CPRI basics
Common Public Radio Interface

The CPRI link is used for sending and receiving high speed data between Base Band (DUx) and Radio Unit (RUx)

To make it easier to understand CPRI you need some basic definitions of how the Radio Data and timing are handled between radio and base band.

Timing and radio data definitions can be “tricky”; don't get hung up on details, try to see the relationship between definitions and CPRI link structure.
**RBS (Radio Base System) hot words expressions with definitions**

- **Base Band (BB)** is a digital unit for decoding or encoding radio data
- **Radio Unit (RU)** sends and receives radio data to and from antenna
- **Downlink (DL)** is the data stream which goes from BB to the radio
- **Uplink (UL)** is the data stream which goes from the radio to BB
Timing hot words expressions with definitions

- **Base Band Clock (BBCLK)** the most important reference clock in the radio base system runs at 30,72Mhz

- **Basic Frame Number (BFN)** is the radio frame number for synchronization of the network of the radio base system (RBS). The number is increased every 10 ms (millisecond).

- A **radio frame** is 10 ms and used for synchronize the RBS network

- The bit speed of the CPRI link is a multiple of BBCLK
  - 40 x 30.72MHz = 1.23 Gbit/s
  - 80 x 30.72MHz = 2.46 Gbit/s
  - 160 x 30.72MHz = 4.91 Gbit/s
  - 320 x 30.72MHz = 9.82 Gbit/s
Radio data handling definitions 1

- What do we do with the signal coming into the antenna?

  - Sample!
  - Samples in CPRI link is called AxC (Antenna system container)
  - At each BBCLK, the radio samples (reads) the antenna
  - When the antenna have been sampled 8 times, the radio have collect samples for one CHIP time

  - One CHIP time = 8 BBCLK 3.84MHz
Radio data handling definitions 2

• What are chips used for?
  – SYMBOLS!

  – 256 CHIPS create one SYMBOL
  – When the antenna have been sampled 8 x 256 times, the radio have received one SYMBOL

  – One SYMBOL= 2048 BBCLK

  – The SYMBOL is the “thing” that carry the data over the air between mobile and RBS
What do you know now

- **Base Band** (BB) is the device handling radio data
- **Radio Unit** (RU) is the device handle the antenna
- **BBCLK** is the system clock (30.72Mhz)
- **BFN** is the synchronization signal (every 10ms)
- **Chip** is 8 (BBCLK) sample from the antenna
- **Symbol** is 256 chip
- **The bit speed on CPRI** is a multiple of BBCLK
- **Samples in CPRI link** are called AxC
CPRI link basic 1

- CPRI is a serial data link, which means the bits are sent like a chain.
- There is one bit stream downlink to the RU
- There is one bit stream uplink to the DU
- CPRI bit stream speed 1.23, 2.46, 4.91 or 9.82 Gbit/s
The text below refer to 2.46 Gbit/s bit stream

• How do we know what the data in the serial stream looks like?
  – We put the bits in packages!
  – Each package contain 512 bits
  – Each package represent a Chip time
  – 480 of 512 bits are used for Samples (AxC)
  – The leftover 32 bits are used as a CW (Control Word)
CPRI link basic 3
The text below refer to 2.46 Gbit/s bit stream

• How will the 512 bits package look?
CPRI link basic 4
The text below refer to 2.46 Gbit/s bit stream

• How are the packages organized?

  – The 512 bit package is called Basic Frame (BF) which represent a Chip.
  – 256 of the BF are packed in bigger boxes called Hyper frame (HF) which represent a Symbol.
  – 150 of the HF are packed in a even bigger box called Radio Frame (10ms).
Control words

The red part of the 512 bits package picture (slide 9) is the 32 bits used for Control word (CW). Those CW:s exist in all Basic frames (BF)

- There are 256 Control words which are repeated every Hyper frame (HF)
- Some Control words have a specified purpose
- Some Control words have the same contents when repeated.
- Some are free to use for your own application
  - Vendor specific
Control words

• This is how the Control words are organized

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<tr>
<th>subchannel number Ns</th>
<th>purpose of subchannel</th>
<th>X=0</th>
<th>X=1</th>
<th>X=2</th>
<th>X=3</th>
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<tr>
<td>0</td>
<td>sync&amp;timing</td>
<td>sync byte K23.5</td>
<td>HPN</td>
<td>BFN-low</td>
<td>BFN-high</td>
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<td>1</td>
<td>slow C&amp;M</td>
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<td>startup</td>
<td>L1-reset-LOS...</td>
<td>pointer p</td>
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</tr>
</tbody>
</table>
Control words

• Control word 0 (red in picture slide 12) is the most important. Why?

  – This CW is used for synchronizing the sender and the receiver of the bit stream.

  – There are other CW:s which are important as well but not for understanding the basic of CPRI
CPRI link basic 5

• How do we know which package is which?
  – Synchronization!!! But with what?
  – K28.5 synch character in Control word 0
Synchronization

When the BFN comes in to the BB part of the system, the CPRI link starts to put everything in place.

- BF counter and the HF counter are set to zero at the BB side.
- At the same time the CPRI link sends the synch character called K28.5.
- The BF counter and the HF counter are set to zero at the radio side, by this K28.5 character.
- The radio side sends a K28.5 back to BB side and now everything is in place.
Now we are synchronized!

- We now know which bit is which, so we can start to exchange data between BB and RU.

- The K28.5 character is repeated for every start of a HF to keep us in synch.

- We even send the number of the valid HF to each other, to keep us safe.
Fancy words for CPRI gurus

- **Jitter buffer** used on the receiving side for synchronize incoming bits to the receiver clock
- **AxC Container or AxC** I/Q sample block
- **CPRI rev** Revision or variant of CPRI (mostly different CW handling)
- **AxC related package** message sent between BB and RU regarding I/Q samples
- **O&M related package** message sent between BB and RU regarding control data
- **CPRI link states A-F** A=standby, B=synchronization, C=protocol setup, D= C&M plane setup, E=interface and vendor specific negotiation, F=operational