PhD Dissertation & Backgrounds

VIRGINIA TECH
DEP. OF COMPUTER SCIENCE
PHD (2021.5)
KIJIN AN
https://kjproj84.github.io

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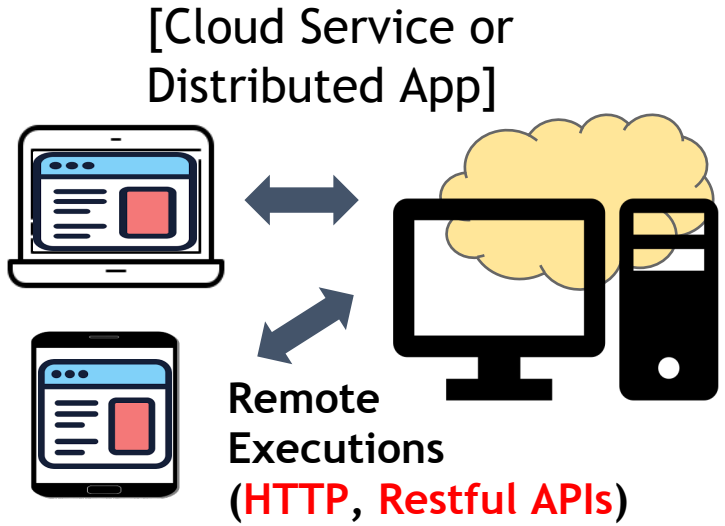
Dissertation Contributions

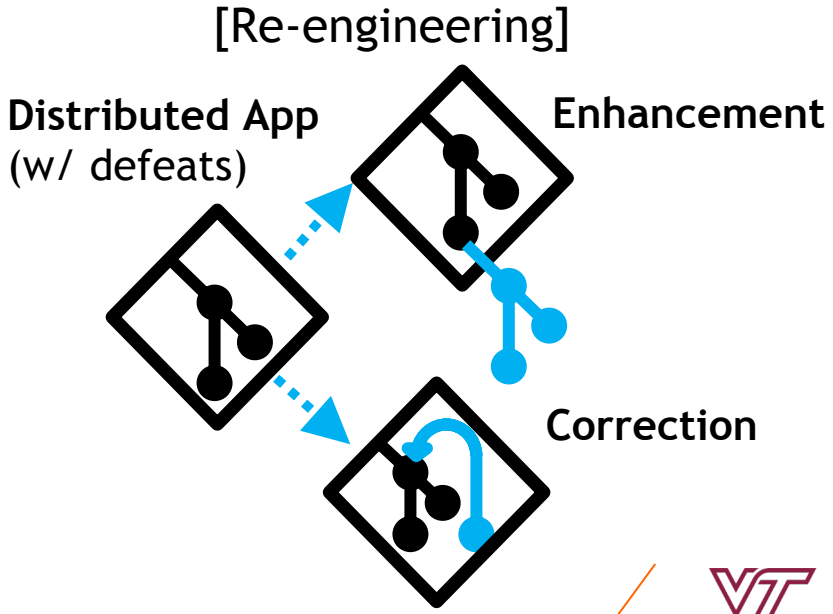
- Advisor: **Eli Tilevich**
- My Research Topic:
  - Software Engineering,
  - Distributed Systems (Web),
  - Wireless Computer Networking

Dr. Tilevich

Dr. Smaragdakis

- New "**Refactoring**": "Client Insourcing"
  - *Creating a Centralized Variant ($\mathcal{P}'$) for the Distributed App/Cloud Service ($\mathcal{P}$)*
- Value and Utility of "Client Insourcing"
  - *"Pinpointing"* Inefficiency of Distributed Programs and *"Assisting"* Programmers for their changes
  - Applying state-of-the-art techniques from **Software Engineering** to address problems in Distributed Apps





