# Welcome to ECE 463! Introduction to Computer Networks Lecture 1

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# Overview

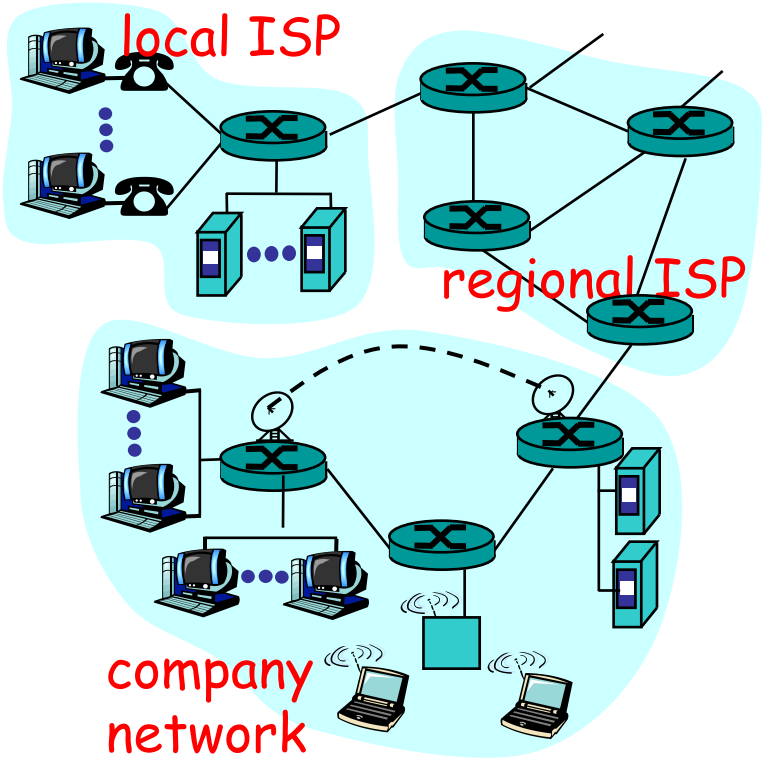
- What this course is about
- Course Administrative Issues

# What this course is about…

- How does the Internet work?
  - What issues arise while designing the Internet?
  - How are they addressed today?
  - Discuss the design alternatives.
- How do you implement software that involves communication between computers?
  - Client-server programming
  - Implementing routing protocols

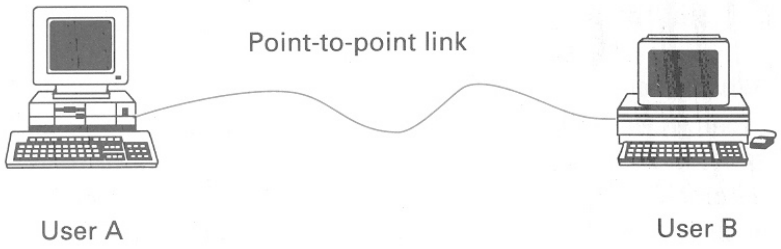
# Internet: Top-down view

- Millions of connected computing devices: *hosts, end-systems*
  - PC's workstations, servers
  - Smartphones
  - Running network applications (Facebook, Twitter etc.)
- *communication links*
  - fiber, copper, radio, satellite
- *Routers:* forward data thru network



