



**ITU Kaleidoscope 2015**  
*Trust in the Information Society*

**WHY WE STILL NEED STANDARDIZED  
INTERNET SPEED MEASUREMENT  
MECHANISMS FOR END USERS**

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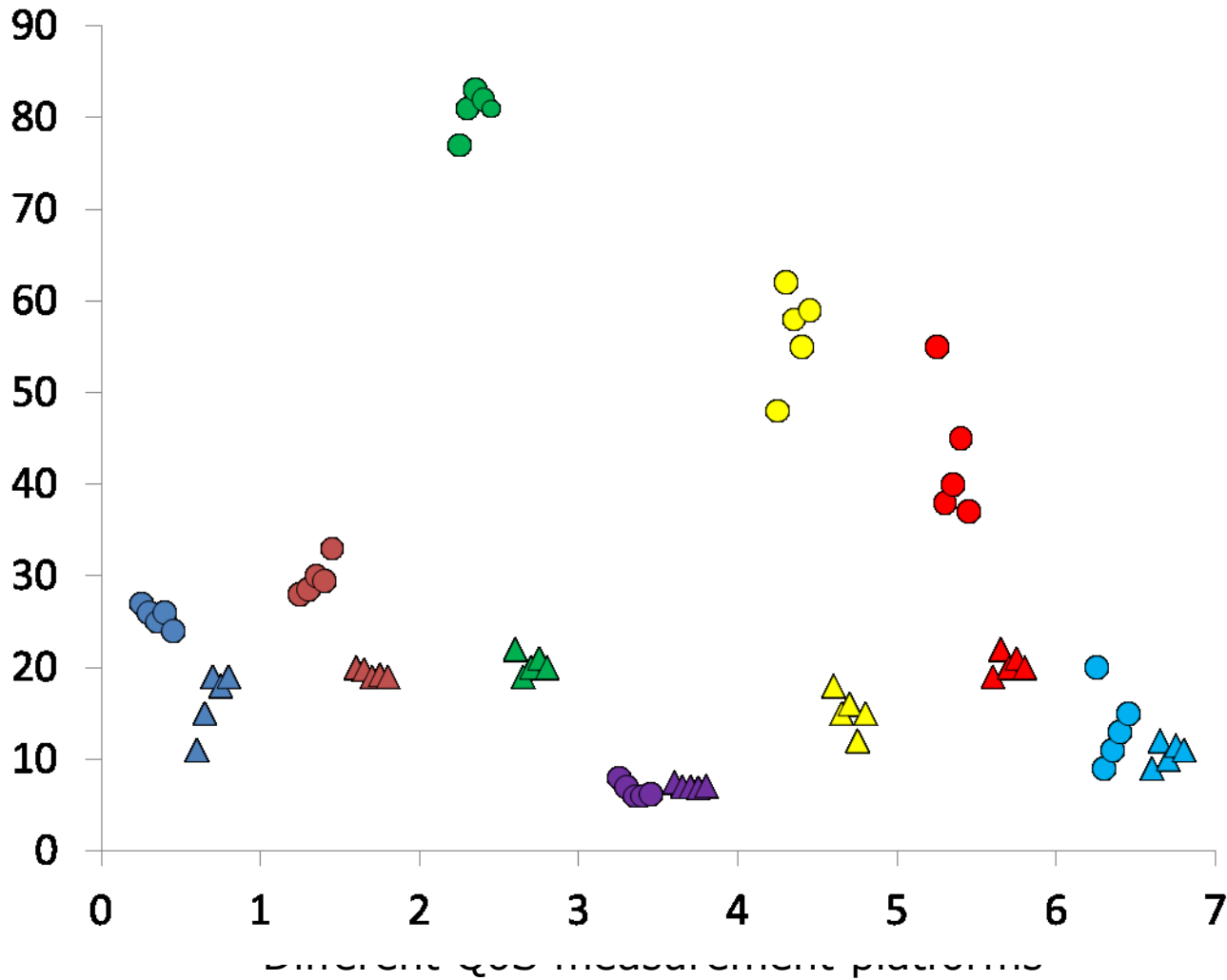
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# Structure

- Introduction
- Background
  - Problems to tackle
- Technical analysis
- Conclusions

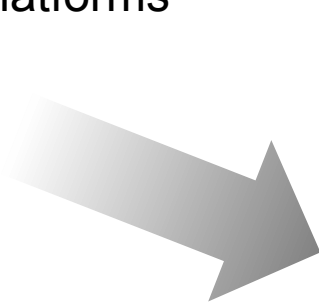
# Introduction (I)



# Introduction (II) - Different Need for Standards

## Approach b Large Scale Platforms

Examples:  
SamKnows  
RIPE Atlas  
Bismark  
Dasu  
\*QoSMeter

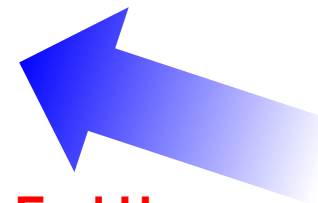


**Regulator**

Reliable  
**Comparable tests**  
Temperature of the broadband market  
SLA's and customer protection

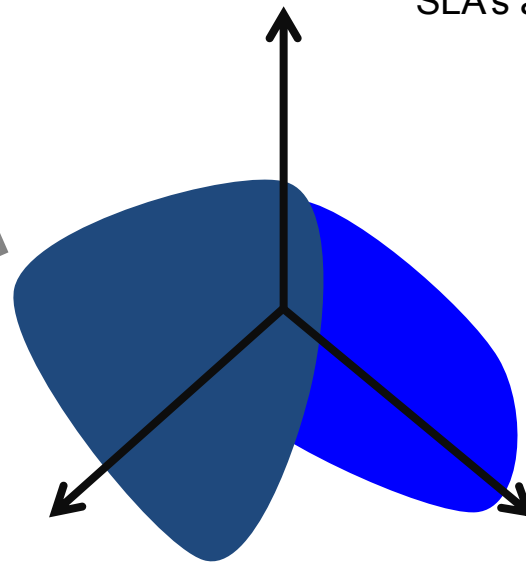
Approach a  
End Users

Examples:  
Speedtest  
RTR  
\*Velocimetro



**Operator**

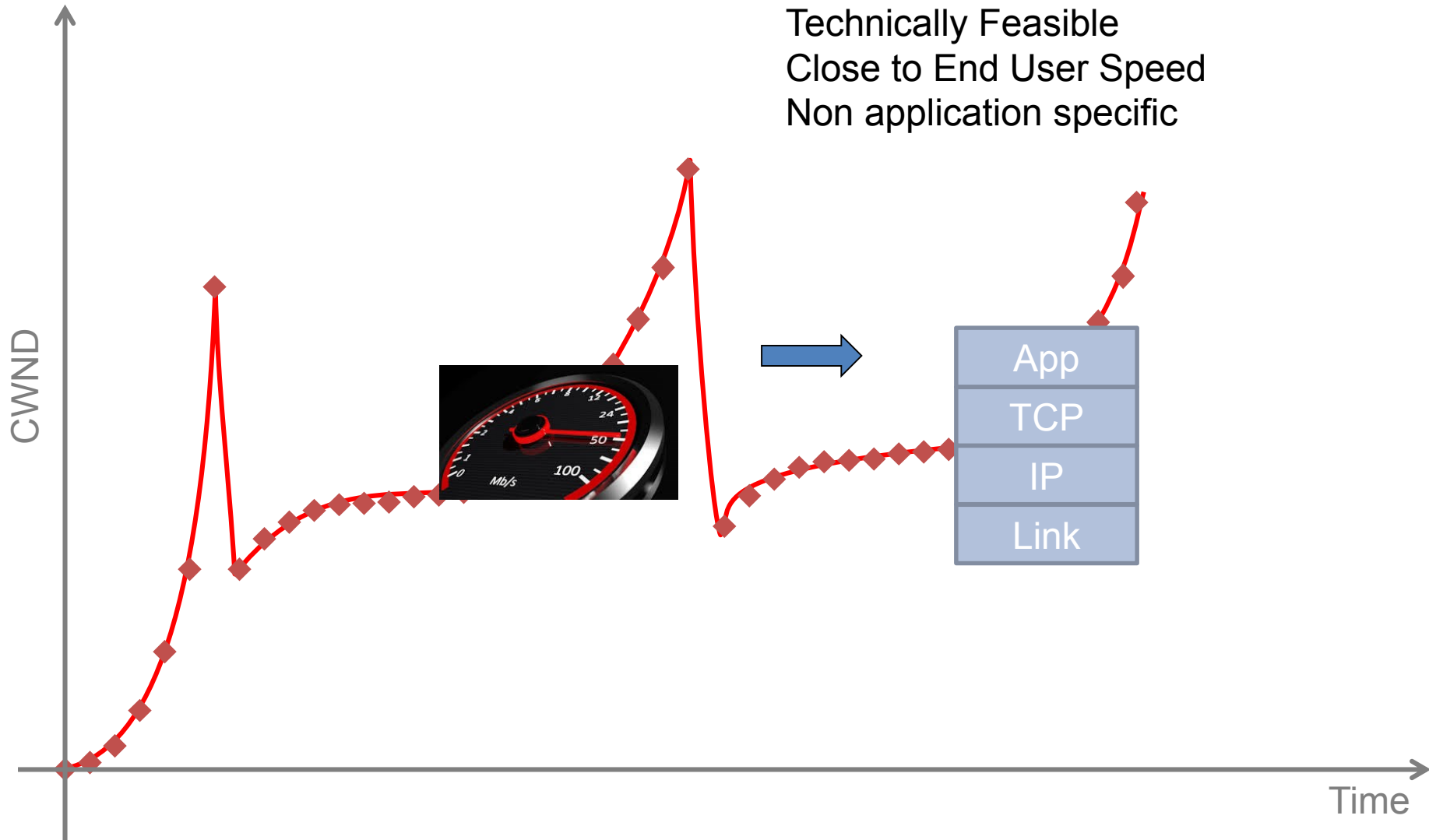
Controllable  
Capability to incorporate multiple metrics  
**Technically sound**  
Ability to identify network problems and their causes



