Networking Education and Research Programs at UVic Computer Science

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Computer Networking

- Networking becomes a foundation in EE/CS
  - theory: e.g., distributed algorithm design
  - practice: e.g., social online networks
- Networking has been driven by
  - communication technologies
    - wireless, cognitive, cooperative communications, etc
  - application requirements
    - multimedia, p2p, IPTV, in-network processing, etc
- Networking is challenging but rewarding
  - sensor, body, vehicular, underwater, planetary, ...

Networking degree option

- UVic Bachelor of Computer Science
  - available from Sept 2008
  - common 1st and 2nd-year curriculum
    - data structures and algorithms, computer architecture, system programming
  - systems/networking courses from the 3rd year
    - operating systems, computer networks
  - advanced networking courses in the 4th year
    - advanced computer/communication networks, wireless mobile networks, (network management and security), ...
  - adopted by Software Engineering for Sept 2009

Our research lab

- Research programs
  - protocols for advanced networking
    - new protocols, focusing on layer 2 to 4
  - performance analysis of networked systems
    - large-scale distributed systems
  - applied network security
    - dependability: reliability, security and testability
- Research theme
  - networking with diversities
    - multi-info, multi-source, multi-path, multi-hop, multi-link...

Recent and current projects

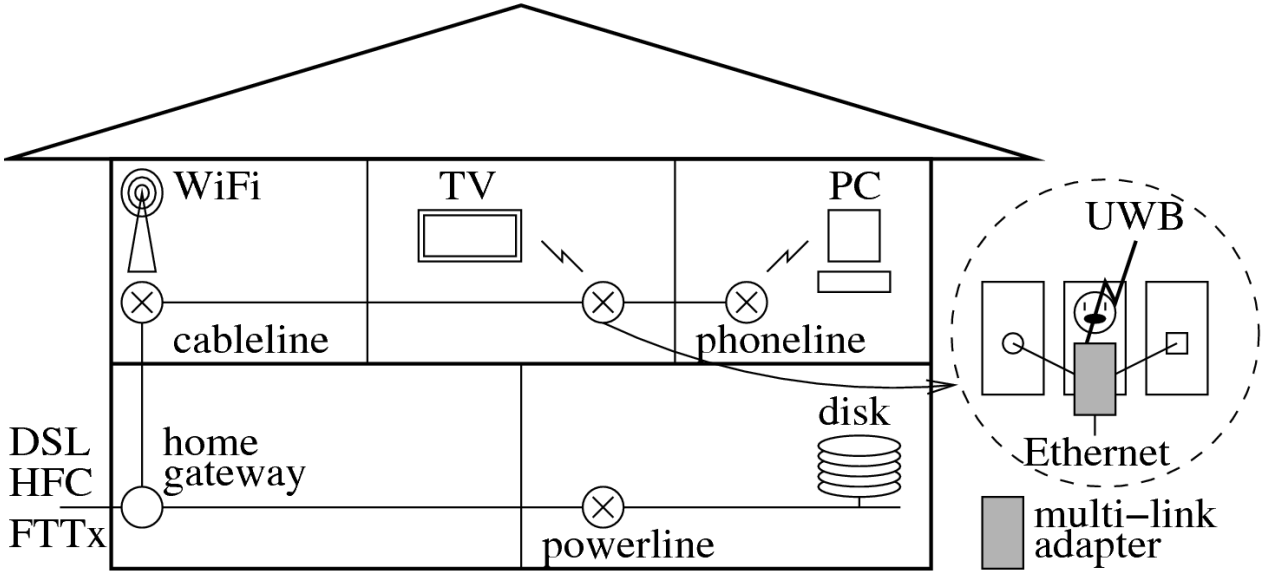
- IPTV in-home distribution
  - multi-hop/link backbone and high-speed access
- IPTV service provisioning
  - P2P IPTV and VoD with NAT support
- Mobile social networks
  - networked virtual community
- Wireless sensor networks
  - topology control and mobile elements
- Vehicular ad hoc networks
  - network connectivity, security and privacy

Internet Protocol Television (IPTV)

- Services: “Quad Play”
  - data: the Internet
  - voice: voice over IP (VoIP)
  - video: Internet Protocol Television (IPTV)
  - mobile: voice, data and video!
- Infrastructures
  - backbone networks: DWDM
  - access networks: ADSL2+, DOCSIS3, FTTx, etc
  - cellular systems: 2.5G, 3G, 4G, ...

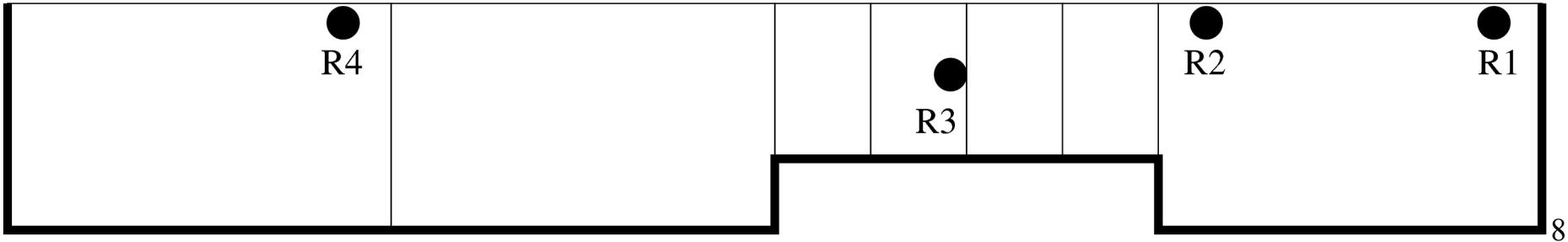
Broadband home networks

- Wired/wireless-hybrid, multi-link architecture
  - cross-room backbones
    - multi-link wired: no-new-wires, or
    - multi-hop wireless: WLAN
  - in-room access
    - high-speed, short range wireless: UWB, mmW



