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Leveraging FTTx infrastructure for mobile backhaul: challenges and opportunities

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Outline

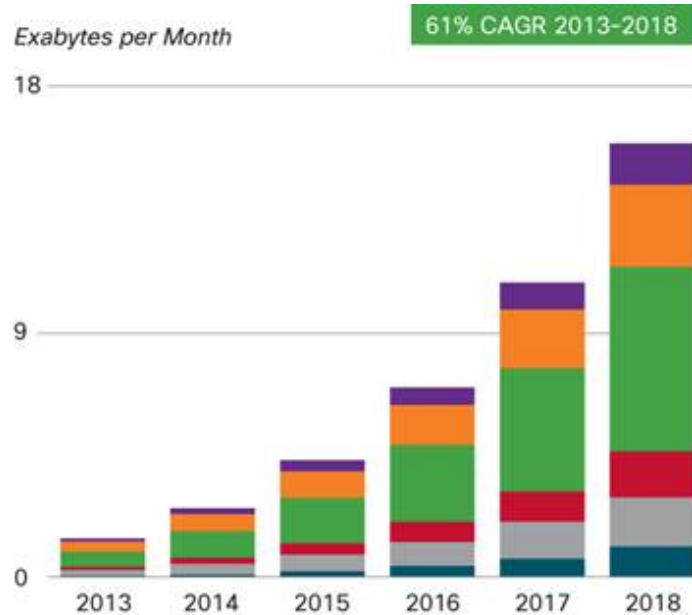
- HetNet and energy efficiency
 - aren't we forgetting anything?
- Backhaul and energy consumption
 - HetNet still worth from an EE perspective?
- Case study: dense urban deployment
 - is there a best "FTTx" solution?
- Conclusions



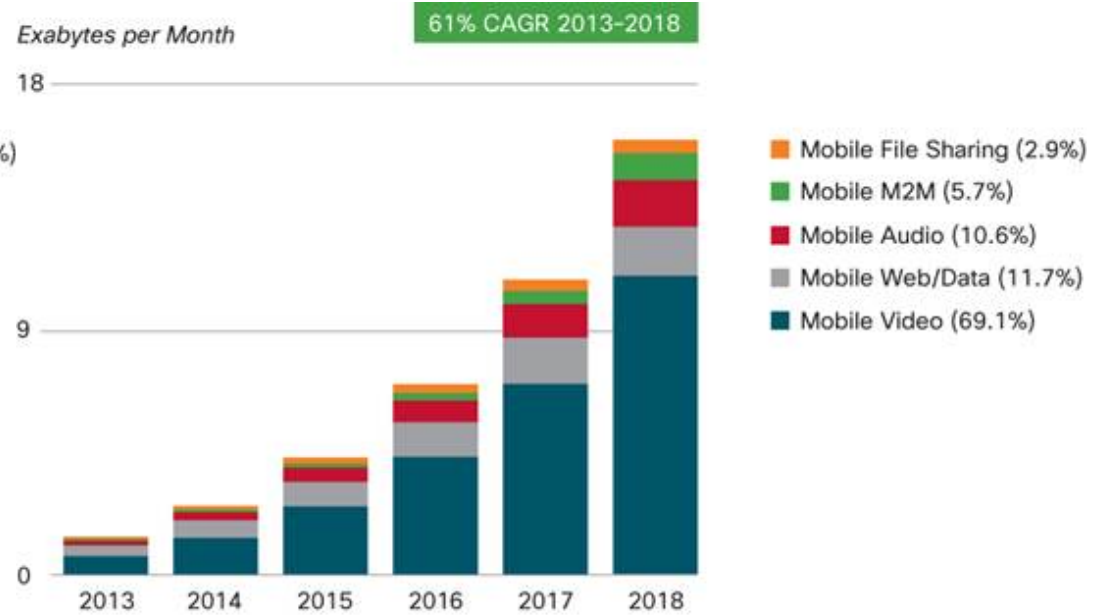
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Energy efficiency in mobile broadband access



Figures in parentheses refer to regional share in 2018.
Source: Cisco VNI Mobile, 2014



Figures in parentheses refer to traffic share in 2018.
Source: Cisco VNI Mobile, 2014

