



Electronics for Industrial Digital Printers

The Architecture of a Universal Solution

Dr John Stanton, Clive Ayling, Phil Duffy
The Technology Partnership PLC (TTP) Cambridge, UK

contents

- benefits of universal solutions for print control electronics and software
- some detail of the challenges for universal print control electronics and software
- the application of new technology to these challenges

benefits of a universal print controller

modular electronics hardware with configurable software brings benefits:

- speed of development of new products
- lower manufacturing costs through higher manufacturing volumes of common parts
- proven re-used technology and less variety for service engineers to handle

New
Product
Development

Manufacturing

Service
and support

applicability of a universal solution

the advantages are lost as the printer production volume rises and customised cost-down design becomes overwhelmingly important

annual printer production volume

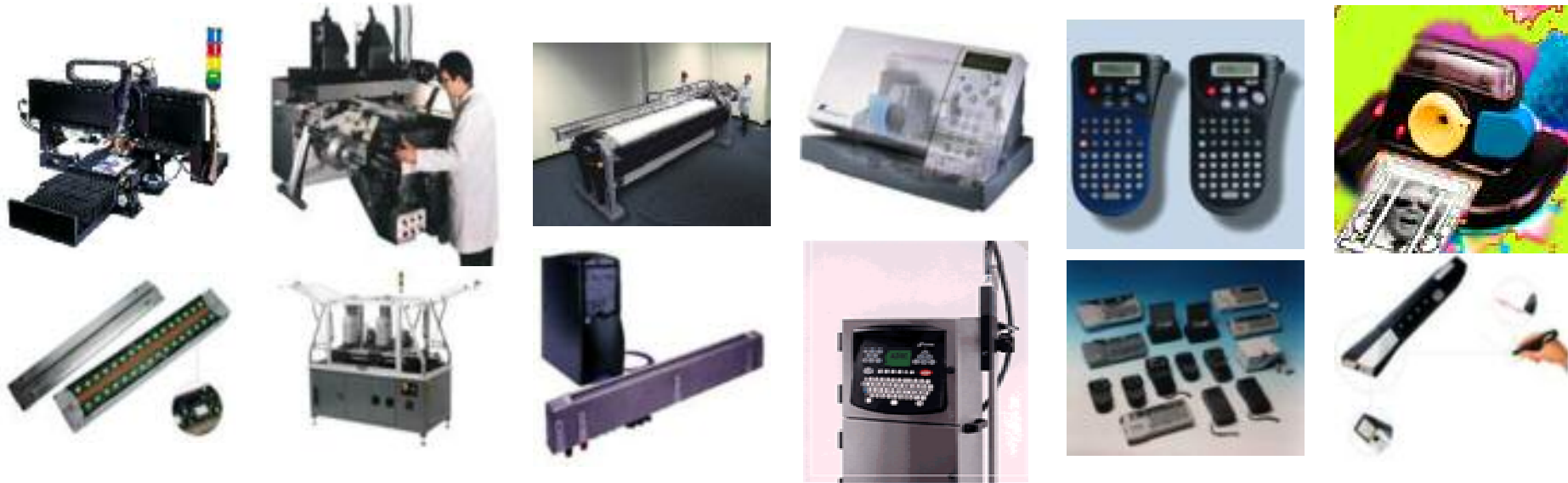
10^{-1}

1

10^2

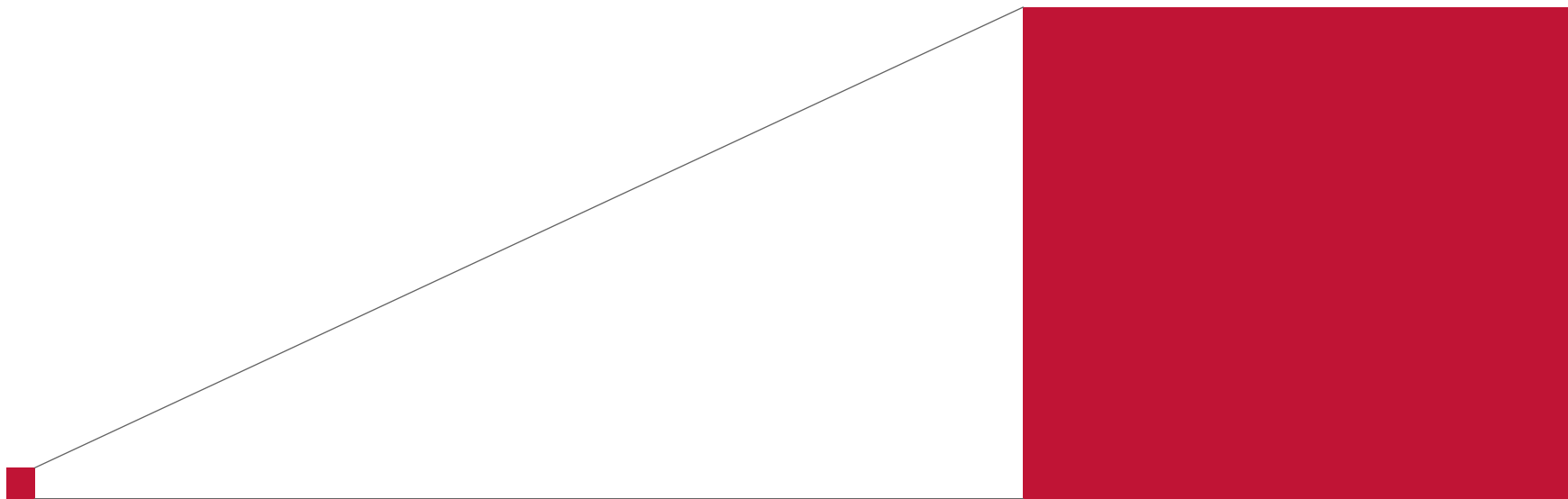
10^4

10^6



challenges – the variety in scale

- 1 to over 100 printheads per system (each distributed over an array and requiring connection)
- data rates from 0.3MB/s for the smallest color solvent inkjet printer to 100MB/s/color for a 20" EP printing press



challenges – the variety in data application

- single printhead or overlapping printheads distributed in an array
- scanning the media or single-pass printing
- redundancy or single-opportunity to print each pixel
- interlacing scans or stitched swaths
- image aligned, stretched, rotated to media or not
- different images being printed by different printheads within the array simultaneously

