Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** <**http://grouper.ieee.org/groups/802/20/**>
Title	**802.20 Technical Overview Presentation**
Date Submitted	**2007-01-15**
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Re:	MBWA Call for Proposals
Abstract	This contribution contains a Technology Overview for a Mobile Broadband Wireless Access (MBWA) system that meets the requirements for the future IEEE 802.20 standard. Both TDD and FDD technologies are included in this document, since there is much in common between the two approaches.
Purpose	For consideration of 802.20 in its efforts to develop an MBWA specification.
Notice	
Release	
Patent Policy	

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Outline of Forward Link (FL) Proposal

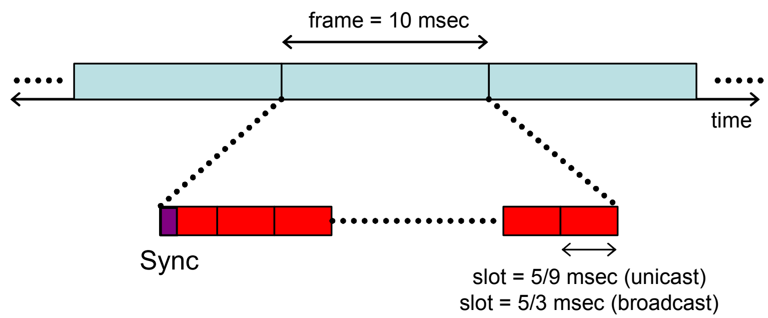
- FL Design Goals
- FL Slot Structure
- FL Unicast Data Frame
- Voice over IP
- FL Unicast Numerology
- Resource Management
- System Timing and Acquisition
- FL Pilot Structure
- FL Transmission Formats
- Control Channels
- FL Antenna System

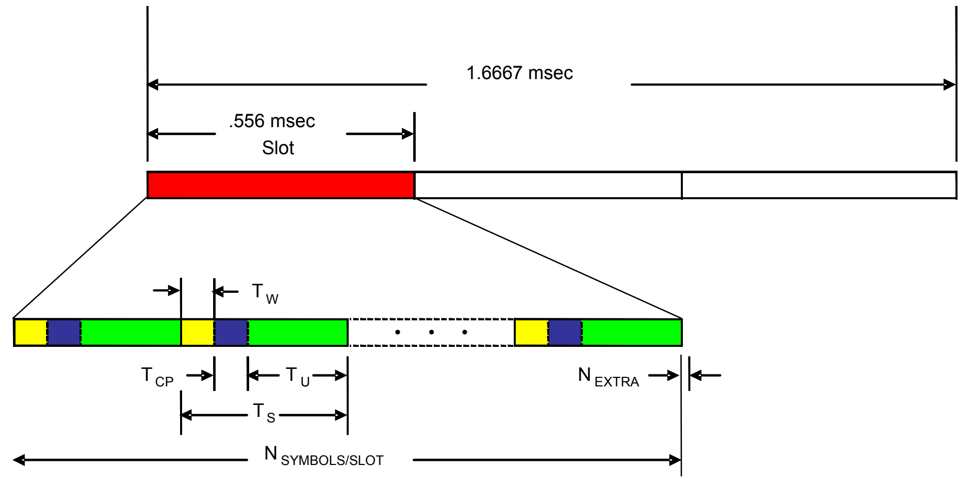
Forward Link Design Goals

- **High data rate, low latency and packet-optimized radio access**
- **Improved Spectral Efficiency**
- **Scalable numerologies, with bandwidths from 1.25MHz to 20MHz**
- **Overhead controlling VoIP minimized**
- **Tolerance for Doppler/Delay spread, phase noise**
- **Low latency**
  - Faster data retransmissions
  - 5 ms for nominal synchronous HARQ mode
- **Multiple Data streams using MIMO**

FL Slot Structure

- **Unicast**
  - 5/3 ms slot divided into 3 OFDM slots
  - 5 OFDM symbols per OFDM slot
  - 4.1 < CP < 6.5 usec urban, 34.2 usec hilly terrain
  - Ramp used to shape spectrum for wide BW
  - Clock based upon N x 1.2288 MHz, where N is an integer
- **Broadcast**
  - Slot length is 5/3 ms
  - 13 OFDM symbols per slot





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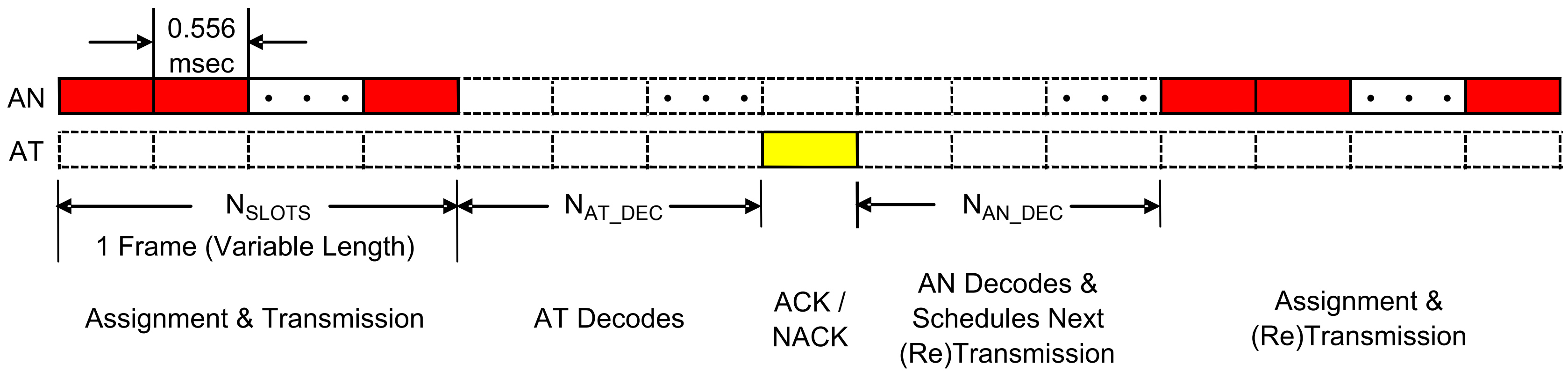
FL Unicast Data Frame (1/2)

- **Use of synchronous and asynchronous HARQ is proposed**
- **Multiple simultaneous HARQ channels**
- **Synchronous HARQ**
  - Fixed relationship between initial and subsequent transmissions
  - Less control overhead required
  - Multi-slot frame
- **Asynchronous HARQ**
  - Multi-slot frame, variable timing, no fixed relationship
  - More control required



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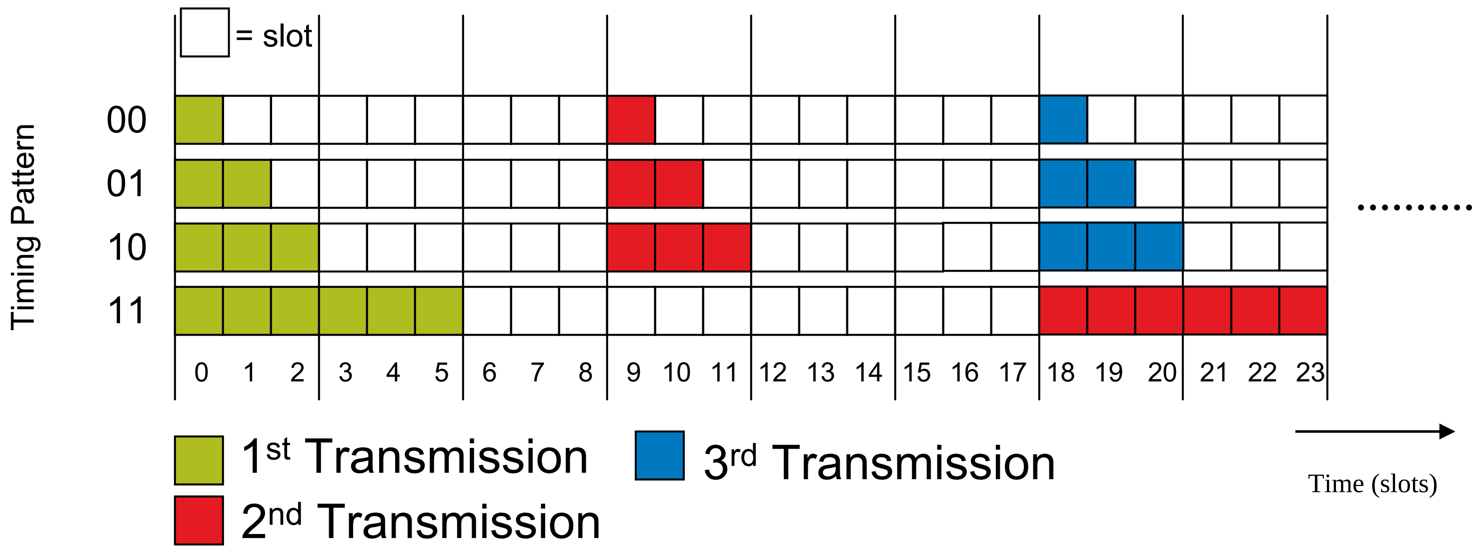
FL Unicast Data Frame (2/2)

