Qualcomm

Qualcomm Technologies, Inc.

MSM89x7 Modem Software Overview

80-P2485-12 Rev. F

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U.S.A.

Revision History

Revision	Date	Description
A	October 2015	Initial release
B	November 2015	Added slide 8, updated slide 19
C	November 2015	Added slide 10; updated slides 6, 12, 14, 19, 20 and 23
D	March 2016	Updated slides 7, 14, and 23
E	May 2016	Updated slide 13
F	January 2018	Added slide 11

Contents

Introduction

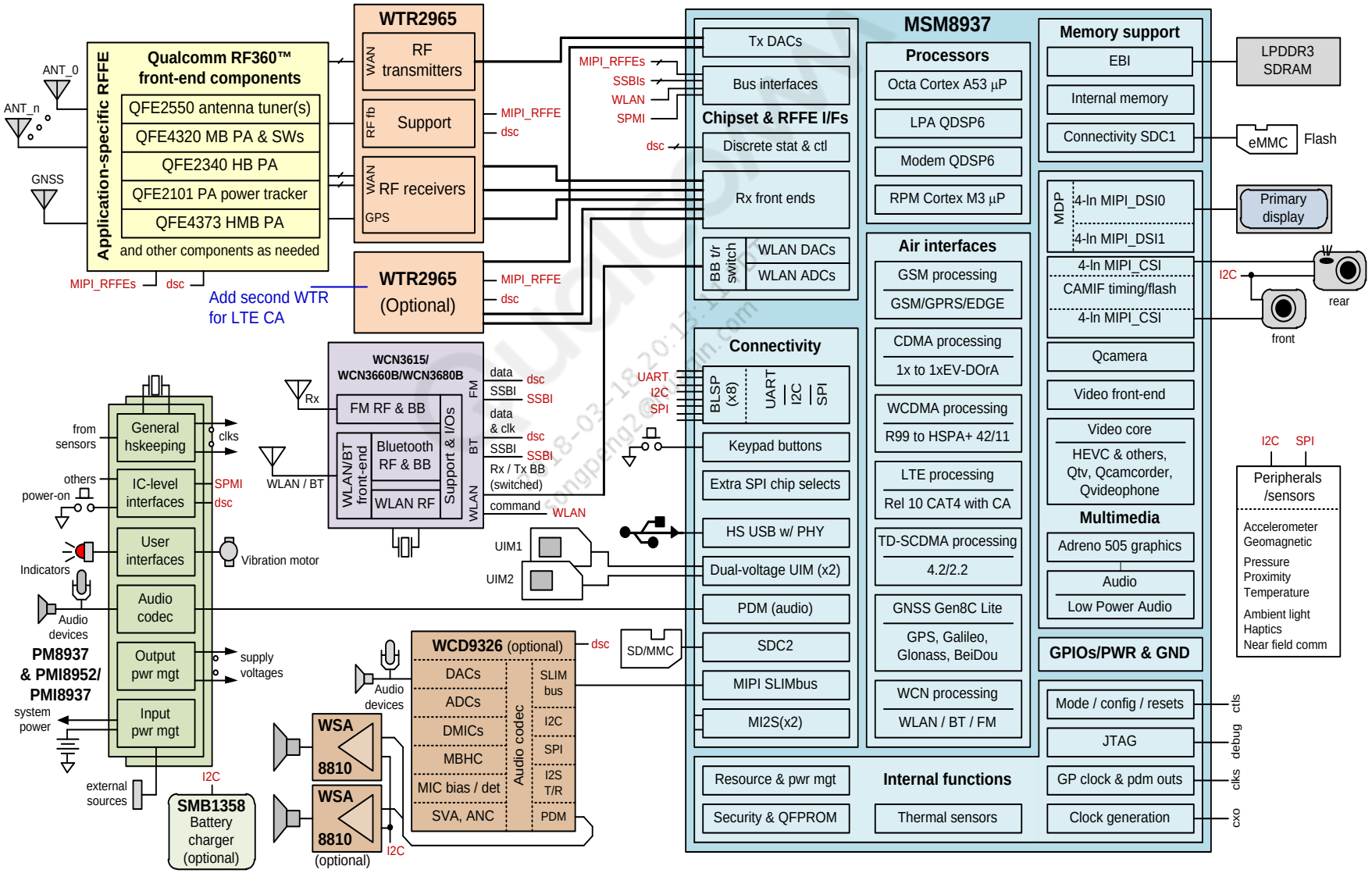
Introduction to MSM89x7

- MSM89x7 is a Cat4 LTE modem with 2x10 carrier aggregation (CA) support (with additional WTR2965 support).
- MSM89x7 modem is primarily derived from the MSM8909 modem
- Interfaces and feature sets similar to MSM8909
- Qualcomm® Hexagon™ DSP processor subsystem is replaced with the newer version – Hexagon (CincoX) processor with 691 MHz speed
- Key features:
  - LTE + CDMA DSDS feature
  - UL 64 QAM
  - VoLTE + CA concurrency

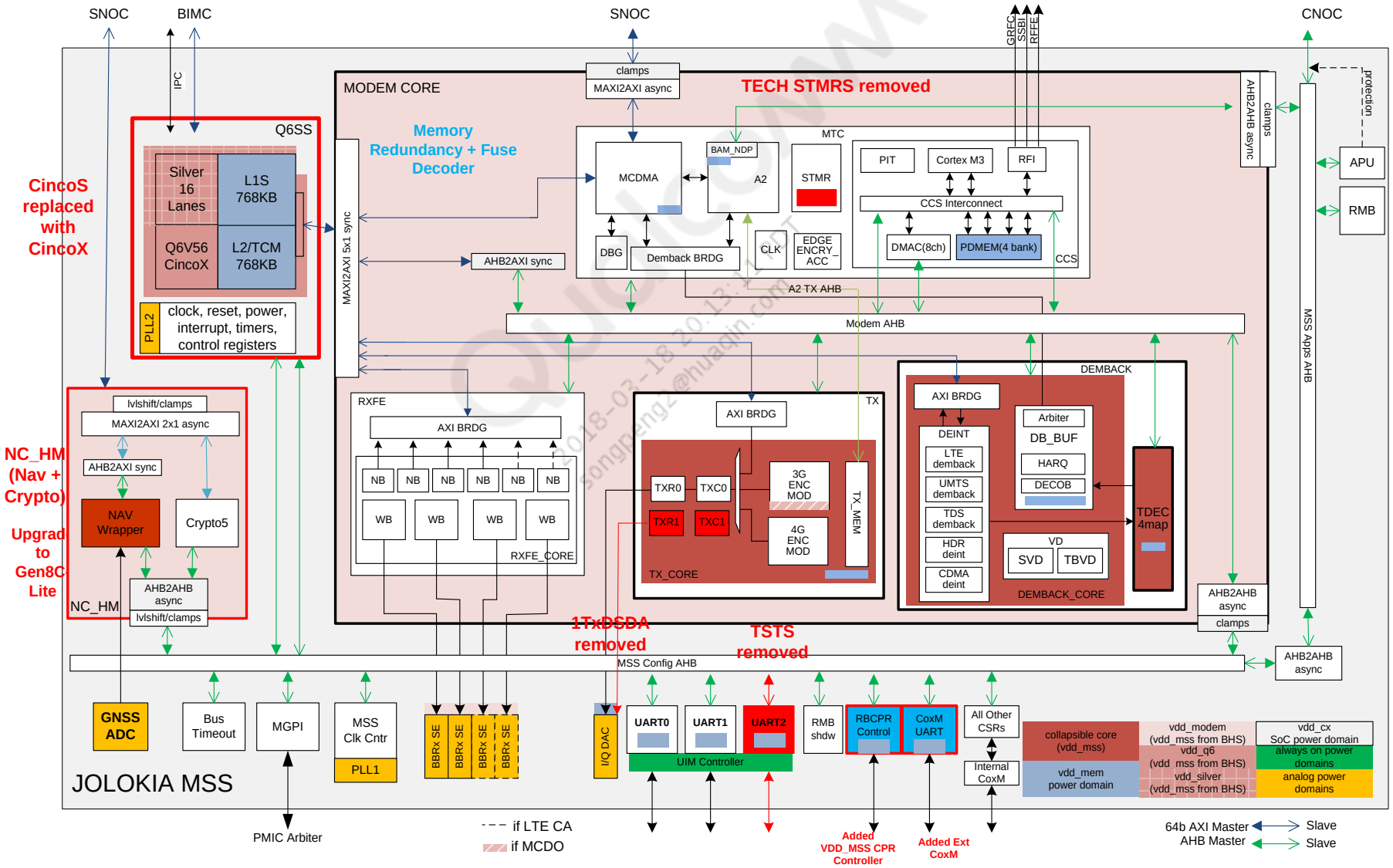
MSM89x7 Variants

Device	Supported airlink technology					μP	Multimedia		
	GSM	WCDMA	TD-SCDMA	LTE	CDMA		Camera	Video decode	Display
MSM8937	to EDGE	to DC-HSPA+	4.2/2.2 Mbps	to Cat4 2x10 CA	to DOrA	Cortex-A53 64-bit Octa core	21 M	1080p	FHD
MSM8917	to EDGE	to DC-HSPA+	4.2/2.2 Mbps	to Cat4 2x10 CA	to DOrA	Cortex-A7 32-bit Quad-core	16 M	720p	qHD