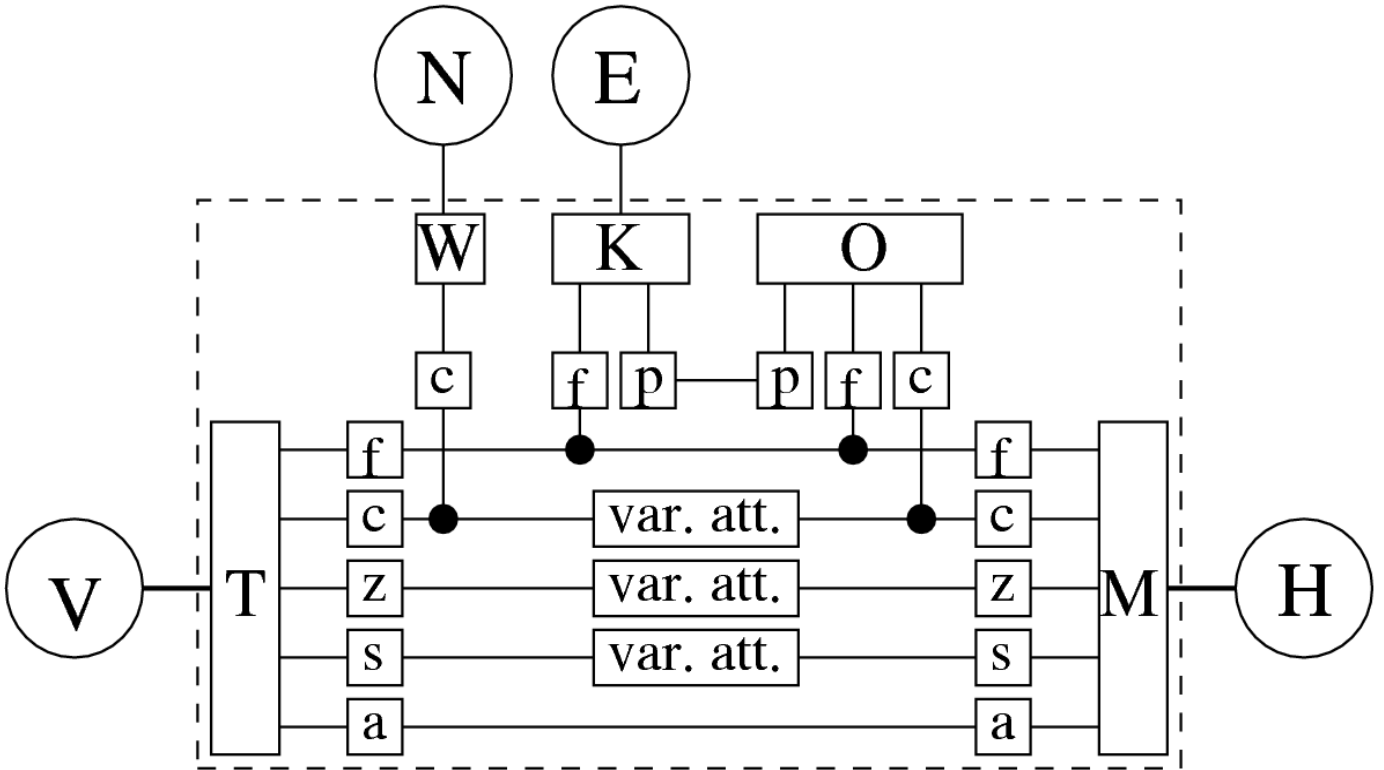
Multi-hop wireless backbone

- Multi-hop wireless testbed [WCNC08LP]
  - Linksys WRT54GL with OpenWRT
  - Broadcom BCM2050 IEEE 802.11b/g
  - TxPower: 18 dBm from R1
    - SNR@R4: 10 dB
    - SNR@R3: 30 dB
    - SNR@R2: 45 dB