- **Variable frame sizes**
  - One slot frame is the most commonly used frame format. Allows sufficient time for AN/AT processing.
  - Two and three slot frames allows more data to be transmitted quickly when CQI is good, while still allowing sufficient time for AN/AT processing.
    - **This is accomplished with only one control channel message**
    - **Three slot frame beneficial for VoIP, since it allows more users per frame thereby resulting in more statistical multiplexing gain.**
  - Six slot frame improves coding gain for weak users with latency tolerant applications



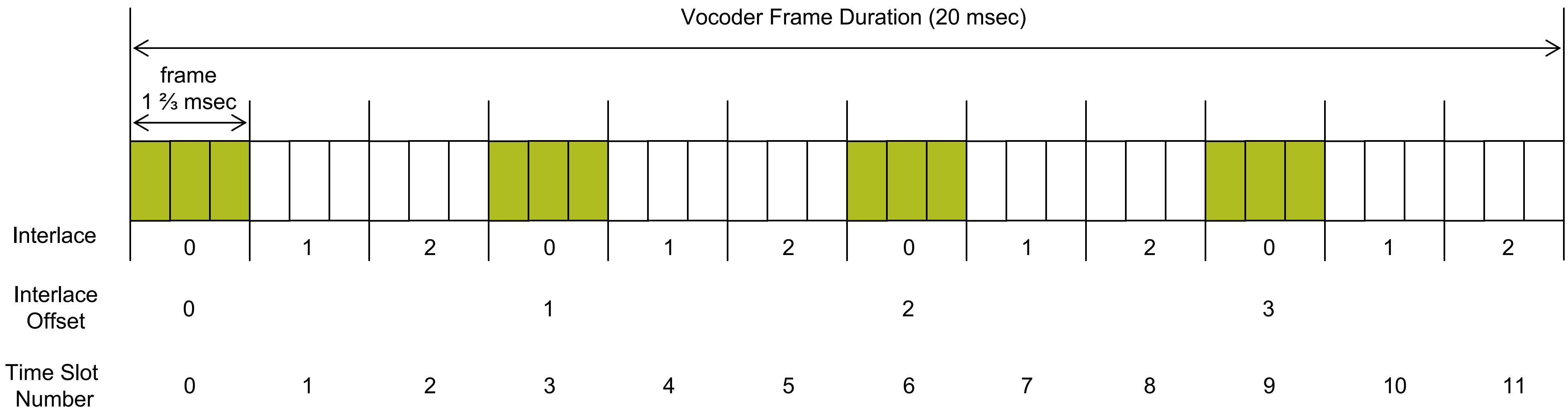
Voice over IP (1/4)

- **Basic Design**
  - Group VoIP users together and assign the group a set of shared time-frequency resource
    - **Two forms of statistical multiplexing possible**
      - ➢Among group members
      - ➢Between initial and subsequent transmissions
  - Unused portion of the shared time-frequency resource can be temporarily assigned to other non-VoIP users
  - Minimize control channel overhead
    - **Control channel overhead can be divided into two parts**
      - ➢Call setup messages
        - Overhead minimization less crucial
        - Group users and address the group (allocate resources, etc.) with a group ID
      - ➢Frame by frame messages
        - Overhead minimization crucial
        - Bitmap signaling is used to distribute resources among users with minimum control

Voice over IP (2/4)

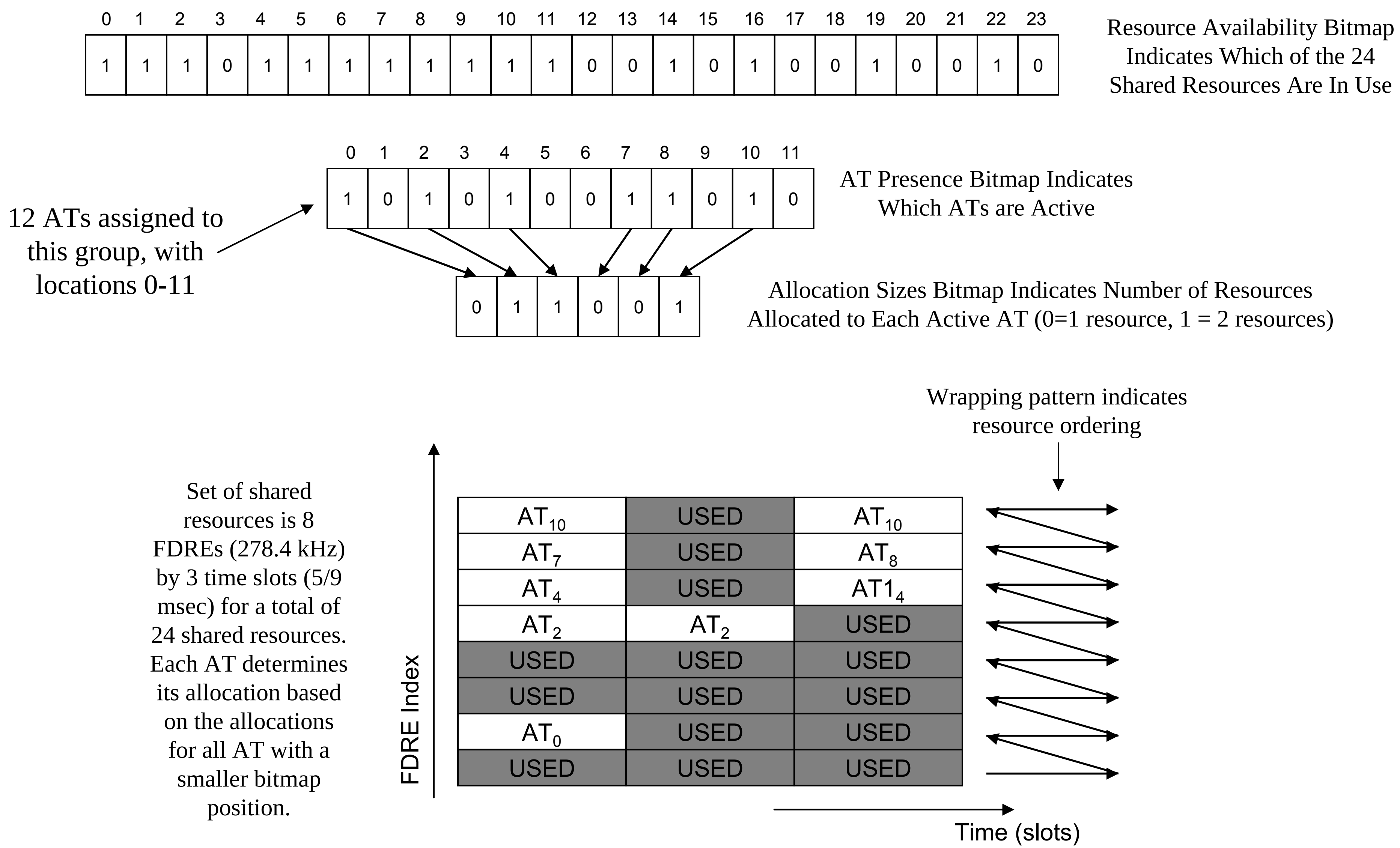
- **3 contiguous slots are concatenated to form a VoIP frame**
  - Transmissions at 5 ms intervals allow up to 4 transmissions per vocoder frame (20 ms) without additional delay
- **ATs are assigned resources in each frame using bitmap signaling**
  - Group would be assigned a set of shared resources persistently.
  - Bitmap signaling is used to determine the exact resource for each AT in each group.
  - Bitmap signaling is used for first and subsequent retransmissions.
  - Bitmap consists of 3 parts:
    - **A Resource Availability Bitmap is used to indicate which of the set of shared resources are in use**
    - **An AT Presence Bitmap is used to indicate which ATs are being served in each voice frame, where each AT corresponds to a location in the bitmap**
    - **An Allocation Sizes or Packet Formats bitmap may be used to indicate number of assigned resources and/or MCS.**
  - Assigned an ACK position based upon relative position in AT Presence Bitmap allows ACKs to be time-multiplexed.