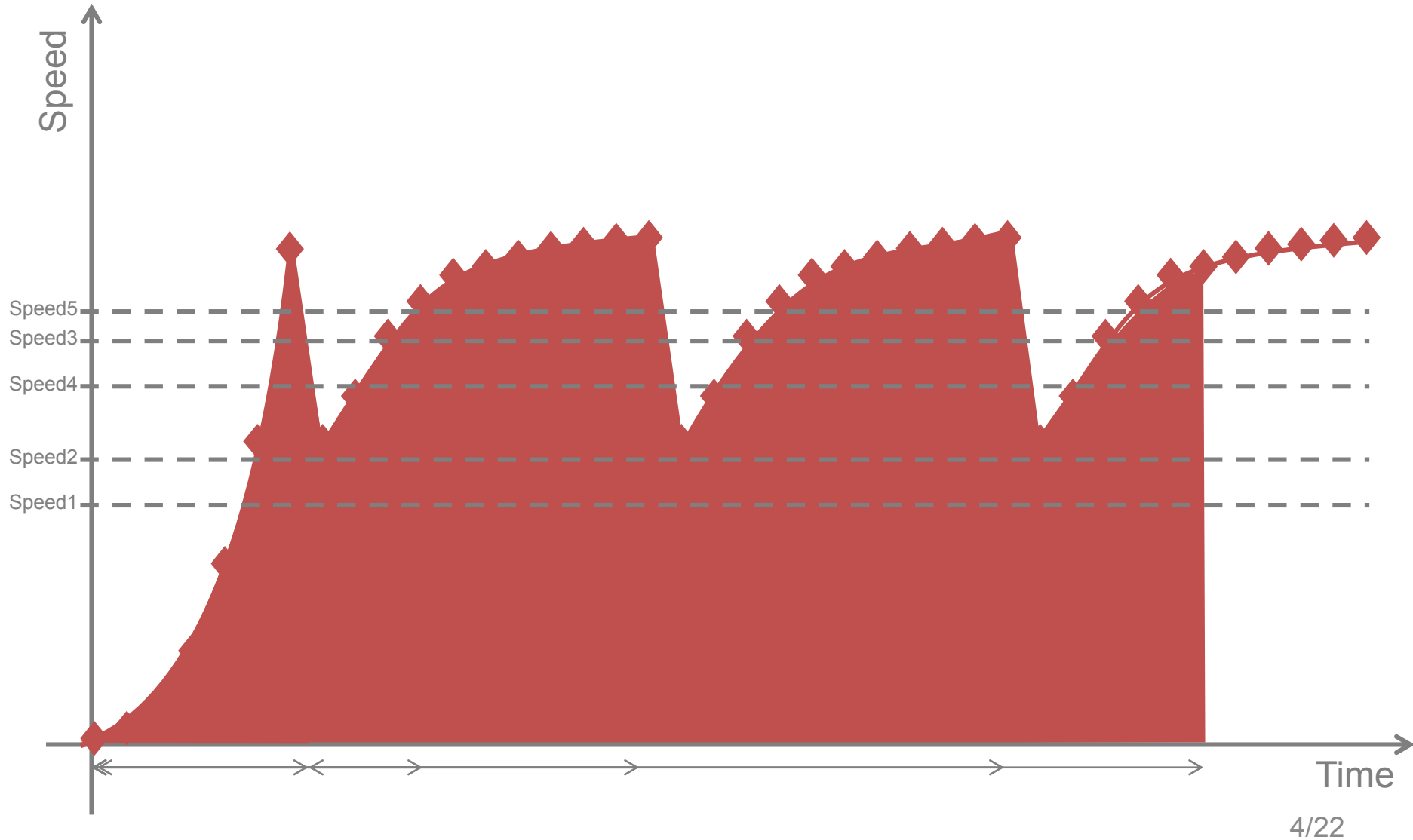
**End Users**

Availability ("time to market")  
Simplicity/understandable to users  
**Technically feasible to deploy in multi-technology UEs (including web browsers, mobile apps in non rooted phones, etc).**  
Comparison with "de facto" standards

