



EENGM4221: Broadband Wireless Communications

Lecture 6: Link Adaptation

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Link Adaptation (1)



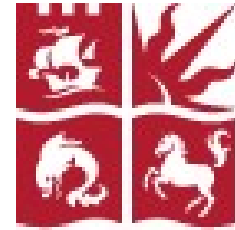
- Link Adaptation involves changing the parameters of a communications system to accommodate variations in Link Quality
- As we have discussed the ‘quality’ of the Link can vary substantially
- With a fixed (non-adaptive) system, we must either:
- Design for the worst (or at least a bad) case and accept that the system under performs some of the time
- Design for the best (or at least a good) case and accept that the system fails some of the time

Link Adaptation (2)

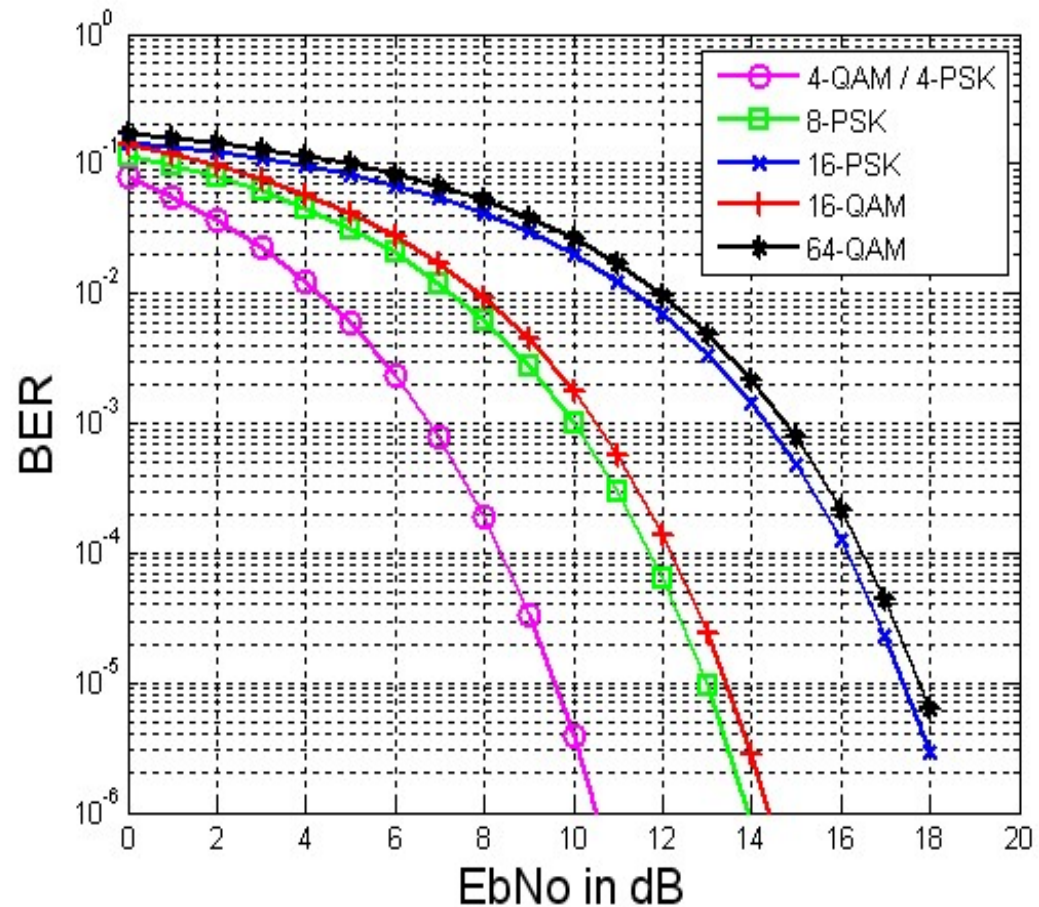


- Alternatively, if we adapt to the link, we may be able to achieve a better result, a system which:
 - Works very well given a good link
 - Works adequately given a bad link
 - Works moderately well in a moderate link,
 - Etc
- i.e. a system which ‘works well’ given the current channel conditions
- What do we mean by ‘works well?’
 - Usually how much throughput is achieved whilst maintaining QoS.