Voice over IP (3/4)



- **ATs are placed into groups (e.g. QPSK group, 16-QAM group, etc)**
  - The same GroupID is assigned to every AT in the group
    - **The GroupID can be used to control the entire group at once, e.g. change the set of shared time-frequency resources**
  - The group is assigned a set of shared time-frequency resources
  - Each AT is assigned a unique location within the group's AT presence bitmap
  - Each AT is assigned an interlace offset indicating in which frame its first transmission will occur
    - **¼ of ATs in the group are assigned to each of the four interlace offsets**
    - **When Resource Availability Bitmap is used, ATs can be assigned a resource once per vocoder frame (i.e. the resource assigned during the ATs interlace offset persists until the next occurrence of the interlace offset)**

Voice over IP (4/4)



FL Unicast Numerology

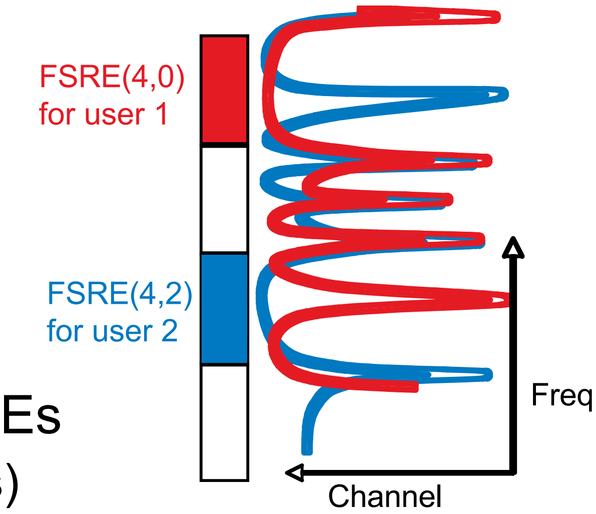
Key Characteristics:

- Uses integer multiple of 1.2288 MHz clock
- 9.6 kHz subcarrier spacing
- Spectrum allocation in steps of 278.4kHz subchannels for frequency selective fading environments
- 16 subchannels in 5 MHz channel

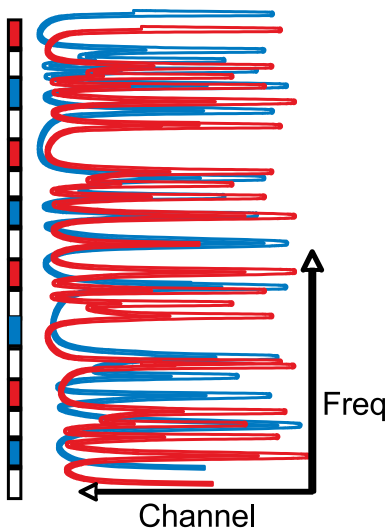
Parameter	Units	Carrier Bandwidth (MHz)					
		1.25	2.5	5	10	15	20
OFDM Slot Duration	ms	0.5556	0.5556	0.5556	0.5556	0.5556	0.5556
OFDM Oversampling Factor (M/N)	(x1.2288MHz)	**1.00**	2.00	4.00	8.00	12.00	16.00
OFDM Sample Rate	Msps	1.2288	2.4576	4.9152	9.8304	14.7456	19.6608
FFT Size		**128**	256	512	1024	1536	2048
# of OFDM Symbols Per Slot		**5**	5	5	5	5	5
OFDM Symbol Duration Total - T_s	us	110.68	110.68	110.68	110.68	110.68	110.68
Useful Symbol Duration - T_u	us	104.17	104.17	104.17	104.17	104.17	104.17
Cyclic Prefix Samples		**8**	**16**	**32**	**40**	**72**	**96**
Cyclic Prefix Duration - T_{CP}	us	6.51	6.51	6.51	4.07	4.88	4.88
Subcarrier Spacing	kHz	9.60	9.60	9.60	9.60	9.60	9.60
# of DC Subcarriers		**1**	1	1	1	1	1
# of Useful Subcarriers Chosen		**116**	**232**	**464**	**928**	**1392**	**1856**
# of Guard Subcarriers - Left		6	12	24	48	72	96
# of Guard Subcarriers - Right		5	11	23	47	71	95
# of Sub-channels		4	8	16	32	48	64
# of Useful Subcarriers/Subchannel		**29**	**29**	**29**	**29**	**29**	**29**
Subchannel Bandwidth	kHz	278.40	278.40	278.40	278.40	278.40	278.40
Occupied Bandwidth	MHz	1.12	2.24	4.46	8.92	13.37	17.83
Spectral Occupancy	%	89.9%	89.5%	89.3%	89.2%	89.2%	89.1%

Frequency Domain Resource Options

- **Frequency Selective Resource Element (FSRE)**
  - Allocate 1 to 16 contiguous subchannels and use frequency selective scheduling to optimize spectrum utilization for AT at that instant
  - Optimizes system for total data capacity
  - Suitable for best-effort traffic
  - Can also allocate multiple non-contiguous FSREs
    - Frequency Diverse Resource Elements (FDivREs)



- **Frequency Distributive Resource Element (FDRE)**
  - Equally spaced subcarriers across FSRE (can be entire carrier BW) to average out frequency selective fading
  - Suitable for low-latency, rate-reserved users, those moving at high speeds, those with low SINRs
  - Subcarrier positions hop from one OFDM symbol to the next to average interference



Selective and Distributive Transmission (1/2)

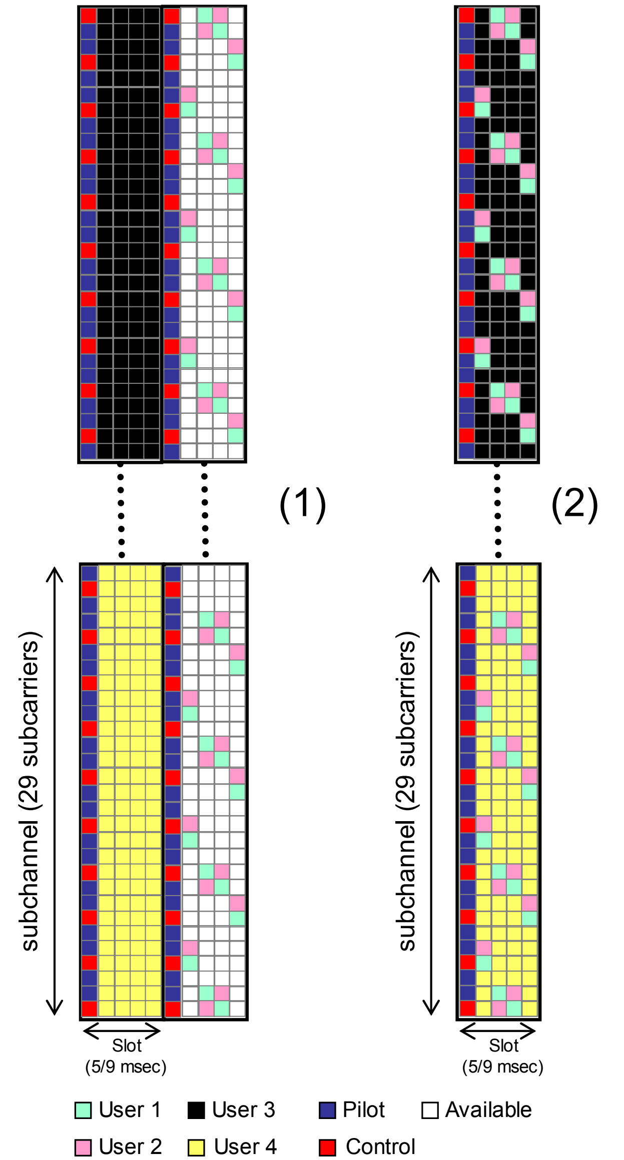
- **There are four options for multiplexing FSREs, FDREs and FDivREs:**