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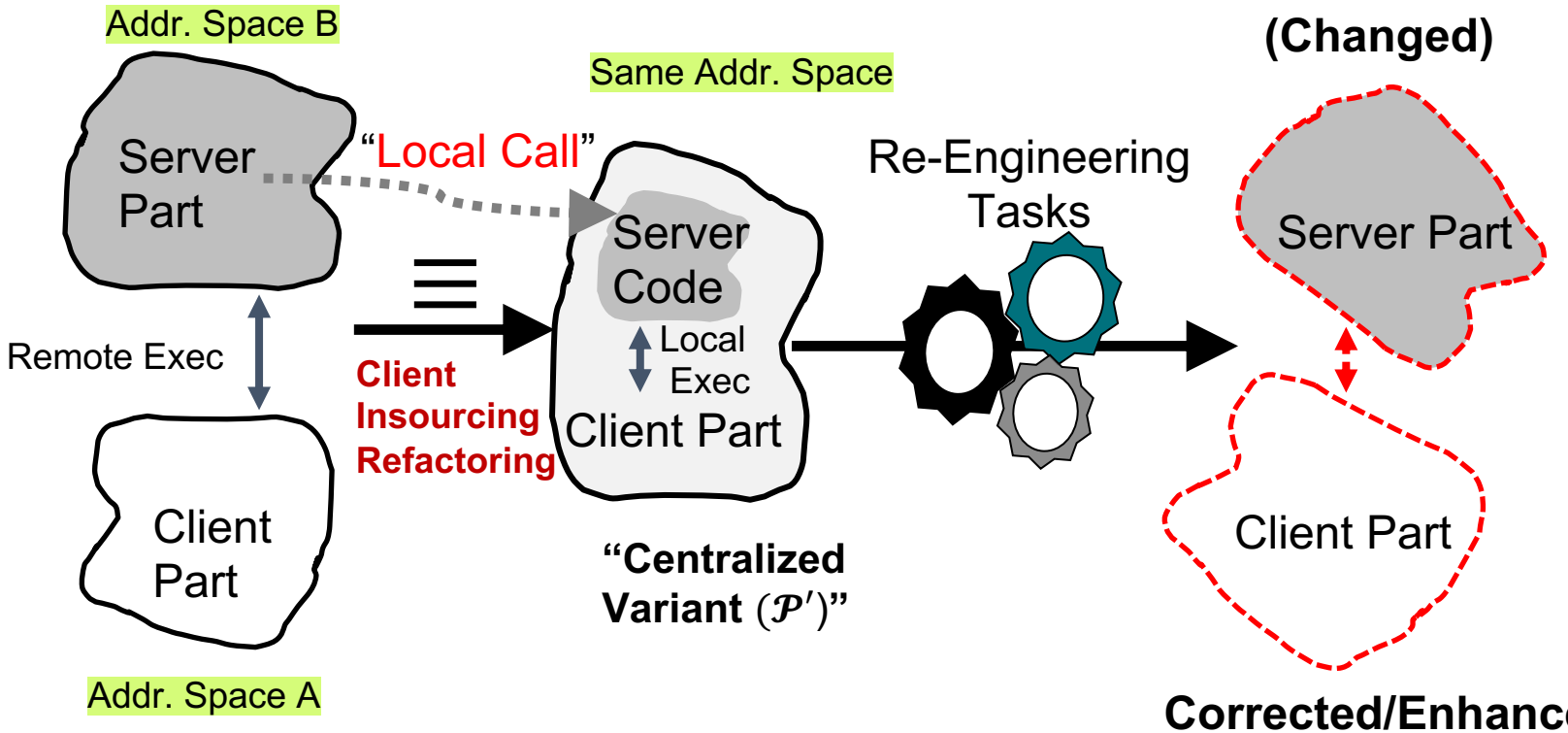
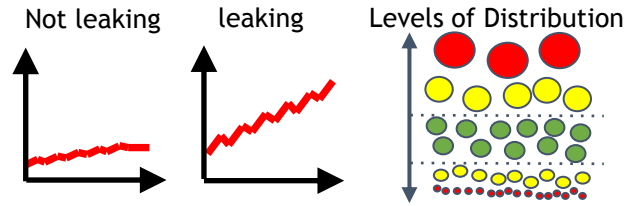
Client Insourcing Refactoring



- **Correcting Distributed Apps**

Debugging Memory Leakage/Performance Bottlenecks (very quickly)

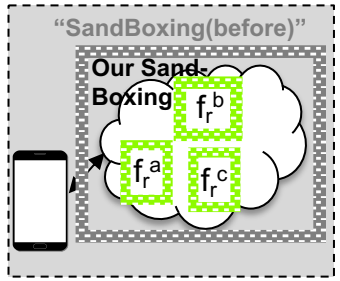
Optimizing Distribution Granuality

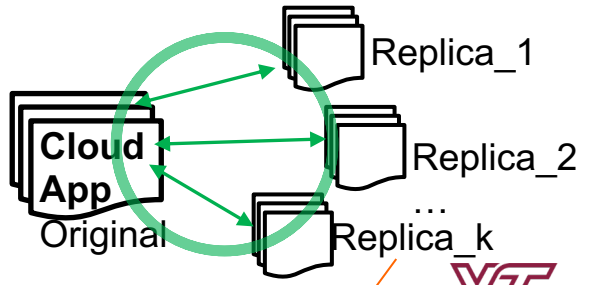


- **Enhancing/Adapting Distributed Apps**

Sandboxing with minimum overheads

Replicating Distributed Apps for Mobiles/Edges





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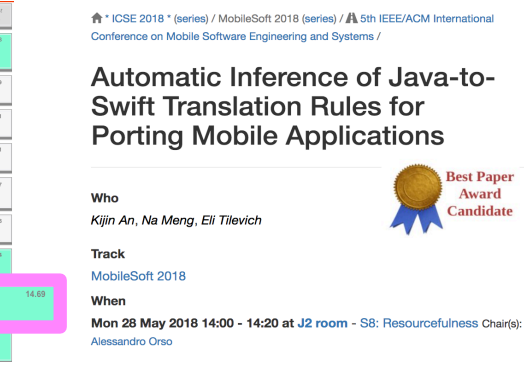
Publications & Honors in PhD

