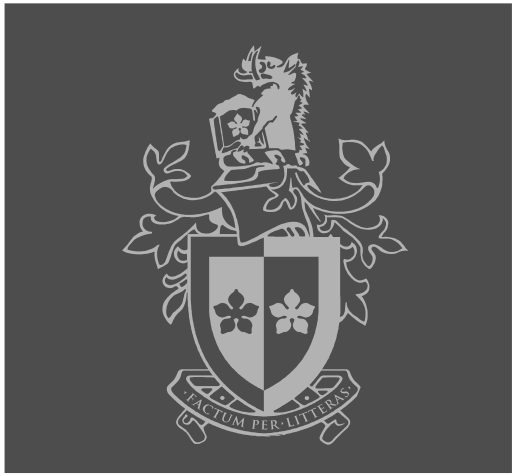
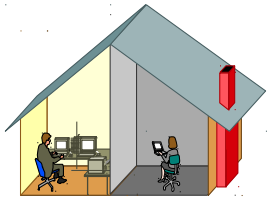
SWINBURNE UNIVERSITY OF TECHNOLOGY

Consumer Internet of Things: Networking challenges

Grenville Armitage



“Smart Worlds” / “Internet of Things”











Wired & Wireless communication paths

email | WWW | phone | ...

SMTP | HTTP | RTP | ...

TCP | UDP | ...

IP

ethernet | PPP | ...

CSMA | async | sonet | ...

copper | fiber | radio | ...

Divergent “application & transport” layers

Common IP layer addressing, routing, transport services

Divergent “link layers”

The Internet

The Cloud

Gmail, Outlook 2010, YAHOO! MAIL, Hotmail, Google, bing, YAHOO!, eBay.com.au, PayPal, amazon, LinkedIn, facebook, Tweet, Dropbox, rackspace HOSTING, ninefold, skype, CISCO TelePresence, Google Cloud Platform, amazon web services EC2 S3 Glacier, Google Apps for Business

The communications perspective

Telecommunications is an *enabler*

- Telemetry *from* smart devices/things
- Control signals *to* smart devices/things
- Data *between* storage, computation, visualisation and control devices

Convergence: “Internet” protocols:

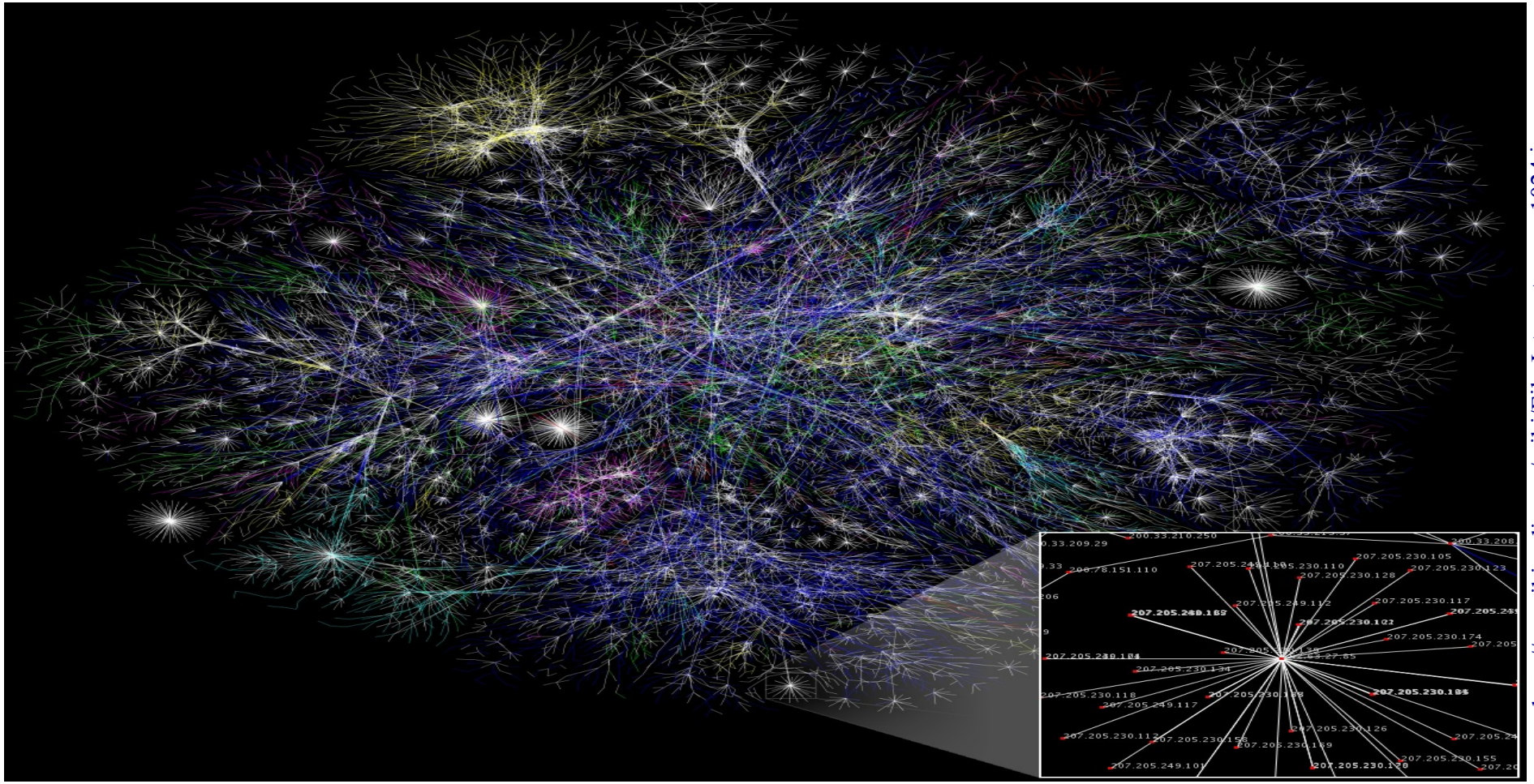
- {TCP,UDP}/IP, HTTP, dynamic routing
- Diverse links: Wireless (WLAN, WiMAX, 3G/4G, Zigbee, Z-Wave…), Fixed (copper, optics, p2p microwave, …)

Communications challenges

- Timeliness, reliability, robustness, efficiency
- …while *things* are mobile & links intermittent
- …while *environments* are insecure or hostile

The Internet has many *things* already

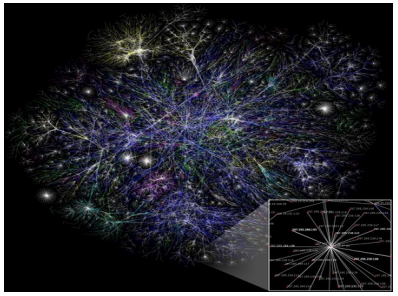
Many, many millions(+) of loosely co-operating, mostly de-coupled devices....



http://en.wikipedia.org/wiki/File:Internet_map_1024.jpg

Happily chattering away....

Many, many millions(+) of loosely co-operating, mostly de-coupled devices....



All trying to locally optimise for their preferred mix of speed,

responsiveness,

consistency,

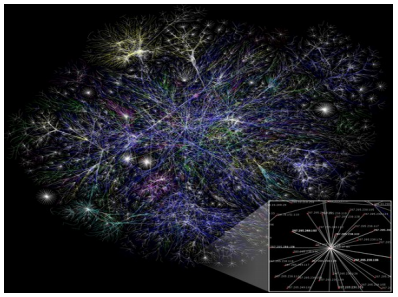
'quality'

price....

http://ny.racked.com/uploads/2011_11_Macys-Black-Firiday-Crowd.png

Enjoying regular traffic jams....

Many, many millions(+) of loosely co-operating, mostly de-coupled devices....



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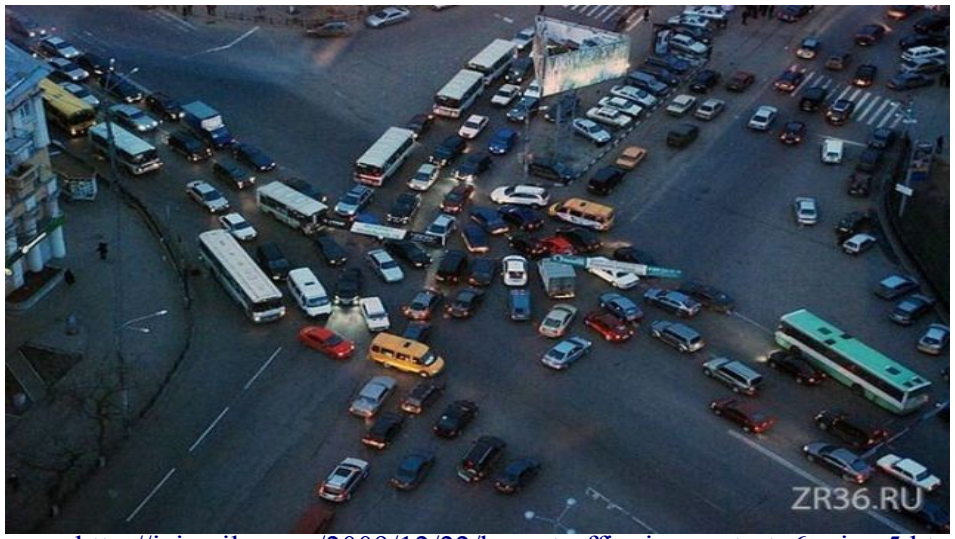
What could possibly go wrong?



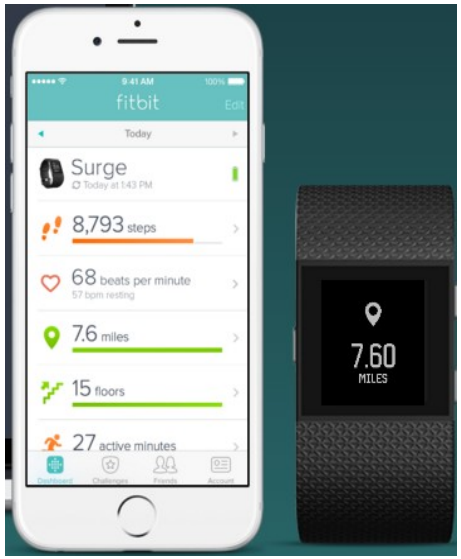
http://izismile.com/2009/12/22/how_traffic_jams_start_6_pics-5.html

More “things” for the home...

Philips Hue: http://www.meethue.com

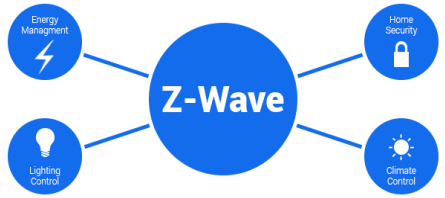
GE Appliances' “Wifi Connect”

Belkin's WeMo home automation

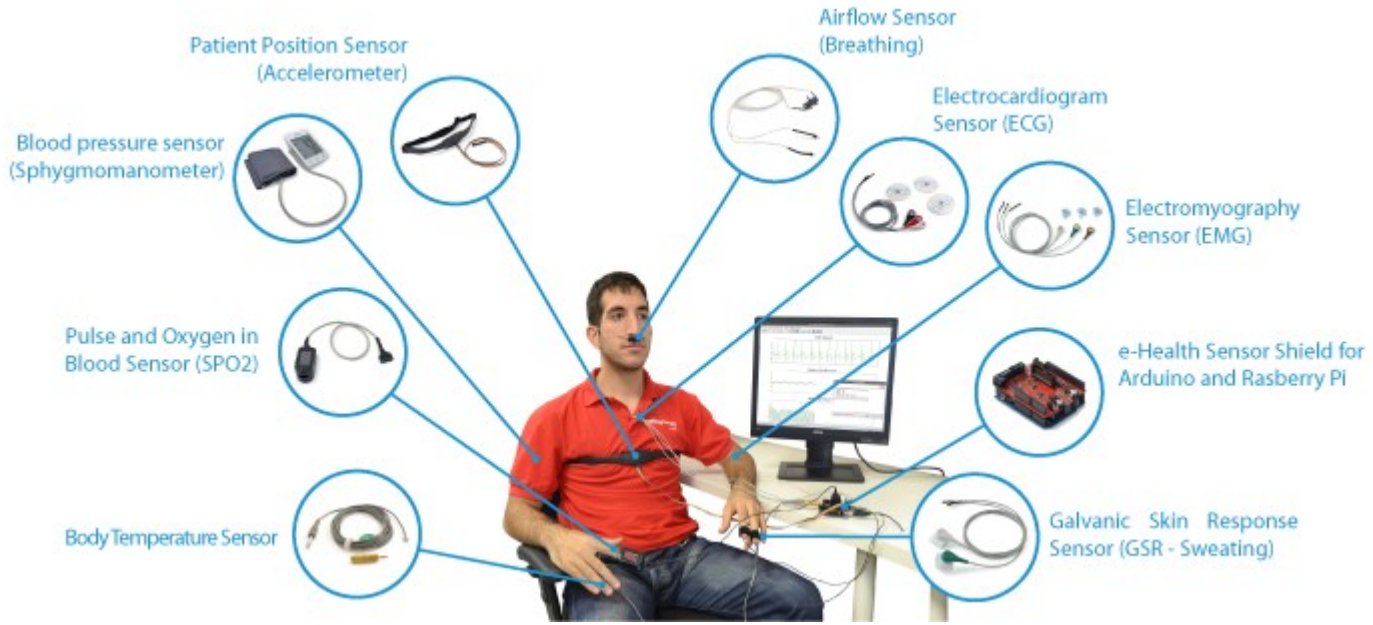


FitBit Surge

Connected Hydration Bottle with Smart Lid



More “things” for the home... #2



https://www.cooking-hacks.com/documentation/tutorials/ehealth-biometric-sensor-platform-arduino-raspberry-pi-medical

(I ran out of time to find more diverse images for tele-health. Sorry.)

Lifestyle automation...

openHAB

"*...software for integrating different home automation systems and technologies into one single solution that allows over-arching automation rules and that offers uniform user interfaces.*"

Addressing the needs of "*...home automation solutions and Internet-of-Things (IoT) gadgets..*"

An "*..Intranet of Things..*"

http://www.openhab.org

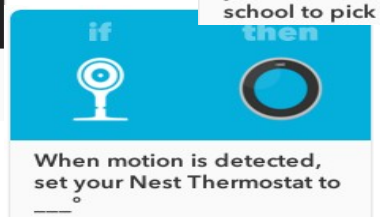
More lifestyle automation...

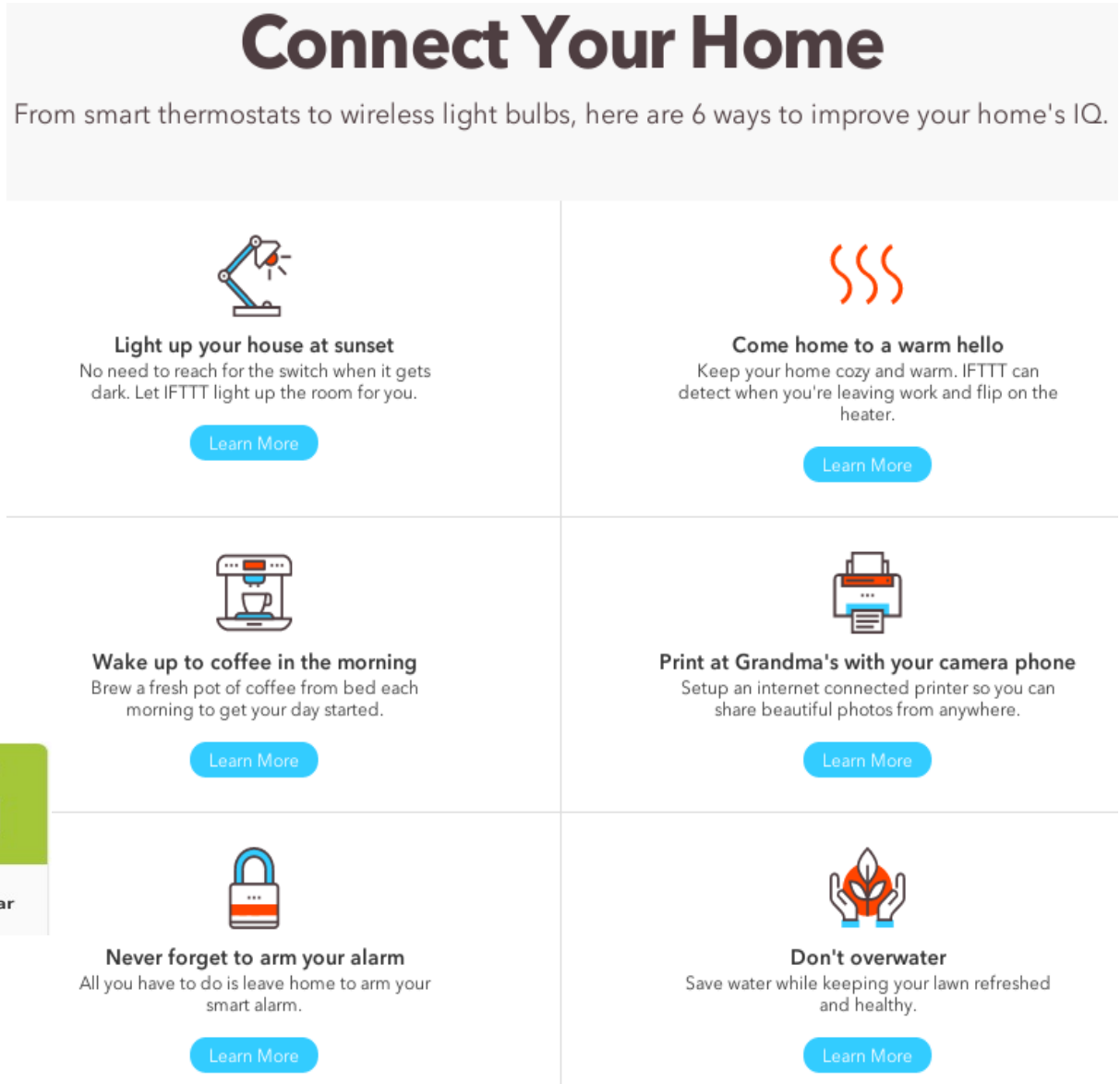
"If This Then That" (IFTTT)

Consumer-friendly "programs" trigger actions based on events

Events: environment sensors, social media activity, ...

Actions may control household devices, ...





https://ifttt.com/categories/connect-your-home

Even more lifestyle automation...