1. Time-multiplex between subchannel-based and subcarrier-based allocations

- Users 3 and 4 are assigned FSREs in first time slot, users 1 and 2 are assigned FDREs in a 2nd time slot
  - **Simplest mechanism for mixing subchannel-based and subcarrier-based allocations**
- Occurs at frame level

2. Users 1 and 2 are assigned FDREs first, then users 3 and 4 are assigned FSREs

- Users 3 and 4 must know location of FDRE users in subchannel



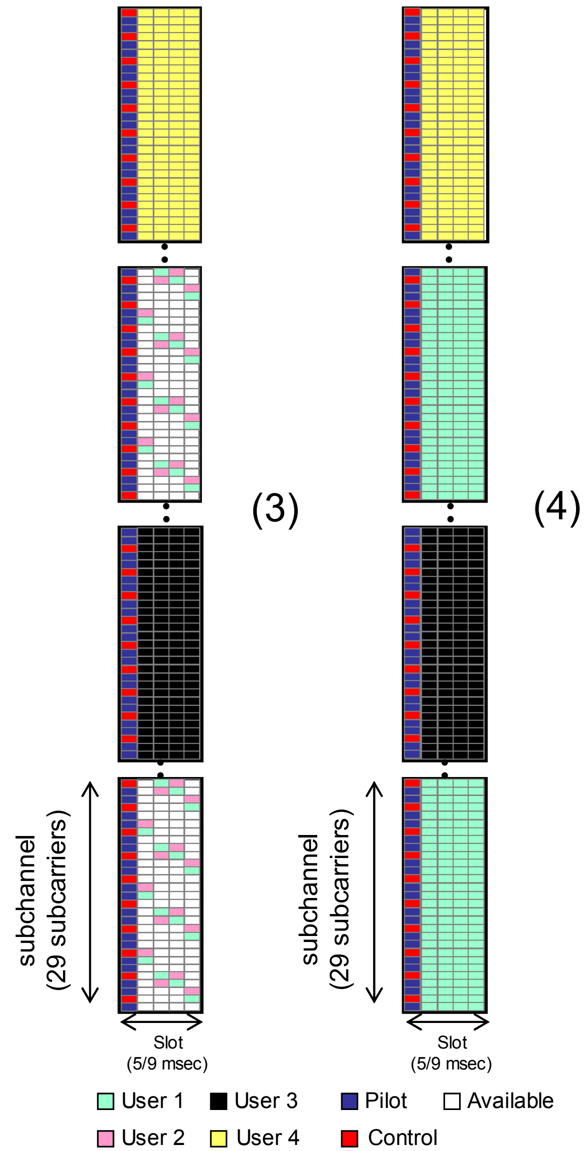
Selective and Distributive Transmission (2/2)

3. Users 3 and 4 are assigned FSREs first, then users 1 and 2 are assigned FDREs

- FSREs and FDREs are not shared in an individual subchannel, as in option 2
- Users 1 and 2 must know where FSRE users are in parent FSRE
  or have their FSRE signalled to them

4. Users 3 and 4 are assigned FSREs while user 1 is assigned an FDivRE

- Only subchannel allocations are allowed, so no need to signal presence of one user to another user
- User 1 is frequency diverse

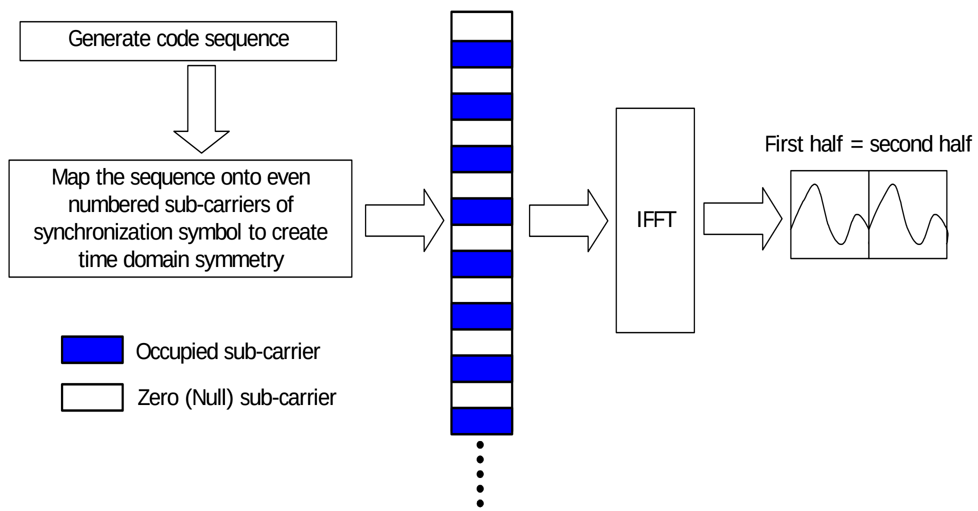


System Timing and Acquisition

- **Acquires timing/frequency synchronization AND initial cell identification quickly**
- **Uses one OFDM symbol per 10ms radio frame**
  - Use Generalized Chirp Like (GCL) sequence for sync symbol:

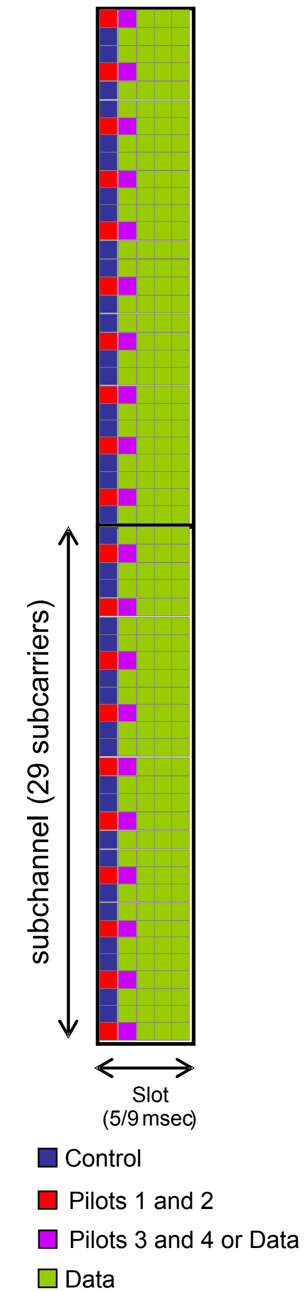
$$s_u(k) = \exp\left\{-j2\pi u \frac{k(k+1)}{2N_G}\right\}, k = 0 \cdots N_G - 1, \quad u = 1 \cdots N_G - 1, \quad u = cell\,index, N_G = prime > \frac{num\_useful\_subcarriers}{2}$$

  - GCL sequence is mapped onto even-numbered subcarriers of sync symbol
  - Time domain symmetry enables simple differential correlation (using $T_u/2$ spacing) without knowing specific sequence for timing and frequency sync
    - **Symbol and radio frame timing identified by detecting peak of differential correlation**
    - **Frequency offset identified by detecting phase of differential correlation**
  - After synchronization, derivative of phase across subcarriers identifies sequence
    - **232 sequences in 5 MHz to distinguish different cells (more can be defined)**
  - Low peak to average power ratio enables power boosting for good coverage



FL Pilot Structure

- **First OFDM symbol per slot has pilot symbols for antennas 1 and 2**
  - Allows receiver to use pilots immediately, without buffering data
  - Enables microsleep
- **Later OFDM symbol has optional antennas 3 and 4 (or more)**
- **Pilots for antennas in the same pairing (1 and 2, 3 and 4) are separated by cyclic shift**
  - All TX antennas in a sector send same pilot sequence with different cyclic delays
  - Antennas 1 and 2 are orthogonal to antennas 3 and 4 in time
  - Antenna 1 is orthogonal to 2 by cyclic shift, and antenna 3 is orthogonal to 4 by cyclic shift
- **Pilots are placed on every third subcarrier**
  - Sufficient frequency resolution and pilot power for channel estimation in high-delay-spread SCM channels
- **Dedicated pilots (not shown) improve channel estimation for 64 QAM and some multiple antenna schemes**
- **Pilots are composed of different GCL sequences for each sector**
  - Excellent cross/auto correlation characteristics
  - Low peak to average power ratio allows power boosting



