



Viewer Intelligence™ to Deliver
The Ultimate Viewing Experience™

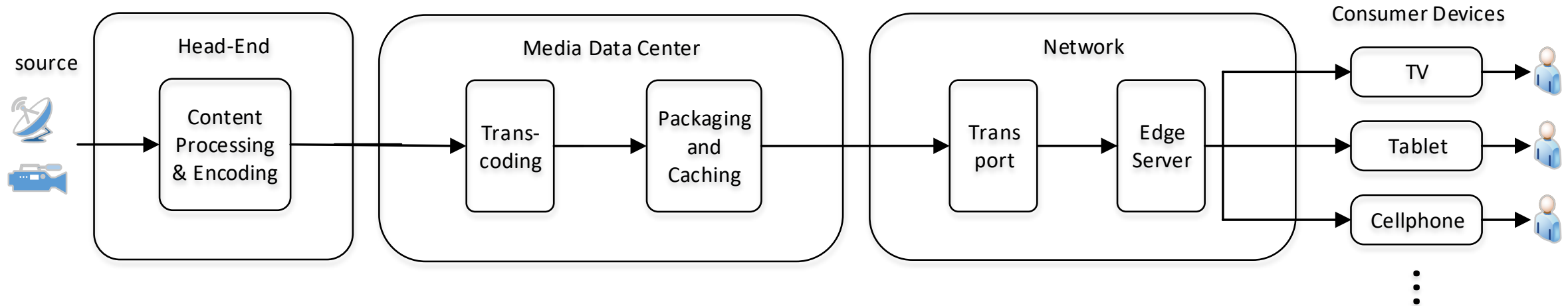
Video Quality-of-Experience Assessment

Zhou Wang

SSIMWAVE INC & University of Waterloo



QUALITY-OF-EXPERIENCE ASSESSMENT IN VIDEO DISTRIBUTION



- How do we ensure end users' quality-of-experience (QoE)?
- How do we ensure content producers' creative intent is faithfully delivered to users?
- How do we save resource/cost without sacrificing user QoE?

QUALITY-OF-EXPERIENCE ASSESSMENT IN VIDEO DISTRIBUTION

Quality-of-Serve (QoS)

Quality-of-Experience (QoE)

QoS
metrics



“Pseudo” QoE
metrics



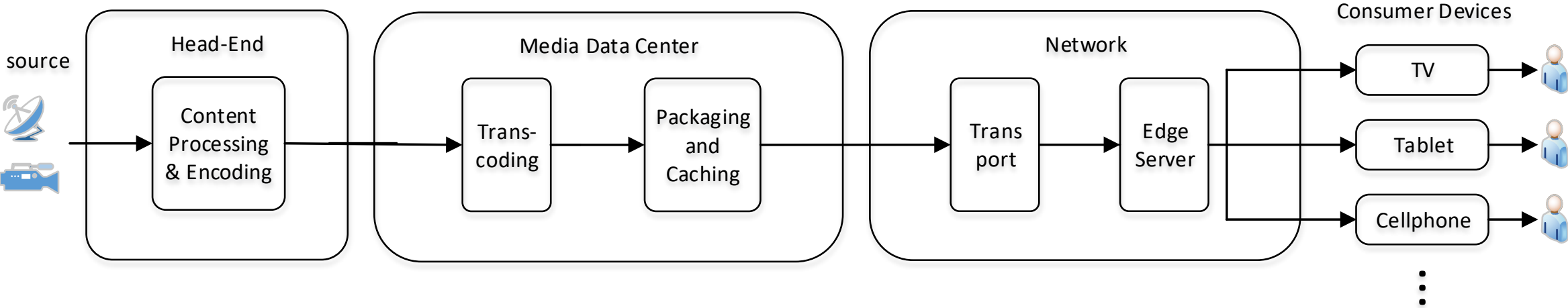
True QoE
metric

bitrate
package drop
network delay
integrity checks
.....

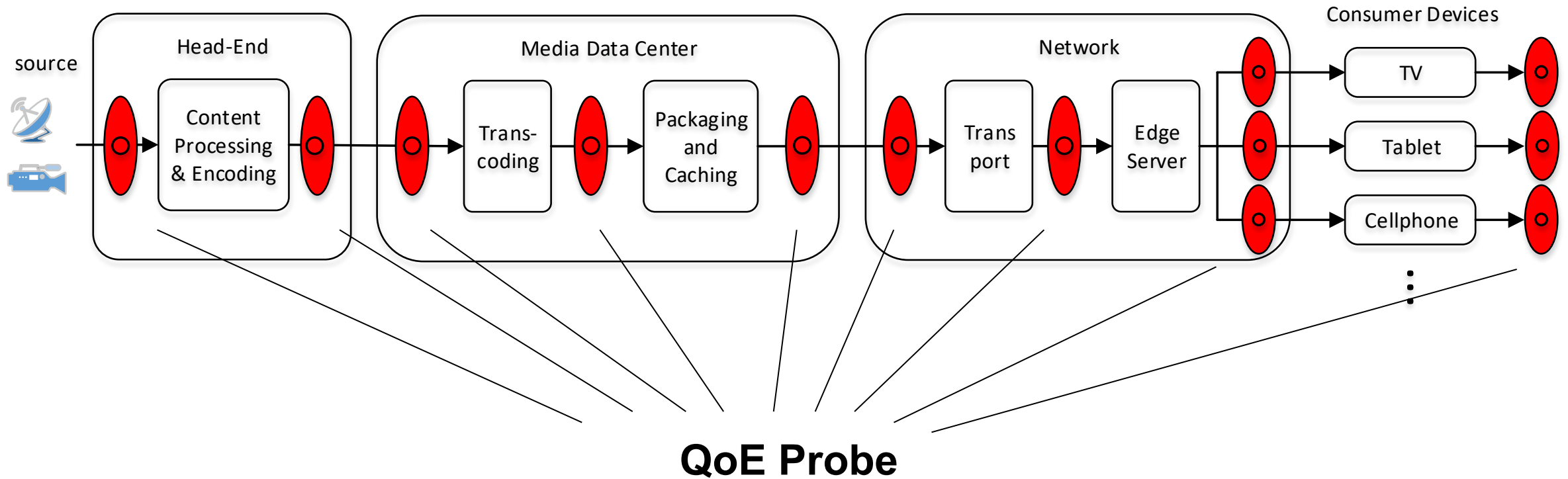
initial buffering
stalling duration
stalling frequency
.....

