GREEN IPTV

A **R**esource and **E**nergy **E**fficient **N**etwork for **IPTV**

FERNANDO M. V. RAMOS

Main objectives of this lecture

General

Illustrate the usual route taken to make computer science research

Specific

Exemplify with a resource and energy efficient network for IPTV

Outline

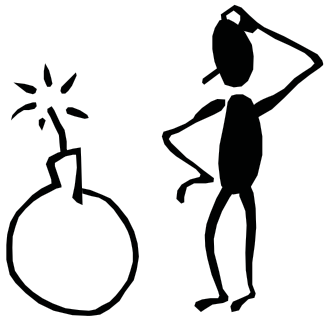
- Route to make computer science research
- IPTV today
- Research example 1: resource and energy consumption in IPTV [Ramos et al. 1]
- Research example 2: zapping delay in IPTV [Ramos et al. 2]
- Take-home message

Outline

- **Route to make computer science research**
- IPTV today
- Research example 1: resource and energy consumption in IPTV [Ramos et al. 1]
- Research example 2: zapping delay in IPTV [Ramos et al. 2]
- Take-home message

1. Look for an opportunity

2. Identify a problem



"The ability to ask the right question is more than half the battle of finding the answer"

Thomas J. Watson

3. Analyse state of the art

4. Propose solution

5. Evaluate solution

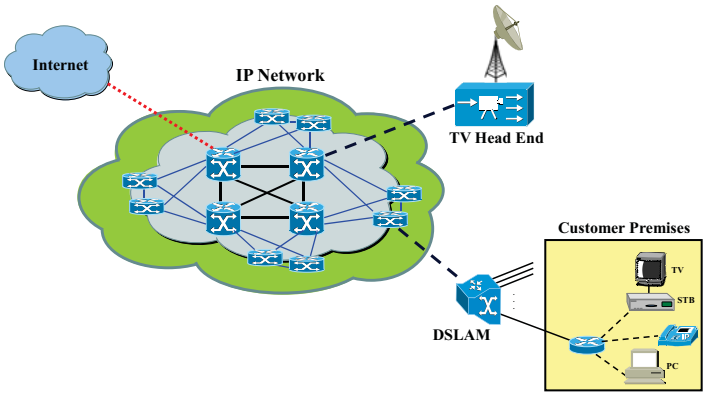
6. Assess relevance

Outline

- Route to make computer science research
- **IPTV today**
- Research example 1: resource and energy consumption in IPTV [Ramos et al. 1]
- Research example 2: zapping delay in IPTV [Ramos et al. 2]
- Take-home message

What is IPTV?

A typical IPTV network



More details

- All TV channels transmitted always everywhere
- IP multicast used
  - PIM-SM
  - Static multicast trees
  - No traffic engineering

Outline

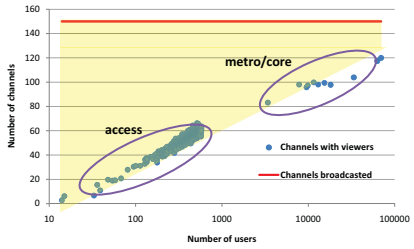
- Route to make computer science research
- IPTV today
- **Research example 1: resource and energy consumption in IPTV [Ramos et al. 1]**
- Research example 2: zapping delay in IPTV [Ramos et al. 2]
- Take-home message

Why IPTV?

- New service on top of an IP network
  - Still an infant: around 5 years old
- The sum of all forms of video (IPTV, VoD, P2P) will account for over 91% of global consumer traffic by 2013 [Cisco]
- In the US there are already more than 5 million IPTV subscribers, and this number is expected to increase to 15.5 million by 2013 [Piper]

Resource inefficiencies

- 90% of all TV viewing is restricted to a small selection of channels [Cha et al.][Qiu et al.]



Waste of bandwidth, waste of energy!

