



ENSC 427 Communications Network
Spring 2011

Final Project Presentation

**Traffic Analysis of Broadband over Power Line
(BPL) over Power Line Communication (PLC)
Medium**

URL: <http://www.sfu.ca/~gba2/>

Team #3:

Gary Brykov

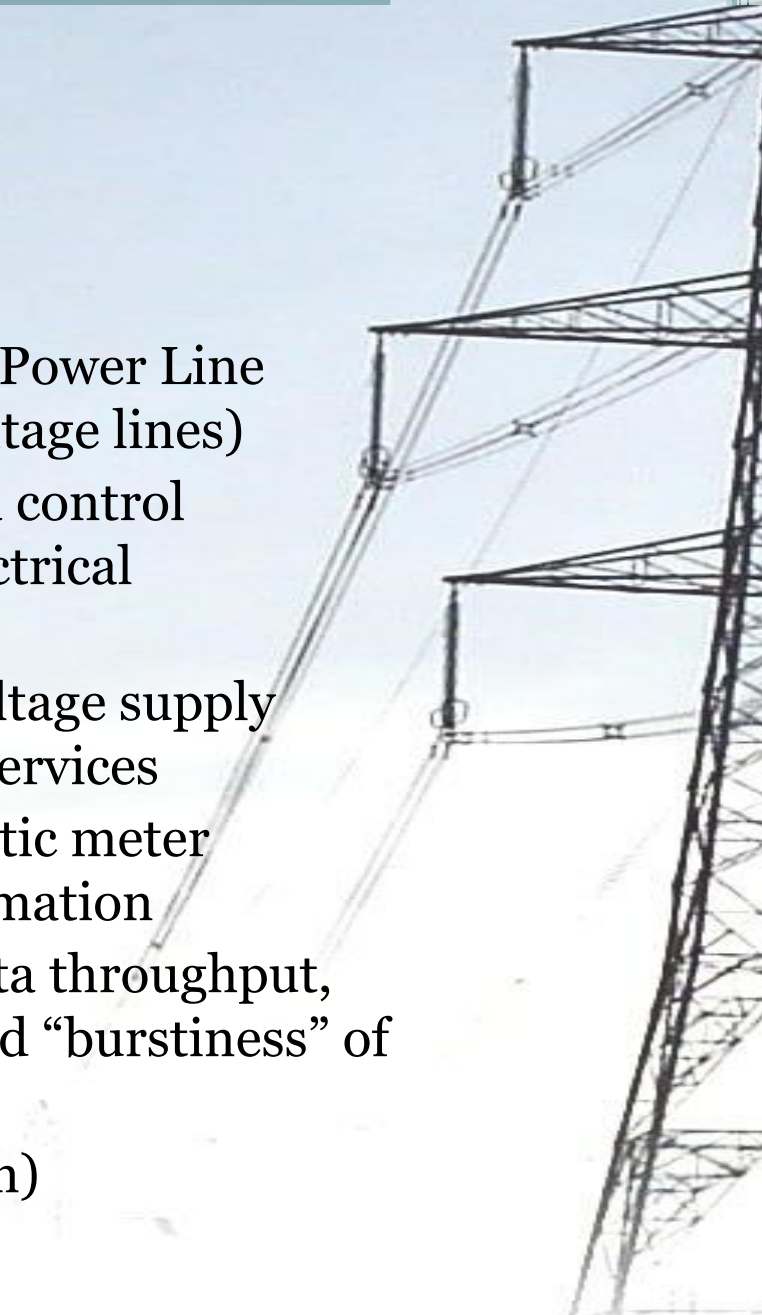
301026383 (gba2@sfu.ca)

Yash Trivedi

301047924 (ymt1@sfu.ca)

