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SYNCHRONIZING CRITICAL OPERATIONS®

PTP and SyncE to improve broadcasting network infrastructure : conclusion of the B21C study

ITSF 2010

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Chief Scientist

B21C PROJECT

- Eureka / Celtic project: Broadcast for the 21st Century
- Propose broadcast standards and techniques in order to facilitate the deployment and early adoption of digital TV for all types of transfer medium:
  - Ground fixed enhanced: DVB – T2
  - Satellites for handheld terminals: DVB – SH
  - Ground for mobile terminals: DVB – H
- Theoretical studies, simulations, network definition, trials, standardization proposals
- 35 European partners: industrial companies, network operators, universities & research centers over 9 countries

On the air delivery synchronization issue

- Drivers for SFN extension:
  - Minimal use of spectrum for high definition services (HDTV)
  - Minimize echoes interference
  - Mobiles roaming without extra management

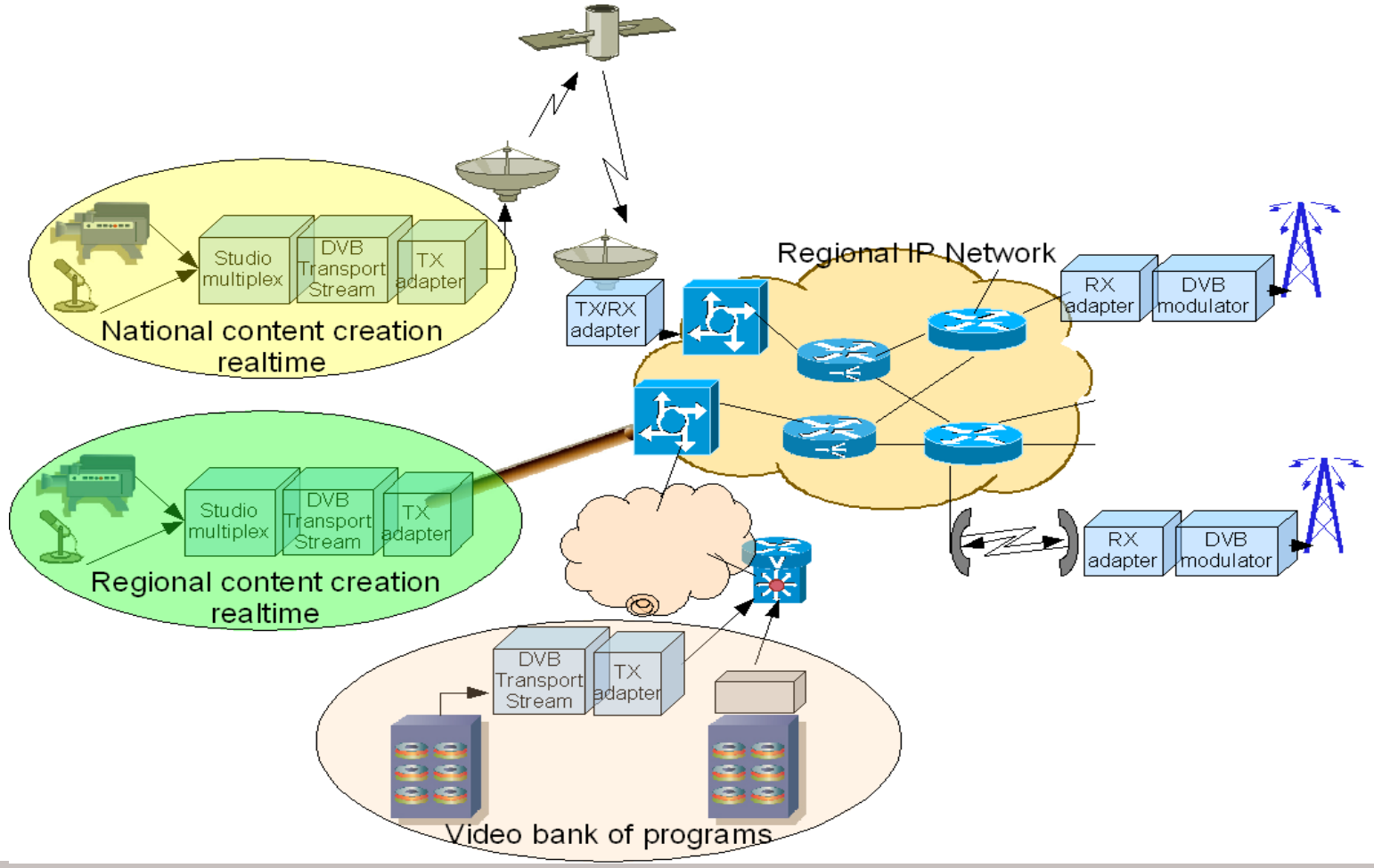
- Technical features:
  - CODFM modulation of radio emission and inter-channel cross talk avoidance require carriers accuracy **ΔF/F < 1.10-9**
  - Same content shall be delivered at the same time on the air from all the SFN area transmitters. The minimum synchronization accuracy is dependant of the coding scheme and the guard interval related to the coverage area.

Synchronization source shall be accurate to 1/10 the guard interval.
General agreement for **1µs** accuracy source

