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REDUCING INTERNET TRANSPORT LATENCY

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Contents:
Deliverable 5.4. QMR11: Report describing the status of the project up to this point.

Financial situation at the end of the quarter

On July 22nd an amendement to the DoW was submitted to the Commission, for adding a web use- case and testbed, and close the financial traffic use-case. Redistribution of resources in order to address the changes described in the amendment were negotiated between the partners individually, and will not have implications for the total requested funding.

The financial report for period 2, from 01/11/2013 to 31/10/2014, was accepted in July 2015. The delay for concluding the financial reporting was caused by necessary corrections to the Form C for some beneficiaries. After EC assessment and approval, SRL received a total amount of 402 954 EUR in July. The payment was distributed among partners in the beginning of August.

Human resources

KaU

The project at Kau is being run by Prof Anna Brunstrom. Per Hurtig, Assistant Prof., Mohammad Rajiullah and Kiran Yedugundla, PhD students, are also working in the project. Dr Stefan Alfredsson and Dr Johan Garcia are funded independently, but are supporting Kau's measurement studies in cellular networks.

UiO

The project at UiO is being run by Prof Michael Welzl, assisted part-time by Prof Stein Gjessing. UiO has recruited David Hayes as a 100% hired postdoc in the project. UiO currently has two students, Safiqul Islam and Naeem Khademi, funded independently, but who make significant contributions to RITE. In the two last quarter, Runa Barik, also an independently funded Ph.D. student, has made contributions.

UoA

The project at UoA is being led by Prof G Fairhurst and Postdoc Raffaello Secchi (100% funded by RITE), assisted by Chamil Kulatunga (100% funded by RITE). The UoA team has been joined by 2 new full-time personnel to support our WP3 activities.

IMT

The project at IMT is being run by Dr. Nicolas Kuhn. Xavier Corbillon has joined IMT as a 100% RITE-funded engineer in March. Nicolas Montavont, Gwendal Simon and Géraldine Texier are funded independently, but are supporting IMT's work on WP1 as students' projects coordinator, or as a mathematical support for the activity on schedulers.

SRL

The project is coordinated by Dr. Andreas Petlund. Dr. David Ros, Prof. Carsten Griwodz, Prof. Pål Halvorsen, Postdoc Iffat Ahmed and Postdoc Ragnhild Eg all contribute to the scientific work. PhD Students Olga Bondarenko and Minoo Kargar Bideh also contribute to the project, but are funded independently. Since July'15 Bob Briscoe has been working for SRL to help complete the obligations passed over from BT.

ALU

For ALU, Koen De Schepper (principal investigator), Inton Tsang and Siyu Tang are contributing to the project.

BT

After Bob Briscoe left BT in May 2015, the principal investigator at BT is Dr Andrea Soppera. Achilles Petras are supporting the work on the newly defined programme of testbed work, having agreed in principle with the PO to complete BT's finance testbed work and shift the focus to Web use-cases on ALU's broadband testbed, with BT working alongside.

Bob Briscoe left BT on 31-May-2015. It is expected that the overall project's ability to deliver will not be affected. The PO is being kept informed of proposed shifts in responsibilities from BT to ALU or SRL for the last few months of the project. The proposed plan to shift responsibilities and budgets is generally favourable to all concerned, therefore it is expected that formal sign-off will not be problematic.

MEGA

Megapop is represented by Christian Tellefsen (CTO). Jørgen Tharaldsen (CEO) assists in dissemination topics and reporting.

Participant Acronym	Names and categories of staff	WP 1		WP 2		WP 3		WP 4		WP 5		Total	
		Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual
SRL	Andreas Petlund, Dr. Carsten Griwodz, Professor Pål Halvorsen, Professor Iffat Ahmed, Post Doc. Olga Bondarenko, PhD Student Minoo Kargar, PhD Student David Ros, Dr. Ragnhild Eg, Post Doc. Elisabeth Andersen, Adm.	33	29,47	9,63	7,67	6,40	5,21	6,90	5,38	18,3	17,43	73,73	65,16
BT	Bob Briscoe, Chief Researcher Achilles Petras, Principle S&IT Andrea Soppera, Principal S&IT Phil Eardley, Senior Researcher	0	0	15	12,38	5,42	8,05	4,5	7,24	0	0	24,92	27,67
ALU	Koen De Schepper Ing-Jyh Tsang Siyu Tang	0	0	38,5	38,58	17	20,68	1,76	1,72	0	0	57,26	60,98
UiO	Michael Welzl, Professor. Stein Gjessing, Professor. David Hayes, Post Doc. Naeem Khademi, PhD Student Safiqul Islam, PhD Student Runa Barik, PhD Student	33	42	8	13	4,5	4,5	2,5	7	0	0	48	66,5
KaU	Anna Brunstrøm, Professor. Per Hurtig, Post Doc. Mohammad Rajiullah, PhD Student Kiran Yedugundla, PhD Student Stefan Alfredsson, Dr. Johan Garcia, Dr.	39,38	41	5,5	5,05	3,63	3,85	1,76	1,84	0	0	50,27	51,74
IMT	Nicolas Kuhn, Post Doc. Xavier Corbillon, Researcher Fellow Nicolas Montavont, Dr. Gwendal Simon, Dr. Géraldine Texier, Dr.	20,15	21,95	25,65	24,29	3,65	3,07	1,82	1,69	0	0	51,27	51
UoA	Gorry Fairhurst, Professor. Rafaello Secchi, Researcher Fellow Chamil Kulatunga, Researcher Fellow Tom Jones, Research Assistant Iain Laermonth, Research Assistant	0	2	33,88	34	12,76	18	3,63	8	0	0	50,27	62
MEGA	Christian Tellefsen Jørgen Tharaldsen	1,83	1,50	0	0	5,5	4,80	0,91	0,88	0	0	8,25	7,18

Figure 1: The cumulative budgeted and contributed person-months since project start for each partner sorted by Work Package.

Project progress

Scientific work

Multipath Activity

In the activity on "Using Multiple Paths to Reduce Latency" we are making ready for the final evaluations in the project and preparing our results for publication. The evaluation of how multipath transport affects the performance of gaming, interactive video and web browsing has been completed and we are working on the final polishing of the paper reporting the results before submission. The Linux implementation of our enhanced MPTCP scheduler that in addition to the measured path RTTs takes the expected evolution of the congestion window and the available data into account has been completed. Evaluations of the algorithm are ongoing, both in an emulated environment and in the real 3G / Wi-Fi testbed in Rennes. To improve the Slow Start phase of MPTCP when sub-flows share a common bottleneck, our Linked Slow start Algorithm (LISA) couples the path rate increases to improve latency by reducing retransmissions and the queueing delay and loss inflicted on other flows. A LISA prototype has been implemented in the Linux kernel and its performance has been evaluated with good results. The results have been documented and submitted to ACM CONEXT.

Traces and measurement Activity

In the "Traces and Measurement" activity, we are currently disseminating the last parts of the work as publication submissions. The CAIDA trace analysis paper is being reworked for resubmission, most likely to a journal. The AQM active measurement tool work is near completion. Here, we are planning to submit one paper to "ValueTools" focusing on the tool itself and one paper to "Passive and Active Measurement" (PAM) with the full evaluation results and analysis, both from "in-the-wild" measurements and from the testbeds.