Link Adaptation – Simple Example (1)



- Consider a communications system employing QAM:
- BER performance is well known:

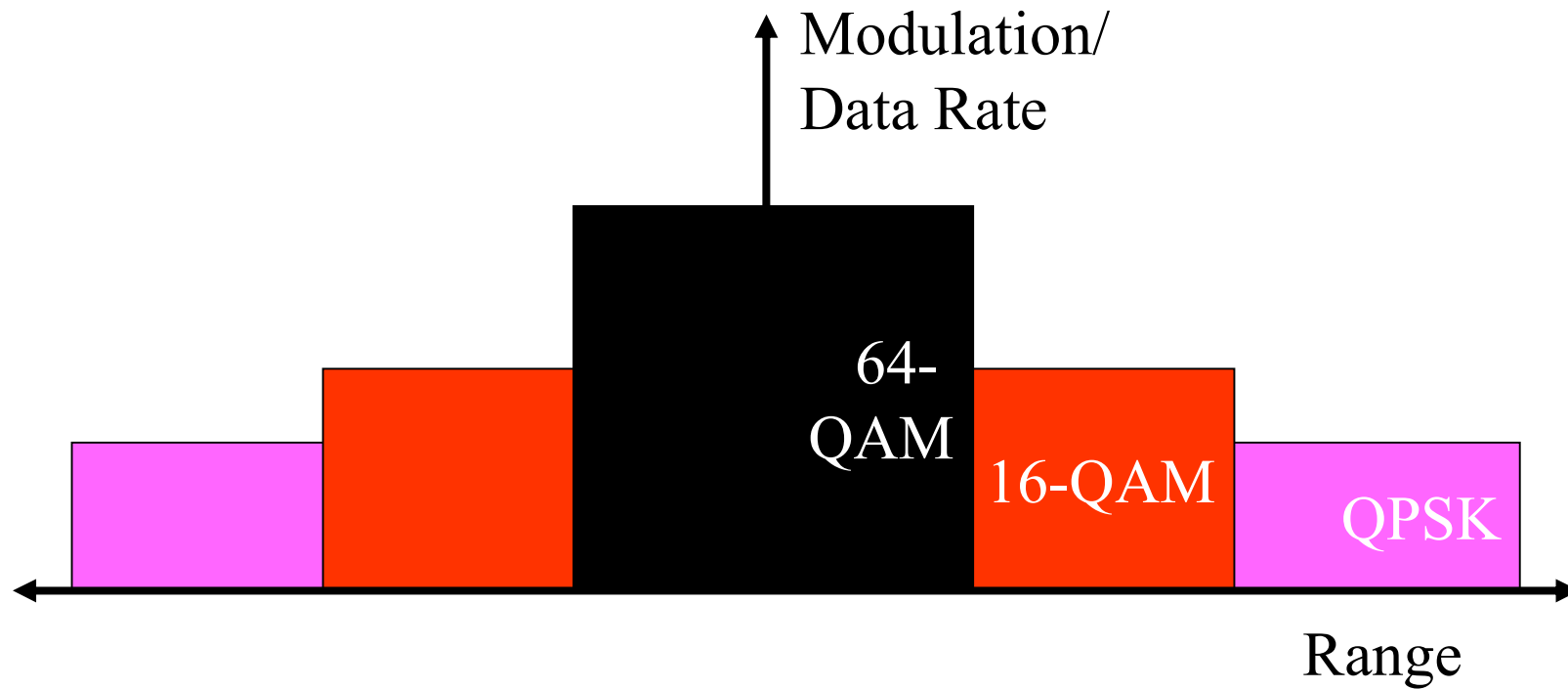


Link Adaptation – Simple Example (2)

