SANS
A Simple Ad hoc Network Simulator

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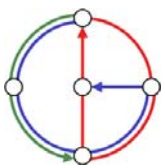
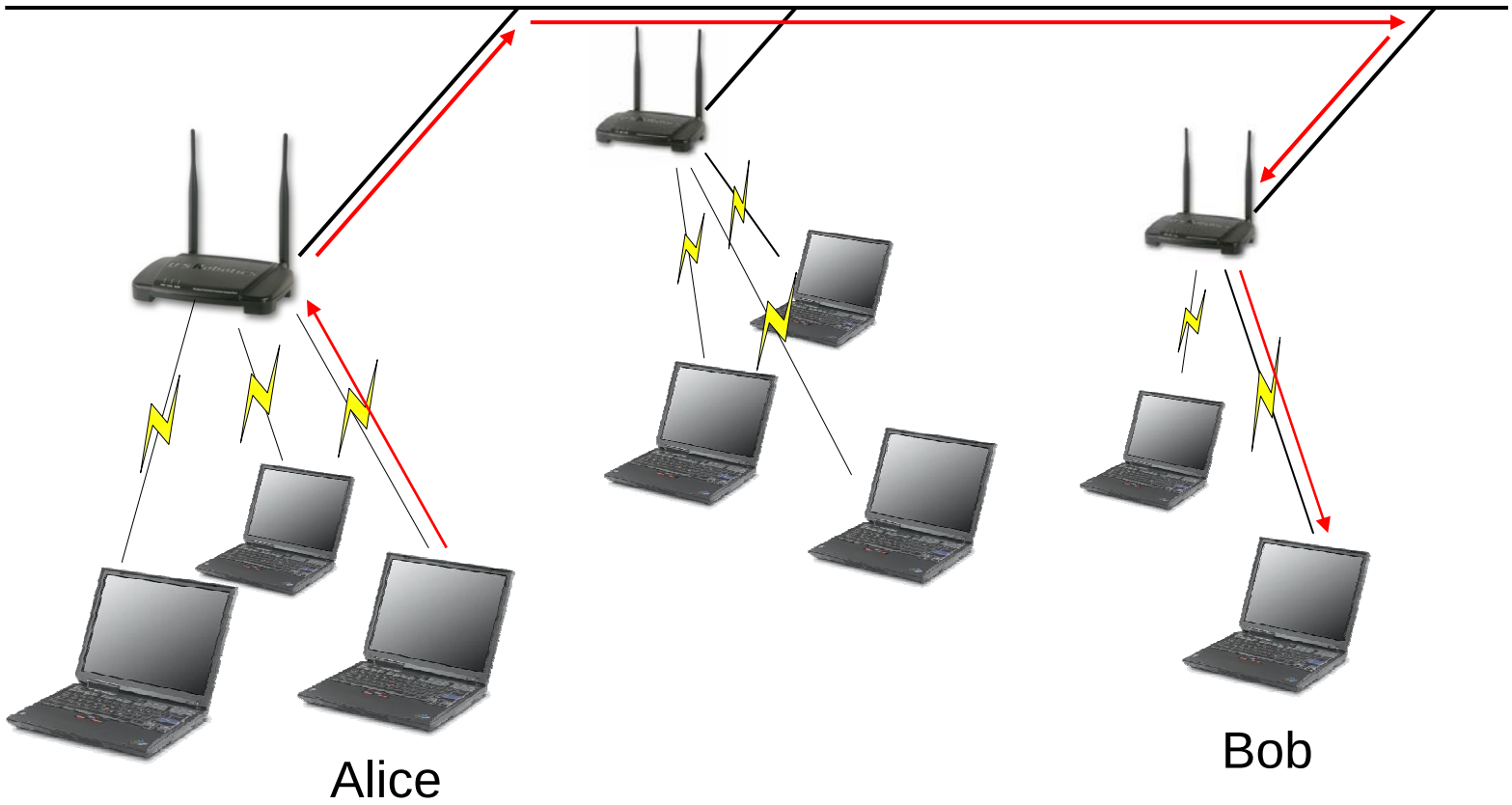
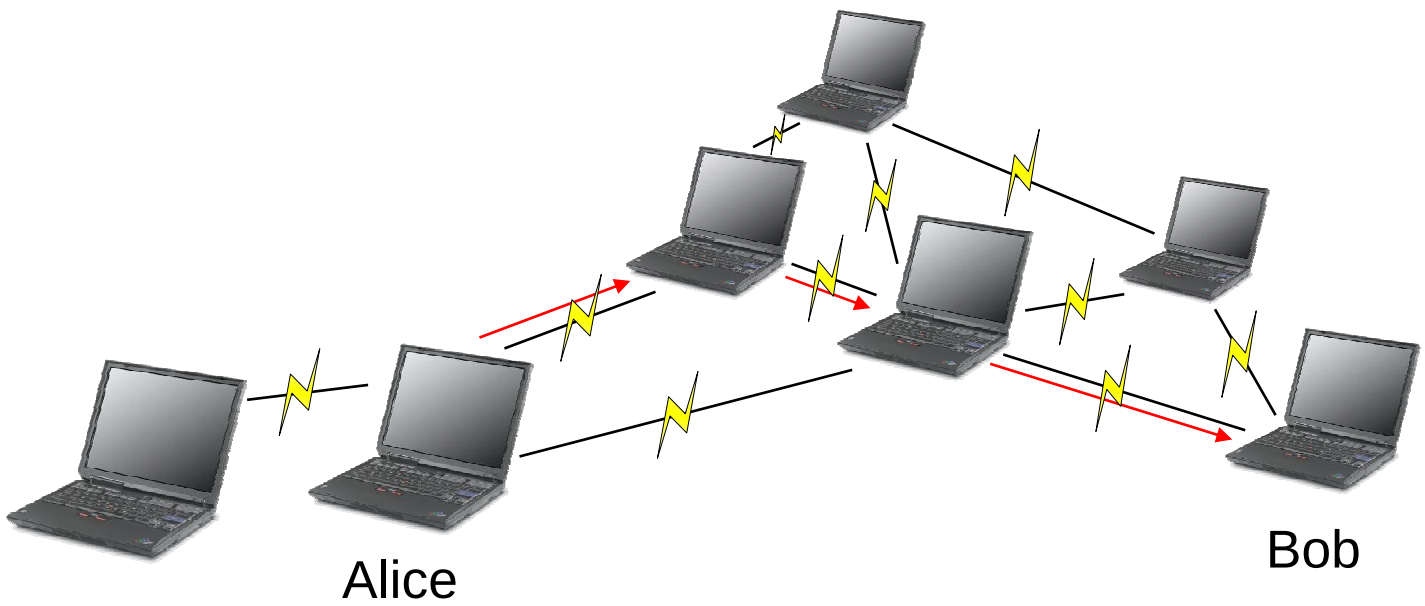


ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

WLAN at Home (Infrastructure Mode)