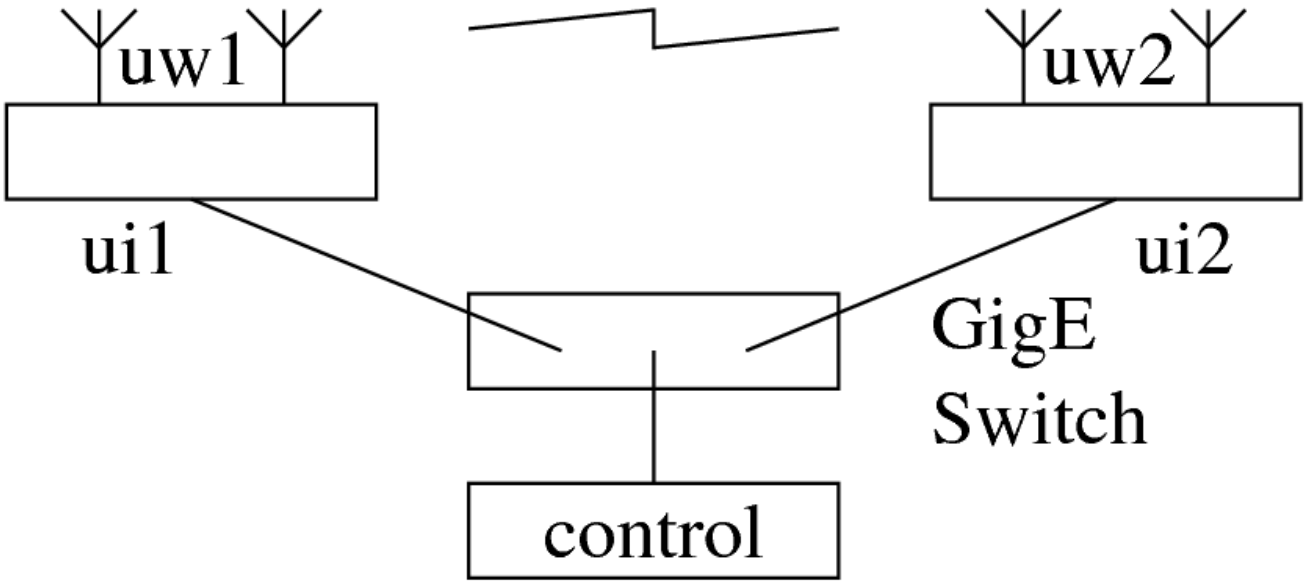
Multi-link wired backbone

- Multi-link “no-new-wires” testbed
  - MoCA
  - HPNA over cable line and phone line
  - HomePlug and HomePlug AV (HPAV)



UWB in-room access

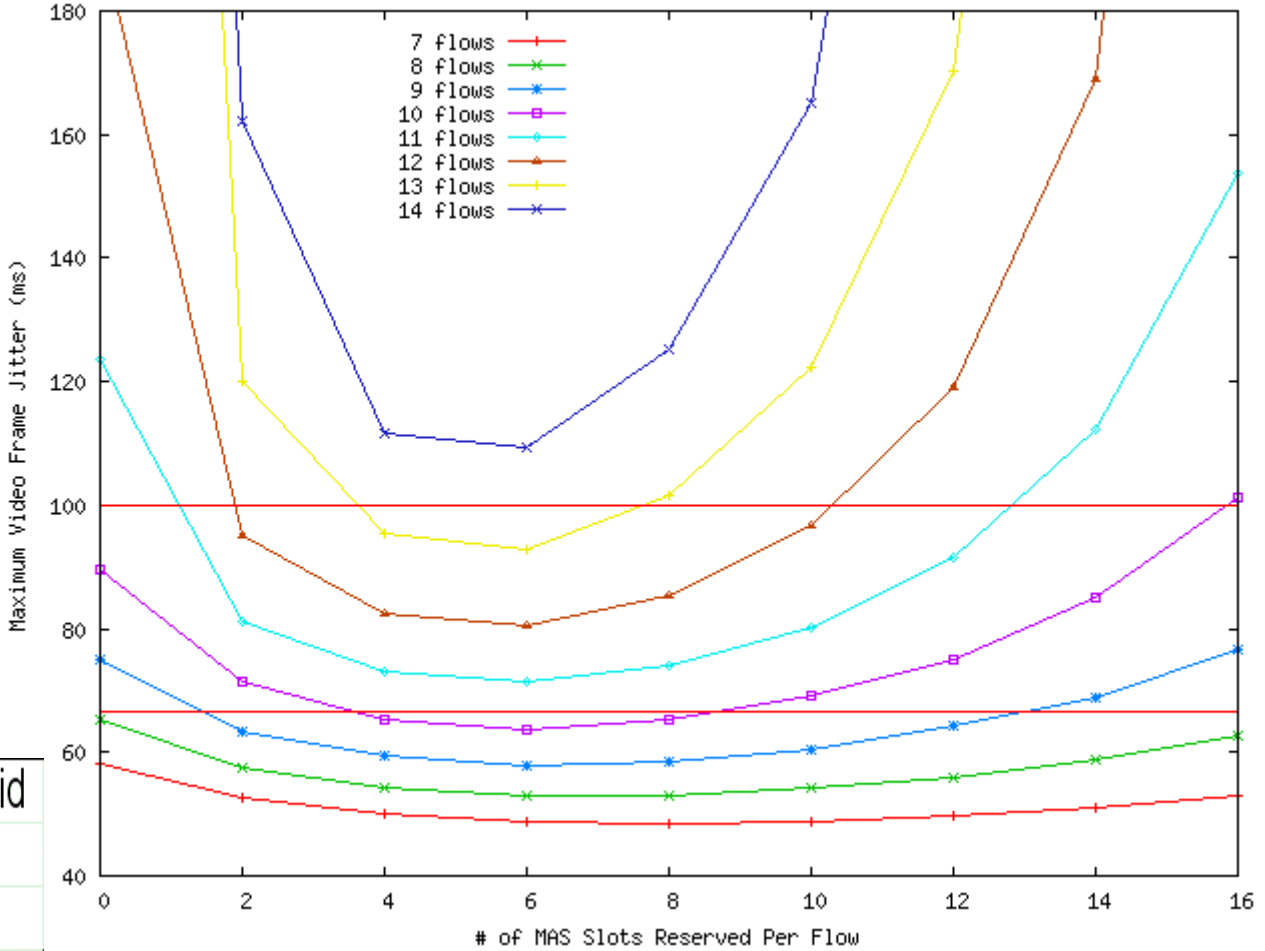
- UWB
  - high-speed, short-range: good for spatial reuse
  - low interference and high resilience to interference
  - prioritized and parameterized access: good for QoS
- WiMedia UWB testbed



