Development of Multipurpose Digital Backend for «Quasar» network radio telescopes

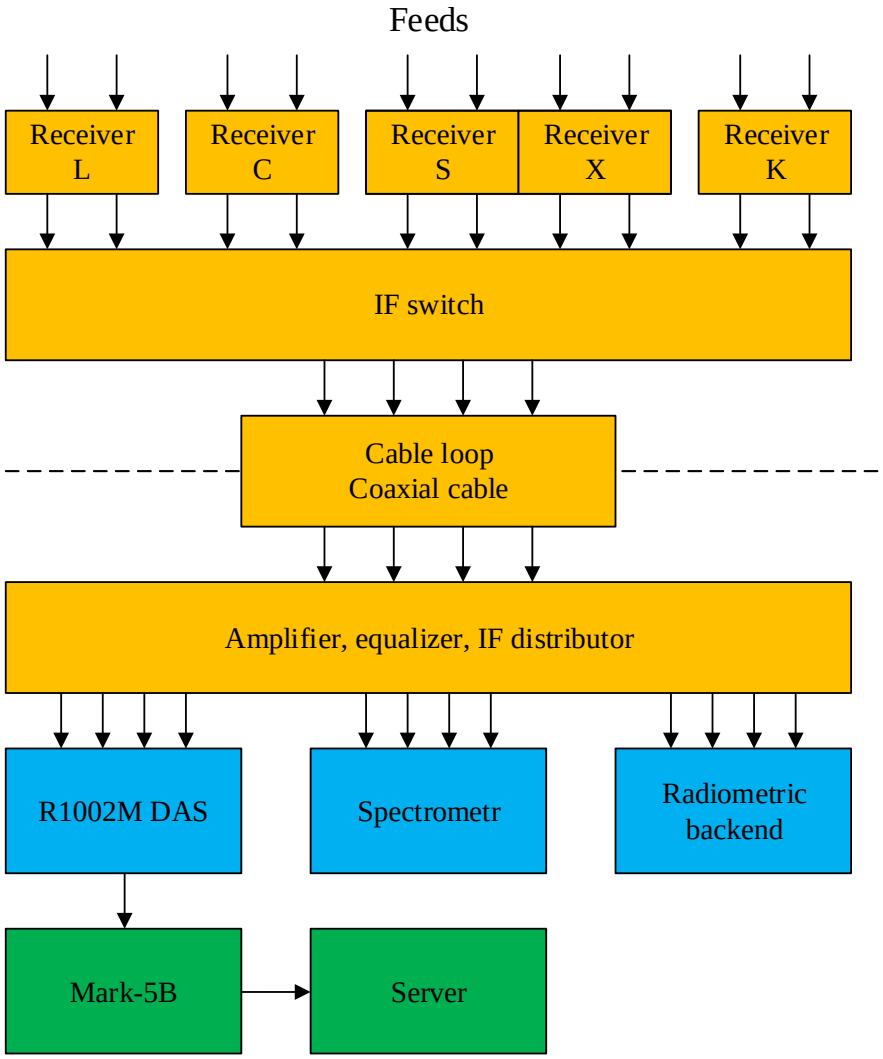
Evgeny Nosov

Institute of Applied Astronomy
Russian Academy of Sciences

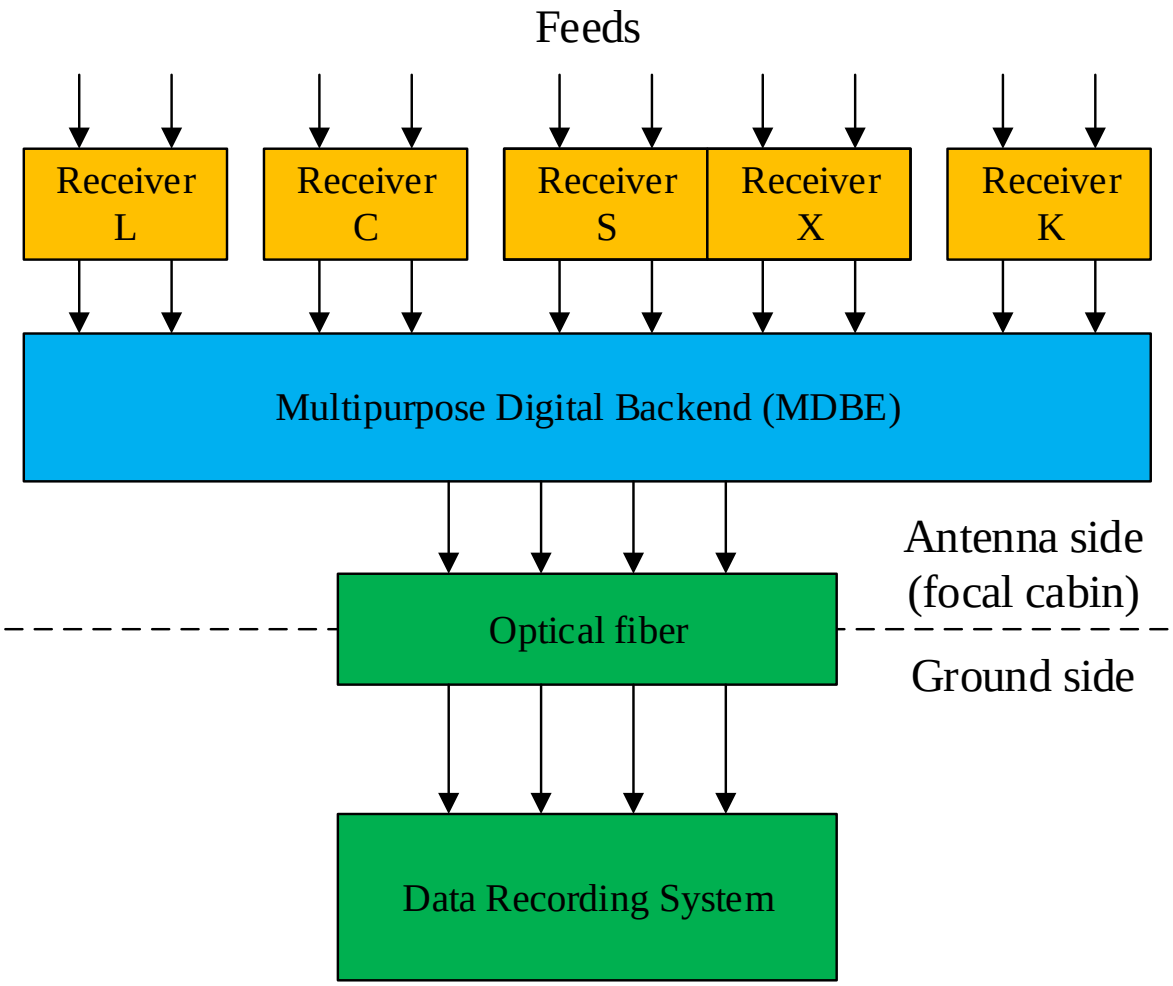
Backends overview for «Quasar» network

Operating mode	RT-32			RT-13
	Svetloe	Zelenchuk.	Badary	Zelen., Badary
VLBI	R1002 DAS (16 downcoverters, 32MHz, Mark5B)			BRAS (direct IF-to-digital, 8ch@512MHz, VDIF, 10GE)
Radiometric	SSRB (digital, with spectral selection)	PRM (analog detector)	PRM (analog detector)	No
Spectrometric	R3902	No	R3901	No

RT-32 signal chain



RT-32 upgraded signal chain



Key requirements

- MDBE should be compatible with both RT-32 and RT-13
- MDBE should be suitable for existing local and international observation programs
- Optical outputs with digital data
- Output data format
  - Mark5B compatible frames for RT-32
  - VDIF for RT-13

Key requirements

- Compatibility with existing receivers:

  input frequency range

  0.1-1 GHz for RT-32

  1-2 GHz for RT-13

  signal power

  -40…-20 dBm for RT-32

  -10…+5 dBm for RT-13

- Up to 1 GHz input bandwidth

- Compatibility with existing synchronization systems:

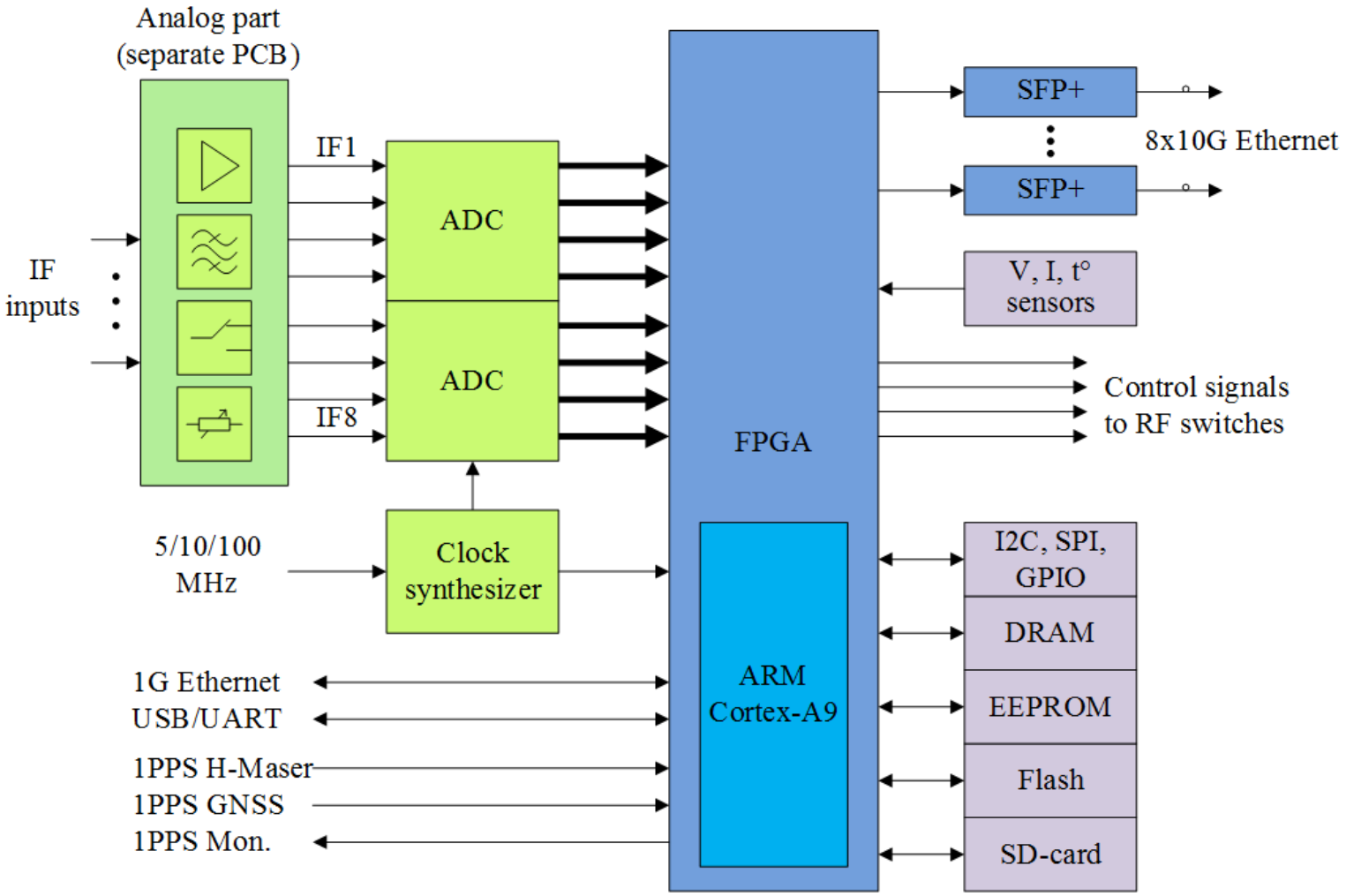
  5 MHz for RT-32

  100 MHz for RT-13

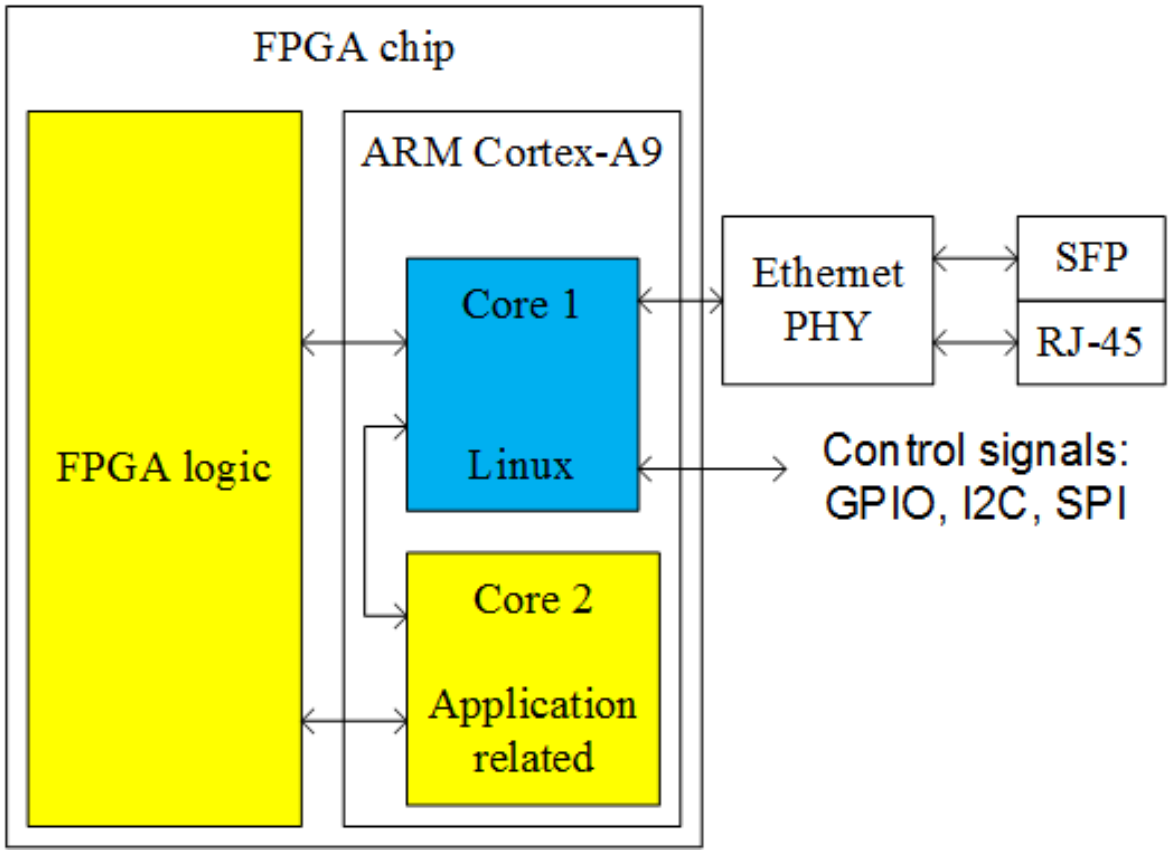
Key requirements

- VLBI, radiometric and spectrometric operating modes
- Easy and fast reconfiguration between operating modes
- Easy upgrade without direct access
- Low EMI emission
- Small size and weight
- Low production cost (<$10k)
- Remote system monitoring and signal analysis functions

MDBE structure



Control system of MDBE



VLBI operating modes

- **Wideband channels mode**
  8 channels @ 512 MHz bandwidth
  4 channels @ 1024 MHz bandwidth
  2 or 8 bits output samples

- **Digital down converters mode (DDC)**
  up to 16 channels @ 32 MHz bandwidth
  fine tunable LO frequency
  any IF-input to any DDC

- **Polyphase filter bank mode (PFB)**
  32/64 MHz channel bandwidth

Operating modes

- **Radiometric backend with RFI suppressing mode**
  Suppressing of pulse-like interference (time domain)
  Suppressing of narrow-band interference (frequency domain)
  Generating of control signals for modulation
  Adjustable frequency and phase of control signals

- **Spectrometer mode**
  up to 32K points

- **Other operating modes could be designed**

Number of IF inputs	10
Number of digitizing wideband channels	8 channels @512MHz 4 channels @1024MHz
ADCs	2 ADCs, 10 bits, Fs=1024/2048 MHz
Automatic gain control	For each channel, 31 dB
Sync signals	5/10/100 MHz (autodetect), 1 PPS x2
Control outputs for modulation	4 channels, independent frequency and phase adjustment
Control interface	10/100/1000 Ethernet
Output interface	8 x 10GE, SFP+ transceivers
Telemetry	Power circuits current and voltage, temperature of PCB, ADCs and FPGA
Size	19” 3U case, 483x132x314 mm (WxHxD)

THANK YOU FOR YOUR ATTENTION!