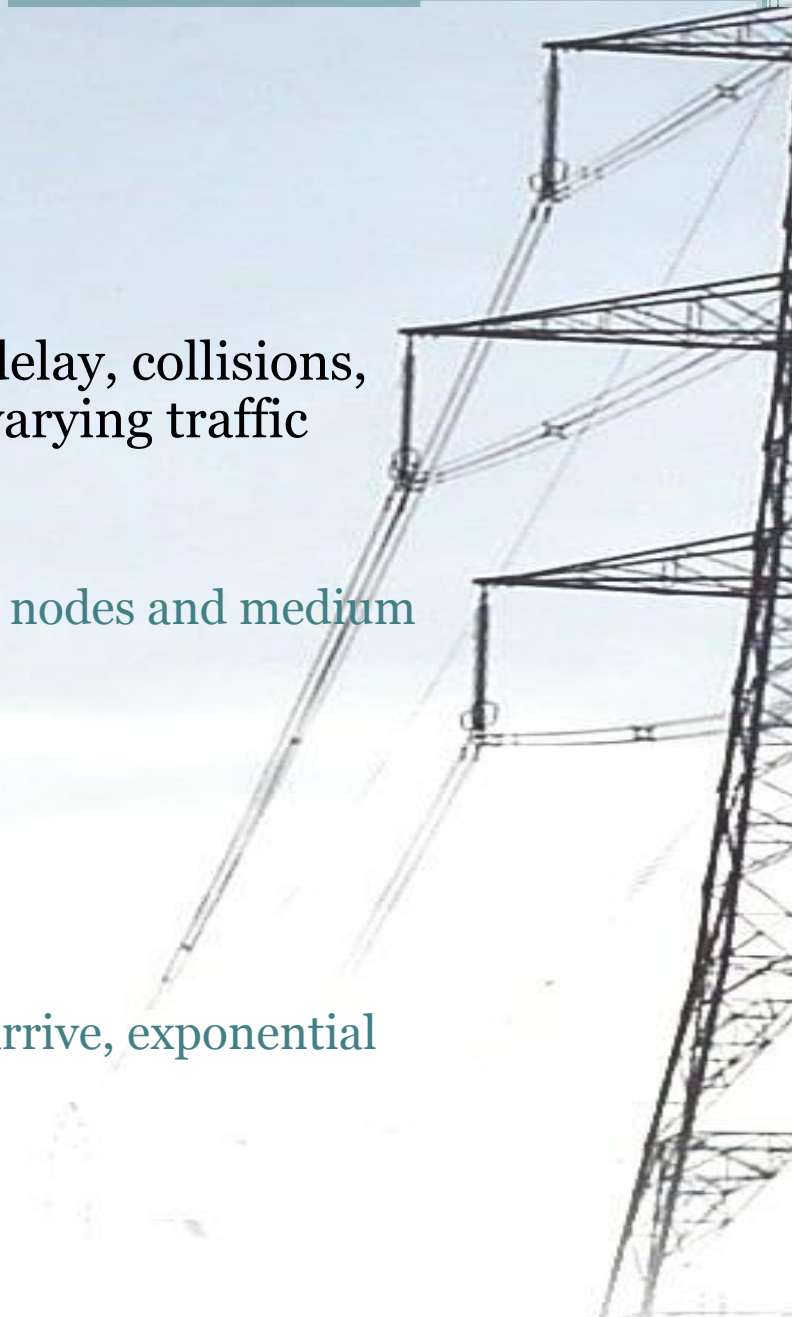
Introduction to BPL and PLC

- Broadband over Power Line (BPL) runs over Power Line Communication (PLC) medium (medium-voltage lines)
- PLC network allows efficient deployment of a control network, taking advantage of the existing electrical infrastructure
- The use of BPL using PLC allows medium-voltage supply networks to deliver various communication services
- Internet access, voice over IP (VoIP), automatic meter reading (AMR), and home and building automation
- Services possible are highly dependant on data throughput, reactance to noise and background traffic, and “burstiness” of transmission
- BPL over PLC provides 200 Mbps (up + down)



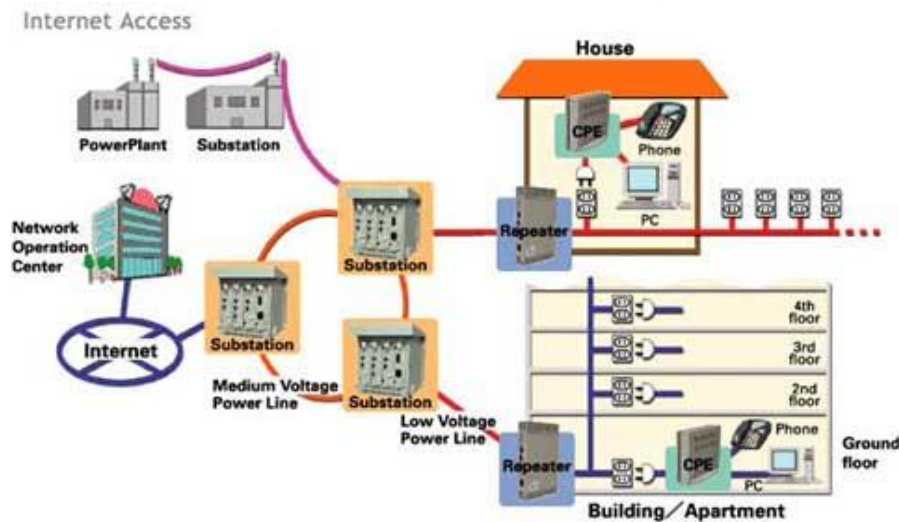
Introduction – Project Idea

- Idea: Analyze data throughput, utilization, delay, collisions, and burstiness (throughput fluctuation) of varying traffic
- Goals:
 - Use OPNET 14.0
 - Create a basic BPL network running over PLC nodes and medium
 - Model different traffic generation schemes
 - Simulate the network operation
 - Analyze and compare results
- Desired Scope:
 - BPL Head-End Unit
 - BPL End-Point Units
 - Various traffic generators (constant size and arrive, exponential size and arrival)
 - PLC medium links



Introduction – The Technology

- Adapters at centralized locations carry broadband internet traffic
- Adapters convert data to special frequencies that can be combined with electricity
- End point BPL modems to separate data from electricity, data sent to Ethernet port