Hybrid approach

- Reserve or not? [JSAC10ZRPCS, ICC10ZCP]
  - reserve: guaranteed QoS, lower utilization
  - contention: higher utilization, statistical QoS
- A hybrid approach
  - reserve a portion
  - contend for burst
  - better QoS
  - better utilization
    - more flows supported

max jitter	DRP-only	PCA-only	DRP/PCA-hybrid
66.67 ms	5	8	10
100 ms	7	10	13

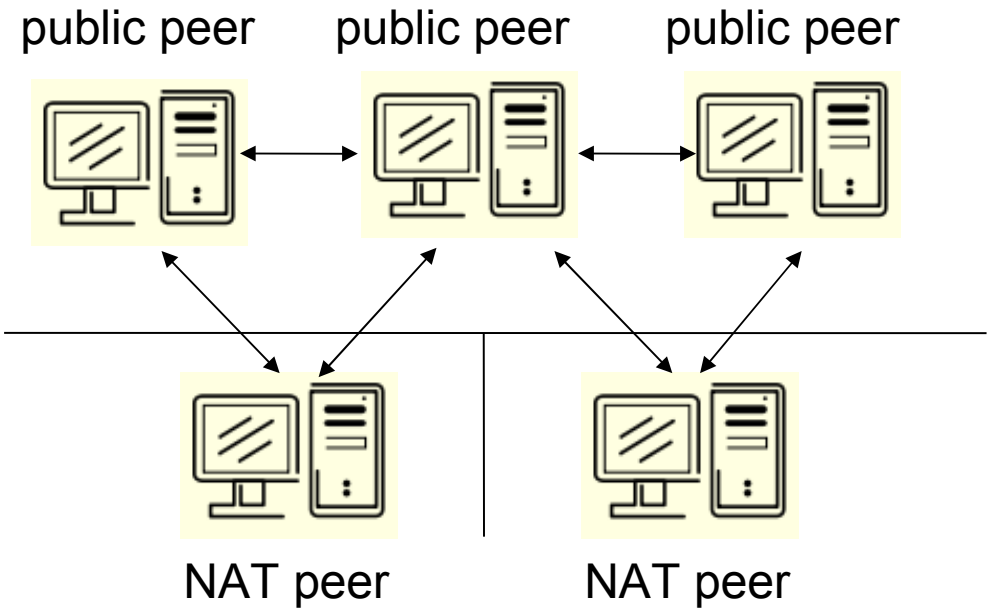


IPTV service provisioning

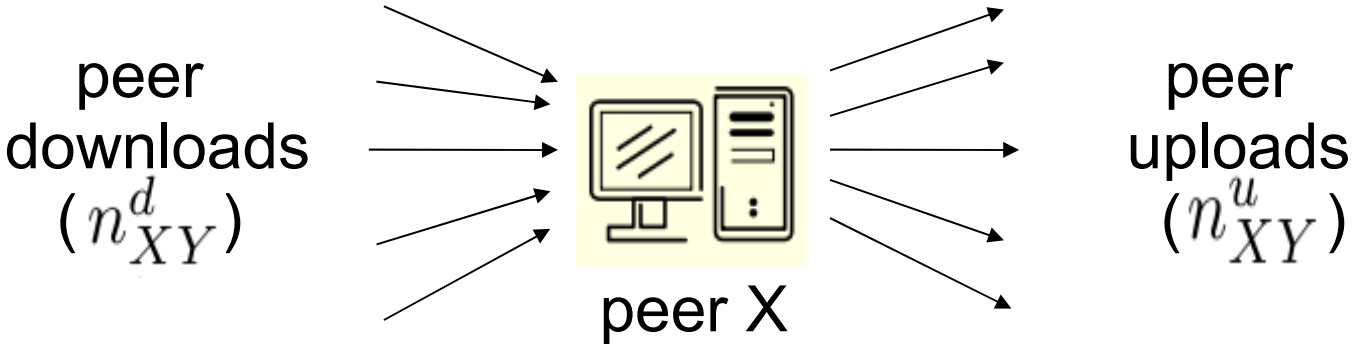
- Hybrid p2p and client-server structure
  - p2p inside service provider networks
    - scalability, efficiency, etc
  - c/s between customer and provider
    - reliability, accountability, etc
- P2P IPTV and VoD
  - network support for p2p applications
    - the impact of NAT and NAT traversal
  - chunk scheduling for p2p IPTV and VoD
    - with or without in-network processing (network coding)
    - cache and bandwidth management

NAT and P2P

- BitTorrent-like system with NAT



- Steady-state analysis [P2P09LP]



P2P video streaming

- Video streaming metrics: live or on-demand
  - user: continuity index, initial delay, etc
  - provider: server load, network load, etc
  - system: peer/piece selection strategy
- P2P video streaming with NAT
  - follow-on BitTorrent and NAT
- P2P video streaming with network coding
  - peer/piece selection strategy, prefetching
  - cache and bandwidth resource management