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FL Transmission Formats

- **Choice of formats**
- **Packet size range is [128,61440] bits for 5 MHz carrier, and varies based upon:**
  - Number of subchannels assigned (1 – 16)
  - Number of slots assigned (1 – 6)
  - Modulation (QPSK, 8PSK, 16 QAM, 64QAM)
  - Coding (R=1/5 & R = 1/3 turbo coding) but effective coding rate for one transmission is up to 0.92
- **Produces peak rate of 18.432 Mbps in 5 MHz for one stream**
  - 64-QAM, coding rate = 0.92, packet size is 10,240 bits
  - All systematic bits sent in first transmission
- **8 transmissions max, preferred average 2-4**
- **Smallest packets use one subchannel**
  - Up to 2048 bits, with six slots, code rate = 0.49

Example Data Rates for Peak Condition in 5 MHz

Data Rate Number	Physical Layer Packet Size (bits)	Number of Adjacent Subchannels	Number of slots in 1 Trans.	Eff Code Rate 1st Trans	Number of Trans to Optimize for	Eff Code Rate Nth Trans	Turbo Code Rate	Mod (Bits / OFDM Sym)	1 Trans Peak Data Rate (kbps)	N Trans Data Rate (kbps)
55	10240	16	1	0.920	2	0.460	0.33	6	18432.0	9216.0
62	61440	16	6	0.920	2	0.460	0.33	6	18432.0	9216.0

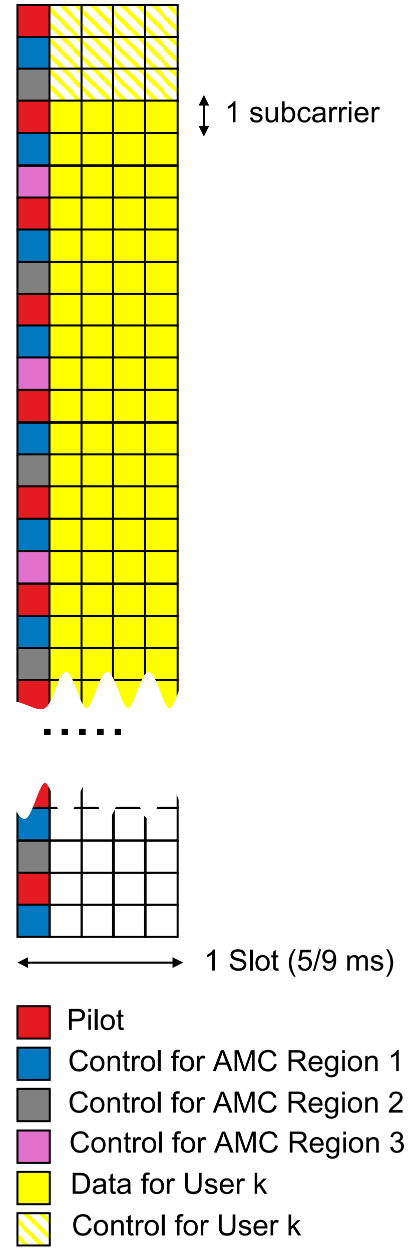
FL Control Channels

Shared control

- Shared control region is TDM'ed at beginning of frame
  - **Enables micro-sleep mode**
  - **Provides good channel estimation (located with pilots)**
  - **Uses frequency distributed resource elements**
- Separated into multiple AMC control regions
  - **ATs with similar RX powers are grouped in same AMC region and coded together**
  - **Each region uses different modulation and coding rate to transmit shared control information**
  - **Efficient - enables modulation and coding of control to adapt to user's SINR**
  - **Region size may be fixed or dynamic**
- Contains AT IDs and their frequency and slots assignments, antenna configuration, etc

Dedicated control possible

- Data-associated control information
  - **HARQ and new data indicator**
  - **MIMO configuration**
- Sent at beginning of resource region assigned to AT
- Encoded separately from data
- May be repeated for edge-of-cell coverage
- Assign reduced control information set to VoIP ATs



FL Antenna System (1/3)

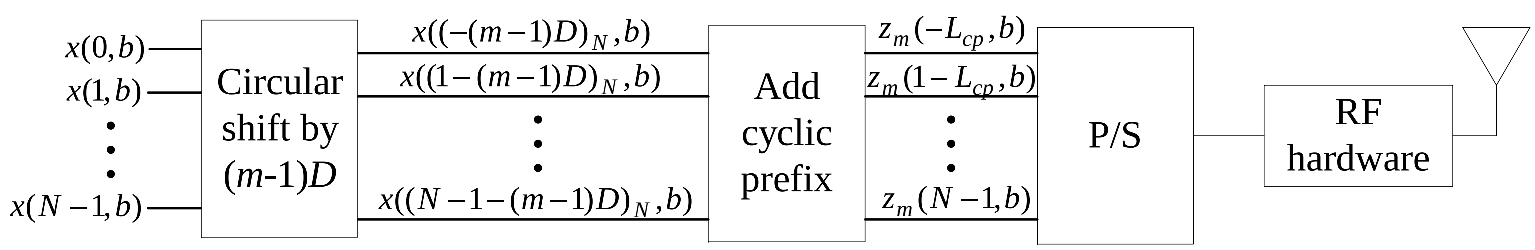
- **Use multiple antennas to increase system capacity**
  - Up to 4 transmit antennas and 2-4 receive antennas on FL
- **Support open- and closed-loop MIMO for data channels**
  - Select open- or closed-loop based on AN's need for channel state info.
  - Prefer closed loop for its higher potential gains
    - **Maximum benefit for < 30 km/h**
  - Dynamically adapt between single- and multi-stream as environment dictates
- **Use transmit diversity techniques for control channels**
  - Cyclic shift diversity
  - Space Time Block codes

FL Antenna System – Data Channel (2/3)

- **Support pre-coded MIMO**
  - AT feedback indices of weight codebooks based on its channel covariance matrix for group of sub-channels.
- **Support single user and multi-user MIMO**
  - AN can serve AT with multiple streams in TDM mode
  - AN can also serve multiple ATs simultaneously over multiple streams (SDMA) on the same subchannels
- **Support opportunistic beamforming**
  - Pilots on TX antennas rotate with predefined set of phases
  - ATs feed back regular CQI
  - AN decides which phase set constructs best combined channel conditions
- **Open-Loop Mode:**
  - Transmit diversity with Cyclic Shift Diversity and STBC
  - To be used together with FDRE

FL Antenna System – Control Channels (3/3)

- **Can’t use beamforming for common control, as beamforming is AT-specific**
- **Use transmit diversity technique**
  - Uses power from all AN antennas
  - Reduces range imbalance between broadcast control channels and beamformed data channels
- **Option 1: Space Time Block codes**
  - Symbols transmitted from all antennas using multiple symbol times
- **Option 2: Cyclic Shift Diversity**
  - Adaptation of delay diversity to OFDM
  - Each antenna element sends circularly-shifted version of same OFDM symbol.
  - Achieves transmit diversity benefit through coding/decoding process
  - Simpler to process than STBCs for > 2 antennas
    - **Cyclic shift channel looks like single transmit antenna channel**
    - **With 4 TX antennas, 4 data symbol times or subcarriers needed to transmit code**
      - ➢Variations across time and freq can be substantial: cyclic shift diversity is much simpler.



