Deliverable D4.2.8
Work Package 4 results and achievements

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ICT SHOK Future Internet Programme
(ICT SHOK FI)

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Executive summary

Title: Work package 4 results and achievements

As Future Internet program is moving to the third phase, work package 4 has been merged with work package 1. Changes in available resources also imply changes to the mode of operation. The testbed and test facilities built in WP4 are now operated in a “maintenance mode”. This extracurricular deliverable sums up work, results, and achievements of WP4 so far.

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1 Introduction

As WP4 is moving to the third phase and the testbed and its facilities are continued in a maintenance mode, it became apparent that it would be useful to summarize the results and achievements of WP4 in an extracurricular deliverable.

1.1 Testbed: Collaboration, Connectivity, Coordination

ICT SHOK Future Internet Testbed is a collaborative concept for implementing a testbed for Internet research both for academic and industrial partners. The concept design and development was done in cooperation between CSC, Tampere University of Technology, Aalto University and Helsinki Institute of Information Technology. Once ICT SHOK Future Internet programme ends, the objective is that the testbed and its services will remain substantially the same as before, and will continue to be used for new services and Internet research in Finland. This objective is pursued by introducing and offering ICT SHOK Future Internet Testbed as a cross-programme testbed for Tekes. Utilising a single collaborative testbed would benefit both the testbed and several research programs requiring its services.

It is hoped that the number of testbed connections and the amount of testing performed will increase in the future. Demonstrations, dissemination and activity with relevant subject matter researchers will speed this up. Testbed participants are encouraged to offer services on the testbed. The offered services can be described and advertised by using service templates and wiki pages. The coordination activity continues to support the developers and testbed adopters on the route to the future networks.

First of the testbed's major benefits and one of its primary architecture design principles is its **collaborative** nature. Instead of designing and deploying overlapping testbed infrastructure, ICT SHOK Future Internet is designed to connect and provide existing research networks and services to a wider audience reducing this way operating and deployment costs. These existing services are then complemented with new testbed services such as dark fiber connectivity and enhanced IP connectivity services.

Enhanced **connectivity** is the second major benefit. In ICT SHOK Future Internet testbed the connectivity is provided on multiple levels from dark fiber to service interconnectivity. In between are the new, developed IP connectivity enhancements bringing the research network services on every academic or corporate researcher's desktop and reach. On an AAA level eduroam, Funet WLAN Roaming and Haka are utilised to provide cross-organisational authentication.

Collaboration and cooperation always need also **coordination**. The design and development of the concept was coordinated by CSC with Tampere University of Technology taking a lead role in architecture design and OpenVPN connectivity suite development coordination. CSC also coordinated and encouraged the testbed service adoption as well as facilitating testing and service provisioning.

ICT SHOK Future Internet testbed provides a cost-efficient collaborative testbed concept and architecture aiming at enhanced connectivity between academic and corporate research and development as well as providing an open innovation platform for new innovations combining both the existing and new services developed in Finland and abroad.

2 Results

In the ICT SHOK Future Internet Phase 2 program plan, generic goals and expected results of the work package (split between two activities) were described. We will take a look back and see how these have been realized.

2.1 Goals

Goal	Description	Result
G1	Testbed and some set of services continues to exist after the programme	YES
G2	Several city-wide or campus-wide networks are connected to the testbed	YES
G3	Programme partners enable service(s) in various different locations	YES
G4	Non-programme partner(s) also utilize the testbed	YES
G5	Several published research papers utilize and acknowledge the testbed	PARTIAL
G6	Several partners accept testbed as a service showcase and test environment	YES
G7	New partner breakthroughs are made by utilising testbed, its services or combining them in innovative ways	UNKNOWN

We summarize these briefly.

G1: moving into the third phase, testbed has been switched to the maintenance mode. Steps have also been taken to ensure the basic services are still available, also after the third phase.

G2: A metro ring network in Oulu was built, and a number of networks were connected (TUT, HUT Comnet, HIIT). Langaton Tampere and Sparknet (Turku) are also part of Funet roaming and as such the testbed; this is likely the largest WLAN authentication testbed in Finland.

G3: Services were available from Tampere, Espoo and Helsinki locations.

G4: “Wireless Tampere” community network was connected to Funet roaming infrastructure and as a result, as part of the testbed (press release 22.6.2009). More widely, the offered capability (e.g. Next media SHOK) did not result in immediate actions.

G5: WP4 is not aware if the research papers have acknowledged the testbed. A master's thesis was written (see below) on building a testbed service. Several papers have been published utilizing the testbed, but testbed has not been specifically acknowledged. EU FP7 Trilogy project has leveraged the testbed. Therefore it is obvious that the testbed has been utilized in research.

G6: The main users of the testbed were WP4 partners and it was used as a showcase in numerous occasions.

G7: It is not known if partner breakthroughs have been achieved.. WP4 partners have certainly been able to combine services in new ways.

2.2 Expected Results

We summarize these briefly:

Expected Result	Description	Result
NETRES1	The partners can co-operate and do research using network infrastructure which is operated by trusted party	YES
NETRES2	The partners can perform testing in more complex way that is possible in ordinary networks	YES
NETRES3	The test infrastructure and setups can be trusted to be stable and the essential parts of the test infrastructure continue even past the programme (with some to-be-specified terms)	YES
NETRES4	The test infrastructure is also provided to non-programme organisations (e.g. ICT SHOK Flexible Services or completely outsiders) on to-be-defined terms	PARTIAL

NETRES1: CSC, as part of its Funet network, has been the trusted party maintaining the network.

NETRES2: Multicast, Ipv6, and non-firewalled and unlimited connectivity have enabled more complex testing scenarios in some partners (at least HUT Comnet).

NETRES3: The centrally managed infrastructure has been stable. For example, HUT Comnet connection downtime between April 2010 and February 2011 has been two minutes, except for maintenance breaks at Comnet premises in May 2010. The essential parts of the testbed are continuing.

NETRES4: The infrastructure is provided and has been offered to non-programme organisations, but due to minimal interest, generic terms and conditions have not been defined.

Expected Result	Description	Result
SERVRES1	A service and test coordination framework is provided which clarifies the roles and responsibilities for all parties	YES
SERVRES2	Test partners are more easily found	YES
SERVRES3	The partners are aware of research activities which are in a testing phase	YES
SERVRES4	Most services are available to any partner at any Finnish location via testbed connectivity	YES
SERVRES5	An implementation of web-based OpenVPN configuration tool (certificates, etc.)	YES
SERVRES6	An plementation and a ready-to-use OpenVPN virtual image for a workstation use case	YES
SERVRES7	A ready-to-use OpenVPN embedded system	PARTIAL
SERVRES8	A ready-to-use OpenVPN server image, configuration and/or documentation	PARTIAL
SERVRES9	Services can be integrated and connected together with the help of testbed services such as federated authentication services	YES
SERVRES10	Introducing a new service to testbed and to other participants is possible quickly and efficiently	YES

We summarize these briefly:

SERVRES1: Deliverables D4.2.2 and D4.2.5, “service development framework”, as well as D4.1.2 on operational procedures described this.

SERVRES2: Newsletters occasionally included a Call for Testers announcement when a subject had come up. A test coordination page was maintained in Wiki.

SERVRES3: Newsletters and the wiki announced the testing phase of new research activities.

SERVRES4: Testbed connectivity reached all the cities where partners have presence. All connectivity requests were followed through.

SERVRES5: PurpleNet was released as open-source (multiple releases) and is available at sourceforge.

SERVRES6: Researcher's Virtual Desktop was released to the public, and the ISO image is available at a Comnet web page. This has been tested and demoed by others.

SERVRES7: OpenVPN embedded system has been available through the duration of the project, but getting it released and/or available to project partners for a longer term has stalled. This is still being worked on, however.

SERVRES8: PurpleNet documentation includes installation instructions also for the server. Separate instructions – directly applicable to the embedded system, for example – was left out of the agenda.

SERVRES9: Service integration has been possible. While not that many services have been offered, for example Langaton Tampere and HIP accounting testbed connecting to Funet roaming architecture is an example of such.

SERVRES10: A new service can be deployed quickly and efficiently, as evidenced by e.g. HIP accounting test.

2.3 Other results

In addition to deliverables listed in Section 4, the work also resulted in several more generic templates and processes that can be leveraged in the continuance of the testbed or internally (locally) in organisations. These include:

- A service description template, and the practices how to fill these up,
- A use case template, and the practices how to fill these up,
- Service development framework
- Operational procedures and a process chart for acquiring a connection

3 Use and dissemination

3.1 Newsletters

Newsletters on topical matters have been published and announced to the programme10-11 times a year. Newsletter has been used to announce new WP4 activities, changes in the services, for call for testers, etc. Overall, it has had significant dissemination function in the programme context.

In 2009 the following newsletters were published (note: 2009 01 through 2009 05 were part of the first phase of the programme).

Issue	Headlines
2009 01	First news bulletin released; First WP4 meeting held; Early version of testbed architecture; Planning and building the metro fiber ring in Oulu region; Call for Testers: HIIT/Gurtov seeks partners for HIP deployment
2009 02	WP4 Project Page Refocused; Preliminary testbed services announced; A case example of a Research Network: TUT Research Network; HUT Comnet built the first routed IP connection; ICT SHOK Future Internet in TREX workshop 2009; 2nd WP4 meeting held
2009 03	The next WP4 meeting on April 1st at 11.30 at HUT Comnet; Paavo Ahonen's article: Shokkihoidolla tulevaisuuden internetiin; The polytechnics are interested in WP4; Funet fiber optical network is progressing
2009 04	Use case examples; Tivit strategy seminar OpenVPN+IPTV demo; HIIT connectivity progress; Funet fiber optical network is progressing
2009 05	Aalto University joining Funet WLAN roaming architecture; HUT Comnet connected to the testbed; JAMK provides SpiderNet testing laboratory and seeks collaboration; Funet DWDM and FI testbed coverage 04/2009 and 12/2009
2009 06	Three deliverables finished: architecture, operations procedures, connectivity establishment report; The testbed architecture; The testbed operations procedures; The testbed connectivity establishment report; Seminar on the direction of the programme + evening sauna & snack on the 16th June 2009
2009 07	New Juniper routers in Funet enhance 1G and 10G connections; Funet fiber optical network extends to Oulu; Researcher questionary on field testing is being prepared, feedback sought
2009 08	Langaton Tampere joins Funet WLAN roaming federation; Testbed Service descriptions updated; TUT's OpenVPN web management solution, PurpleNet, is being Open Sourced; ICT SHOK FI presentation at NORDUnet2009 conference
2009 09	New opportunities opening to international co-operation; 10 gigabit testing planned in Tampere; OpenVPN virtual connectivity suite in development
2009 10	The ICT SHOK Future Internet testbed service development framework; The ICT SHOK Future Internet testbed services report; WP4 virtual connectivity demoed at TIVIT Foresight seminar 4.11.2009; Funet fiber optical network covers now most of Finland
2009 11	Testbed Survey results; Testbed architecture to be published as a TUT technical report; Call for partners: RadSec testing

In 2010:

Issue	Headlines
2010 01	10G connectivity available in Tampere; CSC donated a Juniper M20 router to HUT Comnet; New PurpleNet server installation instructions available; TREX Workshop 19.2.2010; Cloud Software SHOK emerging with connectivity needs
2010 02	TREX Workshop 2010 was a Success!; Aalto OpenVPN image connects desktop users to research network services; Funet WLAN roaming service update – new features, enhanced reliability
2010 03	The new Funet 10Gbps router backbone reached final extent; CSC donated another Juniper M20 router to University of Helsinki; WP4@SHOK Summit 20.4.2010
2010 04	OpenVPN and Wireless Roaming Demos at SHOK Summit; Aalto University's OpenVPN live-CD for Researcher's Virtual Desktop; Mobile WLAN Access-point Eduroam Configuration
2010 05	Featured testbed use case: Aalto University light paths; The revised version of testbed architecture completed; WP4 Testbed poster accepted for Terena Networking Conference
2010 06	Feature testbed use case: Comnet connection; Revised OpenVPN installation instructions for Ubuntu LTS 08.04 and beyond published; The revised version of testbed backbone operations procedures; Connecting Rovaniemi and Joensuu underway; WP4 Testbed presented at Terena Networking Conference (TNC2010)
2010 07	Featured testbed use case: PlanetLab; Funet DWDM network reaches Rovaniemi and Joensuu; Evolution of Funet DWDM network will be presented in CEF, Prague
2010 08	Featured testbed use case: Reseacher's Virtual Desktop; Call for Testers: OpenVPN-box test drive; Testbed solution for campuses disseminated
2010 09	Featured use case: International light path connectivity; WP4 deliverable D4.2.4 published: a summary of OpenVPN connectivity options; Future Internet Testbed @IT2010 Joensuu; Testbed service development framework and testbed services deliverables updated; Wireless support for Tivit Foresight 2010 and Mindtrek 2010 participants
2010 10	Featured use case: Mobile authentication in access networks; Testbed continues in the project 3rd phase, but WP4 is winding down; Future Internet presented at Funet Annual User Meeting 2010

And in the continuation phase in 2011:

Issue	Headlines
2011 01	Featured use case: Funet IP routed connection; Ipv4 to Ipv6 multicast translation service in the testbed; Ipv4 runout at hand: Ipv6 testing possibilities in the testbed; Funet WLAN Roaming utilised in testing WP3 non-repudiation work; Call for Testers:OpenVPN Suite test drive
2011 02	NAT64 tests starting in TUT; Ficora/ISOC seminar on Ipv6 on April 4th, 2011; Call for testers: eduroam WLAN access point test drive
2011 03	WP4 closes – the final newsletter; Memorandum of Understanding on testbeds: services will contiue; WP4 highlights deliverable published; Funet DWDM network update: new sites in Helsinki and extensions elsewhere; Future Internet Testbed International Collaboration with IIP/Poland; Future Internet Testbed in GN3 Ipv6 workshop

3.2 Presentations and posters

Testbed presentations in various conferences and/or internal events picked up pace in 2010. In addition, a couple of roll-ups and posters were prepared and these were present in various events:

- 16.6.2009, FI 2nd phase kickoff: Huhtanen/Savola on WP4 Phase 2 objectives
- 19.2.2010, TREX Workshop 2010: Huhtanen K., Savola P., ICT SHOK Future Internet WP4 Testbed

- 19.2.2010, TREX Workshop 2010: Huhtanen K., Roaming with Wireless Tampere and FunetWLAN Roaming
- 31.5.2010, Terena Networking Conference, Huhtanen K., Miettinen J., Savola P., ICT SHOK Future Internet Testbed poster.
- 4.6.2010, AAPA (Funet polytechnics forum), Jari Miettinen on Funet services and testbeds.
- 18.8.2010, Funet työvaliokunta (members meeting): Pekka Savola on ICT SHOK FI: “Tutkimusryhmien tietoverkkotarpeet ja ratkaisut”.
- 13-14.9.2010, Customer Empowered Fibre workshop, CZ: Matti Laipio on Funet DWDM Backbone roll-out 2008--2010.
- 12-13.10.2010, "Yliopistojen IT-päivät" (Universities ICT seminar): a stand with ICT SHOK FI and testbed roll-up.
- 30.11.2010, Funet tekniset päivät (annual meeting): Peuhkuri on Future Internet.
- 15.2.2011, Future Internet results seminar: Huhtanen on PurpleNet – OpenVPN management solution.
- 15.2.2011, Future Internet results seminar: Peuhkuri on Researcher's Virtual Desktop using OpenVPN Tunneling.
- 25.3.2011, GN3 IPv6 workshop: Kiviniemi on IPv4 to IPv6 multicast Translator; Suhonen on NAT64.

3.3 Software and other publications

WP4 participants have published the following open-source software:

- PurpleNet, OpenVPN User Interface, with revised installation instructions (http://purplenet.sourceforge.net/installing-purplenet-ubuntu-8.04-lts.txt)
- OpenVPN live-CD for Researcher's Virtual Desktop (http://www.netlab.tkk.fi/tutkimus/fi-shok/usecase.html).

Iikka Jaakkola, when working on the latter software, published a Master's thesis “ Virtuaalikone ja -verkkoympäristön hyödyntäminen tietoverkkotekniikan tutkimus- ja opetusympäristöjen rakentamisessa” (Aalto University Faculty of Electronics, Communications and Automation. June 2010).

3.4 Collaboration

WP4 had a number of collaboration activities, both internally, nationally and internationally:

- Center for Internet Excellence (CIE, Oulu) was contacted, but there was no response.
- Testbed survey: creating and sending the survey and results analysis was conducted
- An international collaboration meeting was held (with NORDUnet APAC, NA regions director) and the topic was also discussed in NORDUnet conference.
- A Letter of Support for EU IST Ozone (aka Onelab3) project was written and LoS was discussed with MANTICORE project.
- A future internet project in Poland (IIP) contacted us in March 2011.