P2P-based similarity search

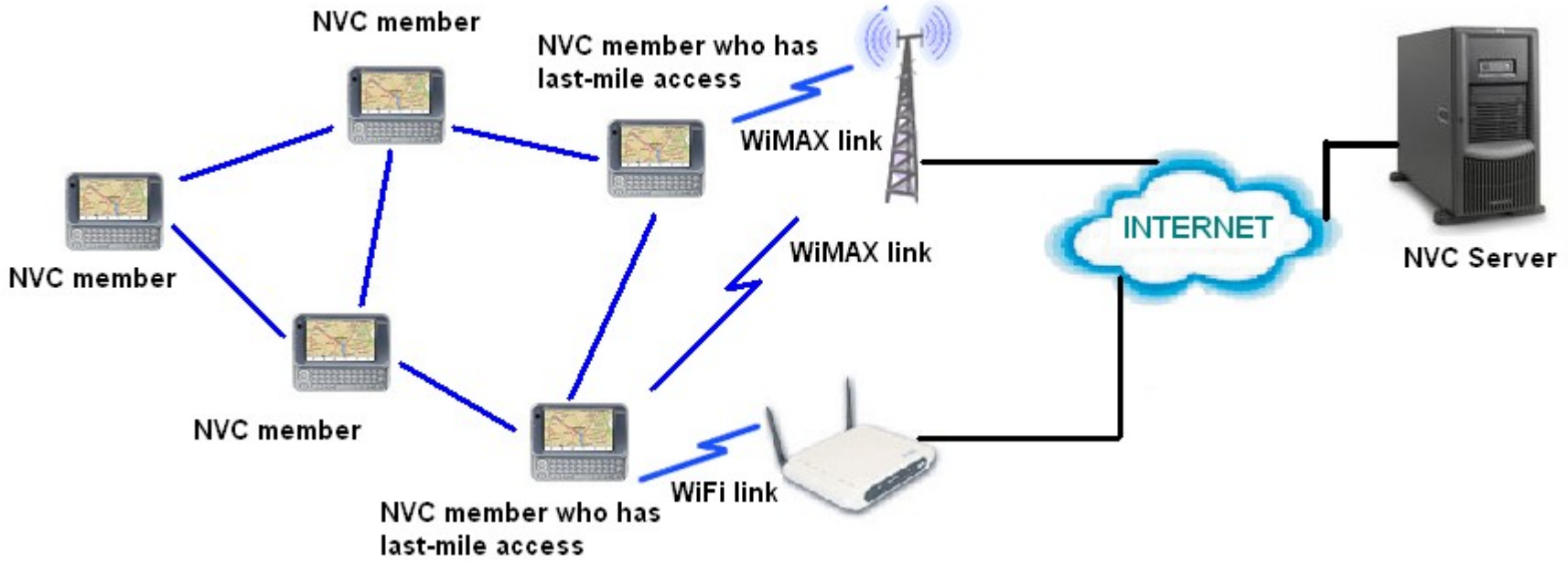
- Content-based high-dimension similarity search
  - images, music, movies, etc with feature vectors
  - KNN query: K nearest neighbors
  - range query: within a given range
- Locality-sensitive hashing
  - based on p-stable distributions
- P2P implementation [MSc11Aidin]
  - based on Chord distributed hash table (DHT)
  - load balancing problem

Mobile wireless multimedia

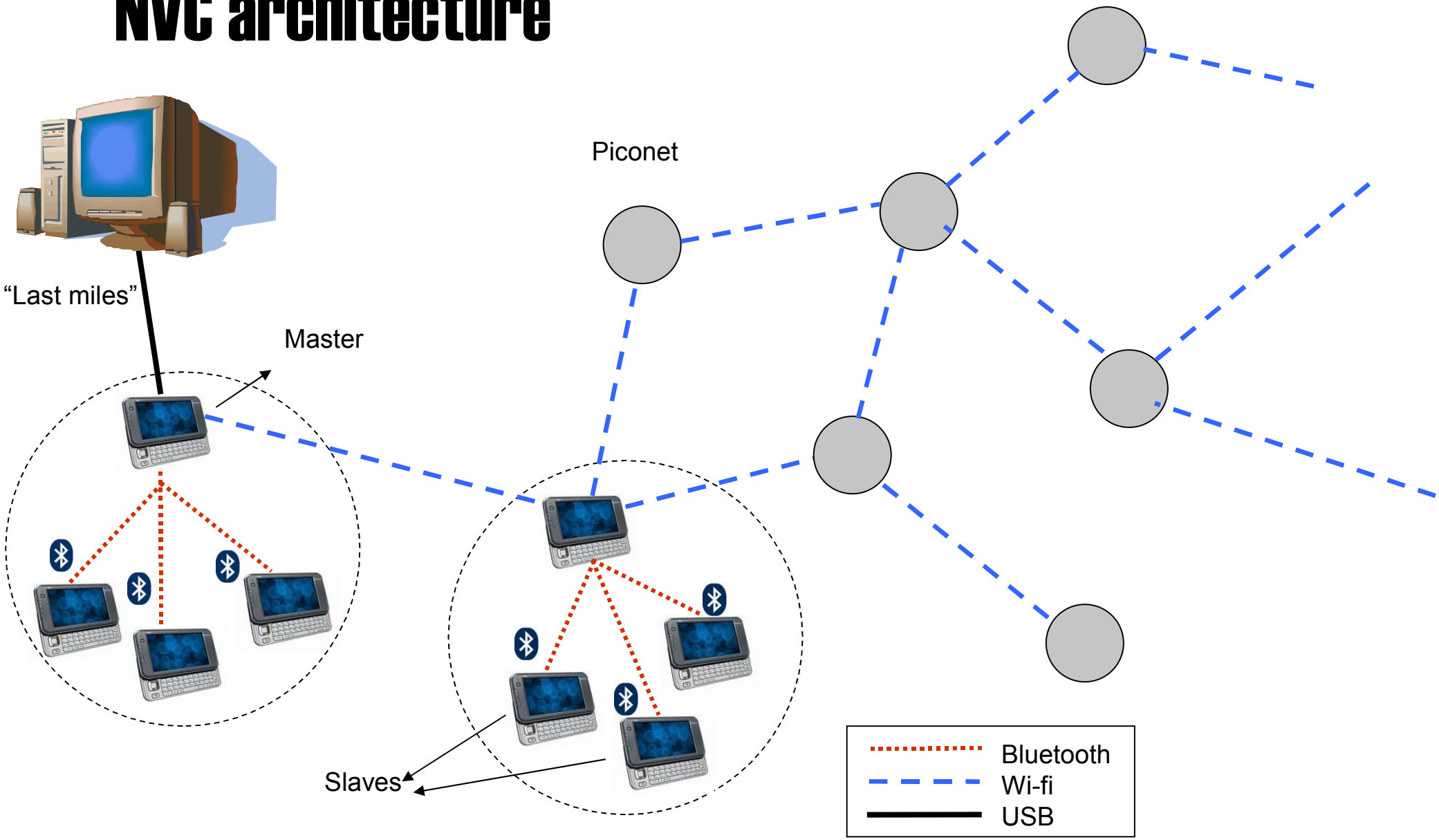
- Voice, data and video in your hands
  - generated from your handset
    - high-quality camera, microphone, with GPS
  - and delivered to your handset
    - IEEE 802.11b/g WLAN
    - Bluetooth WPAN
    - cellular system, WiMax WWAN coming
    - USB/WUSB networking
  - with the assistance of the community
    - when you are not “one-hop” away from the Internet

