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The Network that Won't Stand Still:

Challenges & Opportunities for Real-Time Mobile Video

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IEEE P1907.1 Working Group Chair

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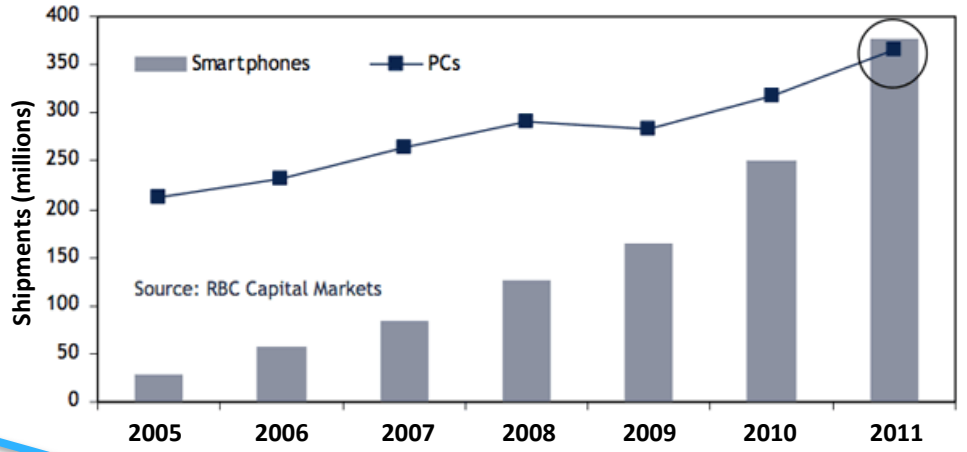
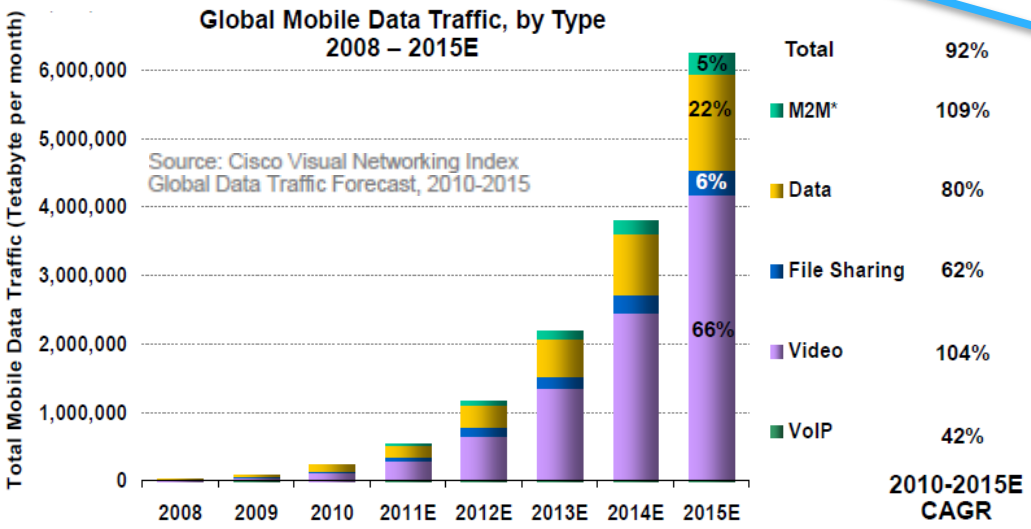
Agenda

- Market Opportunity and Challenges
  - Video bandwidth load vs. cellular data capacity
- Technical Challenges
  - One-way video broadcast vs. real-time video interaction
  - Delivering End-to-End User Quality of Experience (E2E QoE)
- Lessons from the "Master Engineer": Mother Nature
  - **Importance of an end-to-end system solution**
- Overview of IEEE P1907.1 Standard
  - Managing E2E QoE
  - Network-adaptive video coding
  - Real-time feedback to link video coding and E2E QoE

