IPOP Overlay and Lake Ecology Expedition

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Eutrophication in lakes

- Lake eutrophication (high nutrient loads) is a global phenomenon that has led to degraded water quality and public health risks
- Harmful algal and cyanobacterial blooms result in noxious and toxic water quality

Lake Sunapee, USA

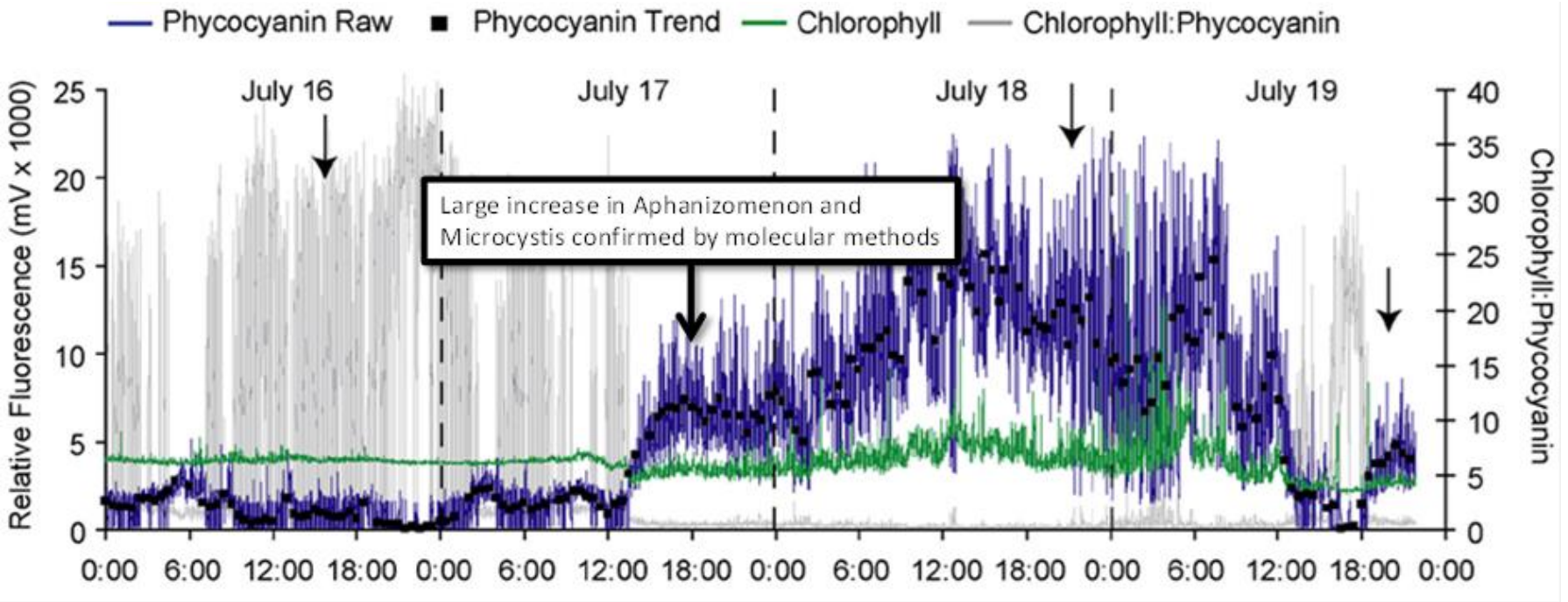
Lake Erken, Sweden

Lake Taihu, China

Eutrophication in lakes

- Lake eutrophication (high nutrient loads) is a global phenomenon that has led to degraded water quality and public health risks
- Harmful algal and cyanobacterial blooms result in noxious and toxic water quality
- Understanding the lake conditions that lead to harmful algal blooms is a high priority for responding to, and mitigating, water quality problems
- Our poor predictive capacity of blooms suggests major shortcomings in data and/or models

