

Modeling the Energy Consumption of Multi-NIC Communication Mechanisms

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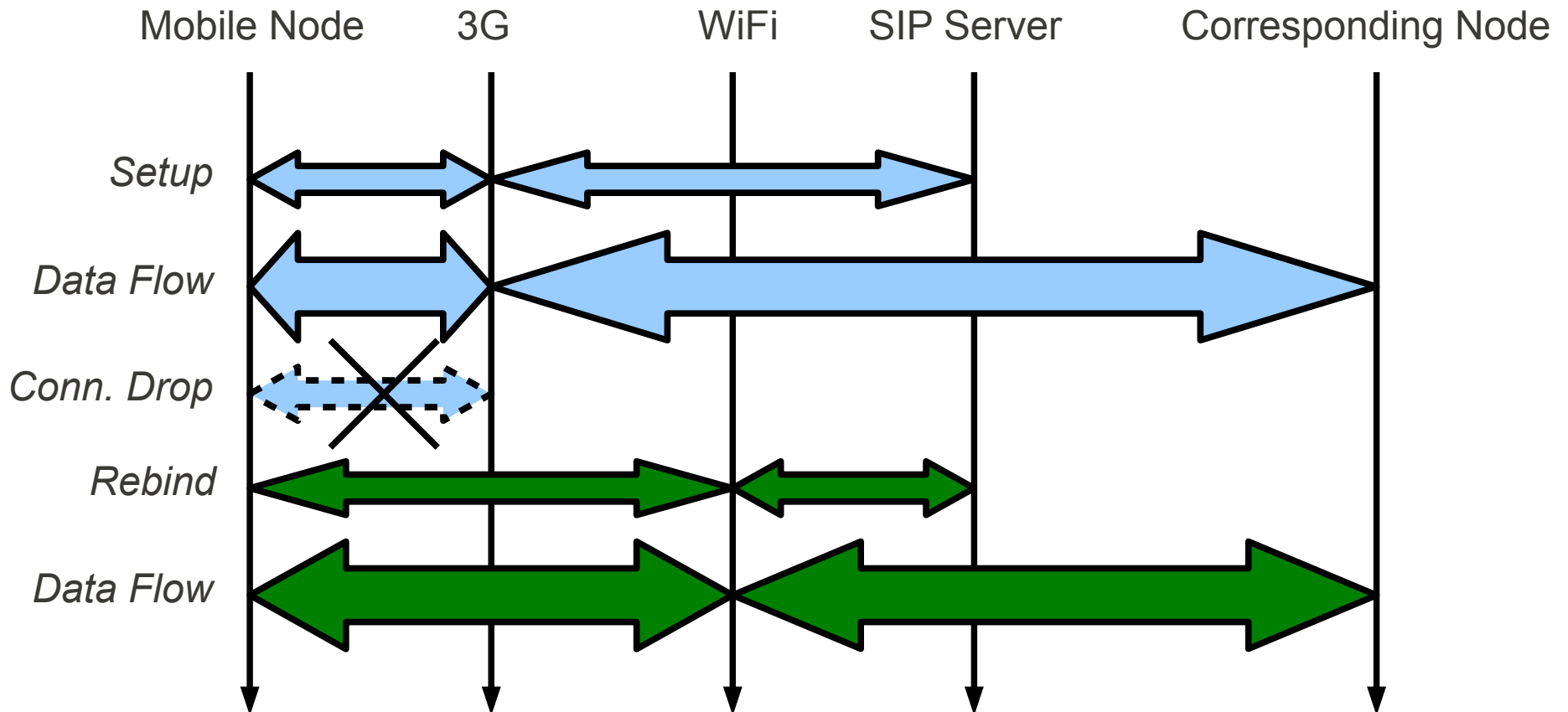
IEEE greencom, 26—28 September 2012

Introduction

- Modern mobile telecommunication technologies allow users to employ different networks to access Internet services (WiFi, 3G, ...)
- Ideally, a Mobile Node (MN) should be able to select dynamically the “best available” network according to some metric
 - e.g., lowest latency; higher throughput; cheaper service...

Session Initiation Protocol (SIP) Approach

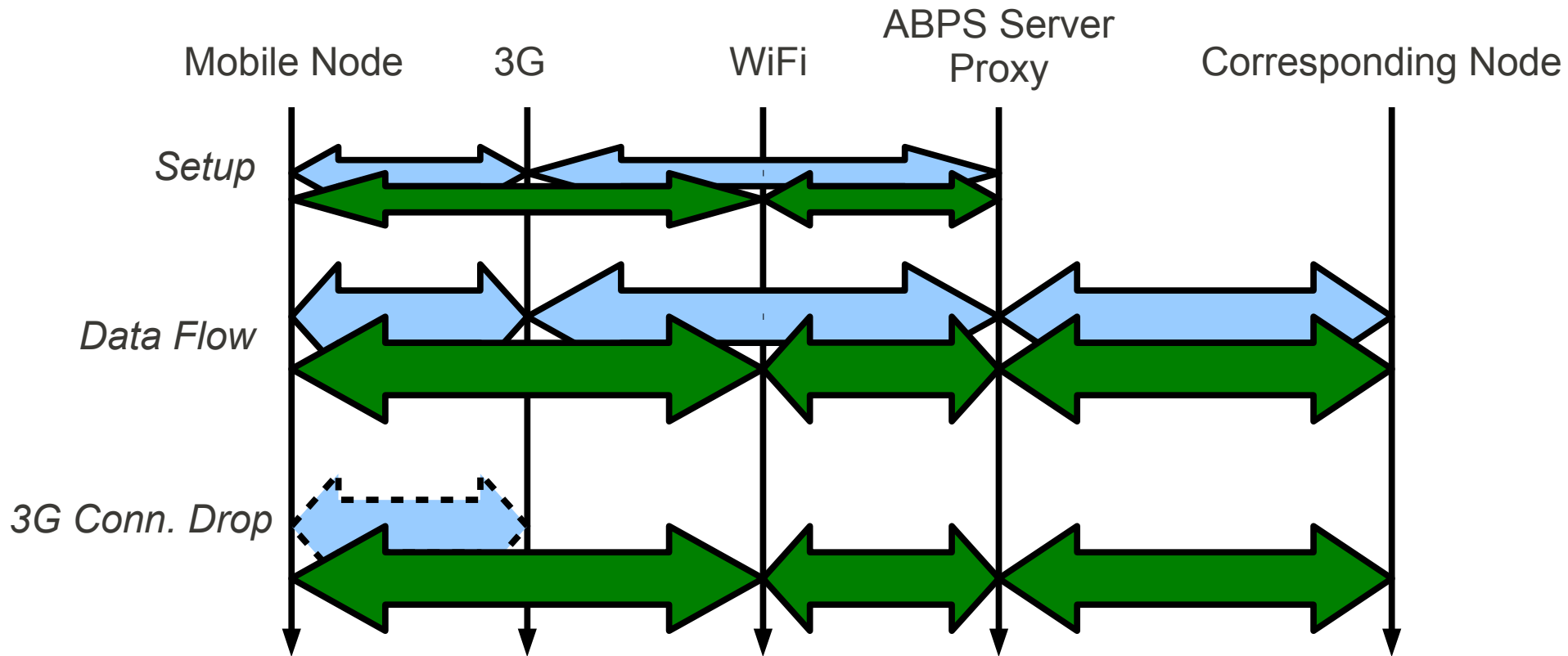
- Use one of the NICs until the connection drops; then, negotiate a new connection on a (possibly) different NIC