Networked Virtual Community

- Multi-hop mobile ad hoc networks
  - IEEE 802.11b/g: wireless back haul
  - Bluetooth: local access
- Incentive for collaboration
- Security at an affordable cost



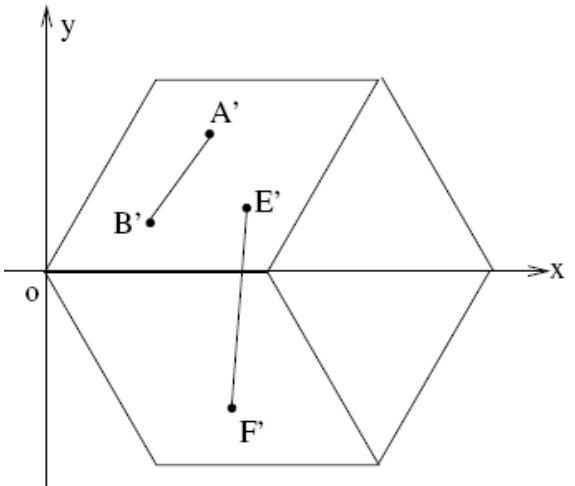
NVC architecture



[NokiaURF09KPPWG]

Rhombuses and hexagons

- Hexagons
  - widely used in cellular communication systems
  - also found in many natural/biological systems
- Rhombuses
  - sectorized cells: one hexagon = 3 rhombuses
  - city roads skewed by hills and lakes, etc
- In both cases
  - within the geometric shape
  - between adjacent geometric shapes
  - with general point distributions

