

Social-Aware Virtual Network Embedding for Wireless Content Delivery

SAViNE

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SAViNE Motivation and Vision



- **Cloud-based Content Delivery Networks** constitute a promising alternative to traditional CDNs.

- The **Wireless Cloud** represents the cloud computing evolution to wireless and mobile environments, allowing "as a service" provisioning over seamlessly integrated wireless access networks (e.g. WLAN, etc.)

- Network design and management needs to take into account the **Social** aspects of operation especially when the transferred content is relevant to the social activities of the users

The proposed experiment aims at exploring how SNA inspired metrics can be adopted for fostering content delivery within the evolving wireless Cloud environment.

Cloud Based CDN



○ Key Problem

Selection of surrogates to efficiently facilitate content delivery.

- **Is it different than surrogate placement solutions for traditional CDNs?**
 - ✓ Results cannot be directly applied to CCDNs [1] e.g. multi-domain environment, replication direction.
- **Can SNA-inspired metrics be beneficial?**

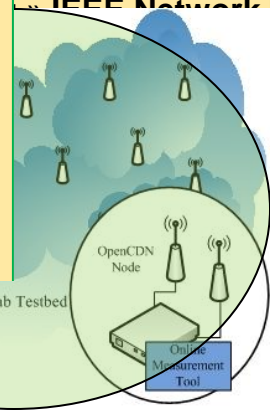
[1] F. Chen, K. Guo, J. Lin, and T. F. La Porta, "Intra-cloud Lightning: Building CDNs in the Cloud," in *IEEE INFOCOM*, pp. 433-441, Mar. 2012.

- Auto SAViNE experiment execution
1. Performance Evaluation and SAViNE validation.
 2. **1. Feasibility:** Performance evaluation of CDNs deployed over the wireless OpenLab infrastructure (NITOS and w-iLab.t) using SAViNE's SNA-inspired surrogate server placement strategies.
 3. **2. Repeatability:** Evaluation of the SAViNE experiment's repeatability over the controlled indoor wireless environment at Zwijnaarde testbed.
 4. **3. Scalability:** Large-scale deployment and evaluation of the proposed SAViNE experiment over the OpenLab infrastructure (including PLE)

h of emerging optimization problems and strategies - joint surrogate placement / social resource mapping problem in the (wireless) cloud

on of key metrics, reflecting the interests of t identified involved players [2][3]. are evaluation. etstbed Requirements.

ppagianni and S. Papavassiliou, "Socio-aware Virtual ... **IEEE Network Magazine**, vol. 6, no. 5, pp. 35 - 43 ,

