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Performance improvement for applying network virtualization in fiber-wireless (FiWi) access networks

Key words: FiWi access networks, Network virtualization, Performance analysis

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Introduction

- Fiber-wireless (FiWi) access networks are an optimal combination of fiber access networks and wireless access networks.
- Access networks require localization, personalization, and diversity.
- In current FiWi access networks, there have been some service management schemes (such as service priority management), but they lack systematic service management.
- To alleviate bandwidth tension and facilitate new service deployment, we attempt to apply network virtualization in FiWi networks, in which the network's control plane and data plane are separated from each other. Based on a previously proposed hierarchical model and service model for FiWi network virtualization, the process of service implementation is described.

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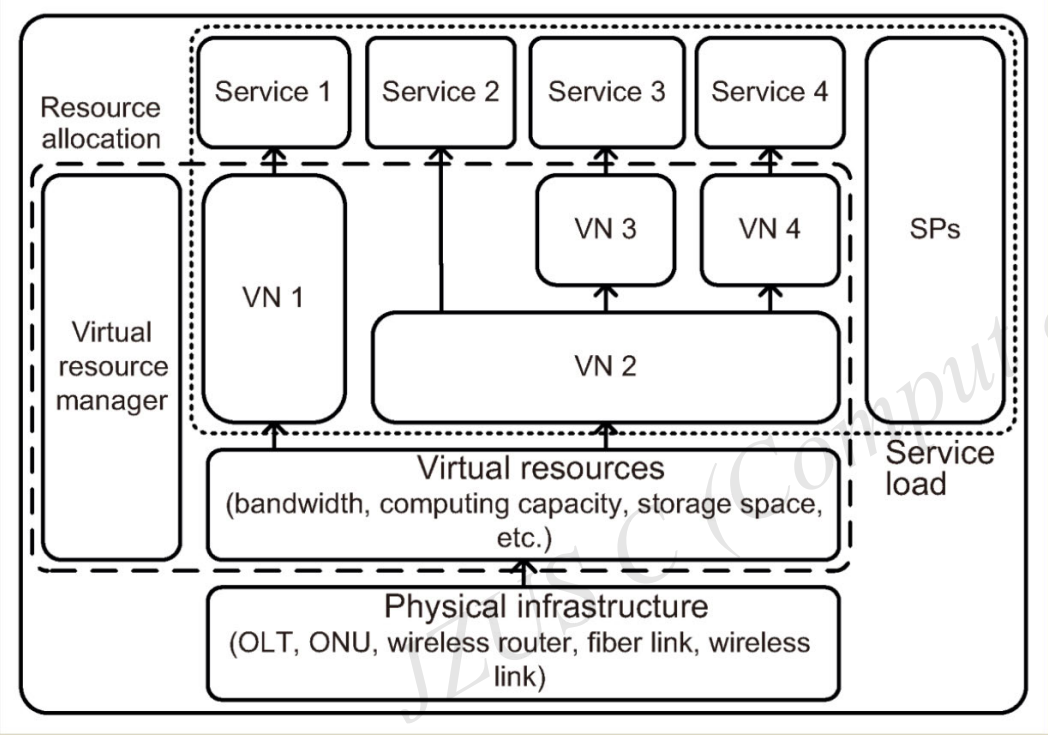
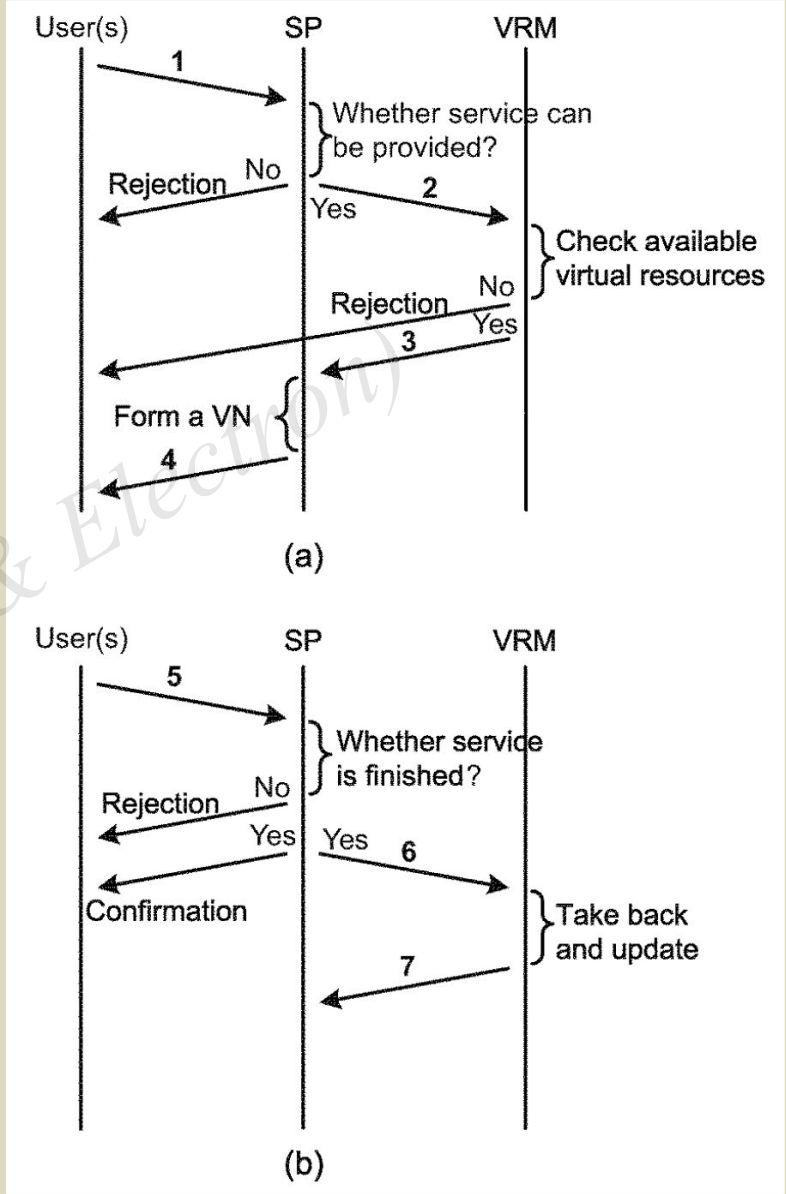
Proposed model