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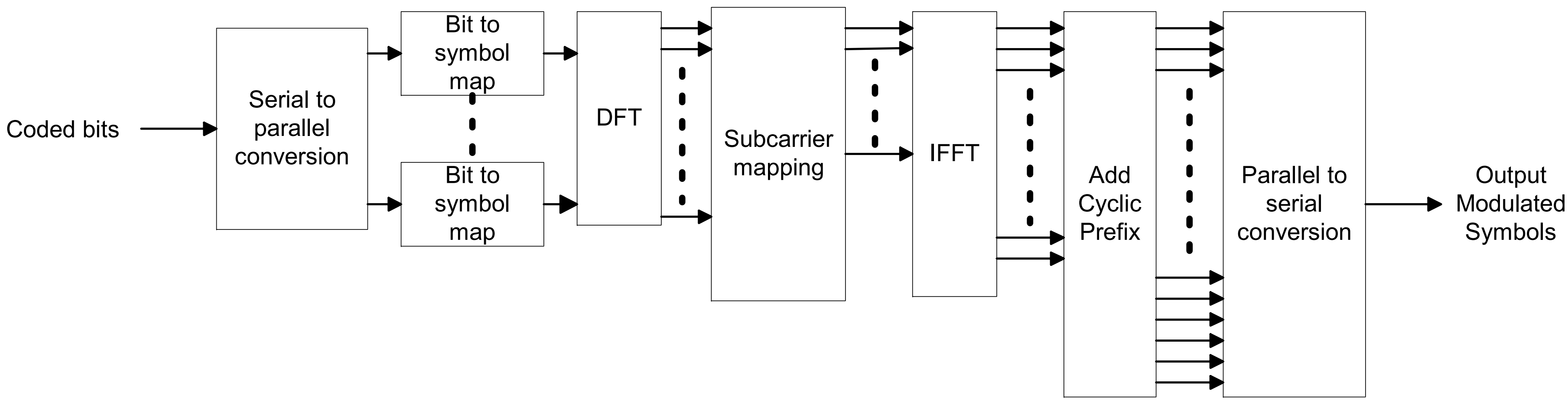
Outline of RL Proposal

- Reverse Link Design Goals
- Single Carrier FDMA approach based on DFT-S-OFDM
- Reverse Link Frame Structure
- Reverse Link Numerology
- Reverse Link Pilot Structure
- Reverse Link Control Channel
- Adaptive Modulation/Coding and HARQ
- RACH Channel
- Interference mitigation/suppression techniques

RL Design Goals

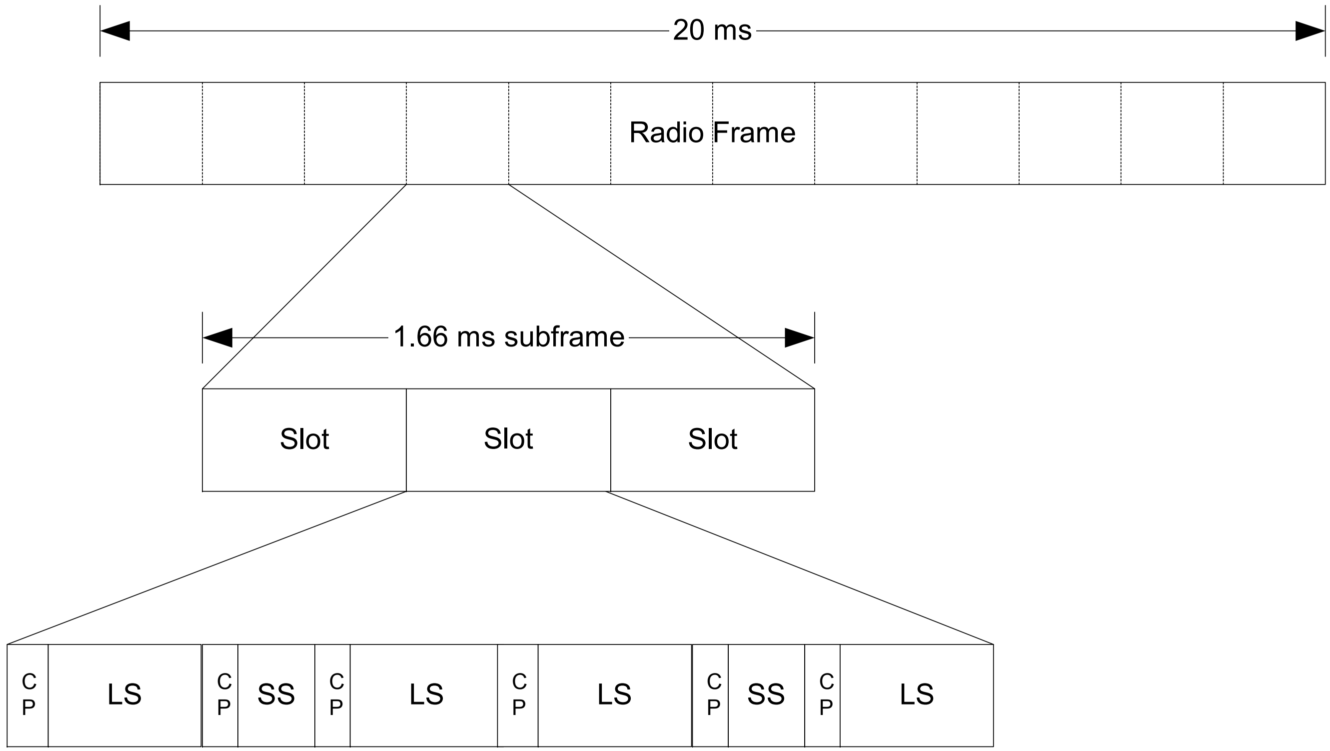
- **Orthogonal RL transmission**
  - Minimizes intra-cell interference → maximizes capacity
- **Minimize inter-cell interference by interference control methods**
- **Flexibility**
  - Support wide range of data rates
  - Support requirements of broad range of applications (low latency vs. high peak throughput)
- **Support adaptive modulation and coding and HARQ for most efficient use of spectrum**
- **Exploit frequency diversity of wideband channels for low rate users**
- **Support for frequency-selective scheduling**
- **Support wide range of spectral allocations: (1.25, 2.5, 5.0, 10.0, 20.0) MHz**
- **Support for advanced multiple antenna techniques like MIMO, SDMA**
- **Short sub-frame size for reduced latency**

Basic Transmission Scheme: DFT Spread-OFDM



- **DFT spreading of data symbols in frequency domain**

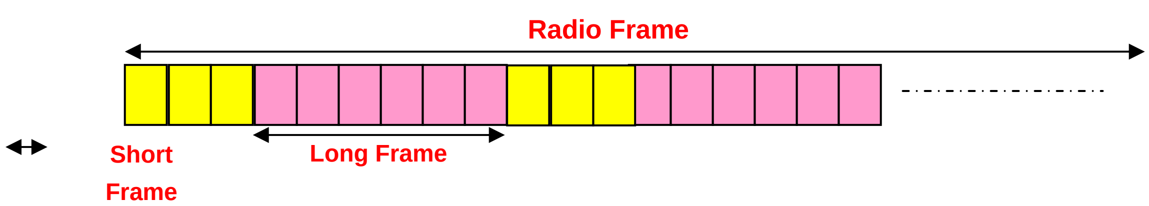
Reverse Link Frame Structure (1/2)



- **Slot consists of 4 long symbols (LS) and 2 short symbols (SS):**
  - TDM of Pilot and Bearer/Control:
    - SS contains reference pilot signals for coherent demodulation
    - LS used for control and/or data transmission

Reverse Link Frame Structure (2/2)

- **Radio frame composed of multiple DFT-S-OFDM slots**
  – 20 msec duration
  – Consists of short and long frames
    - **Short frame consists of 1 DFT-S-OFDM slot**
      - ➢ For small packets, low latency
    - **Long frame consists of 3 or 6 DFT-S-OFDM slots**
      - ➢ For larger packets
      - ➢ Lower control overhead
      - ➢ Avoids fragmentation
      - ➢ Edge of cell operation
    - **Selection optimized according to QoS**
  – Radio Frame can have mix of short and long frame:



Reverse Link Numerology

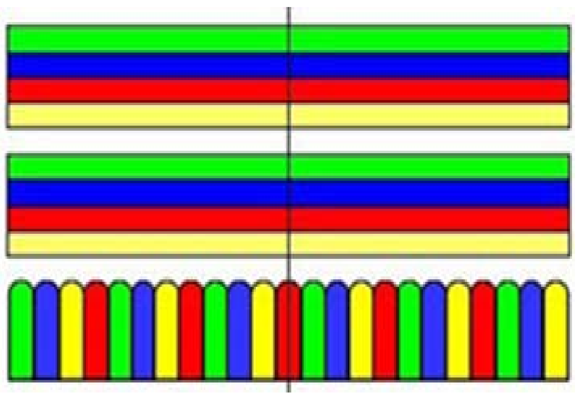
Parameter	Units					
Carrier Bandwidth	MHz	1.25	2.5	5	10	20
Oversampling Factor		1	2	4	8	16
Sample Rate	Msps	1.2288	2.4576	4.9152	9.8304	19.6608
FFT Size		128	256	512	1024	2048
Long Symbols Per Slot		4	4	4	4	4
Short Symbols Per Slot		2	2	2	2	2
Symbol Duration Total - Ts	us	109.86	109.86	109.86	109.86	109.86
Useful Symbol Duration - Tu	us	104.17	104.17	104.17	104.17	104.17
Cyclic Prefix Samples		5	10	20	40	80
Cyclic Prefix Duration	us	4.07	4.07	4.07	4.07	4.07
Window Samples		2	4	8	16	32
WIndow Duration	us	1.63	1.63	1.63	1.63	1.63
Extra Samples per Subframe		2	4	8	16	32
Samples per subframe		2048	4096	8192	16384	32768
Subframe Duration	us	1666.67	1666.67	1666.67	1666.67	1666.67
Subcarrier Spacing	kHz	9.60	9.60	9.60	9.60	9.60
# of Useful Subcarriers in 90% BW		117	234	469	938	1875
# of Useful Subcarriers Chosen		112	240	480	960	1920
# of Guard Subcarriers - Left		8	8	16	32	64
# of Guard Subcarriers - Right		8	8	16	32	64
# of Sub-channels		7	15	30	60	120
# of Useful Subcarriers/Subchannel		16	16	16	16	16
Subchannel Bandwidth	kHz	153.6	153.6	153.6	153.6	153.6
Occupied Bandwidth	MHz	1.08	2.30	4.61	9.22	18.43
Spectral Occupancy	%	86.0%	92.2%	92.2%	92.2%	92.2%

