SOFTWARE DEFINED RADIO ARCHITECTURES EVALUATION

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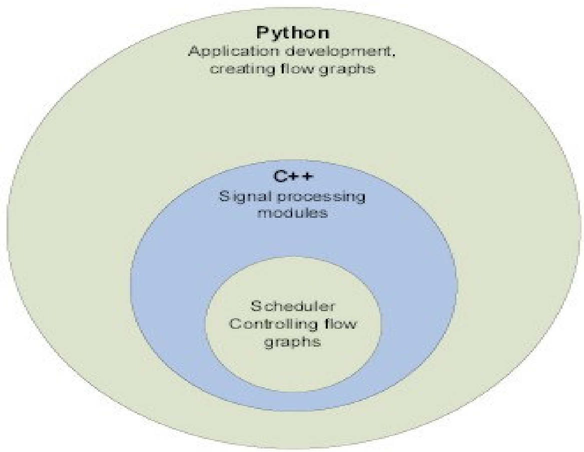
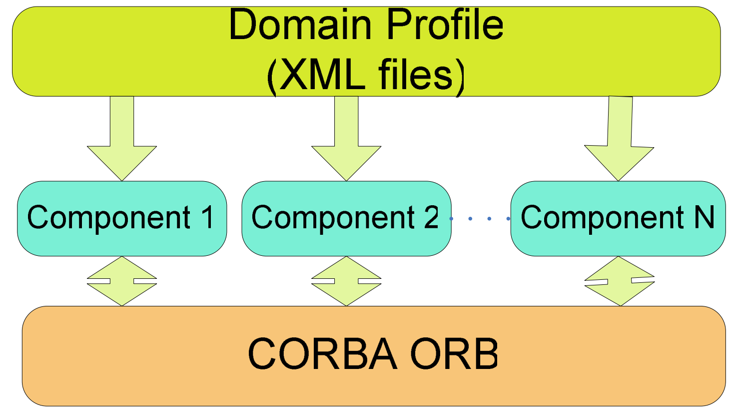
Software Defined Radio Architectures Overview

- OSSIE and GNU Radio represent the two main open-source SDR architectures nowadays.

- Both of them are based on the same principle:
  - Waveform re-configurability.
  - Multiplatform implementation.
  - Standard component libraries.

Software Defined Radio Architectures Overview





- GNU Radio:
  - Components implemented in C++.
  - Python is used to build up the flow graph.
  - One process with possibility of multiple threads. Direct function calls.
- OSSIE:
  - Components implemented in C++.
  - Assembling module using XML.
  - CORBA is used for multi-process communications.

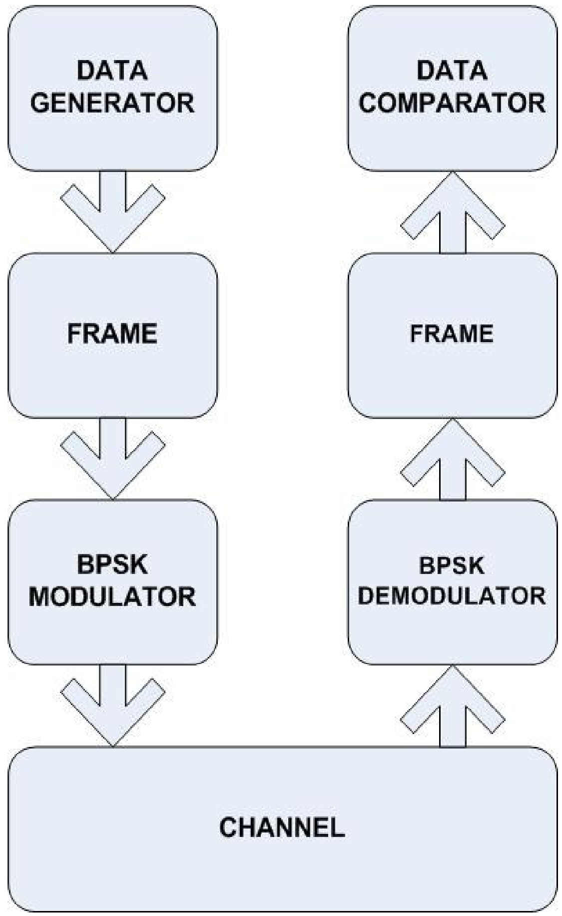
Evaluation Methodology:

Objectives

- OSSIE and GNU Radio performance.
- Common hardware platform.
- Equivalent waveform.
- Full-duplex upper limit on throughput.
- No physical interfaces constrains.
- Analysis of the performance’s causes.