Market Opportunity

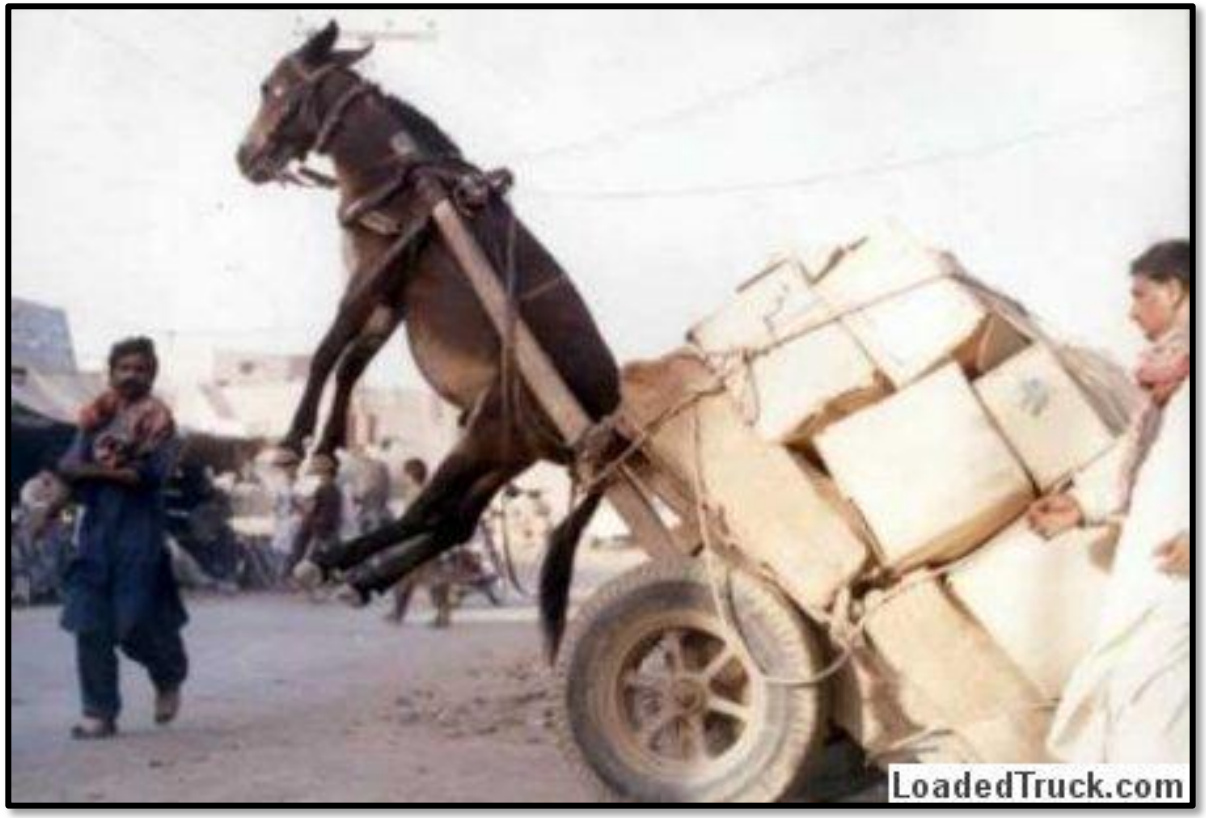
Smartphone sales surpass PC sales in 2011