MSM8937 Functional Block Diagram



MSM8937 Software Block Diagram and Deltas to MSM8909/MSM8916



High-level Significant Changes

- Significant changes in the MSM89x7 modem with respect to MSM8909/MSM8916 include the following:
  - Modem is on a separate VDD_MSS rail for load balancing on PMIC
  - Audio moves to a separate LPASS processor
  - UL 64 QAM to support another 25 Mbps increase in UL
  - L2 tags reduced to 256 instead of 512
  - New voltage levels SVS+ and Nom+ (digital power rail) introduced. This helps in power saving in modem scenario like throughput in Cat3 scenario.
  - UART added for external support of Wi-Fi for WAN – WLAN coexistence
  - GPS Gen 8C-lite (MSM8937) and Gen 8C-feather (MSM8917)
  - Tech-specific STMR blocks/TSTS UART are removed because of migration to VSTMR and TSTS feature not being supported

New Features

MPSS.JO.1.2	MPSS.JO.2.0	MPSS.JO.3.0	MPSS.JO.3.1
▪ MSM8937.LA.1.0 (02/29/2016 CS) ▪ MSM8937.LA.1.0.1 (04/29/2016 CS) ▪ MSM8937.LA.1.0.2 (10/31/2016 CS) ▪ MSM8917.LA.1.0.2 (10/31/2016 CS)	▪ MSM8937.LA.2.0 (09/30/2016 CS) ▪ MSM8917.LA.2.0 (09/30/2016 CS) ▪ MSM8937.LA.2.0.1 (06/16/3017 CS)	▪ MSM8937.LA.3.0 (01/12/2017 CS) ▪ MSM8917.LA.3.0 (01/12/2017 CS) ▪ MSM8937.LA.3.0.1 (09/29/2017 CS) ▪ MSM8917.LA.3.0.1 (09/29/2017 CS)	CS 01/31/2018
MPSS.JO.1.0 content, plus: ▪ WTR2965 support; ▪ DR-VCC ▪ DSDS L/W/T/G+1x/G ▪ IMS upgrades	MPSS.JO.1.2 content, plus: ▪ 1xSCH to G tune-away ▪ G to L tune-away	MPSS.JO.2.0 content, plus: ▪ L+W SR-DSDS ▪ IMS spec upgrade ▪ QGP FRs support ▪ Cat4 2x10 MHz DLCA with DSDS ▪ B71 support	MPSS.JO.3.0 content, plus: ▪ IMS spec upgrade ▪ UL 64 QAM ▪ 1xSRLTE+W ▪ HP UE support

Modem Capabilities

Modem Capabilities

Feature	MSM89x7
GERAN	
SAIC for GMSK data (MCS1-4)	Yes
SAIC for 8-PSK data (MCS5-9)	Yes
DTM MSC 11	Yes
EDGE MSC 30-33	Yes
A5/4 voice ciphering	Yes
VAMOS I+II	Yes
UMTS	
HSDPA Cat 24 (DC+64 QAM) - 42 Mbps	Yes
HS-FACH/RACH	Yes
CPC (DTX/DRX)	Yes
3-cell QICE (3-2-2 iterations per carrier) with RxD	Yes
APT/EPT	Yes
WCDMA AS Div	Yes
DB-DC-HSDPA	No
Multiflow HSDPA SF-DC	No
HSUPA Cat 6 5.76 Mbps	Yes
DC-HSUPA Rel9 Cat 8 11.2 Mbps	No
Scalable-UMTS	No

Modem Capabilities (cont.)

Feature	MSM89x7
TD-SCDMA	
TDS HSUPA Cat 5/6 (2.2 Mbps)	Yes
TDS HSDPA Cat 24 64 QAM (4.2 Mbps)	Yes
RxD	No
APT/EPT	Yes
TD-SCDMA ASDiv	No
CDMA	
DOrA (3.1/1.8 Mbps fwd/rev)	Yes
DOrB Multi-AT Page	No
DOrB 1-carrier 4.9Mbps	No
1xAdvanced (RC11/RC8 fwd/rev SCH 307 kbps)	Yes
RxD	Yes
ASDiv	Yes
gRICE	Yes
APT/EPT	Yes

Modem Capabilities (cont.)