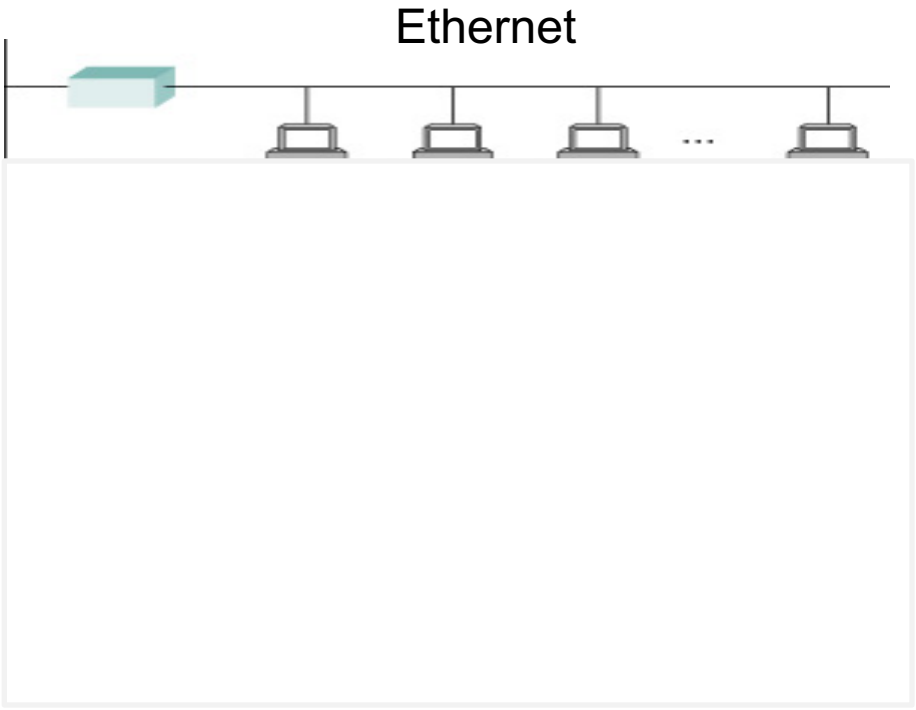
# The simplest network

- Set of nodes interconnected to permit exchange of information.



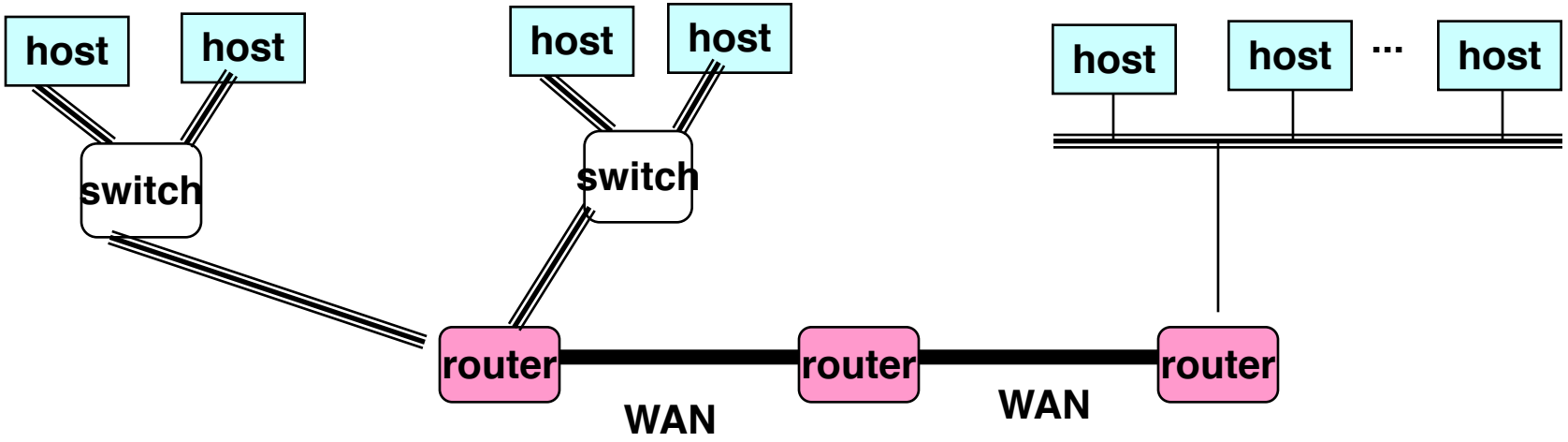
# Local Area Networks (LANs)

- Issues with LANs?




# Internetworks

- Multiple incompatible LANs can be physically connected by specialized computers called *routers*.
- The connected networks are called an *internetwork*.
  - The "*Internet*" is one (very big & successful) example of an internetwork

