ASIC solution for Software Defined Radio regenerative payload

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Introduction – “the context”

- LEO HTS, GEO VHTS promise a change in satellite service and economy
  - Higher capacity (300 to 1000 Gbps with very wide bandwidth)
  - Higher throughput
  - Lower bandwidth costs
- A main challenge the satellite industry is facing is how to provide this amount of traffic
  - In the right place
  - Efficiently
  - Economically

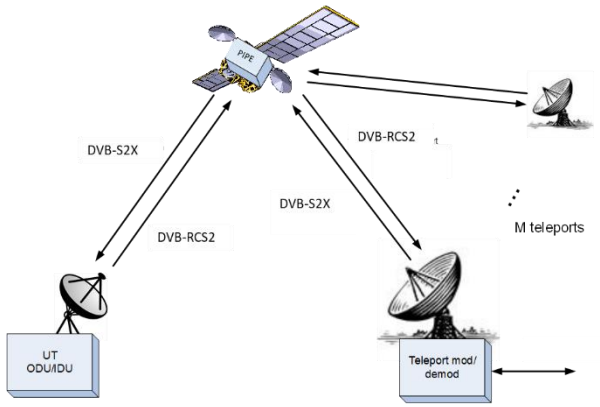
Bent Pipe architecture- ground segment

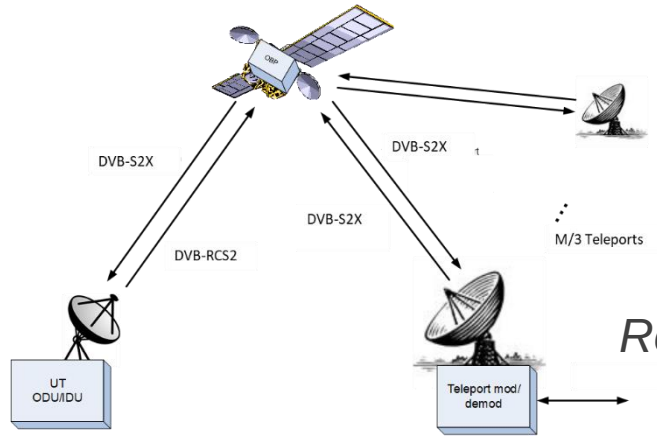
- Bent Pipe architecture gateway link efficiency is limited by the user link budget
- Typical link budget numbers (forward link)
  - 2-2.5 Bps/Hz
  - Es/No ~9.5dB (@ peak)
  - Return link is 1-1.5 bps
- Gateway link in Ka band (2.5 GHz, 2 Pols)
  - 500 GHz (@2bps/Hz avg.)
  - 100 GW links
- In a LEO bent pipe environment a gateway is required in every service area

Gateway versus Satellite CAPEX

The solution -> Decoupling The User and Gateway Link

Bent Pipe





Regenerative Processing

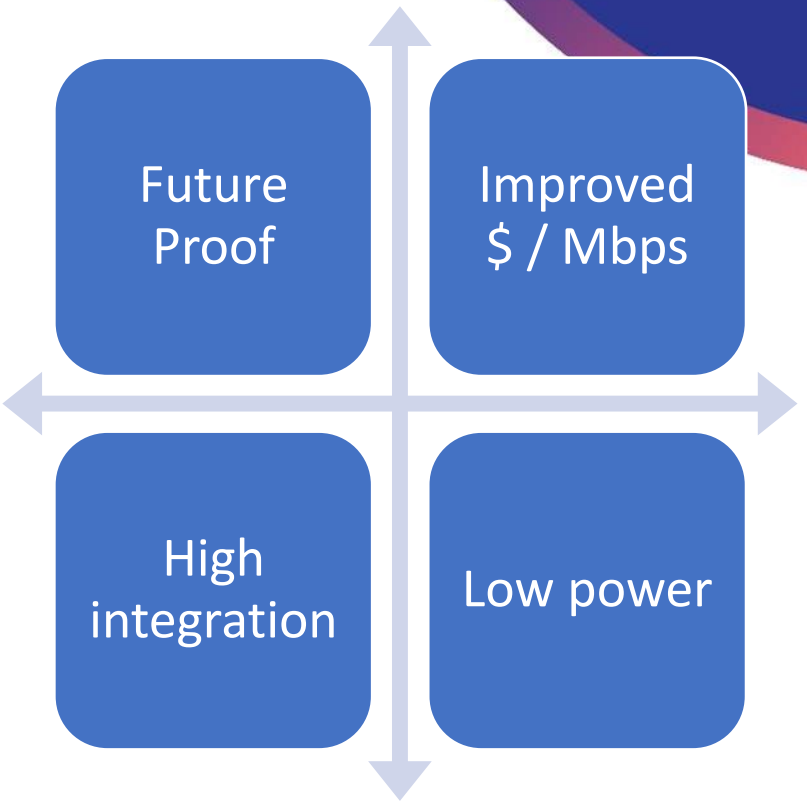
		Bent Pipe PL	Regenerative PL
Uplink	**EIRPe [dBW]**	73	73
	Frequency [GHz]	29.5	29.5
	Free Space Loss [dB]	213.2	213.2
	G/Ts [dB/K]	19.3	19.3
	Es/No	21.5	21.5
Downlink	**Average EIRPd**	60	NA
	Frequency [GHz]	19.7	
	Free Space Loss [dB]	209.7	
	G/Te [dB/K]	17.5	
	Es/No	9.7	
Total	**Es/No**	9.4	21.5
Bit/Hz		2.63	5.9

Regenerative Payload – Beam Hopping

- Native support of dynamic beam hopping
  - Dynamic allocation of satellite resources
    - Better utilization of the satellite power resources
  - Reduced complexity and cost of the satellite payload
  - Support of wide carriers
    - More efficient power utilization both on ground and on board the satellite

If It's so Good ?.....

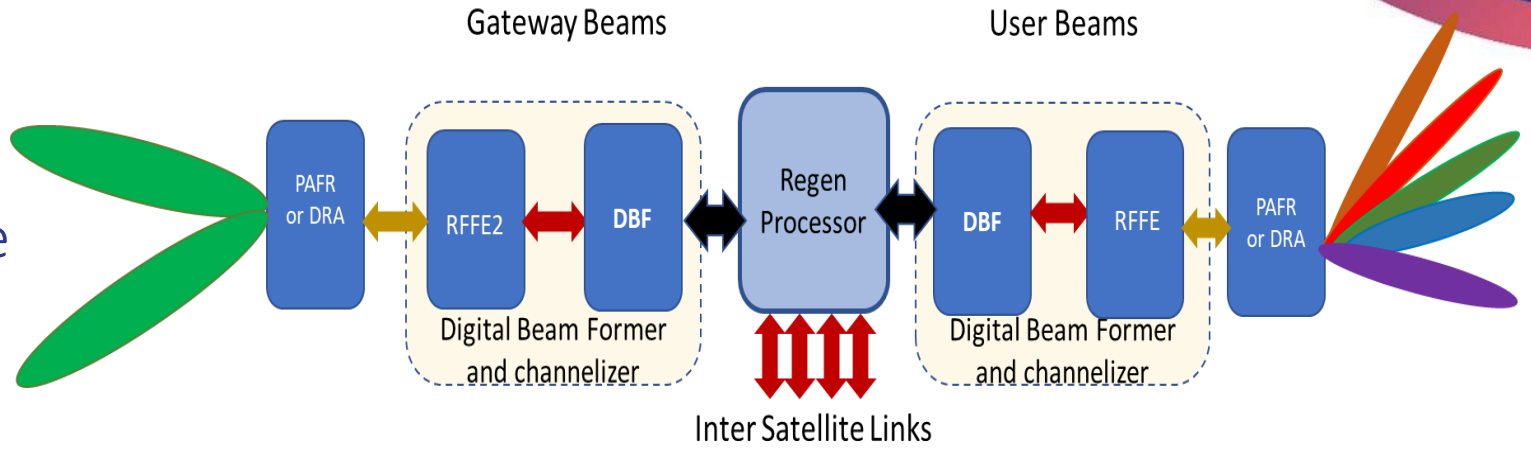
- **Future Proofing**
  - Q: Satellites last 10-15 years, how to keep them current with technology?
  - A: (1): Software Defined Radio technology enable making changes in waveforms and parameters
    - (2): Closed Garden vs. Open Garden
    - (3): Constellations life span
- **Payload Power Consumption**
  - Q: With traditional FPGA/ASIC it is prohibitive
  - A: Modern silicon geometries can process many Gbps in few Watts
- **Cost**
  - Q: Designing Space ASICs is costly
  - A: Partnership (ESA), Volume (LEO)