Networks signals Activity

By integrating and evaluating the RITE mechanisms related to "network latency improvements by making a better use of explicit network signals", a set of important mechanisms has been identified that were brought together in a deployment and migration roadmap. These mechanisms have been extensively disseminated in appropriate IETF working groups and submitted to or presented in conferences.

- UiO and UoA have collected inputs on their initial draft to say why ECN is useful (draft-welzl-ecn-benefits-00) and submitted an update for the Prague IETF meeting (draft-ietf-aqm-benefits). This draft has completed IETF WGLC with an intention to publish as an Informational Document. The draft is currently in AD evaluation and will be updated after the review is completed and then submitted for general IETF review.
- BT, supported by UoA has drafted two liaison statements between the IETF and respectively the IEEE and the 3GPP. The liaisons are to solicit input to the IETF draft giving guidelines on the addition of explicit congestion notification to protocols that encapsulate IP. The IEEE liaison found no objections, and the 3GPP liaison is still generating discussion between the two organisations.
- UoA evaluated support for ECN in the Internet by measuring traversability of ECT/CE codepoints and ECN-related TCP flags from three vantage points to a large selection of webservers (over 500,000). Brian Trammell (from ETHZ outside RITE) collaborated on this measurement study with providing the base for the tools and assisting with performing the measurements. A second study explored a different scenario, joint UoA and SRL. This confirmed the results found in the original study. Experiments were also conducted in this quarter at UoA to explore the impact of home gateways, and complete the above measurement campaign. This work contributes to WP2 and WP3.
- UiO and UoA completed joint work on new transport methods that can utilise ECN signalling in the general Internet. This method, Alternative Backoff with ECN, or "ABE", has been evaluated using simulation and local testbeds. The results have been available in a project report - available to partners that describes joint work with an external partner (on the RITE advisory board). Work is underway to release a public version of this report. An individual Internet draft, draft-khademi-alternativebackoff-ecn-00, has been produced, "TCP Alternative Backoff with ECN". This has been presented at the IETF TCPM WG in Prague, and is to be evaluated by the IRTF the ICCRG. Further updates are expected. A joint publication is being prepared on this work.
- UoA completed integration of the ECN ABE mechanisms into the Linux release to be used in the ALU testbed scenario (to be evaluated in WP3).
- SRL, ALU and BT have further evaluated the Dual Queue Coupled AQM with a Priority scheduler on the video test-bed. Next to flow fairness between TCP-Cubic and DCTCP, also dynamic scenarios were evaluated, showing stunningly small queuing delays for DCTCP traffic. A graphical user interface was added showing live throughput, drop/mark probabilities, link utilisation and queuing delays, for demonstration purposes. This successfully showed the DualQ Coupled AQM in IETF during a presentation in the AQM working group and provided an open demonstration during the plenary bits-n-bytes session at the Prague IETF.
- ALU, BT and SRL have proposed DCTCP improvements to support Internet compatibility and further low latency improvements in line with TCP' (PRIme). During IETF in Prague we organised an ad-hoc BarBof to define an action plan to get these improvements implemented in platforms supporting DCTCP. An IETF mailing list was setup, and called TCP-Prague as the resulting TCP would not be restricted to Data Centres anymore.
- See also the 'GUTS' activity report later for progress on the Accurate ECN (AccECN) modification to TCP, which ensures more immediate ECN signalling is rapidly fed back to the source. AccECN is a prerequisite for deployment of more immediate ECN signalling, as well as for GUTS.

Testbeds Activity

In the previous quarters the testbed activities focused on assembling the implementation of selected techniques developed by WP1 and WP2 for the respective on-line gaming, web application and interactive video testbeds. Once this was achieved the focuses evolved to extensive test and validation of the techniques in testbeds as close as possible to a production network. Magapop has modified their servers to include the modification developed from WP1, e.g. RTOR/TLPR, new-CWV, RDB and ABE. Modification of client application to allow auto play is available on the HockyApp, this made it more active and without the need of human intervention. Tests have being done to check those modification and extensive test specially using ABE is being performed. Extensive test has being done for the Dual Queue Coupled AQM (DQCA), these test validated both the web application and interactive video use cases.

Performance of the DQCA was analyzed under several different background and foreground traffic, both with steady state and Dynamic load conditions. The aim was to verify how DQCA improved latency for traffic under severe and diverse background web traffic conditions, the results of these tests can be found in the paper: 'Data Centre to the Home': Ultra-Low Latency for All' to Submitted to CoNEXT 2015. BT has worked closely with ALU on the evaluation of RITE mechanisms for Web applications reusing the ALU low-latency testbed. BT and ALU finalized the QoS Simplification plan and laid down the principles for a best practice implementation that relies on AQM mechanisms rather than Diffserv. Furthermore, this quarter saw a lot of activity and effort in preparation and demonstration of the DQCA system used for interactive video and web applications presented at IETF 93 - Bits-N-Bites. The activities included setup of a compact demo, from scratch (3 servers and 2 client laptops), that could be shipped and effective demo to the IETF community.

AQM Activity

The AQM activity efforts can be divided into five parts:

- Parameters sensitivity study (UiO, UoA, IMT,SRL): in this sub-activity, we have come to the following high-level conclusions that neither CoDel nor PIE can self-tune their dropping policy, and suggesting that no parameters have to be tuned for some specific scenarios is wrong. We define the "working areas", the network characteristics (bottleneck capacity, RTT) for which AQM schemes work as they have been designed for, i.e. maintaining a high bottleneck utilisation and controlling the average (resp. maximum) queuing delay with PIE (resp. CoDel). This work has been extended and submitted to an international journal.

- Conceiving a new AQM scheme (IMT, SRL, UoA) (1/2): based on the results provided by the "parameters sensitivity study" sub-activity, we explored an idea based on mixing PIE and CoDel to take the best of the two algorithms. Early results seem to show that our proposal, Maximum and Average Delay with PIE (MADPIE), enables control of both the average and maximum queuing delay, which tends to also reduce the RTT sensitivity of PIE. This work has been extended and submitted to an international journal.

- Conceiving a new AQM scheme (ALU, BT) (2/2): for the evaluations of DCTCP and Immediate ECN (see Network Signal activity), a novel AQM has been conceived. This AQM does not increase its dropping probability as a linear function of the queue size, but rather exploits a convex curve. It is being called 'Curvy RED'. The performance of curved AQMs has been evaluated on the ALU testbed, and testing continues (see Network Signalling activity).

- Constraints that TCP places on all drop-based AQMs (BT, ALU) (1/2): We realised that Curvy RED (see above) with different values of curviness emulates the steady state of different AQMs, e.g. RED, CoDel, PIE. Analytically, we combined an idealised but sufficient model of TCP traffic with the Curvy RED formula to explain why attempting to keep delay constant (as PIE and CoDel do) is a bad idea, because it requires excessively high drop at high loads. This was prompted by high measured drop levels from PIE and CoDel at high load during comparative testing against the DualQ AQM. This proved that the dropping and marking behaviours of an AQM should be different. A presentation on this topic was given to the IETF AQM WG in July.