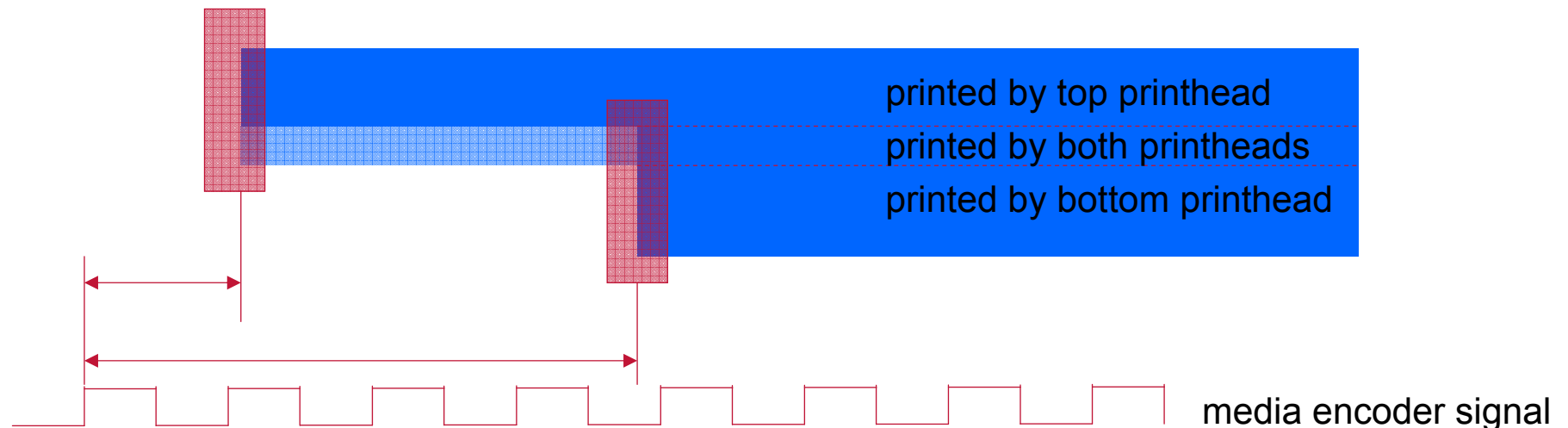
some universal tasks

- retrieval of image bitmap data sources from disk
- assembly of full image and adaptation to actual media alignment*
- splitting the image into swaths*
- splitting the swath into printhead fire swaths and padding the swath to full height of the printhead*
- buffering the printhead fire swaths
- tracking the encoder count position for image start for each printhead
- electrically configuring each printhead and monitoring performance
- creating drive signals for each printhead
- synchronising each printhead firing

*where necessary

sending data to heads

- image size can be controlled by using a non-integer ratio between encoder frequency and printhead firing frequency
- head alignment can be simplified by using head positions defined as non-integer number of image pixels
- the joins in the image between swaths from overlapping printheads can be hidden by using algorithms to share the data