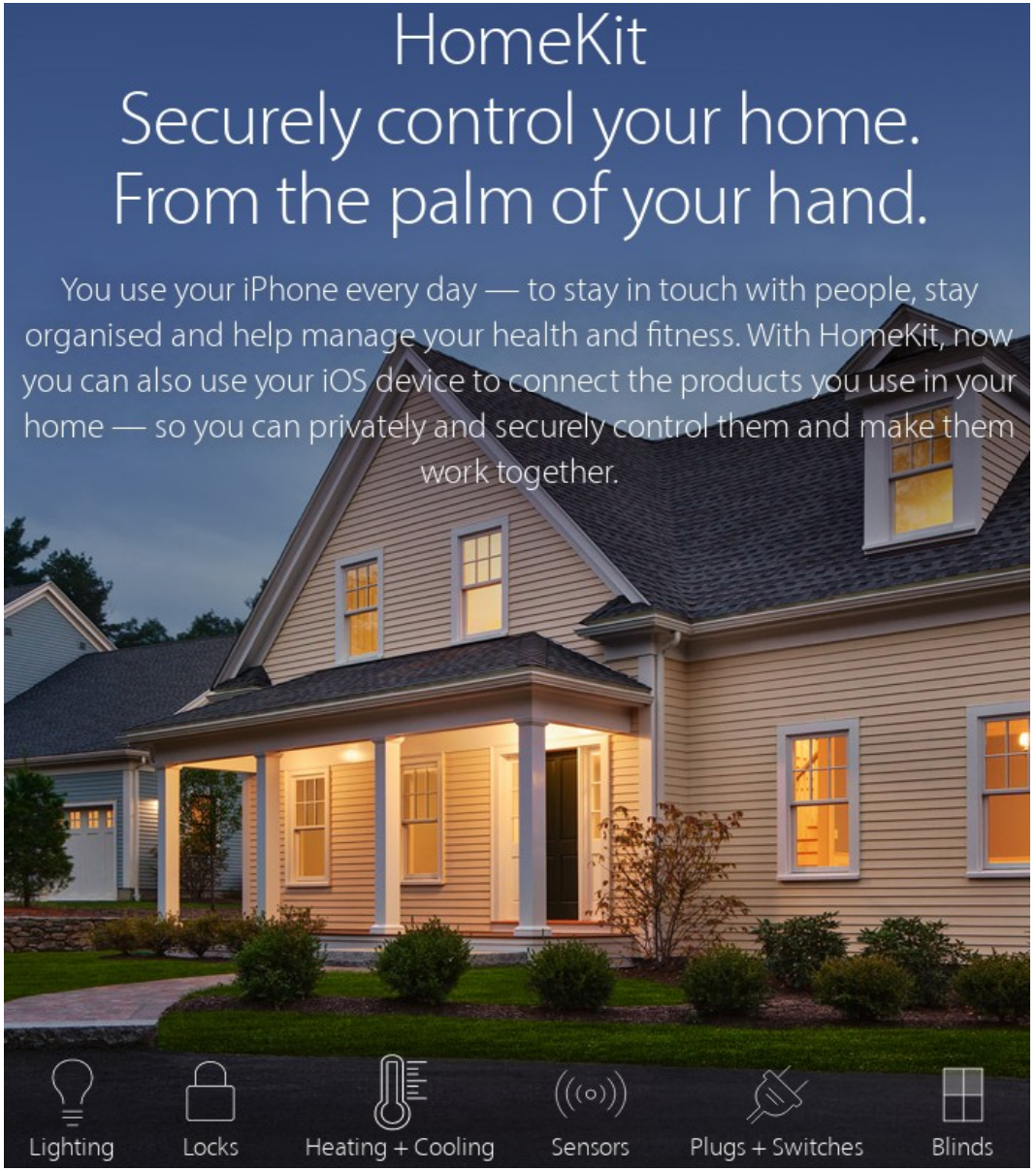
Apple HomeKit

Consumer-friendly, iOS-based, integrated control of household devices, ...

Simple triggers (you control)

Environmental triggers (rules)

Integrated with Siri: "*Turn on the TV....*", "*Movie night...*"



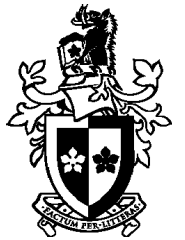
http://www.apple.com/au/ios/homekit

Reliance on offsite 3rd parties

Some of these are cloud-based services

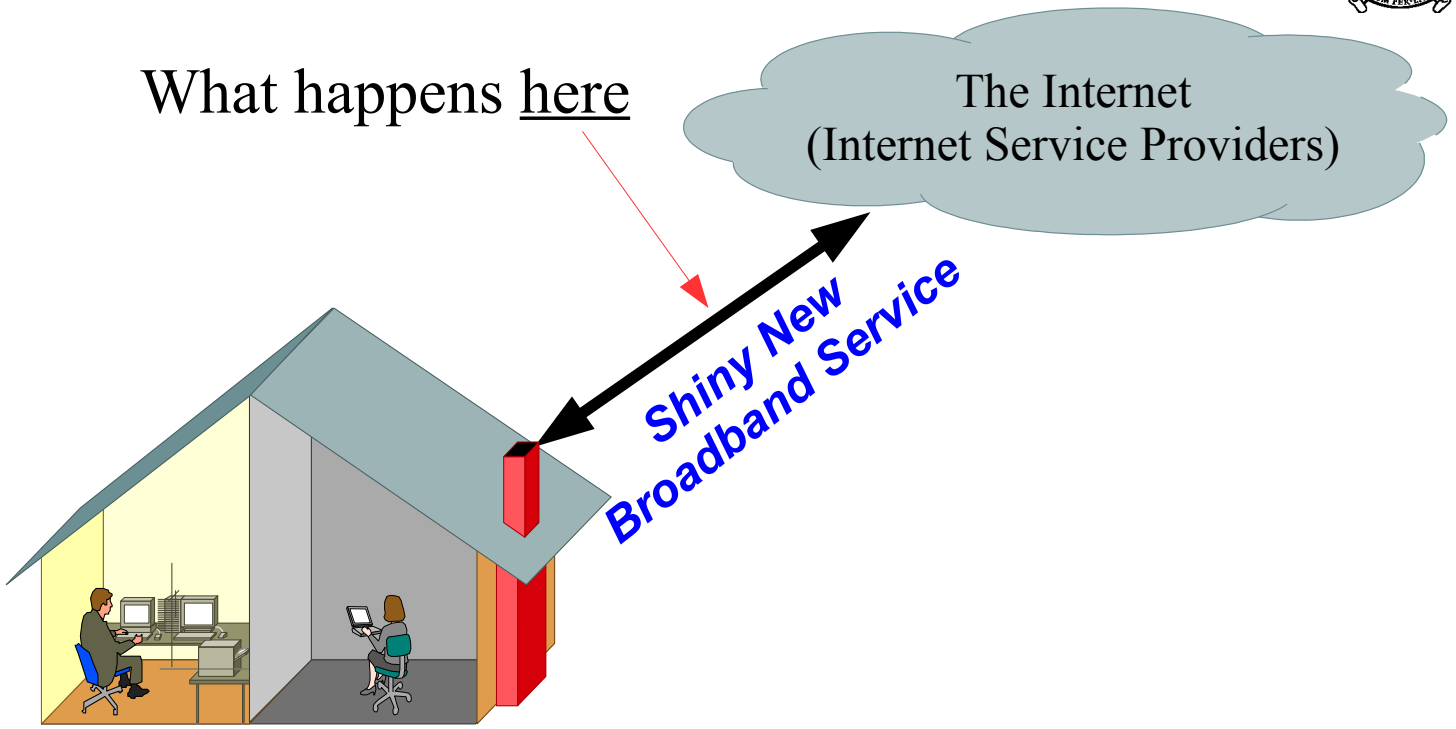
- Offsite servers link devices & user controls (phone, etc)
- Offsite servers instantiate stand-alone 'smart' rules
- Responsiveness and reliability constrained by your wired or 3G/4G Internet access

