



# ECE363

# Communication

# Networks

Dr. Lin Cai  
Dept. of Electrical and Computer Engineering  
University of Victoria  
Victoria, BC V8W 3P6 Canada

# About the instructor

- Dr. Lin Cai
- Engineering Office Wing 317
- Email: [cai@ece.uvic.ca](mailto:cai@ece.uvic.ca)
- Web: <http://www.ece.uvic.ca/~cai>
- Course web:

<http://www.ece.uvic.ca/~cai/363-outline.html>

- Office hours: TW10:30-11:30 am, or by appointment

# About the labs

- Four labs
  - Check [UVic timetable](#) for your lab time/location

# Assessment

- Assignments: 10%
- Labs: 20%
- Mid-term 1: 15% (Jan. 24)
- Mid-term 2: 15% (March 1)
- Final exam: 40% (TBD)

# Why take this course?

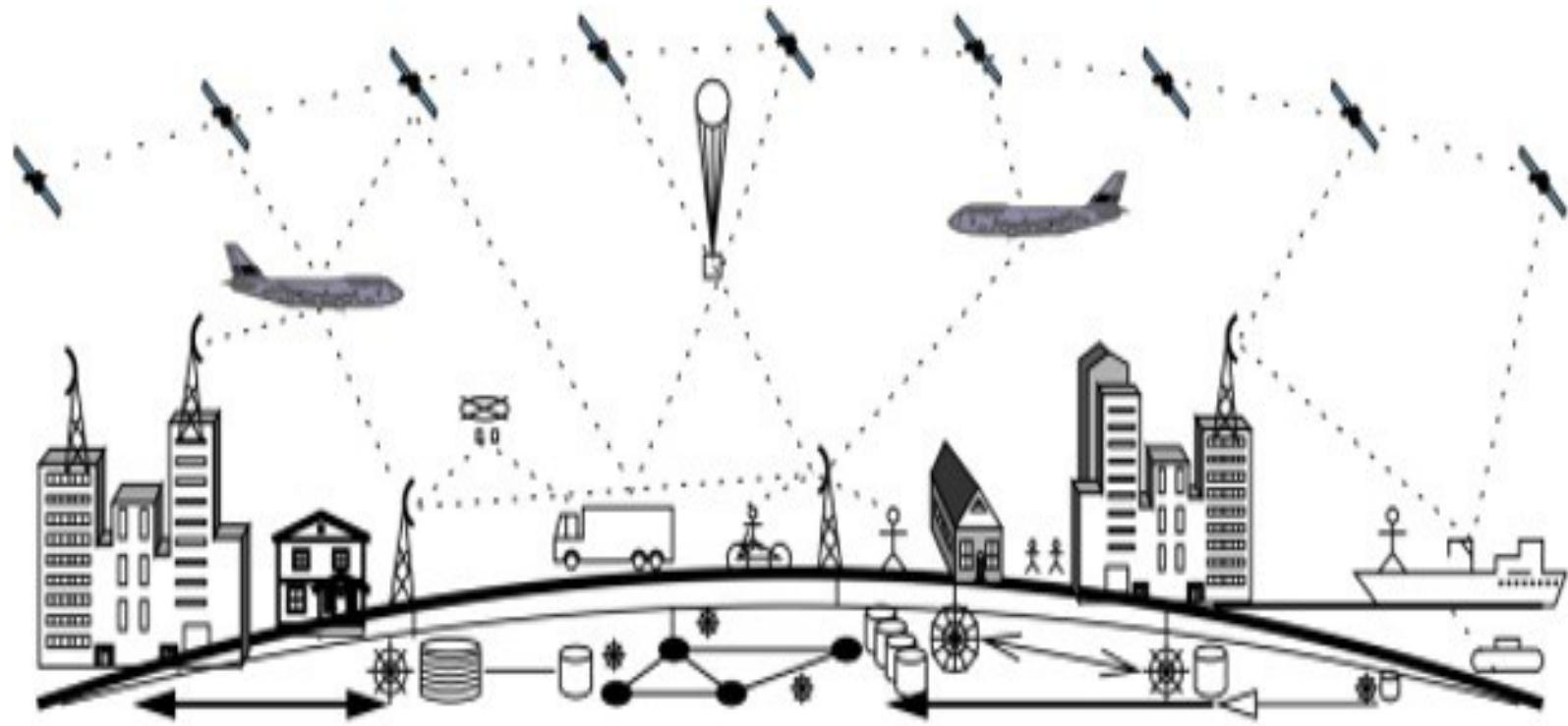
- How to use networks
  - Not as a network user
  - But as a network engineer/programmer/researcher!
- How to design/engineer network
  - or design any large-scale, distributed systems
- How to implement network protocols and algorithms