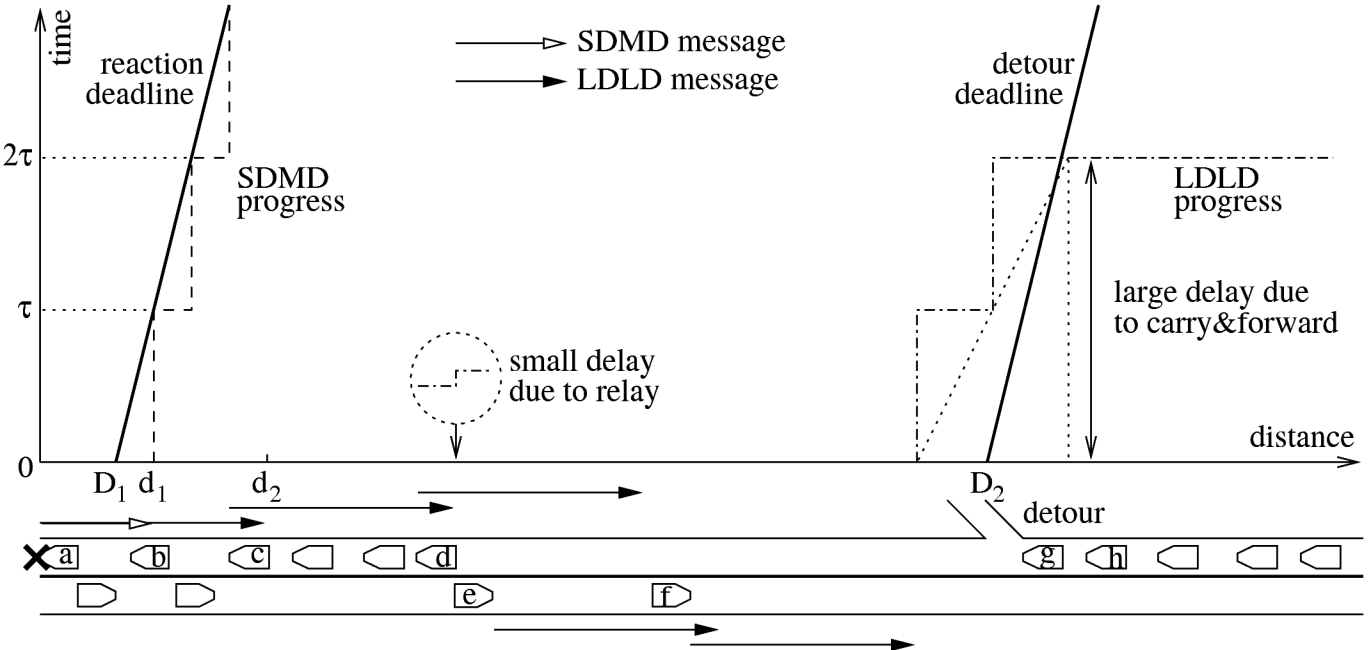


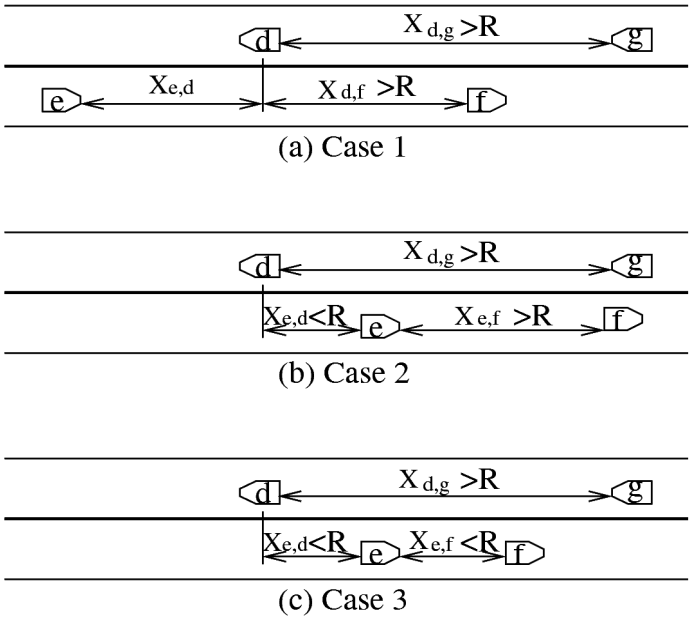
Mobile sensor networks

- Store-carry-(process-)forward
  - energy-constrained networks
    - direct communication over long distance
    - multi-hop communication with traffic aggregation
  - sparse networks, not always connected
- A new approach: mobile element
  - reduce and balance energy consumption
    - prolong network lifetime
  - but increased data collection latency
- Key problem: mobility scheduling

Vehicular ad hoc networks

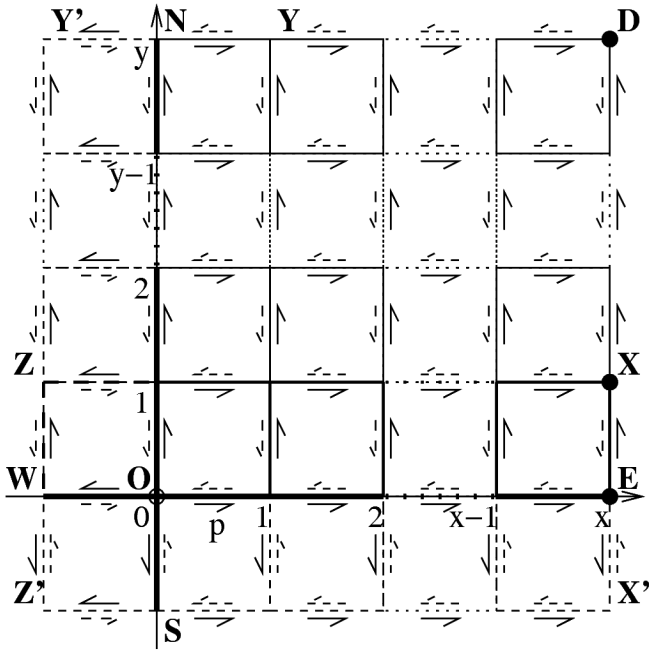
- One-dimensional highway
  - time/location-critical message propagation
  - cluster size and distribution
  - reverse traffic [JSAC10ZPLC]

