

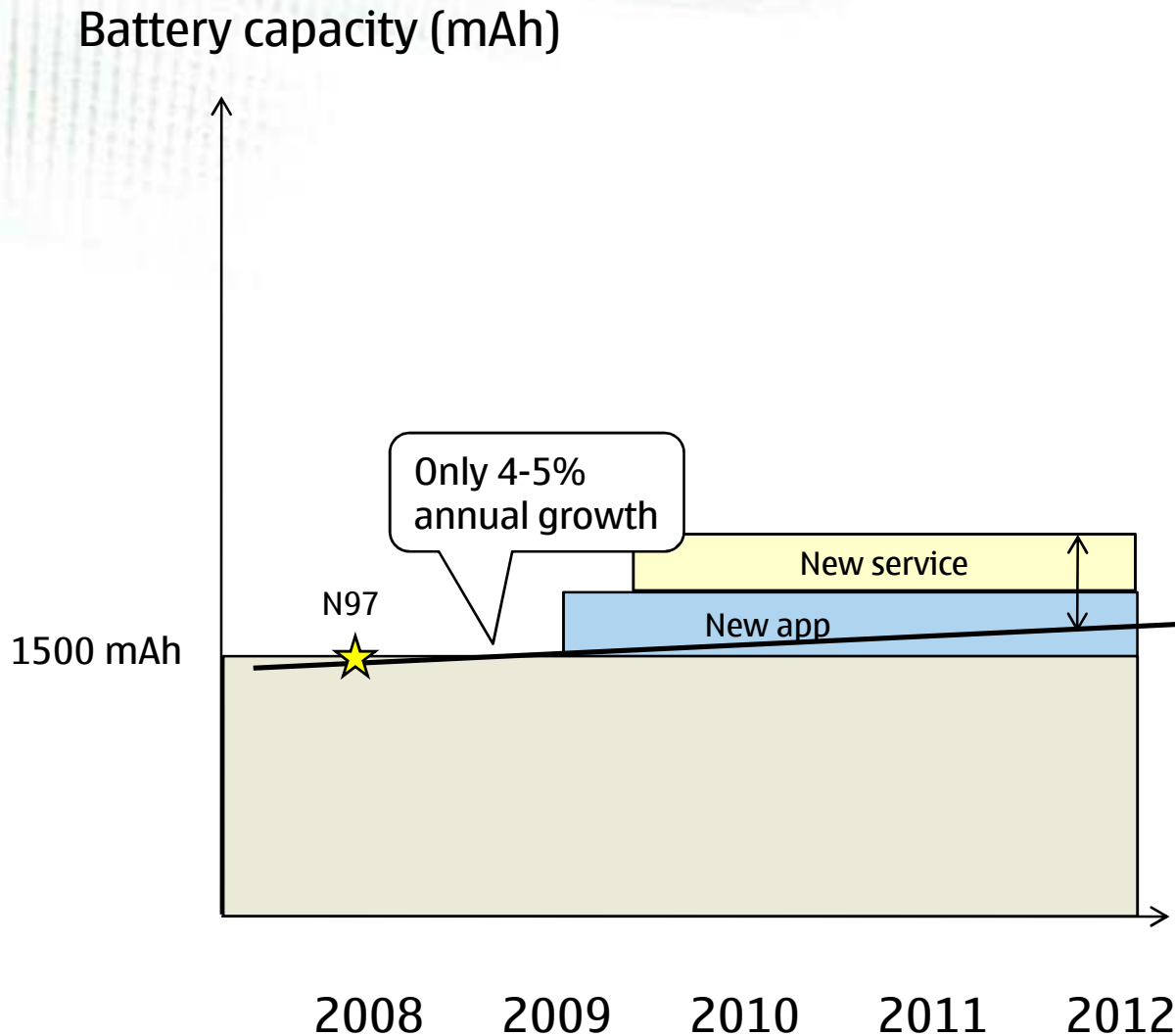


Energy-Efficient Mobile Applications Issues and Examples

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Gap between Battery Capacity and App Needs



- More frequent charging
- Physically larger batteries => larger devices
- Less new services and application
- Break-throughs in battery technology
- Smarter usage of battery capacity



Where Energy is Spent?

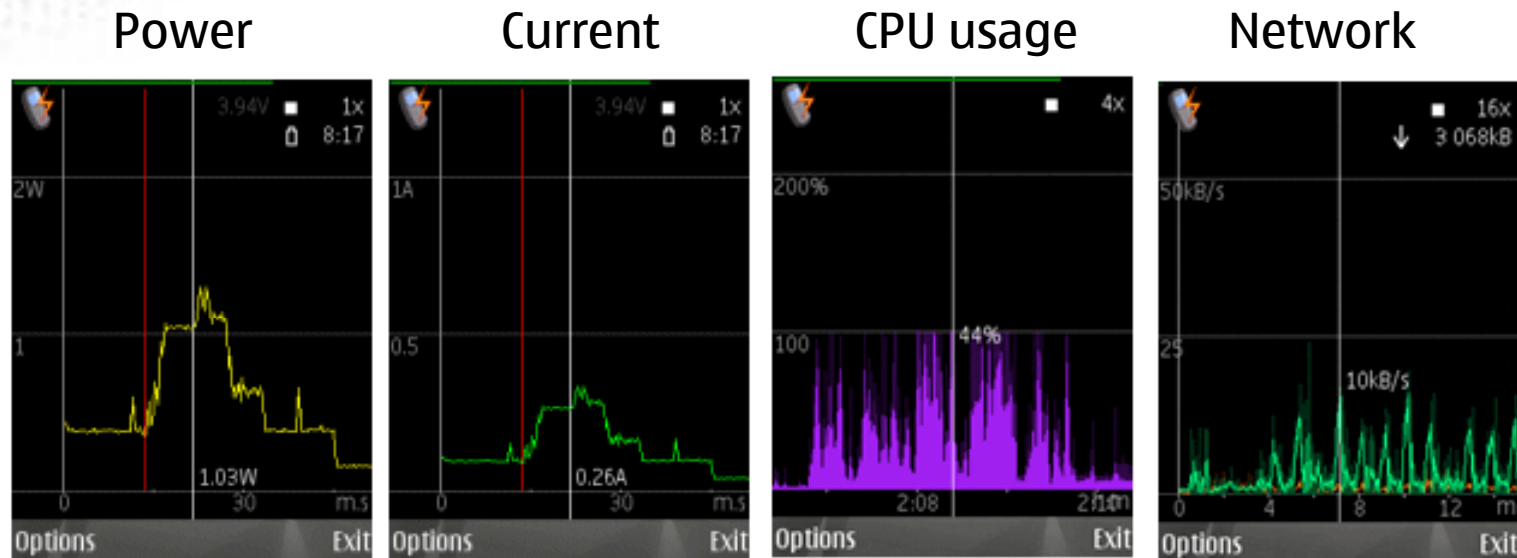
System component	Energy consumption (mW)
RF receiver and cellular modem	1200
Application processors and memories	600
User interface (audio, display, keyboard; with backlights)	1000
Mass memories	200
Total	3000

Energy consumption in streaming 384kbit/s video (Silven and Jyrkkä, 2007)