seeing like humans

QUALITY-OF-EXPERIENCE ASSESSMENT IN VIDEO DISTRIBUTION



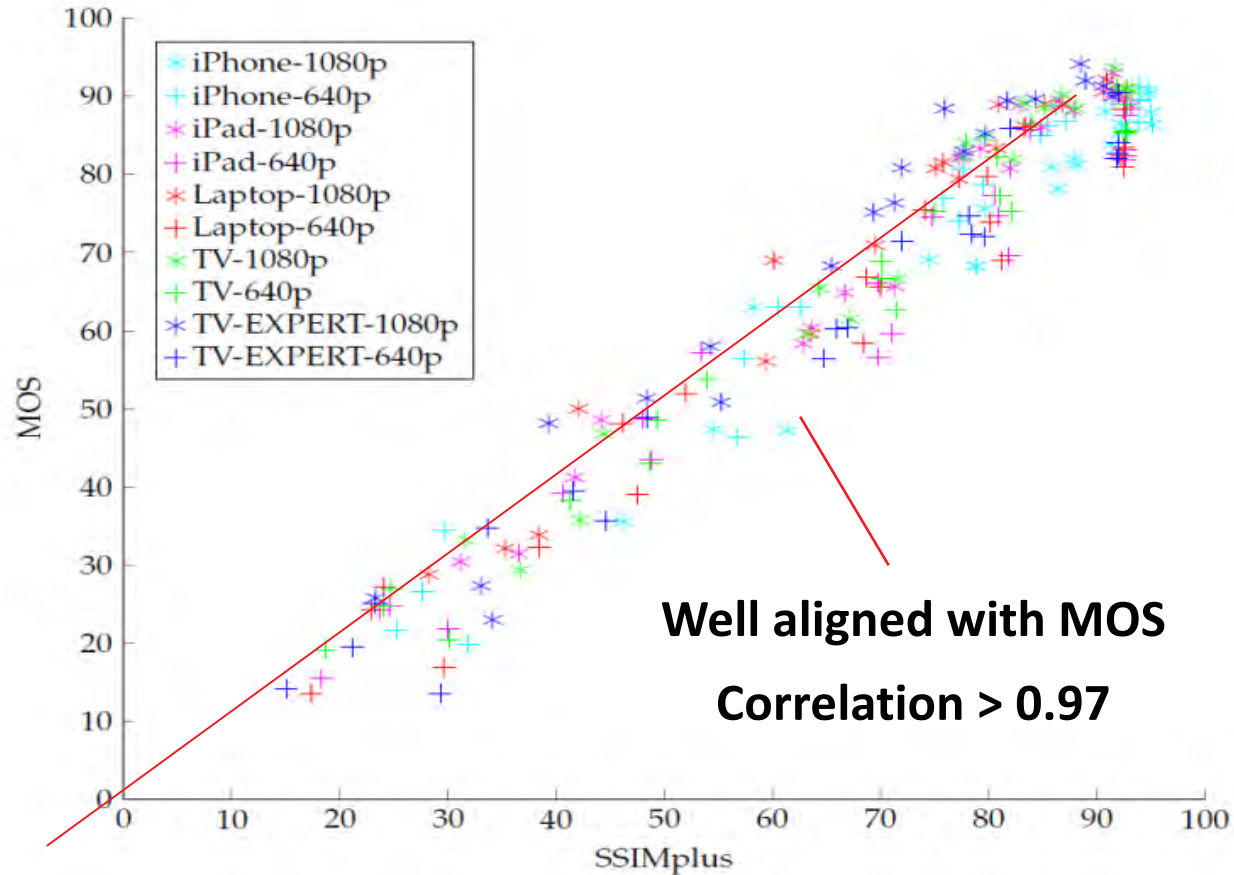
QUALITY-OF-EXPERIENCE ASSESSMENT IN VIDEO DISTRIBUTION



DESIRED PROPERTIES OF QOE METRICS

- High accuracy, high speed
- Easy-to-understand, easy-to-use
- High precision (fine granularity)
- Consistent scoring across content, resolution, dynamic range, viewing device/condition
- Spatial alignment, temporal alignment
- Versatile: full-reference, no-reference, degraded-reference
- End-to-end: consistent scoring between server and client

