# VOIP and Video on a City-wide Scale

# VOIP packets inefficient over 802.11 protocols

- ***Intended for asynchronous not isochronous networking.***
- ***Poor latency and jitter control , degrades with more clients***

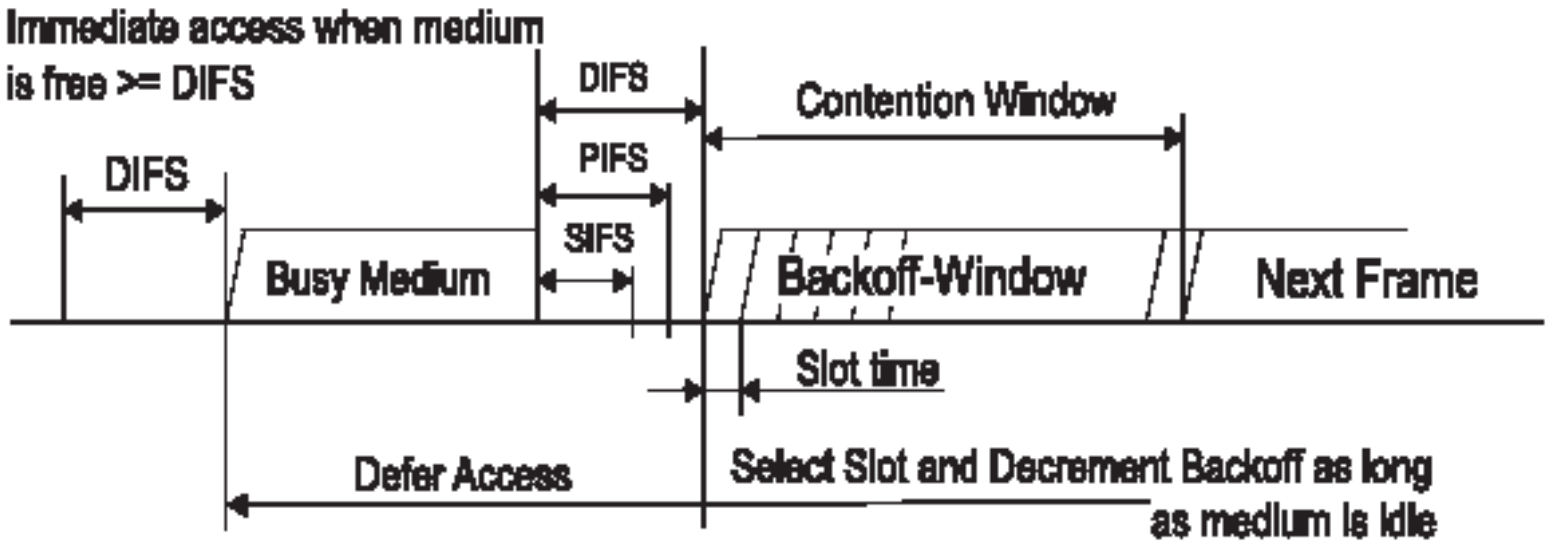
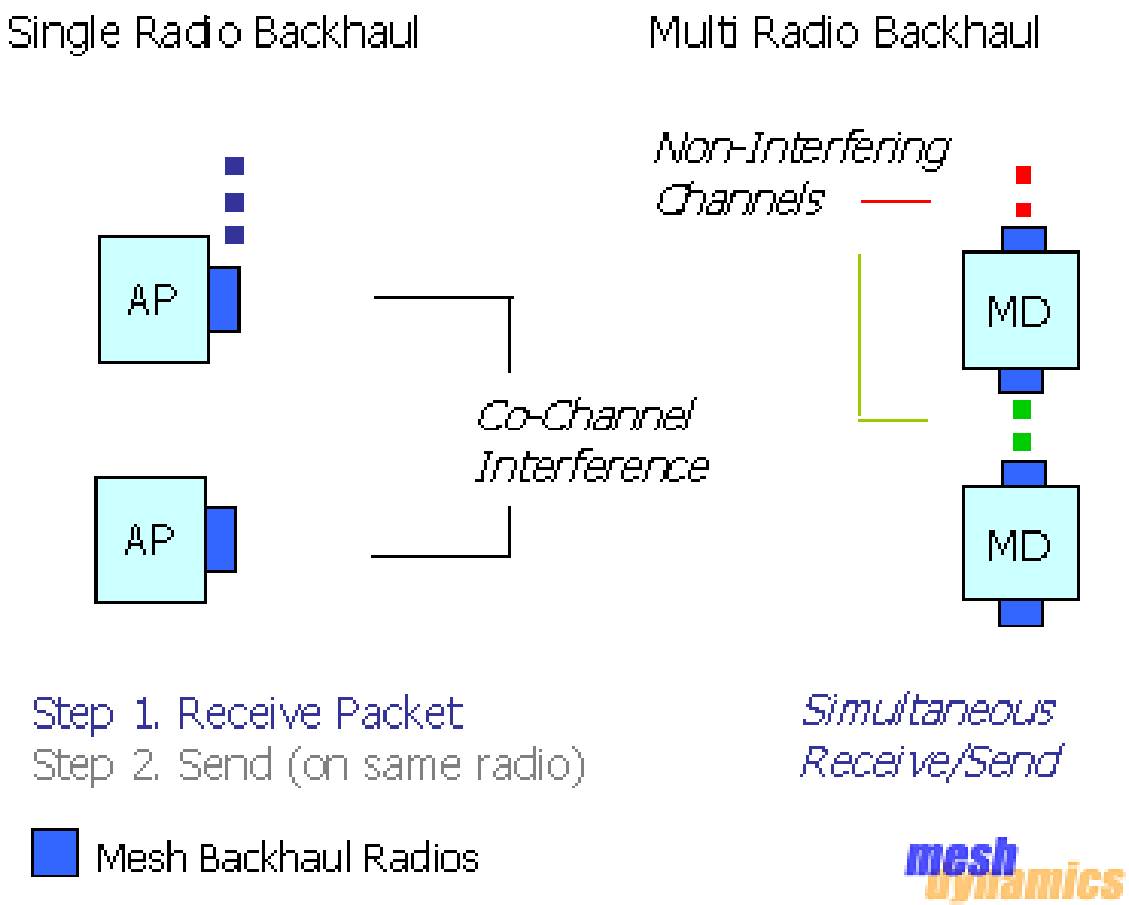



Figure 51—Basic access method

- ***Backhaul must contain jitter and latency over multiple hops***
- ***Access Point software should help remove contention at the source***

