

Beyond IP: Network Protocols to meet the demands of 2030

Kevin Smith, Vodafone : ITU-T FG NET-2030 Workshop, Feb 2019



KDE

Information superhighways of 2030

Optical

Radio

Other...



The legacy Internet protocol suite persists...despite being designed under very different conditions:

1970s






Everything changes.....

2020s

- Wired access
- No mobility
- Memory is scarce & slow
- Bandwidth is fixed and limited
- Not secure
- Mains-powered clients
- Delivery acknowledgements

- Wireless access
- Frequent, rapid mobility
- Memory is plentiful & fast
- Bandwidth is high but volatile
- Security by design
- Battery-powered clients
- Quality guarantees

TCP/IP on cellular: report card

	Network issue:	Network workaround:
 Low application bits per Hz/s	Reduced spectral efficiency	Power, ROHC
 No native mobility/multihoming	Overlay required	Encapsulations
 No native security	Overlay required	IPsec, DDoS controls
 E2E congestion controls	Radio volatility	TCP optimisers
 No intrinsic QoS/context	Best effort delivery	DPI/traffic detection

= costly overheads and workarounds, reduced performance

This impacts the mobile operator challenge:

- Deliver **much more data** over a **wider coverage** area
- Offer **low latency, faster mobility, guaranteed reliability**
- Support **low-power connections, in challenging environments**
- And do this **securely** and **sustainably**

Increasing capacity alone will not meet new demands

Not just the application bits!

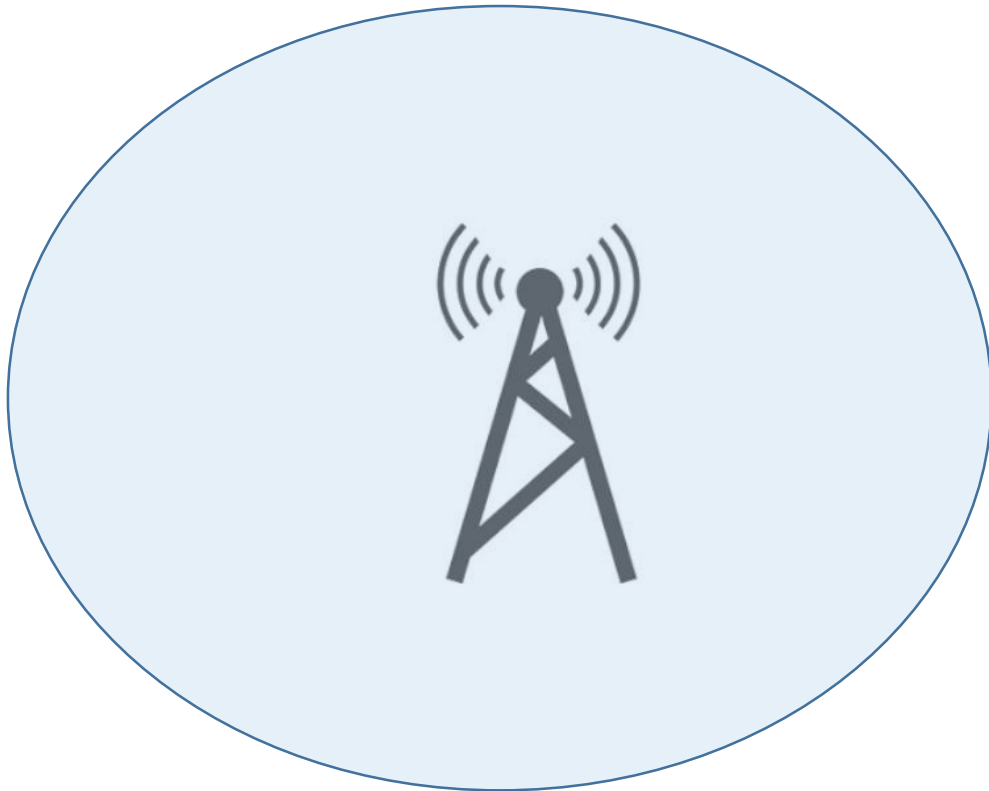
User plane latency	eMBB: 4ms URLLC: 1ms	Single user for small IP packets for both DL and UL (eMBB and URLLC)
Control plane latency	20ms (encouraged to consider 10ms)	Transition from Idle to Active (eMBB and URLLC)
Connection Density	1M devices per km ²	For mMTC
Reliability	99.9999% success prob.	32 L2 bytes within 1ms at cell edge

Or more!

Think of the power!!!

