



SIMBED and SIMBED+

Large Experiments

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Outline



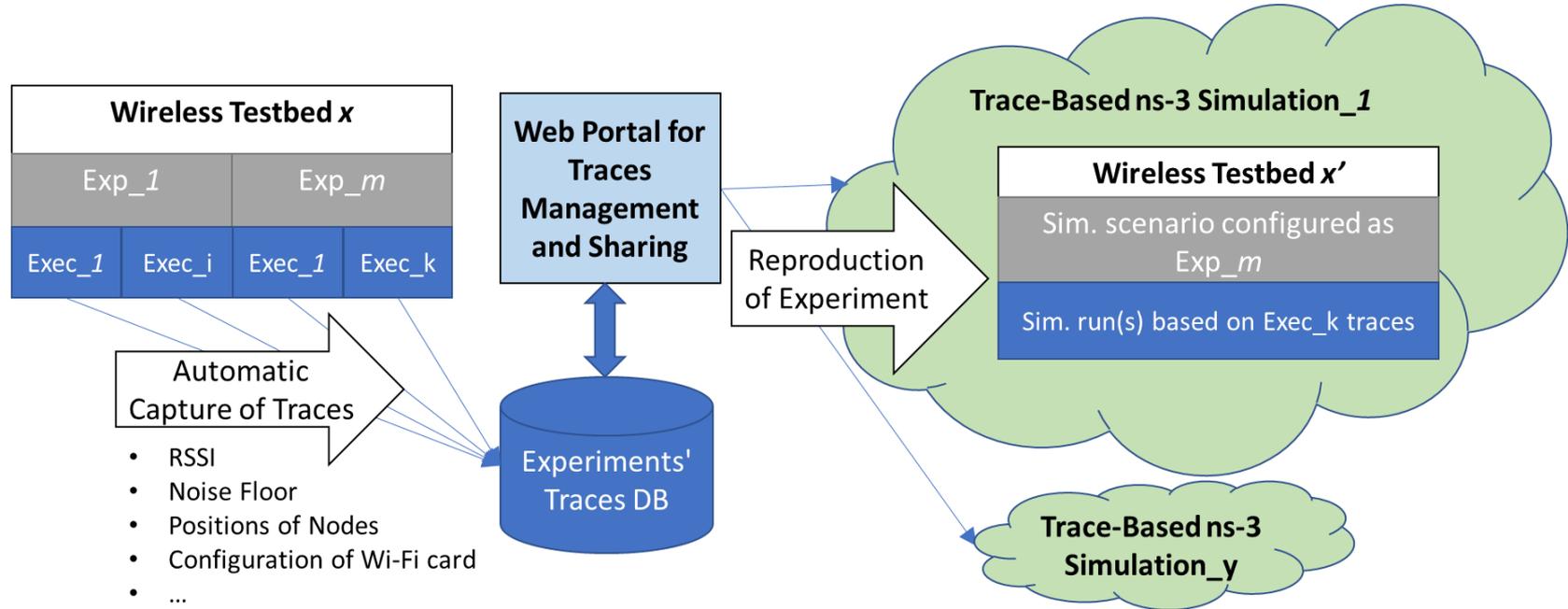
- **Background and motivation**
- **Offline Experimentation Approach**
- **SIMBED**
- **SIMBED+**
- **Conclusions**
- **Business Impact**

Background and Motivation



- Testbeds are getting more **complex** and **costly**
- **Reproducibility** may not be assured
 - **Private** testbeds
 - Testbeds may be **changed** / become **no longer available**
 - **Simulation** is too optimistic
 - **Unstable physical conditions** → Link quality, mobility patterns

Offline Experimentation Approach



Large scale validation needed → SIMBED

SIMBED

**Offline Real-World
Wireless Networking
Experimentation
using ns-3**

(2018-2019)

SIMBED OC3 Large Experiment



OBJECTIVES

- **Repeat and Reproduce** past experiments
- **Adapt Offline Experimentation (OE)** approach for Fed4FIRE+
 - Capture traces of **link quality** and **node positions**
 - Reproduce conditions of past experiments using **Trace-based ns-3 Simulations**
- **Validate OE approach** using **NITOS** and **w-iLab.t**
- **Promote interaction** between experimentation and simulation

SIMBED

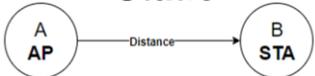
EXPERIMENT SET-UP



Some key features

- Baremetal access
- Custom OS image and drivers
 - ath9k
- Easy remote access
- Fast Internet access

