3GPP TSG RAN5 Meeting #101
Chicago, United States, Nov 13-17th

R5-236572r2

Discussion – Software Implementation of NR Applicability Specifications - RF Updates, Conclusions and Next Steps

Qualcomm

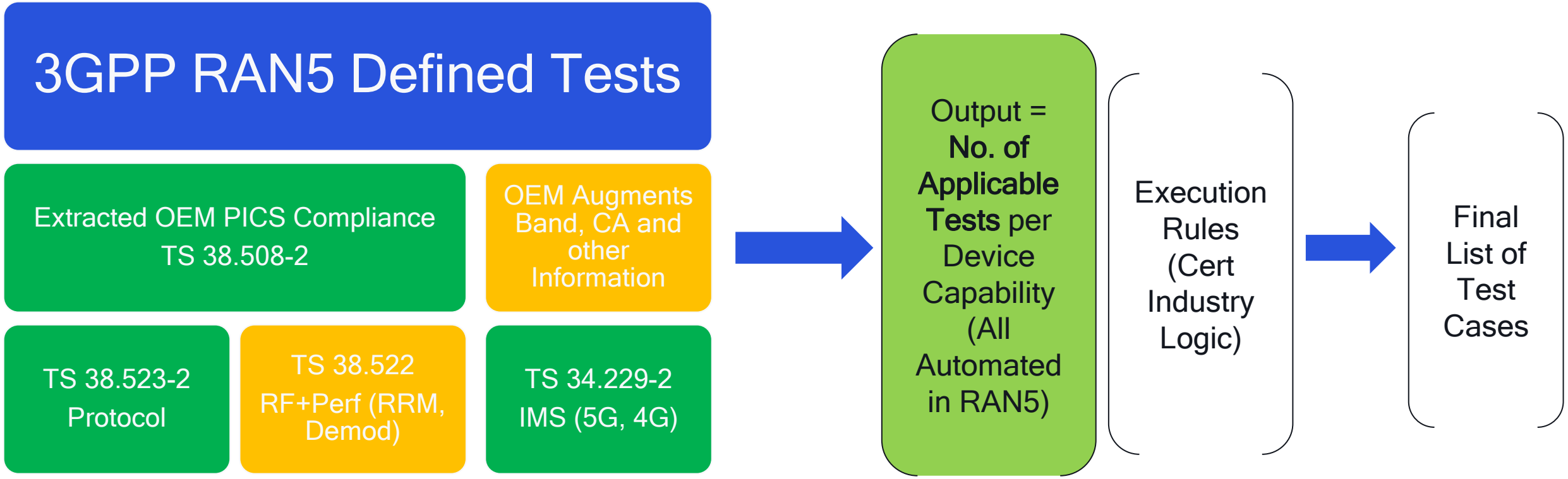
Updates, Agenda for Discussion

- Recap of Issues in last meeting:
  - How to classify sub-tests
  - Needs harmonization across SDOs
  - How to handle branching
  - Output Format

- Introduction of Pseudo code/Flow chart diagram for the SW implementation
  - Updates to PRD Document
  - Handling of additional information
  - Example of Pseudo Code
  - Example of Flow Chart

- Next Steps, Proposals
  - Prototype/Psuedo Code to Mainline

Background – Overall Industry value



Updates:

- Based on proposal in R5-233200 and outcome in RAN5#99, a separate exploder has been created - 3GPP_TSG_RAN_WG5_APPLICABILITY
- Green items above now have Prototype SW Implementation

Proposal 2 – SW implementation of TS 38.522 (RF, RRM, Demod)

Identify Relevant PICS (including bands), from TS 38.508-2 for the DUT

UE Features in Condition Set (C) in TS 38.522 ✖ Apply Tested Bands Selection Set (D) in TS 38.522 ✖ Apply CA/DC Configuration (E) in TS 38.522 ✖ Apply Branching Criteria - PC, RX → New SW Implementation of TS 38.522 (Handle Additional Comments, Notes) = Output = **List of Applicable Tests** per Device Capability