# Mesh Backhaul Architecture Comparison for VoIP




- ***Backhaul must contain jitter and latency over multiple hops***
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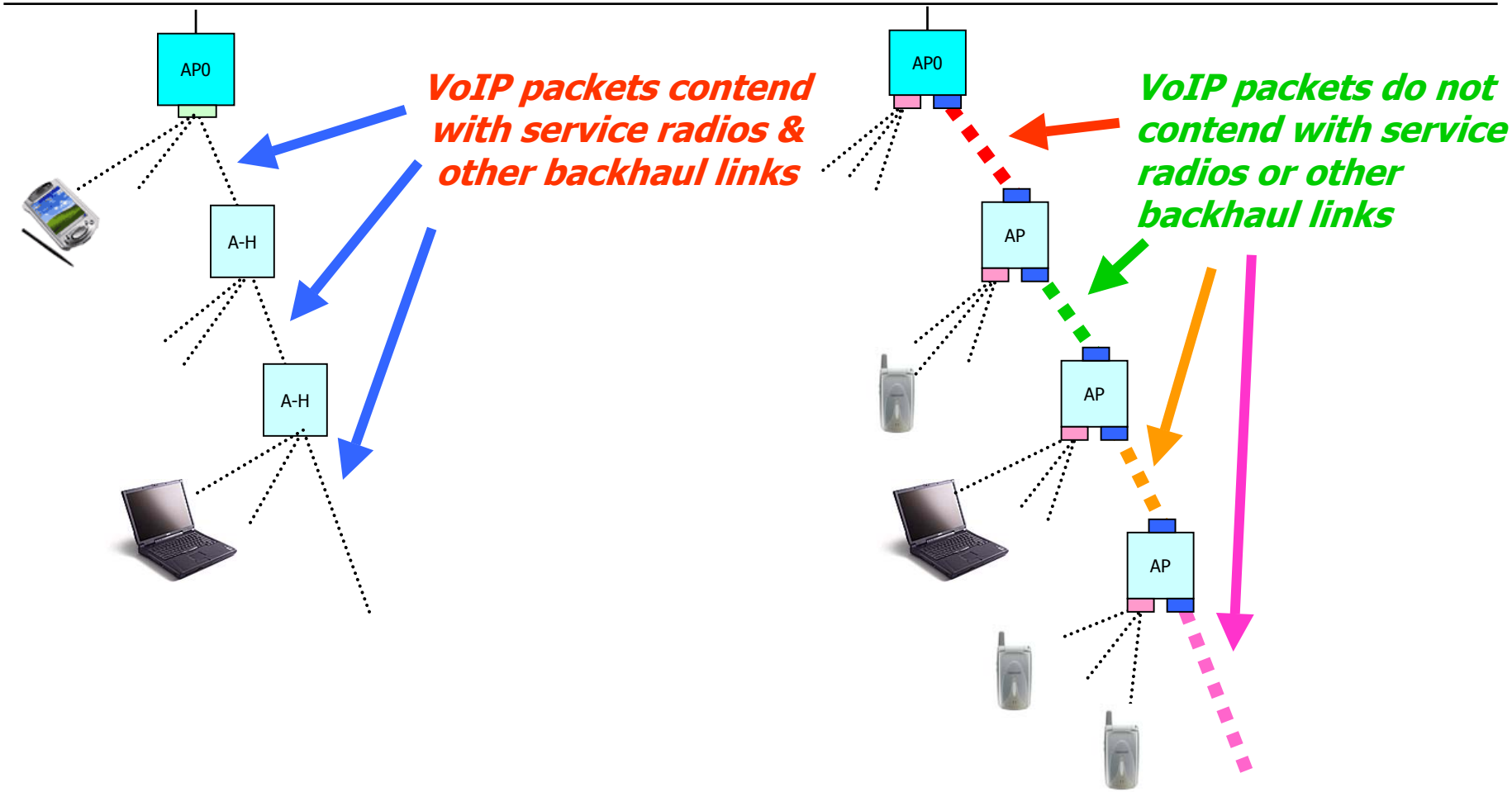
# Mesh Backhaul Architecture Comparison for VoIP

**1-Radio Ad Hoc Mesh**

Structure Mesh™ with Multi-Radio, Multi-Channel Backhaul

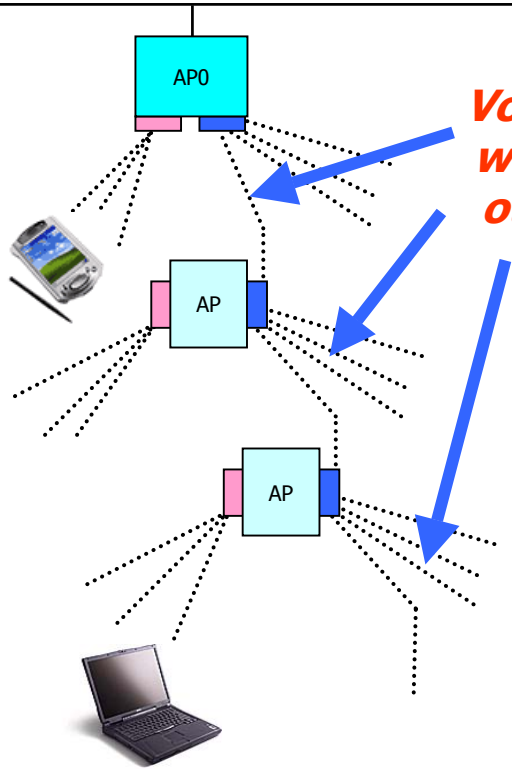



- ***Backhaul must contain jitter and latency over multiple hops***
- ***Access Point software should help remove contention at the source***

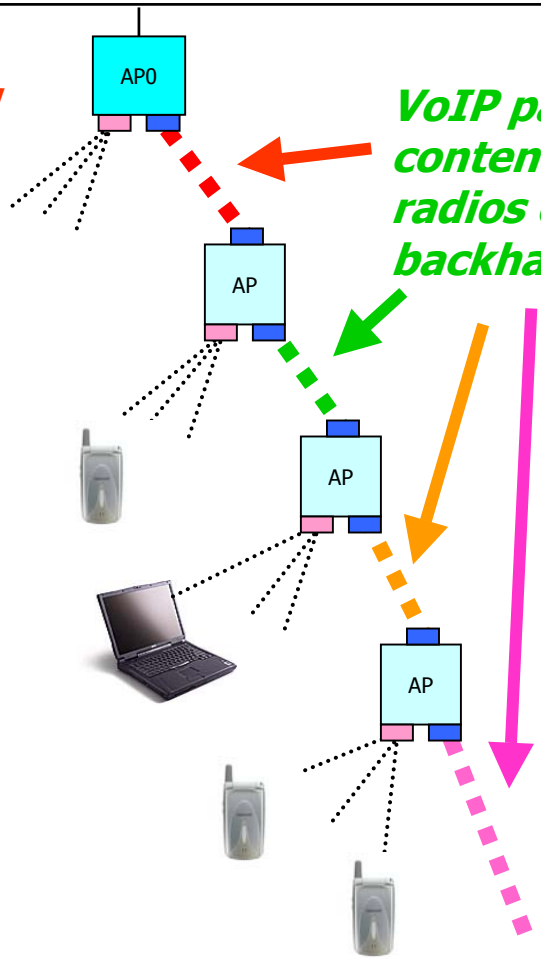
# Mesh Backhaul Architecture Comparison for VoIP