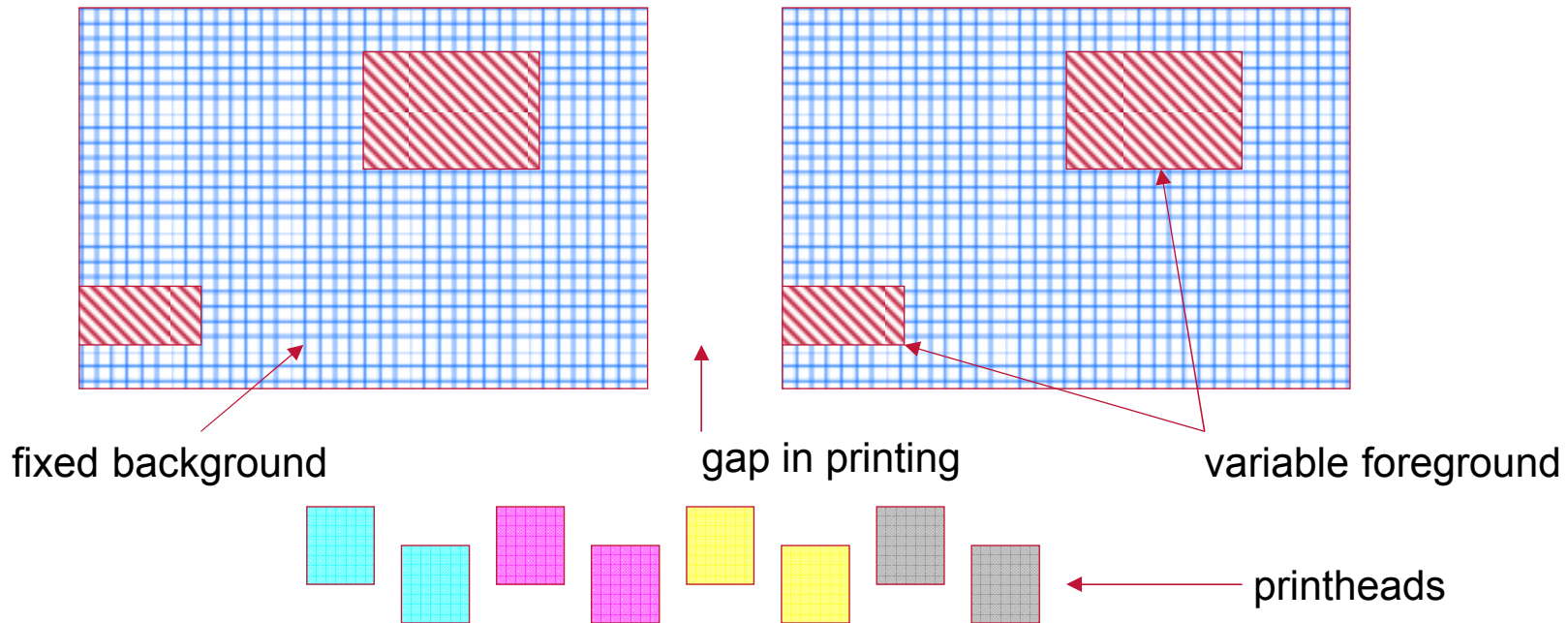
scanning challenges

- reversing direction
 - arrays of heads
 - heads with multiple rows of nozzles
 - time of flight corrections
- the need for swath interlacing or swath overlap methods
- coping with bursts of fully-variable data up to 5m long
- potential need to re-align data to fiducials already present on the media



single pass challenges

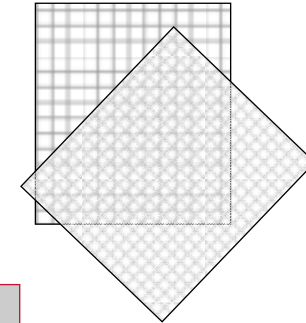
- most single pass applications have largely repeating image (perhaps a photo-realistic image fixed background with variable graphic foreground superimposed)



- some printheads may need to start printing the following image before the first image is complete

inkjet deposition challenges

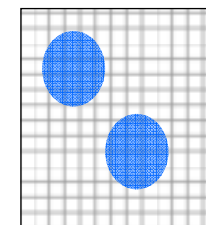
- aligning the deposition image to the actual media position (offsets in x,y,θ and stretch in x,y)



- applying process methods to avoid using badly-performing nozzles in the printhead[s]



- RIPping, utilizing knowledge of how the drop size matches the resolution and how drops coalesce on the media