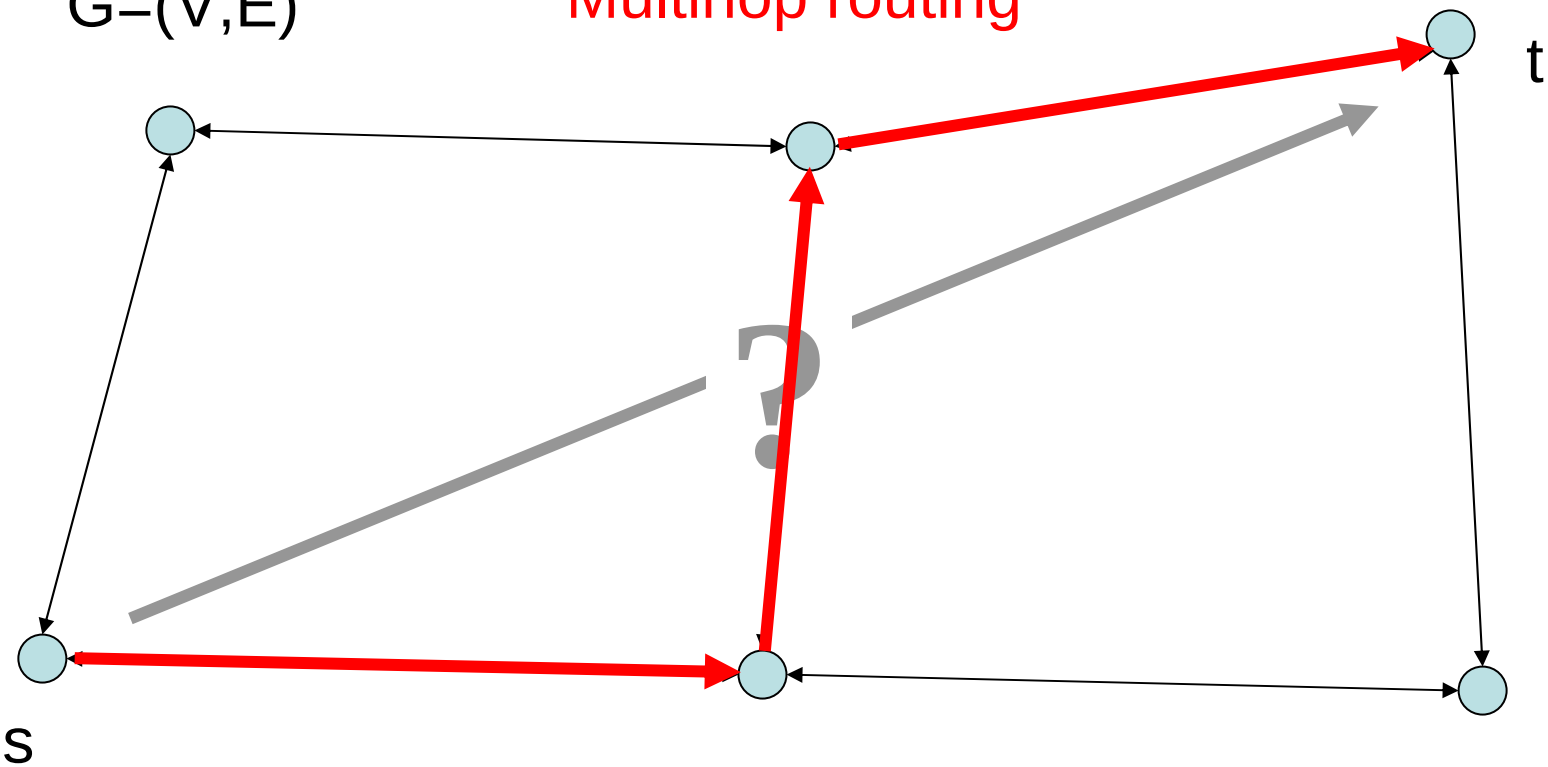
WLAN in the Woods (Ad Hoc Mode)

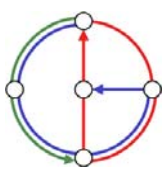


Routing

G=(V,E)

Multihop routing





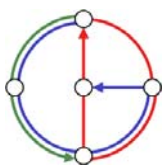
Routing: Internet vs. Ad Hoc Networks

Internet

- Dedicated routers
- Mostly static structure
- Low packet loss
- Unlimited energy

Ad Hoc Networks

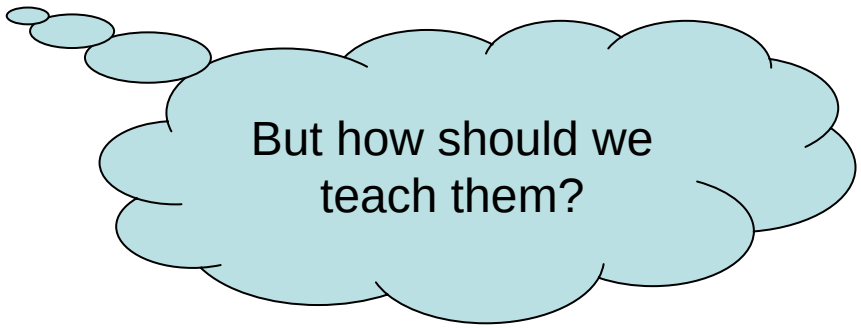
- No (or little) pre-deployed infrastructure
- Highly dynamic topology
- High packet loss
- Battery lifetime

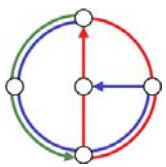


Consequences

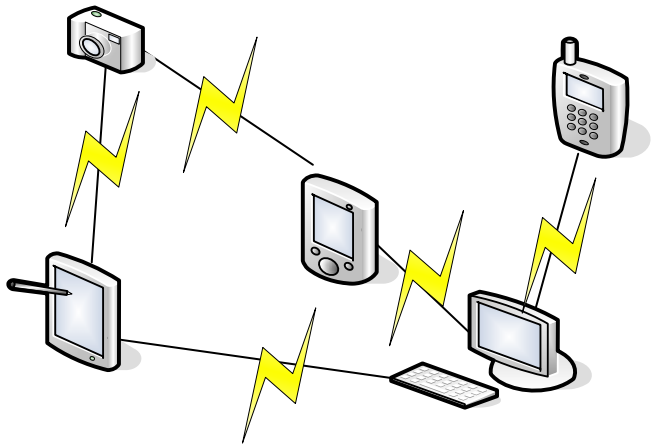
- Routing and Medium Access Control (MAC) are difficult tasks in ad hoc networks
  - Existing solutions for wired networks are not well suited for use in ad hoc networks
  - New paradigms and algorithms need to be developed

Lots of work for coming generations of computer scientists





Teaching the Concepts of Ad Hoc Networks



Theory

Practical Exercises

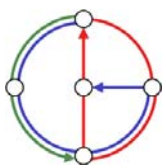
Graph Theory

Implementation of Applications

Existing Algorithms

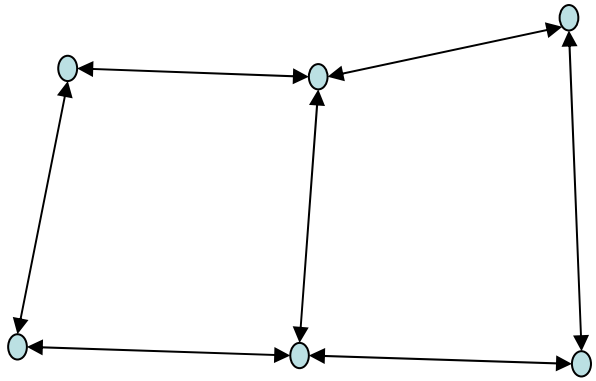
Electrical Engineering

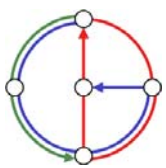
Existing Systems



Practical Exercises

- Requirements
  - One or more devices offering a radio network interface
    - Notebook
    - PDA
  - Test network consisting of several nodes

