WP 3100 : Encapsulation and IP Mapping

Rider to the ARTES 5 Adaptive Coding and Modulation (ACM) Project
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Objective of Work Package

• Design of return link framing structure and IP-mapping with optimum performance for future return link interactive systems
  – Minimum overhead
  – High spectral and power efficiency
  – RRM simplicity and flexibility!
• Using input from:
  – WP3300 FEC and WP3400 Modem Performance
  – Using assumptions of:
    • Traffic scenarios (traffic distribution found from literature, measurements etc)
    • System scenario (from ACM main project)
  – DVB-RCS standard
  – GSE (Generic Stream Encapsulation) specifications
Return Link Frame format with ACM

- Current RCS systems implement Adaptive Coding through Satellite Terminal (ST) frequency hopping between carriers of different data rates
- With the introduction of high order modulations this becomes inefficient because of the many modulation formats/coding rates combinations (ACM modes), which are used in the system
  - Bandwidth segmentation among carrier types per ST type and MODCOD would imply an important loss because of unpredictability of traffic and fading variations

Need for ACM mode change
burst by burst in the same carrier
Fixed Information Length (FIL)

• Fill Problem
• TBTP is semi-static
• Allocation Problem
  • complex to allocate resources
  • inefficient, will get empty slots
  • difficult to keep jitter constant
  • TBTP structure must be signalled (overhead)
Fixed Burst Length (FBL)

- No padding due to fill
- TBTP is (semi-) static (can change symbol rates)
- Simplified resource allocation
  - simple, all slots can be used
  - efficient, no empty slots
  - jitter is constant
  - No signalling of TBTP structure necessary
GSE Protocol

• Generic Stream Encapsulation Protocol (GSE) considered:
  - Devised primarily for efficient IP encapsulation over DVB-S2/GS with ACM (Interactive/ Professional application areas)
  - DVB-TM extended the scope of GSE, which shall horizontally replace MPE/MPEG TS in the second generation IP-based DVB systems.
  - DVB-SH introduces a generic stream interface
  - Specifications to be approved by DVB-TM in March 2007
  - Layer 2 security to be introduced by 09/2007
What is GSE? (I)

- GSE protocol allows for direct encapsulation of IP and other protocol packets over physical layer bursts/frames
- It replaces MPE/MPEG-TS or AAL5/ATM encapsulation
- Key GSE functionalities:
  - Multiprotocol **encapsulation** support capabilities:
    - IPv4, IPv6, MPEG, ATM, Ethernet, …
  - Transparent to **network layer functionalities**:
    - IP encryption and IP header compression
  - Several **addressing** modes supported:
    - 6 Bytes MAC Address (including multicast and unicast)
    - No Address (IP-header processing)
    - 3 Bytes Address (optional for the receiver)
      - Implicit binding to Group ID/logon ID in DVB-RCS networks -> important overhead saving
      - ATM VPI/VCI could also be used
What is GSE? (II)

• Fully flexible **fragmentation** of PDUs over physical layer frames
  – Reassembly process is based on Fragmentation ID labels
  – Reassembled PDU integrity guaranteed by a CRC check

• GSE is **future proof**
  – New link protocols can be included through specific
    protocol type values
  – Can be extended to include Layer 2 security
GSE Protocol: GSE Packets format

No fragmentation
- 4 bytes
- 4 bytes CRC

Present in the modified version only

Fragmentation
- 7 bytes 1st fragment
- 3 bytes following fragments
- 4 byte CRC
GSE for the return link: Motivation

• The selected FBL solution calls for Layer 3 Packets encapsulation over a variable information burst length -> MPEG and ATM are no longer appropriate
  – RRM simplicity and flexibility leading to:
    – improved system efficiency (no bandwidth segmentation)
    – real time jitter sensitive applications requirements satisfaction
  – No padding loss
  – Suitability to the utilization of interference cancellation techniques for system capacity increase

• Advantage of utilizing the same encapsulation protocol as in the forward link
  – Re-use of protocol SW

