

# SeNeTs – Test and Validation Environment for Applications in Large-Scale Wireless Sensor Networks

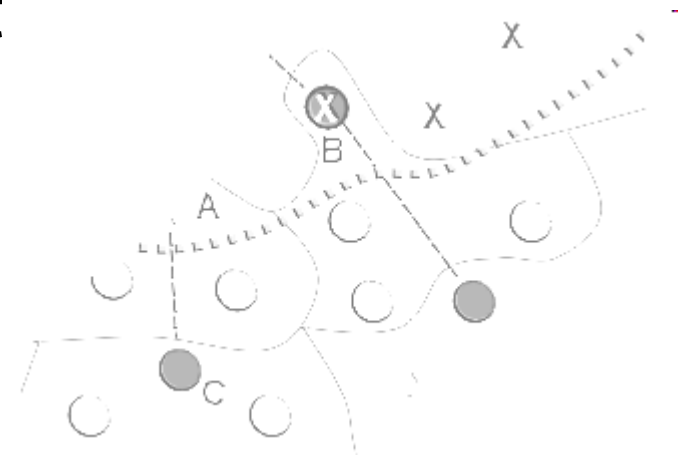
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University of Rostock

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Berlin, 2004/06/25

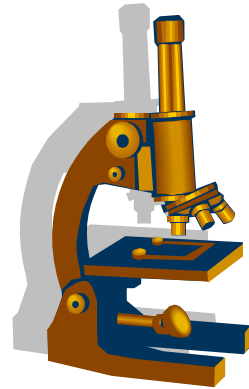


# Outline

- Introduction
  - Sensor Networks
- SeNeTs Environment
  - Architecture
  - Environment Management
  - Example Application
- Conclusion



# Introduction



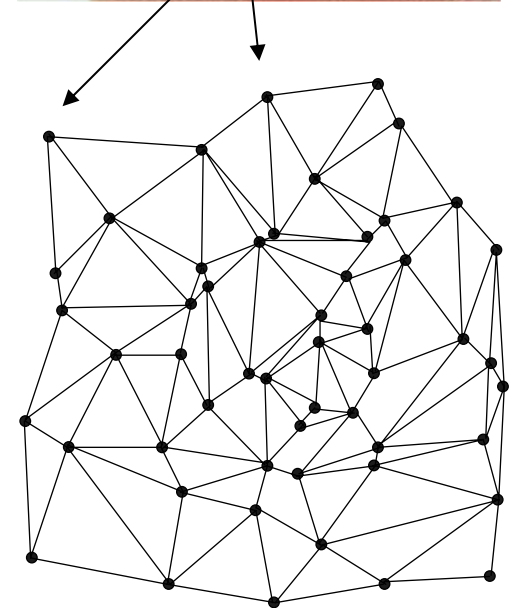
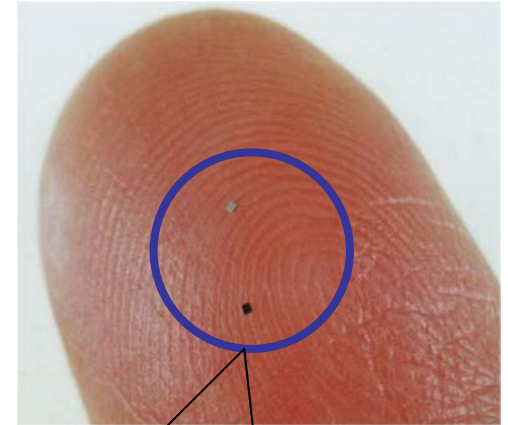
# Definition

## Sensor Networks:

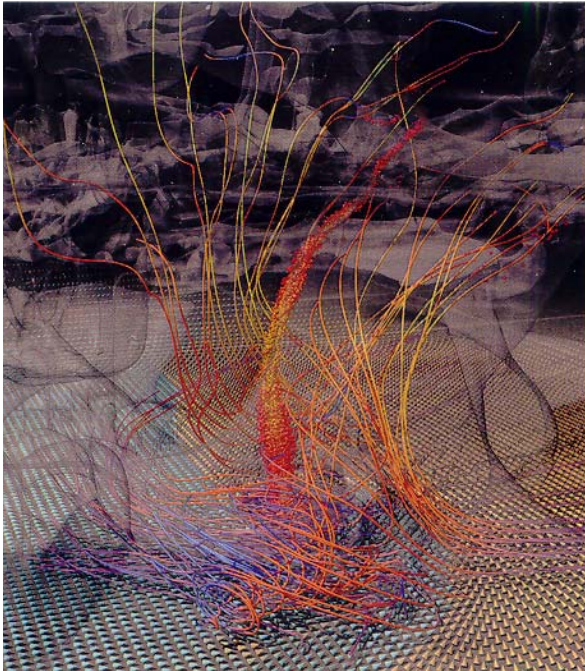
- Hundreds of sensor nodes
- Randomly distributed
- Wireless communication

## Properties

- Rapidly changing network topology
- Self organizing
- Cooperative processing
- Potential mobile nodes
- Resource critical (Power, Memory, Computation)
- Very error-prone



