
PCI
SIG™

Wireless Form Factor
Draft Version 0.3

Ron Shaw / Dell – Chairman

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Introduction to WFF Wireless Form Factor

Ron Shaw / Chairman

What is PCI Express WFF?

- Wireless Optimized Form Factor
  - ✓ WPAN / WLAN / WWAN / WMAN
  - ✓ Existing and emerging wireless standards
- Thin form factor
  - ✓ Designed for notebook LCD panels
- BTO/CTO solutions
  - ✓ End users need access to replace SIM modules.
- PCI Express and USB 2.0 enabled
  - ✓ OEM selected

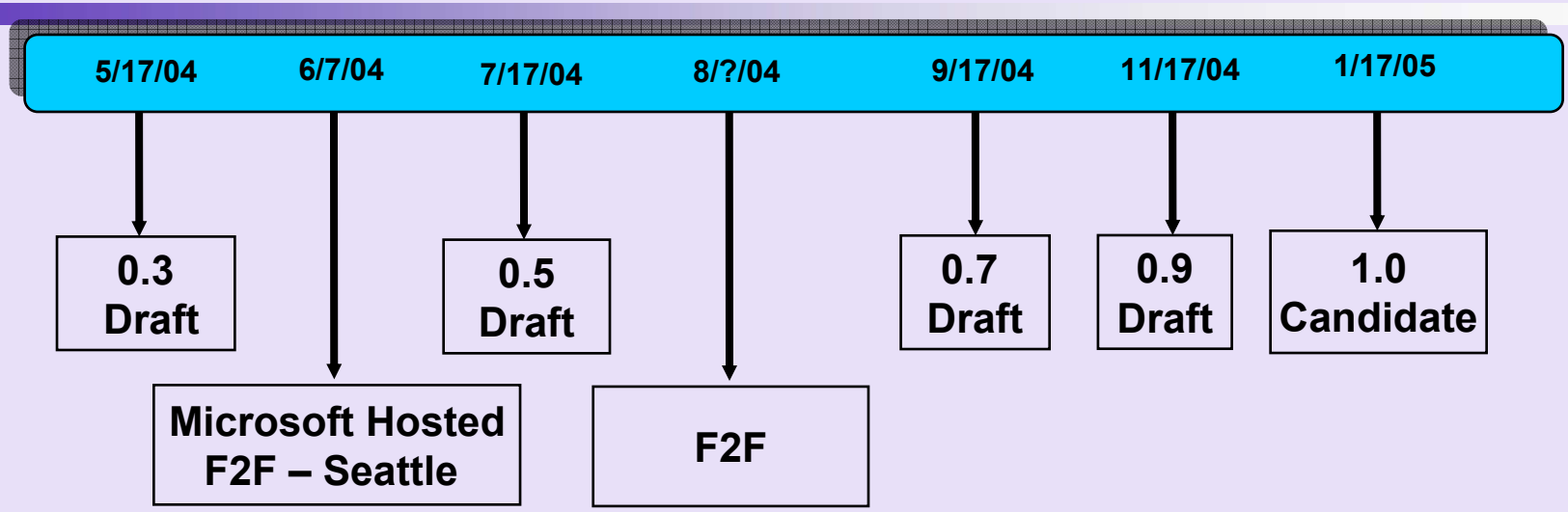
Features and Benefits

- Upgradeability / Serviceability
  - ✓ Removable / replaceable.
- Software Compatibility
  - ✓ PCI Express and USB 2.0
- Ease of design
  - ✓ Digital / analog / RF separation.
- Power Management
  - ✓ Supports PCI Express power management features.