- Constraints that TCP places on all drop-based AQMs (BT, ALU) (2/2): Again, during DualQ testing we noticed that the AQM seemed to become ineffective once load increased sufficiently to reduce each flow to about 2.5Mb/s. On further investigation we discovered this was due to the minimum number of packets in flight that TCP allows itself. We very roughly estimated how prevalent this effect might be and found that it affects about 50% of the operating range of residential broadband in a typically-sized EU country. Thus we have discovered that, even if AQM is widely deployed, TCP will override its attempts to keep delay low in many cases. We gave a presentation to the IRTF congestion control research group highlihgting this problem and calling for collective effort to ensure TCP includes code to pace packets properly when the Round Trip Time is below its current operating range.

- Low-capacity and high RTT networks (UoA, IMT, SRL): we have evaluated the performance of CoDel and FQ-CoDel over capacity-limited networks with large Round-Trip Time (RTT). We have shown that in such settings, these AQM schemes have trouble in controlling the queuing delay, resulting in momentarily high queuing delay or low bottleneck utilisation, even if they are claimed to be insensitive to link rates and round-trip delays. We have shown that it is possible to adapt the parameterisation of CoDel and FQ-CoDel to offer a higher bottleneck utilisation while maintaining a low queuing delay. We have run experiments over both an emulated testbed and a satellite access network. These results have been presented at EUCNC 2015.

- Priority Scheduling and Flow Starvation for Thin Streams with FQ-CoDel (IMT, UoA): FQ-CoDel features: (1) priority scheduling for low-rate traffic; (2) flow isolation; (3) queue management with CoDel. In this period, we

fill a gap in the understanding of FQ-CoDel by analyzing what features are of interests for providing low latency for thin streams applications. We provide the first analysis of the limits of the flow starvation mechanisms and show that FQ-CoDel is vulnerable to Denial of Service (DoS) attacks. This work has been presented in the RITE's special session at EUCNC 2015.

Latency for multimedia Activity

IMT has carried out work on coexistence issues of Lower-than-Best-Effort traffic and Active Queue Management schemes, based on simulations and presented in D2.3. We specify the parameterisations of some LBE and AQM variants that prevent LBE traffic from grabbing as much capacity as best effort traffic. Linux kernel implementations of CDG and FLOWER, two candidates for carrying out LBE traffic, will soon be available and could be exploited to further confirm our conclusions and assess the coexistence of LBE and AQM. Due to the lack of time, future experiments on this topic will not be carried out inside the RITE project, but RITE partners actively contributed to show the importance of this issue, e.g. by exhibiting LEDBAT's issues, by introducing AQM-LBE interaction scenario in the AQM evaluation guidelines, and by highlighting that adequate and conjoint parameterisations of LBE and AQM that can solve the issue. At IETF93, we noticed high interest in this topic inside the community (as seen at the talk at ICCRG on this problem).

UiO has continued its work on shared bottleneck detection with SRL, and presented an updated Internet-draft on SBD at IETF-93. The Internet-draft on coupled congestion control was updated to specify how to apply coupling to one of the mechanisms in the IETF RMCAT group, NADA, and the draft's presentation at IETF-93 showed first results with another RMCAT mechanism: GCC.

Performance of Application-Limited Traffic Activity

Most of the activity in Application Limited traffic was concluded in the last quarter and contributions have been summarised in deliverable D1.3. At the plenary meeting in Prague, plans have been made to finalise and disseminate the RITE Linux integration testbed. The testbed will include also the kernel patches for RDB (Redundant Data Bundling), which will be presented in LCN 2015.

Getting Up To Speed (GUTS)

A draft version of the paper from BT, KAU, SRL and UoA entitled "What Use is Top Speed without Acceleration?" has been completed and circulated for review. The aim of the paper is to build a model that shows how much getting up to the speed is becoming the major component of latency as network links get faster. In order to substantiate the model, BT, KAU and SRL have done a longitudinal study of Internet flow sizes based on CAIDA traces. We have supplemented this analysis with traces from the Norwegian University of Agder, because we were concerned that CAIDA's measurements are taken at peering points, and therefore do not see CDN traffic within ISPs. The University traffic is consistent with CAIDA's. However we are also arranging to gather new comprehensive traces of residential broadband traffic from BT PlusNet, so far without success. To prove our hypothesis that performance is becoming more limited by slow-start than capacity, KAU, SRL and BT proved that slow-start does not only appear at the beginning of each connection, using techniques to identify 'train-starts' by their timing, irrespective of whether they appear when a new flow identifier appears, or whether the train shares multiple identifiers.

Originally, the GUTS work was designed to prove that end-system techniques to solve the GUTS problem had reached their limit, and therefore it would be necessary to reach consensus on a new incrementally deployable signal at the upper interface to IP (between hosts and network). However, the analysis has shown that it may still be possible for end-system-only changes to scale long-term. Therefore the message of the paper is being suitably modified. This also means that developing a signalling mechanism acceptable to the industry (e.g. Queue View (QV) that has been reported earlier) might not be the critical path.

Nonetheless, it is still necessary to improve the accuracy of TCP's feedback for the one network signal that is already standardised (ECN). As explained under Network Signals, Accurate ECN feedback (AccECN) is particularly important to make DCTCP robust to loss, if it is to be safe to use alongside general traffic on the Internet. The AccECN protocol specifies a new TCP receiver behaviour that reflects ECN signals back to the sender, which will allow future evolution of a range of different sender behaviours without having to deploy new receiver code for each case. This is a pre-requisite for low latency schemes, including new signals for getting up to speed fast (e.g., Immediate ECN and Queue View) as well as for ECN path testing, and for new schemes to reduce latency, particularly Data Centre TCP and ConEx.

Our requirements statement for accurate ECN feedback (co-authored by BT with non-RITE partners) was published by the IETF as RFC 7560 in August 2015. This paves the way for the IETF's TCP maintenance WG to charter work on a solution, which we are negotiating with the chairs.

The candidate solution that BT co-authored with non-RITE partners, called the Accurate ECN (AccECN) feedback protocol, had been on hold until it was clearer whether the more general 'Inner Space' idea has a chance to be adopted by the IETF (see 'Cutting Protocol Chatter' later). We have now decided to go ahead with AccECN, but only using one variant based on TCP options, not the other based on re-purposing the TCP Urgent Pointer. This may not work in all deployments, but its incremental deployability will be improved if our Inner Space proposal becomes widely used (see later). The AccECN work has now been taken over from BT by SRL and after weeks of intense design sessions, and a major new revision has just been submitted to the IETF TCP maintenance WG. It is far simpler the spec is much shorter than the previous draft. It has always been recognised that tradeoffs between requirements will be necessary. Previously all requirements were met except complexity. This time, overhead is not always as low as we would have liked (from zero to 11B of option header, typically 5B or zero).

Cutting Protocol Chatter

The project has added this new activity to address the problem of handshaking delay in transport protocols, which our latency survey identifies as a major source of delay. It particular addresses handshaking in security and multipath protocols, but also more generally.

In Jul'14, within another EU project (Trilogy 2), BT proposed a method called 'Inner Space', which makes space for TCP control options within the TCP payload. The method has proved to have considerable potential for reducing handshaking latency. This latency aspect has been investigated within RITE, while Trilogy 2 will continue to develop the base protocol.

