MP-DCCP UE IMPLEMENTATION

https://tools.ietf.org/html/draft-amend-tsvwg-multipath-dccp-03
https://tools.ietf.org/html/draft-amend-tsvwg-multipath-framework-mpdccp-01
https://tools.ietf.org/html/draft-amend-tsvwg-dccp-udp-header-conversion-01

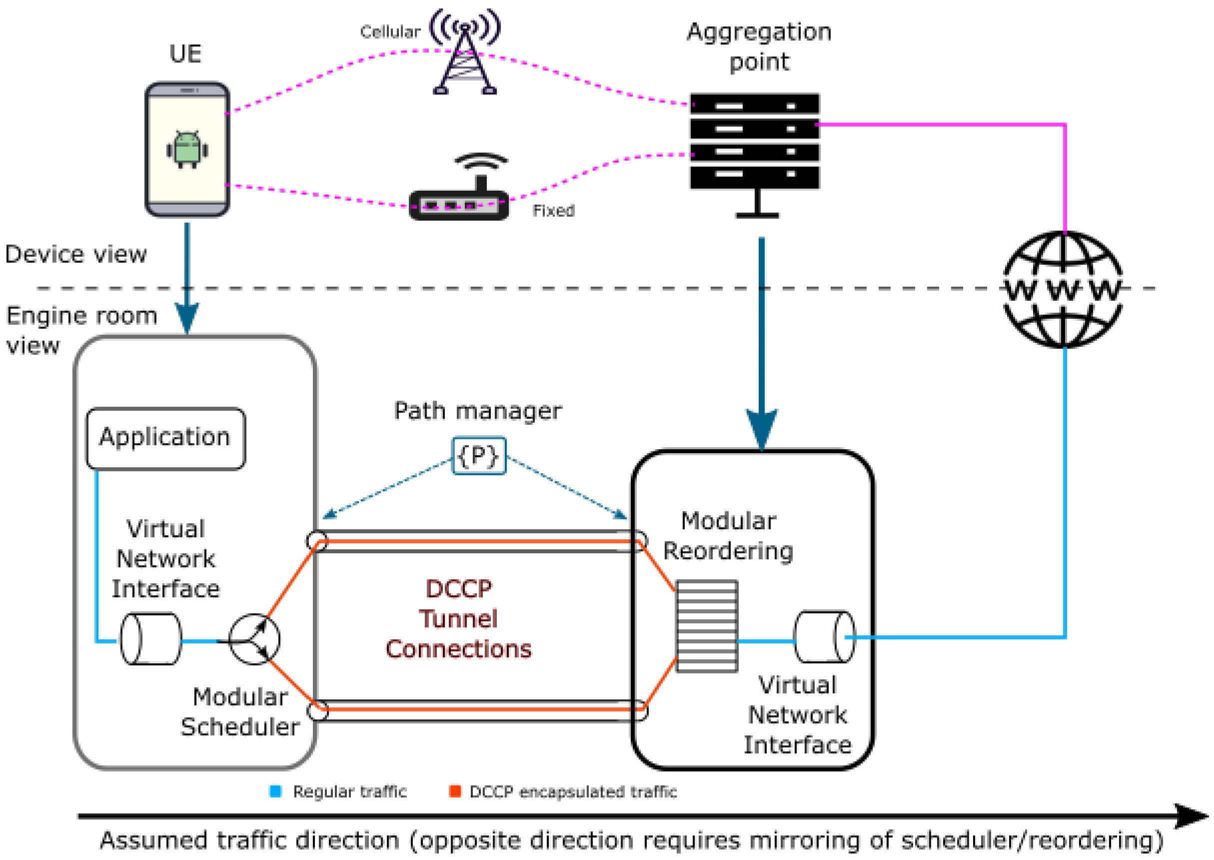
Markus Amend, markus.amend@telekom.de, Deutsche Telekom, IETF 109, Nov. 2020

LIFE IS FOR SHARING.

MP-DCCP PROTOTYPE DESCRIPTION 1/2

Functional overview

- Multipath solution for UDP – IP traffic
- Performs link aggregation by using DCCP as the core protocol.
- Deploys DCCP Extensions for Multipath Operation – MP-DCCP https://tools.ietf.org/html/draft-amend-tsvwg-multipath-dccp-03
- Architecture comprises modular scheduler/reordering scheme
- DCCP tunnel per path – following guidelines on https://tools.ietf.org/html/draft-amend-tsvwg-multipath-framework-mpdccp-01
- DCCP - UDP header overhead free conversion -> solve lack of DCCP support in middle boxes -> implemented as specified in https://tools.ietf.org/html/draft-amend-tsvwg-dccp-udp-header-conversion-01

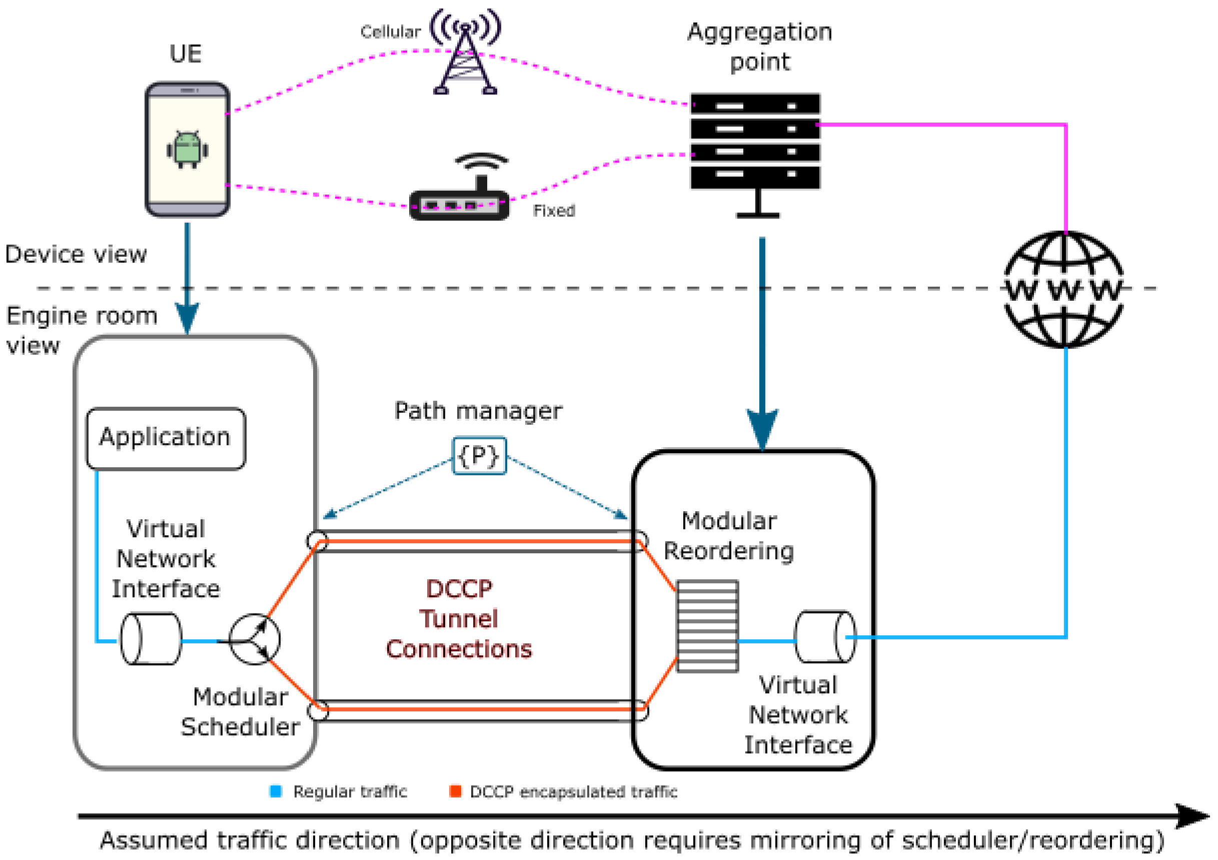


MP-DCCP PROTOTYPE DESCRIPTION 2/2

Deployment settings

- Implemented as a loadable Linux kernel module
- Deployed over commercial network -> Aggregation point located in a cloud internet server
- UE specifications:
  - Google Pixel 4
  - OS -> Android version 10
- Server – specifications
  - DELL PowerEdge R640
  - OS -> Debian GNU/Linux 9 (stretch)