Feature	MSM89x7
LTE	
LTE Cat4	Yes
eMBMS	Yes
VoLTE	Yes
TM9 (FDD up to 4 Tx – TDD up to 8 Tx)	No
Rel-11 ZUC	Yes
Rel-11 Special Subframe for TDD	Yes
LTE Rel-10 MDT with Location info	Yes
TDD SDL (Rel-12 proposal only at this time, not yet study item)	No
FDD LTE Cat 4 intraband non-contiguous CA 2x10 MHz	Yes
FDD LTE Cat 4 intraband contiguous CA 2x10 MHz	Yes
TDD LTE Cat 4 interband CA 2x10 MHz	No
TDD LTE Cat 4 intraband non-contiguous CA 2x10 MHz	No
TDD LTE Cat 4 intraband contiguous CA 2x10 MHz	No
FDD LTE Cat 4 interband CA 2x10 MHz	Yes
LTE TDD Interfreq measurement without Gap for CA	No
QCF – Hotspot offload	No
QCF – VoIP offload	No
QCF – RLC aggregation	No
IPv6 prefix delegation	No
UL 64 QAM	Yes

Modem Capabilities (cont.)

Feature	MSM89x7
Multitechnology features	
Single-SIM	
SLTE	No
SR-LTE (LTE 1x Hybrid mode)	Yes
SV-LTE(FDD/TDD)	No
SV-LTE with 1Tx/1 Rx (LTE Cat 4)	No
SV-LTE with 1Tx/2 Rx (LTE Cat 4)	No
S-HDR single band	No
SV-DO single band	No
SG-LTE	No
SG-LTE with 1x/2Rx	No

Modem Capabilities (cont.)

Feature	MSM89x7
Dual-SIM Dual-Standby (DSDS)	
DSDS W/G+G	Yes
DSDS TDS/G+G	Yes
DSDS C+G	Yes
DSDS HSUPA Cat 6	Yes
DSDS L/W/G+G with CSFB to W/G	Yes
DSDS L/TDS/G+G with CSFB to TDS/G	Yes
DSDS W (Cat24/Cat8 DL/UL)/G+G	No
DSDS 1xSRLTE+G	Yes
DSDS VoLTE+G	Yes
DSDS eMBMS+G	Yes
DSDS L+C	Yes
DSDS LTE/W/G+G (LTE Cat 4 with 2x10 MHz CA)	Yes
DSDS LTE/W/G+G (LTE Cat 6 with 2x20 MHz CA)	No
Triple-SIM Triple-Standby	No
DSDA	No
DRDS	No

MSM89x7 Definition Snapshot

Feature/Technology	MSM8937	MSM8917
LTE	Cat4 20 MHz ▪ Supports CA	Same as MSM8937
UMTS	Cat24 DC-HSPA + 42 Mbps, single carrier HSUPA	Same as MSM8937
GERAN	EGPRS R99 592/236.9 kbps (MSC 33) ▪ Supports GERAN-EV TDEC	Same as MSM8937
1xA	1xAdvanced – 307.2 kbps FL/307.2 kbps RL	Same as MSM8937
DO	▪ Supports Rev A single carrier ▪ Does not support Rev B	Same as MSM8937
SRLTE	1X + LTE with single radio ▪ One active RAT, other in standby ▪ No SVDO or SVLTE, SGLTE, SGTDS	Same as MSM8937
TD-SCDMA	CCSA Rel 3/HSDPA/HSUPA/DL Cat 24 4.2 Mbps	Same as MSM8937
Multi-SIM	DSDS ▪ No DSDA	Same as MSM8937

Modem Capabilities

- Technology-specific data rates

Air interface	Standard reference	Peak data rates
CDMA2000	3GPP2 IS-2000 Release C, E, F 1X Advanced	▪ DL – 307.2 Kbps ▪ UL – 307.2 Kbps
1xEV-DO	3GPP2 1xEV-DO Release A	▪ DL – 3.1 Mbps ▪ UL – 1.8 Mbps
GERAN	▪ EDGE Multislot Class 33 ▪ 2-carrier DL	▪ DL – 236 Kbps ▪ UL – 59.2 Kbps
WCDMA	▪ 3GPP Release 8 ▪ Cat24 HSDPA and Cat6 HSUPA	▪ DL – 42.2 Mbps ▪ UL – 5.76 Mbps
TD-SCDMA	▪ CCSA Release 3 ▪ Cat23	▪ DL – 4.2 Mbps ▪ UL – 2.2 Mbps
LTE FDD	▪ 3GPP Release 8 – Cat4 ▪ 20 MHz interband CA	▪ DL – 150 Mbps ▪ UL – 50 Mbps
LTE TDD	▪ 3GPP Release 8 – Cat4 ▪ Configure 5 DL, Configure 1 UL	▪ DL – 130 Mbps ▪ UL – 35 Mbps

Modem Capabilities (cont.)