**"Dual Radio Mesh"**

Structure Mesh™ with Multi-Radio, Multi-Channel Backhaul




***VoIP packets contend with service radios & other backhaul links***

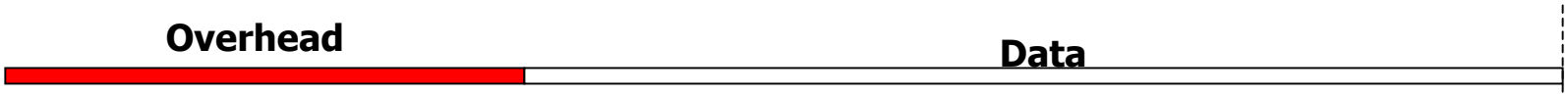



***VoIP packets do not contend with service radios or other backhaul links***

- ***Backhaul must contain jitter and latency over multiple hops***
- ***Access Point software should help remove contention at the source***

# Small packets (e.g VOIP) inefficient over 802.11

- Typical Data Packet = 1500 bytes (1.44mS, incl .4mS ovhd)

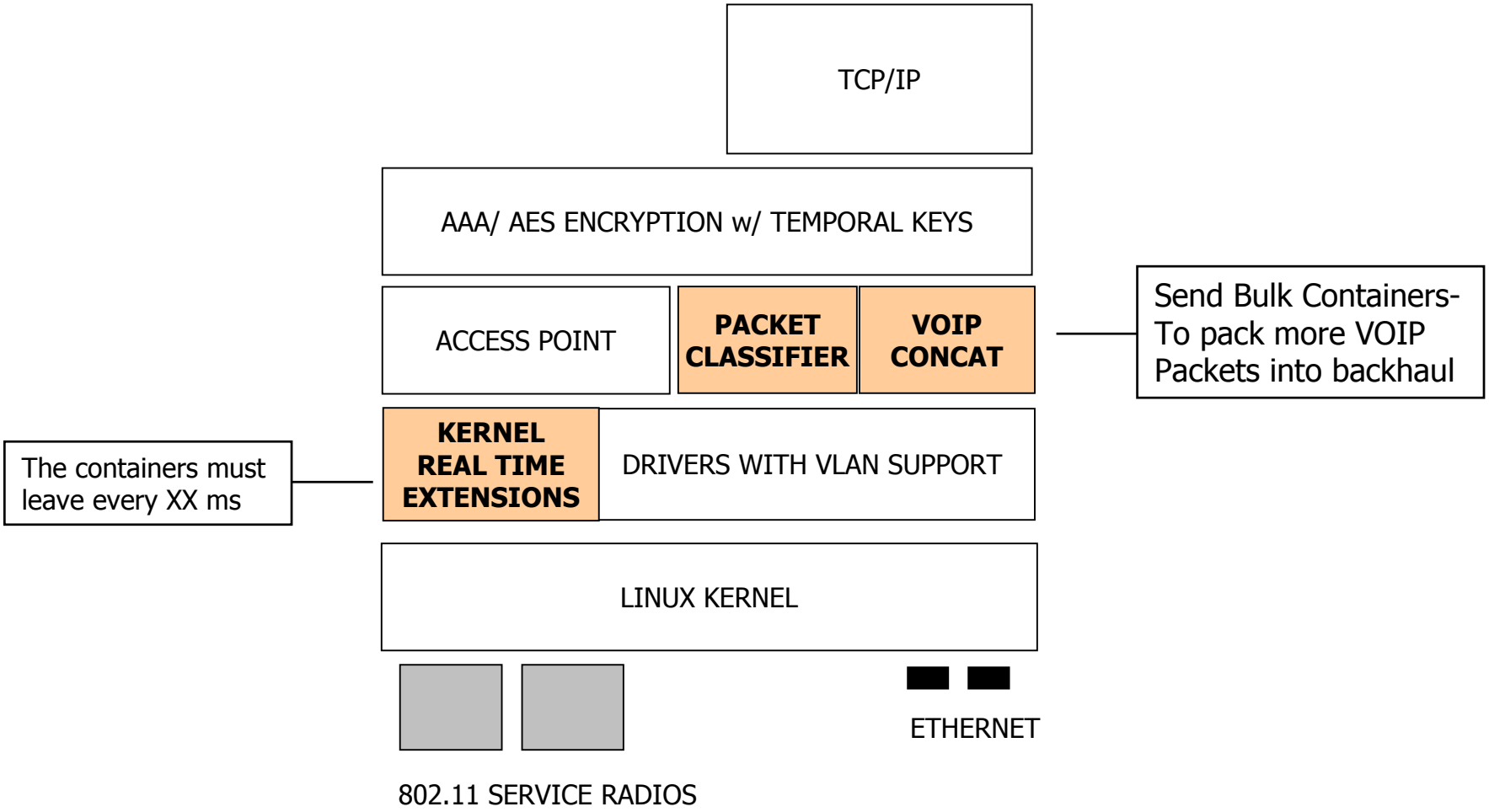



- VoIP Packet (G.711 Codec) = 230 bytes (.56 mS, incl .4mS ovhd)


- VoIP Packet (G.729 Codec) = 90 bytes (.46, incl .4mS ovhd)