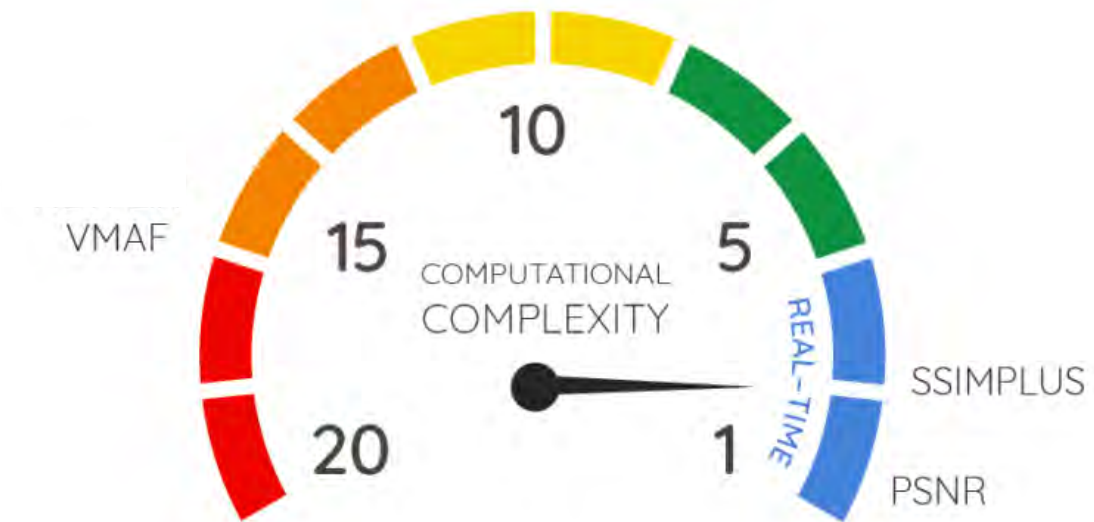
SSIMPLUS – HIGH ACCURACY



Only metric achieving 0.9 average correlation with MOS

Database	PSNR	VMAF	SSIMPLUS
AVERAGE	0.756	0.853	0.900
CSIQVQA	0.575	0.662	0.903
ECVQ	0.740	0.736	0.882
EVVQ	0.771	0.874	0.922
IVP	0.820	0.879	0.862
IRCCyN_IVC_1080i	0.653	0.791	0.855
IRCCyN_IVC_Influence	0.817	0.942	0.935
IRCCyN_IVC_SVC4QoE	0.846	0.920	0.909
JEG264HMIX1	0.770	0.930	0.915
MobileVQA	0.824	0.956	0.941
VQEGHD3	0.741	0.841	0.875

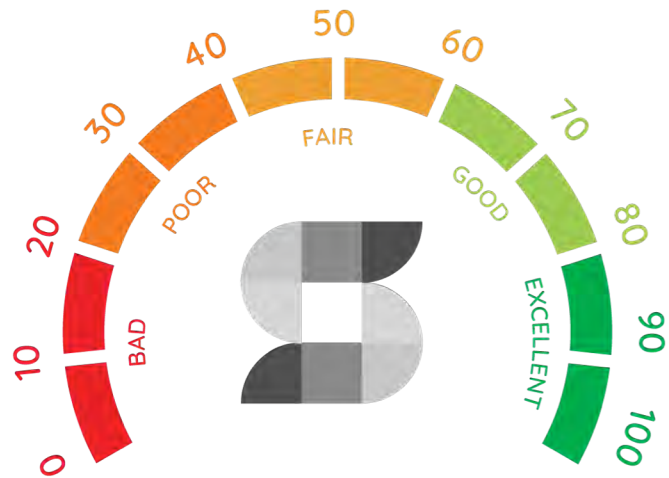
SSIMPLUS – HIGH SPEED



Computational Complexity	PSNR	VMAF	SSIMPLUS
	1.0	16.4	1.5

SSIMPLUS – EASY-TO-UNDERSTAND, EASY-TO-USE

Large-scale deployment, running 24/7



quality meter

Region: Denver
Active Services: 48
Add Service +

87% Critical Errors
Warnings 100%

Outgoing Streams
Quality of Delivery: 99 Overall
Quality of Experience: 72 Overall

