DIGITAL SOVEREIGNTY IN PRACTICE

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LEVERAGING INT AND ML FOR A RESPONSIBLE INTERNET

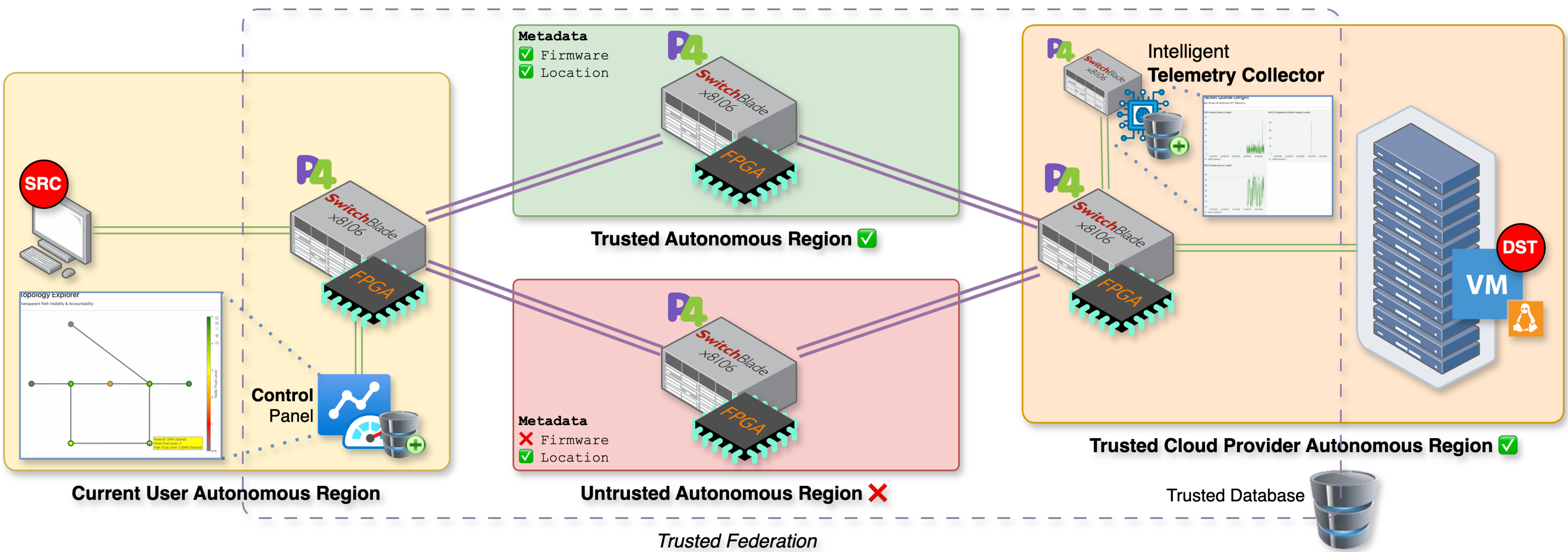
KEY POINTS OF RESPONSIBLE INTERNET

- Digital Autonomy: Ensuring society's critical systems are resilient against manipulation and surveillance.
- User Empowerment: Allowing individuals to choose trusted networking equipment and specify data handling preferences.
- Transparency and Trust: Enabling verification of good-faith operator actions and precise tracing of incidents or attacks.
- Emerging Technologies: Leveraging programmable networks, Machine Learning, and Intent-Based Networking to enhance security and control.
- Real-time Visibility: Programmable Data Planes and In-band Network Telemetry can provide detailed network insights directly within data packets.

CONTRIBUTION

- User-defined Data Path Control: Designed an operator platform that empowers users to specify, monitor, and verify their data flows using INT for transparency.
- RL-based Route Optimization: Developed a Reinforcement Learning approach within a programmable P4 switch that autonomously selects the optimal and secure network paths based on real-time INT metrics and user-defined preferences—directly in the data plane without control plane intervention.
- Real-world Validation: Demonstrated the practicality and feasibility of our Responsible Internet solution through realistic experimentation conducted on the FABRIC network infrastructure.

DEMONSTRATION SCENARIO



- 4 USA Sites, simulating 4 operators in 4 different states.
- 4 P4 FPGA switches that embed telemetry data.
- Intelligent telemetry collector choosing data flow based on user preferences.

