Flexible SDN/NFV-based SON testbed for 5G mobile networks

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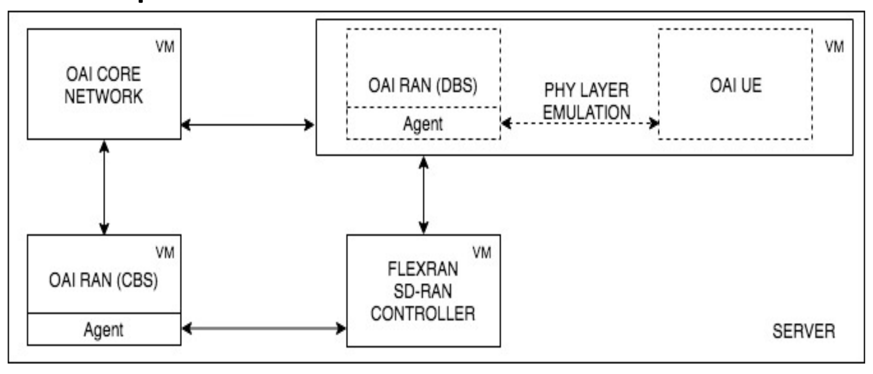
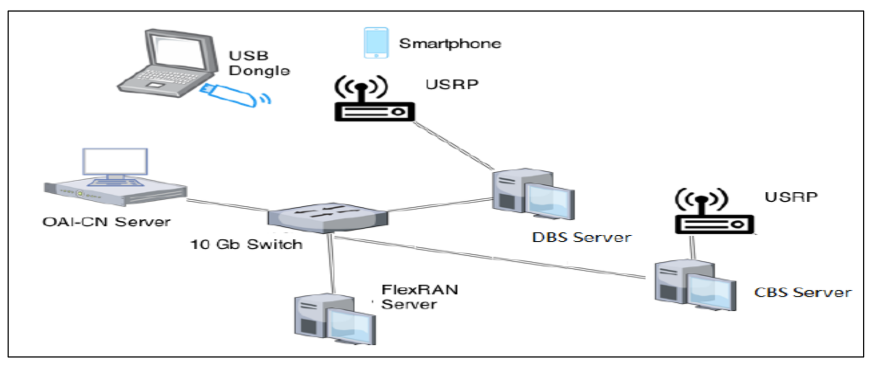
Research topic

The Scope of the research activity is to investigate the impact of the Software Defined Networking (SDN), Network Function Virtualization (NFV) and Self Organizing Network (SON) in future mobile networks, focusing on Cloud/Virtual Radio Access Networks (C/V-RAN). SDN, NFV, SON and C/V-RAN are recognized as key enabling solutions for the future mobile networks. The research activity is conducted in the context of a research collaboration between the University of Glasgow and the University of Catania, both participating to the Mosaic5G Research Project as contributor members.

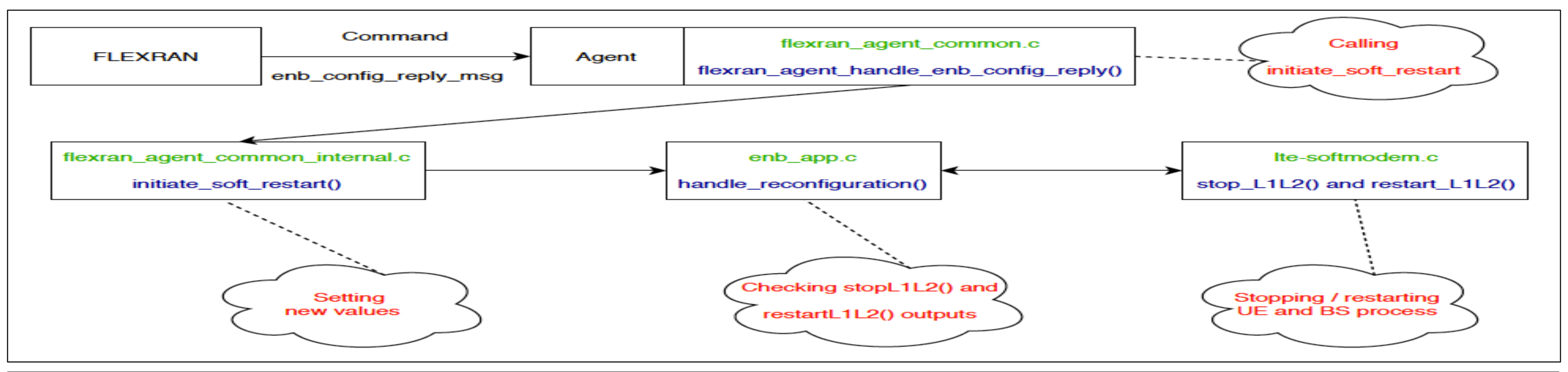
Flexible SDN/NFV-based SON testbed for 5G mobile networks