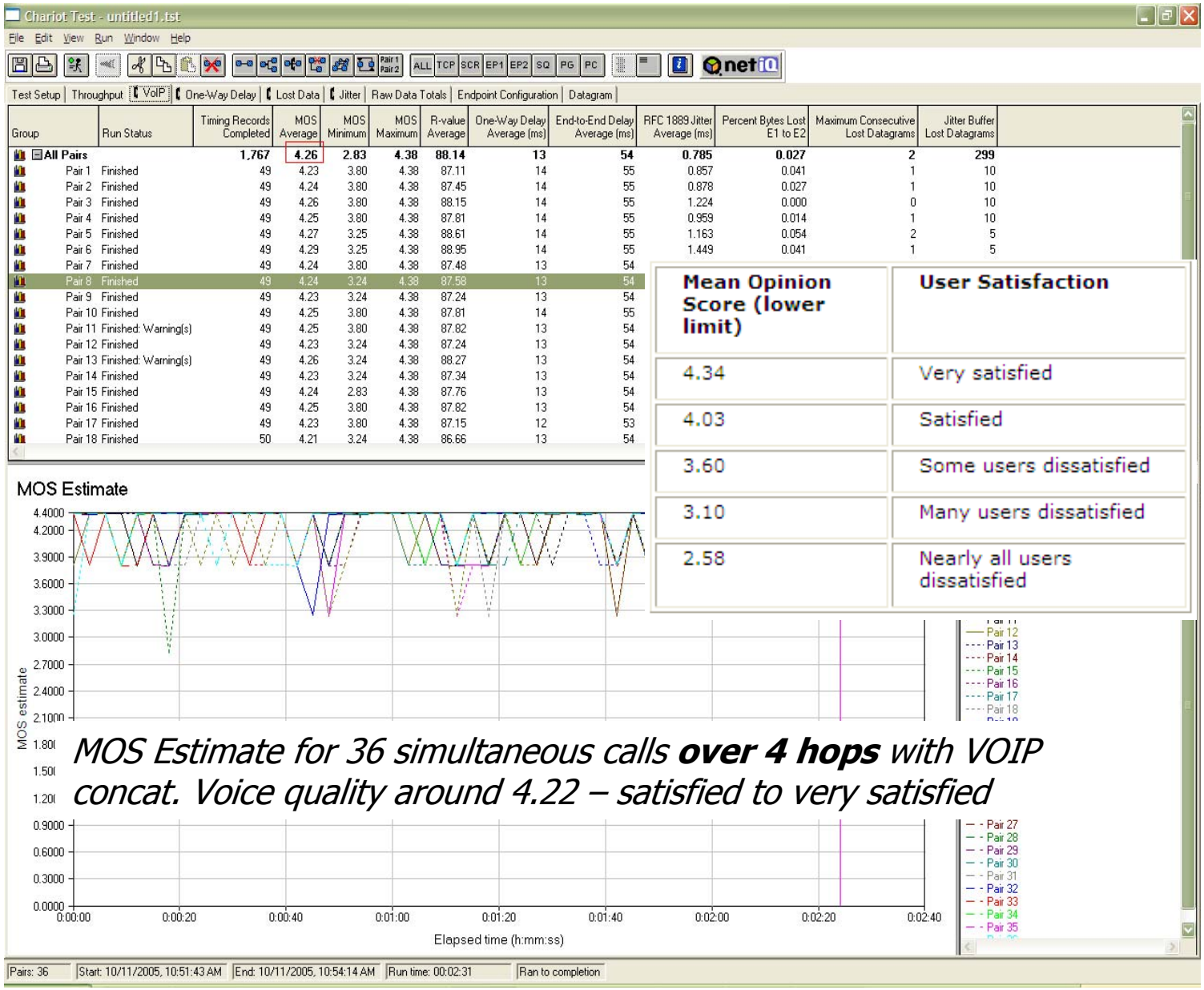

- ***Backhaul must contain jitter and latency over multiple hops***
- ***Access Point software should help remove contention at the source***

# Increase VOIP capacity with "bulk containers"



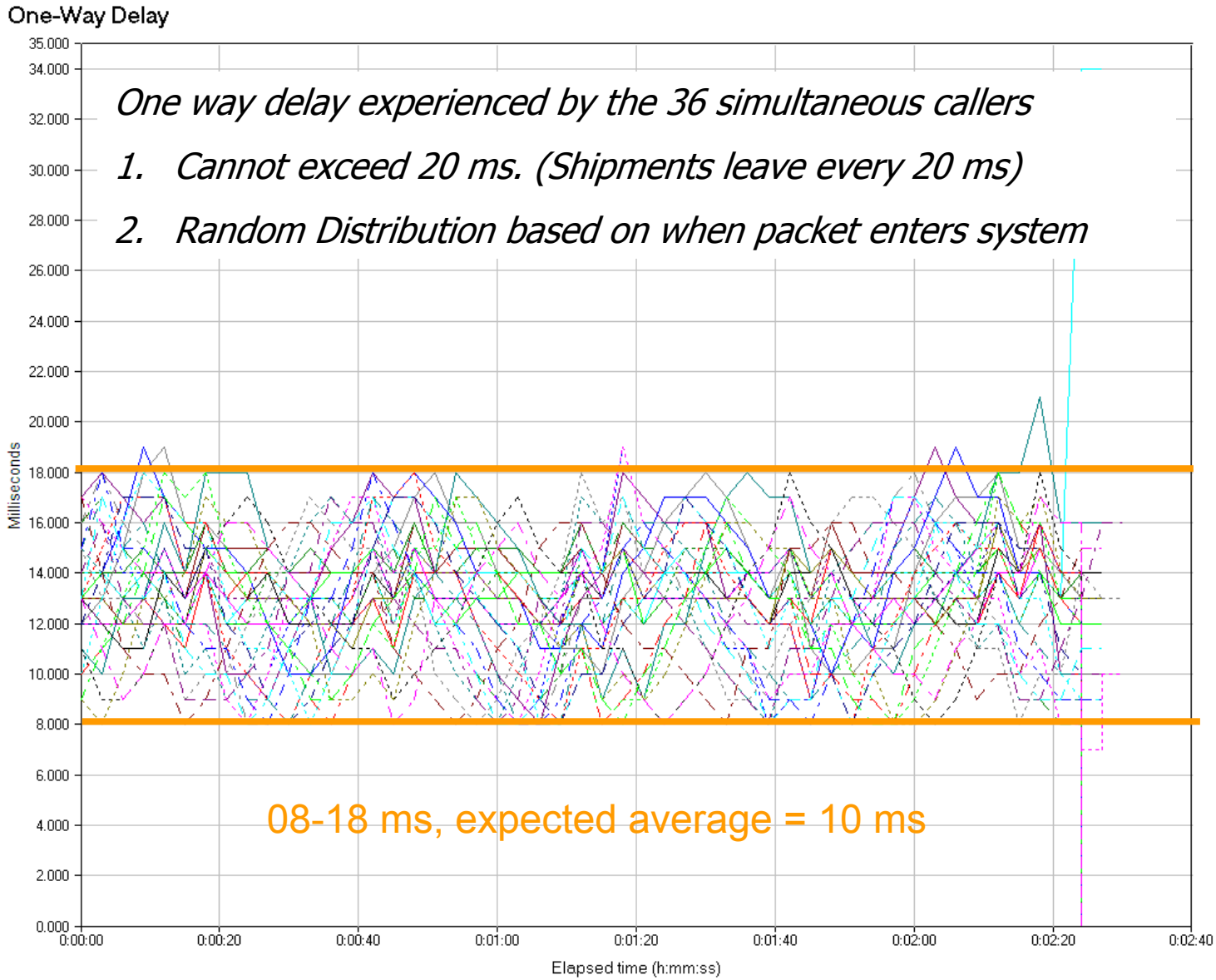

- ***Backhaul must contain jitter and latency over multiple hops***
- ***Access Point software should help remove contention at the source***