# Motivation



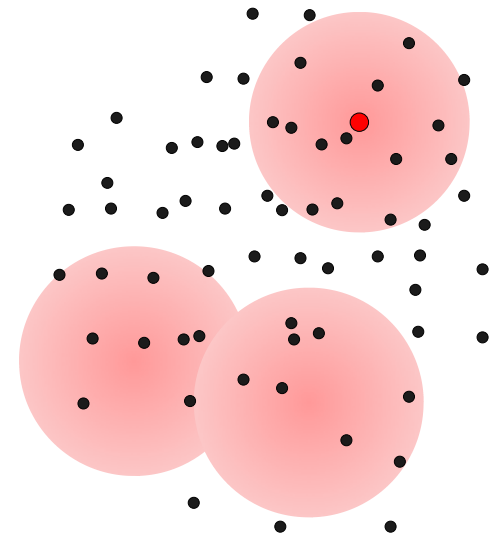
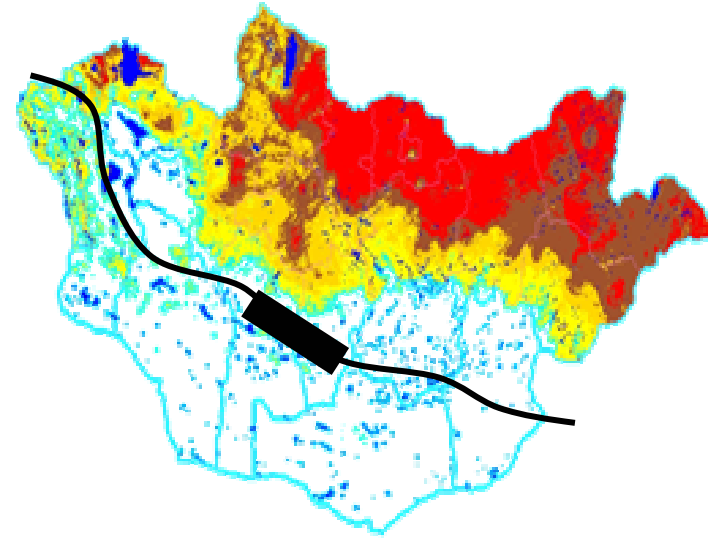
## What are sensor networks good for?

- Analyse, observe, explore, and monitor the environment
- Examples:
  - Monitoring tornados
  - Tracking forest fire fronts

# Software Development

## Software Considerations

- Autonomously running software on sensor nodes
- Self organizing network
- Reliable and timely network operations
- Resource-aware (RAM, power, communication overhead)
- Services
  - „Where is the fire?“
  - „What is the averaged temperature near the train station?“
- Error-prone sensor nodes



# Requirements during Test-Phase

## Application-specific requirements:

- Software updates
- Controlling applications
- Debugging
- Receiving logging messages

## Network-specific requirements:

- Simple administration of all nodes
- Scripting of commands
- Test under several environment conditions

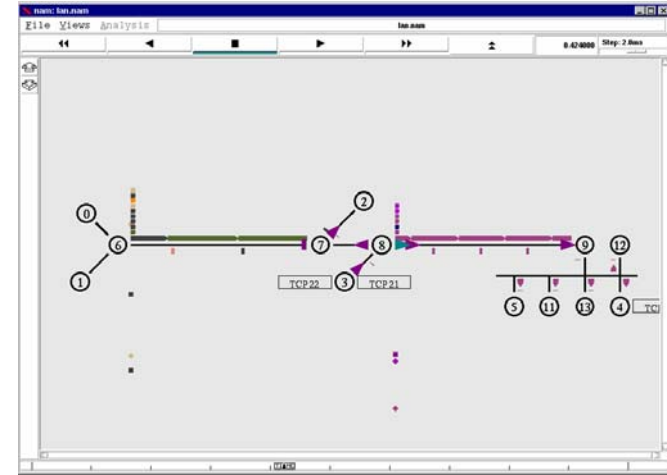


Flood prevention by dike observation

# Software Test in Simulators

## Simulations:

- Produce first and important insights
- Proof of functionality




## Problematic:

- **Sequential processing** of concurrently triggered events
- **Simplified** wireless channel models
- Support of **new wireless transmission techniques**
- **Reuse of source code** is not guaranteed

# Software Test on Target Platforms

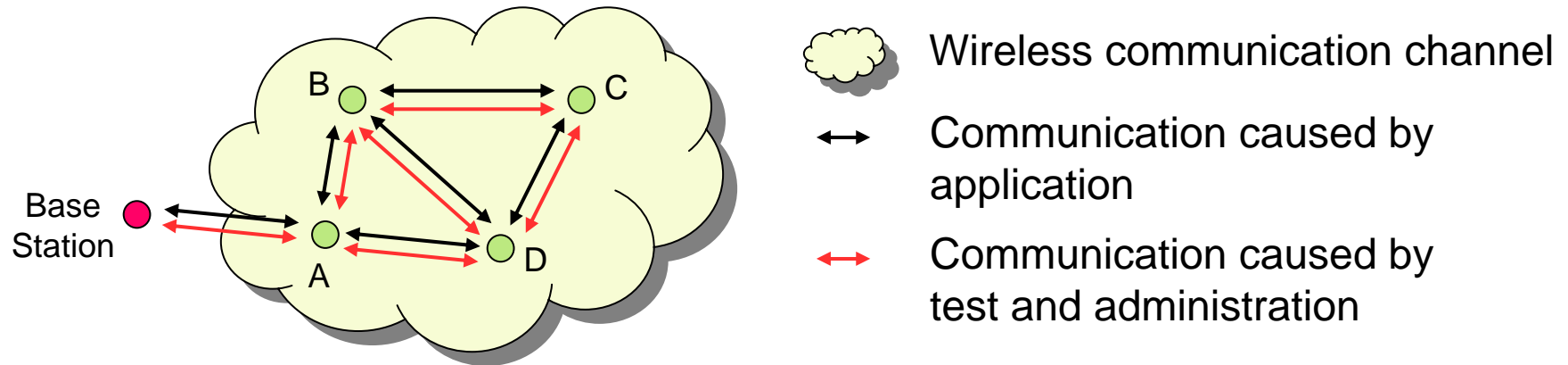
## Target Implementation:

- Hundreds of sensor nodes are required
- Mostly only few prototypes of sensor nodes available
- Nodes are still in development phase  very expensive



Real target implementation is mostly unapplicable due to lack of sensor nodes!

