Deliverable FI3-D1.4.1
Implementation of multiaccess enhanced bittorrent for mobile devices

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Tivit Future Internet Program
(Tivit FI)

Period: 1.4.2011 – 30.4.2012

Tivit, Strategisen huippuosaamisen keskittymän tutkimusohjelma

Rahoituspäätös 1171/10, 30.12.2010, Dnro 2790/31/2010

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This work was supported by TEKES as part of the Future Internet programme of TIVIT (Finnish Strategic Centre for Science, Technology and Innovation in the field of ICT).

Executive summary / Internal release

Title: Implementation of multiaccess enhanced bittorrent for mobile devices

FI3-WP1 showcase implementation demonstrating the gains of multipath/multi-access communications together with optimized interface selection.

Content: Description of an implementation of multi-access enhanced BitTorrent.

Impact: The described implementation is a core part of WP1 showcase. It demonstrates that the developed solutions can be implemented in real equipment and network environments.

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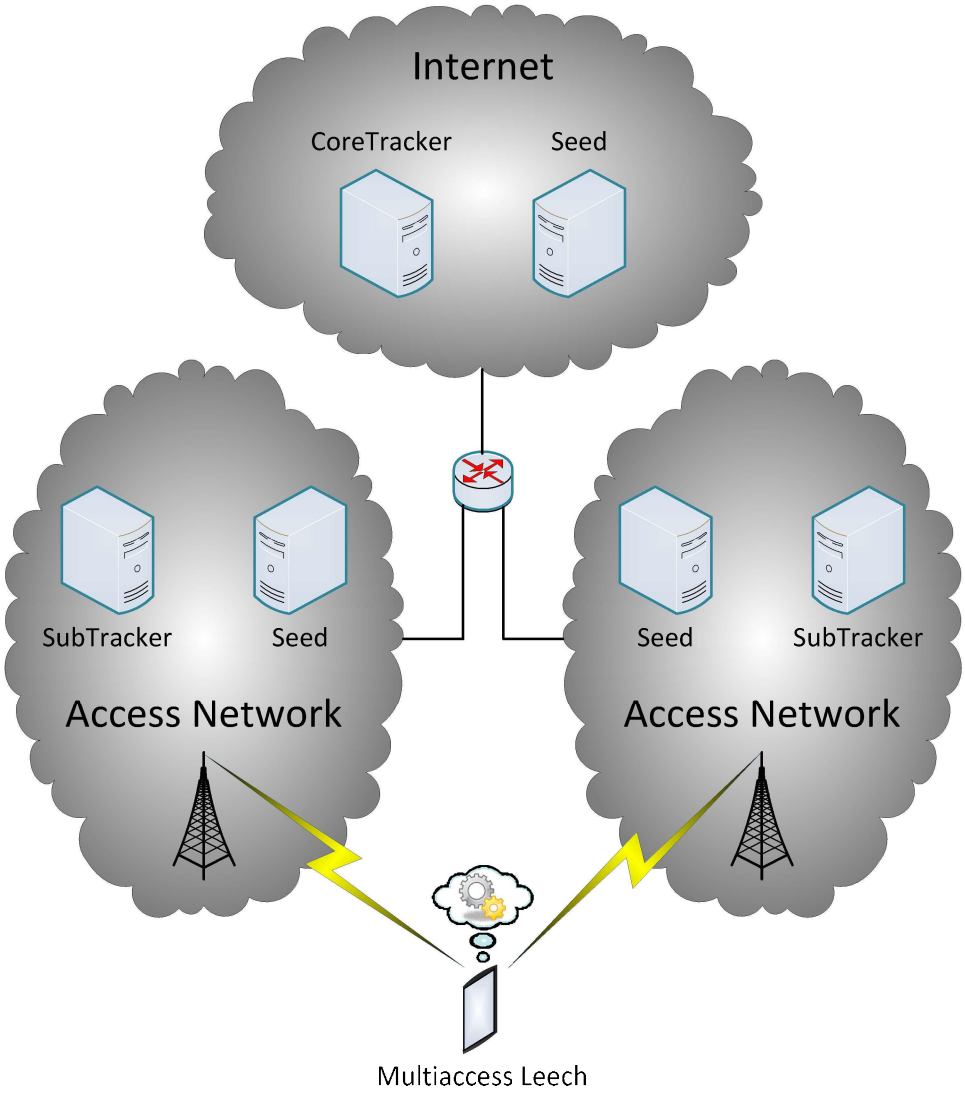
BitTorrent is one of the most popular peer-to-peer content distribution networks with a three-fourths share of peer-to-peer traffic, and more than one-third share of today's Internet traffic when measuring single protocols. In peer-to-peer systems, the actual content is replicated to a large set of peers, which results in enhanced download performance and scalability compared with traditional client-server based systems. It also allows the content to be downloaded from several peers simultaneously.