• Efficiency gain is dependent on the actual traffic distribution:
  – 10% up to 35% with respect to AAL5/ATM
  – 3% up to 15% with respect to MPE/MPEG

• In addition to the throughput gain, a power efficiency gain is achieved thanks to the utilization of burst lengths matched to the traffic nature

• GSE is robust with respect to different traffic distributions
GSE for the return link: specific issues

- Two alternative design considered in the activity:
  - No CRC per full encapsulated PDU (as from current GSE specs)
    - CRC-32 to be added per burst
  - Modified version:
    - Use CRC pr. IP packet instead in stead of pr. burst
    - Motivation: Reduced overhead since DVB-S2 has very long frames (burst), but DVB-RCS has short (bursts).
- Simulations performed for the two solutions to assess the gain in terms of overhead
- GSE encapsulator at the ST fragments incoming PDUs based on the burst length assigned by the RRM and signalled through TBTP
- Thanks to the FragID presence, PDU fragments with different QoS requirements can be interleaved to ensure real-time traffic requirements satisfaction
Traffic Model

Traffic Model based on specific traffic cases
- IPLEN is length of IP packet
- ATRAINLEN is average length of a sequence (train) of IP packets with length IPLEN

Nominal Traffic Case

<table>
<thead>
<tr>
<th>Case</th>
<th>IPLEN [bytes]</th>
<th>ATRAINLEN [Bytes]</th>
<th>[IP Packets]</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>120</td>
<td>3</td>
<td>Short ACK train</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>240</td>
<td>6</td>
<td>Typical ACK train</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>1200</td>
<td>30</td>
<td>Large ACK train</td>
</tr>
<tr>
<td>4</td>
<td>1476</td>
<td>29520</td>
<td>20</td>
<td>Web object flight (WOF)</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
<td>Infinite</td>
<td>Infinite</td>
<td>VoIP</td>
</tr>
</tbody>
</table>

A VoIP case with compressed header IPLEN = 44 bytes was also simulated
A VoIP packet is 4 voice samples a 10 ms (10 bytes) in one burst
Protocol emulation program:
Emulate GSE protocol by encapsulating IP packets.
Input:
- IP packet length
- IP packet train length
- Burst length (KBYTE)

For each TRAINLEN calculate
- Number of bursts,
- Overhead
- Padding
Average by assuming Poisson distribution of TRAINLEN
=> Input to burst length optimisation
From traffic measurements a nominal traffic distribution model was made:

<table>
<thead>
<tr>
<th>Case</th>
<th>Description</th>
<th>Traffic Distribution Packets [%]</th>
<th>Traffic Distribution Bytes [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Short ACK train</td>
<td>12.5</td>
<td>1.8</td>
</tr>
<tr>
<td>2</td>
<td>Typical ACK train</td>
<td>20</td>
<td>2.9</td>
</tr>
<tr>
<td>3</td>
<td>Large ACK train</td>
<td>2.5</td>
<td>0.4</td>
</tr>
<tr>
<td>4</td>
<td>Web Object Flight (WOF)</td>
<td>15</td>
<td>80.4</td>
</tr>
<tr>
<td>5</td>
<td>VoIP Case</td>
<td>50</td>
<td>14.5</td>
</tr>
</tbody>
</table>

The measurement did not include VoIP, but this is interesting for DVB-RCS so a relatively large amount of VoIP was assumed for the nominal case.
Traffic Distribution Scenarios

Different traffic scenarios investigated

![Diagram showing packets and bytes density]