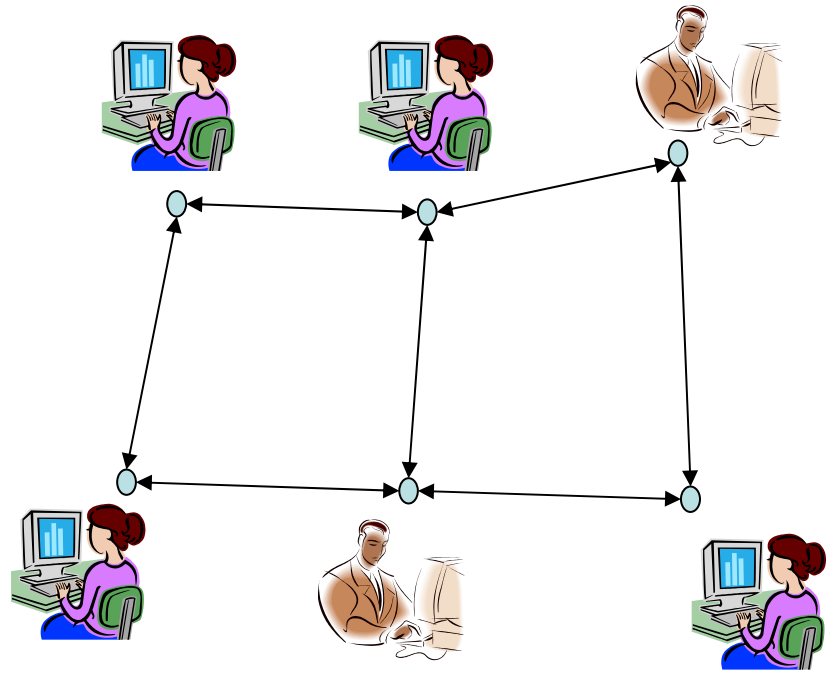


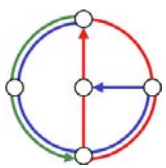


Students as Nodes

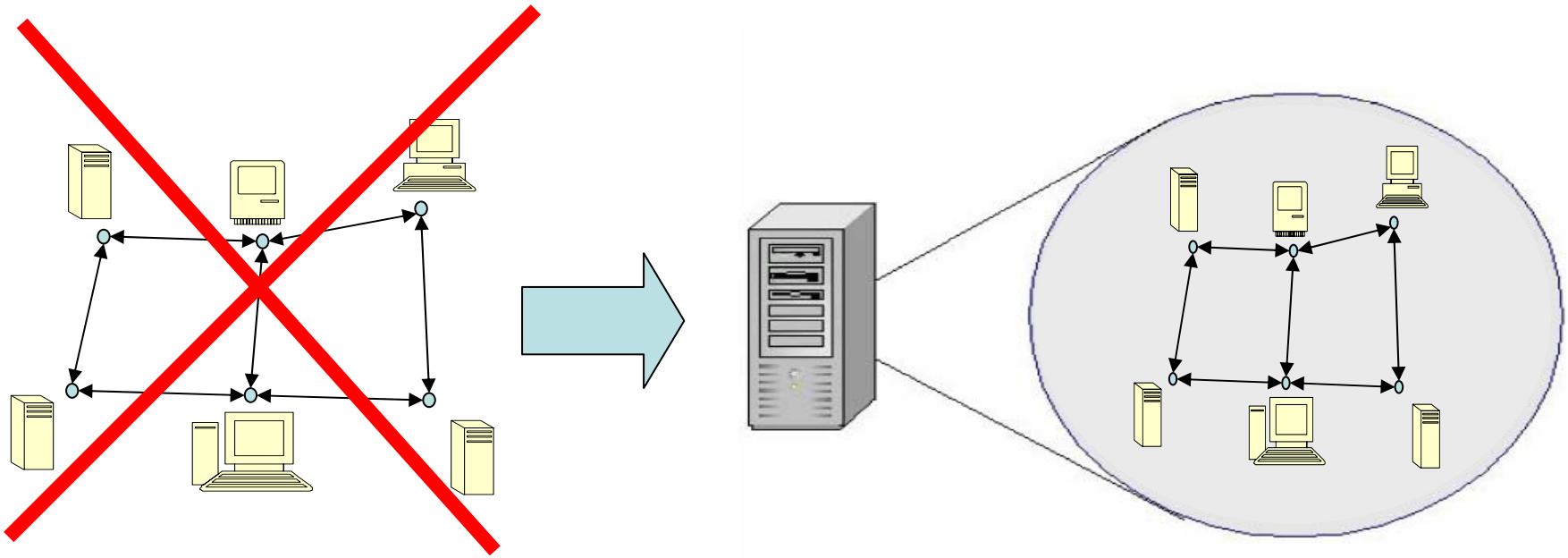
- Each student represents a node of the graph
  - Nearly no control over the topology
  - Requires many participants and a lot of space
  - Results of experiments are not reproducible
  - Debugging is almost impossible
- Is there a better solution?

  ⇒ Simulation is an alternative

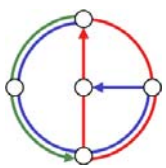




Simulation



- Each instance of the program represents a virtual node
- The simulating PC controls the network topology

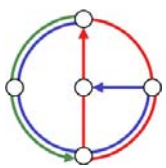


Existing Simulators

- Various simulators exist focusing
  - on functionality
  - not on usability for untrained users

- ns2
  - ☑ General purpose simulator for all network layers
  - ☑ Very powerful

  - ☒ Requires special scripts
  - ☒ Highly complex to use

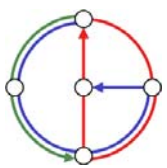


SANS

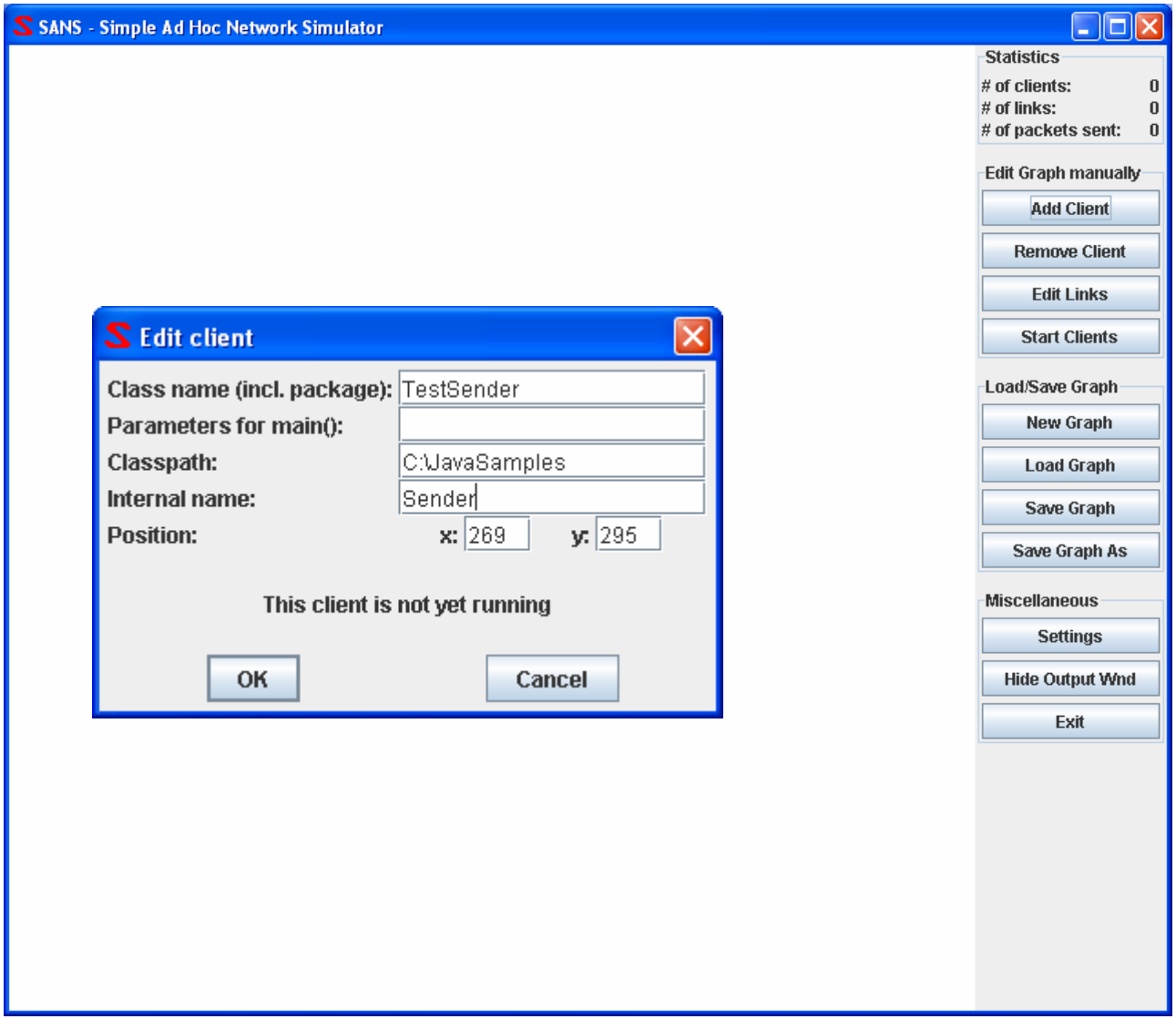
- SANS has been designed for use in exercises

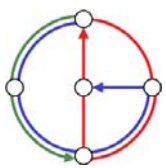
  ☑ Intuitive “Point and Click” user interface
  ☑ Support for generic Java programs
  ☑ Platform independent
  ☑ Real-time simulation execution
  ☑ Programs developed in SANS also run on real hardware
  ☑ Small size (70 kB)

