Rush Popcorn and Network Routing

TOPIC
Mathematical Connections and Problem Solving

KEY QUESTIONS
How do you develop a delivery route system to quickly deliver popcorn?
What are the best places for Internet Exchange Points to maximize network speed?

LEARNING GOALS
Students will:
• Use numeric and descriptive data to create an efficient delivery system
• Become more efficient with working with maps
• Learn how network routing works
• Make decisions about whether or not a solution meets the needs of a client
• Communicate the solution clearly to the client

GUIDING DOCUMENTS
This activity has the potential to address many mathematics and science standards, as well as address engineering principles. Please see pages 4-5 for a complete list of mathematics and science standards.

RECOMMENDED SUPPLIES FOR ALL MODEL-ELICITING ACTIVITIES
It is recommended to have all of these supplies in a central location in the room. It is recommended to let the students know that they are available, but not to encourage them to use anything in particular.

• Overhead transparencies and transparency markers/pens, whiteboards and markers, posterboards, or other presentation tools such as a document camera.
• Calculators
• Rulers, scissors, tape
• Markers, colored pencils, pencils
• Construction paper, graph paper, lined paper
• Paper towels or tissues (for cleaning transparencies)
• Manila folders or paper clips for collecting the students’ work

• Optional: Computers with programs such as Microsoft Word and Excel

WHAT ARE MODEL-ELICITING ACTIVITIES (MEAs)?
Model-Eliciting Activities are problem activities explicitly designed to help students develop conceptual foundations for deeper and higher order ideas in mathematics, science, engineering, and other disciplines. Each task asks students to mathematically interpret a complex real-world situation and requires the formation of a mathematical description, procedure, or method for the purpose of making a decision for a realistic client. Because teams of students are producing a description, procedure, or method (instead of a one-word or one-number answer), students’ solutions to the task reveal explicitly how they are thinking about the given situation.

THE Rush Popcorn and Network Routing MEA CONSISTS OF FIVE COMPONENTS:
1) Newspaper article: Students individually read the newspaper article to become familiar with the context of the problem. This handout is on pages 6-7.
2) Readiness questions: Students individually answer these reading comprehension questions about the newspaper article to become even more familiar with the context and beginning thinking about the problem. This handout is on page 8.
3) Problem statement: In teams of three or four, students work on the problem statement for 45 – 90 minutes. This time range depends on the amount of self-reflection and revision you want the students to do. It can be shorter if you are looking for students’ first thoughts, and can be longer if you expect a polished solution and well-written letter. The handouts are on pages 9-12.
4) Process of sharing solutions: Each team writes their solution in a letter or memo to the client. Then, each team presents their solution to the class. Whole class discussion is intermingled
with these presentations to discuss the different solutions, the mathematics involved, and the effectiveness of the different solutions in meeting the needs of the client.

In totality, each MEA takes approximately 2-3 class periods to implement, but can be shortened by having students do the individual work during out-of-class time. The Presentation Form can be useful and is explained on page 4 and found on page 21.

5) Optional Follow up activity (Network Routing): Delivering Popcorn relates to different areas where routing is used. In this activity students will learn more about network routing and the most efficient places to place Internet Exchange Points for fastest service. Page 12 contains background information. Page 13 has Reflection Questions. Pages 15-16 are the main activity for students work on.

RECOMMENDED PROGRESSION OF THE Rush Popcorn/Network Routing MEA

While other implementation options are possible for MEAs, it is recommended that the MEA be implemented in a cooperative learning format. Numerous research studies have proven cooperative learning to be effective at improving student achievement, understanding, and problem solving skills. In this method students will complete work individually (Newspaper article and readiness questions; as well as initial thoughts on the problem statement) and then work together as a group. This is important because brainstorming works best when students have individual time to think before working as a group. Students can be graded on both their individual and group contributions. Social skills’ discussion at the beginning of the MEA and reflection questions at the end of the MEA are also essential aspects of cooperative learning.

Social Skills (3-5 minutes)
Students must be taught how to communicate and work well in groups. Several social skills that are essential to group work are decision-making, asking questions, and communicating and listening. The teacher can show part of a YouTube video and discuss aspects of these skills before beginning the MEA.