<table>
<thead>
<tr>
<th>Description</th>
<th>Nominal Case</th>
<th>ACK Centric</th>
<th>WOF Centric</th>
<th>VoIP Centric</th>
<th>VoIP Centric Header Compression</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PD</td>
<td>BD</td>
<td>PD</td>
<td>BD</td>
<td>PD</td>
</tr>
<tr>
<td>Short ACK train</td>
<td>12.5%</td>
<td>1.8%</td>
<td>40%</td>
<td>13%</td>
<td>12% 0.7%</td>
</tr>
<tr>
<td>Typ. ACK train</td>
<td>20%</td>
<td>2.9%</td>
<td>25%</td>
<td>6%</td>
<td>20% 1.1%</td>
</tr>
<tr>
<td>Large ACK train</td>
<td>2.5%</td>
<td>0.4%</td>
<td>5%</td>
<td>2%</td>
<td>2.5% 0.1%</td>
</tr>
<tr>
<td>Web object flight</td>
<td>15%</td>
<td>80%</td>
<td>5%</td>
<td>59%</td>
<td>50% 97%</td>
</tr>
<tr>
<td>VoIP Case</td>
<td>50%</td>
<td>14.5%</td>
<td>30%</td>
<td>19%</td>
<td>15% 1.6%</td>
</tr>
<tr>
<td>Spectral Eff. N_{opt}</td>
<td>730</td>
<td>670</td>
<td>1370</td>
<td>730</td>
<td>450</td>
</tr>
</tbody>
</table>

Packets density

Bytes density
Jitter Requirements

VoIP assumptions

- G729A Codec assumed
- 1 Voice sample 10 bytes (10 ms of voice)
- N voice samples are packet into one voice block, N=4 used in analysis giving a voice block of:
  - 80 bytes with full headers (IP, RTP)
  - 44 bytes with header compression
- Maximum two (40 ms) voice blocks in one physical burst
- Jitter should be within 10-30 ms
  - Jitter is reduced by play-out delay buffer
Modem Performance (I)

- Modem assumptions based on simulation results
- Overhead required (depending on modulation, code rate and block length)
- Modem performance (depending on modulation, code rate and block length)
- HPA loss included (depending on modulation)
- Burst length optimisation performed on the baseline demodulator performance, but including that anticipated improvement was possible. The performance was checked with the optimised demodulator algorithms.


## Modem Performance (II)

### Overhead (UW Length and Pilot Period)

<table>
<thead>
<tr>
<th>BLOCK LENGTH [Information bits]</th>
<th>408</th>
<th>816</th>
<th>1504</th>
<th>3008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N_{UW}</td>
<td>L_p</td>
<td>N_{UW}</td>
<td>L_p</td>
</tr>
<tr>
<td>QPSK r = 1/3</td>
<td>48</td>
<td>20</td>
<td>48</td>
<td>20</td>
</tr>
<tr>
<td>r = 1/2</td>
<td>48</td>
<td>50</td>
<td>48</td>
<td>50</td>
</tr>
<tr>
<td>r = 3/4</td>
<td>32</td>
<td>50</td>
<td>32</td>
<td>100</td>
</tr>
<tr>
<td>r = 6/7</td>
<td>16</td>
<td>100</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>8PSK</td>
<td>16</td>
<td>10</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>16APSK</td>
<td>16</td>
<td>8</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>

### Modem Loss

<table>
<thead>
<tr>
<th>BLOCK LENGTH [Information bits]</th>
<th>408</th>
<th>816</th>
<th>1504</th>
<th>3008</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPSK r = 1/3</td>
<td>0.38</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>r = 1/2</td>
<td>0.34</td>
<td>0.34</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>r = 6/7</td>
<td>0.25</td>
<td>0.35</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>8PSK r = 2/3</td>
<td>1.0</td>
<td>0.65</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>r = 6/7</td>
<td>1.6</td>
<td>0.75</td>
<td>0.70</td>
<td>0.60</td>
</tr>
<tr>
<td>16APSK r = 2/3</td>
<td>0.6</td>
<td>0.6</td>
<td>0.35</td>
<td>0.25</td>
</tr>
</tbody>
</table>

### HPA Loss

<table>
<thead>
<tr>
<th>Modulation</th>
<th>HPA Loss [dB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPSK</td>
<td>0.2</td>
</tr>
<tr>
<td>8PSK</td>
<td>0.4</td>
</tr>
<tr>
<td>16APSK</td>
<td>0.5</td>
</tr>
</tbody>
</table>
MODCOD Distribution