RL Pilot Structure

- **Pilot Design Options for Localized Data allocation**
  - Localized pilots occupying same spectrum as data
  - Distributed pilots confined to same bandwidth as data
  - Pilot occupying partly different spectrum than data in ≥ 1 short symbol
    - Allows for CQI estimation for other frequencies for potential future scheduling
- Pilot Design Options for Distributed Data allocation:

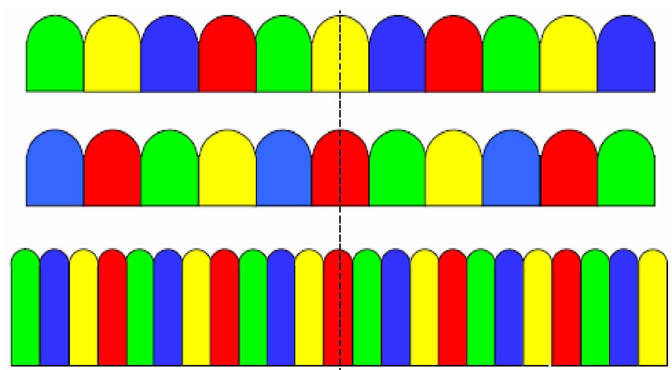
Code domain pilots occupying continuous common spectrum:

- Separability of pilots by sequence properties
- *e.g.*, cyclic time shifts of a common GCL/CAZAC sequence



Distributed orthogonal pilots with frequency domain staggering:

- Orthogonality by assigning disjoint sets of sub-carriers to different ATs
- Sub-carriers used by AT shifted from one Short symbol to next (*staggered*)



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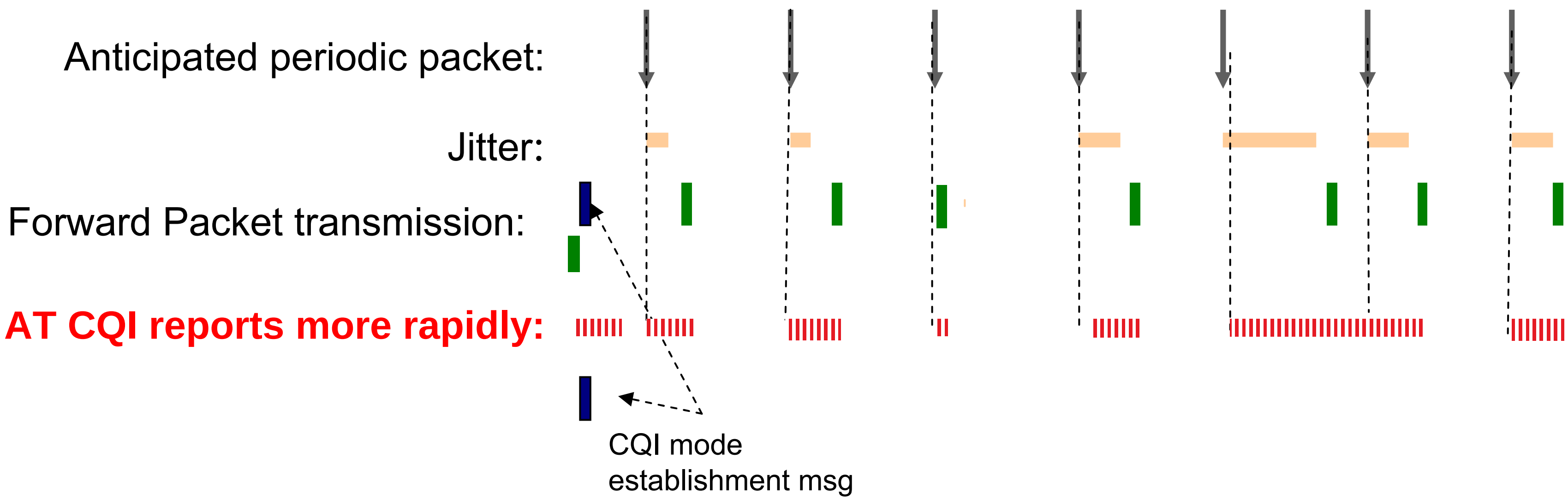
RL Control Channel (1/2)

- **2 types of L1/L2 control signaling:**
  - Data associated control signaling
    - **MCS, packet size, HARQ information, … for RL bearer**
    - **MIMO/SDMA signaling**
  - Data non-associated control signaling
    - **CQI, Ack/Nack, and precoding information related to FL data transmission**
    - **Scheduling requests for RL transmissions**
- **Multiplexing options for control signaling:**
  - Data associated control always *multiplexed* with bearer data
    - **Bearer and data sent using either distributed or localized allocation**
    - **Location of control known through explicit or implicit signaling**
  - Data non-associated control signaling
    - **Scheduling requests may be sent using contention approach (pre-defined time-frequency region)**
    - **CQI, Ack/Nack and Precoding feedback**
      - ➢ *Multiplexed* with data (possibly via puncturing) when AT has data to send
      - ➢ Sent on pre-defined time-frequency resource when AT has no data to send (TDM or CDM fashion)
    - **Direct Channel Feedback used for maximum performance and requires an entire OFDM symbol**

RL Control Channel (2/2)

- **CQI reports according to service specific policy agreement with AN**
  - Maximizes freshness of CQI reports when network actually transmitting
  - Minimizes overhead signaling to change CQI reporting rates
- **For any streaming service, e.g. telephony, video,…, AT:**
  - Starts reporting CQI every Z msecs, until receives 1 packet, or inactivity expires



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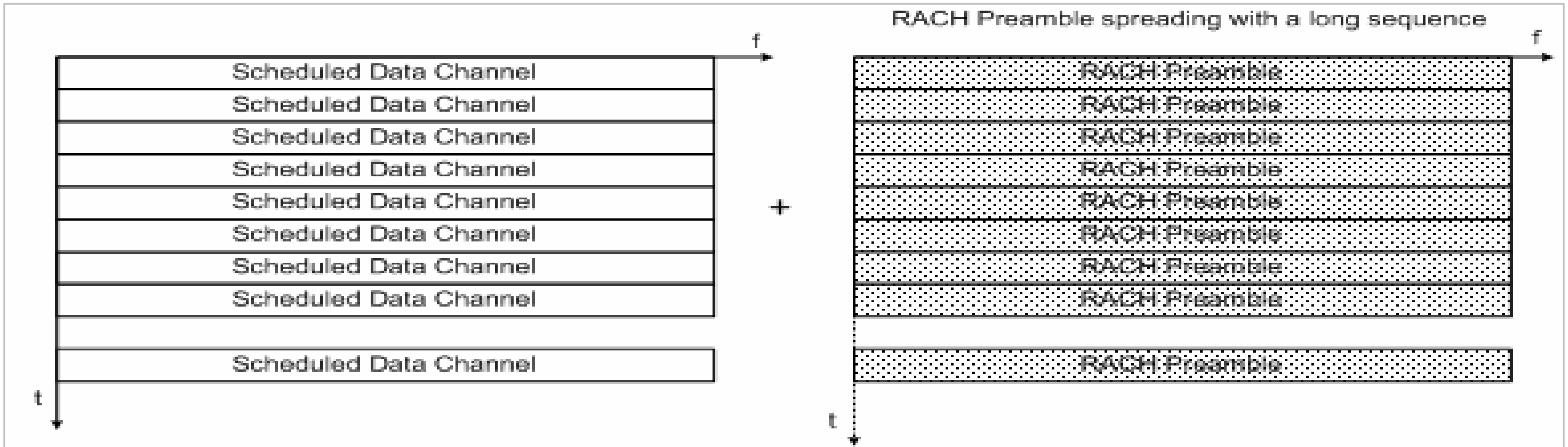
Adaptive Modulation/Coding and HARQ