# *Next generation communication networks?*

- Infinite possibilities
- Limited collections and view of each individual

**Turning Bricks into Jade 抛砖引玉**

# Ubiquitous network: Space/air/ground/water



- Ubiquitous: anywhere, anytime, any devices
- Future growth driven by new ***communication technologies, paradigms, and applications***

# *Driven forces*



# New Applications – Multimedia

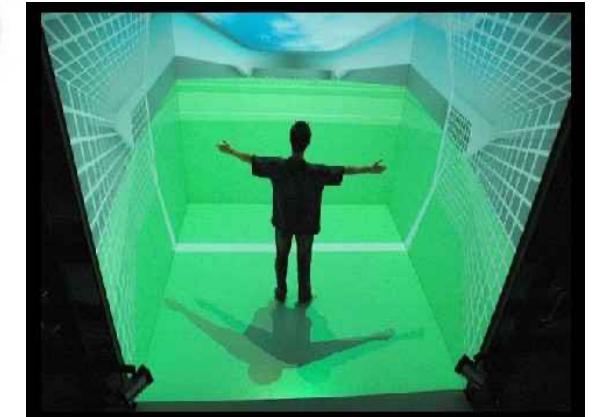


IPTV/VoD



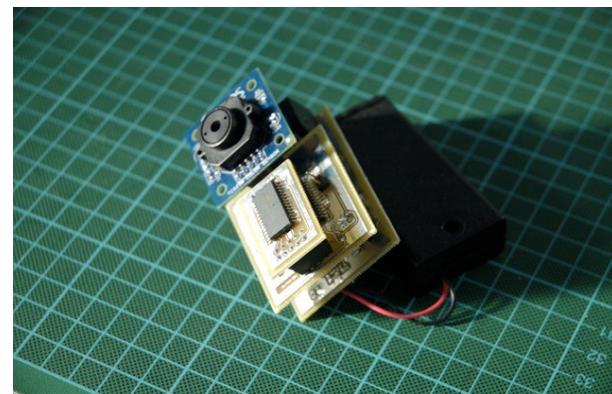
[http://www.academyconfidential.co.uk/images/3D\\_01.jpg](http://www.academyconfidential.co.uk/images/3D_01.jpg)