  ☒ Limited underlying communication protocol
  ☒ Limited scalability

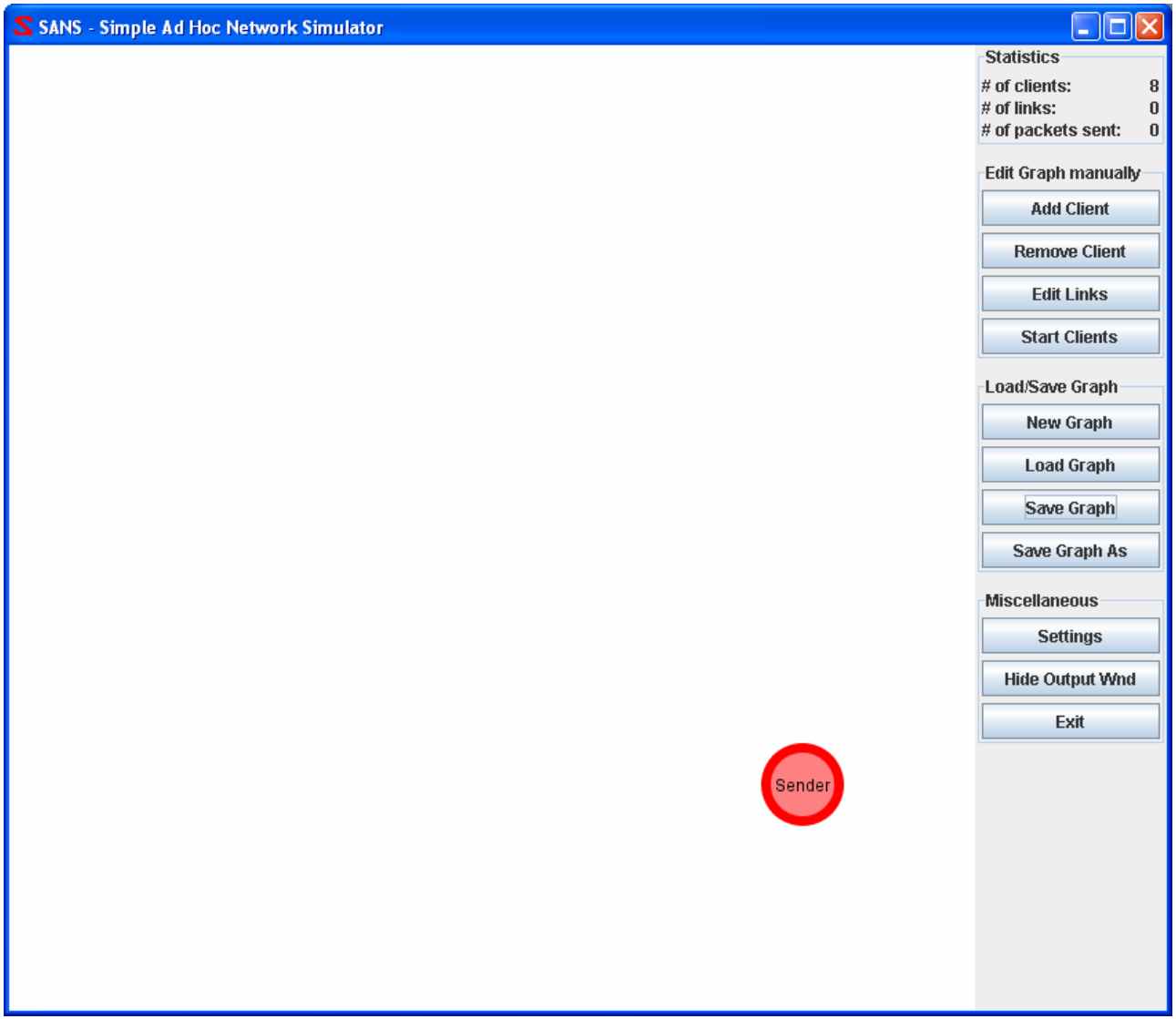


SANS: Interface



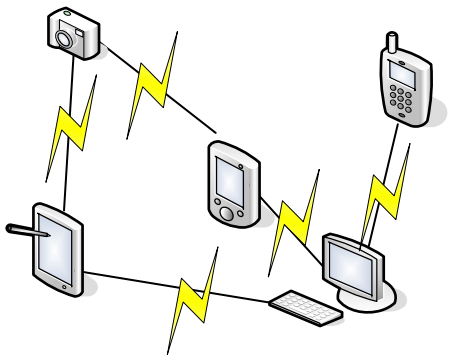


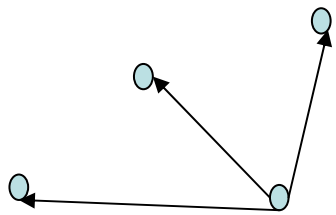
SANS: Interface

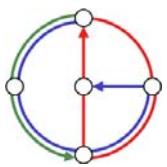


Programs running on nodes

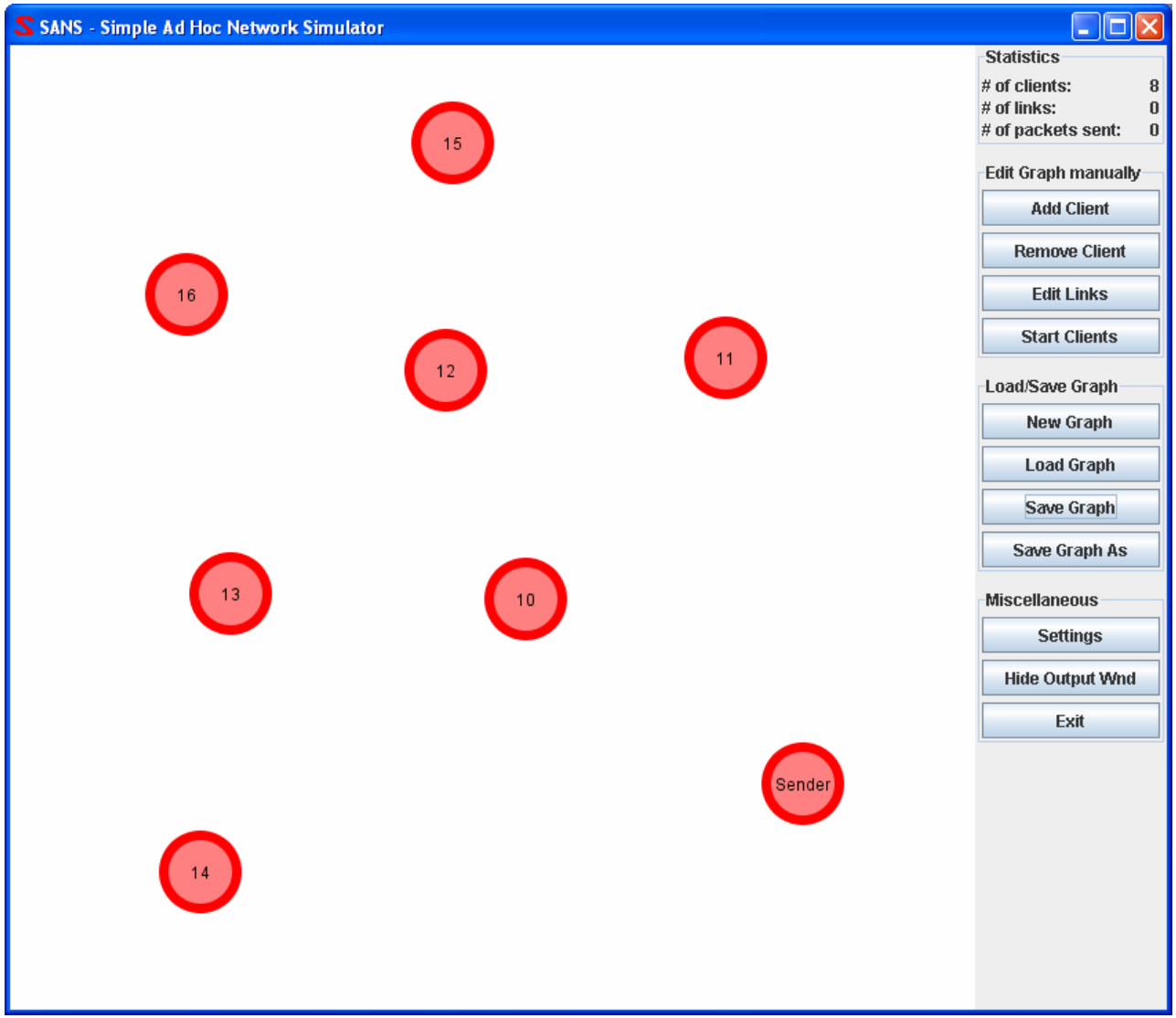
- Generic Java programs which also run on real hardware
  - Students may run their applications on notebooks or PDAs
- Communication must be UDP
  - For a good simulation of the properties of ad hoc networks, UDP Multicasts are well suited