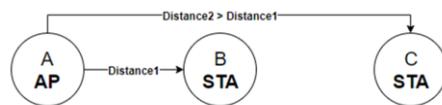
Static



Mobile



Multiple STAs



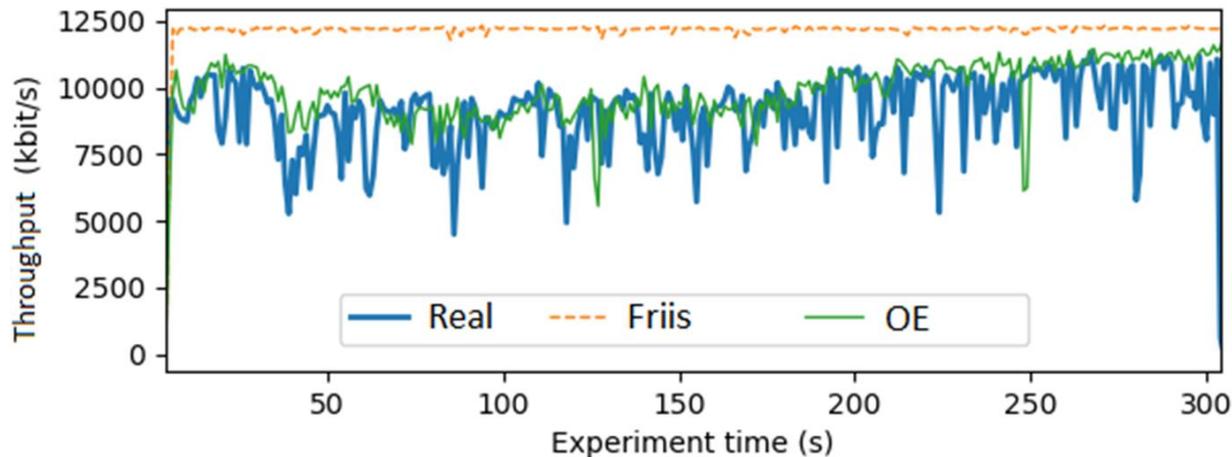
Bidirectional



SIMBED

RESULTS