High-frequency bloom data

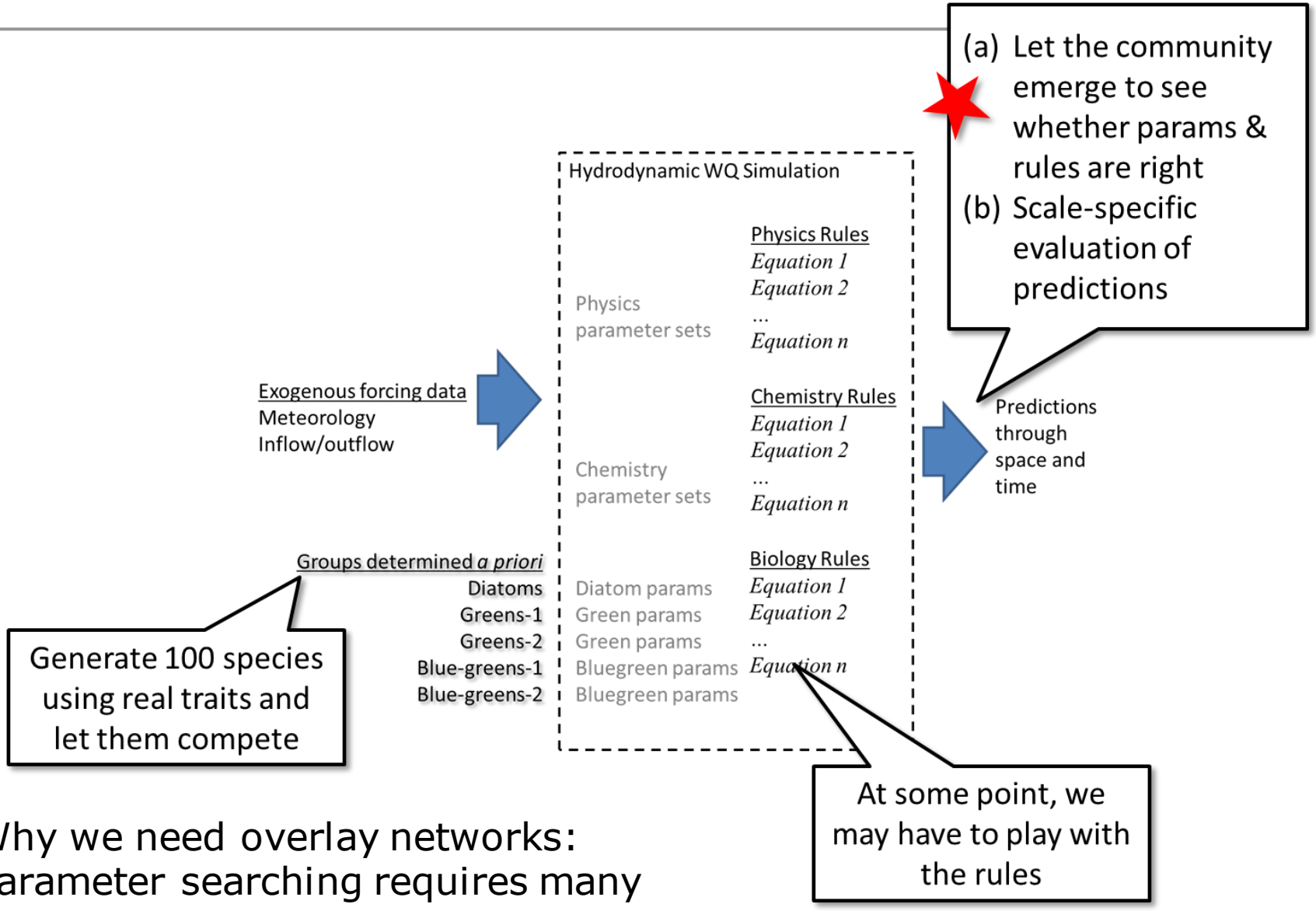


Time series of sensor network data show rapid growth (a.k.a. "bloom") in cyanobacteria on July 17 that led to degradation of water quality. Data from the sensing buoy alerted researchers to this bloom prompting collection and analysis of manual samples that identified the species as the potentially toxic Aphanizomenon and Microcystis. The wax and wane of this bloom would otherwise have been missed by traditional sampling protocols, which are infrequent.

Goals

- Calibrate a new hydrodynamic-water quality model, GLM-FABM-AED, to Lake Mendota, Wisconsin (USA).
- Investigate whether the model can reproduce the observed lake physical-biological features of interest
- Consider many different species that are part of the phytoplankton community in lakes
- Expand research to additional lakes

GLM: our Lake Model



Why we need overlay networks: Parameter searching requires many simulations- this is not very efficient on 1 machine

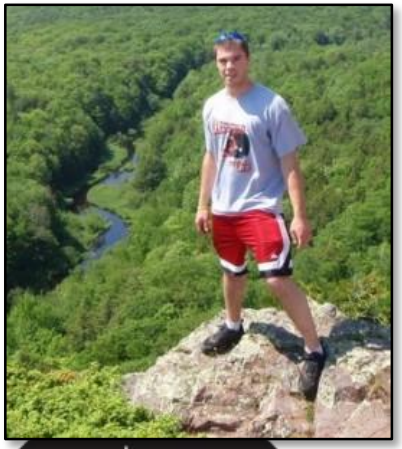
Resources

- Distributed team of scientists
- Distributed computers
- Data from GLEON

University of Wisconsin

Paul Hanson

Cayelan Carey
Virginia Tech.



