Experimental Methodology for Real Overlays
Algorithm and Protocol validation methods

- Simulation
- Experimentation
- Analytical Modelling
- Emulation

+ Realism
- Repeatability

- Realism
+ Repeatability
Validation flavors

**Experimentation**
- Physical reality
- Deployment in Large Scale
- Real traffic
- Failures, unexpected events

**Emulation**
- Simulated PHY
- Virtual nodes
- Generated traffic
- Controllable depending on layer emulation

**Simulation**
- Model representation
- Possibly more scalable
- Synthetic traffic
- Fully controllable & Ideal conditions

Model improvement
Using validation - examples

**Experimentation**
- For algorithm/protocol deployment
- For PHY and MAC layer proposals
- For wide scale real world tests

**Emulation**
- For small scale experiments
- For testing under controlled conditions
- For flexible infrastructure experimentation

**Simulation**
- For large scale systems
- For protocols and algorithms where there is no current physical support
- For proof of concepts
- For proposals where the underlying models are accurate
Validation flavors

**Experimentation**
- Network environment parameters
- Exogenous Traffic generation

**Emulation**
- Virtual Environment
- Injected traffic

**Simulation**
- Adjustable Parameters
- Fully controllable traffic
Example: Bittorrent protocol

Experimentation
- Create customized clients
- Test the clients on Planetlab

Emulation
- Create clients running on virtual nodes
- Generate traffic

Simulation
- Create nodes with the algorithm
- Create synthetic background traffic
Example: Rate adaptation mechanism

**Experimentation**
- Change driver code
- Capture and analyze traffic on a WLAN

**Emulation**
- Create a virtual device and a driver
- Use a virtual configurable channel

**Simulation**
- Create nodes with the rate adaptation algorithm
- Analyze the behavior with a channel model
Current snapshot

- Real Overlay
  - PR
  - RT/C
  - OS
  - RT

- Orbit
  - PR
  - C
  - OS
  - RT

- Emulab
  - M
  - RT/C
  - OS
  - RT

- Simulation
  - M
  - C
  - NOS
  - ST

- Phys. Reality
- Real Traf/Control
- Op. System
- Real Time
What is missing?

Why experimentation is not as common?
- It is difficult to set up an experimental network
  - Improve PlanetLab
- Experiments are not fully repeatable
  - Need for a measurement tool and infrastructure
- Experimentation is not as flexible as simulation
  - Use simulation and/or experimentation
- It's more expensive
  - Federated platforms reduce the cost
The methodology

- Scenario Definition
- Parameter Configuration
- Multiple Runs, Capture
- Processing
- Analysis
- Storage
The data sources

Packet Logs

PHY Level statistics

MAC Level statistics

TCP/IP statistics

Access Point statistics

Application statistics
The measurement challenges

- Accurate representation of events
- Data fusion from sources (sensors!)
- Structures to standardize the data
- Instrumentation of interfaces and applications
- Common syntax to process data
- Platform calibration
- Easier, faster, cheaper, smarter...
Still cooking

- Experimentation scheduling - beta
- Data processing - alpha
- Output generation – basic functionality.
- Integration – coming soon

```
SELECT retry from wlan where addr="00:1B:11:1B:96:22";
SELECT rate from radiotap where mactime<9000 and mactime>1000;
```
Thank You for Your Attention!