# Software Test on Target Platforms II



- Increased communication!
- Wireless communication channel acts as **bottleneck!**
- Results become unrealistic or false!

Administration and test must not affect  
sensor network application!

# SeNeTs Environment

## - Architecture -



# Software Test in SeNeTs

## Main problems during test-phase:

- Simulations unaccurate
- Lack of real sensor nodes
- Extensive administration
- Bottleneck effect

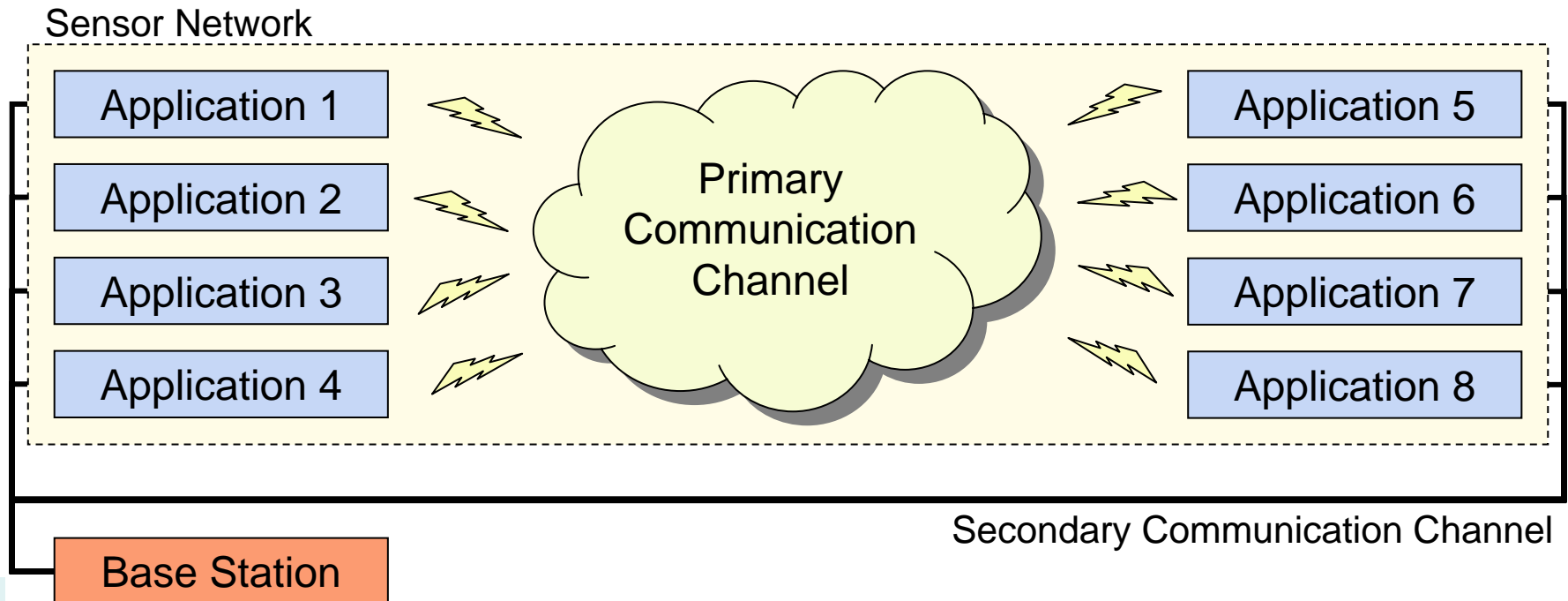
## Approach:

- Equip personal computers (hosts) with
  - sensors
  - transmission devices
- Emulate sensor networks with existing networks
- Administrate sensor network via backbone



