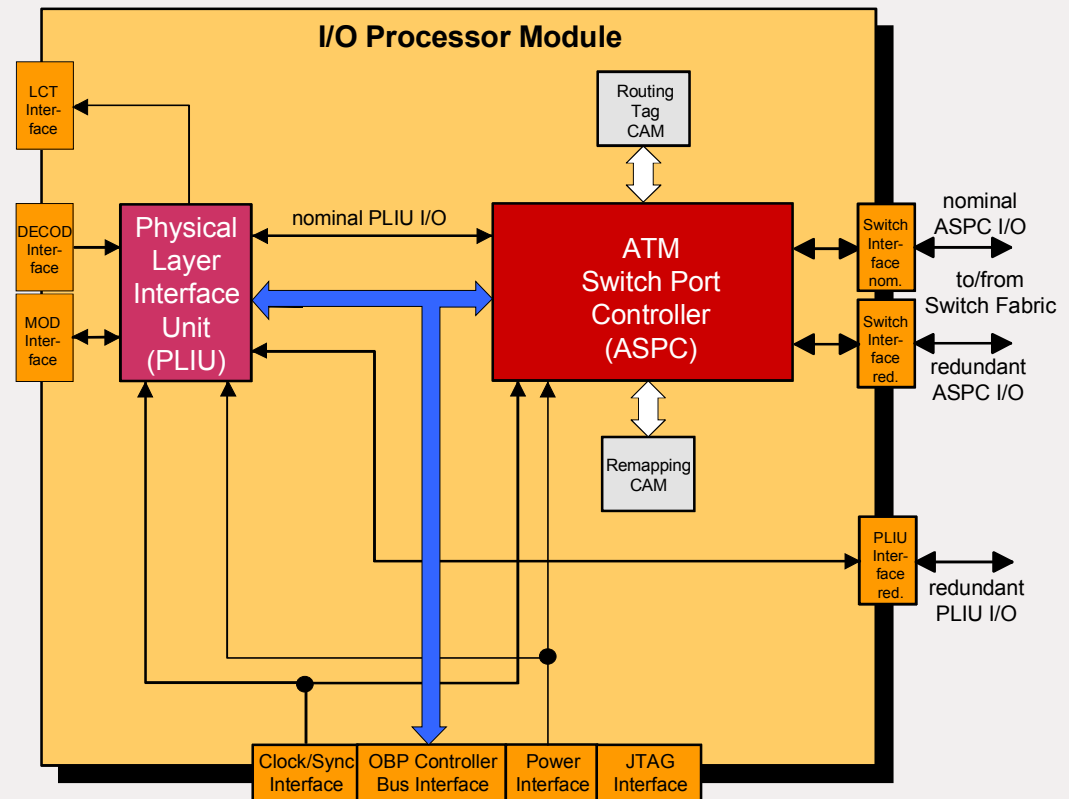
# I/O Processor Module

## Physical Layer Interface Unit

- Cell delineation
  - HEC generation/verification <sup>1)</sup>
  - Cell rate decoupling <sup>1)</sup>
  - Timestamp generation and insertion capability <sup>1)</sup>
- <sup>1)</sup> modes of operations can be enabled/disabled by telecommand