- **Modulation**
  - QPSK, 8PSK, 16QAM, and 64-QAM (*optional*) support at AT
- **Coding**
  - Tail-biting convolutional code (K=9, ¼)
    - **Used for packet size < 200 bits**
    - **Rate matching**
  - Turbo Code without tail bits
    - **Used for packet size >= 200 bits**
    - **R=1/5 mother code**
    - **Rate matching**
- **HARQ: Synchronous N channel Stop-and-Wait Protocol**
  - No explicit signaling of HARQ process number
    - **Retransmissions occur every N slots up to Max TX or until early termination**
    - **Retransmissions use same Transmission format as 1st packet transmission**
    - **Retransmissions use same Modulation Coding scheme as 1st packet transmission**
    - **Retransmissions use same number of subchannels and same subchannel IDs**
  - Support
    - **Chase Combining**
    - **Partial Chase Combining**
    - **Incremental Redundancy (IR)**

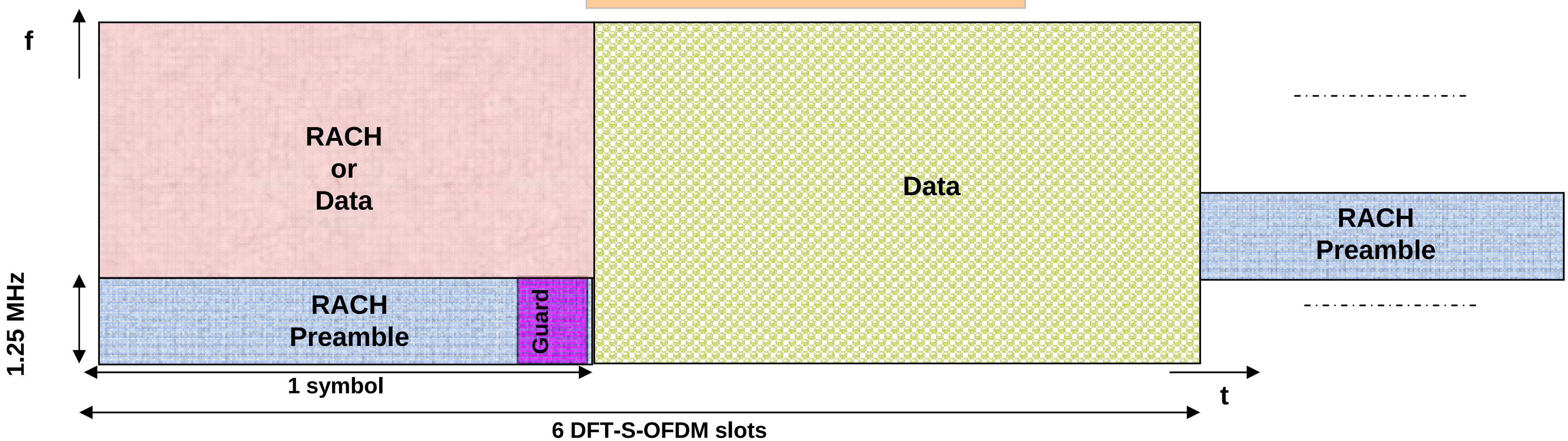
Random Access Channel – RACH (1/2)

- **Non-synchronized RACH**
  - Used when AT has not been time synchronized
  - Used when AT looses RL time synchronization
  - CDM based (provides more flexibility) or TDM/FDM based
  - Length of RACH burst: One or two DFT-S-OFDM slots once or twice every radio frame
- **Synchronized RACH**
  - Used for transmitting RL scheduling requests
  - TDM/FDM based
  - Length of RACH burst: One DFT-S-OFDM symbol once every few DO slots (*e.g.*, once every 2 slots)
- **RACH preamble needs to have good correlation properties (choose CAZAC/GCL sequence)**

Random Access Channel – RACH (2/2)



CDM of RACH and Scheduled Data



TDM/FDM of RACH and Scheduled Data

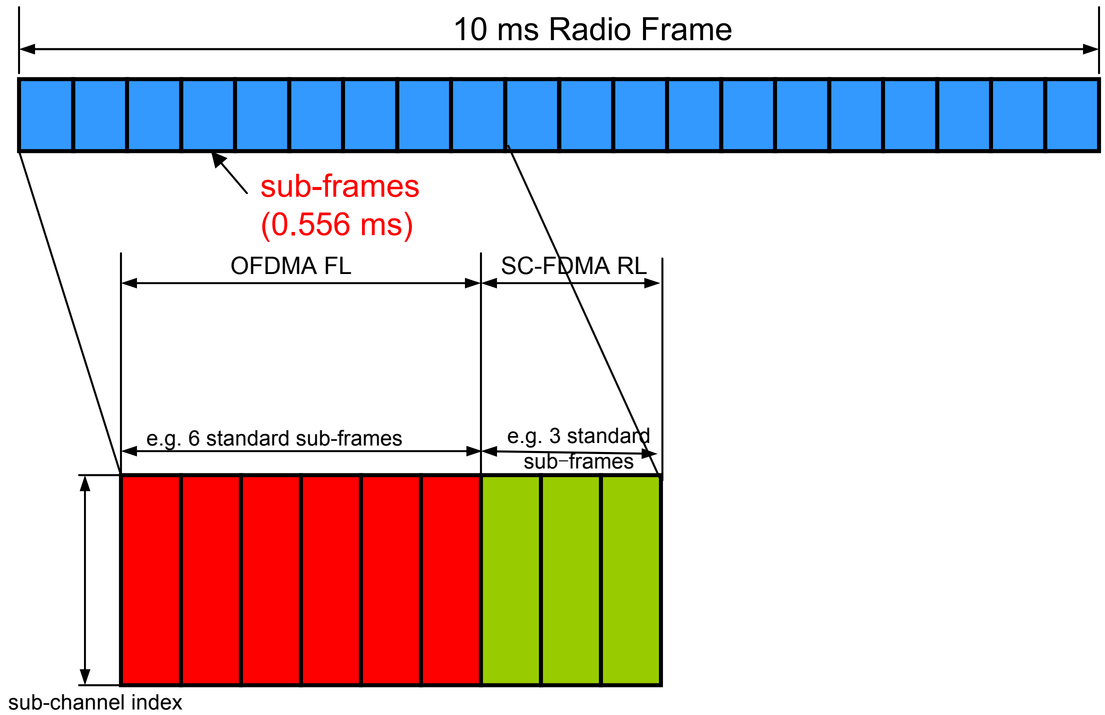
Interference Mitigation/Suppression Techniques

- **Fractional Power Control (FPC)**
  - Control AT RL transmit power according to fractional path loss of AT
- **Minimum Bandwidth (MBW) Resource Allocation**
  - Minimize assigned sub-bands (transmit bandwidth) to ATs
  - Effectively more chance (bandwidth) for ATs to transmit
  - At same time effectively boost power of power-limited ATs
- **Interference Management**
  - Sort ATs within sector according to their path loss
  - Assign time/frequency resources to sorted ATs with similar channel condition

TDD Support

- **TDD Benefits**
  - No need for paired spectrum allocation
  - Tunability of FL and RL capacity
    - **Different FL and RL split depending upon traffic pattern**
  - Channel Reciprocity
    - **Simplified Adaptive Antenna system operation**
    - **Simplified Link Adaptation**
- **TDD Limitations**
  - ANs in same geographic region using same or nearby RF channels must be time synchronized, and should use same FL/RL boundary setting
    - **Prevents one AN’s (AT’s) transmitter from interfering with another AN’s (AT’s) receiver**
  - Network synchronization may be difficult to achieve across multiple operators and puts constraints on moving the TDD boundary
    - **Important issue for large-scale, multi-operator TDD deployments**
  - TDD duty cycle can also impact PA efficiency and current drain

TDD Support



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Thank You