- Experimental results have shown that power consumption related to networking activities is approximately 10% of the overall power consumption in a laptop computer, but it raises over 50% in current handheld devices. Anastasi et al, 2003

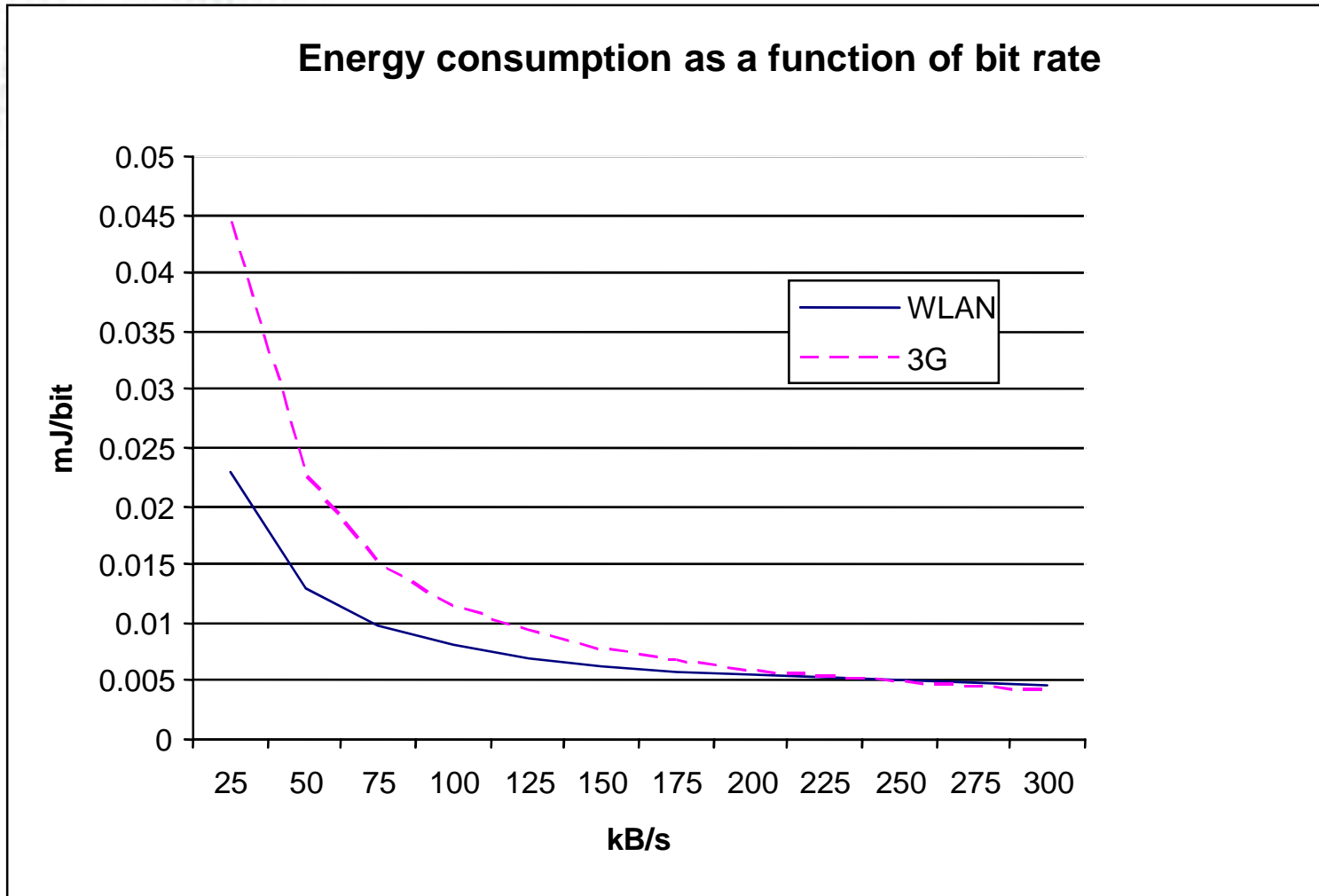
Nokia Energy Profiler

- No need for external metering devices. This is a normal Symbian application.



S60 3rd edition and later Nokia phones
forum.nokia.com

Higher Bit Rate -> More Energy-Efficient

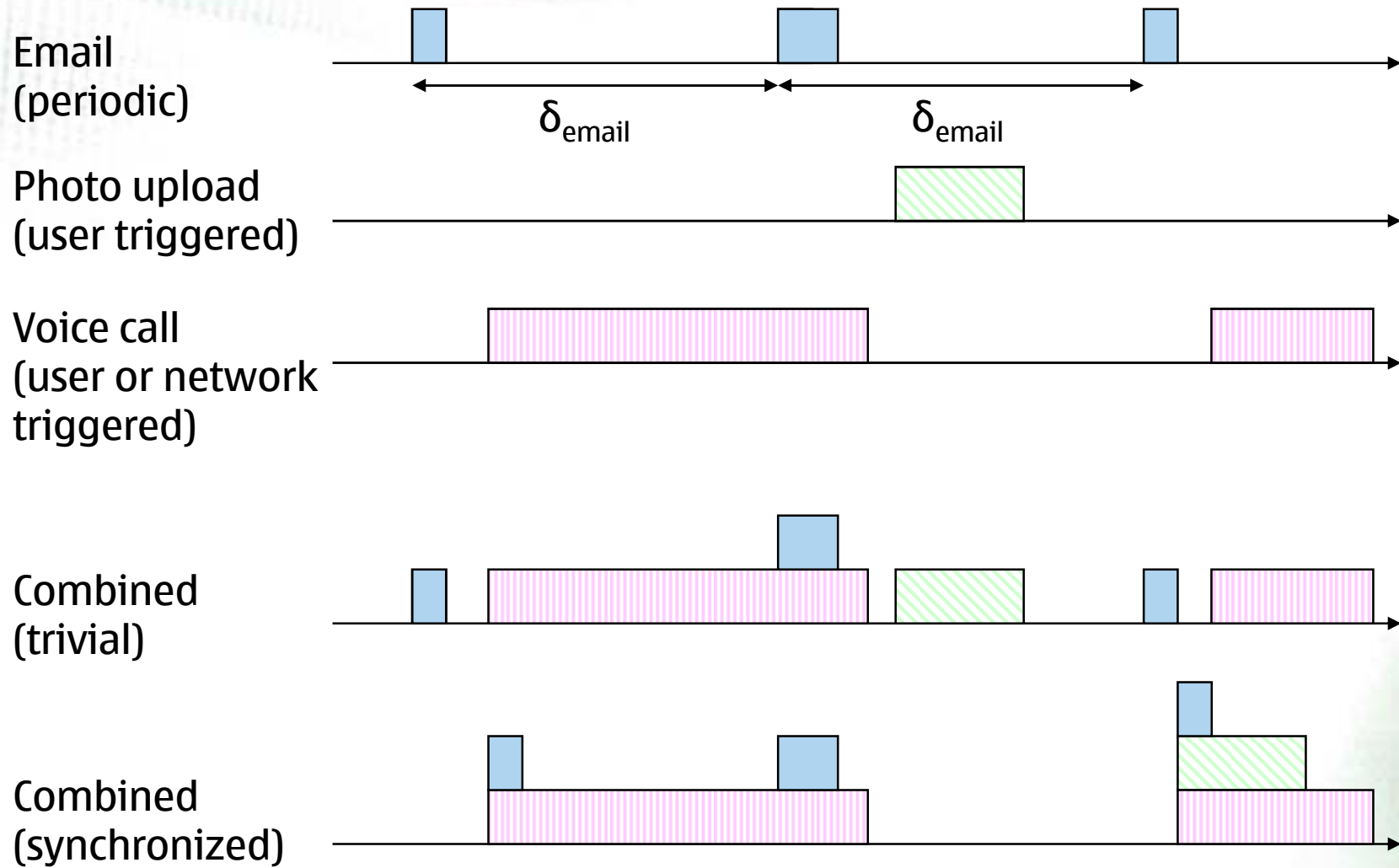




Parallel Data Transfer

Nurminen, J.K., Nöyränen, J., "Parallel Data Transfer with Voice Calls for Energy-Efficient Mobile Services," The Second International ICST Conference on MOBILE Wireless MiddleWARE, Operating Systems, and Applications (Mobilware 2009), Berlin, Germany, April 2009

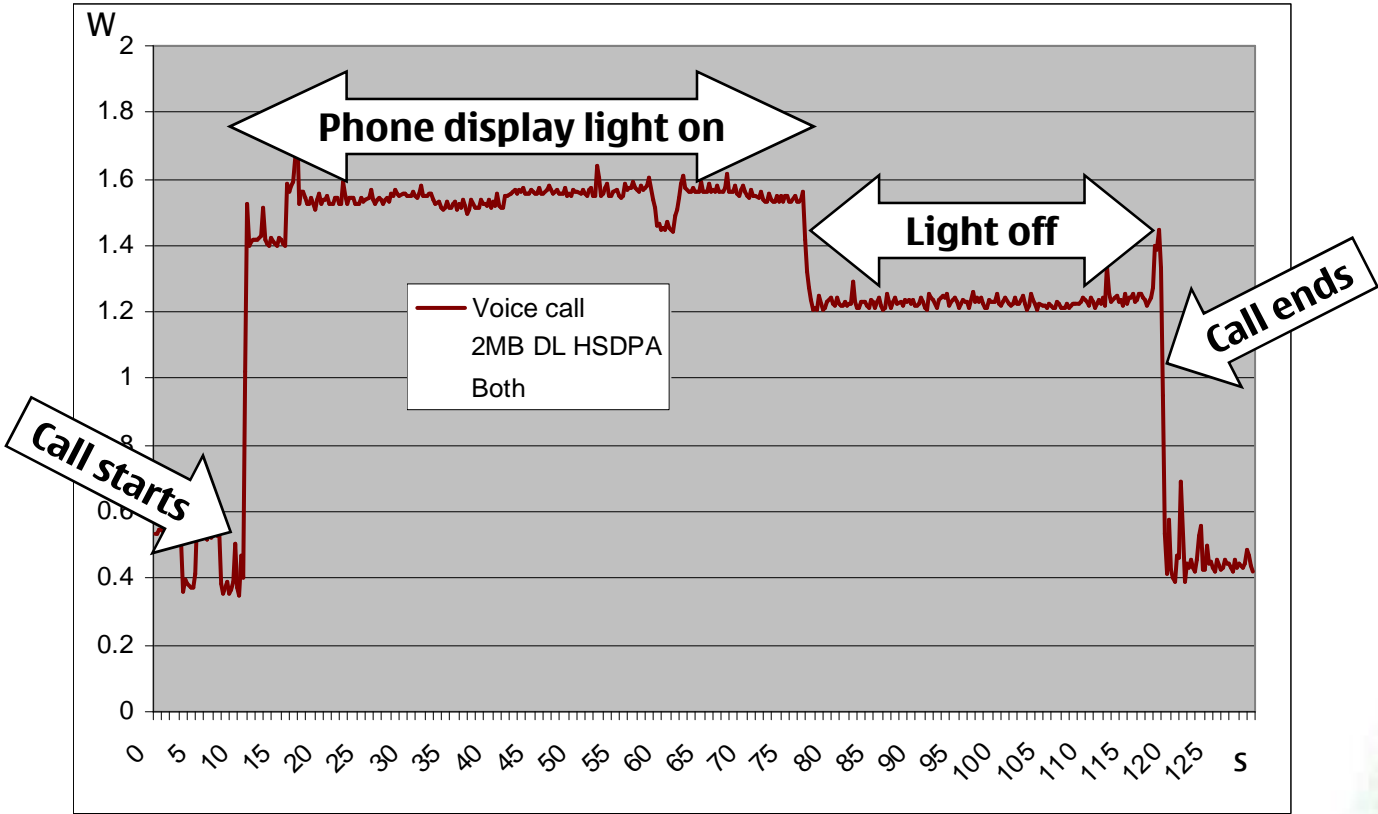
Application Cooperation



N96 Power measurements

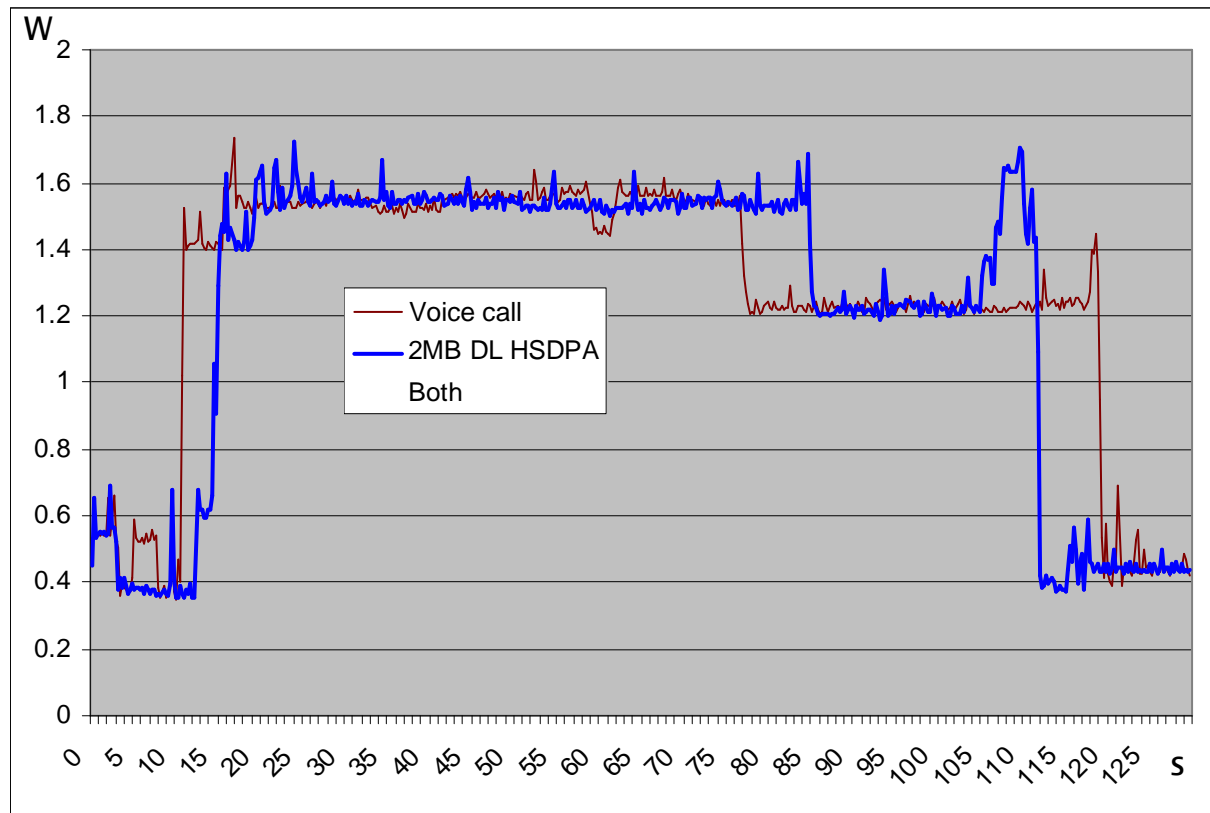


Normal voice call ~2 min



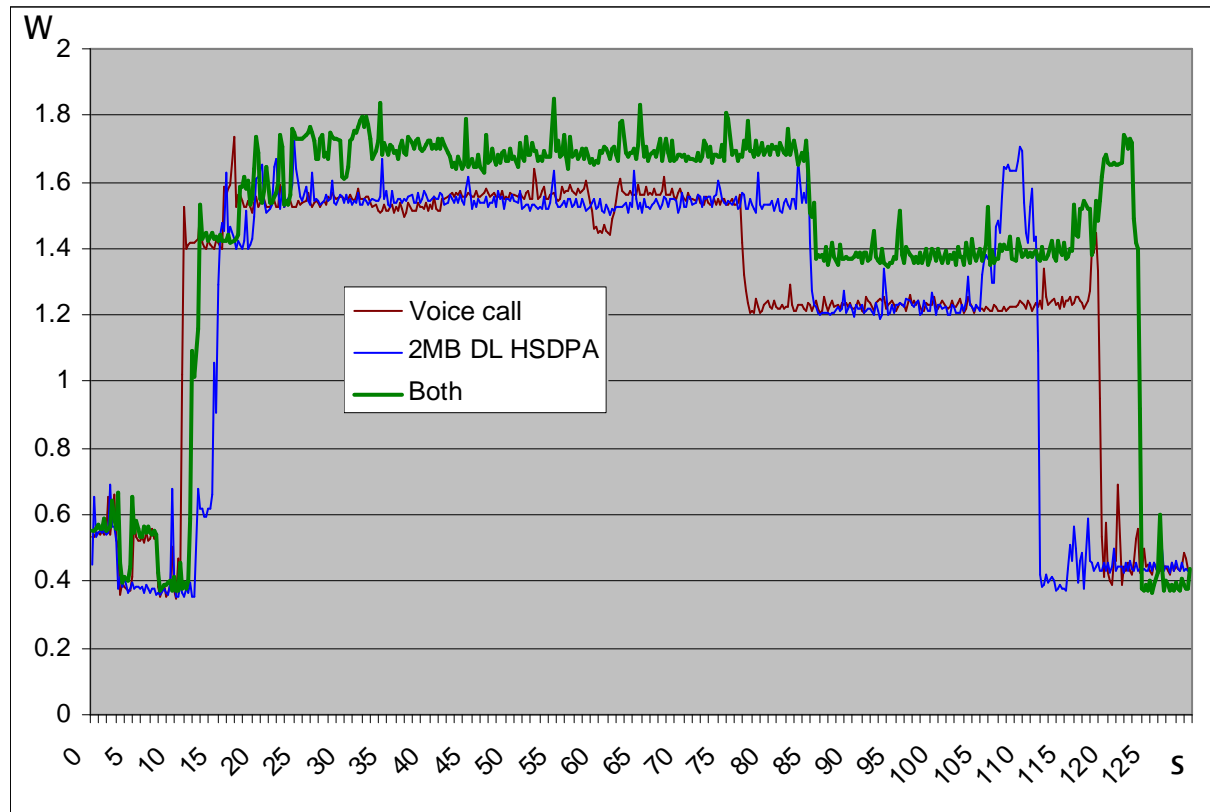
N96 Power measurements

2MB email attachment download with CDMA2100 HSDPA (3,5G)



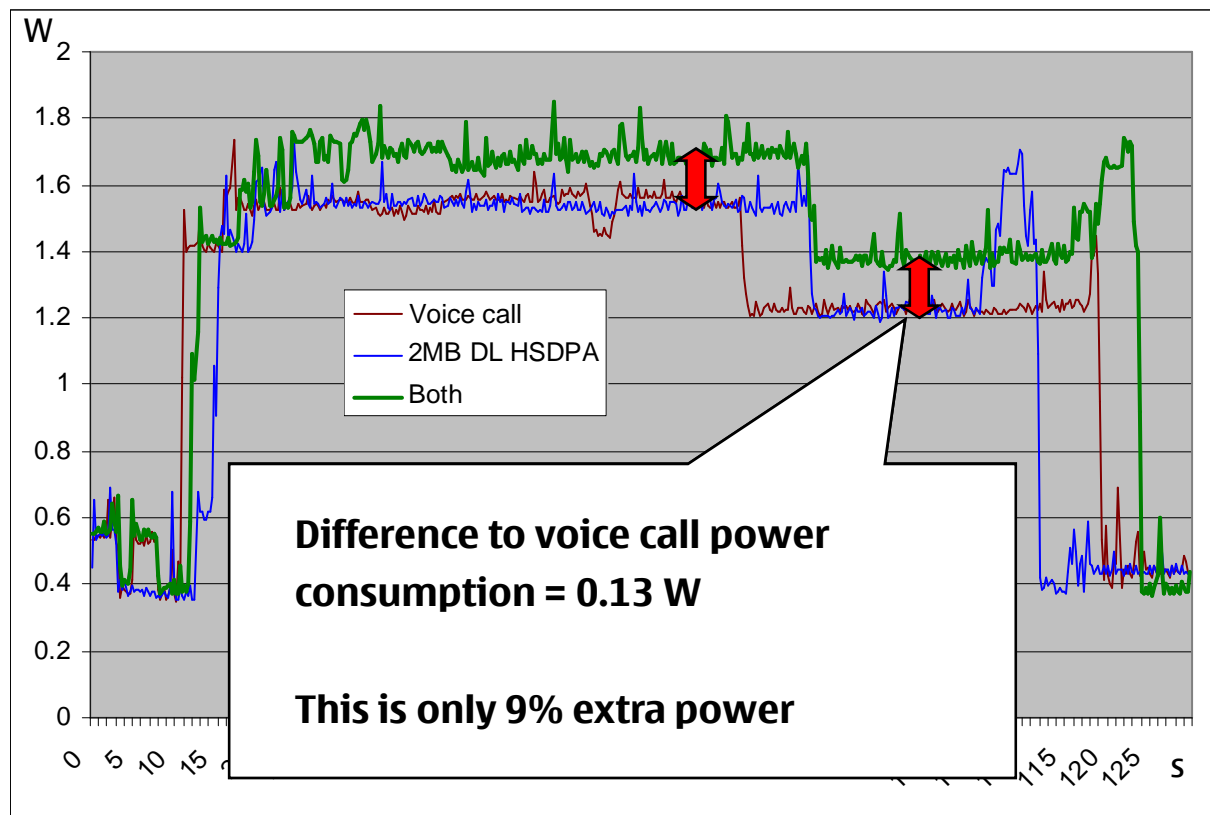
N96 Power measurements

Voice call and 2MB download with CDMA2100 HSDPA



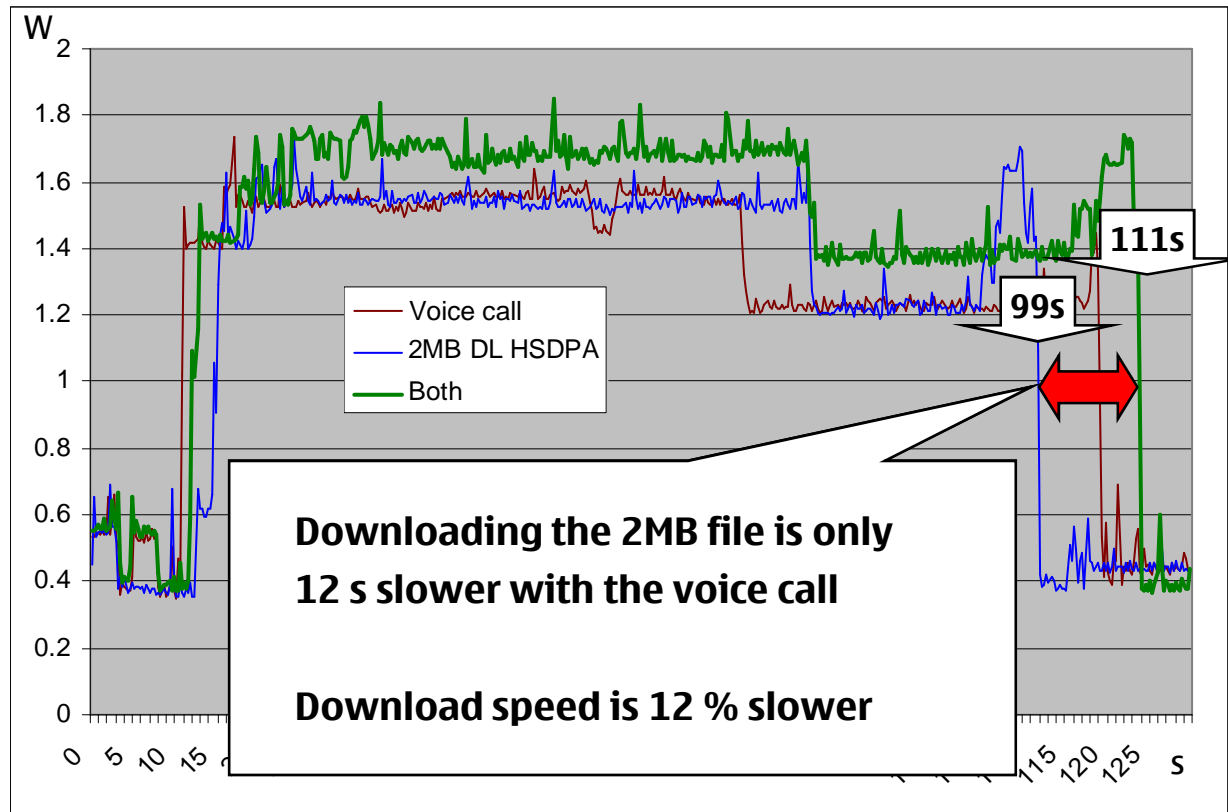
N96 Power measurements

Voice call and 2MB download with CDMA2100 HSDPA



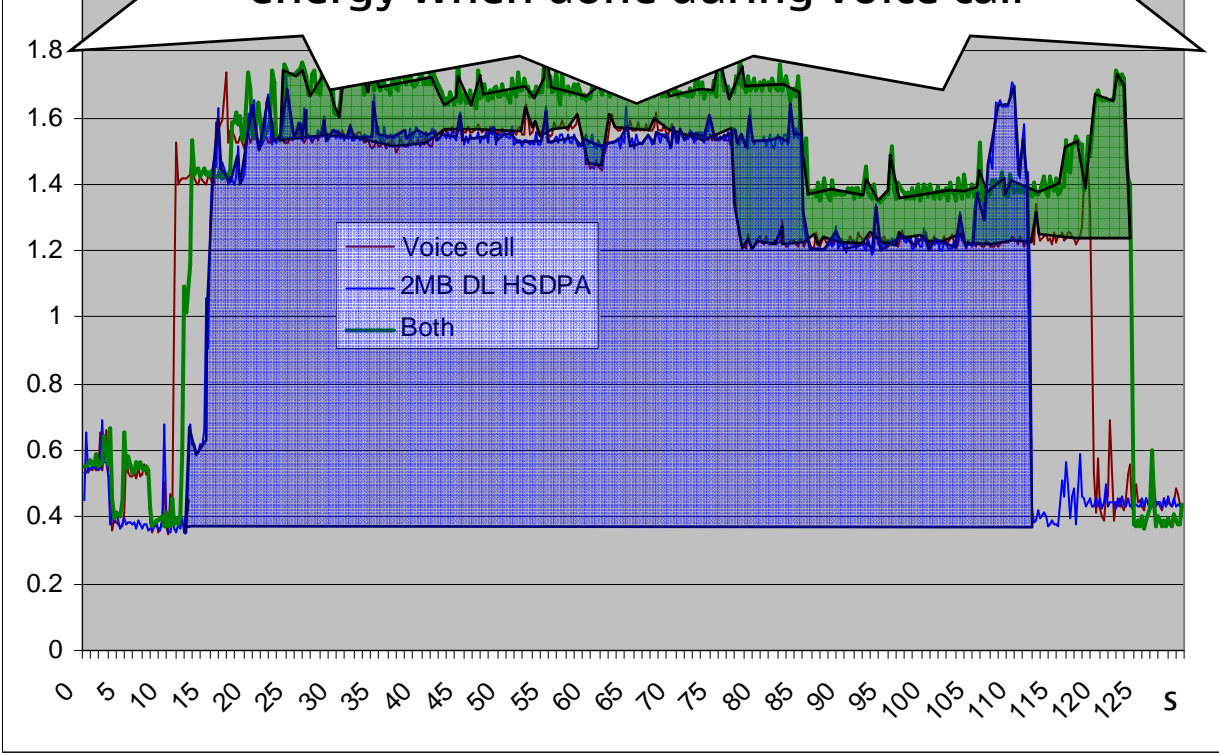
N96 Power measurements

Voice call and 2MB download with CDMA2100 HSDPA

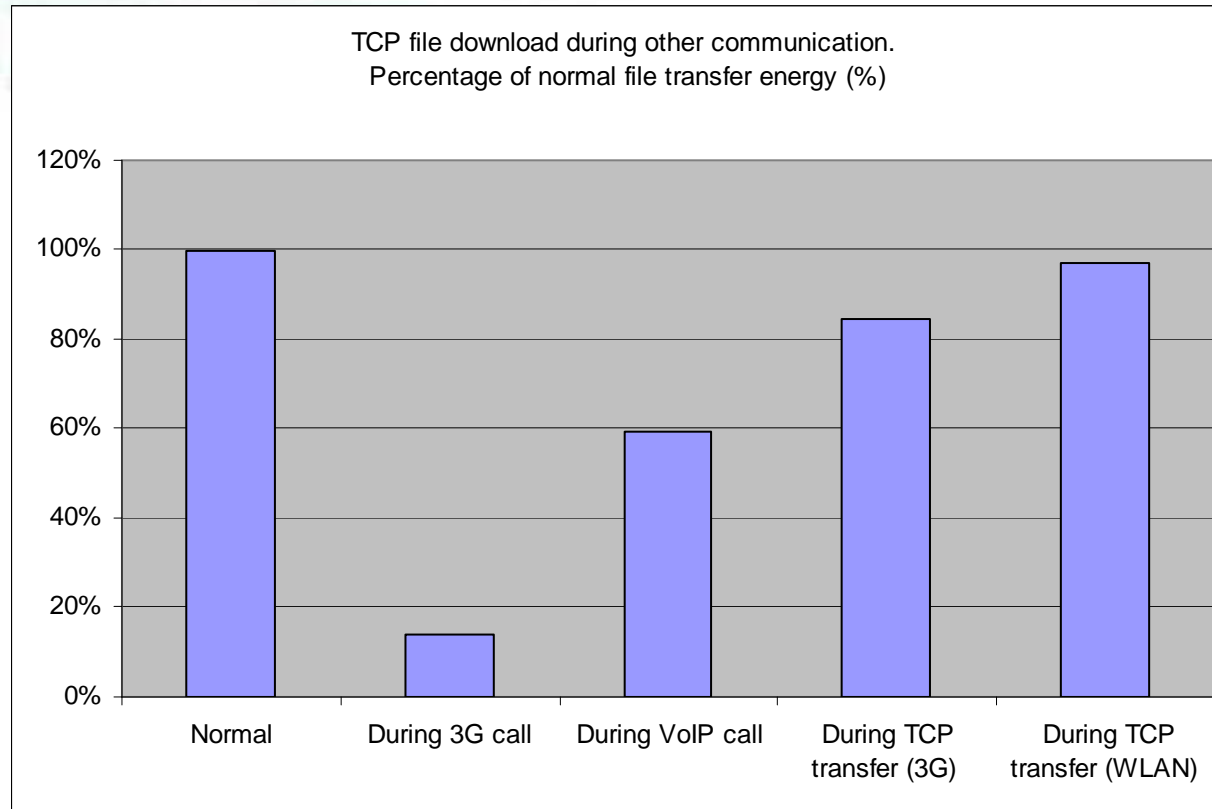


N96 Power measurements

Download requires only
14%
energy when done during voice call



Parallel connections save energy



- The benefit is clear in case of voice call and VoIP call. (in case of VoIP call the effect of U-APSD power save mode was not investigated)