Mobile data traffic dominated by video, already >50% in 2010

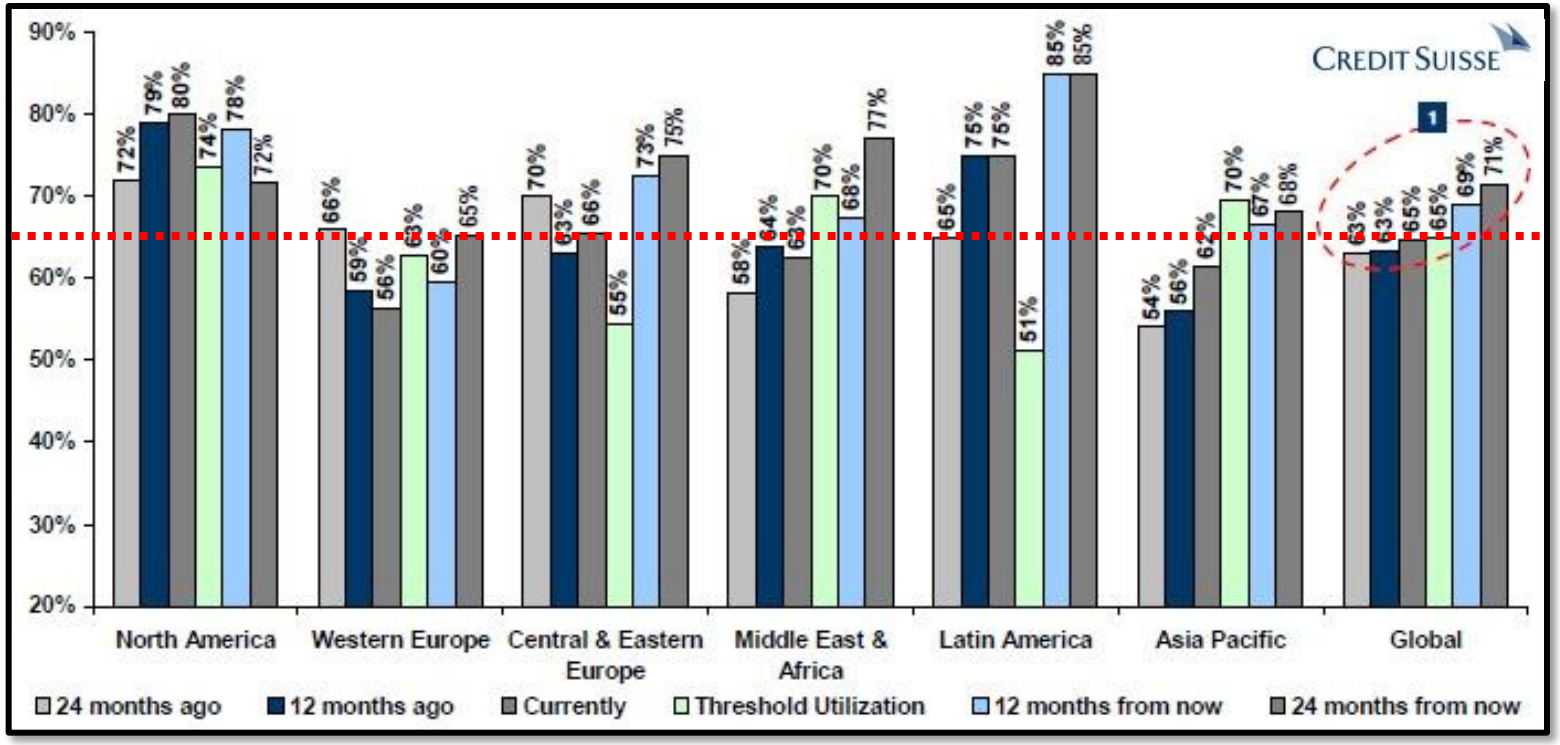
Market Challenge



Video Bandwidth Load vs. Cellular Data Capacity

Market Challenge… it's Global

- Mobile network utilization rates have already reached threshold levels of 65% globally, triggering requirement for additional CapEx spending (source: Credit Suisse, July 2011)



http://www.fiercemobilecontent.com/pages/credit-suisse-wireless-network-utilization-levels-globally-are-threshold-le