# Concatenation Performance Results- Satisfaction

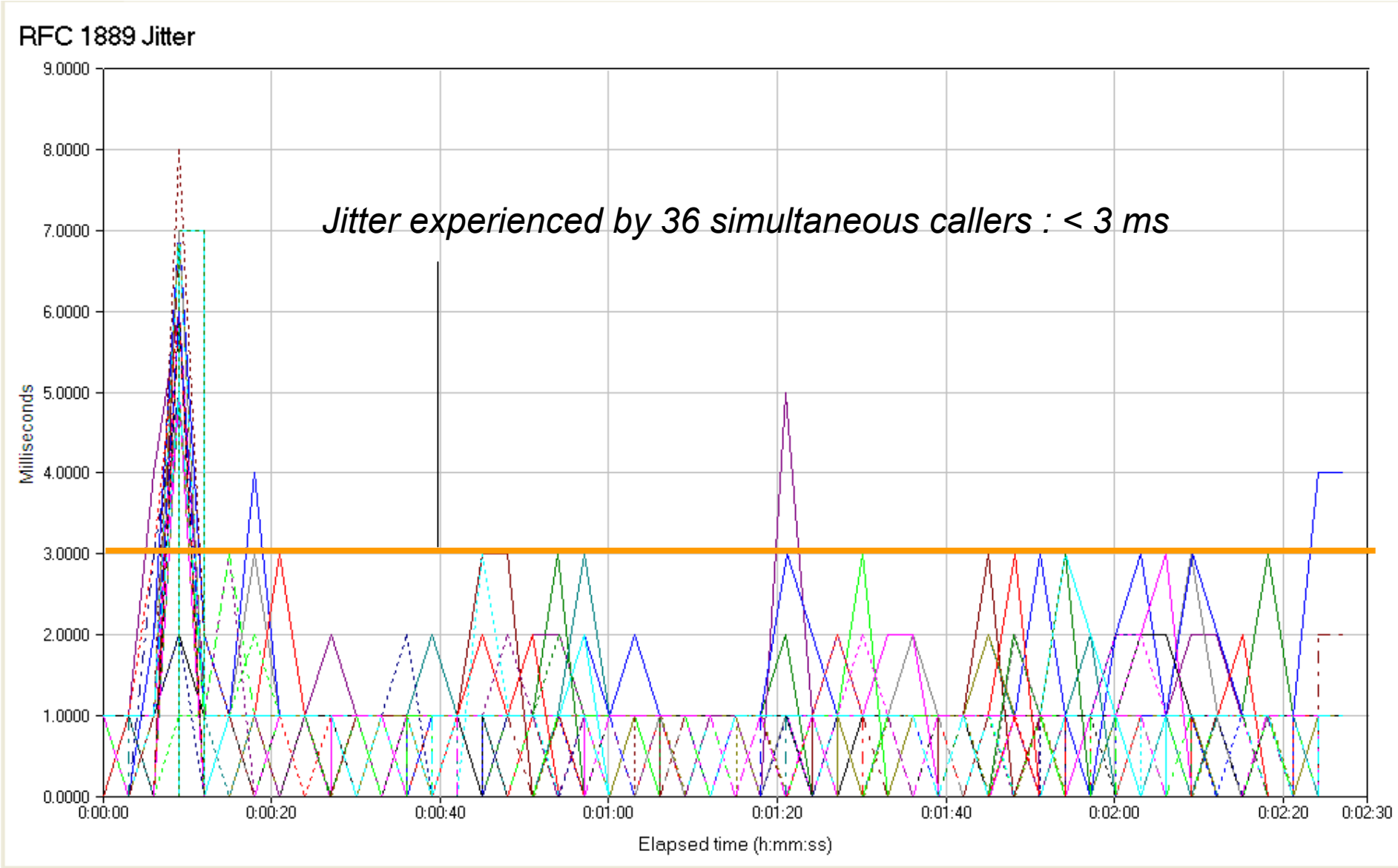



*MOS Estimate for 36 simultaneous calls **over 4 hops** with VOIP concat. Voice quality around 4.22 – satisfied to very satisfied*

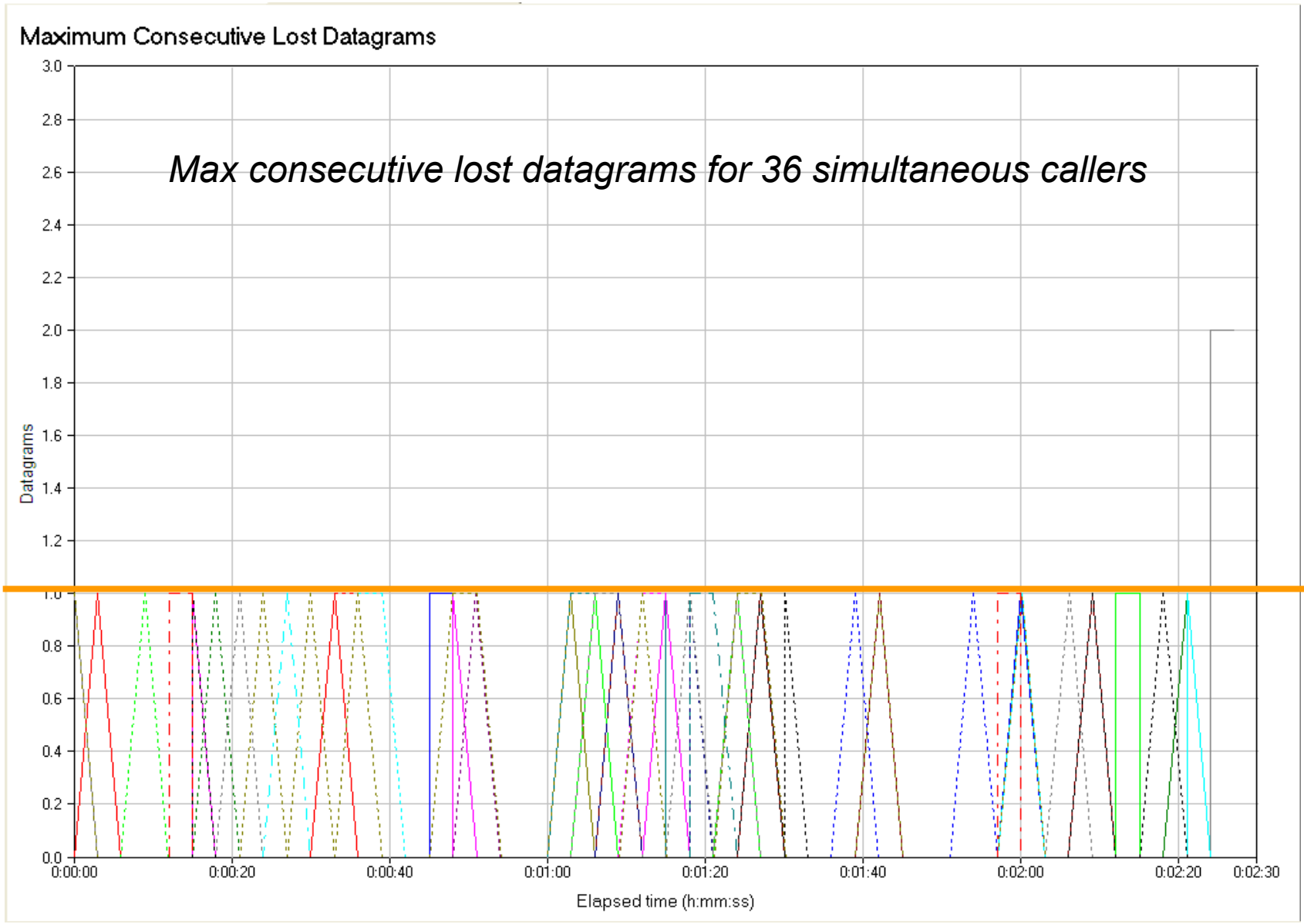
# Concatenation Performance Results- Latency