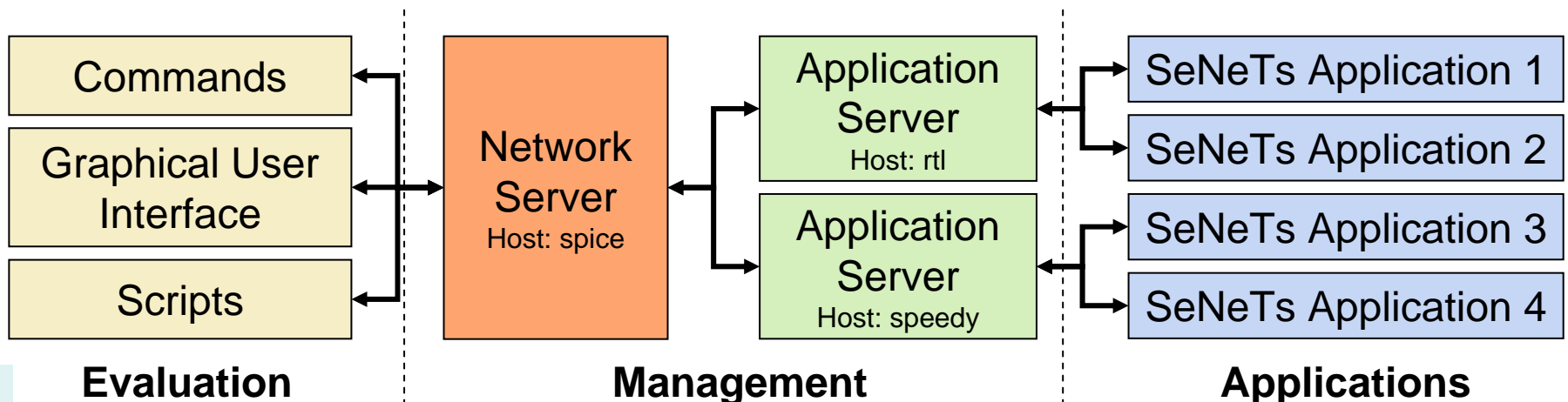
# Communication Channels

- Applications communicate using primary channel
- Administration via secondary communication channel
  - ... prevents bottleneck effect
  - ... eliminates impact of test and administration to primary wireless communication channel



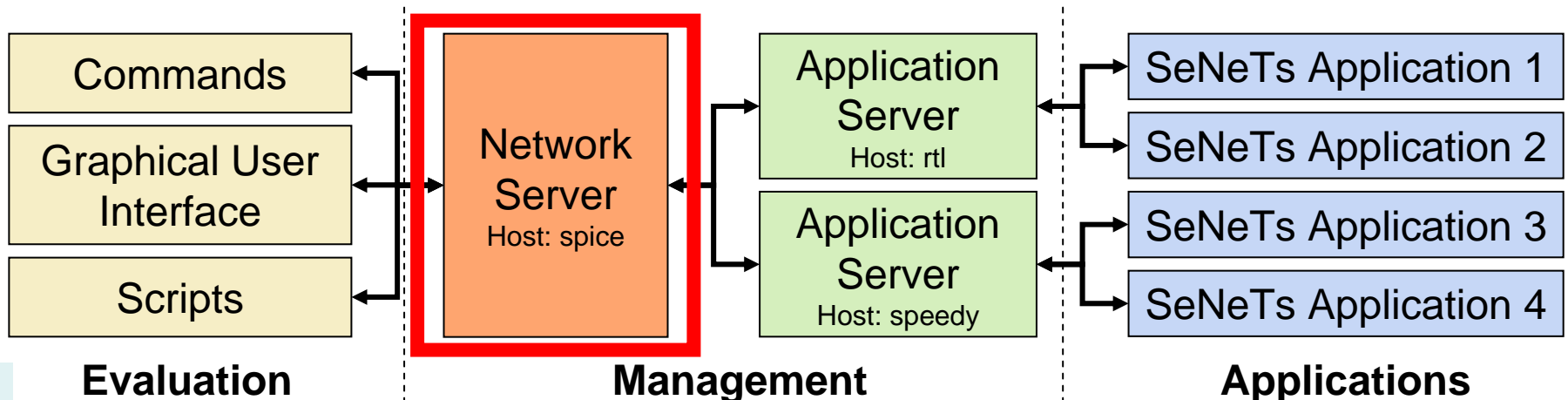
# SeNeTs Architecture

- Hierarchical network architecture
- Loosely coupled components
- Additional features:
  - Logging and controlling of remote sensor nodes
  - Software updates
  - Communication management (secondary channel)



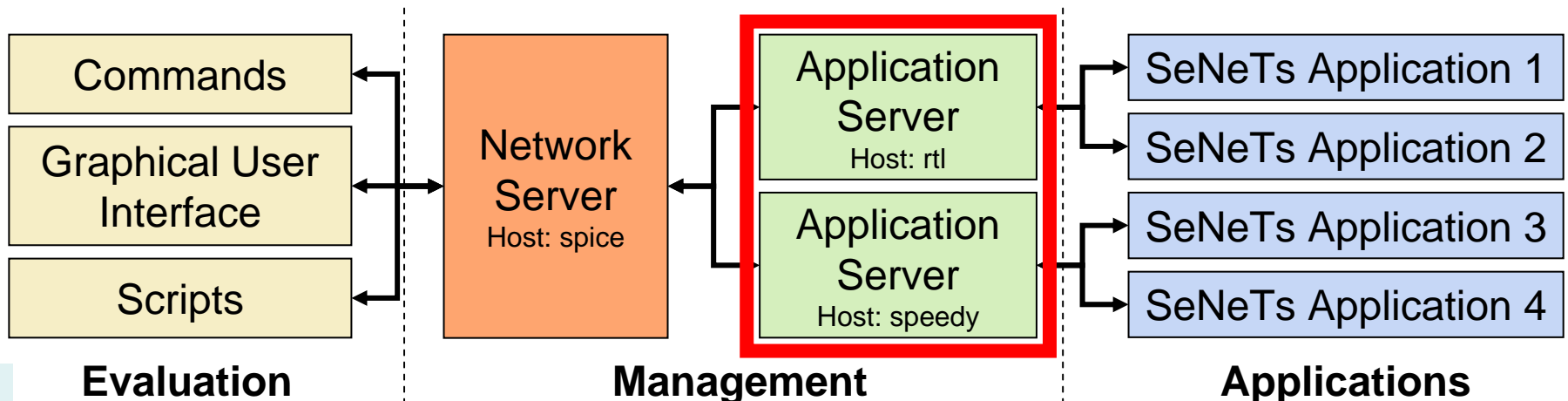
# Network Server

- Administrates sensor networks
- Communicates via pipes using the secondary transmission channel
- External configuration via commands and scripts
- Receives logging messages from sensor node applications
- Terminal-based service in the host-system