- Modem subsystem comparison

Feature	MSM8937	MSM8917
CDMA2000 1X	✓	✓
1xAdvanced	✓	✓
SVLTE	–	–
GSM/EDGE	✓	✓
WCDMA R99	✓	✓
UMTS HSDPA	Cat24	Cat24
	42.2 Mbps	42.2 Mbps
UMTS HSUPA	Cat 6	Cat 6
	5.76 Mbps	5.76 Mbps
HSPA+	✓	✓
QICE for HSPA+	✓	✓
Dual-carrier HSDPA+	✓	✓
Dual-carrier HSUPA+	–	–
LTE	✓	✓
TD-SCDMA	✓	✓
GPS	Gen8C Lite	Gen8Cf
ET support	–	–
Shared software/firmware Hexagon processor	✓	✓
Shared modem software/firmware + voice Hexagon processor	✓	✓
CA	✓	✓
DSDA	–	–

Tune-Away Support in MSM8937/MSM8917

SIM1/SIM2	To GSM	From GSM	From CDMA	To CDMA
GSM	Y	Y	N	Y
WCDMA	Y	Y	N	Y
TD-SCDMA	Y	Y	N	Y
CDMA	N	Y	X	X
DO	Y	N	X	X
LTE	Y	N	N	Y

X – Not applicable

RF Card Details

- Key WTR2965 device advantages are summarized in the table
- QFEs supported from the Qualcomm® RF Front End (RFFE) solution are QFE2340, QFE4320, QFE4373, QFE430X, QFE2550, QFE2101, and QFE1040.

Characteristics	WTR2965
Operating bands	▪ LTE-FDD – B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, B11, B12, B13, B14, B17, B18, B19, B20, B21, B23, B24, B25, B26, B27, B28, B29, B30, B32 ▪ LTE-TDD – B33, B35, B36, B37, B38, B39, B40, B41/B41-XGP, B44 ▪ WCDMA – B1, B2, B3, B4, B5, B6, B8, B9 ▪ TD-SCDMA – B34, B39, B40 ▪ CDMA – BC6, BC1, BC15, BC0 ▪ GSM – 1900, 1800, 850, 900
WAN Tx outputs	4 – All wideband for flexibility
WAN Tx driver amplifiers	1 – Supports all bands
WAN PRx inputs	8 – 3 LB, 3 MB, 2 HB
WAN DRx inputs	8 – 3 LB, 3 MB, 2 HB
WAN downconverters	3 – 1 PRx, 1 DRx, 1 SAWless
Rx LO distribution	Simplified (fewer down converters)
Package	3.29 x 3.26 mm fan-out, wafer-level
Number of pins and pitch	59 pins at 0.40-mm pitch

Cat4 and CA Support

Cat4 and CA Support

- Capable of supporting Cat4 data rates DL/UL 150/50 (FDD) and 130/35 (TDD)
- With 64 QAM enabled, UL can increase by 25 Mbps
- Supports CA on FDD only
  - Supports 10 + 10 MHz interband and intraband CA
- CA is ON by default
- CA can be disabled by setting /nv/item_files/modem/lte/common/ca_disable to 1

Note: For more details on the DL CA bands that are supported in different RF cards, see *RFC configuration in MSM89x7 RF Software Overview* (80-P2485-3) document.

Modem Virtual System Timer (VSTMR) Implementation

Modem VSTMR Implementation

- System timer (STMR) is a counter, which maintains a time reference at a specified rate. In MPSS.DPM.1.x (Dime) and earlier modems, there were technology-specific blocks that provided the STMR functionality corresponding to each technology.
  - For 1X, this rate is Chipx8 (1.2288 MHz x 8)
  - For LTE, this rate is 30.72 MHz
- In MSM89x7 modem, technology-specific STMRs are replaced with a single universal STMR, which runs at XO clk – 19.2 MHz.
- This is achieved by having a translation service in software code, which helps in performing the translation from base XO timeline to technology-specific timeline. This implementation is referred to as VSTMR.