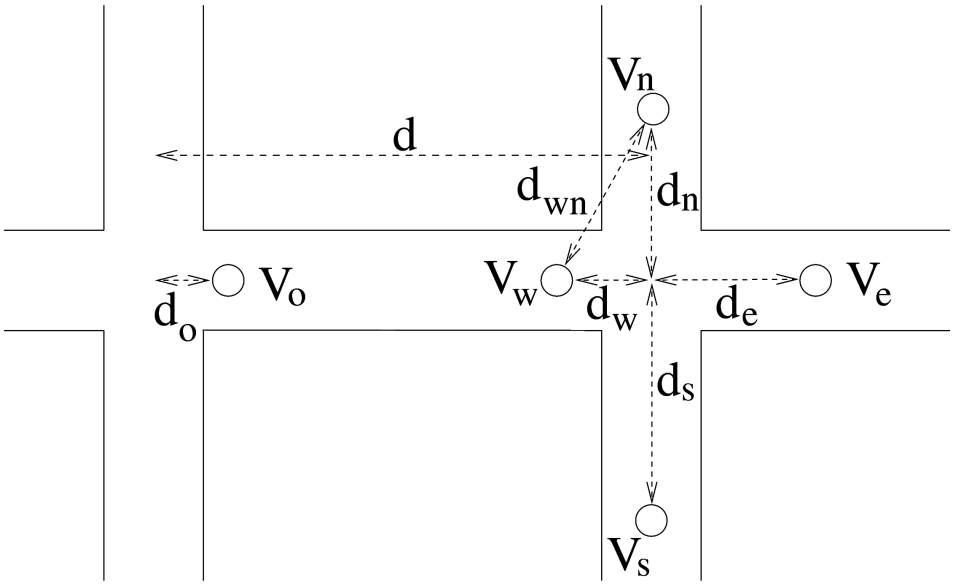




Vehicular ad hoc networks

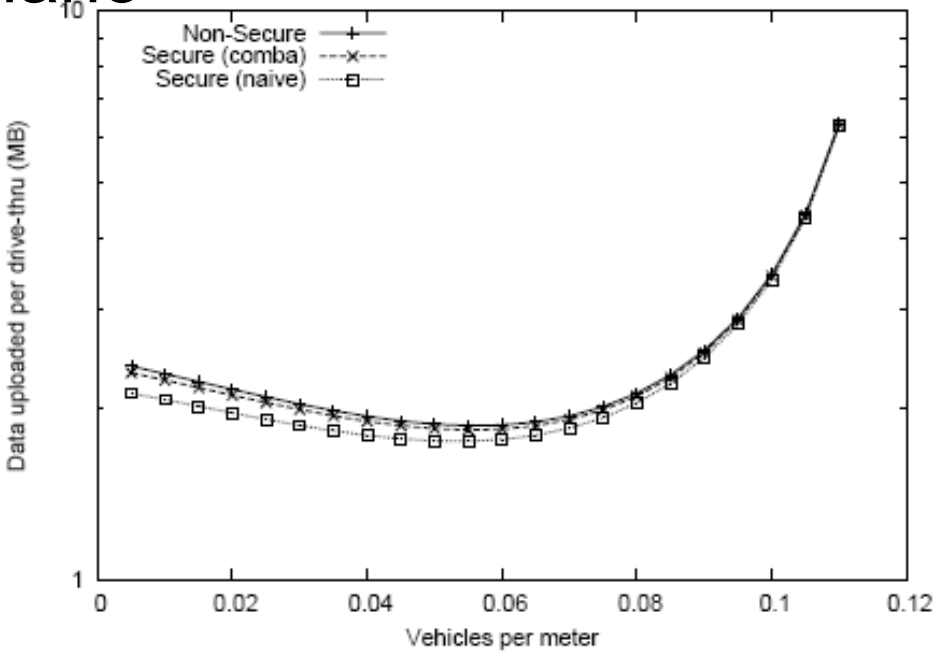
- two-dimensional city
  - 1-d
  - 2-d ladder, 2-d lattice [VANET10ZPC]





VANET security

- Time and location sensitive
  - information security: opportunistic channel, relay
  - user privacy: who, when and where
- Certificateless secure upload
  - in a drive-thru Internet scenario
  - secure association
  - data burst



Networking research at UVic

- Computer Science
  - computer communication networks
  - wireless mobile networks
  - network management and security
  - distributed multimedia systems
- Electrical Engineering
  - wireless communication networks
  - optical communication networks
  - digital signal processing

Graduate study at UVic

- Entry points: January, May and September
  - most September; some January; few May
- Good academic record
  - GPA threshold (normally 80%; exceptions possible)
- Good research record
  - for Masters: some research/competition experience
  - for PhD: research experience and some publication
- Good English proficiency
  - TOEFL: 90 (20/section); IELTS: 6.5 (6); exceptions

GPA (in increasing importance): overall, major, in the last two yeas

Some hints on application

- For most universities in North America
  - be focused: know your research interest
  - be prepared: complete documents as required
  - be honest, polite and professional
- Common mistakes
  - spam professors or secretaries
  - misinformed choices
    - who and what more important than which and where
  - give false promises or break commitments

Financial support

- China Scholarship Council (CSC)
  - CSC-UVic PhD Fellowship
  - Visiting Professor/Scholar Fellowship
- UVic Fellowship
- Research Assistantship
- Teaching Assistantship
- MITACS Globalink, Accelerate, Elevate, etc
- Vanier Canada Graduate Scholarship
- Banting Post-Doctoral Fellowship

Financial support (1)

- China Scholarship Council (CSC)
  - CSC-UVic PhD Fellowship
    - visiting UVic for PhD research (12~24 months)
    - studying at UVic for PhD degree (48 months)
    - application deadline at CSC: March 25
    - open to working professionals as well this year
  - Visiting Professor/Scholar Fellowship
- with top-up support from research advisor
  - to cover UVic tuition

Financial support (2)

- UVic Fellowship
  - entrance fellowship: academic and research record
  - automatically considered for complete applications
  - in CS: 1 year for Master's and 2 years for PhD
  - with top-up/subsequent support from research advisor
- Research Assistantship from research advisor
- Teaching Assistantship for TA duties
  - allocated by the dept and assigned by TA union
  - supplemented by Academic Income Supplement (AIS)

in addition, annual UVic Graduate Awards

Financial support (3)

- MITACS
  - Globalink for 3rd-year undergrad students
    - 10 to 12-week of summer research internship in Canada
    - work with faculty members and grad students
  - Accelerate for graduate students
    - 4 to 6-month of research internship with industry
  - Elevate for postdoctoral fellows
    - 2-year PDF: strategic or industrial
- UVic Cooperative Education (Co-Op) program
  - largest in Western Canada

Financial support (4)

- Open to international students
  - Vanier Canada Graduate Scholarship
    - 3-year, $50K/year with UVic top-up
  - Banting Post-Doctoral Fellowship
    - 2-year, $70K/year with UVic top-up
- Open to Canadian or Permanent Resident
  - Canada Graduate Scholarship (CGS)
  - NSERC Post-Graduate Scholarship (PGS)
  - NSERC Post-Doctoral Fellowship (PDF)

Work opportunities

- Work permit
  - on-campus work permit
  - co-op work permit
  - bridge work permit
  - postgraduate work permit (3-year, open employers)
- Immigration
  - Canada Experience Class (CEC)
  - BC Provincial Nomination Program (PNP)
  - 2nd-year PhD students program

Thanks!

Questions?

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