IDF13

Display Technologies for Intel® Graphics

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GVCS001

intel Look Inside.™

Agenda

- Mobile Industry Processor Interface (MIPI*) Based Displays
  - Overview
  - Enabling considerations
  - Scalable model for fast time to market
- Display Power Savings
  - Display power consumption
  - Display power savings features
- Miracast* Wireless Display Demo

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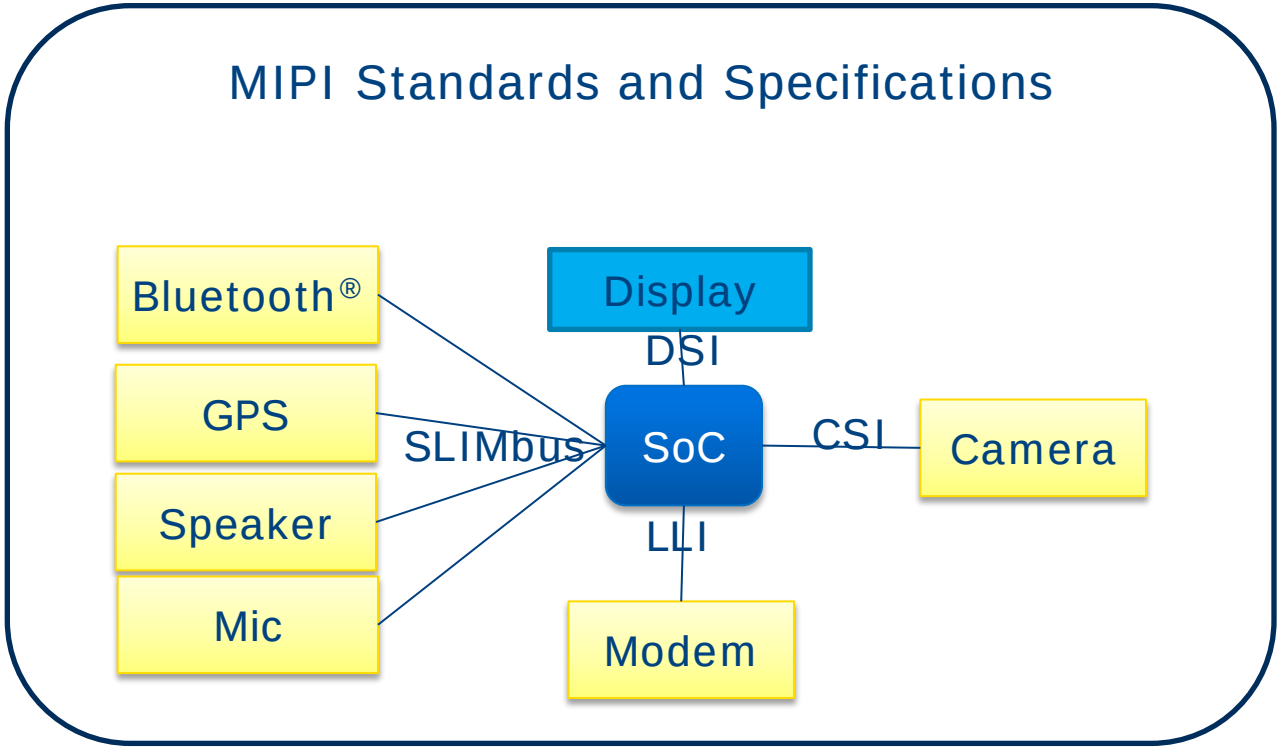
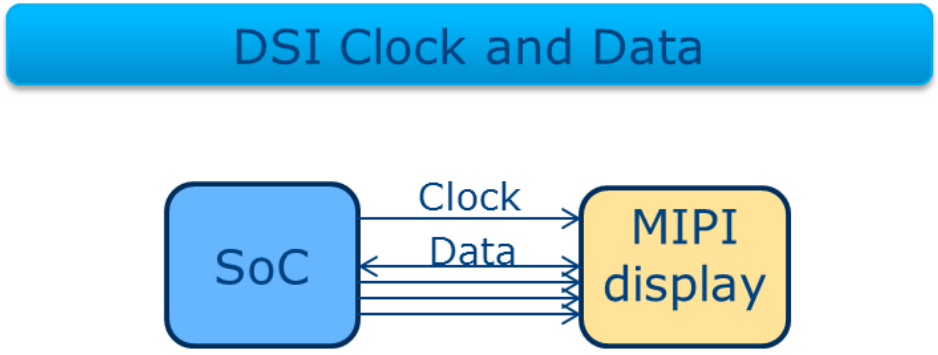
  - Display power savings features

- Miracast* Wireless Display Demo

MIPI* Display Overview



MIPI* Display Overview - DSI



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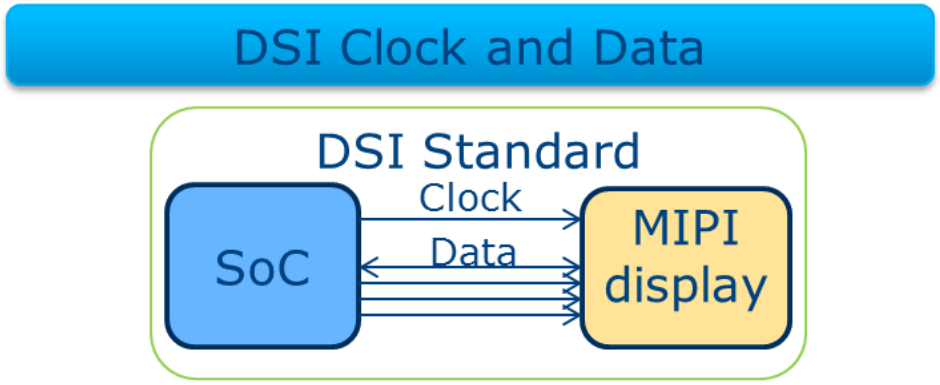

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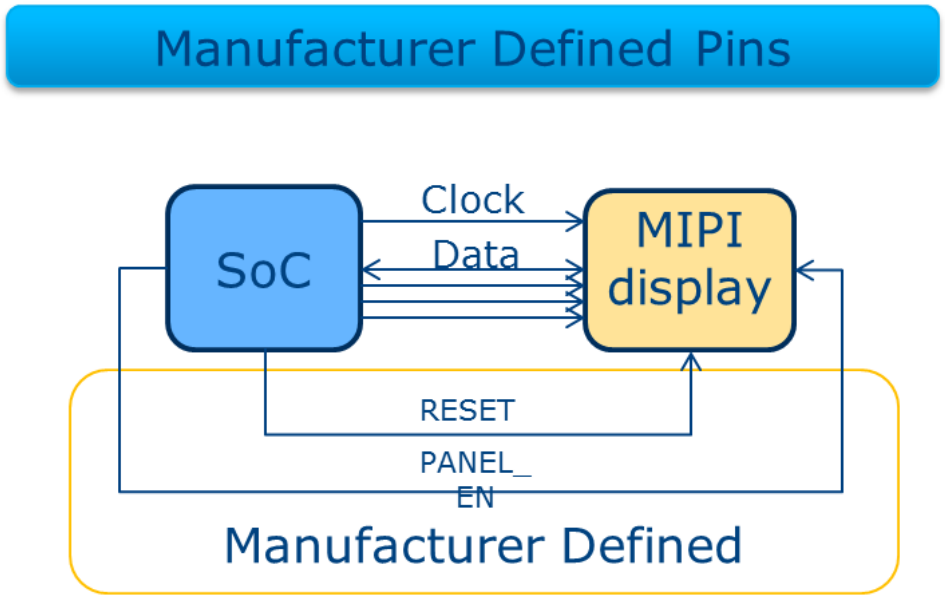