Craig Snortheim

Renato Figueiredo
University of Florida

PACIFIC RIM APPLICATIONS AND GRID MIDDLEWARE ASSEMBLY
PRAGMA

+

GLEON

Bringing it all together

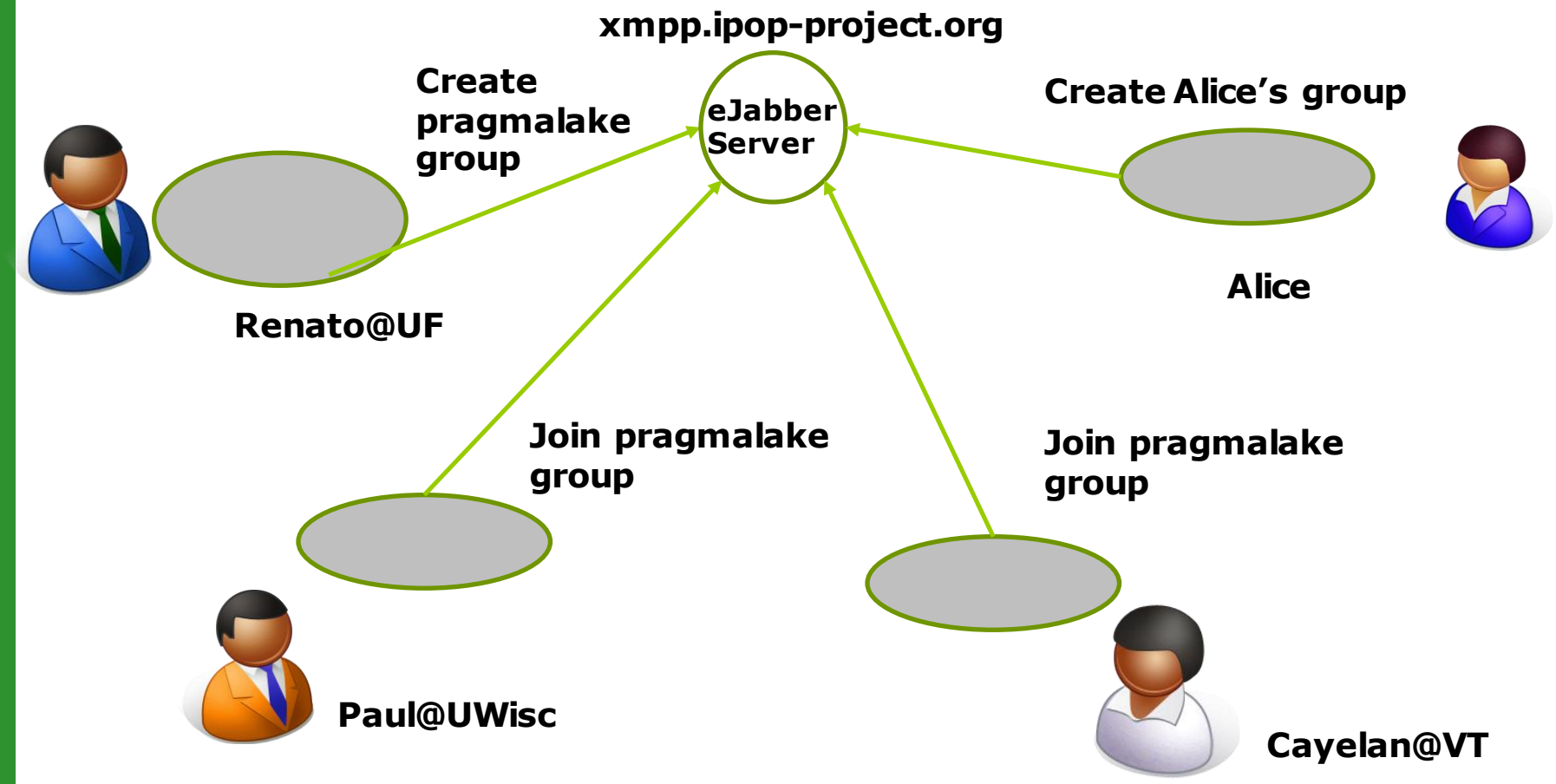
- Distributed resources are available
  - Desktops, servers, cloud
  - Challenges: aggregating them in user-friendly manner, and with low administrative overhead
- Community-preferred software environments
  - Windows, R
  - Challenge: expose user's preferred environments; do not rely on users adapting to a new setup
- Technical approach
  - Easy-to-use virtual network software automatically creates a "trust envelope" around the resources
  - Run unmodified O/Ss, HTCondor

IP-over-P2P (IPOP) Overlay

- "User-Defined Networking"
  - SDN that users can deploy
    - User-level; easy to use
  - VPN software – only needed at endpoints
    - Cloud VMs, personal computers, mobile devices
  - Map social network to virtual network links
    - E.g. Pragma lake researchers
  - P2P VPN links rather than centralized gateway

Cluster VPN in 3 Easy Steps

- Step 1: create a group on an XMPP server
  - UF manages one – you can also deploy your own