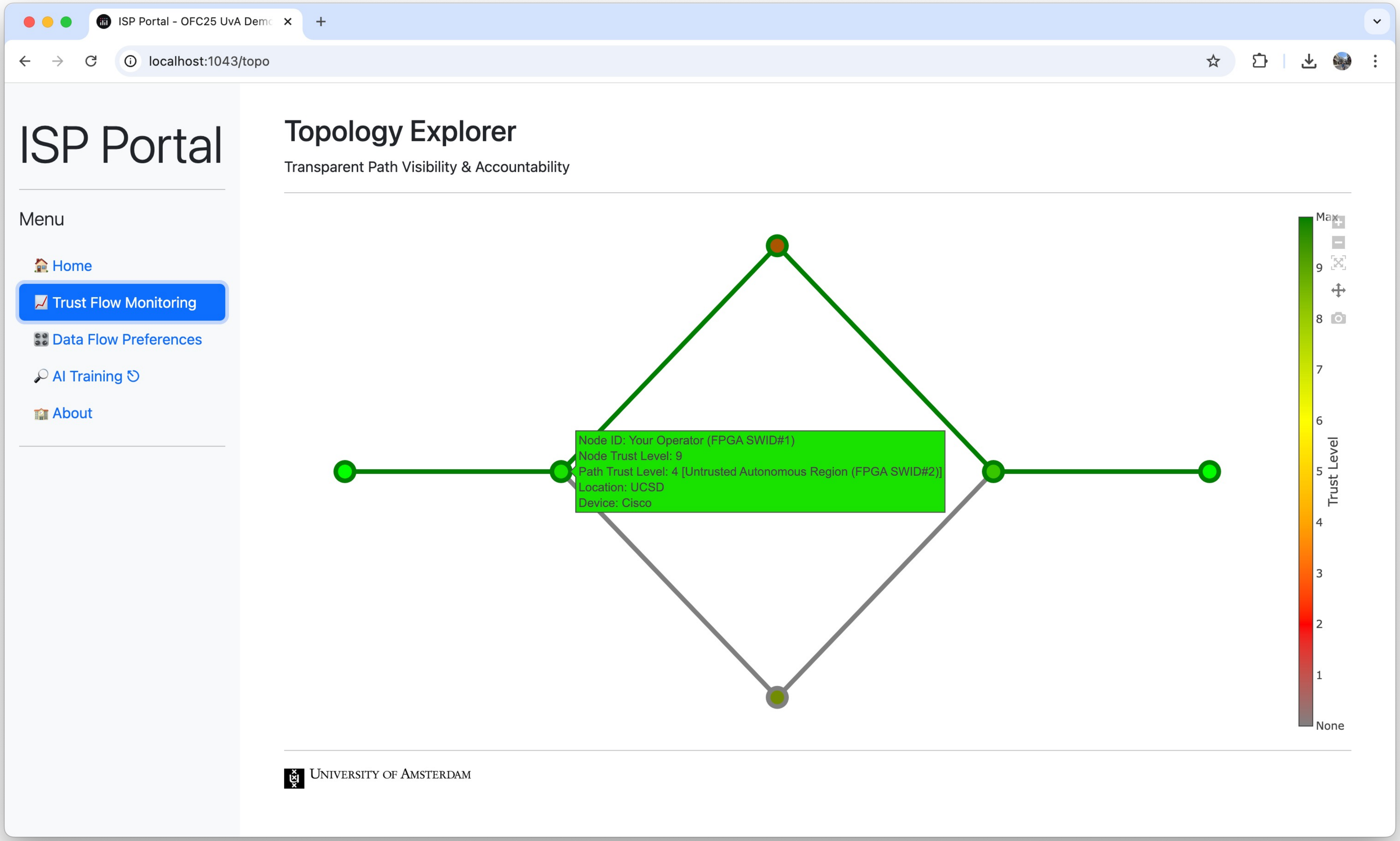
SCENARIO I – USER INTENT-DRIVEN TRAFFIC CONTROL

- Users define personalized preferences (trusted devices, geographical locations) through the Control Panel.
- Live Topology Visualization: Real-time network topology network map displays the user data flow.
- Dynamic Data Path Reconfiguration: Users specify trust criteria, prompting the network P4-programmable switches to autonomously adapt data flow paths accordingly.
- Real-time Integrity Monitoring: Users actively monitor data flow integrity and compliance with trust settings directly through the Control Panel.