(https://www.youtube.com/user/flowmathematics)

Newspaper Article and Readiness Questions:
The purpose of the newspaper article and the readiness questions is to introduce the students to the context of the problem.

(10 minutes): Give the article and the questions to the students the day before for homework. Then, in the next class, discuss as a class the answers to the readiness questions before beginning to discuss the problem statement.

Problem Statement:
You may want to read the problem statement to the students and then identify as a class: a) the client that the students are working for and b) the product that the students are being asked to produce. Once you have addressed the points above, allow the students to work on the problem statement. Let the students know that they will be sharing their solution to the rest of the class. Tell students you that you will randomly pick a group member to present for each group. Tell the students that they need to make sure that everyone understands their group’s solution so they need to be sure to work together well. The group member who will present can be picked by assigning each group member a number.

Working on the Problem Statement (35-50 minutes): Place the students in teams of three or four. Students should begin to work by sharing their initial ideas for solving the problem. If you already use teams in your classroom, it is best if you continue with these same teams since results for MEAs are better when the students have already developed a working relationship with their team members. If you do not use teams in your classroom and classroom management is an issue, the teacher may form the teams. If classroom management is not an issue, the students may form their own teams. You may
want to have the students choose a name for their team to promote unity.

**Teachers’ role:** As they work, your role should be one of a facilitator and observer. Avoid questions or comments that steer the students toward a particular solution. Try to answer their questions with questions so that the student teams figure out their own issues. Also during this time, try to get a sense of how the students are solving the problem so that you can ask them questions about their solutions during their presentations.

**Presentations of Solutions (15-30 minutes):** The teams present their solutions to the class. There are several options of how you do this. Doing this electronically or assigning students to give feedback as out-of-class work can lessen the time spent on presentations. If you choose to do this in class, which offers the richest discussions, the following are recommendations for implementation. Each presentation typically takes 3 – 5 minutes. You may want to limit the number of presentations to five or six or limit the number of presentations to the number of original (or significantly different) solutions to the MEA.

Before beginning the presentations, encourage the other students to not only listen to the other teams’ presentations but also to a) **try to understand the other teams’ solutions** and b) **consider how well these other solutions meet the needs of the client.** You may want to offer points to students that ask ‘good’ questions of the other teams, or you may want students to complete a reflection page (explanation – page 4, form – page 23) in which they explain how they would revise their solution after hearing about the other solutions. As students offer their presentations and ask questions, whole class discussions should be intermixed with the presentations in order to address conflicts or differences in solutions. When the presentations are over, collect the student teams’ memos/letters, presentation overheads, and any other work you would like to look over or assess.

**ASSESSMENT OF STUDENTS’ WORK**

You can decide if you wish to evaluate the students’ work. If you decide to do so, you may find the following Assessment Guide Rubric helpful:

**Performance Level Effectiveness:** Does the solution meet the client’s needs?

- **Requires redirection:** The product is on the wrong track. Working longer or harder with this approach will not work. The students may need additional feedback from the teacher.

- **Requires major extensions or refinements:** The product is a good start toward meeting the client’s needs, but a lot more work is needed to respond to all of the issues.

- **Requires editing and revisions:** The product is on a good track to be used. It still needs modifications, additions or refinements.

- **Useful for this specific data given, but not shareable and reusable OR Almost shareable and reusable but requires minor revisions:** No changes will be needed to meet the immediate needs of the client for this set of data, but not generalized OR Small changes needed to meet the generalized needs of the client.

- **Share-able or re-usable:** The tool not only works for the immediate solution, but it would be easy for others to modify and use in similar situations. OR The solution goes above and beyond meeting the immediate needs of the client.
IMPLEMENTING AN MEA WITH STUDENTS FOR THE FIRST TIME

You may want to let students know the following about MEAs:

• MEAs are longer problems; there are no immediate answers. Instead, students should expect to work on the problem and gradually revise their solution over a period of 45 minutes to an hour.

• MEAs often have more than one solution or one way of thinking about the problem.

• Let the students know ahead of time that they will be presenting their solutions to the class. Tell them to prepare for a 3-5 minute presentation, and that they may use overhead transparencies or other visuals during their presentation.