Introduction – The Technology cont'd

- BiPAC 2300 BPL Access Head-End Unit



- BiPAC 2103 BPL Access End-Point Unit



- PLC Medium Voltage Aluminum Power Line



- 100BaseT Duplex Ethernet Link



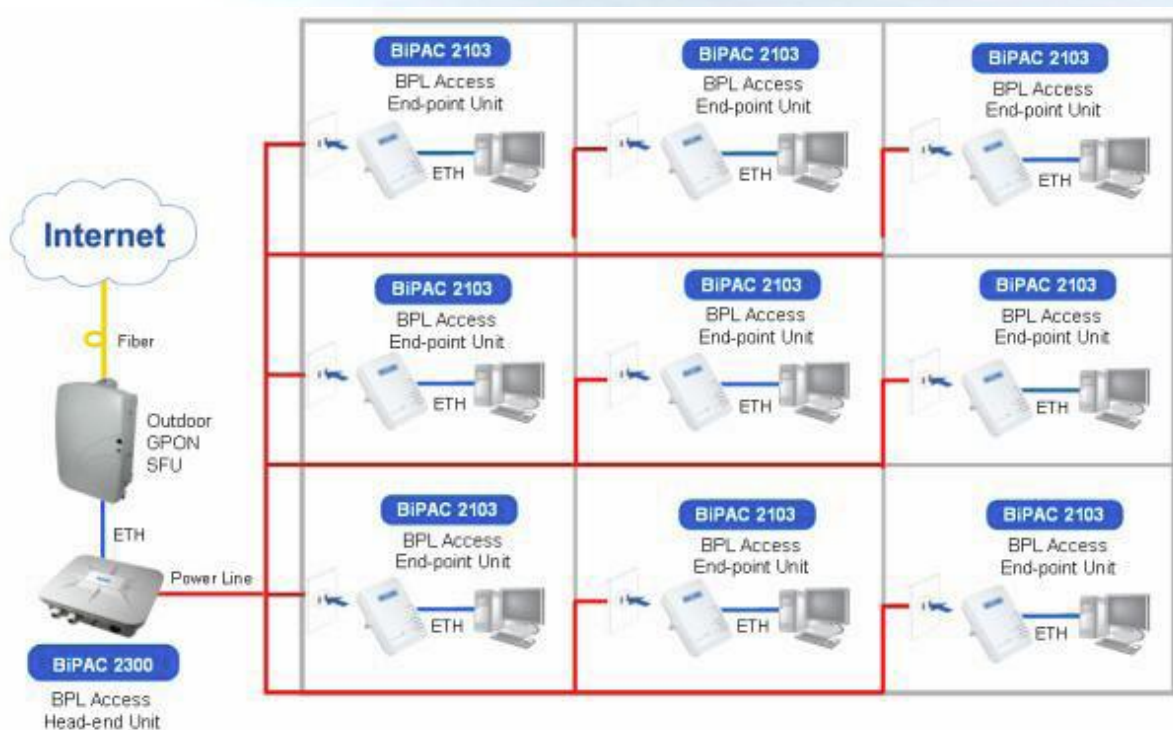
Introduction – Why BPL/PLC?

- Reduced power costs and pollution
- Increased reliability and security
- Electrical Infrastructure already exists
- No need for additional modems or routers besides head-end/end-point units
- AMR/SmartGrid overlay capability – effective control over the power transmission grid to increase efficiency and transmission while reducing costs



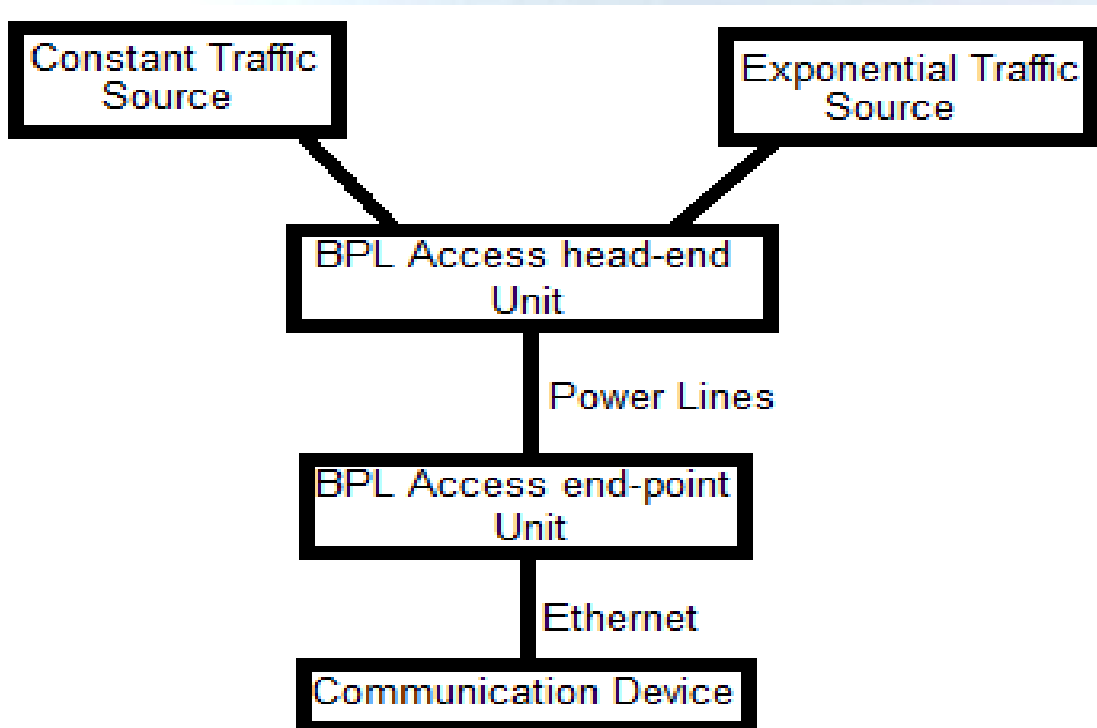
Implementation Details – Overall Design

- Network diagram:

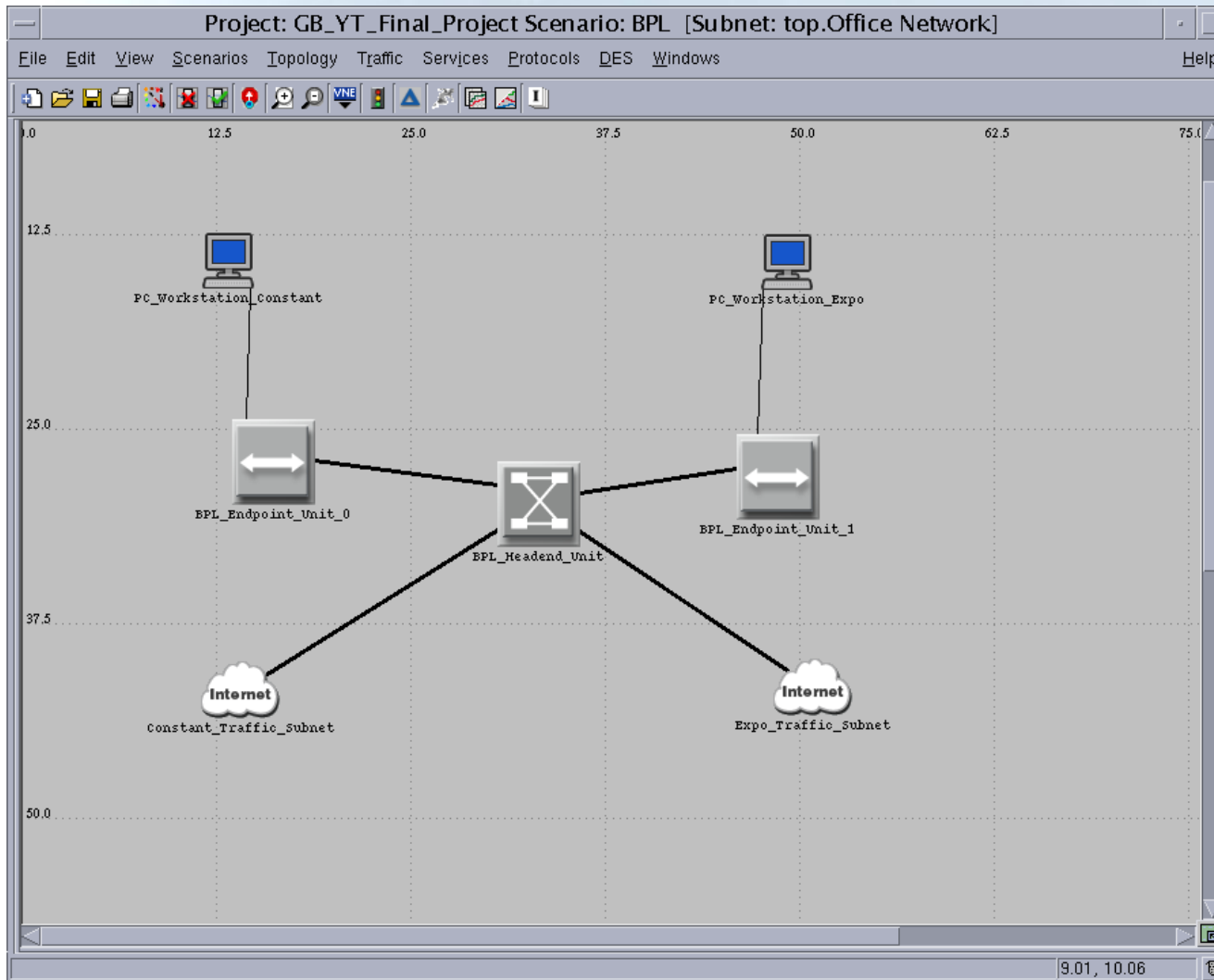


Implementation Details – Overall Design cont'd

- Model diagram:

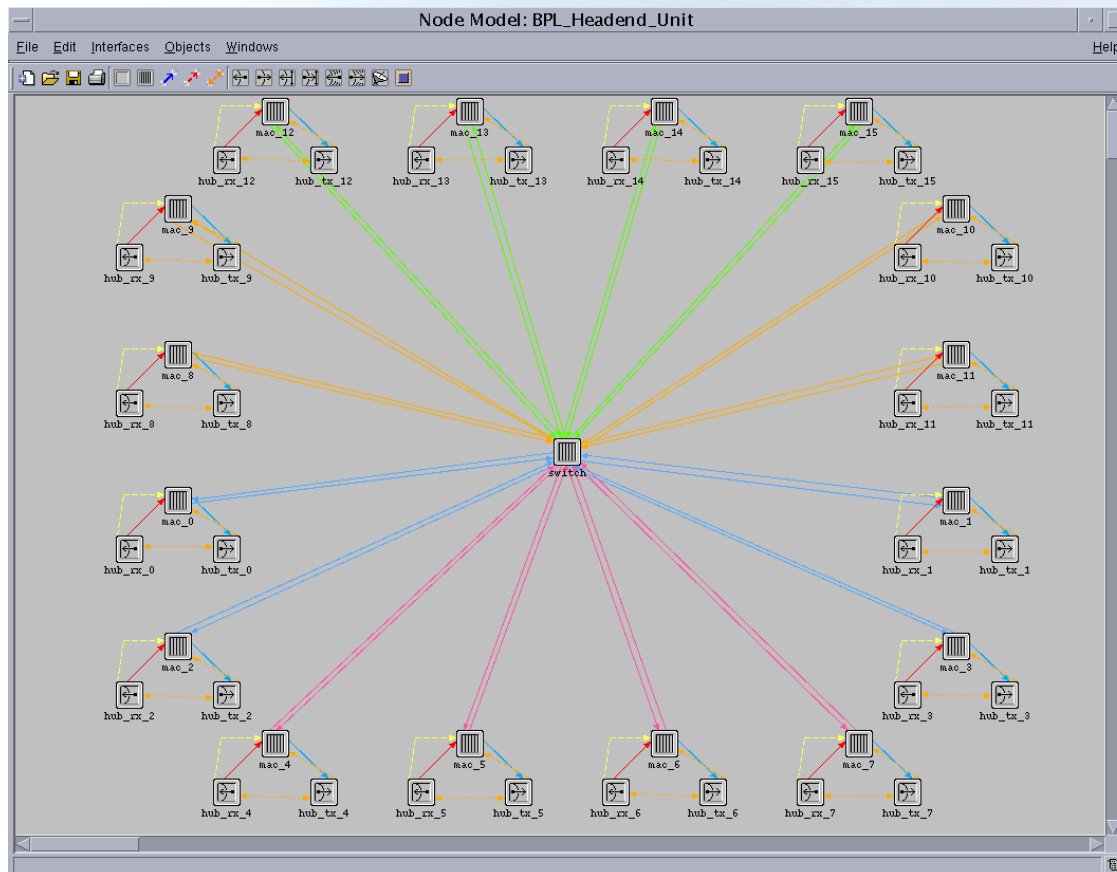


Implementation Details – System Schematic



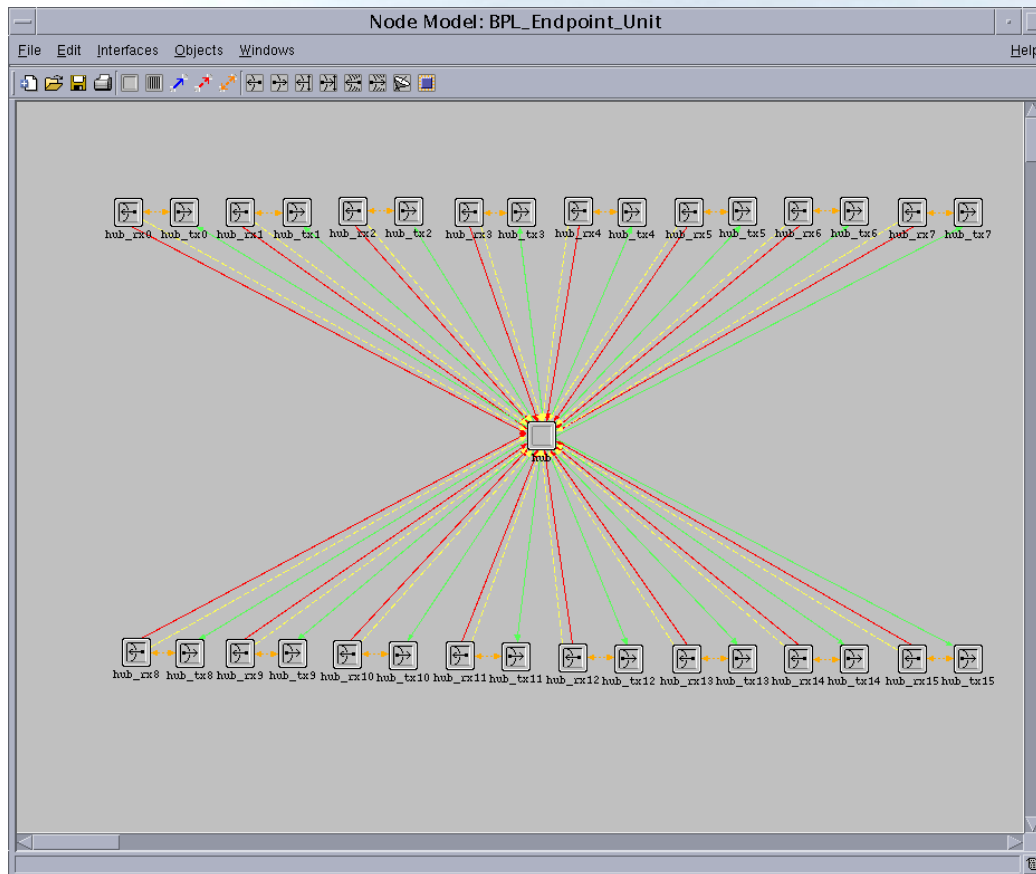
Implementation Details – Node Models

- BPL Access Head-End Unit



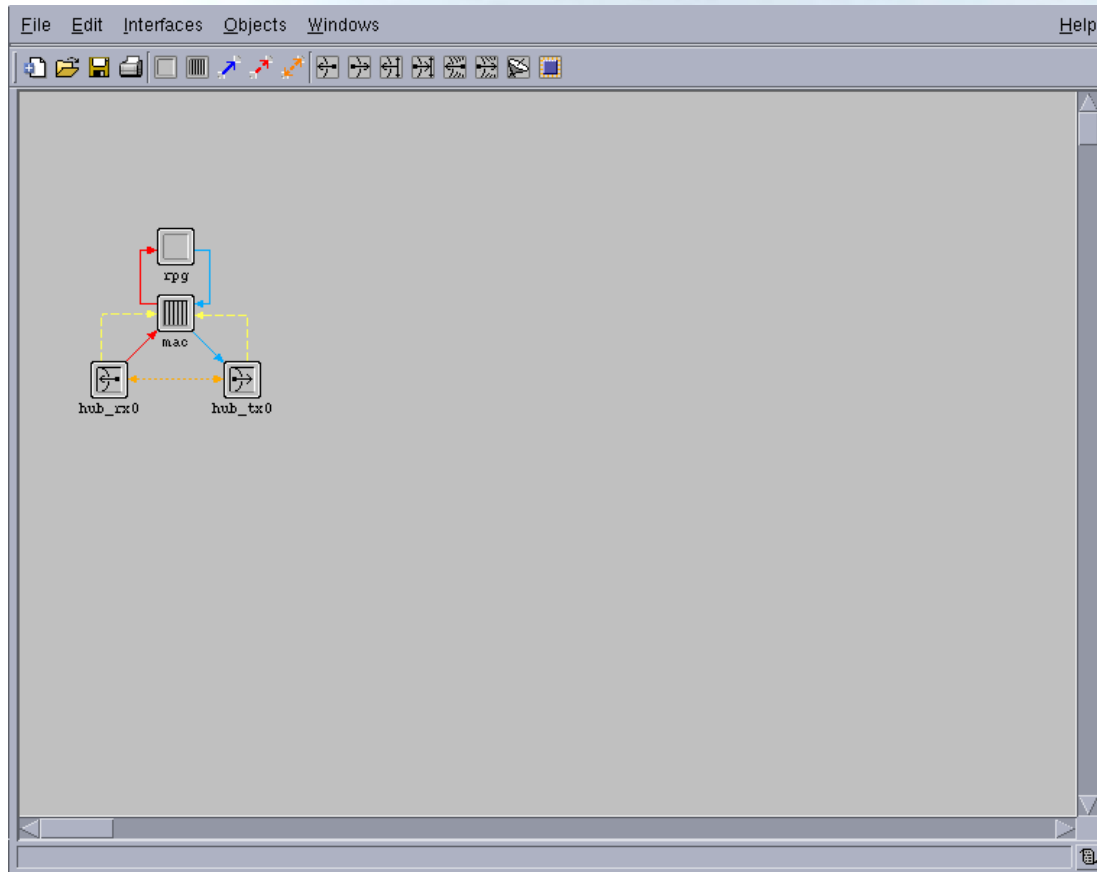
Implementation Details – Node Models cont'd