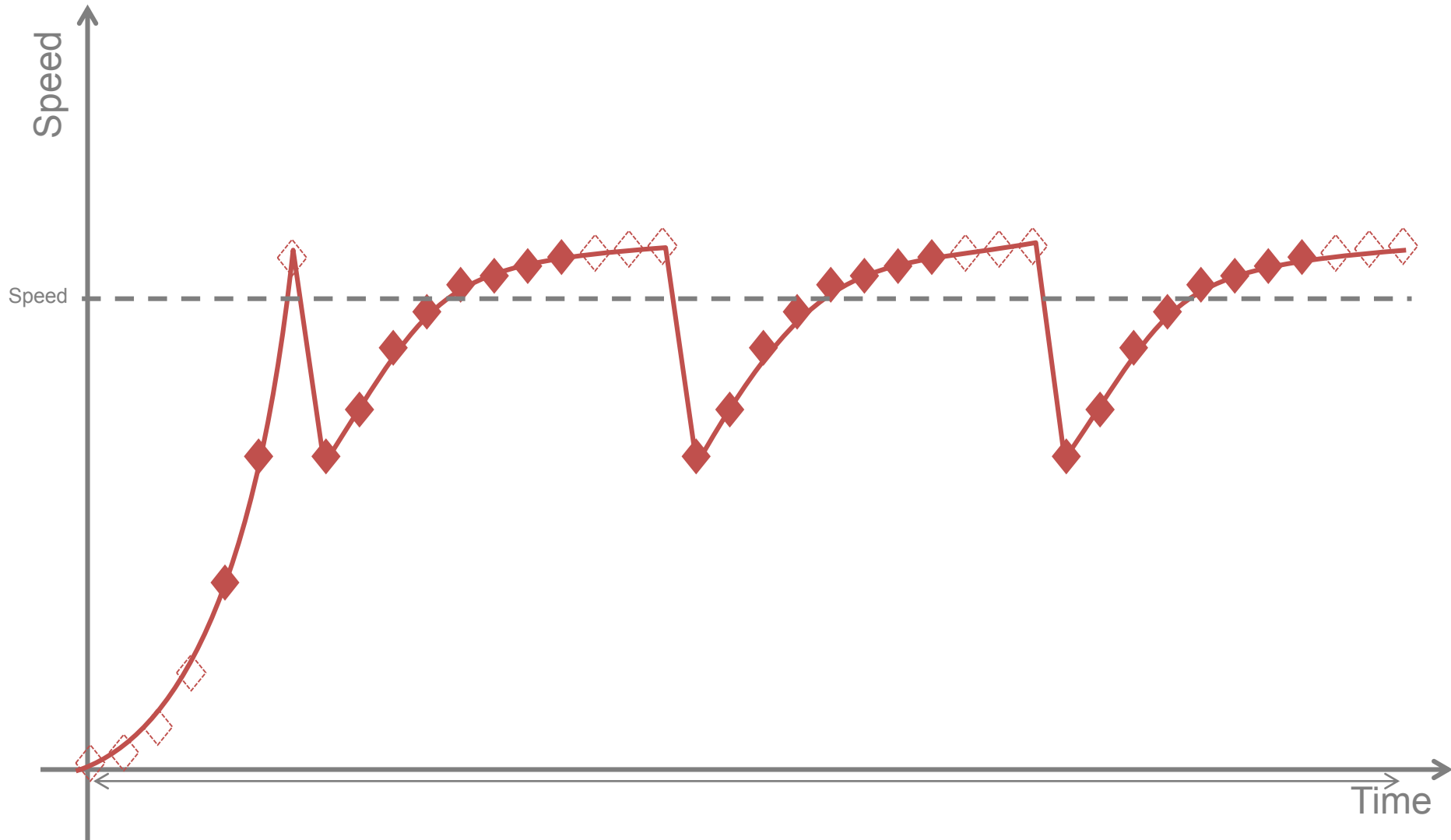
# Introduction (III) - CWND evolution



# Introduction (IV) Transport level speed



# Introduction (IV) Alternative metric

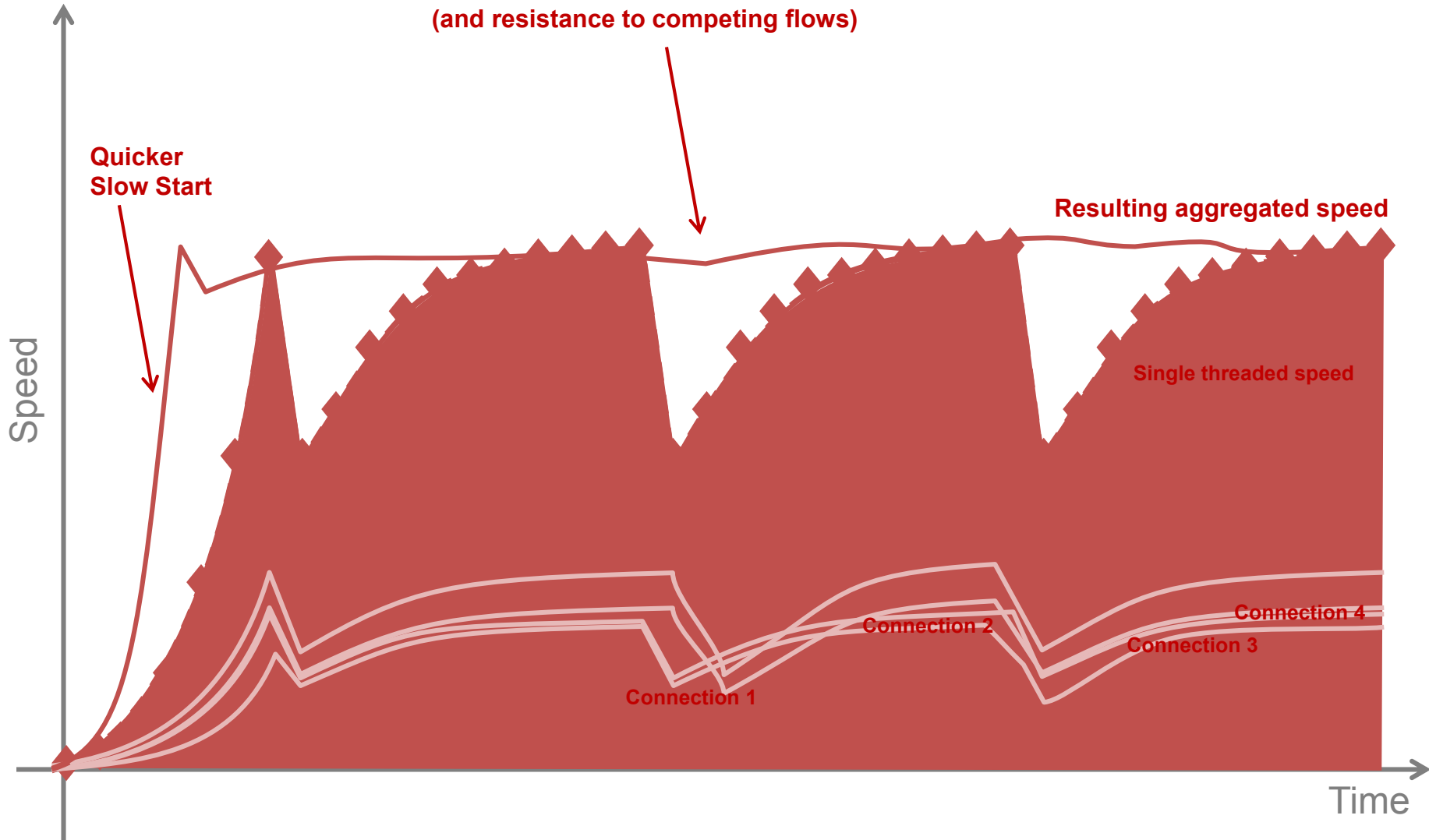


# Introduction (V) - multithread

More stable evolution  
(and resistance to competing flows)

Quicker  
Slow Start

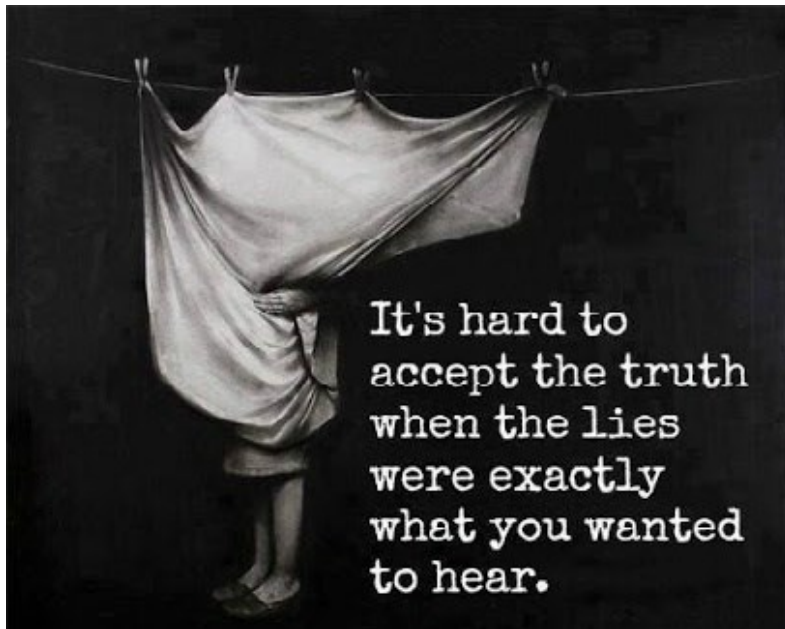
Resulting aggregated speed





# What do users want and who can they trust?

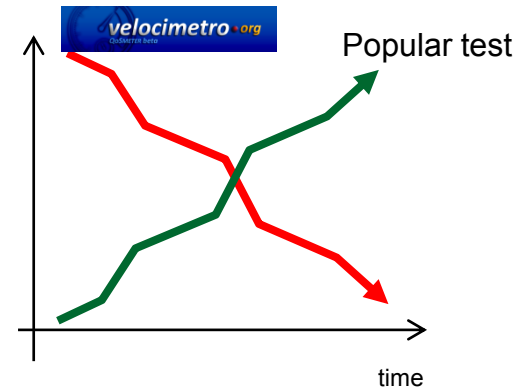
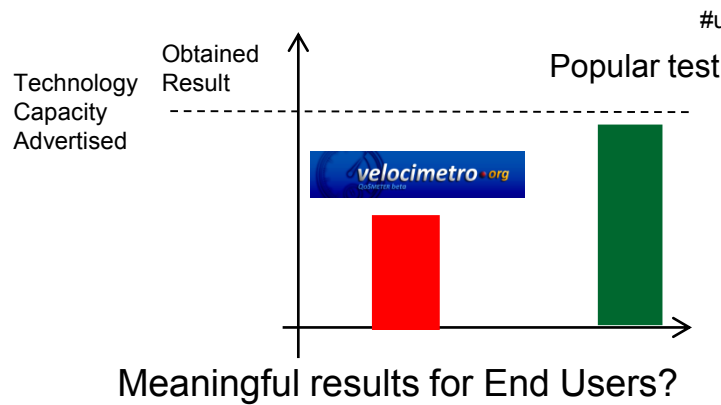
It's so easy to believe someone when they're telling you exactly what you want to hear.



# EHU's sad history



2001  
BTC (Download Time)  
Single Thread



Multithread  
Easy to use/web based  
Closer to "available path capacity"

## Multiple metrics



2007  
Platform ~  
Velocimetro as a plugin  
Need to Download/Install  
GUI/CLI-automated versions

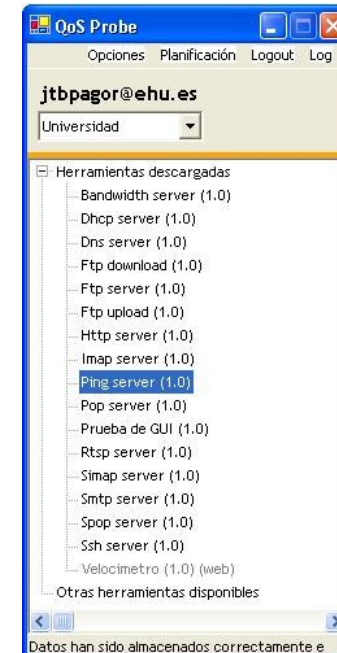
```

QoSMETER CLIENT
QoSMeter Alpha Preview

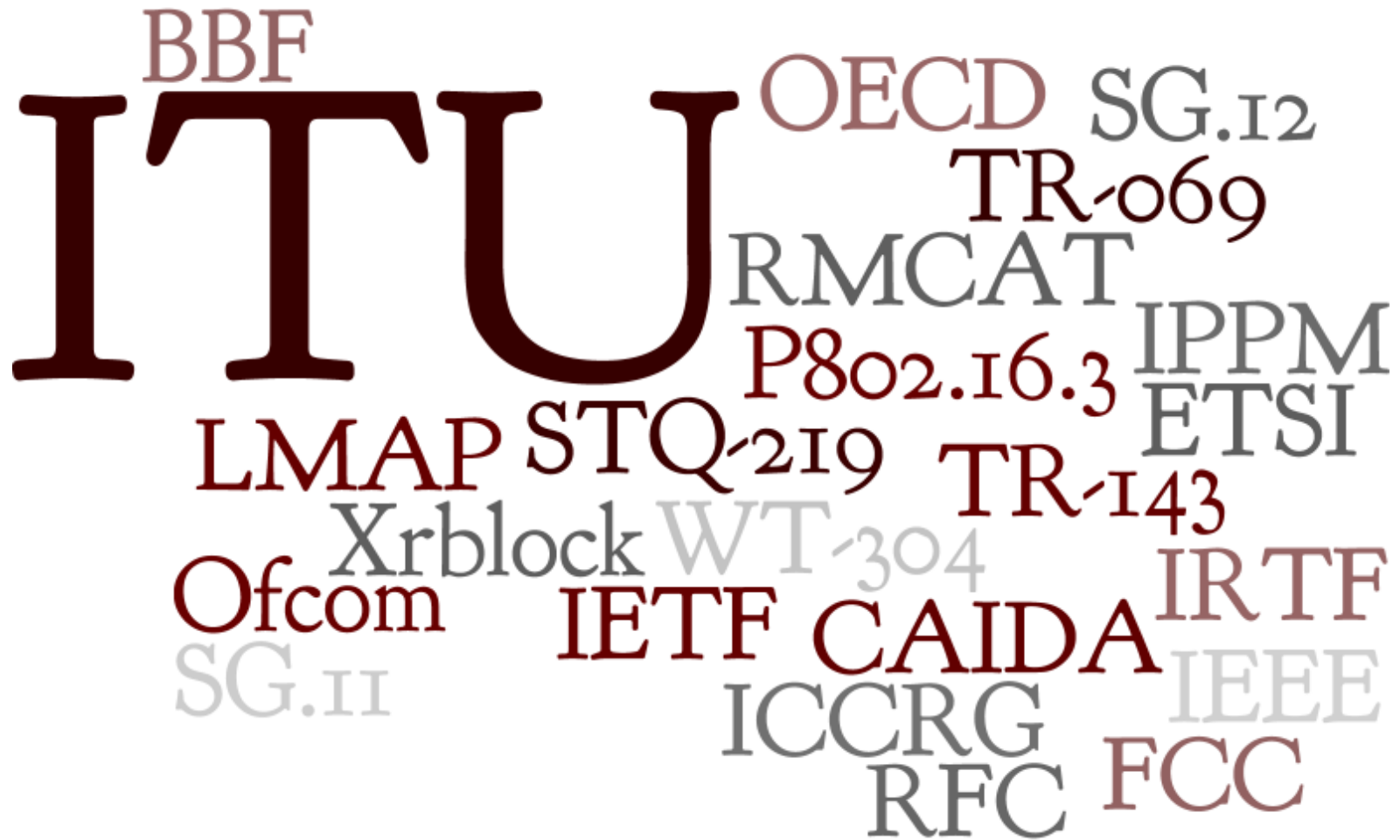
QoSMeter> login
Login: usuario@ehu.es
Please enter your password :
Login ok

QoSMeter> services
Available tools are:
Ping test
Http test
Ftp test
Dns test
Dhcp test
Sntp test

QoSMeter> exec http
Executing http test
    
```