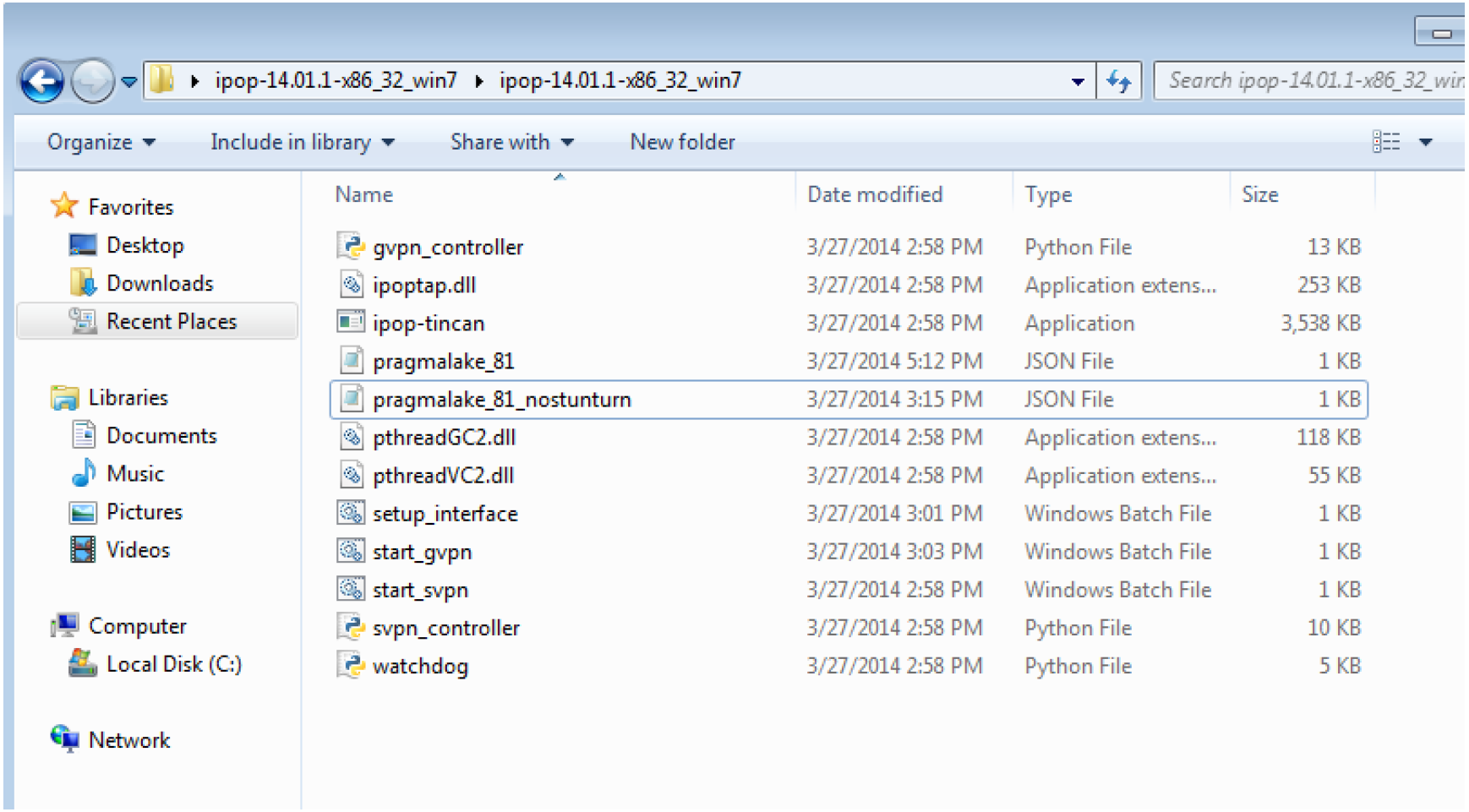
Cluster VPN in 3 Easy Steps

- Step 2: generate configuration files for nodes
  - IPOP takes JSON configuration file at each node
  - We have a script for that