• Let the students know that you won’t be answering questions such as “Is this the right way to do it?” or “Are we done yet?” You can tell them that you will answer clarification questions, but that you will not guide them through the MEA.

• Remind students to make sure that they have returned to the problem statement to verify that they have fully answered the question.

• If students struggle with writing the letter, encourage them to read the letter out loud to each other. This usually helps them identify omissions and errors.

OBSERVING STUDENTS AS THEY WORK ON THE Rush Popcorn/Network Routing MEA

You may find the Observation Form (page 19) useful for making notes about one or more of your teams of students as they work on the MEA. We have found that the form could be filled out “real-time” as you observe the students working or sometime shortly after you observe the students. The form can be used to record observations about what concepts the students are using, how they are interacting as a team, how they are organizing the data, what tools they use, what revisions to their solutions they may make, and any other miscellaneous comments.

PRESENTATION FORM (Optional)

As the teams of students present their solutions to the class, you may find it helpful to have each student complete the presentation form on page 20. This form asks students to evaluate and provide feedback about the solutions of at least two teams. It also asks students to consider how they would revise their own solution to the Paper Airplane MEA after hearing of the other teams’ solutions.

STUDENT REFLECTION FORM

You may find the Student Reflection Form (page 21) useful for concluding the MEA with the students. The form is a debriefing tool, and it asks students to consider the concepts that they used in solving the MEA and to consider how they would revise their previous solution after hearing of all the different solutions presented by the various teams. Students typically fill out this form after the team presentations.

STANDARDS ADDRESSED

NCTM MATHEMATICS STANDARDS

Numbers and Operations:

• Work flexibly with fractions, decimals, and percents to solve problems

• Understand and use ratios and proportions to represent quantitative relationships

• Understand the meaning and effects of arithmetic operations with fractions, decimals, and integers

• Judge the reasonableness of numerical computations and their results

Algebra
• Represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules
• Relate and compare different forms of representation for a relationship
• Model and solve contextualized problems using various representations, such as graphs, tables, and equations
• Use symbolic algebra to represent and explain mathematical relationships
• Identify essential quantitative relationships in a situation and determine the class or classes of functions that might model the relationships
• Draw reasonable conclusions about a situation being modeled

Geometry
• Use Cartesian coordinates and other coordinate systems, such as navigational, polar, or spherical systems, to analyze geometric situations
• Use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest such as art and architecture

Measurement
• Solve simple problems involving rates and derived measurements for such attributes as velocity and density

Problem Solving
• Build new mathematical knowledge through problem solving
• Solve problems that arise in mathematics and in other contexts
• Apply and adapt a variety of appropriate strategies to solve problems
• Monitor and reflect on the process of mathematical problem solving

Reasoning and Proof
• Develop and evaluate mathematical arguments and proofs

Communication
• Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
• Analyze and evaluate the mathematical thinking and strategies of others

Connections
• Recognize and use connections among mathematical ideas
• Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
• Recognize and apply mathematics in contexts outside of mathematics

Representation
• Use representations to model and interpret physical, social, and mathematical phenomena

NRC Science Standards

Inquiry
• Use appropriate tools and techniques to gather, analyze and interpret data
• Develop descriptions, explanations, predictions, and models using evidence
• Think critically and logically to make the relationships between evidence and explanations
• Recognize and analyze alternative explanations and predictions
• Communicate scientific procedures and explanations
• Use mathematics in all aspects of scientific inquiry

Motions and Forces
• The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph

Abilities of Technological Design
• Identify appropriate problems for technological design.
• Design a solution or product.
• Evaluate completed technological designs or products.
• Communicate the process of technological design.

Understandings About Science and Technology
• Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials, or effects of weather and friction; other constraints limit choices in the design, for example, environmental protection, human safety, and aesthetics.
• Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems.
• Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.
• Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

Common Core Math Standards
• 5 MD-2: represent and interpret data
• 6 SP-1 Recognize a statistical question as one that anticipates variability in the data
related to the question and accounts for it in the answers. For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question because one anticipates variability in students' ages.