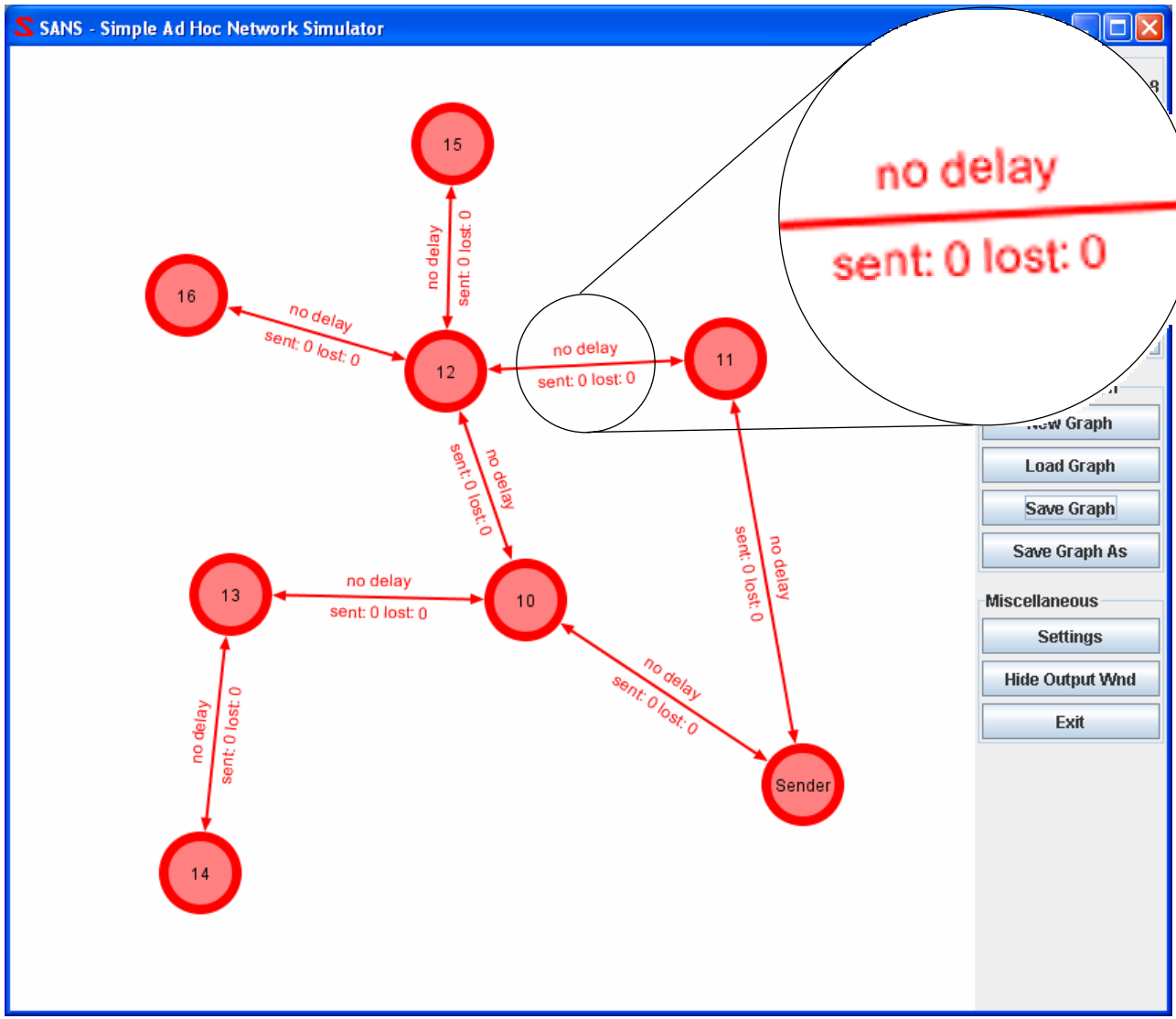




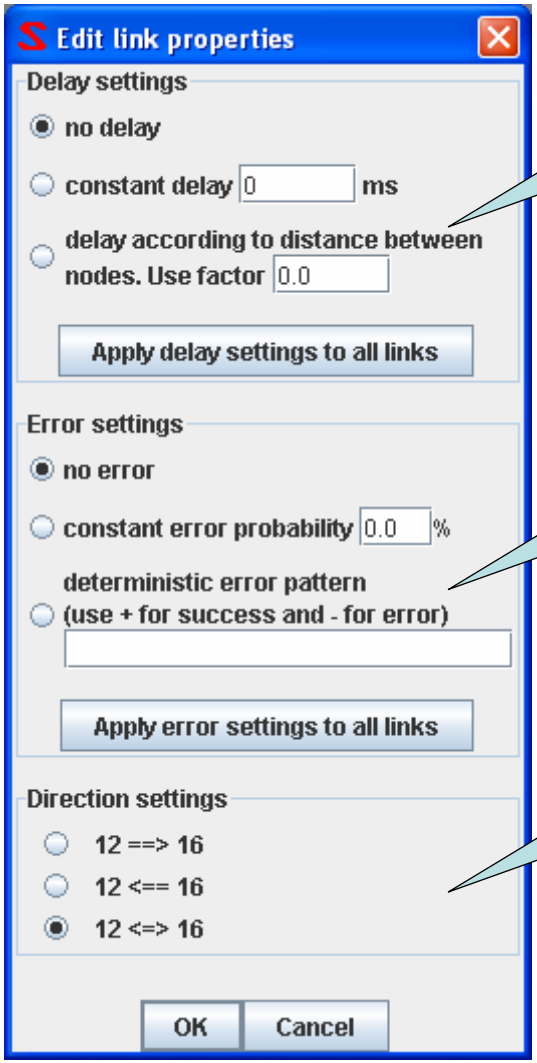
SANS: Interface



SANS: Adding Edges



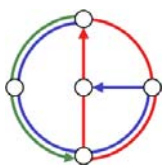
SANS: Link Properties



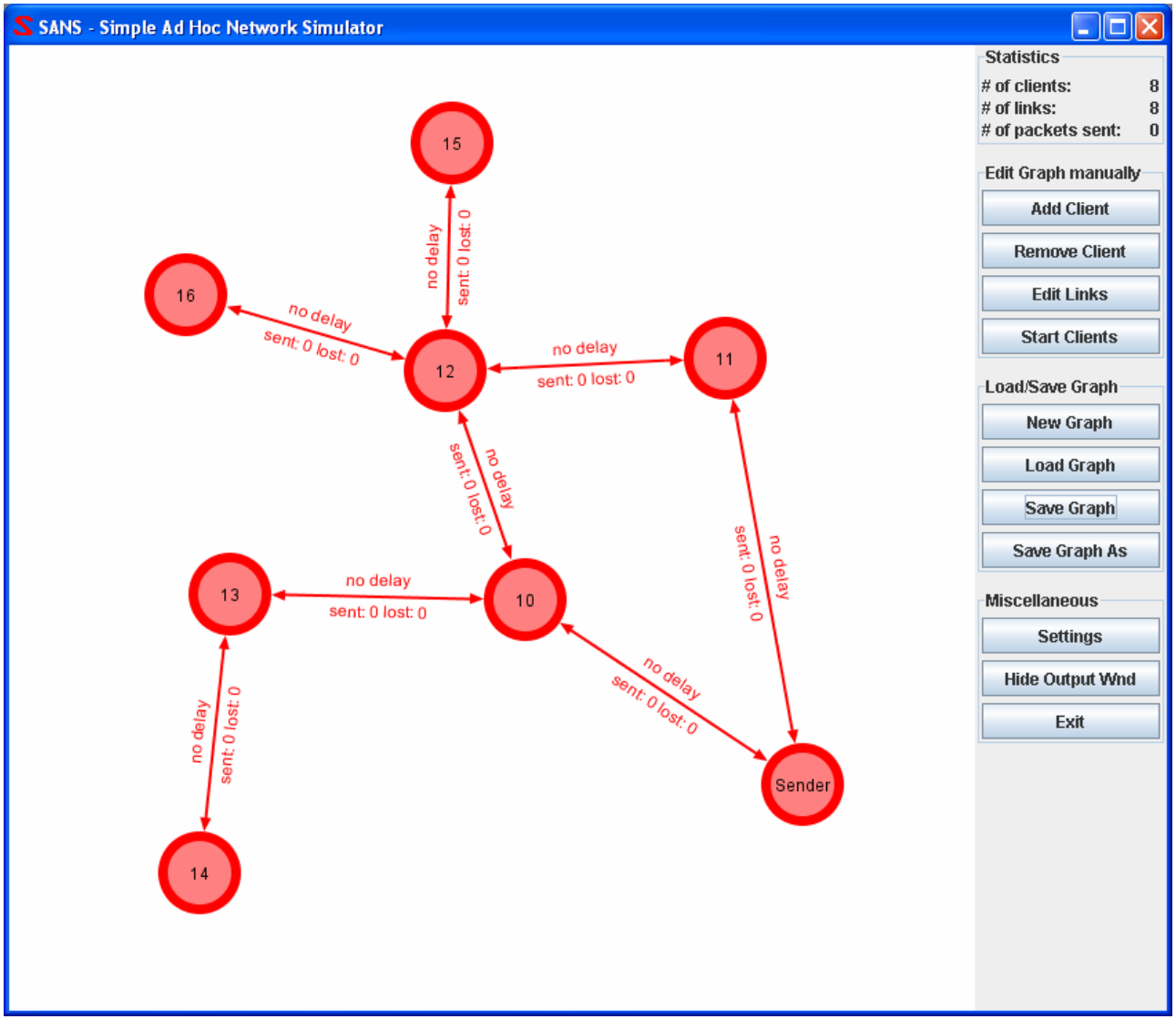
Transmission delay

