Algorithm for Multimedia Traffic Management based on SDN In NRENs

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Plan

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  - Quality of teaching
  - Massification in universities
- An ever-increasing need for skills exchanges
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- An ever-increasing need for skills exchanges
- Apparition of NREN(National Research and Education Network)
  - Advanced Teaching
  - Boost Research, and so on

But :

- Need for bandwith
  - remote-teaching
  - Video conference, and so on
  - Multicast IP
- Multicast Open Shortest Path First[1](MOSPF)
  - Overloaded routers

Then :

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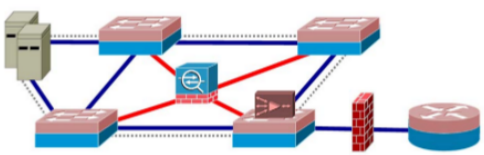
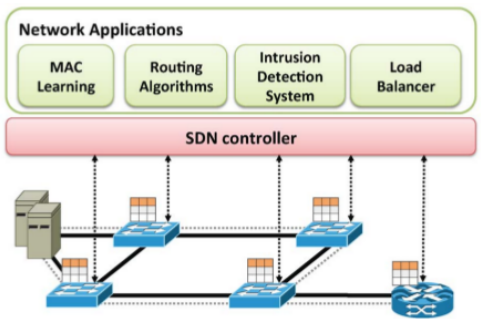


(a) traditional Network



(b) SDN

- SDN
  - Increase controler load
  - Centralized management
- NREN
  - Wide area Network
  - set of Domains(universities, Research centers) without fonctional dependencies
- Then :
  1. How to effectively manage bandwidth using IP multicast based on SDN ?
  2. How to ensure the continuity of multicast traffic between NREN entities(domains) ?

Objective

Enable better multimedia traffic management in NRENs to facilitate online courses based on IP multicasting adapted to the SDN context.

- Multicast IP
  - Groups management ;
  - **Tree construction** ,and so on.

Tableau 1 – Comparison of related works

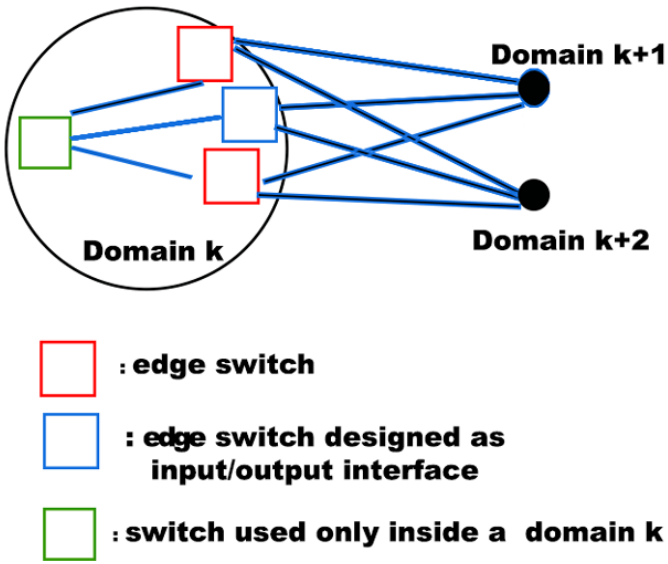
	Initial latency	Type of multicast Tree	Load	Type Rx	Nb Domains
Multiflow[3]	High	Tree per-source	Strong	LAN	One
CastFlow[4]	Medium	Tree per-source	Strong	LAN	One
MTCP[5]	Medium	Tree per-source	Strong	LAN	One
DuSM[6]	Low	Tree per-group	Medium	DataCenter	One
LAMA[7]	Low	Tree per-multi group	small	WAN	One