# Concatenation Performance Results- Jitter



# Concatenation Performance Results- Packet Loss



# Structured Mesh™ Backhaul Characteristics

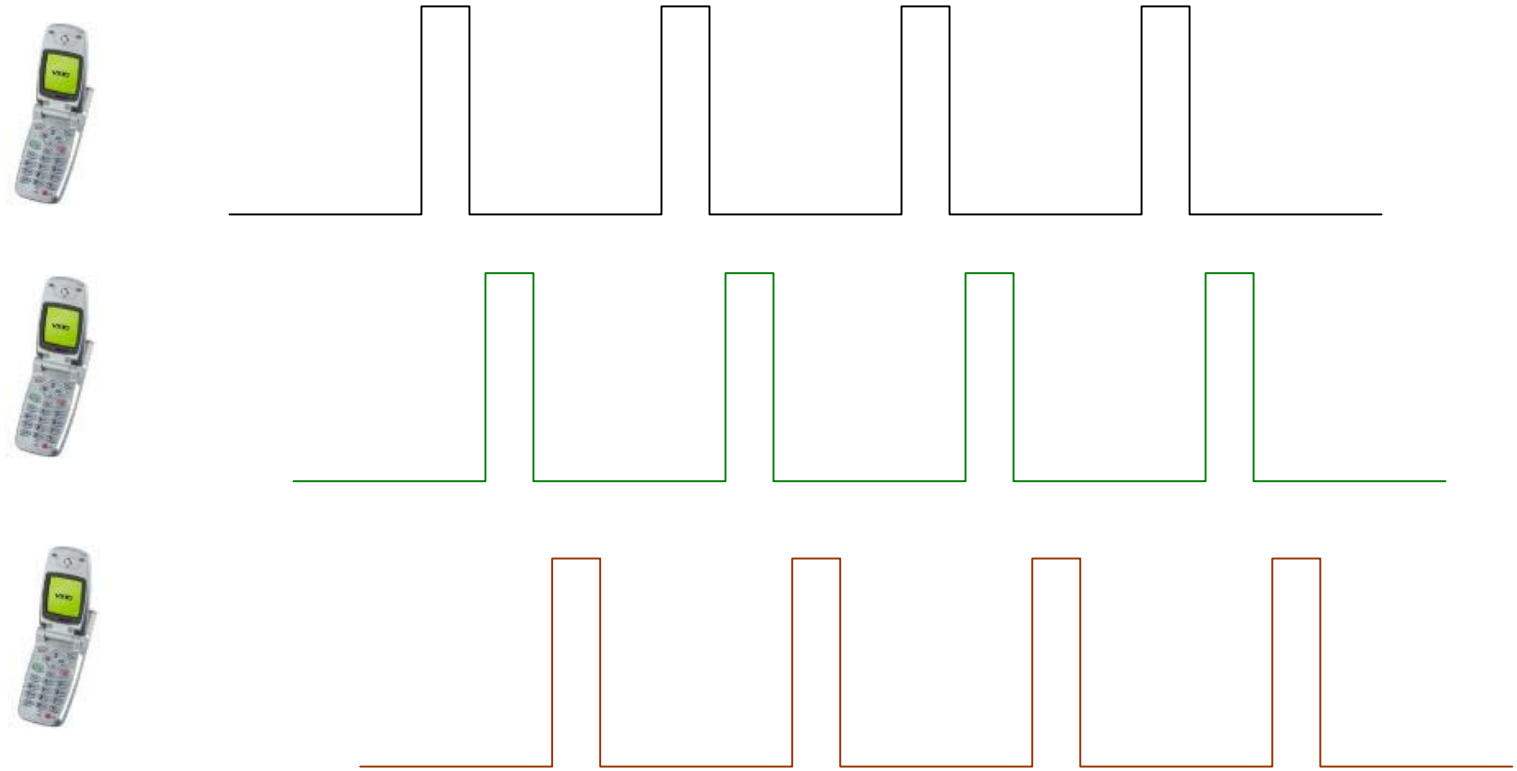
*Backhaul has low latency and jitter because*

1. *No degradation over multiple hops – needed for city wide mesh*
2. *Efficient Bulk container transport of VOIP packets*

✓ ***Backhaul must contain jitter and latency over multiple hops***

***Access Point software should help remove contention at the source***

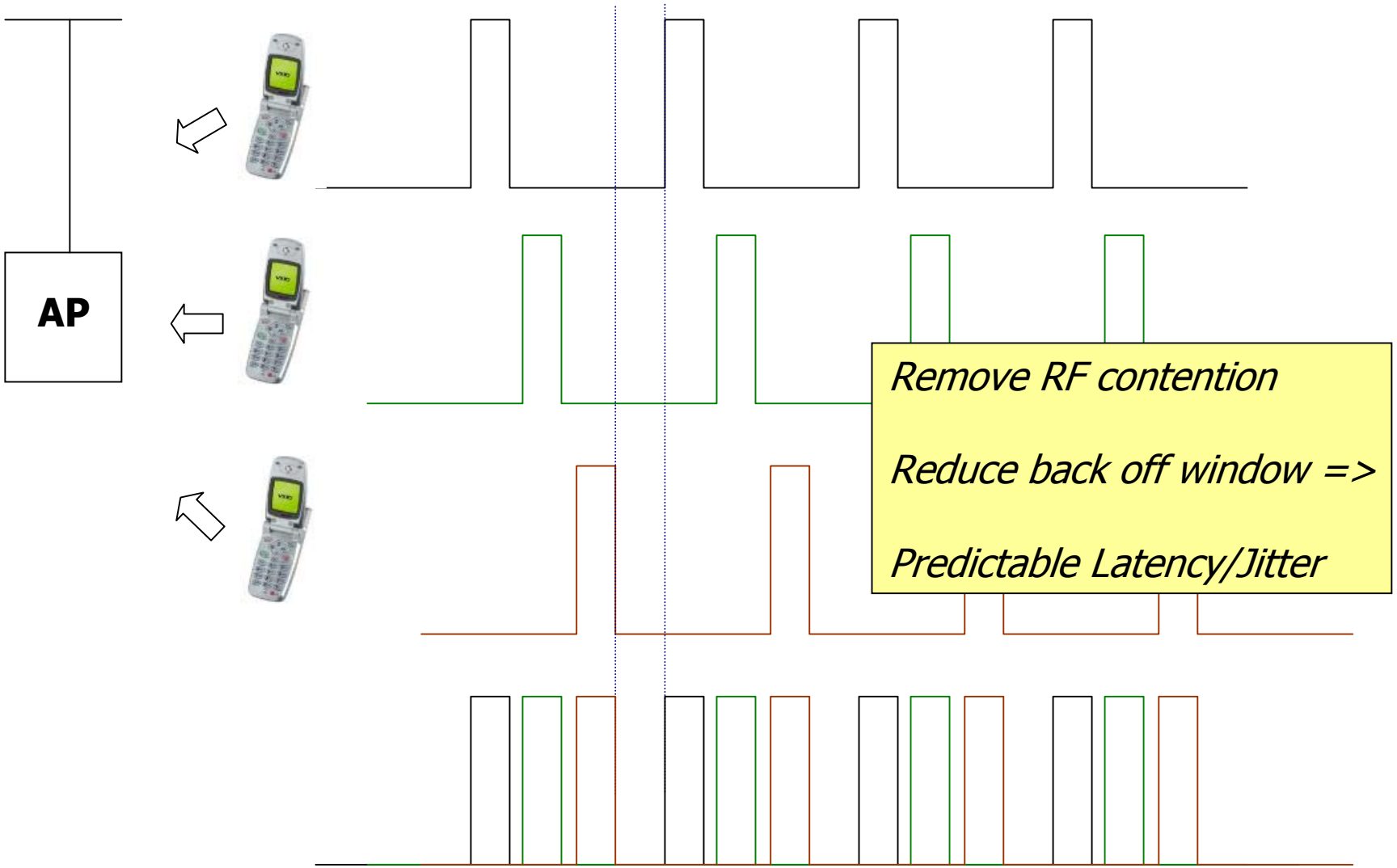
# Time Division Multiple Access is "regular"