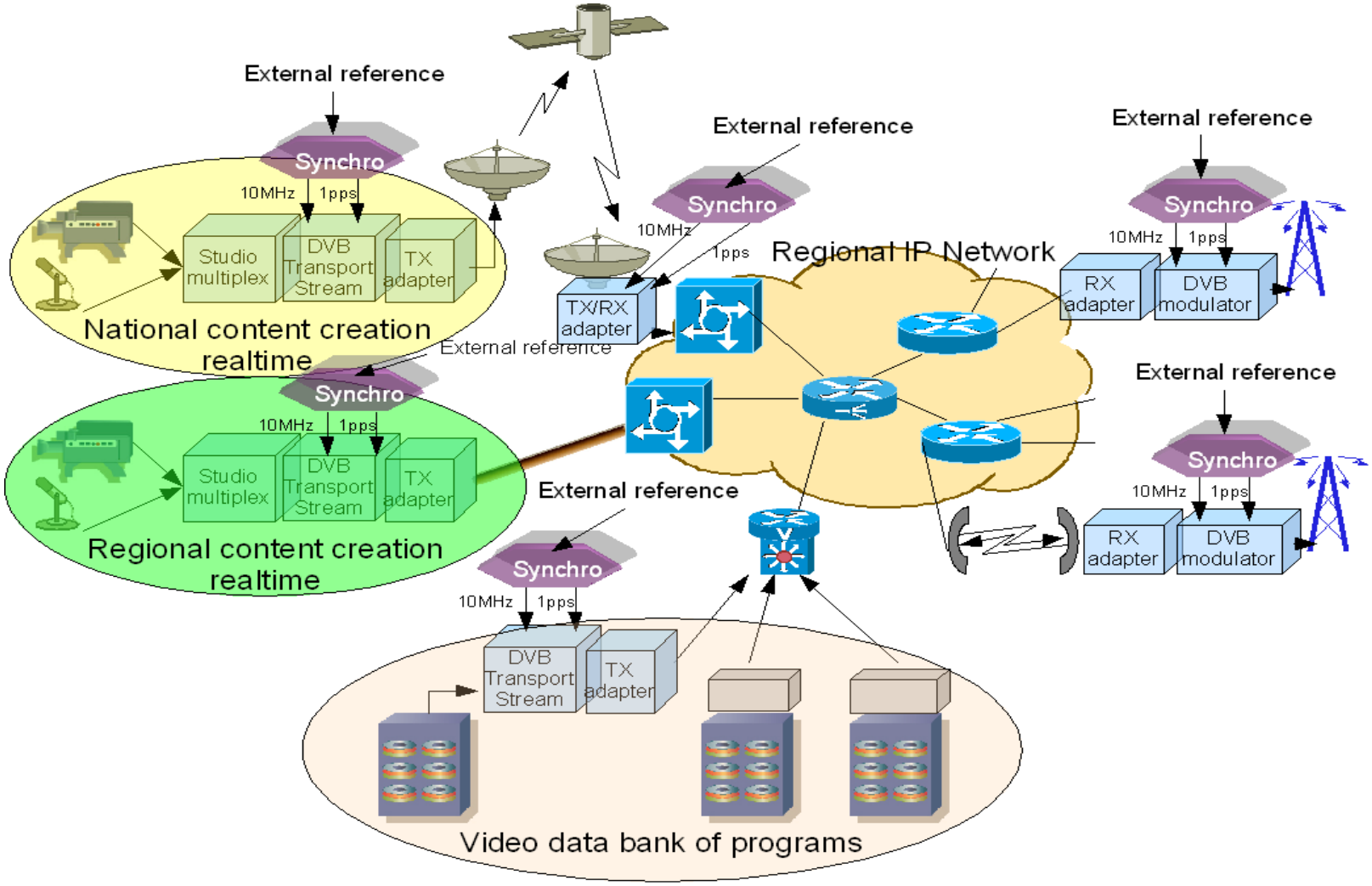
GI duration	Modulation
224 µs	8k 1/2
112 µs	8k 1/4
56 µs	8k 1/8
28 µs	8K 1/32

Video content dissemination to transmission sites

- Aggregation of multiple medias: heterogeneous media path



Synchronization spread over delivery network



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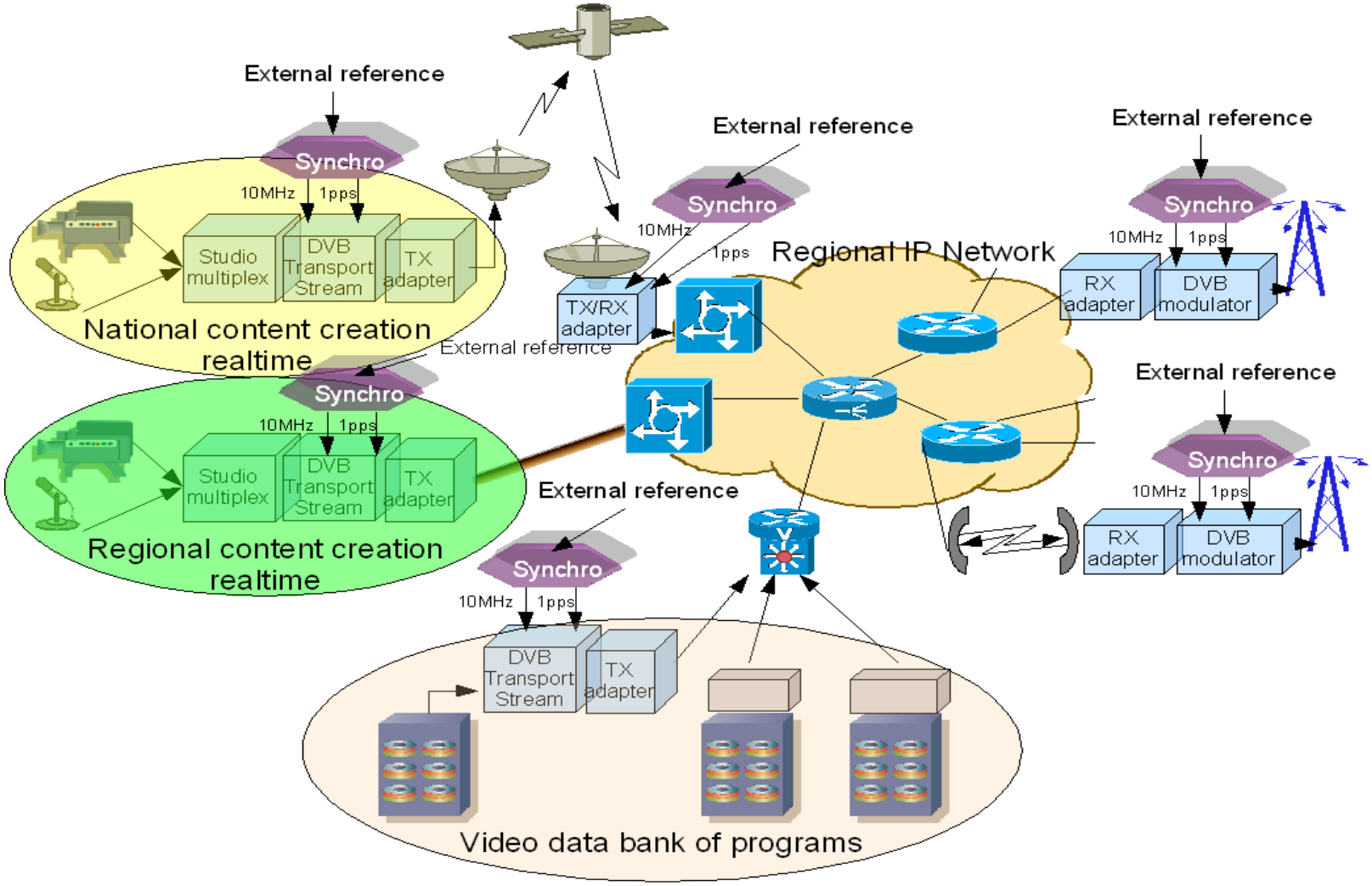
B21C Synchronization service improvement