(full list: https://kjproj84.github.io/publications)

No.	Paper	Conference	Area	
1.	Client Insourcing Refactoring	**WWW 2020** (19%, 217/1129, Top-tier)	System (Web)	1st Author/2
2.	D-Goldilocks	**SANER 2020** (21%, 42/199)	Software Engineering	1st Author/2
3.	Catch&Release (Debugging)	**ICWE 2019** (25%, 26/106)	System (Web)	1st Author/2
4.	Comm Web Vessels	**ICWE 2021** (17%, 22/128, Best Paper 🏆)	System (Web)	1st Author/2
5.	EdgeFy: Edge-based framework	**Submitted**	System (Middleware)	1st Author/2
6.	**[Appendix] Project1**: Differencing Cross-platform Apps	**MobileSoft 2018** (Nominated for Best Paper)	Software Engineering	1st Author/3
7.	**[Appendix] Project2**: Distributing Embedded Apps for Trusted Exec.	**GPCE 2018**	Software Engineering	2nd Author/3
8.		**Journal of Com. Lang.** (Nominated for Best Paper)	Software Engineering	2nd Author/3

- Main work presented in WWW 2020 (Top-tier)
- One Best Paper Award & Two Best Paper Nominations



- Two Doctoral Symposium Papers in WWW 2020 and ICWE 2019
- Two Spotlights from CS@VT

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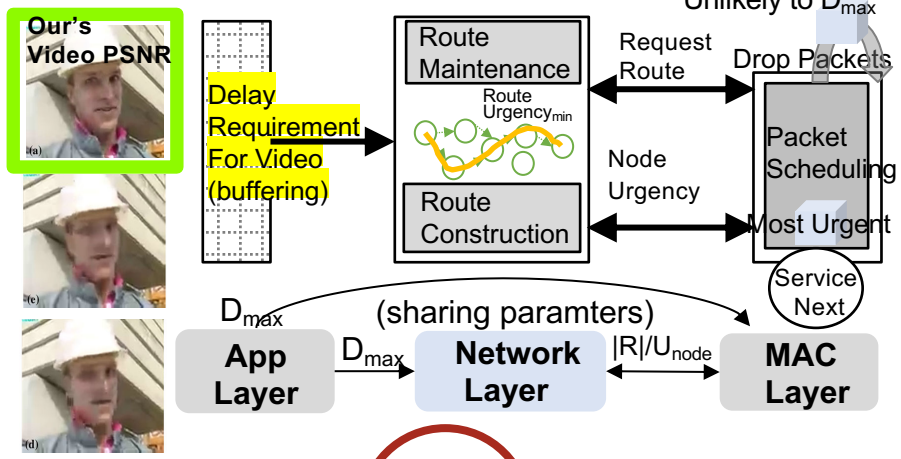
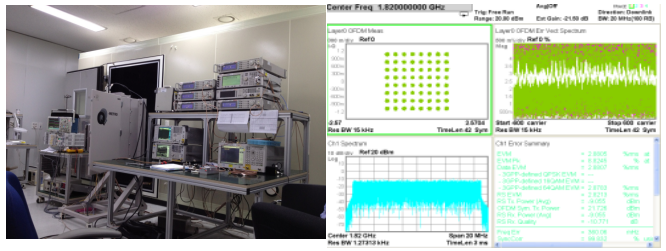
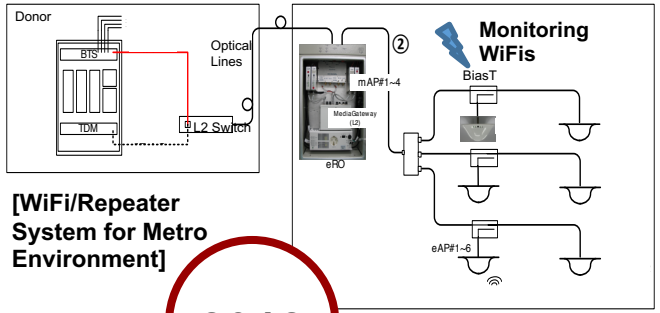
Before PhD Program:

1. "Computer Networking'' && "Wireless Network"
2. "Cloud-based Distributed Systems"

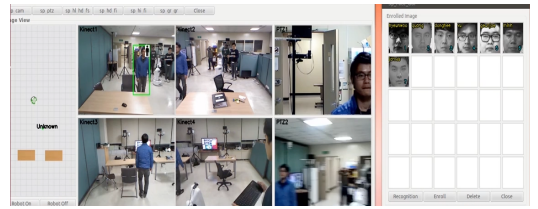




[4G Wireless Network Equipment R&D: Spectrum Analysis]



[WiFi/Repeater System for Metro Environment]