Description and objective

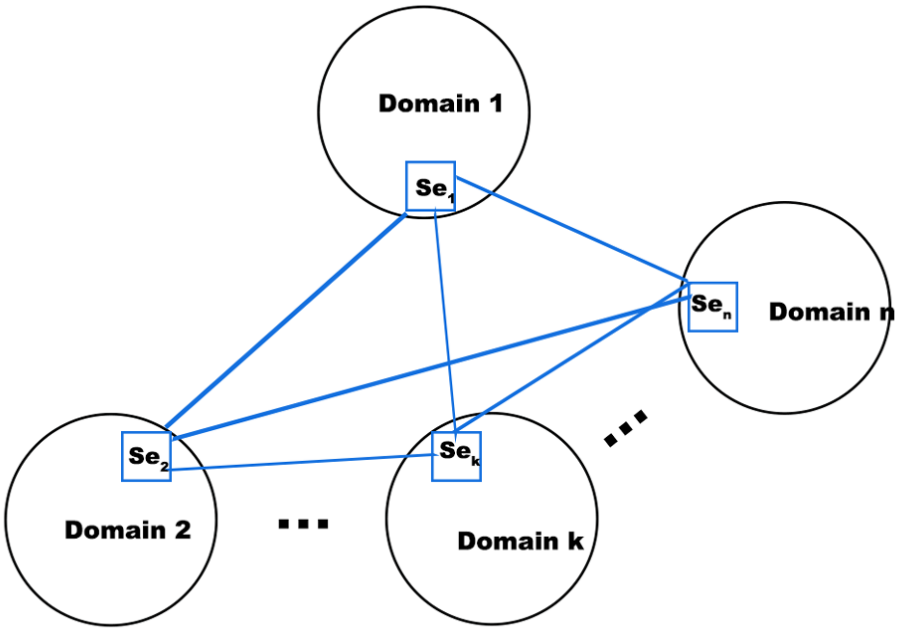
- $G = \{V, E\}$ graph denote NREN topology, where V= $\{node\}$ et E = $\{link\}$. n |domains/NREN|.
- $G_1, G_2, ..., G_n$ The sub-graphs each representing the topology of an domain of an NREN.
- M_k,S_k,H_k/G_k ;$M_k = \{source\}$, $S_k = \{switch\}$,$H_k = \{host\}$
- $\forall s_k \in G_k$, we have $C(s_k)$ and B; load et Bandwitch
- $M_k = MD_k \cup M\overline{D}_k$

With MD_k is the set of multicast sources that belong to the same domain as their destination hosts. And $M\overline{D}_k$ is the set of multicast sources that do not belong to the same domain as their destination hosts.
Given the graph of NREN topology $G = \{V, E\}$, we aim :

1. For each item md_k^i of MD_k We have to find a tree to reach all of its destinations belonging to H_k.
2. For each item $\overline{md}_k^i$ of $M\overline{D}_k$ We need to find a tree to reach all its destinations.



(a) Architecture of a NREN domain



(b) Multi-domains architecture of a NREN

Intra-Domain Component

Our intra-domain component is strongly inspired by Locality Aware Multicast Approach[7](LAMA)since we have only modified one stage of the algorithm which includes three steps(algorithm 1) :

Algorithm 1: *algo_intra – domain*

```
1 begin
2     Step 1 : Clustering multicast groups according to threshold
        distance
3     Step 2 : Select a proper RP according to switch load and
        minimal distance between switches
4     step 3 : Tree construction from RP to reach hosts
5 end
```

Inter-Domains Component

Process

1. We proceed before any tree-building process, at the election of the switch of the edged edge denoted Se among the set of candidate switches belonging to SB (the set of edge switches, i.e those connected to at least one switch in all other domains). Se is chosen such that its charge $C(Se)$ is the smallest of its domain(Algorithm2)
2. For an external multicast source $m\overline{d}$, we then compute the shortest path to the elected border switch of the domain in which the destination hosts are located, denoted Se_h(Algorithm3)
3. Finally, in the domain where the $m\overline{d}$ destinations are located, we construct the tree of the shortest paths from the edge switch of this domain to the destinations of $M\overline{D}$(Algorithm4).

