Performance of Host Identity Protocol on Nokia Internet Tablet

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Outline

- Nokia 770 specifications
- Porting items
- Test environment
- Basic HIP properties and non-HIP characteristics measured
- Measurement results & Analysis
- Conclusions

Why Nokia 770?

- PDA with very limited resources
- Mobile client (HIP supports mobility)
- Great amount of applications that might utilize the benefits of HIP (*i.e. Internet Telephony, Web, Media etc.*)
- Linux-based (open source platform, easy porting)

Technical specifications

- *Processor*
  - a 220-MHz, ARM9-based Texas Instruments (TI) OMAP 1710
- *Memory*
  - 64 MB DDR RAM
  - user-available 64 MB of internal Flash
  - RS-MMC (Reduced Size – MultiMediaCard) slot up to 2 GB currently
- *Connectivity*
  - WLAN – IEEE 802.11b/g
  - Bluetooth 1.2
- *Power*
  - a 1500-mAh BP-5L Li-Polymer battery
- *Operating System*
  - Internet Tablet OS 2006 edition (embedded Debian)
    - GNOME-based graphical user interface
    - Linux 2.6.16 kernel

Porting HIPL to Tablet

- Customizing Tablet's kernel to support HIP
  - patching, configuring
- *Scratchbox* cross-compilation toolkit
  - cross-compiling the kernel and HIPL userspace code
- Packaging software to be deployed on the device
- Flashing kernel image, installing packages

Network Setup

Ubuntu 6.06 Dapper Drake
Linux Kernel 2.6.15.7

IEEE 802.11g

Intel Pentium 4 CPU 3.00 GHz
1 GB RAM

Tablet-to-PC

Tablet-to-Tablet

Laptop-to-PC

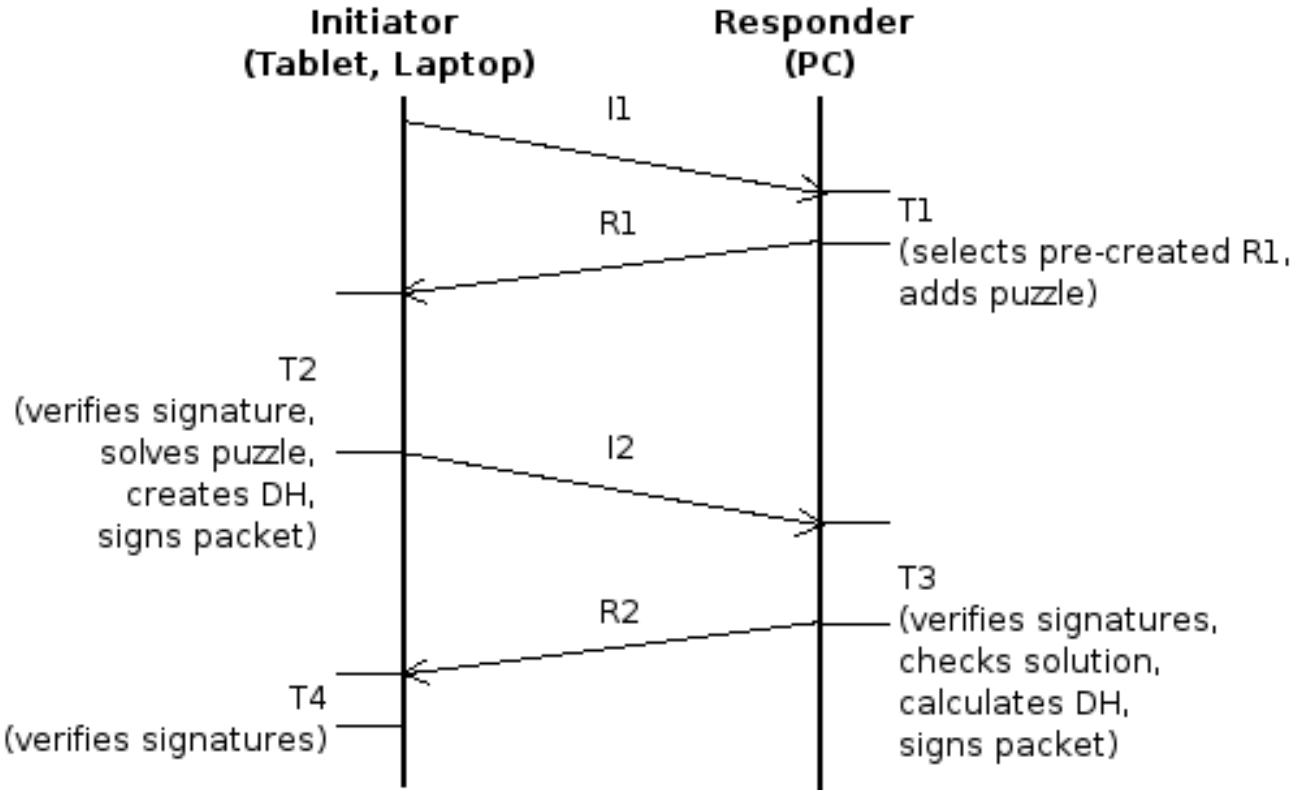
Intel Pentium 1.6 GHz
IBM R51 Laptop
1 GB RAM

Embedded Debian
Linux Kernel 2.6.16

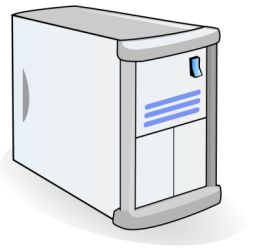
Basic Characteristics

- Duration of HIP Base Exchange
- Round Trip Time
- TCP Throughput
- Duration of Mobility Update
- Power consumption

Times Measured

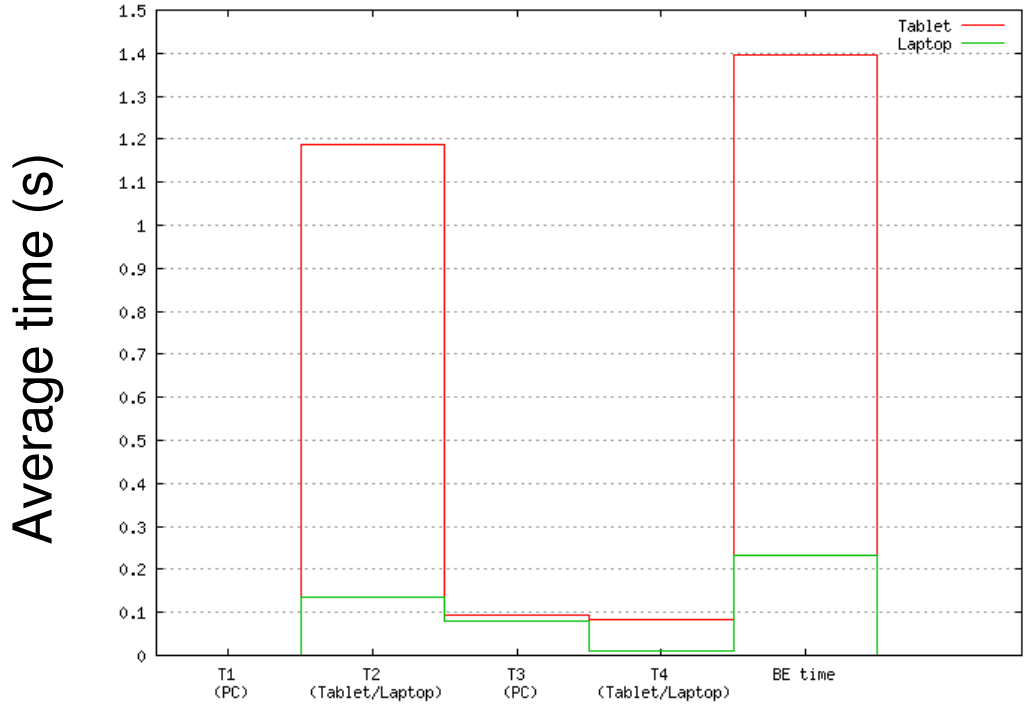


Mobile terminal

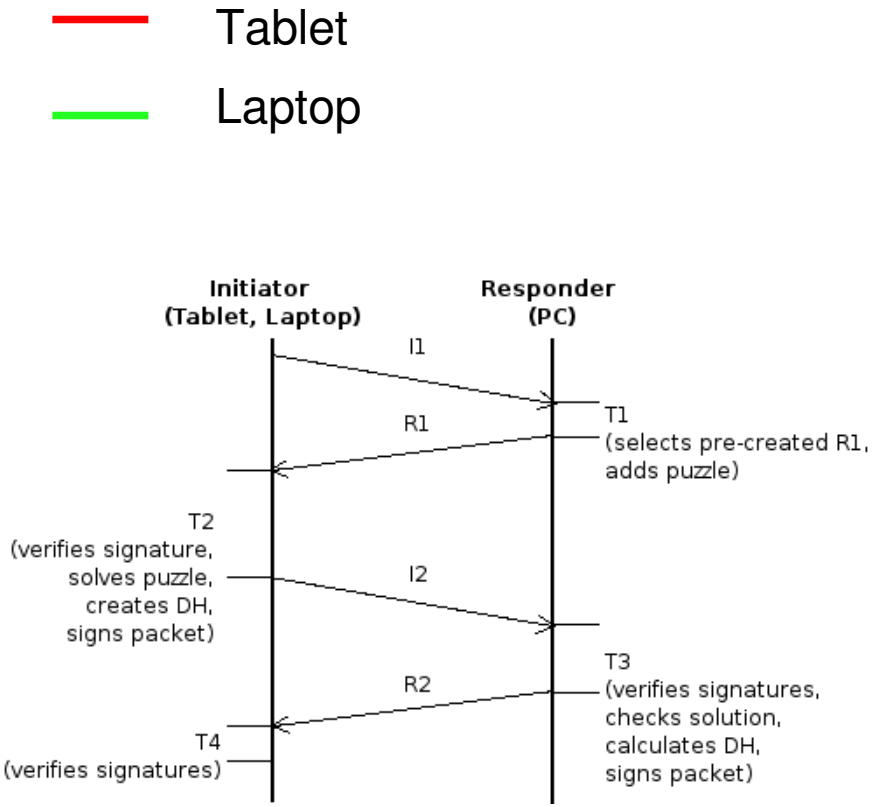


Server

Duration of HIP handshake stages