Always Best Packet Switching (ABPS) Approach

- Cross-layer architecture to use all available networks
- Communication active even in presence of vertical and/or horizontal hand-offs
- Interactive multimedia services
 - SIP/RTP/RTCP over UDP
 - TCP
 - Even in presence of firewalls and NATs

Always Best Packet Switching (ABPS) Approach

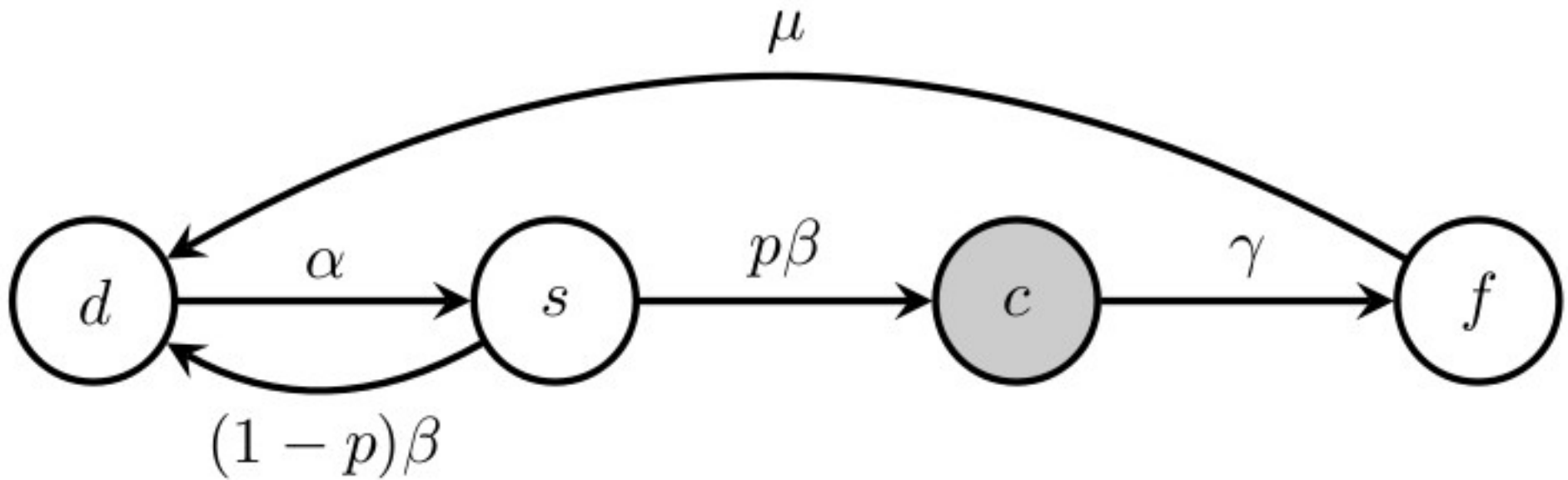


- ABPS Client Proxy component running on the MN not shown
- Transparent to user application, handoff is handled by ABPS