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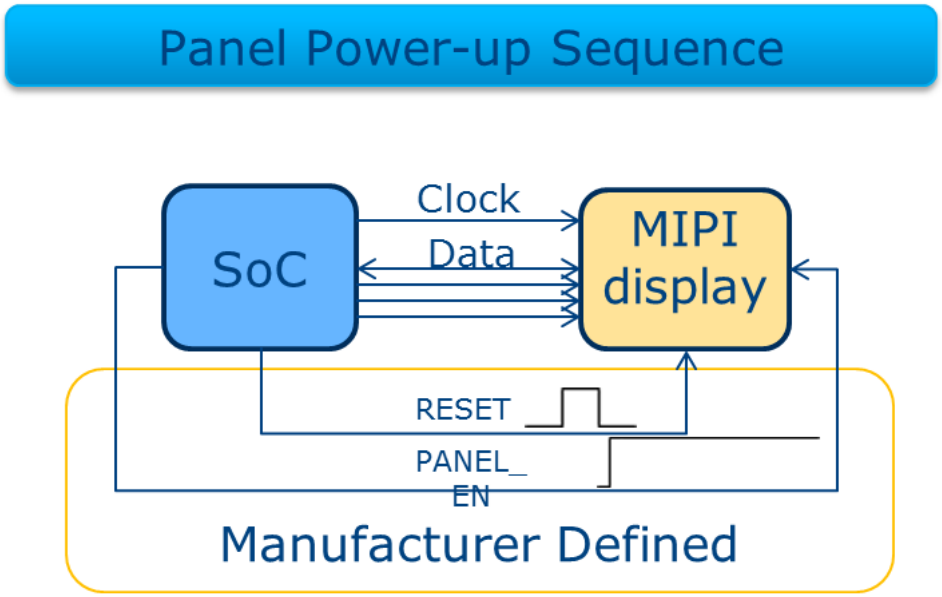

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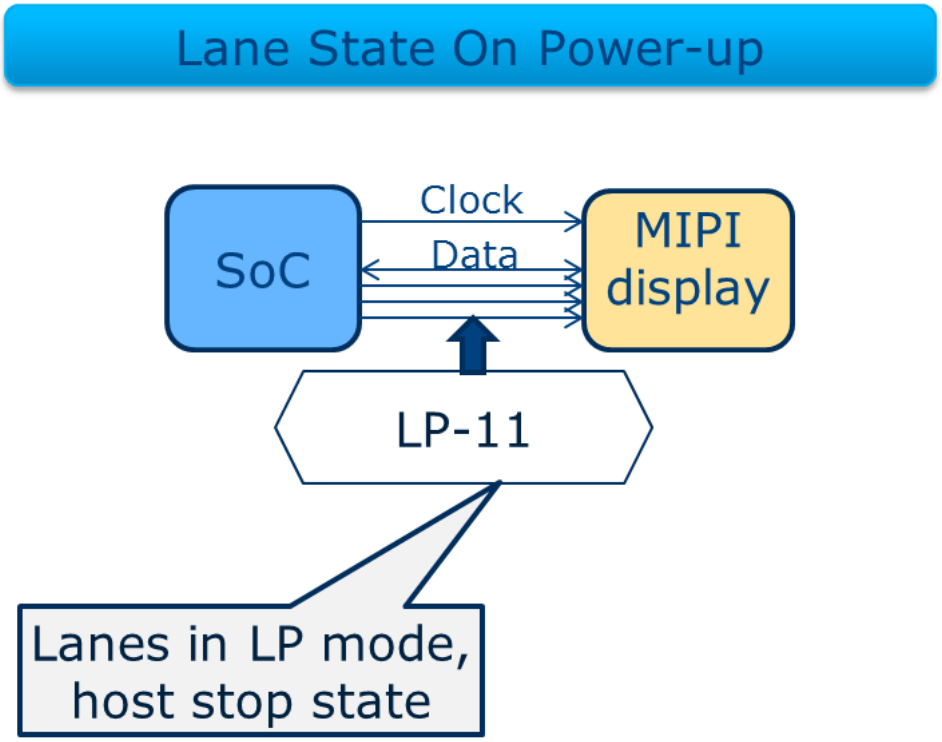

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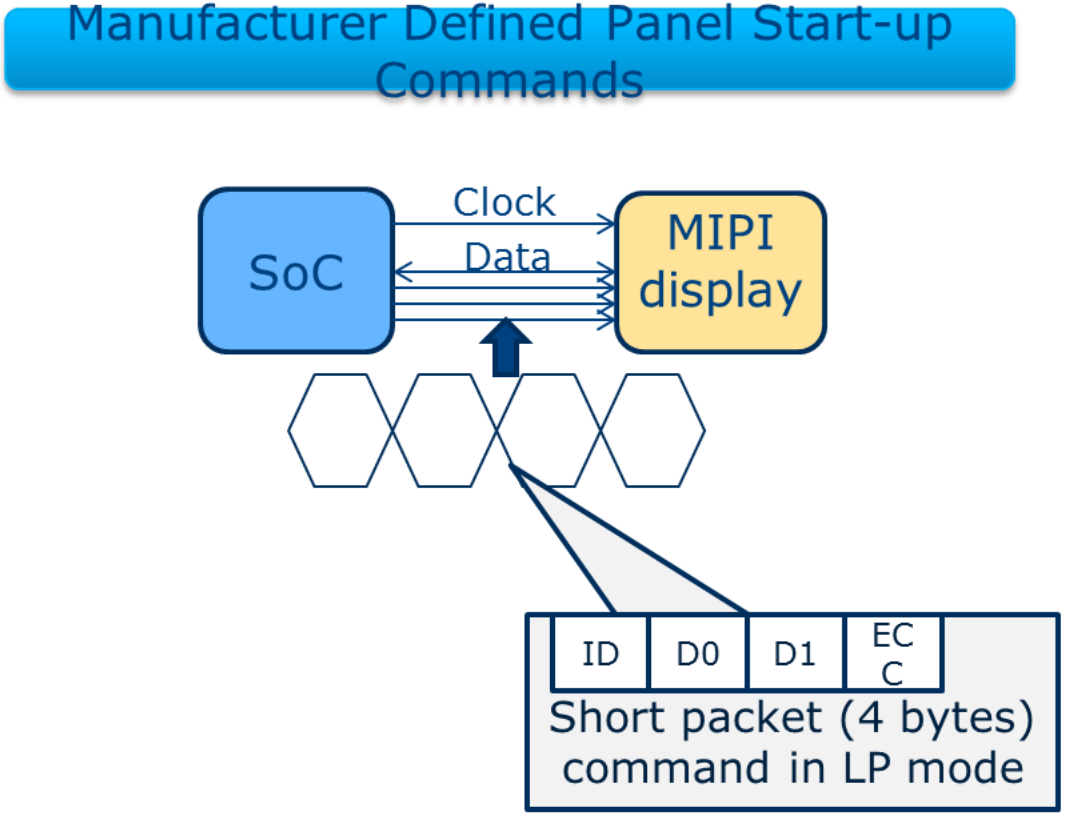

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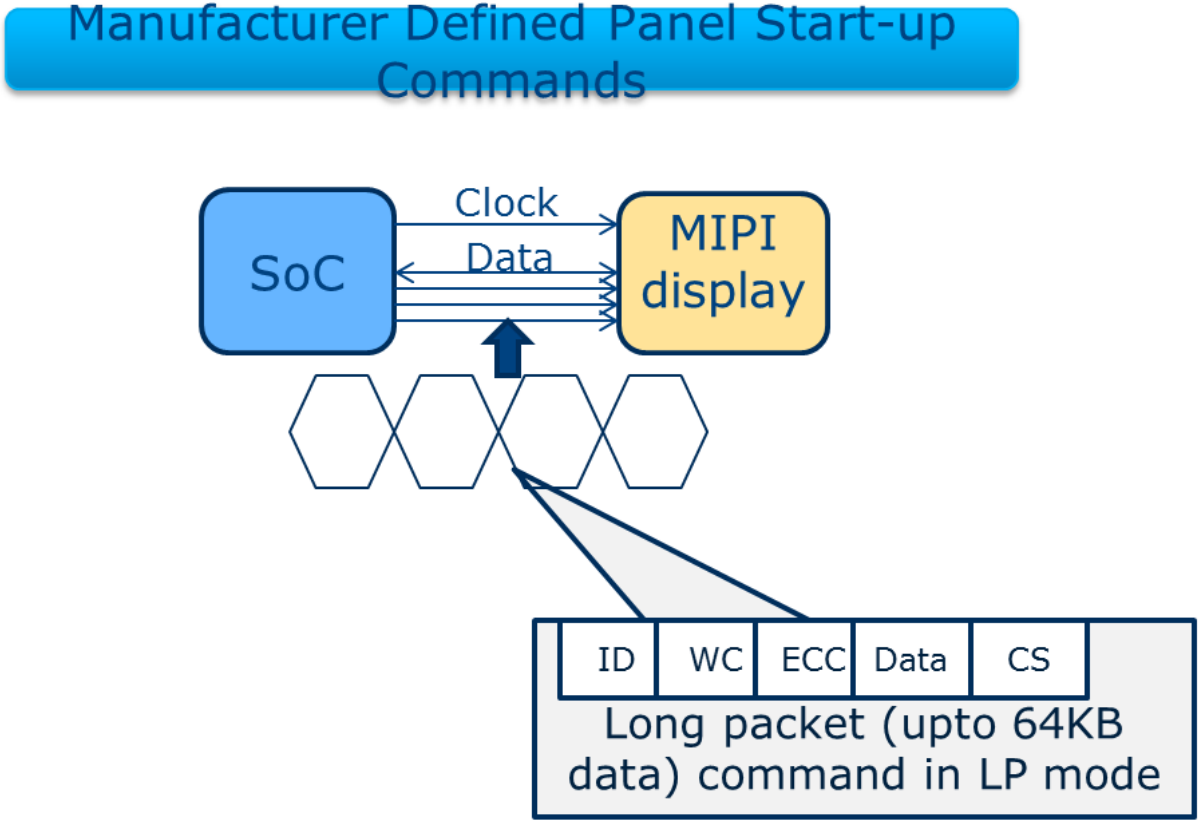