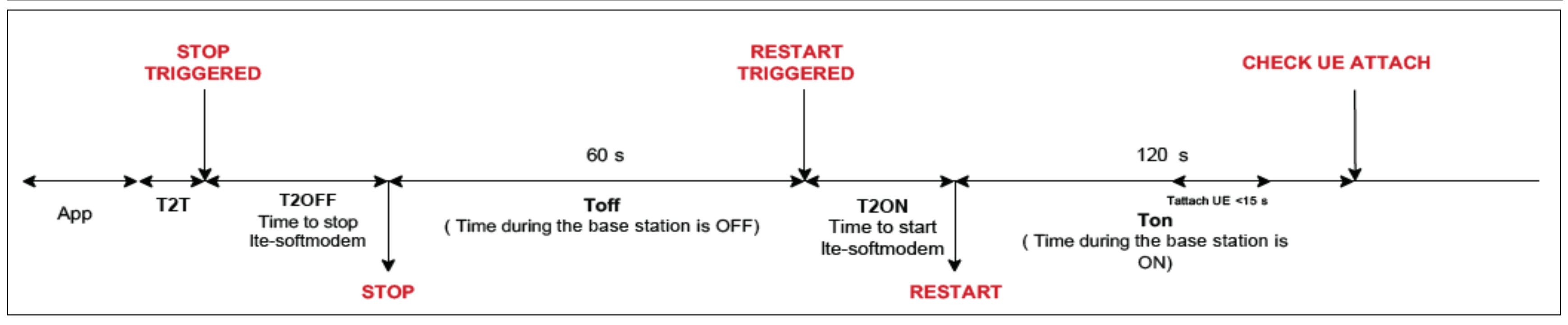
We propose a flexible SDN/NFV-based SON testbed for future 5G mobile networks. The main contribution of our work is to cover the need for a Control Data Separation Architecture (CDSA) based testbed, enabling the investigation of the NG-SON capabilities for practical implementations. We focus our proposal on two experimental setups, a real one and a virtualized one, both based on the FlexRAN and OpenAirInterface software tools.