Both UE and server run Linux kernel version 4.14.111



PREPARED FOR 3GPP ATSSS UDP OR IP SUPPORT

- AT-**S**teering (path selection), **S**witching (seamless handover) and **S**plitting (path aggregation) functions are enabled by the "combination" of the scheduling, reordering and path-management features of the MP-DCCP prototype

Path Manager	Scheduler	Reordering
▪ Detects local network interfaces and initiates connection on UE side → **Enables Steering** ▪ Reacts to changes in the network (Interface status, IP address) → **Triggers Switching**	▪ Selects the subflow (path) through which data is to be sent → **Executes Steering and Switching** ▪ Distributes traffic among subflows → **Executes Splitting**	▪ Compensate overall packet scrambling introduced by different path latencies → **Supports Splitting**

- They require, as well the transmission of signaling information -> achieved by implementing Multipath Options defined in https://tools.ietf.org/html/draft-amend-tsvwg-multipath-dccp-03 like MP_SEQ, MP_RTT, *MP_PATH_INFO, *MP_REMOVEPATH

* still implementation specific, definition will be added to MP-DCCP IETF draft soon

PROTOTYPE SCHEDULING OPTIONS IN LINE WITH 3GPP ATSSS

Scheduling algorithms deployed in the prototype cover the steering options specified at 3GPP ATSSS release 16 and discussed in release 17 study phase

- **Cheapest Pipe First** → priority-based mechanism allows the operator to assign a cost value to each network path.
  - Sends data on cheapest flow whenever possible (if there is room in the congestion window)
  - If the congestion window of the cheapest path is full, it sends on the next available path → splitting
  - If more than one path has the lowest cost → the path with the lowest SRTT is selected
- **Handover** → Works as Cheapest Pipe First without aggregation
  - Sends data on the prioritized path (main path), as long as the DCCP tunnel is available
  - If the DCCP tunnel is broken, it sends on the next available path → switching
- **Round Robin** → Distributes the traffic equally among the paths available (splitting/load balancing)
- **Fixed Ratio**
- **Redundant**

REORDERING OPTIONS

- **Active Fixed →** Reads packets MP_SEQ, if a gap is detected, packets are stored in a buffer
  - Packets are stored until the missing packet arrives or until a fixed timeout expires
- **Active Adaptive →** Same buffer mechanism as in Active Fixed
  - The buffer timeout value is dynamically set depending on the delay difference of the paths
  - the path delay information is estimated by the transmitting end CC algorithm and sent to the receiver by using MP_RTT option

---

- **Delay equalization function**
  - minimize reordering effort
  - reduction of delay difference between paths
  - adds delay to the data flows corresponding to the faster paths

Further info https://tools.ietf.org/html/draft-amend-iccrg-multipath-reordering-01

