Mobile Video Trends & Study of Real-Time, Delay Sensitive Video over LTE

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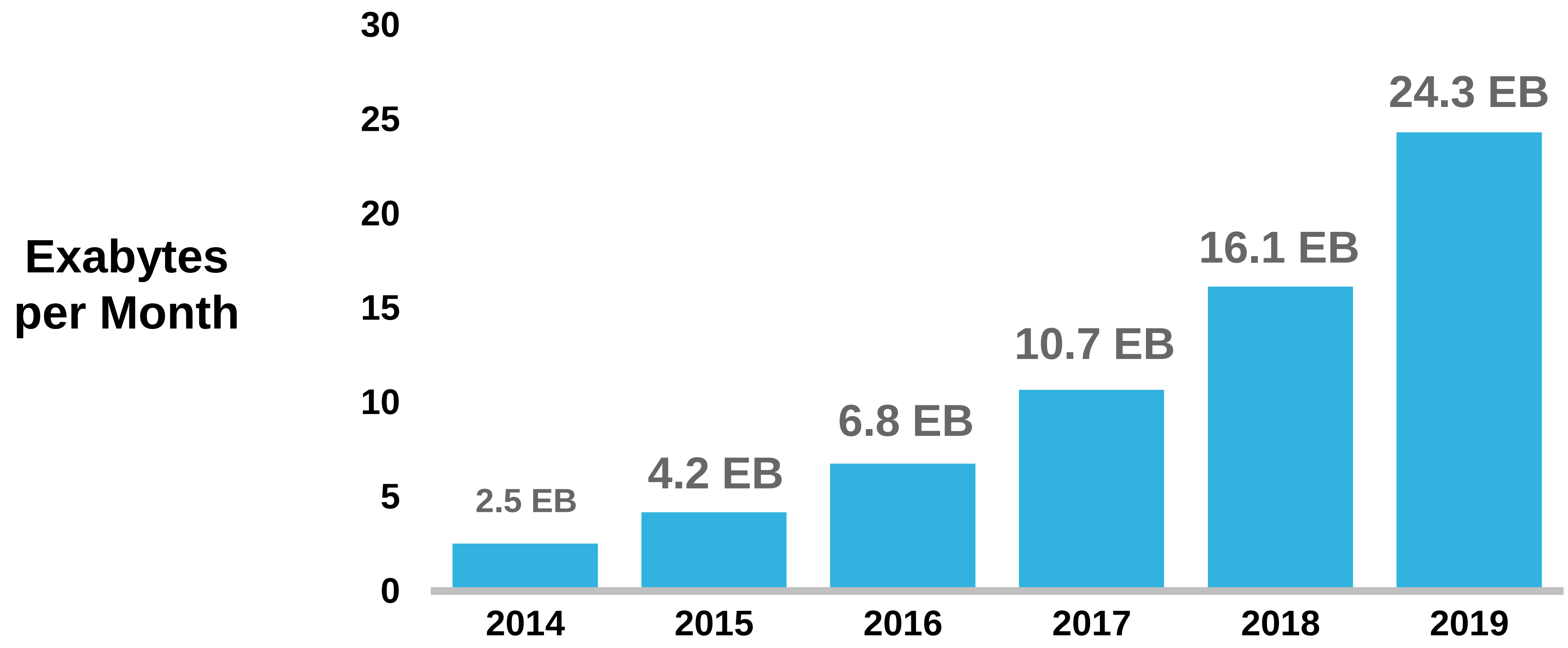
Outline

- Global Mobile Data Growth Trends (Cisco VNI data)
- Studies of Real-Time, Delay Sensitive Video over LTE

Global Mobile Data Traffic Growth

Global Mobile Data Traffic will Increase 10-Fold from 2014–2019

57% CAGR 2014–2019



Source: Cisco VNI Global Mobile Data Traffic Forecast, 2014–2019

Average Mobile User (Cellular Traffic per Month)