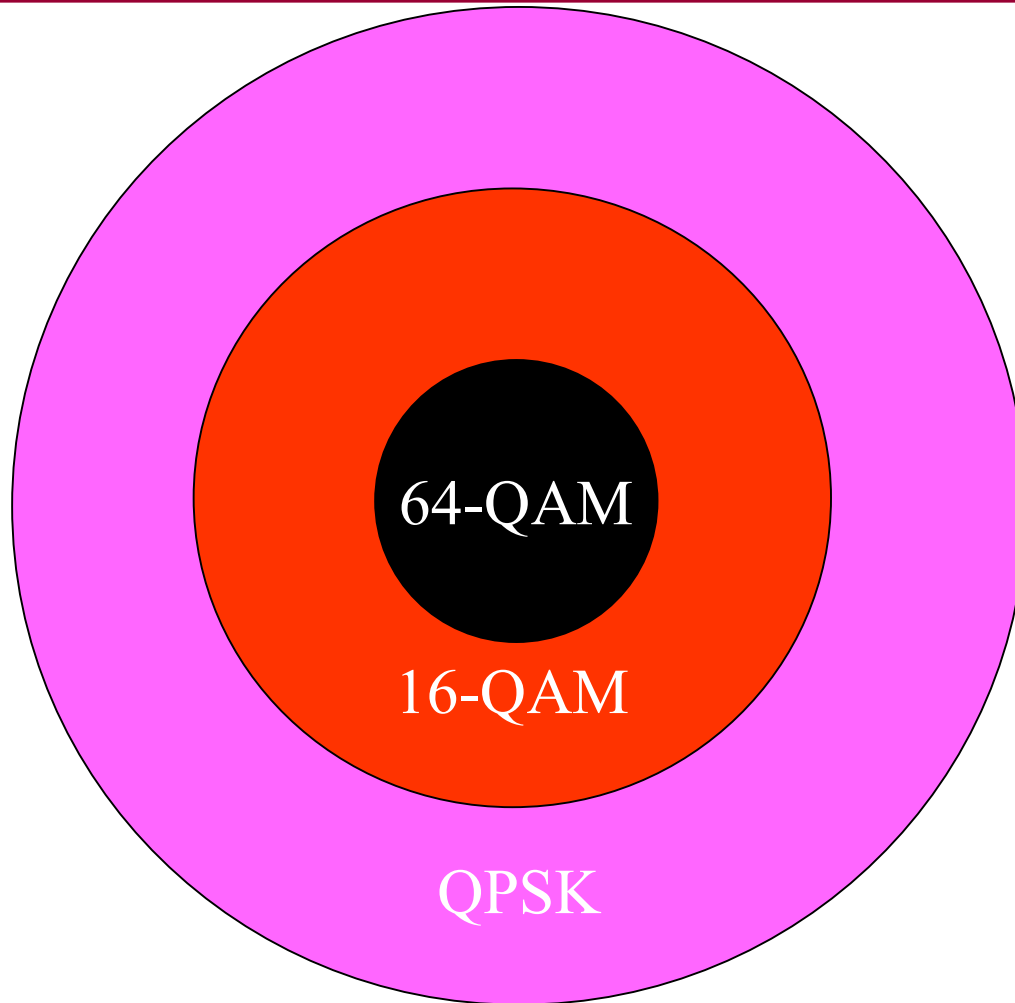


- Assuming we need a BER 10^{-6} , we could use:
 - QPSK in which case we get 2bits/s/Hz and need ~13dB SNR
 - 16-QAM in which case we get 4bits/s/Hz and need ~18dB SNR
 - 64-QAM in which case we get 6bits/s/Hz and need ~27dB SNR

Link Adaptation – Simple Example (3)

