The Industrial-Academic Interface

A story of successful collaboration between industry and academia.

by

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Ways to Collaborate

1. **In the public domain.**

   – Publicize project/engineering information and hope academics do something with it.

     • **i.e., publish papers about it.**

2. **Through direct partnership.**

   – Partnership between industrial and academic groups to solve a particular problem.

     • **My focus in this talk.**

This Talk

- The story of successful (and ongoing) collaboration between
    - a **Northrop Grumman research and development group** and
    - **UNC-Chapel Hill's Real-Time Systems group**.

This Talk

- I think the interesting lessons, that may be useful to others, revolve around the "**collaborative interface.**"

- In other words, how do you successfully **transfer knowledge** from industry to academia and back in a way that is **mutually beneficial?**

Outline

1. Background:

   – who, what, when, where, why.

2. Knowledge transfer **from NGC to UNC.**

3. Knowledge transfer **from UNC to NGC.**

UNC Real-Time Systems Group

- 2 professors and 11 PhD students.
- Strong focus on both the "more **theoretical**" (scheduling) and "more **applied**" (operating systems).
- Very interested in **multicore.**

Our Methodology

- Develop **new theory.**

  - Mostly, solving dozens of problems relating to achieving timing guarantees efficiently on multicore platforms.

- Perform **implementation studies** to determine **real-world usefulness** of new and existing theory.

Linux Testbed for Multiprocessor Scheduling in Real-Time Systems

Who Funds Us?

- **Now:**
  - National Science Foundation (3 grants).
  - U.S. Army Research Office.
  - U.S. Air Force Office of Scientific Research.
  - Northrop Grumman Corp.
  - U.S. Air Force Research Lab, Rome, NY.

- **Recently:**
  - AT&T Research, Intel, IBM, Sun Microsystems.

NGC Group

- "Research and Development."
- Let me qualify that:
  - Development: New software for **next-generation UAVs.**
  - Research: Since what they're doing has never been done, there is some **applied research** involved.

NGC Group

- Focus on mission management software for Navy UCAS / UCLASS program.

Our Research for NGC

- Next-gen mission management software:
  - "Smarter" than a human pilot.
  - **Computationally intensive** workload.
  - **Dynamic** workload.
  - Needs **multiple cores.**
  - Must meet **timing guarantees.**

> **Our research:**
> **What kind of OS platform do you need?**

MCAR Workshop (2009)

- MCAR: Mixed Criticality Architecture Review.

- UNC and NGC **collaboration developed out of this workshop.**

- Note: This is an example of what I earlier called "public domain" collaboration.

Basic Structure

- Two students and two professors working on NGC-inspired problems part time.
  - Myself and **Jeremy Erickson**
- During the summer, the students do **internships** with the NGC group.

Challenges

1. Complex **restrictions on information.**

   – Proprietary.

   – Restricted by ITAR.

   – Classified.

2. Lack of hands-on **practical engineering knowledge.**

Solutions

1. Summer **internships.**

2. **Translation** of information to academic (public) context.

3. NGC **approval** of publications.

4. New UNC **avionics course.**

Internships

- Multiple "man-summers" spent at NGC.
- As NGC employees:
  - **Access to proprietary NGC information.**
  - **Access to relevant classified information.**
  - **Gain firsthand experience of the problem domain.**
  - **Can't bring much of their knowledge back to UNC (directly).**

Translating Information

- **Proxy domain**
  - Model the problem in a non-proprietary/non-classified way.
  - e.g. represent UAVs on a mission as honeybees collecting honey.

- **Strip out details**
  - e.g. talk about "long-running optimization problems" instead of the specific operation being performed.

NGC Approval

- **Approval process** for UNC publications relating to NGC work.
  - Makes NGC comfortable.
- Previously agreed-upon **timing** and **protocol.**
  - Makes UNC comfortable.

Avionics Course

- Internships gave us a "magnified view of a small area" of avionics.

- To gain broader domain knowledge, the UNC group created an **Avionics course** in the computer science department.

- Approx. 10 students taking the course.

Avionics Course Structure

- Students look up avionics-related info **online** and present it to the class.

- Syllabus designed by the two UNC/NGC interns.

    – Ask NGC engineers for **additional background information** when needed.

Avionics Course Topics

- Certification requirements.
- Security requirements.
- Avionics RTOSs.
- Mixed Criticality.
- Middleware.
- Communication.
- Fault Tolerance.
- …etc.

Work Products

1. Comprehensive **technical report.**

2. Direct contribution during **internships.**

3. Published conference **paper.**

Technical Report

- How to bring together **existing research** and **new research** to support a **framework** to **solve their problems.**

- Developed over the last semester.

Internship Contributions

- Internship has been a mechanism to begin **applying** existing and new research results to NGC's problem domain.

Published Conference Paper

- NGC co-author.

- Presents some **preliminary research results** on mixed criticality multicore scheduling.