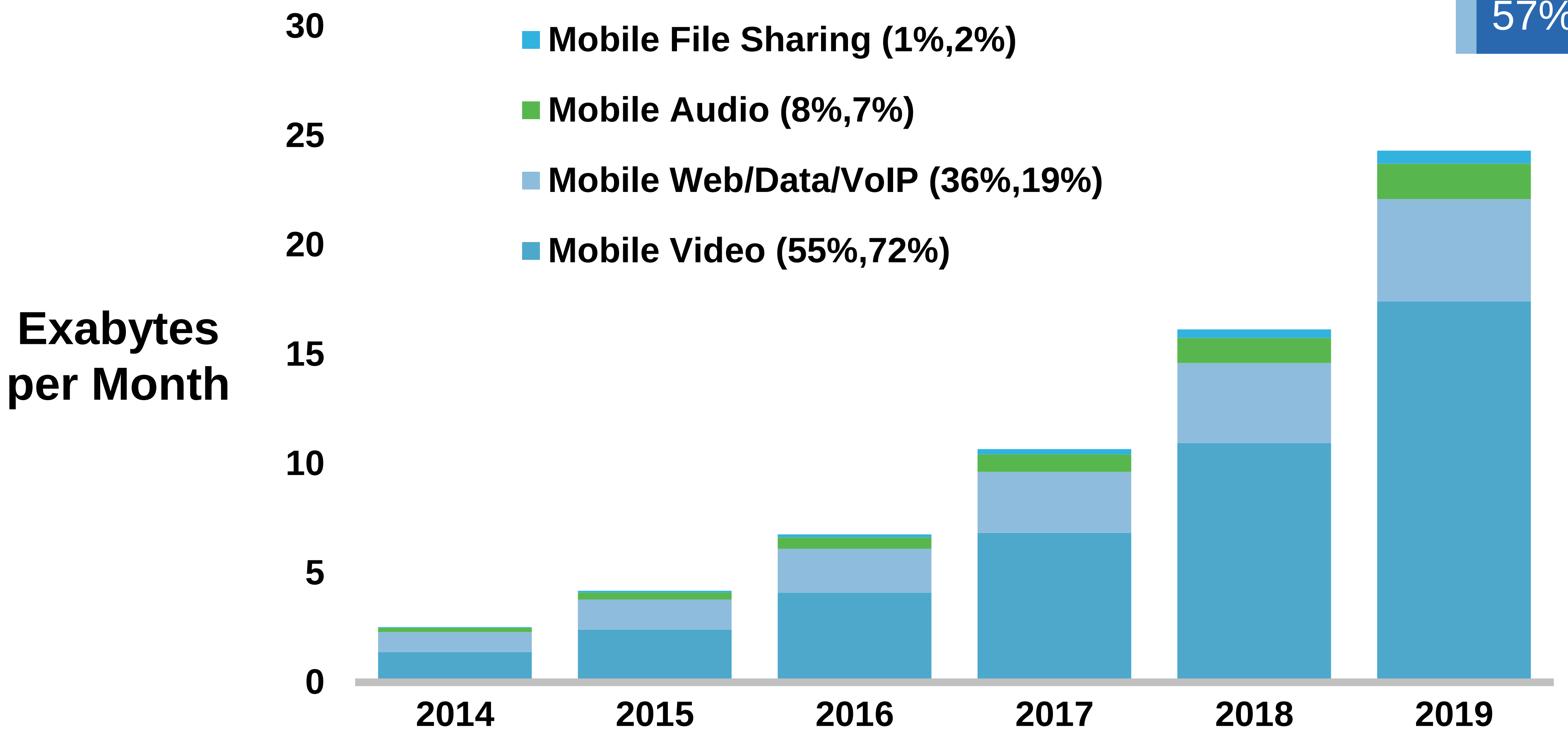
Sample Global Usage

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2014–2019

Global Mobile Data Traffic Growth / Apps

Video to Exceed 72 Percent of Mobile Data Traffic by 2019

57% CAGR 2014–2019



* Figures (n) refer to 2014 and 2019 mobile data traffic shares

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2014–2019

Global Mobile Video Traffic

By 2019, Video Will Drive 72% of Mobile Traffic, Up from 55% in 2014

North America

75% of traffic by 2019
54% CAGR

Western Europe

74% of traffic by 2019
56% CAGR

Central/Eastern Europe

70% of traffic by 2019
83% CAGR

Latin America

72% of traffic by 2019
69% CAGR

Middle East & Africa

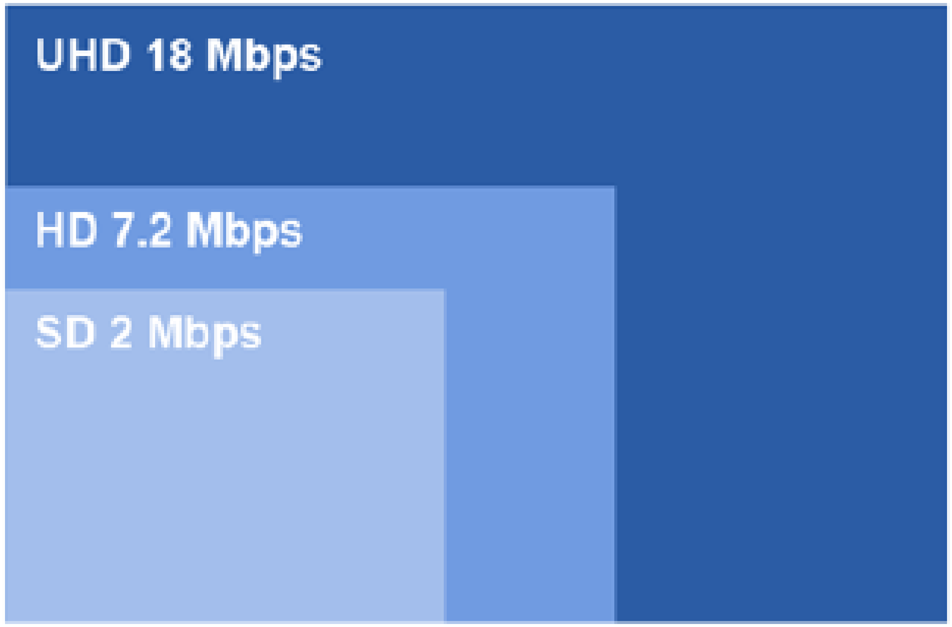
68% of traffic by 2019
84% CAGR

