

# Adaptive Modulation

A Tool for Efficient Spectrum Utilization

# Scope




- What is spectrum efficiency?
- Adaptive Modulation User Guide
- Rules of Engagement

# Spectrum Efficiency Objective

- For a given channel between point A and B:
  - Maximize link uptime
  - Maximize information transfer
  - Minimize transmission errors

without interfering with other spectrum users

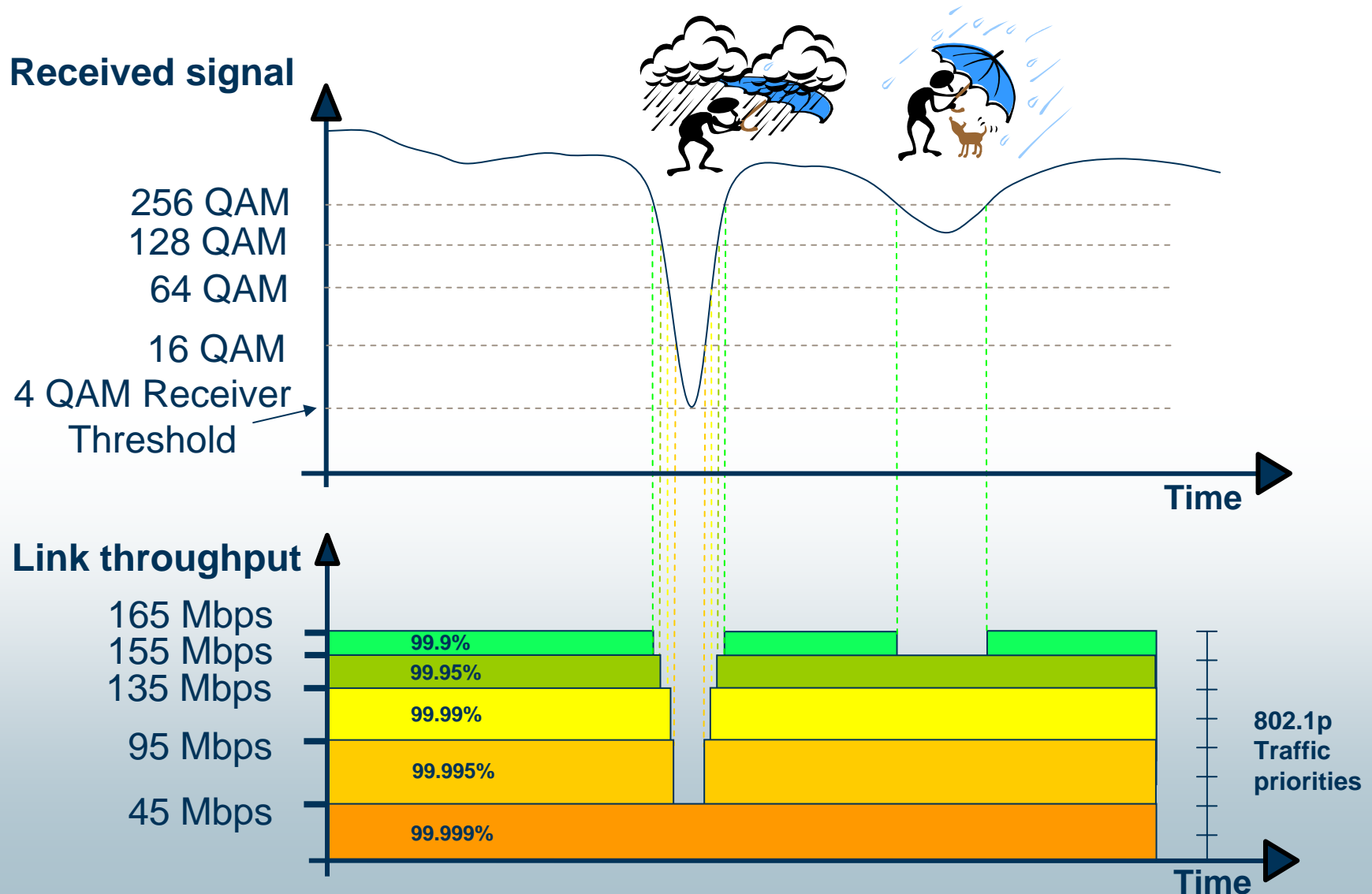
# Link Dimensioning for Efficiency

- Maximize Up Time  low modulation and throughput
- Maximize Information Transfer  high modulation and error rate
- Minimize Transmission Errors  low modulation and throughput



