A Hypothesis Testing Framework for Network Security

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Goals

To develop analysis methodologies needed to support scientific reasoning about the security of networks, with a focus on information and data flow security. The core of this vision is Network Hypothesis Testing Methodology (**NetHTM**), a set of techniques for performing and integrating security analyses applied at different network layers, in different ways, to pose and rigorously answer quantitative hypotheses about the end-to-end security of a network.
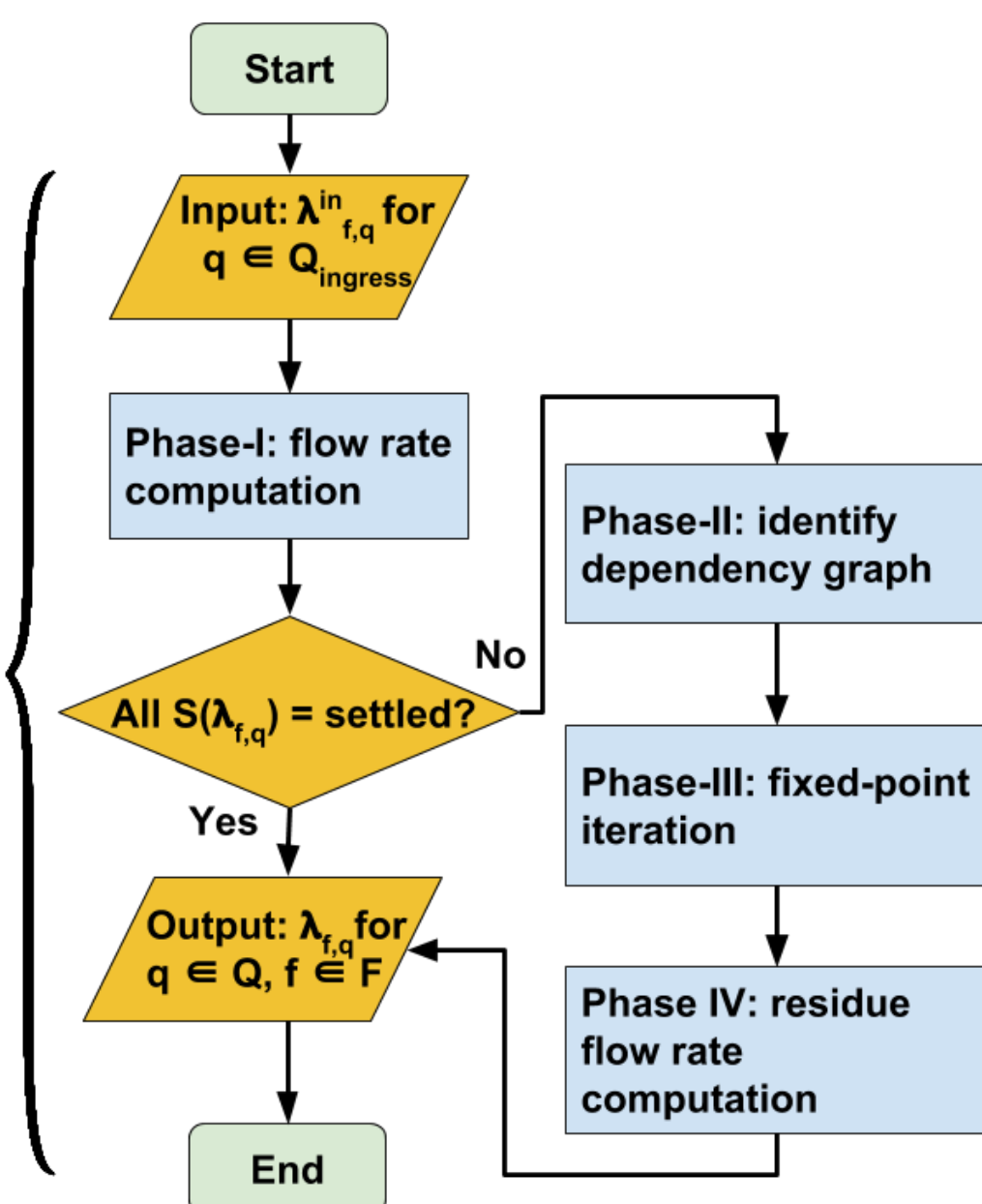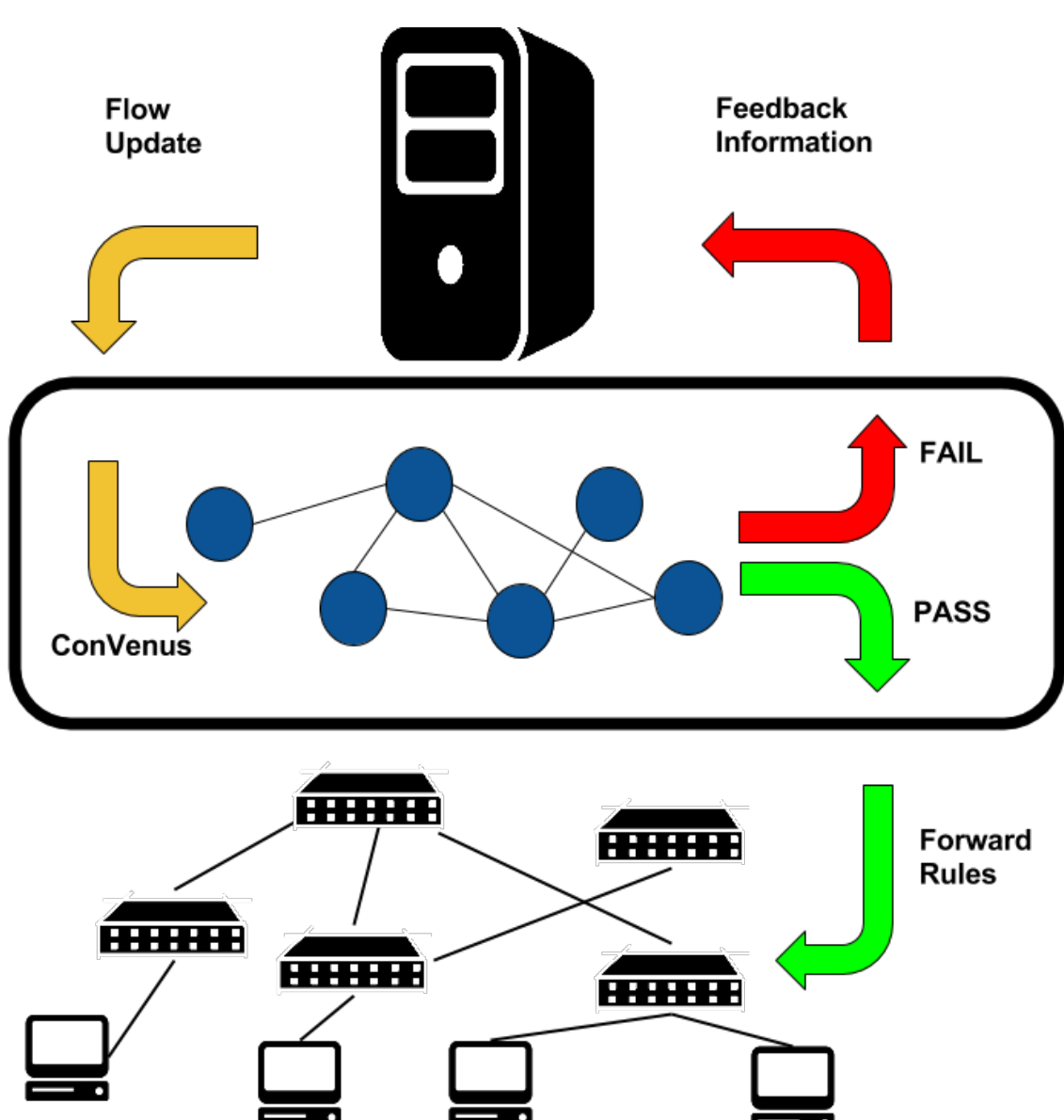
Hard Problems Addressed

