Telecom Standards for Resilient Timing

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Agenda

- IEEE P1952 Project
- ITU-T Documents for timing
- ITU-T Defined resilient clocks
- Additional ITU-T resilience mechanisms
- Summary
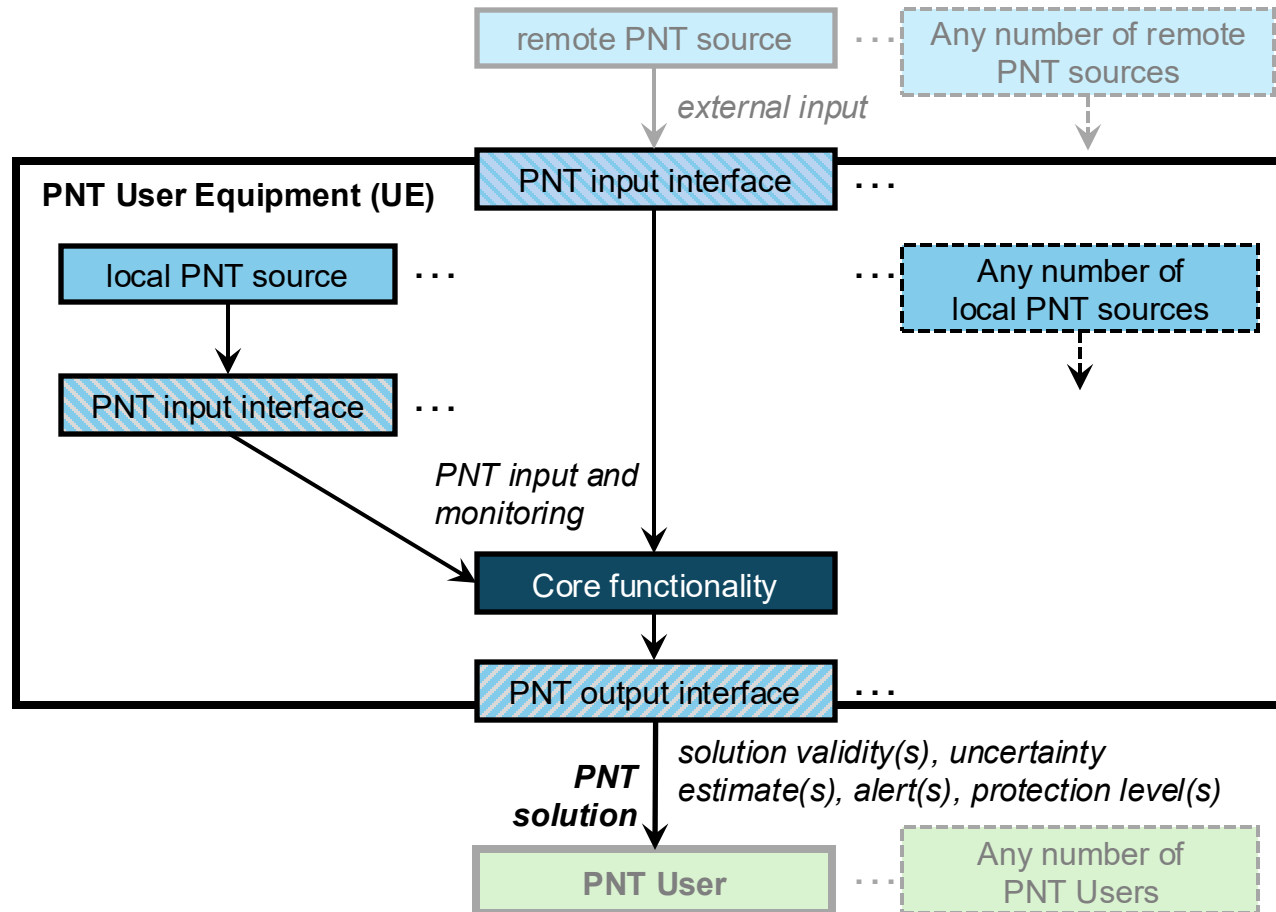
GNSS vulnerability to jamming and spoofing