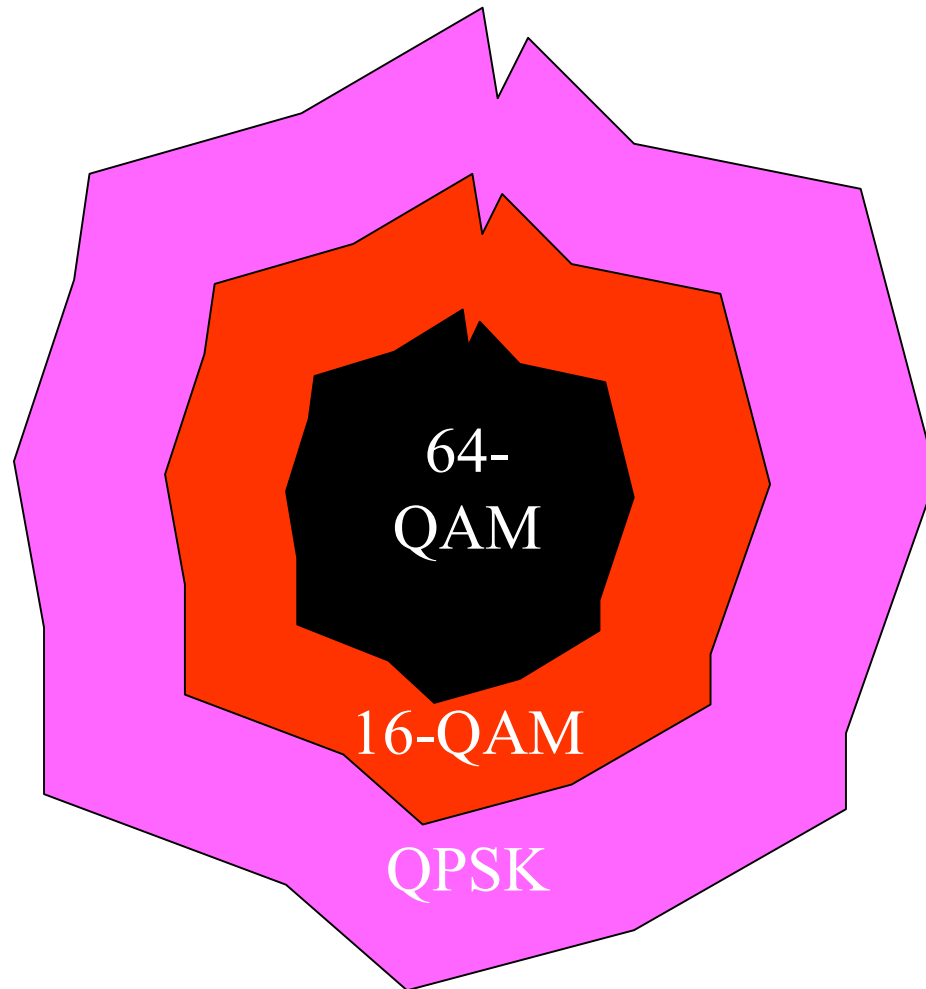


Link Adaptation – Simple Example (4)