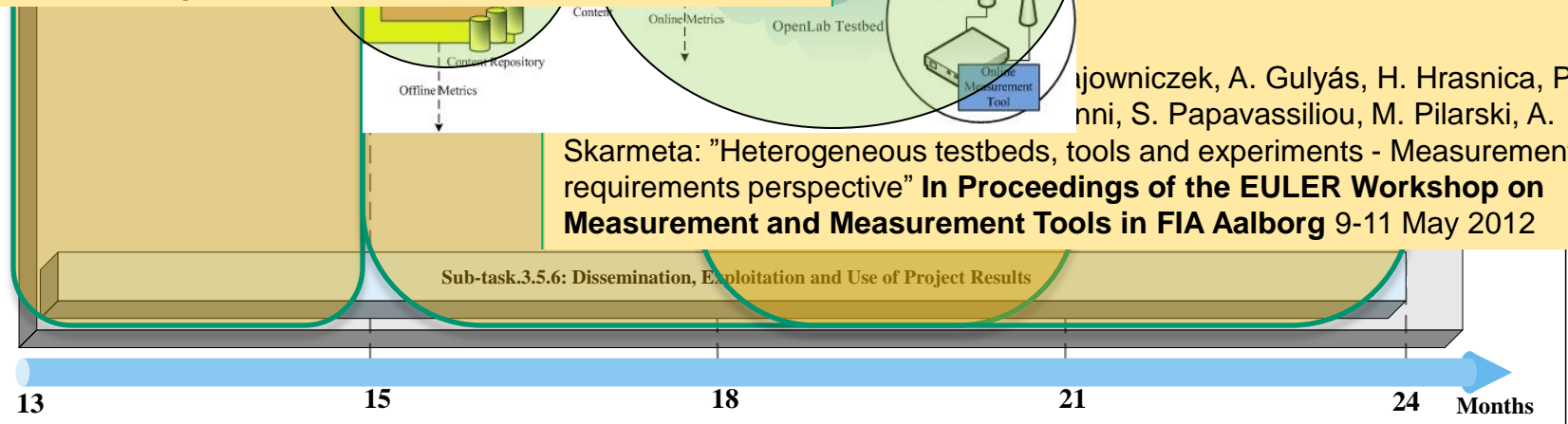


S. Papavassiliou, "A Cloud-oriented Modeling and Assessment," **IEEE TDSC Assessment: metrics, algorithms, techniques.**, vol 10, no 5, pp. 287 - 300,

ijowniczek, A. Gulyás, H. Hrasnica, P. nni, S. Papavassiliou, M. Pilarski, A.

Skarmeta: "Heterogeneous testbeds, tools and experiments - Measurement requirements perspective" **In Proceedings of the EULER Workshop on Measurement and Measurement Tools in FIA Aalborg 9-11 May 2012**

Sub-task.3.5.6: Dissemination, Exploitation and Use of Project Results



OpenLab Tools Used



OMF (Load SAVINE images)
Node Location (<http://am.wilab2.test/phpmyadmin>)
OpenVPN server (virtualwall.test.ibbt.be)



OMF (Load SAVINE images)
Node Info (Advertisement RSpec)
Node Location Info (<http://nitlab.inf.uth.gr/NITlab/index.php/software-tools/distance-tool>)



Node Info and Location (Advertisement RSpec)
Slicestat (<http://codeen.cs.princeton.edu/slicestat/>)
DummyNet (<https://www.planet-lab.eu/doc/guides/user/practices/emulation>)

OpenLab Benefits



Validate SAViNE via experimentation



Test SAViNE feasibility in a controlled wireless environment (Zwijnaarde testbed)



Test SAViNE feasibility in real world settings



Large scale deployment (200 nodes)

Performance Evaluation Metrics

Offline
Metrics

Mapping Cost	The cost of mapping a CDN on the testbed equals the amount of required bandwidth for all content distribution substrate paths as defined by the surrogate placement solution augmented by the computing resources allocated to each surrogate node.
CDN Deployment Cost	The overall cost of deploying a CDN is based on the adopted cost models (retrieval, update, storage [10]). The cost is essentially comprised by (i) the cost for storing the content at the selected sites (ii) the access cost of CDN end-users within the area of service (iii) the cost of updating the content at the transit/surrogate servers
Number of Surrogate Servers	The number of nodes that are selected by the placement algorithm to host a surrogate server.
Path Length	The average number of hops between CDN end-users and the origin server in a particular CDN solution.
Shortest Path Betweenness Centrality	Shortest Path Betweenness Centrality for a particular CDN solution is defined as the average of individual SPBCs of the selected surrogates comprising the final CDN solution.

Performance Evaluation Metrics

Response Time	User perceived service response time.
Throughput	Surrogate throughput measured on the server interfaces.
CPU Load	The average load of the surrogate server aggregated over a pre-specified time window.
Cache Hit Ratio	The ratio of the number of cached content versus total content requested.
Client Requests per Surrogate	The average number of the connected clients per Surrogate
Average Distance per Surrogate	The average distance of the connected clients from the Surrogate
SNR	Signal to noise ratio is a relative measure of the received signal power compared to the noise power in the wireless channel.