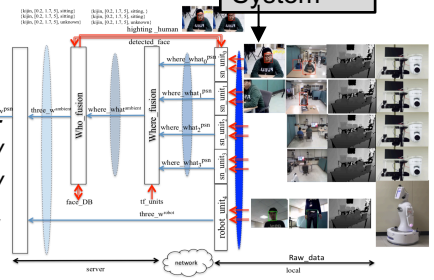


Sensor Units X *N*

Scale /Fault Tolerant

Distributed System

{Who/ Where/ Wat}



2009

Value Creating University
POSTECH
POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY

MS: Computer Networking (2 years)

- **MS Thesis: A Cross-layer** Scheme for **Video Data** Transmission
- **Routing** Protocols for Ad hoc Networking: AODV, DSR
- **MAC Scheduler**: WLAN or Zigbee
- ICC 2009 (Conf), ACM/Springer Wireless Network 2013 (Journal)

2012

Industry #1

SK telesys

(Network) System Software Engineer
(3 years 4 months)

- Developing/Optimizing **Wireless Network** Equipment (3G/4G Base Station, Repeater)
- WiFi/Repeater System : Remote Management tool for Metro (TR-069)
- Developing Business Functions for WiFi/VoIP System (Asterisk, SIP/RTP)

2015

Industry #2

KIST 한국과학기술연구원
Korea Institute of Science and Technology

(Top Korean National Lab)
Software Engineer/Researcher
(2 years 10 months)

- **Cloud-based Distributed System** for a Robot Service
- **Scale/Fault Tolerant** for **Sensor Units** x *N*
- **Web-based Service Scheduler**

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Beginning my PhD Program (2015.8~)

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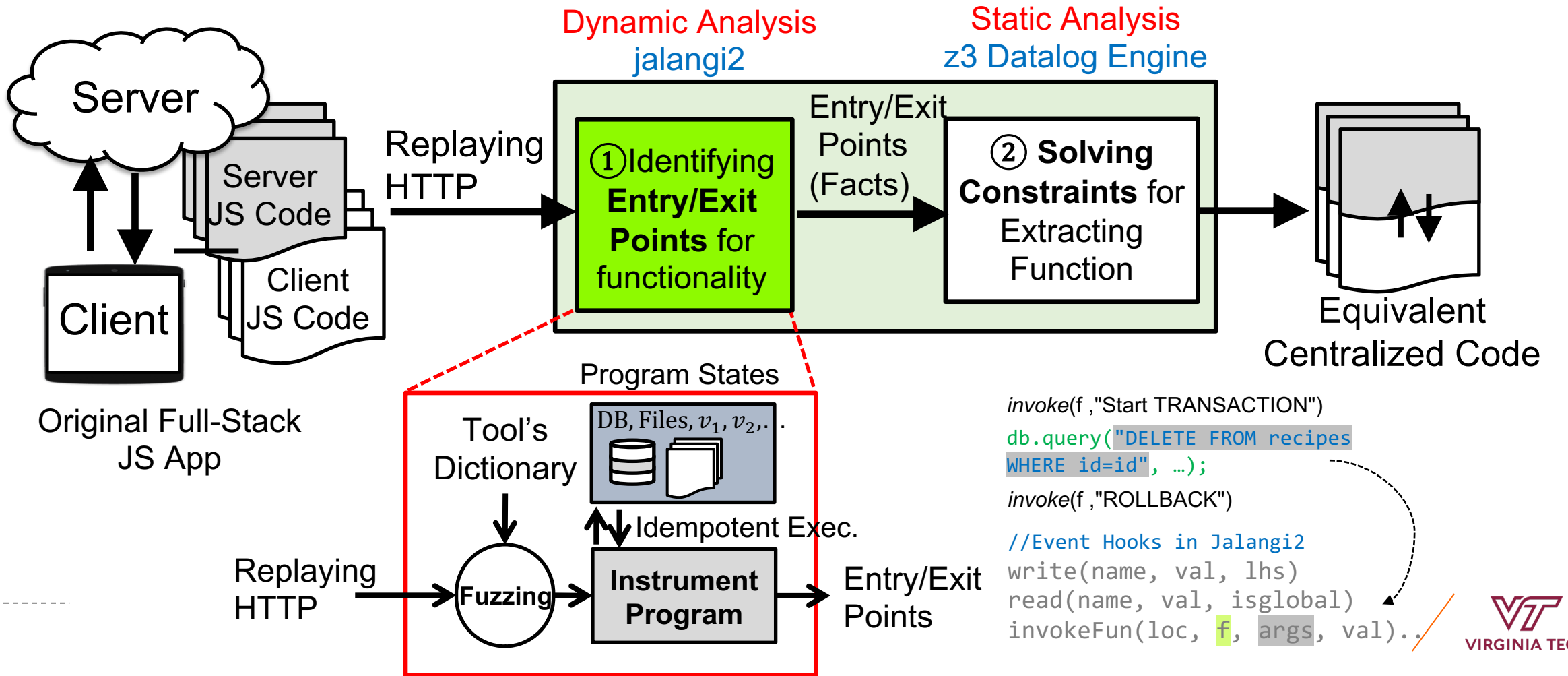
Client Insourcing Refactoring [WWW 2020]