Source Streams
Quality of Delivery: 99 Overall
Quality of Experience: 89 Overall

Bandwidth
Service Average: 6.46 Mb/s
Total Bandwidth: 310.231 Mb/s

SSIMWAVE

Filter: All

Data Mode: Video Mode Search

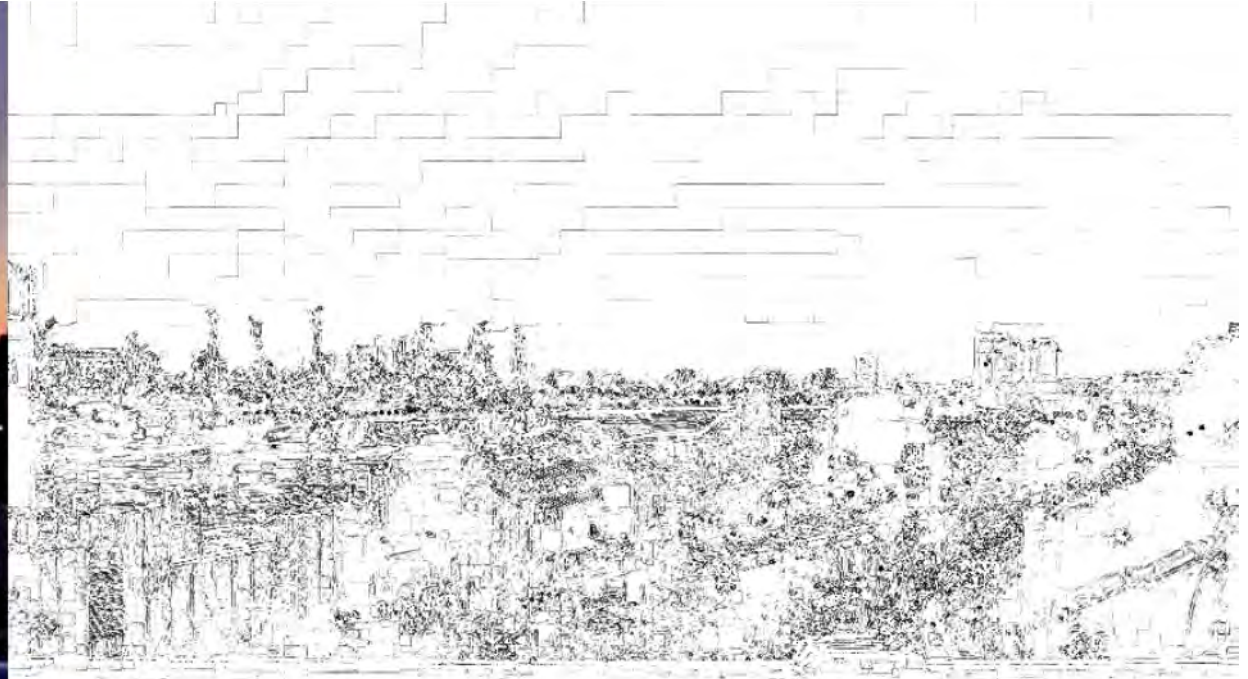
Bravo E HD-A (72) (100)	CNBC E HD-A (72) (100)	USA E HD-A (84) (100)	Syfy E HD-A (69) (100)	MSNBC HD-A (77) (100)	Oxygen E HD-A (81) (100)	A and E HD-A (74) (100)	ActionMax East HD-A (74) (100)
ActionMax West HD-A (80) (100)	AMC HD-A (58) (100)	Animal Planet E HD-A (72) (100)	Animal Planet W HD-A (65) (100)	AXS TV HD-A (77) (100)	BleacherSport ENG (74) (100)	BleacherSport SPA (74) (100)	Bloomberg HD-A (78) (100)
Comedy Central HD-A (78) (100)	CBS Sports E HD-A (78) (100)	Cinemax (Latino) East HD-A (72) (100)	Cinemax East HD-A (78) (100)	Cinemax West HD-A (75) (100)	CMT East HD-A (82) (100)	CMT West HD-A (82) (100)	Comedy Central East HD-A (65) (100)
Destination America HD-A (78) (100)	Discovery HD-A (76) (100)	Discovery W HD-A (78) (100)	E! East HD-A (81) (100)	Esquire HD-A (81) (100)	Fuse HD-A (80) (100)	FYI HD-A (74) (100)	FYI West-A (87) (100)
Galavision East HD-A (76) (100)	GSN HD-VPA (76) (100)	HBO E HD-A (82) (100)	HIM Movie&Mysteries HD-A (82) (100)	IFC HD-A (87) (100)	Show Extreme W HD-A (77) (100)	Smithsonian E HD-A (78) (100)	VH1 East HD-A (77) (100)
VH1 W HD-A (74) (100)	WE HD-A (88) (100)	5StarMax East HD-A (84) (100)	BBC America E HD-A (80) (100)	BBC America W HD-A (82) (100)	Discovery Family HD-A (82) (100)	GSN E HD-A (82) (100)	HBO Latino West HD-A (81) (100)

SSIMPLUS – HIGH PRECISION (FINE GRANULARITY)