The considerable progress made on Inner Space in previous quarters (in both T2 and RITE) was put on hold when the person involved left BT. The success of other RITE activities has also made it hard to pick up this work. The idea had already arrived late in the project, so we now expect that the only activity in RITE will be to keep the momentum going, so that it can be picked up in a different project later.

UoA has completed a study to understand the latency benefits and drawbacks of replacing existing HTTP/1.1 systems with HTTP/2. In particular, a set of experiments to measure the page load time (PLT) of web pages of different lengths and object size composition was carried out over a satellite link; the most challenging environment for web interactive applications. The results show that HTTP/2 offers significant benefits in terms of reducing the page load times (PLT) in different scenarios, including cases with performance enhancement proxies (PEPs) and encrypted tunnels. However, it was also observed that the default HTTP/2 configuration is optimised for low-delay Internet paths and may not be the most efficient solution for high-latency paths. The work was accepted for the EIA conference on Wireless and Satellite Systems, and presented in July'15.

Dissemination activities

Workshops

A special session on Reducing Internet Latency was arranged by RITE at the European Conference on Networks and Communications (EuCNC 2015) in Paris. The special session was held on Tuesday June 30 featured four paper presentations:

- Internet Latency: Causes, Solutions and Trade-offs
- Reducing Transport Latency using Multi-path Protocols
- Evaluation of Priority Scheduling and Flow Starvation for Thin Streams with FQ-CoDel
- Coupled Congestion Control for WebRTC

All papers were authored by RITE researchers, with contributions from in total seven RITE partners. The session was well received and spurred a number of interesting discussions.

Educational Materials

The process of story-boarding the second RITE video is in progress. The audience will be industry decision-makers, and the main messages have been agreed.In order to get the most publicity around the finalization of the project, the launch of this video has been re-scheduled to coincide with the project end press release.

Industry dissemination

The RITE project was present with a stand at the Bits-n-Bites session at IETF-93 in Prague. The technical focus of the RITE stand was to show the latency benefit of Explicit Congestion Notification (ECN) and to demonstrate the Dual Queue AQM. This enables coexistence between Data Centre TCP-like congestion control and traditional TCP congestion control over a bottleneck. The demonstration was a great success and generated a queue of interested people throughout the session—significantly surpsassing any other exhibition stand. The technology gathered interest from several major equipment vendors, ISPs and operating system developers.

ALU's presentation of the same technology to the IETF AQM WG (about 400 people) the previous day was part of the reason for the interest. A video of this is available in the IETF's regular proceedings. It shows the sub-millisecond broadband queuing latency being demonstrated live on ALU's video testbed by remote access. We also advertised the Bit-n-Bites exhibition in a number of working groups relevant to real-time applications.

The RITE animated video was also on display during Bits-n-Bites. The video explains the fundamental questions that the RITE project tackles, providing people with a brief introduction to the challenges of Internet latency. Quizzes allowed the crowd to compete for RITE giveaways.

A professional video of the event has been prepared and is in its final editing and approval stage. An article for the IETF Journal is also in preparation.

Reported in previous QMRs:

- RITE Latency Video Animation. Posted on the RITE Web site 23-Oct-2014 at `http://riteproject.eu/resources/internet-latency/` with supporting materials:
    1. A quiz made in Kahoot!:
    2. An activity sheet with experiments to perform using any computer.
    3. A fact sheet
    4. A teacher's guide (to be available 3-Nov-2014).
- The video is also posted on YouTube at `http://youtu.be/F1a-eMF9xdY`.
- Analytics are in place to track popularity of the site, and the video.
- The scripting and production process of the animation was managed by RITE partners, in particular SRL and BT, with useful review comments from all partners during the process.

Accepted papers

- B.O. Ronning, J. Markussen, I. Ahmed, A. Petlund, C. Griwodz, Pål Halvorsen, "Latency and fairness tradeoff for thin-streams using redundant data bundling in TCP", accepted at LCN 2015, Clearwater (US).
- E.Grigorescu, C. Kulatunga, N. Kuhn, G. Fairhurst "Evaluation of Priority Scheduling and Flow Starvation for Thin Streams with FQ-CoDel", EUCNC 2015, Special Session.
- C. Kulatunga, N. Kuhn, G. Fairhurst, D. Ros. "Tackling Bufferbloat in Capacity-limited Networks with a Large RTT", EUCNC 2015.

Reported in previous QMRs:

- I. Ahmed, A. Petlund "Analysing User Satisfaction in Next Generation Networks for Multimedia Multicast Transmission" - Accepted in IEEE QoMEX 2015.
- E.Grigorescu, C. Kulatunga, N. Kuhn, G. Fairhurst "Evaluation of Priority Scheduling and Flow Starvation for Thin Streams with FQ-CoDel", EUCNC Special Session.
- C. Kulatunga, N. Kuhn, G. Fairhurst, D. Ros. "Tackling Bufferbloat in Capacity-limited Networks with a Large RTT" - Accepted for publication in EUCNC.
- N. Iya, N. Kuhn, F. Verdicchio, G. Fairhurst "Analyzing the impact of bufferbloat on latency-sensitive applications" - To appear in IEEE ICC 2015
- K. Raaen, A. Petlund "How much delay is there really in current games?" - The ACM Multimedia Systems 2015 Conference.