- **Fuzzing HTTP** records, **Idempotent** Executions



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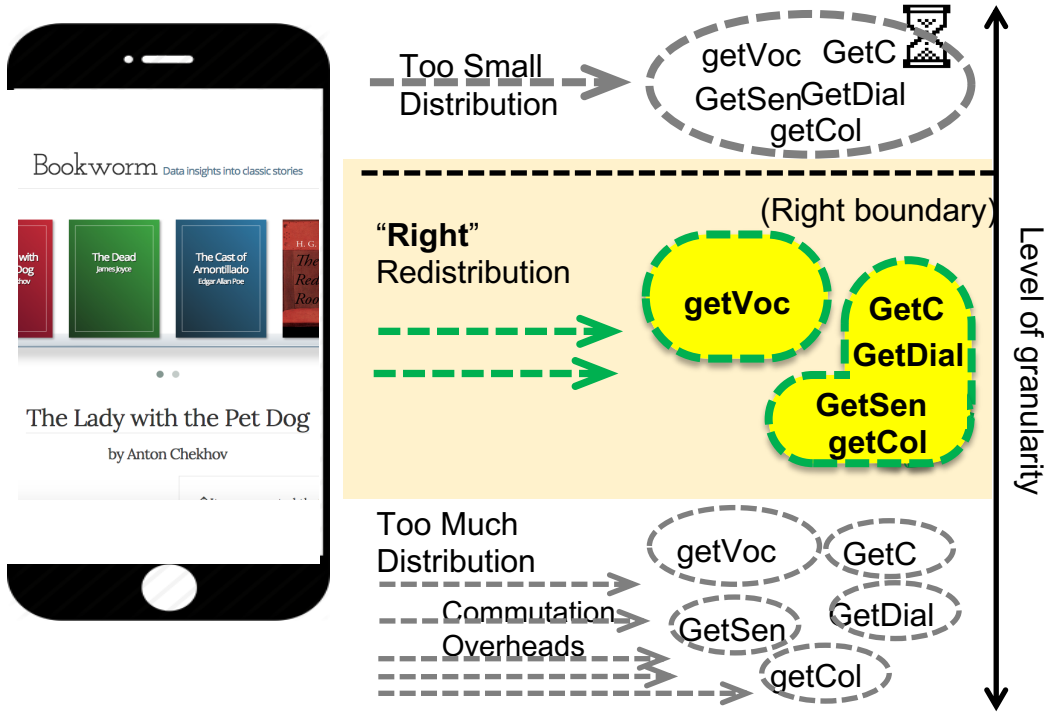
Application 1: Optimizing Cloud Services [SANER 2020]

Restructuring Distribution

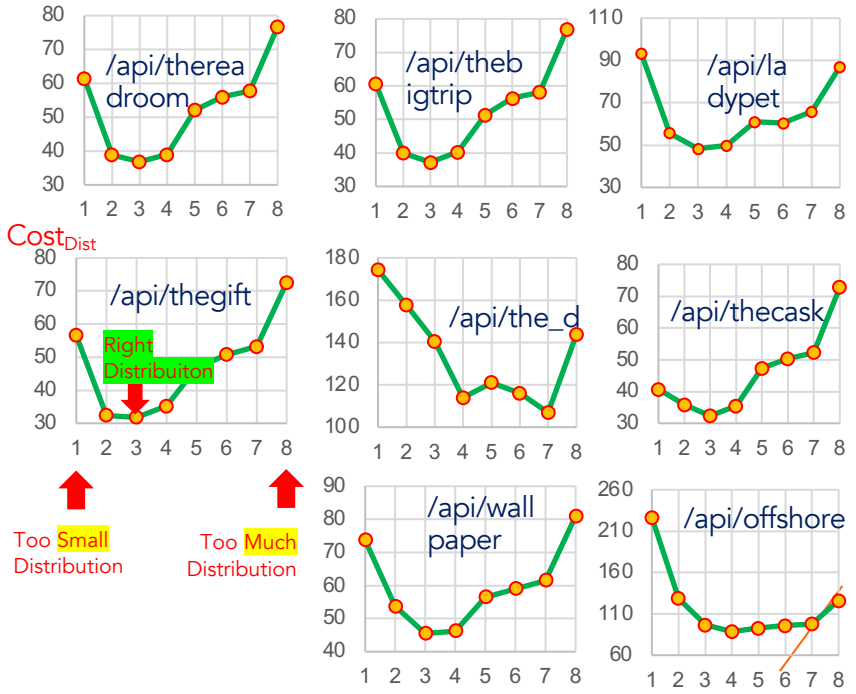
- Correcting ill-conceived Distributions
  - Ex) Nano-service anti pattern



Client-Side

Server-Side (/api/ladydog)