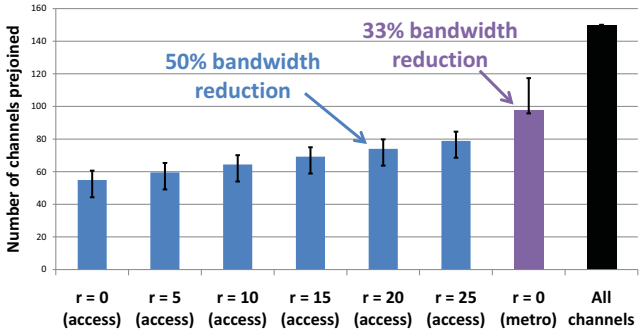
Selective pre-fetching of TV channels

- Instead of each node pre-fetching all TV channels, **pre-fetch only a selection** of channels
- Pre-fetch **active channels** (channels for which there are viewers) + a **small number of inactive channels**
- **Room size** = number of inactive channels pre-fetched

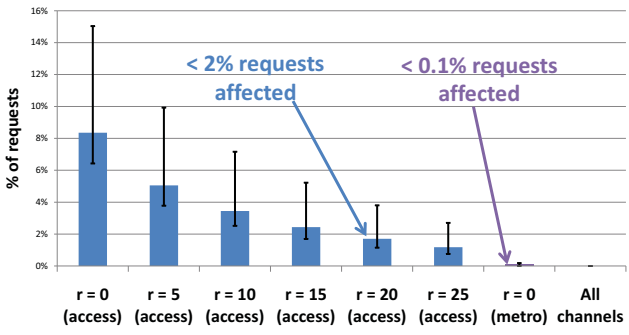
Trace-driven simulation

- Using huge dataset from a nationwide IPTV provider:
  - 255k users, 6 months, 150 TV channels, 622 DSLAMs, 11 regions

Results – bandwidth savings



Results – requests affected



"Is it worth it?", part 1

Scenario	Media format	Bit rate	TV channels	Bandwidth savings
Today	SDTV	4 Mbps	150	0.3 Gbps
In 2-4 years	HDTV	20 Mbps	700	7 Gbps
In 10-15 years	4K	200 Mbps	3000	300 Gbps

"Is it worth it?", part 1

Scenario	Media format	Bit rate	TV channels	Bandwidth savings
Today	SDTV	4 Mbps	150	0.3 Gbps
In 2-4 years	HDTV	20 Mbps	700	7 Gbps
In 10-15 years	4K	200 Mbps	3000	300 Gbps

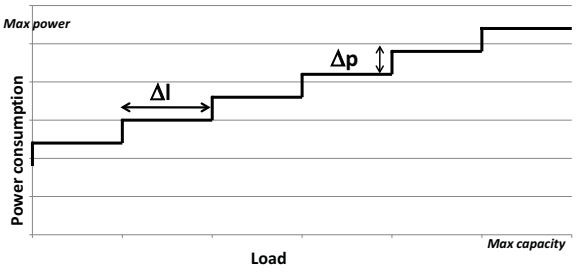
Conclusion

Today probably not, in the future probably yes

1. opportunities 2. problem 3. state of the art 4. solution 5. evaluation **6. relevance**

What about energy savings?

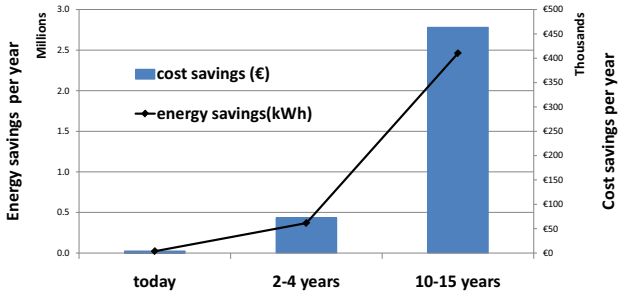
Router power consumption model



- We assume the router can turn off ports not in use
- Δl and Δp based on real measurements [Chabarek et al.]
- 250 edge routers + 50 core routers

