Making Trustable Satellite Experiments
an Application to a VoIP Scenario

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Motivation of this work

• Performing SATCOM experiments can be
  – Costly
  – Difficult to config/assess parameters
  – Not possible

• Motivates the use of simulated/emulated environments
Lucky me, I can access to a SATCOM

- ISAE-SUPAERO is the first aeronautical engineering school in France (under French ministry of defence umbrella)
- In the French aerospace valley (south-west of France) - AIRBUS, Thales Alenia Space, CNES (French space agency), ... 
- CNES provides CESARS platform (real SATCOM links, various configurations)
- I need to request a slot to use it…
  - But I’m not the only one!
OpenSAND emulator

OpenSAND provides an easy and flexible way to emulate an end-to-end satellite communication system.

**Topology**

OpenSAND allows to emulate:
- mesh and star configuration schemes,
- as well as multipoint and multigateway topologies.
http://opensand.org

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Network-to-network Interconnection
OpenSAND supports IPv4, IPv6 and Ethernet connectivity.
It can be interconnected with real equipment and other IP-based networks (terrestrial and/or satellite), or even the Internet backbone.
http://opensand.org
Let’s consider this experimental path

● Note that I mainly test e2e components
  – apps (assessing QoE), transport protocols, AL-FEC, erasure coding protocols (TETRYS, SWIF, RLNC...)

● A possible experimental path could be
  1. simulation (basic algorithm)
  2. emulation (with real apps, assessing QoE)
  3. real testing (to confirm results)
Let’s analyze

● If results are distant between simulation and emulation
  – Not a problem to explain as we abstract/simplify the system

● What if results are distant between emulation and real testing?
  – More subtle, where does the problem come from? Do I have set the right parameters? Are there hidden parameters? Is the comparison consistent? Can I expect the result?
The challenge → How can I trust my satellite experiments’ outcome?

- QoS modeling of a satellite system can often lead to non-conclusive or ambiguous results
- It’s a complex system
- We assess the performance of two of them
  - Mininet
  - OpenSAND
- With a VoIP scenario
- Objective to assess either G711 or G723 performs better over SATCOM
- And estimate the distance with real SATCOM measurements
MININET

- Well-adopted network emulator
- Gain popularity due to its capability to reproduce trustable experiments
  - See: https://reproducingnetworkresearch.wordpress.com/
- VMs are utterly isolated
  - The load does not impact performance
- See: http://mininet.org

(b) Mininet standalone
OpenSAND

- Realistic SATCOM emulation system provided by CNES
- Source code open
- Full-team working on it providing free support for users

Visit: [http://opensand.org](http://opensand.org)
(a) Real satellite access (CESARS)
QoS metrics (loss, delay)

Theoretical saturation point is 35 flows
QoE metric $\rightarrow$ MOS = $f$(QoS)
QoE metric (MOS)

- Mininet well-behaves before the saturation point but it’s a side effect
- OpenSAND allocation scheme is **static CRA** and then **dynamic RBDC**
- We suspect real-link use **FCA-kind** scheme (confidential vendor)
Conclusion

● Does my emulator reproduce all network conditions?
  – Think about before/after the saturation point
  – In our case: interested only above the saturation point
  – But we could have also tuned our emulator to mimic the whole behavior

● When you know what you seek to measure, you know what you can choose
  – We wanted guidelines
  – Now ready to test other cases, codecs, video flows, etc

● Use OpenSAND and feedback us your configs!
  – OpenSAND can be easily tuned to fit your real satellite link characteristics
Thank you

Questions?