Ph.D. Candidate

Hung Van Cao

Graduate Academic Unit

Geodesy & Geomatics Engineering

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November 29, 2019

1:00 p.m.

ADI Studio (HC-25)
Head Hall

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Examining Board:
Dr. Yun Zhang (Geodesy & Geomatics Eng.)
Dr. David Coleman (Geodesy & Geomatics Eng.)
Dr. Wei Song (Computer Science)
Dr. Monica Wachowicz (Geodesy & Geomatics Eng.) Supervisor

External Examiner:
Dr. Xin Wang
Dept. of Geomatics Engineering
University of Calgary

The Oral Examination will be chaired by:
Dr. Sasha Mullally, Associate Dean of Graduate Studies

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2016 – present	PhD candidate, University of New Brunswick
2017 – 2018	Diploma in University Teaching, University of New Brunswick
2014 – 2015	MSc in Computer Science, University College Dublin, Ireland
2006 – 2011	BEng in Computer Engineering, University of Information Technology, Vietnam National University Ho Chi Minh City, Vietnam

Selected Publications:

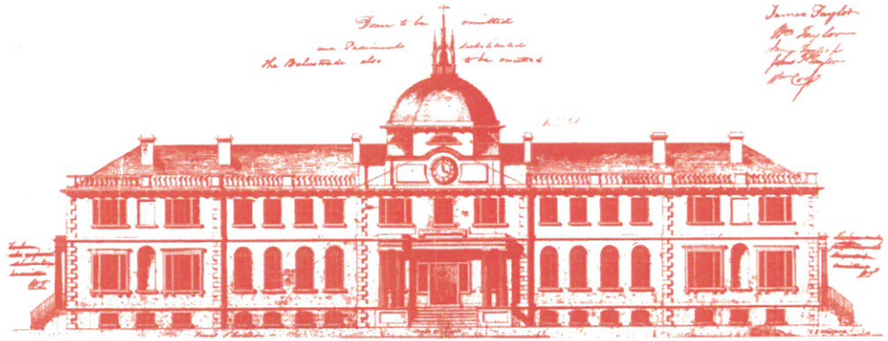
1. **Cao, H.**, & Wachowicz, M. (2019). An Edge-Fog-Cloud Architecture of Streaming Analytics for Internet of Things Applications. **Special Issue** Edge/Fog/Cloud Computing in the Internet of Things. In *Sensors,* 19(16), 3594. (**Peer Reviewed** - Impact Factor: 3.031)
2. **Cao, H.**, Wachowicz, M., Renso, C., & Carlini, E. (2019). Analytics Everywhere: generating insights from the Internet of Things. In *IEEE Access*, 7, 71749-71769. (**Peer Reviewed** - Impact Factor: 4.098)
3. **Cao, H.**, & Wachowicz, M. (2019). The design of an IoT-GIS platform for performing automated analytical tasks. In *Computers, Environment and Urban Systems,* 74, 23-40. (**Peer Reviewed** - Impact Factor: 3.393)
4. **Cao, H.**, & Wachowicz, M. (2019). Analytics Everywhere for streaming IoT data. In *2019 Sixth International Conference on Internet of Things: Systems, Management and Security*. IEEE. Granada, Spain. (**Peer Reviewed** - Accepted)
5. **Cao, H.**, Brown M., Chen L., Smith R., & Wachowicz, M. (2019). Lessons learned from integrating batch and stream processing using IoT data. In *2019 Sixth International Conference on Internet of Things: Systems, Management and Security*. IEEE. Granada, Spain. (**Peer Reviewed** - Accepted)
6. Parise A., Callejo, M. A. M., **Cao, H.**, Mendonca, M., Kohli, H., & Wachowicz, M. (2019). Indoor Occupancy Prediction using an IoT Platform. In *2019 Sixth International Conference on Internet of Things: Systems, Management and Security*. IEEE. Granada, Spain. (**Peer Reviewed** - Accepted)
7. **Cao, H.**, Wachowicz, M., Renso, C., & Carlini, E. (2018). An edge-fog-cloud platform for anticipatory learning process designed for internet of mobile things. In *arXiv:1711.09745*.
8. **Cao, H.**, Wachowicz, M., & Cha, S. (2017, December). Developing an edge computing platform for real-time descriptive analytics. In *Big Data (Big Data), 2017 IEEE International Conference on (pp. 4546-4554).* IEEE. Boston, MA, USA. (**Peer Reviewed**)
9. Maduako, I., **Cao, H.**, Hernandez, L., & Wachowicz, M. (2017, October). Combining edge and cloud computing for mobility analytics. In *Proceedings of the Second ACM/IEEE Symposium on Edge Computing (p. 22).* ACM. San Jose, CA, USA. (**Peer Reviewed**)
10. Hernandez, L., **Cao, H.**, & Wachowicz, M. (2017, October). Implementing an Edge-Fog-Cloud architecture for stream data management. In *Fog World Congress (FWC), 2017 IEEE (pp. 1-6).* IEEE. Santa Clara, CA, USA. (**Peer Reviewed**)
11. **Cao, H.**, & Wachowicz, M. (2017, August). The design of a streaming analytical workflow for processing massive transit feeds. In *2nd International Symposium on Spatiotemporal Computing.* Harvard University, Cambridge, MA, USA. (**Peer Reviewed**).
12. **Cao, H.** (2017). What is the next innovation after the internet of things?. In *arXiv:1708.07160*.

Several other Publications

Developing an Analytics Everywhere Framework for the Internet of Things

Abstract

Despite many efforts on developing protocols, architectures, and physical infrastructures for the Internet of Things (IoT), previous research has failed to fully provide automated analytical capabilities for exploring IoT data streams in a timely way. Mobility and co-location, coupled with unprecedented volumes of data streams generated by geo-distributed IoT devices, create many data challenges for extracting meaningful insights. This research work aims at exploring an edge-fog-cloud continuum to develop automated analytical tasks for not only providing higher-level intelligence from continuous IoT data streams but also generating long-term predictions from accumulated IoT data streams. Towards this end, a conceptual framework, called *"Analytics Everywhere"*, is proposed to integrate analytical capabilities according to their data life-cycles using different computational resources. Three main pillars of this framework are introduced: resource capability, analytical capability, and data life-cycle. First, resource capability consists of a network of distributed compute nodes that can handle automated analytical tasks either independently or in parallel, concurrently or in a distributed manner. Second, analytical capability orchestrates the execution of algorithms to perform streaming descriptive, diagnostic, and predictive analytics. Finally, data life-cycles are designed to manage both continuous and accumulated IoT data streams. The research outcomes from a smart parking and a smart transit scenario have confirmed that a single computational resource is not sufficient to support all analytical capabilities that are needed for IoT applications. Moreover, the implemented architecture relied on an edge-fog-cloud continuum and offered some empirical advantages: (1) on-demand and scalable storage; (2) seamlessly coordination of automated analytical tasks; (3) awareness of the geo-distribution and mobility of IoT devices; (4) latency-sensitive data life-cycles; and (5) resource contention mitigation.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

The University of New Brunswick recognizes that the university sits on traditional Wolastoqey territory. The river that runs right by our university – the St. John River – is also known as Wolastoq, along which live the Wolastoqiyik -- the people of the beautiful and bountiful river.

UNIVERSITY OF NEW BRUNSWICK
SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Hung Cao

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY