Session 4

Sync Testing etc….

ITSF06
Prague
Nov 06

The Need for Immunity, Transfer and Availability Standards

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This Presentation

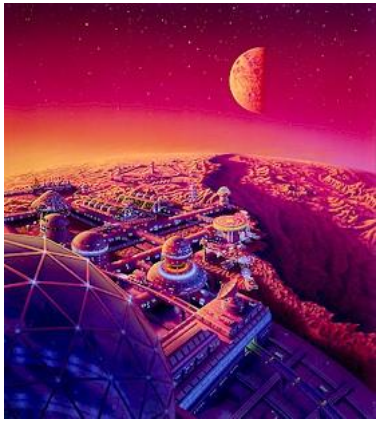
- Background & Introduction
- Why do we need Testing & Availability Standards?
- Immunity, Transfer and Availability
- Case Studies
- Future Activity
- Conclusions

Background

- The “Telecom World” as we know it is changing
  - The Net-Heads have won!
  - Next Generation Networks are here
  - Revenge of the Bell-heads!
    - G.8261 (G.pactiming) is now consented
    - A digital revolution is underway
- This Means….
  - We used to be concerned about bit-rate timing
    - Many current applications still are!
  - We must now concern ourselves with the synchronicity of packets
    - Preserve QoS in certain types of application
    - e.g. VoIP, IPTV, Streaming Video, mapping of bit rate into RF stability
- But there’s a “Black Hole”
  - No testing Standards with respect to “Time” and “Timing”
  - No “Availability” Standards
  - This is “Déjà vu” for those who have worked through the PDH/SDH_SONET transition

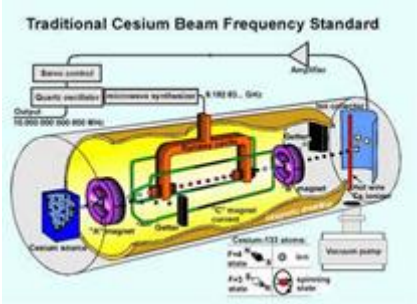
Sync Transport over the Ages

- The Past - T1/E1 at 1.544/2.048 Mbps
  - Timing signal is recovered from the bit rate
    - Susceptible to phase perturbations in the traffic feed
    - Many applications take timing from the traffic feed
- The Present - SONET/SDH via OCS/STM Overhead
  - Delivers a stable analog timing signal traceable to something…..
    - Hopefully your PRC!
    - Legacy pre ’95 T1/E1 timed applications susceptible to Pointers
      - Some designers have tried to immunize application
- The Future – NGN via Ethernet cloud
  - In band? – using clever two way time transfer correction algorithms
  - Overhead? – G.8261 - G-Pactiming
    - What chance legacy applications?
    - They still take timing off T1/E1 leased lines