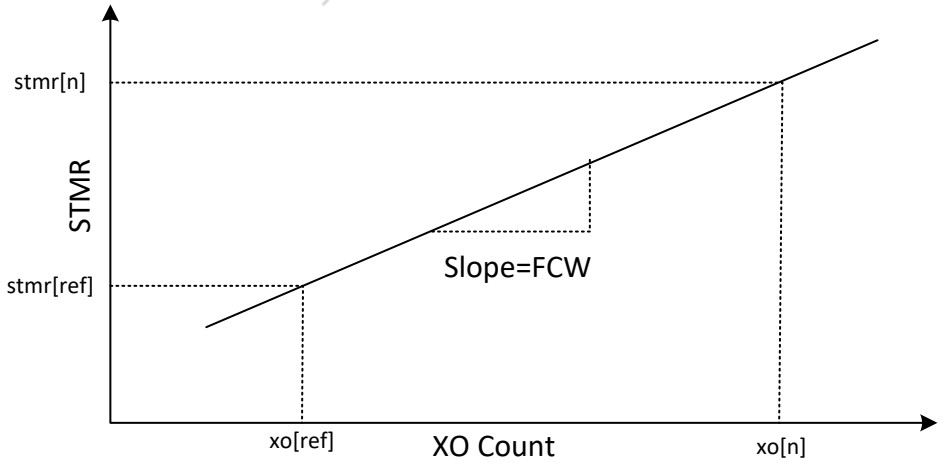
VSTMR Counter Implementation

- The desired STMR rate is a linear function of XO count, as shown in the figure below. Frequency code word (FCW) is the slope of the line.
- The relationship can be expressed as:

$$stmr[n] = stmr[ref] + (xo[n] - xo[ref]) * FCW$$

- FCW is defined as a ratio of STMR rate to XO (19.2 MHz), converted to a fixed-point value. Using signed Q30 provides ratios up to 2*XO, which is adequate for all technologies:

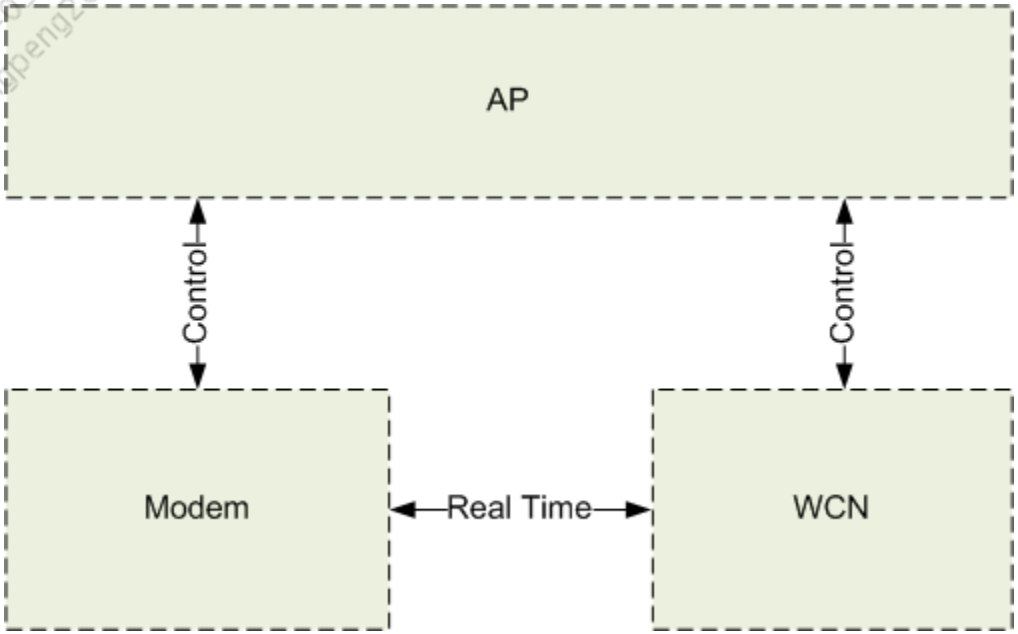
$$FCW = \frac{rate_{stmr}}{rate_{xo}} * 2^{30} = \frac{rate_{stmr}}{19.2\ MHz} * 2^{30}$$