Identify Relevant PICS, (ex. from TS 38.508-2) for the DUT → Feed These to Condition Set (C) in TS 38.523-2 or TS 34.229-2 → TTCN/Non-TTCN Implementation of TS 38.523-2 or TS 34.229-2 = Output = No. of Applicable Tests for Band Under Test

PICS	PICS Def	TRUE/FALSE
pc_5GCN	UE Supporting 5GS	TRUE
pc_as_ReflectivQoS	Support of reflective QoS	TRUE

C21A	IF A.4.1-5/1 AND A.4.3.7-1/4 THEN R ELSE N/A			UEs supporting 5G Core and reflective QoS
7.1.4.1	SDAP Data Transfer and PDU Header Handling UL/DL	Rel-15	C21A	UEs supporting 5G Core and reflective QoS

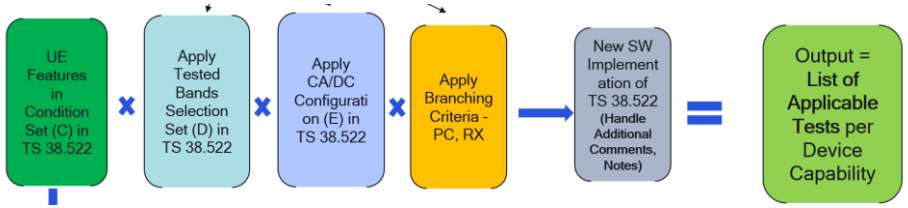
Test Case Selected
Test Case 7.1.4.1

(C) Conditions are similar to Signaling
However, RF/RRM/Demod has unique – super conditions,

- Selection Set (D),
- CA/DC Configuration (E)
- Branching criteria unique

Also, unlike SIGNALLING, RF/RRM/Demod subtest cases may have different applicability, while 38.522 doesn't capture in that level of granularity

Proposal 2 - SW implementation of TS 38.522 (RF, RRM, Demod)



Clause	TC Title	Release	Applicability		Tested Bands/CA-Configurations Selection	Branch	Additional Information
			Condition	Comment			
6	Transmitter Characteristics						
6.2.1	UE maximum output power	Rel-15	C001l	UEs supporting 5GS FR1 not supporting txDiversity-r16 and not supporting RedCap	D001	PC1 PC2 PC3	
6.2.2	UE maximum output power reduction	Rel-15	C001h	UEs supporting 5GS FR1 not supporting txDiversity-r16	D001	PC1 PC2 PC3	Test execution is not necessary if TS 38.521-1 TC 6.5.2.4.1 is executed. Skip TC 6.2.2 if UE supports NSA and TS 38.521-3 TC 6.2B.2.3 or 6.5B.2.3.3.1 has been executed.
6.2A.1.1	UE maximum output power for CA (2UL CA)	Rel-15	C004	UEs supporting 5GS FR1 and CA (2UL CA)	E015 E015a	**Inter-band CA**: PC2, PC3	
6.2A.2.1	UE maximum output power reduction for CA (2UL CA)	Rel-15	C004	UEs supporting 5GS FR1 and CA (2UL CA)	E015	**Inter-band CA**: PC3 **Intra-band contiguous CA**: PC2, PC3 **Intra-band non-contiguous CA**: PC3	Test execution is not necessary if TS 38.521-1 TC 6.5A.2.4.1.1 is executed.
6.2A.3.1	UE additional maximum output power reduction for CA (2UL CA)	Rel-15	C004	UEs supporting 5GS FR1 and CA (2UL CA)	E015	**Inter-band CA**: PC3 **Intra-band contiguous CA**: PC2, PC3	Test execution is not necessary if TS 38.521-1 TC 6.5A.2.3 and 6.5A.3.3 are executed.

