PANEL TOPIC - Long Range Dependence and Markovian Models

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Long Range Dependence

- Mathematical definition of a LRD process: **asymptotic** definitions

- In [Bolot et al] \(^a\) and [Nogueira et al] \(^b\): to match the LRD is only required within time-scales of interest to the system under study.

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Long Range Dependence

In some measures, as queuing behavior [Salvador et al] and loss rate [Bolot et al], the traffic model needs only to capture the correlation structure of the source up to the correlation horizon.

Traditional traffic models can be used :)
Markovian is not Poisson

- Poisson is Markovian
- Markovian >> Poisson - MMPP, Markovian Arrival Process (MAP), etc.
- Typical quote from LRD literature “Prior to the work by Leand, et. al., the Poisson model was the most common used model for network traffic” - This in incorrect and misleading to students coming into the field [LUCANTONI, 2001 - ITC]
Markovian is not Poisson

Many LRD papers compare their results only to Poisson or at most a 2-state MMPP.

Although MAP’s are technically SRD, the exponential tail may not become dominant for some time (medium range dependence), and approximate a LRD in the relevance correlation lag?
Approximating LRD - MMPP

- Results in [Salvador et al]
- A novel feature of this approach is that the number of time scales is part of fitting procedure
- Trace Bellcore data - p.Oct.tl
- Fit results in an 88-state MMPP

“Multiscale Fitting Procedure using Markov Modulated Poisson Processes”
Paulo Salvador, Rui Valadas and Antonio Pacheco - Infocom 2002
Approximating LRD - MMPP

Figure 4. Probability function, pOct.TL.
Approximating LRD-MMPP

Figure 5. Autocovariance, pOct.TL.
Approximating LRD Traffic

- Results in [Andersen et al]
- Bellcore trace - Superposition of four two-state MMPP
- Matches correlation lags over 4 orders of magnitude

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Approximating LRD Traffic
Conclusion

As we can see in these examples and in other papers, if networks are operated in regions when LRD might have an effect on performance, then existing Markovian models can be used for dimensioning.

So we can re-use the well-known analytical queuing theory techniques developed so far in order to evaluate network performance.

It is a GOOD IDEA, am I right????? :)
Some Questions

- Some authors said that the parametrization process is one drawback of using Markov Models. Is it completely true?
- Do all measures sensitivity to LRD traffic?
- There are some LRD limit results in literature. Are these results new? I mean, do these results show something that can not be captured by Markovian Models?