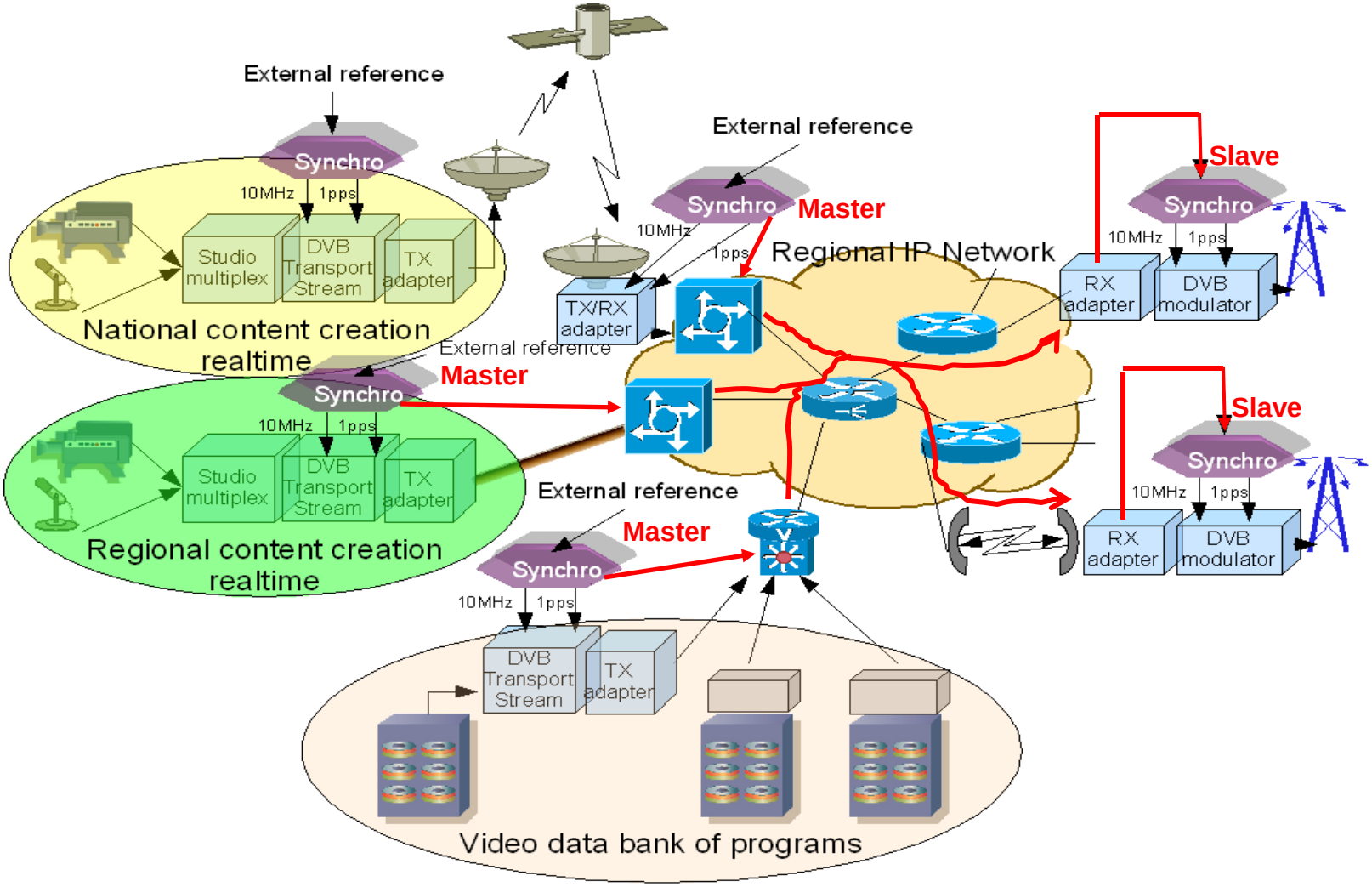
- Main targets:
  - Find alternate to GPS innovative synchronization solution to deliver Time & Frequency references to all transmission sites by using installed content delivery architectures
  - Optimize CAPEX & OPEX of synchronization service
  - Use standard technologies

- Technology selection: IEEE 1588v2
  - Benefit of video content encapsulation in IP packets extending from content creation to on the air broadcasting
  - Segment the path in homogeneous media segment

Current status: synchronization spread over



Mitigation: synchronization segmented and using the network



IEEE 1588 synchronization threat

- Specific video stream and heterogeneous network constraints

  - Path link bandwidth dispersion generate additional jitter.
  - Main traffic stream is standardized packets 1380 bytes.
  - Legacy Network Elements jitter shall be mitigated.
  - Path switch shall disrupt synchronization accuracy.
  - Dissymmetry of the concurrent data load shall be compensated.
  - Variation on traffic load shall produce non stationary path asymmetry that cannot be mitigated.