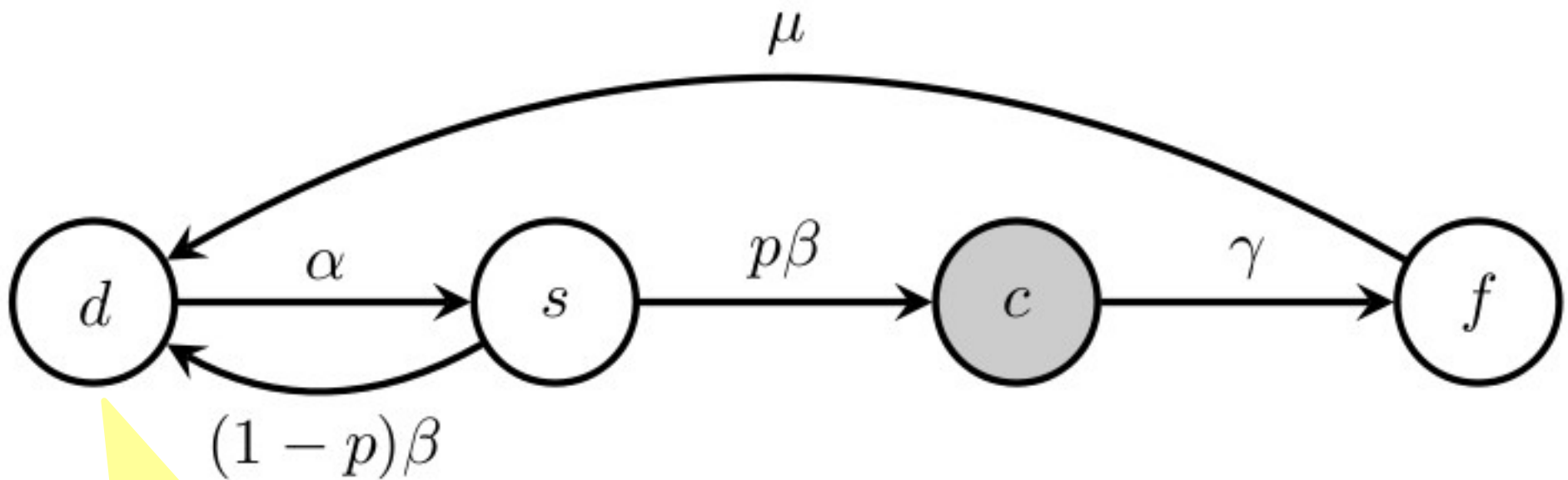
Analysis

- Use of multiple NICs can be good for availability / reliability, but it may be bad for power consumption
- Testing multi-NIC communication mechanisms under different scenarios by direct measurement is not practical
- Performance models based on CTMCs with rewards
 - Simple models, used to perform “what-if” analysis
 - Can be generalized to different multi-NIC mechanisms
 - Markov models analyzed using the Octave Queueing Toolbox
<http://moreno.marzolla.name/software/queueing/>
- As a use case, we employ the model to compare the power consumption of SIP, ABPS and single NIC (3G) interface

Single Interface Model

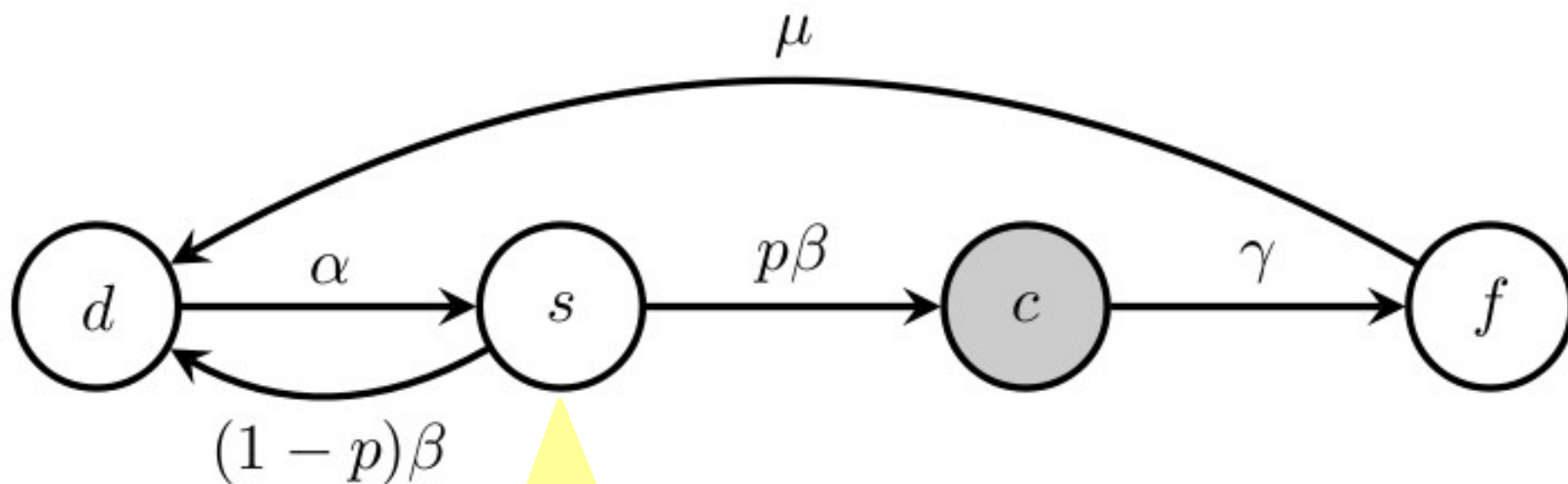


Single Interface Model



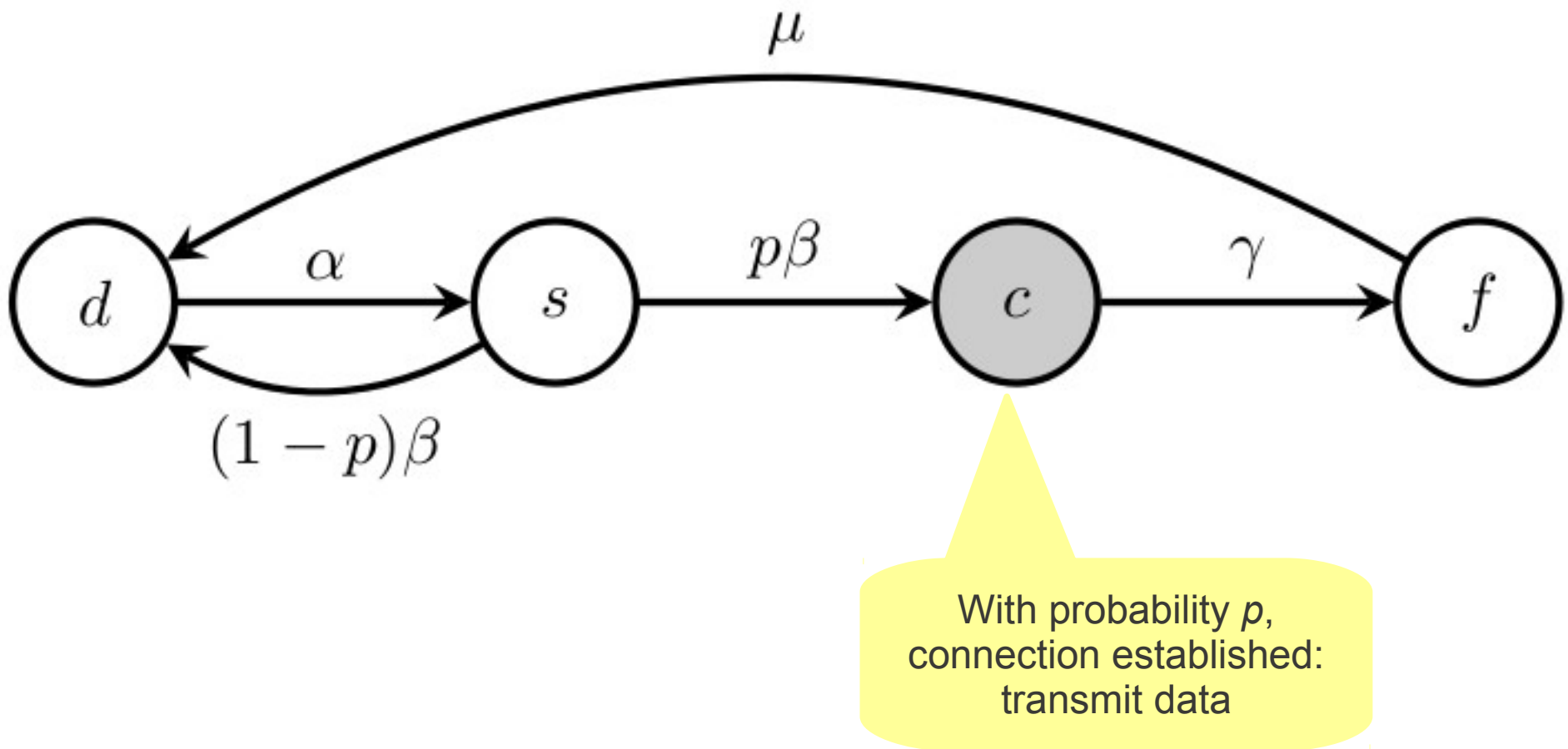
Node disconnected;
scans for available
networks