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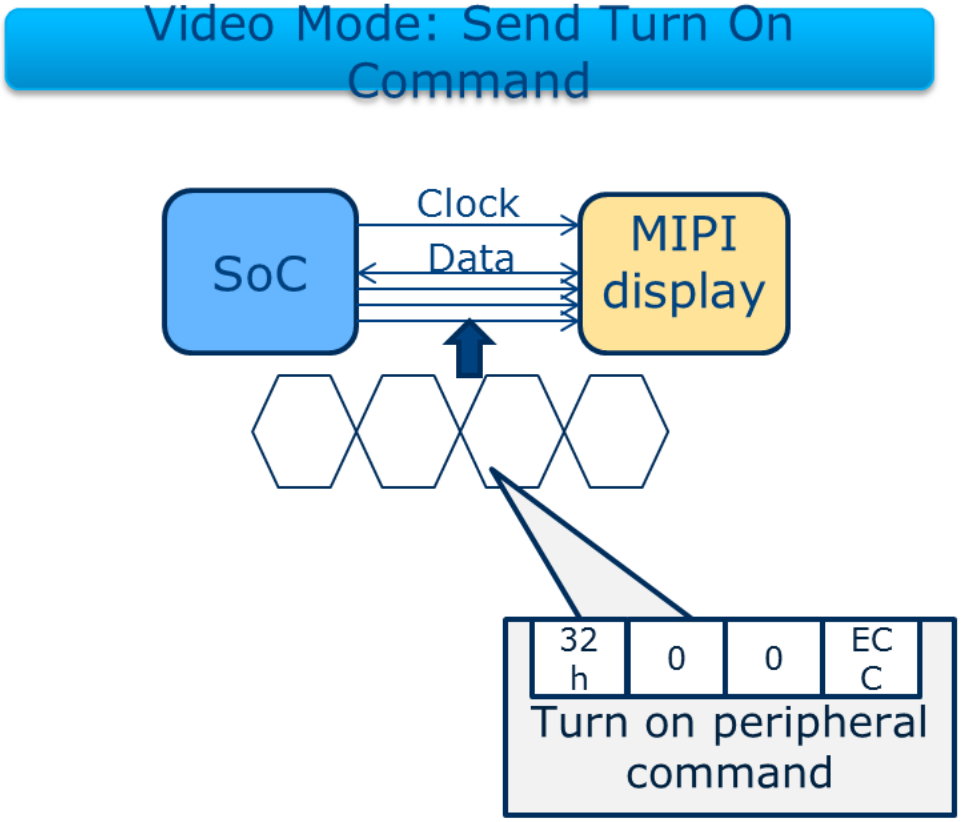

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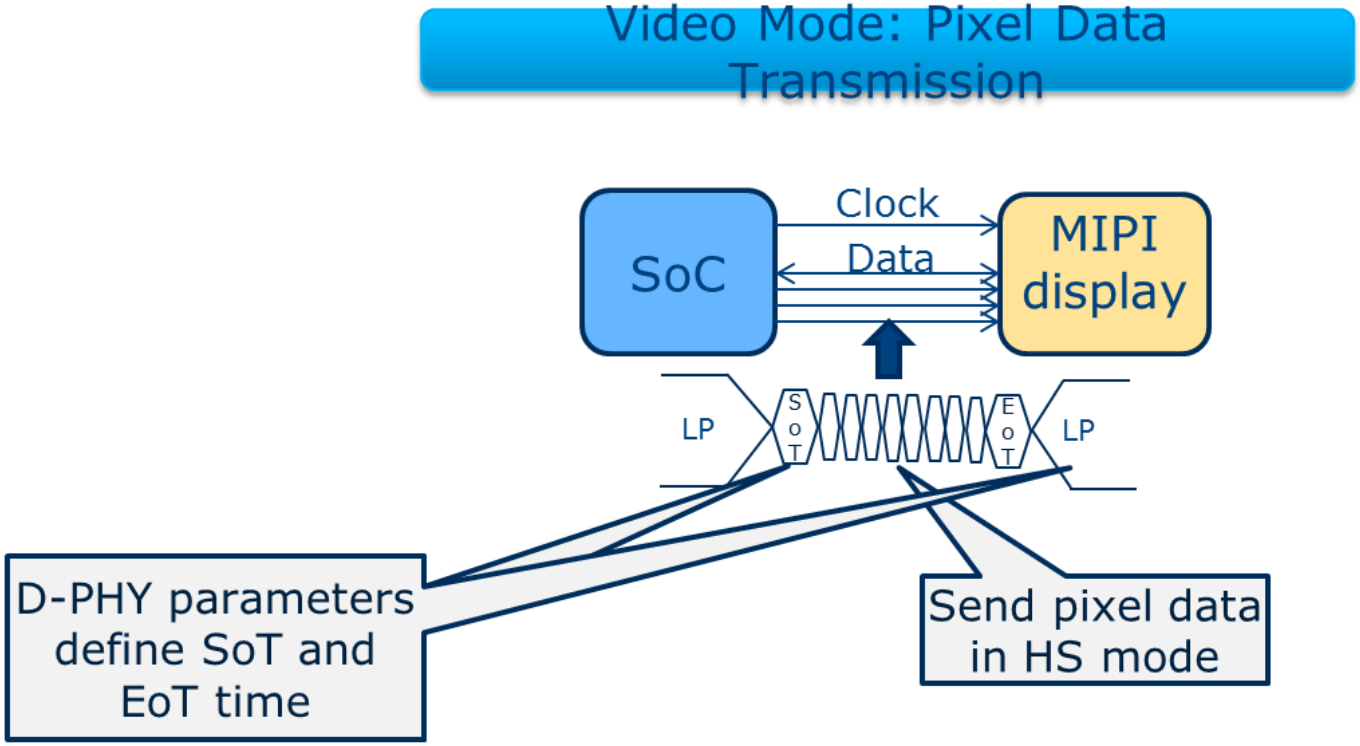