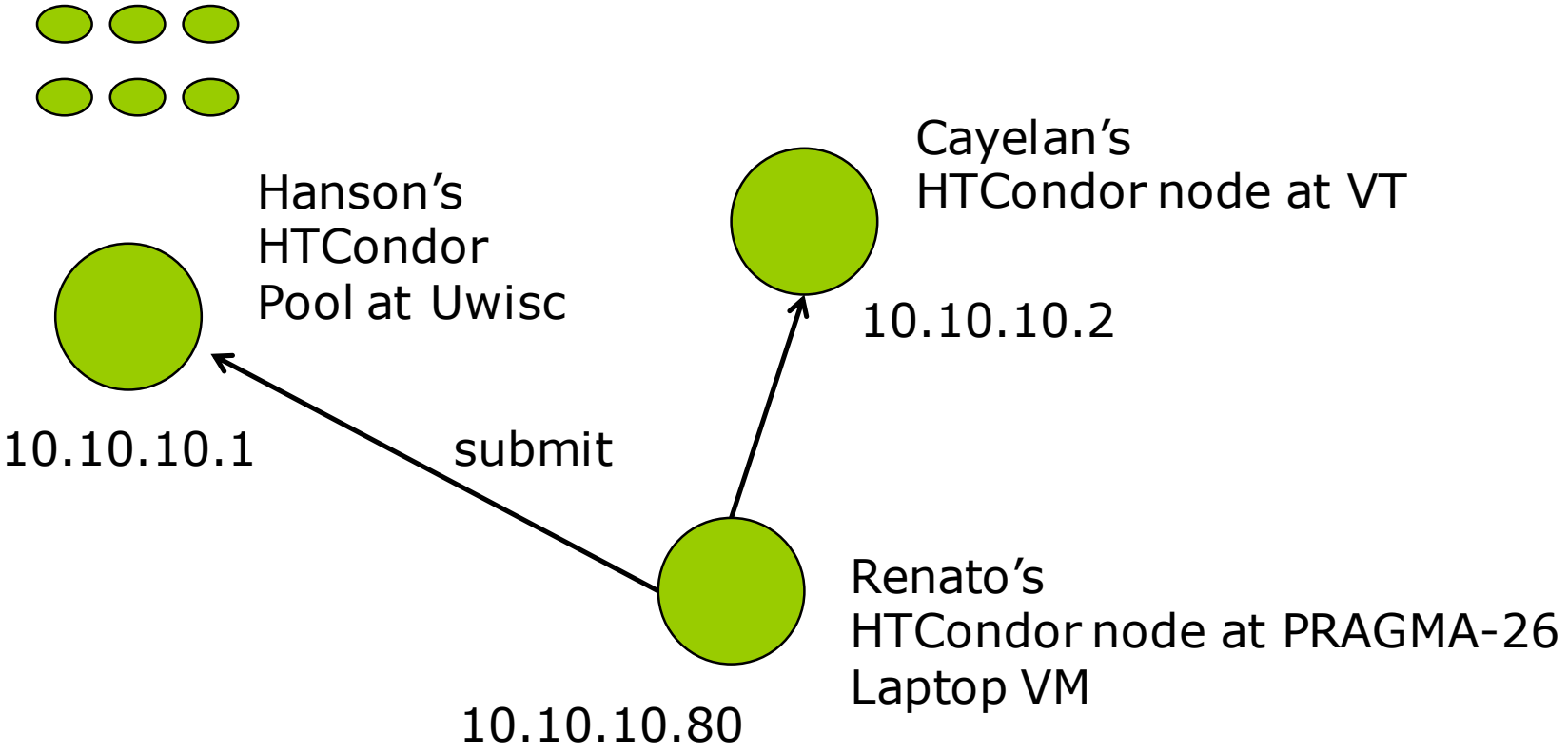

```
{    "ip4_mask": 24,
    "xmpp_password": "cw3r582o9q99dr4fd9u8tontezsdov",
    "xmpp_host": "xmpp.ipop-project.org",
    "xmpp_username_short": "pragmalake_81",
    "xmpp_username": "pragmalake_81@xmpp.ipop-project.org",
    "sec": true,
    "ip4": "10.10.10.81",
}
```