- Mobile broadband data usage is experiencing a dramatic growth (11 fold since 2013)
- Clear challenge ahead: meeting the expected 2020-2025 traffic levels maintaining current or (at least) low power consumption figures



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Possible solution: HetNet deployments

- HetNet is an alternative to macro cell densification
- Rationale: tailor network deployment to the expected traffic levels
 - selectively add small high-capacity BSs only where needed (hotspots)
- What happens to the aggregated data?
 - impact of backhaul on energy consumption and cost is usually neglected



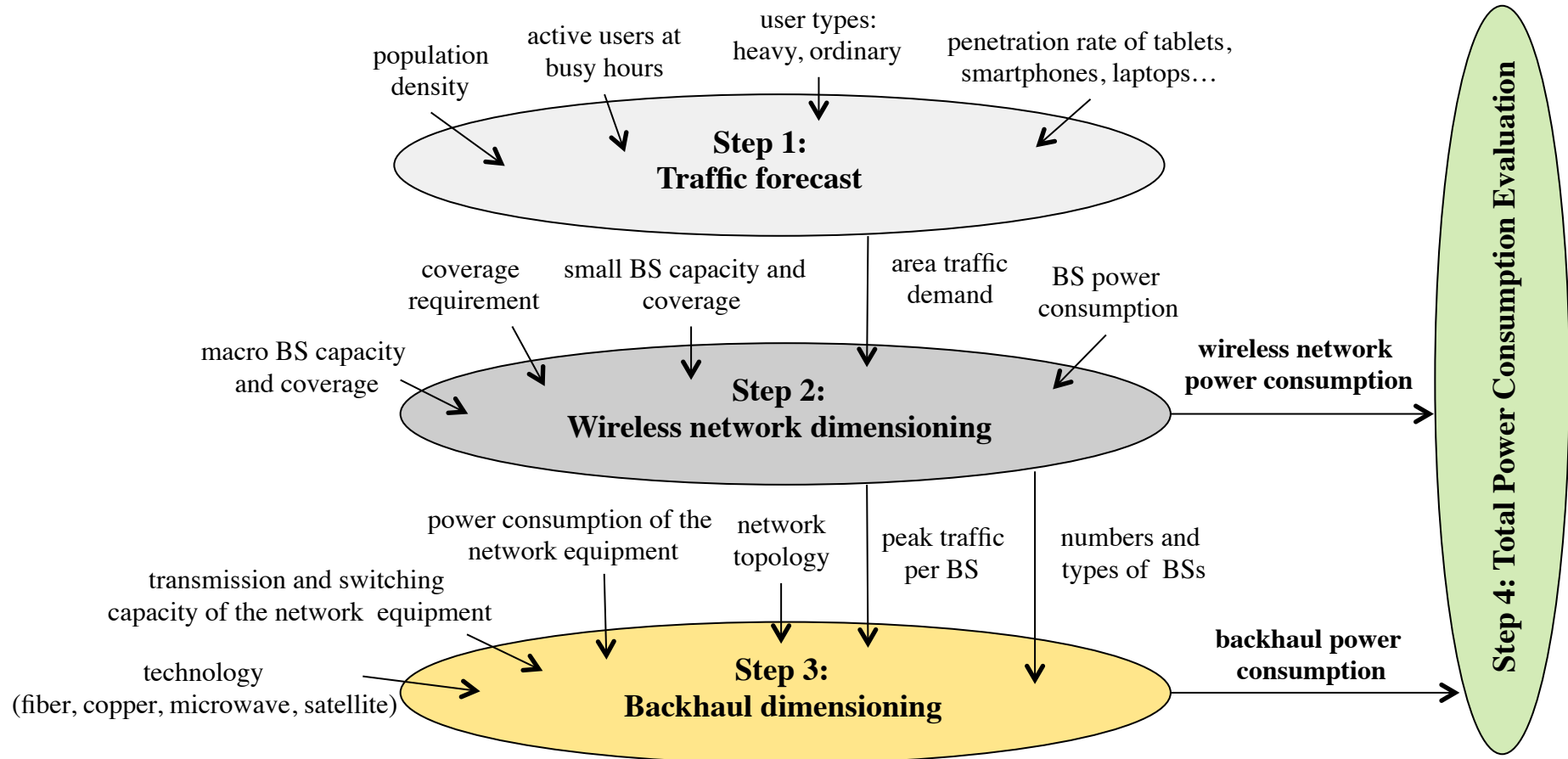
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Role of backhaul in HetNet?