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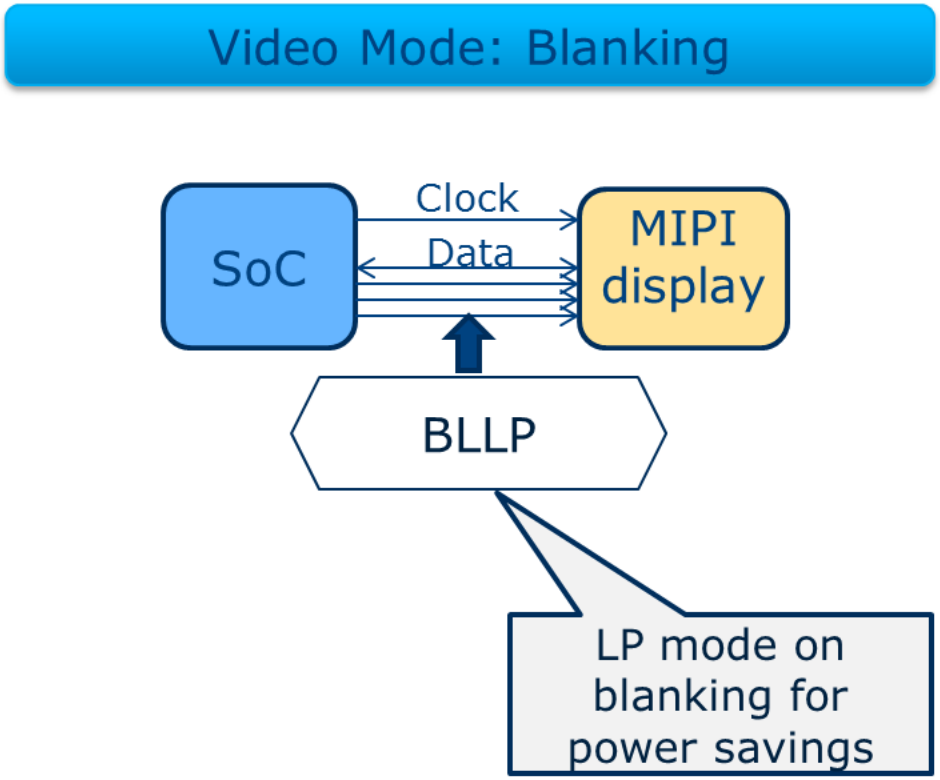

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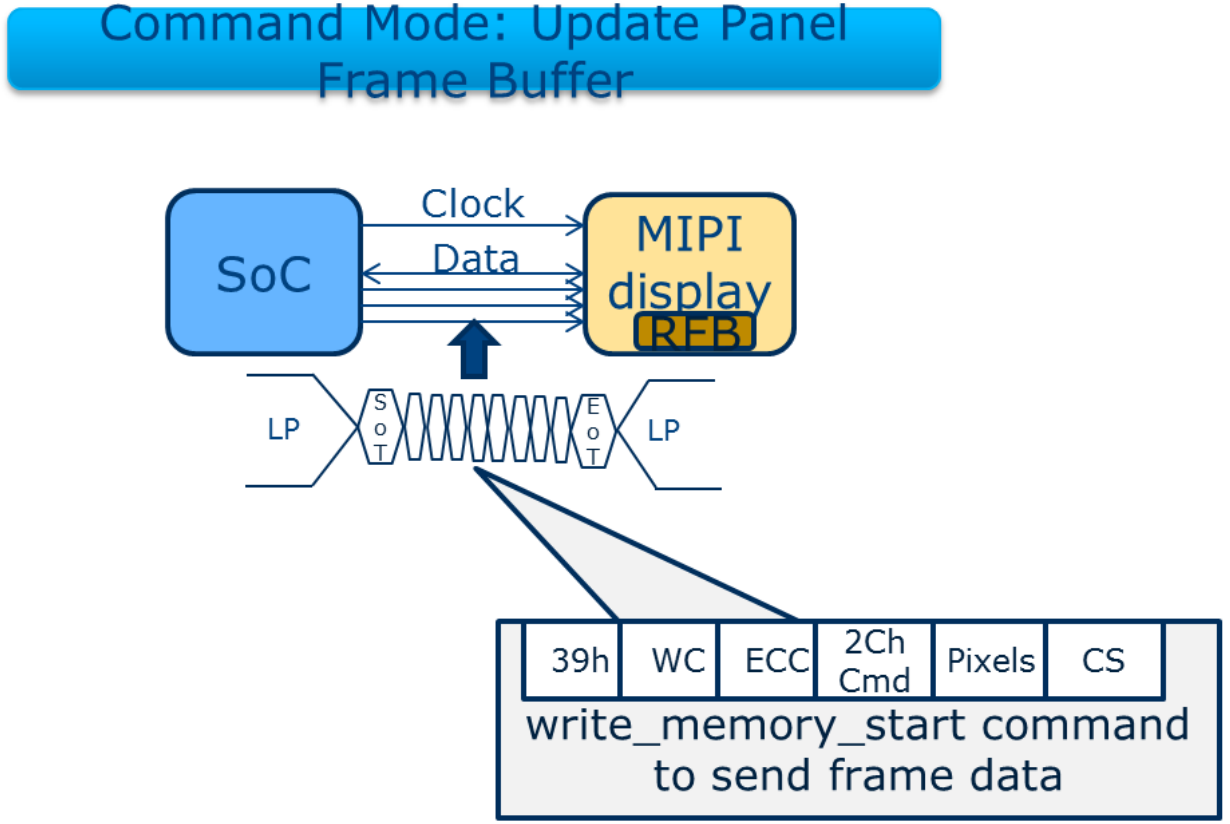

MIPI* Display Support on Intel Platforms

Intel Atom processor Z2760
MIPI DSI 1.01
4 lanes
1366x768

MIPI to LVDS bridge + 11” LVDS Panels	11” Native MIPI

Intel® Atom™ processor based Bay Trail platform

MIPI DSI 1.01
2x4 lanes (Dual-link)
Single-link -1920x1200
Dual-link – 2560x1600

~10” native MIPI

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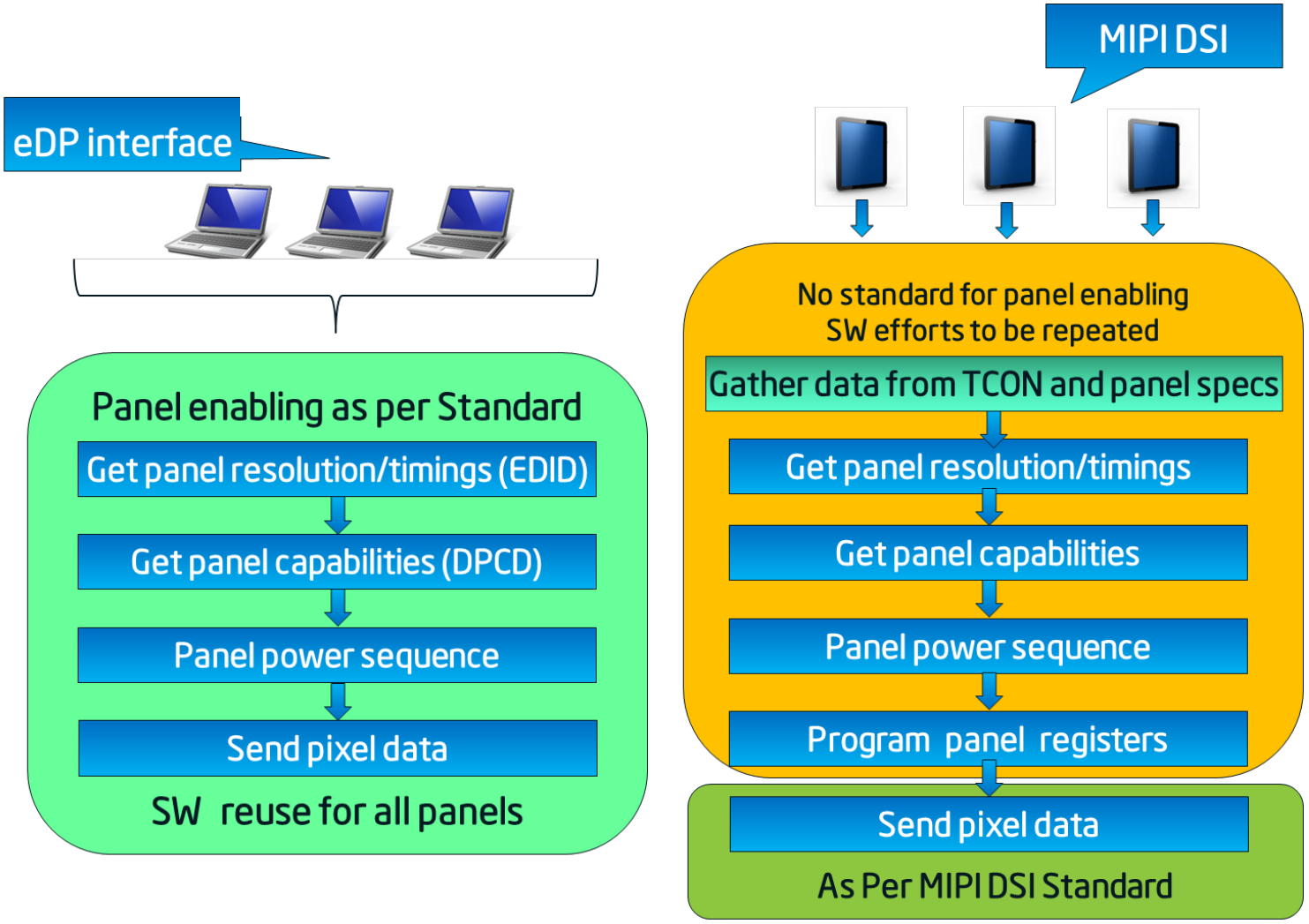
MIPI* vs. eDP* Panel Enabling