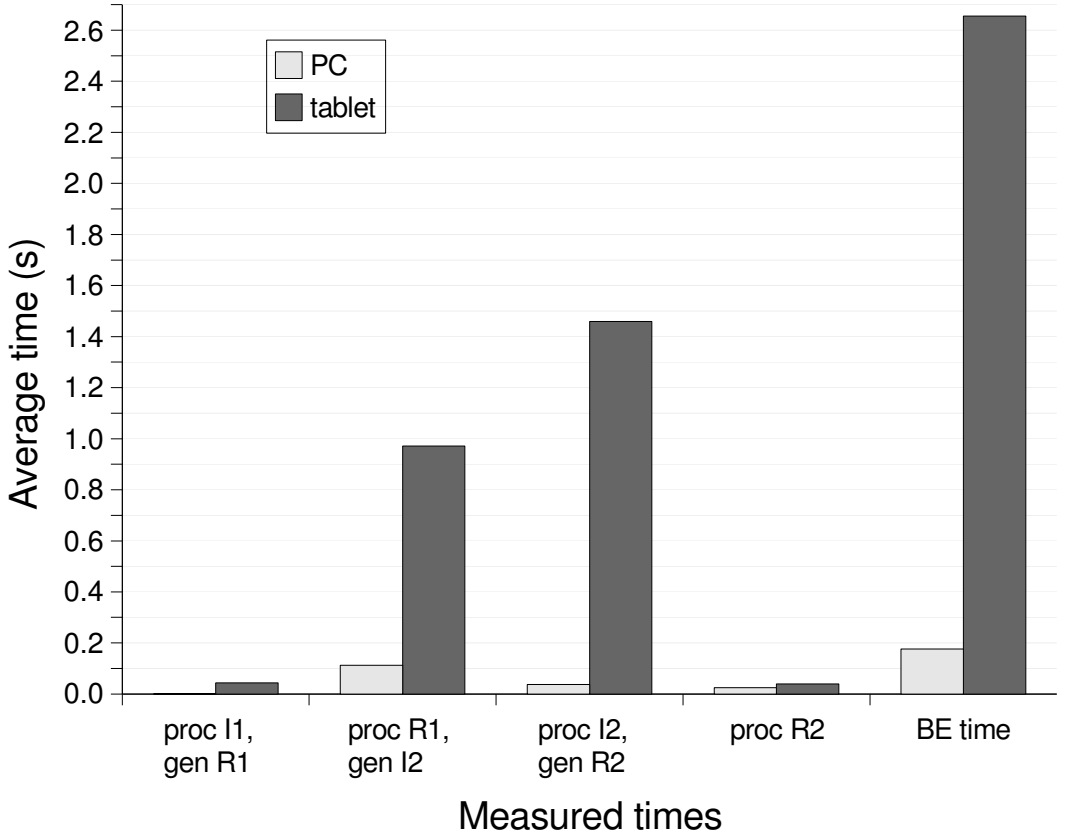


BE stages and total time



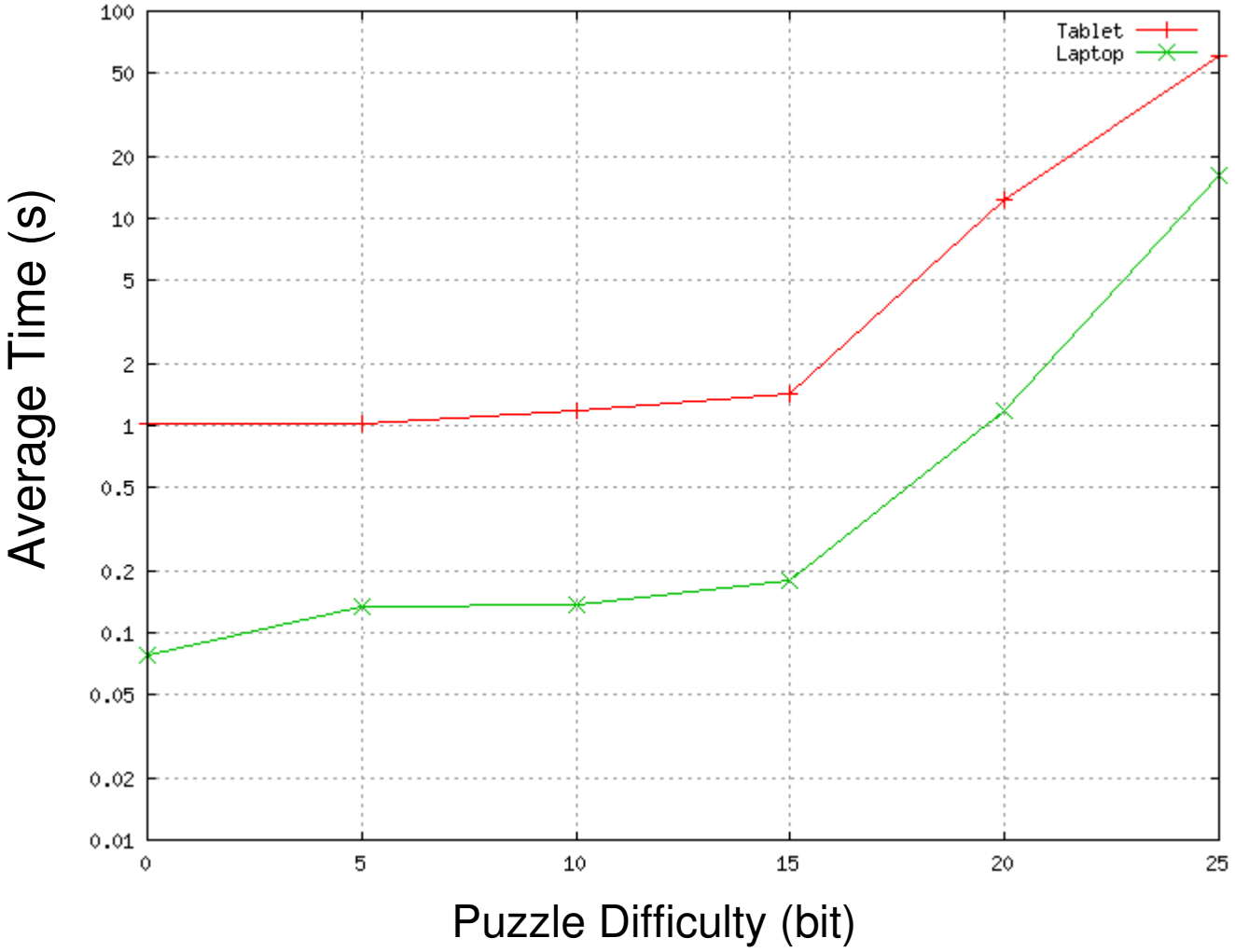
(1024-bit keys, puzzle difficulty of ten)

Duration of HIP handshake stages (2)