(And *someone* knows what your house is doing...)



So what?

A weak point: the internet plumbing...



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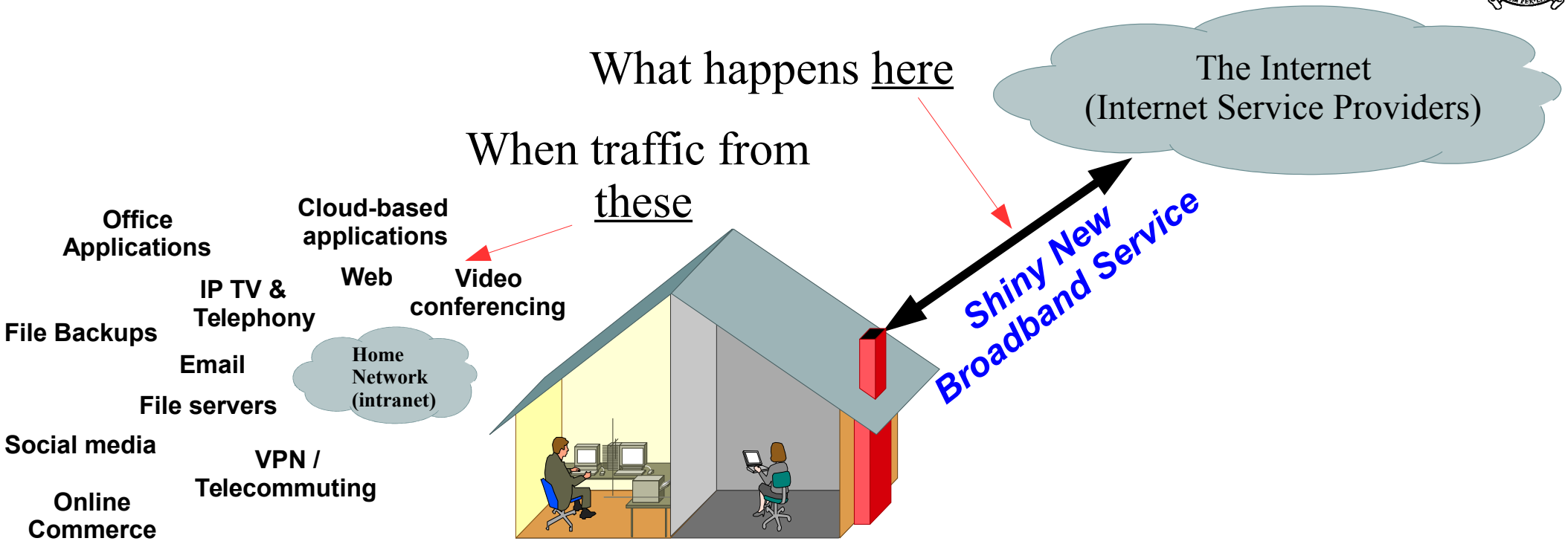