C001h	IF (A.4.1-1/1 OR A.4.1-1/2) AND A.4.1-2/7 AND A.4.1-3/1 AND NOT A.4.3.2-1/84 THEN R ELSE N/A
C001i	IF (A.4.1-1/1 OR A.4.1-1/2) AND A.4.1-2/7 AND A.4.1-3/1 AND A.4.3.2A.1-1/2 THEN R ELSE N/A

Table 4.0-2: Tested Bands Selection Criteria

Code	Tested Bands Selection Criteria	Comment
D001	A.4.3.1-1 OR A.4.3.1-2	All supported FDD or TDD FR1 bands
D002	Void	
D003	A.4.3.1-5	All supported FR1 SUL Bands
D004	{n1, n2, n3, n5, n7, n8, n12, n14, n20, n25, n28, n30, n34, n38, n39, n40, n41, n50, n51, n65, n66, n70, n71, n74, n75, n76}	All supported bands among n1, n2, n3, n5, n7, n8, n12, n14, n20, n25, n28, n30, n34, n38, n39, n40, n41, n50, n51, n65, n66, n70, n71, n74, n75, n76
D005	A.4.3.1-3	All supported FR2 Bands
D006	Void	
D007	Void	
D008	ANY((A.4.3.1-1) AND 10MHz)	Any FDD FR1 band within the set supporting 10 MHz UE Channel BW
D009	ANY((A.4.3.1-2) AND 20MHz)	Any TDD FR1 band within the set supporting 20 MHz UE Channel BW
D010	ANY((A.4.3.1-2) AND 40MHz)	Any TDD FR1 band within the set supporting 40 MHz UE Channel BW
D011	A.4.3.9-4a OR A.4.3.9-4b	All supported 4 Rx antenna ports Bands
D012	A.4.3.9-12 AND FDD	All supported FDD FR1 band with UL MIMO capabilities

Band Selection is based on set theory. For each feature, item number shall correspond to the Band number. The result is the set of bands for which the test shall be conducted. The following operators are used:

AND: Set intersection ($\cap$). {n1,n2} AND {n2,n3} = {n2}
OR: Set union ($\cup$). {n1,n2} OR {n2,n3} = {n1,n2,n3}
NOT: Set complement (\), full set being all bands. NOT{n1} = {All bands except n1}
Also note that this is set without repetitions so {n1} AND {n1} = {n1}

The following basic sets are used:

{n1,n2}: Explicitly given band set
10MHz: All bands supporting 10 MHz
FDD: All bands in FDD mode

Code	Tested CA/DC Configuration Selection Criteria	Comment
E001	DL_2CC(A.4.3.2A.2.1-3) AND A.4.3.2B.2.0-1/1 AND NOT UL(A.4.3.2A.2.1-2)	All supported intra-band contiguous CA Configurations with 2 carriers in DL but no CA in UL
E002	DL_2CC(A.4.3.2A.4.1-3) AND A.4.3.2B.2.0-1/1 AND NOT UL(A.4.3.2A.4.1-2)	All supported inter-band CA Configurations with 2 carriers in DL but no CA in UL
E003	UL_2CC(A.4.3.2B.2.1-2) AND A.4.3.2B.2.0-2/1	All supported Intra-band contiguous EN-DC configurations in FR1 (2UL CCs)
E003a	DL_2CC(A.4.3.2B.2.1-2) AND A.4.3.2B.2.0-1/1	All supported Intra-band contiguous EN-DC configurations in FR1 (2DL CCs)
E004	UL_2CC(A.4.3.2B.2.2-2) AND A.4.3.2B.2.0-2/1	All supported Intra-band non-contiguous EN-DC configurations in FR1 (2UL CCs)
E004a	DL_2CC(A.4.3.2B.2.2-2) AND A.4.3.2B.2.0-1/1	All supported Intra-band non-contiguous EN-DC configurations in FR1 (2DL CCs)

- (C) Conditions are binary, similar to Signaling
  - However, RF/RRM/Demod works differently,
  - it can create multiple instances/branches of test cases from the same core requirements,
    - based on Code D or Code E

Proposed Output Templates

Matrix Format	DCC Format	Hybrid Format (Proposed)
Each Test case/subtest case will have their own row Branches (AKA Bands, CA, PCs, Number of Rx etc) will be captured in Columns	Each test case/subtests and all possible branches will have their own row	Each test case/subtests will have its own row All possible branches will have their own tab