- M. Rajiullah, P. Hurtig, A. Brunstrom, A. Petlund, M. Welzl, "An Evaluation of Tail Loss Recovery Mechanisms for TCP", ACM SIGCOMM CCR, 45(1), January 2015.
- B. Briscoe, "Tunnelling through Inner Space", Position Paper for the Internet Architecture Board (IAB) workshop on Stack Evolution in a Middlebox Internet, Jan 2015
- Welzl, M., Fairhurst, G., and Ros, D., "Ossification: a result of not even trying?", Position Paper for the Internet Architecture Board (IAB) workshop on Stack Evolution in a Middlebox Internet, Jan 2015
- Mirja Kühlewind (ETH Zürich), David Wagner, Juan Manuel Reyes Espinosa (Uni Stuttgart) and Bob Briscoe (BT), "Using Data Center TCP (DCTCP) in the Internet," Proc. 3rd IEEE Wkshp on Telecommunications Standards: From Research to Standards (Dec 2014)
- I. Ahmed, L. Badia, A. Petlund, C. Griwodz and P. Halvorsen, "Analysis of SR ARQ Delays Using Data-bundling over Markov Channels", IEEE ISCC 2014.
- C. Paasch, S. Ferlin, O. Alay, O. Bonaventure, "Experimental evaluation of multipath TCP schedulers", accepted for publication, ACM SIGCOMM Capacity Sharing Workshop (CSWS'14), 18 August 2014, Chicago, USA.
- D. Hayes, S. Ferlin-Oliveira, M. Welzl, "Practical Passive Shared Bottleneck Detection using Shape Summary Statistics", IEEE LCN 2014, 8-11.
- B. Briscoe, A. Brunstrom, A. Petlund, D. Hayes, D. Ros, I-J. Tsang, S. Gjessing, G. Fairhurst, C. Griwodz, "Reducing Internet Latency: A Survey of Techniques and their Merits", IEEE Communication Surveys and Tutorials, 2014, accepted for publication.
- Y. Elkhatib, G. Tyson, M. Welzl, "Can SPDY Really Make the Web Faster?", NETWORKING 2014. 2-4.June 2014, Trondheim, Norway.
- S. Islam, M. Welzl, S. Gjessing, N. Khademi, "Coupled Congestion Control for RTP Media", ACM SIGCOMM Capacity Sharing Workshop (CSWS'14), 18 August 2014, Chicago, USA.
- Ford, M. (Ed.) and others, Workshop Report: Reducing Internet Latency, 2013, ACM Computer Communications Review (Editorial Zone) 44(2) 80–86 (Apr 2014)
- N. Kuhn, E. Lochin, A. Mifdaoui, G. Sarwar, O. Mehani, R. Boreli, "DAPS: Intelligent Delay-Aware Packet Scheduling for Multipath Transport", Proceedings of IEEE ICC, June 2014.
- J. Garcia, S. Alfredsson, A. Brunstrom, "A Measurement Based Study of TCP Protocol Efficiency in Cellular Networks", Proceedings of 10th International Workshop on Wireless Network Measurements and Experimentation, May, 2014.
- S. Nazir, Z. Hossain, R. Secchi, M. Broadbent, A. Petlund, and G. Fairhurst. "Performance Evaluation of Congestion Window Validation for DASH Transport", in Proc. of NOSSDAV '14, pp 67-72, March 2014, Singapore.
- N. Khademi, D. Ros, M. Welzl, "The New AQM Kids on the Block: An Experimental Evaluation of CoDel and PIE", Accepted for publication in IEEE Global Internet Symposium (co-located with INFOCOM 2014).
- S. Islam, M. Welzl, S. Gjessing, "One Control to Rule Them All - Coupled Congestion Control for RTP Media", poster, Packet Video Workshop 2013, 13 December 2013, San Jose.
- E. Grigorescu, C. Kulatunga, G. Fairhurst, "Evaluation of the Impact of Packet Drops due to AQM over Capacity Limited Paths", Capacity Sharing Workshop 2013, Goettingen.
- N. Iya, F. Verdicchio, G. Fairhurst, "Congestion-Aware Scalable Video Streaming", Capacity Sharing Workshop 2013, Goettingen.
- G. Fairhurst, et al "Evaluation of delay-based CC for Interactive Video" Capacity-Sharing Workshop 2013.
- M. Welzl, G. Fairhurst, N. Khademi "ECN & Early ECN Marking" Position paper for ISOC Workshop on Reducing Internet Latency.
- A. Petlund, A. Brunstrøm, J. Markussen, M. Fuchs: "On the Treatment of Application-Limited Streams", Position paper for ISOC Workshop on Reducing Internet Latency
- D. Hayes, D. Ros, "Delay-based Congestion Control for Low Latency", Position paper for ISOC Workshop on Reducing Internet Latency

- B. Briscoe, A. Brunstrom, A. Petlund, D. Ros, D. Hayes, I.Tsang, S. Gjessing, G. Fairhurst: "A Survey of Latency Reducing Techniques and their Merits", Position paper for ISOC Workshop on Reducing Internet Latency
- B. Briscoe. "Up to Speed with Queue View (QV)" BT Technical Report TR-TUB8-2013-001 (2013)
- A. Brunstrom, A. Petlund, M. Rajiullah. "Reducing Internet Transport Latency for Thin Streams and Short Flows" Future Network and MobileSummit 2013, poster submission.
- S. Alfredsson, G. Del Giudice, J. Garcia, A. Brunstrom, L. De Cicco, S. Mascolo. "Impact of TCP Congestion Control on Bufferbloat in Cellular Networks", Accepted for publication at IEEE WoWMoM 2013, June 2013.
- S. Alfredsson, G. Del Giudice, J. Garcia, A. Brunstrom, L. De Cicco, S. Mascolo. "Observations of Bufferbloat in Swedish Cellular Networks", to be presented at 9th Swedish National Computer Networking Workshop, June 2013.
- D. Ros and M. Welzl. "Assessing LEDBAT's Delay Impact", accepted for publication to IEEE Communications Letters.
- A. Sathiaseelan, R. Secchi, G. Fairhurst, "Enhancing TCP to Support Rate-Limited Traffic", Accepted to ACM CoNEXT 2012.

Standardisation

Standardisation Highlights in Q11:

- The IETF has published 2 RFCs co-authored by RITE partners, both of which were first drafted at the start of the project.
- Two IETF drafts are still progressing through the final steering group and editor stages before being published as RFCs.
- One RITE IETF draft has been adopted, to fulful a chartered WG milestone
- RITE partners have published two new 'individual' IETF drafts (i.e. not yet adopted onto a WG agenda)
- See also the report on the highly successful RITE exhibition stand at the IETF Bits-n-Bites session, reported under 'Industry Dissemination' above.

Standards presentations

IETF presentations

- S. Islam, "Coupled congestion control with RTP", RMCAT WG, IETF-93, Prague.
- D. Hayes, "Shared Bottleneck Detection for Coupled Congestion Control for RTP Media", RMCAT WG, IETF-93, Prague.
- N. Kuhn, "AQM Characterization Guidelines", AQM WG, IETF-93, Prague.
- G. Fairhurst and M. Welzl, "The Benefits of using Explicit Congestion Notification (ECN) "
- B. Briscoe, "Questioning a Fixed Delay Target", AQM WG, IETF-93, Prague.
- K. De Schepper, "DualQ Coupled AQM"', AQM WG, IETF-93, Prague.
- B. Briscoe, "Review: PIE AQM" (In Proceedings, but sesssion ran out of time).
- N. Khademi, "TCP Alternative Backoff with ECN" TCPM WG, IETF-93, Prague.
- J. Kaippallimalil "Guidelines for Adding Congestion Notification to Protocols that Encapsulate IP ", TSVWG WG, IETF-93, Prague.

Reported in previous QMRs:

- M. Welzl, "Coupled Congestion Control for RTP Media (draft-welzl-rmcat-coupled-cc-04)", RMCAT, IETF-92, Dallas, USA.
- B. Briscoe (BT), "Guidelines for Adding Congestion Notification to Protocols that Encapsulate IP," 92nd IETF, Transport Area (tsvwg) Working Group, Dallas, TX, US, Mar 2015 (with non-RITE co-authors).
- Koen de Schepper, Inton Tsang (Al-Lu), Olga Bondarenko (SRL) and Bob Briscoe (BT), "Data Centre to the Home," Internet Research Task Force (IRTF) Internet congestion control research group (ICCRG), Dallas, TX, US, Mar 2015.
- Gorry Fairhurst & Raffaello Secchi (UoA), "Updating TCP to support Rate-Limited Traffic", 92nd IETF, TCPM WG, Dallas, TX, US, Mar 2015
- Per Hurtig, Anna Brunstrom (presenter), Andreas Petlund, Michael Welzl, "TCP and SCTP RTO Restart", 92nd IETF, TCPM WG, Dallas, TX, US, Mar 2015
- Nicolas Kuhn (IMT), Naeem Khademi (UiO), Preethi Natarajan (Cisco), David Ros (SRL), "AQM Evaluation Guidelines", 92nd IETF, AQM WG, Dallas, TX, US, Mar 2015
- Gorry Fairhurst (UoA) & Michael Welzl (UiO), "The Benefits and Pitfalls of using ECN" draft-ietf-aqm-ecn-benefits-01, 92nd IETF, AQM WG, Dallas, TX, US, Mar 2015
- B. Briscoe, "Tunnelling through Inner Space," Internet Architecture Board (IAB) workshop on Stack Evolution in a Middlebox Internet, Jan 2015
- B. Briscoe, "Inner Space for TCP increased TCP security (tcpinc)," TCP Increased Security (tcpinc) WG, IETF-91, Honolulu, US, Nov 2014
- B. Briscoe, "Inner Space," TCPM WG, IETF-91, Honolulu, US, Nov 2014
- M. Welzl, "The Benefits and Pitfalls of using Explicit Congestion Notification" (ECN) (draft-ietf-aqm-ecn-benefits-00)", AQM WG, IETF-91, Honolulu.
- N. Khademi, "AQM Evaluation Guidelines" (draft-kuhn-aqm-eval-guidelines)", AQM WG, IETF-91, Honolulu.
- M. Welzl, "TCP and SCTP RTO Restart" (draft-ietf-tcpm-rtorestart-04)", TCPM, IETF-91, Honolulu.
- D. Hayes, "Shared Bottleneck Detection for Coupled Congestion Control for RTP Media"(draft-hayes-rmcat-sbd-01), RMCAT WG, IETF-91, Honolulu.
- S. Islam, "Coupled Congestion Control for RTP Media" (draft-welzl-rmcat-coupled-cc-04), RMCAT WG, IETF-91, Honolulu.
- N. Kuhn, P. Natarajan, D. Ros, N. Khademi, "AQM Evaluation", AQM WG, IETF-90, Toronto.
- F. Baker, G. Fairhurst, "AQM Recommendation (2309bis)", AQM WG | IETF-90, Toronto.
- M. Welzl, S. Islam, S. Gjessing, "Practical Shared Bottleneck Detection for Coupled Congestion Control", RMCAT WG, IETF-90, Toronto.
- G. Fairhurst, R. Secchi, A. Sathiaseelaan, "Updating TCP to support Rate-Limited Traffic", TCPM WG, IETF-90, Toronto.
- P. Hurtig, A. Brunstrom, A. Petlund, M. Welzl, "TCP and SCTP RTO Restart", TCPM WG, IETF-90, Toronto.
- B. Briscoe, R. Scheffenegger, M. Kuhlewind, "Accurate ECN", TCPM WG, IETF-90, Toronto.
- G. Fairhurst, "Circuit Breakers", TSVWG WG, IETF-90, Toronto.
- M. Welzl, G. Fairhurst, "The Benefits to Applications of using ECN", TSVWG WG, IETF-90, Toronto.
- B. Trammell, "TAPS BOF", TAPS BoF, IETF-90, Toronto.
- B. Briscoe, R. Scheffenegger, M. Kuhlewind, "More Accurate ECN Feedback Reflector", IRTF Data Centre Latency RG, IETF-90, Toronto.

- B. Briscoe, A. Brunstrom, A. Petlund, D. Hayes, D. Ros, I-J. Tsang, S. Gjessing, G. Fairhurst, C. Griwodz, M. Welzl, "Reducing Internet Latency", IRTF Data Centre Latency RG, IETF-90, Toronto.
- N. Kuhn, P. Natarjan, D. Ros, N, Khademi. "AQM Evaluation", AQM WG, IETF-89, London.
- G. Fairhurst, F. Baker. "AQM Recommendation," AQM WG, IETF-89, London.
- M. Welzl, G. Fairhurst. "The Benefits to Applications of using Explicit Congestion Notification (ECN)", AQM WG, IETF-89, London.
- M.J. Montpetit, I. Zhovnirovsky, B. Reuther. "How could Transport Services be provided?" TAPS BoF, IETF-89 London.
- G. Fairhurst, R. Secchi, Z. Hossain. "Updating TCP to support Rate-Limited Traffic". TCPM WG, IETF-89 London.
- P. Hurtig, A. Brunstrom, A. Petlund, M. Welzl. "TCP and SCTP RTO Restart". TCPM WG, IETF-89, London.
- B. Briscoe, J. Kaippallimalil, P. Thaler. "ECN Encapsulation". TSVWG, IETF-89, London.
- G. Fairhurst, F. Baker. "AQM Recommendation," AQM WG, IETF-88, Vancouver.
- N. Khademi, A. Bagayoko, G. Fairhurst, C. Kulatunga, D. Ros, M. Welzl. "AQM Evaluation". AQM WG, IETF-88, Vancouver.
- G. Fairhurst, A. Sathiaseelan, R. Secchi. "TCP new-CWV". TCPM WG, IETF-88, Vancouver.
- P.Hurtig, A. Brunstrom, A. Petlund, M. Welzl. "TCP and SCTP RTO Restart, TCPM WG, IETF-88, Vancouver.
- B. Briscoe, J. Kaippallimalil, P. Thaler. "ECN Encaps Guidelines", TSVWG, IETF-88, Vancouver.
- T. Moncaster, M. Welzl, D. Ros, "Transport Services BOF plan". TSVWG, IETF-88, Vancouver.
- T. Moncaster, M. Welzl, D. Ros. "Transport Services BOF plan". ICCRG, IETF-88, Vancouver.
- M. Welzl, S. Islam, S. Gjessing. "Coupled Congestion Control for RTP media". RMCAT WG, IETF-88, Vancouver.
- B. Briscoe, M. Kuhlewind, D. Wagner, M. Espinosa. "Immediate ECN". TSVWG, IETF-88, Vancouver.
- G. Fairhurst, A. Sathiaseelan, R. Secchi. "TCP new-CWV". TCPM WG, IETF-87, Berlin.
- A. Brunstrom. "TCP RTO Restart". TCPM WG, IETF-87, Berlin.
- N. Kuhn, G. Sarwar, E. Lochin, R. Boreli, A. Mifdaoui. "MPTCP Scheduling". ICCRG, IETF-87, Berlin.
- M. Welzl, S. Islam, S. Gjessing. "Coupled Congestion Control for RTP media". RMCAT WG, IETF-87, Berlin.
- F. Baker, "AQM Recommendation". AQM BoF, IETF-87, Berlin.
- G. Fairhurst, A. Sathiaseelan, R. Secchi. "TCP new-CWV, IETF-86, Orlando.
- P. Hurtig, A. Brunstrom, A. Petlund, M. Welzl. "TCP RTO Restart". TCPM WG, IETF-86, Orlando.
- B. Briscoe, J. Kaippallimalil, P. Thaler. "ECN Encaps Guidelines". TSVWG, IETF-86, Orlando.
- M. Welzl. "Coupled Congestion Control for RTP media". RMCAT WG, IETF-86, Orlando.
- G. Fairhurst, B. Briscoe. "Advice on network buffering". ICCRG, IETF-86, Orlando.
- B. Briscoe. "ECN Encaps Guidelines". TSVWG, IETF-85, Atlanta.
- G. Fairhurst, A. Sathiaseelan. "TCP new-CWV". ICCRG, IETF-85, Atlanta.
- G. Fairhurst, A. Sathiaseelan. "TCP RTO Restart". TCPM WG, IETF-85, Atlanta.
- M. Welzl. "TCP RTO Restart". TCPM WG, IETF-85, Atlanta.