Modulation agility is the tool to achieve spectrum efficiency

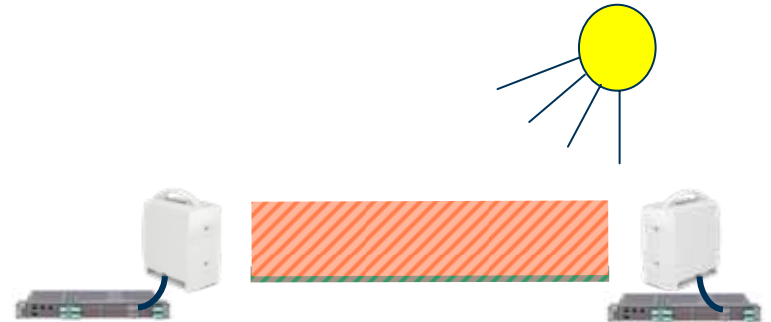
# Adaptive Modulation Principle



# Hitless Adaptive Modulation

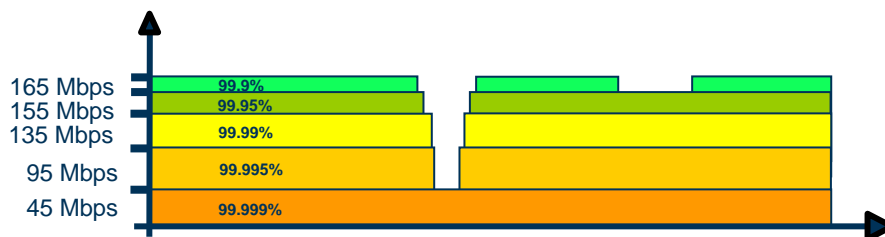
## Weather Aware Availability

- Maximum throughput (CIR + BE) available under normal conditions
- Limited throughput (CIR + limited BE) available under unfavorable conditions



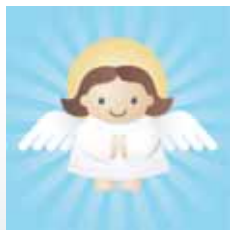
**For hybrid traffic environment, CIR includes TDM traffic**

# Ethics of Adaptive Modulation



To achieve a certain throughput at a given availability, you can dimension as...

Angel



or

Demon



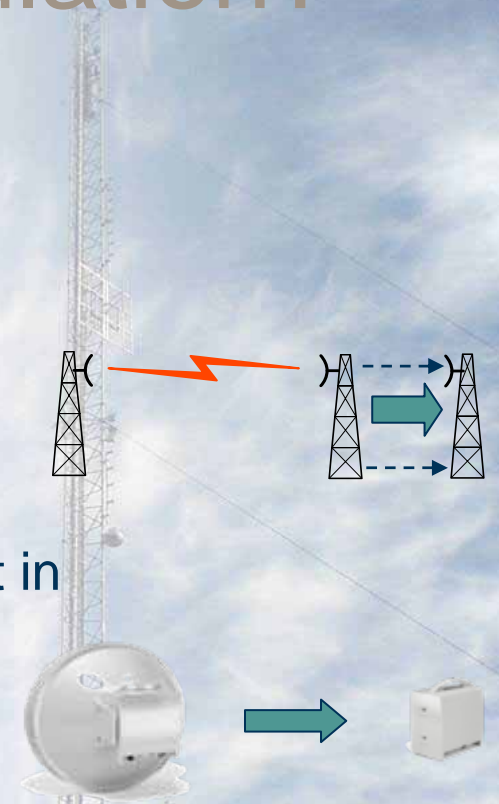
- Perform conservative dimensioning
- Rely on Adaptive Modulation for extra fade margin on limited occasions
- Achieve high throughput with high availability!

- Perform aggressive dimensioning
- Rely on Adaptive Modulation for extra fade margin whenever needed
- Achieve low throughput at high availability!

# How to use Adaptive Modulation?

- New network roll-out

- Balancing hop length and availability for Best Effort traffic can increase hop lengths
- Optimizing Best Effort availability can result in smaller antennas and lower lease costs.



- Network evolution - TDM to packet migration

- Limit the investment cost by adding Best effort traffic while keeping the installed antenna and the availability on priority traffic



# Rules of Engagement for Adaptive Modulation

- Dimension links for CIR + certain amount of BE traffic
- Observe existing FCC rules for payload in the lower bands under normal operating conditions
- Maintain power level throughout the modulation range

# Summary

- Adaptive Modulation optimizes spectrum utilization by enabling transmission in temporal situations when no meaningful transmission would be possible.
- In packet environment, availability is a grade of service parameter and not a determinant of link up-time.
- Compliance with regulatory requirements on spectrum utilization is incumbent upon the designer and the frequency coordinator and not the equipment vendor

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