Cluster VPN in 3 Easy Steps

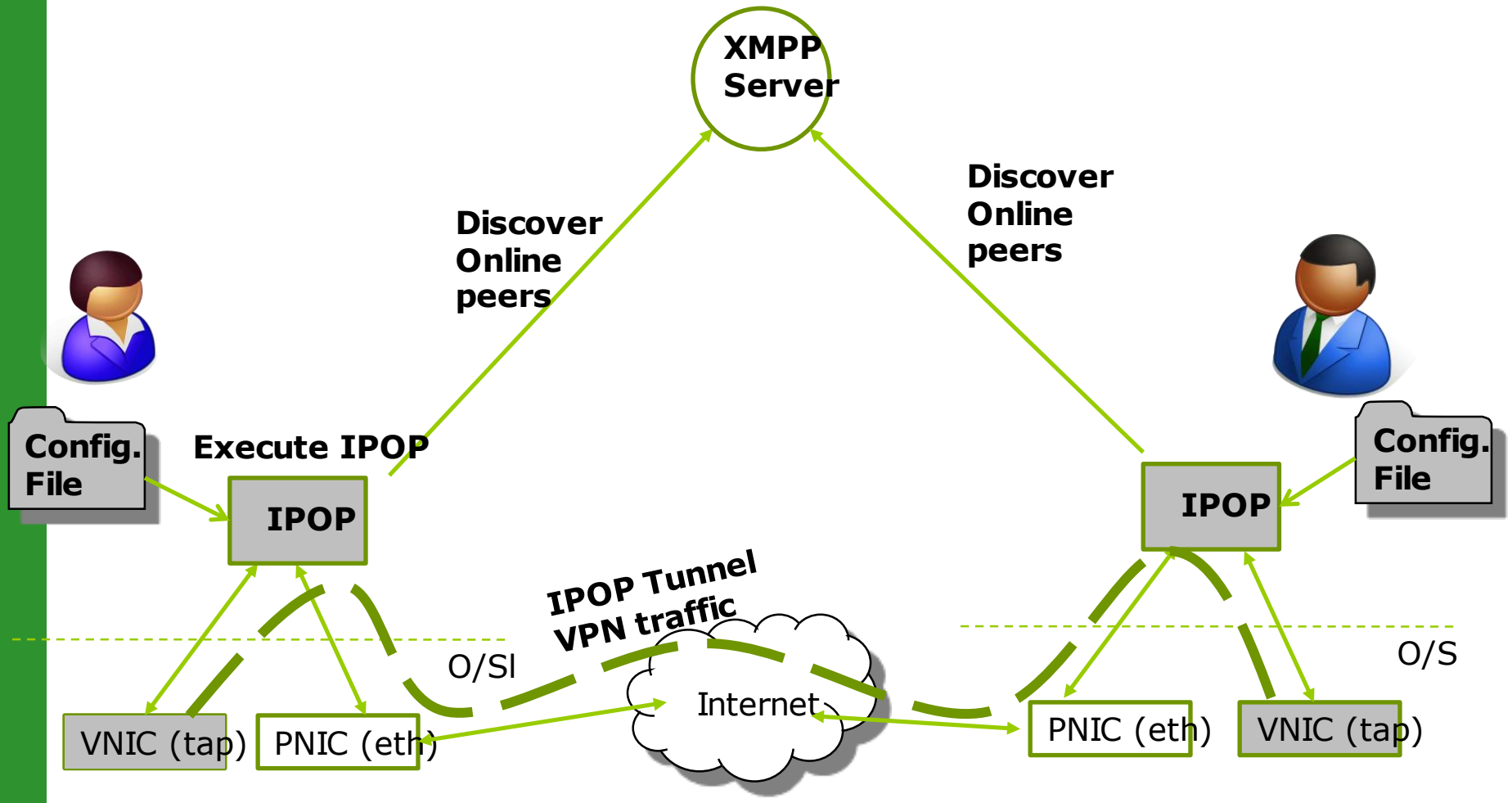
- Step 3: Deploy IPOP in each node



Demonstration



Under the hood



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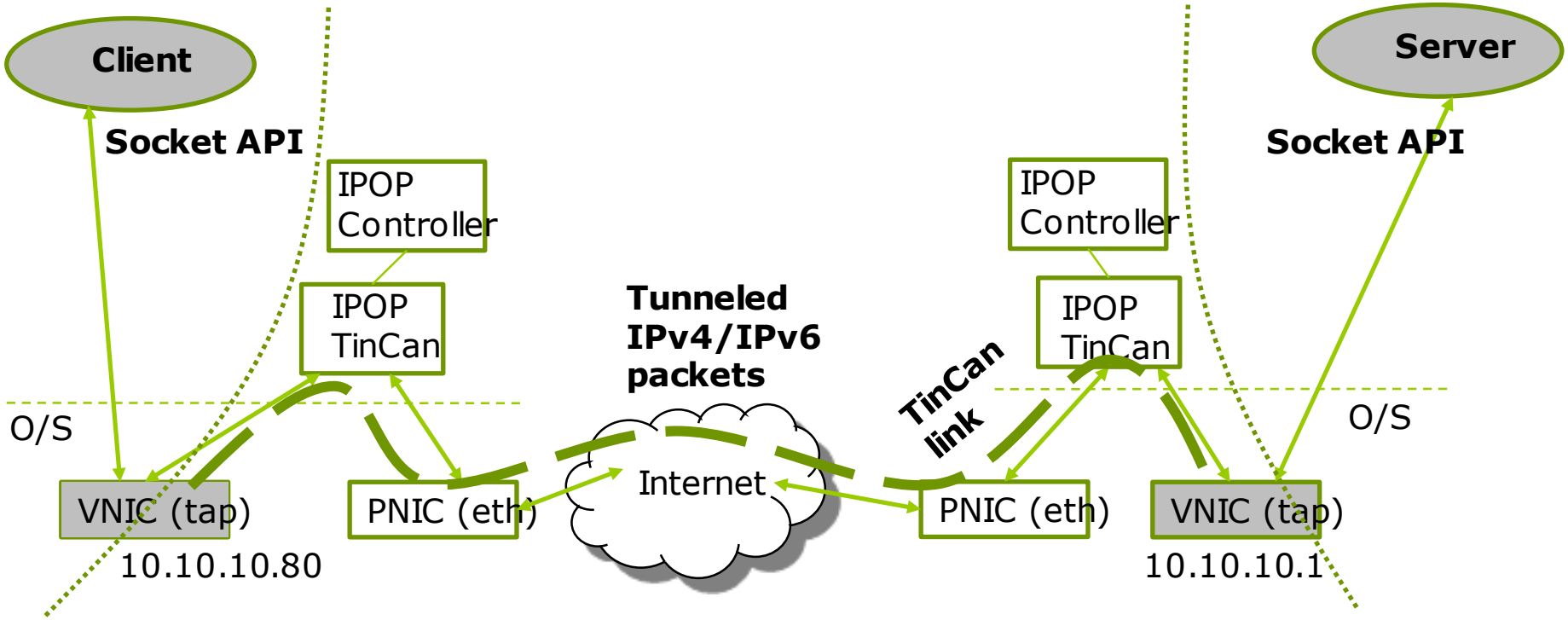
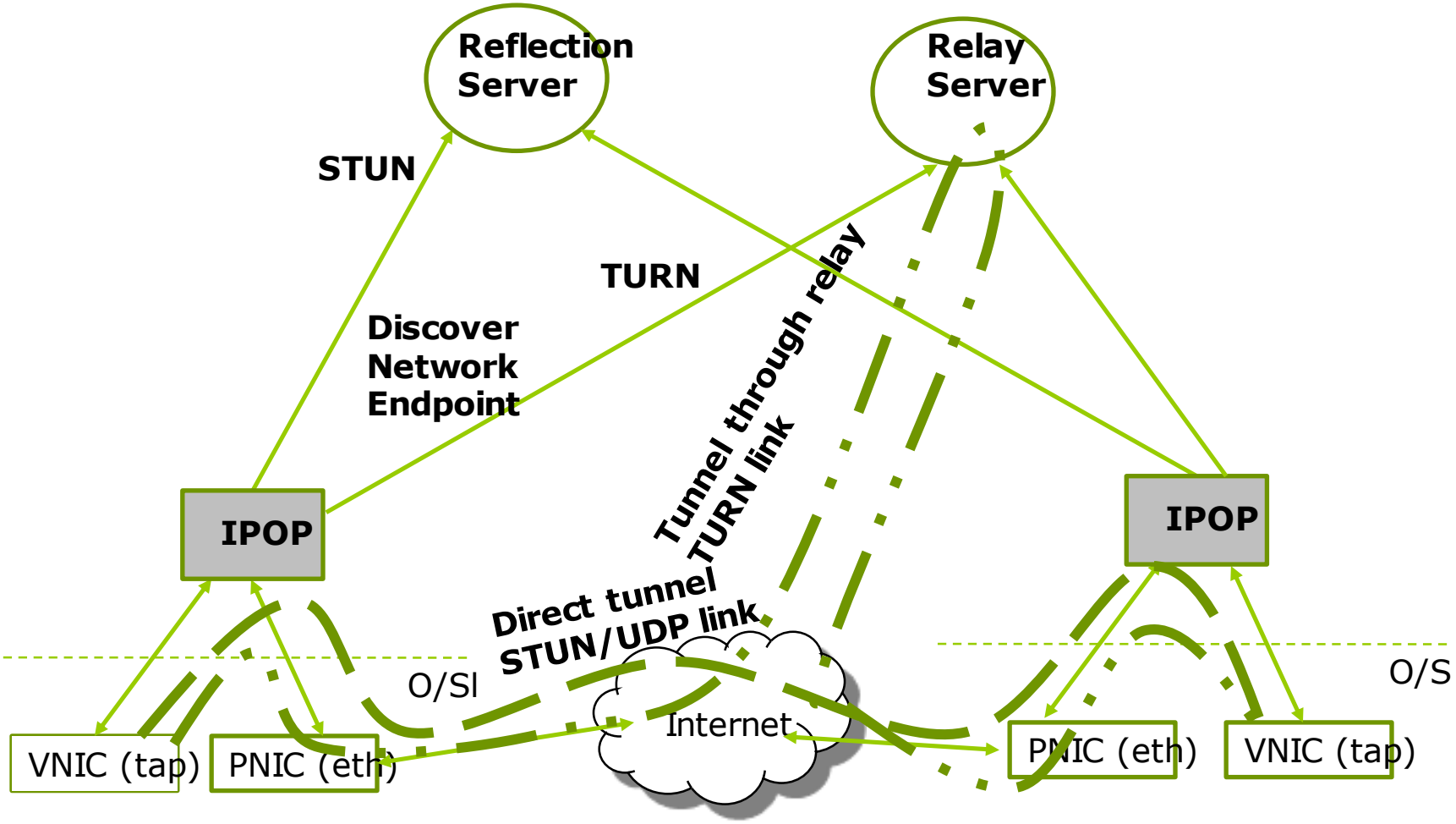


Under the hood



Accomplishments

- Deployment of IPOP overlay network – PRAGMA lake expedition
- Cross-institution HTCondor pools
  - U. Florida, U. Wisconsin, Virginia Tech
  - Desktops, servers; virtual and physical
  - Ability to grow to tap additional resources
    - VMs at these (and other institutions)
    - Including commercial clouds