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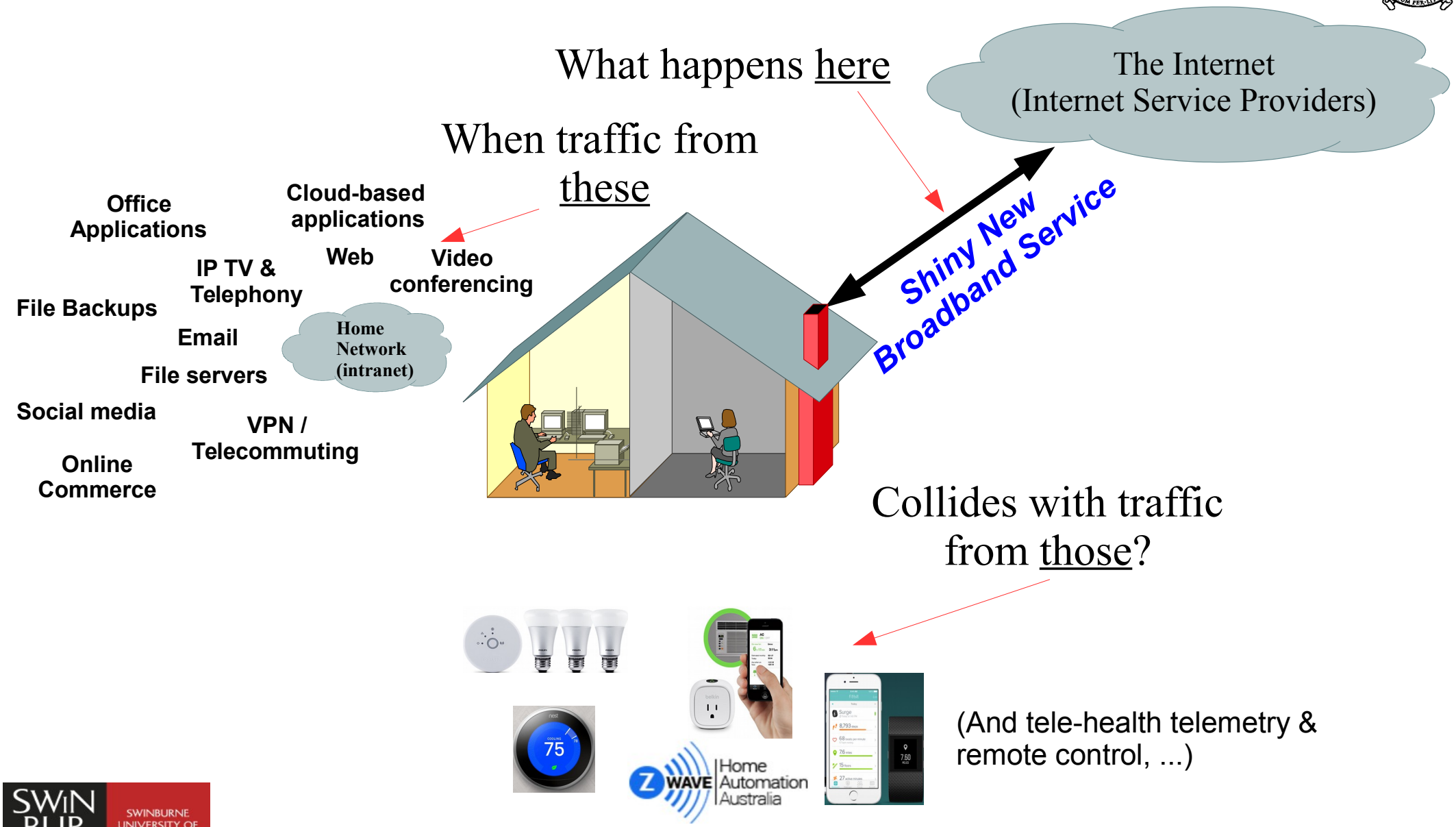


Consumer internet is... challenging

- Link layer sync issues
  - ADSL & DOCSIS come and go at inopportune times
    - No-one promises 5-nines service anyway...

- "Bufferbloat"
  - Long-lived/bulk TCP data flows fill traditional buffers, so all traffic sees large RTT spikes (gateways, Wifi APs, ...)
  - Responsiveness declines for all offsite services

