

Large Scale and Immediate Broadband Operations in AWS-3 Spectrum Using IPW 3GPP Rel 7 TD-CDMA and Rel 8 LTE

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IPWireless Is A Leader in TDD Mobile Broadband Technologies

- 3GPP mobile broadband products since 2001
 - Current commercial products use 3GPP Rel 7 TD-CDMA
 - Rel 8 LTE in development
 - SDR NodeB software upgradable Rel 7 to Rel 8, and dual mode UE's
- Major customers globally
 - T-Mobile Czech Republic
 - New York City “NYCWiN”
 - Other commercial mobile broadband networks in US, UK, Indonesia, Malaysia, NZ
 - Govt. / Public Safety deployments in Georgia, Montana, Florida
- IPWireless specializes in implementing 3GPP standards in new /non-standard bands, and for specialized markets such as public safety and Government
- IPWireless is a California based, employee owned company with 2 major US corporations as minority strategic investors

By auctioning AWS-3 immediately and permitting TDD use, FCC can maximize the value of the band and create public benefit

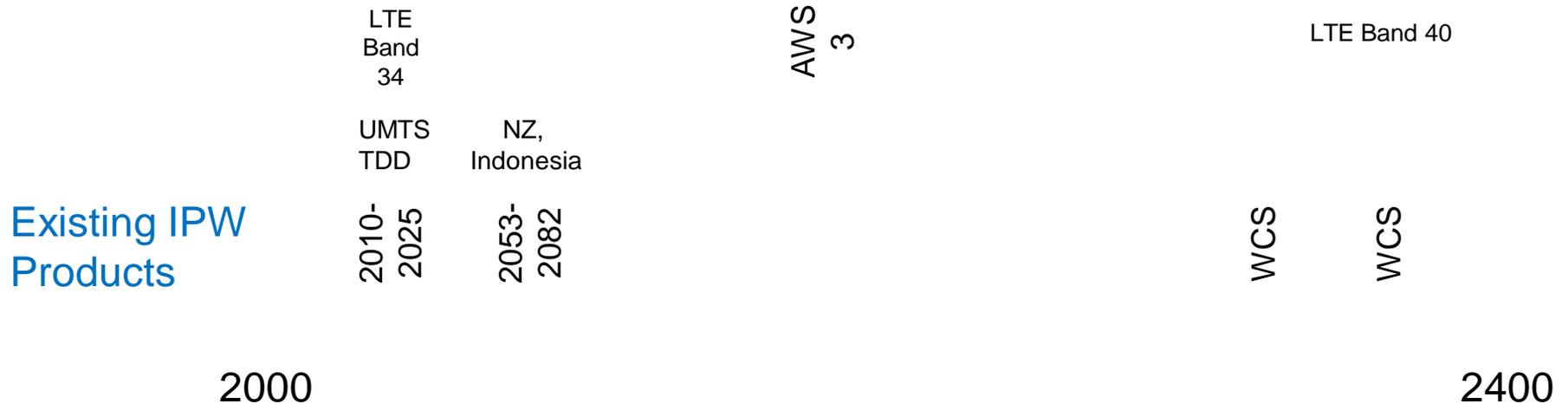
- Recently some parties have proposed pairing AWS-3 with 1755-1780 MHz to “maximize its value.”
 - 1755-1780 MHz is currently used by federal users, no specific plans for relocation
 - Relocation of federal incumbents, and long term military assets are especially sensitive and will take a long time.
- FCC can maximize the potential of AWS-3 by allowing nationwide TDD operations in the band to provide broadband services.
 - Delay waiting for hypothetical pairing possibility is fatal to the public benefit and to innovators like IPW.
- Our presentation today shows how millions of consumers can get broadband using IPW’s current suite of products –a scalable system that is immediately available, deployed internationally and in the US in nearby TDD spectrum and that is forward compatible with the emerging TD-LTE systems
- Allowing IPW and its service partners to invest in AWS-3 will generate greater access to broadband, new jobs and new competition based on exploiting TDD technologies – NOW!

Standards Based 3GPP TDD Operation Should Be Permitted in AWS-3

A	B	C	D	E	F	AWS-3	MSS	
2110						2155	2180	2200

- Available AWS-3 spectrum up to 25 MHz
- Rel 7 TD-CDMA supports 5 and 10 MHz carriers
 - 2 x 10 MHz carriers + 5 MHz Carrier, or
 - 5 x 5 MHz carriers, or
 - 2 x 10 MHz carriers + 5 MHz guard band
- Rel 8 LTE supports 1.25, 3, 5, 10, 20 MHz carriers
 - 1 x 20 MHz carrier, plus 5 MHz carrier, or
 - 2 x 10 MHz carriers + 5 MHz carrier, or
 - 1 x 20 MHz carrier, plus 5 MHz guard band, or
 - 2 x 10 MHz carriers + 5 MHz guard band

Existing IPWireless Products Work in Nearby Adjacent TDD Spectrum in the US and in Other Countries



- Feasible to quickly re-band IPW base stations and user equipment to AWS-3
- IPW has the expertise to expedite the re-banding once the service and technical rules for AWS-3 are finalized;
 - Service operators waiting for the rules before investing in re-banding.