- 6 SP-2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.
- 6 SP-3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.
- 6 SP-4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- 6 SP-5 Summarize numerical data sets in relation to their context, such as by:
  a. Reporting the number of observations.
  b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
  c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.
  d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

- High School S-IC-1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

### Standards for Mathematical Practices integration with MEAs

<table>
<thead>
<tr>
<th>Mathematical Practice</th>
<th>How it occurs in MEAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Make sense of problems and persevere in solving them.</td>
<td>As participants work through iterations of their models they continue to gain new insights into ways to use mathematics to develop their models. The structure of MEAs allows for participants to stay engaged and to have sustained problem solving experiences.</td>
</tr>
<tr>
<td>2. Reason abstractly and quantitatively</td>
<td>MEAs allow participants to both contextualize, by focusing on the real world context of the situation, and decontextualize by representing a situation symbolically.</td>
</tr>
<tr>
<td>3. Construct viable arguments and</td>
<td>Throughout MEAs while groups are</td>
</tr>
<tr>
<td>critique the reasoning of others.</td>
<td>working and presenting their models.</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>4. Model with mathematics.</td>
<td>This is the essential focus of MEAs; for participants to apply the mathematics that they know to solve problems in everyday life, society, or the workplace. This is done through iterative cycles of model construction, evaluation, and revision.</td>
</tr>
<tr>
<td>5. Use appropriate tools strategically.</td>
<td>Materials are made available for groups as they work on MEAs including graph paper, graphing calculators, computers, applets, dynamic software, spreadsheets, and measuring devices.</td>
</tr>
<tr>
<td>6. Attend to precision.</td>
<td>Precise communication is essential in MEAs and participants develop the ability to communicate their mathematical understanding through different representations including written, verbal, symbolic, graphical, pictorial, concrete, and realistic.</td>
</tr>
<tr>
<td>7. Look for and</td>
<td>Participants in MEAs</td>
</tr>
</tbody>
</table>
Snack shipment delayed: holiday party in jeopardy

LAFAYETTE, Ind. – ‘Twas a week before the holiday season and all through the house, not a creature was snacking on the local schools’ popcorn. Not because the popcorn tastes bad, but because it hasn’t arrived yet.

And that has Carson Middle School students worried that their customers might not understand why their holiday snacks are stuck in a Chicago warehouse. Plus, the fundraiser’s money – which was due last week and hasn’t even been thought of with the goods stuck in Chicago – was for the school’s annual holiday party.

Every year, the Carson Middle School Student Council sponsors the Holiday Party. This year the student council had sold 450 canisters of flavored popcorn to the community and raised more than $300 for their party. But with no popcorn delivered and no money brought in, the holiday season is looking grim for the students.

“We’ve heard from the company and they said they would get the popcorn to us by Thursday, Dec. 14,” said Nancy Gummer, a student council representative. “We’ll sort out who ordered what late Thursday night and have them ready to go home with the students on Friday and hopefully have the money Monday morning so we can have the party on Tuesday.”

The money will be used for purchasing decorations, party favors, food, music and a visit from Santa Claus for the party. In fact, the fundraiser worked so well – in terms of the money raised – that the students will use it next year as well.

The student council members sold six flavors of popcorn: caramel, white cheddar, barbecue, nacho, ranch and butter. The popcorn company packages the popcorn in circular canisters that are twelve inches high with a diameter of ten inches, complete with a holiday and seasonal decoration.
Most of the residents that ordered the flavored popcorn intend to give the popcorn as gifts. The student council assured these people that the popcorn would be delivered by Dec. 10, but they had to push the delivery date back to Dec. 15 due to the mix up. The new delivery date should still allow plenty of time for mailing and delivery.

If a student or their family purchased some of the flavored popcorn, the student can pick up their order from the front office on Friday. Popcorn ordered by anyone that does not have a child attending Carson Middle School will be hand-delivered no later than Saturday evening.

Steve Delsemme, a member of the delivery team for the student council, said the student council has faced greater challenges. “It may be difficult to get all of these orders delivered, but we promise to get the flavored popcorn completely delivered by Saturday night. In fact, we are having an emergency student council meeting tomorrow to put together delivery routes,” said Delsemme.