- Most HetNet studies consider only the aggregated power consumption of the base stations
- What if backhaul has a significant share of the energy consumption of a converged access infrastructure?
 - will HetNet still be convenient?
 - what is the best backhaul technology?

EE impact of backhaul: methodology





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Use case: urban scenario

- **Traffic forecast (step 1)**: long-term traffic models from literature

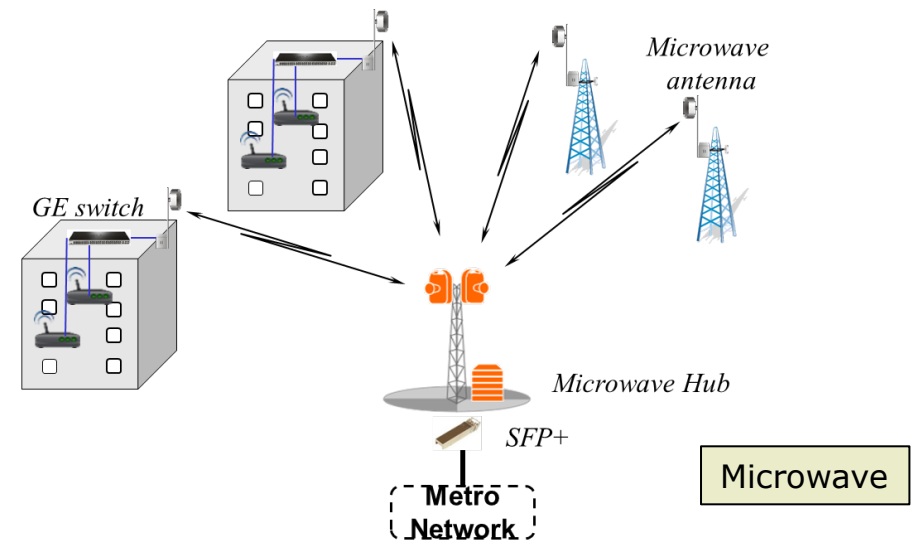
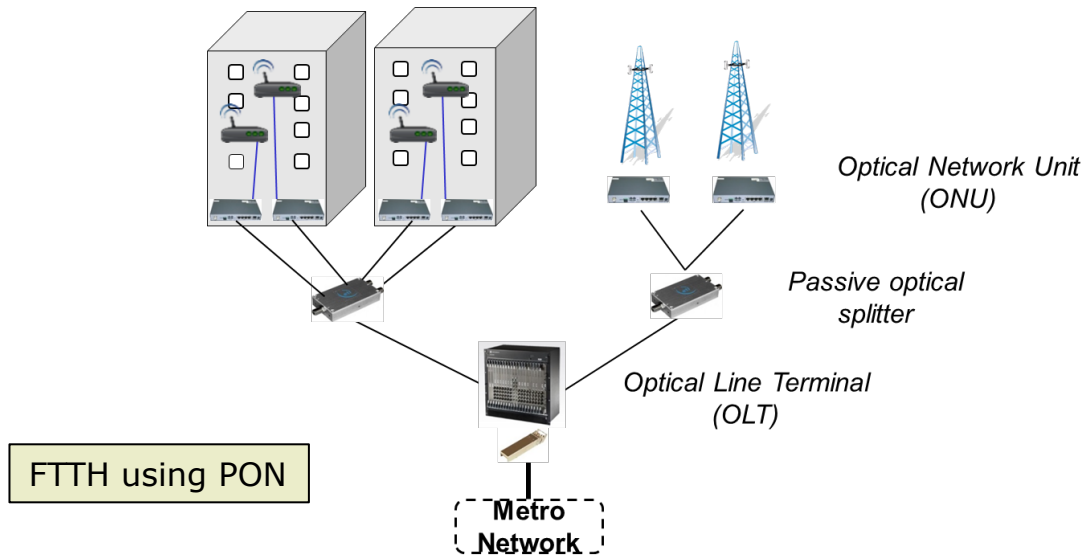
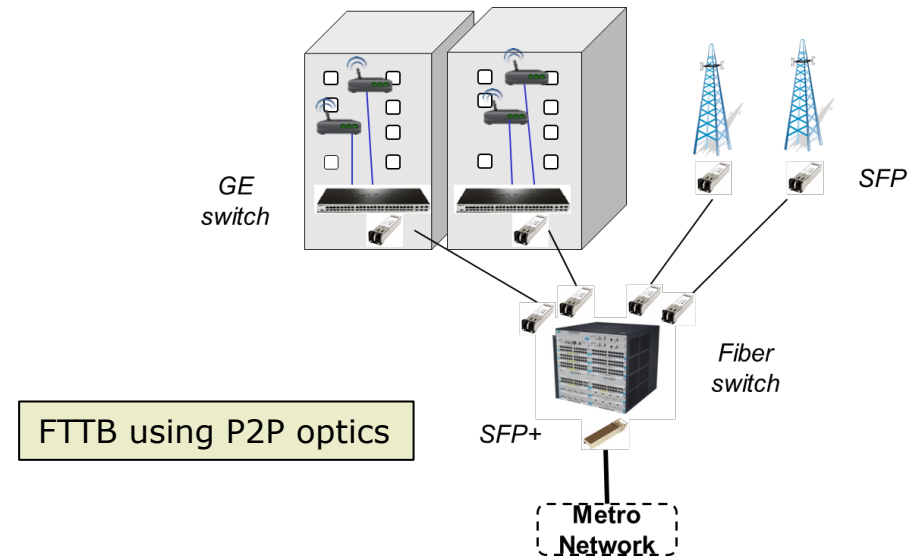
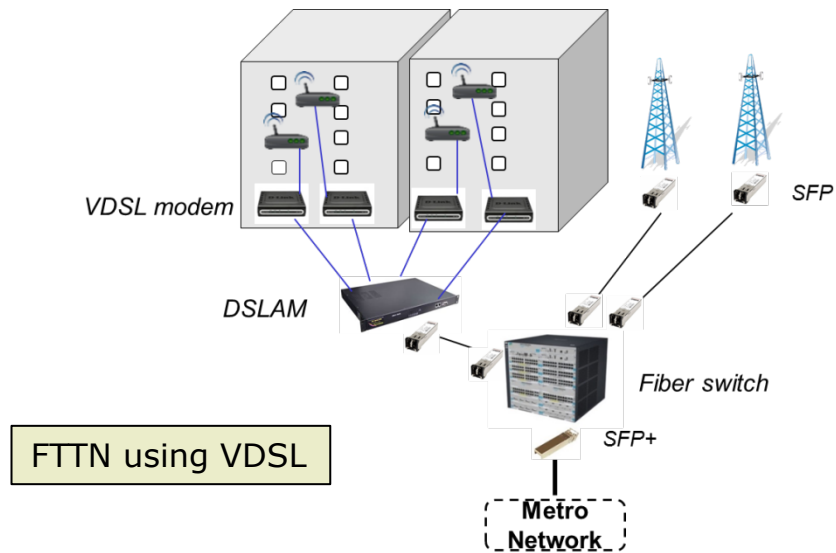
$$R(t) = \rho \alpha(t) \sum_k r_k s_k, \quad [\text{Mbps}/\text{km}^2]$$