3D-TV



<http://youreyeonthefuture.files.wordpress.com/2009/09/virtual-reality-3.jpg>

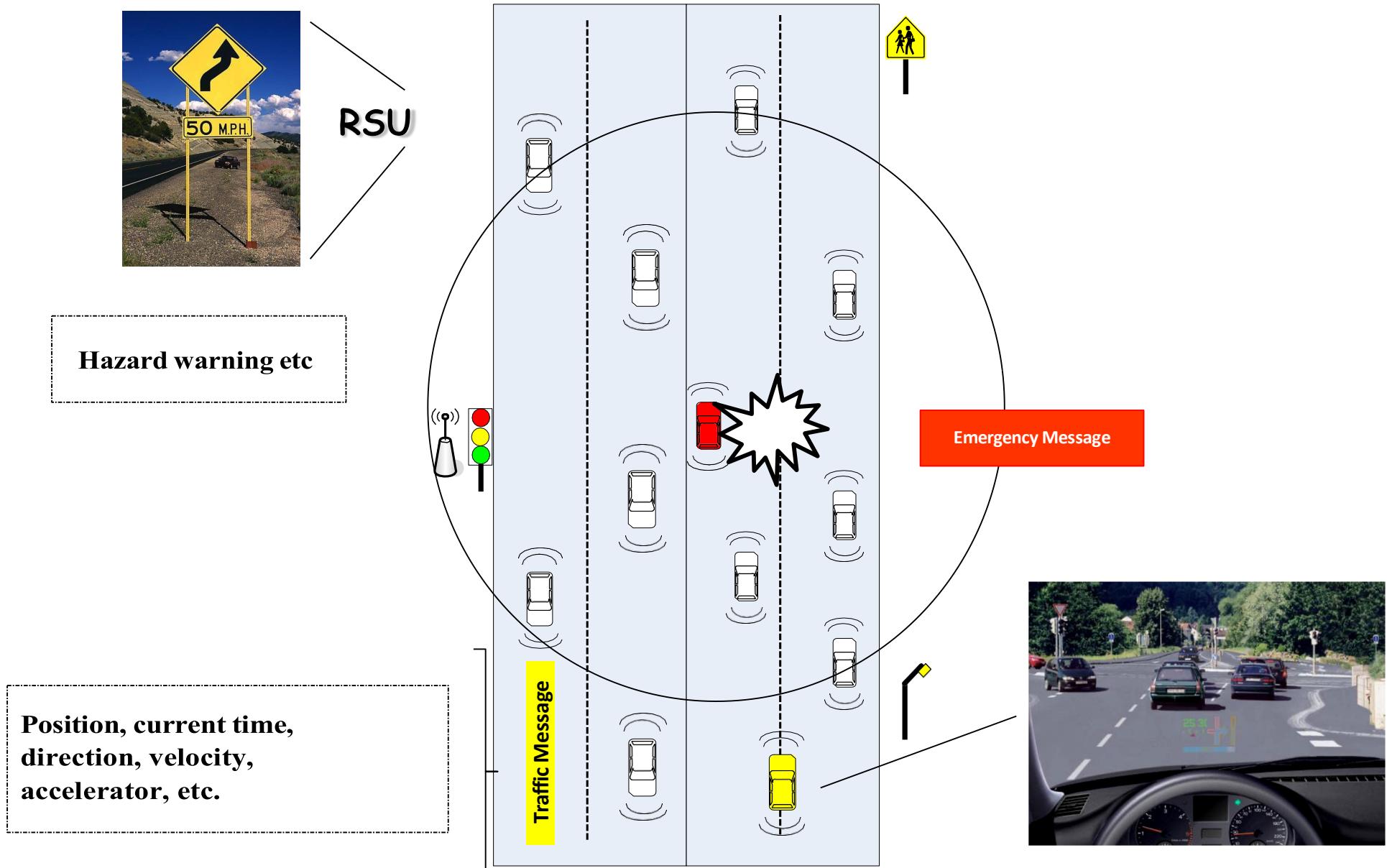
Virtual Reality



[http://www.bash-design.com/pic/one\\_pixel\\_camera\\_1.png](http://www.bash-design.com/pic/one_pixel_camera_1.png)

One-pixel camera using compressive sensing

# New Applications – VANET



# New Applications – Human-cyber-physical interactions



New applications for real-time interactions  
between human, cyber systems, physical  
systems

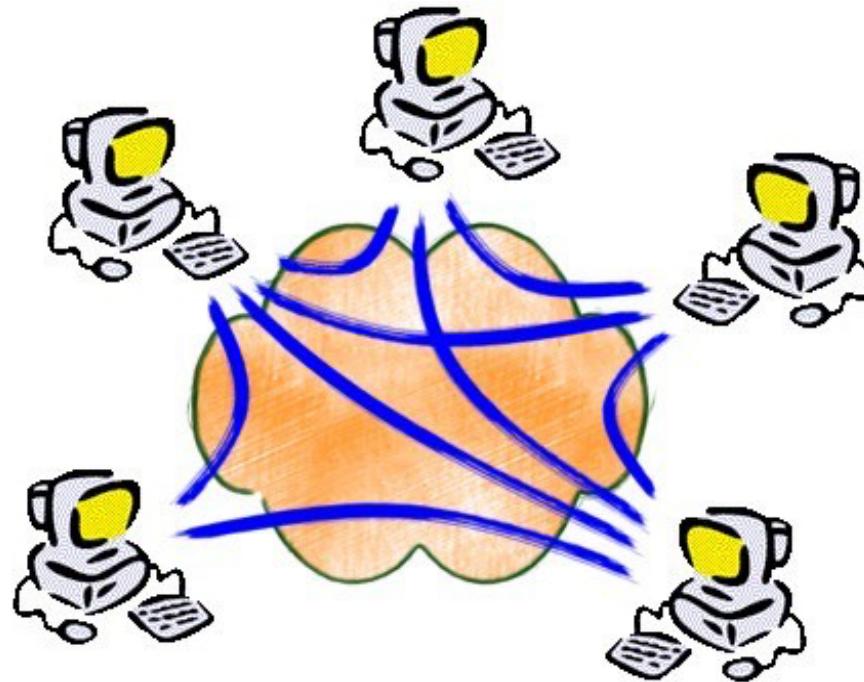
# New Applications – Social Network Services, Metaverse



[http://mootee.typepad.com/photos/uncategorized/2008/05/13/picture\\_6.png](http://mootee.typepad.com/photos/uncategorized/2008/05/13/picture_6.png)  
<https://coinpedia.org/beginners-guide/what-is-metaverse/>

Government, business, personal (dating), educational, medical applications ...