## Current Situation [Standards]



A word cloud featuring various standards and organizations. The largest and most prominent text is 'ITU' in a dark red, serif font. Other significant text includes 'BBF' in a smaller dark red font above 'ITU', and 'OECD' and 'SG.I2' in a dark red font to the right of 'ITU'. Other words in various sizes and colors (dark red, grey) include: 'TR-069', 'RMCAT', 'IPPM', 'P802.16.3', 'ETSI', 'LMAP', 'STQ-219', 'TR-143', 'Xrblock', 'WT-304', 'Ofcom', 'IETF', 'CAIDA', 'IRTF', 'SG.II', 'ICCRG', 'IEEE', 'RFC', and 'FCC'.

# Current Situation [Regulation - OECD report-]

Country	Authority	Approach(es)		Purpose(s)				
		Fixed or unspecified broadband	Mobile broadband	1. Consumer empowerment	2. Network development	3. Competition enhancement	4. Net neutrality	5. Others
Australia	Department of communications	EAM	EAM					x
Austria	RTR	EAM	EAM	x	x	x	x	
Canada	CRTC	EDM		x	x			
Czech Rep.	CTU		PSM-ISP and PSM for comparison	x	x	x		x
Denmark	Danish Business Authority	EAM	EAM	x				
France	ARCEP	PSM-ISP	PSM	x	x			
Germany	Bundesnetzagentur	PSM (-2013) EAM (2015-)	PSM (2012); EAM (2015-)	x	x			
Greece	EETT	PSM and EAM	PSM and EAM	x	x			
Italy	AGCOM	EAM and PSM for check	PSM	x	x			
Korea	Ministry of Science, ICT and Future Planning	PSM and PSM-ISP	PSM	x				
New Zealand	Commerce Commission	EDM		x	x	x		
...	...	...	...		x			

**End-user Application Measurement (EAM):** Daily use of an end-user's computer or mobile phone is employed for measurement with an application or browser under the user's control.

**End-user Device Measurement (EDM):** Tests are done by specific devices which are installed by end users for measurement, but they are separated from the daily use of computers and mobile phones thus controlled remotely by the project, and

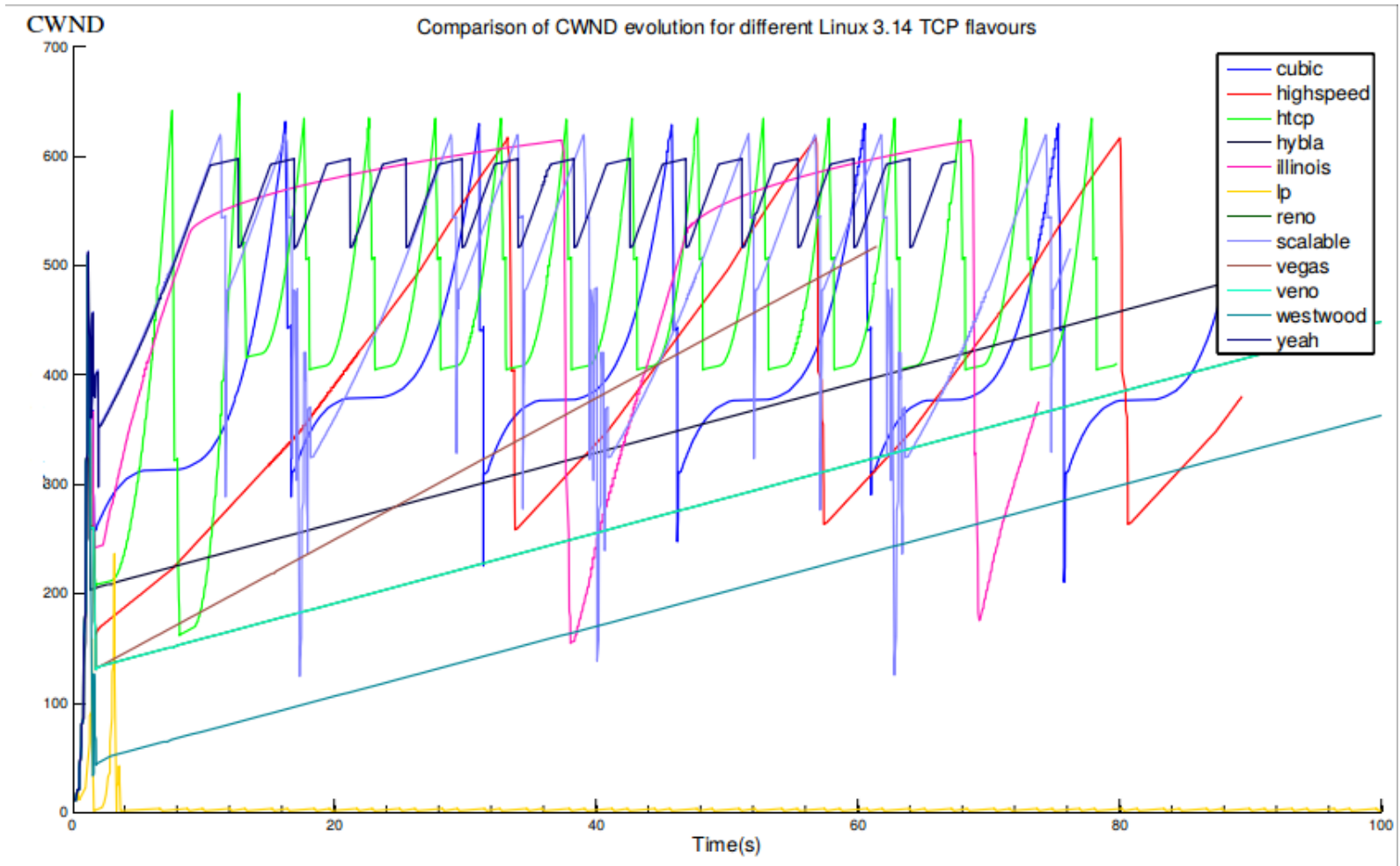
**Project Self Measurement (PSM):** The project itself installs or allocates and controls a device or computer to do tests. Unless otherwise noted, measurements are done by some entity different from the measured ISPs, but if it is done by the ISPs themselves with controlled methodology then the document calls it PSM-ISP for distinction.

# Technical Analysis on TCP

- Motivation: TCP's multiple faces
- Overall methodology
- Multiple constraints
  - TCP dynamics
  - Buffer size effects
  - Bufferbloat effect
- Multiple parallel TCP connection based tests
- Real World