Diagram illustrating the traffic forecast equation $R(t) = \rho \alpha(t) \sum_k r_k s_k$ with annotations:

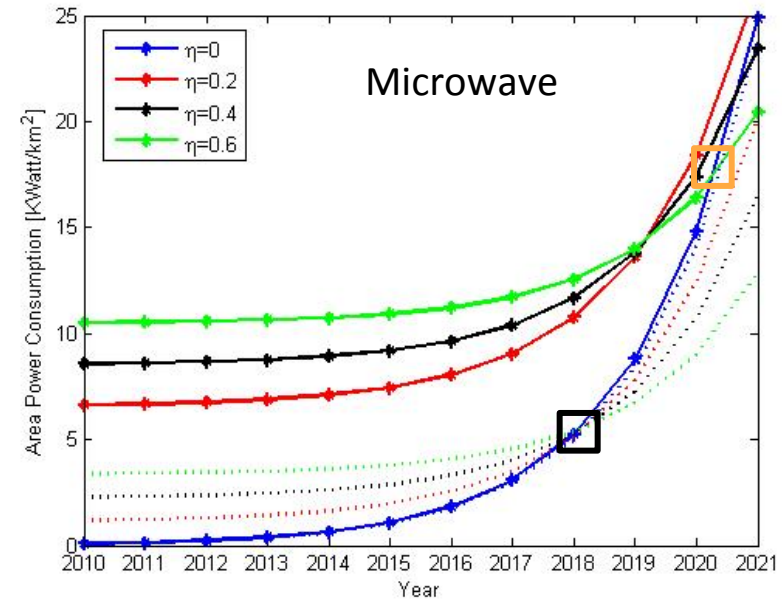
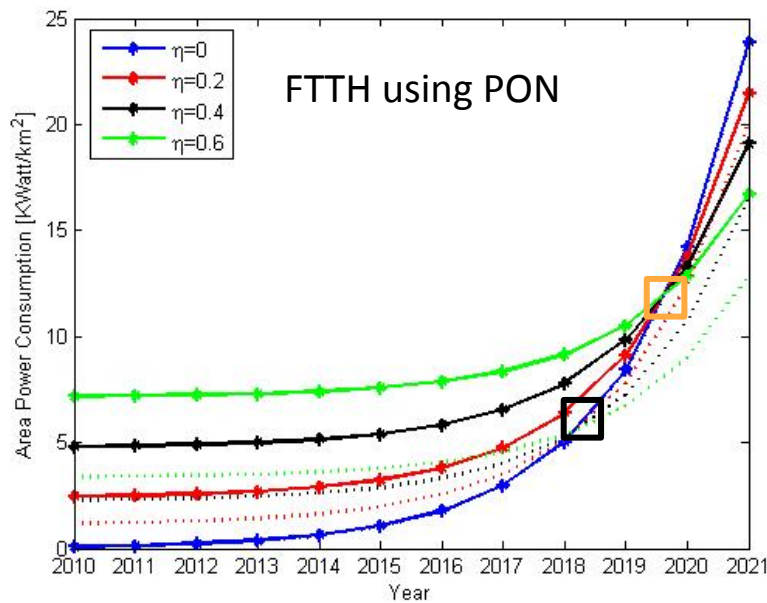
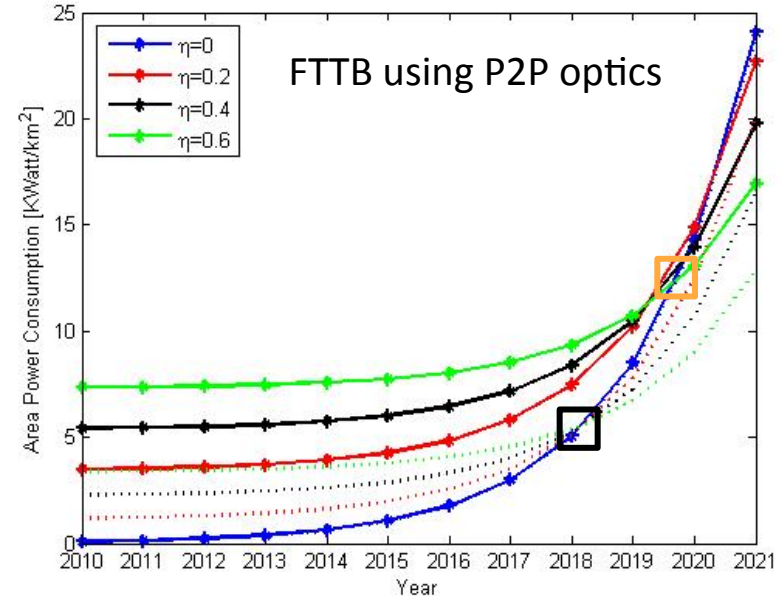
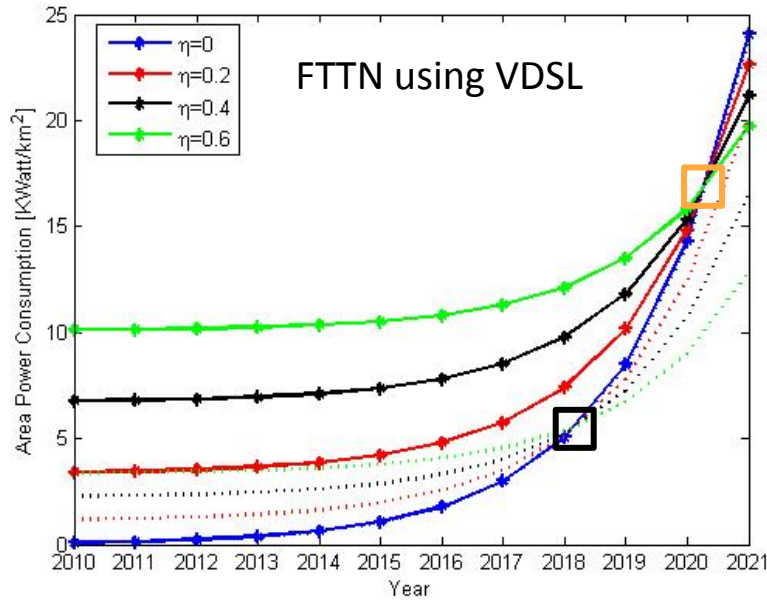
- ρ : user density, $\rho = 3000$ user/ Km^2
- $\alpha(t)$: daily traffic variation, $\alpha(t) = \alpha_{\max} = 16\%$
- r_k : avg. traffic demand for terminal k
- s_k : ratio of subscribers for terminal k