## ATM Switch Port Controller

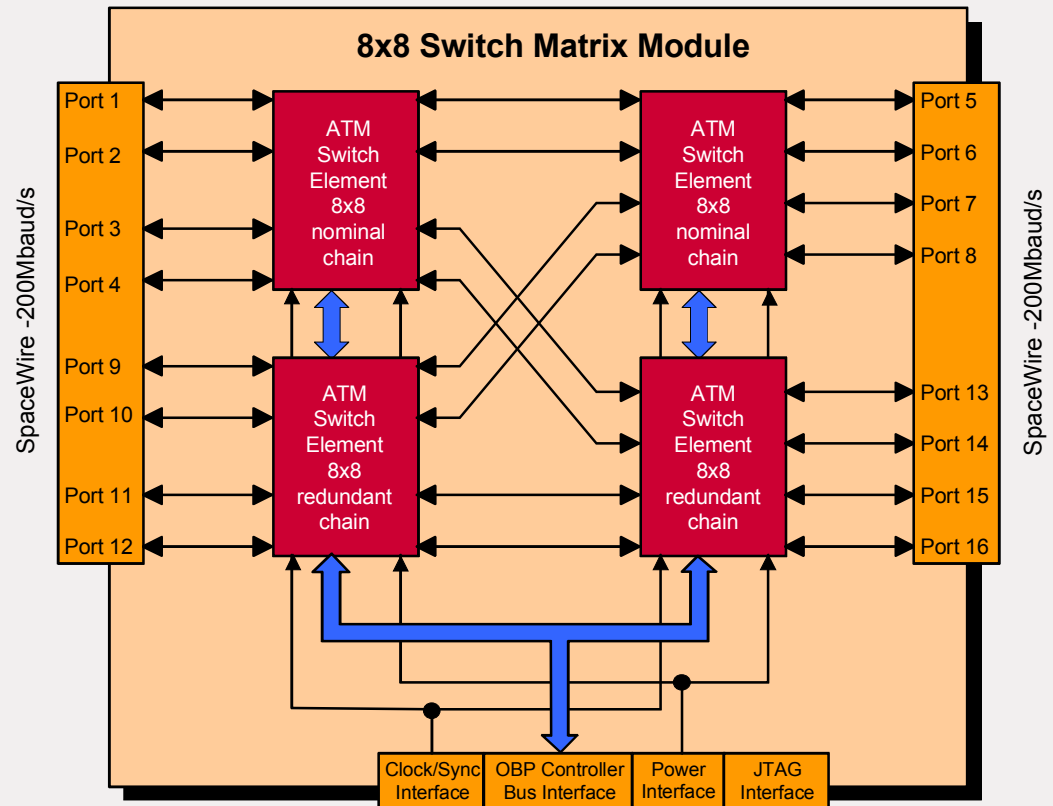
- Configurable routing modes:
  - ↓ VP cross-connect (VPI translation & remapping only)
  - ↓ VP/VC cross-connect (VPI and VCI translation & remapping)
- Dual-redundant high-speed links to the switch fabric (SpaceWire 200 Mbaud/s)
- Cell extraction and insertion capability via the OBP Controller Interface