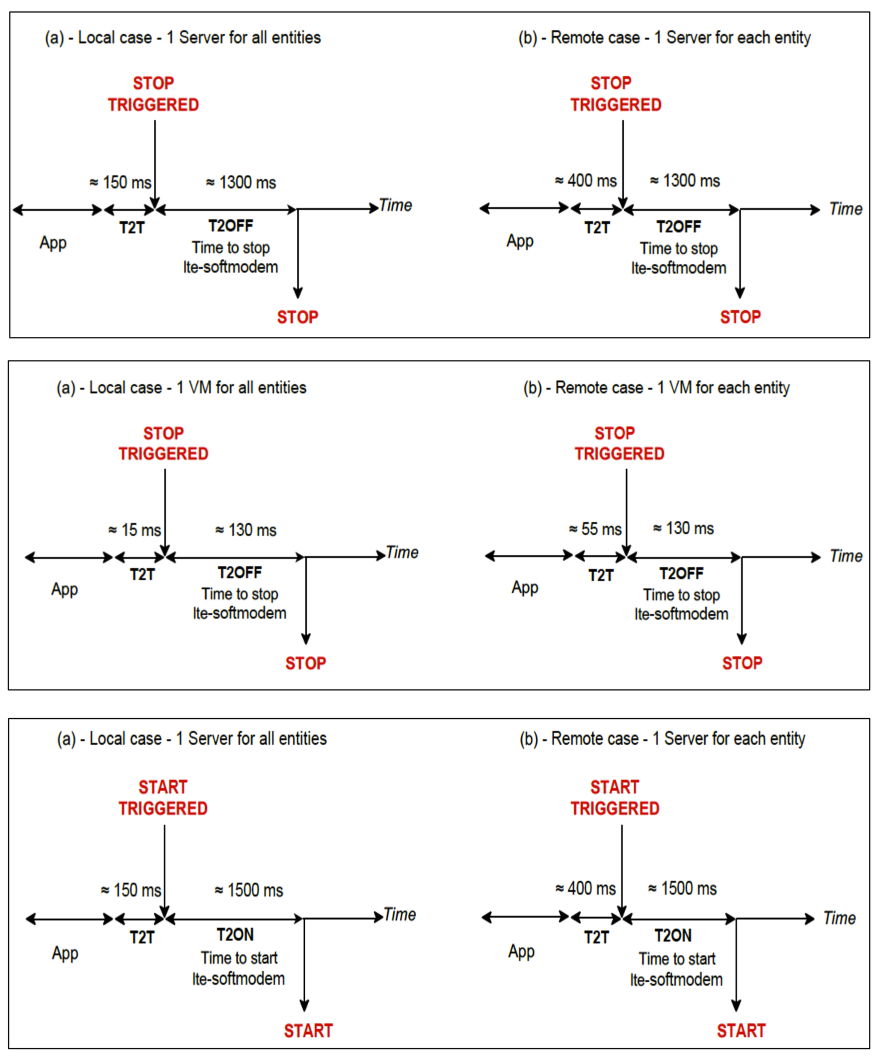


We consider three steps. In the first step we create an application, in order to dynamically trigger the instantiation of a base station in terms of virtualized or real entities. In the second step, we implement specific commands by editing the native code, running on top of FlexRAN/OpenAirInterface, to dynamically manage the RAN entities life-cycle.