- The benefit of parallel TCP is less clear and depends on the relative speeds of the connections and of the independence of the paths of the TCP connections)
- Measured with N95

Nurminen, J.K., "Parallel connections and their effect to battery consumption of a mobile phone," 7th IEEE Consumer Communications & Networking Conference CCNC'2010, Las Vegas, Nevada, January 2010

NOKIA



CloudTorrent

BitTorrent content to mobiles via cloud

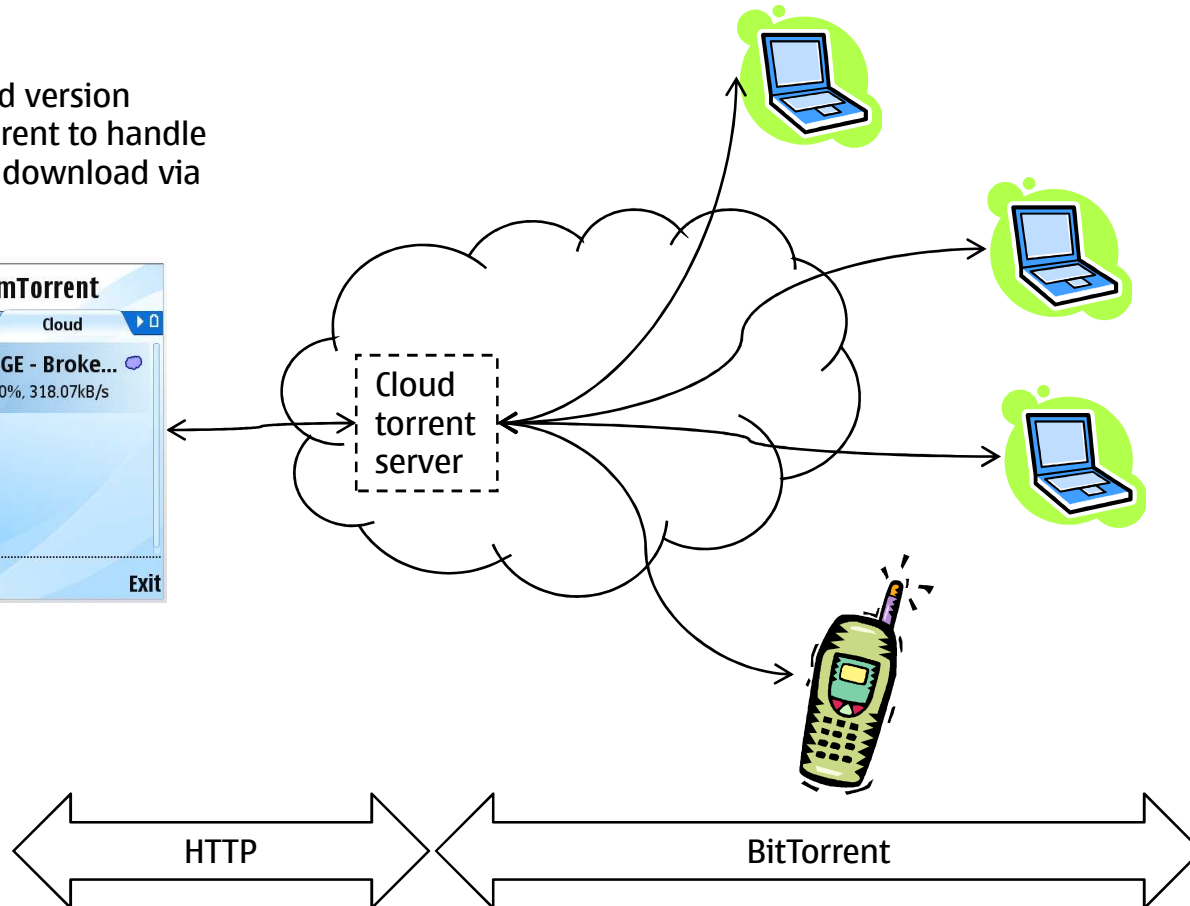
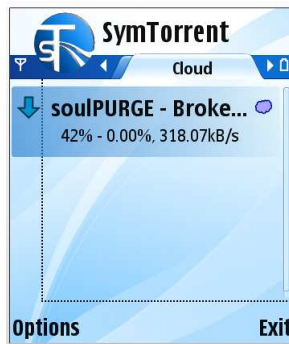
Kelenyi, I., Nurminen, J.K., "CloudTorrent – Energy-Efficient BitTorrent Content Sharing for Mobile Devices via Cloud Services," short paper, [7th IEEE Consumer Communications & Networking Conference CCNC'2010, Las Vegas, Nevada, January 2010 \(to appear\)](#)

