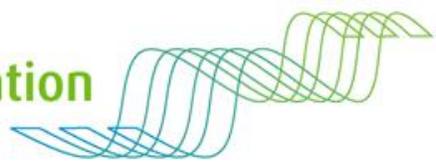


Green Meter for Core Networks

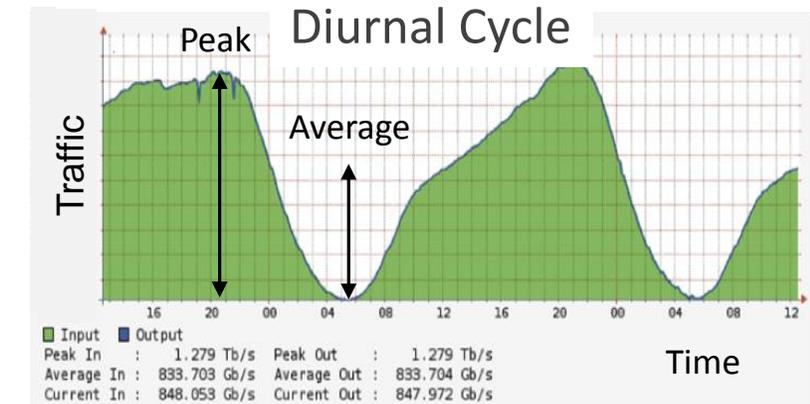
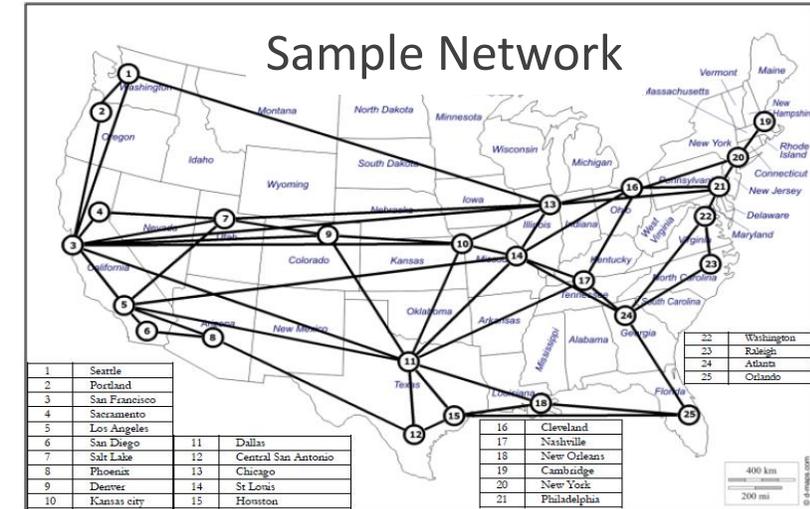




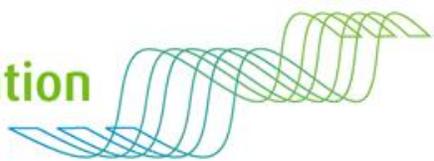
Green Meter Assessment for Core Networks

CHALLENGE AND BREAKTHROUGHS

- Traffic in core and backbone networks of the Internet will increase 10-fold between 2010 and 2020
- Energy efficiency improvements not keeping pace with traffic growth
- Core network energy consumption will more than double from 2010 to 2020 with “business as usual” technology evolution only
- Targeting traffic growth with net energy reduction