WLAN-WAN Coexistence

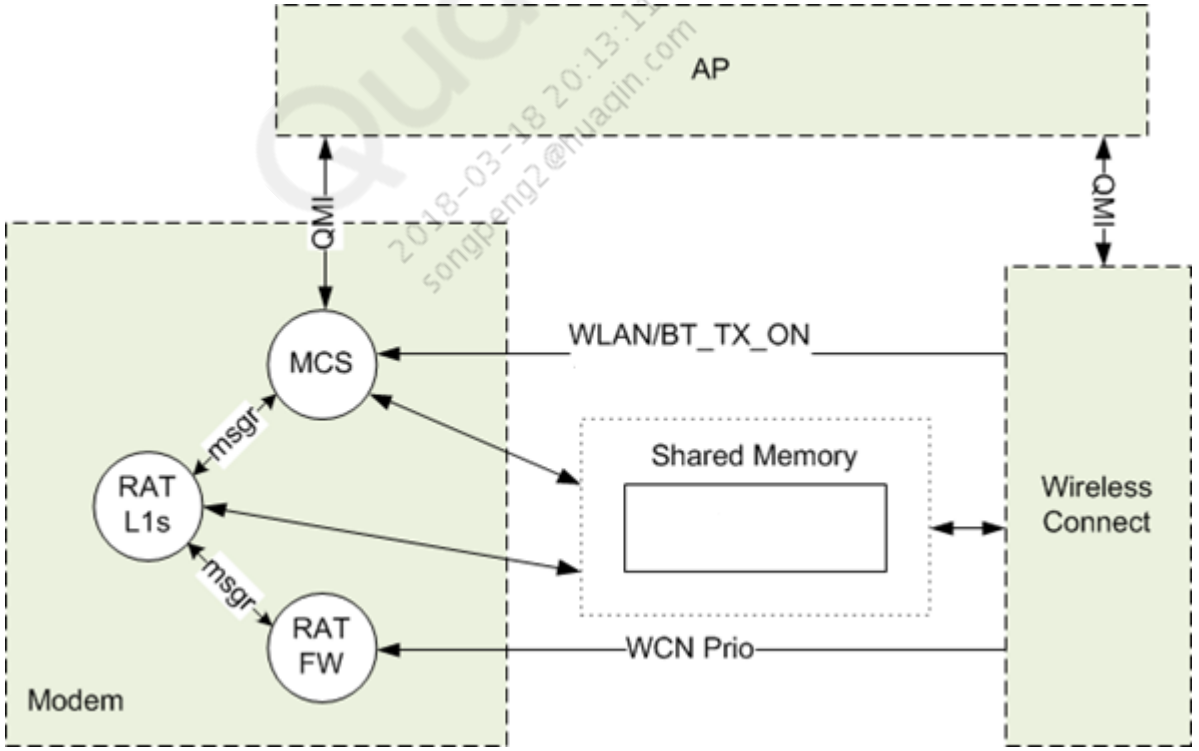
WLAN-WAN Coexistence

- The functionality is similar to the MSM8916 coexistence feature
- High-level requirements
  - Control data exchange between the APSS and modem:
    - RAT channel information
    - WCN channel information
    - Power limiting
    - Metrics
  - Real-time data exchanged between the modem and WCN:
    - Frame timing
    - Modem Tx activity
    - Modem Rx activity
    - WCN priority actions
    - Advance Tx notify
    - Tracking inactivity duration



High-Level Architecture

- Control messaging exchange between modem and APSS via QMI
- Real-time “data plane” messaging through shared memory:
  - Shared memory communication between modem and WLAN
  - For interprocessor communication, interrupts are required in every way between WCN and WAN modem



Coexistence Software Features

- LTE-WLAN coexistence handling is converted to use shared memory, instead of the legacy QMI-Lite for scalability with the support of multiple RATs.
- TD-SCDMA real-time coexistence handling is included; currently, only basic channel avoidance is implemented.
- GSM real-time coexistence handling is implemented through this feature.
- Coexistence algorithms on the modem can be extended to use BT_TX_ON and WLAN_TX_ON.
- An SMSM state is maintained for both sides to notify Sleep/Awake status to the other side. This value is then read before sending to ensure that the other side is not being woken up for the message. There must be no requirement for any message to actually wake up the other side.
- There is no external WCI-2 support.