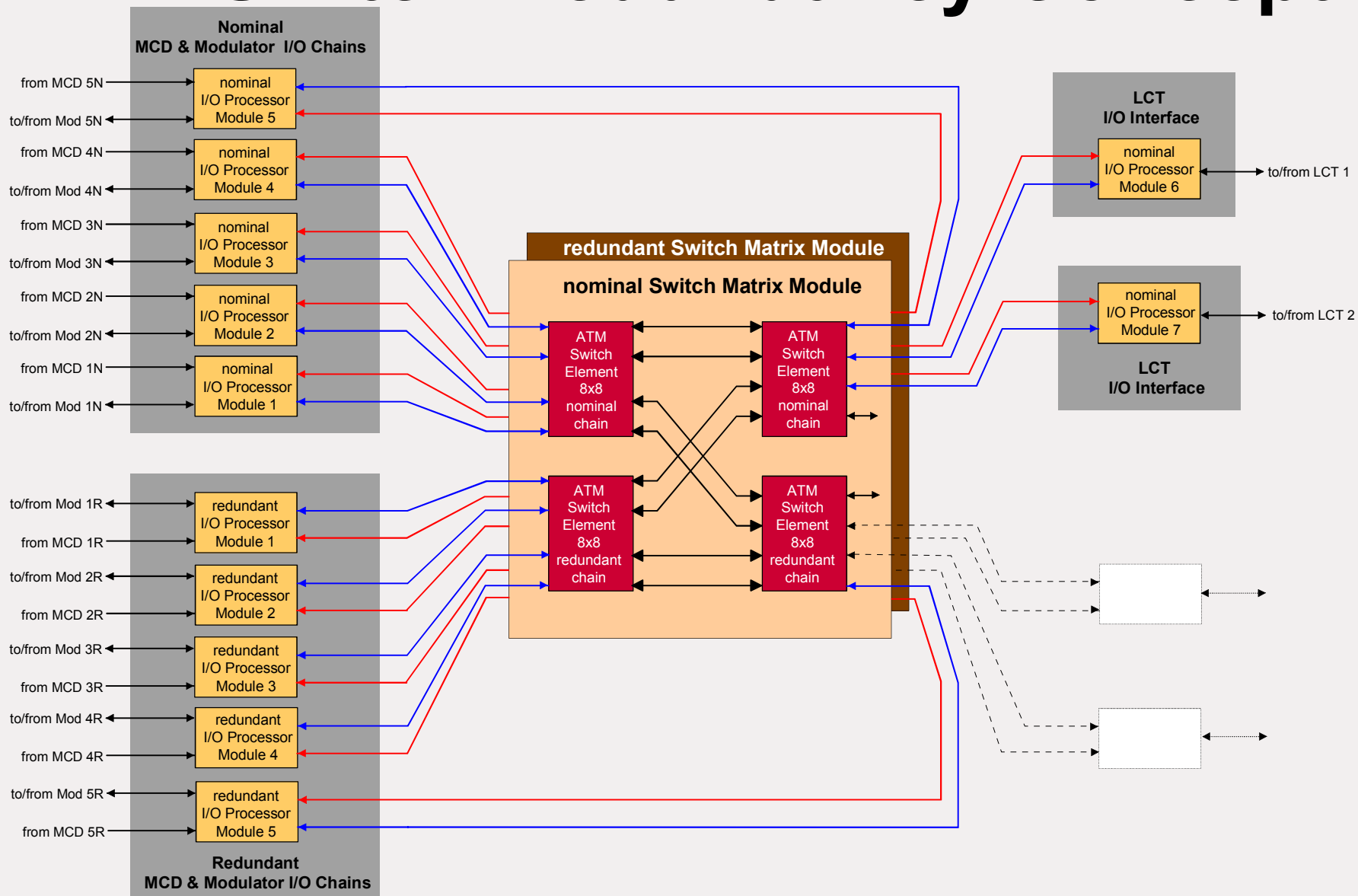
# Switch Matrix Module

## ATM Switch Element

- 8 Input and output ports
- 200 Mbaud/s port speed (SpaceWire)
- 1.25 Gbps aggregate throughput
- Self-routing
- Spatial multicast capability



# Switch Redundancy Concept



# OBP Switch Traffic Statistics (Up-Stream)

- Number of cells detected in sync classes
- Total number of received cells per port
- Number of received error free cells
- Number of received cells with corrupted header
- Number of received cells with corrected header
- Number of discarded cells with detected header errors (detection mode only)
- Number of discarded cells with non-correctable header errors (correction mode only)
- Number of discarded idle cells
- Number of cells forwarded to the ATM layer (without idle and discarded cells)
- Number of discarded cells with invalid/unassigned VPI/VCI
- Number of cells lost due to input buffer overflow