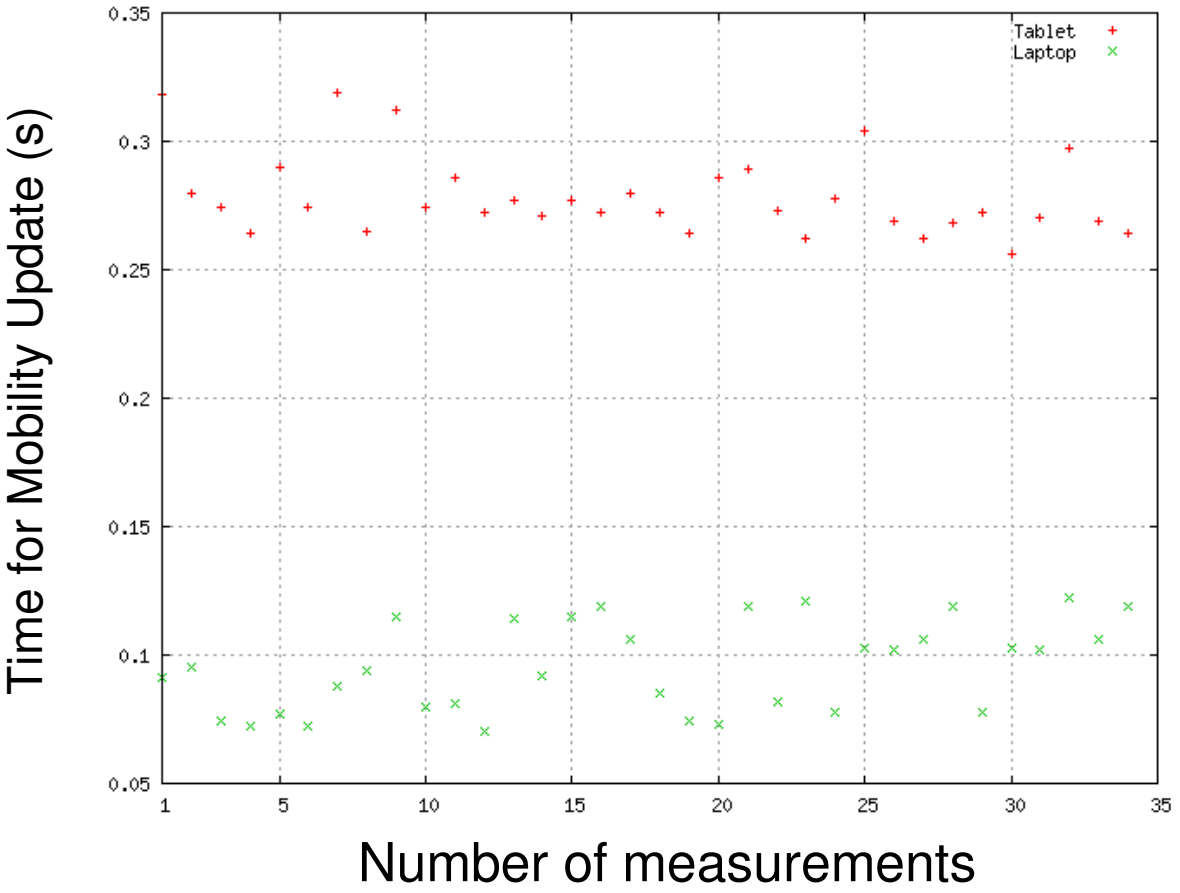
Results obtained from Tablet-to-Tablet and PC-to-PC scenarios