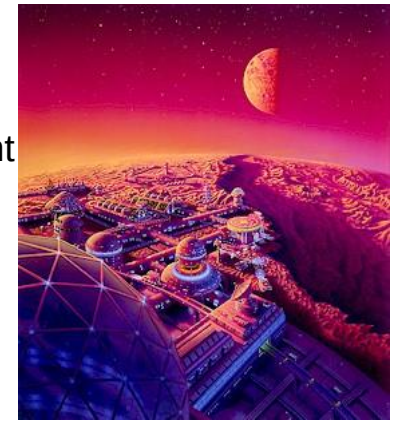


The Changing Priorities of Sync

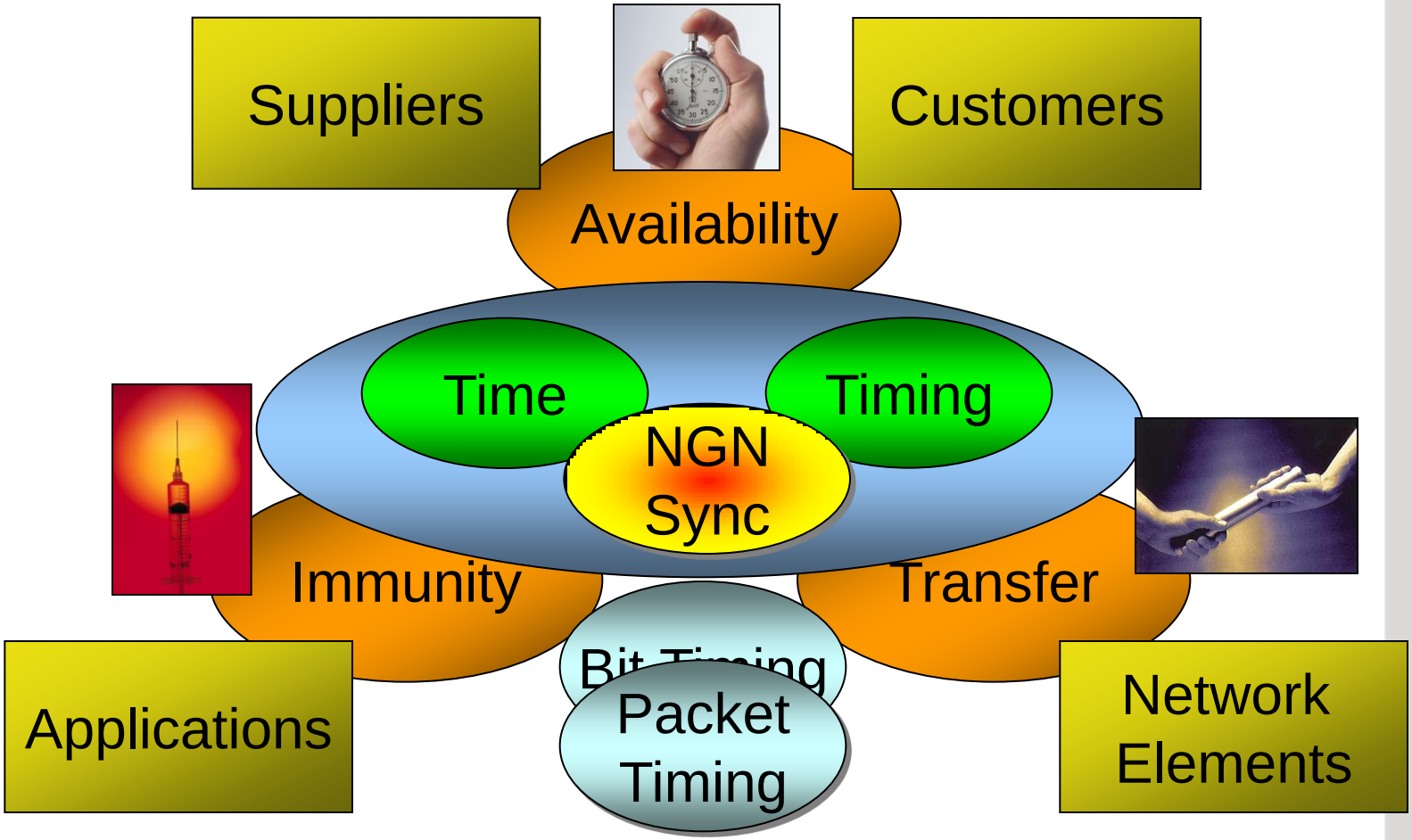
- Our SyncWorld used to be all about…
  - Stability from Cs
  - **Core** Network Architecture
  - Careful Network Planning
  - Design to Standards
  - 95% Bit Rate Timing with a little bit of NTP
  - Well ordered, stable, predictable



- Now….
  - Many new applications at the edge
    - Location, Wireless, Broadband, Triple Play
    - IPTV, TDTV, VoIP, TDD, LTE, Femtocells
  - Service Level Agreements on such esoteric aspects as Time Stamping, 1 µsec relativity to UTC!
  - Packet Rate Timing, Packet Delay Variation?
  - Sync from GNSS – Dual GPS/Galileo chip sets in 2 years?
  - Planning becomes irrelevant, but jamming becomes prevalent
  - A chaotic SyncWorld, unpredictable traceability
- In the Future – our SyncWorld will be defined by….
  - Interworking with legacy applications
  - The ability of applications to survive in this brave new world
  - Network Elements that transport “Time and Timing”
  - **Immunity, Transfer and Availability**

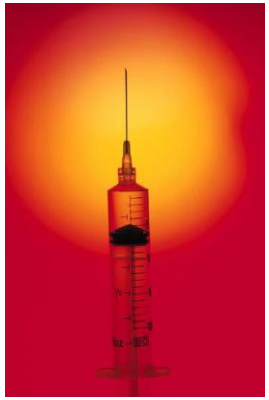


Sync - The Eternal Triangle!



Wander/PDV Immunity

- Immunity is the tolerance of an application to wander or packet delay variation (pdv)
  - What wander/pdv degrades it? (Susceptibility)
  - What wander/pdv has it been designed to tolerate?
  - What is it's actual wander/pdv immunity threshold?
  - What wander/pdv breaks my application?
  - Can it survive catastrophic sync failure?
    - Remember the SONET/SDH Pointer experience
  - What Wander/PDV Immunity Standards exist?



Wander Transfer

- Wander Transfer is a measure of the ability of an element or network route to pass wander which is…
  - Fit for Purpose
  - Does it attenuate or amplify wander?
- Testing would assess the suitability of an element or traffic transport process for use in a network for a particular application
  - E1 circuit emulation products
  - Two Way time transfer algorithms
  - Routing and switching elements
- Parameters to explore
  - Ability of edge products to attenuate wander/pdv
  - Ability of network products to transmit “fit-for-purpose” sync
  - Impact of network congestion
  - Impact of asymmetrical network paths
  - Use of buffers (extra delay), (wander amplification)
- What Wander Transfer Standards exist?

Network Availability

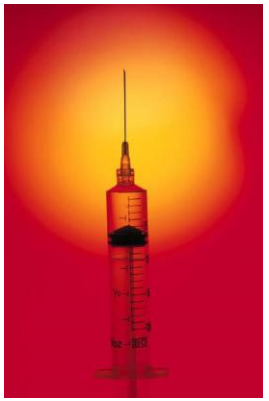
- Availability (with respect to sync)
  - Assume that we define the wander immunity threshold for an application
    - For how long must it be available?
    - At what quality?
    - We must monitor 24x7!
    - Are we allowed periods of degradation?
      - VoIP drop-outs (Norman Collier effect)
      - IPTV freeze frame
    - For how long can we allow degraded operation
      - Clearly application dependent
      - So we must test the application susceptibility
    - Is complete application failure acceptable?
      - Can't make a voice call
      - Can't collect emails
      - TV transmission fails
      - Emergency services comms failure
  - What Sync Availability Standards exist?

Wander Immunity & Transfer

- We are familiar with NEBS/CE Mark testing – elements of which can include
  - Radiated and conducted emissions
  - Susceptibility/Immunity to interference
- So why not Wander Immunity testing?
  - Imagine a Standard like the CE mark family
  - Radiated/Conducted Emissions maps into Wander Transfer
  - Susceptibility/Immunity maps into Wander Immunity

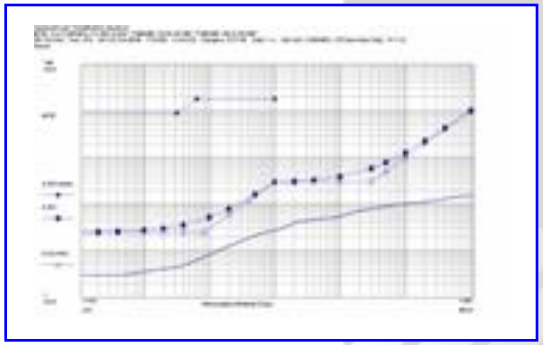
The Immunity Challenge

- Let's define what we will test
  - T1/E1 connected products
  - Where they look to the connection port for sync
  - Applications where time and timing is important
  - Assess the timing recovery technique within the application. PLL, NCO, TWTT
- Define a Test Process
  - What parameter shall we vary?
    - MTIE – Maximum Time Interval Error
    - Time is the 4th dimension - a fundamental parameter
    - Susceptibility to the rate of change of time is a key application differentiator
  - What equipment shall we use?
    - We must vary the rate of change of time
    - Some sort of wander generator
    - More ideas later…..