CloudTorrent

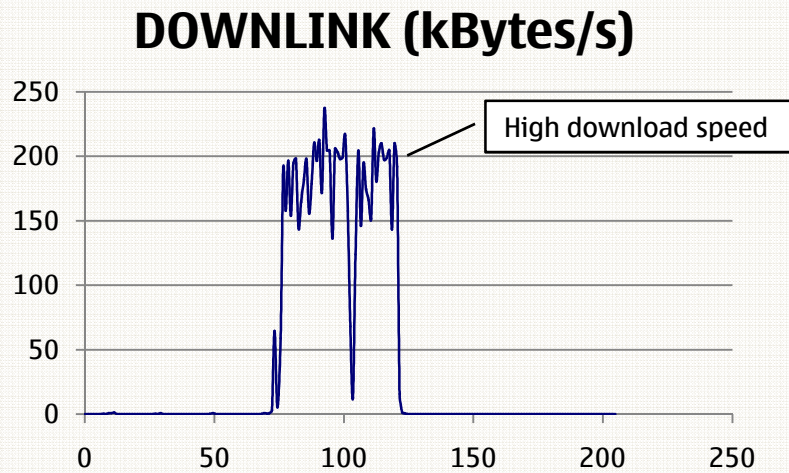
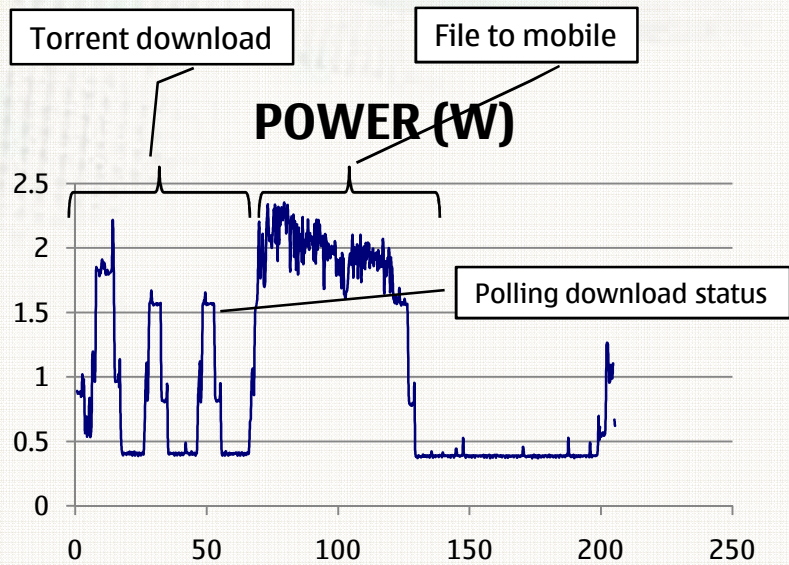
[http://wikis.in.nokia.com/pub/Tritium/WebHome/CloudTorrent_\(for_review\).pdf](http://wikis.in.nokia.com/pub/Tritium/WebHome/CloudTorrent_(for_review).pdf)

65% energy saving, 60% time saving

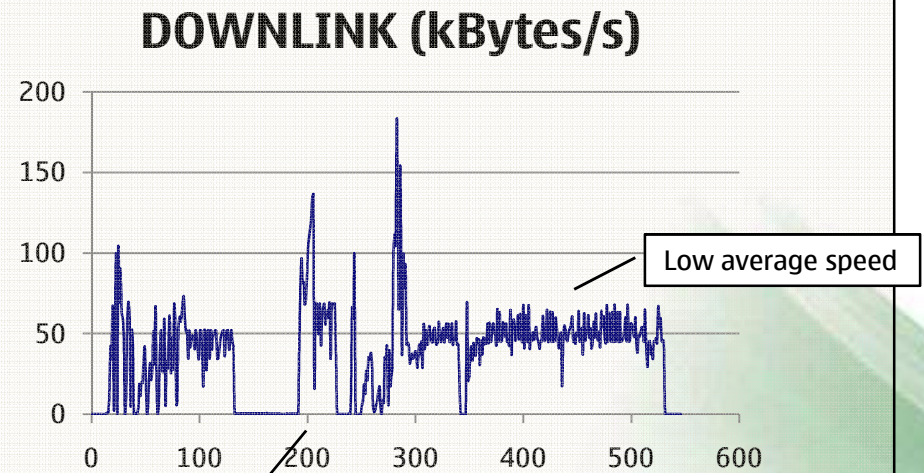
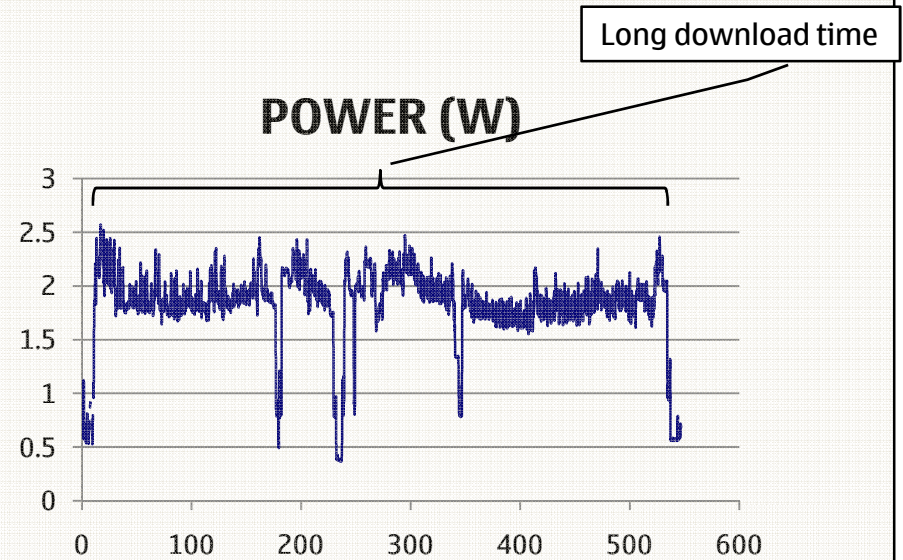
Updated version
SymTorrent to handle
torrent download via
server