NR_Band	n93A_PC2	n94A_PC3	n94A_PC2_2Rx	n94A_PC2_4Rx	n99A-n98A	n99A-n88(2A)	n98A-n99(2A)-n97A
SCS	30	30	30	30	30	30	30
TC							
TC1	T	F	F	T	F	F	F
TC2	F	F	F	F	F	F	F
TC3	F	T	F	F	T	F	F
TC4	T	F	F	T	F	F	F
TC5 Subtest1	F	T	F	F	T	F	F
TC5 Subtest2	F	F	T	F	F	T	T

O	P	Q
NR_Band		Appplicability
TC	TC	
TC1	TC1-n93A_PC2	T
TC5 Subtest1	TC5 Subtest1-n93A_PC2	F
TC5 Subtest2	TC5 Subtest2-n93A_PC2	F
TC1	TC1-n94A_PC3	T
TC5 Subtest1	TC5 Subtest1-n94A_PC3	F
TC5 Subtest2	TC5 Subtest2-n94A_PC3	F
TC1	TC1-n94A_PC2_4Rx	T
TC5 Subtest1	TC5 Subtest1-n94A_PC2_4Rx	F
TC5 Subtest2	TC5 Subtest2-n94A_PC2_4Rx	F
TC1	TC1-n98A-n99(2A)-n97A	T
TC5 Subtest1	TC5 Subtest1-n98A-n99(2A)-n97A	F
TC5 Subtest2	TC5 Subtest2-n98A-n99(2A)-n97A	F

NR_Band	n99A-n98A	n99A-n88(2A)	n98A-n99(2A)-n97A	n99A-n98A	n99A-n88(2A)	n98A-n99(2A)-n97A
SCS	30	30	30	30	30	30
Name						
TC1	F	F	F	T	F	F
TC2	F	F	F	F	F	F
TC3	T	F	F	F	T	F
TC4	F	F	F	T	F	F
TC5 Subte	T	F	F	F	T	F
TC5 Subte	F	T	T	F	F	T