- **MODCOD distribution based on system simulations from ACM Modem Phase 1**
- **MODCOD distribution approximately same for both consumers (512 ks/s) and SME (2 Mbps) since larger antenna for SME.**
Figure of Merit

**Spectral Efficiency**

\[ \eta_{IP} = \frac{K_{IP}}{\text{BURSTLEN}}. \]

- The number of IP bits per transmitted symbol, including all overhead
- \( K_{IP} \) number of IP bits in burst, \( \text{BURSTLEN} \) is burst length

**Power Efficiency**

\[ \frac{E_{b_{IP}}}{N_0} = \frac{E_s}{N_0} - 10 \log_{10} 10(\eta_{IP}). \]

- The actual energy used to transmit each IP bit. \( E_s/N_0 \) is the energy used to transmit one channel symbol.

A reduction of protocol or burst format overhead can be used both to improve either spectral or power efficiency or both.
Methodology for Burst Length Optimisation

For all MODCODs m {

For all burst lengths BLEN {

- Find physical layer overhead (PHYOH) for a given MODCOD and BLEN
- Find symbols available for information data $K_s = BLEN - PHYOH$
- Find required $E_s/N_0$ in order to demodulate the burst for a certain PER.
- Find bytes available for encapsulated IP data $K_{BYTE} = K_s*M*r/8$
- Emulate GSE protocol for each traffic scenario (assume Poisson distribution of TRAINLEN, except for VoIP) and determine the average overhead and padding.
- Find the power efficiency $E_{bIP}/N_0(BLEN,m)$ and spectral efficiency $\eta_{IP}(BLEN,m)$ for the given burst length and MODCOD.}

Average for all MODCODs

Average for all Traffic Cases
Final sensitivity analysis
The spectral and power is averaged for all FEC code rates (uniform distribution)
- For Short/Typical Ack train short bursts is optimum (2-400 symbols)
- For WOF a long burst is optimum (> 2000 symbols)
- Long bursts have better FEC/modem performance. This is not modelled in the spectral Efficiency figure of merit. Taken into account in the power efficiency figures.
Encapsulation and Padding Loss (QPSK)

Plots showing details of encapsulation and padding loss.
Actual overhead depends on how well an IP packet fit a container size
- A 40 bytes IP packet fits exactly a 40 bytes container size giving no padding overhead, but very badly to a 39 bytes container.
This effect gives very rugged curves (actually even more rugged than plot shows)
Traffic is modelled as train of IP packets so this reduces variations.
**8PSK**

**Spectral Efficiency**

**Power Efficiency**

Averaged over all 8PSK FEC rates

Same as for QPSK, but now a burst contains more data and compared to QPSK shorter bursts will be optimum
Averaged over all 16APSK FEC rates
Even shorter bursts is optimum
The burst length optimisation was based on the chosen MODCOD distribution

Optimum single burst length:
- Spectral efficiency: 730 symbols
- Power efficiency: 890 symbols
Multiple Burst Lengths (I)

- Assume that a burst is either 1 or 2 basic slots
  - As assumed in RRM project (ARTES-1)
- General solution: A burst can use 1 or N basic slots
  (N fixed, i.e. still only two burst types)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Slot 11 1 ms</th>
<th>Slot 12 1 ms</th>
<th>Slot 13 1 ms</th>
<th>Slot 14 1 ms</th>
<th>Slot 15 1 ms</th>
<th>Slot 16 1 ms</th>
<th>Slot 17 1 ms</th>
<th>Slot 18 1 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1024 kS/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>512 kS/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>512 kS/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>256 kS/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Superframe duration is a multiple of 4 ms

Slot 1 - 4 ms  Slot 2 - 4 ms

- Burst using 2 basic slots
Multiple Burst Lengths (II)