Algorithm 2: *Election_switch_Se*

Data: $G = \{V, E\}$, SB
Result: Se
begin
    Choose the border switch Se such as $C(Se) = \min_{Sb^i \in SB} C(Sb^i)$;
end

Algorithm 3: *Gestion_du_trafic_multimedia_sortant*

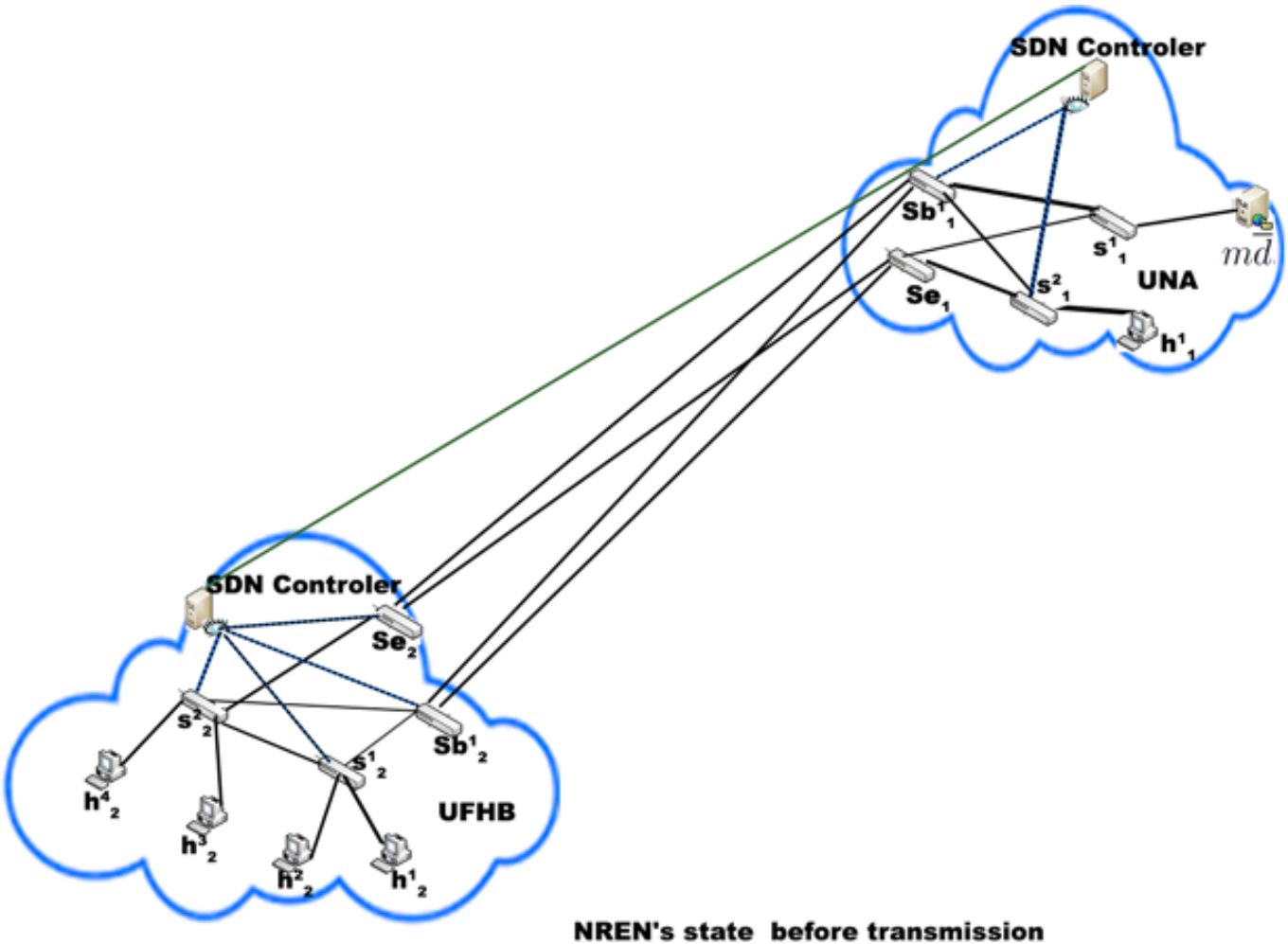
Data: $G = \{V, E\}$, $m\overline{d}$, Se_h, Se
Result: $P(m\overline{d}, Se_h)$
begin
    $P(m\overline{d}, Se_h) \longleftarrow Dijkstra(G, m\overline{d}, Se)$;
    $P(m\overline{d}, Se_h) \longleftarrow P(m\overline{d}, Se_h) \cup (Se, Se_h)$;
end