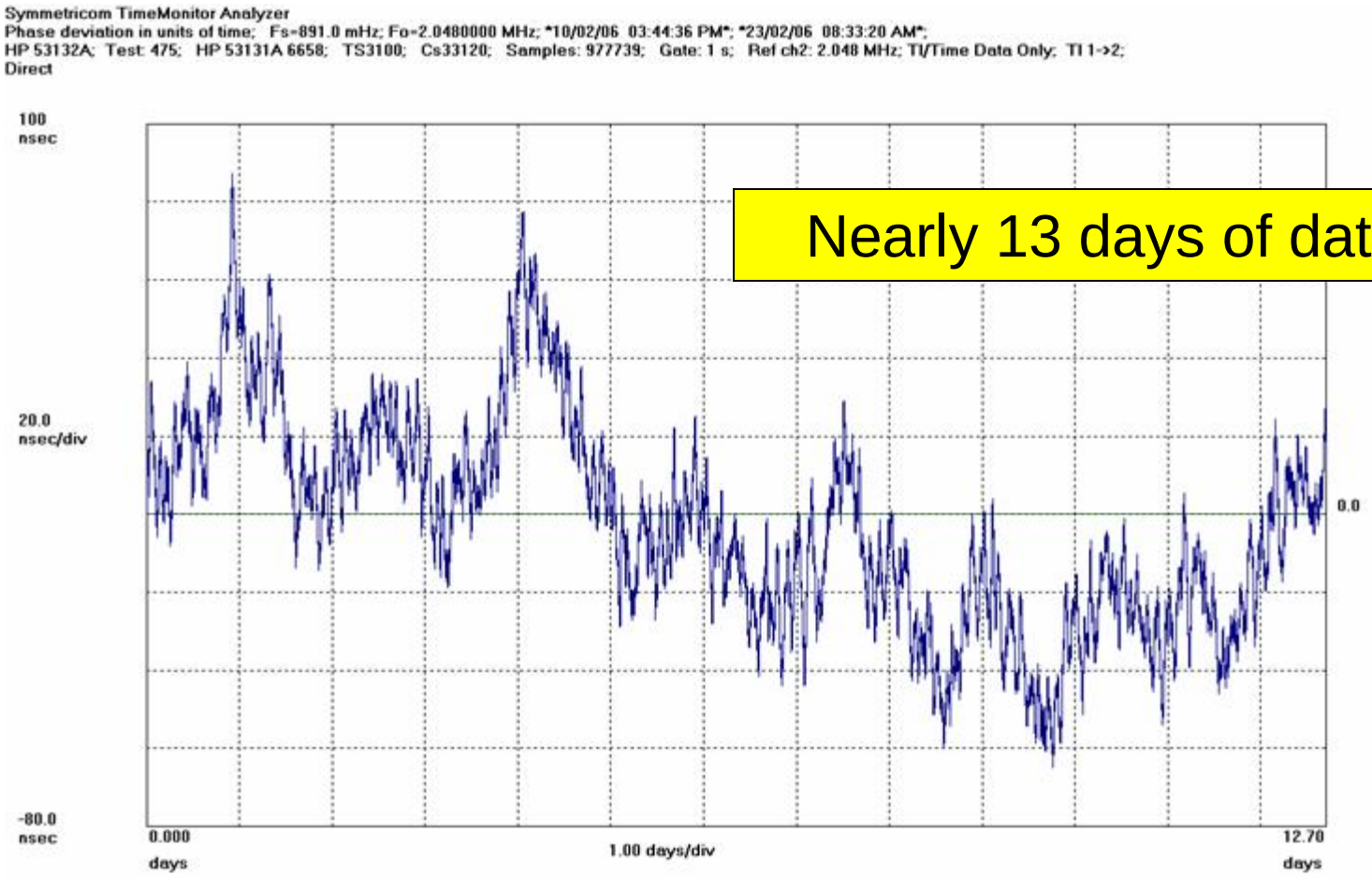


MTIE - Refresher

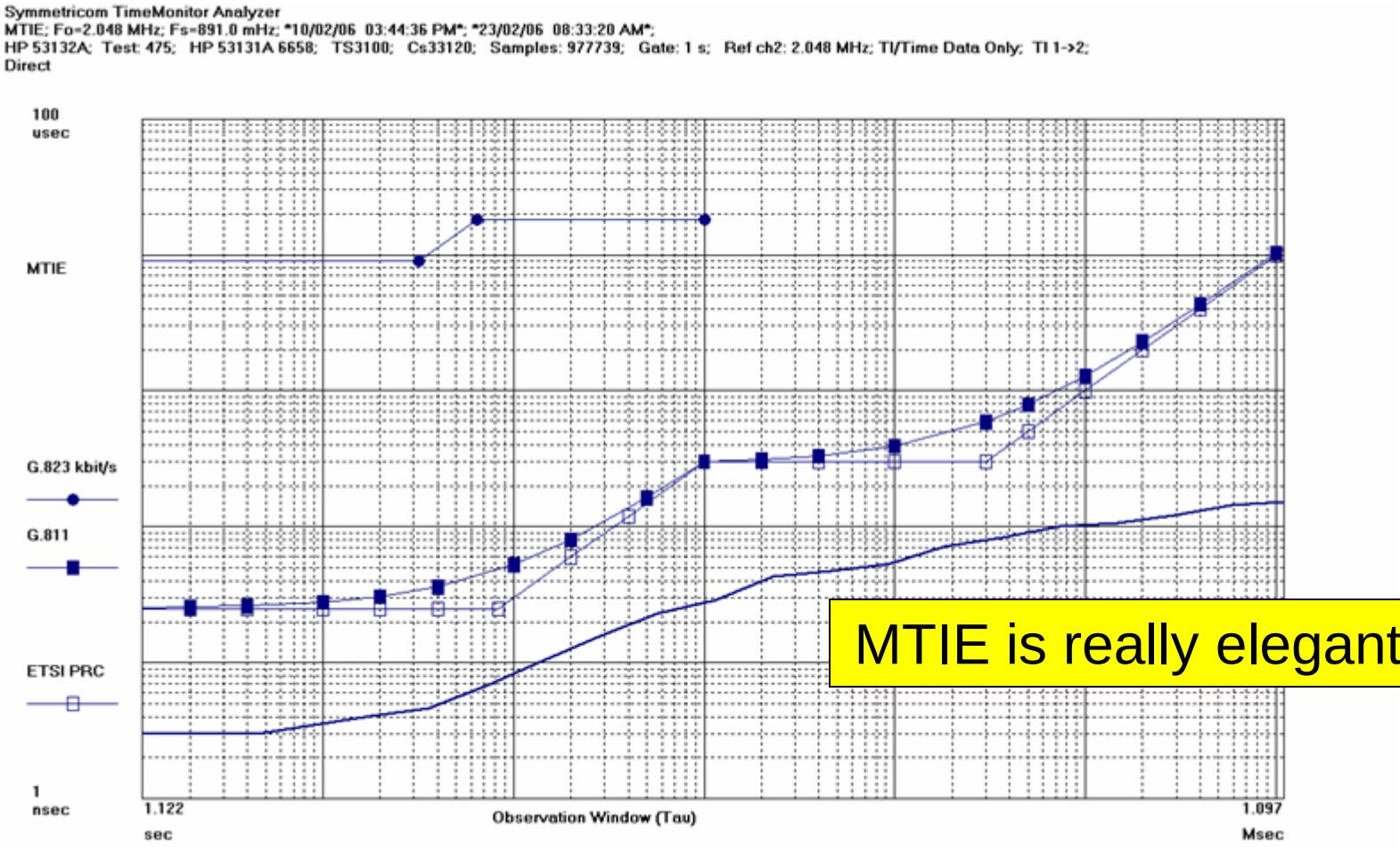
- MTIE – Maximum Time Interval Error
  - The maximum phase error (wander) in a given observation window or interval
  - The bigger the observation interval the larger the error
- Positives…
  - Extremely elegant metric
    - Compress a million data points into a simple 12 point graph!
    - A day of data in one small picture
    - 10 days of data into the same picture (if you want)
    - Instant characterisation and go/no-go
    - Comparison with many ETSI/ITU/ANSI Standards masks
- Negatives…
  - Cumbersome and long winded testing process
    - Expensive specialist test equipment
    - **Like watching paint dry**!