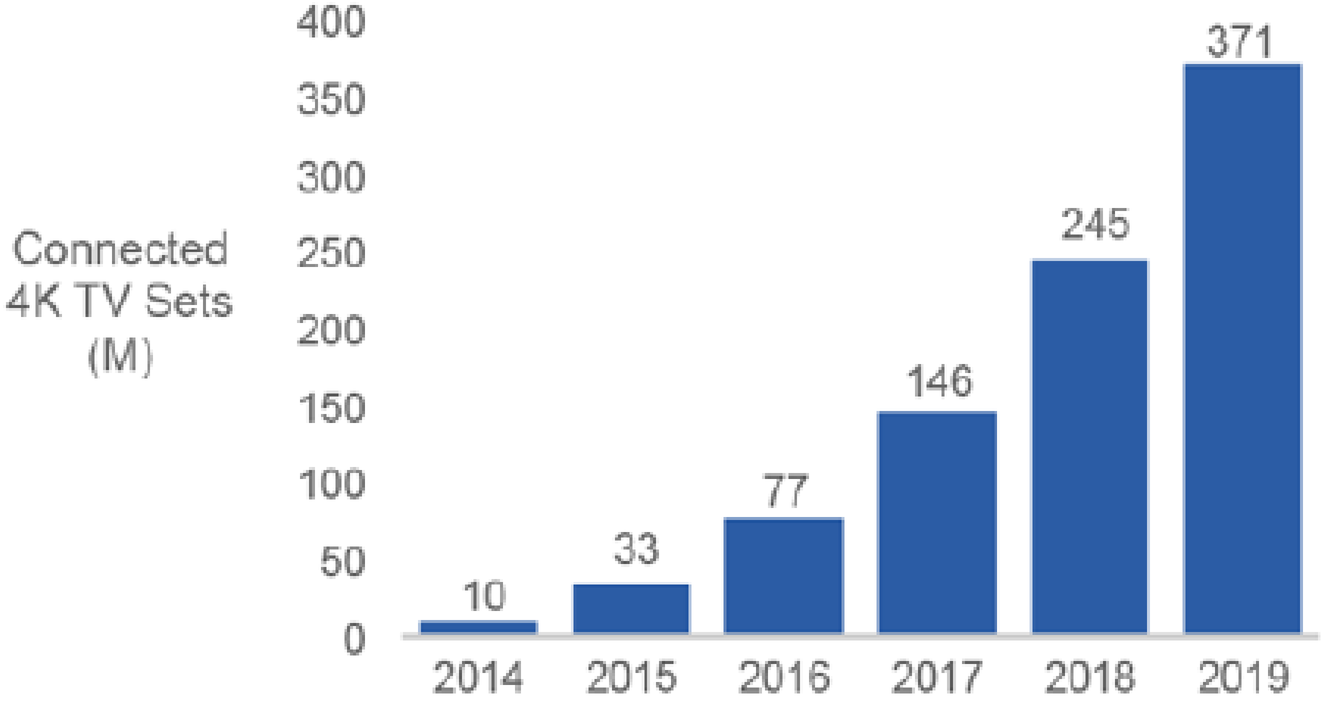
Asia Pacific

71% of traffic by 2019
67% CAGR

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2014–2019

Increasing Video Definition
By 2019, More Than 30% of Connected Flat-Panel TV Sets Will Be 4K





Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Outline

- Global Mobile Data Growth Trends (Cisco VNI data)
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Real-Time, Delay Sensitive Video over LTE

Objective:

- To understand capacity of real-time, delay sensitive video+audio traffic (e.g. video conferencing) over LTE, and evaluate the impact of QCI assignments on the capacity requirements for video conferencing & residual background FTP traffic that can be supported.

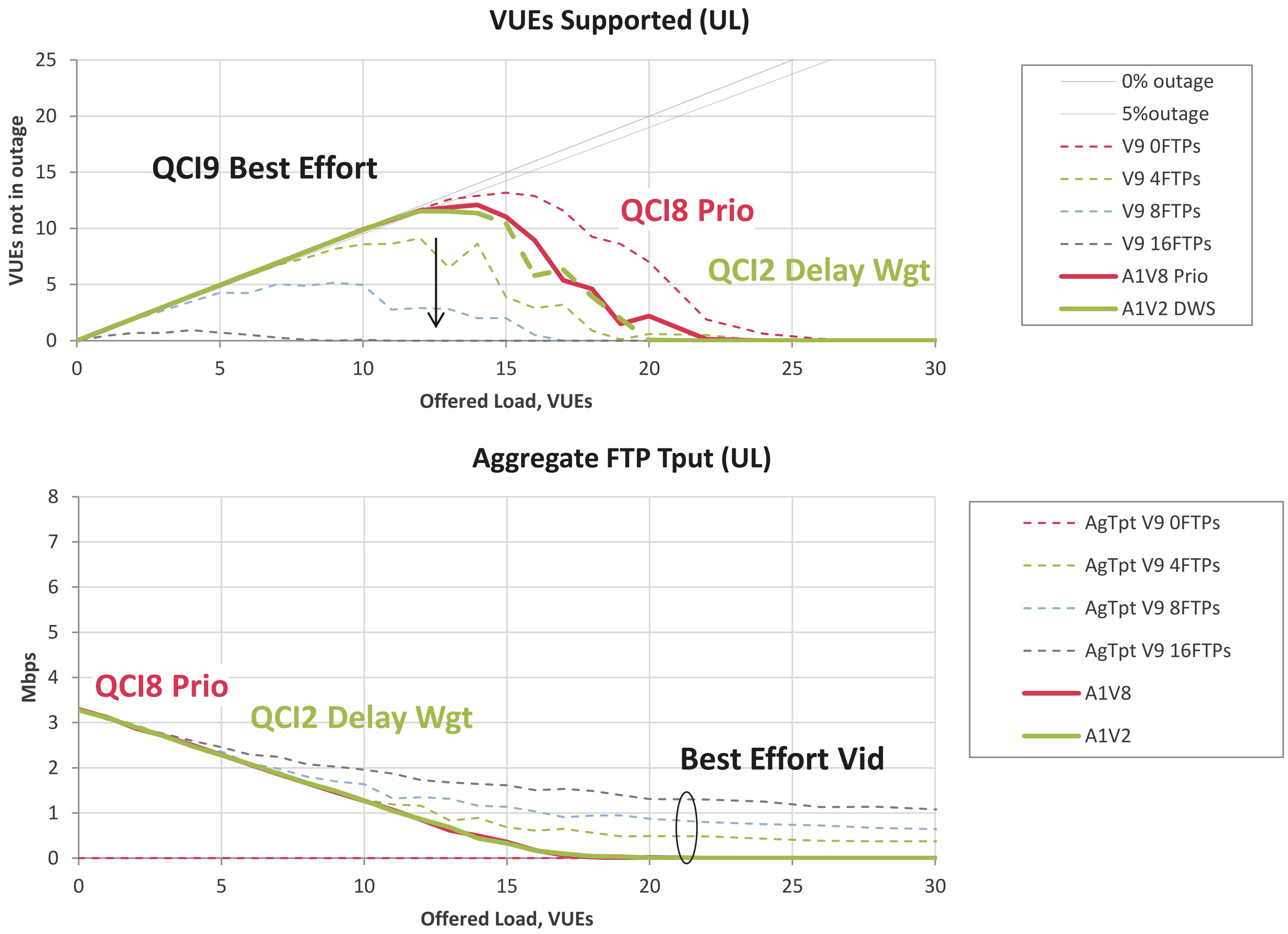
Approach:

- Collaboration with Real Wireless to develop simulation capability accounting for RF network, system level, link level & time domain packet scheduling which used ‘real world’ traffic obtained from devices running the Cisco Jabber codec.
- Evaluated delays to individual IP packets due to buffering for multi-user scheduling of video & audio flows for UEs supporting Jabber, in the presence of other UEs performing file transfers.
- Worst case delay performance determined UE outage. Capacity defined as <5% UEs in outage in any given network.

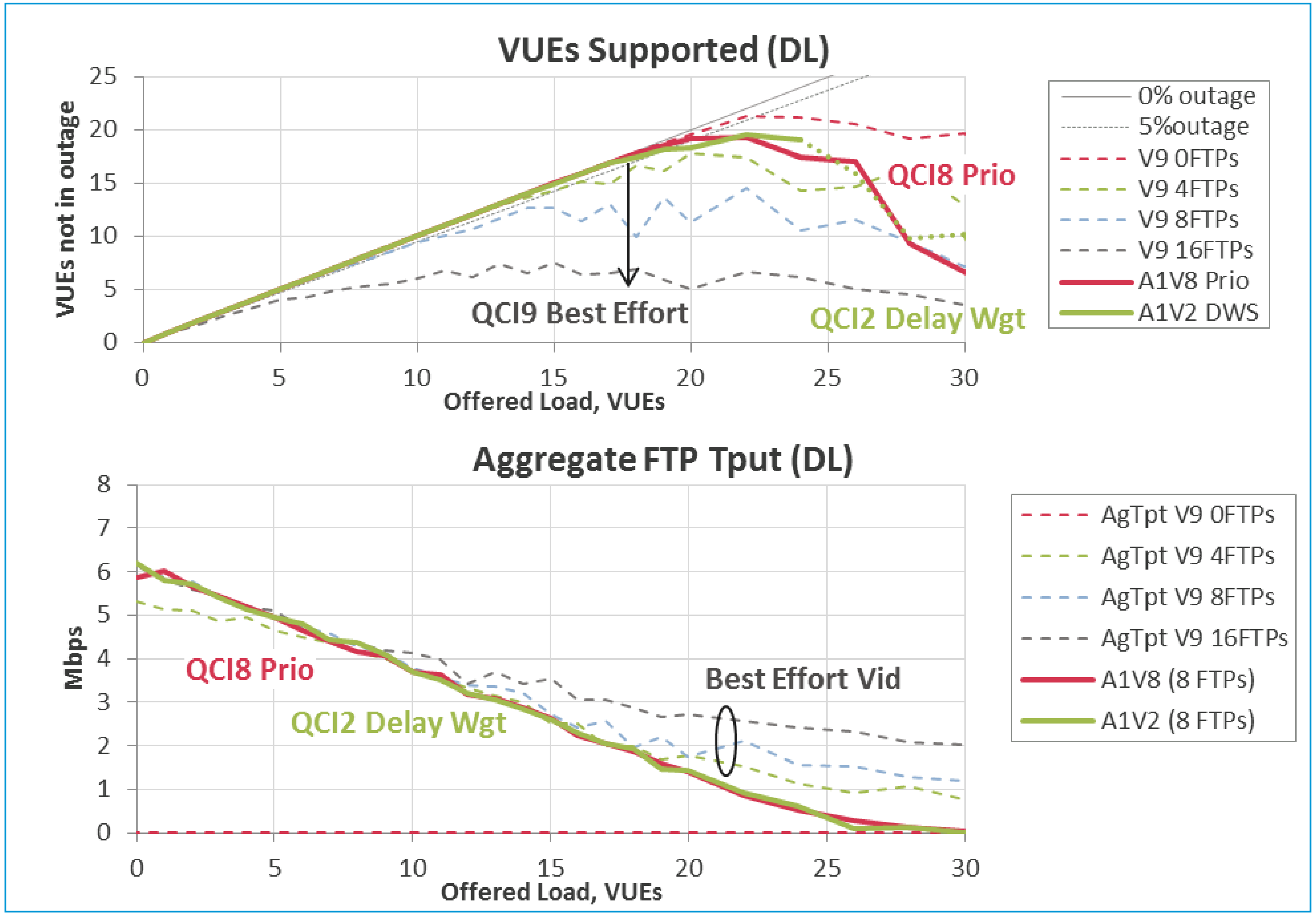
High Level Summary of Assumptions

- 2x10 MHz FDD LTE carriers @ 700 MHz with 2x2 (DL) and 1x2 (UL) MIMO
- 19x3 sector sites with wrap around
- Dense urban morphology
- FTP model for background users
  - 0.5 Mbyte packets
  - 2 s mean inter-arrival time
- 256k Jabber codec → ~220 kbps mean
- 80 kbps for audio
- VoLTE assumed 12.65 kbps WB-AMR
- QCI8 traffic prioritized over QCI9 traffic
- QCI2 uses GBR with delay weighted scheduler

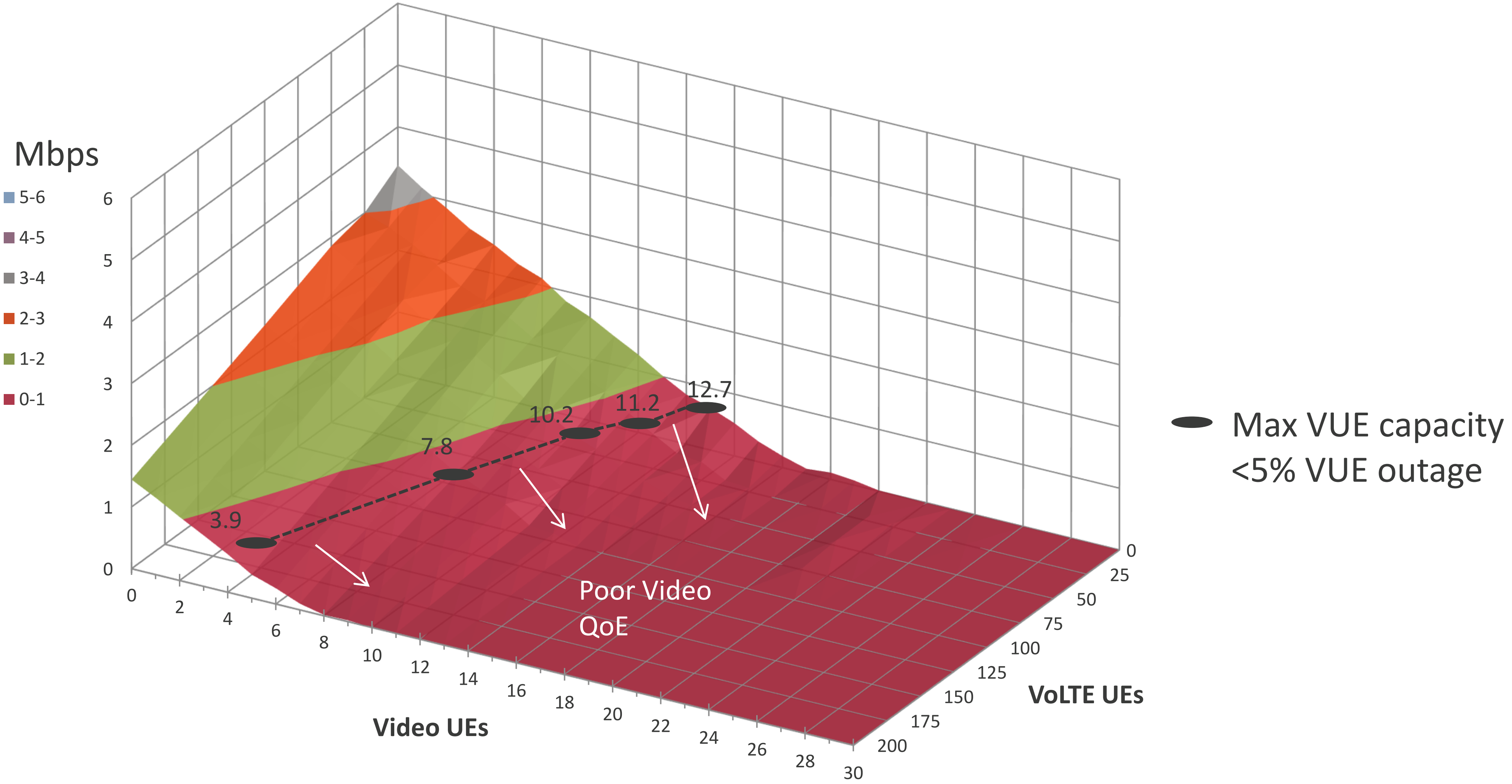
Results – Uplink, 256k video



Results – Downlink, 256k video

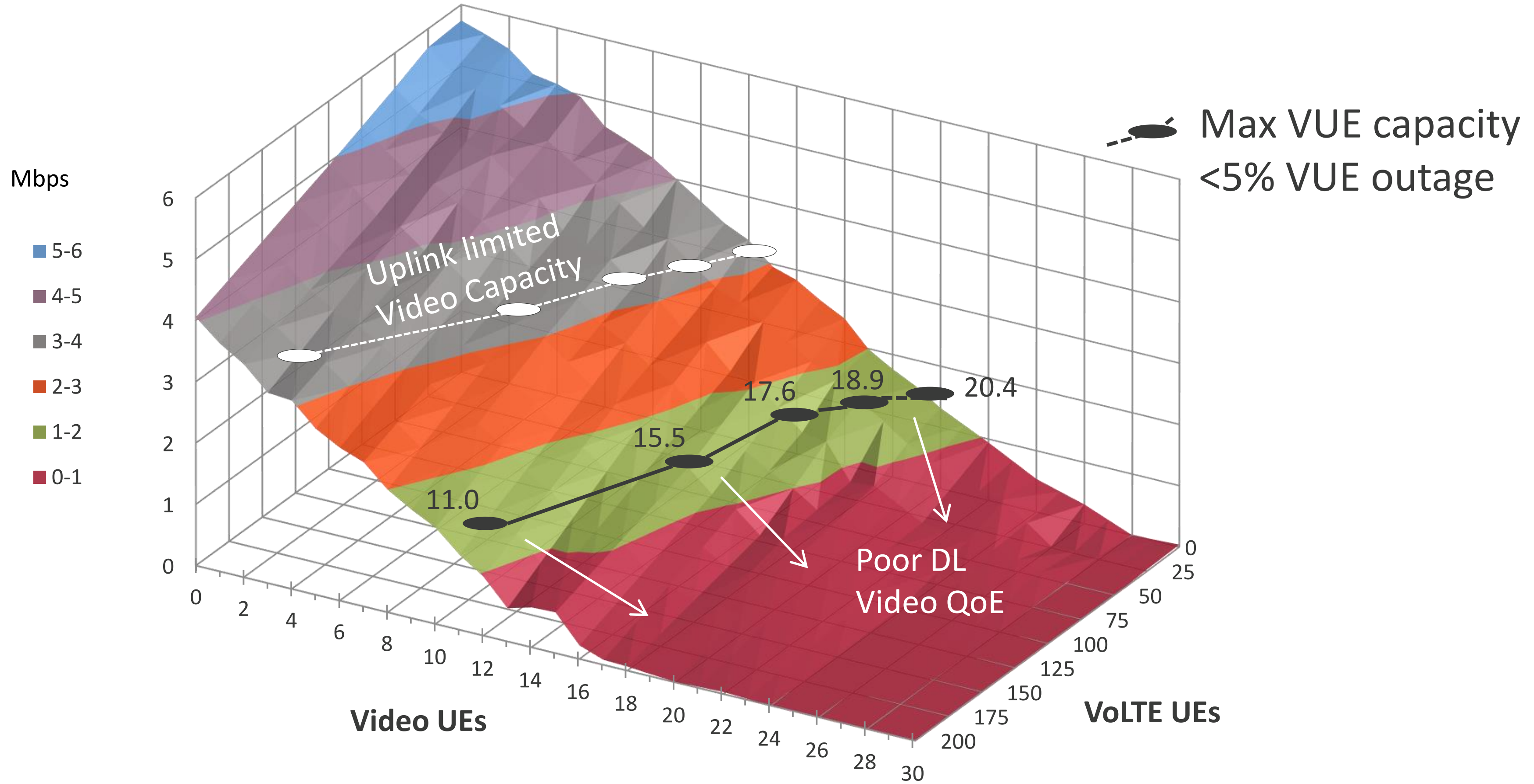


Aggregate FTP Tput – Uplink, 5 FTP UEs, A1V8 for 256k Video



- Shows UL Cell capacity remaining for FTP for given VoLTE & Video Loads
- Loading to 5% VUE outage always leaves around 0.7 Mbps FTP Tput