Algorithm 4: *Gestion_du_trafic_multimedia_entrant*

Data: $G = \{V, E\}$, s_h^b, H_m
Result: T
begin
    // H_m Represents the set of destination hosts of a source m
    $T \longleftarrow arbre\_couvrant(Se_h, H_m)$
end

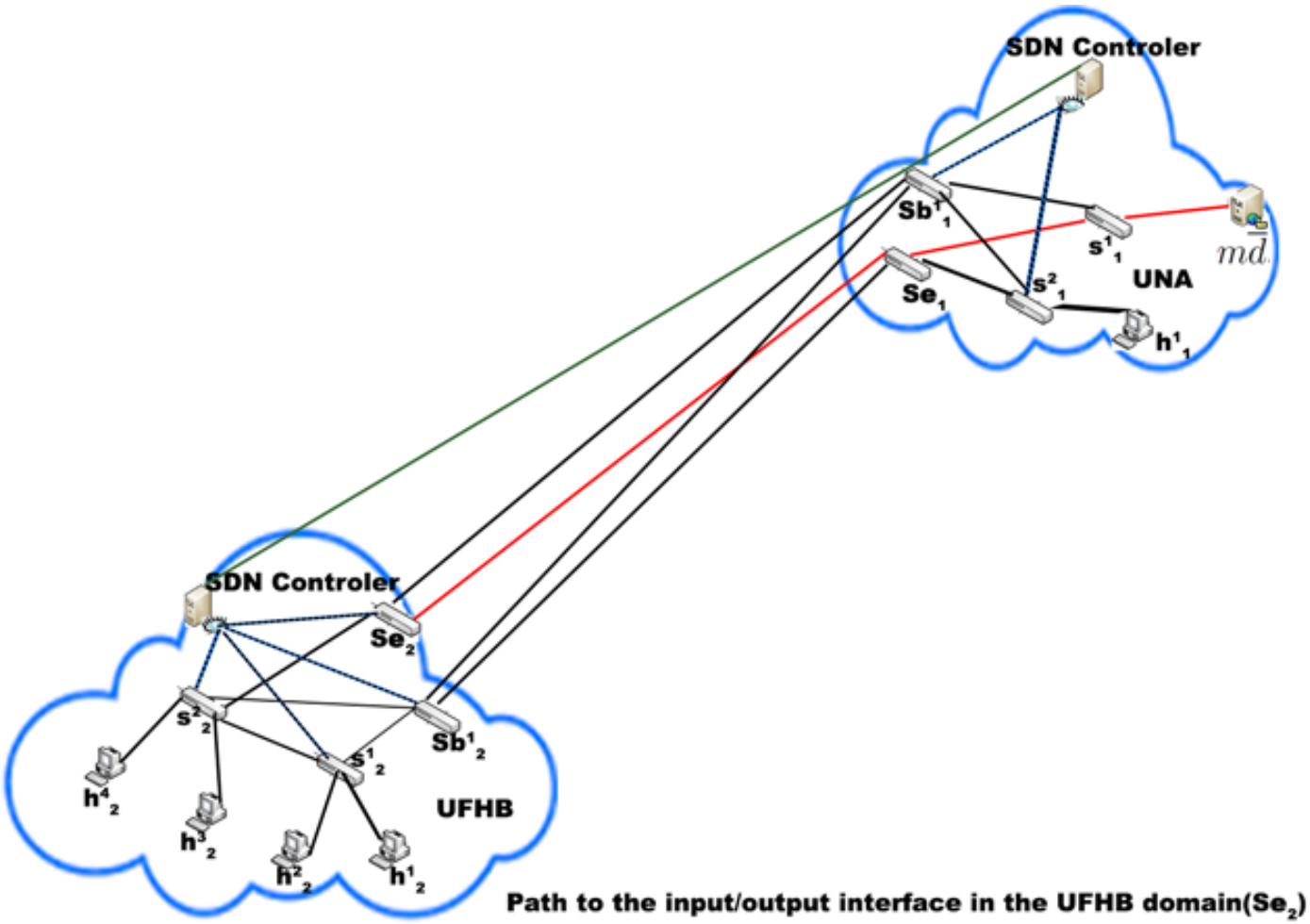
In conclusion, we obtain the final tree T defined as follows : $T = P(m\overline{d}, Se_h) \cup T$.