Market Challenge… it's Expensive

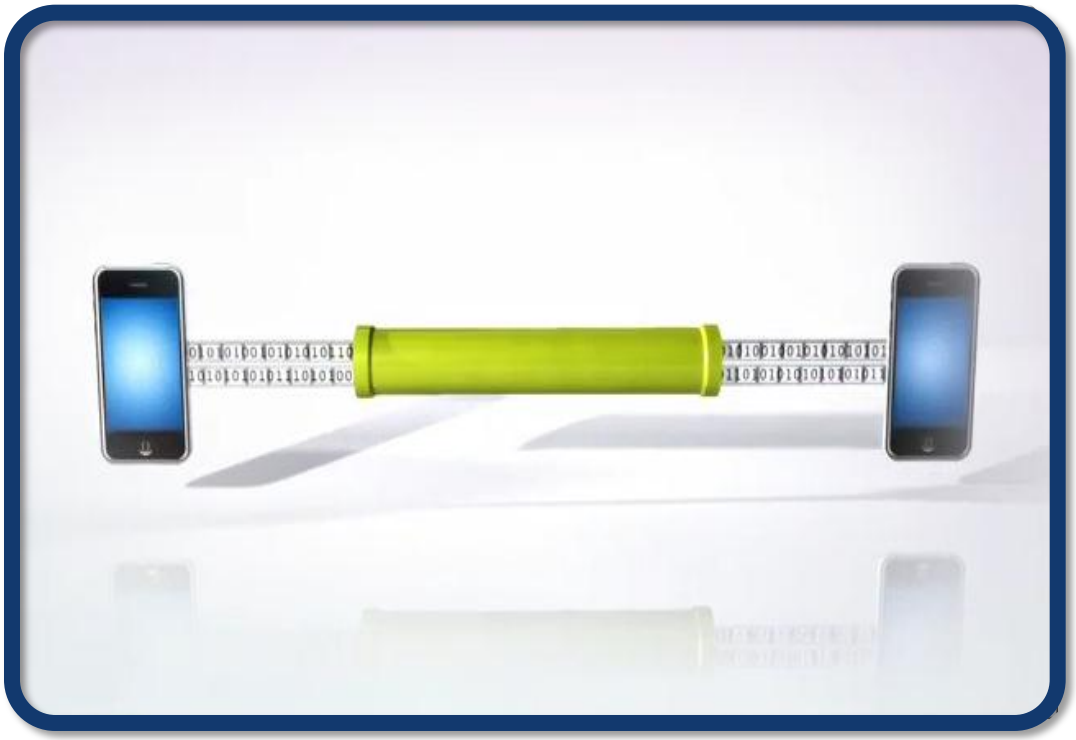
- **Cost of delivering mobile data could rise to $370 billion by 2016***
  - Device, app, service innovations all increase demand for mobile spectrum & infrastructure
- **Operators trying to "off-load" data traffic to WiFi hotspots**
  - Reduce congestion and infrastructure costs, improve user experience
- **Network congestion and user experience continue to deteriorate**
  - Proliferation of smartphones, other connected devices ("on-loading")
  - Users demanding ubiquitous access (i.e. mobile, not just WiFi)
- **The major culprit is video…**
  - Significant opportunity to deliver better User Quality of Experience to more users for any given investment in spectrum and infrastructure

***Juniper Research – 8/3/2011 - http://www.totaltele.com/view.aspx?C=0&ID=466780)**

Video Broadcast / Download…

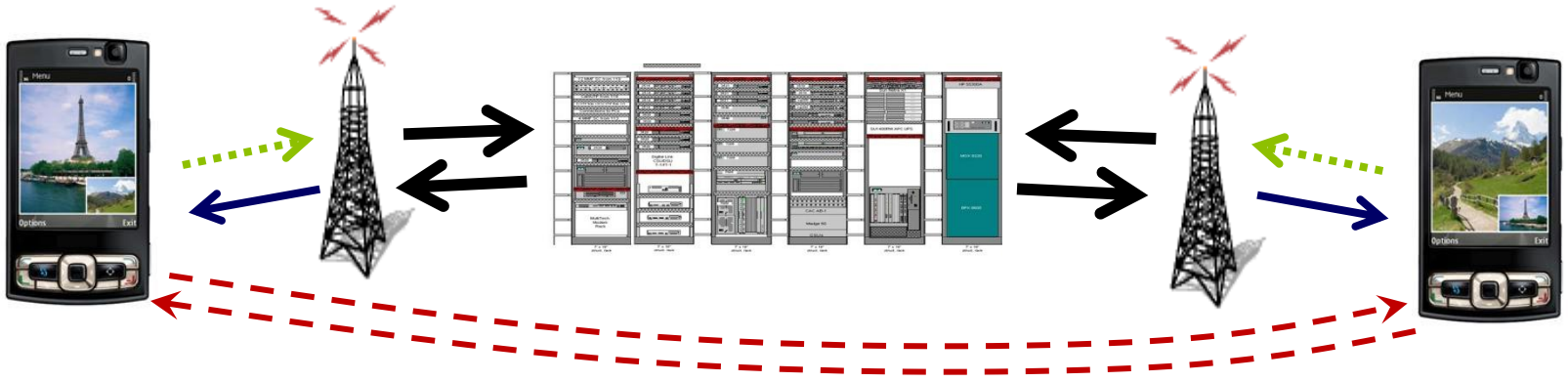
- Studio production environment
- Big, one-way, stable broadcast data pipes
- Can resend and buffer video packets to smooth out network glitches
- Inexpensive broadcast bandwidth

… vs. Real-Time Mobile Video



- “Production environment” = user with mobile device
- Small, two-way, constantly fluctuating mobile data pipes
- Can’t resend / buffer video packets to smooth out network glitches
- Expensive mobile bandwidth

Cellular Networks Fluctuate!