<table>
<thead>
<tr>
<th></th>
<th>Spectral Efficiency</th>
<th>Power Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N_{1_{opt}}, N_{2_{opt}}$ [symbols]</td>
<td>$\eta_{IP}$ [bits/symbol]</td>
</tr>
<tr>
<td>Single Burst Length</td>
<td>730</td>
<td>1.71</td>
</tr>
<tr>
<td>Two Burst Lengths</td>
<td>(690,1380)</td>
<td>1.74</td>
</tr>
<tr>
<td>$N_2=2*N_1$</td>
<td>(730,2190)</td>
<td>1.75</td>
</tr>
<tr>
<td>Two Burst Lengths</td>
<td>(570,22809)</td>
<td>1.75</td>
</tr>
<tr>
<td>$N_2=3*N_1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Burst Lengths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N_2=4*N_1$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

-The two burst length solution was not found to be significantly better than a single burst length for the nominal traffic scenario.
- However, what happens for different traffic scenarios ....
Traffic Distribution Sensitivity: Single Burst Length

A single burst length of 700-900 symbols would be in-efficient for VoIP, not ideal for WOF.

Y-axis is delta change from optimum.
Traffic Distribution Sensitivity: Double Burst Length

N2 = 3*N1 is most robust solution for all traffic scenarios
N1=540 is optimum with respect to power efficiency
Further Sensitivity Analysis

• Other IP packet lengths (ACK, Web Objects Flight, VoIP with or without header compression)
  – 40 or 52 byte ACK has little impact on optimum burst length
  – 1476 or 1500 bytes IP packet length has little impact
  – 80 or 44 byte VoIP has some impact (not dramatic)

• Traffic Distribution
  - Web browsing - ACK Centric
  - VoIP - VoIP Centric
  - File/Object transfers – WOF Centric
  - Solution chosen to be robust against traffic distribution, see previous slide for results

• Link budget assumptions/ MODCOD distribution
  – Lower C/(N+I); More coding and robust modulation => Longer optimum burst length
  – High C/(N+I); Less coding and less robust modulation => Shorter optimum burst lengths
  – Test +/- 3dB change in link budget
    – 3% loss in spectral efficiency
    – 0.1 dB loss in power efficiency

• Modem performance
  - Better overall performance with improved algorithms
  - Same optimum burst lengths

• Conclusion: Chosen solution is robust against parameter changes
FIL and FBL Comparison

Spectral Efficiency

<table>
<thead>
<tr>
<th>Traffic Cases</th>
<th>1-ATM K = 424 bits</th>
<th>MPEG K=1504 bits</th>
<th>GSE Protocol N₁=540, N₂=1620 symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>1.55</td>
<td>1.77</td>
<td>1.83</td>
</tr>
<tr>
<td>ACK Centric</td>
<td>1.50</td>
<td>1.60</td>
<td>1.67</td>
</tr>
<tr>
<td>WOF Centric</td>
<td>1.60</td>
<td>1.84</td>
<td>1.89</td>
</tr>
<tr>
<td>VoIP Centric w/header compression</td>
<td>1.20 (1.48)</td>
<td>1.40</td>
<td>1.61</td>
</tr>
</tbody>
</table>

18% gain wrt ATM
14% gain wrt MPEG
33% gain wrt ATM

Power Efficiency

<table>
<thead>
<tr>
<th>Traffic Cases</th>
<th>1-ATM K = 424 bits</th>
<th>MPEG K=1504 bits</th>
<th>GSE Protocol N₁=540, N₂=1620 symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>9.23</td>
<td>6.98</td>
<td>6.56</td>
</tr>
<tr>
<td>ACK Centric</td>
<td>9.40</td>
<td>7.75</td>
<td>7.41</td>
</tr>
<tr>
<td>WOF Centric</td>
<td>9.11</td>
<td>6.74</td>
<td>6.14</td>
</tr>
<tr>
<td>VoIP Centric w/header compression</td>
<td>11.00 (9.33)</td>
<td>8.48</td>
<td>7.59</td>
</tr>
</tbody>
</table>

The power efficiency gain is due to the utilization of the long burst size in particular for long IP packets.
Comparison against DVB-RCS

- For DVB-RCS either 1-ATM (53 bytes) or 1-MPEG (188 bytes) burst containers
- Demodulator loss is:
  - 0.3 dB for ATM (a bit optimistic using conventional algorithms)
  - 0.25 MPEG