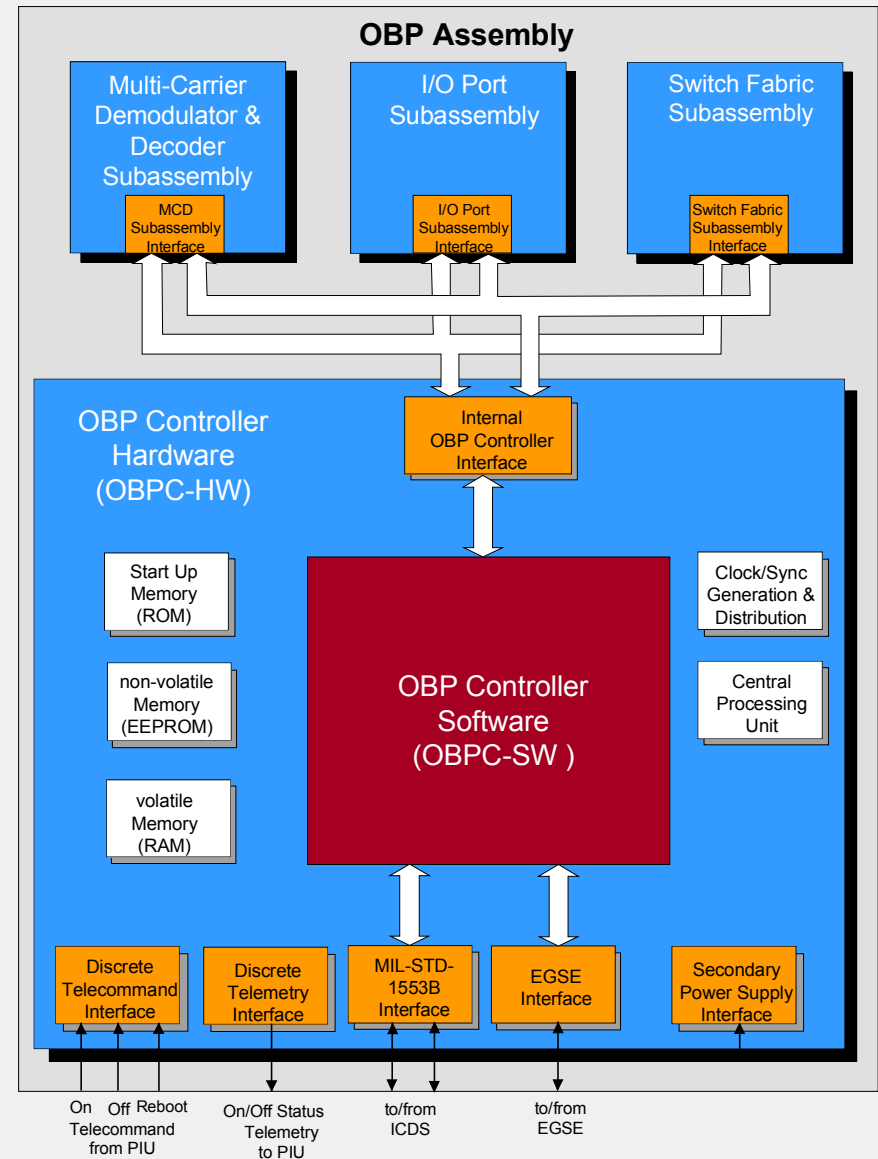
# OBP Switch Traffic Statistics (Down-Stream)

- Number of cells lost due to output buffer overflow
- Number of information cells forwarded to the convergence sublayer
- Total number of generated and inserted idle cells
- Number of outgoing (transmitted) cells



# OBP Controller Block Diagram

- Telecommand Data Handling
- Telemetry Data Handling
- Health and Safety Monitoring
- Clock/Sync Generation & Distribution
- Time Management
- Support of Diagnostic and Test Functions
- Support of OBP Switch Management and Control
- Support of Traffic Statistics



