Exploring Photonics

What is Photonics? Imagine a computer chip made purely of glass, using optical properties to perform functions previously done using electronic components. This is PHOTONICS.

Load up the Photonic Simulator:
- Website address: http://web.science.mq.edu.au/groups/cudos/education/Simulator.html
- Select “Build a Photonic Network”

Activity 1a. Build a simple optical network
1. Select CHALLENGE 1 on the simulator
2. Read the challenge, then click on the CHALLENGE 1 button
3. Build your first network, send a message!

Type your message here:
Hello world

Send
Activity 1b. What is happening?

4. Click “Show Photon Values” ON
5. Slow down the photon speed using the slider
6. Write your name in the message box, press Send.
7. Observe how your name is transformed into a digital signal.

Activity 1 Questions:
1a) What is the digital version of your name? _______________________________________

1b) What do you think the photon source is? ________________________________

1c) How do you think the photon source is making the '0's and '1'? ______________________
_____________________________________________________________________________

1d) Why is your name converted to 0s and 1s? ________________________________
_____________________________________________________________________________

Finding out more:
Visit the Photonics Dictionary and read the sections “How do I encode text for transmission?” and “What is an optical signal?”

=> Continue to the next page for Activity#2
Activity 2. Exploring Optical Networks and Signal Strength

1. Select CHALLENGE 2 on the simulator
2. Read the Tips and Things to note – pay special attention to the information about Power.
   Questions:
   What is the Power of the pulse? __________________
   What happens to the power when the signal is split? __________________
   What does the amplifier do to the power? ___________________________
   3. Set up a waveguide to Tim’s place.
   4. Send a message to Tim’s place
      Question: What is the power of the signal arriving at Tim’s place? __________
   5. Double click on the waveguide to remove it, then set up a waveguide to Louise’s place.
   6. Send a message to Louise’s place
      Question: What is the power of the signal arriving at Louise’s place? ______________
      Question: Why is this different to the power at Tim’s place? ___________________
   7. Remove the waveguide.
   8. Select Place Component, then drag a Splitter across to the network.
   9. Select Draw Waveguide
      10. Build the network using only the splitter so your message goes to both Tim and Louise at the same time.
      11. Send a message.
          Question: What happened? _____________________________________________
          _________________________________________________________________
          Question: Why? ____________________________________________________

      Hint: Look at the power of the signals arriving at the houses
      12. Use one or more amplifiers in your design to fix up the signals.
          Question: How is the amplifier helping? _________________________________
          _________________________________________________________________
          _________________________________________________________________

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Activity 3. Combining Signals

1. Select CHALLENGE 3 on the simulator
2. Read the Tips and Things to note
   1. Build a network using only the Coupler. Send the messages.
      Describe what happens and why: _______________________________
      __________________________________________________________

2. Rebuild your network by adding in a Buffer between the second photon source and Coupler.
   Describe what happens and why? ________________________________________________
   _____________________________________________________ _________________________

3. Add in one or more amplifiers to solve the challenge.

4. Draw your solution of Challenge#3 here:

5. Question: Why did you need to use an amplifier? _____________________________________
   _______________________________________________________________ _______________

Finding out more:
- Select the “Watch a Video” button and watch a description of how a photonic chip is able to work with light signals without converting the data to an electrical signal.
- Visit the ‘Catalyst’ website at http://www.abc.net.au/catalyst/stories/2675781.htm

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Teacher Notes

• This activity sheet scaffolds the first three challenges on the Photonics Simulator to help students go beyond intuitively or experimentally solving the Challenges.
• Once they have thought more deeply about the first three challenges, they should find the remaining challenges much easier to solve based on their understanding of what is happening.
• Some students may prefer to immediately tackle the challenges before doing the worksheet – in which case they can just revisit the activity after they have solved the challenge.
• A pedagogical challenge presented by the simulator is it gives the impression the components are discrete elements of a large optical network, whereas in reality it is modelling elements used to build a photonic chip. While there is applicable metaphor to larger systems, more advanced students will see through the metaphors and ask deeper questions. (Or have we misunderstood?)
• The remaining challenges will make more contextual sense once students have understood what a Photonics chips is, and the challenges the designers face.

Question: The collision modelled in Challenge#2 shows the CAT and DOG signals interleaved as CDATOG (or something similar). We question however if the resulting collision would more likely be a garbled signal resulting from a logical Oring of the signals, rather than the preservation of discrete time shifted bytes – generating a similar effect to that displayed for power loss.