RESULTS – STEERING & SWITCHING

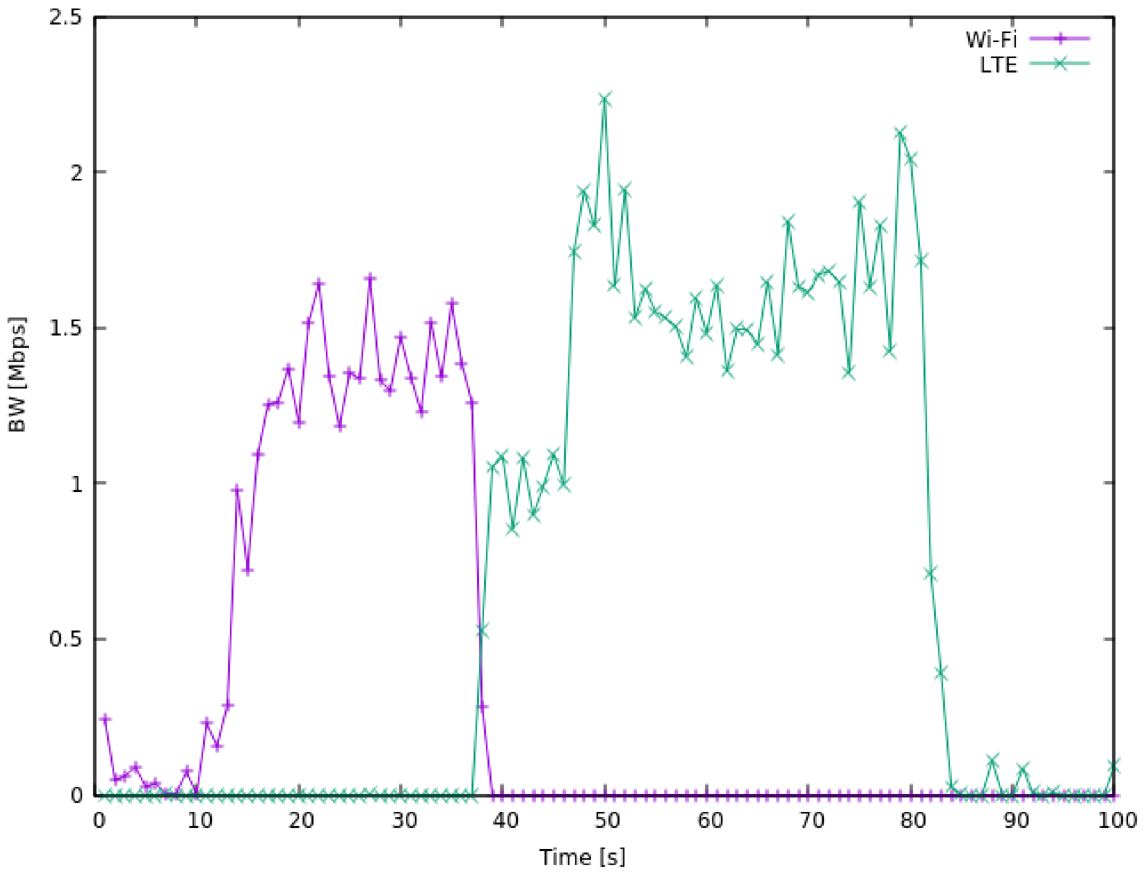
Test description

A skype video call was set up from the UE having WiFi and LTE interfaces enabled. During the call the Wifi interface was turned off.

- Scheduler type → Handover
- Priority set on → Wifi path
- For t < 37 s → WiFi and LTE interfaces are UP
- For t ≥ 37s → WiFi interface is disabled
- Congestion control → CCID2