Measured Network Impairments	units	typical
Round trip delay	(msec)	300 - 1600
Uplink delay	(msec)	200 - 1000
Downlink delay	(msec)	100 - 600
Jitter	(msec)	100 - 250
Packet loss	(%)	0.33 - 3
Effective real-time uplink bandwidth	(kbps)	150 - 250
Effective real-time downlink bandwidth	(kbps)	300 - 600

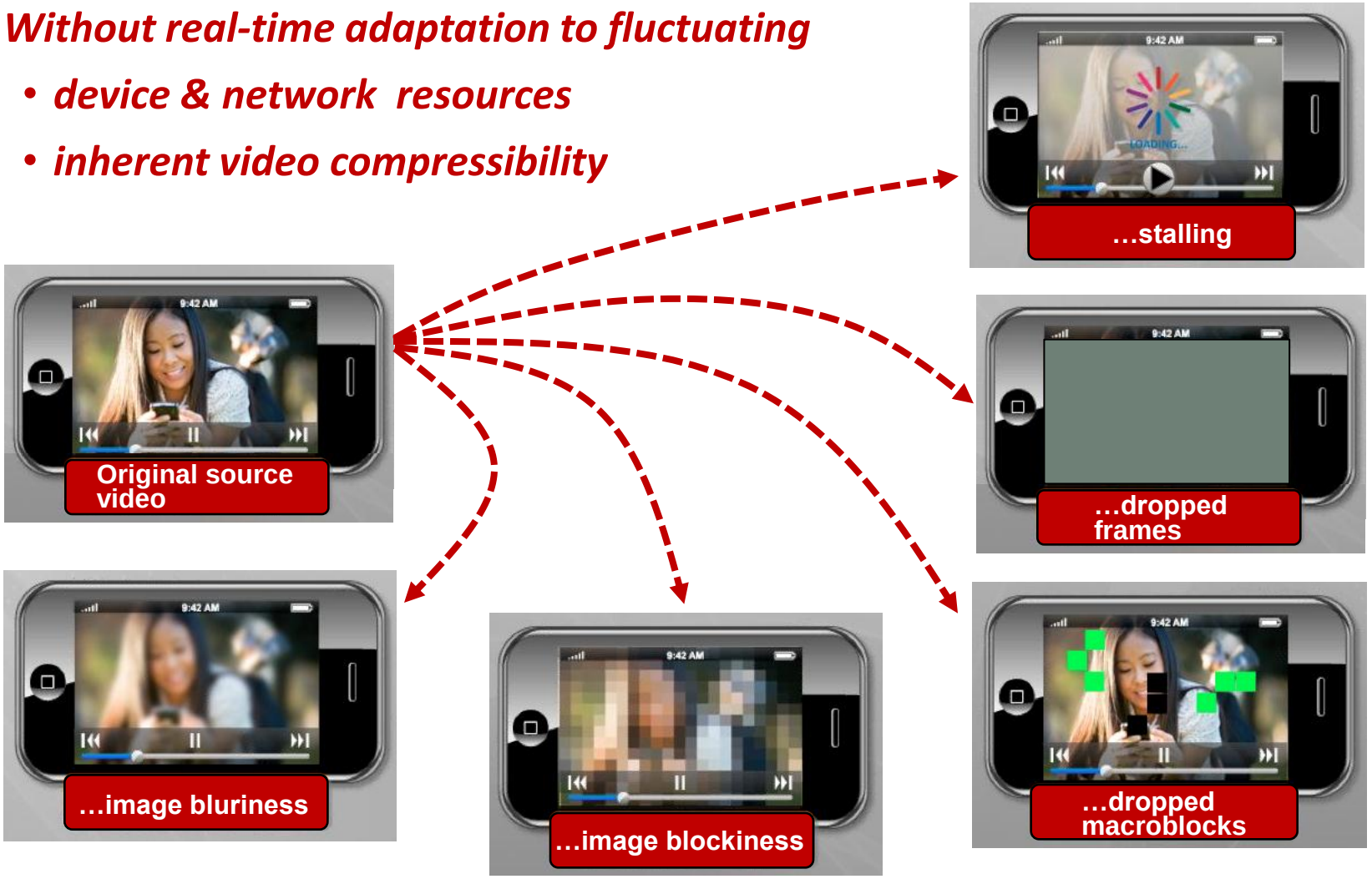
In a broadcast network or corporate videoconferencing network, these fluctuations would be considered