the two critical data rates

from PC to print controller the average data rate matters as the print controller buffers the data:

- a low cost wide format inkjet printer: 0.7 MBytes/sec
- a high value flatbed inkjet printer: 6.4 MBytes/sec
- a single pass 8" narrow web printer: 29 MBytes/sec

from print controller to each printhead the maximum data rate matters as the printheads may have bursts of maximum frequency use:

- a thermal inkjet printhead: 1.8 MBytes/sec
- a piezo inkjet printhead: 1.3 MBytes/sec
- a grayscale piezo inkjet printhead: 5 MBytes/sec

printhead-specific electronics

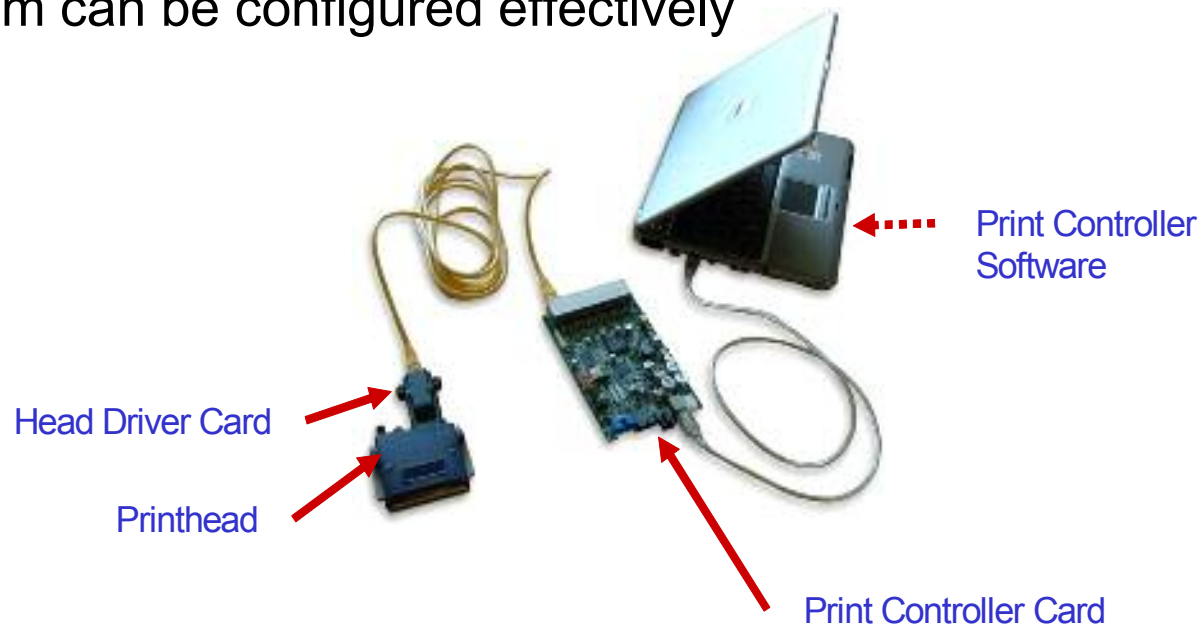
- some printhead-specific electronics (a “head driver card” or “head personality card”) is necessary to give all printhead types a common interface to the print controller
- where printheads have integral electronics the head driver card can be simpler than when the head driver card needs also to digitally-define and create fire pulse waveforms for driving the piezo movements