Modern end user devices are typically equipped with multiple, usually wireless, network interfaces such as 3G, WiFi and Bluetooth. This enables them not only to be used in various network environments, but also in principle to gain advantage from different technology networks overlapping each other and thus being available to a device simultaneously.

We have implemented a content distribution system based on the hugely popular BitTorrent able to cater for the multiaccess capabilities of modern end devices. In addition our prototype provides a method for downloading content as locally as possible from the nearest available source in the network which is beneficial not only to the user but also to the operator of the network as it reduces cross-operator traffic. With these qualities the prototype has shown to be able to provide high performance gains and reduce the amount of cross-domain network traffic while being also scalable.

The popular peer-to-peer content distribution network BitTorrent and modern multiaccess capable end devices are an efficient combo if equipped with enough intelligence to coordinate their actions in heterogeneous multiaccess environments. In BitTorrent, the content is inherently replicated to multiple locations, and if an end device intelligently chooses the location from which to download the content, it can optimize for example throughput or energy efficiency while also minimizing cross-domain traffic.

Our prototype employs this type of enhanced multiaccess capable BitTorrent implementation capable of intelligently choosing the sources of the downloaded data. This has in our experiments proven to be able to provide benefits for both the user and the network operator. With our prototype the user gains optimized operation in different aspects of the user experience such as the device's battery life or the download time. The relative importance of these criteria can of course be fine-tuned by the user. The operator on the other hand benefits from the reduced cross-operator traffic and the ability of the application to optimize its performance in case of dynamically changing operator policies which minimizes the disturbances this creates for the user.



IMPLEMENTATION OF MULTIACCESS ENHANCED BITTORRENT

INTRODUCTION

BitTorrent is one of the most popular peer-to-peer content distribution networks with a three-fourths share of peer-to-peer traffic, and more than one-third share of today's Internet traffic when measuring single protocols. In peer-to-peer systems, the actual content is replicated to a large set of peers, which results in enhanced download performance and scalability compared with traditional client-server based systems. It also allows the content to be downloaded from several peers simultaneously.

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BITTORRENT

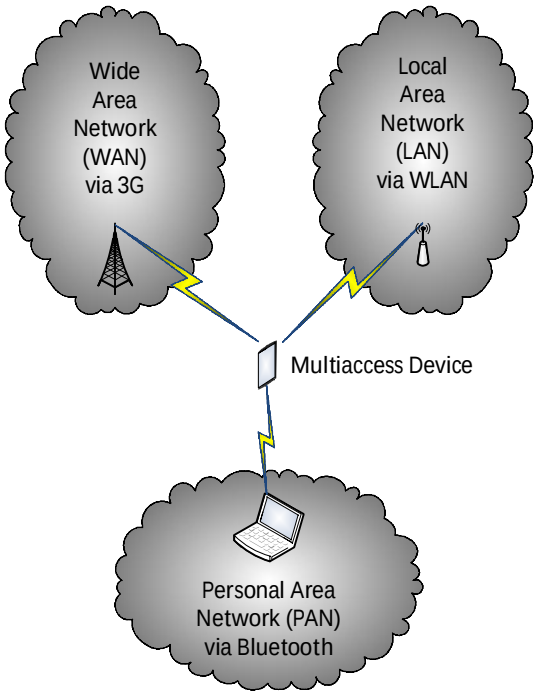
BitTorrent operates as follows: When a need for content distribution is observed, the first thing to be done is to create a .torrent file. The .torrent file cannot be created without having the complete data file. The client software at the initial seed, that is, the initiator of the content distribution, creates this .torrent file. After the creation of the .torrent, it is necessary to make the .torrent file available to other users. This is typically done by uploading the .torrent to a public (or a private) web server. Some of the tracker implementations also require it before servicing any peers. Finally, the initial seed opens the .torrent file with a client, contacts the tracker to join the swarm and is ready to upload the content. This is known as seeding. After these steps, the content is available to the leeches.

To download the content from other peer(s), a leech has to join a special torrent session that is separate from all downloads. The sessions are specified by the .torrent file, which contains metadata about the downloadable file and the tracker's Uniform Resource Location (URL). The first thing that has to be done before downloading is therefore to search and download this metadata file from, for example, a web server. Once the leech has the .torrent file, it opens the file with a client and asks for peers from the tracker with a tracker announce message. The tracker maintains a list of peers in the transfer session being the only centralized entity in a BitTorrent network (trackerless extensions are also available, e.g. DHT). The tracker does not participate in the actual content distribution; it only returns the peer list (for the first leech, the location of the initial seed) of this particular content distribution session. The leech contacts the initial seed and begins the download over BitTorrent's peer-wire protocol. Any additional peers wanting to download the content can use this procedure.