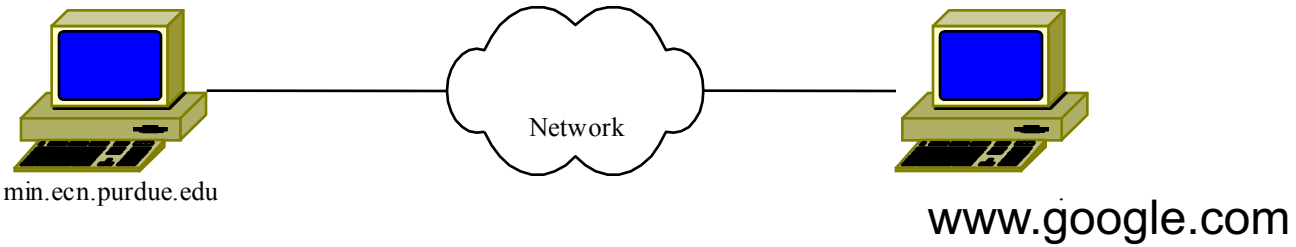



**Connected LANs might be completely different (e.g., Ethernet and WiFi)**

# Internet Operational View

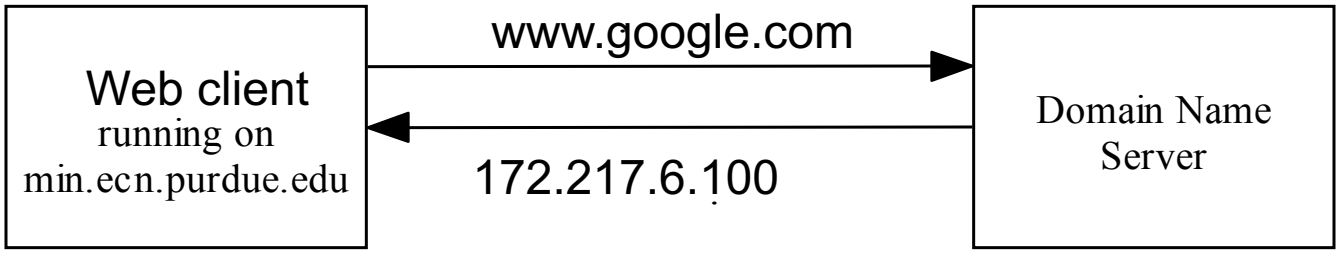
- What happens when we type

`http://www.google.com/`



# Web Download

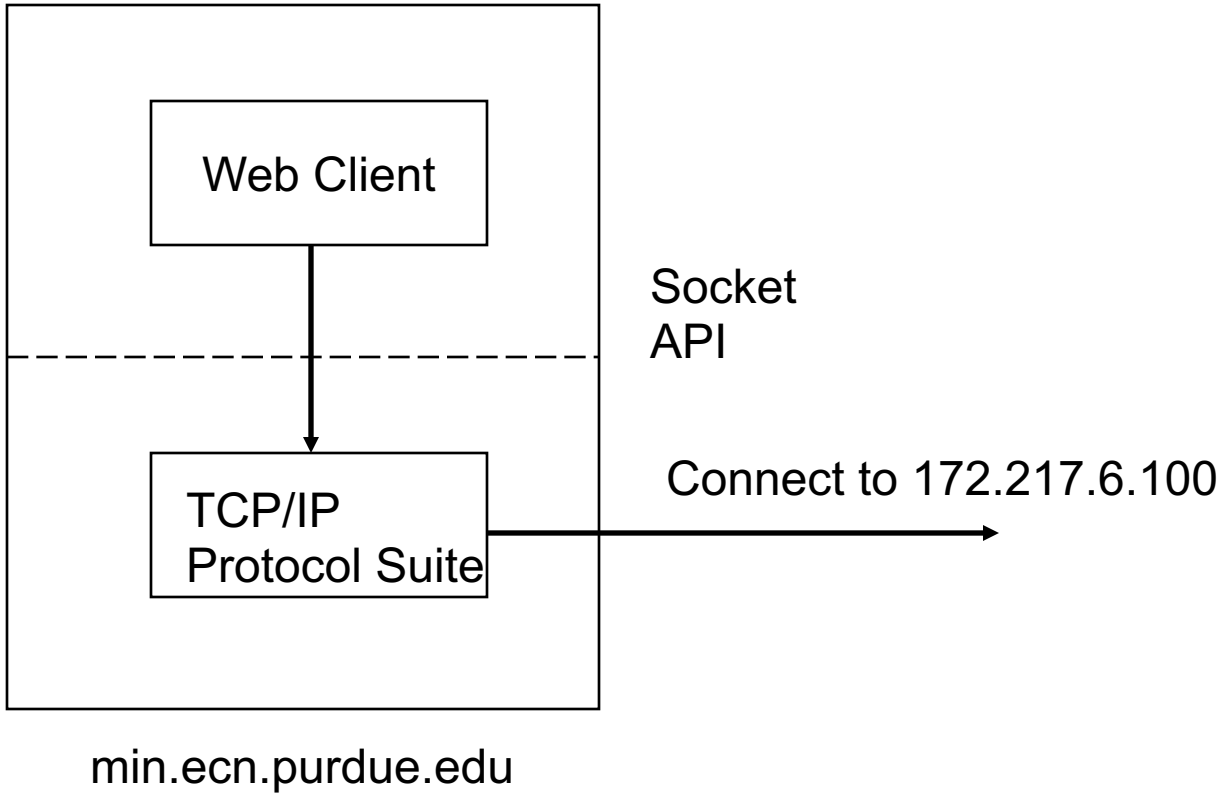
- Step 1: The web client program accesses a database that translates the hostname `www.google.com` into IP address.