test video frame



pixel-precision quality map



SSIMPLUS – CONSISTENT SCORING

**cross resolution/
frame rate**



**cross
user device**



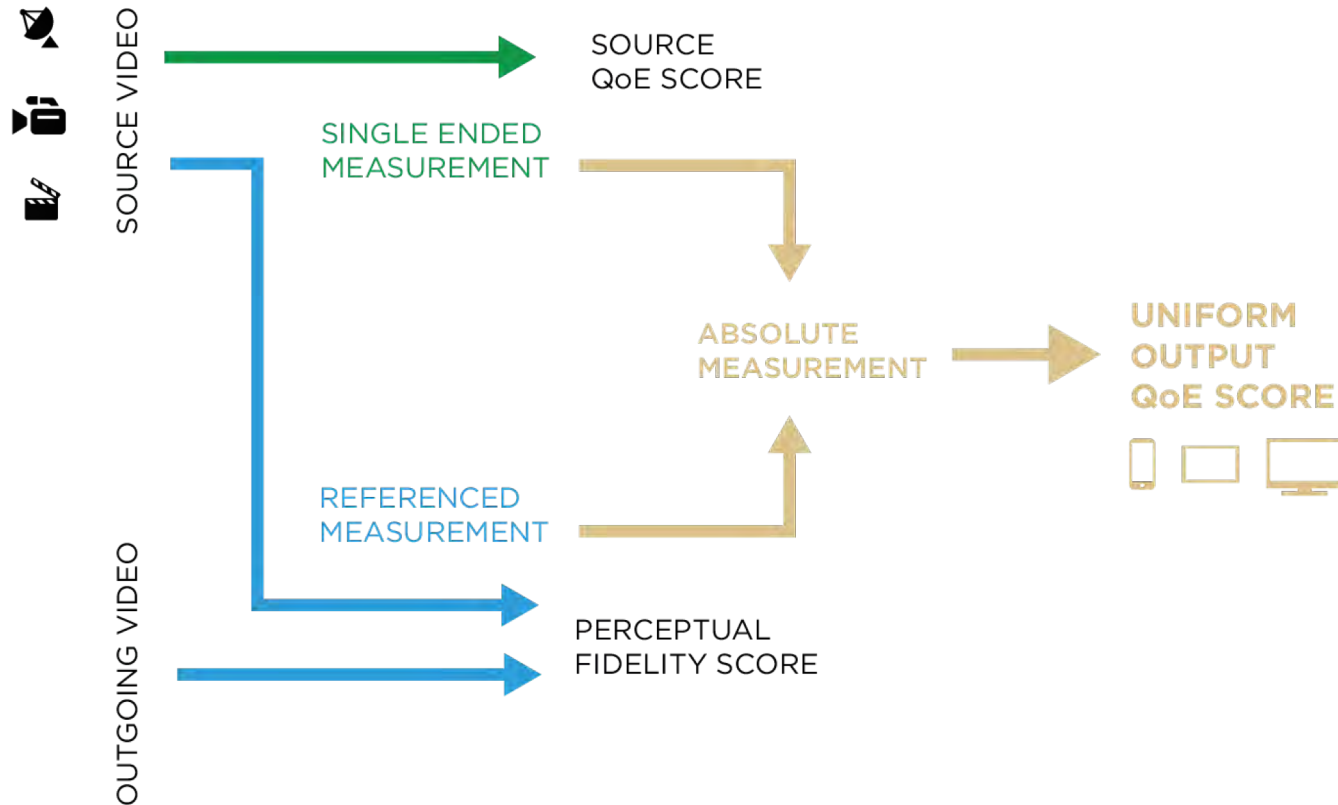
**cross
dynamic range**



**cross
video content**



SSIMPLUS – HIGH VERSATILITY