# Housekeeping TM/TC Interface

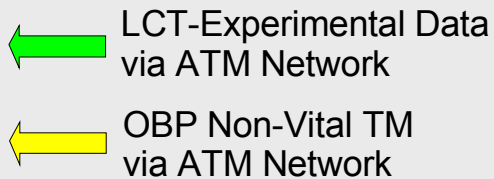
- **OBP Controller**



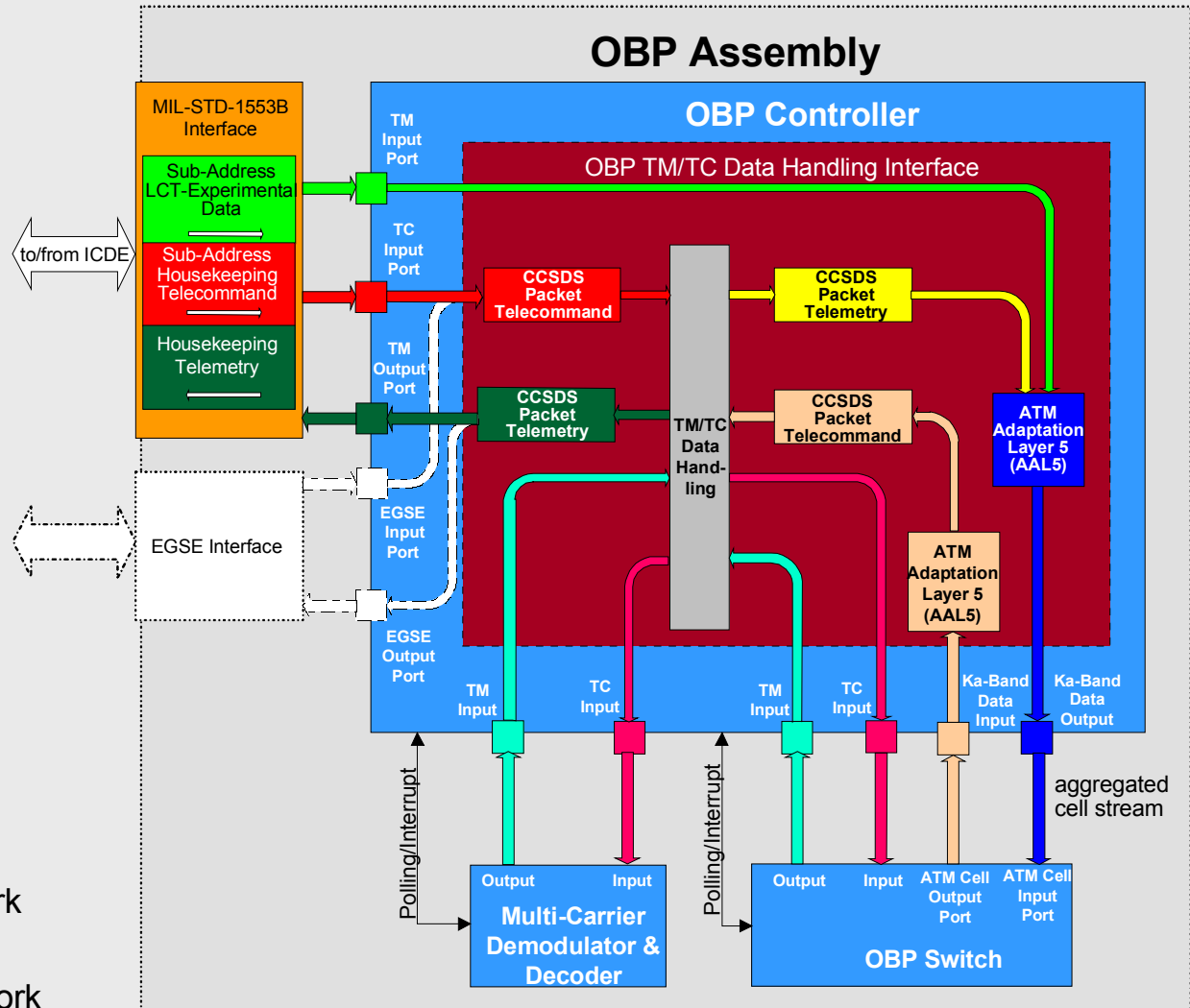
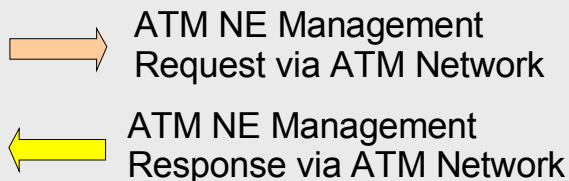
- **Housekeeping TM/TC via S-Band**