Targeted Applications

- WPAN
  - ✓ Bluetooth / UWB
- WLAN
  - ✓ 802.11b/g/a/n
- WWAN –
  - ✓ GSM/GPRS / UMTS / CDMA / Edge / WCDMA
- WMAN
  - ✓ 802.16 a/e
- Other
  - ✓ UHF / VHF / GPS / 802.20

When and Who

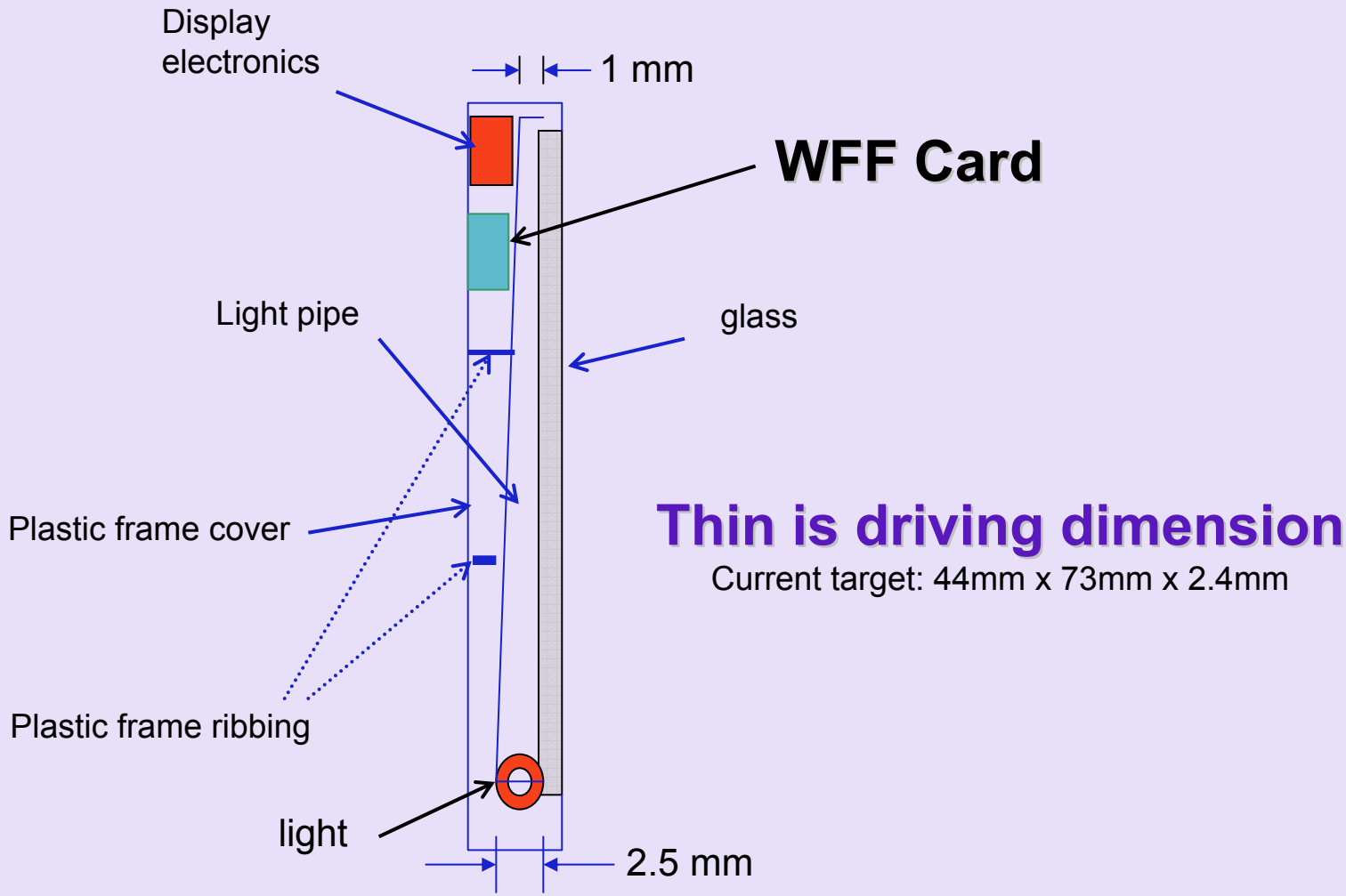


- Members
  - ✓ Broadcom / Dell / FCI USA / Foxconn / HP / IBM / Intel
  - ✓ Microsoft / Molex / RF Micro Devices / Qualcomm
- Observers
  - ✓ AboCom / AMD / Agere / Ample Communications / Asustek Computer
  - ✓ Atheros Communications / Comax Technology / Philips Semiconductors
  - ✓ Phoenix Technologies / TI / Tyco Electronics / ULi Corporation

