



# Scholarly Research

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## *A Guide for Research Students*

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# Introduction

- The 5W+H of Scholarly Research
  - ◆ What?
  - ◆ Why?
  - ◆ Who?
  - ◆ Where?
  - ◆ When?
  - ◆ How?
- Tips and Pitfalls



# What is research?

- Basic Research
  - ◆ Discovery and Understanding
- Applied Research
  - ◆ Problem Solving
  - ◆ Advancing the State-of-the-Art



# Why do research?

- Basic Research
  - ◆ Advancing Human Knowledge
- Applied Research
  - ◆ Solving Existing Problems
  - ◆ Improving Existing Processes and Methods (a.k.a. Technology)



# Who do research?

- Academic Institutions
  - ◆ Universities, Research Institutes
- Government Research Labs
  - ◆ NASA, DoE, NIST, etc.
- Industry Research Labs
  - ◆ Lucent/Bell Labs, Microsoft Research, etc.



# Where is research?

- Research Conferences
  - ◆ Organized around research areas
  - ◆ E.g. INFOCOM, ICC, GLOBECOM, etc.
- Research Publications
  - ◆ Conference Proceedings
  - ◆ Journals and Magazines
- Online Resources
  - ◆ [iel.ihs.com](http://iel.ihs.com) - IEEE E-Library



# When do we publish research results?

- Early/Preliminary Results
  - ◆ Conferences
  - ◆ Letter-type Journals
    - ◆ IEEE Communications Letters
- Complete Results
  - ◆ Journals



# How do we do research?

- Key Steps
  - ◆ Identify a Problem
  - ◆ Understand existing solutions
  - ◆ Propose a *better* Solution
  - ◆ Analyze the Solution
  - ◆ Report results via publications



# How do we do research?

- Identify a Problem
  - ◆ Define the problem
    - ◆ How important is the problem?
    - ◆ Is it potentially tractable?
  - ◆ Define the objective
    - ◆ What do we expect from the solution?



# How do we do research?

- Understand existing solutions
  - ◆ Literature Study / Survey
    - ✦ Read all related publications you can find.
    - ✦ Try to create a taxonomy for existing solutions.
    - ✦ Compare existing solutions and identify their strengths and weaknesses.



# How do we do research?

- Understand existing solutions
  - ◆ Useful Tools
    - ◆ IEEE Online Digital Library at <http://iel.his.com>
    - ◆ ACM Digital Library at <http://www.acm.org/dl/>
    - ◆ CS Technical Reports at <http://www.ncstr1.org>
    - ◆ NEC ResearchIndex at <http://www.researchindex.com>
    - ◆ The Google search engine at <http://www.google.com>



# How do we do research?

- Propose a *better* solution
  - ◆ How *better*?
    - ◆ Less storage?
    - ◆ Less bandwidth?
    - ◆ Shorter delay/time?
    - ◆ Lower cost?
    - ◆ etc.



# How do we do research?

- Propose a *better* solution
  - ◆ What are the tradeoffs?
    - ✦ Do we need more buffer space to reduce bandwidth requirement?
    - ✦ Do we need more bandwidth to shorten the response time?
    - ✦ Do we need more delay to reduce buffer requirement?



# How do we do research?

- Propose a *better* solution
  - ◆ What are the limitations?
    - ✦ Does it always that much better or it only perform well under certain conditions?
    - ✦ Does it require any special support from other parts of the system?



# How do we do research?

- Analyze the solution
  - ◆ Mathematical Analysis
  - ◆ Simulation
  - ◆ Experimentation

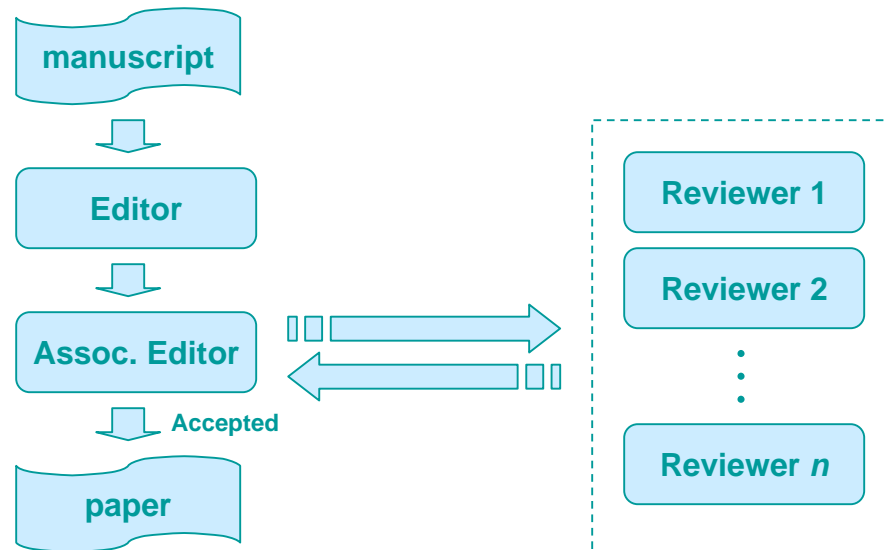


# How do we do research?

- Report results via publications
  - ◆ Report early results via conference
  - ◆ Report complete results via journal
    - ◆ IEEE Transactions on
      - Circuits and Systems for Video Technology
      - Multimedia
      - Parallel and Distributed Systems
      - Communications
    - ◆ etc.

# How do we do research?

- Report results via publications
  - ◆ The Review Process:





# Tips and Pitfalls

- Depth of Research
  - ◆ The more in-depth the study the better.
  - ◆ Depth includes:
    - ✦ consideration of alternatives
    - ✦ consideration of factors
    - ✦ understanding of the problem
    - ✦ understanding of the solution



# Tips and Pitfalls

- Absolute Precision

- ◆ Observations and conclusions must be based on **facts**, not just intuitions or speculations.

- ◆ Facts are

- ◆ results from analysis, simulation, or experiments.



# Tips and Pitfalls

- Motivation Awareness
  - ◆ Each and every step of your solution must be justified, and motivated.
  - ◆ Never propose anything without reason(s) to back it up.



# Tips and Pitfalls

- Critical Thinking
  - ◆ Question everything, including your own ideas.
  - ◆ Verify all your claims, quantitatively.



# Tips and Pitfalls

- Good Writing is Essential
  - ◆ Read books on English writing
  - ◆ Read technical journal papers and learn their writing style
  - ◆ *Everyone can acquire good technical writing skill if one makes the effort.*



# Tips and Pitfalls

- Good Presentation is Essential
  - ◆ Read books on presentation skills
  - ◆ Practice, observe, and more practices
  - ◆ *Everyone can acquire good presentation skill if one makes the effort.*