- Determine which functional distribution would minimize the cost of distributions
  - $C_{Dist_Exec}(\mathbf{r}) = \alpha \cdot latency(\mathbf{r}) + (1-\alpha) \cdot \Sigma\ resource(\mathbf{r})$
- Large Distribution Space: Our Tool automates!
  - Ex) 394 × **4139** ~= **1.6 × 10⁶** ULOCs



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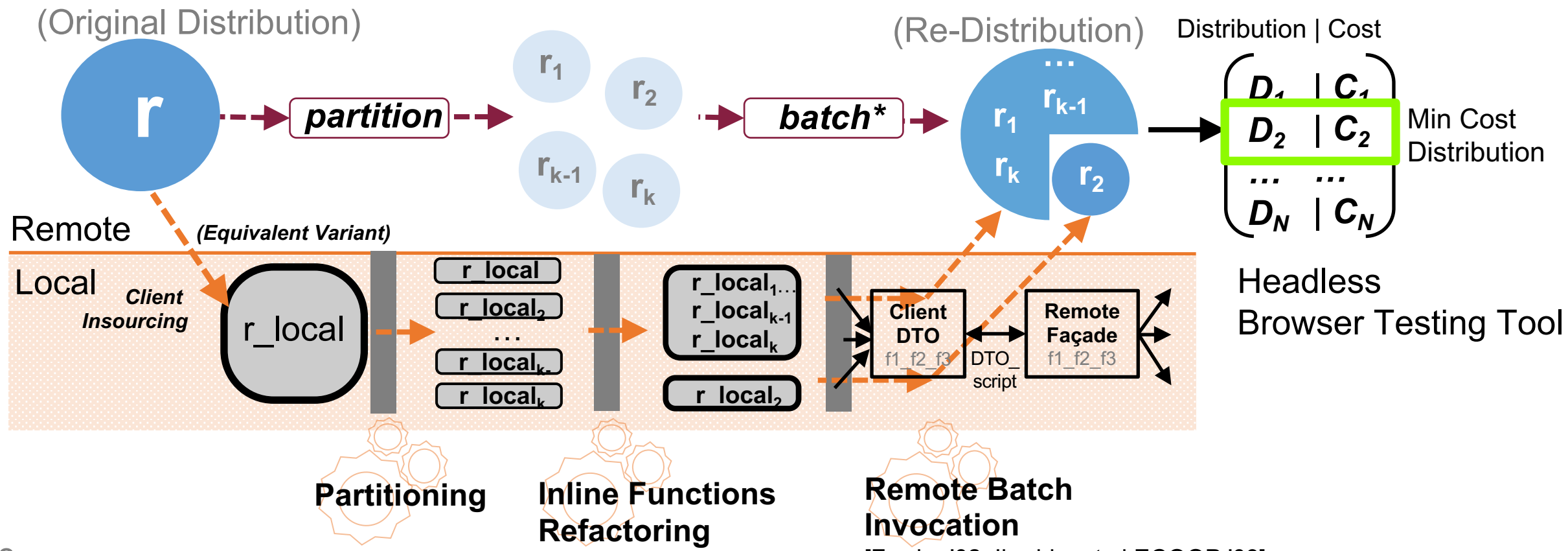
Application 1: Optimizing Cloud Services [SANER 2020]