relative sizes of head driver cards for the 318-nozzle greyscale ToshibaTec printhead (small) and the 256-nozzle binary Spectra printhead (larger due to presence of digital firepulse electronics)

architectural philosophy

- Maximum use of the power a PC
- Minimum electronics in each head driver card
- Modular print controller cards so both the smallest and largest system can be configured effectively

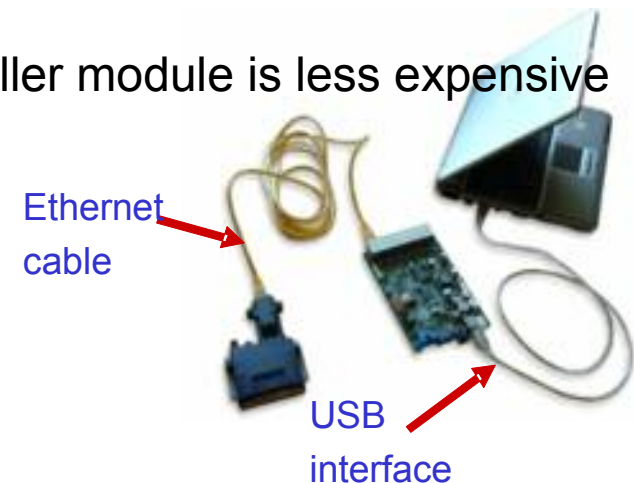


 Meteor print controller (ref[1])

which technology to use

From the PC to the print controller:

- Interfaces fitted as standard to a PC
 - USB1.1, USB2.0, IEEE1394(Firewire™), gigabit Ethernet..
- PCI-based interface boards
 - Fibre-optics, expansion cards of standard interfaces...
- We preferred USB2.0
 - 480MBytes/sec nominal and over 400Mbits/sec achieved in our tests
 - additional host controllers available for under \$20 to further increase data rate
 - very asymmetric electrically so the print controller module is less expensive
 - adequate length (5m but expandable to 25m)
 - most commonly-available PC interface
 - data transfers are error corrected



From the print controller to the printhead:

- any standard cable (we preferred Ethernet cable)

summary

key enablers for new universal print controllers are:

- very fast PCs
- USB2.0

with these a universal print controller solution can be viable

- for all printhead types
- in any size of configuration
- in all print applications
- for all print systems and printers in low-medium volume production

for more information

- presenter: John.Stanton@ttp.com
- co-authors: Clive.Ayling@ttp.com and Phil.Duffy@ttp.com
- company: www.ttp.com, enquiries@ttp.com, +44 1763 262626
- Meteor universal print controller: www.ttpgroup.com/meteor