Illustration of inter-domains component



NREN's state before transmission

Illustration of inter-domains component



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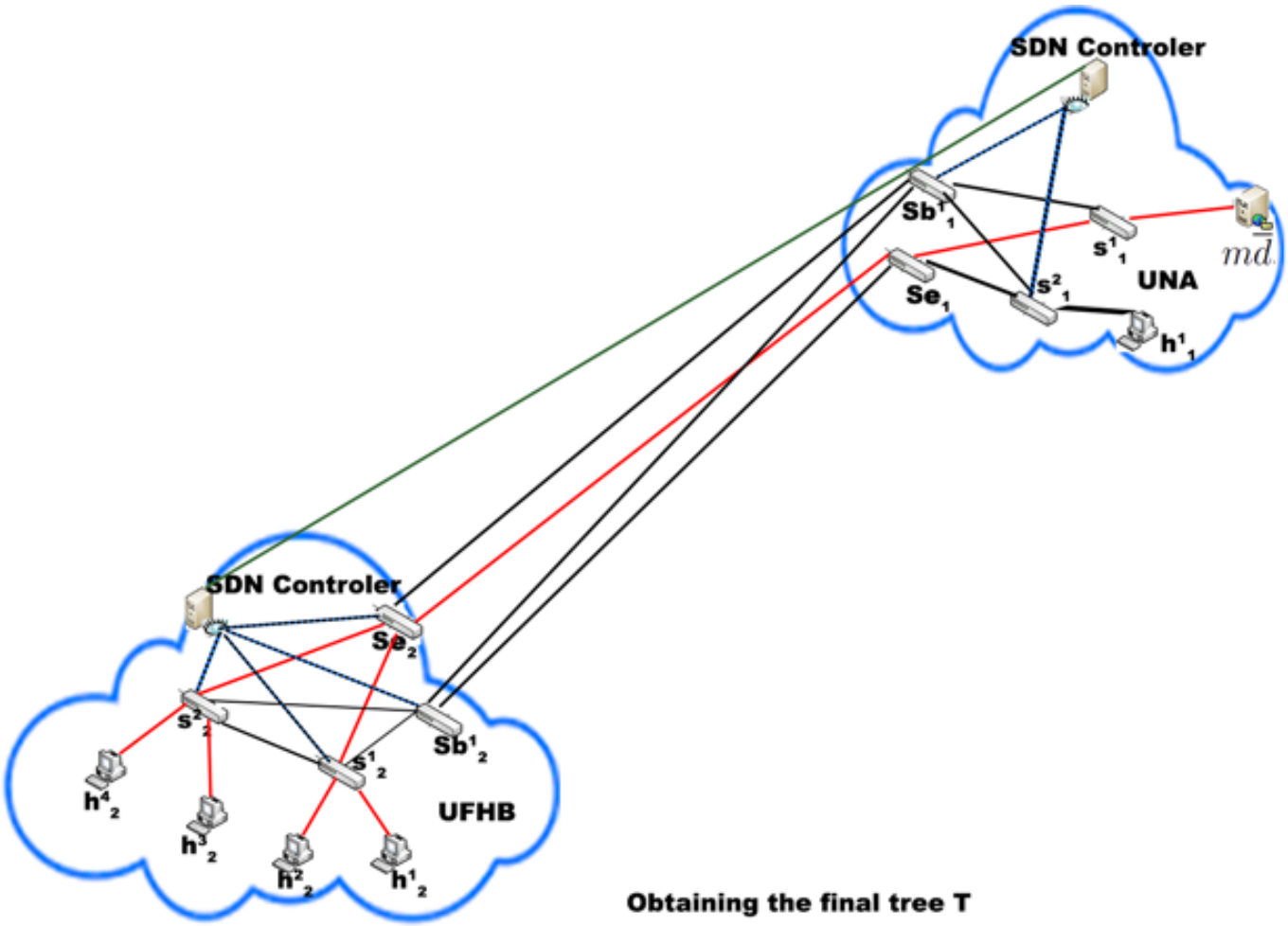