- ***"very poor network environment" (best case)***
- ***"unusable" (worst case)***

User Quality of Experience

Without real-time adaptation to fluctuating

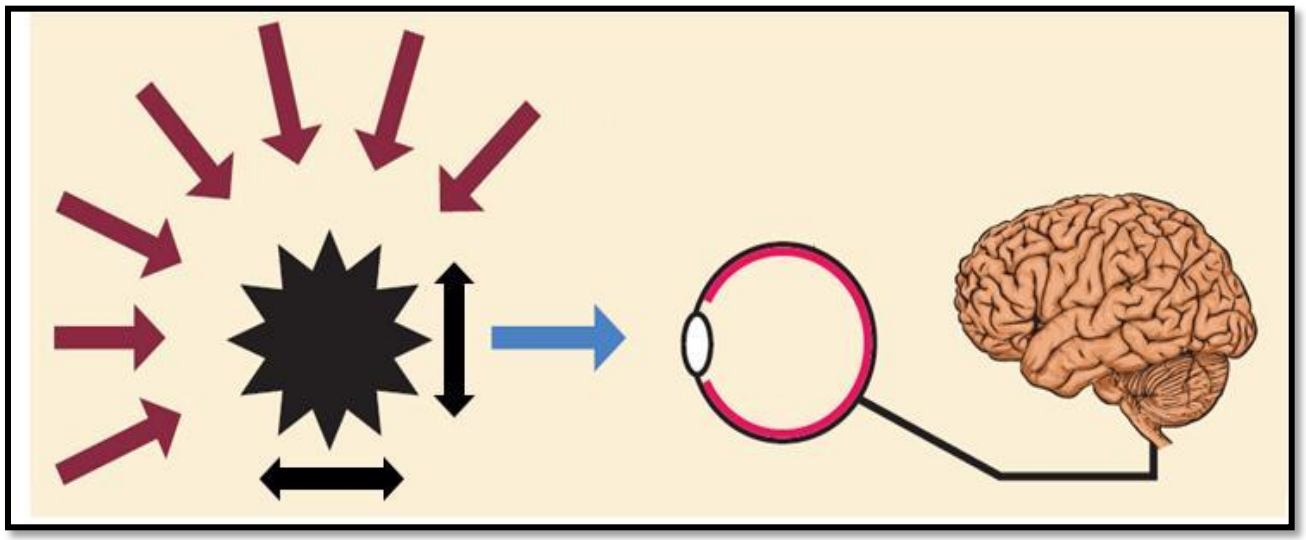
- *device & network resources*
- *inherent video compressibility*



Lessons from Mother Nature (1)

Human Visual System (HVS) adaptively allocates "encoding resources" in real-time to perceptually important regions, based upon

- ***chrominance, luminance, contrast, and structure***
- ***spatial, temporal, intensity-dependent sensitivities***



- Very different from broadcast video encoding (processing of large GOPs, block-based image segmentation, machine-based MSE/PSNR)
- Exploited in machine vision, synthetic graphics