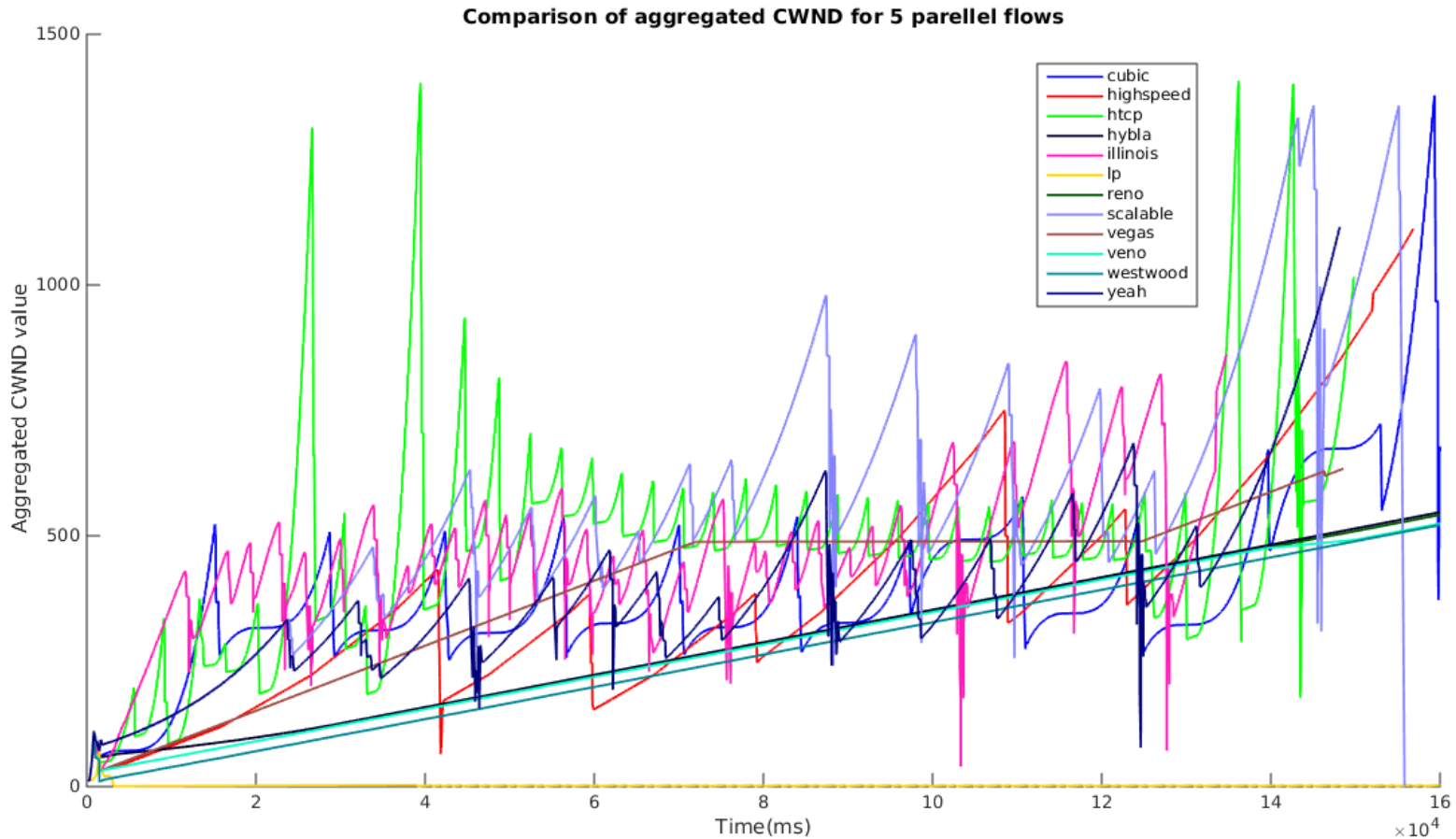
# Technical Analysis - Use of TCP (I)

- TCP flavours performance under same circumstances

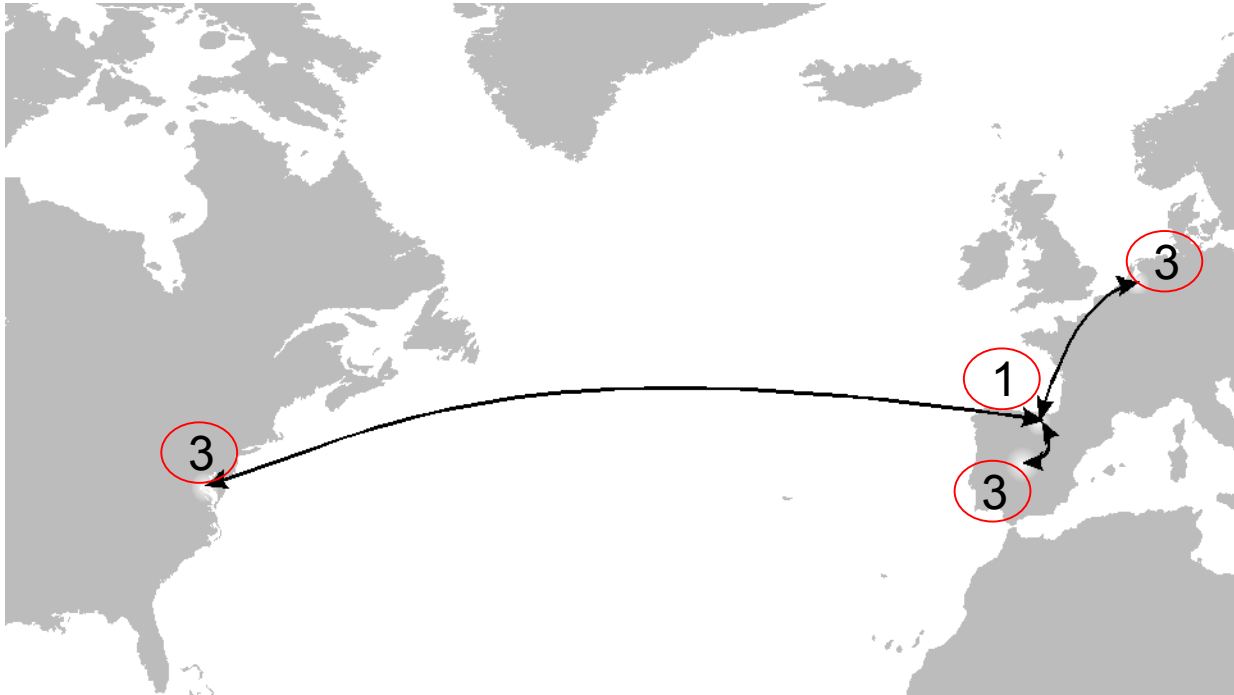


# Technical Analysis - Use of TCP (II)

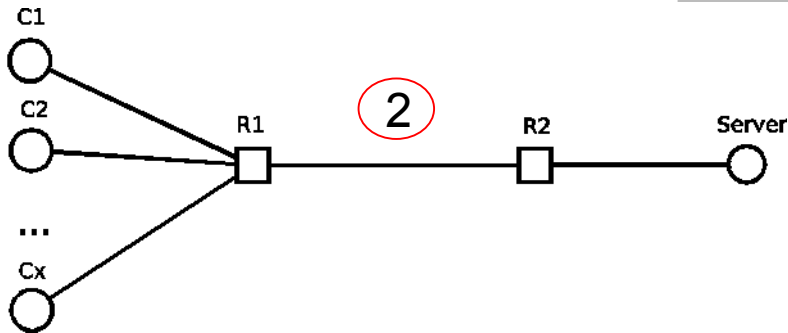
- TCP flavours aggregated CWND in multi-thread tests



# Methodology (I)



- ① Traffic sniffing
- ② NS-3 + DCE
- ③ Real deployment



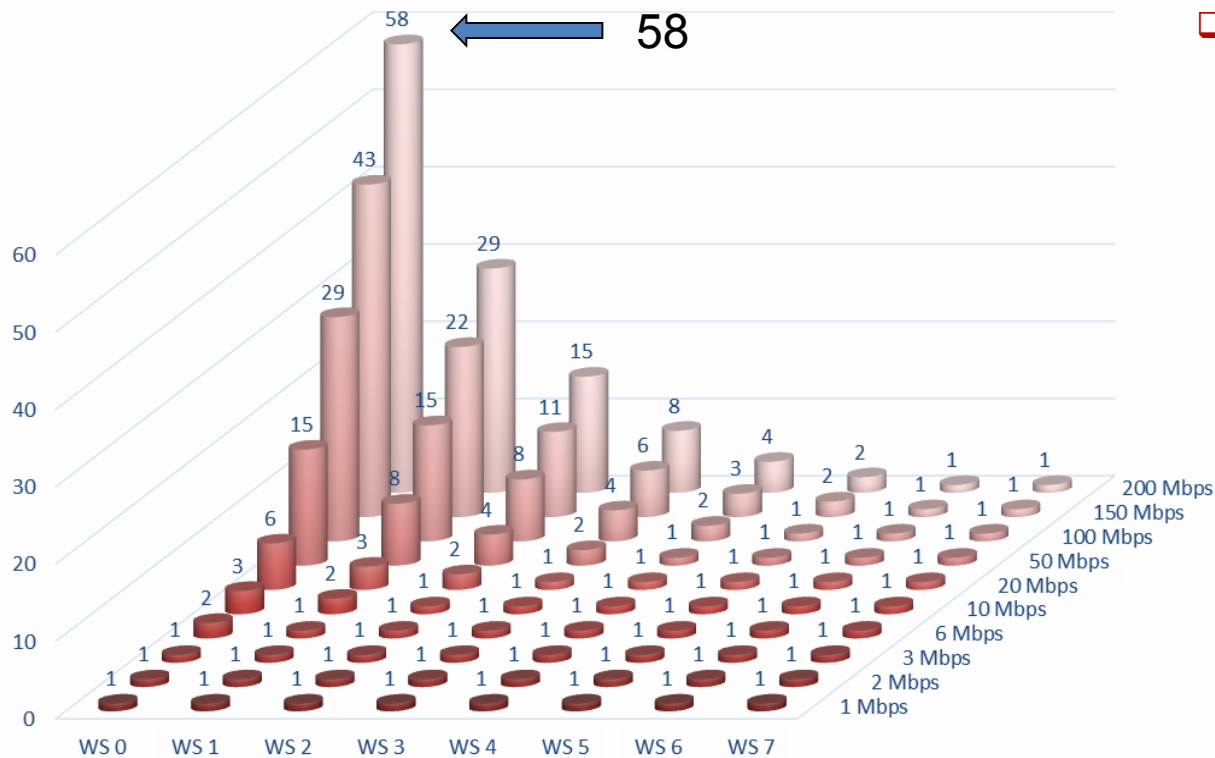
- 3 stages to define MEWS (Maximum effective window size) as a stop criteria in bulk capacity measurements, taking into account both fixed and dynamic TCP constraints



