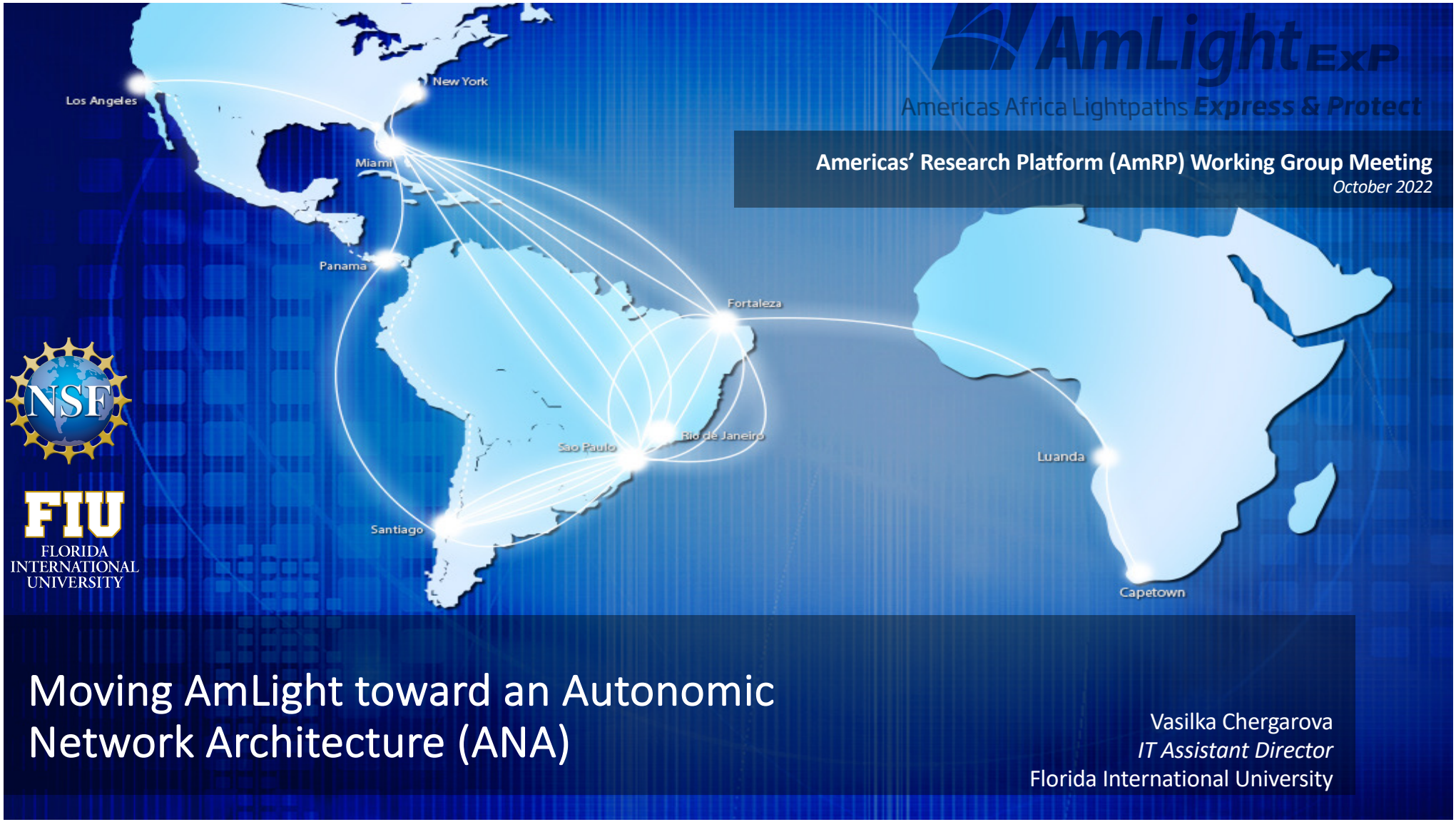
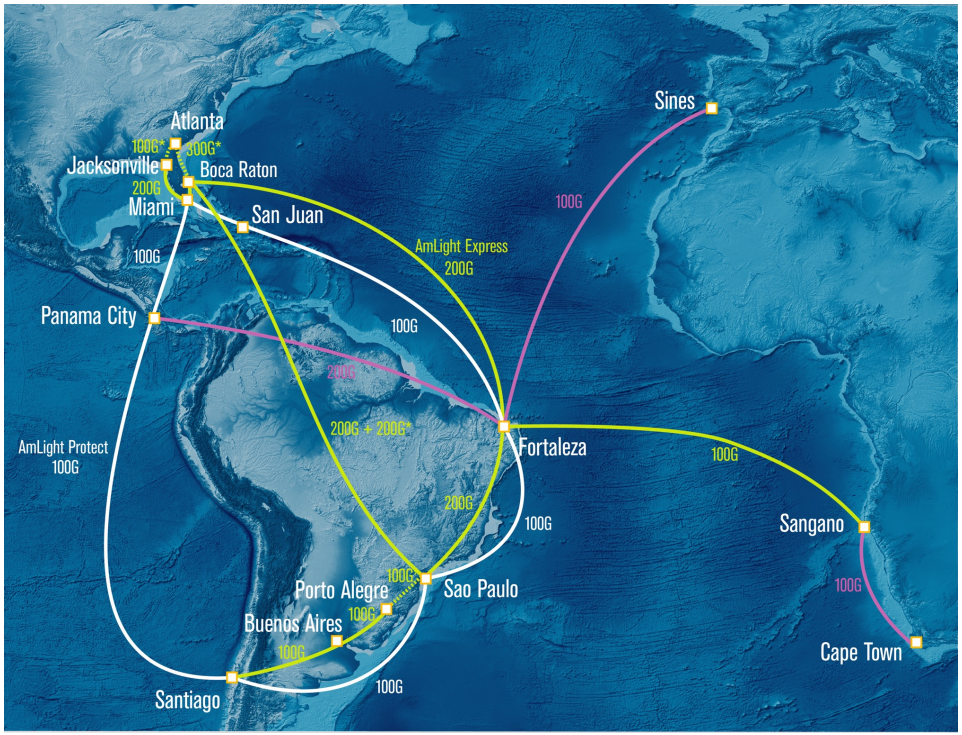