Design Goal Details

Walter Fry / Vice-Chairman

LCD Panel implementation



Thin is driving dimension

Current target: 44mm x 73mm x 2.4mm

Comparisons

Description	WFF concept	ExpressCard Standard	PCI Express Mini
Dimensions	44x73 mm	34x75 or 54x75 mm	30x51 mm
z-height	2.4 mm	5 mm	5 mm
Antenna support	▪ Area for antenna on card ▪ Defined location for RF connector for off board antennas	▪ Antennas may be supported by extending the card outwards ▪ No RF connector support for off board antennas	▪ Limited integrated antenna support ▪ Optional RF connector
Location	▪ Optimized for display enclosure to support multiple slots ▪ Reduced thermal and system noise issues ▪ Minimum coax cables to support off board antennas and less signal loss	▪ Intended for the base, not optimized for in display panel ▪ Requires additional system's real estate and volume to support multiple slots ▪ Performance is impacted by system's EMI, thermal and motherboard noise	▪ Intended for the base, not optimized for in display panel ▪ Coax cable required for antenna in the LCD Panel ▪ Performance is impacted by system's EMI, thermal and motherboard noise
SIM card	On Card	Not Specified	Off Card

Wireless Frequency Bands

Frequencies	Applications	Standards
824-894	WWAN	CDMA, GSM, TDMA
832-925	WWAN	CDMA PDC
880-960	WWAN	GSM
1575		GPS
1710-1880	WWAN	GSM
1750-1870	WWAN	CDMA
1850-1990	WWAN	CDMA, GSM, TDMA
1920-2170	WWAN	CDMA, UMTS)
2400-2500 MHz	WLAN / WPAN	ISM (BT, 802.11-1997/-1999, 802.11b-1999, 802.11g-2003)
4920-5875 MHz	WWAN / WPAN	U-NII, ETSI low/med/high, Japanese bands (802.11a-1999)
3100-10600 MHz	WPAN	UWB (802.15.3a)

Wireless Characteristics

	Specification Target Objective	Minimum Acceptable
WLAN support	802.11a/b/g/n	Same
WWAN support	CDMA 1x-DV, DO, GPRS, EDGE, WCDMA	Same
WMAN support	802.16a/e	Same
WPAN support	Bluetooth, UWB-P	Same
Other wireless	UHF/VHF bands	802.20, GPS
SIM support	User installable SIM with removal of card not required Notebook ON insert/remove	User installable SIM with removal of card acceptable for access Notebook OFF insert/remove
Coexistence support	Yes – specified	Yes – pins reserved but open
RF output control	Same as Mini Card	Same
Signal status indicators	Same as Mini Card	Same
Antenna support	4 (2x2 MIMO/diversity)	2 (diversity)

Form-Factor Characteristics

	Specification Target Objective	Minimum Acceptable
Card format	Internal exposed PWB	Same
Maximum outline	44mm x 73mm	**Major Open**
Thickness	2.4mm maximum Antenna section TBD	**Major Open**
Feature support	Radio, SIM and antenna	Same
Primary supply power	~6W – single rail	~3W – single rail
Auxiliary (standby) power	0.8W – on primary rail	Same
Voltage source tolerance	±8% at connector interface	Same
Maximum thermal dissipated power (on-card)	2W	**Major Open** **(WWAN driving factor)**
User touch requirements	SIM access compatible	Same

Host Characteristics

	Specification Target Objective	Minimum Acceptable
Data interface support	PCI Express and/or USB **Major Open** **May an OEM support only one of the interfaces?**	If both implemented, simultaneous operation must be possible
Maximum number of card sockets supportable by host	No inherent limit	**Open**
SMBus support	Defined but optional	Same