This project covers four hard problems:

- Predictive security metrics
- Scalability and composability
- Policy-governed secure collaboration
- Resilient architectures

Research Results

- Developed a verification platform to model and verify hypotheses about **end-to-end network behavior**, even with **uncertainty** about timing in distributed network.
- Leveraged this technique in network control system to dynamically preserve specified properties across time, such as loop-freedom, absence to black-hole, way-pointing, and congestion-freedom
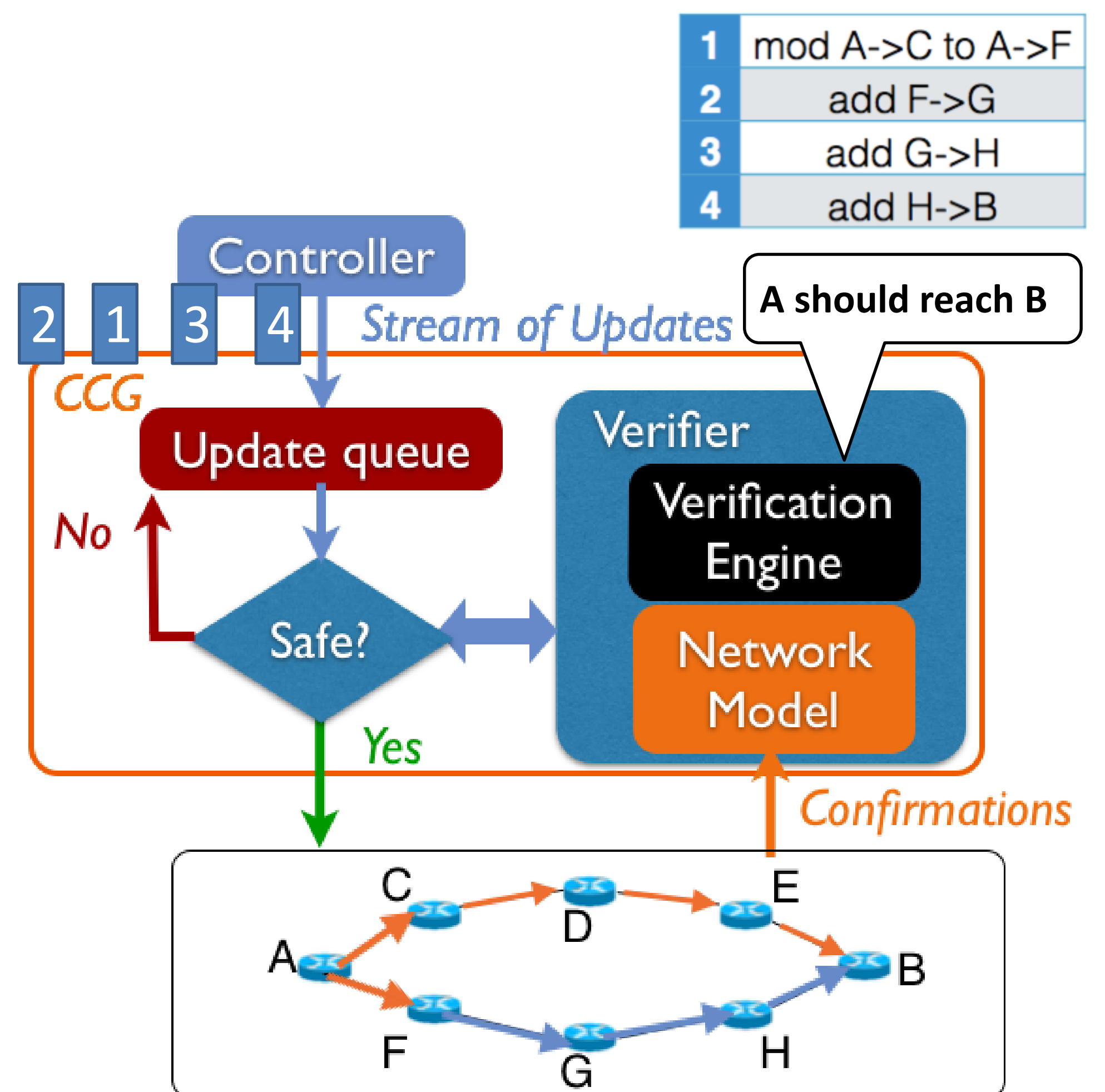
Research Plan

Foundational rigorous network model

- Develop technology to rigorously model network dynamics
- Develop technology to model virtualized networks
- Develop a database representation of network behavior

Effective evaluation methodologies designed scale to large and complex systems

- Develop scalable evaluation methodology via the marriage of emulation and simulation
- Develop a hybrid platform to realize the network models and the verification algorithms developed earlier
- Investigate the impact of various cyber-attacks on network behavior

CCG: Enforcing Generalized Consistency Properties in Software-Defined Networks (NSDI'15)

ConVenus: Congestion Verification of Network Updates in SDN (WSC'16)

Acknowledgement

SCIENCE OF SECURITY
VIRTUAL ORGANIZATION
Funded by the National Security Agency.

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