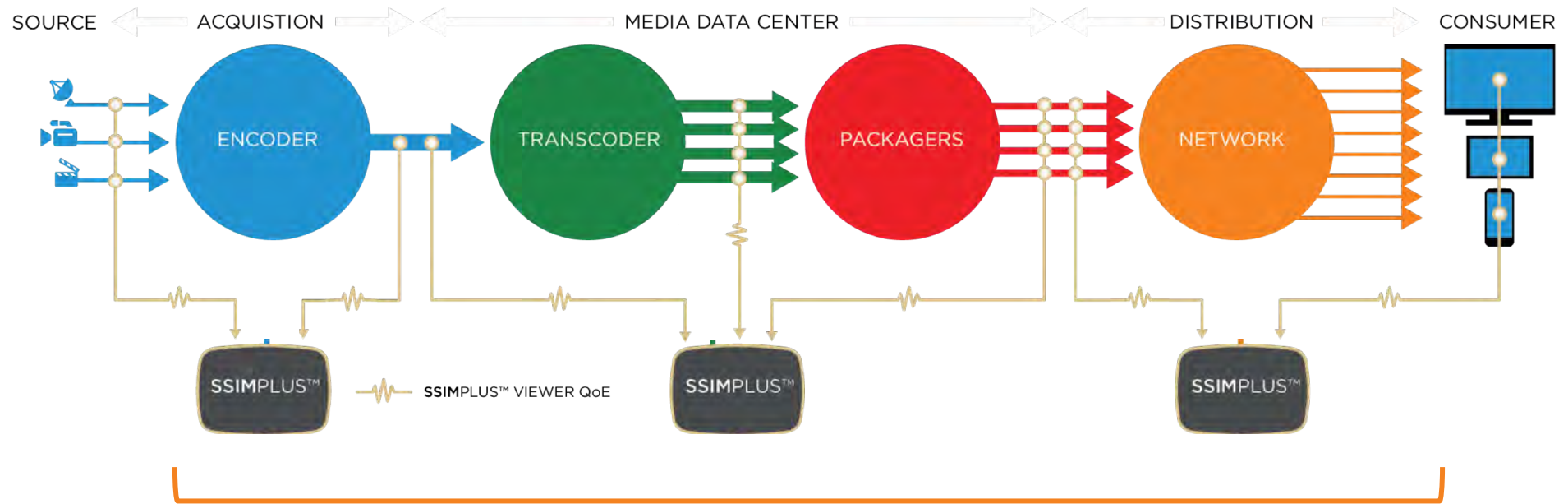
For source

- Single-ended no-reference (NR) quality assessment

For test

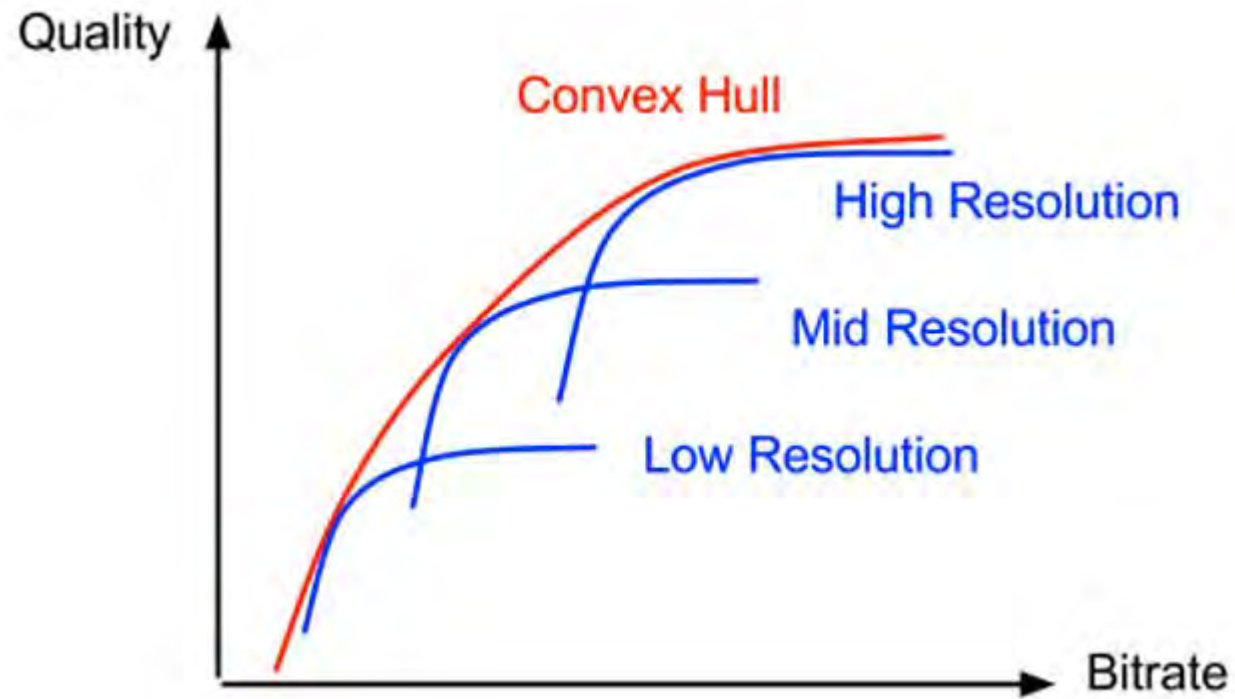
- Double-ended full-reference (FR) perceptual fidelity assessment
- Degraded-reference (DR) absolute quality assessment