“We just hope the community understands what happened and will help us in the future and that they enjoy their popcorn this holiday season,” said Delsemme.
Readiness Questions

1. How did the Carson Middle School Student Council raise money for their annual Holiday Party?

2. How much money did the student council raise?

3. When will the popcorn be delivered to Carson Middle School?

4. In what two ways will the popcorn be given to the people that ordered popcorn?

5. What is the student council's deadline for delivering the popcorn?

Dear Students,

We are really excited about our upcoming Holiday Party! But first, we have to deliver the flavored popcorn orders. Here are the details about the deliveries:

• All of the orders must be delivered by 6 pm on Saturday, December 15.
• We will be delivering the popcorn orders from our homes instead of from school.
• We have included a list of the popcorn tins that need to be delivered.
• We have also included our addresses, the times that we are available to deliver popcorn, and our means of transportation.

We need your help to determine who should deliver what popcorn orders and a route of delivery for each of us. We also need you to determine what time each delivery will be made, because we have to call the customers on Friday to let them know what time they
can expect to receive their popcorn orders. Our customers need a time estimate accurate to within \( \frac{1}{2} \) hour.

In addition to your delivery routes and time estimates, write a list of steps to follow in designing delivery routes. This will allow us to plan our own delivery routes for future fundraisers.

Please write a letter containing your delivery routes, time estimates, and steps to Nancy, the student council secretary.

Thank you,

Steve, Mary, Julie, Tom, and Juan

Carson Middle School Student Council members
<table>
<thead>
<tr>
<th>NAME</th>
<th>ADDRESS</th>
<th>MAP LOCATION</th>
<th>MEANS OF TRANSPORTATION</th>
<th>TIME AVAILABLE TO DELIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve</td>
<td>1536 S. 27th St.</td>
<td>L24</td>
<td>Bike: His parents only allow him to go one mile from the house. He can bike one mile in seven minutes</td>
<td>1:30 – 3:30 pm</td>
</tr>
<tr>
<td>Mary</td>
<td>500 Tinkler St.</td>
<td>D6</td>
<td>Older brother can drive her in his car: They can drive one mile in three minutes with stop signs.</td>
<td>1:00 – 4:00 pm</td>
</tr>
<tr>
<td>Julie</td>
<td>620 Knight St.</td>
<td>J8</td>
<td>Walk: She can walk one mile in 15 minutes.</td>
<td>3:30 – 4:30 pm</td>
</tr>
<tr>
<td>Tom</td>
<td>400 Scott St.</td>
<td>I14</td>
<td>Walk with cart. He can walk one mile in 23 minutes.</td>
<td>1:00 – 3:30 pm</td>
</tr>
<tr>
<td>Juan</td>
<td>450 Kossuth St</td>
<td>W22</td>
<td>Bike with cart. He can bike one mile in 9 minutes.</td>
<td>2:00 – 4:00 pm</td>
</tr>
</tbody>
</table>

On the delivery map notice the scale on the top right of the map to help you determine how many deliveries each student could do.
## POPCORN ORDERS