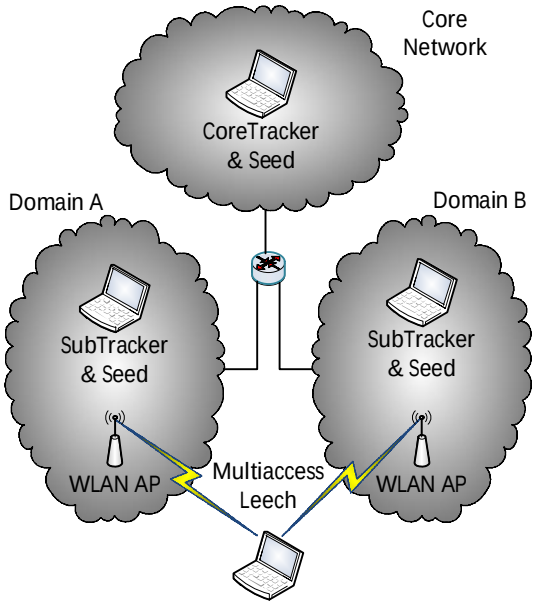
MULTIACCESS CONCEPT

The concept of multiaccess has become relevant, as modern end user devices are typically equipped with network adapters for multiple different network technologies. And on the other hand network environment has become more heterogeneous with multiple different networks with different technologies being available to the devices, even simultaneously. The concept of multiaccess simply means the ability of the devices to use these different networks, preferably intelligently and seamlessly.

An even more intriguing concept is that of simultaneous multiaccess, which is relevant when, two or more networks are available to a device at the same time. For example, if you have a WiFi access point in your home network and your Internet tablet has both 3G and WiFi interfaces, it is in principle able to connect to both your LAN via WiFi and the operator provided WAN via 3G while at home. A device able to intelligently use both of the networks simultaneously, i.e. use simultaneous multiaccess, could for example maximize its network throughput or the reliability of the network connection by doing so.



MULTIACCESS BITTORRENT PROTOTYPE

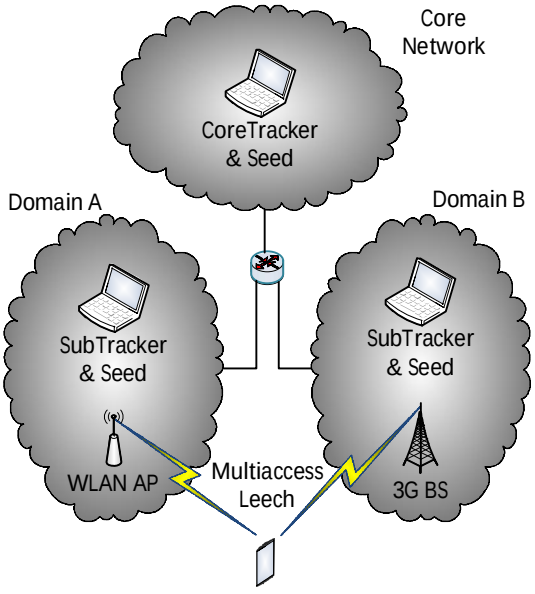


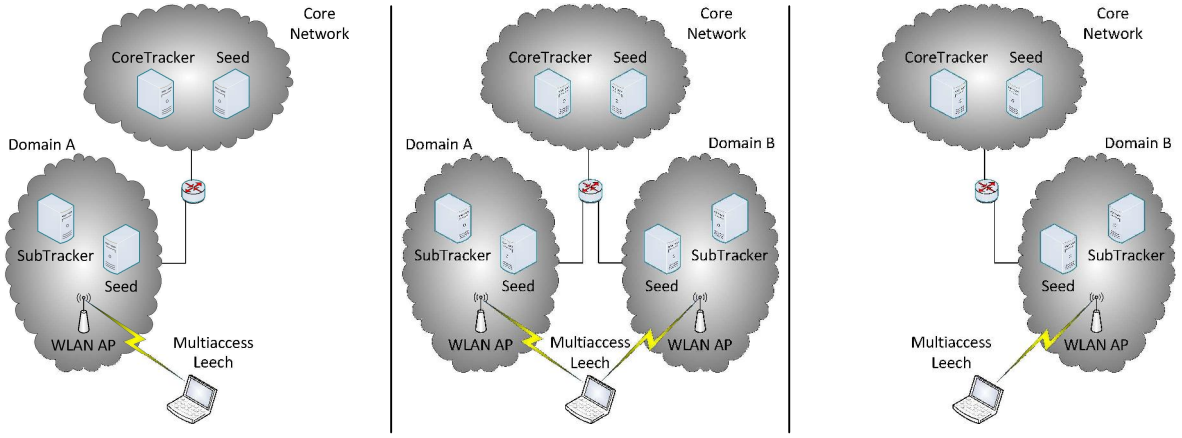
The prototype comprises of two wireless access domains ("Domain A" and "Domain B" which are separate subnets with different global IPv6 address ranges) and a third domain ("Core Network"). Each domain has a BitTorrent tracker and seed. These resources enable evaluating and demonstrating of different scenarios surrounding multiaccess BitTorrent. In our laboratory we have two running realizations of this three-domain concept: one with two WLAN access domains and laptop as an end device and one with WLAN and 3G access domains and a Nokia N900 smartphone as the end device. In both realizations the CoreTracker and the Seed are run in one laptop, as are the SubTracker and the Seed in both access domains respectively. The laptops have Ubuntu Linux operating systems and are connected to the network by 100 Mbps Ethernet connection. For the BitTorrent we use the IPv6-compatible BitTornado client, which we have extended to support simultaneous multiaccess. Traffic is localized through the two-tier hierarchy of CoreTracker(s)-SubTracker(s), which is coordinated by extending standard BitTorrent HTTP-based communication between the tracker and the client.