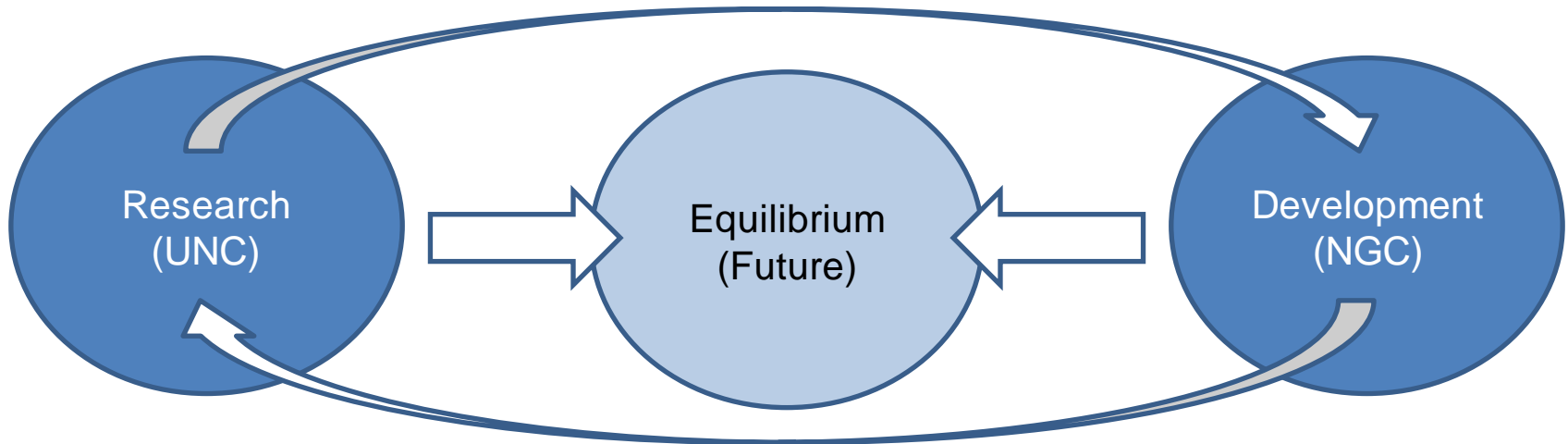- Exposes the real-time community to important real-world problems.

R&D Feedback Cycle

- UNC: Ongoing **research.**
  - Must fit NGC's actual development.
- NGC: Ongoing **development.**
  - Must fit formalisms proposed by UNC.
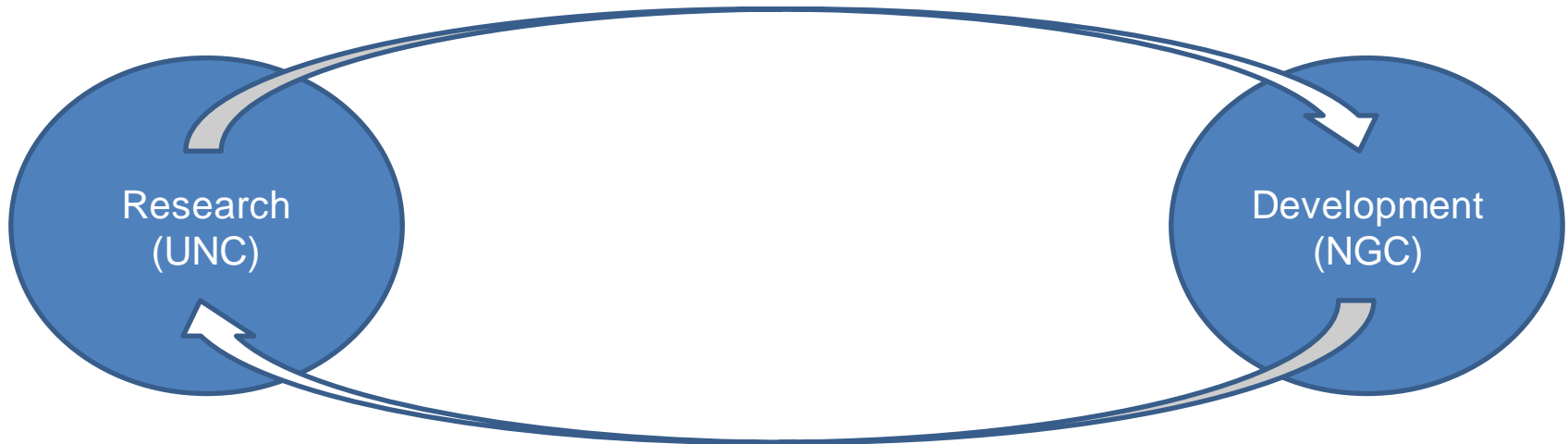
R&D Feedback Cycle

- Eventually, **both sides must converge.**

Conclusions

- Sharing information across the academic/industrial boundary can be **tricky,** but can also be **rewarding.**

- I hope the audience gained **ideas** or **insight** that they can make use of in current or future collaboration.

Questions?

Citations

- **Presenter:** http://cs.unc.edu/~mollison
- **Real-Time Systems Group:** http://cs.unc.edu/~anderson/real-time
- **LITMUS^{RT}:** http://cs.unc.edu/~anderson/litmus-rt
- **MCAR workshop:** http://www.cse.wustl.edu/~cdgill/CPSWEEK09_MCAR/mcar_workshop.html
- **Publication:** M. Mollison, J. Erickson, J. Anderson, S. Baruah, and J. Scoredos, " Mixed Criticality Real-Time Scheduling for Multicore Systems", Proceedings of the 7th IEEE International Conference on Embedded Software and Systems, pp. 1864-1871, June 2010.