Available technology makes it possible

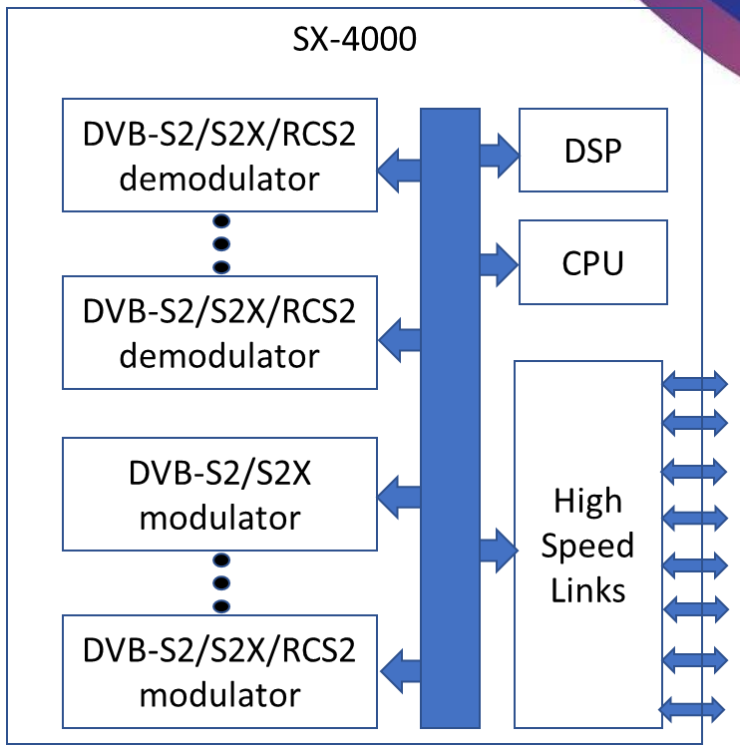
Payload Architecture

- Digital Beam Former
  - Generate multiple simultaneous beams
- Sampled data is being demodulated by the Regenerative Processor
- Decoded information is routed to the destination (GW, User, ISL)
- Data is modulated in the correct Modcod
- Native beam hopping support



SX4000 Regenerative Processor ASIC

- Software Defined Radio Architecture
- Multiple wide band (1GHz) DVB-S2X modulators
- Multiple wide band DVB-S2X demodulators
- Multiple burst RCS2 demodulators
- Beam hopping support (Super-Frame)
- Complete DVB-S2X MODCOD range from 256 APSK to Very Low SNR support
- High speed and low speed interfaces
- DSP and CPU sub-system
- Expansion switch
  - Packet forwarding from/to the modem



Regenerative Payload Processor Advantages

- Gateway and user links decoupling
  - More than 60% of CAPEX and OPEX saving on the ground infrastructure at full deployment
  - Graceful gradual deployment of gateways
- Native support of dynamic beam hopping
  - Better utilization of the satellite resources
  - Reduced complexity and cost of the satellite payload
- Support of wide carriers
  - More efficient power utilization both on ground and on board the satellite
- Routing traffic is done on the payload
  - Route to Inter-satellite links in LEO constellations
  - Single Hop Mesh communication
- Reduced number of required gateways in LEO by routing traffic through constellation
- Simplify gateway link equipment to SCPC links

Summary

- VHTS and LEO HTS constellations require immense amounts of information to be passed to the users
- The gateway becomes a major costs and logistics challenge
- Regenerative payload improves gateway link efficiency and enables smart routing between GW links and ISL, leading to a significant cost saving
- Software Defined Radio provides an answer to future proofing the payload
- Modern silicon technology enables high speed processing with low power
- Rad hardening is required to withstand all orbits radiation exposure
- SatixFy designs SX4000, a Rad Hard, SDR payload regenerative processor