Feasibility

SNA-VSP outperforms all greedy heuristics in terms of metrics related to CDN deployment and operation



	SNA-VSP	SNA-GVSP	GS
Mapping Cost (%)	-	16.25	23.66
CDN Dep. Cost (%)	-	19.62	26.66
SS	6	10	11
Path Length	2.54	2.34	2.65
SPBC	0.057	0.053	0.021

	SNA-VSP	SNA-GVSP	GS
Response Time	1.71	2.42	3.52
Client Request per Surrogate	7.33	4.4	4
Average Distance per Surrogate	5.97	5.98	6.06
Cache Hit Ratio	0.45	0.31	0.20
Throughput (%)	46.3	5.17	-
	2.47	0.2	-

Adopting SNA features contributes to the



The results at NITOS testbed, validate the results obtained at the w-iLab.t, for a CDN deployed in real world settings.



Repeatability

❑ Temporal Repeatability

CPU load, throughput, response time, SNR

30 trials over a week

One-way ANOVA statistical Analysis

❑ Spatial Repeatability

CPU load, throughput, response time, SNR

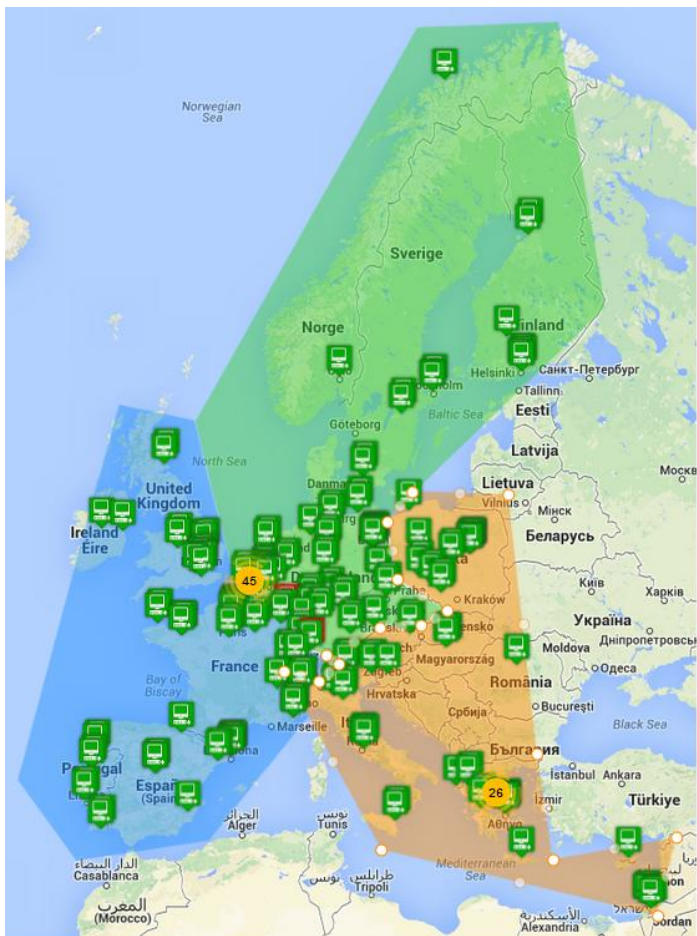
Two symmetrical topologies

Two-tailed z-test
Paired t-test

✓ **Experimental results are repeatable**



Scalability



Federation between PlanetLab – w-iLab.t
PlanetLab splits in three sectors (varying set of end users 100-200 at a step of 50)

Region	East	West	North
	Poland (17)	Spain (8)	Germany (28)
	Italy (9)	France (22)	Finland (5)
	Israel (4)	UK (11)	Belgium (8)
	Greece (13)	Portugal (3)	Czech (2)
	Hungary (3)	Ireland (3)	Sweden (4)
	Austria (4)	Switzerland (7)	Denmark (2)
	Cyprus (1)		Netherlands (1)
Total	51	54	50

Thank you for your attention!