CloudTorrent



SymTorrent



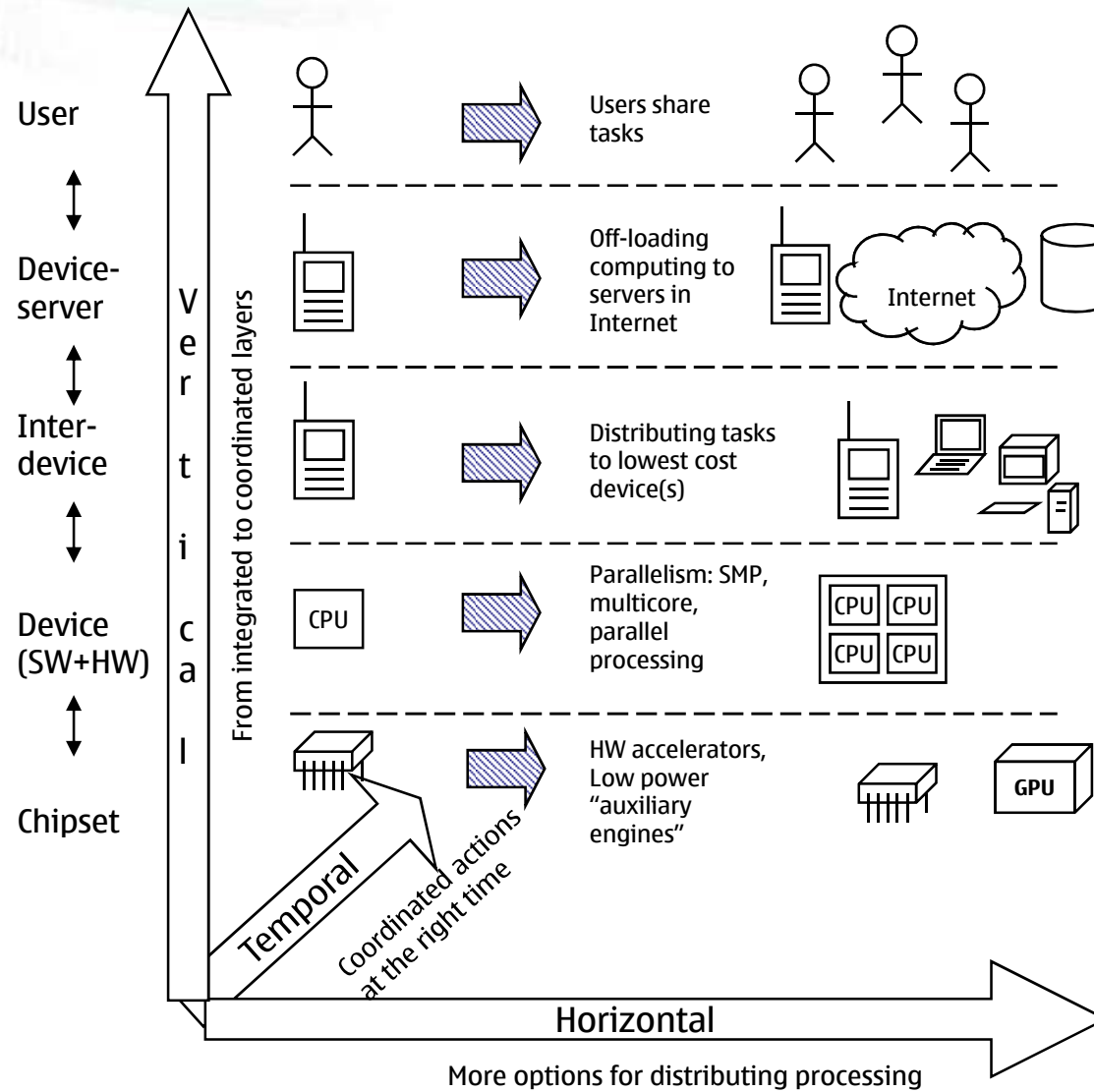
Vulnerable to network and peer variability



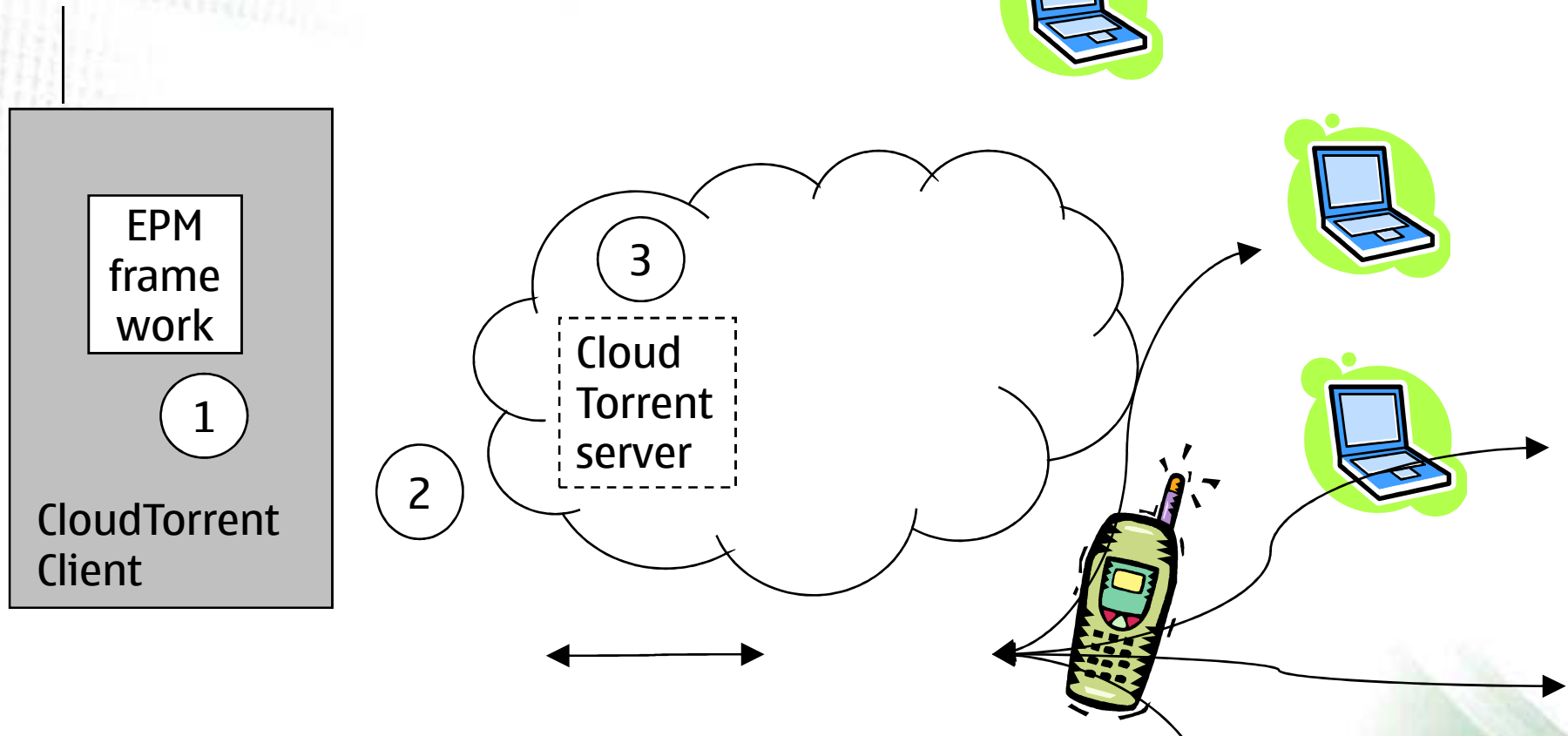


Holistic EPM

Dimensions of Holistic EPM



Example: Combining three axes to a common holistic algorithm



1) EPM framework
95%

+

2) Data transfer during 3G call
20%

+

3) Proxy in the cloud
30%

=

5% energy compared to normal BitTorrent



Thank You!

Questions?