MTIE Reduces this



To this…

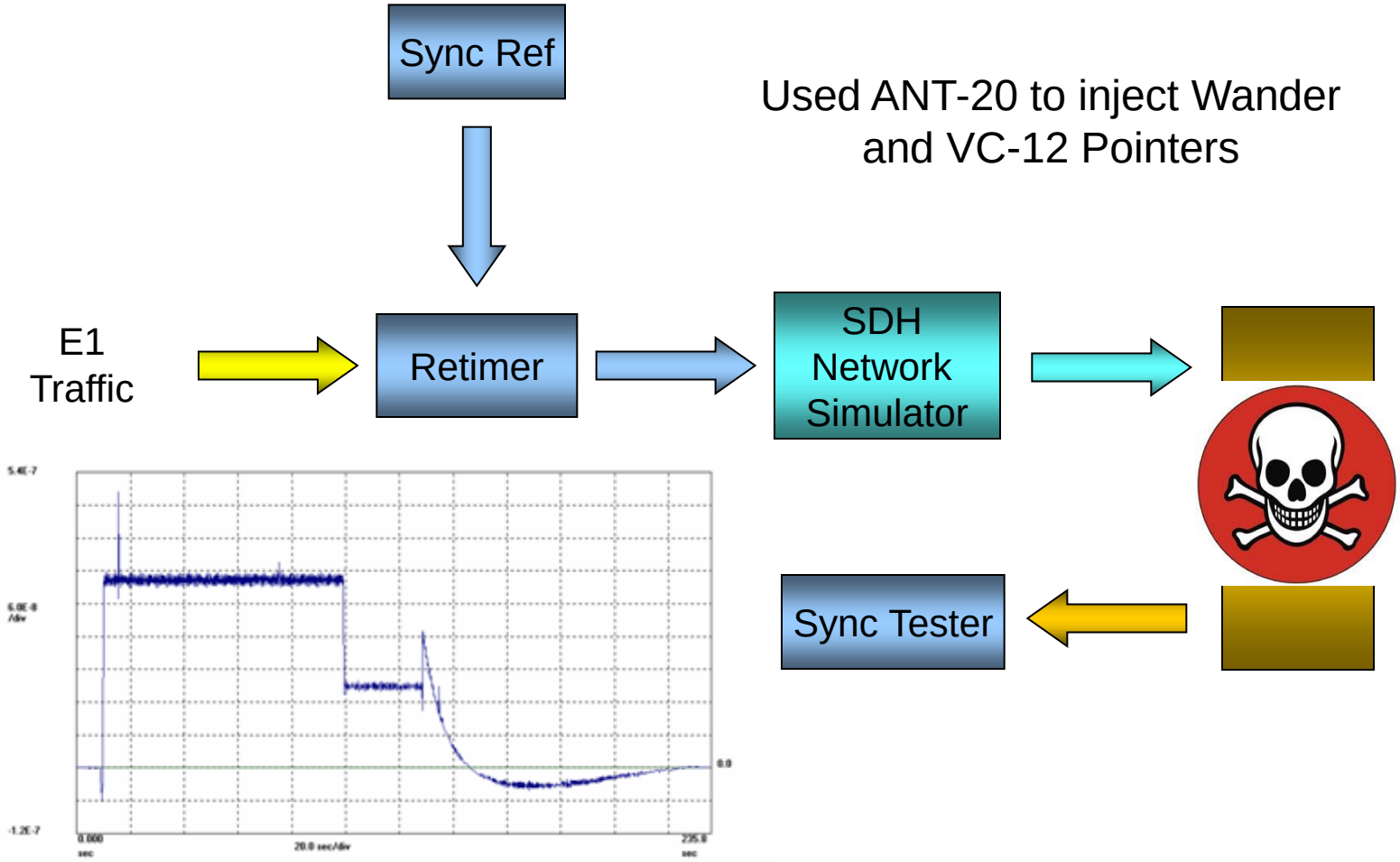


MTIE is really elegant!

Actual Project – Wander Immunity

- GSM Base Station
  - Problem
    - Catastrophic field failures of GSM base stations
    - Some base stations seemed more susceptible than others
  - Commission
    - Find out what is causing the problem
  - Strategy
    - Inject different types of wander or phase perturbations into the E1 input of Base Station
    - Monitor the E1 return path
  - Deliverable
    - Report and recommendations