Restructuring Distribution



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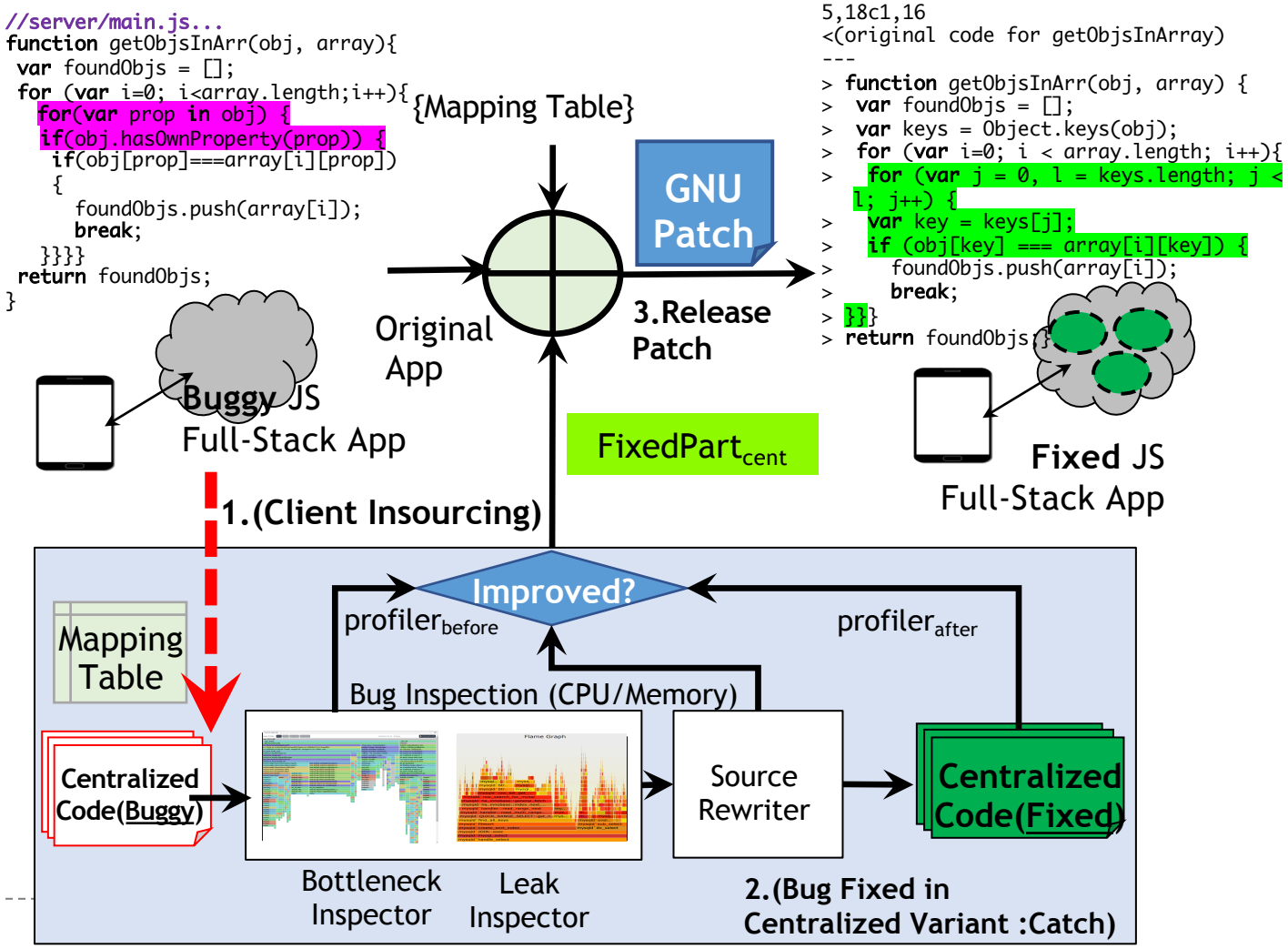
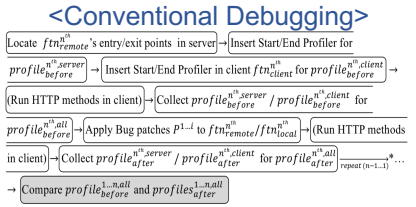
Application 2: Bug Fixes in Distributed Apps [ICWE 2019]



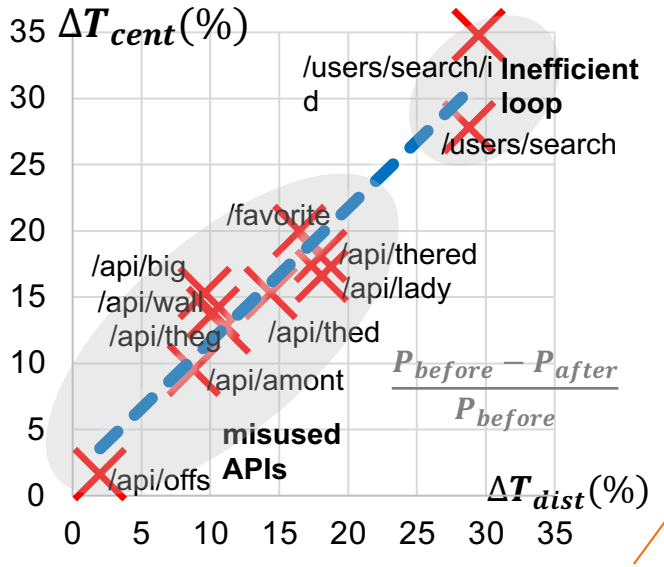
- Fixing Bugs in Centralized Variants and Generating Patches
- **90%** Reduced Time to execute Debugging Task