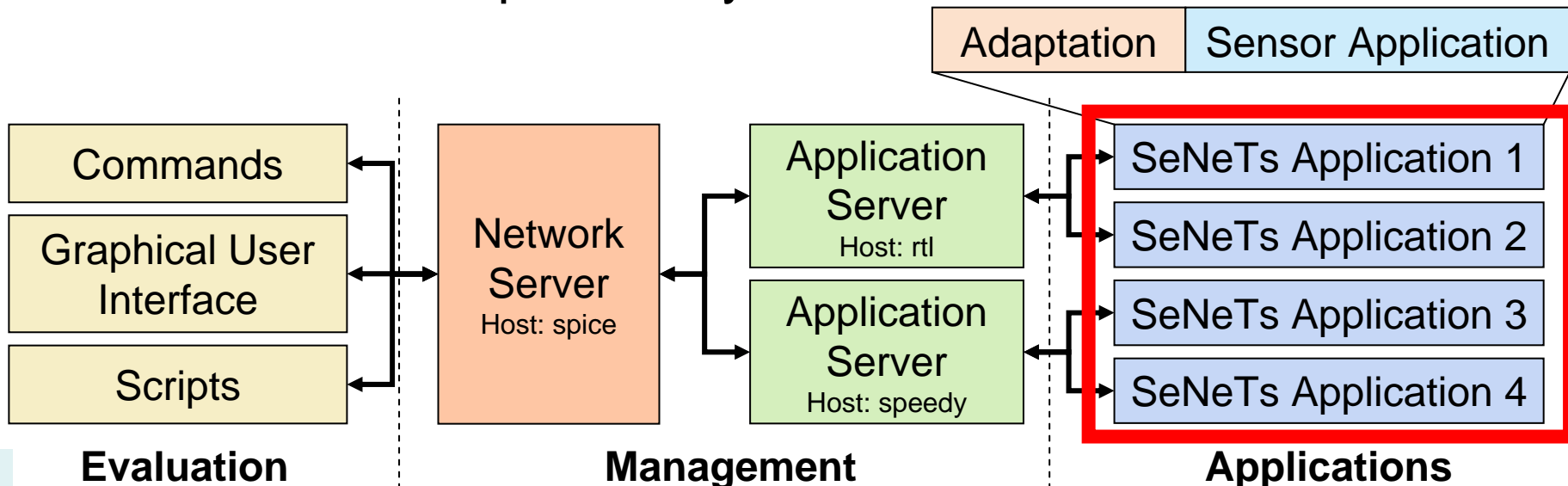
# Application Server

- Manages instances of SeNeTs applications on one host
- Independent of network server
- Communicates via pipes with applications and network server
- Terminal-based service in the host-system



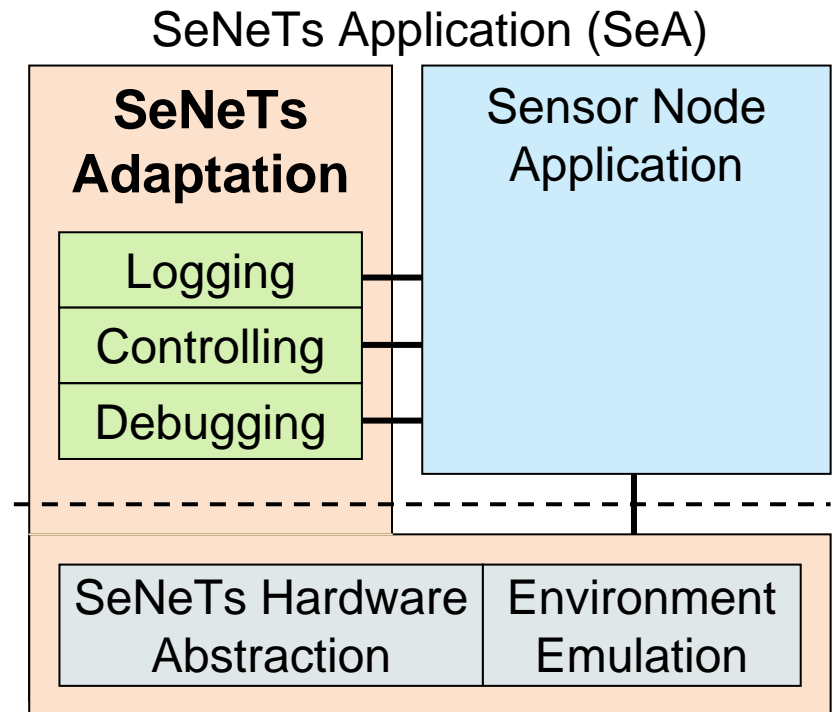
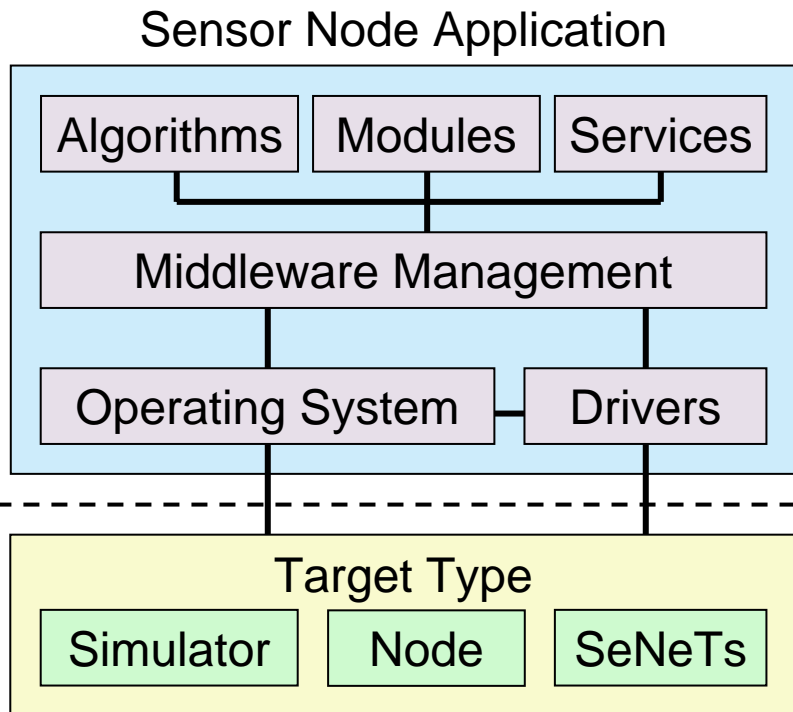
# SeNeTs Application