Evaluation Methodology:

Software Loopback Test Structure



- Test-bed: 3GHz Pentium 4 CPU and 1024 MB of RAM.
- Operating system: Ubuntu 7.1
- Framework versions:
  - OSSIE 0.6.2
  - GNU Radio 3.1.2
- Main factors:
  - Low-complexity waveform.
  - Components availability.
- Information generation:
  - OSSIE:
    - Pre-allocated data block.
    - Fixed packet size of 64 MB.
  - GNU Radio:
    - Dynamic generation of the packets using the packet number.
    - The size can be selected.

Test Results:

CPU Load

- CPU monitoring using the Linux `top` command for data transmission.

- Fixed packet size: 64 MB.

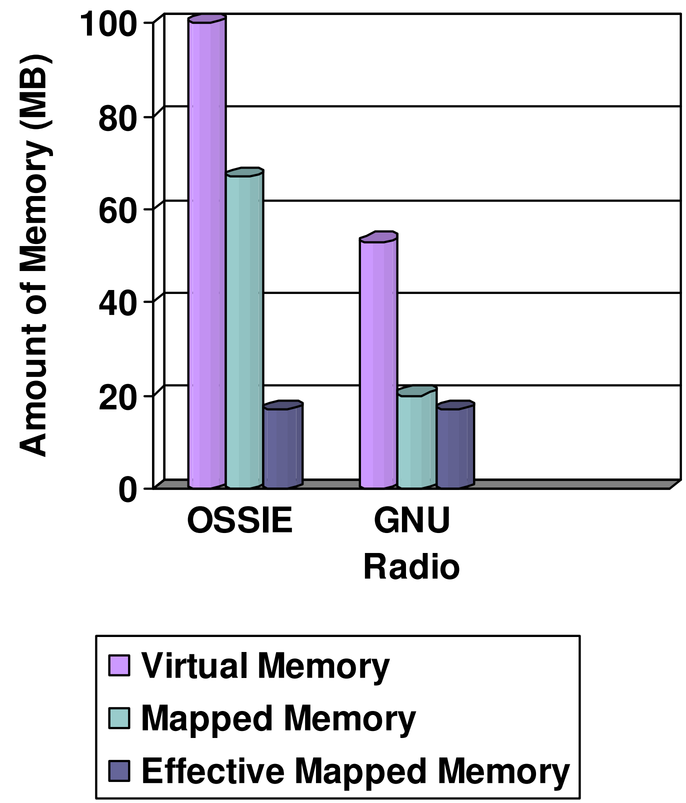
- Both frameworks use roughly the **100%** of the CPU capacity.
  - GNU Radio with one single process.
  - OSSIE individual components:10 to 20% of CPU load each.
  - No source of non-computation delays (i.e. interfaces with RF front-ends).

- Reasonable to assume linearity between the performance and the processor's speed.
  - GPP vs. Embedded

Test Results:

Memory Load

- `exmap` tool for memory monitor: suitable for virtual and share memory analysis.
- Virtual memory: total amount requested by a process but not fully used.
- Shared memory (i.e. common libraries):
  Each N-process uses 1/N.
- Both applications could run within a 32 to 64 MB memory.



Test Results:

Data Throughput

- Estimation of the maximum full-duplex throughput achievable for each framework.
- Fixed amount of information (10 MB) vs Packet size.