Service model for FiWi network virtualization



Detailed process of service realization in the virtualization of FiWi networks: (a) service request; (b) service removal

Performance analysis

Bandwidth for links:

$$\sum_{k=1}^{M_i} B_{\mathrm{V}}(e^{\mathrm{S}}, v_i^{\mathrm{S}}, k) \le B_{\mathrm{S}}(e^{\mathrm{S}}, v_i^{\mathrm{S}}),$$

Throughput for nodes:

$$\begin{aligned}\mathrm{Throughput}_{v_j^m} &= 2\sum_{h=1}^{N-1}\sum_{i=1,i\neq j}^{N}\frac{l_{ij}^{mh}\mathrm{sum}_{ij}^{m}}{T(i,j)}\\ &= 2\sum_{h=1}^{n}\sum_{i=1,i\neq j}^{N}\frac{l_{ij}^{mh}D(1-P_{\mathrm{e}}^{m}(h))}{ht_{\mathrm{w}}}\\ &+\sum_{h=n+1}^{N-1}\sum_{i=1,i\neq j}^{N}\frac{l_{ij}^{mh}D(1-P_{\mathrm{e}}^{m}(h))}{ht_{\mathrm{w}}}\\ &+\sum_{h=n+1}^{N-1}\sum_{i=1,i\neq j}^{N}+\frac{l_{ij}^{mh}D(1-P_{\mathrm{e}}^{m}(h))}{(h-1)t_{\mathrm{w}}+t_{\mathrm{f}}},\end{aligned}$$

Multipath flow transmission:

$$\mathrm{Availability} = 1-\left[1-(1-p)^{n_{\mathrm{P}}}\right]^{m_{\mathrm{VN}}}.$$