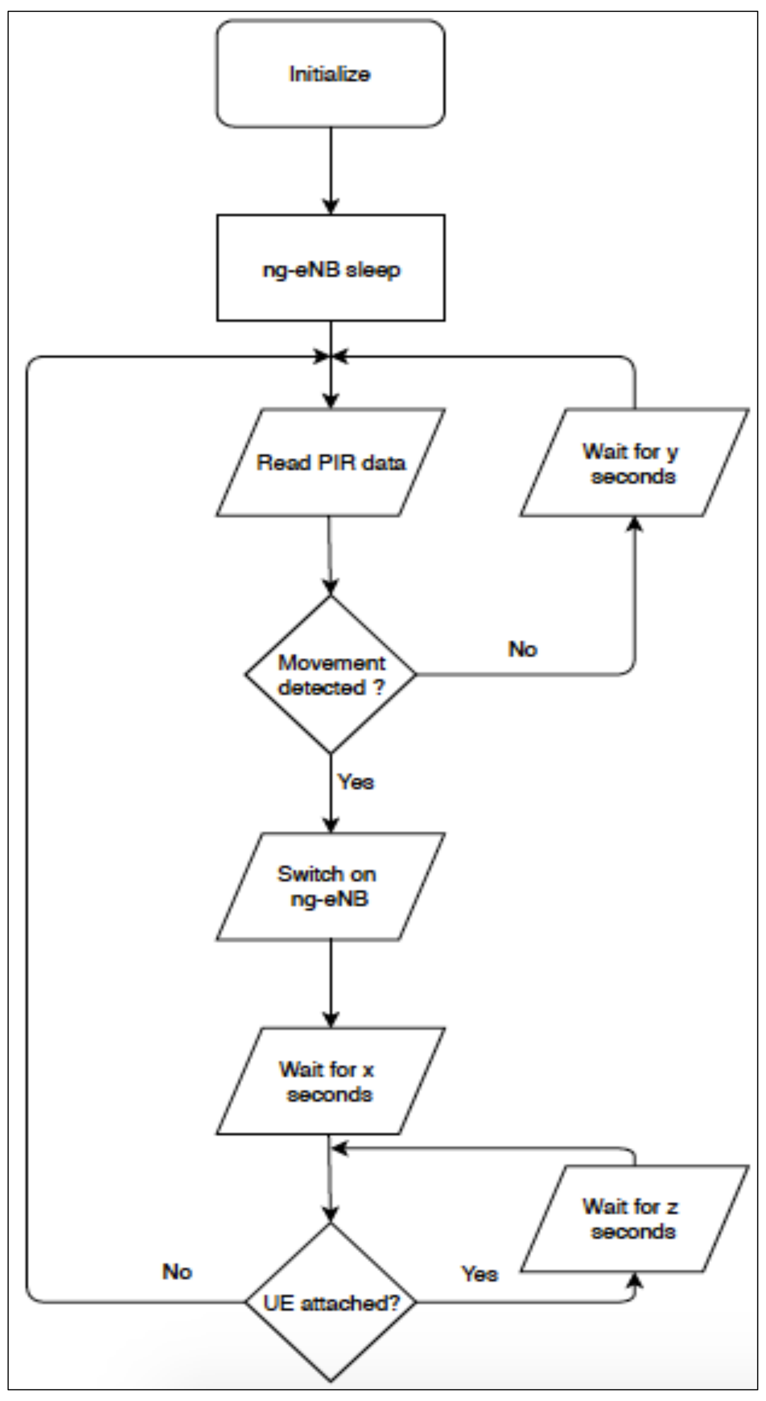




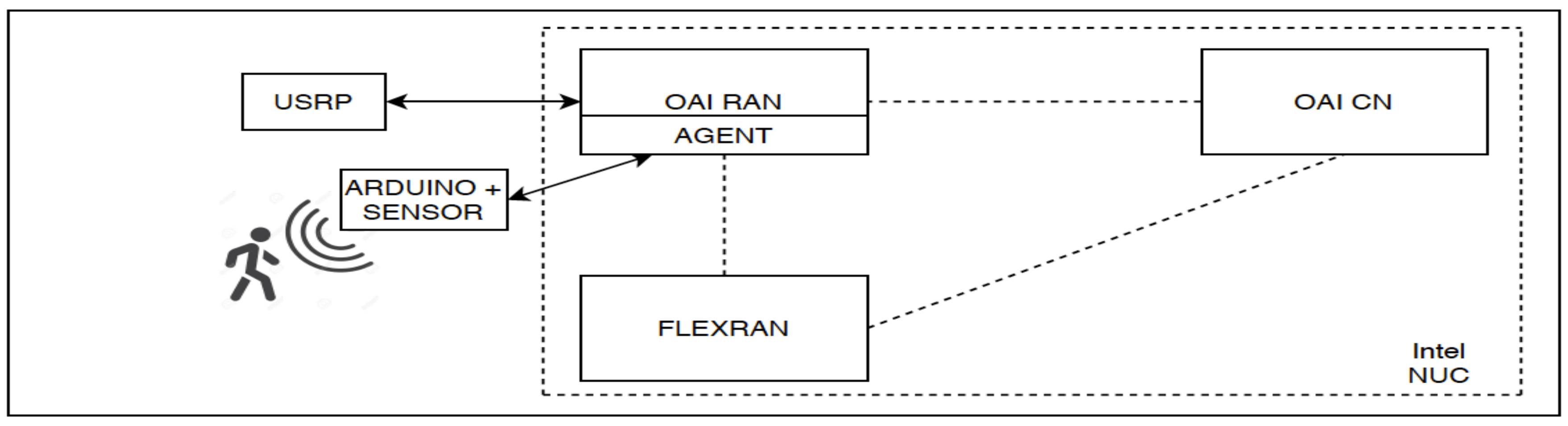
The figures show an example of a specific execution of the Stop&Restart command and the time measurements conducted on both setups. Finally, we perform time measurements, concerning the RAN entities activation / deactivation procedures. The results permit us to validate the NG-SON capabilities of our testbed and the measured timings are remarkable feedbacks for future 5G deployments. Thus our testbed is an ideal enabler for the development of various 5G use cases and a starting point to enable design and comparison of more sophisticated control applications, with its significant closeness to real network deployment criticalities.