Aggregate FTP Tput – Downlink, 5 FTP UEs, A1V8 for 256k Video



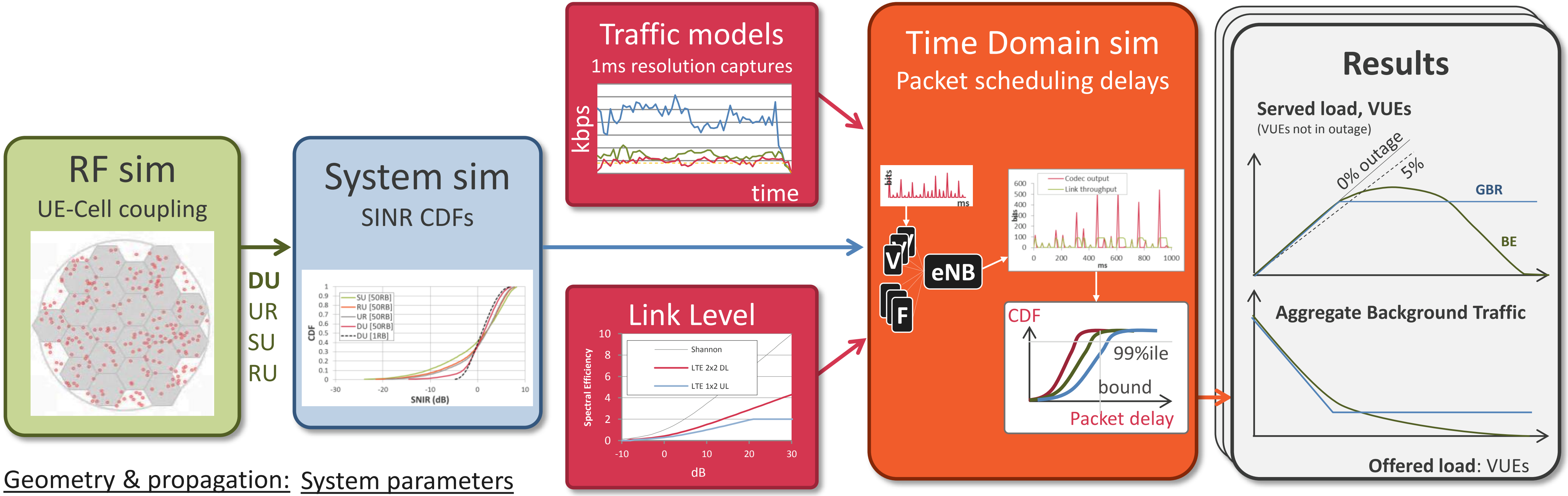
- Shows DL Cell capacity remaining for FTP at given VoLTE & Video Loads
- Loading to 5% DL VUE outage always leaves around ~1.5 Mbps FTP Tput
- Where VUE loading is uplink limited, DL FTP Tput is higher, at around ~3.2Mbps