<table>
<thead>
<tr>
<th>Figure of Merit</th>
<th>Spectral Efficiency [IP bits/symbol]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encapsulation</td>
<td>ATM</td>
</tr>
<tr>
<td>Nominal</td>
<td>1.32</td>
</tr>
<tr>
<td>ACK Centric</td>
<td>1.28</td>
</tr>
<tr>
<td>WOF Centric</td>
<td>1.36</td>
</tr>
<tr>
<td>VoIP Centric w/header Compression</td>
<td>1.02 (1.27*)</td>
</tr>
</tbody>
</table>

*) 57 byte ATM container size

Also power efficiency gain can be achieved
GSE Protocol Assumption

• Comparison of GSE protocol versions:
  – Modified (CRC pr. IP packet)
  – Original (CRC pr. burst)

• Nominal Traffic Scenario:
  – Small advantage of modified version (up to 1%)

• VoIP Scenario (using header compression)
  – Small advantage of original protocol (up to 1%)

• Conclusion:
  – Not justified to modify the GSE protocol for RL and should use the standard GSE protocol used for FL.
### Burst Format Definitions

<table>
<thead>
<tr>
<th>MOD/COD</th>
<th>Modulation</th>
<th>r</th>
<th>Information length [Bits/Bytes]</th>
<th>IP length [symbols]</th>
<th>UW Length [symbols]</th>
<th>Pilots NP (PP) [symbols]</th>
<th>$E_b/N_0$ [dB]</th>
<th>$\eta_{IP}$ [bit/symbol]</th>
<th>$E_{bit}/N_0$ [dB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>QPSK</td>
<td>1/3</td>
<td>312/39</td>
<td>462</td>
<td>48</td>
<td>26 (20)</td>
<td>1.0</td>
<td>0.58</td>
<td>3.38</td>
</tr>
<tr>
<td>S2</td>
<td>QPSK</td>
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</table>
Signalling Issues (I)

No explicit signalling of burst type is necessary
- If a terminal gets allocated \( M = 3N + K \) consecutive slots it must transmit \( N \) long burst and then \( K \) short bursts, \( K = 0, 1 \) or 2.
- Might increase jitter to mix short and long burst, but DAMA controller should ensure that terminal gets allocated capacity with fixed distance for jitter sensitive services
- Association of traffic with burst types
  - Can be based on VBDC. DAMA controller should allocate long bursts as much as possible to maximise efficiency
  - For RBDC below certain level should use short bursts to minimise jitter
Signalling Issues (II)

Update of TCT and TPTB tables proposed (similar to what has been proposed in the ESA RRM project)

TCT Table
- New Timeslot (FBL)
- Split UW and pilots must be signalled

TPTB Table
- MODCOD long burst
- MODCOD short burst

Assuming MODCOD pre-defined in new standard, otherwise TCT table must be used to signal MODCOD definitions
Conclusion (I)

- A frame/burst format suitable for utilization of ACM over the return link of future interactive systems has been proposed
- Fixed burst length gives significantly simplified and improved RRM efficiency
- GSE protocol assumed for mapping IP packets over variable information length bursts
  - No modification of GSE protocol necessary
- New FEC scheme improves demodulator performance
- New burst format simplifies and enhances burst synchronisation
Conclusion (II)

• A detailed cross-layer optimization has been carried out for devising burst formats:
  – Different applications and traffic models considered
  – MODCOD distributions assumed as from system simulation results
  – Sensitivity analysis for assessing robustness of the devised solution
• 2 (Short and long) burst lengths selected to improve efficiency against different applications and traffic distributions
• Simulation results have shown an efficiency gain of
  – 10% up to 35% with respect to AAL5/ATM and 3% up to 15% with respect to MPE/MPEG assuming the same physical layer performances
  – 40% up to 60% with respect to AAL5/ATM and 20% up to 30% with respect to MPE/MPEG when the current DVB-RCS standard is assumed as the benchmark
• Minor changes to TCT and TBTP tables required