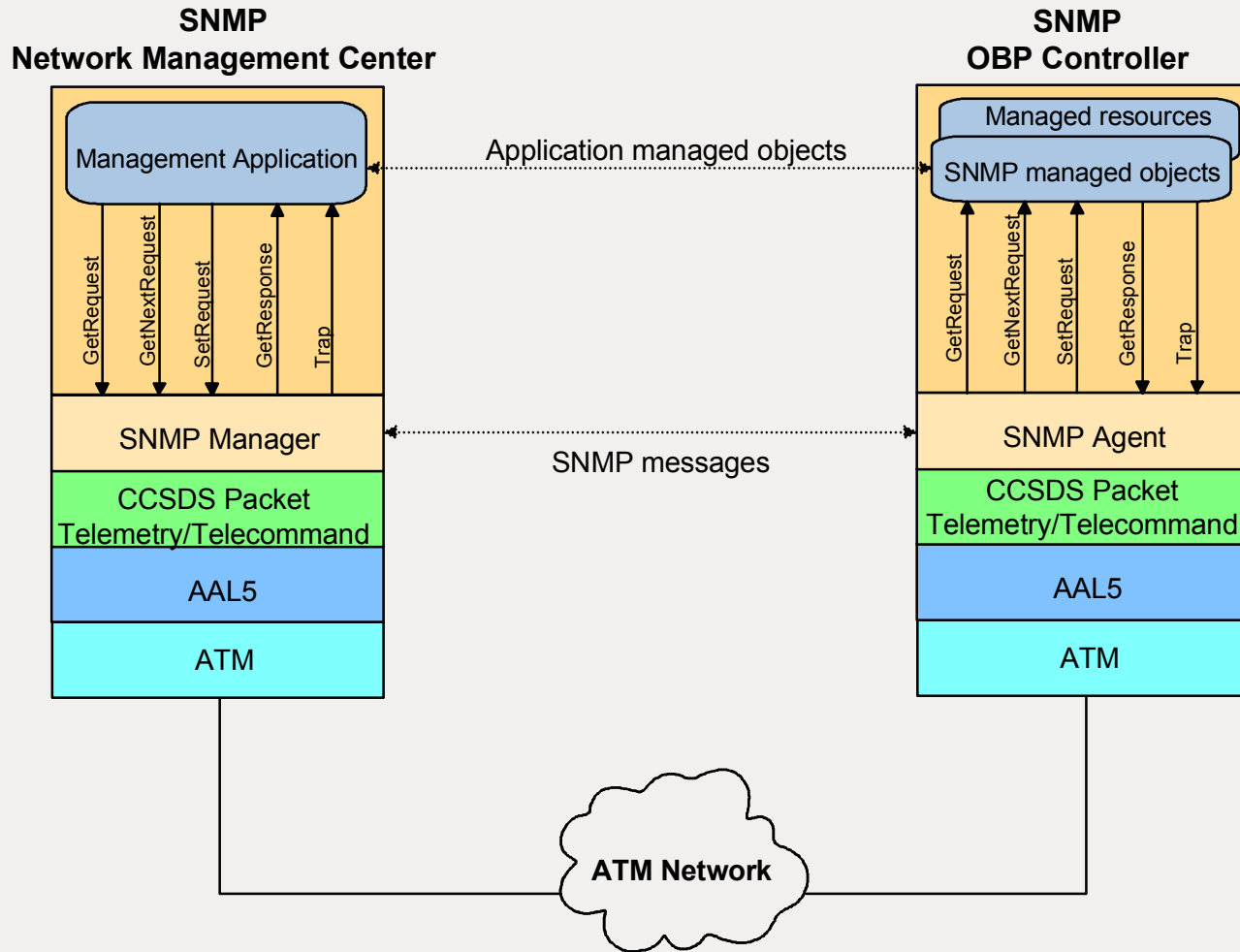
- **Experimental Data and Non-Vital TM via Ka-Band**