Packet drop policy

Link direction



SANS: Flooding Example



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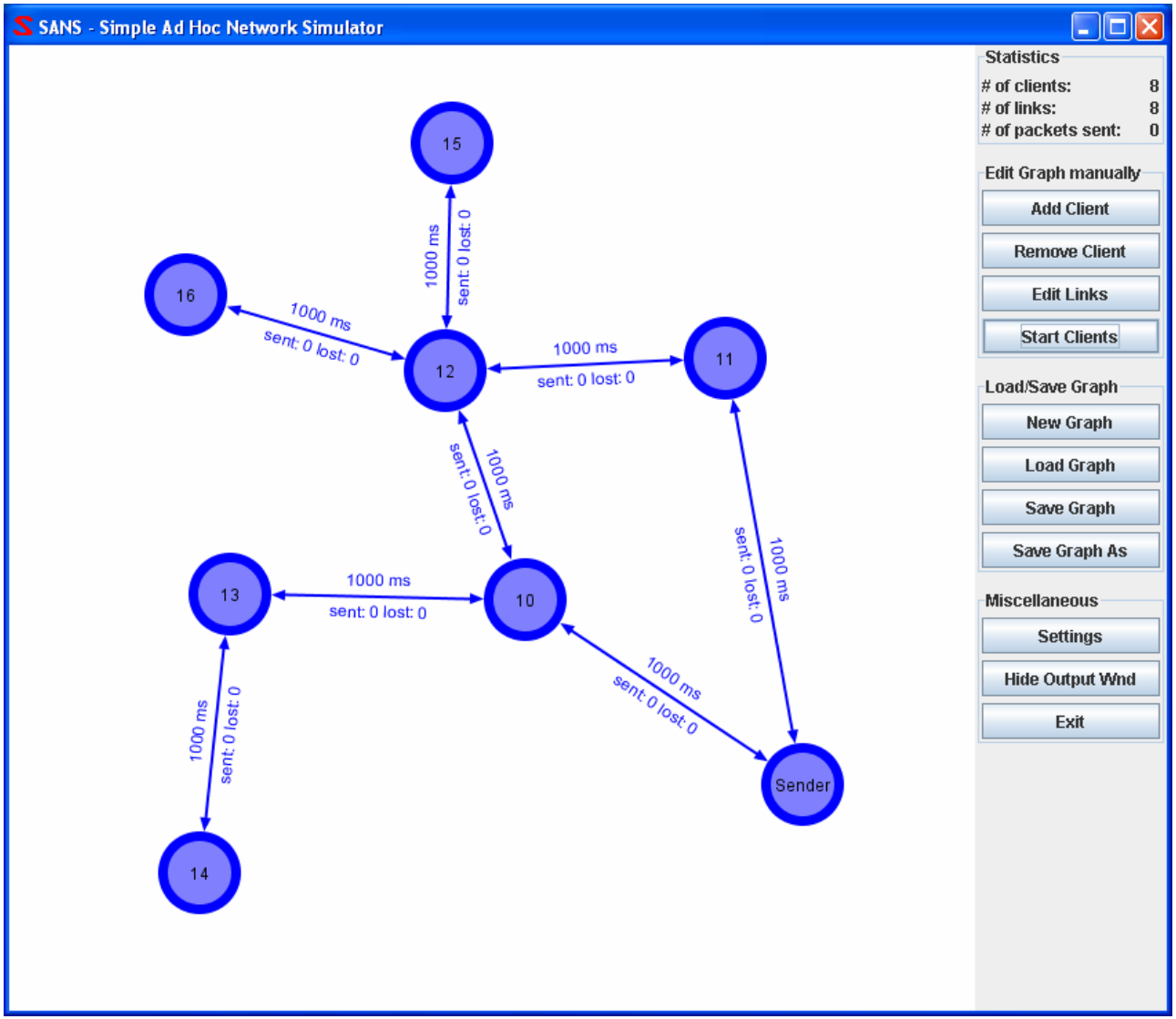

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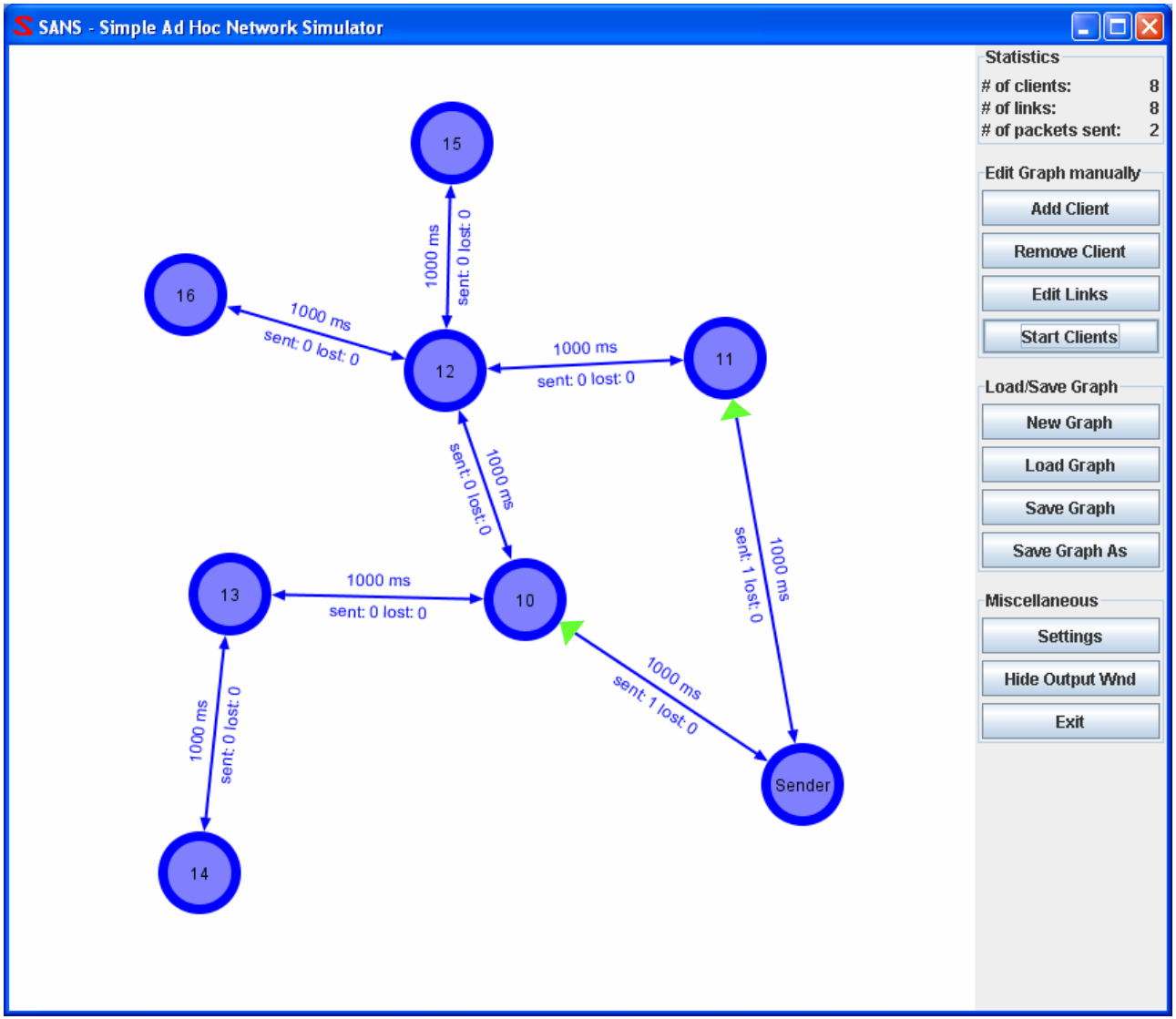