SSIMPLUS – END-TO-END CONSISTENT QUALITY MONITORING



MEASURE END-TO-END

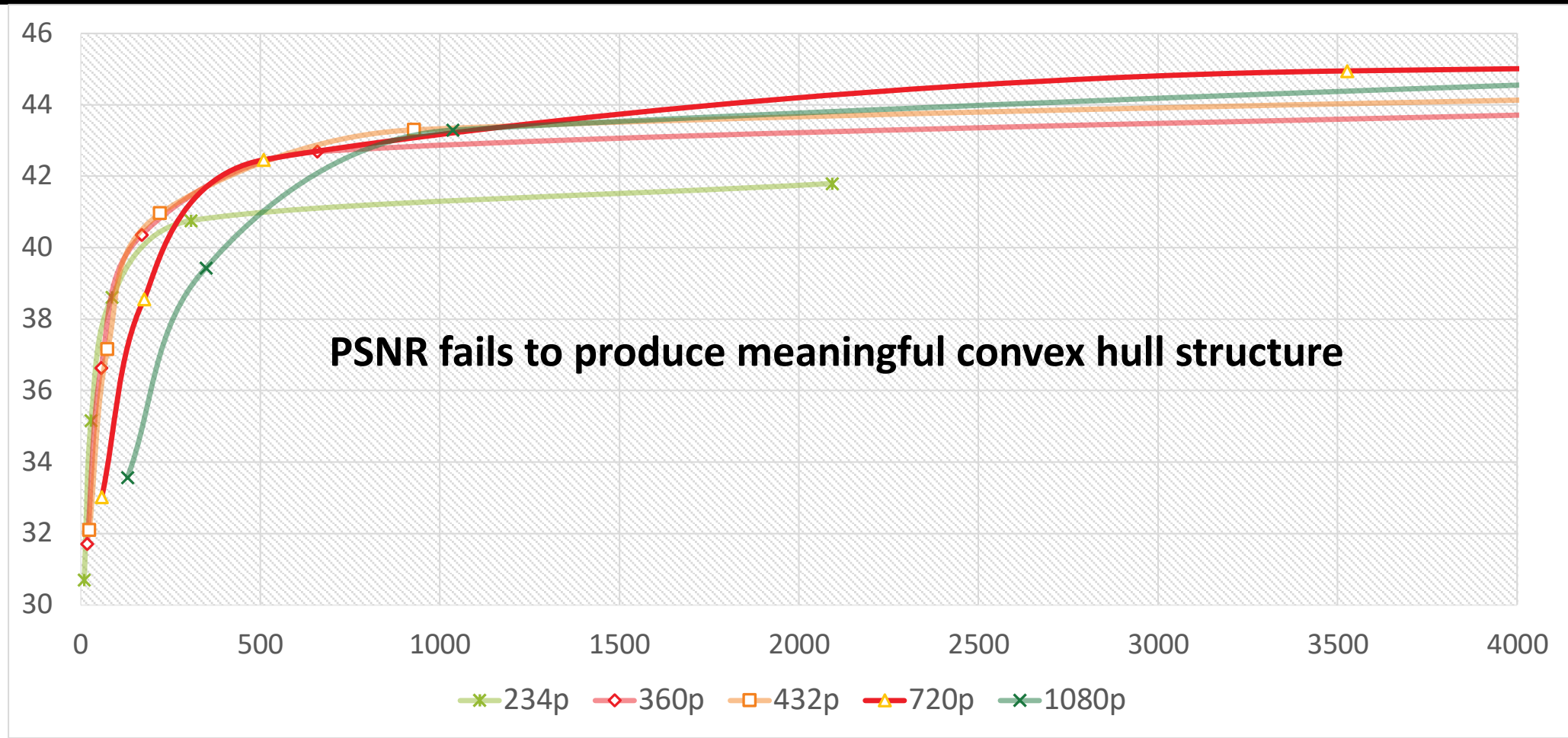
CROSS-RESOLUTION QUALITY ASSESSMENT



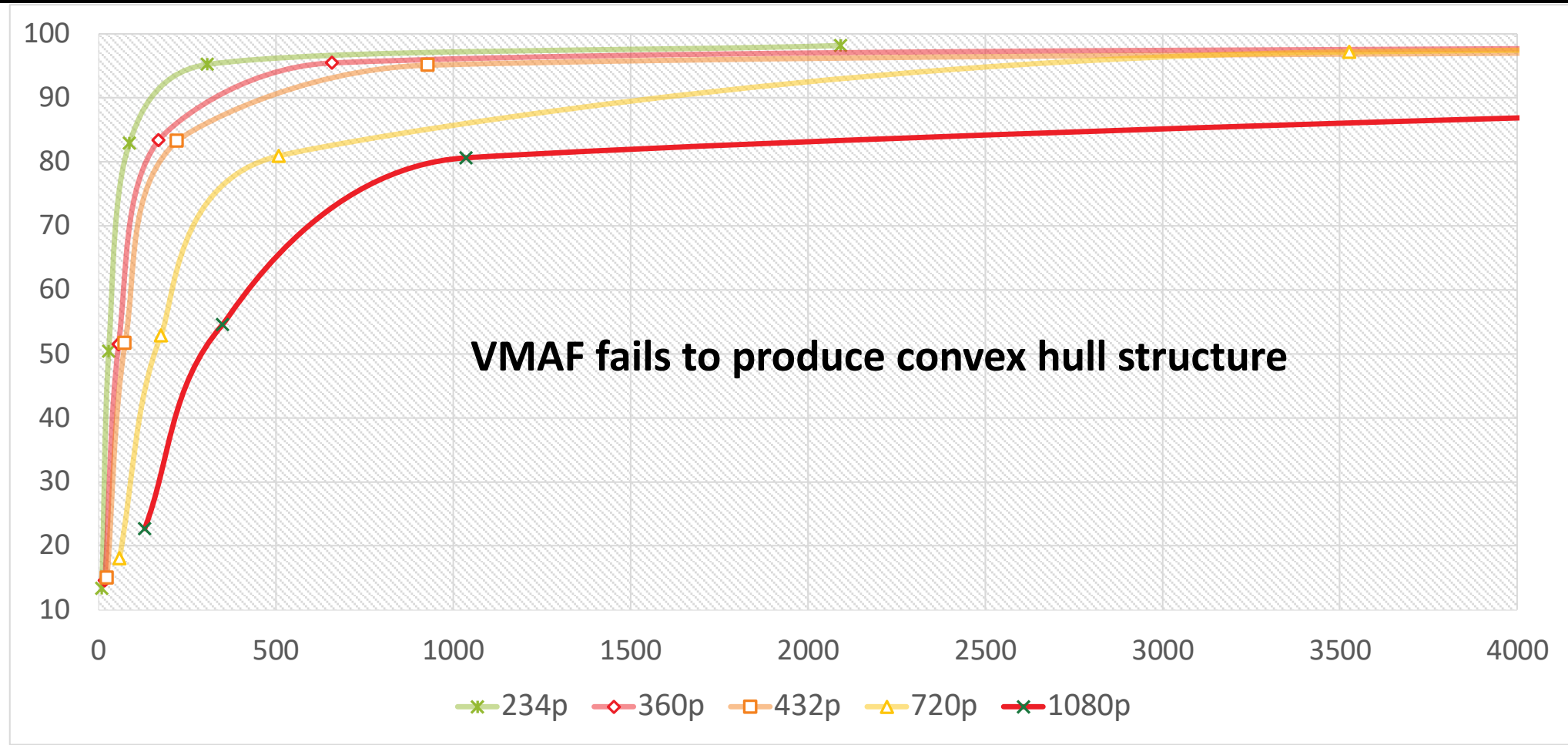
The ideal convex hull structure for rate-quality envelop