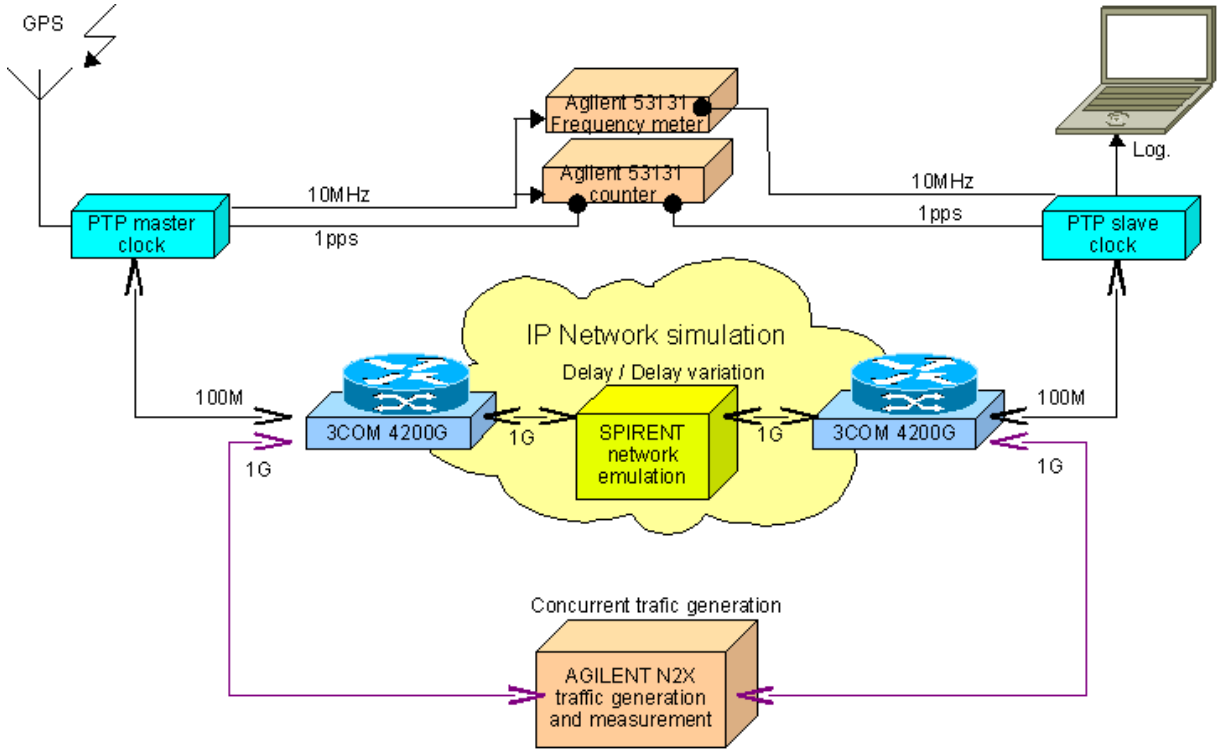
MAN synchronization characterization

- Regional area network characteristics:
  - Virtual Private LAN Services (VPLS) is used including MultiProtocol Label Switching (MPLS).
  - Specific low layer services shall not be mandate.
  - Quality of synchronization services in those network path are not generic compatible with IEEE1588v2 packets accurate transit (leased links).
  - To avoid packet queuing collision, operators are maintaining path load average < 50% of maximum bandwidth.

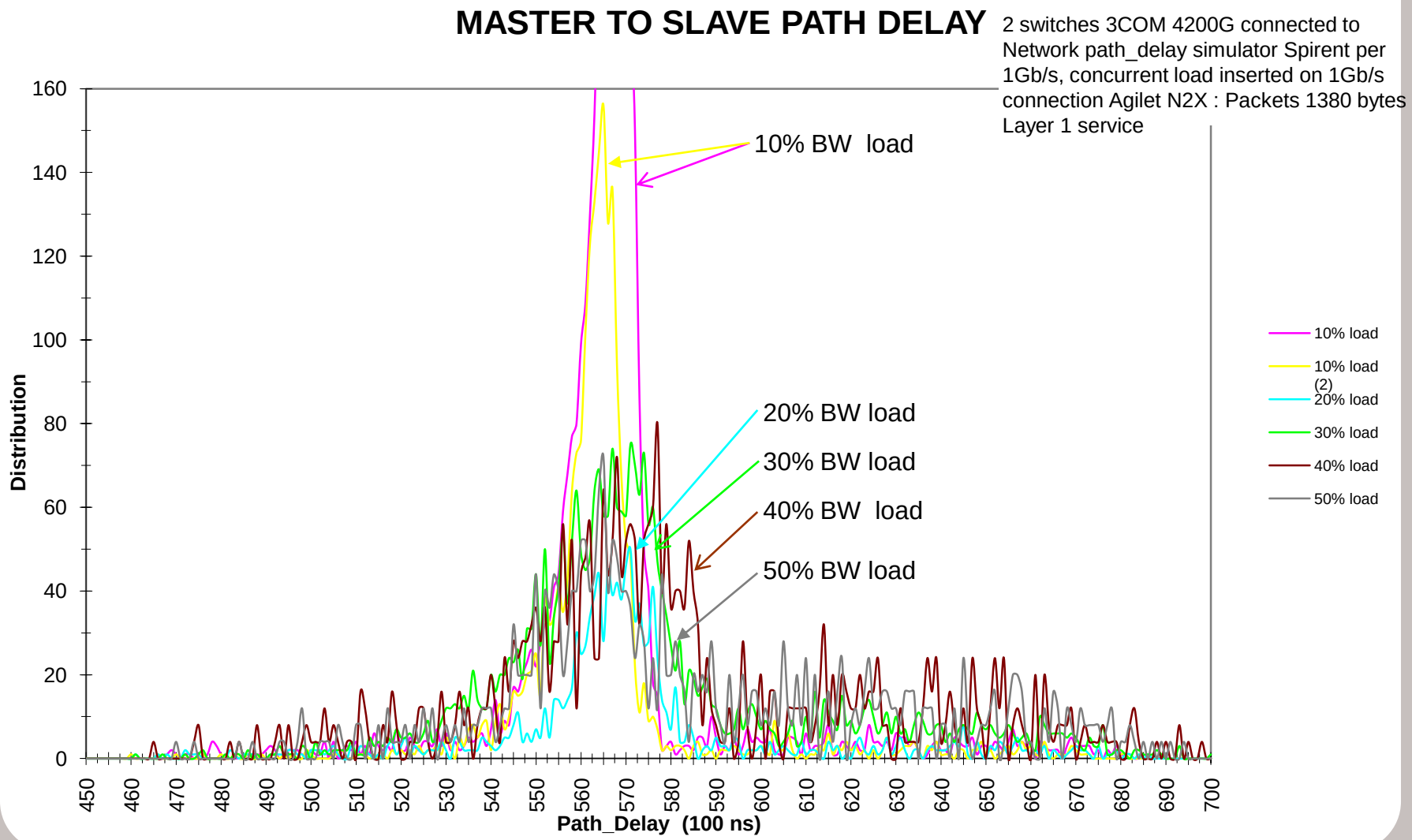
- Test with simulation of wired IP network
  - Simulated residence time and residence time variation equivalent to 4 switches.
  - Injection of traffic up to 50% of the total bandwidth.
  - Extraction of the master to slave single path delay.