- The distributed database used is called the Domain Name System (DNS)

# Web Download

- Step 2: `min.ecn.purdue.edu` tries to establish a connection to the machine with address 172.217.6.100



# Web Download

- Step 3: Packets are **routed** between client and server

- Routing Protocols/Algorithms

# What path is taken to get to Google? Traceroute tool

traceroute to www.google.com (172.217.6.100), 30 hops max, 60 byte packets

- 1 128.46.4.2 (128.46.4.2) 0.741 ms 128.46.4.3 (128.46.4.3) 0.702 ms 128.46.4.2 (128.46.4.2) 0.857 ms
- 2 lamb-20-c7710-02-ptp-e2-13-1.tcom.purdue.edu (172.28.249.106) 0.690 ms 0.963 ms 1.242 ms
- 3 tel-210-c7710-01-ptp-e1-11-1.tcom.purdue.edu (172.28.249.18) 3.307 ms 3.502 ms 3.734 ms
- 4 lamb-20-c7710-01-ptp-e1-3-1.tcom.purdue.edu (172.28.249.1) 14.625 ms 14.862 ms indiana-gigapop-lldc-internet-mx960.tcom.purdue.edu (192.5.40.187) 2.653 ms
- 5 et-1-3-0.1.rtr.ictc.indiana.gigapop.net (149.165.255.193) 4.004 ms 4.011 ms indiana-gigapop-lldc-internet-mx960.tcom.purdue.edu (192.5.40.187) 2.629 ms
- 6 et-1-3-0.1.rtr.ictc.indiana.gigapop.net (149.165.255.193) 4.042 ms lo-0.1.rtr2.chic.indiana.gigapop.net (149.165.255.6) 7.761 ms et-1-3-0.1.rtr.ictc.indiana.gigapop.net (149.165.255.193) 4.340 ms
- 7 et-1-1-0.2290.sw2.600wchicag.omnipop.btaa.org (149.165.183.90) 8.820 ms 6.960 ms 6.971 ms
- 8 r-equinix-isp-ae2-2275.wiscnet.net (140.189.9.137) 7.684 ms 8.434 ms 7.975 ms
- 9 r-equinix-isp-ae2-2275.wiscnet.net (140.189.9.137) 7.602 ms 7.626 ms 7.931 ms
- 10 108.170.244.1 (108.170.244.1) 6.907 ms 108.170.243.225 (108.170.243.225) 9.060 ms 72.14.218.180 (72.14.218.180) 7.209 ms
- 11 108.170.243.225 (108.170.243.225) 8.200 ms 108.170.238.91 (108.170.238.91) 6.880 ms 6.870 ms
- 12 ord37s03-in-f4.1e100.net (172.217.6.100) 6.820 ms 6.841 ms 108.170.238.89 (108.170.238.89) 7.026 ms