<table>
<thead>
<tr>
<th>CUSTOMER</th>
<th>NUMBER OF POPCORN TINS</th>
<th>ADDRESS</th>
<th>MAP LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kim Baker</td>
<td>3</td>
<td>215 Cincinnati St.</td>
<td>I4</td>
</tr>
<tr>
<td>Arnold Johnson</td>
<td>6</td>
<td>108 O’Ferrall St.</td>
<td>L13</td>
</tr>
<tr>
<td>Brian Keeran</td>
<td>1</td>
<td>4124 S. 23rd St.</td>
<td>J24</td>
</tr>
<tr>
<td>Charles Kelley</td>
<td>5</td>
<td>3000 N. 36th St.</td>
<td>W4</td>
</tr>
<tr>
<td>Diane Lamaster</td>
<td>3</td>
<td>225 Clarkson Dr.</td>
<td>R12</td>
</tr>
<tr>
<td>Connie Lane</td>
<td>4</td>
<td>108 N. 24th St.</td>
<td>J11</td>
</tr>
<tr>
<td>Frederick Linder</td>
<td>3</td>
<td>210 Warner St.</td>
<td>N24</td>
</tr>
<tr>
<td>Lillian McAndrews</td>
<td>2</td>
<td>542 Farabee Dr. N.</td>
<td>W10</td>
</tr>
<tr>
<td>Ted Matthews</td>
<td>2</td>
<td>348 Kossuth St.</td>
<td>D22</td>
</tr>
<tr>
<td>Jeanne Maxwell</td>
<td>4</td>
<td>420 Purdue St.</td>
<td>E19</td>
</tr>
<tr>
<td>Deloris Meier</td>
<td>1</td>
<td>412 Cason St.</td>
<td>E8</td>
</tr>
<tr>
<td>Judy Olhausen</td>
<td>6</td>
<td>420 Cincinnati St.</td>
<td>K4</td>
</tr>
<tr>
<td>Jason Olinger</td>
<td>4</td>
<td>526 Morland Dr.</td>
<td>V20</td>
</tr>
<tr>
<td>Anthony Peterson</td>
<td>4</td>
<td>5476 N. Earl Ave.</td>
<td>Q2</td>
</tr>
<tr>
<td>Eugene Potts</td>
<td>4</td>
<td>578 S. 30th St.</td>
<td>O20</td>
</tr>
<tr>
<td>Rachel Ravin</td>
<td>4</td>
<td>635 Cason St.</td>
<td>G7</td>
</tr>
<tr>
<td>Lee Rosen</td>
<td>2</td>
<td>310 Wallace Ave.</td>
<td>M17</td>
</tr>
<tr>
<td>Paul Shank</td>
<td>6</td>
<td>112 N 25th St.</td>
<td>K9</td>
</tr>
<tr>
<td>David Seymour</td>
<td>4</td>
<td>312 Grant St.</td>
<td>F13</td>
</tr>
<tr>
<td>Justin Talbott</td>
<td>5</td>
<td>584 Center St.</td>
<td>B15</td>
</tr>
<tr>
<td>Gary Thompson</td>
<td>3</td>
<td>720 Kossuth St.</td>
<td>G22</td>
</tr>
<tr>
<td>Melinda Urich</td>
<td>5</td>
<td>262 Ferry St.</td>
<td>F9</td>
</tr>
</tbody>
</table>
railroad tracks
Network Routing

Finding the most efficient way to deliver popcorn is related to many different topics. Your group may have used different paths to try to figure out the best way to send the popcorn with your three delivery options. For this problem you had three people with three modes of transportation: walk, bicycle and car. The more time you spent working on the problem the better and more efficient your delivery method probably became.

When you were working on this problem you were planning routes for the popcorn to be delivered. Routing is used in the telephone network, electronic data networks like the Internet and transportation networks. Routing is the process of selecting paths in a network or map which to send network information or packets of information. These packets of information may be sent through intermediate nodes. The nodes are connection points, redistribution points, or an endpoint. In this situation you selected paths on a street map in which to send the popcorn to different houses. The starting houses served as nodes along with each house along the delivery route. Some popcorn bins were not delivered until the end because not everyone could have their popcorn delivered at once. Computers can keep track of the different routes that information are sent on and use this information for more efficient routing.

Every computer has what is called an IP address that is similar to a house address. It is a way for information to be sent from one computer to another. It may also be used for access to an electronic data network like the Internet. If you have ever visited a website that took a long time for the page to load it might have been that too many people were trying to access that website. The information could not be sent out quickly enough to everyone that wanted it. In some cases if too many people try to log into a website it may cause the website to crash. This would cause no one to be able to get the information. It would almost be like having everyone in your class try to fit through the door at the same time to leave at the end of the day. No one would go anywhere because everyone would be stuck. If you have an email address, it also has a specific IP address that allows your emails to be sent to another email address.
Reflection Questions

1. Why was it important for the popcorn to be delivered by a certain time?

2. Why is it important for information to be sent quickly on the Internet?

3. In what ways is network routing similar to getting popcorn delivered to different people’s homes?

4. What does a computer or an email address have that is similar to a person’s home address?

5. What happens if too many people are trying to send information on a network?

6. How does this information relate to the telephone network?

7. How does this information relate to transportation networks like highways or airspace for planes?
There are four main delivery methods that network routing uses. Unicast is the dominant method for the Internet.

![Diagram of delivery methods: Anycast, broadcast, Multicast, Unicast]

Read through the four situations below and decide which delivery method would be the most appropriate. Be sure to explain your reasoning. The whole population in this case is the town of Lafayette, IN.