- Connected to Application Server
- Runs as terminal process in host system
- Can run without established pipes
- Consists of
  - Original sensor node application
  - SeNeTs Adaptation layer



# SeNeTs Adaptation

- required to adapt sensor node application to host system
- can be removed simply by recompilation

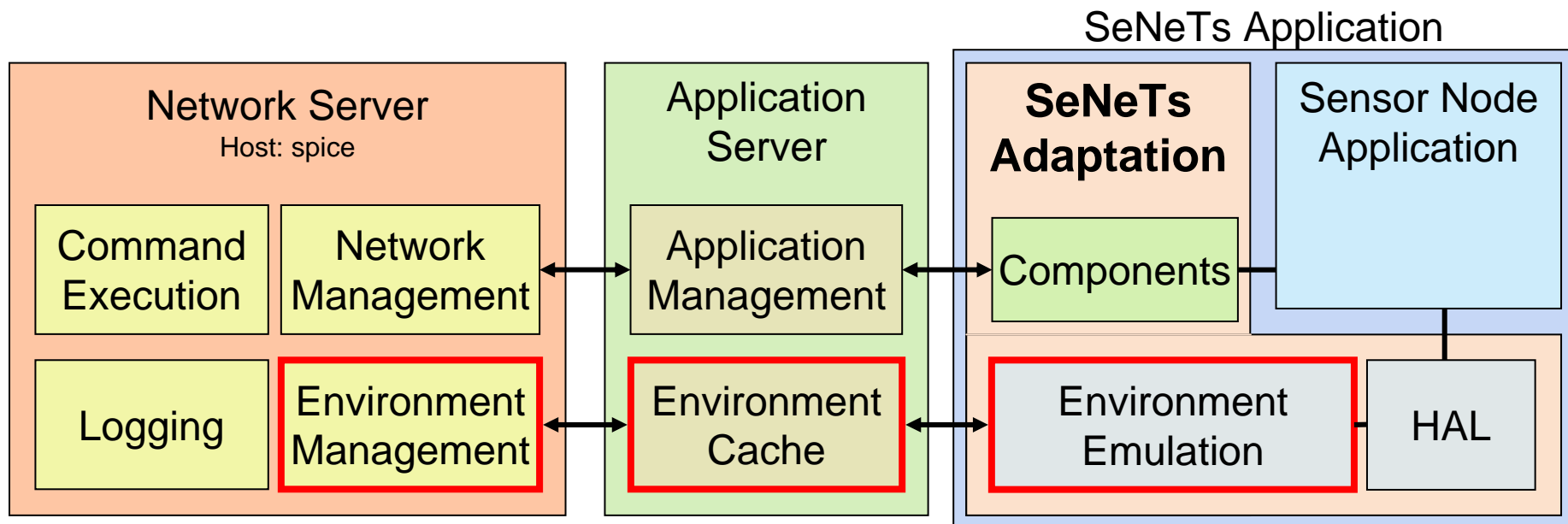


# Environment Management

- Provides valid environment data under laboratory conditions
- Environment conditions pre-defined by the developer