MIPI* -DSI Panel Interface considerations

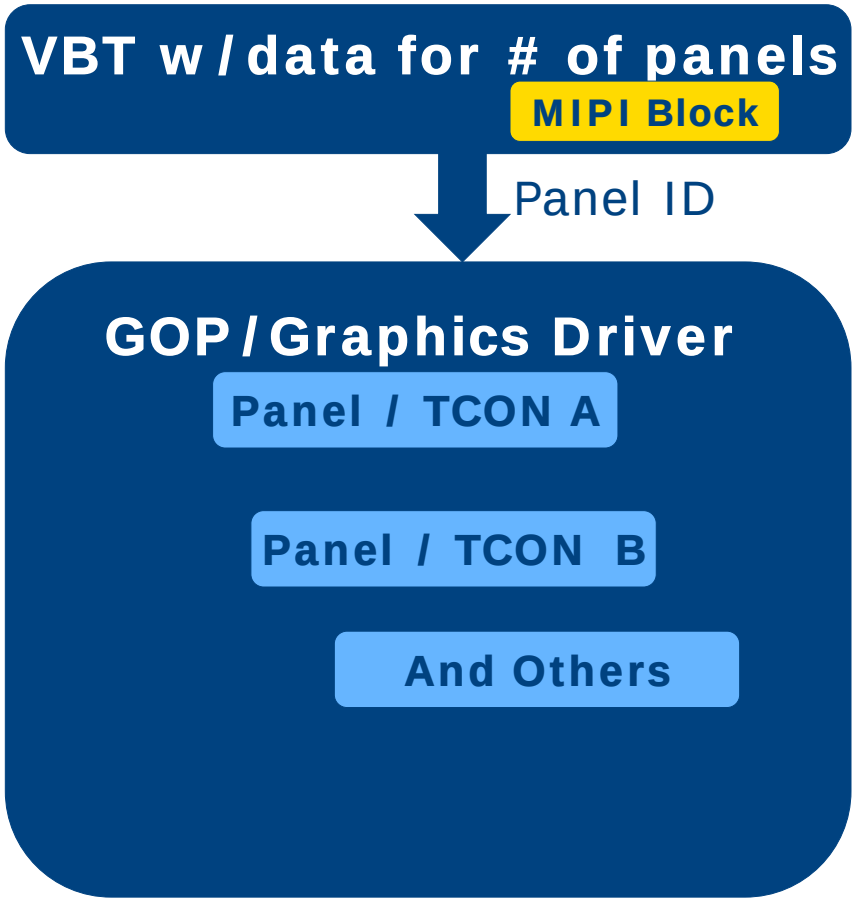
- Panel Variations: Command Mode / Video Mode: W & w/o burst mode; sync events or sync pulses; preferred operating mode
- EDID support is not uniform or consistent
- Panel resolution and timing parameters
- Number of DSI lanes needed / used
- Pixel formats supported by the p… …commended format
- Recommended data rate/D… …equency
- Panel power up seq… …ns, signals and delays
- LP to HS and … …witching time requirements
- Recom… …alues for DPHY parameters THS-PREPARE, T…, TCLK-TRAIL, THS-ZERO, EOT packet
- R…ster programming (EPROM based or by host) during power up/down; programming sequence; default values
- Panel backlight control (external PWM?)
- CABC support and register programming sequence
- Other value-add features supported on the panel; its enabling

Too many Configuration Items!

MIPI* Panel Enabling Implications

Panel Implementations	Hardware/Software Impact
No EDID	Software: EDID should be configured in VBT
Variance in panel capability (lane count, command/video mode, etc.)	Software: The panel parameters must be configured and read from VBT
Panel power sequence (pin controls and delays)	Software: Driver code addition for panel power sequence
No internal EPROM for panel register initialization	Software: Driver code addition of command sequence for panel register initialization
Non-standard pin assignment, cable, connector	Hardware: Add-on card and cable design according variance in panel pins for Reference Hardware platform