1. A tornado is heading towards the town and the sheriff wants to warn people to seek shelter.

2. The principal of the local middle school wants to send a congratulations letter to a middle school student that has won student of the month.

3. The mayor wants to send a message to citizens that are old enough to vote about the town’s voting procedures.

4. A 7th grade student is so happy that he received an “A” on his math test that he is singing as he walks down the street.
When you access the Internet, you are gaining access through what is called an ISP. An ISP is an Internet service provider. There are different companies that a person can pay to have access to the Internet. ISPs themselves are connected to IXP’s, internet exchange points, which are similar to large nodes. IXP’s are physical locations where ISP’s connect with one another and allow Internet traffic to be exchanged. This leads to cheaper costs and faster speeds. These IXP’s control how information is routed. The largest ISP’s are really a fiber optic backbone for an entire nation or region to make sure everything works well. Fiber optic lines, undersea cables or satellite links connects these backbones around the world. It takes a lot of cord and cable to make sure that Internet service is available to the most amounts of people. In order to be the most efficient and save the most money, the placement of IXP’s is important. There are no IXP’s in the diagram below but the local, regional, or world ISP’s could be connected to an IXP.

Look at the maps of the United States on the next pages. Think about what areas are the most populated. Your task is to decide where would be the best locations to place ten IXP’s in order for information to be sent the quickest. When placing your ten IXP’s try to think about what areas have more people and also try to place the ten IXP’s so that they could be connected with the least amount of cable. Write a letter to the President of the FCC (Federal Communications Commission) that explains why you placed the IXP’s in the locations that you did and why it would be the most efficient. Try to write general directions as well for the most efficient way to place any amount of IXP’s.
Information that could be shared after students have shared their ideas

List of main IXP locations in the United States

Chicago, Illinois
Los Angeles, California
Atlanta, Georgia
Phoenix, Arizona
New York, New York
Boston, Massachusetts
Hawaii
Minneapolis, Minnesota
Miami, Florida
Portland, Oregon
Seattle, Washington
Dallas, Texas
San Francisco, California
Vienna, Virginia
Philadelphia, Pennsylvania
Help to explain IXP’s

Sources:

http://www.comptechdoc.org/independent/networking/guide/netrouting.html
http://searchSOA.techtarget.com/sDefinition/0,,sid26_gci214106,00.html
http://www.howstuffworks.com/web-server.htm
http://www.webopedia.com/TERM/I/ISP.html
http://en.wikipedia.org/wiki/Internet_Exchange_Point
http://en.wikipedia.org/wiki/List_of_Internet_exchange_points#North_America
OBSERVATION FORM FOR TEACHER - Rush Popcorn MEA

Team: ________________________________

Math Concepts Used:
What mathematical concepts and skills did the students use to solve the problem?

Team Interactions:
How did the students interact within their team or share insights with each other?

Data Organization & Problem Perspective:
How did the students organize the problem data? How did the students interpret the task? What perspective did they take?

Tools:
What tools did the students use? How did they use these tools?

Miscellaneous Comments about the team functionality or the problem:

Cycles of Assessment & Justification:
How did the students question their problem-solving processes and their results? How did they justify their assumptions and results? What cycles did they go through?
**PRESENTATION FORM – Rush Popcorn MEA**

Name______________________________________

While the presentations are happening, choose TWO teams to evaluate. Look for things that you like about their solution and/or things that you would change in their solution. You are not evaluating their style of presenting. For example, don't write, “They should have organized their presentation better.” Evaluate their solution only.

Team _________________________________

What I liked about their solution:

What I didn’t like about their solution:

Team _________________________________

What I liked about their solution:

What I didn’t like about their solution:

After seeing the other presentations, how would you change your solution? If you would not change your solution, give reasons why your solution does not need changes.
STUDENT REFLECTION FORM – Rush Popcorn MEA

Name ___________________________ Date__________________________

1. What mathematical or scientific concepts and skills (e.g. ratios, proportions, forces, etc.) did you use to solve this problem?

2. How well did you understand the concepts you used?

   Not at all  A little bit  Some  Most of it  All of it

   Explain your choice:

3. How well did your team work together? How could you improve your teamwork?

4. Did this activity change how you think about mathematics?