MAN synchronization characterization

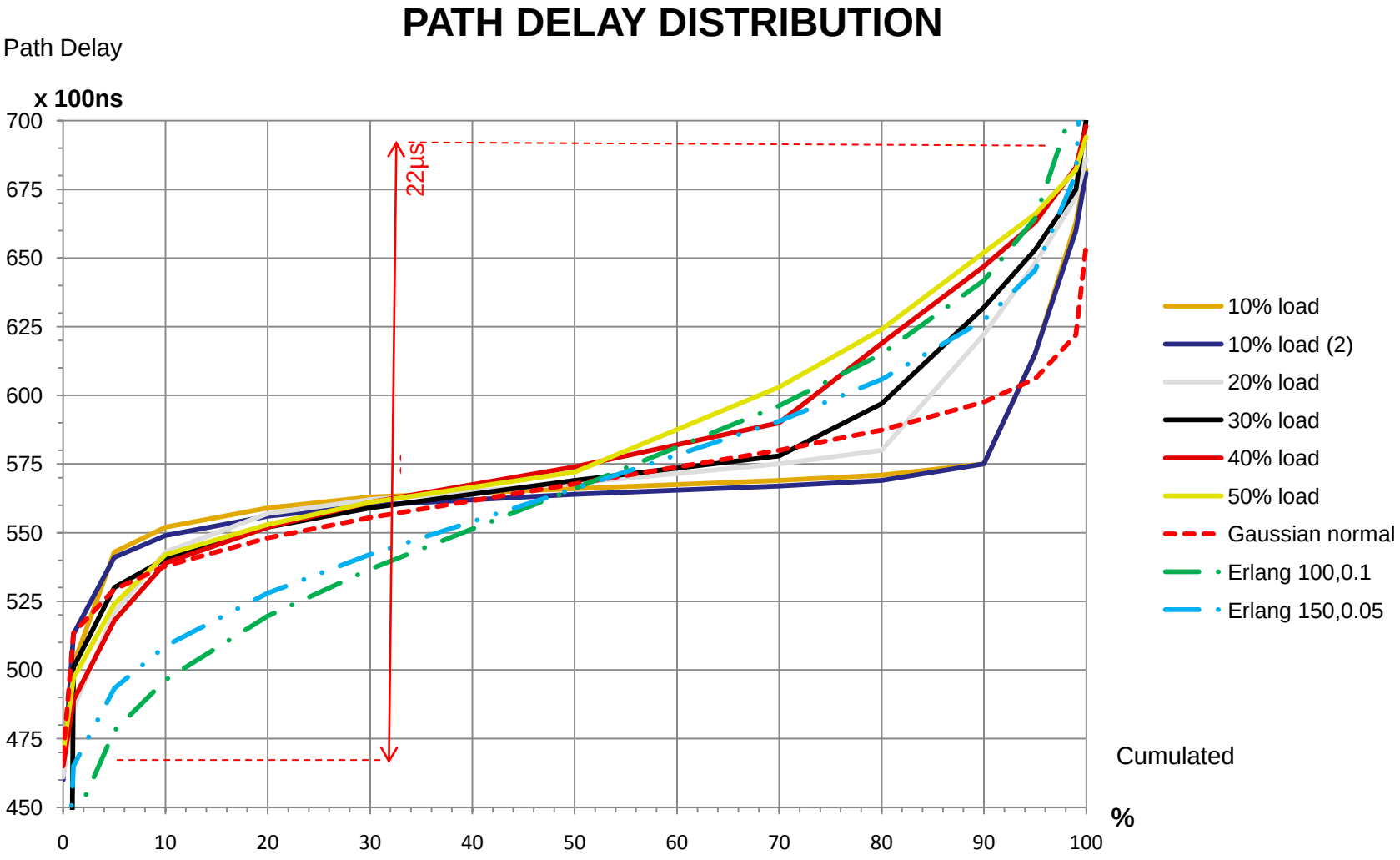
- Synoptic:



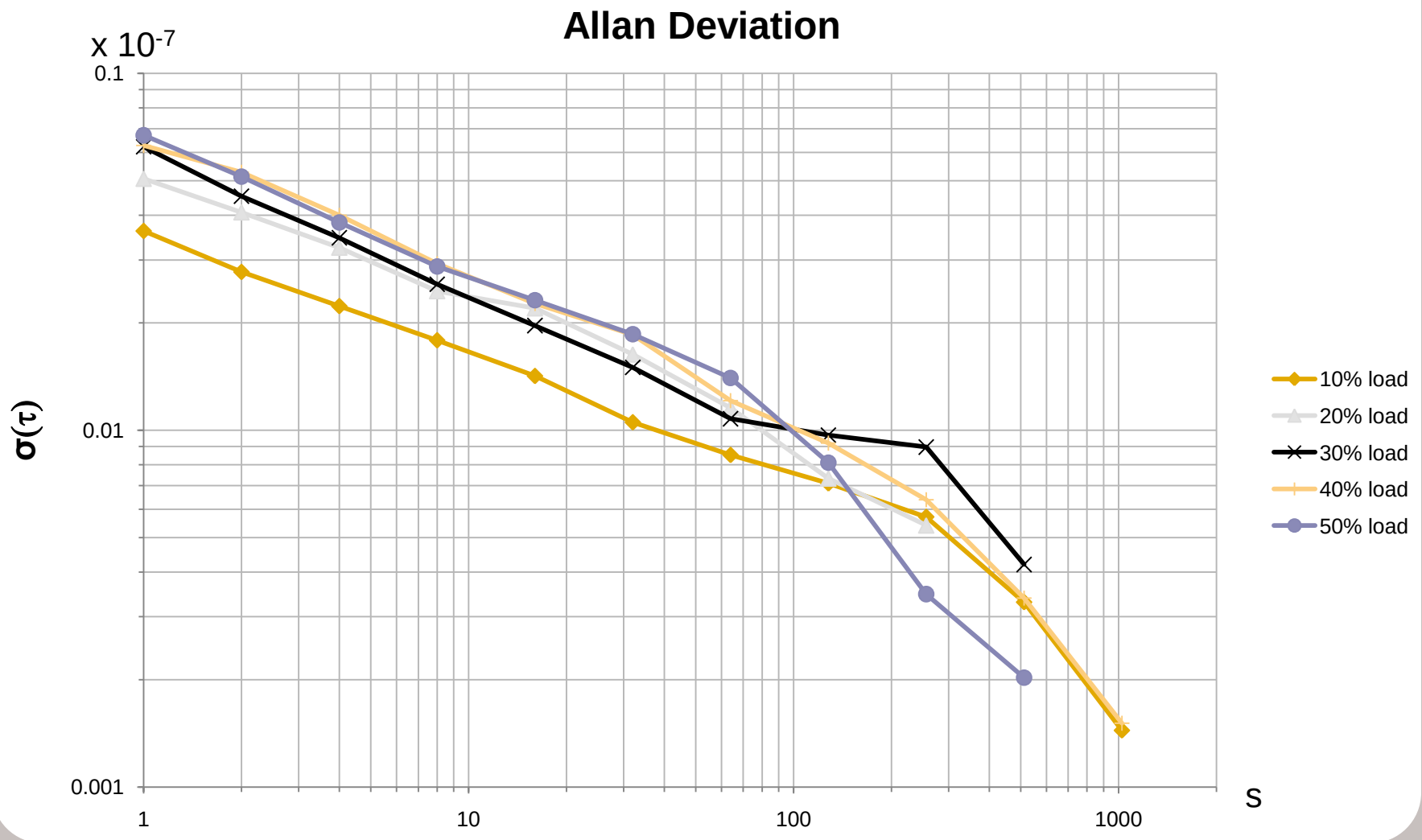
MAN synchronization vs load



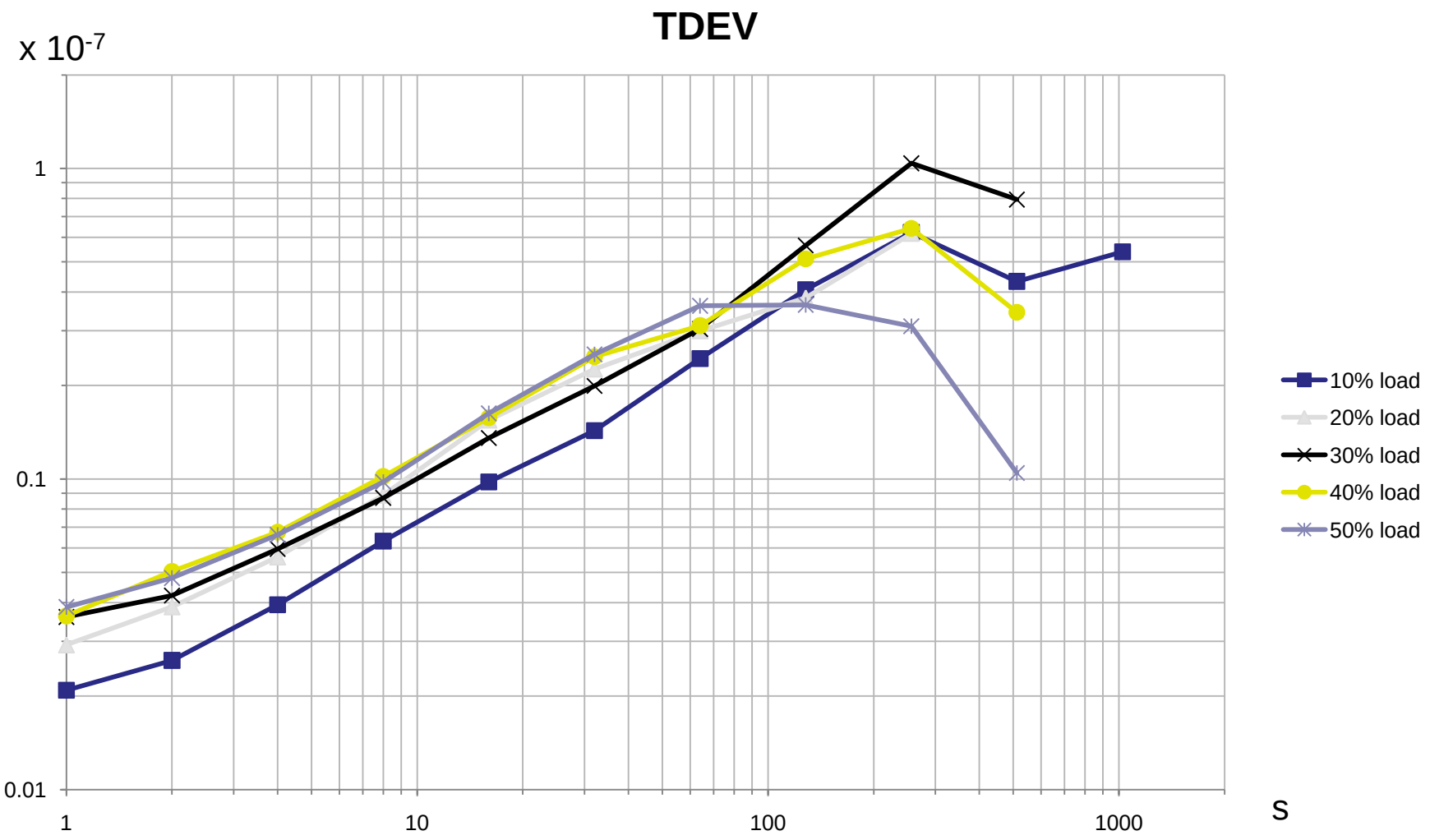
MAN synchronization statistics



MAN synchronization statistics



MAN synchronization statistics



MAN synchronization

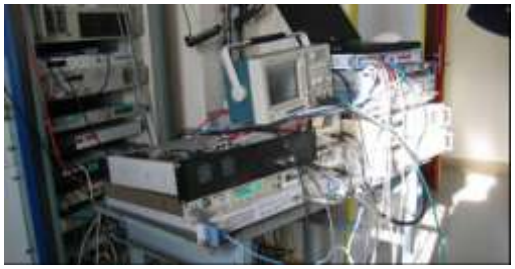
- Statistics conclusions:

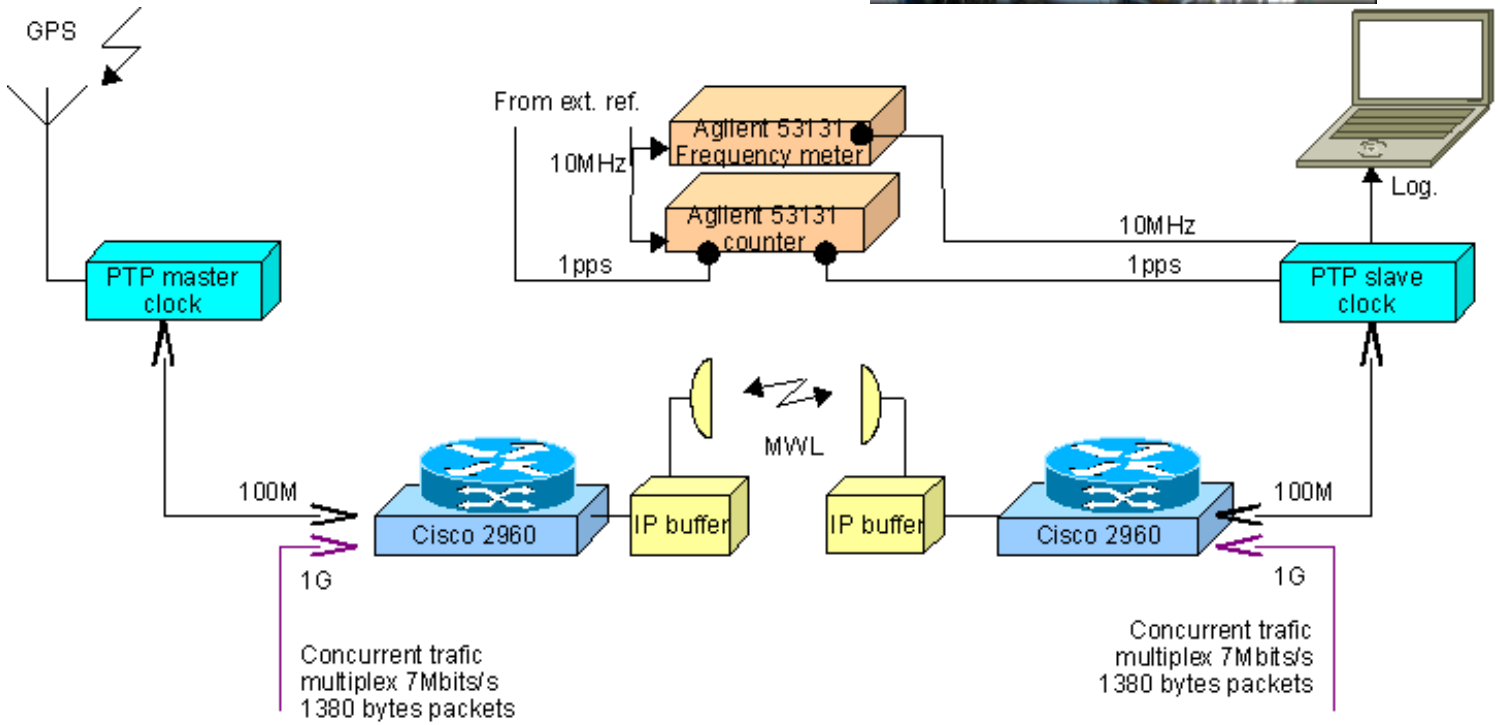
  - There is a minimum value.
  - There is a maximum value as soon as network is not over loaded.
  - Lower part of the statistics are Gaussian.
  - Higher part of the statistics are shifting from Gaussian to high order Erlang with increasing load on the path.

  - The use of 30 centiles measurement statistic leads to ≤ ± 1 µs variation for a fixed path.
  - This enable to converge quickly as confidence in such statistic does nor require many samples.