Puzzle Difficulty Impact



R1 processing time dependence on the puzzle difficulty

Duration of Mobility Update



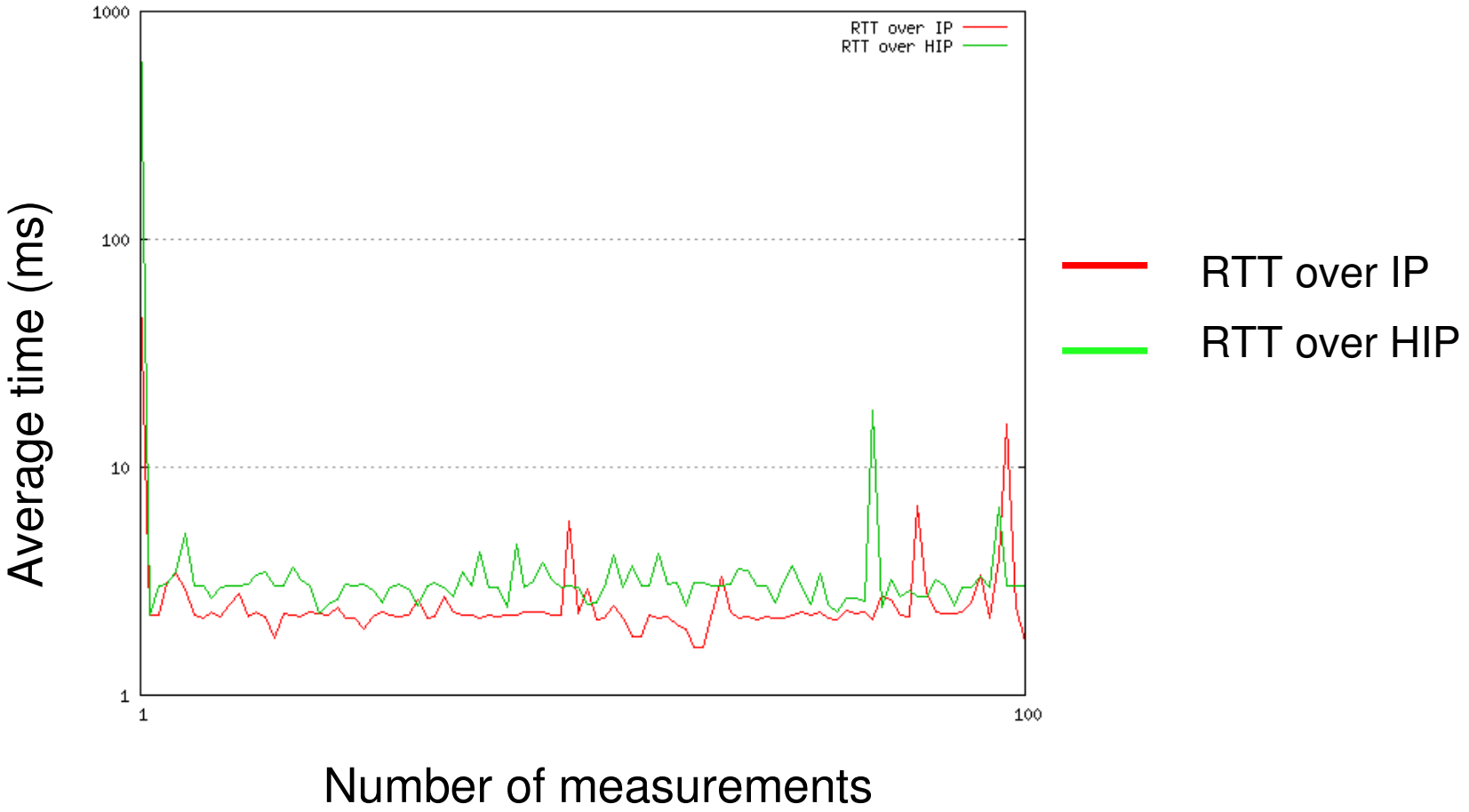
Average time: Tablet – 287 ms; Laptop – 100 ms

Round Trip Time

RTT	**Mean, ms**			**Standard deviation, ms**		
	IPv6 (64 B)	IPv6 (116 B)	IPv6/HIP ESP, 116B	IPv6 (64 B)	IPv6 (116 B)	IPv6/HIP (ESP)
PC -> Tablet	2.223	2.358	2.936	0.470	0.425	0.931
Tablet -> PC	1.901	1.900	2.748	0.332	1.235	1.347
PC -> Laptop	1.026	1.049	1.177	0.340	0.312	0.243
Laptop -> PC	1.065	1.070	1.207	0.338	0.427	0.502

Average Round Trip Time with various size packet

Round Trip Time (cont'd)