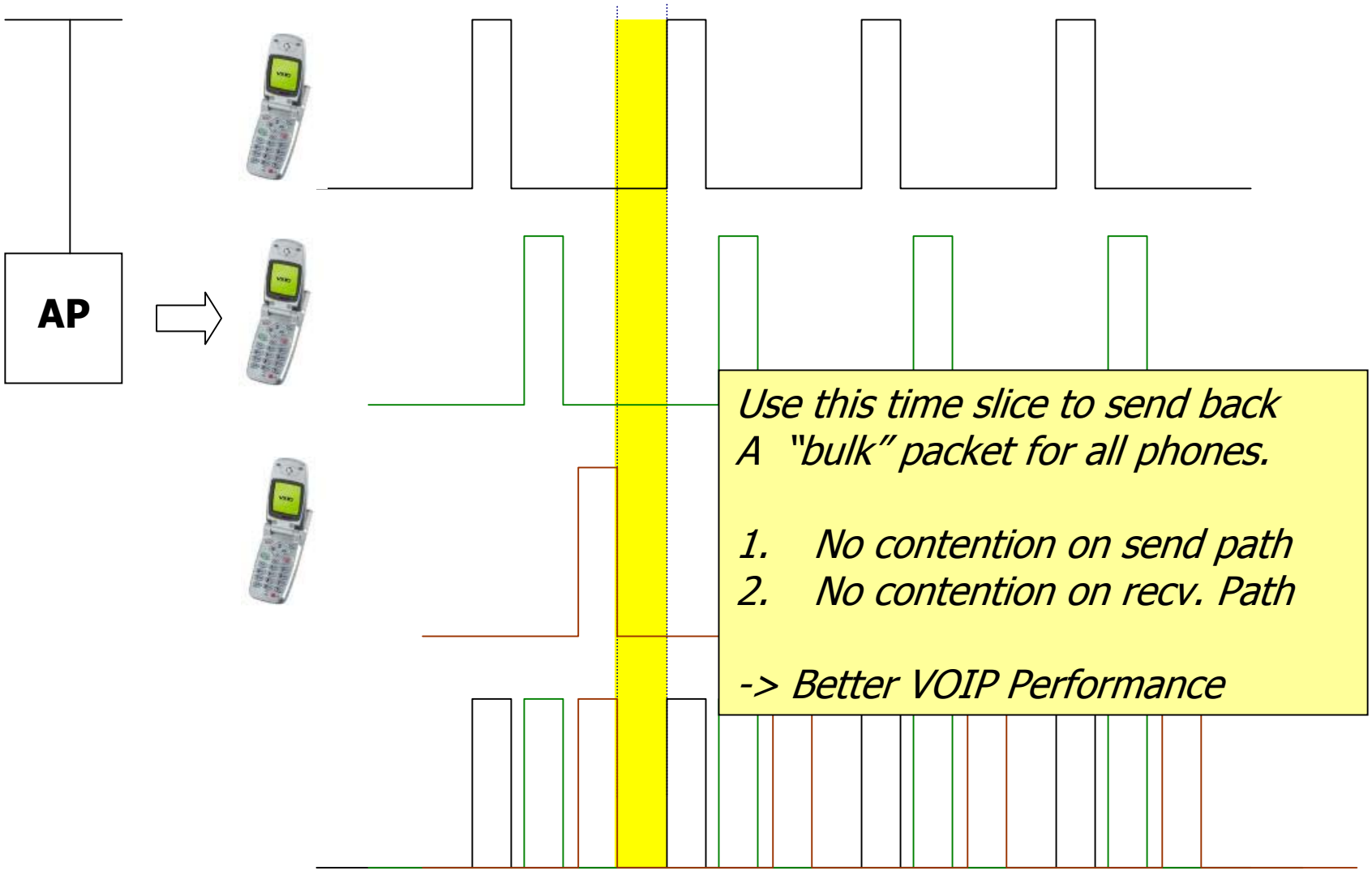
- ***Everyone is allocated a time slot***
- ***Intended for isochronous communications***
- ***Predictable latency and jitter control***