IETF documents

RITE was involved in the following drafts that have been published as RFCs:

- F. Baker, G. Fairhurst, "IETF Recommendations Regarding Active Queue Management," <RFC7567> Status: "Best Current Practice" (2015-02-25).
- M. Kühlewind, R. Scheffenegger, and B. Briscoe, "Problem Statement and Requirements for a More Accurate ECN Feedback" <RFC7560>. RFC status: "INF".

RITE is involved in the following drafts that are either in the IETF's steering group processing phase or the RFC Editor phase, prior to publication as RFCs:

- G. Fairhurst, A. Sathiaseelan, R. Secchi, "Updating TCP to support Rate-Limited Traffic" <draft-ietf-tcpm-newcwv-13> (2015-06-25) Intended RFC status: "EXP". Current status: RFC Editor Queue.
- Hurtig, P. Brunstrom, Petlund, A. Welzl, M., "TCP and SCTP RTO Restart," IETF Internet-Draft <draft-ietf-tcpm-rtorestart-08> (2015-06-18) Intended RFC status: "EXP". Current status: Area Director Evaluation.

RITE is involved in the following drafts that have been adopted by an IETF working group onto its standardisation agenda as a "WG document":

- N.Kuhn, P. Natarajan, N. Khademi and D. Ros. "AQM Characterization Guidelines." <draft-ietf-aqm-eval-guidelines-07.txt> (2015-07-06). Intended RFC status: "INF". Current status: AQM Working group document. Working group last call Aug 2015.
- M. Welzl and G. Fairhurst, "The Benefits of using Explicit Congestion Notification (ECN)" <Internet-draft draft-ietf-aqm-ecn-benefits-03.txt> (2015-07-27). Intended RFC status: "INF". Current status: AQM Working group document. Working group last call Apr 2015.
- Bob Briscoe, John Kaippallimalil and Pat Thaler "Guidelines for Adding Congestion Notification to Protocols that Encapsulate IP", <draft-ietf-tsvwg-ecn-encap-guidelines-02> (Mar 2015). Intended RFC status: "BCP". Current Status: TSVWG WG document; Liaison Correspondence in Progress with 3GPP and completed with IEEE.
- D. Hayes, S. Ferlin, M. Welzl, "Shared Bottleneck Detection for Coupled Congestion Control for RTP Media", <draft-ietf-rmcat-sbd-01.txt> (2015-07-01). Intended RFC status: "EXP". Current Status: RMCAT WG document;

RITE has also submitted updated versions of the following individual drafts to be considered for adoption onto the IETF's standardisation agenda:

- M. Welzl, S. Islam, S. Gjessing, "Coupled Congestion Control for RTP Media", Internet-draft draft-welzl-rmcat-coupled-cc-05.txt, (June 2015). Intended RFC status: "EXP".
- B. Briscoe, M. Kuehlewind and R. Scheffenegger, "More Accurate ECN Feedback in TCP" <draft-kuehlewind-tcpm-accurate-ecn-04> (2015-09-06). Intended RFC status: "EXP".
- Bob Briscoe , "Inner Space for All TCP Options," IETF Internet-Draft <draft-briscoe-tcpm-inspace-mode-tcpbis-00> (Mar 2015) (Work in Progress). Intended RFC status: "EXP".
- K. De Schepper, B. Briscoe (Ed), O. Bondarenko and I. Tsang, 'DualQ Coupled AQM for Low Latency, Low Loss and Scalable Throughput" <draft-briscoe-aqm-dualq-coupled-00> (2015-08-07). Intended RFC status: "EXP".

Two RITE partners have provided in-depth review of IETF drafts in the last quarter:

- G. Fairhurst made a detailed review of the characterization guidelines.
- B. Briscoe made a detailed review of PIE algorithm, which has been reported in D2.3

Reported in previous QMRs:

- Welzl, M. Islam, S. Gjessing, S, "Coupled Congestion Control for RTP Media" < draft-welzl-rmcat-coupled-cc-04> (2014-10-24) Current Status: Individual draft. Presented at IETF-91.
- "Shared Bottleneck Detection for Coupled Congestion Control for RTP Media" < draft-hayes-rmcat-sbd-02> (2015-03-03) Current Status: Individual draft. Presented at IETF-92.
- Hayes, D., Ferlin, S., Welzl, M., "Shared Bottleneck Detection for Coupled Congestion Control for RTP Media" < draft-hayes-rmcat-sbd-01> (2014-10-27) Current Status: Individual draft. Presented at IETF-91.
- G. Fairhurst, "Network Transport Circuit Breakers" <draft-ietf-tsvwg-circuit-breaker> Intended RFC status: "BCP". Current status: Accepted as a working group item within the IETF TSVWG WG.
- IETF Recommendations Regarding Active Queue Management.

  <draft-ietf-aqm-recommendation-07> (2014-08-05)

  <draft-ietf-aqm-recommendation-08> (2014-08-13)

  Intended RFC status: "Best Current Practice". Current status: "WG Consensus: Waiting for Write-Up Jan 2014"
- AQM Characterization Guidelines.

  <draft-kuhn-aqm-eval-guidelines-02> (2014-08-11)

  <draft-ietf-aqm-eval-guidelines-00> (2014-09-18)

  Current status: Accepted as a working group item - we are waiting for comments on the document. An updated version of the document will be presented at IETF91.
- The Benefits and Pitfalls of using Explicit Congestion Notification

  <draft-ietf-aqm-ecn-benefits-00> (2014-10-24)

  Current status: Accepted as a working group item.
- Extended TCP Option Space in the Payload of an Alternative SYN

  <draft-briscoe-tcpm-syn-op-sis-00> (2014-07-21)

  <draft-briscoe-tcpm-syn-op-sis-01> (2014-07-22)

  <draft-briscoe-tcpm-syn-op-sis-02> (2014-10-24)

  Current Status: Superceded by inner-space below (Joint work with Trilogy 2 project)
- Inner Space for TCP Options

  <draft-briscoe-tcpm-inner-space-00> (2014-10-19)

  <draft-briscoe-tcpm-inner-space-01> (2014-10-27)

  Current Status: Individual Draft. Invited to be presented at IETF-91 (Joint work with Trilogy 2 project)
- Services provided by IETF transport protocols and congestion control mechanisms <draft-fairhurst-taps-transports-00> (2014-10-27) Current status: Individual draft.
- IETF Transport Services (taps) WG Charter <`http://tools.ietf.org/wg/taps/charters`> (2014-09-24) Current status: WG and charter approved.
- M. Welzl, "Transport Services (TAPS) Birds-of-a-Feather," IETF Journal, Volume 10, Issue 1, July 2014. Invited paper.
- F. Baker, G. Fairhurst, "IETF Recommendations Regarding Active Queue Management," IETF Internet-Draft:

  <draft-ietf-aqm-recommendation-04> (2014-05-14)

  <draft-ietf-aqm-recommendation-05> (2014-06-24)

  <draft-ietf-aqm-recommendation-06> (2014-07-01)