## Example:

- Test of applications measuring temperatures

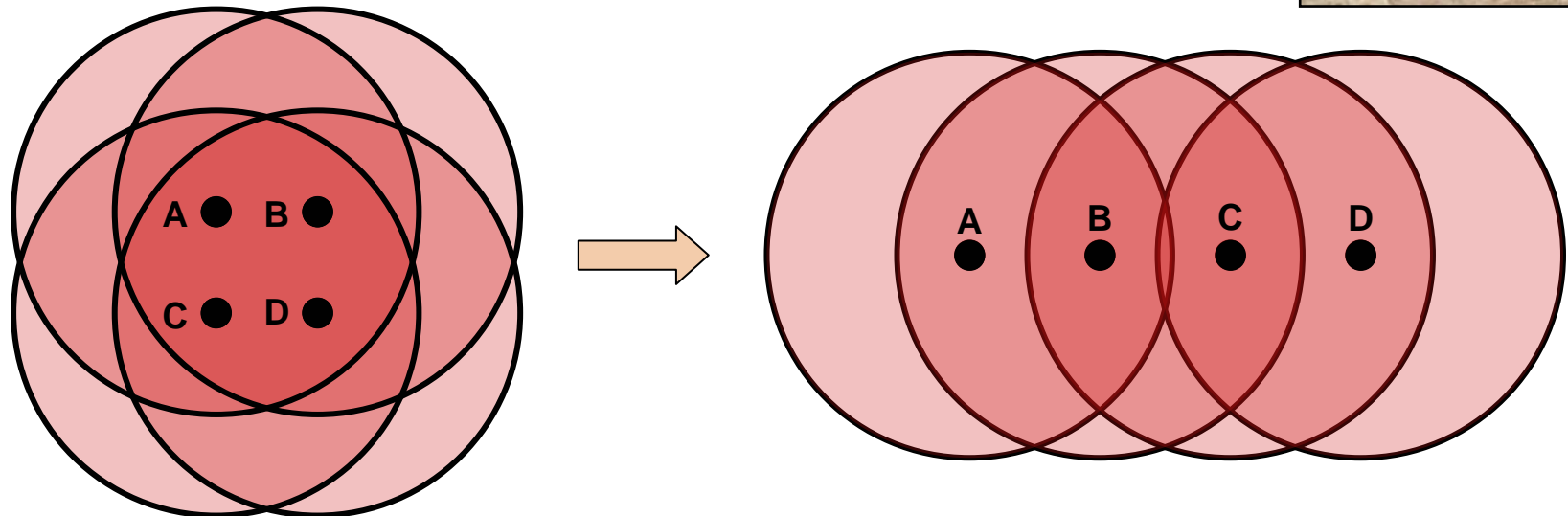


# Position-based Filtering

- Physical and virtual positions do not match
- All nodes in transmission range to each other



Filtering of all messages received from nodes that are not in virtual transmission range.



Physically arranged nodes (Lab)

Virtually arranged nodes (Reality)

# SeNeTs – Current State

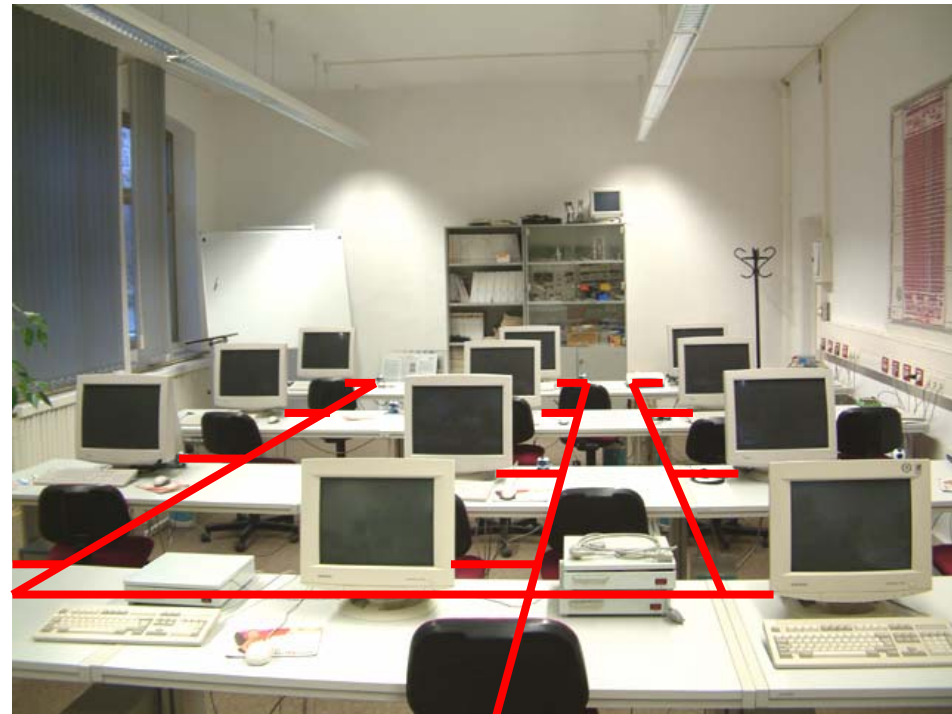
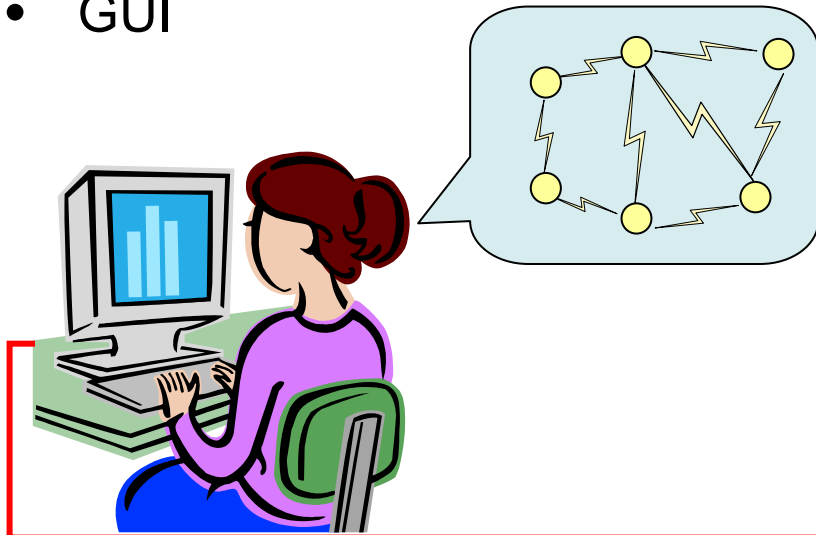
## Completed:

- Platform independent (Linux, Windows)
- Two example applications (ANSI C)
- Application Server (C++)
- Network Server (C++)



## ToDo:

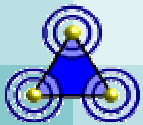
- Environment Management
- GUI



Commands via TCP/IP

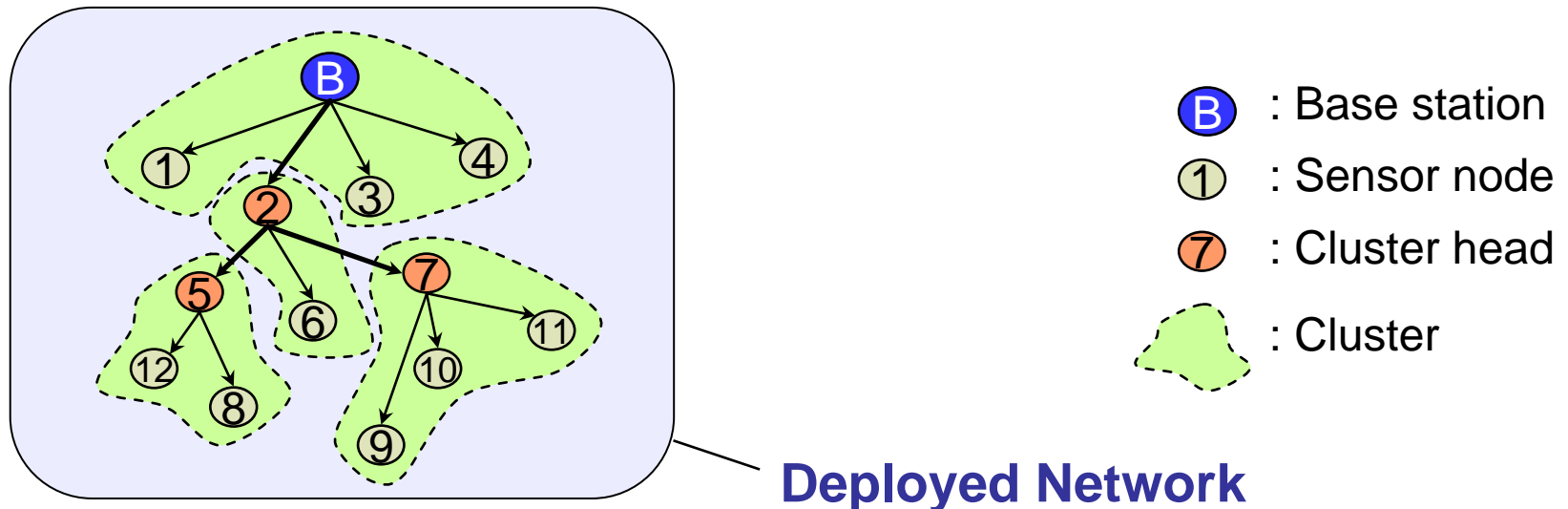
# SeNeTs Environment

- Example Application -



# Data Collection Protocol

- Data Collection Protocol – a communication protocol for sensor networks
- Optimized for Bluetooth-equipped sensor nodes
- Builds a tree of clusters and collects data to a central base station
- Not affected by piconet or scatternet restrictions



# Advantages using SeNeTs

- Extensive emulation and test of DCP-based networks
- Proof of concept
- SeNeTs emulation provided essential insights of protocol design.
  - Synchronizing Page/Inq. scan modes
  - Test of multihop functionality
  - Proof of concept



# Conclusion

## Issue:

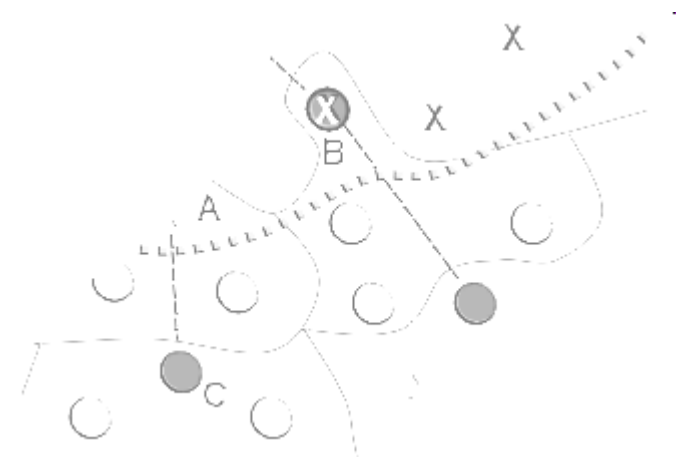
- Test and validation of sensor network applications

## Approach: **SeNeTs environment**

- Test and validation of applications
- Prevents communication overload
- supports test with pre-defined environment data

## Validation:

- Data Collection Protocol



# Thank you

Web: [www.senets.org](http://www.senets.org)