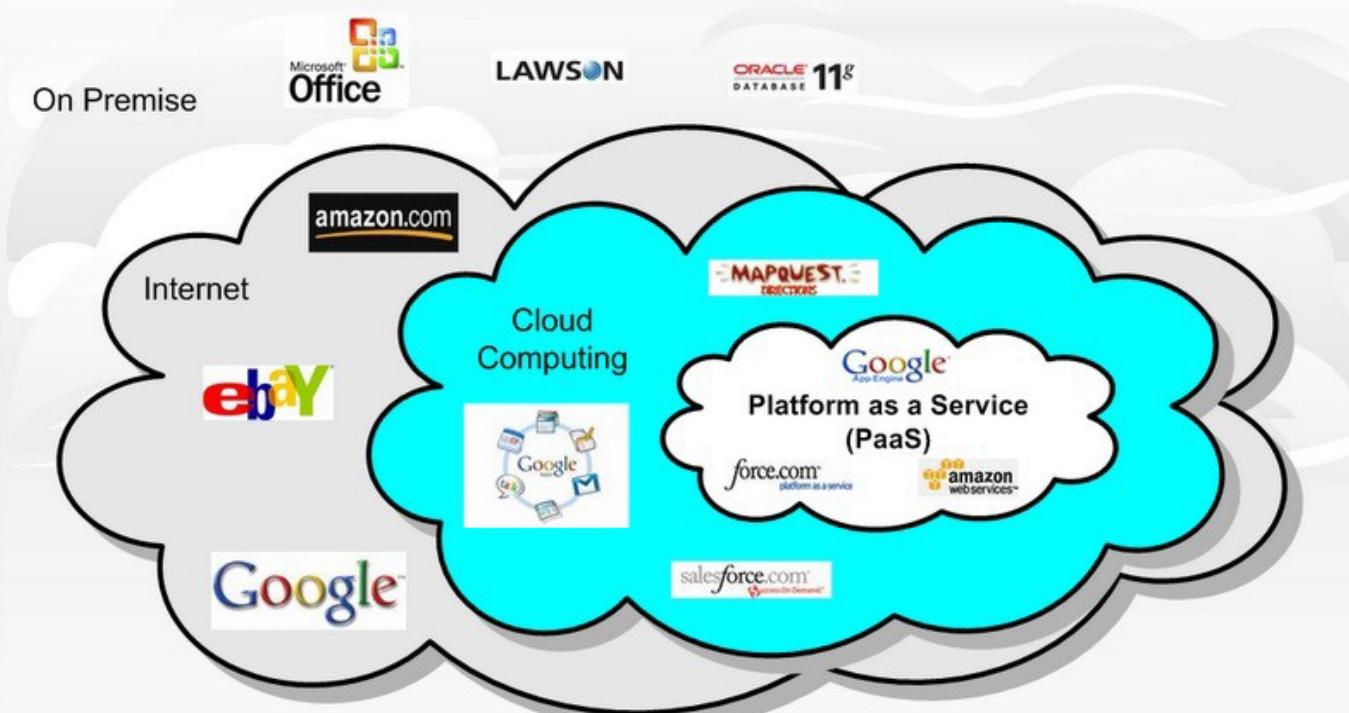
# New Paradigms – P2P, Web 3.0



<http://www.cs.virginia.edu/~mngroup/hypercast/images/network.jpg>

- P2P: Participants be both clients and servers
- Web 3.0: semantic web, decentralization, block chain, AI, connectivity and ubiquity and spatial computing