You've seen 100 versions of this slide at the WSTS, so let's move on

IEEE P1952 project

- Resilient Positioning, Navigation and Timing User Equipment Working Group
- Project to create an IEEE standard
  - Standard for Resilient Positioning, Navigation and Timing User Equipment
- **In Scope**
  - Requirements on behaviors of PNT User Equipment
  - Defines levels of resilience for PNT UE
- **Out of scope**
  - Requirements on PNT source systems (e.g. GPS Constellation)
  - UE design or technologies to achieve resilience levels

PNT User Equipment

PNT User Equipment (UE)

remote PNT source · · · Any number of remote PNT sources

external input

PNT input interface · · ·

local PNT source · · · · · · Any number of local PNT sources

PNT input interface · · ·

PNT input and monitoring

Core functionality

PNT output interface · · ·

PNT solution — solution validity(s), uncertainty estimate(s), alert(s), protection level(s)

PNT User · · · Any number of PNT Users

P1952 has a very broad concept of "User"

Examples of P1952 User Equipment

Equipment	User
GNSS receiver	PRTC vendor
PRTC	Timing architect
Timing network	Network operator

P1952 Adversity Categories

- P1952 Resilience is focused on resilience to PNT adversities
  Out of scope:
  - General reliability
  - Design flaws that do not affect PNT performance
  - Power disruptions

- PNT adversities are: natural, unintentional or malicious disturbances of the PNT <u>input</u> signals

- Adversity Examples for timing systems:
  - GNSS jamming/interference
  - GNSS spoofing
  - GNSS ionospheric delay variation
  - GNSS system errors

  - PTP Asymmetry
  - PTP Rogue T-GMs
  - PTP message manipulation
  - PTP delay attacks
  - Loss of SyncE

P1952 Resilience Levels

Resilience level	Description
1. Detect and alert	Detect any adversity serious enough to cause the equipment to fail to meet its PNT output performance specifications
2. Recover automatically	When the adversity is no longer happening
3. Resist	Continue to meet minimum acceptable performance requirements for some time, i.e. holdover
4. Withstand	Continue to meet minimum performance requirements in steady state
5. Verify	Verify that the received PNT information is correct

Note Each resilience level also inherits the requirements from lower levels

P1952 status

- Work in progress

- Most normative clauses close to a complete draft

- Some informative clauses not started, and might not be included

- Language defining resilience levels mostly stable

- Clause on adversities went through working group ballot

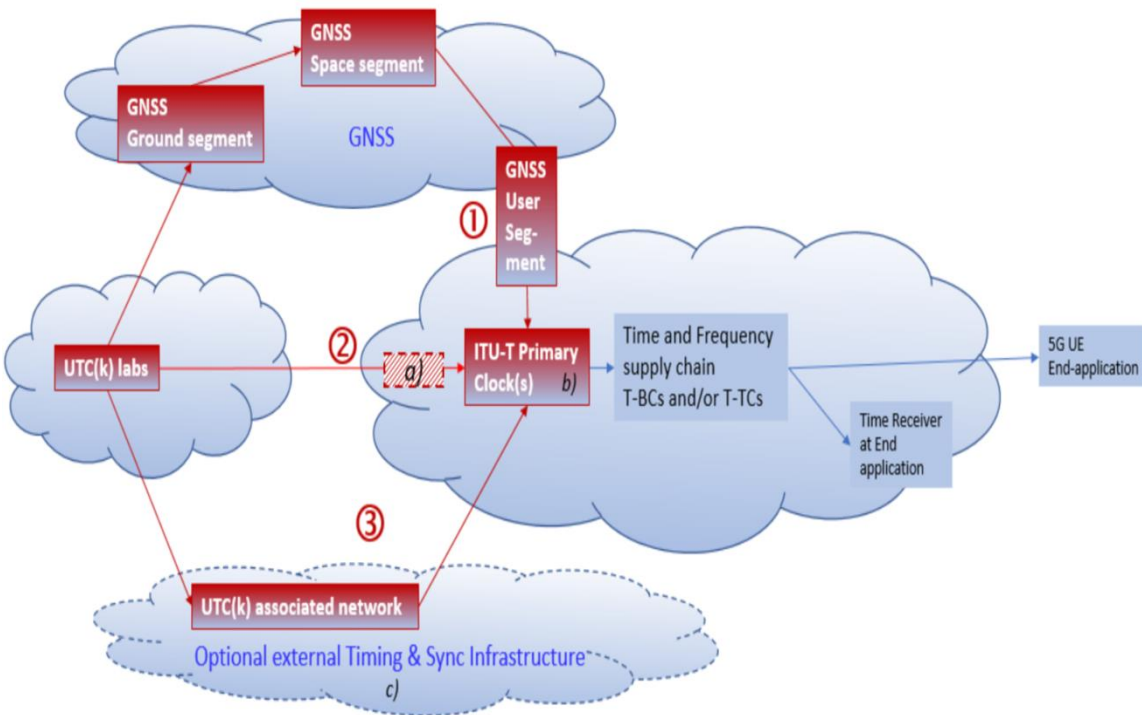- Full document ready for working group ballot by the end of the year