# Methodology (II)

- Stage ① - Window Scaling analysis (I) - Theory

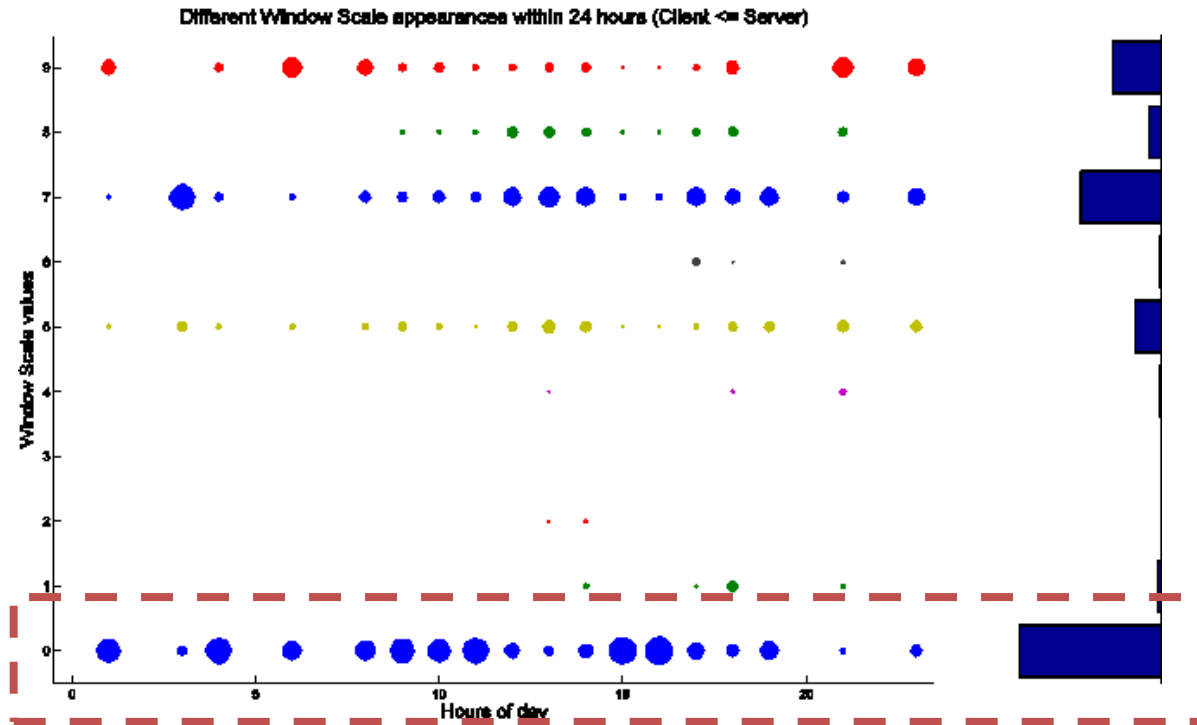
Number of concurrent TCP connections to achieve maximum goodput for different negotiated WS (RTT 150ms)



- The impact of non WS negotiation on parallel connection number to achieve certain BDP.

# Methodology (III)

- Stage ① - Window Scaling analysis (II) - Evidence



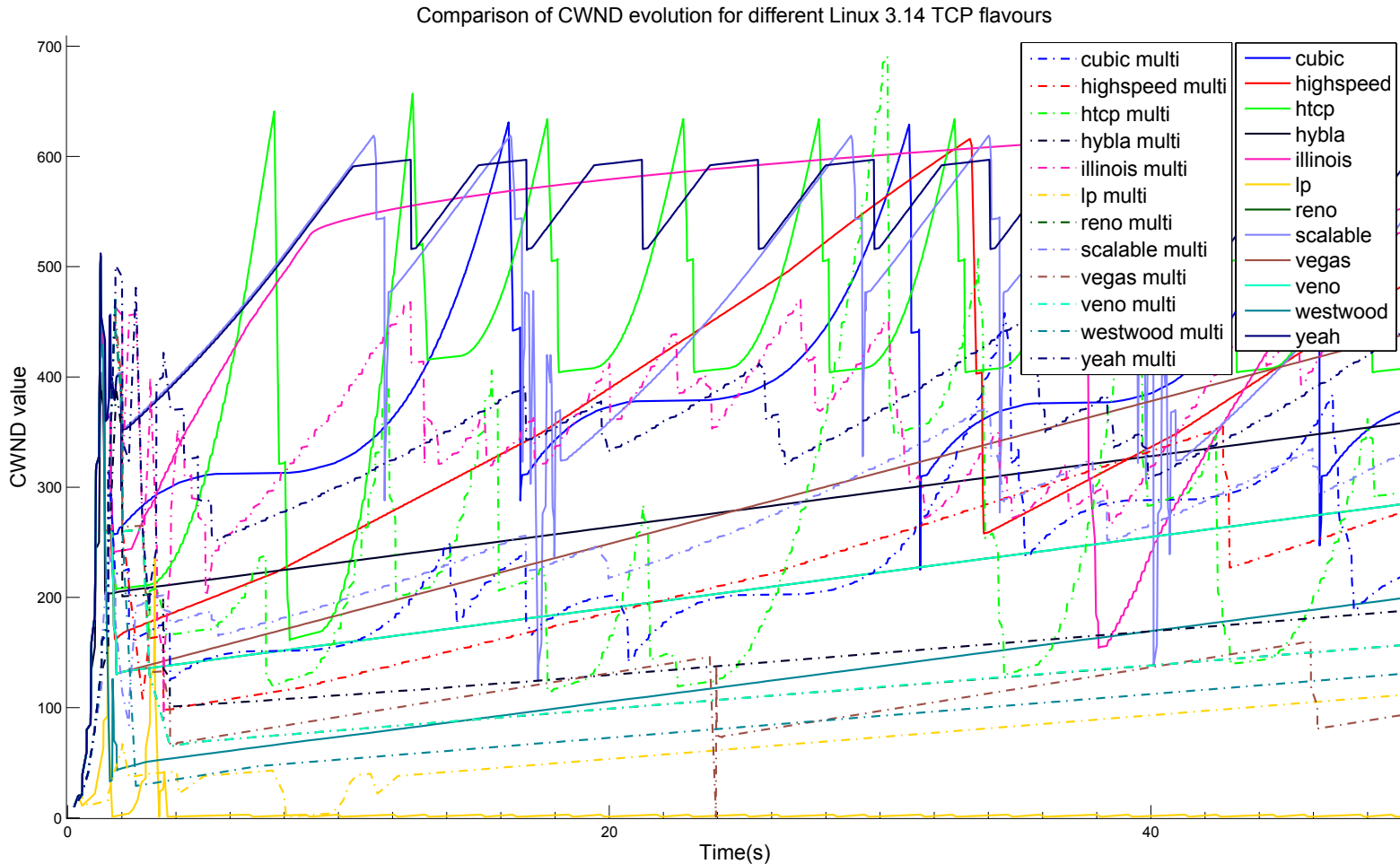
- Diverse buffer capacities due to equipment heterogeneity. Laptops, probes, smartphones, servers and so on.
- High percentage of WS=0, resulting in a maximum achievable capacity of 64KB in the receiving buffer.
- Essential assessment to ensure measurement reliability.

# Methodology (IV)

- Stage ① - Window Scaling analysis (III) – Conclusions
  - (Un)solvable constraints
    - ❖ Non-WS – Avoidable through multithreading. Sometimes unfeasible number of concurrent connections is needed.
    - ❖ Buffers – The maximum capacity of the buffer is a clear boundary. However, nowadays is strange to find a server with very limited receiving buffer.
    - ❖ High RTT – Only dodgeable lengthening measurement time.
  - Proposal
    - ❖ WS consideration - to help in connections number decision and to check whether this constraints has prevent users from achieving maximum available bandwidth.