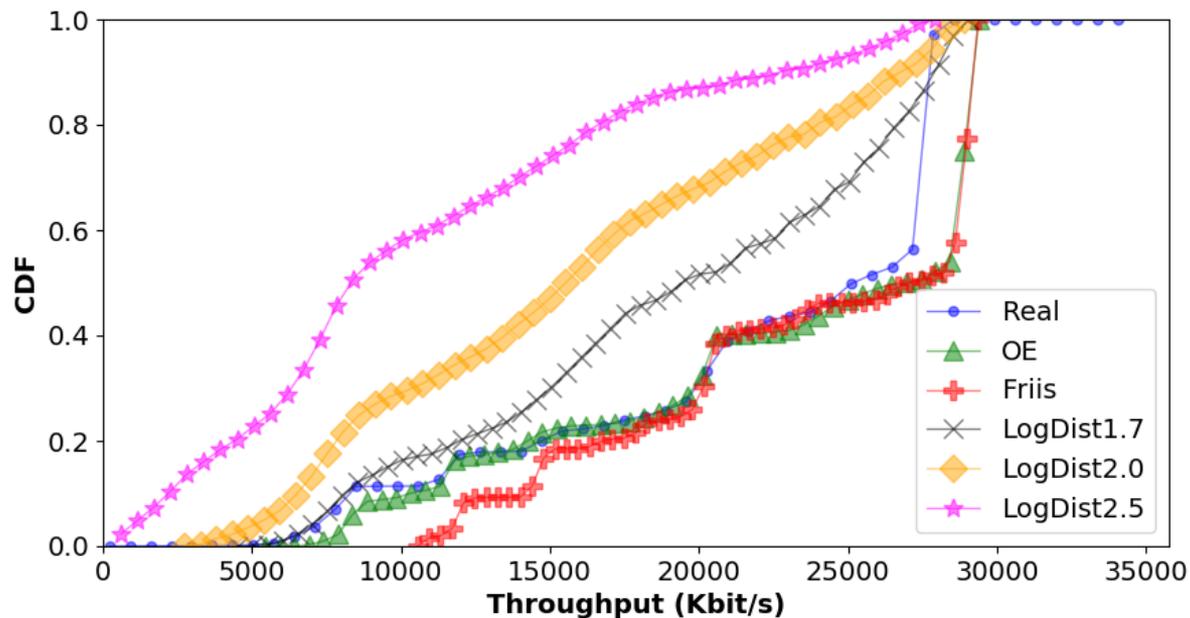
Example of static P2P experiment



SIMBED

RESULTS

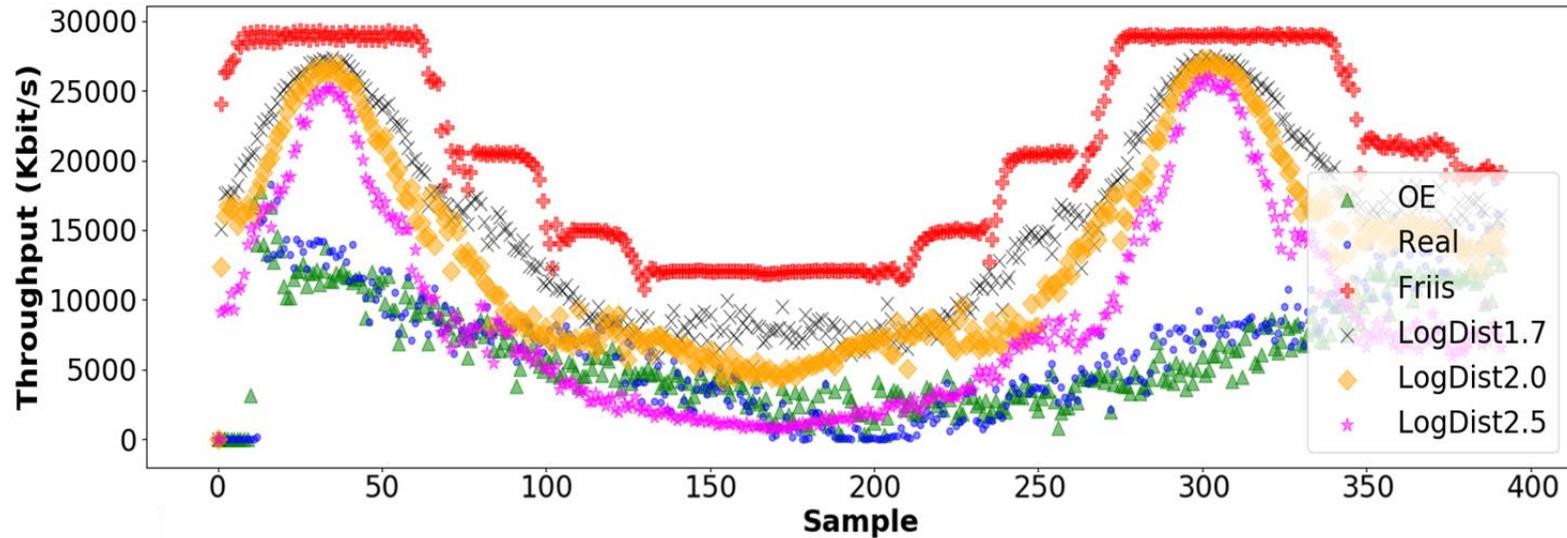
w-iLab.2 P2P (static, auto-rate)