3.5 Testing and testbed usage

- Funet DWDM, fiber optic network, and 10G router coverage increased during the program so that light paths or routed IP connections became cost-effectively available anywhere in Finland.
- Two routed IP connection (HUT Comnet, HIIT Kumpula) were built, tested and regularly used. The former has also been published and disseminated in various events. A couple of others were also discussed but were discontinued due to various reasons. A couple of light paths were also tentatively discussed, but were mostly discontinued due to the missing drivers for deployment.
- D4.2.6 (testbed services) lists 18 available services and categorizes them in a table. D4.1.1 (testbed architecture) lists 16 use cases which demonstrate the applicability and combine these services.
- Seven Call for Testers (participants sought) articles were published in the newsletter or otherwise recorded. (HIP deployment in 2009/01, OpenFlow in 2009/03, JAMK in 2009/05, Peer-to-peer Radius/RadSec in 2009/11, OpenVPN box test drive in 2010/08 and 2011/01, Eduroam WLAN access point test drive in 2011/02)
- Some 5-6 rather tentative ideas were discussed and recorded in testing coordination wiki. In addition, there were 9-12 tentative ideas which were also pursued and recorded in the wiki. Some of these were concerning international or external collaboration.
- Funet WLAN roaming is used in HIP non-repudiation test (Newsletter 01/2011)

3.6 Demos

- TIVIT Foresight seminar (November 2009) had a demo stand with OpenVPN connectivity suite demos
- SHOK Summit (April 2010) had three demos (two OpenVPN, one Langaton Tampere/WLAN roaming), Future Internet testbed slideshow, and a roll-up.
- Tivit Foresight Seminar and Mindtrek (October 2010) had a wireless Funet roaming/eduroam-capable network.
- FI results seminar (Feb 2011) had two demos and the poster.
- GN3 IPv6 workshop (Mar 2011) had a demo, poster and some material.

Rollups and posters have also been present at a couple of other events. Printouts from public deliverables have usually been available at these events as well.

4 Deliverables

The following table lists the deliverables as listed in the second phase program plan. With the exception of test bulletins, all of these are public and are available at www.futureinternet.fi. The contiuance reports that were initially scheduled as a part of the continuance of the second phase have been superseded by the third phase deliverables.

Deliverable	Name	Due	Status
DA4.1.1	The 2nd version of testbed backbone architecture	May-10	DONE May-10
DA4.1.2	The 2nd version of testbed backbone operations procedures	May-10	DONE May-10
DA4.1.3	The report on continuance of the network	May-11	NEXT PHASE
Deliverable	**Name**	**Due**	**Status**
DA4.2.1	Test bulletins and calls for partners(multiple)	Multiple	DONE 19 Jun-09 through Mar-11
DA4.2.2	The initial service development framework	Oct-09	DONE Dec-09
DA4.2.3	The initial report of testbed services	Oct-09	DONE Dec-09
DA4.2.4	Terminal connectivity enhancement solution (OpenVPN)	Jan-10	DONE Sep-10
DA4.2.5	The updated service development framework	Oct-10	DONE Oct-10
DA4.2.6	The updated report of testbed services	Oct-10	DONE Oct-10
DA4.2.7	The report on continuance of the services	May-11	NEXT PHASE
DA4.2.8	Work Package 4 results and achievements	-	DONE Mar-11

Two versions of testbed backbone architecture (D4.1.1) were also printed in Tampere University of Technology. Department of Communications Engineering research reports series (2010:1).

5 Conclusions

It was expected that it might prove difficult to actually get people to use the testbed: doing so would take researchers' time off from other, often more straightforward activities and funding, administrative and operational issues might also cause bottlenecks. Nonetheless, WP4 was active in building up capabilities and disseminating testbed possibilities both internally (monthly newsletters, surveys, presentations) and externally (demos, posters, presentations, public deliverables).

During the latter half of the second phase, WP4 focused on OpenVPN-related services, and a number of prototypes were developed and open-sourced. These were also demoed in numerous events. These could form a basis for either virtualized testing later on or could be used in breakthroughs elsewhere.

Developing service descriptions and use cases give an overview of the testbed potential and how it had been used in a couple of occasions. These also provide a foundation for future work.

There was significant collaboration between organizations and a testbed and connectivity mechanisms were built together. A particular example of such are the aforementioned suite of OpenVPN connectivity tools, developed and shared in a joint fashion. These tools form a basis which can be used in a cost-effectively and simply in the future in direct collaboration, as a platform in TEKES or other projects – there is no need to re-invent and rebuild the same infrastructure.