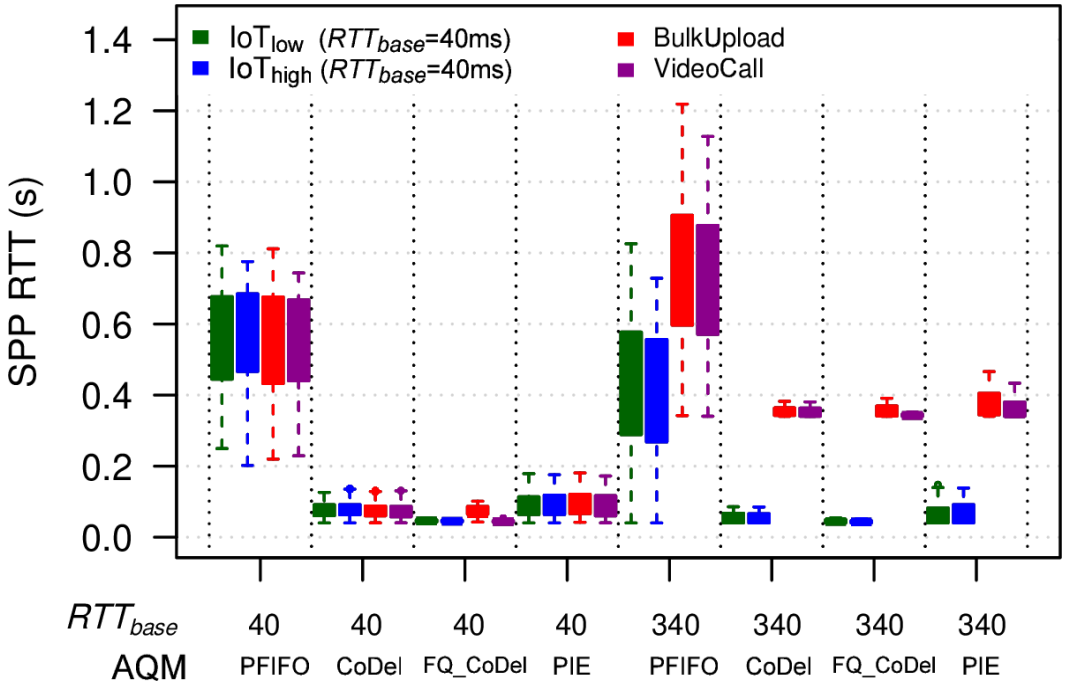
  (Oh, and *curious* security practices by device vendors....)

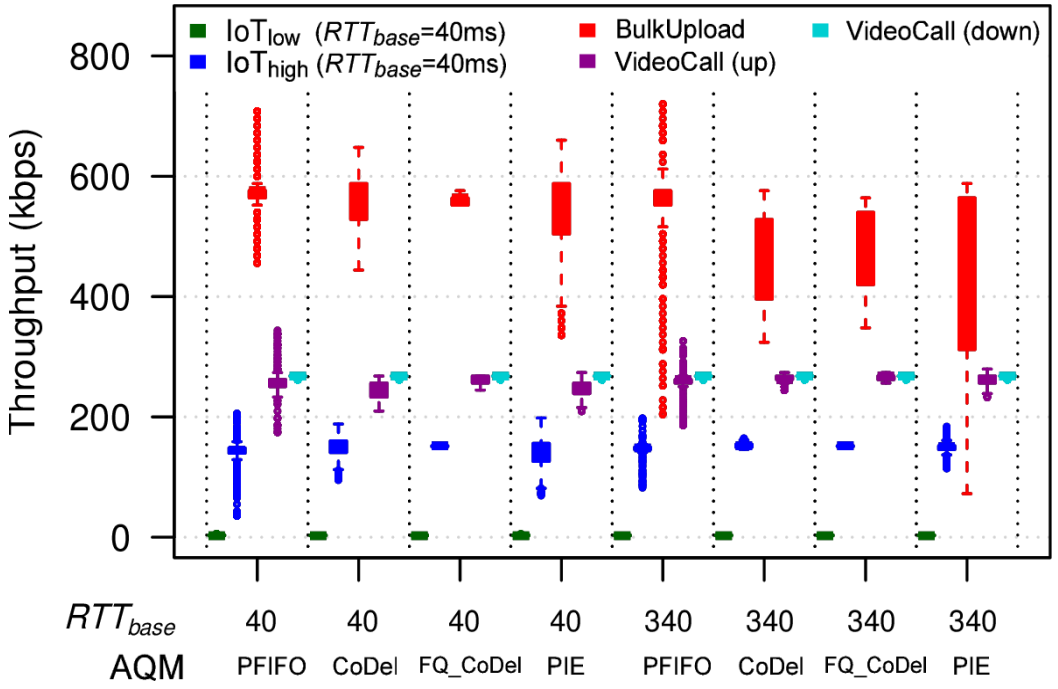
An open topic: Peaceful coexistence

(or: *sharing the home Internet access link*)

- Interactions with consumer entertainment traffic
  - Modeling the impact network of streaming TV, etc...
- Enhanced transport protocols?
  - multi-path TCP, delay-sensitive TCP, scavenger TCP, …
- Better queue/buffer management?
  - Active Queue Management (CoDel, PIE)
  - Dynamic flow isolation (FQ-CoDel, FQ-PIE)

AQM helps reduce RTT

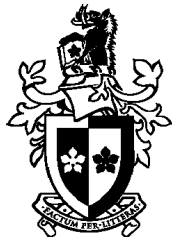




Throughput and RTT of four flows at 12/1Mbps (Base RTT={40,340}ms for non-IoT flows)

(PFIFO is prevalent gateway queue management. CoDel, FQ_CoDel and PIE are new AQM algorithms.)

Some overlapping CAIA work



- Cisco-funded (and jointly with SISR)

  "An integrated social and technical evaluation of household broadband service requirements for educational innovation and the Internet of Things"

- Comcast-funded

  “Independent implementation of modern Active Queue Management in FreeBSD”

- Netflix-funded

  “Support for a PhD program in high performance IP-based content delivery”

- Cisco / FreeBSD Foundation funded

  “FreeBSD implementation of Multi-path TCP”, “New TCP congestion control protocols”