Example: a reliable low-latency service

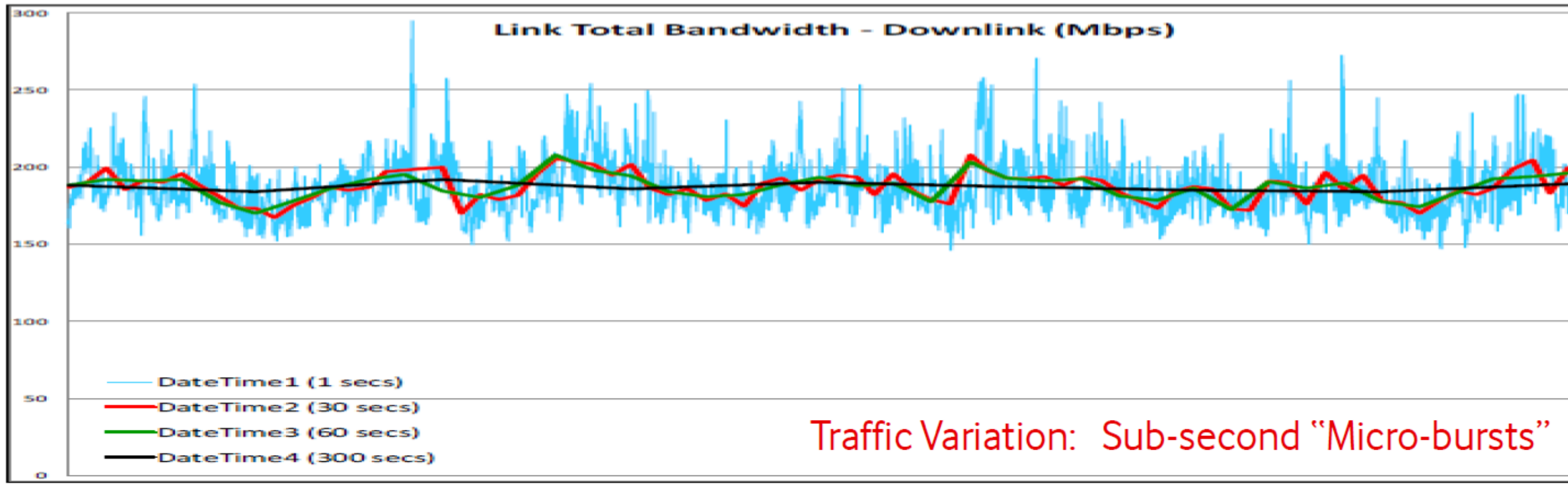
- A network dimensioned for 1Mbps uplink at cell edge



- Low-latency: first packet must arrive with high reliability
- Packet Error Rate 10% \rightarrow 0.1% = 10-20dB extra link budget
- Either: the distance to terminal is reduced; or the power is increased; or the data payload is reduced.
- ~18 bytes per $\sim 140\mu\text{s}$ transmission time interval
- TCP/IPv4 header alone is 40 bytes. Header compression is not sustainable

Providing **bandwidth**-> delivering **quality**

- Historic model: throughput, Mb/**second**
- Variance *within a second* impacts reliability for sub-second use cases.
- Supply predictable quality, not ‘average bandwidth’



**So...what are
the options?**

incredibly
LARGE

Option 1:
Keep adding
compute power,
spectrum, energy
...and cost

car engines

24-litre W12



A male athlete is captured in a dynamic running pose on a grassy field. He is wearing a teal t-shirt with a pink graphic, black leggings, and teal sneakers. A black resistance band is attached to his waist and extends to a weight plate on the ground behind him. The background shows a blue track, a concrete wall, and hills under a cloudy sky.

Option 2:
Remove the burdens

Updated protocol design context

Wireless access, high/volatile bandwidth



Short congestion control loops

Frequent, rapid mobility



Path-independent identifiers

Cheap, fast memory



Flow state at routers

Battery-powered clients



Reduce headers

Security by design



System-level access controls

Delivery guarantees



Auditable quality

Candidate technologies under research

RINA:

Recursive Internet Architecture (non-IP, non-OSI, full naming and addressing architecture) ([ETSI GR NGP 009](#))

Flexilink:

High-performance forwarding with synchronised, guaranteed and best-effort services ([ETSI GS NGP 13](#))

Software Defined Radio:

Radios for general-purpose compute motherboards; programmable baseband

Quality Attenuation:

Network performance science to improve contention management ([Reading list](#))

Open Source LTE stacks:

To work around dependency on legacy protocols.

How this can help our challenge

- Deliver an **increasing amount of data** over a **wider coverage** area
- Do so :
 - within a **decreasing time**
 - with **faster mobility**
 - with **guaranteed reliability**
- And do this **securely** and **sustainably**

Security by design

Network quality,
network efficiency

Efficient protocols,
short control loops

Auditable and tuneable per
delay/loss tolerance of the
application

Improved power
efficiency



It's a wrap

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