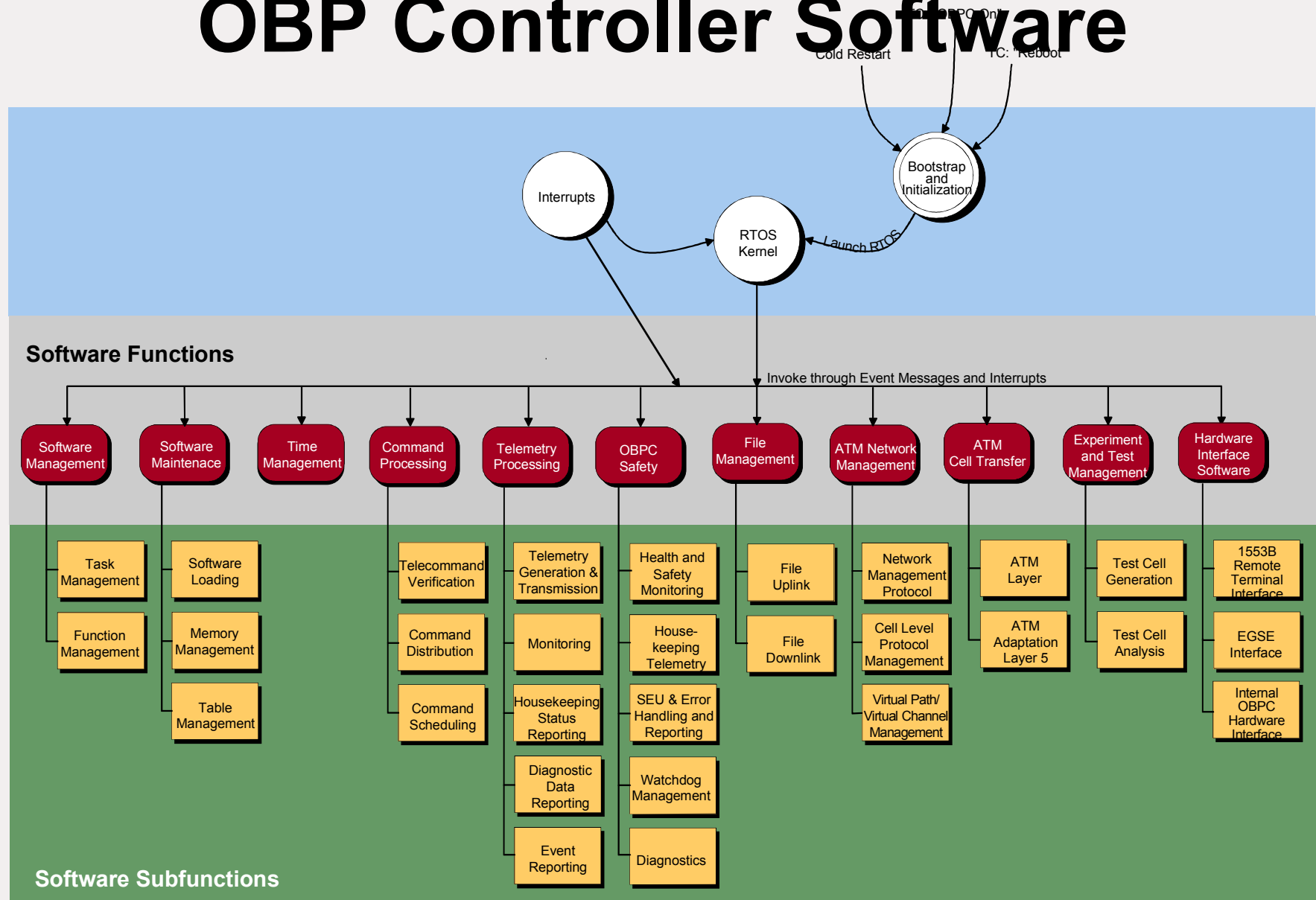
- **ATM Network Element Management via Ka-Band**



# ATM Network Element Management Protocol Architecture



# OBP Controller Software



## Summary

The presentation discussed the following subjects:

- MEDIS Satellite System
  - ↓ System Requirements
  - ↓ Baseline System Configuration
  - ↓ System Functionality
  - ↓ Protocol Architecture
- MEDIS Payload
  - ↓ Payload Block Diagram
  - ↓ Redundancy
  - ↓ Payload Mass Budget
  - ↓ Payload DC Power
- OBP Assembly
  - ↓ Assembly Block Diagram
  - ↓ Assembly Performance
- OBP Switch
  - ↓ Switch Block Diagram
  - ↓ I/O Processor Module
  - ↓ Switch Matrix Module
  - ↓ Redundancy Concept
  - ↓ Traffic Statistics
- OBP Controller
  - ↓ Controller Block Diagram
  - ↓ Housekeeping TM/TC I/F
  - ↓ ATM NE Management
  - ↓ Controller Software