ITU-T Resilience Appendix
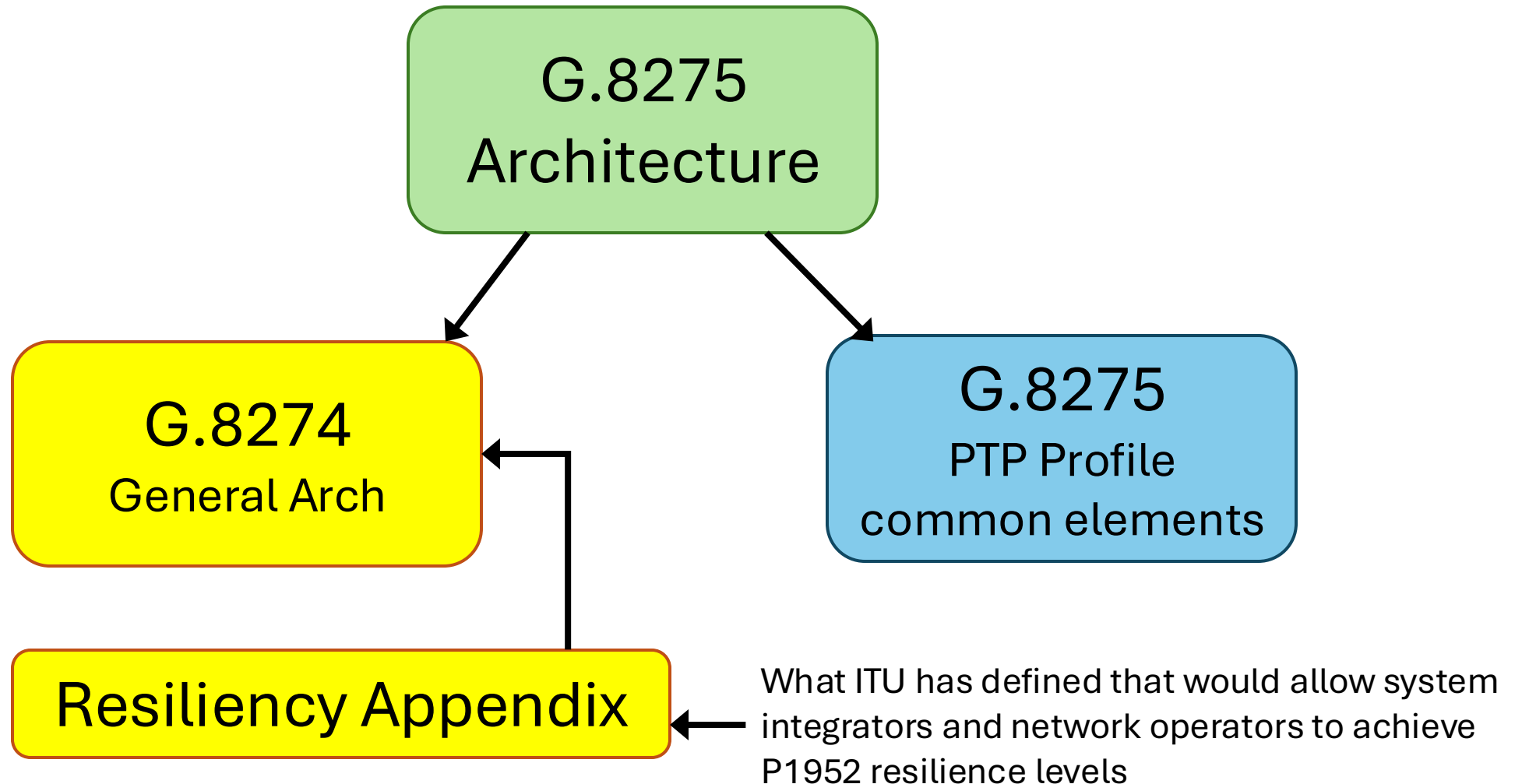
ITU-T defined primary clocks