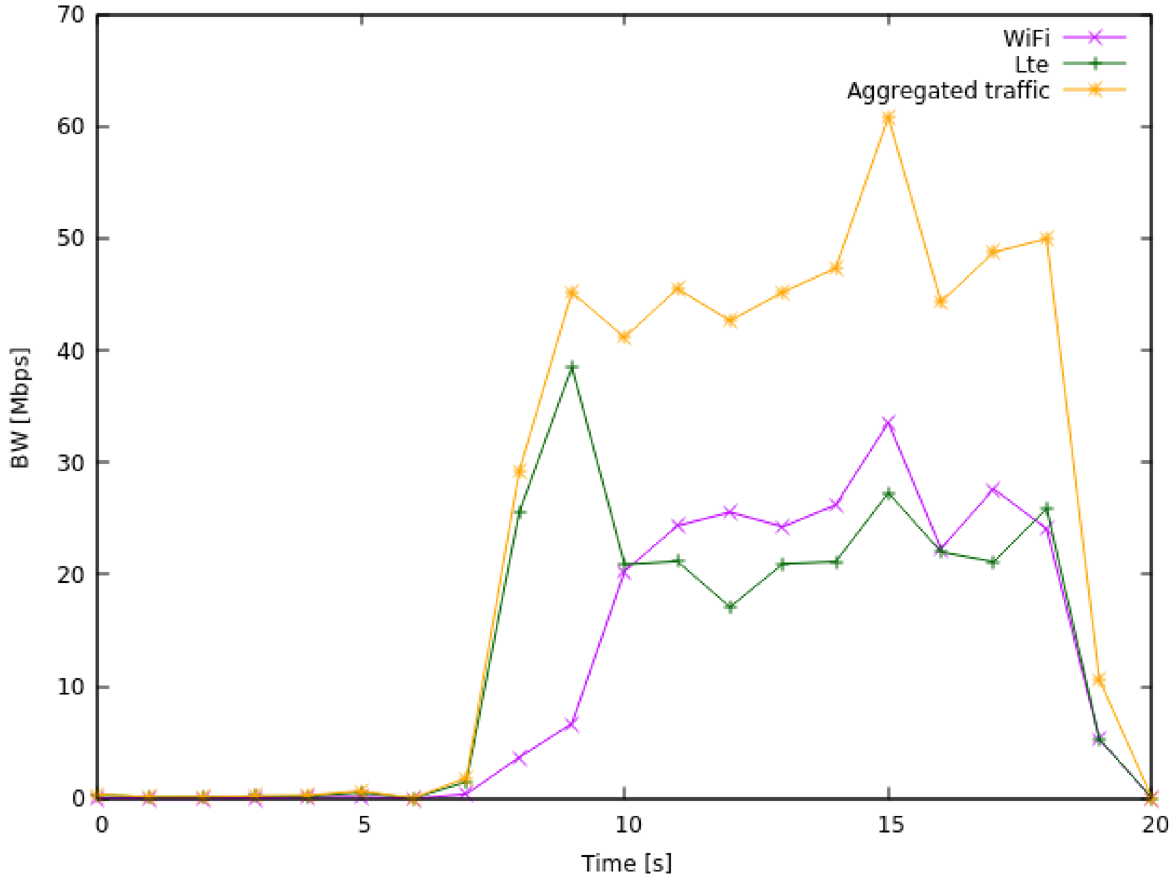
The priority setting works properly, routing the traffic towards the WiFi path. Once this interface is disabled, the path manager reacts removing the corresponding subflow and sending signaling (MP_REMOVEPATH) to the server. The scheduler routes the traffic to the LTE interface.

During and after the switching the video call remains active



EARLY RESULTS – SPLITTING

- Splitting functionality is supported in the prototype by the modular scheduler.
- The scheduling algorithms provide different options of traffic distribution among the flows
  - Cheapest Pipe First
  - Round Robin
  - Fixed Ration
- Although the splitting function is supported, achieving an optimal performance still requires investigation
- Test with CPF scheduler (aggregation)
  - Uplink traffic generated with speedtest app
  - Priority set on LTE



While first results gives encouraging results it was identified, that the splitting performance has dependencies on CC, reordering, scheduling, RTT ratio*

* Further info: MP-DCCP simulation results presented at this IETF109 ICCRG session

ADITIONAL FEATURES – CONGESTION CONTROL

- Splitting performance is directly affected by the Congestion Control algorithm in use
- DCCP Linux kernel implementation provides CCID2 and CCID3 Congestion Control algorithms → Packet loss triggered
- The MP-DCCP prototype extends Linux Kernel DCCP with an implementation of BBR v1 congestion control algorithm as part of the DCCP - CCID framework
- Results presented in https://datatracker.ietf.org/meeting/106/materials/slides-106-iccrg-a-multipath-framework-for-udp-traffic-over-heterogeneous-access-networks prove the BBR implementation for DCCP has better performance in multipath setups than CCID2 and CCID3
- Performance of BBR v2 seems to add further improvements in a multi-path scenario as identified in internal tests

CONCLUSION

- Native Android mobile phone implementation and testing over commercial networks reveals functionality for path selection and seamless handover.
- Splitting/Aggregation is supported by design but needs further investigation

NEXT STEPS

- Update MP-DCCP draft according to current development
- DT internal process initiated to publish MP-DCCP open source!
- Continue research on MP-DCCP splitting/aggregation performance with our academic partner Karlstad University/City, University of London

Ready for Adoption?