Single Interface Model

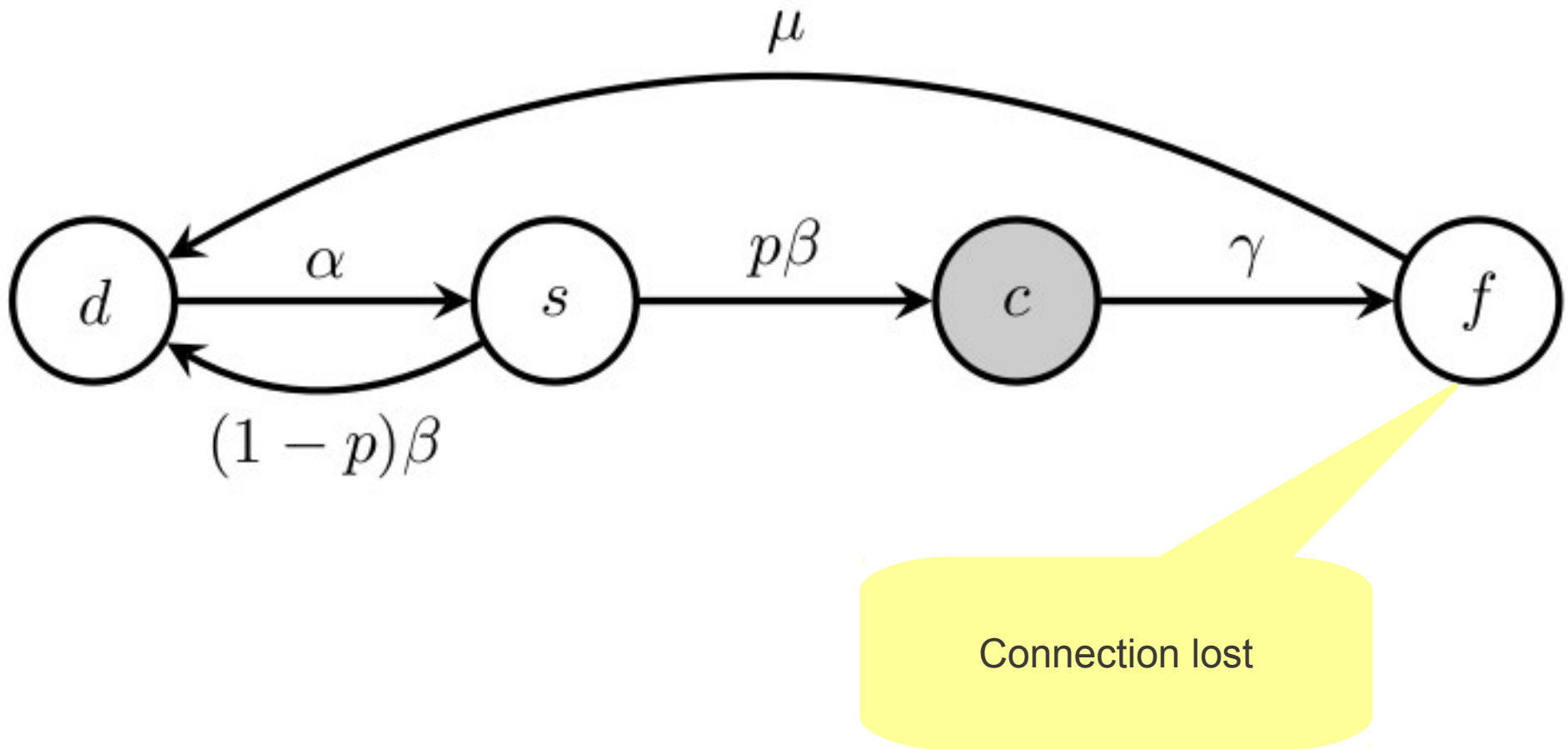


Network found; attempt
to setup a connection

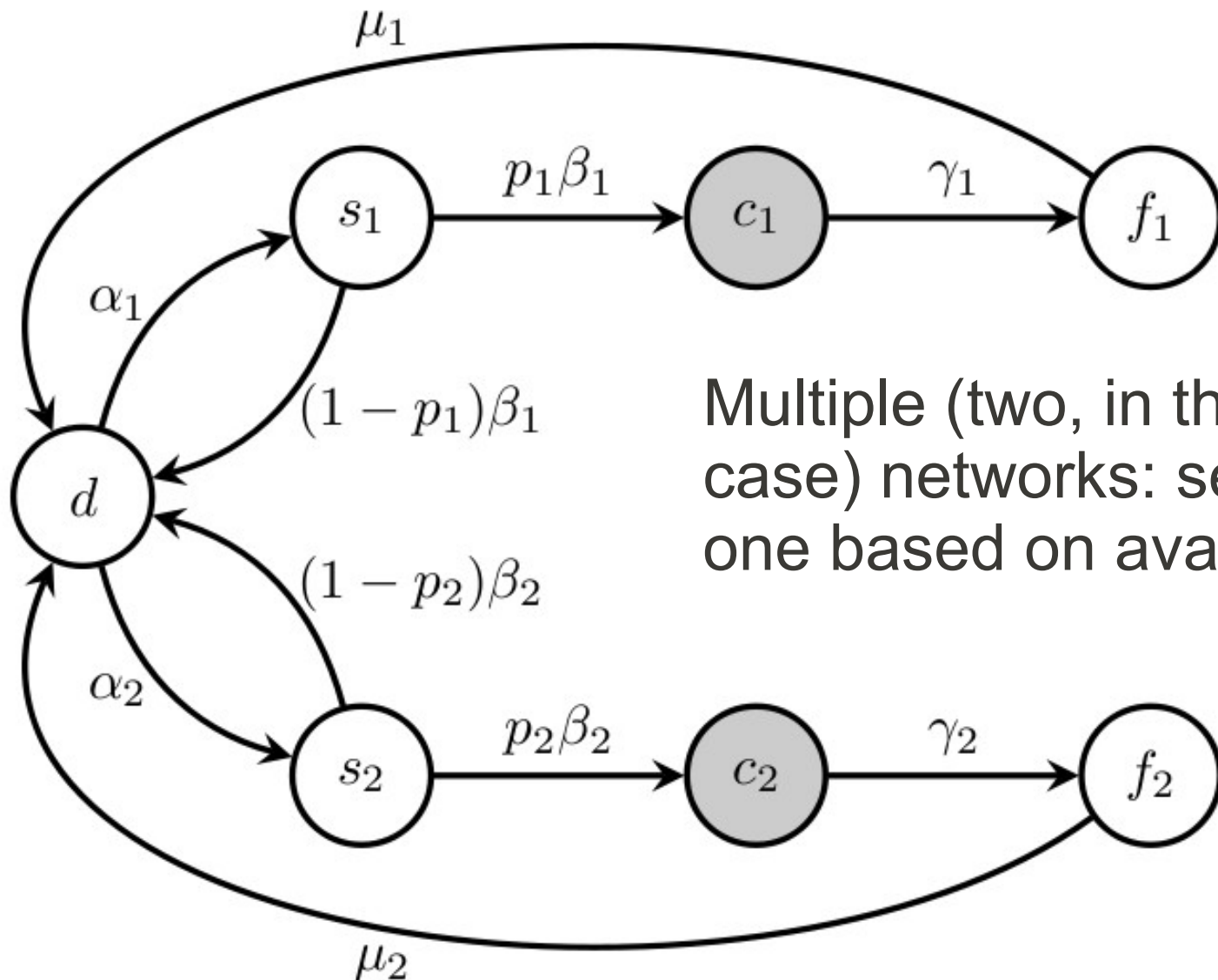
Single Interface Model



Single Interface Model

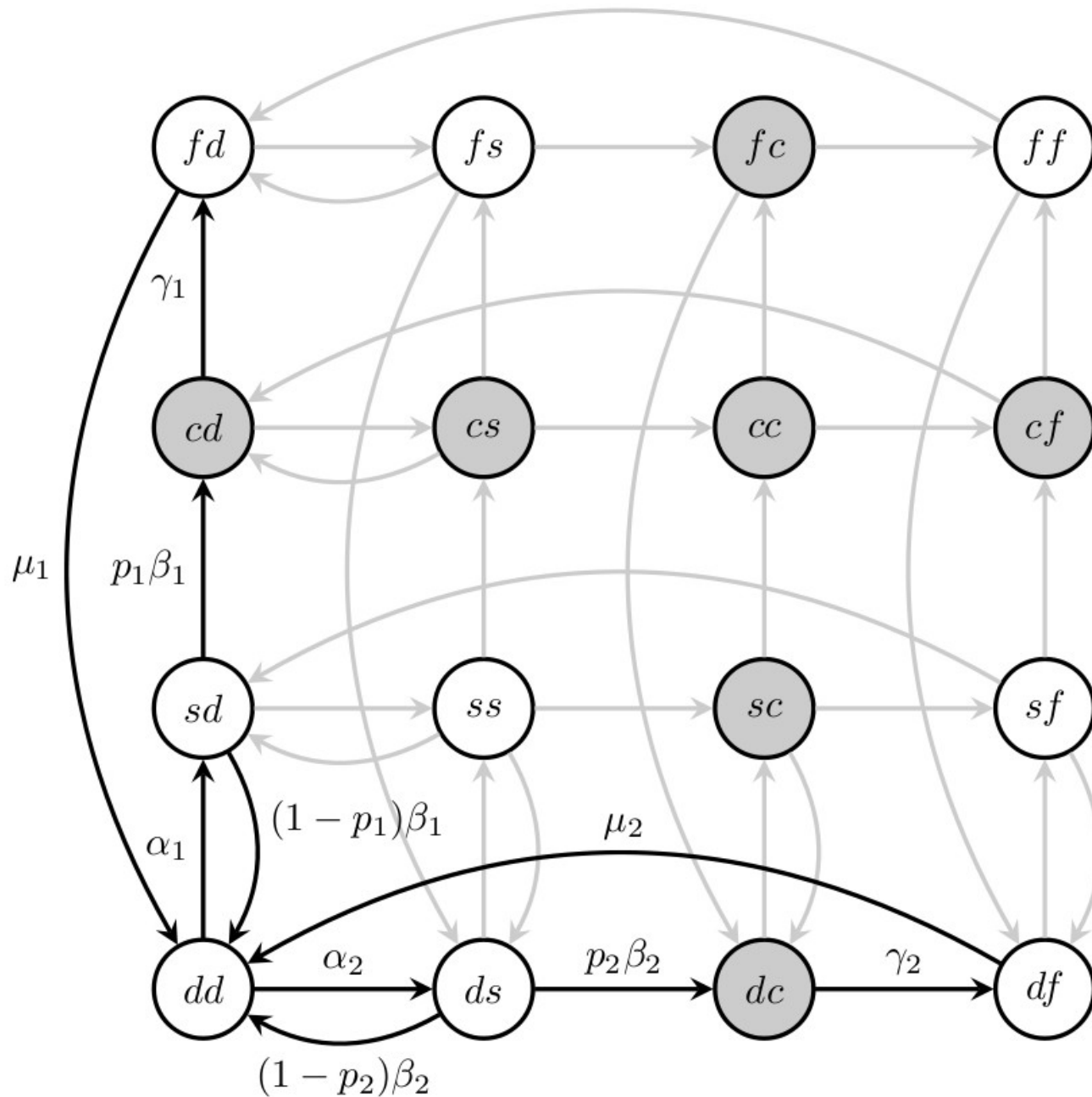


Multiple Interfaces: SIP



Multiple (two, in this case) networks: select one based on availability