SIMBED

RESULTS

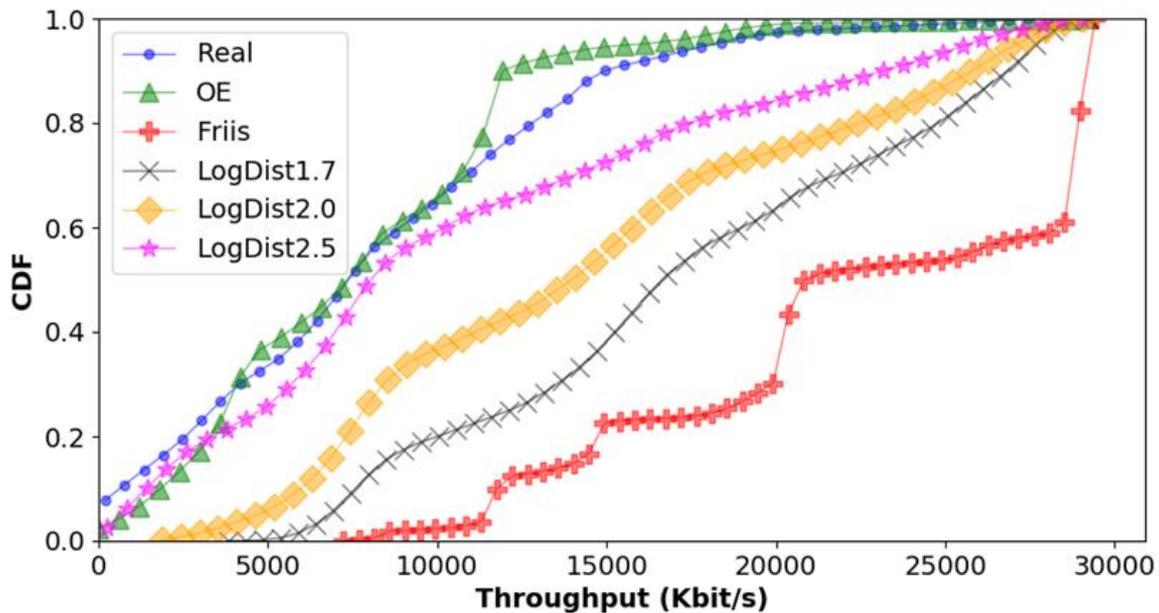
Example of mobile experiment



SIMBED

RESULTS

w-iLab.2 P2P (mobile, auto-rate)



SIMBED+

**Replicable Real
Wireless Networking
Experiments using
ns-3**

(2019-2020)

SIMBED+ OC5 Large Experiment



GOAL

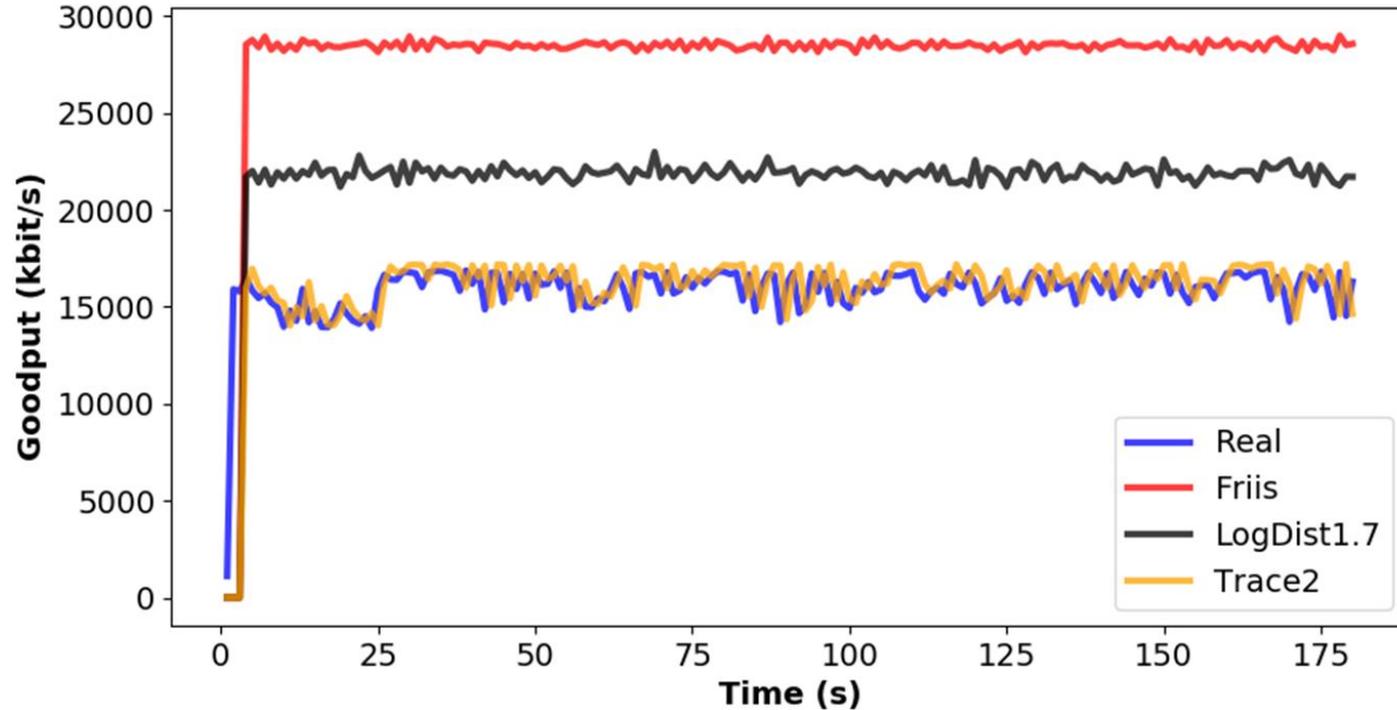
- **SIMBED** was focused on controlled scenarios and SISO
- **Validate OE Approach in uncontrolled scenarios**
 - Improve **MIMO** simulation accuracy
 - ns-3 always uses the maximum number of configured radio streams
 - Reproduce **channel occupancy**
 - ns-3 scenarios assume no interference / spectrum sharing from concurrent networks