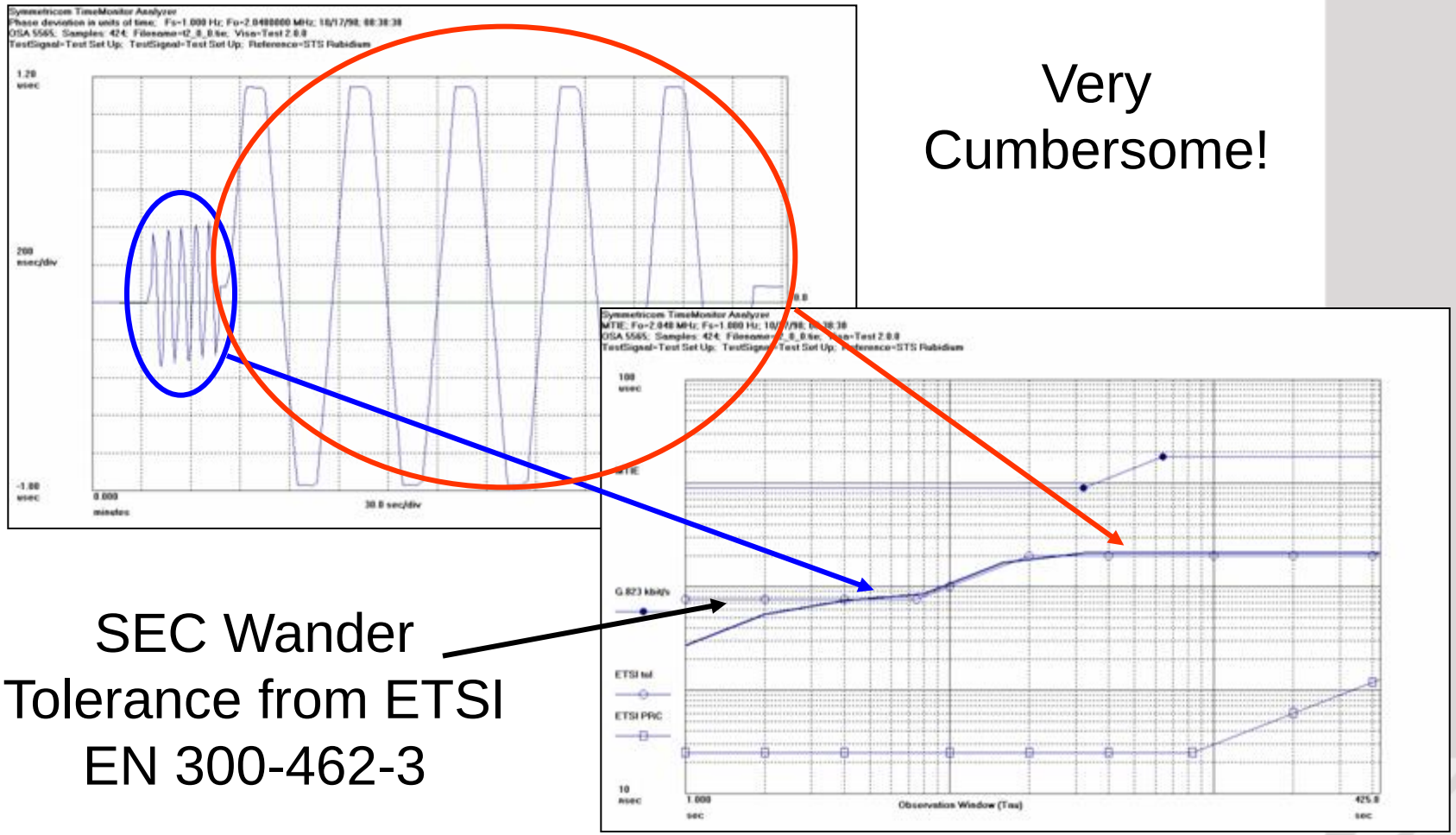
Test Set-Up


Sync Ref
Used ANT-20 to inject Wander
and VC-12 Pointers
E1
Traffic
Retimer
SDH
Network
Simulator
Sync Tester

Some Findings

- We discovered that the Base Station was critically susceptible to VC-12 Pointers
- We analysed 3 different Base Station technologies
- We were also able to show the wander immunity of each Base Station technology
- We showed that a stressed SDH network was not a good host for a Wireless network
- We did these tests in 1998!
  - Last Century
  - 8 Years ago
  - With what?

Test with ANT-20



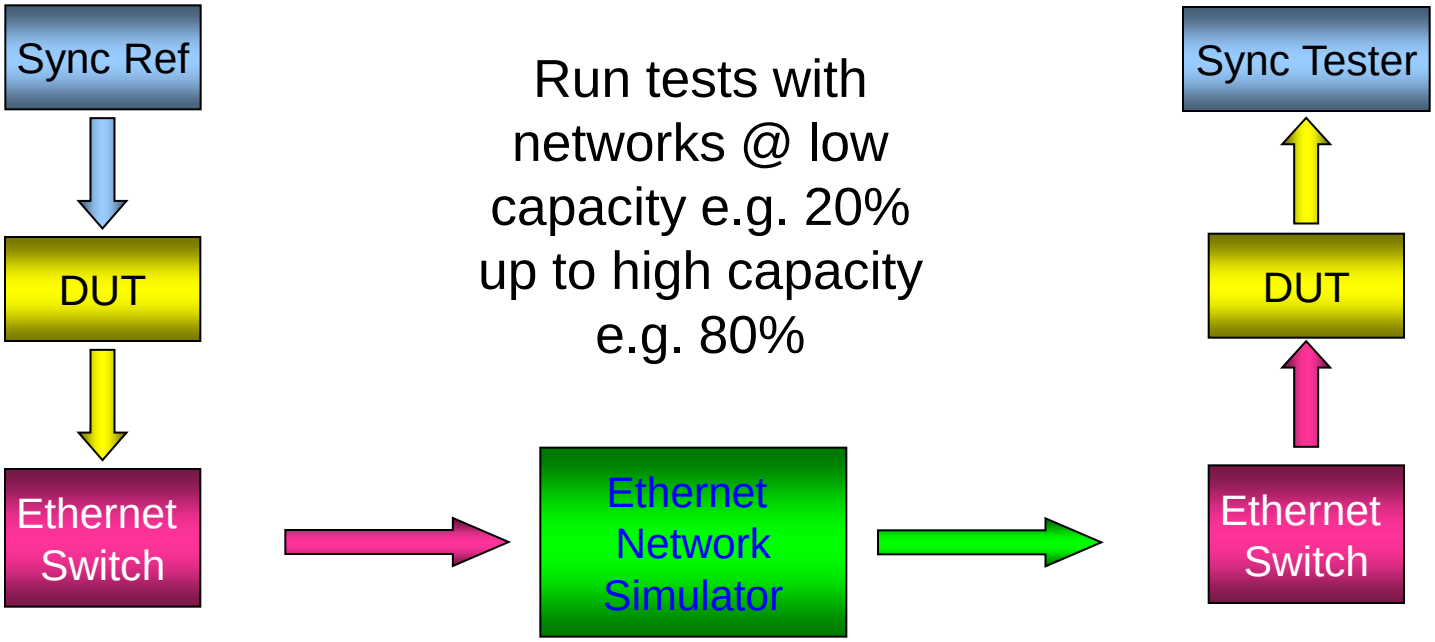
Very Cumbersome!