1. opportunities 2. problem 3. state of the art 4. solution 5. evaluation **6. relevance**

"Is it worth it?", part 2



Conclusion

Today not, in the future maybe

1. opportunities 2. problem 3. state of the art 4. solution 5. evaluation **6. relevance**

Outline

- Route to make computer science research
- IPTV today
- Research example 1: resource and energy consumption in IPTV [Ramos et al. 1]
- **Research example 2: zapping delay in IPTV [Ramos et al. 2]**
- Take-home message

Zapping delay

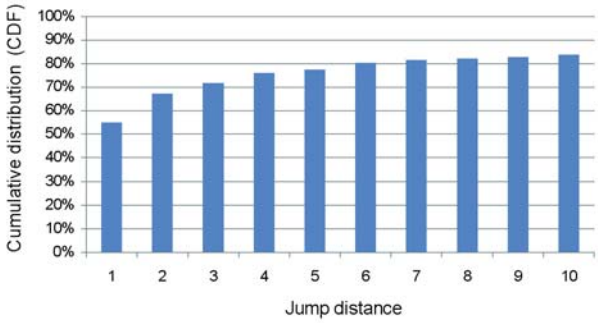
- In IPTV this delay can add up to two seconds or more
  - should be below 430ms[Kooij et al.]

Several solutions proposed

- Video coding and processing techniques
- Network level

- Problems of existing solutions:
  - Complexity
  - Additional video servers needed

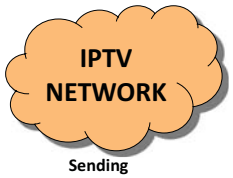
Most zapping is linear...



IPTV today

Requesting channel 3

Requesting channel 3

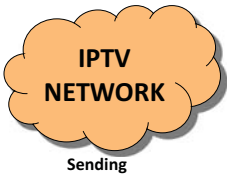


Sending channel 3

IPTV with channel smurfing

Requesting channel 3

Requesting channel 2,3,4



Sending channel 2,3,4

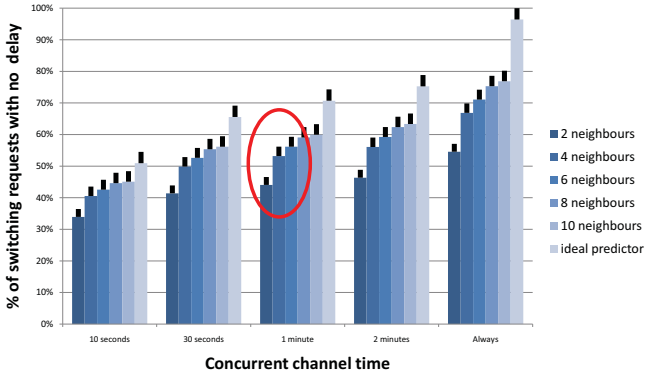
Channel smurfing

- Besides the channel requested, send **N** neighbouring channels concurrently for **C** seconds.

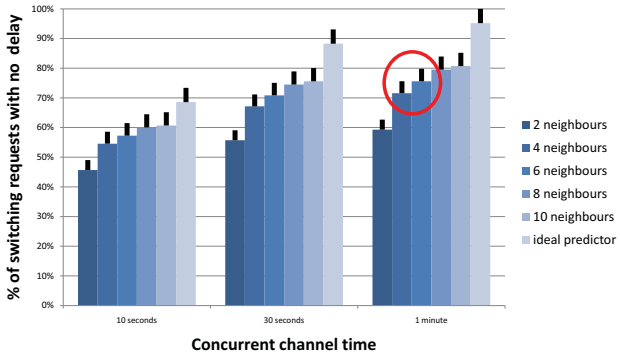
Trace-driven simulation

- Using huge dataset from a nationwide IPTV provider:
  - 255k users, 6 months, 150 TV channels, 622 DSLAMs, 11 regions

