Research challenges in the large-scale computational modeling of networks

Wenji Wu, Phil DeMar

wenji@fnal.gov, demar@fnal.gov

Fermilab

COMBINE: COmputational Modeling of BIg Networks Workshop

September 11 – 12, Washington DC

Topics

- Previous network modeling & simulation projects

- Research challenges in the large-scale computational modeling of networks

- What are we interested?

Previous Network Modeling and Simulation Projects

- **Data Network Security Modeling & Simulation Project (partnered with Army Research Laboratory)**

  - Design and Implement a whole package of IP network security attacking models using OPNET Modeler.

    - *ICMP Redirect Attack*, *ICMP Smurf Attack*, *ICMP Destination Unreachable Attack*,

    - *OSPF Max-Age Attack*, *OSPF Max-sequence Attack*,

    - *DSR Back-Hole Attack*, *DSR Selective-Forwarding Attack*, and *AODV Deceiving-Route Attack* etc.

  - The security attacking models are used to analyze the effects of information based network faults on TCP/IP networks.

Previous Network Modeling and Simulation Projects

- **Modeling and Simulation of Optical Networks Using a Virtual GMPLS-Based Optical Switching Router**

  - Designed and modeled a Virtual Optical Switching Router (VOSR) using OPNET Modeler.

  - The VOSR models provide a framework to analyze and evaluate various wavelength routing and assignment algorithms in optical networks.

Previous Network Modeling and Simulation Projects

- **MANET-enabled OSPF Routing Protocol (Partnered with BAE Systems)**

    - Develop and implement an MANET-enabled OSPF routing protocol. A new OSPF MANET (wireless) interface is designed to make MANET extensions to OSPFv2, adapting OSPFv2 to the wireless environment. The MANET-enabled OSPF enables a unified routing protocol for both wired and wireless networks.

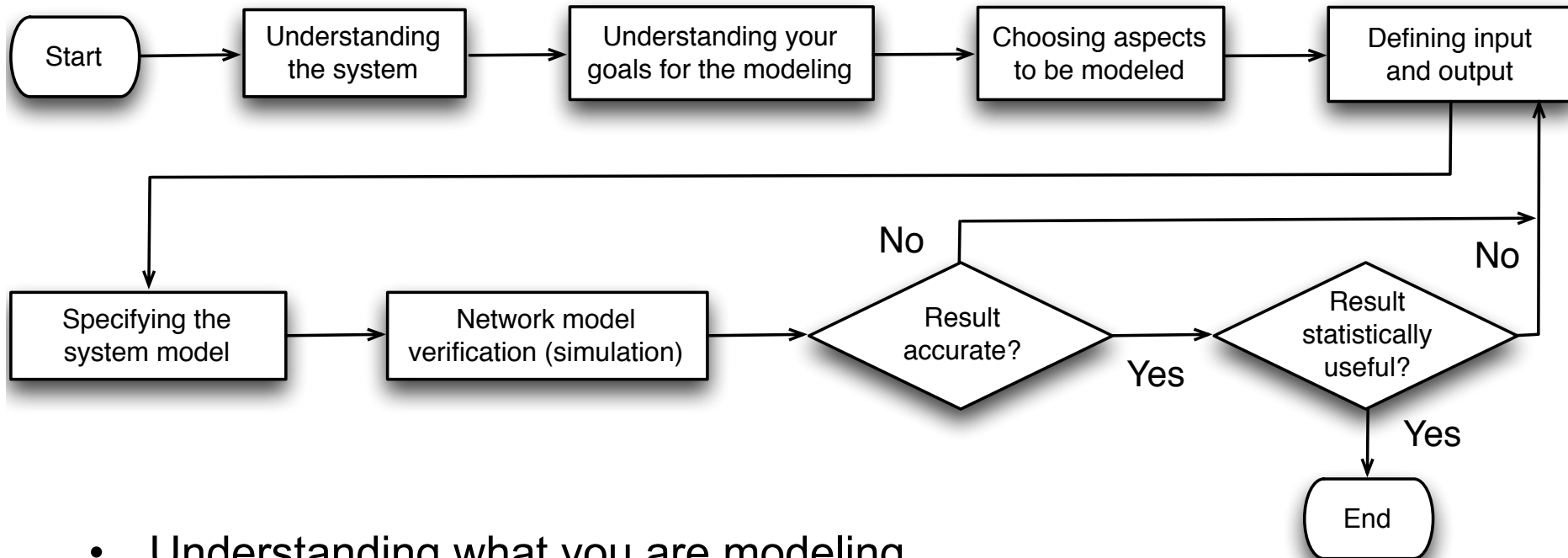   - The MANET-enabled OSPF is modeled and implemented with OPNET Modeler.

    MANET – Mobile Ad-hoc Networks

Research challenges in the large-scale computational modeling of networks

Network Modeling Methodology

- Understanding what you are modeling
- Granularity
- Defining Data
- Results

Challenge 1:
Understanding what your are modeling

- **You must understand the proposed system to model it accurately.**
  - ❑ The model cannot be more accurate than your understanding.
  - ❑ However, our goal is to better understand computer networks by using large-scale computation modeling as a research tool..
  - ❑ The chicken and egg problem? an iterative and incremental process? Or both?

- **Understanding your goals.**
  - ❑ What general questions do you want the large-scale computational modeling of networks to answer?

- **From the general questions, formulate specific research objectives.**

Challenge 2: Choosing the Granularity Required

- Granularity is the level of detail.
- Choose a granularity sufficient to answer all questions.
- Often, some portions of a model require fine granularity, and others much less.
- How to make the optimal tradeoff?

Challenge 3: Model Verification

- Are the models that I developed correct and accurate?

- How can I validate and verify it?

- Which data should I use to validate and verify my models?

Challenge 4: Scalability

- Do existing network modeling & simulation tools scale to extreme-scale computing?
  - Ns2, ns3, OPNET Modeler

What are we interested?

- Using network modeling and simulation as a tool to understand and facilitate
    - Distributed data management
    - Large-scale data movement