- BPL Access End-Point Unit



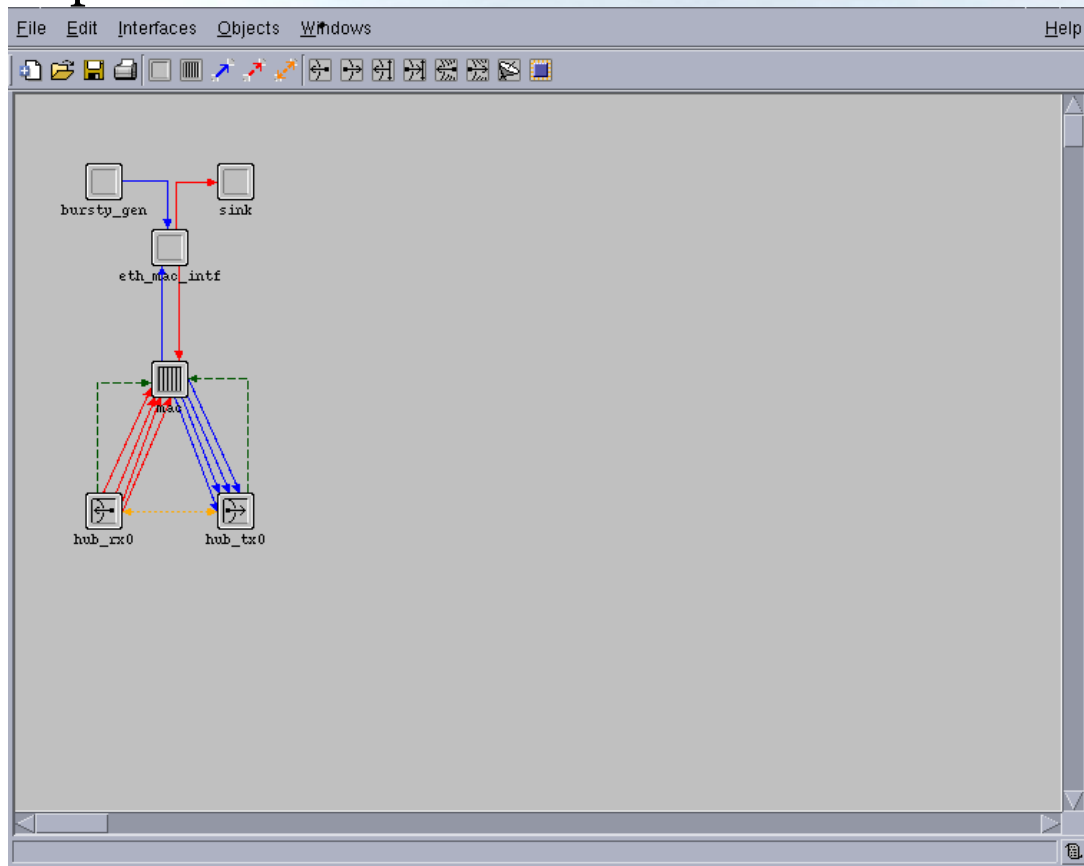
Implementation Details – Node Models cont'd

- Constant Traffic Source



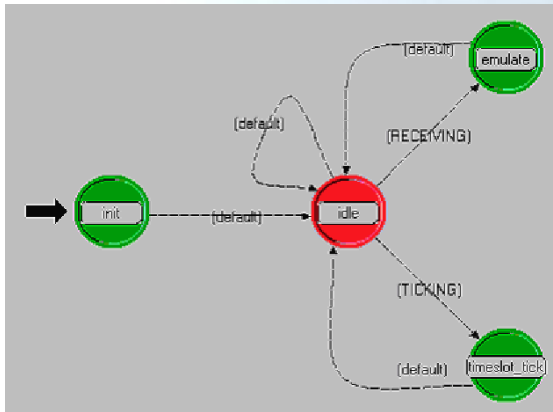
Implementation Details – Node Models cont'd

- Exponential Traffic Source



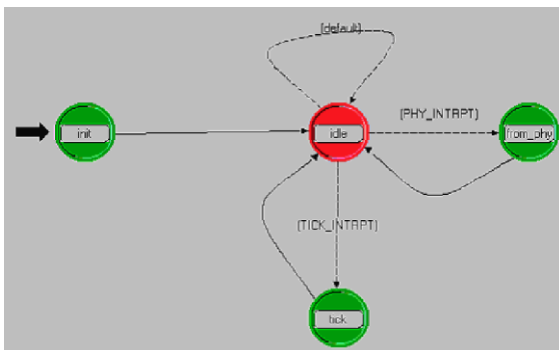
Implementation Details – Process Models

- Hub_Tx in BPL Head-End Unit



- Receives data from subnet
- Emulates physical medium
- Sends results to switch process

- Hub_Rx in BPL Head-End Unit



- Receives data from head-end unit
- Converts electrical signal to ethernet
- Sends results to workstation

Implementation Details – Traffic Generators

- Constant Traffic Subnet



- Generates self-similar packets
- Interarrival time is constant

- Exponential Traffic Subnet



- Generates exponential distribution of packets
- Interarrival time follows exponential distribution