# Methodology (V)

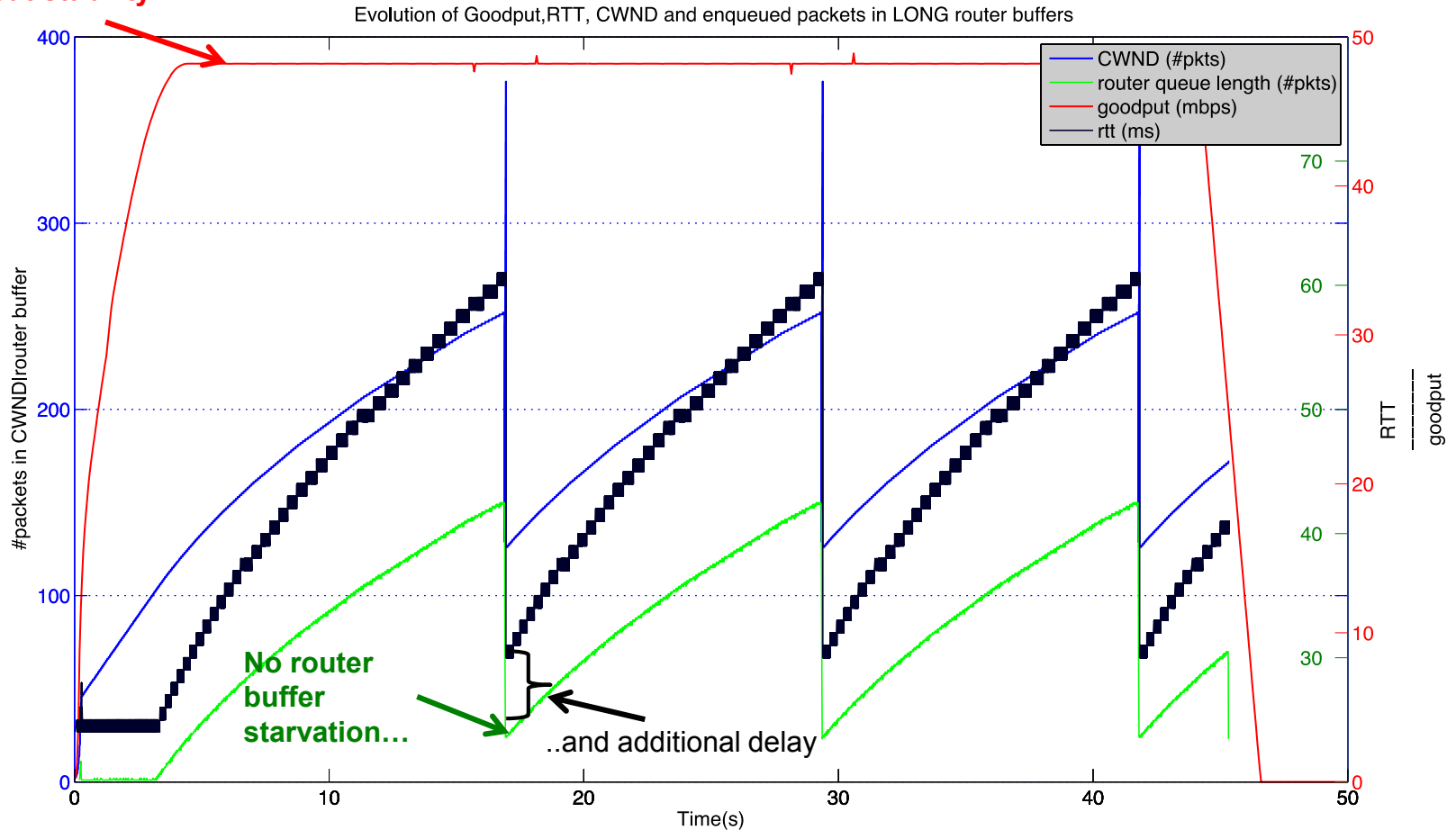
- Stage ② - Simulated/Emulated environment (I)



# Methodology (VI) Too long queues

- Stage ② - Simulated/Emulated environment (II)

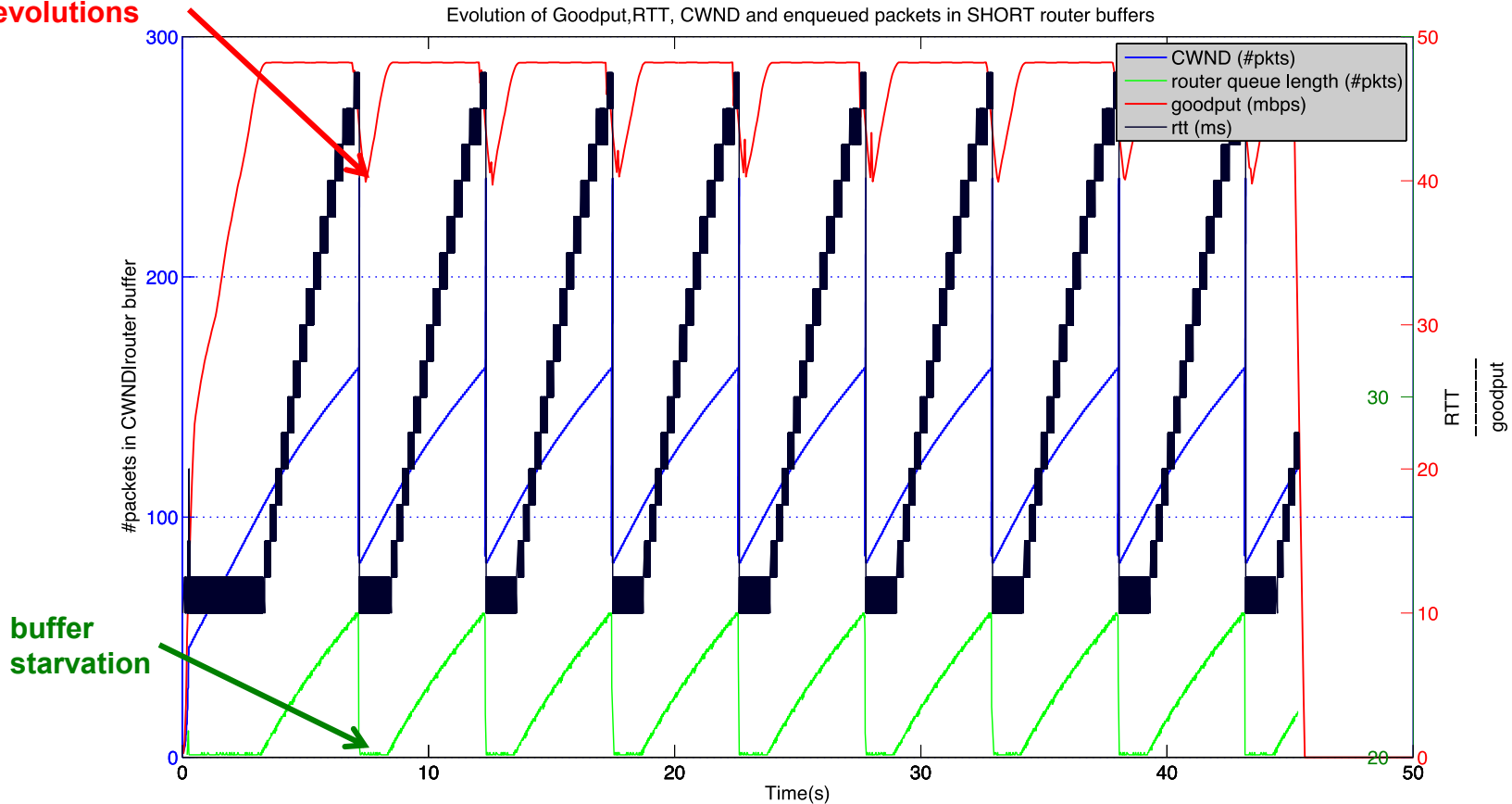
Goodput stability



# Methodology (VII)

- Stage ② - Simulated/Emulated environment (III)

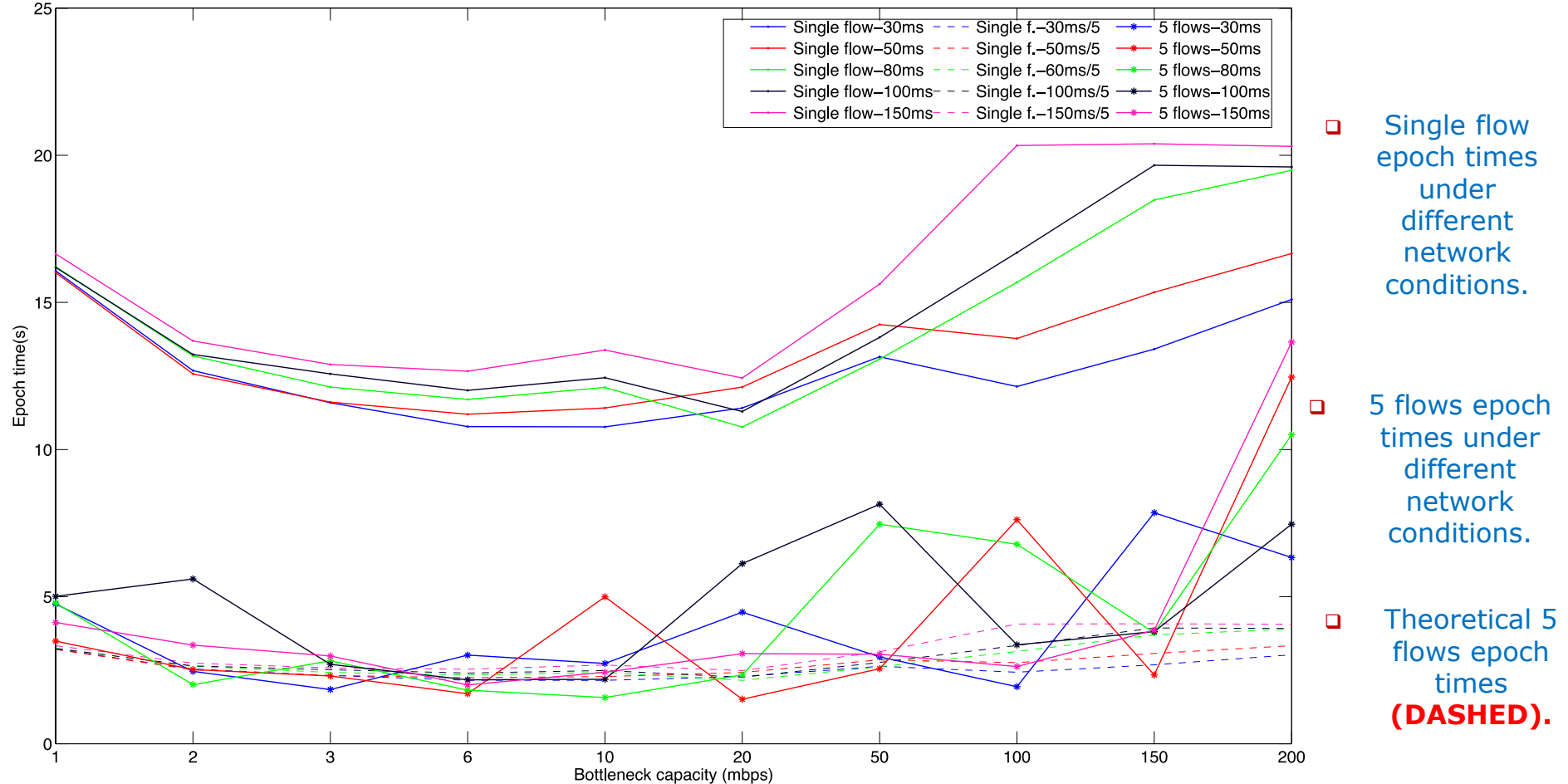
Goodput follows CWND evolutions



# Methodology (VIII)

- Stage ② - Simulated/Emulated environment (IV)