- ***Challenge: TDMA like behavior within 802.11 framework***

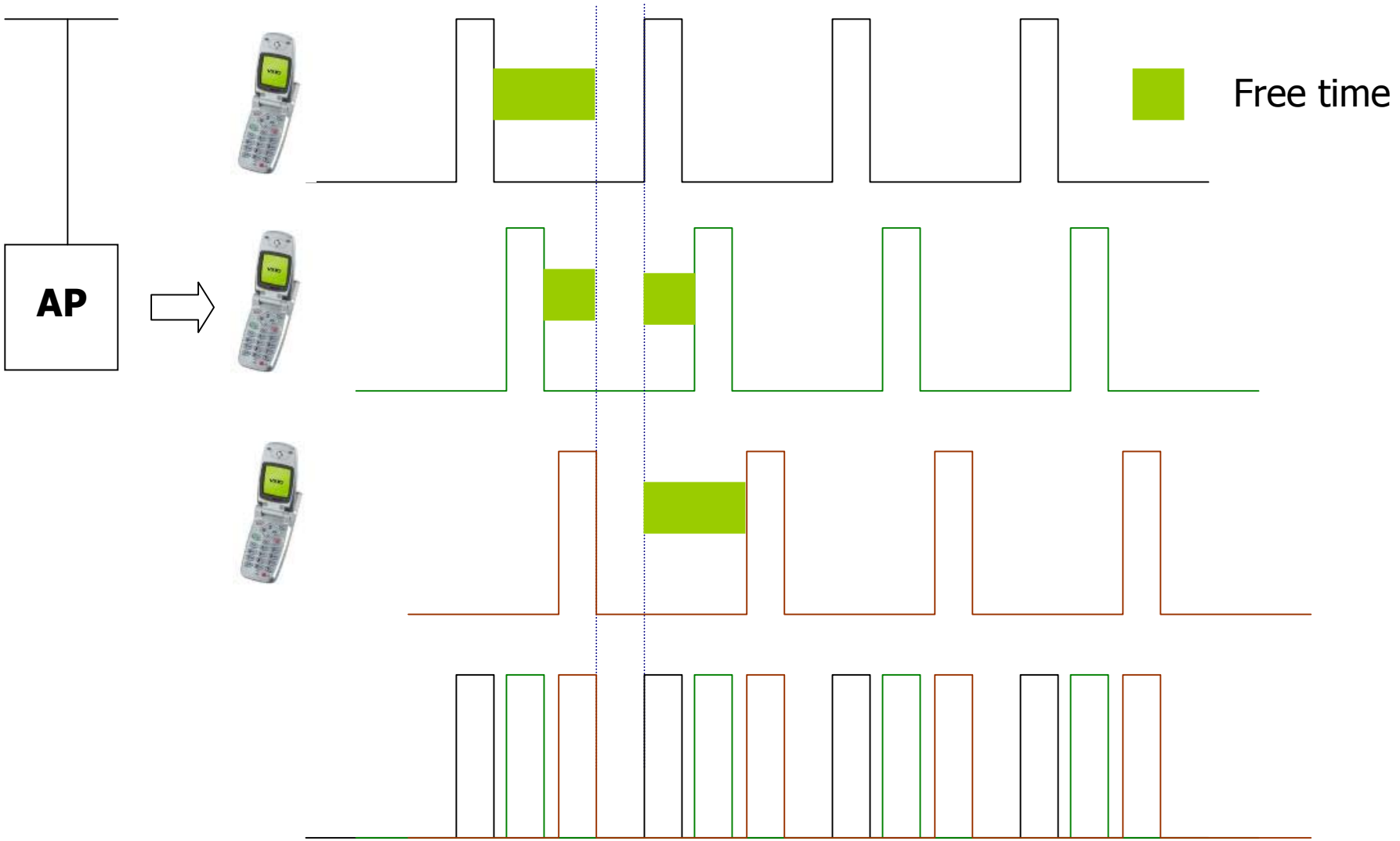
# 1. Give each phone a "time slice" to send



# 2. Use a common "bulk container" to receive



# Each Phone has time to do "Other Stuff".



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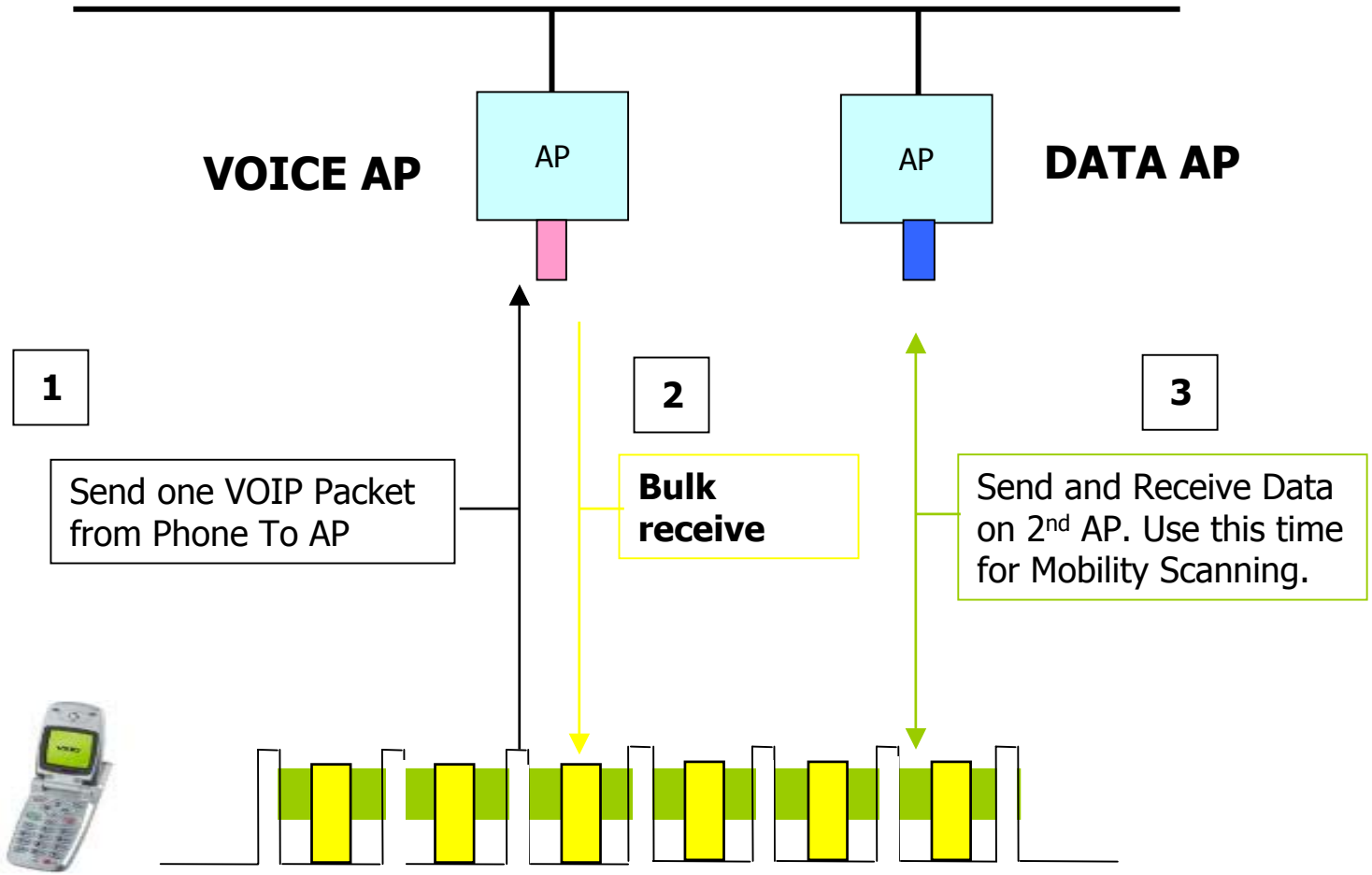

# Summary

*Backhaul has low latency and jitter because*

1. *No degradation over multiple hops – needed for city wide mesh*
2. *Bulk container transport of VCIP packets*

*Access Point with "TDMA like" enhancements for:*

1. *No contention on send cycle with Time Slices*
2. *No contention on receive cycle, with bulk broadcast*

✓ ***Backhaul must contain jitter and latency over multiple hops***

✓ ***Access Point software should help remove contention at the source***