SEC Wander Tolerance from ETSI EN 300-462-3

Actual Project – Wander Transfer

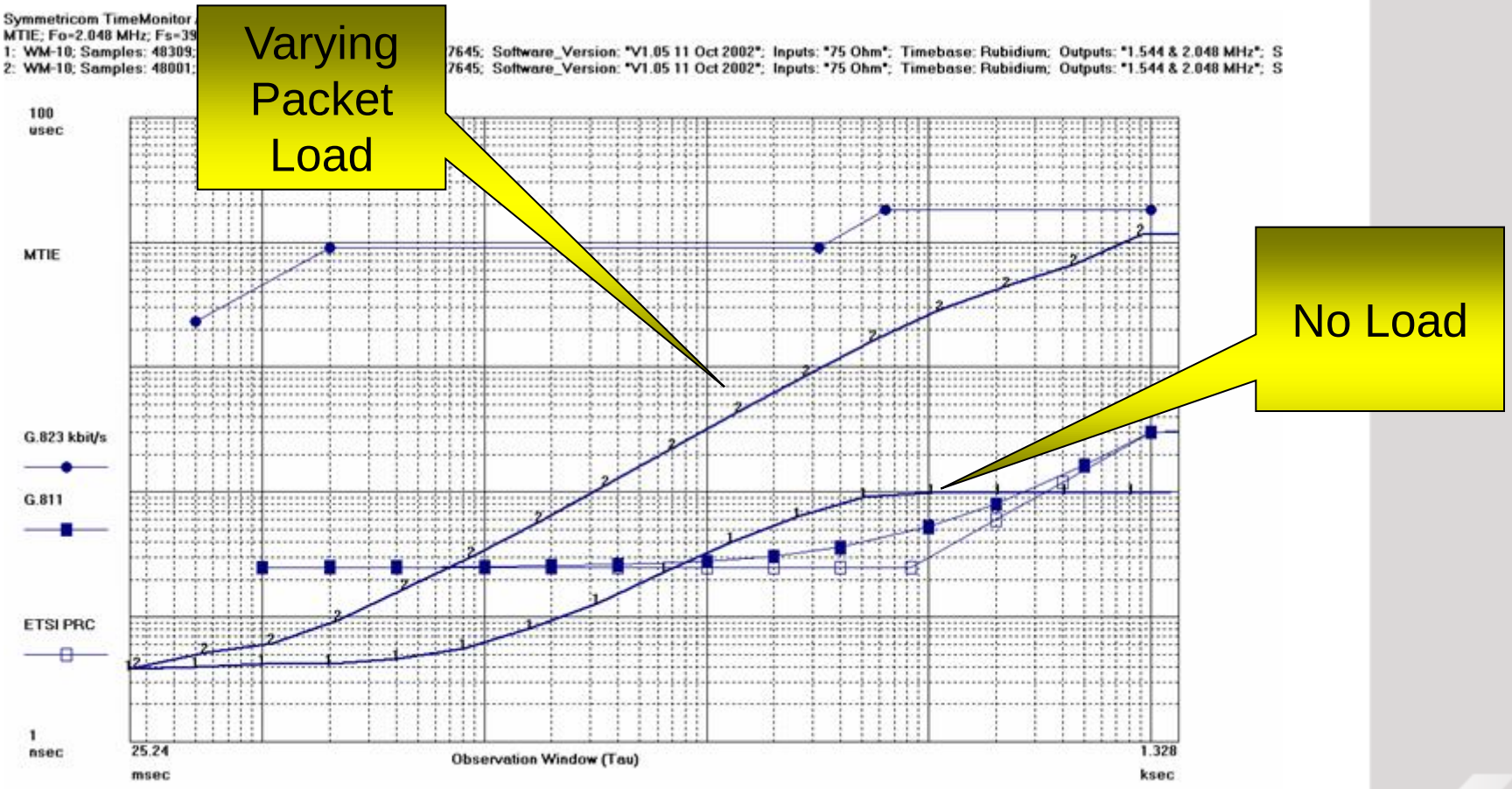
- E1 Circuit Emulation Silicon
  - Problem
    - Client needed to assess suitability of product to deliver sync
    - Application GSM Base Station E1 delivery
  - Commission
    - Assess Transfer characteristic under different network conditions
  - Strategy
    - Agree GSM base station Wander Immunity Standard
    - Inject PRC quality sync into Ethernet test network,
    - Vary traffic density
    - Monitor circuit emulated E1 at application delivery port
  - Deliverable
    - Report