PC2 | PC3 | PC2_2Rx | PC2_4Rx

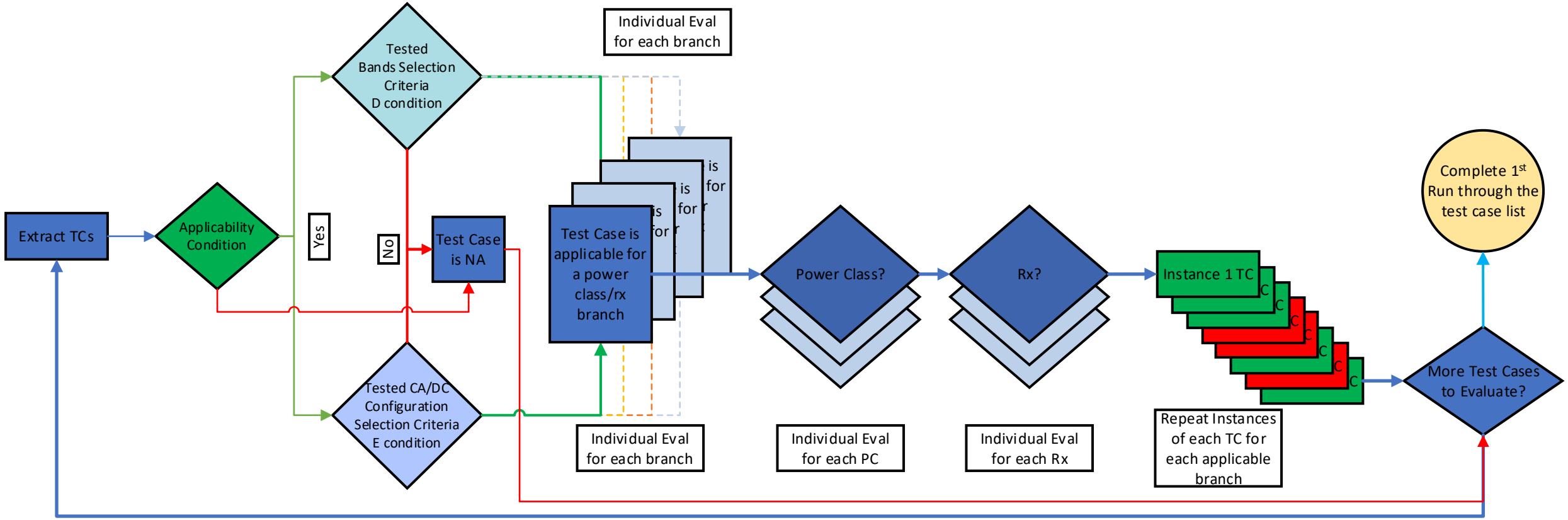
Example Test Cases

Clause	TC Title	Release	Applicability		Tested Bands/CA-Configurations Selection	Branch	Additional Information
			Condition	Comment			
6	Transmitter Characteristics						
6.2.1	UE maximum output power	Rel-15	C001l	UEs supporting 5GS FR1 not supporting txDiversity-r16 and not supporting RedCap	D001	PC1 PC2 PC3	
6.2.2	UE maximum output power reduction	Rel-15	C001h	UEs supporting 5GS FR1 not supporting txDiversity-r16	D001	PC1 PC2 PC3	Test execution is not necessary if TS 38.521-1 TC 6.5.2.4.1 is executed. Skip TC 6.2.2 if UE supports NSA and TS 38.521-3 TC 6.2B.2.3 or 6.5B.2.3.3.1 has been executed.
6.2.3	UE additional maximum output power reduction	Rel-15	C001h	UEs supporting 5GS FR1 not supporting txDiversity-r16	D001	PC1 PC2 PC3	Test execution is not necessary if TS 38.521-1 TC 6.5.2.3, 6.5.2.4.2 and 6.5.3.3 are executed. Skip TC 6.2.3 if UE supports NSA and TS 38.521-3 TC 6.2B.3.3 has been executed or TS 38.521-3 TCs 6.5B.2.3.2, 6.5B.2.3.3.2 and 6.5B.4.3 have been executed.
6.2.4	Configured transmitted power	Rel-15	C001h	UEs supporting 5GS FR1 not supporting txDiversity-r16	D001	PC1 PC2 PC3	
6.2A.1.1	UE maximum output power for CA (2UL CA)	Rel-15	C004	UEs supporting 5GS FR1 and CA (2UL CA)	E015 E015a	**Inter-band CA**: PC2, PC3	

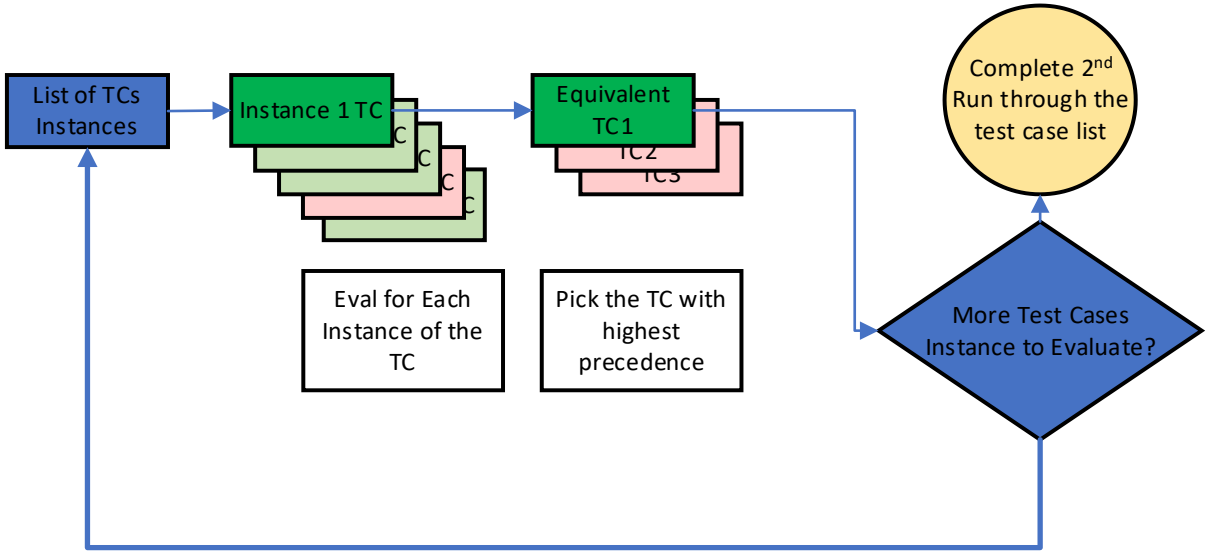
Here for TC 6.2.2

- If the UE satisfied C condition, it will be applicable for all FDD/TDD FR1 bands the UE supports and all the power class UE supports
- If the UE supports n1, n3, n66 and PC2, PC3 for example, there will be 6 instances for this test case for the given UE (3 Choice 2)
- Now Additional information introduces complexity, where execution requirement depends on applicability of 6.5.2.4 and 6.2B.2.3
- We propose we replace the additional information column with more machine-readable statement for 6.2.2
  - i.e. 6.2B.2.3 > 6.5B.2.3.3.1 > 6.5.2.4.1> 6.2.2
  - FFS – Needs to studied per Area (RF, RRM and Demod) and machine-readable info to be captured