- **Wireless network dimensioning (step 2)**:
 - Homogeneous deployment: macro BS only
 - Heterogeneous deployment: macro BS + small indoor BS
- **Backhaul dimensioning (step 3)**:
 - Fiber-to-the-node (FTTN) using VDSL
 - Fiber-to-the-building (FTTB) using P2P optical links
 - Fiber-to-the-home (FTTH) using PON
 - Microwave
- **Scenario**: $10 \times 10 \text{ km}^2$ area, with various pen. rates (η)
- **Terminals**: tablet, smartphone, and laptops

Backhaul architectures



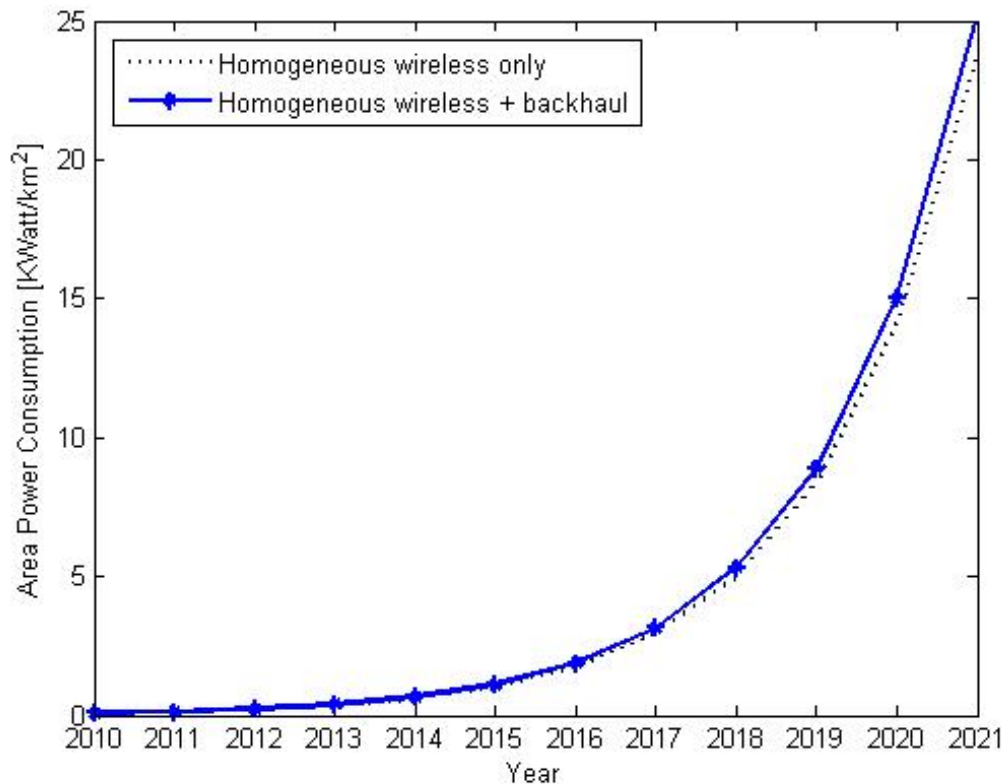
Power consumption: fixed η



Power consumption: varying η

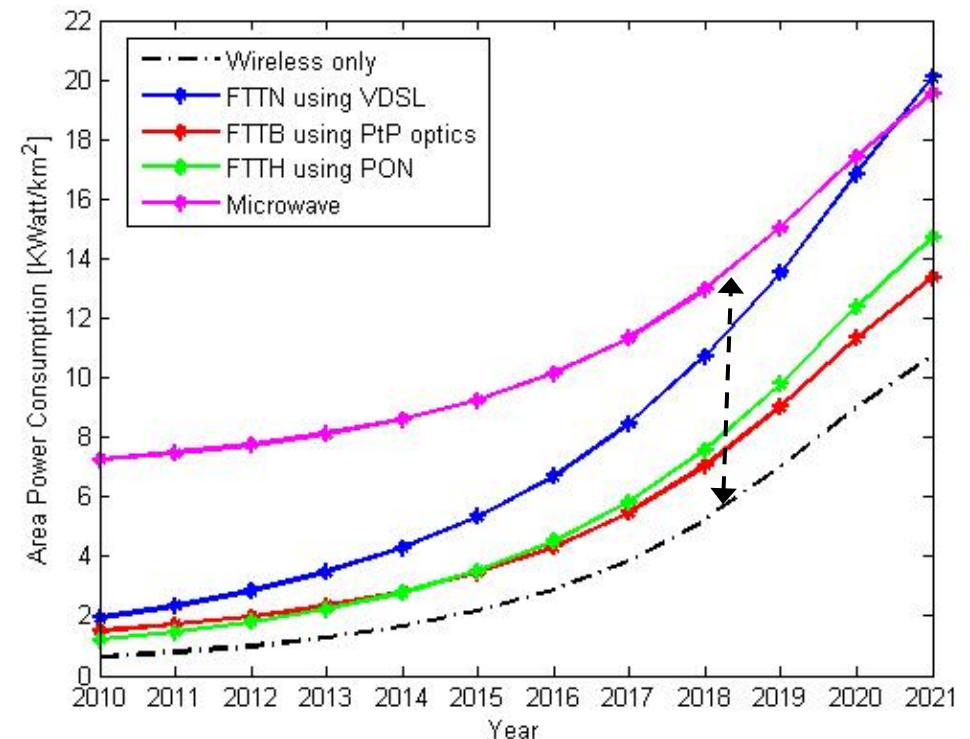
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- $\eta \in [0.1, 0.6]$ increases linearly in the considered region of $10 \times 10 \text{ km}^2$



- Impact of backhaul on homogeneous wireless networks in 2020: **6%**

- Impact of backhaul on HetNet wireless networks in 2020: **50%**





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Conclusions

- Analyzed the role of backhaul in HetNet deployments
- FTTB/FTTH showed very good performance limiting considerably the energy impact of the backhaul segment in dense urban scenario deployments
- Interesting to consider for the future:
 - Energy is only one of the many factors accounted in OPEX: total cost of ownership (TCO) consideration are need
 - rural areas: first results for FTTB/FTTH EE results also encouraging, but CAPEX vs. OPEX rationale will be different
 - fronthaul: allows for additional features (e.g., BBU hoteling) but what are the tradeoffs at play here?



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Acknowledgments

● People

- Matteo Fiorani
- Fabricio Farias
- Mats Nilsson
- Sibel Tombaz
- Anders Västberg
- Joao Weil
- Lena Wosinska

● Projects

- **eWIN**: Energy-efficient wireless networking
<http://wireless.kth.se/blog/projects/ewin/>
- **GreenHaul**: Energy efficient backhauling for HetNet wireless deployments
<http://web.it.kth.se/~pmonti/GreenHaul/>
- **5GrEEn**: Towards Green 5G Mobile Networks
<http://www.eitictlabs.eu/innovation-areas/future-networking-solutions/5green-towards-green-5g-mobile-networks/>

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18th conference on Optical Network Design and Modeling 2014

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