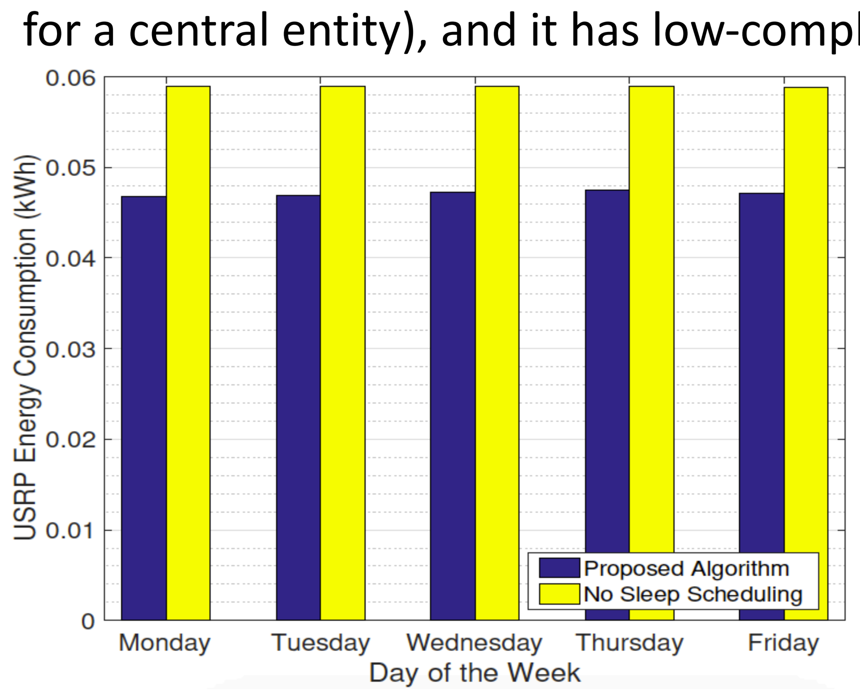
Motion Sensor-based Small Cell Sleep Scheduling for 5G Networks