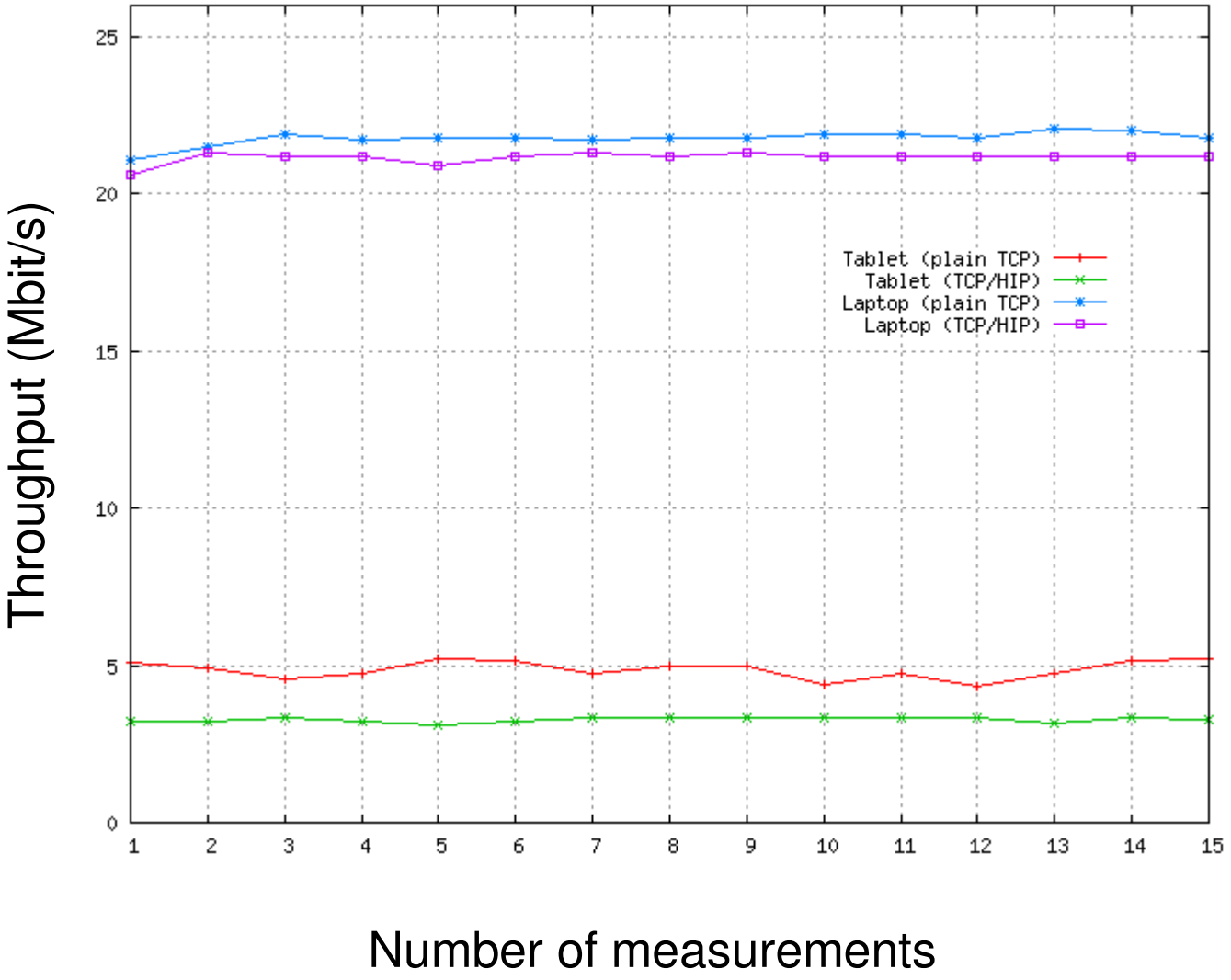
PC as the initiator of the HIP BE

TCP Throughput

Throughput	**Mean (Mbit/s)**				**Standard deviation (Mbit/s)**			
	TCP	TCP/HIP	TCP + WPA	TCP/HIP + WPA	TCP	TCP/HIP	TCP + WPA	TCP/HIP + WPA
Tablet -> PC	4.86	3.27	4.841	3.137	0.28	0.08	0.052	0.030
Laptop -> PC	21.77	21.16	-	-	0.23	0.18	-	-

Average TCP throughput in different scenarios

TCP Throughput (cont'd)



Power consumption

Applications/Mode	Current (mA)
HIP Base Exchange	360
ESP traffic (*iperf* with HIP)	380
Plain TCP (*iperf* without HIP)	380
Video stream from a server	> 500
Local video	270
Audio stream from a server	400 - 500
Local audio	200
Browsing (active WLAN)	350 - 500
Passive WLAN	120
Activating screen	120 - 140
Sleeping mode	< 10

Current consumption by applications

Power consumption (cont'd)

- Constant data transmitting over WLAN utilizes Tablet's CPU fully
  - in this case battery lifetime does not differ much for HIP and non-HIP applications (3.5 – 4 hours)
  - both control messages and data plane consume similar amount of power at a moment
- If compared to data throughput HIP does consume more energy than plain TCP/IP
  - ESP data encapsulation requires a notably longer CPU utilization to perform a task (send a certain amount of data)
  - The more time is needed the more energy will be consumed in total for an operation by the Nokia Tablet