Learn more about IPOP

- Low-barrier open-source overlay technology to create “trust envelopes” for PRAGMA collaborations
- www.ipop-project.org
  - White paper, videos, tutorials
- New code release (v14.01)
  - www.github.com/ipop-project
  - Linux, Windows – desktops/servers
  - Android, OpenWRT – mobile, wireless routers
- XMPP server to bootstrap VPNs

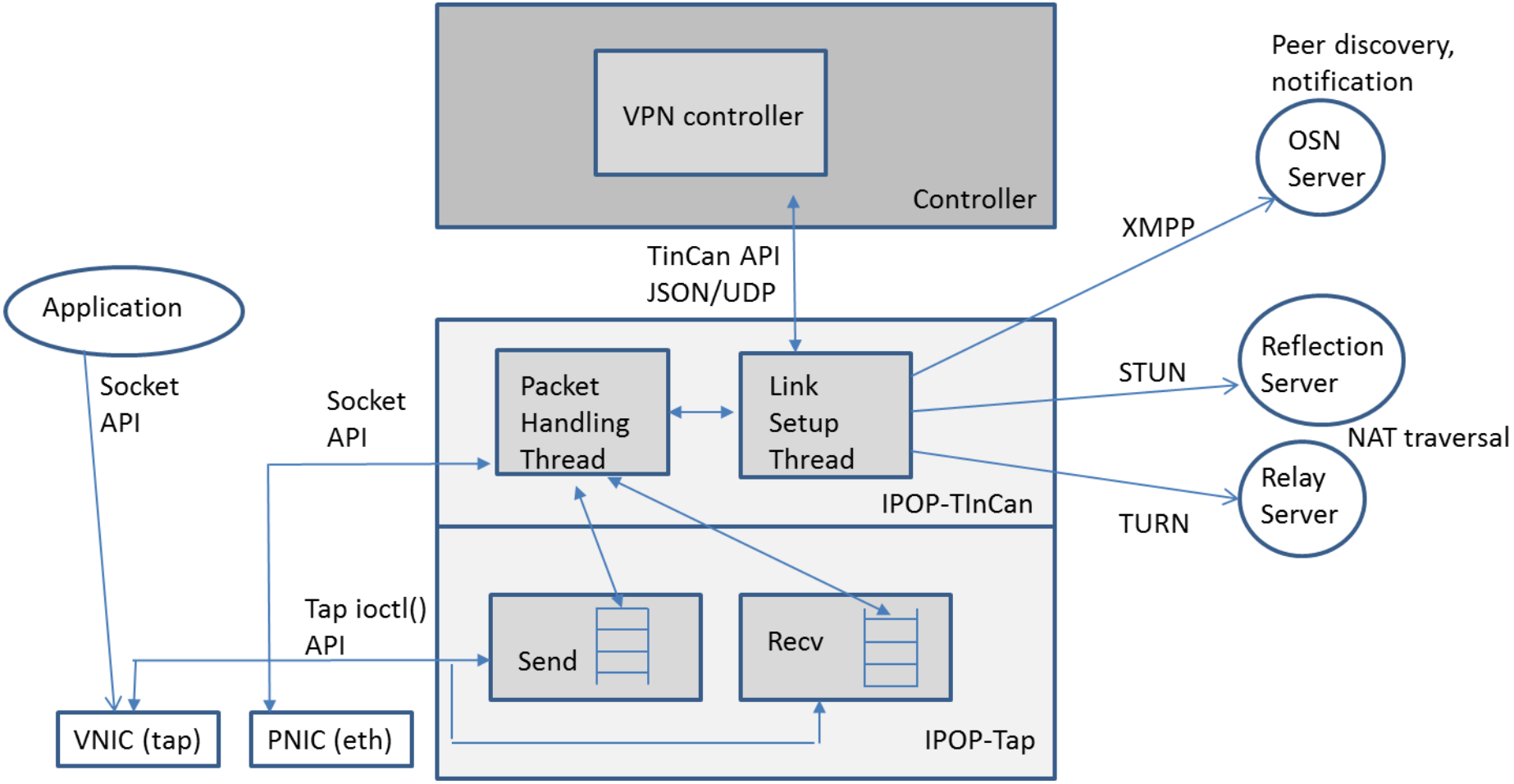
Acknowledgments

- Luke Winslow (U. Wisc), Ken Subratie, Pierre St. Juste (UFL)

Backup slides

Progress – IPOP Overlay

- Release 14.01 architecture



Progress – IPOP overlay

- Major code redesign
  - Decoupled architecture:
  - TinCan links - datapath
    - End-to-end private tunnel links with NAT traversal
    - C/C++; reuses libjingle, XMPP, STUN, TURN
  - VPN controllers – GroupVPN and SocialVPN
    - Setup TinCan links (on-demand, proactively)
    - Configure virtual IP addresses
    - JSON/RPC API ; Python, or other languages
  - IPv6 support