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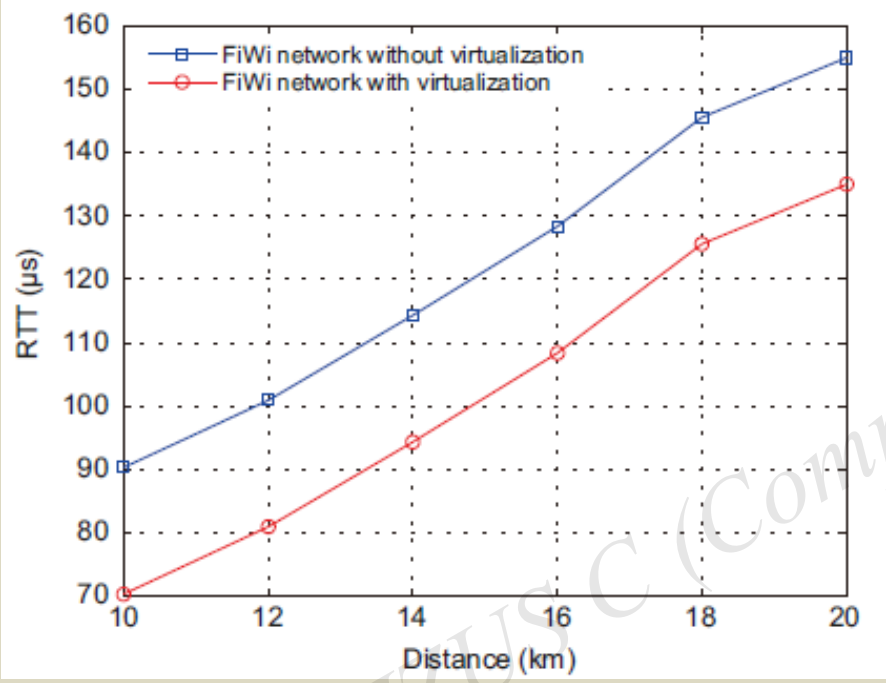
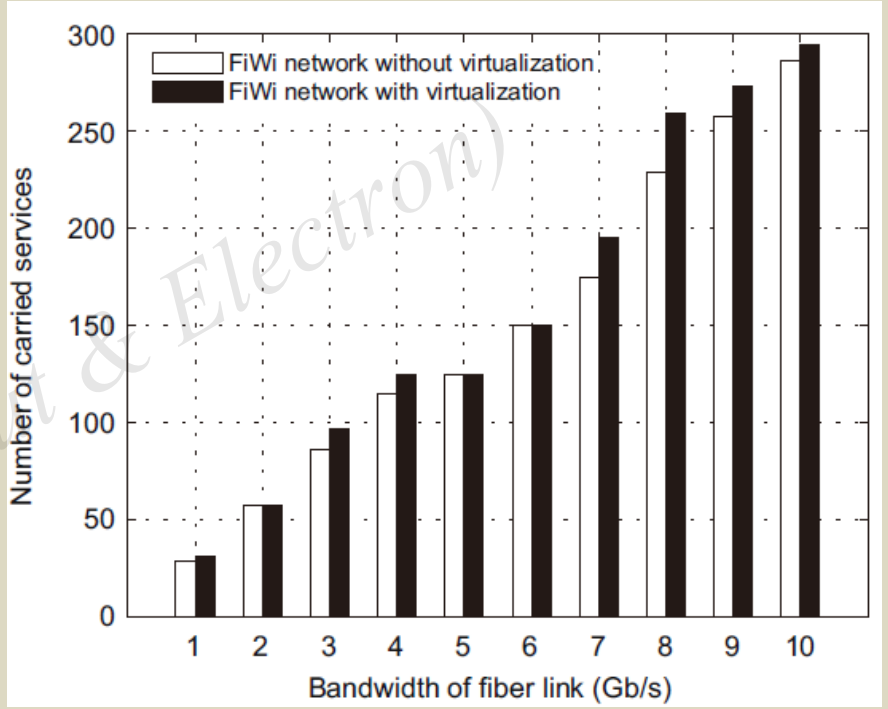
Numerical results (I)