MWL synchronization characterization

- Synoptic:

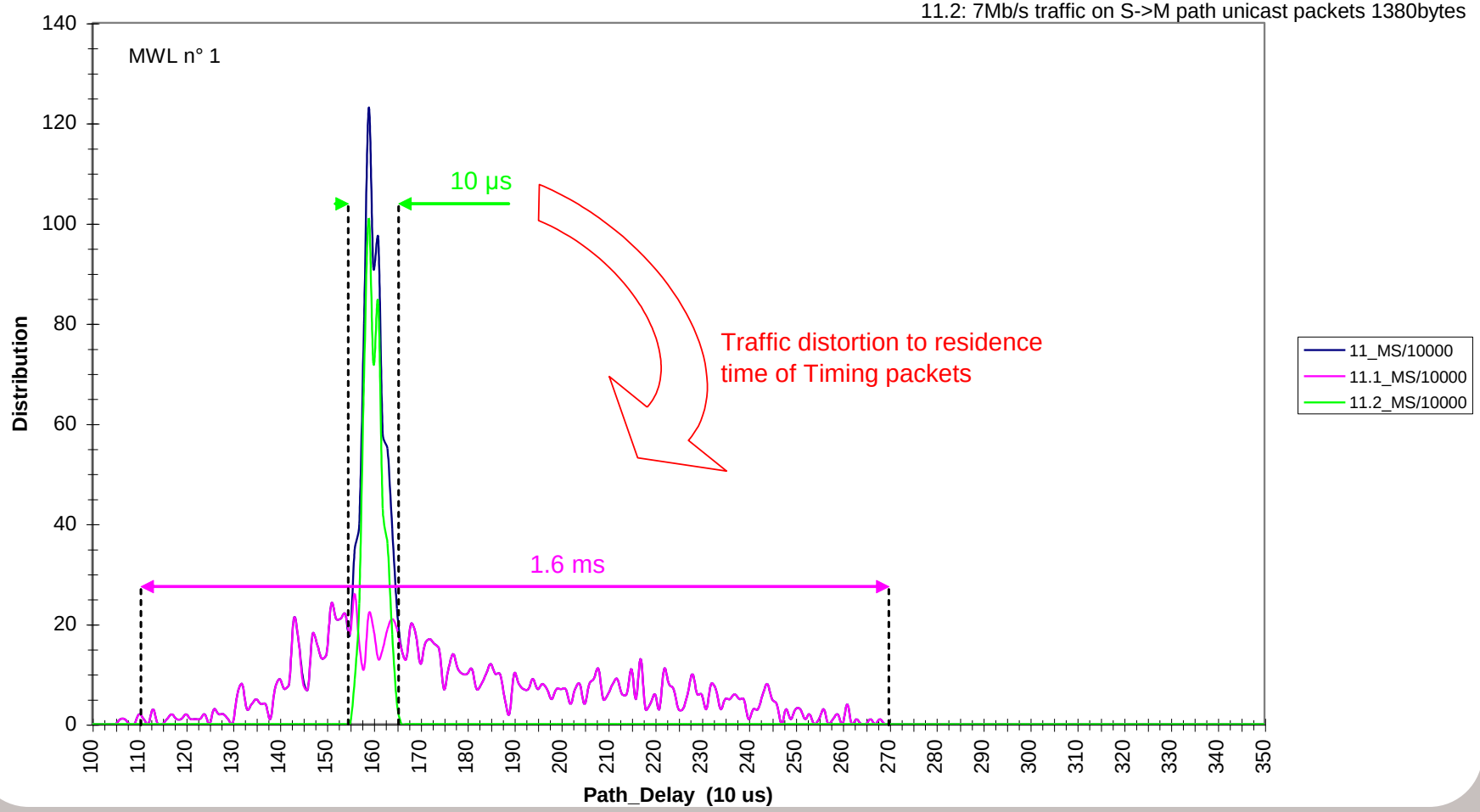




MWL synchronization characterization

Test 11: Master to Salve

MWL length 7km, BW= 34Mb/s ; 11: total
11.1: 7Mb/s traffic on both path unicast packets 1380bytes
traffic is different on each path (programm and simulated)
11.2: 7Mb/s traffic on S->M path unicast packets 1380bytes



MWL synchronization

- Statistics conclusions:

  - Bandwidth restriction in radio link introduce high jitter:
    packet 1380 bytes are 325 µs long in a 34Mb/s link.
  - Additive jitter is introduced within IP buffers that aggregate traffic.
  - No way to use without Layer 1 modification.

  - Switching between path will introduce high variation. Knowledge of route is mandatory for synchronization equipment.
  - Radio carrier synthonization with SyncE frequency may be of great help to synchronization performance.

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Network synchronization and timing transfer capabilities analysis

- Approach: Segmentation of the distribution network
- The synchronization traffic shall use the same path than content
  - Content delivery and synchronization service remains consistent, no separate disruptions to manage.
  - Enhanced availability and lower the monitoring cost on operation
- Some external common references shall remain to maintain network segments to be interoperable and avoid interference with other network implementations
- 2 main segments : Sub segments :

Long range transfer	Satellite link
	Optical WAN
Metropolitan area or regional transfer	Wired MAN
	MWL

Network synchronization transfer capabilities analysis

- Satellite links:
  - Not able to replace GPS and no threat.
- WAN ON:
  - Variation of minimum latency vs load ≤ ± 2 µs on a 2000km 9 hops path (load<50%).
  - Can replace GPS in limited span.
- MAN wired:
  - Variation of minimum latency vs load ≤ ± 1 µs on a 4 hops path (load<50%).
  - Alternate statistics 30 centiles and SyncE will help support quick recovery of path switching.
  - Can replace GPS.
- MWL:
  - Require layer 1 modification like radio synthonization, performances out of range on legacy equipments.
  - Not able to replace GPS without introduction of new technology.

- Thanks for support from:

CELTIC
Telecommunication Solutions

DVB
Digital Video Broadcasting

B21C

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Introducing the Pendulum STA-61 Sync Tester/Analyzer

- A synchronization test platform for Next Generation Networks (NGN)

- Test & Analyze Sync in various networks:
  - E1/T1/STM1 in SDH/SONET
  - 125 MHz clock in 1 GBps SyncE
  - 1-pps in PTP
  - PDV test & analysis (later availability)
- Modular multi-input measurements
  - 1 to 6 ch simultaneously
- Comparison with standard masks
- Accurate
  - High-stability Rubidium reference
  - GPS-disciplining option
  - Battery backup option
- Portable
- Easy-to-Use
- Large color LCD screen

Thanks for attending.

Questions ?