In the first realization both access domains have an IEEE 802.11g WLAN access point and the Multiaccess Leech is a laptop with two WLAN network cards which can access both domains simultaneously. In the second realization one access domain has an IEEE 802.11g WLAN access point and the other access domain is routed through TeliaSonera's IPv6 capable 3G network. The end device in the second realization is a Nokia N900 smartphone running a custom IPv6 enabled kernel.

The signalling of the BitTorrent software has been extended to support simultaneous multiaccess by adding a new field into the announce message (peer reguest) towards the CoreTracker. This field contains a domain identifier, which informs the CoreTracker of the domain(s) that the wireless end-user is currently connected. With that information, the CoreTracker is able to send the SubTracker address(es) of the domain(s) in an extended announce reply. After this the client at the end-user device contacts the SubTracker by standard BitTorrent mechanisms, and discovers the peer(s) in the domain(s) that are closest to the end-user.

Both of realizations use different criteria to decide which of the available interfaces the BitTorrent should use for content download. In the double WLAN setup information for decision making is gathered by probes monitoring the access points in the access networks and information sources on the device providing information on battery level of the device, energy consumption of the interfaces, received signal strength at the wireless interfaces and available BitTorrent peers in the domains. This information is further processed by a three-tier fuzzy logic system resulting in a simple preference value for each network interface which the BitTorrent uses to choose the suitable accesses. In the other setup the N900 also receives information on the load of the WLAN AP from a probe. In addition it receives access policies from the 3G network operator via ANDSF and monitors the availability of the interfaces based on DBUS messages on the devices. On the basis of this information the BitTorrent client chooses the most suitable interfaces for data transfer.





DEMONSTRATION SCENARIO

A basic demonstration and test scenario with the double WLAN realization of the concept could for example be the following; The Multiaccess Leech is downloading content within range of two accessa networks, but one of the networks is experiencing heavy traffic and thus the BitTorrent is choosing to download the content using only one interface, the one connected to the less used network. After a while the the level of the traffic lowers also in the second network which prompts the BitTorrent to employ also the second interface for the download, and gain full benefits of simultaneous multiaccess, almost doubling the received data stream. After this the traffic of other users starts saturate first chosen access point. As this escalates to a point where the received data stream through that access point is negligible compared to that of the second access point, the BitTorrent decides to continue using only the latter, thus doing its part in easing the load on the first access point while also conserving energy.

SUMMARY

The popular peer-to-peer content distribution network BitTorrent and modern multiaccess capable end devices are an efficient combo if equipped with enough intelligence to coordinate their actions in heterogeneous multiaccess environments. In BitTorrent, the content is inherently replicated to multiple locations, and if an end device intelligently chooses the location from which to download the content, it can optimize for example throughput or energy efficiency while also minimizing cross-domain traffic.

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The current prototype is of course just one step in the direction of an autonomous cognitive network engulfing both the network components and the end devices alike. This network forming an intelligently functioning cloud of devices incorporating self*-funtionality by being able autonomously distribute load, heal itself or route around broken fragments while all the time maximizing the QoE for the user and minimizing OPEX for the operator.

MORE INFO

Pentikousis K. & Rautio T. (2010) *A Multiaccess Network of Information*, WoWMoM 2010, Montreal, QC, Canada, 14-17 June 2010.

Rautio T., Mämmelä O. & Mäkelä J. (2010) *A Multiaccess NetInf: a prototype and simulations.* TridentCom 2010, Berlin, Germany, 18-20 May 2010.

Rautio T. (2010) *Enhanced Peer Discovery for Multiaccess Peer-to-Peer Networks*, Master's thesis, University of Oulu, April, 2010.

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