<Conventional Debugging>



<Our Simplification>

Reduced Steps



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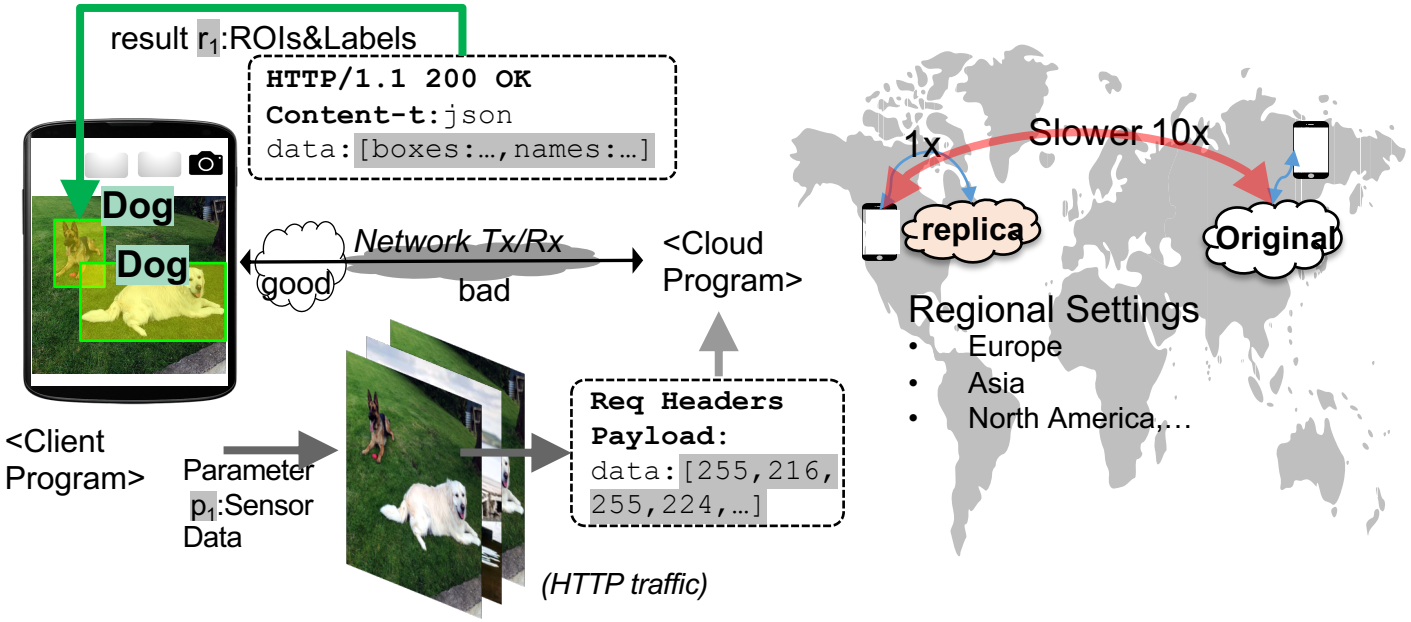
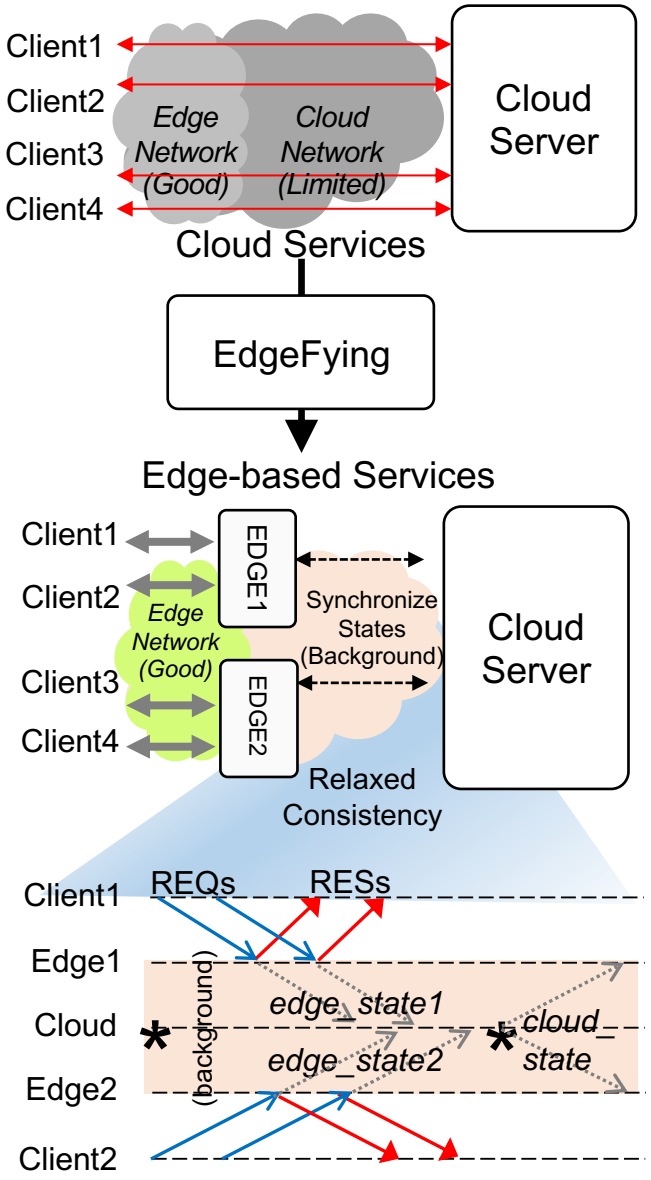
Application 3: EdgeFying Cloud Services (Submitted)

- **Locality** of Cloud services, **Data Deluge** on Network Bottleneck
  - Replicating {$state_{init}$, ftn_{init}} of Cloud Service
  - Synchronizing States: Cloud and Edge Replicas
  - Correctness of Transformation: Isabelle HOL framework
  - Performance Compared to other Proxy Techniques



ex) Apps of ML (tf.js)



ex) Heroku: Cloud Platform

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