TD-CDMA and LTE Performance Generate Competitive Wireless Broadband Services (3GPP 19-Cell Simulations)

Technology Option	TD-CDMA ER-7 Mobile/Portable 10MHz TDD	TD-CDMA ER-7 Fixed 10MHz TDD	LTE Mobile/Portable 10 MHz TDD	LTE Mobile/Portable 20 MHz TDD
Downlink				
Peak	28 Mbps	28 Mbps	35 Mbps	70 Mbps
Average	8 Mbps	13.7 Mbps	6.5 Mbps	13 Mbps
Cell Edge	3.2 Mbps	>8 Mbps	1.3 Mbps	2.6 Mbps
Uplink				
Peak	8 Mbps	8 Mbps	8.3 Mbps	16.6 Mbps
Average	2.0 Mbps	3.4Mbps	2.5 Mbps	5 Mbps
Cell Edge	0.5 Mbps	>1.5 Mbps	0.3 Mbps	2 Mbps

TDD 2:1 DL:UL ratio

TD-CDMA Capacity Estimates per base station and Potential Nationwide Coverage Stats (based on TD-CDMA)

	20 MHz TDD, 3 sector	20MHz TDD, 6 sector
System Average throughput		
Average DL throughput per sector Mbps	16	11.2 From 3GPP 19-cell simulation
Average DL throughput per cell site Mbps	48	67.2 For 6 sector, assume sector throughput due to increased inter-sector interference
User Traffic and SLA		
SLA rate	768	3000
Oversubscription n:1	20	20
Long term average (LTA) traffic per user	38	150
Active Users per site in Busy Hour		
10 MHz TDD, 3 sector	563	144 90% scheduling efficiency assumed (ie packing users into available layer 1 resource)
20 MHz TDD, 3 sector	1125	288
20MHz TDD, 6 sector	1575	403
Total Subscribers Supported		
% of subscribers active in Busy Hour	40%	
Total Subscribers		
10 MHz TDD, 3 sector	1406	360
20 MHz TDD, 3 sector	2813	720
20MHz TDD, 6 sector	3938	1008
Network Wide User Capacity		
20,000 cell site network, 20 MHz 3 sector (millions)	56.3	14.4
20,000 cell site network, 20 MHz 6 sector (millions)	78.8	20.2

Note- this is based on mobile/portable service. Fixed service capacity higher (ref. slide 6)

NYCWiN Throughput / Capacity – A Real World Example (Confidential)

- System Design

- Designed to provide NYC across all the boroughs with a broadband data network that provides coverage and capacity for public safety applications (using unpaired 2.5 GHz spectrum)
- Recently upgraded from Rel 5 to Enhanced Release 7 - Adds DL MIMO, DL and UL GMUD interference cancellation, 64 QAM modulation on DL and UL
- **Downlink Per sector (10 MHz TDD)**
 - **Peak 28 Mbps, Average 8 Mbps, cell edge 3.2 Mbps**
- **Uplink Per sector (10 MHz TDD)**
 - **Peak 8 Mbps, Average 2 Mbps, cell edge 0.5 Mbps**

- Increasing to 20 MHz doubles these rates

Actual Performance

- NYC (also 10 MHz TDD) reports users are typically experiencing 8-10 Mbps DL and 2.5 Mbps UL
- **Total network wide capacity (based on average sector throughput) is Downlink 9.1 Gbps, Uplink 2.2 Gbps**
- Based on typical broadband user traffic, this network, designed for public safety applications, can support ~250,000 users assuming typical public safety traffic patterns [~400 cell sites]

Coexistence Scenarios

2155
2145

2180

F
(DL)

AWS-3

MSS
(DL)

FDD UE
Rx

TDD Tx & Rx

**Coexistence
to AWS-F**

UE Rx
UE Rx

BTS Tx
UE Tx

Only occurs if FDD UE is near TDD BTS antenna
Occurs if FDD UE is in close proximity to TDD UE, eg in the same room

**Coexistence
to MSS**

BTS Tx
UE Tx

UE Rx
UE Rx

Only occurs if FDD UE is near TDD BTS antenna
Occurs if FDD UE is in close proximity to TDD UE, eg in the same room

- **Mitigation**

- Both NodeB and UE can easily implement a tighter emission mask than the standard $43+10 \log(P)$
- 5 MHz total guard band available
- Ability to notch UE transmit at frequency of adjacent band if required (see following slide)
- Coexistent less of an issue with packet based technologies

Filtering example – handset notch filter

- IMB Coexistence Adjacent to W-CDMA (1900)

Used for a IMB broadcast receiver to operate in a smartphone at 1900-1910 MHz adjacent to the W-CDMA uplink transmitter at 1920-1925 MHz *in the same device* (i.e. no separation distance)