SCENARIO II – AUTONOMOUS LEARNING-DRIVEN IN-NETWORK CONTROL

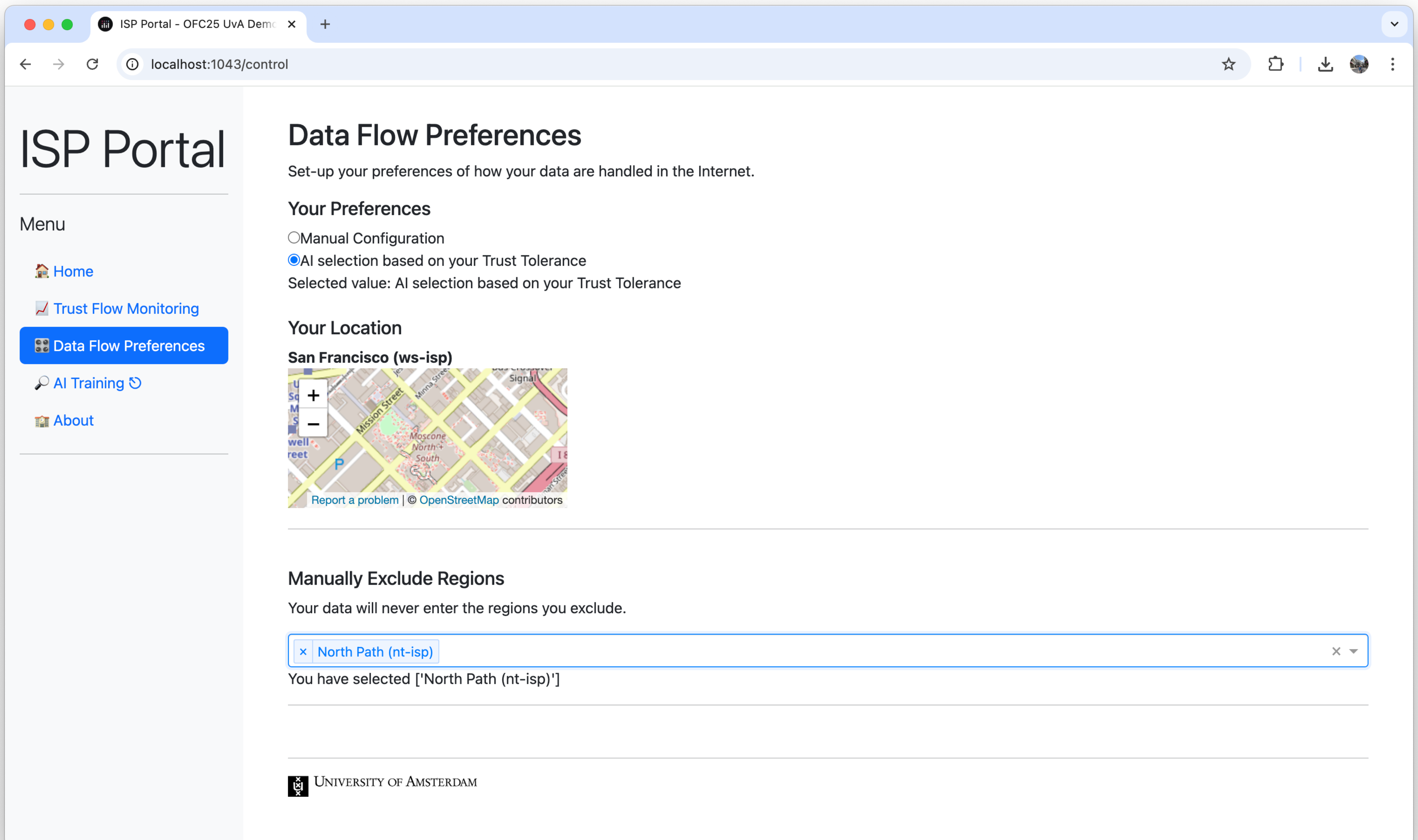
- INT-based Real-time Metrics: Network devices continuously embed telemetry metadata into packets, capturing detailed performance and trust metrics.
- Reinforcement Learning (RL) Integration: An Intelligent Telemetry Collector uses RL algorithms within programmable devices to process telemetry data, determining optimal path based on user-defined trust policies. The RL-based agent autonomously learns and dynamically adjusts network paths, responding in real-time to changing security conditions and network states.
- Transparent AI-driven Control: Users can observe AI-driven route optimization decisions and resulting network adaptations transparently via the Control Panel.

PATH MONITORING



SCREENSHOTS

USER TRAFFIC FLOW PREFERENCES



POC EVALUATION

- Real-time Path Tracing: Embedding P4-switch metadata into packet headers using INT, eliminating the need for external probes or tracing software.
- Dynamic User Control: Real-time user-driven path customization based on specified trust preferences.
- Adaptive Routing Validation: User preference driven path selection.

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THANK YOU