OBJECTIVES

- **Repeat and Reproduce** past experiments executed in non-controlled environments
 - Introduce MIMO and shared radio spectrum support
- **Adapt Offline Experimentation** (OE) approach for Fed4FIRE+
 - Capture traces of **link information** and **positions of nodes**
 - Reproduce conditions of past experiments using **Trace-based ns-3 Simulations**
- **Evaluate OE approach** using **w-iLab.t** and CityLab
- **Promote interaction** between experimentation and simulation

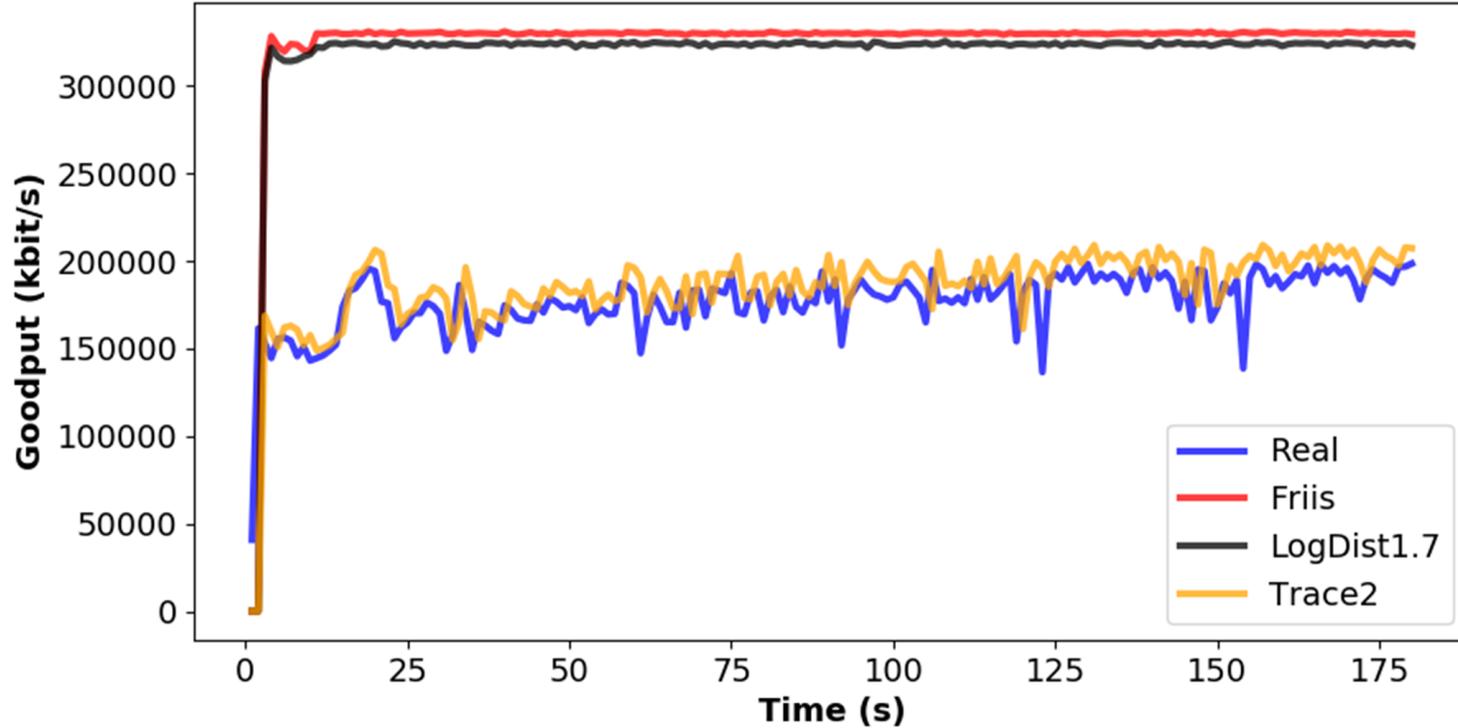
SIMBED+

EXAMPLE OF IEEE 802.11A EXPERIMENT



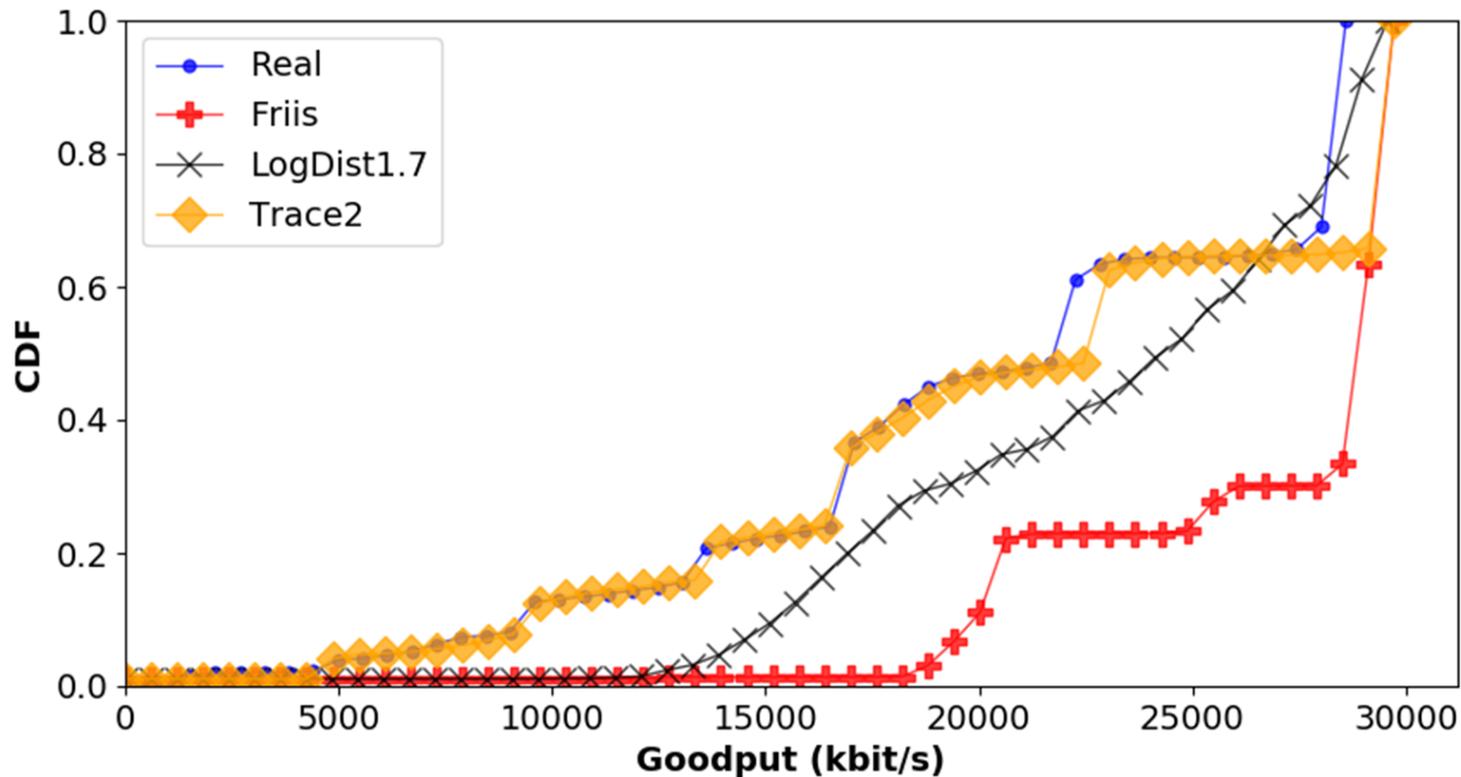
SIMBED+

EXAMPLE OF IEEE 802.11N EXPERIMENT