Multiple Interfaces: ABPS



Multiple (two) networks: all can be used at the same time

Analysis

- We consider different durations for UMTS (500s—2500s) and WiFi (5s—50s) connections
- Other parameters are set as follows

	α	β	γ	μ	p
UMTS (NIC 1)	1/6.024	1/1.5	1/500 – 1/2500	1	0.99
Wi-Fi (NIC 2)	1/7.5	1/1.5	1/5 – 1/50	1	0.9

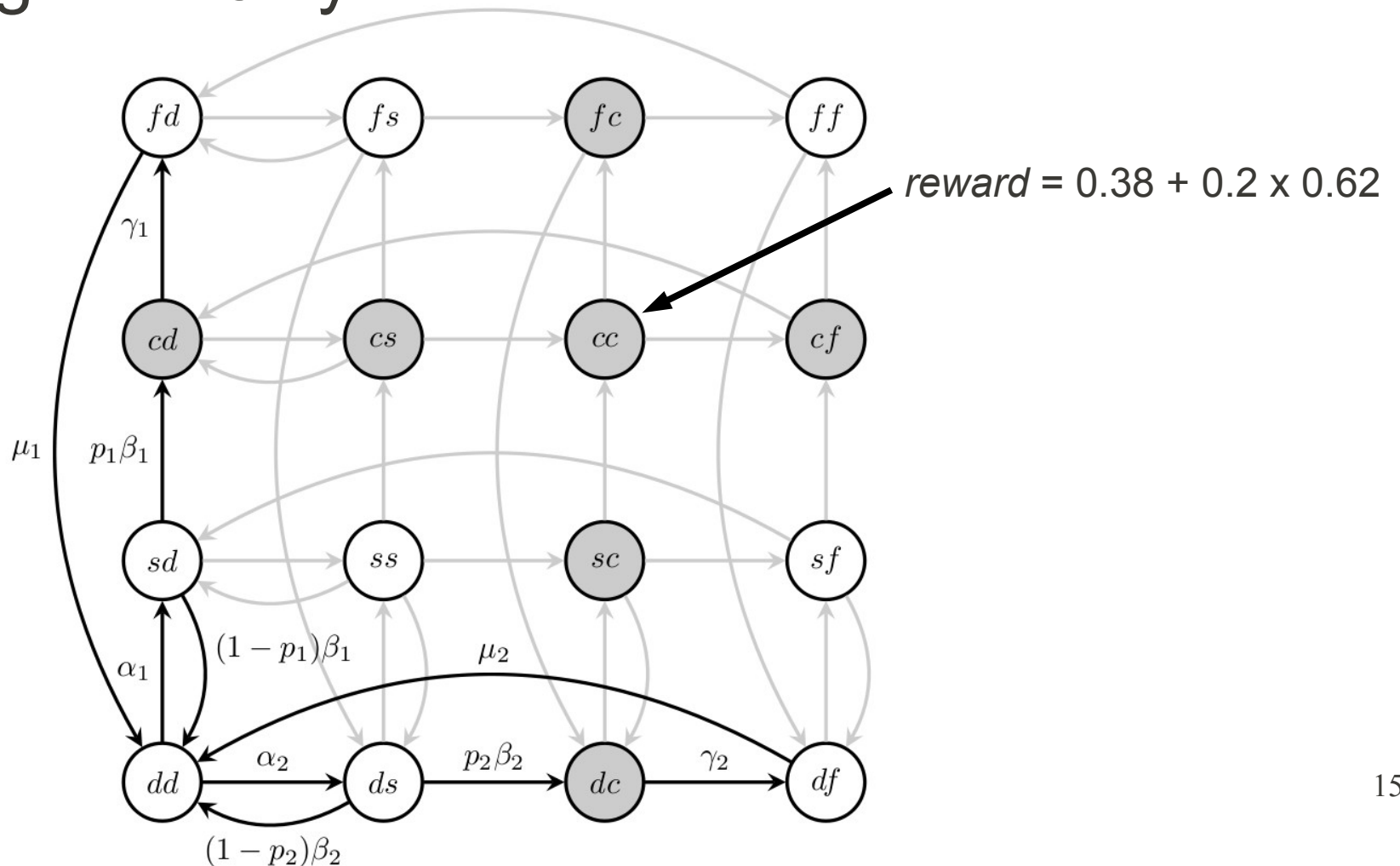
- Power consumption (in W)

N. Balasubramanian, A. Balasubramanian, and A. Venkataramani, “Energy consumption in mobile phones: a measurement study and implications for network applications,” Proc. 9th ACM SIGCOMM conf. on Internet measurement, pp. 280–293.