Conclusions

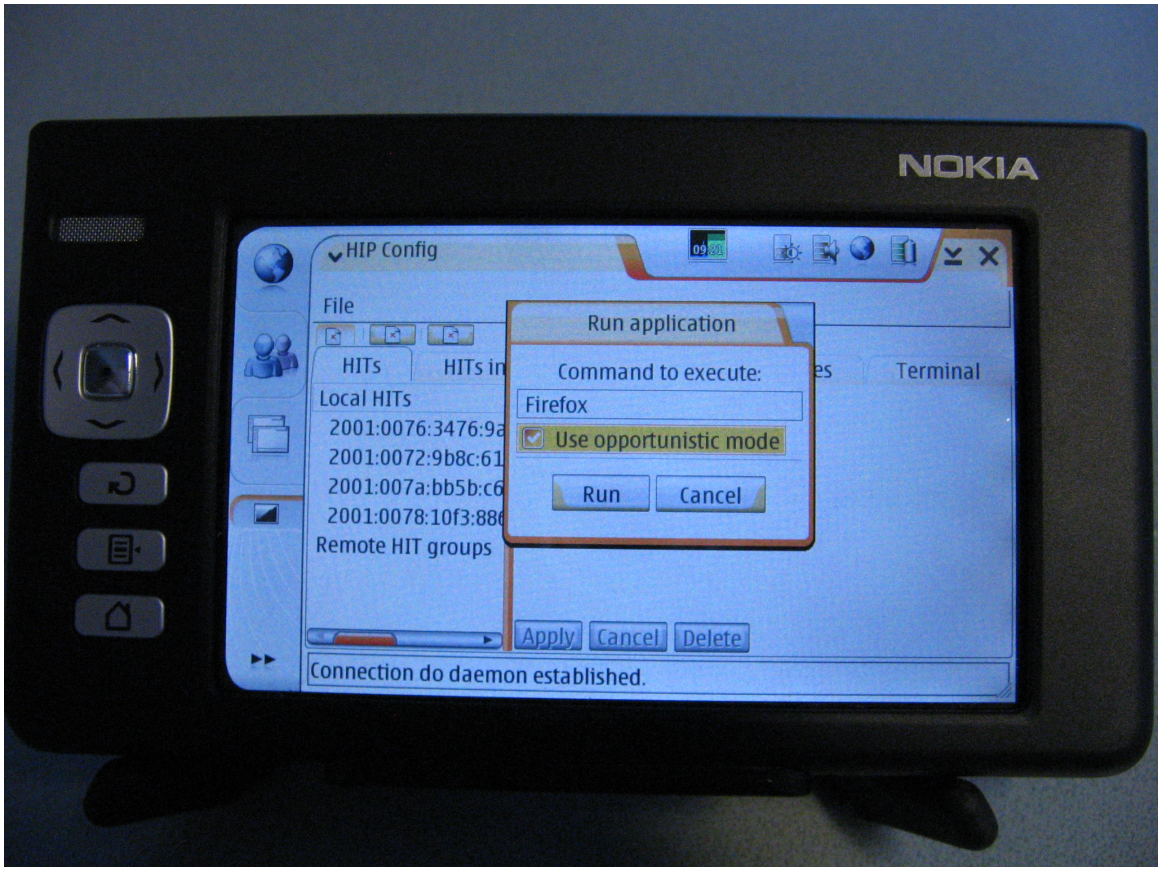
- Crypto operations cost much
  - Tablet-to-PC handshake consumes 1.4 sec
  - Two tablets need nearly two times more (2.6 sec)
  - Duration of mobility update 287 ms
- Results indicate the time for a single HIP association
  - in reality, there might be several associations at the same time
- Throughput and latency are seriously affected on the Tablet by ESP encryption involved with HIP
  - Tablet CPU constraints the accessible throughput over 802.11g WLAN to 5 Mbit/s (in contrast, 1.6-GHz laptop reaches 20 Mbit/s)
  - HIP reduces this value by 35 % for Tablet and by 3% for Laptop
  - The RTT is increased by HIP by 35-45%

Conclusions (2)

- What do results particularly mean for the end users?
  - How big delays will be in real life scenarios with different applications?
  - HIP influence on particular applications? (i.e. impact on QoS for VoIP, IP-TV etc.)
  - Benefits vs. overhead
- ...

Thank You! Questions?

- Packages and documentation available at
  `http://www.infrahip.net/MERCoNe`



HIP Mobility Update

Old IP

HIP Base Exchange

audio stream over HIP

Nokia 770 Mobile Node
HIP Initiator

HIP Update

Audio Streaming Server
HIP Responder

New IP