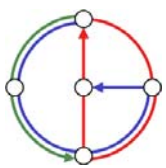

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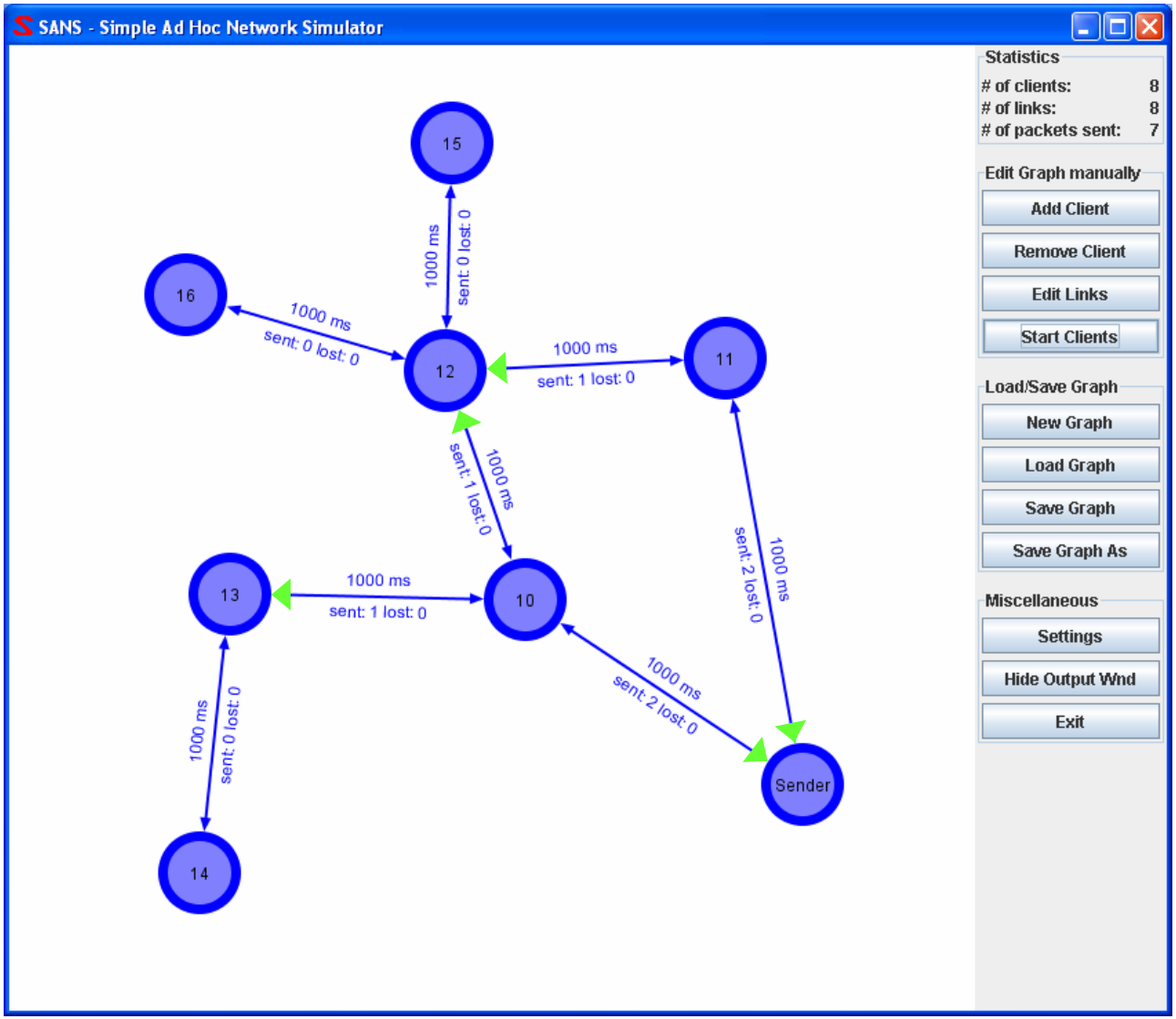