Comparison of Epoch Times (Cubic)



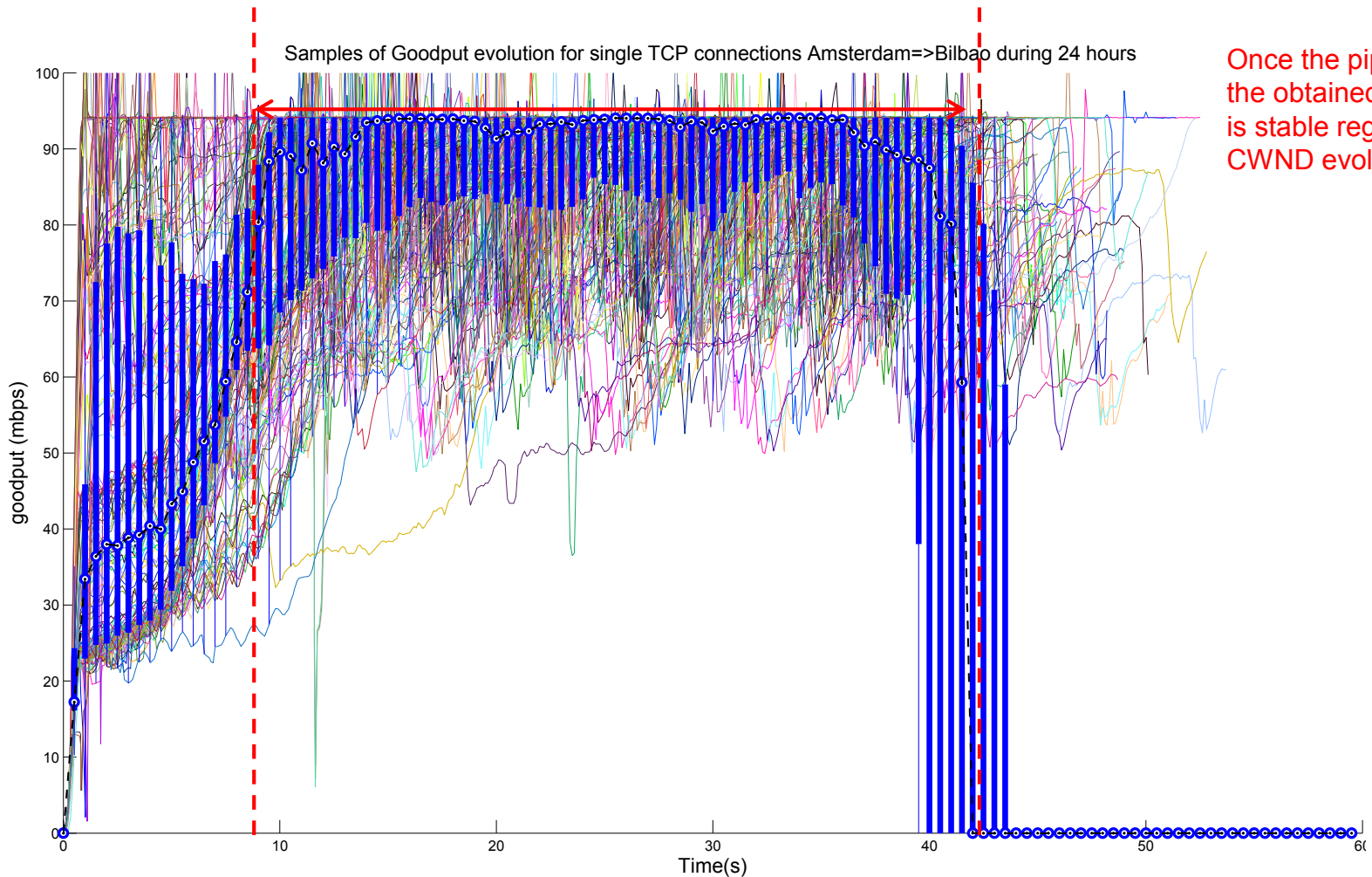
Single flow epoch times under different network conditions.

5 flows epoch times under different network conditions.

Theoretical 5 flows epoch times (DASHED).

# Methodology (IX)

- Stage ③ - Evidences in Real World traffic (I)

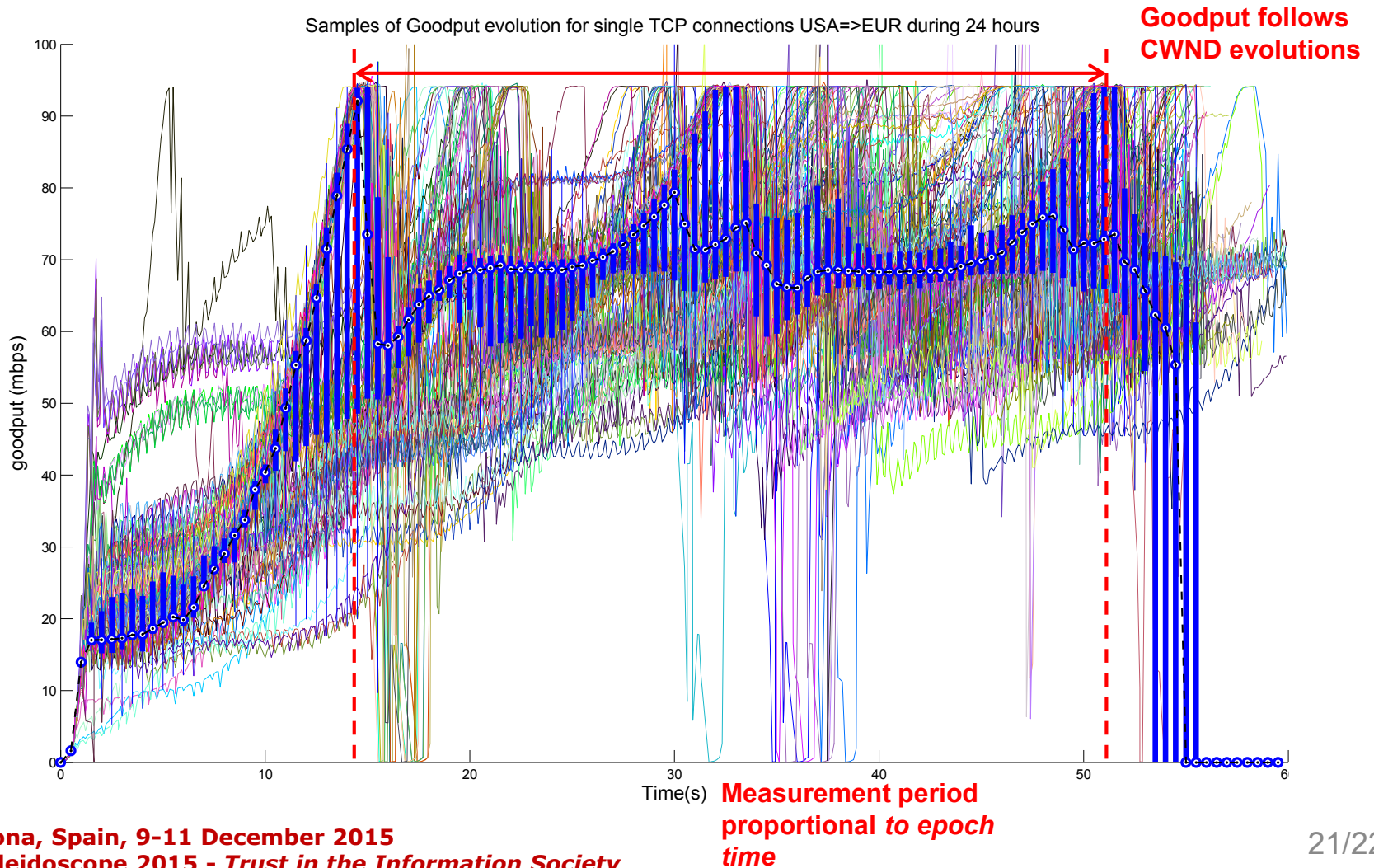


Once the pipe is full the obtained goodput is stable regardless CWND evolution.



# Methodology (X)

- Stage ③ - Evidences in Real World traffic (II)



# Conclusions

- Analysis of current status of *Speed* tests
- Analysis of technical problems
  - Fixed constraints
  - Dynamic constraints
  - Test requirements from users POV
- Tentative Conclusions
  - Multithreaded TCP connection test.
  - Warning upon suspicious tests.
  - Reasonable “epoch-time” related test duration
- Future work
  - Competing flows randomness
  - Wireless links variable capacity
  - Deep study of real deployments regarding different OS and web browser/mobile app.
  - Required signaling to remove as much as possible TCP flavour dependence.

# Q&A