NGN Sync Test Process



This will test whether a product is fit for purpose

Results - E1 Circuit Em



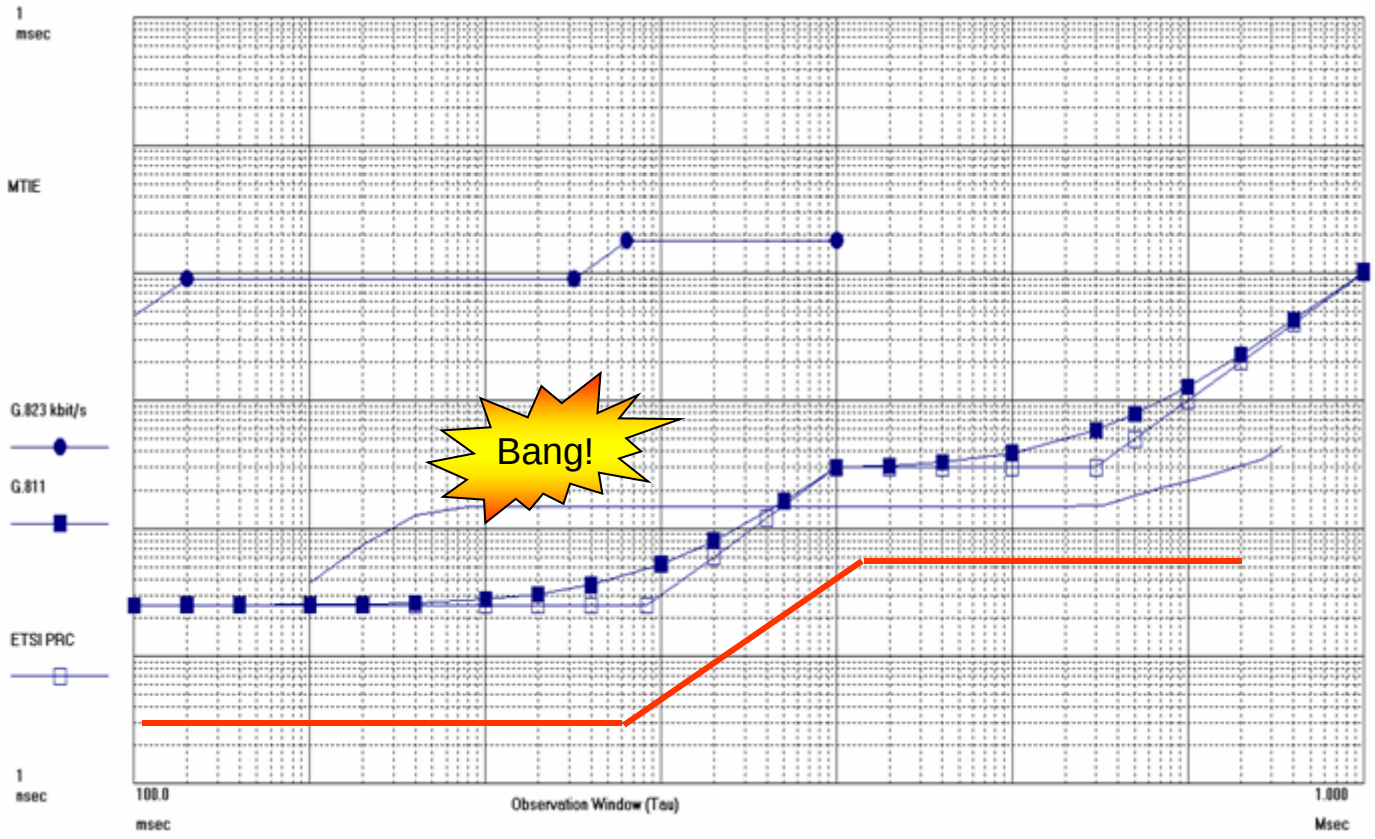
Sync Availability Standards

- Needed so SLAs can be defined
- We need to know the wander immunity threshold for the application
- Measure MTIE and analyse in 15 minute blocks
  - Ian Wright's proposals @ WSTS05 and ITSF05
- If MTIE is acceptable (i.e. below application immunity threshold) in a 15 minute block
  - ….then ☑
- If MTIE unacceptable at any point in a 15 minute block
  - ….then ☒
- SLA must define…
  - Immunity threshold in terms of MTIE
  - How many ☒ in a given period e.g. 1 year as a %
  - What is acceptable 5x9s?
  - Skype is about half a nine!

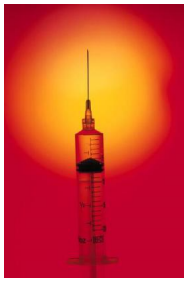
Future Work

- Chronos WanderCrawler™ Concept
- Take one Application Timing Recovery Circuit
  - Prior knowledge of the internal timing recovery technique is useful
    - e.g. has the PLL got a 10 or 1000 second loop time constant?
    - Does it use a low cost VCXO, more expensive OCXO or Rubidium?
    - Does it use TWTT, OWTT, some other clever algorithm?
    - This will assist identification of the most susceptible MTIE observation interval
- Application Failure
  - Define acceptable and unacceptable behaviour
- Start with MTIE which is acceptable to the application
  - e.g. G.811 PRC mask
  - 3GPP - 50ppB, 100ppB, TDD/LTE
- Then increase the MTIE
  - i.e. move it up the graph
    - …until the application behaviour becomes unacceptable
  - Focus on critical observation interval
    - This will be dependent on the application timing recovery circuit

WanderCrawler™ Concept



Conclusions



- Immunity, Transfer and Availability
  - Inextricably linked
- Testing is not trivial
- No Standards exist
- We need to make them exist!
- We can't ignore the problem
- Chronos has won a UK Gov't DTi Grant of **>€100,000** to investigate the development of a **Sync Susceptibility Testing Process and Sync Availability Standard**

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