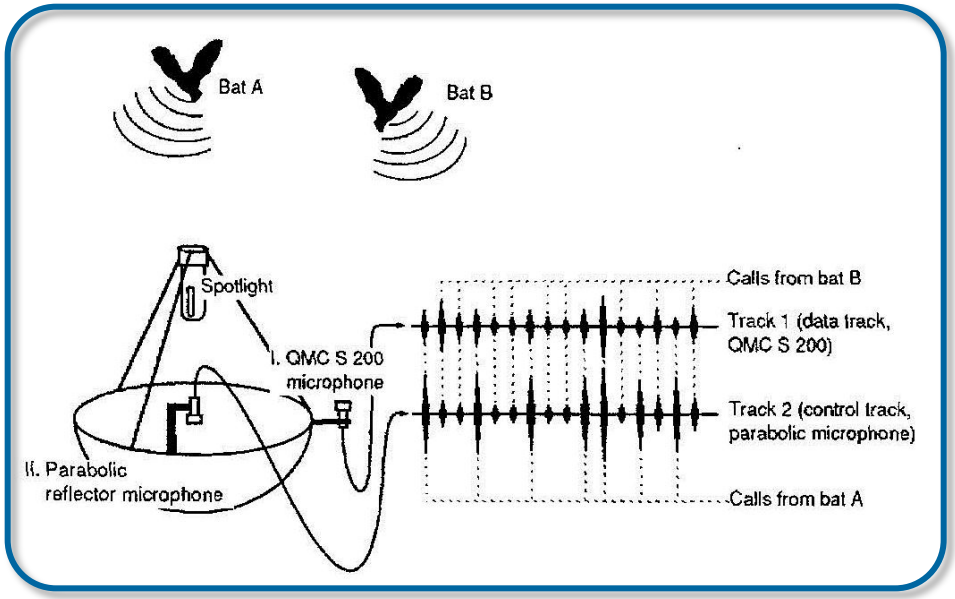
HVS-Based Video Coding: Benefits

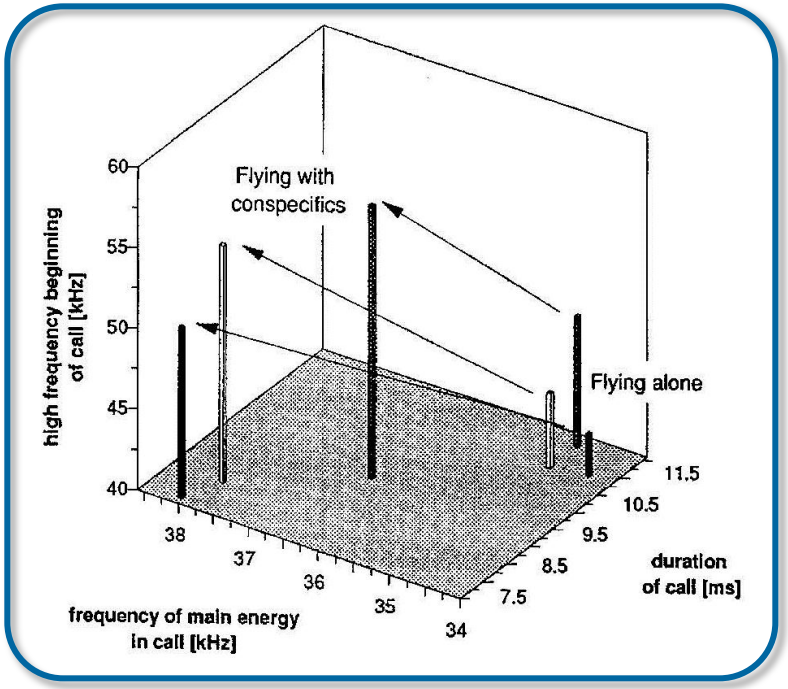
LCVC vs. CBP… which is which?

- HVS model incorporated into video compression engine can
  - reduce computational complexity; **and**
  - achieve lower compressed video bitrates; **and**
  - enhance real-time adaptation to fluctuating network resources

Lessons from Mother Nature (2)

Importance of real-time "network feedback" for user E2E QoE





- Flying bats constantly adapt their echolocation signals (calls/sec, energy/call, frequency distribution/call) as number and proximity of other bats varies

"*Flexible bat echolocation: the influence of individual, habitat and conspecifics on sonar signal design*", Martin K. Obrist, Behav Ecol Sociobiol (1995) 36: 207-219, Springer-Verlag 1995

IEEE P1907.1
"Real-Time Mobile Video"

Application Scenarios

- **Real-time video connectivity** is becoming a **key feature** in a wide range of mobile Internet services
- New standard could enable high-quality, real-time, network-adaptive video chat & multi-party video interaction to be **embedded in any mobile Internet browser, app, game, device, or service**