Relationship between RTT for the end user and the distance between OLT and ONU



Capacity of fiber subnetwork link

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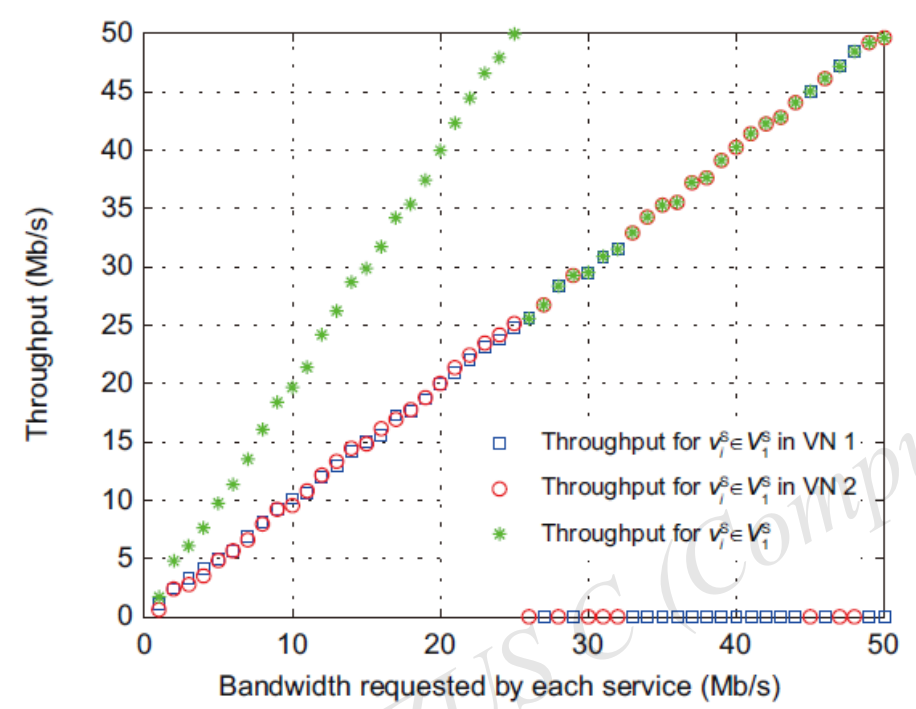
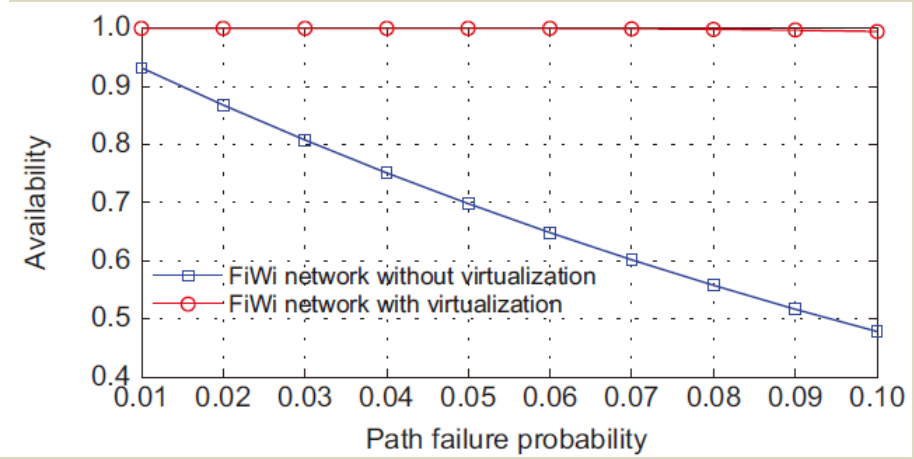
Numerical results (II)



Throughput for $v_i^S \in V_2^S$

Path availability



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Conclusions

- To alleviate bandwidth tension and facilitate new service deployment, we apply network virtualization in the FiWi network, which separates the control plane from the data plane of the network.
- Based on the proposed hierarchical model and service model, the performances of the FiWi network with or without network virtualization are analyzed in detail.
- Simulation results show that network virtualization improves the performance of the FiWi network.

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