Primary Source		Imple-men-tation variant number	Additional sources (external primary clocks)						
			None	external Frequency		external Phase/time			
				PRC via high-accuracy time transfer	PRC via SyncE	Phase/time via high-accuracy time transfer	via PTP-FTS profile	via PTP-APTS profile	UTC(k)
1	PRTC (G.8272)	1	x						
		2			x				
		3					x		
2	ePRTC (G.8272.1)	4	x						
		5			x				
		6							x
3	cnPRTC (G.8272.2)	7	x						
		8							x

Primary clocks and resilience levels

IEEE P1952 Resilience Level			Proposal	threat duration time	PRTC			ePRTC			cnPRTC	
					PRTC	PRTC with SyncE	PRTC with APTS	ePRTC	ePRTC with SyncE	ePRTC with UTC(k)	cnPRTC	cnPRTC with UTC(k)
1	Detect / Alert		The ability to detect an adversity that might impact performance and generate an alert.	With the available on-board resources of the specific primary clock variants, resilience level 1 should be met without restrictions.		x	x	x	x	x	x	x	x
2	Recover		The ability to automatically recover and operate normally after an adversity.	With the available on-board resources of the specific primary clock variants, resilience level 2 should be met without restrictions.		x	x	x	x	x	x	x	x
3	Resist		The ability to operate during an adversity, perhaps with reduced performance, but still within specifications, **for a specified length of time.**	It is proposed to consider the maximul lenght of time for fulfillment of resilience level 3.	<< 1 day	x	x	x	x	x	x	x	x
					1 - 40 days	-	based on SyncE	based on PTS	x	x	x	x	x
					> 40 days	-			-	based on PRC via SyncE	x	(x)	x
4	With-stand		Withstand: The ability to operate during an adversity, perhaps with reduced performance, but still within specifications, **indefinitely**.	A indefinitely withstand can be guarantied with usage of external UTC(k) only.		-	-	-	-	-	-	-	x
5	Verify		The ability to determine that information from a PNT source is accurate.	A indefinitely withstand can be guarantied with usage of external UTC(k) only.		-	-	-	-	-	-	-	x

Beyond primary references

IEEE P1952 Resilience Level	Mitigation mechanism	ITU-T Recommendations	Relevant adversities
1 Detect	Monitoring	G.8275.1, Annex G	PTP asymmetry, PTP delay attacks
1 Alert	Management	Under study	All adversities
2 Recover	Under study	Under study	All adversities
3 Resist	Holdover, SyncE	G.8272, G.8272.1, G.8275.2, G.781	GNSS jamming, GNSS spoofing if detected, PTP protocol attacks if detected
4 Withstand	APTP	G.8271.2, Appendix I	GNSS jamming, GNSS spoofing if detected
4 Withstand	timeTransmitter only ports	G.8275, Annex E	PTP protocol attacks
5 Verify	APTP	G.8271.2, Appendix I	PTP asymmetry, PTP delay attacks

Possible future work for Q13/15 on resilience:
- Guidelines for GNSS receivers and antennas to mitigate jamming and spoofing.
- PTP security (this work is already started).
- Expand architecture for use of multiple time sources to support voting algorithms (this work is already started).

Summary

- IEEE P1952 Project
  - Defines Resilience levels for PNT User Equipment
  - Behaviors equipment should exhibit when PNT inputs experience adversities

- ITU-T Resiliency Appendix
  - Tables pointing to ITU recommended:
    - network architectures
    - technologies
    - specifications
  - That could be used to achieve the various P1952 resilience levels

Thank you for your attention

If you do not get your questions answered in the Q&A Pannel, find us in the coffee break or send me email:

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