Current Driver Model for MIPI*

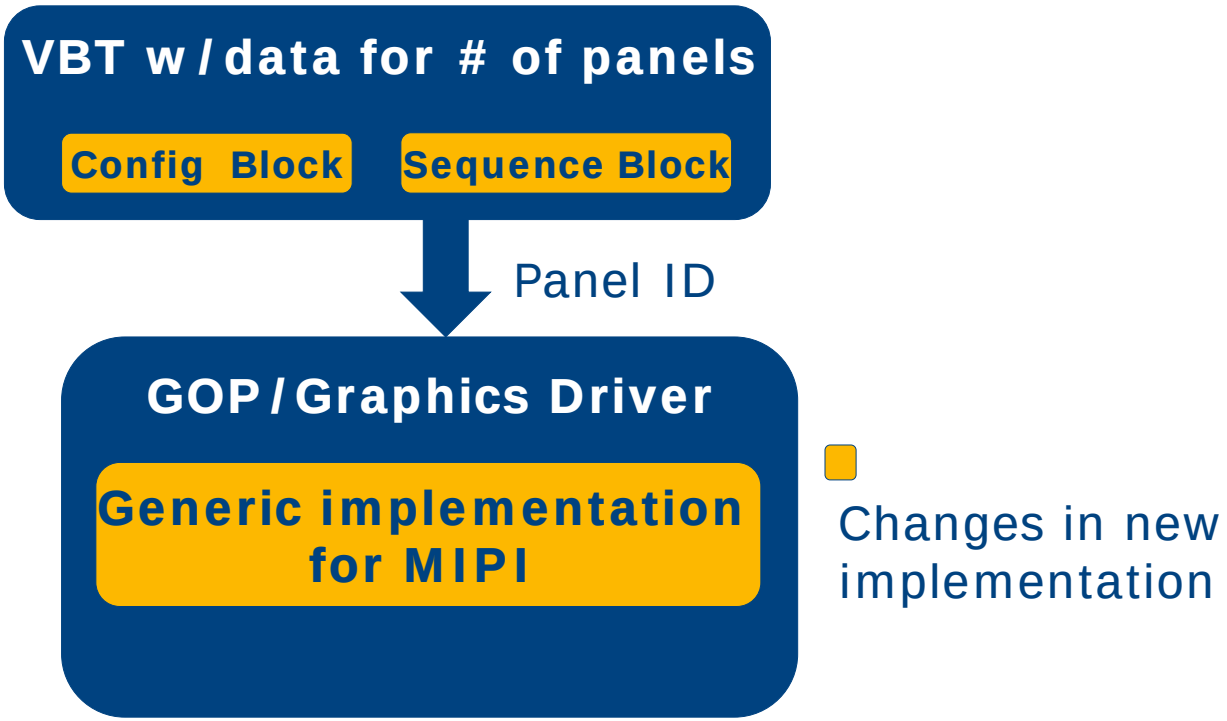


MIPI block in firmware with basic config data used in existing platforms

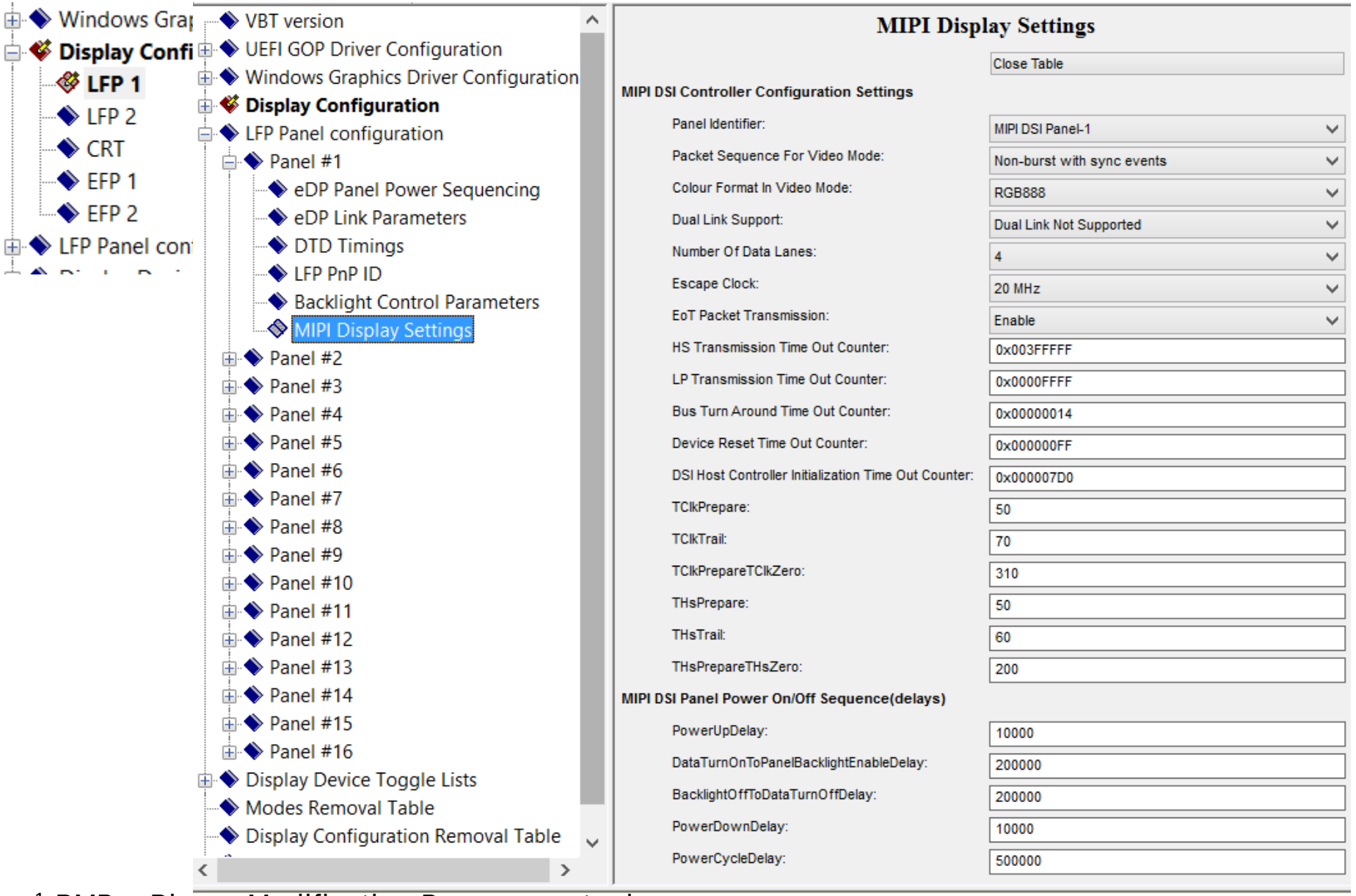
MIPI* panel enabling sequence hard coded in driver for each panel

Towards a Generic Model

- Goals:
  - No driver code changes
  - Support in both GOP and driver
  - Extends to all types of MIPI* panels/TCON:
  - Scalable for future features / specs / platforms



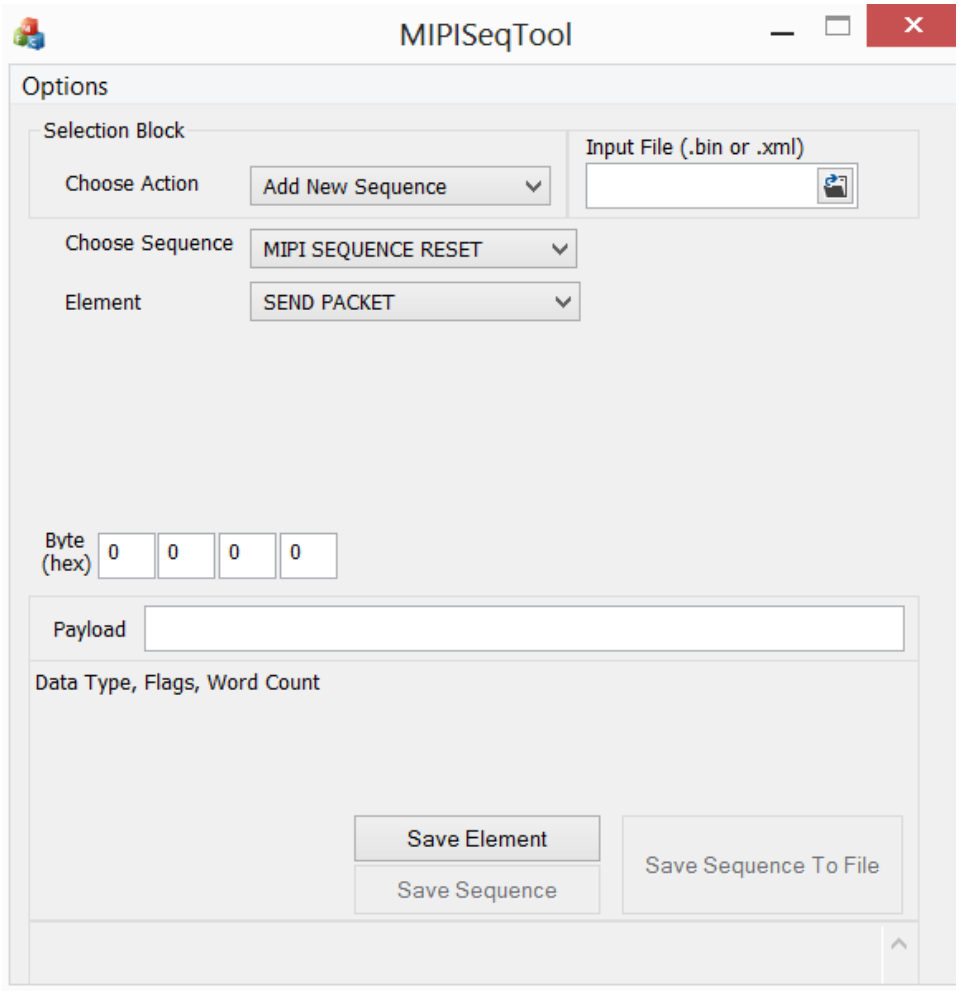
BMP[1] Settings for Configuration Block



[1] BMP – Binary Modification Program -- tool

MIPI* Sequences Programming

- MIPI* Sequences
  - Reset assert/de-assert sequence
  - Programming panel OTP by sending DCS commands
  - Display ON/OFF sequence
  - Backlight ON/OFF sequence
- Sequence Operations
  - Delay
  - Send MIPI packets
  - GPIO programming
  - MMIO programming