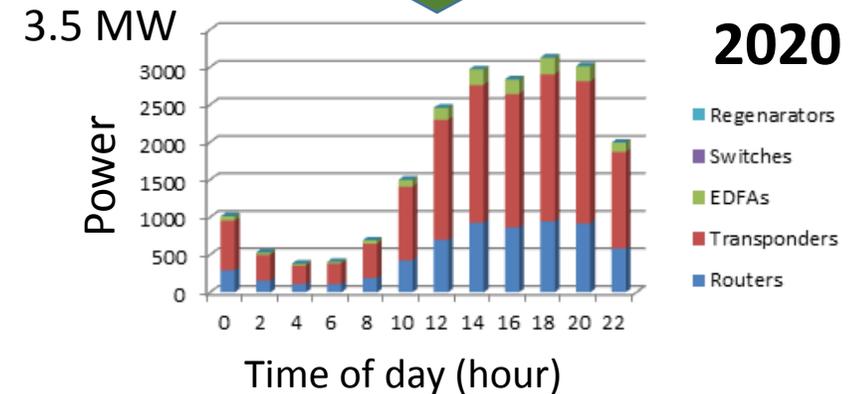
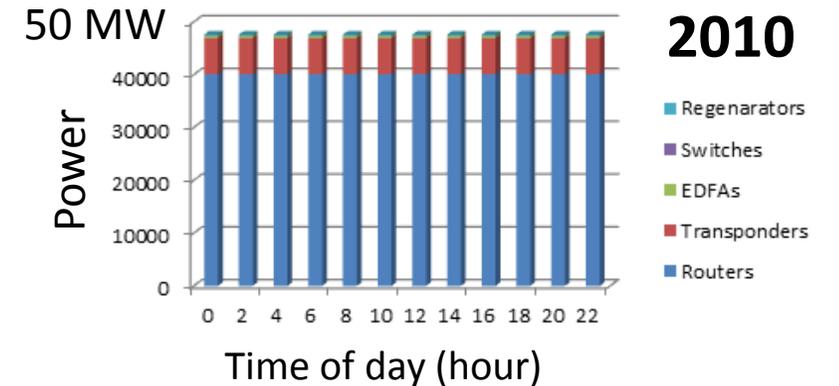
Inventing and Evaluating Portfolio of Technologies for Core Network Energy Efficiency



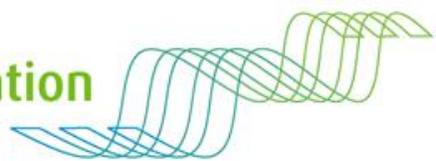
Green Meter Assessment for Core Networks

APPROACH

- Forecast traffic growth from 2010 to 2020 and construct diurnal cycle traffic matrix for sample networks
- Multi-layer network modelling to capture state of the art, business as usual and GreenTouch technologies
- Detailed computer optimization using a “Mixed Integer Linear Program”
- Evaluate individual and cumulative energy efficiency gains provided by different technologies

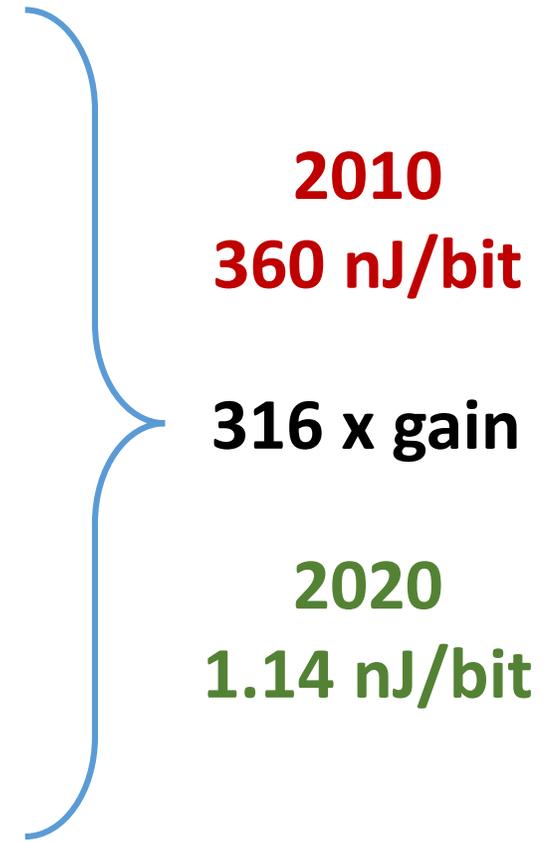


Increasing Energy Efficiency of Core Networks by 316x Compared to 2010 Reference



Green Meter Assessment for Core Networks

Portfolio of 2020 Technologies	Efficiency Gains
Business as Usual (Moore's Law Improvement)	4.23x
GreenTouch Equipment Innovations - Optical Interconnects - Optimized Packet Processing - Link-Optimized Signal Processing in Transponders	4.73x
Deployment and Management of Protection Equipment	1.96x
Router Bypass & Sleep Modes During Off-Peak	2.13x
Dynamically Allocated Line Rates (40G, 100G, 400G, 1T)	1.21x
Optimized Network Direct Path Topology	1.43x
Optimized Distributed Cloud and Virtualisation	2.19x



Enabling a 96% Decrease in Net Energy Consumption in Future Core Networks