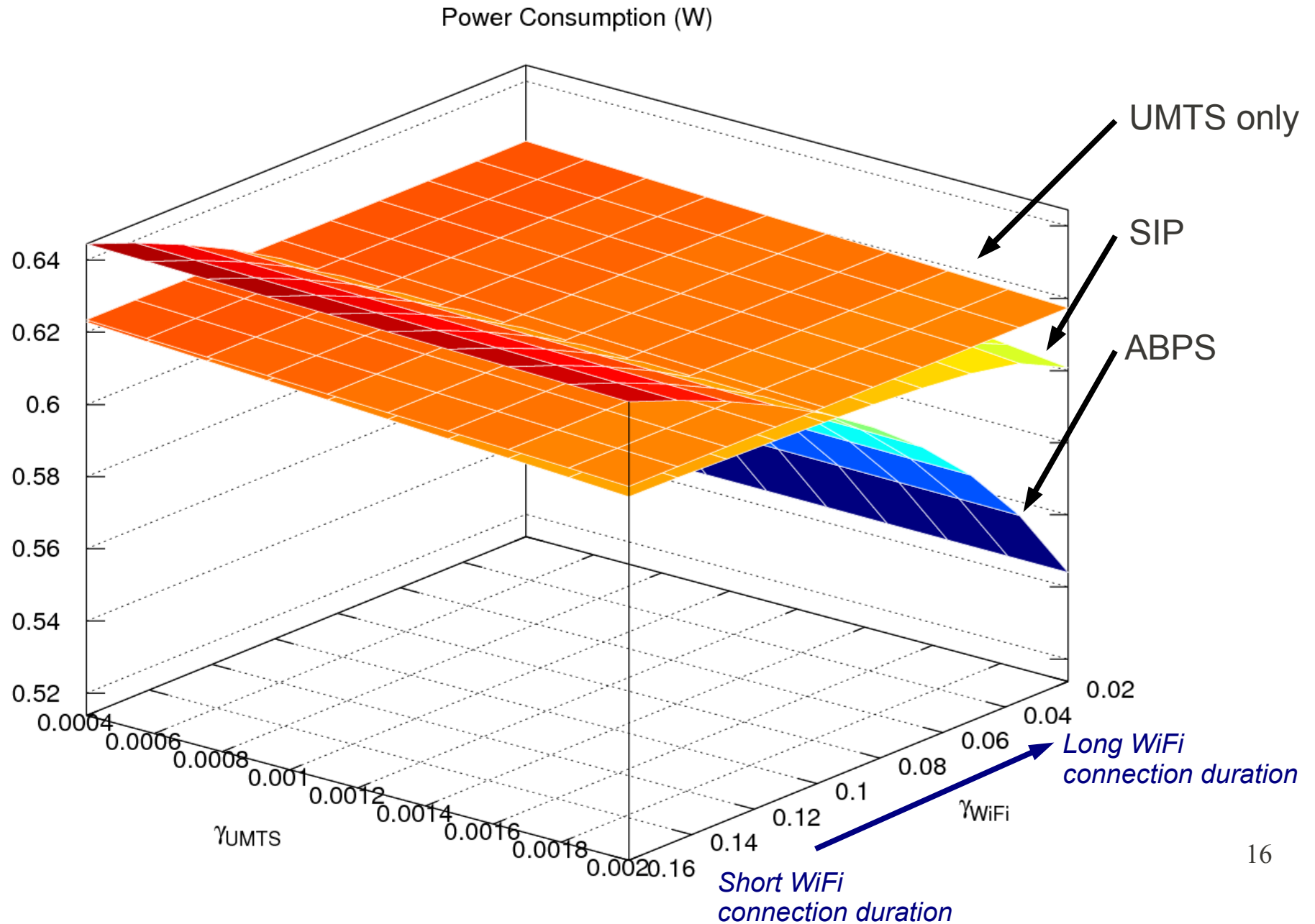
	d	s	c	f
\mathbf{r}_{UMTS}	0.12	0.31	0.62	0.25
$\mathbf{r}_{\text{Wi-Fi}}$	0.08	0.19	0.38	0.15

Analysis (cont.)

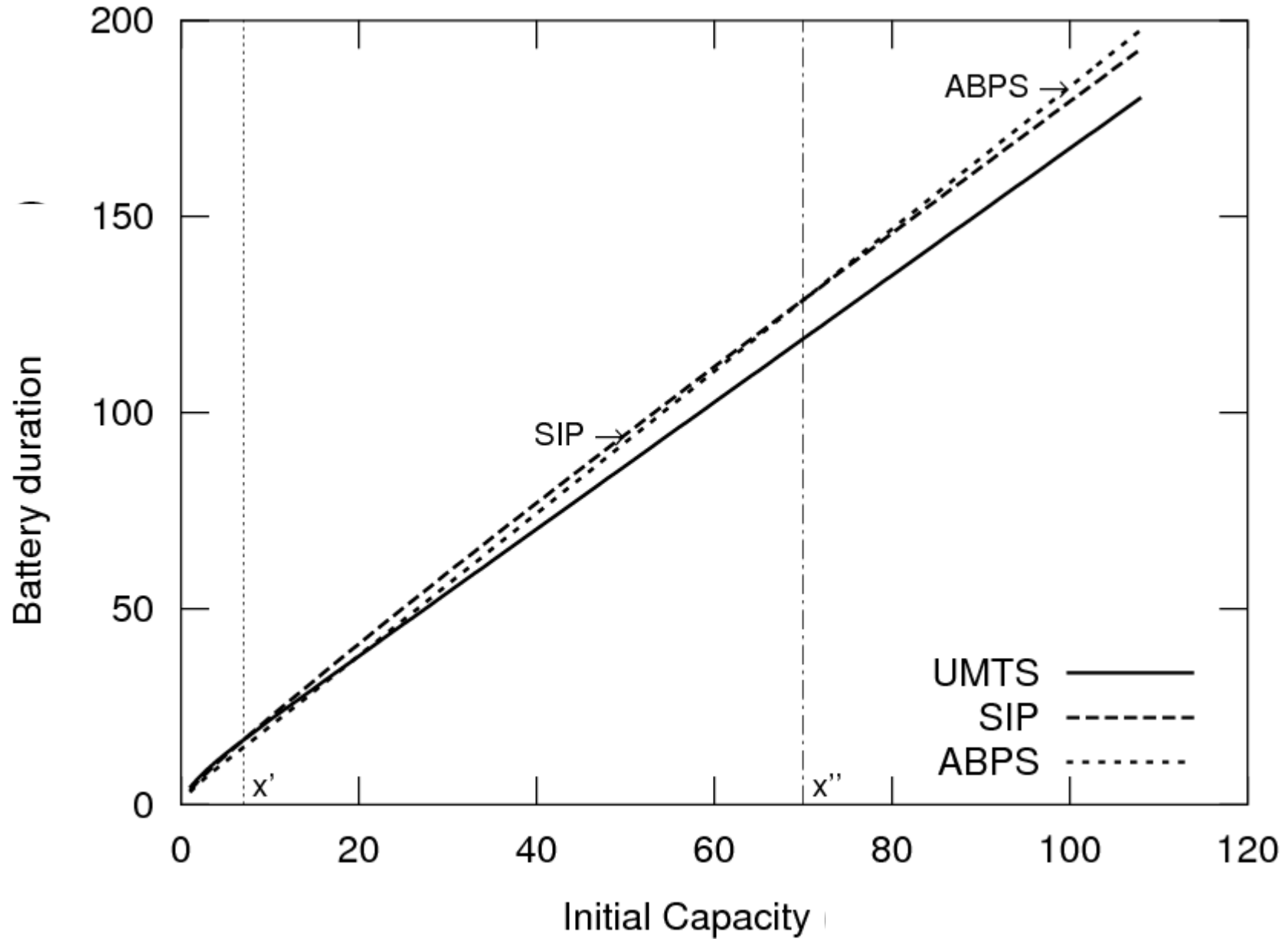
- We assume that ABPS in state cc transmits using WiFi only