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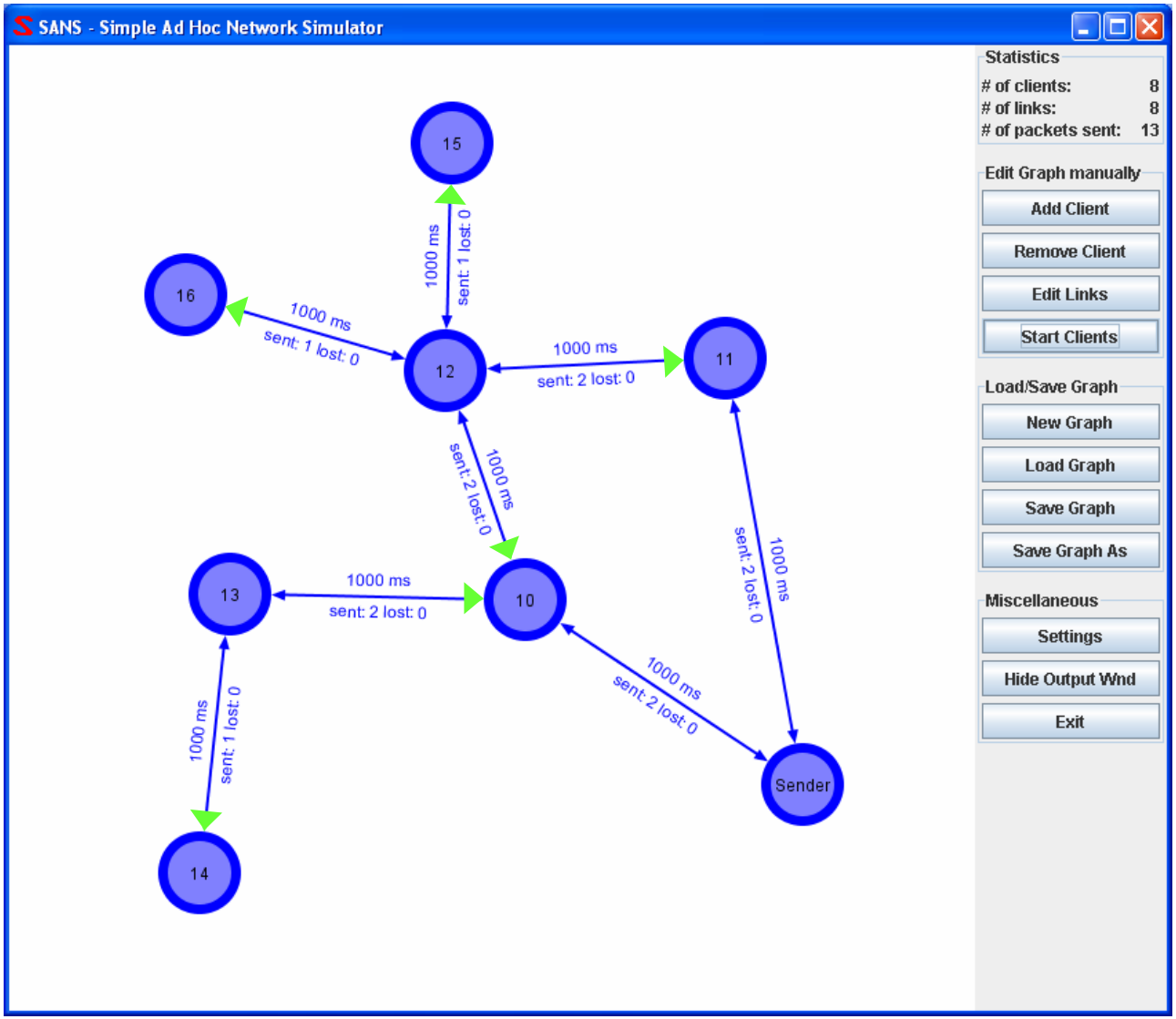
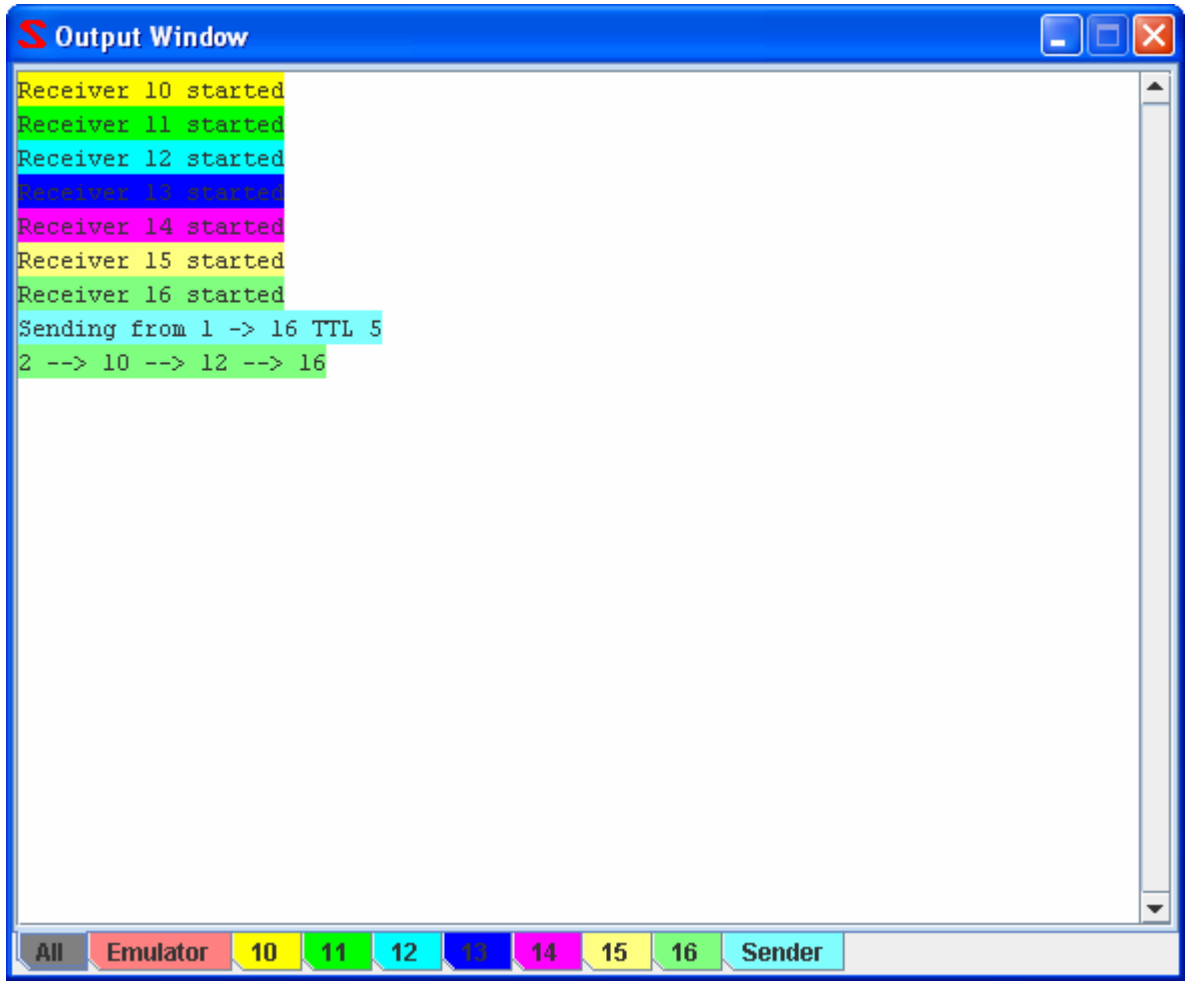
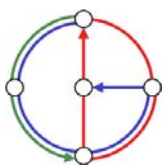


SANS: Console Output

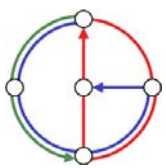




SANS in use

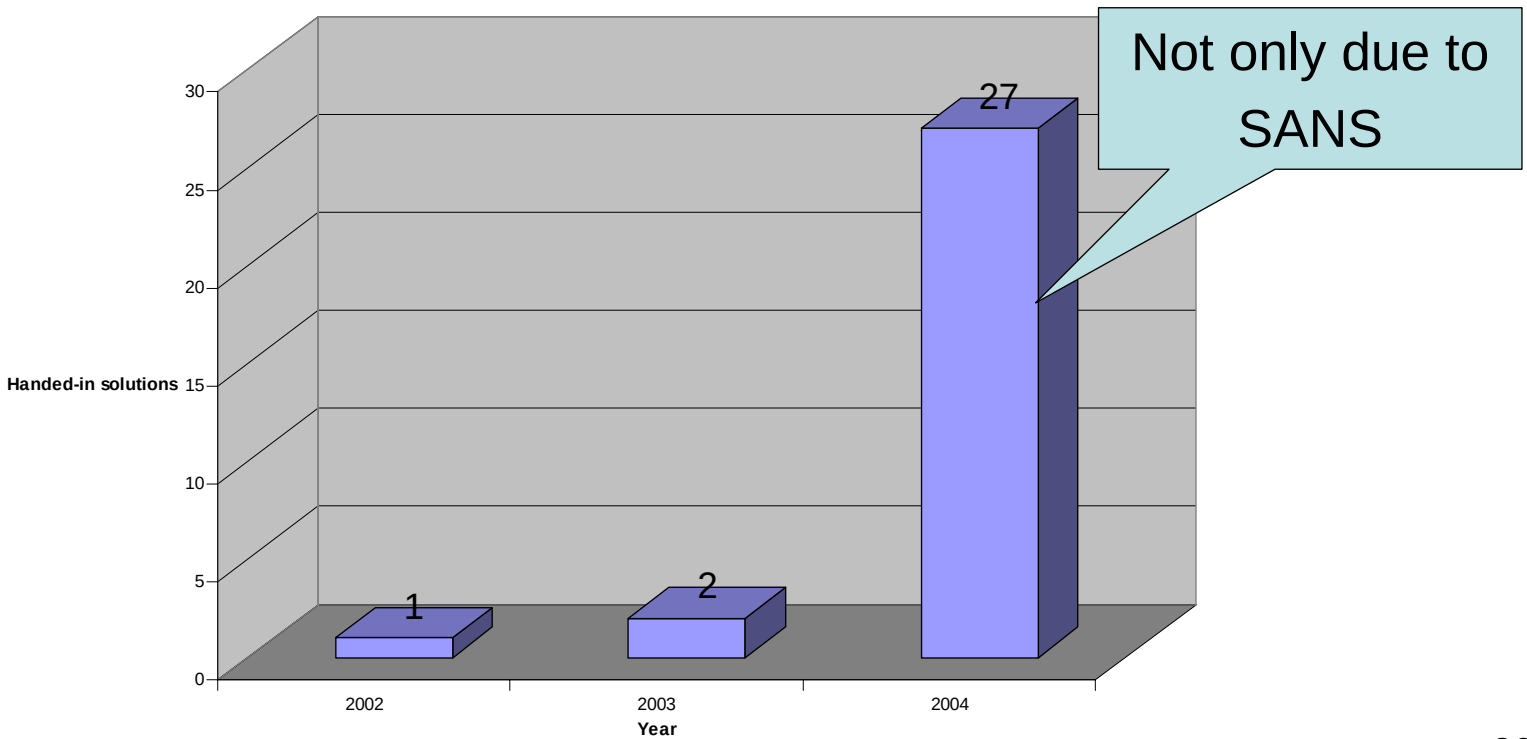
- “Mobile Computing” at ETH Zurich
- Server-less instant messenger as a long term homework
  - Find other users in the network
  - Send and receive messages to users not within direct communication range
  - Relay messages for other users

- The same task was assigned in three consecutive years



SANS in use

- The number of students was about 90 people and did not fluctuate much between 2002 and 2004
- 2-3 students/team
- Number of handed-in complete solutions by year:



The End

Download SANS at

http://dcg.ethz.ch/projects/SANS/Simulator.jar