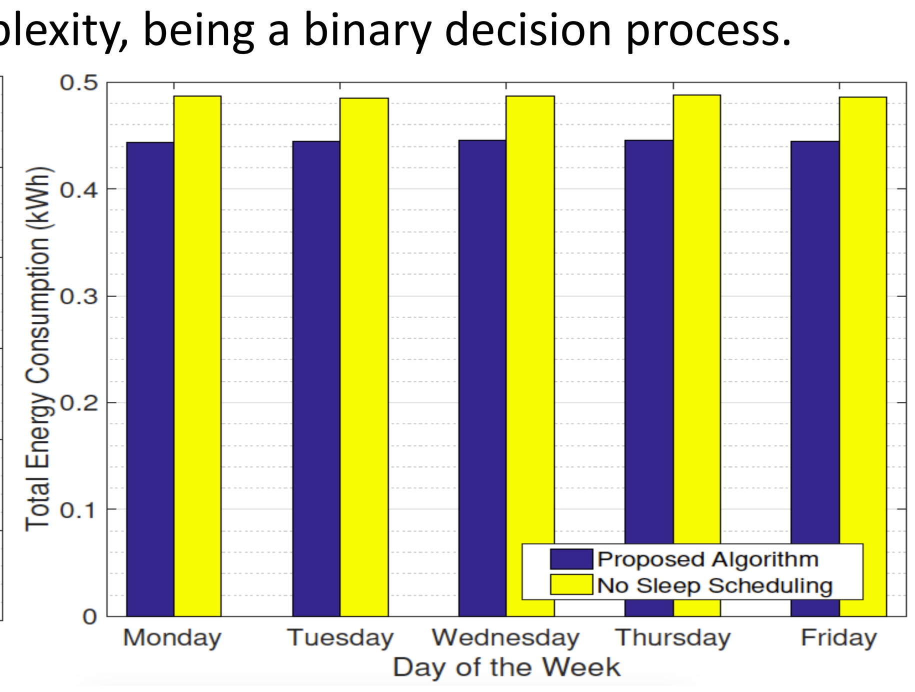


In this paper, we have proposed and implemented on a real testbed, a low-cost, low-complexity Small Cell (SC) sleep scheduling algorithm to minimize the energy consumption of SCs in 5G networks. An HC-SR501 PIR motion sensor and an Arduino Uno board are used in order to detect user presence in an environment of interest. While in sleep mode, the ng-eNB periodically scans its serial port every y seconds for updates from the motion detection circuit to wake up. If a motion is detected, the Arduino board writes the binary value "1", denoting "ON" to the serial port. Once the ng-eNB reads this ON value, it wakes up for x seconds and waits for users to connect to it. If no users connect within this time, the ng-eNB goes back to sleep, starts scanning the serial port again. However, if there is a user connected, the ng-eNB will not go to sleep and will periodically check every z seconds until no user is connected before going back to sleep.



We implement the proposed algorithm using OpenAirInterface and FlexRAN to switch off the RF frontend of the ng-eNB SDR. Figures show the total energy consumption and the USRP energy consumption of our SC sleep scheduling algorithm versus the no sleep scheduling approach. Our approach achieves an average of 8% energy saving in the first case and about 20% in the second case. Our proposal is a good example of D-SON, since the decisions are made locally (no need for a central entity), and it has low-complexity, being a binary decision process.





Work in progress and future goals

The research activities are still in progress. We develop an improved and more efficient version of the algorithm exploiting Machine Learning techniques. We exploit network traffic pattern prediction to determine small cell SDR switching on/off based on datasets. To this end, we optimize the energy efficiency algorithm code in order to include input data from machine learning and consequent power meter measurement showed a significant improving on energy saving. We also develop a RAN Slicing application capable of dynamically performing RAN slice allocation, based on a real-time evaluation. The research activity involve two further research collaborations. The first one with Bristol Is Open, a joint venture between the University of Bristol and Bristol City Council, with the aim of deploying a SDN/NFV based testbed to prove the application of this two paradigms in the context of mobile core networks and the second with the telco research team in Milan of Altran, engineering consulting company, focusing on the virtualization of the IP Multimedia Subsystem (IMS) network architecture in the context of the Voice over 5G. The results of these two further research collaboration will be presented in future relative publications.

Publications

[1] G. C. Valastro, D. Panno, and S. Riolo, "A SDN/NFV-based C-RAN architecture for 5G Mobile Networks," in IEEE MoWNeT 2018
[2] Y. A. Sambo, G. C. Valastro, G. M. M. Patanè, M. Ozturk, S. Hussain, M. A. Imran and D. Panno, "Motion Sensor-based Small Cell Sleep Scheduling for 5G Networks," in IEEE CAMAD 2019
[3] G. M. M. Patanè, G. C. Valastro, Y. A. Sambo, M. Ozturk, S. Hussain, D. Panno and M. A. Imran, "Flexible SDN/NFV-based SON testbed for 5G mobile networks," in DS-RT 2019
[4] M. Ozturk, G. C. Valastro, Y. A. Sambo, G. M. M. Patanè, S. Hussain, D. Panno and M. A. Imran, "Machine Learning based Predictive Cell Switching," in IEEE Communication Letters Journal, IEEE, (Under Submission).
[5] G. C. Valastro, Y. A. Sambo, G. M. M. Patanè, S. Hussain, D. Panno and M. A. Imran, "SDN/NFV based RAN Slicing Application for 5G mobile networks," in IEEE Journal (Under Submission).
[6] E. Catania, A. La Corte, D. Panno and G. C. Valastro, "IoT Privacy in Ultra-Dense Networks," in Journal, (Under Submission).