# Traceroute to host in India

traceroute to www.tajmahal.gov.in (182.18.143.72), 30 hops max, 60 byte packets

- 1 128.46.4.2 (128.46.4.2) 0.535 ms 128.46.4.3 (128.46.4.3) 0.700 ms 0.866 ms
- 2 lamb-20-c7710-02-ptp-e2-11-1.tcom.purdue.edu (172.28.249.102) 0.676 ms lamb-20-c7710-02-ptp-e2-13-1.tcom.purdue.edu (172.28.249.106) 0.939 ms lamb-20-c7710-02-ptp-e2-11-1.tcom.purdue.edu (172.28.249.102) 1.213 ms
- 3 lamb-20-c7710-01-ptp-e1-1-1.tcom.purdue.edu (172.28.249.12) 11.634 ms tel-210-c7710-01-ptp-e1-11-1.tcom.purdue.edu (172.28.249.18) 0.669 ms 0.899 ms
- 4 lamb-20-c7710-01-ptp-e1-3-1.tcom.purdue.edu (172.28.249.1) 11.872 ms indiana-gigapop-lldc-internet-mx960.tcom.purdue.edu (192.5.40.187) 2.998 ms lamb-20-c7710-01-ptp-e1-3-1.tcom.purdue.edu (172.28.249.1) 12.146 ms
- 5 et-8-0-0.1235.rtsw.indi.net.internet2.edu (64.57.21.173) 2.716 ms 2.694 ms indiana-gigapop-lldc-internet-mx960.tcom.purdue.edu (192.5.40.187) 2.929 ms
- 6 ae-5.4079.rtsw.chic.net.internet2.edu (162.252.70.152) 6.437 ms 11.153 ms et-8-0-0.1235.rtsw.indi.net.internet2.edu (64.57.21.173) 8.220 ms
- 7 ae-5.4079.rtsw.chic.net.internet2.edu (162.252.70.152) 7.467 ms 7.363 ms ae-3.4079.rtsw.kans.net.internet2.edu (162.252.70.141) 17.382 ms
- 8 ae-5.4079.rtsw.salt.net.internet2.edu (162.252.70.145) 37.229 ms 37.389 ms 37.133 ms
- 9 lo-0.8.rtsw.losa.net.internet2.edu (64.57.20.255) 49.928 ms ae-5.4079.rtsw.salt.net.internet2.edu (162.252.70.145) 37.152 ms lo-0.8.rtsw.losa.net.internet2.edu (64.57.20.255) 50.167 ms
- 10 lo-0.8.rtsw.losa.net.internet2.edu (64.57.20.255) 49.922 ms 49.996 ms gi1--1.wil04.net.telstraglobal.net (206.223.123.11) 50.087 ms
- 11 gi1--1.wil04.net.telstraglobal.net (206.223.123.11) 50.018 ms 50.146 ms 49.844 ms
- 12 i-93.1wlt-core02.telstraglobal.net (202.84.253.85) 58.344 ms i-15006.sgpl-core02.telstraglobal.net (202.84.140.233) 231.777 ms 232.764 ms
- 13 i-15006.sgpl-core02.telstraglobal.net (202.84.140.233) 232.122 ms 232.509 ms i-93.istt04.telstraglobal.net (202.84.224.190) 231.634 ms
- 14 unknown.telstraglobal.net (202.127.73.102) 218.320 ms i-93.istt04.telstraglobal.net (202.84.224.190) 231.581 ms unknown.telstraglobal.net (202.127.73.102) 217.861 ms
- 15 116.119.35.139 (116.119.35.139) 263.525 ms unknown.telstraglobal.net (202.127.73.102) 218.112 ms 217.906 ms
- 16 125.16.26.235 (125.16.26.235) 260.916 ms 182.79.135.102 (182.79.135.102) 263.322 ms 125.16.26.235 (125.16.26.235) 262.237 ms
- 17 125.16.26.235 (125.16.26.235) 262.139 ms 103.233.124.11 (103.233.124.11) 264.380 ms 125.16.26.235 (125.16.26.235) 262.177 ms
- 18 103.233.124.19 (103.233.124.19) 263.017 ms 103.233.124.27 (103.233.124.27) 264.128 ms 103.233.124.11 (103.233.124.11) 262.556 ms

# So, what does a network do?

- Provide *connectivity* and *resource sharing.*
- Problems:
  - *Routing: Which path should I follow?*
  - *Flow Control: How to avoid congestions?*
  - *Addressing: How to specify a node?*
  - *Security: How can privacy and integrity be maintained?*
  - *Much much more…*

# Course Communication

- Actively monitor Brightspace announcements and emails, as well as discussion boards.
  - It is your responsibility to periodically monitor Brightspace and keep up with any important announcements in Brightspace, or the discussion boards.
- Email instructor or TA for personal/specific issues
- See Syllabus for detailed course policies

# Prerequisites

- Prerequisites:
  - ECE 264 (C programming).
  - ECE 368 (Data Structures)
- System may allow you to register without 368.
  - If you have not taken 368, the course is not appropriate for you. Please talk to me.

# Lectures

- Lectures will be by Zoom
  - Allows all students to participate in all lectures
  - Students under quarantine may attend
  - Students not on campus may attend.
- Lectures will be interactive
  - Chat messages with question in text
  - “Raise hand” feature, and you can ask a question
  - Will include activities (e.g., problem solving sessions)
- Please, ask questions!