Summary

- VNI results show that video continues to drive up mobile data usage and continues to become larger percentage of mobile data usage.
- Higher resolution video means there will always be a pent up demand for higher data rates to improve video QoE.
- Capacity for real-time, delay sensitive video (e.g. video conferencing) is UL limited.
- Prioritizing real-time, delay sensitive video through either non-GBR QCI8 or GBR QCI2 significantly improves QoE of video users with modest impact to residual capacity for FTP users.
- GBR based QCI2 provides the benefit of admission control to insure that video users achieve desired QoE.

Backup

Simulation Overview



<u>Geometry & propagation:</u>
Site locations
UE distribution
Antenna paths
path loss
Shadowing
Building penetration

<u>System parameters</u>
Transmit power
UL power control
System bandwidth
Noise figures

<u>Link parameters</u>
MIMO configuration & adaptation
Fast fading channel model

<u>Scheduler parameters</u>
Traffic models: video, audio, FTP
QCI assignments. GBR rates
Scheduler/ Call admission policy
Packet and UE outage KPIs

Geometry and Propagation Assumptions (RF Sim)

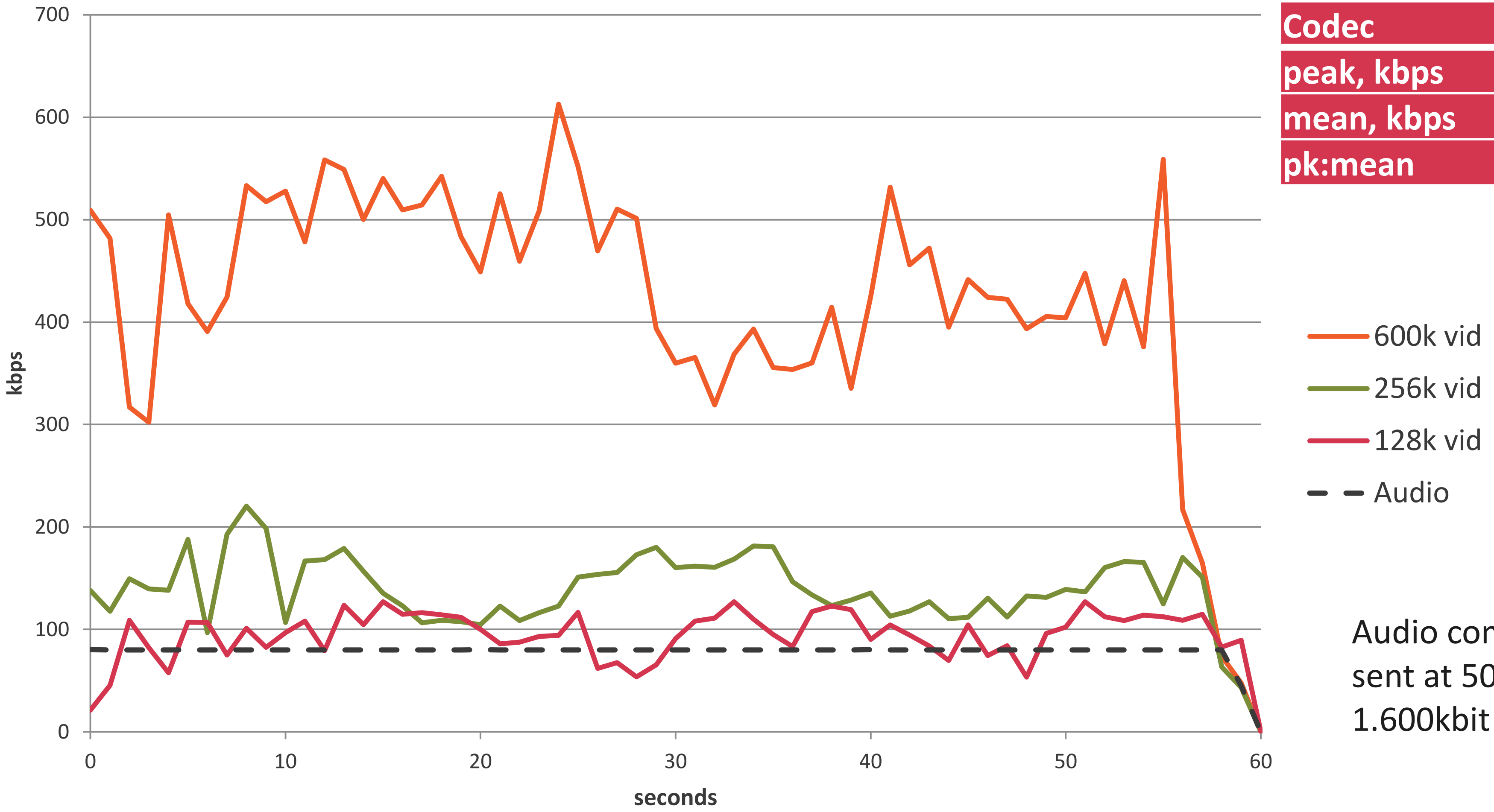
Parameter	Morphology			
	Dense Urban	Urban	Suburban	Rural
Network size	19 x 3 sector sites	19 x 3 sector sites	19 x 3 sector sites	19 x 3 sector sites
Sector orientation	cloverleaf	cloverleaf	cloverleaf	cloverleaf
ISD, km	0.5	1	3	10
UE spatial distribution	uniform area	uniform area	uniform area	uniform area
Path Loss Model	Hata Dense Urban	Hata Urban	Hata Suburban	Hata Rural
BS Antenna Height, m	25	20	20	30
UE Antenna Height, m	1.5	1.5	1.5	1.5
Frequency Band	DL: 747-757 MHz UL: 777-787 MHz	DL: 747-757 MHz UL: 777-787 MHz	DL: 747-757 MHz UL: 777-787 MHz	DL: 747-757 MHz UL: 777-787 MHz
Carrier Bandwidth	10 MHz	10 MHz	10 MHz	10 MHz
MIMO	DL:2x2, UL: 1x2	DL:2x2, UL: 1x2	DL:2x2, UL: 1x2	DL:2x2, UL: 1x2
Shadow fade standard deviation, dB	6.9	6.9	8.3	8.3
Shadow fade correlation	0.5 site-to-site 1.0 sector-sector	0.5 site-to-site 1.0 sector-sector	0.5 site-to-site 1.0 sector-sector	0.5 site-to-site 1.0 sector-sector
% indoor users	85	85	85	85
Mean BPL, dB	18	15	12	6
Std dev of BPL, dB	6.8	6.8	6.8	6.8
Macro antenna gain, dBi	14	14	14	14
Macro antenna BW, deg	65	65	65	65
UE antenna gain, dBi	0	0	0	0
Min coupling Loss, dB	70	70	70	80