Connector Characteristics

	Specification Target Objective	Minimum Acceptable
System connector pin count	32	Open
Antenna connector frequency	Supports up to 10.6 GHz	Supports up to 3000 MHz
Durability	As needed to support SIM insertion and upgrade model	Same as Mini Card (50 to support installation & serviceability model)
Reliability	Same as Mini Card	Same
Insertion / removal force	Consistent with no tools required usage model	Same
Environmental	Same as Mini Card	Same
PCI Signal Integrity	Generation 1 only	Same
USB Signal Integrity	USB 2.0	Same

Draft 0.3
Working Proposal Detail

Brad Saunders / Editor

Deep Dive Subject Areas

- Areas where major opens or tradeoffs exist
- Current deep dive subjects
  - ✓ Z-height requirements
  - ✓ Power / Thermal requirements
  - ✓ Connector design requirements
  - ✓ Antenna requirements
  - ✓ SIM usage model
  - ✓ Co-existence requirements
  - ✓ Signal list / connector pinout
  - ✓ Upgradeability model (user vs. technician)

Specification validation

- Most significant areas that will need validation before specification is complete
  - ✓ PCI Express / USB 2.0 signal integrity
  - ✓ Thermal capacity
  - ✓ LCD interaction : thermals and noise
  - ✓ EMI / EMC
- Validation techniques
  - ✓ Testing with prototype solution
  - ✓ Modeling / detailed analysis

Draft 0.3 Card Design

- 44mm x 73mm x 2.4mm card
  - ✓ 40mm x 61mm for electronics
  - ✓ 40mm x 12mm for antenna / electronics
  - ✓ 2mm keep-out for each rail
- Open card to reduce size and cost.
- Card based extraction
  - ✓ No ejector mechanism required on host.

Draft 0.3 Interface Signals

PCI Express WFF Card System Interface Signals			
Signal Group	**Signal**	**Direction**	**USAGE**
Power	+3.3 aux (3 pins)	Source	USB and PCI Express
	GND (7 Pins*)	Return	
PCI Express	PETp0, PETn0	Input	PCI Express
	PERp0, PERn0	Output	
	REFCLK+, REFCLK–	Input	
	PERST#	Input	
	CLKREQ#	Output (OD)	
USB	USB_D+, USB_D–	I/O	USB
LED	WPAN, WLAN, WWAN	Output	Optional
Coexistence	I'm Busy, You're Busy	I/O	Optional
Reserved	(2 pins)		No Connect
Auxiliary Signals (3.3V Compliant)	Card Presence	Output	Optional
	WAKE#	Output (OD)	Optional
	RF Disable	Input	USB and PCI Express
	SMB_DATA, SMB_CLK	I/O	Optional

* some used for signal isolation

Draft 0.3 Connector

- Beam on Blade
  - ✓ 1mm spacing
  - ✓ Single Row
  - ✓ Two level contacts
  - ✓ 1500 cycles to support SIM swapping
- Friction fit
  - ✓ Guide rails / connector provide retention
  - ✓ Additional retention may be provide by host design.
- PCB
  - ✓ 0.65mm thickness

Draft 0.3 On Card Antenna

- Integrated antenna area defined
  - ✓ Lower cost overall solution (host and module costs)
    - Homologation costs reduced when integrated.
    - System burden reduced when integrated.
  - ✓ 12mm area defined for integrated antennas
  - ✓ Host needs to allow for antenna in this area
  - ✓ Card may have electronics in this area

Draft 0.3 Off Card Antenna

- Off card antenna connector defined
  - ✓ Two piece antenna connector – Higher performance
  - ✓ Located in rail system keep out area.
  - ✓ Allow for full card area for electronics.

Draft 0.3 SIM support

- On card SIM support – Required
  - ✓ Card manufacturer defines location
  - ✓ May require removal of WFF card to change
- Defined area – Target
  - ✓ Allows OEM to provide access without removal

Draft 0.3 Power

- Thermal
  - ✓ 2 W maximum sustained
- Electrical
  - ✓ Single Rail – 3.3V (sources $3.3V_{AUX}$ as well)
  - ✓ 6 W Runtime – Maximum Instantaneous Power
  - ✓ 0.8 W Suspend – Average Suspend Power

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