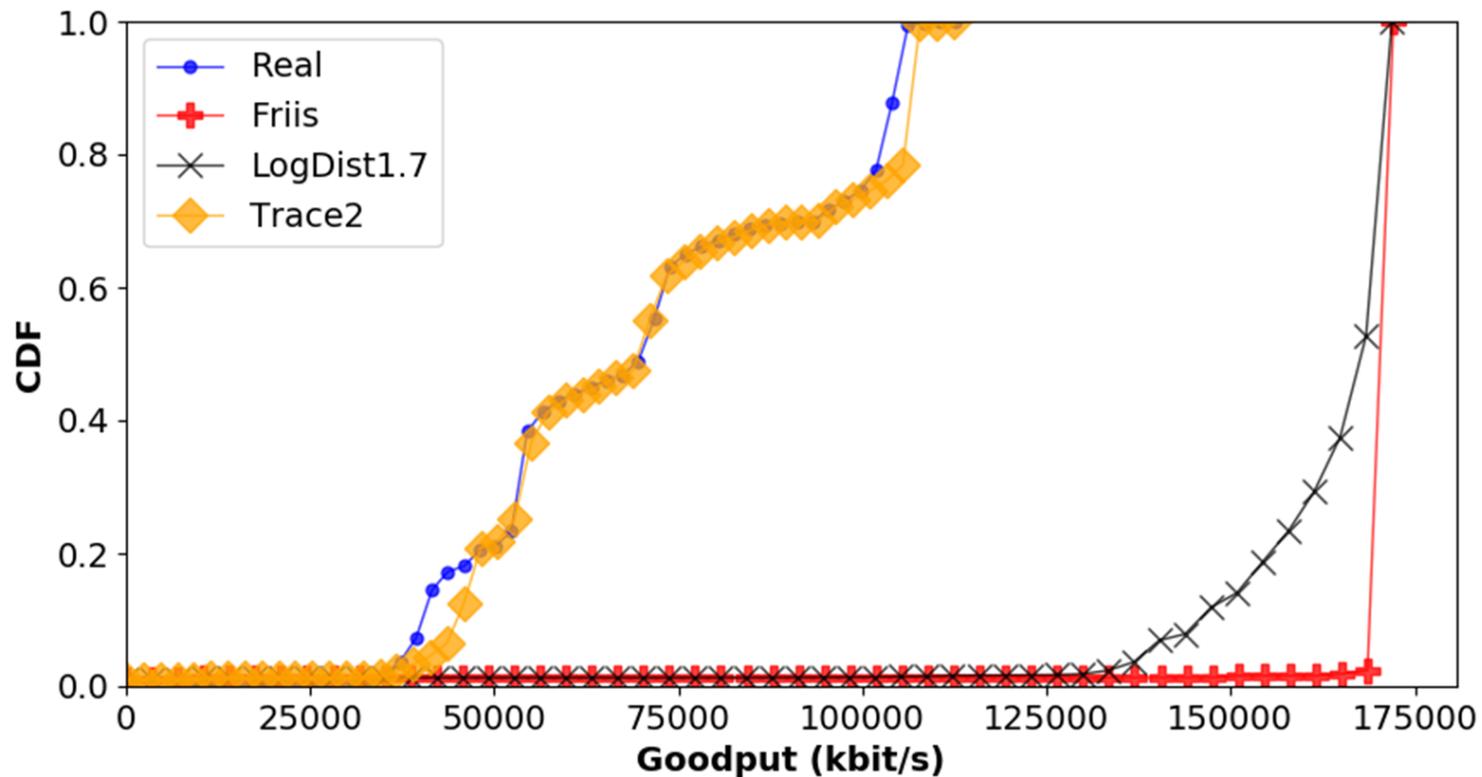
SIMBED+

IEEE 802.11A SISO @ 20 MHz



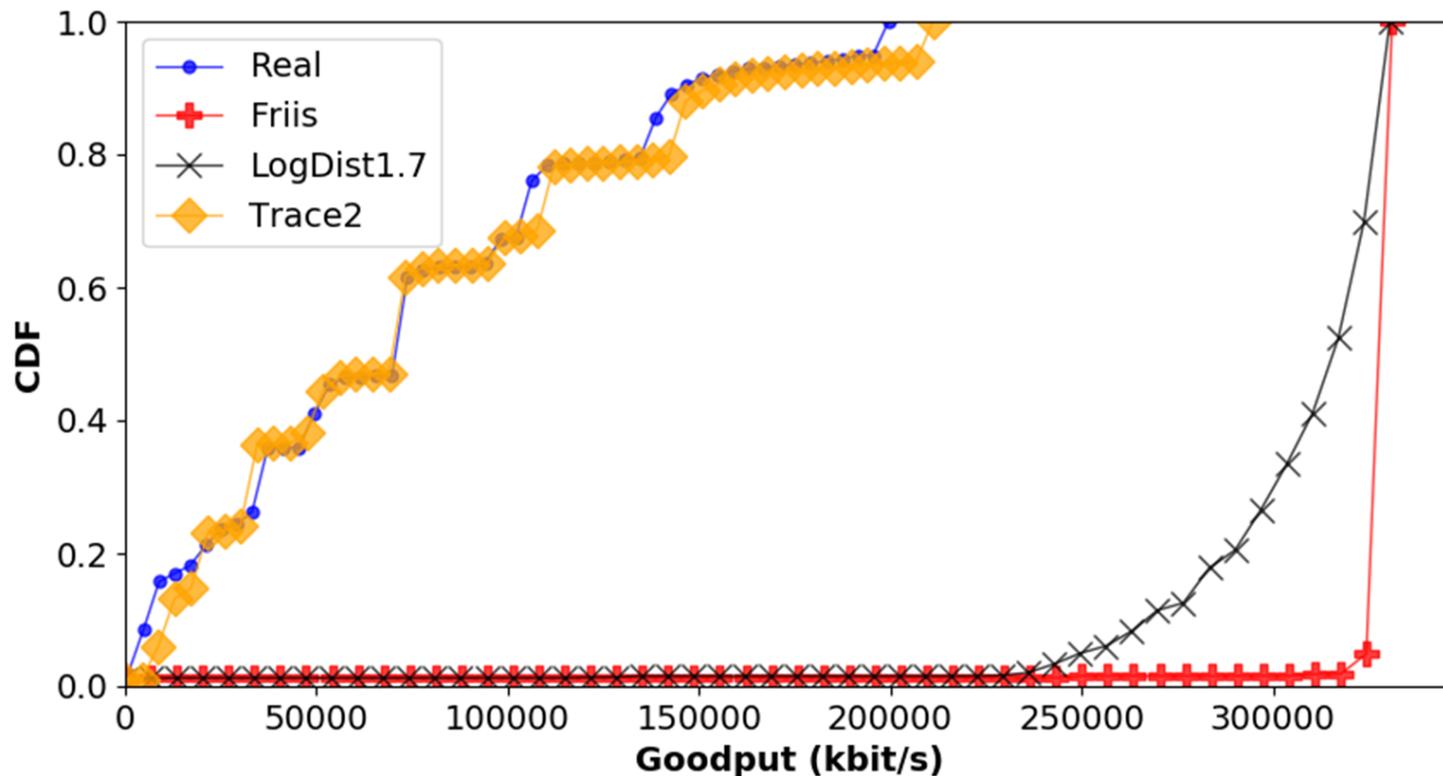
SIMBED+

IEEE 802.11N MIMO 3X3 @ 20 MHZ



SIMBED+

IEEE 802.11N MIMO 3X3 @ 40 MHZ



Conclusions



- **OE** approach was evaluated in large scale
- **OE** approach → **repetition & reproduction of experiments**
 - Even if real **testbed** becomes **unavailable**
- **MIMO** and **Channel Occupancy** support
 - Improves OE accuracy for uncontrolled testbed scenarios

Business Impact

Business Impact

IMPACT ON OUR BUSINESS

- SIMBED(+) demonstrated OE is a valid approach
- High impact in all R&D activities depending on experimentation