Transmit power

DL: eNodeB +46dBm (PA output)

UL: UE +24dBm EIRP

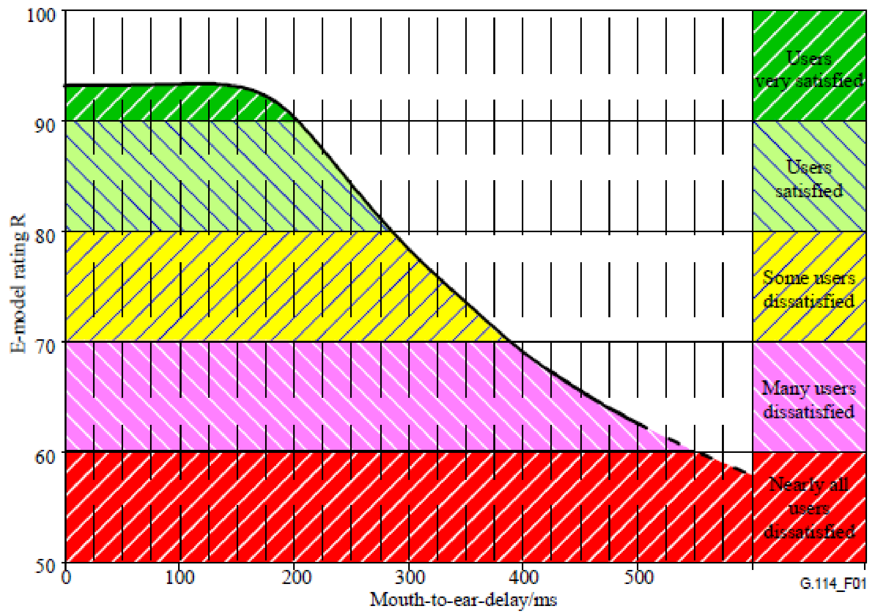
Video and Audio Traffic Captured from PVE (Jabber)



Codec	128kbps	256kbps	600kbps
peak, kbps	127.2	220.4	612.8
mean, kbps	95.4	140.3	428.1
pk:mean	1.33	1.57	1.43

Audio comprises 1600bit packets sent at 50fps:
1.600kbit x 50fps = 80 kbps

Delay bound: 55ms for air interface & buffering



- Based on G.114 ITU-T, assume a maximum tolerable one-way (i.e. mouth to ear) delay of ~280ms to keep users satisfied. Delay budget analysis:
  - ~35 ms of delay in the UE on the originating side (due to 20 ms packet framing, 10 ms processing and 5 ms look ahead)
  - ~35 ms of delay in the UE on the terminating side (due to de-jitter buffering and processing)
  - ~50ms from the originating eNB to the core network (i.e. P-GW) due to eNB processing, GW processing, Backhaul, Echo Cancellers, PSTN (for voice), routers, etc.
  - ~50ms from core network to terminating eNB (due to the same as above)
- This adds up to 170ms, leaving ~110ms for the air-interface (55ms for the UL and 55ms for the DL). So the proposal is to use 55ms for the air-interface delay budget in each direction**.**
- **We assume a mean air interface delay of ~5ms, allowing 50ms for buffering delay**