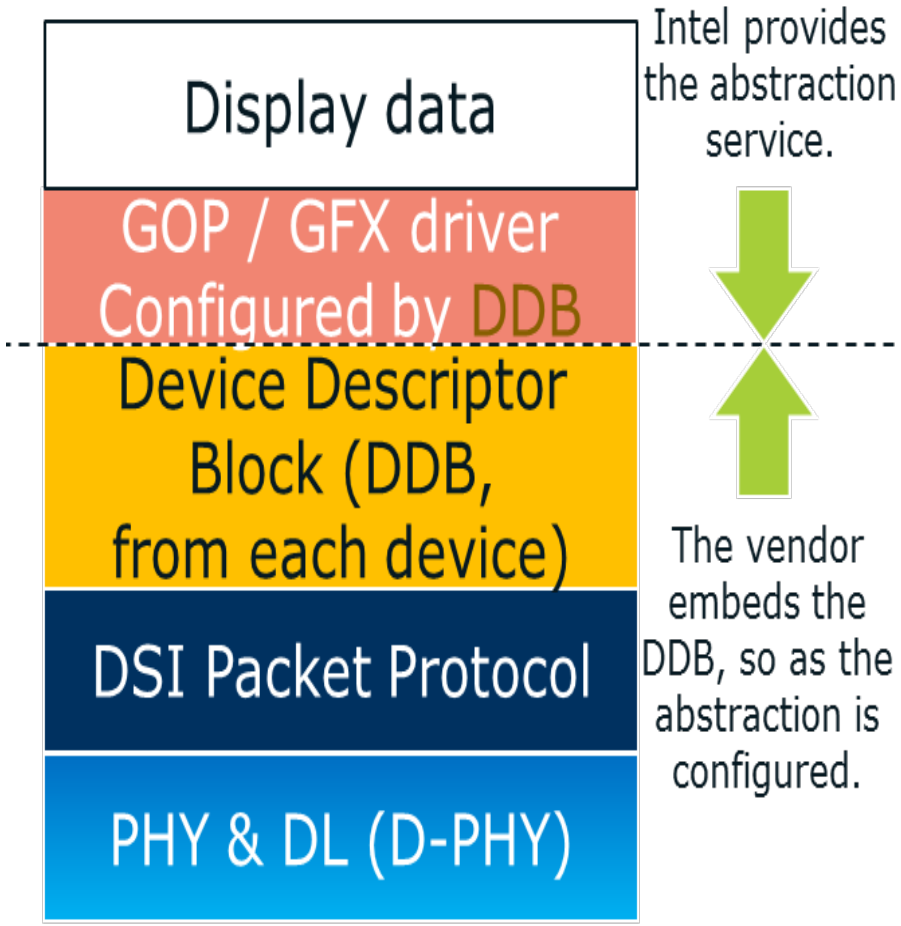
Generic MIPI* Design Advantages

Existing model for MIPI* in driver	Generic MIPI support in driver
Updates and rebuild GOP/Gfx driver per panel	No panel specific GOP/Gfx driver changes
Panels, AIC needed w/driver developers	Easy panel enabling w/ just VBT modification (more virtual developers, i.e., AE, OEM)
Requires more panel enabling time	Saves panel enabling effort
Driver update for TCON issues (post-launch issues will need driver updates)	No driver updates fixing TCON specific issues (post-launch issues will need driver updates)
Not scalable for newer features/ Panels/ platforms	Easily scalable for supporting newer features/ panels/ platforms
Supports both Android* & Windows*	Supports both Android & Windows

Towards Further Standardization

- Intel working to define a standard MIPI* panel descriptor
- Goal is to implement the standard descriptor among panel TCONs
- Driver would read the panel descriptor from the panel and take the enabling actions

- Next steps / Call to action
  - TCON vendor collaboration for common DDB format



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Display Power Savings

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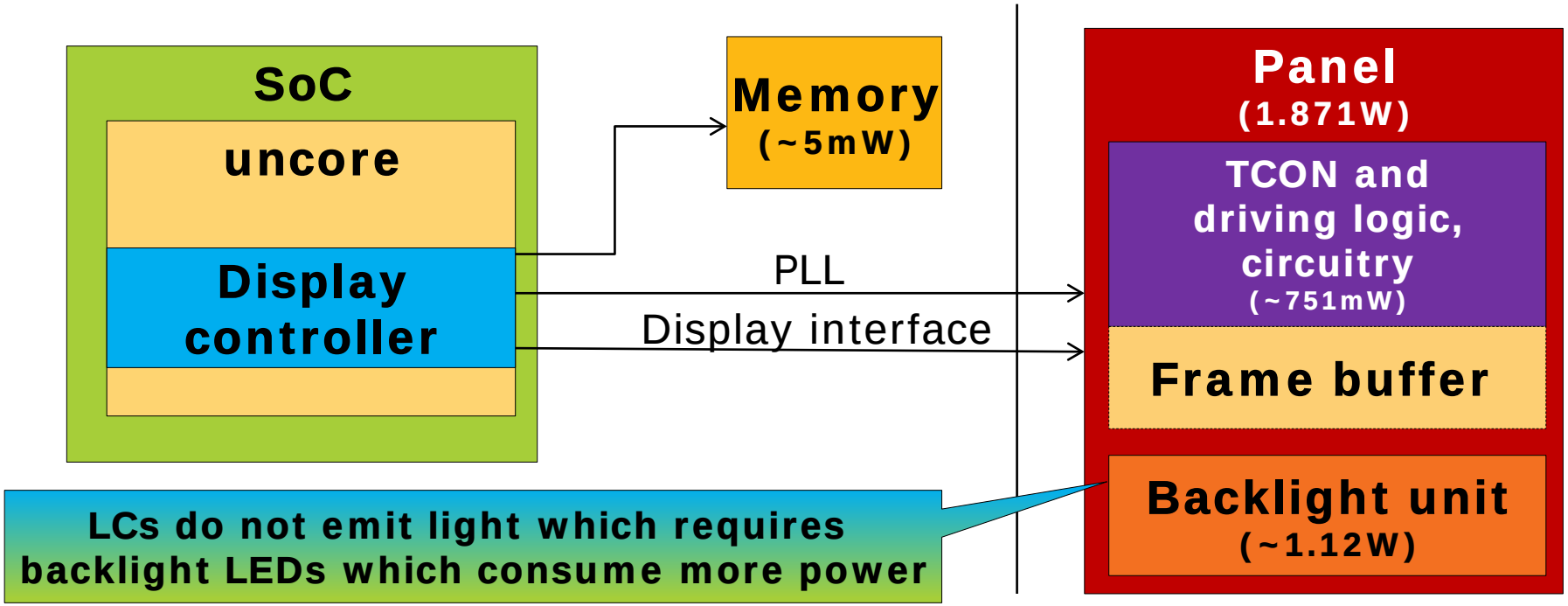
- Display power consumption
- Display power saving features
  - Backlight control
  - Intel® Display Power Saving Technology (Intel® DPST)
  - Content Adaptive Backlight Control (CABC)
  - DPST vs. CABC backlight power comparison
  - Windows* 8 adaptive brightness control
  - MIPI* display self refresh
  - Embedded DisplayPort* (eDP) panel self refresh
  - Other power saving options
  - Co-existence of display power savings features

Display Power Consumption

Display sub-components that consume power



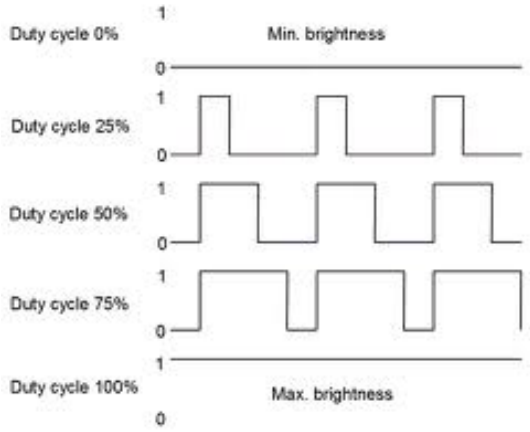
- On a sub 3W tablet platform, display consumes about 50-70% of power
- Backlight power – about 60-75% of panel power

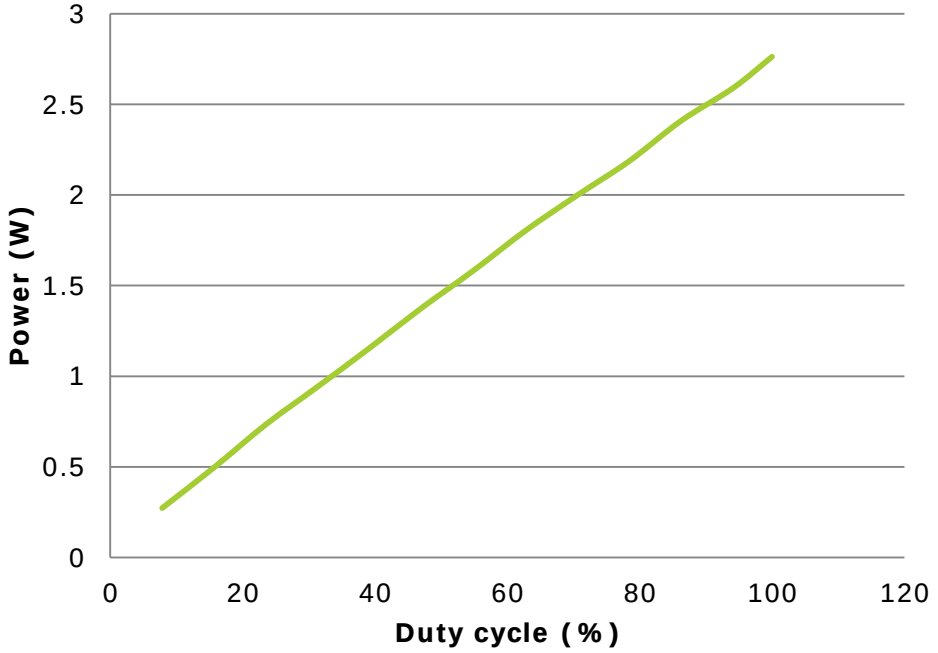
- Intel® Atom™ Processor Z2760 platform power data
- MIPI* to LVDS + 11.6” panel
- Web browsing scenario power