Obtaining the final tree T

In short

1. **How to effectively manage bandwidth using IP multicast based on SDN ?**
   - Algorithm of intra-domain traffic management strongly inspired by LAMA
2. **How to ensure the continuity of multicast traffic between NREN entities(domains) ?**
   - Multi-Domains Architecture for NREN
   - Inter-domain traffic management algorithm

Future works

- Management of groups with sources and hosts of differents domains
- Multi-group approach at a cross-domain component level ?

[1] J. Moy. Multicast extensions to ospf. RFC 1584, RFC Editor, March 1994.

[2] Diego Kreutz, Fernando M. V. Ramos, Paulo Esteves Verissimo, Christian Esteve Rothenberg, Siamak Azodolmolky, and Steve Uhlig. Software-defined networking : A comprehensive survey. *Proceedings of the IEEE*, 103(1) :14–76, Jan 2015. ISSN 1558-2256. doi : 10.1109/jproc.2014.2371999. URL `http://dx.doi.org/10.1109/jproc.2014.2371999`.

[3] Lucas Bondan, Lucas Fernando Müller, and Maicon Kist. Multiflow : Multicast clean-slate with anticipated route calculation on OpenFlow programmable networks. *Journal of Applied Computing Research*, 2(2), apr 2013. doi : 10.4013/jacr.2012.22.02. URL `https://doi.org/10.4013%2Fjacr.2012.22.02`.

[4] Cesar A. C. Marcondes, Tiago P. C. Santos, Arthur P. Godoy, Caio C. Viel, and Cesar A. C. Teixeira. CastFlow : Clean-slate multicast approach using in-advance path processing in programmable networks. In *2012 IEEE Symposium on Computers and Communications (ISCC)*. Institute of Electrical and Electronics Engineers (IEEE), jul

2012. doi : 10.1109/iscc.2012.6249274. URL https://doi.org/10.1109%2Fiscc.2012.6249274.

[5] Miao Zhao, Bin Jia, Mingquan Wu, Heather Yu, and Yang Xu. Software defined network-enabled multicast for multi-party video conferencing systems. In *2014 IEEE International Conference on Communications (ICC)*. Institute of Electrical and Electronics Engineers (IEEE), jun 2014. doi : 10.1109/icc.2014.6883572. URL https://doi.org/10.1109%2Ficc.2014.6883572.

[6] Wenzhi Cui and Chen Qian. Dual-structure data center multicast using software defined networking. *CoRR*, abs/1403.8065, 2014. URL http://arxiv.org/abs/1403.8065.

[7] Ying-Dar Lin, Yuan-Cheng Lai, Hung-Yi Teng, Chun-Chieh Liao, and Yi-Chih Kao. Scalable multicasting with multiple shared trees in software defined networking. *Journal of Network and Computer Applications*, 78 :125–133, jan 2017. doi : 10.1016/j.jnca.2016.11.014. URL `https://doi.org/10.1016%2Fj.jnca.2016.11.014`.