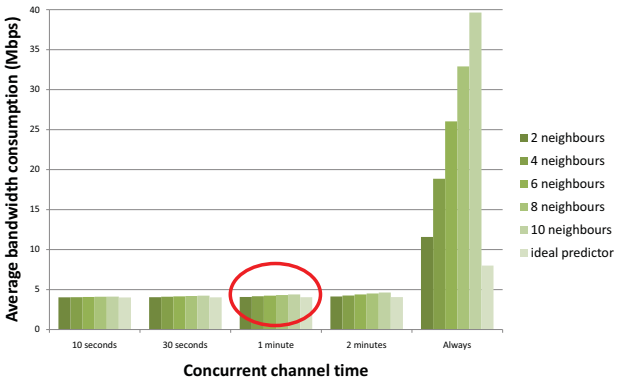
Results – requests with no delay



Results – requests with no delay (zapping periods only)

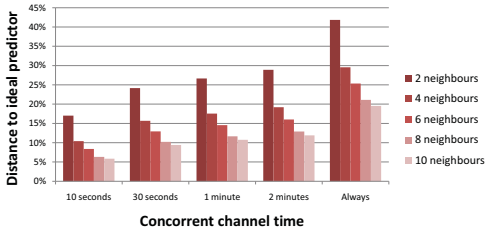


Results – average bandwidth



Is it worth it?

- Very simple to implement
  - Small software upgrade
  - No additional video servers needed
  - Performance close to optimal predictor



Outline

- Route to make computer science research
- IPTV today
- Research example 1: resource and energy consumption in IPTV [Ramos et al. 1]
- Research example 2: zapping delay in IPTV [Ramos et al. 2]
- **Take-home message**

Take-home message

1. Computer science knowledge can be used in novel, practical, useful ways
2. It is important to build realistic scenarios to evaluate our ideas
3. It is fundamental to accept that any technical solution has limitations and that these should not be concealed
4. Be aware that a solution to a problem is only relevant if the benefits clearly outweigh the disadvantages

Interested in these matters?
Any idea what the "G" in GREEN could stand for? ☺
Feel free to contact me:
fernando.ramos@cl.cam.ac.uk

References

[Cha et al.] M. Cha, P. Rodriguez, J. Crowcroft, S. Moon, and X. Amatriain. *Watching television over an IP network*. In Proc. ACM IMC, 2008.

[Chabarek et al.] J. Chabarek, J. Sommers, P. Barford, C. Estan, D. Tsiang, and S. Wright. *Power awareness in network design and routing.* In Proc. IEEE INFOCOM, 2008.

[Cisco] *Cisco visual networking index: Forecast and methodology* 2008-2013, 2008.

[Kooij et al.] R. Kooij, K. Ahmed, K. Brunnstr¨om, and K. Acreo. *Perceived quality of channel zapping.* In proceedings of the IASTED , 2006.

[Piper] B. Piper. *United states IPTV market sizing: 2009-2013*. Technical report, Strategy Analytics, 2009.

[Qiu et al.] T. Qiu, Z. Ge, S. Lee, J. Wang, Q. Zhao, and J. Xu. *Modeling channel popularity dynamics in a large IPTV system.* In Proc. ACM SIGMETRICS, 2009.

[Ramos et al. 1] F.M.V. Ramos, R.J. Gibbens, F. Song, P. Rodriguez, J. Crowcroft, I.H. White. *Reducing energy consumption in IPTV networks by selective pre-joining of channels.* Submitted to ACM SIGCOMM Workshop on Green Networking.

[Ramos et al. 2] F.M.V. Ramos, J. Crowcroft, R.J. Gibbens, P. Rodriguez, I.H. White. *Channel Smurfing: Minimising Channel Switching Delay in IPTV Distribution Networks*. IWITMA 2010 (To appear)