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Advanced Network Architecture Research Group
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A Managed Self-Organization Method for Controlling Multiple VNTs in WDM-based Optical Networks

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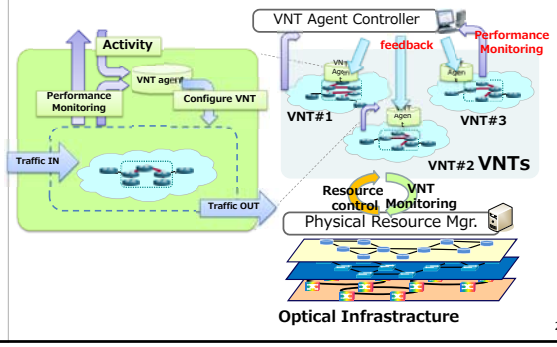
Managed Self-organization in WDM networks



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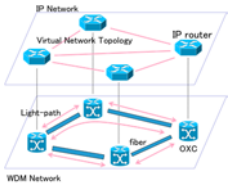
WDM network and VNT control

- **WDM (Wavelength Division Multiplexing) network**
  - Establish light-paths by wavelength routing
- **VNT (Virtual Network Topology)**
  - Configured by light-paths
  - Accommodate IP traffic
- **VNT control**
  - Configure VNT adaptively
    - Avoid overcrowding
    - Accommodate IP traffic efficiently



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Research Purpose

- **Multiple VNTs over a WDM-based optical network**
  - Overlay services on existing IP-based networks
  - Assign one or more VNTs to each service
- **Problems of existing VNT control methods**
  - Collect traffic demand matrix information
  - High computational complexity and computation time
- **Difficulty of Self organized VNT control [1,2]**
  - Design emergent behavior
  - But difficult to control the performance

Managed Self-organized control

[1] Y. Koizumi, T. Miyamura, S. Arakawa, E. Oki, K. Shiomoto, and M. Murata, "Adaptive virtual network topology control based on attractor selection," *Journal of Lightwave Technology*, vol. 28, pp. 1720–1731, Dec. 2010.
[2] Y. Minami, Y. Koizumi, S. Arakawa, T. Miyamura, K. Shiomoto, and M. Murata, "Adaptive virtual network topology control in WDM-based optical networks," in *Proceedings of INTERNET*, Sept. 2010.

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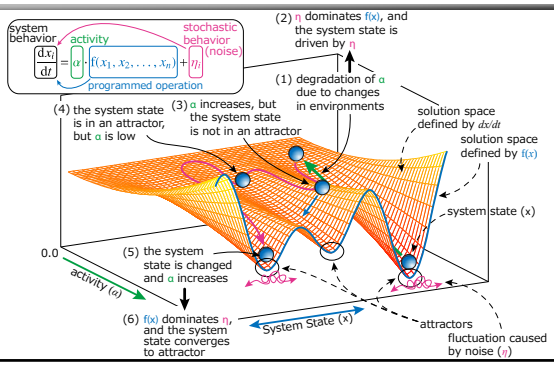
Self organized VNT control



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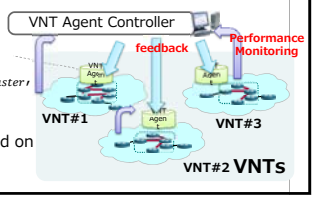
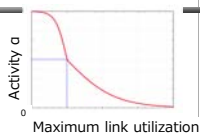
Managed Self-Organization Method for Controlling Multiple VNT

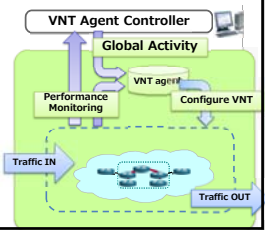
- **Self-organized control for each VNT**
  - VNT agent i monitors performance of its VNT
  - Calculate activity α_i from the performance (maximum link utilization)
    - High activity → VNT is controlled by f(x)
    - Low activity → VNT is controlled by η , i.e., is configured randomly
- **Feedback from "global activity" from VNT agent controller**
  - Calculate "global activity", α_{master}, from activities of each VNT
  - Feedback α_{master} to VNT agents
  - VNT agent control VNT i based on α_{master} and α_i

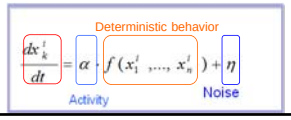


Information Exchange between controller and agent

- **VNT agent for VNT i**
  - Monitoring the performance of VNT i
  - Maximum link utilization(u_i) →calculate activity α_i → submit α_i to VNT agent controller
  - Receive α_{master} from VNT Agent controller
- $\alpha \leftarrow min(\alpha_{master}, \alpha_i)$

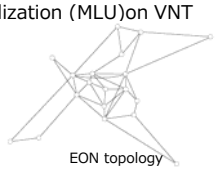






Simulation environment

- **Number of VNTs : 2**
- **EON topology: 19-node 39-link**
  - Numbers of transmitters and receivers are eight
- **Configure VNT at every minutes**
- **Performance metric**
  - Maximum link utilization (MLU)on VNT
  - Target MLU: 0.5



EON topology

Effect of Managed Self-organized Control

- **Traffic demand changes at 10 [minutes]**
- **Without managed self-organized control**
  - Activity of VNT0 is high, but activity of VNT1 is low
  - VNT1 tries to find good VNT, but cannot find.
- **With managed self-organized control**
  - Both VNT0 and VNT1 find good VNTs and maximum link utilization is lower than 0.5 at time 60.