Moving AmLight toward an Autonomic Network Architecture (ANA)

Vasilka Chergarova
IT Assistant Director
Florida International University

AmLight Network

- Distributed Open Exchange Point (OXP)
- 600Gbps of upstream capacity between the U.S. and Latin America, and 100Gbps to Africa
  - +200Gbps from Brazil to the U.S. (2023)
- 2+ Tbps of international connectivity
  - Spectrum (green), Leased (white), plus waves provided by RedClara and SANReN/TENET (pink)
- NAPs: Florida(3), Brazil(2), Chile, Puerto Rico, Panama, and South Africa
  - Soon: Atlanta, Georgia
- Production SDN network since 2014:
  - 20+ SDN devices
  - OpenFlow 1.0 -> 1.3 (2022) -> P4/BFRuntime (future)



* and dashed lines represent on going efforts

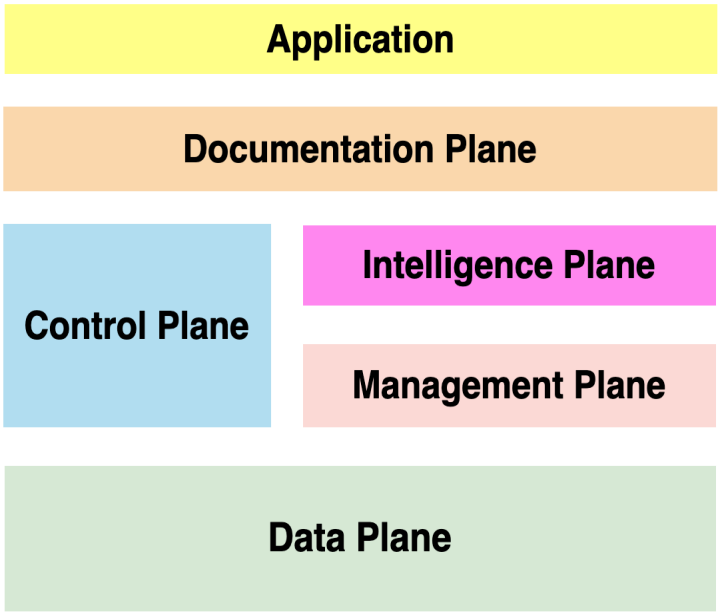
AmLight ExP
Americas Lightpaths Express & Protect

Autonomic Network Architecture (ANA)

- Autonomic Networking Architecture (ANA) creates the definitions and design goals for a self-managed network:
  - Self-configuration: Functions do not require configuration, by either an administrator or a management system. They configure themselves, based on self-knowledge.
  - Self-healing: Autonomic functions adapt on their own to changes in the environment and heal problems automatically, for instance fiber cuts, power outages, and software crash.
  - **Self-optimizing: Autonomic functions automatically determine ways to optimize their behavior against a set of well-defined goals.**
  - Self-protection: Autonomic functions automatically secure themselves against potential attacks.

AmLight SDN Architecture – 2021-2025

- Brand-new Data Plane:
  - P4/Tofino switches replacing legacy devices
    - OpenFlow 1.3+1.4 & P4Runtime for southbound
    - Legacy routers replaced by Juniper MX204 routers
  - Ciena Waveserver Ai/5 transponders
    - Streaming telemetry-capable devices and REST API for monitoring
- Enhanced Management Plane:
  - The Optical and Packet Telemetry Collector (OPTC) will collect, and process telemetry data exported by SDN switches and optical transponders
  - OPTC will collect per-packet delay, jitter, and queue occupancy; top talkers; path taken; optical attenuation and post-FEC, and event logs:
    - P4/In-band Network Telemetry
    - Juniper Telemetry Interface
    - Ciena gNMI/gNOI



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Intelligence Plane (New Goal!)