Implementation Details – OPNET Configuration

- **OPNET 14.0 Configuration File**

#number of logical channels

log_channels : 1

#tells what type of protocol exists in each logical channel

log_channel_0 : BPL_PLC

#log_channel_1 : BPL_alt

#log_channel_2 : BPL_alt

#tells the number of slave nodes

slave_nodes : 2

#initial repeater level

repeat_downlink : 1

repeat_uplink : 1

#number of retries

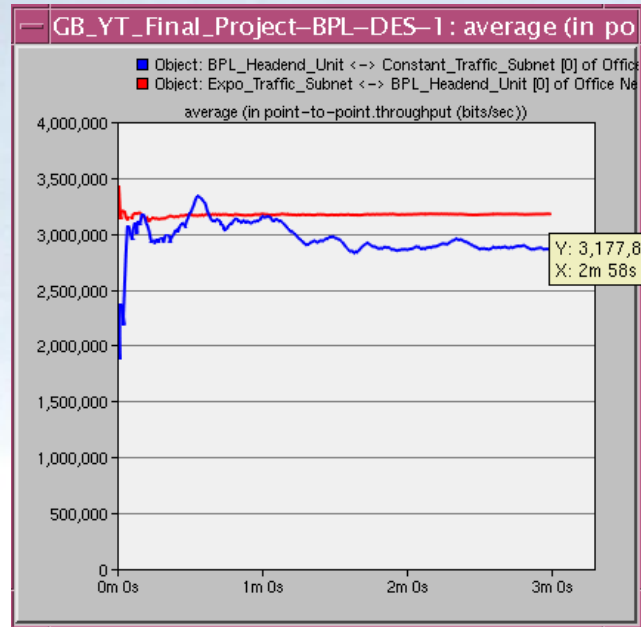
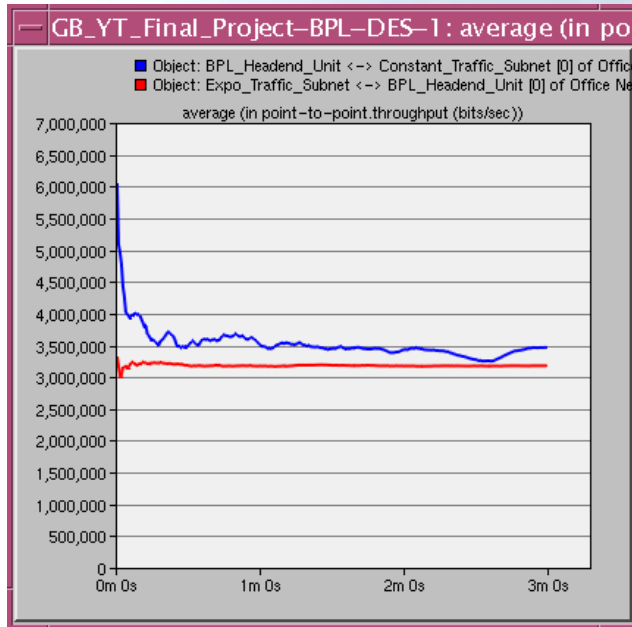
number_retries : 2

#timeslot for start of collecting statistics

start_timeslot : 0



Discussion – Some Results



- Data throughput between traffic generator and head-end unit
- Down and up traffic
- Result summary: Exponential traffic shows less burstiness, delay, and collisions. See project report for full results.

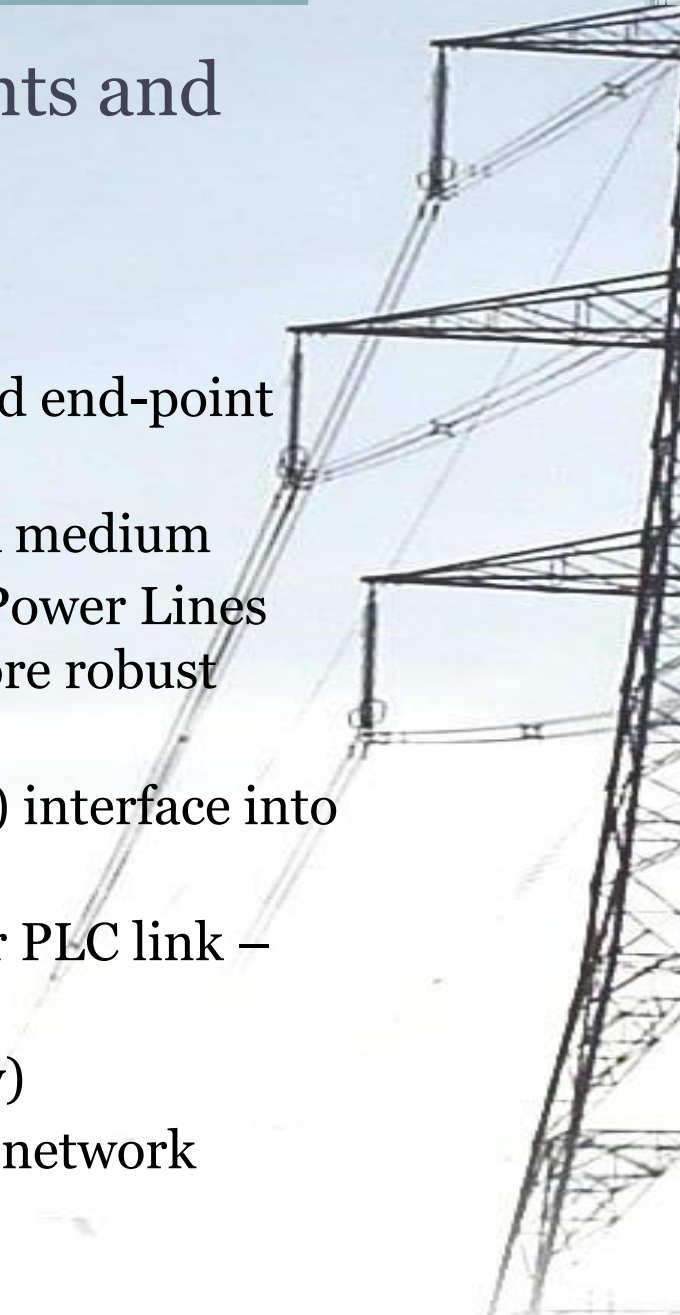
Discussion – Challenges

- OPNET crashes, library errors, login issues, remote access problems
- OPNET provides no native support for PLC medium
- Lack of relevant models available on OPNET online library
- BPL and PLC relatively new technology
- Lack for relevant documentation available