- Hurtig, P. Brunstrom, Petlund, A. Welzl, M., "TCP and SCTP RTO Restart," IETF Internet-Draft <draft-ietf-tcpm-rtorestart-03> (2014-07-04)
- Hayes, D. Ros, D. Andrew, L.L.H. Floyd, S., "Common TCP Evaluation Suite," IETF Internet-Draft <draft-irtf-iccrg-tcpeval-01> (2014-07-01)
- Kuehlewind, M., Scheffenegger , R. & Briscoe, B "Problem Statement and Requirements for More Accurate ECN Feedback," IETF Internet-Draft <draft-ietf-tcpm-accecn-reqs-07> (Jul 2014).
- Briscoe, B., Scheffenegger & Kuehlewind, M. "More Accurate ECN Feedback in TCP (AccECN)," IETF Internet-Draft <draft-kuehlewind-tcpm-accurate-ecn-03> (Jul 2014).
- N. Kuhn, P. Natarajan, D. Ros, N. Khademi "AQM evaluation guidelines," IETF Internet-Draft <draft-kuhn-aqm-eval-guidelines-02> (2014-08-11)
- Welzl, M. Islam, S. Gjessing, S, "Coupled congestion control for RTP media," IETF Internet-Draft <draft-welzl-rmcat-coupled-cc-03> (2014-05-07)
- G. Fairhurst "Network Transport Circuit Breakers," IETF Internet-Draft <draft-fairhurst-tsvwg-circuit-breaker-01> (2014-05-04)
- N. Kuhn, P. Natarajan, D. Ros, N. Khademi, "AQM evaluation guidelines", IETF Work in Progress winthin the IETF AQM WG
- F. Baker, G. Fairhurst, "IETF Recommendations Regarding Active Queue Management", IETF Work in Progress within the IETF AQM WG.
- Per Hurtig, Stein Gjessing, Michael Welzl, and Martin Sustrik. "Transport APIs". IETF Internet-Draft, work in progress, December 15, draft-hurtig-tsvwg-transport-apis-00.
- F. Baker, G. Fairhurst , "IETF Recommendations Regarding Active Queue Management", IETF Work in Progress within the IETF AQM WG.
- A. Petlund, "Transport Services and low latency". IETF Internet-Draft, work in progress, February 14, 2014, draft-petlund-latency-transport-services-00.
- Toby Moncaster (ed.), Jon Crowcroft, Michael Welzl, David Ros, Michael Tuexen, "Problem Statement: Why the IETF Needs Defined Transport Services", draft-moncaster-tsvwg-transport-services
- D. Hayes, D. Ros, L.L.H. Andrew, S. Floyd, "Common TCP Evaluation Suite".
- G. Fairhurst, A.Sathiaseelan, R. Secchi, "Updating TCP to support Rate-Limited Traffic", IETF Work in Progress within the IETF TCPM WG.
- G. Fairhurst, B. Briscoe, "Advice on network buffering", IETF Work in Progress (Individual submission).
- P. Hurtig, A. Brunstrom, A. Petlund, M. Welzl, "TCP and SCTP RTO Restart", Internet Draft draft-ietf-tcpm-rtorestart, work in progress, July 2014.
- M. Welzl, S.Islam, S. Gjessing: "Coupled congestion control for RTP media", draft-welzl-rmcat-coupled-cc
- B. Briscoe, John Kaippallimalil and Pat Thaler "Guidelines for Adding Congestion Notification to Protocols that Encapsulate IP", draft-briscoe-tsvwg-ecn-encap-guidelines
- Per Hurtig (ed.), Stein Gjessing, Michael Welzl, Martin Sustrik, "Transport APIs", draft-hurtig-tsvwg-transport-apis

Project management status

Plenary meetings

- Meeting July 17. - July 19. in Prague, in conjunction with the IETF-93, hosted by SRL.

Plenary audio/video conferences

- July 15. Teleconference
- June 24. Teleconference
- May 20. Teleconference

Status of deliverables

- D5.4 - Quarterly management report #10. Submitted May 1st 2015.
- D5.4 - Quarterly management report #9. Submitted February 1st 2015.
- Second Periodic Report #2. Submitted December 30th 2014.
- D5.3 - Quarterly management report #8. Submitted November 1st 2014.
- D3.2 - Testbed presentation. Submitted November 1st 2014.
- D5.3 - Quarterly management report #7. Submitted August 8th 2014.
- D2.2 - Report on design and initial evaluation of network and interaction techniques. Submitted August 7th 2014.
- D1.2 - Report on design and initial evaluation of end-system, application-layer and API mechanisms. Submitted August 4th 2014.
- D5.3 - Quarterly management report #6. Submitted May 1st 2014.
- D5.3 - Quarterly management report #5. Submitted February 1st 2014.
- First Periodic Report #1. Submitted January 3rd 2014.
- D5.2 - Quarterly management report #4. Submitted November 1st 2013.
- D5.2 - Quarterly management report #3. Submitted August 1st 2013.
- D5.2 - Quarterly management report #2. Submitted May 1st 2013.
- D5.2 - Quarterly management report #1. Submitted February 1st 2013.
- D4.1 - Outline dissemination plan. Submitted February 1st 2013.
- D5.1 - Interim report on deployment and use of the project management tools. Submitted February 1st 2013.
- D3.1 - Traffic pattern analysis and data set acquisition report. Submitted August 8th 2013.
- D1.1 - End-system analysis and preliminary development report. Submitted November 1. 2013
- D2.1 - Network systems analysis and preliminary development report. Submitted November 1. 2013.

Milestones

MS7: Satisfactory dissemination plan ready

The dissemination plan was submitted in February 2013. The plan was approved by all partners in the consortium and deemed satisfactory for the project. No significant deviations from the dissemination plan outlined in the proposal were recorded.

MS1: Completion of Problem area analysis for end systems

The initial analysis phase was completed in August 2013. The outcomes of this phase are documented in deliverable 1.1.

MS2: Completion of analysis for network and interaction

The initial analysis phase was completed in August 2013. The outcomes of this phase are documented in deliverable 2.1.

MS3: Preliminaries for testbed preparation ready

The testbed preliminaries and preparations, gathering of traces and compilation of tools phase was completed in August 2013. The outcomes of this phase are documented in deliverable 3.1.

MS4: End-system mechanisms for reducing latency showing expected effects

The mechanisms explored shows latency reduction in accordance with the expected scope of effect outlined in the analysis phase.

MS5: Network and interaction mechanisms for reducing latency showing expected effects

The mechanisms explored shows latency reduction in accordance with the expected scope of effect outlined in the analysis phase.

MS6: Testbeds ready

The ALU testbed is ready and was demonstrated in the second technical review of RITE. The Megapop testbed is ready and all the relevant RITE mechanisms for testing has been successfully integrated. The work on the financial testbed has been terminated and, as described in the periodic report and at the second technical review, this use-case are being refocused into a web scenario use case. An amendment to the DoW for this change is ready to be submitted as soon as the financial reporting is finished.

MS8: Prototypes developed and evaluated for the most promising end-system mechanisms

From the work previously done in WP1, the most promising concepts have been chosen for prototyping. The prototypes has been evaluated anc we can document the expected latency-reducing effects.

MS9: Prototypes developed and evaluated for the most promising network and interaction mechanisms

From the work previously done in WP2, the most promising concepts have been chosen for prototyping. The prototypes has been evaluated anc we can document the expected latency-reducing effects.

All milestones have been completed according to schedule