Data Module

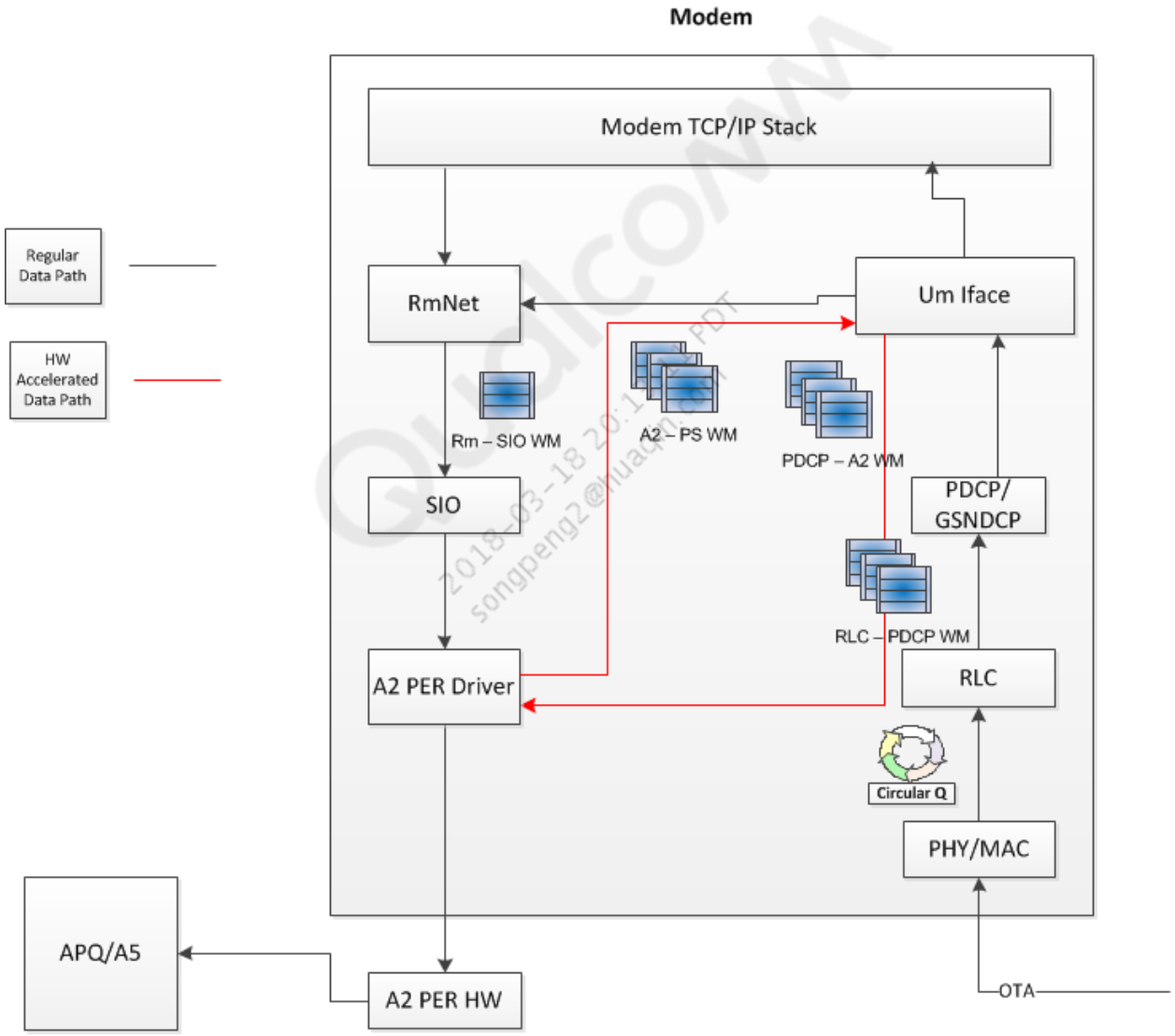
- Accelerate DL path (A2 path) for LTE/WCDMA/GSM
- Make data path manager (DPM) new module work with A2
  - DPM manages L2 – A2 and A2 – PS WMs
  - Generates UID for each bearer
  - Manages bridging and unbridging of bearers
  - Uses a common signal handler for all RATs
  - Same logic for all 3GPP RATs resulting in consistent behavior
- Optimize the UL and DL data path
- Dynamic port configuration (this can be static but dynamic is preferred)
- Single QMUX control channel
  - Use single QMUX channel and bind QMI clients to it

Note: The new profile technology type, EPC, is not recommended for MSM89x7.

Data Module (cont.)

- QMAP muxing
  - Netmgrd uses config_db to enable/configure RMNET_DATA on top of BAM, and uses WDA to negotiate these parameters with the modem
  - RMNET_DATA to support QMAP muxing and DL aggregation
- Unified storage format for all 3GPP and eHRPD profiles
- Support for WLAN offload scenarios
  - Interworking WLAN (IWLAN) with WWAN – Use of WLAN to access EPC core via the IWLAN_S2B connectivity interface through ePDG per the 3GPP Rel 8 and Rel 10 specifications.
    - Allows IP continuity between WLAN and WWAN EPC technologies (LTE, EHRPD, and so on)
    - Support for MAPCON where PDNs can coexist and connect to the network backend via both WLAN and WWAN RATs simultaneously
    - NSWO – Use of WLAN to directly access the Internet without going through EPC

DL, UL Data Path Architecture for all RATs on MSM89x7



Note: LTE uses circular Q instead of RLC-PDCP WM, similar to earlier chipsets.

References

Title	Number
Qualcomm Technologies, Inc.	
MSM89x7 RF Software Overview	80-P2485-3
Standards	
Mobility between 3GPP-Wireless Local Area Network (WLAN) Interworking and 3GPP Systems	3GPP TS 23.327
3GPP Systems to Wireless Local Area Network (WLAN) Interworking; System Description	3GPP TS 23.234

Acronym or term	Definition
DPM	Data path manager
FCW	Frequency code word
QICE	Qualcomm interference cancellation and equalization
QMI	Qualcomm MSM interface
QMUX	QMI multiplexing protocol
QMAP	Qualcomm MUX and aggregation protocol
RFFE	RF front end
VSTMR	Virtual system timer

Questions?

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