Discussion – Possible Improvements and Future Work

- Increase scope by adding workstation nodes and end-point units
- Create a node that better emulates the PLC link medium
- Implement Remote Energy Management over Power Lines and Internet (REMPLI) Project libraries for more robust simulation
- Incorporate iAd Physical Layer Emulator (C++) interface into OPNET to achieve greater model accuracy
- Add more types of traffic to be transmitted over PLC link – voice, AMR
- Obtain more metrics (jitter, packet loss, latency)
- Introduce background load and noise into PLC network



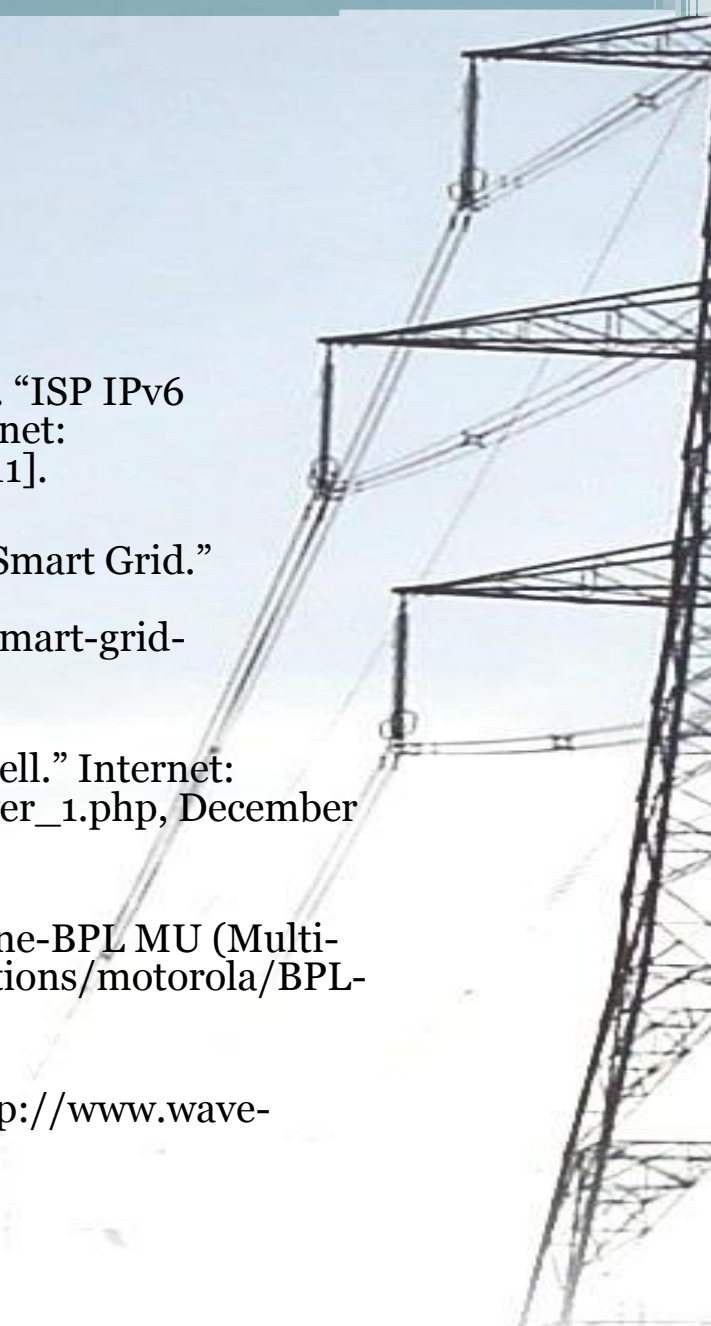
Discussion – Lessons Learned

- Potential of BPL over PLC as a robust communication medium
- Using OPNET to effectively model a network
- Modifying existing models to suit our design
- Creating a process model from scratch using Proto-C
- Reading and analyzing simulation results
- Managing time and resources to complete project



References

- [1]Ahmed, A., Asadullah, S., Palet, J., Popoviciu, C., Savola, P. “ISP IPv6 Deployment Scenarios in Broadband Access Networks.” Internet: www.ietf.org/rfc/rfc4779.txt, January 2007 [February 19, 2011].
- [2]Balls, C., Battaglini, A., Haas, A., Lilliestam, J. “The SuperSmart Grid.” Internet: <http://www.supersmartgrid.net/wp-content/uploads/2008/06/battaglini-lilliestam-2008-supersmart-grid-tallberg1.pdf>, June 18, 2008 [February 19, 2011].
- [3]Du Bois, D. “Broadband Over Powerlines (BPL) in a Nutshell.” Internet: http://energypriorities.com/entries/2004/12/broadband_over_1.php, December 09, 2004 [February 19, 2011].
- [4]Motorola, Inc. “Motorola Canopy Broadband over Powerline-BPL MU (Multi-Unit) Solutions.” Internet: <http://www.netlinkweb.com/solutions/motorola/BPL-applications/BPL-MU.asp>, March 2010 [February 19, 2011].
- [5]Stenger, J. “Broadband Power Line Tutorial.” Internet: <http://www.wave-report.com/blog/?p=52>, December 29, 2010 [March 9, 2011].



Thank You!