Display Power Saving Features

Backlight Control

- PWM signals control backlight intensity and power
- OS reduces backlight on
  - User inactivity
  - Ambient light change
- User backlight adjustment

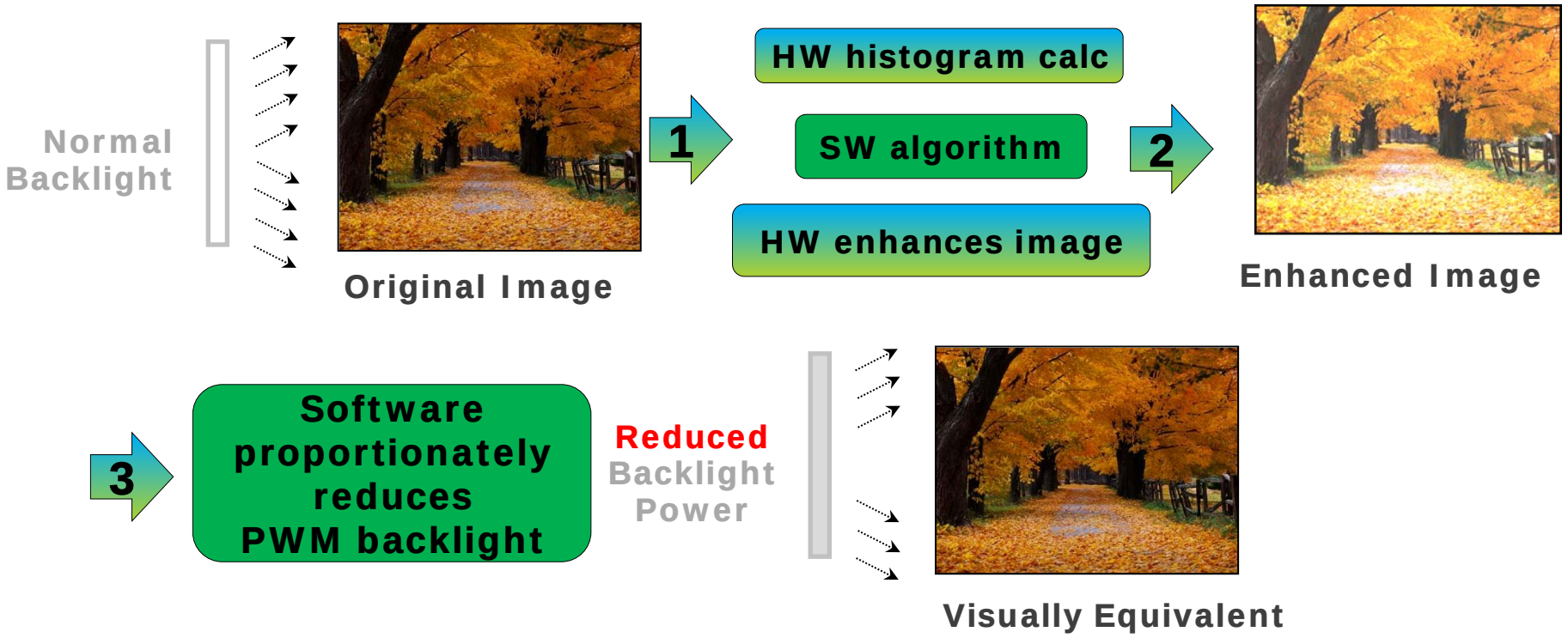




Controlling backlight intensity linearly impacts power

Intel® Display Power Saving Technology (Intel® DPST)

- A power savings technology that reduces backlight power
- Increases pixel luminance and reduces backlight with minimum visual impact



For DVD workloads, Intel DPST 6.0 reduces backlight power by about 70%

Content Adaptive Backlight Control (CABC)

- Similar concept as Intel® Display Power Saving Technology (Intel® DPST), reduces backlight power
- Implementation is on the panel and proprietary to vendor
- Supported on MIPI* panels/bridges
- Controlled through MCS packets on MIPI
- Intel DPST and CABC cannot be enabled together

CABC on Intel® Atom™ Z2760 processor reduces backlight power by about 33% on video playback scenarios

In general for command mode MIPI panels CABC is preferred

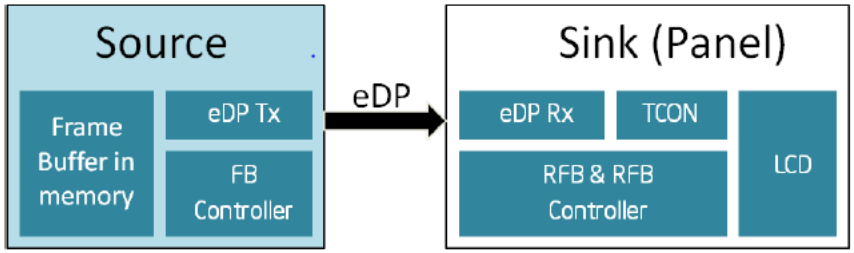
Windows* 8 Adaptive Brightness Control

- OS policy for backlight control algorithms
- Requires a balance between power and user experience
- OS controls DPST/CABC
- OS enables CABC based on scenario
- Enabled in battery power and disabled on AC power
- Lower aggressiveness with desktop, browsing, photos, static content
- Higher aggressiveness with dynamic content like video

MIPI* Display Self Refresh

- Supported on MIPI* command mode panels
- Pixels are sent to panel only on demand
- Display engine is active only when pixels are fetched
- DSI PLL can be power gated when OS detects idleness
- Display memory bandwidth is not consumed when display is idle

Embedded DisplayPort* (eDP) Panel Self Refresh (PSR)



- Similar to MIPI* DSR, utilizes panel frame buffer
- Supported on eDP 1.3 with PSR panels
- Hardware detects idle display and enters PSR active
- Display engine clock gated on PSR active
- Software needs to exit PSR on user activity

PSR and DSR save power on display engine, memory panel power on I/O, but panel frame buffer will consume power SoC+memory+panel savings could save ~17%

Other Power Saving Options

- Max FIFO
  - Combine display FIFO in single display
  - Reduces internal clock activity and memory I/O
  - Saves power on display engine and memory I/O

- Dynamic Voltage Frequency Scaling
  - Set Core Display clock according to the max resolution
  - Display vnn scales according to CD clock
  - Saves power on display engine

Coexistence of Display Power Savings Features

	eDP PSR	MIPI DSR	DPST	CABC	DVFS	Max FIFO	Backlight control
eDP PSR		NA	Yes	NA	Yes	Yes	Yes
MIPI* DSR			Yes	Yes	Yes	Yes	Yes
DPST				NA	Yes	Yes	Yes
CABC					Yes	Yes	Yes
DVFS						Yes	Yes
Max FIFO							Yes
Backlight control							

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Miracast* Wireless Display Demo

Summary

- MIPI*-DSI Displays
  - Intel scalable model is imperative for time to market
  - Need OxM, Panel, TCON support for success
  - Further standardization opportunities need industry support
- Display Power Management
  - Several techniques exist to fine tune design for optimal power performance
    - Screen size, resolution; Panel type, capability – will drive right power optimization schemes

Next Steps

- MIPI* – DSI Displays
  - Needs Industry Collaboration – Panel, TCON, OxM, IHV to drive efficient design and robust enabling

Additional Sources of Information

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Additional info on the web – **www.mipi.org**

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