# Recording availability

- Material relevant to the lectures that week will be uploaded by the end of each week.
  - Either recordings from Zoom lectures (or)
  - Or, Boilercast recording from 2019 lectures (Traditional lecture with doc-cam)
- In some cases, live sessions may refer you to Boilercast19 recordings for some content.
- The extra time would be used for more activities, Q&A, and smaller group discussions and interactions.

# Tentative Exam Dates

- Mid Term I. Wed, Oct 7th
- Mid Term II Wed, Nov 11th
- Final: As per university schedule
- Exams will be conducted online (Brightspace)
  - We may use Respondus Monitor, or Zoom-based proctoring
  - You are expected to have access to a Webcam.
- Working out logistics (timings of the exam etc). Likely
  - Synchronous online exam either during class hour, or an evening online exam.
  - If time is not friendly to students in other time zones, and there is sufficient demand, may offer one other synchronous exam slot.

# Exam scheduling

- Bring any conflicts to my attention at least one week before the exam date.
- Only emergencies (e.g., medical reasons) will be considered later.
    - Written documentation must be provided.
    - Unacceptable reasons listed in class syllabus

# Programming Projects

- Two programming projects planned.
- Project 1. Implementing Web-Client, and concurrent web-server (individual)
  - Released towards the end of the second week of class, runs through September. 3 weeks with weekly submissions required
- Project 2. Implementing a (simplified) routing protocol (possibly groups of 2: to be decided).
  - Released in mid October. Runs through mid November.
- **Mandatory to turn in projects to meet outcomes/pass the course**
  - **Must meet  satisfactory requirements**

# Programming Projects Logistics

- Designated Lab: Any Linux/Unix Lab.

- Make sure you have an account
  - Contact esite@ecn.purdue.edu if you can't login

# Programming project expectations

- For projects in groups everyone should understand issues
  - Watch for examination questions..
  - Oral interviews on the code.
- TA support limited
  - Only limited help per student, cannot expect extensive help debugging code.
  - You should do your due diligence debugging etc.
  - Auto-graded projects: must work for our test cases.
- Please take the course only if you have a strong C programming and Data Structures background.

# Homeworks

- Auto-gradeable Brightspace assignments
- Expect assignments every week or two, with short turn-around time.
- Assignments will prepare you for the examinations

# Tentative Schedule

| Week # | Week of | Topics |
|---|---|---|
| 1 | 8/24 | Internet Architecture and Layering |
| 2 | 8/31 | Socket Programming. |
| 3 | 9/7 | Network Performance, Ethernet |
| 4 | 9/14 | Ethernet +Interconnects, Socket Programming |
| 5 | 9/21 | Interconnects |
| 6 | 9/28 | Error Detection + IP Addressing |
| 7 | 10/5 | Mid Term I: Review and Exam (Tentative) |
| 8 | 10/12 | IP Routing |
| 9 | 10/19 | Threads, ARP + Interconnects |
| 10 | 10/26 | IP Fragmentation + TCP |
| 11 | 11/2 | TCP Reliability + Flow Control |
| 12 | 11/9 | Mid Term II + TCP Congestion Control |
| 13 | 11/16 | TCP Congestion Control |
| 14 | 11/23 | DNS |
| 15 | 11/30 | Security + Finals Review |

# EMERGENCY PREPAREDNESS – A MESSAGE FROM PURDUE

To report an emergency, call 911. To obtain updates regarding an ongoing emergency, sign up for Purdue Alert text messages, view www.purdue.edu/ea.

There are nearly 300 Emergency Telephones outdoors across campus and in parking garages that connect directly to the PUPD. If you feel threatened or need help, push the button and you will be connected immediately.

If we hear a fire alarm during class we will immediately suspend class, evacuate the building, and proceed outdoors. Do not use the elevator.

If we are notified during class of a Shelter in Place requirement for a tornado warning, we will suspend class and shelter in [the basement].

If we are notified during class of a Shelter in Place requirement for a hazardous materials release, or a civil disturbance, including a shooting or other use of weapons, we will suspend class and shelter in the classroom, shutting the door and turning off the lights.

Please review the Emergency Preparedness website for additional information.
http://www.purdue.edu/ehps/emergency_preparedness/index.html