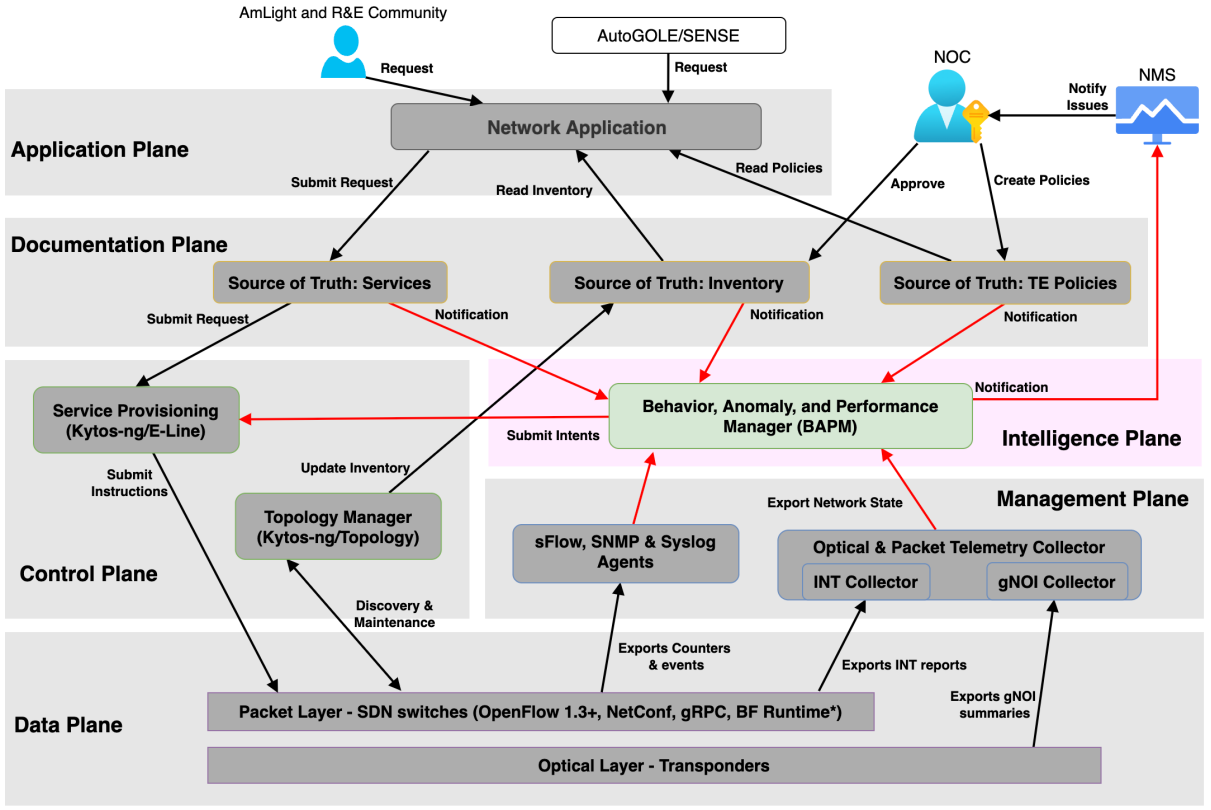
1. *Gets inventory, policies, and services from the Documentation Plane*
2. *Gets telemetry reports from the Management Plane*
3. *Profiles AmLight's traffic every 100-500ms*
   - *Discovers performance issues and traffic anomalies*
4. *Makes suggestions to the Control Plane*
   - *Steer traffic, Load balance services, Rate-limit anomalies,*

Change of mindset compared to the previous AmLight-ExP project

- Creates a closed-loop control for self-optimization
- Goal is to be prepared for sub-second optimization and debugging
- Behavior, Anomaly, and Performance Manager (BAPM) is the component responsible for the intelligence

Examples of policies:

- 80+% BW utilization >= 2s
- 50+% [Queue Occupancy] >= 2s
- Number of path changes >= 5 in 2h



AmLight ExP
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Conclusion: How will ANA support our goals?

- AmLight has many links and multiple paths between its sites:
  - From Chile to Jacksonville, there are more than 25 possible paths to take
  - With this new architecture, we expect to efficiently load balance network services across links, while respecting user constraints and requirements

- AmLight has an SLA-driven packet-loss-intolerant and sub-minute-response-time-expected science application:
  - With per-packet telemetry and sub-second network profiling capabilities, AmLight will be prepared to optimize its network under 1 second.
  - With optical telemetry, AmLight will anticipate issues with the substrate and steer traffic out of the substrate before adverse events happen.

Julio Ibarra, FIU, PI
Heidi Morgan, USC-ISI, Co-PI
Jeronimo Bezerra, FIU, Co-PI
Donald Cox, Vanderbilt, Co-PI
Luis Lopez, USP, Co-PI

contacts@amlight.net