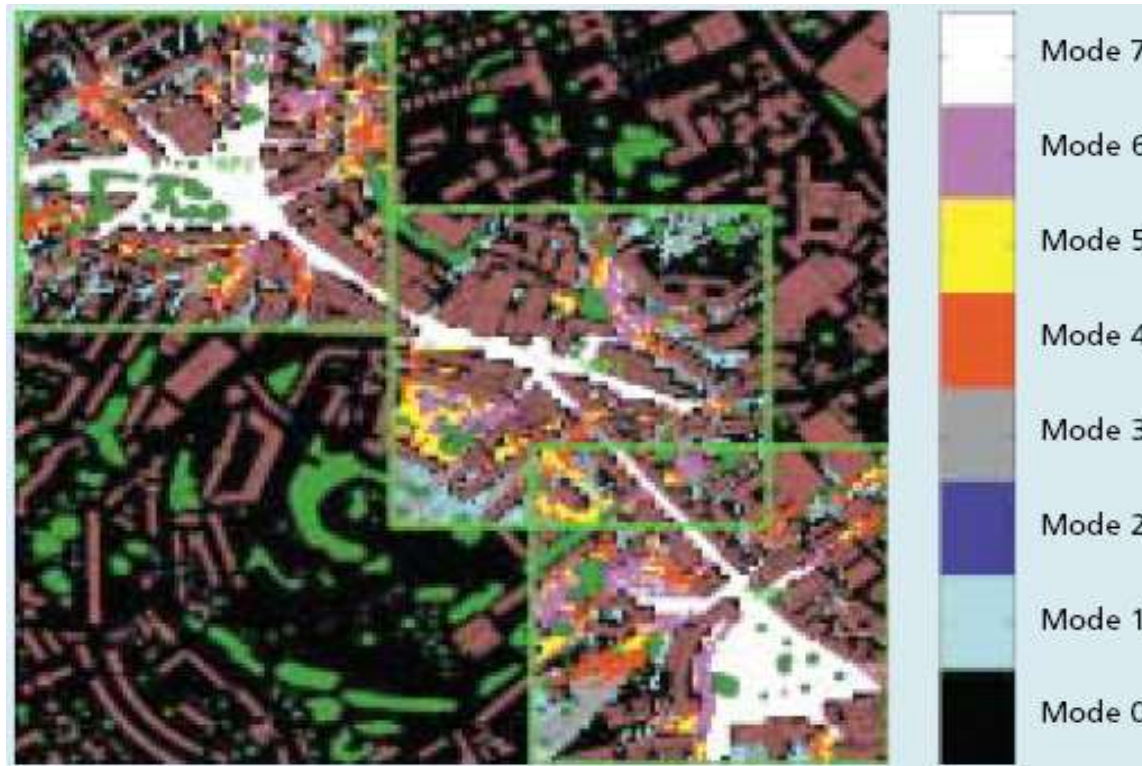
- Circles aren't very realistic really...

Link Adaptation – Simple Example (5)



- More Realistically, allowing for Shadowing Effects, the coverage areas won't be circular
- A bit like a contour map but showing data rate, not altitude

Link Adaptation – More Detailed Example



- Mode Selection on the Triangle.
- Considers 802.11a (8 modes BPSK-64-QAM and $\frac{1}{2}$ - $\frac{3}{4}$ rate codes)
- Finer Granularity
- Source: CCR

Link Adaptation – Per User QoS



- Link Adaptation is very useful when trying to provide QoS
 - Provides a mechanism for trading off data rate vs reliability (PER and hence delay and loss)
- LA can also be applied on a per user basis e.g. to give one user with a weak signal lower throughput whilst also giving another with a better signal a higher throughput
 - The overall throughput will be the aggregate of all the users
- LA is not a panacea:
 - Poor signal still gives poor data rate
 - It is not a guarantee of QoS

Link Adaptation – Its Out There



- Link Adaptivity is now recognised as a vital feature for modern Communications systems
- GSM added LA for GPRS (code rates)
- UMTS had limited LA capability from the outset (code lengths)
 - More support added later in HSDPA and HSUPA (modulation and coding)
- 802.11 “WiFi” started with limited support for LA (packet size)
 - Later added explicit support for LA for a,b,g,n (modulation and coding rate)
- Bluetooth has limited LA capabilities (code rate and packet size)
- 802.16 “WiMax”, 4G, 5G all incorporated LA from the outset

Review of Lecture 6



- Link Adaptation makes the communication system adaptive to link quality
- This is very helpful when we are trying to achieve good QoS whilst the link quality varies, hence it is used in lots of modern systems
- Most commonly, modulation scheme and coding rate are adapted
 - Hence ‘Adaptive Modulation and Coding’
- This is the concept. In a synchronous session we will investigate:
 - Algorithms for link adaptation
 - Some of the (undeclared) assumptions made in this lecture