Source: <https://medium.com/netflix-techblog/per-title-encode-optimization-7e99442b62a2>

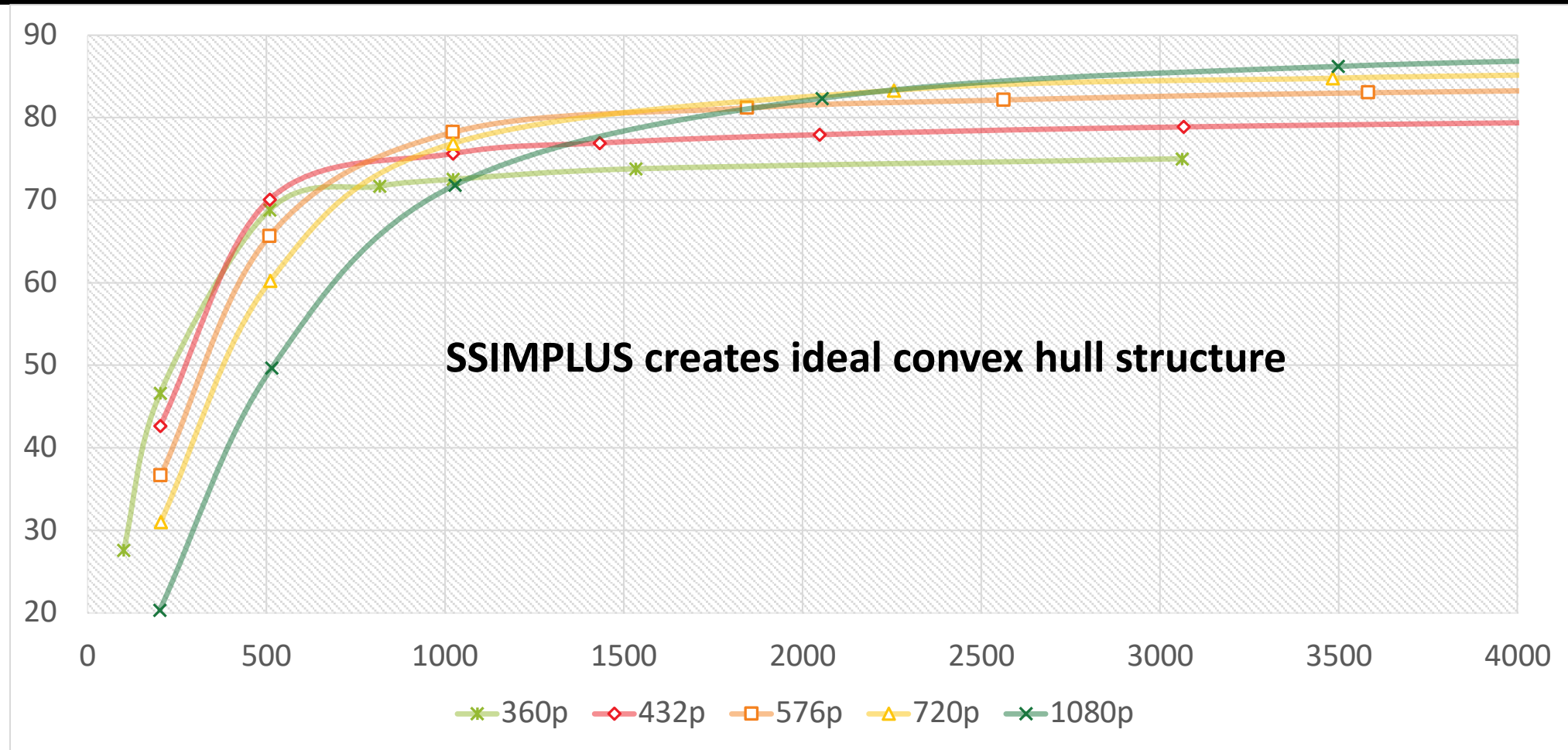
CROSS-RESOLUTION QUALITY ASSESSMENT: PSNR



CROSS-RESOLUTION QUALITY ASSESSMENT: VMAF



CROSS-RESOLUTION QUALITY ASSESSMENT: SSIMPLUS



SUMMARY

Features	PSNR	VMAF	SSIMPLUS
High accuracy	X	√?	√
High speed	√	X	√
Ease-of-understanding, ease-of-use	√	X	√
High precision (fine granularity)	√	X	√
Consistency across spatial resolution	X	X	√
Consistency across frame rate	X	X	√
Consistency across dynamic range	X	X	√
Consistency across viewer device/condition	X	X	√
Spatial alignment/temporal alignment	X	X	√
Full-reference	√	√	√
No-reference/degraded-reference	X	X	√
End-to-end consistency	X	X	√

SUMMARY

- High accuracy, high speed
- Easy-to-understand, easy-to-use
- High precision (fine granularity)
- Consistent scoring across content, resolution, dynamic range, viewing device/condition
- Spatial alignment, temporal alignment
- Versatile: full-reference, no-reference, degraded-reference
- End-to-end: consistent scoring between server and client

SSIMPLUS: the only metric that satisfies all conditions