IEEE 1907.1 Working Group

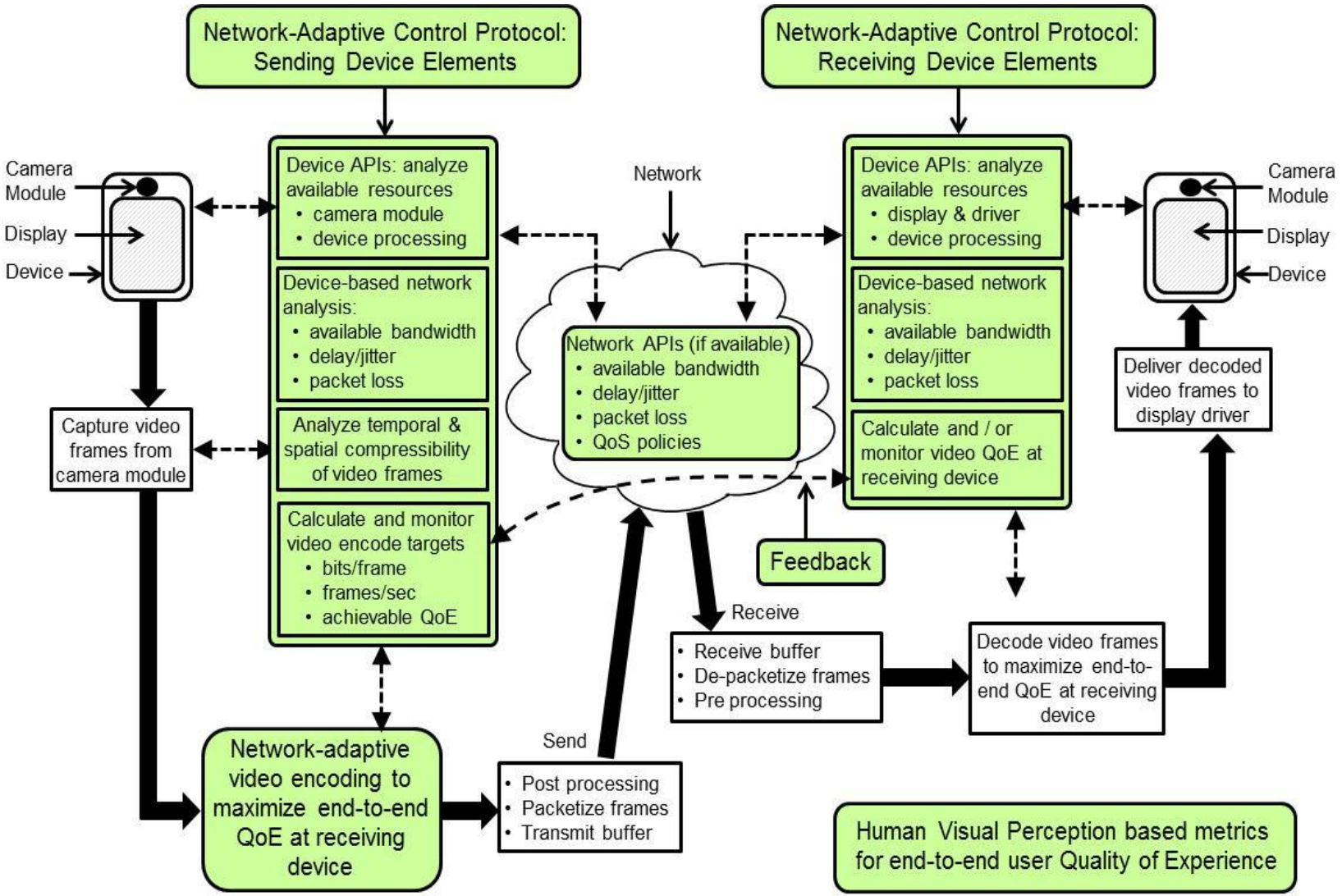
"Network-Adaptive Quality of Experience (QoE) Management for Real-Time Mobile Video Communications"

Scope of the Standard

- End-to-end QoE: Standardized human visual perception-based metrics for real-time video
- Network-adaptive video encoding and decoding algorithms
- Real-time feedback control mechanisms for end-to-end video QoE

Asia-Pacific Meeting - Sept 8, 2011
JW Marriott Hotel, Seoul, Korea.

IEEE 1907.1 - Scope of Standard



Summary

- Real-time mobile video is not just a codec problem …
- … or just a device problem,
- … or just an infrastructure problem,
- … or just a network capacity utilization problem …

- **Real-time mobile video is an end-to-end system problem, and it requires an end-to-end system solution**

- The entire mobile industry value chain will benefit from the IEEE P1907.1 standard, **to help achieve the full potential of Real-Time Mobile Video in the marketplace!**

Thank You!

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