Algorithm: Test Case Selection



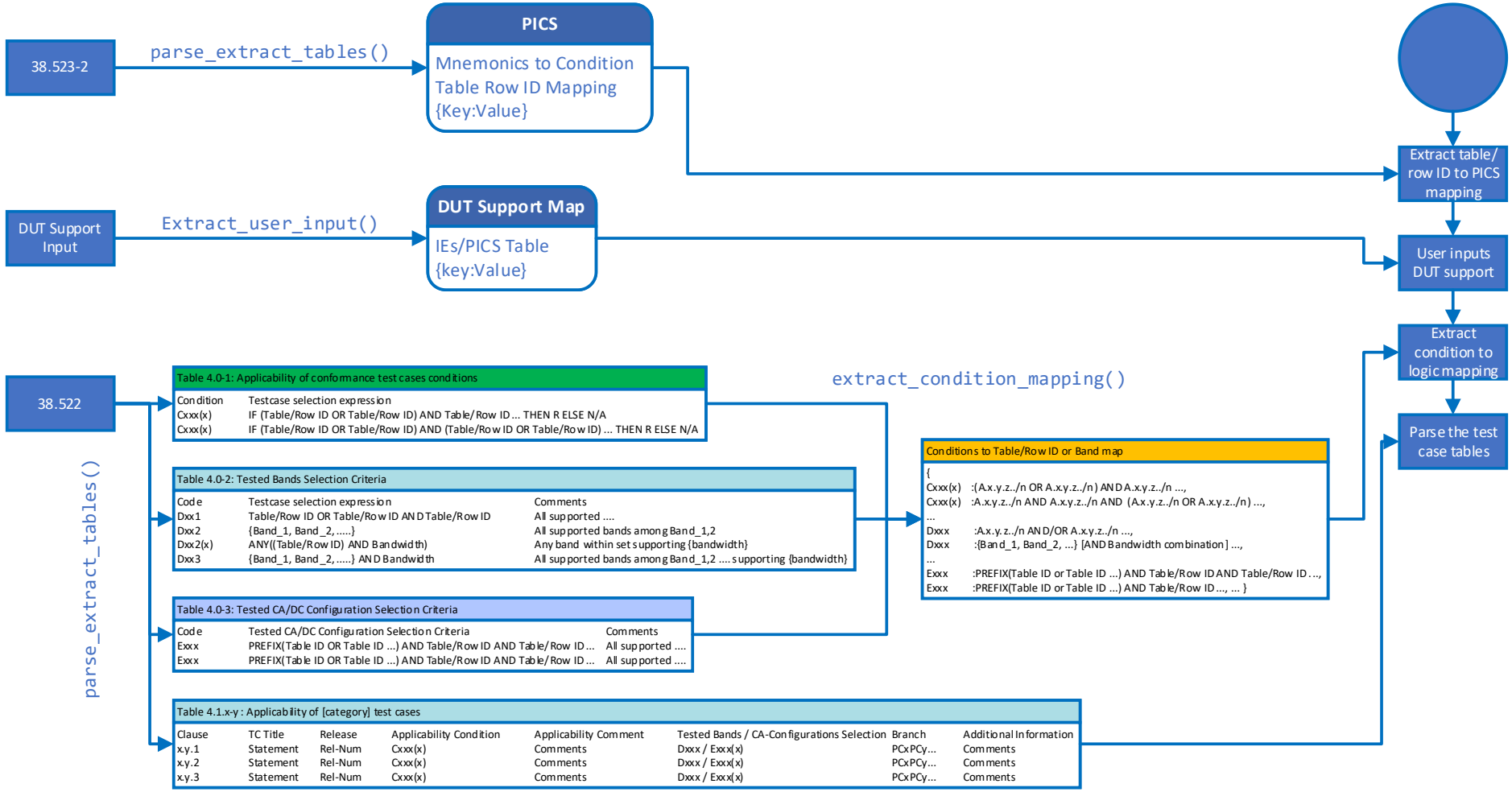
Algorithm: Test Instance Selection



NR_Band	n99A-n98A	n99A-n88(2A)	n98A-n99(2A)-n97	n99A-n98A	n99A-n88(2A)	n98A-n99(2A)-n97
SCS	30	30	30	30	30	30
Name						
TC1	F	F	F	T	F	F
TC2	F	F	F	F	F	F
TC3	T	F	F	F	T	F
TC4	F	F	F	T	F	F
TC5 Subte	T	F	F	F	T	F
TC5 Subte	F	T	T	F	F	T

PC2 | PC3 | PC2_2Rx | PC2_4Rx

Data Flow: Specification Extraction



Pseudo Code Example

- Test Case/Test Case Instance Selection

```
For each testcase in testcases
    If C condition is TRUE
        Evaluate Band Selection Criteria (B)
            For each B condition evaluated to be TRUE
                Evaluate CA/DC Criteria (E)
                    For each E condition Evalue to be TRUE
                        Evaluate PowerClass Applicable for the DUT (PC)
                            For each PowerClass to be TRUE
                                Evaluate Rx Branches for the DUT (RX)
                                    For each RX branches to be TRUE
                                        Mark the test case instance as Applicable
                                    else
                                        Mark the test case instance NA
                                else
                                    Mark the test case instance NA

                        else
                            Mark the test case instance NA
                else
                    Mark the test case instance NA
        else
            Mark the test case instance NA
    else
        Mark the test case NA



For each test case instance
    Evaluate additional information for set of same TC
        read precendence amongst test case set
            mark the test case instance with highest precendence as Applicable
            mark other instances as NA
```

Next Steps:

1. Progress Summary - Outline of Data Extraction and Pseudo Code to produce desired output ready for SW implementation, PRD18 can be used to document.

2. SW implementation does not need to be made public, currently, what is of interest is simply the outputs of the SW execution.

3. **Continue study phase evaluation further to** –

    1. Which parts or whole project is useful and most required from Industry, continue discussion on Applicability Exploder and seek feedback.
    2. The format & delivery timeline of the outputs.

4. **FFS**
    1. Convert “Additional Information” column in TS38.522 in machine readable format, this will need continuous evaluation.

References:-

- RAN5#100: R5-234319 Progress on Proposal-2 : TS 38.522 early study and challenges in implementation, **Qualcomm**

- RAN5#99: R5-233200 SW Implementation of RAN5 Applicability, **Qualcomm**