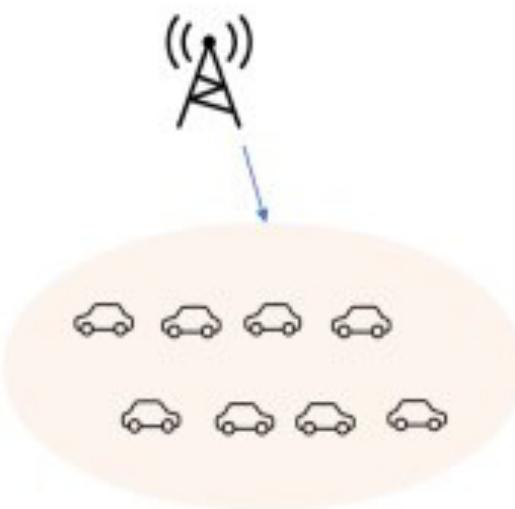
# New Paradigms – Cloud/edge Computing



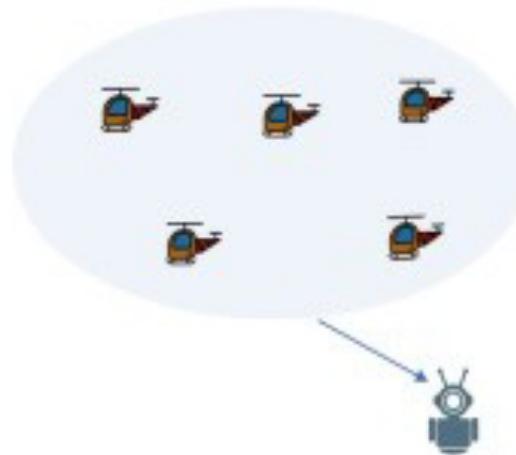
<http://lh3.ggpht.com/madgreek65/SFQrZpyMzYI/AAAAAAAACFA/W7b9AWYQgec/s800/cloud%20computing.png>

- Cloud computing: Scalable and virtualized resources
- Edge computing: Faster and data privacy

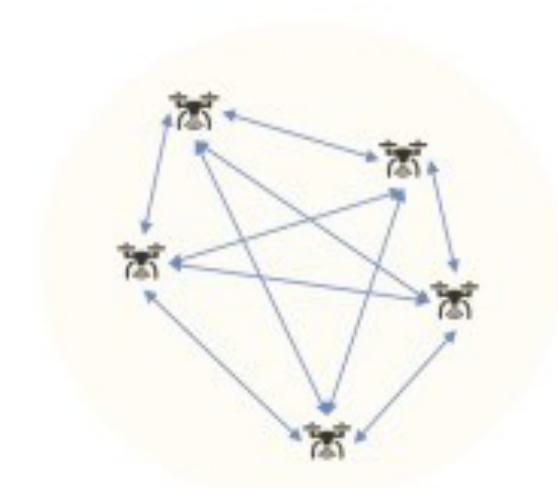
# New Paradigms – \*-cast



Broadcast/Multicast (one-to-many)



Incast (many-to-one)



Group-cast (many-to-many)

# New Communication Technologies

- Different spectrum
  - Sonar, microwave, millimeter-wave (mmWave), Terahertz, laser, ...
- Challenged environment
  - Under-water, under-ground, deep space, ...
- Nanonet, quantum computing ...

# AI for Network and Network for AI



- From data  
→ information  
→ knowledge

*Driven forces*

***Networking challenges?***



# Challenges

- Support heterogenous applications with
  - Different traffic characteristics
  - Various QoS requirements: delay, jitter, loss, throughput requirements
- Bandwidth burden from new service paradigms
  - Peer-to-peer: relieve the bottleneck at the cost of potentially waste bandwidth
  - Cloud computing: scalability, fault-tolerance, capacity, privacy and security
    - TCP incast problem

# Challenges (cont'd)

- Broadband wireless communication channels
  - Time-varying, location-dependent, and frequency-selective fading, shadowing, interference
- Underwater acoustic communication channels
  - Low bandwidth, high propagation delay
- Nano-scale communication channels?
- ...

# Challenges (cont'd)

- Advanced PHY layer control mechanisms
  - adaptive modulation/coding
  - diversity
    - space, time, frequency
    - user cooperation
  - ...
- Impact of network topologies and mobility
- Constraints: energy, cost, environment, safety, security, ...

**Challenges = Opportunities**

*Driven forces*

*Networking challenges?*

***Key to opportunities***



# Course materials

- .Textbook
  - Computer networks, 4th edition (CN)
    - Lecture notes

<http://www.ece.uvic.ca/~cai/363-schedule.html>

- Explore further
  - Internet
  - Google

# Networking research @ UVic

- Inter-disciplinary
  - Elec. & Comp. Eng.
  - Computer Science
  - Mechanical Engineering
  - Neptune/Venus: a network under the ocean
  - ...



<http://www.venus.uvic.ca/>

<http://www.neptunecanada.ca/>

# Our research interests

- Topology control for wireless networks
- Wireless channel modeling
- MAC and scheduling
- TCP-friendly congestion control, performance and stability analysis
- IPTV/Video over wireless
- VANET, sensor networks, under-water acoustic communication networks, smart grid, cloud computing .....
- Network for AI and AI for network
- 6G protocol architecture
- .....

# Questions?



<http://koolmornings.files.wordpress.com/2009/09/uvic-rabbit.jpg>

**Thank you for your attention!**