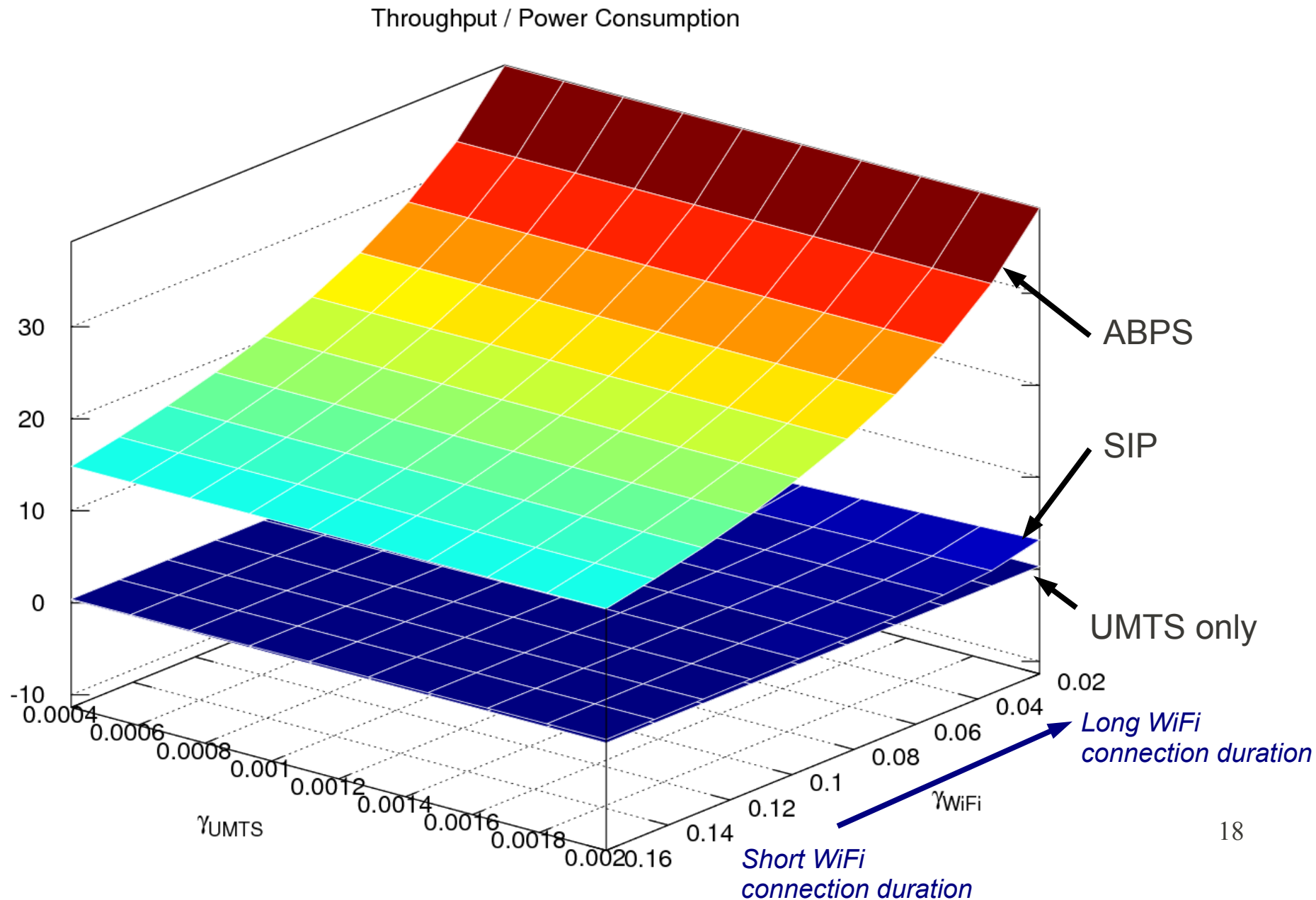
Steady-State Power Consumption (W)



Battery Duration



Throughput/Power Consumption ratio



Conclusions and Future Works

- We demonstrated the use of Markov models to analyze the power consumption of multi-NIC communication mechanisms
- The model has been applied to SIP and ABPS to show the kind of questions it can answer
- The model can be easily extended to compute other performance measures (reliability, connection availability and so on)
 - S. Ferretti, V. Ghini, M. Marzolla, F. Panzieri, *Modeling the Always Best Packet Switching Mechanism*, proc. NGMAST 2012
- We are currently trying to setup a suitable measurement infrastructure to validate the power consumption model on real hardware