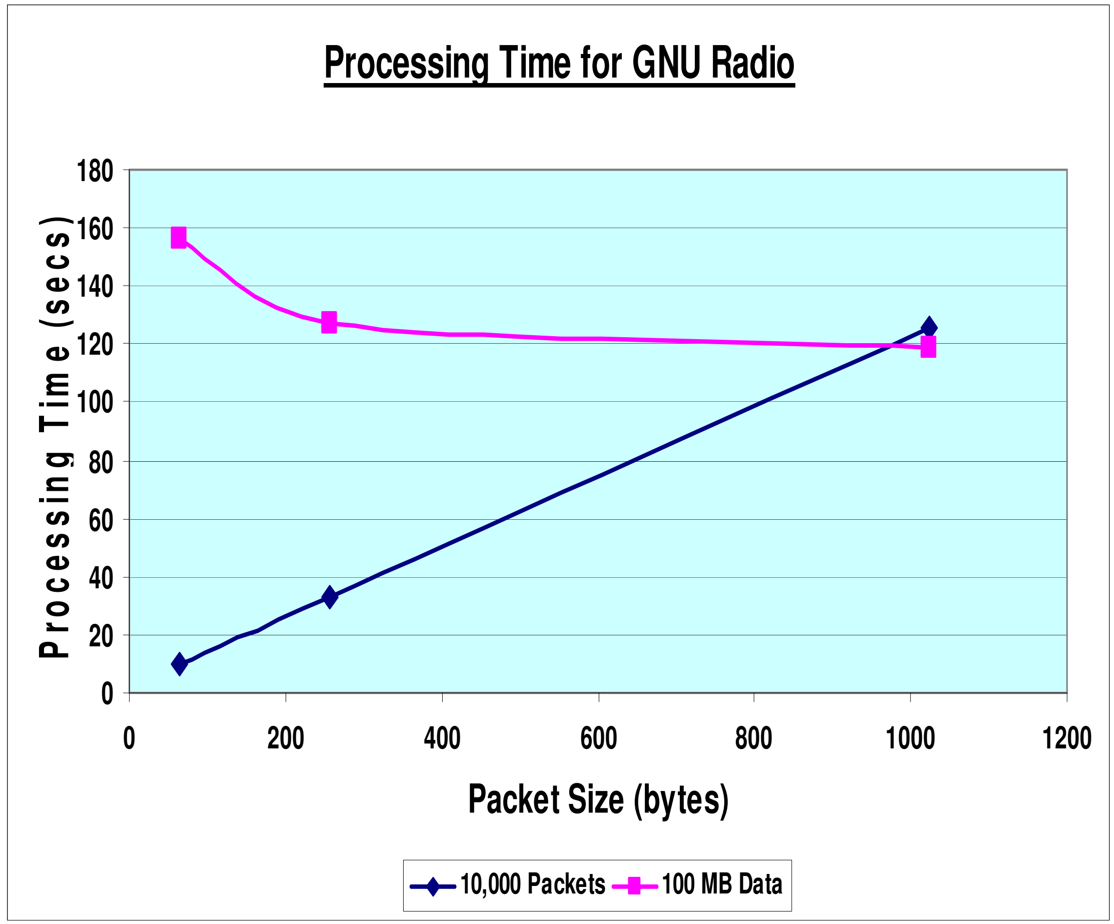
Framework	Packet Size (bytes)	Throughput (Mbps)
OSSIE	64	0.72
GNU Radio	64	0.59
GNU Radio	256	0.68
GNU Radio	1024	0.71

- Initial conclusions
  - Performance equal (and not very good) in both
  - Reasonable to assume double performance for half-duplex radio.
  - More realistic waveform would lead to lower performance.
  - In GNU Radio part of the code is written in Python -> Maybe explanation for the performance.
  - CORBA used in OSSIE -> Worse performance than GNU Radio could be expected.

Test Results:

Computation Profiling

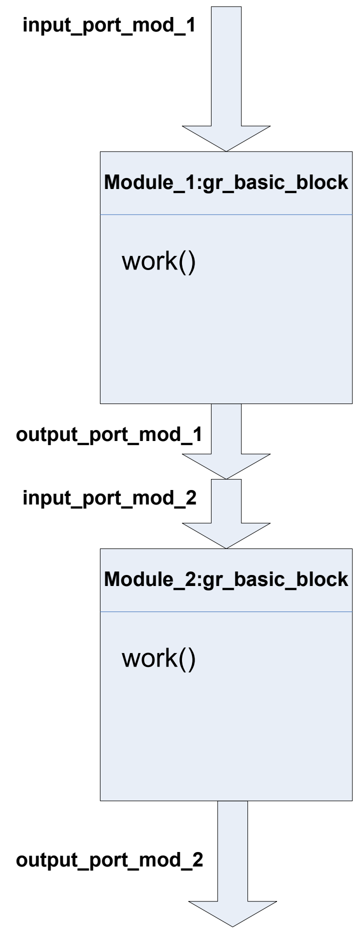
- Why is maximum bit rate rather slow?
  - Profile to look for computation hotspots
  - Easy Python profiling using `cProfile`.
- Small difference for fixed amount of data sent.
- Dramatic increase for a fixed amount of packets and size variations.
- Results approx. linear with amount of data sent
  -> data movement/copying takes most time



Test Results:

Computation Profile

- Data moving management made by memory copying:
  - "work()" method.
  - Modules with different I/O types: array copying element by element.
  - Modules with equal I/O types: "memcpy" function.



- Possible improvement: Pointers manipulation instead of memcpy when input and output data are identical.

Conclusions

- Deeper profiling and further optimization still possible
- Loopback test is a reasonable estimator of upper bound throughput performance.
- Can expect real SDR applications to achieve lower performance.
- Maximum through put achieved was around 700 kbps for both frameworks:
  - OSSIE slightly faster.
  - Surprisingly low.
  - Reasonable to assume linear improvement with a processor speed incensement.
- Smaller granularity vs. Software Radio

Thank you
Any questions?

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