 - Reduce costs and manpower involved
 - Enable repeatability and reproducibility of experiments
- Validation of OE approach increases confidence to use it in
 - Future projects
 - MSc and PhD theses

Business Impact

VALUE PERCEIVED

- **Gained knowledge**
 - Radio link asymmetry
 - Ath9k debug mode
 - How to use Fed4FIRE+ Wi-Fi resources
- **Acquired new competences**
 - Experimentation over federated testbeds
 - Large experiments orchestration
 - Results/trace data processing
- **New ideas for our roadmap**
 - Keep improving OE approach
 - Work together with Fed4FIRE+
 - Offline Experimentation as a Service (OEaS)
 - Augmented Experimentation as a Service (AEaS)

Business Impact

VALUE PERCEIVED

- 6 scientific publications
 - 5 conference papers (2 in preparation)
 - 1 journal paper (in preparation)
- Contribution for PhD thesis
- OE approach being used in current research projects

Business Impact

VALUE PERCEIVED

- Validation of OE approach through well-known and controlled environments provided by NITOS, w-iLab.t and Citylab
- Without Fed4FIRE+
 - Limited to small-scale custom/private testbeds
 - Need to adapt our methodology to each testbed
 - **OE approach validation would be less credible**



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WWW.FED4FIRE.EU